



RESEARCH CENTER

FIELD

Activity Report 2017

Section Software

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ANTIQUÉ Project-Team

6. New Software and Platforms

6.1. APRON

SCIENTIFIC DESCRIPTION: The APRON library is intended to be a common interface to various underlying libraries/abstract domains and to provide additional services that can be implemented independently from the underlying library/abstract domain, as shown by the poster on the right (presented at the SAS 2007 conference. You may also look at:

FUNCTIONAL DESCRIPTION: The Apron library is dedicated to the static analysis of the numerical variables of a program by abstract interpretation. Its goal is threefold: provide ready-to-use numerical abstractions under a common API for analysis implementers, encourage the research in numerical abstract domains by providing a platform for integration and comparison of domains, and provide a teaching and demonstration tool to disseminate knowledge on abstract interpretation.

- Participants: Antoine Miné and Bertrand Jeannet
- Contact: Antoine Miné
- URL: <http://apron.cri.ensmp.fr/library/>

6.2. Astrée

The AstréeA Static Analyzer of Asynchronous Software

KEYWORDS: Static analysis - Static program analysis - Program verification - Software Verification - Abstraction

SCIENTIFIC DESCRIPTION: Astrée analyzes structured C programs, with complex memory usages, but without dynamic memory allocation nor recursion. This encompasses many embedded programs as found in earth transportation, nuclear energy, medical instrumentation, and aerospace applications, in particular synchronous control/command. The whole analysis process is entirely automatic.

Astrée discovers all runtime errors including:

undefined behaviors in the terms of the ANSI C99 norm of the C language (such as division by 0 or out of bounds array indexing),

any violation of the implementation-specific behavior as defined in the relevant Application Binary Interface (such as the size of integers and arithmetic overflows),

any potentially harmful or incorrect use of C violating optional user-defined programming guidelines (such as no modular arithmetic for integers, even though this might be the hardware choice),

failure of user-defined assertions.

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Astrée is a static analyzer for sequential programs based on abstract interpretation. The Astrée static analyzer aims at proving the absence of runtime errors in programs written in the C programming language.

- Participants: Antoine Miné, Jérôme Feret, Laurent Mauborgne, Patrick Cousot, Radhia Cousot and Xavier Rival
- Partners: CNRS - ENS Paris - AbsInt Angewandte Informatik GmbH
- Contact: Patrick Cousot
- URL: <http://www.astree.ens.fr/>

6.3. AstréeA

The AstréeA Static Analyzer of Asynchronous Software

KEYWORDS: Static analysis - Static program analysis

SCIENTIFIC DESCRIPTION: AstréeA analyzes C programs composed of a fixed set of threads that communicate through a shared memory and synchronization primitives (mutexes, FIFOs, blackboards, etc.), but without recursion nor dynamic creation of memory, threads nor synchronization objects. AstréeA assumes a real-time scheduler, where thread scheduling strictly obeys the fixed priority of threads. Our model follows the ARINC 653 OS specification used in embedded industrial aeronautic software. Additionally, AstréeA employs a weakly-consistent memory semantics to model memory accesses not protected by a mutex, in order to take into account soundly hardware and compiler-level program transformations (such as optimizations). AstréeA checks for the same run-time errors as Astrée, with the addition of data-races.

FUNCTIONAL DESCRIPTION: AstréeA is a static analyzer prototype for parallel software based on abstract interpretation. The AstréeA prototype is a fork of the Astrée static analyzer that adds support for analyzing parallel embedded C software.

- Participants: Antoine Miné, Jérôme Feret, Patrick Cousot, Radhia Cousot and Xavier Rival
- Partners: CNRS - ENS Paris - AbsInt Angewandte Informatik GmbH
- Contact: Patrick Cousot
- URL: <http://www.astreea.ens.fr/>

6.4. ClangML

KEYWORD: Compilation

FUNCTIONAL DESCRIPTION: ClangML is an OCaml binding with the Clang front-end of the LLVM compiler suite. Its goal is to provide an easy to use solution to parse a wide range of C programs, that can be called from static analysis tools implemented in OCaml, which allows to test them on existing programs written in C (or in other idioms derived from C) without having to redesign a front-end from scratch. ClangML features an interface to a large set of internal AST nodes of Clang, with an easy to use API. Currently, ClangML supports all C language AST nodes, as well as a large part of the C nodes related to C++ and Objective-C.

- Participants: Devin Mccoughlin, François Berenger and Pippijn Van Steenhoven
- Contact: Xavier Rival
- URL: <https://github.com/Antique-team/clangml/tree/master/clang>

6.5. FuncTion

SCIENTIFIC DESCRIPTION: FuncTion is based on an extension to liveness properties of the framework to analyze termination by abstract interpretation proposed by Patrick Cousot and Radhia Cousot. FuncTion infers ranking functions using piecewise-defined abstract domains. Several domains are available to partition the ranking function, including intervals, octagons, and polyhedra. Two domains are also available to represent the value of ranking functions: a domain of affine ranking functions, and a domain of ordinal-valued ranking functions (which allows handling programs with unbounded non-determinism).

FUNCTIONAL DESCRIPTION: FuncTion is a research prototype static analyzer to analyze the termination and functional liveness properties of programs. It accepts programs in a small non-deterministic imperative language. It is also parameterized by a property: either termination, or a recurrence or a guarantee property (according to the classification by Manna and Pnueli of program properties). It then performs a backward static analysis that automatically infers sufficient conditions at the beginning of the program so that all executions satisfying the conditions also satisfy the property.

- Participants: Antoine Miné and Caterina Urban
- Contact: Caterina Urban
- URL: <http://www.di.ens.fr/~urban/FuncTion.html>

6.6. HOO

Heap Abstraction for Open Objects

FUNCTIONAL DESCRIPTION: JSAna with HOO is a static analyzer for JavaScript programs. The primary component, HOO, which is designed to be reusable by itself, is an abstract domain for a dynamic language heap. A dynamic language heap consists of open, extensible objects linked together by pointers. Uniquely, HOO abstracts these extensible objects, where attribute/field names of objects may be unknown. Additionally, it contains features to keeping precise track of attribute name/value relationships as well as calling unknown functions through desynchronized separation.

As a library, HOO is useful for any dynamic language static analysis. It is designed to allow abstractions for values to be easily swapped out for different abstractions, allowing it to be used for a wide-range of dynamic languages outside of JavaScript.

- Participant: Arlen Cox
- Contact: Arlen Cox

6.7. MemCAD

The MemCAD static analyzer

KEYWORDS: Static analysis - Abstraction

FUNCTIONAL DESCRIPTION: MemCAD is a static analyzer that focuses on memory abstraction. It takes as input C programs, and computes invariants on the data structures manipulated by the programs. It can also verify memory safety. It comprises several memory abstract domains, including a flat representation, and two graph abstractions with summaries based on inductive definitions of data-structures, such as lists and trees and several combination operators for memory abstract domains (hierarchical abstraction, reduced product). The purpose of this construction is to offer a great flexibility in the memory abstraction, so as to either make very efficient static analyses of relatively simple programs, or still quite efficient static analyses of very involved pieces of code. The implementation consists of over 30 000 lines of ML code, and relies on the ClangML front-end. The current implementation comes with over 300 small size test cases that are used as regression tests.

- Participants: Antoine Toubhans, François Berenger, Huisong Li and Xavier Rival
- Contact: Xavier Rival
- URL: <http://www.di.ens.fr/~rival/memcad.html>

6.8. OPENKAPPA

La plateforme de modélisation OpenKappa

KEYWORDS: Model reduction - Simulation - Static analysis - Modeling - Systems Biology

SCIENTIFIC DESCRIPTION: OpenKappa is a collection of tools to build, debug and run models of biological pathways. It contains a compiler for the Kappa Language, a static analyzer (for debugging models), a simulator, a compression tool for causal traces, and a model reduction tool.

- Participants: Jean Krivine, Jérôme Feret, Kim Quyen Ly, Pierre Boutillier, Russ Harmer, Vincent Danos and Walter Fontana
- Partners: ENS Lyon - Université Paris-Diderot - HARVARD Medical School
- Contact: Jérôme Feret
- URL: <http://www.kappalanguage.org/>

6.9. QUICr

FUNCTIONAL DESCRIPTION: QUICr is an OCaml library that implements a parametric abstract domain for sets. It is constructed as a functor that accepts any numeric abstract domain that can be adapted to the interface and produces an abstract domain for sets of numbers combined with numbers. It is relational, flexible, and tunable. It serves as a basis for future exploration of set abstraction.

- Participant: Arlen Cox
- Contact: Arlen Cox

6.10. LCertify

KEYWORD: Compilation

SCIENTIFIC DESCRIPTION: The compilation certification process is performed automatically, thanks to a prover designed specifically. The automatic proof is done at a level of abstraction which has been defined so that the result of the proof of equivalence is strong enough for the goals mentioned above and so that the proof obligations can be solved by efficient algorithms.

FUNCTIONAL DESCRIPTION: Abstract interpretation, Certified compilation, Static analysis, Translation validation, Verifier. The main goal of this software project is to make it possible to certify automatically the compilation of large safety critical software, by proving that the compiled code is correct with respect to the source code: When the proof succeeds, this guarantees semantic equivalence. Furthermore, this approach should allow to meet some domain specific software qualification criteria (such as those in DO-178 regulations for avionics software), since it allows proving that successive development levels are correct with respect to each other i.e., that they implement the same specification. Last, this technique also justifies the use of source level static analyses, even when an assembly level certification would be required, since it establishes separately that the source and the compiled code are equivalent. It ensures that no compiler bug did cause incorrect code to be generated.

- Participant: Xavier Rival
- Partners: CNRS - ENS Paris
- Contact: Xavier Rival
- URL: <http://www.di.ens.fr/~rival/lcertify.html>

6.11. Zarith

FUNCTIONAL DESCRIPTION: Zarith is a small (10K lines) OCaml library that implements arithmetic and logical operations over arbitrary-precision integers. It is based on the GNU MP library to efficiently implement arithmetic over big integers. Special care has been taken to ensure the efficiency of the library also for small integers: small integers are represented as Caml unboxed integers and use a specific C code path. Moreover, optimized assembly versions of small integer operations are provided for a few common architectures.

Zarith is currently used in the Astrée analyzer to enable the sound analysis of programs featuring 64-bit (or larger) integers. It is also used in the Frama-C analyzer platform developed at CEA LIST and Inria Saclay.

- Participants: Antoine Miné, Pascal Cuoq and Xavier Leroy
- Contact: Antoine Miné
- URL: <http://forge.ocamlcore.org/projects/zarith>

AOSTE2 Team

6. New Software and Platforms

6.1. SynDEx

KEYWORDS: Distributed - Optimization - Real time - Embedded systems - Scheduling analyses

SCIENTIFIC DESCRIPTION: SynDEx is a system level CAD software implementing the AAA methodology for rapid prototyping and for optimizing distributed real-time embedded applications. It is developed in OCaml.

Architectures are represented as graphical block diagrams composed of programmable (processors) and non-programmable (ASIC, FPGA) computing components, interconnected by communication media (shared memories, links and busses for message passing). In order to deal with heterogeneous architectures it may feature several components of the same kind but with different characteristics.

Two types of non-functional properties can be specified for each task of the algorithm graph. First, a period that does not depend on the hardware architecture. Second, real-time features that depend on the different types of hardware components, ranging amongst execution and data transfer time, memory, etc.. Requirements are generally constraints on deadline equal to period, latency between any pair of tasks in the algorithm graph, dependence between tasks, etc.

Exploration of alternative allocations of the algorithm onto the architecture may be performed manually and/or automatically. The latter is achieved by performing real-time multiprocessor schedulability analyses and optimization heuristics based on the minimization of temporal or resource criteria. For example while satisfying deadline and latency constraints they can minimize the total execution time (makespan) of the application onto the given architecture, as well as the amount of memory. The results of each exploration is visualized as timing diagrams simulating the distributed real-time implementation.

Finally, real-time distributed embedded code can be automatically generated for dedicated distributed real-time executives, possibly calling services of resident real-time operating systems such as Linux/RTAI or Osek for instance. These executives are deadlock-free, based on off-line scheduling policies. Dedicated executives induce minimal overhead, and are built from processor-dependent executive kernels. To this date, executive kernels are provided for: TMS320C40, PIC18F2680, i80386, MC68332, MPC555, i80C196 and Unix/Linux workstations. Executive kernels for other processors can be achieved at reasonable cost following these examples as patterns.

FUNCTIONAL DESCRIPTION: Software for optimising the implementation of embedded distributed real-time applications and generating efficient and correct by construction code

NEWS OF THE YEAR: We improved the distribution and scheduling heuristics to take into account the needs of co-simulation.

- Participant: Yves Sorel
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- URL: <http://www.syndex.org>

6.2. EVT Kopernic

KEYWORDS: Embedded systems - Worst Case Execution Time - Real-time application - Statistics

SCIENTIFIC DESCRIPTION: The EVT-Kopernic tool is an implementation of the Extreme Value Theory (EVT) for the problem of the statistical estimation of worst-case bounds for the execution time of a program on a processor. Our implementation uses the two versions of EVT - GEV and GPD - to propose two independent methods of estimation. Their results are compared and only results that are sufficiently close allow to validate an estimation. Our tool is proved predictable by its unique choice of block (GEV) and threshold (GPD) while proposing reproducible estimations.

FUNCTIONAL DESCRIPTION: EVT-Kopernic is tool proposing a statistical estimation for bounds on worst-case execution time of a program on a processor. The estimator takes into account dependences between execution times by learning from the history of execution, while dealing also with cases of small variability of the execution times.

NEWS OF THE YEAR: Any statistical estimator should come with an representative measurement protocole based on the processus of composition, proved correct. We propose the first such principle of composition while using a Bayesien modeling taking into account iteratively different measurement models. The composition model has been described in a patent submitted this year with a scientific publication under preparation.

- Participants: Adriana Gogonel and Liliana Cucu
- Contact: Adriana Gogonel
- URL: <http://inria-rscript.serveftp.com/>

6.3. LoPhT-manycore

Logical to Physical Time compiler for many cores

KEYWORDS: Real time - Compilation - Task scheduling - Automatic parallelization

SCIENTIFIC DESCRIPTION: Lopht is a system-level compiler for embedded systems, whose objective is to fully automate the implementation process for certain classes of embedded systems. Like in a classical compiler (e.g. gcc), its input is formed of two objects. The first is a program providing a platform-indepedent description of the functionality to implement and of the non-functional requirements it must satisfy (e.g. real-time, partitioning). This is provided under the form of a data-flow synchronous program annotated with non-functional requirements. The second is a description of the implementation platform, defining the topology of the platform, the capacity of its elements, and possibly platform-dependent requirements (e.g. allocation).

From these inputs, Lopht produces all the C code and configuration information needed to allow compilation and execution on the physical target platform. Implementations are correct by construction Resulting implementations are functionally correct and satisfy the non-functional requirements. Lopht-manycore is a version of Lopht targeting shared-memory many-core architectures.

The algorithmic core of Lopht-manycore is formed of timing analysis, allocation, scheduling, and code generation heuristics which rely on four fundamental choices. 1) A static (off-line) real-time scheduling approach where allocation and scheduling are represented using time tables (also known as scheduling or reservation tables). 2) Scalability, attained through the use of low-complexity heuristics for all synthesis and associated analysis steps. 3) Efficiency (of generated implementations) is attained through the use of precise representations of both functionality and the platform, which allow for fine-grain allocation of resources such as CPU, memory, and communication devices such as network-on-chip multiplexers. 4) Full automation, including that of the timing analysis phase.

The last point is characteristic to Lopht-manycore. Existing methods for schedulability analysis and real-time software synthesis assume the existence of a high-level timing characterization that hides much of the hardware complexity. For instance, a common hypothesis is that synchronization and interference costs are accounted for in the duration of computations. However, the high-level timing characterization is seldom (if ever) soundly derived from the properties of the platform and the program. In practice, large margins (e.g. 100%) with little formal justification are added to computation durations to account for hidden hardware complexity. Lopht-manycore overcomes this limitation. Starting from the worst-case execution time (WCET) estimations of computation operations and from a precise and safe timing model of the platform, it maintains a precise timing accounting throughout the mapping process. To do this, timing accounting must take into account all details of allocation, scheduling, and code generation, which in turn must satisfy specific hypotheses.

FUNCTIONAL DESCRIPTION: Accepted input languages for functional specifications include dialects of Lustre such as Heptagon and Scade v4. To ensure the respect of real-time requirements, Lopht-manycore pilots the use of the worst-case execution time (WCET) analysis tool (ait from AbsInt). By doing this, and by using a precise timing model for the platform, Lopht-manycore eliminates the need to adjust the WCET values through the addition of margins to the WCET values that are usually both large and without formal safety guarantees. The output of Lopht-manycore is formed of all the multi-threaded C code and configuration information needed to allow compilation, linking/loading, and real-time execution on the target platform.

NEWS OF THE YEAR: In the framework of the ITEA3 ASSUME project we have extended the Lopht-manycore to allow multiple cores to access the same memory bank at the same time. To do this, the timing accounting of Lopht has been extended to take into account memory access interferences during the allocation and scheduling process. Lopht now also pilots the aiT static WCET analysis tool from AbsInt by generating the analysis scripts, thus ensuring the consistency between the hypotheses made by Lopht and the way timing analysis is performed by aiT. As a result, we are now able to synthesize code for the computing clusters of the Kalray MPPA256 platform. Lopht-manycore is evaluated on avionics case studies in the perspective of increasing its technology readiness level for this application class.

- Participants: Dumitru Potop-Butucaru and Keryan Didier
- Contact: Dumitru Potop-Butucaru

ARIC Project-Team

6. New Software and Platforms

6.1. FPLLL

KEYWORDS: Euclidean Lattices - Computer algebra system (CAS) - Cryptography

SCIENTIFIC DESCRIPTION: The fplll library is used or has been adapted to be integrated within several mathematical computation systems such as Magma, Sage, and PariGP. It is also used for cryptanalytic purposes, to test the resistance of cryptographic primitives.

FUNCTIONAL DESCRIPTION: fplll contains implementations of several lattice algorithms. The implementation relies on floating-point orthogonalization, and LLL is central to the code, hence the name.

It includes implementations of floating-point LLL reduction algorithms, offering different speed/guarantees ratios. It contains a 'wrapper' choosing the estimated best sequence of variants in order to provide a guaranteed output as fast as possible. In the case of the wrapper, the succession of variants is oblivious to the user.

It includes an implementation of the BKZ reduction algorithm, including the BKZ-2.0 improvements (extreme enumeration pruning, pre-processing of blocks, early termination). Additionally, Slide reduction and self dual BKZ are supported.

It also includes a floating-point implementation of the Kannan-Fincke-Pohst algorithm that finds a shortest non-zero lattice vector. For the same task, the GaussSieve algorithm is also available in fplll. Finally, it contains a variant of the enumeration algorithm that computes a lattice vector closest to a given vector belonging to the real span of the lattice.

- Author: Damien Stehlé
- Contact: Damien Stehlé
- URL: <https://github.com/fplll/fplll>

6.2. Gfun

generating functions package

KEYWORD: Symbolic computation

FUNCTIONAL DESCRIPTION: Gfun is a Maple package for the manipulation of linear recurrence or differential equations. It provides tools for guessing a sequence or a series from its first terms, for manipulating rigorously solutions of linear differential or recurrence equations, using the equation as a data-structure.

- Contact: Bruno Salvy
- URL: <http://perso.ens-lyon.fr/bruno.salvy/software/the-gfun-package/>

6.3. GNU-MPFR

KEYWORDS: Multiple-Precision - Floating-point - Correct Rounding

FUNCTIONAL DESCRIPTION: GNU MPFR is an efficient multiple-precision floating-point library with well-defined semantics (copying the good ideas from the IEEE-754 standard), in particular correct rounding in 5 rounding modes. GNU MPFR provides about 80 mathematical functions, in addition to utility functions (assignments, conversions...). Special data (Not a Number, infinities, signed zeros) are handled like in the IEEE-754 standard.

- Participants: Guillaume Hanrot, Paul Zimmermann, Philippe Théveny and Vincent Lefèvre
- Contact: Vincent Lefèvre
- URL: <http://www.mpfr.org/>

6.4. Sipe

KEYWORDS: Floating-point - Correct Rounding

FUNCTIONAL DESCRIPTION: Sipe is a mini-library in the form of a C header file, to perform radix-2 floating-point computations in very low precisions with correct rounding, either to nearest or toward zero. The goal of such a tool is to do proofs of algorithms/properties or computations of tight error bounds in these precisions by exhaustive tests, in order to try to generalize them to higher precisions. The currently supported operations are addition, subtraction, multiplication (possibly with the error term), fused multiply-add/subtract (FMA/FMS), and miscellaneous comparisons and conversions. Sipe provides two implementations of these operations, with the same API and the same behavior: one based on integer arithmetic, and a new one based on floating-point arithmetic.

- Participant: Vincent Lefèvre
- Contact: Vincent Lefèvre
- URL: <https://www.vinc17.net/research/sipe/>

6.5. LinBox

KEYWORD: Exact linear algebra

FUNCTIONAL DESCRIPTION: LinBox is an open-source C++ template library for exact, high-performance linear algebra computations. It is considered as the reference library for numerous computations (such as linear system solving, rank, characteristic polynomial, Smith normal forms,...) over finite fields and integers with dense, sparse, and structured matrices.

- Participants: Clément Pernet and Thierry Gautier
- Contact: Clément Pernet
- URL: <http://linalg.org/>

6.6. HPLLL

KEYWORDS: Computer algebra system (CAS) - Euclidean Lattices

FUNCTIONAL DESCRIPTION: Software library for linear algebra and Euclidean lattice problems

- Contact: Gilles Villard
- URL: <http://perso.ens-lyon.fr/gilles.villard/hplll/>

AROMATH Project-Team

5. New Software and Platforms

5.1. Platforms

5.1.1. *Axel*

KEYWORDS: Algorithm , CAD , Numerical algorithm , Geometric algorithms

SCIENTIFIC DESCRIPTION

Axel is an algebraic geometric modeler that aims at providing “algebraic modeling” tools for the manipulation and computation with curves, surfaces or volumes described by semi-algebraic representations. These include parametric and implicit representations of geometric objects. Axel also provides algorithms to compute intersection points or curves, singularities of algebraic curves or surfaces, certified topology of curves and surfaces, etc. A plugin mechanism allows to extend easily the data types and functions available in the platform.

FUNCTIONAL DESCRIPTION

Axel is a cross platform software to visualize, manipulate and compute 3D objects. It is composed of a main application and several plugins. The main application provides atomic geometric data and processes, a viewer based on VTK, a GUI to handle objects, to select data, to apply process on them and to visualize the results. The plugins provides more data with their reader, writer, converter and interactors, more processes on the new or atomic data. It is written in C++ and thanks to a wrapping system using SWIG, its data structures and algorithms can be integrated into C# programs, as well as Python. The software is distributed as a source package, as well as binary packages for Linux, MacOSX and Windows.

- Participants: Nicolas Douillet, Anaïs Ducoffe, Valentin Michelet, Bernard Mourrain, Meriadeg Perrinel, Stéphane Chau and Julien Wintz
- Contact: Bernard Mourrain
- URL: <http://axel.inria.fr/>

Collaboration with Elisa Berrini (MyCFD, Sophia), Tor Dokken (Gotoools library, Oslo, Norway), Angelos Mantzaflaris (GISMO library, Linz, Austria), Laura Saini (Post-Doc GALAAD/Missler, TopSolid), Gang Xu (Hangzhou Dianzi University, China), Meng Wu (Hefei University of Technology, China).

5.1.2. *Dtk-Nurbs-Probing*

KEYWORDS: CAO - Algebraic geometric modeler

SCIENTIFIC DESCRIPTION

This library offers tools for computing intersection between linear primitives and the constitutive elements of CAD objects (curves and surfaces). It is thus possible to compute intersections between a linear primitive with a trimmed NURBS surface, as well as untrimmed, moreover with a Bezier surface. It is also possible, in the xy plane, to compute the intersections between linear primitives and NURBS curves as well as Bezier curves.

FUNCTIONAL DESCRIPTION

Polynomial/rational defined primitives intersection with linear primitives under the form of a dtk plugin.

- Authors: Come Le Breton, Laurent Busé, Pierre Alliez, Julien Wintz, Thibaud Kloczko.
- Contact: Laurent Busé
- URL: <http://nurbsprobing.inria.fr/>

Collaboration with Pierre Alliez (Titane) and the industrial partner GeometryFactory (Sophia).

CAIRN Project-Team

6. New Software and Platforms

6.1. Gecos

Generic Compiler Suite

KEYWORDS: Source-to-source compiler - Model-driven software engineering - Retargetable compilation

SCIENTIFIC DESCRIPTION: The Gecos (Generic Compiler Suite) project is a source-to-source compiler infrastructure developed in the Cairn group since 2004. It was designed to enable fast prototyping of program analysis and transformation for hardware synthesis and retargetable compilation domains.

Gecos is Java based and takes advantage of modern model driven software engineering practices. It uses the Eclipse Modeling Framework (EMF) as an underlying infrastructure and takes benefits of its features to make it easily extensible. Gecos is open-source and is hosted on the Inria gforge.

The Gecos infrastructure is still under very active development, and serves as a backbone infrastructure to projects of the group. Part of the framework is jointly developed with Colorado State University and between 2012 and 2015 it was used in the context of the FP7 ALMA European project. The Gecos infrastructure is currently used by the EMMATRIX start-up, a spin-off from the ALMA project which aims at commercializing the results of the project, and in the context of the H2020 ARGO European project.

FUNCTIONAL DESCRIPTION: GeCoS provides a programme transformation toolbox facilitating parallelisation of applications for heterogeneous multiprocessor embedded platforms. In addition to targeting programmable processors, GeCoS can regenerate optimised code for High Level Synthesis tools.

- Participants: Tomofumi Yuki, Thomas Lefeuvre, Imèn Fassi, Mickael Dardaillon, Ali Hassan El Moussawi and Steven Derrien
- Partner: Université de Rennes 1
- Contact: Steven Derrien
- URL: <http://gecos.gforge.inria.fr>

6.2. ID-Fix

Infrastructure for the Design of Fixed-point systems

KEYWORDS: Energy efficiency - Dynamic range evaluation - Accuracy optimization - Fixed-point arithmetic - Analytic Evaluation - Embedded systems - Code optimisation

SCIENTIFIC DESCRIPTION: The different techniques proposed by the team for fixed-point conversion are implemented on the ID.Fix infrastructure. The application is described with a C code using floating-point data types and different pragmas, used to specify parameters (dynamic, input/output word-length, delay operations) for the fixed-point conversion. This tool determines and optimizes the fixed-point specification and then, generates a C code using fixed-point data types (ac_fixed) from Mentor Graphics. The infrastructure is made-up of two main modules corresponding to the fixed-point conversion (ID.Fix-Conv) and the accuracy evaluation (ID.Fix-Eval)

FUNCTIONAL DESCRIPTION: ID.Fix focuses on computational precision accuracy and can provide an optimised specification using fixed point arithmetic from a C source code with floating point data types. Fixed point arithmetic is very widely used in embedded systems as it provides better performance and is much more energy efficient. ID.Fix used an analytic programme model which means it can explore more solutions and thereby produce much more efficient code.

- Participant: Olivier Sentieys
- Partner: Université de Rennes 1
- Contact: Olivier Sentieys
- URL: <http://idfix.gforge.inria.fr>

6.3. Platforms

6.3.1. Zyggie

KEYWORDS: Health - Biomechanics - Wireless body sensor networks - Low power - Gesture recognition - Hardware platform - Software platform - Localization

SCIENTIFIC DESCRIPTION: Zyggie is a hardware and software wireless body sensor network platform. Each sensor node, attached to different parts of the human body, contains inertial sensors (IMU) (accelerometer, gyrometer, compass and barometer), an embedded processor and a low-power radio module to communicate data to a coordinator node connected to a computer, tablet or smartphone. One of the system's key innovations is that it collects data from sensors as well as on distances estimated from the power of the radio signal received to make the 3D location of the nodes more precise and thus prevent IMU sensor drift and power consumption overhead. Zyggie can be used to determine posture or gestures and mainly has applications in sport, healthcare and the multimedia industry.

FUNCTIONAL DESCRIPTION: The Zyggie sensor platform was developed to create an autonomous Wireless Body Sensor Network (WBSN) with the capabilities of monitoring body movements. The Zyggie platform is part of the BoWI project funded by CominLabs. Zyggie is composed of a processor, a radio transceiver and different sensors including an Inertial Measurement Unit (IMU) with 3-axis accelerometer, gyrometer, and magnetometer. Zyggie is used for evaluating data fusion algorithms, low power computing algorithms, wireless protocols, and body channel characterization in the BoWI project.

The Zyggie V2 prototype includes the following features: a 32-bit microcontroller to manage a custom MAC layer and processe quaternions based on IMU measures, and an UWB radio from DecaWave to measure distances between nodes with Time of Flight (ToF).

- Participants: Arnaud Carer and Olivier Sentieys
- Partners: Lab-STICC - Université de Rennes 1
- Contact: Olivier Sentieys
- URL: <http://www.bowi.cominlabs.ueb.eu/fr/zyggie-wbsn-platform>



Figure 3. CAIRN's Zyggie platform for WBSN

CAMUS Team

6. New Software and Platforms

6.1. APOLLO

Automatic speculative POLyhedral Loop Optimizer

KEYWORD: Automatic parallelization

FUNCTIONAL DESCRIPTION: APOLLO is dedicated to automatic, dynamic and speculative parallelization of loop nests that cannot be handled efficiently at compile-time. It is composed of a static part consisting of specific passes in the LLVM compiler suite, plus a modified Clang frontend, and a dynamic part consisting of a runtime system. It can apply on-the-fly any kind of polyhedral transformations, including tiling, and can handle nonlinear loops, as while-loops referencing memory through pointers and indirections.

- Participants: Aravind Sukumaran-Rajam, Juan Manuel Martinez Caamaño, Manuel Selva and Philippe Clauss
- Contact: Philippe Clauss
- URL: <http://apollo.gforge.inria.fr>

6.2. Clan

A Polyhedral Representation Extraction Tool for C-Based High Level Languages

KEYWORD: Polyhedral compilation

FUNCTIONAL DESCRIPTION: Clan is a free software and library which translates some particular parts of high level programs written in C, C++ or Java into a polyhedral representation called OpenScop. This representation may be manipulated by other tools to, e.g., achieve complex analyses or program restructurations (for optimization, parallelization or any other kind of manipulation). It has been created to avoid tedious and error-prone input file writing for polyhedral tools (such as CLooG, LeTSeE, Candl etc.). Using Clan, the user has to deal with source codes based on C grammar only (as C, C++ or Java). Clan is notably the frontend of the two major high-level compilers Pluto and PoCC.

- Participants: Cédric Bastoul and Imèn Fassi
- Contact: Cédric Bastoul
- URL: http://icps.u-strasbg.fr/people/bastoul/public_html/development/clan/

6.3. Clay

Chunky Loop Alteration wizardrY

FUNCTIONAL DESCRIPTION: Clay is a free software and library devoted to semi-automatic optimization using the polyhedral model. It can input a high-level program or its polyhedral representation and transform it according to a transformation script. Classic loop transformations primitives are provided. Clay is able to check for the legality of the complete sequence of transformation and to suggest corrections to the user if the original semantics is not preserved.

- Participant: Cédric Bastoul
- Contact: Cédric Bastoul
- URL: http://icps.u-strasbg.fr/people/bastoul/public_html/development/clay/

6.4. CLooG

Code Generator in the Polyhedral Model

FUNCTIONAL DESCRIPTION: CLoog is a free software and library to generate code (or an abstract syntax tree of a code) for scanning Z-polyhedra. That is, it finds a code (e.g. in C, FORTRAN...) that reaches each integral point of one or more parameterized polyhedra. CLoog has been originally written to solve the code generation problem for optimizing compilers based on the polyhedral model. Nevertheless it is used now in various area e.g. to build control automata for high-level synthesis or to find the best polynomial approximation of a function. CLoog may help in any situation where scanning polyhedra matters. While the user has full control on generated code quality, CLoog is designed to avoid control overhead and to produce a very effective code. CLoog is widely used (including by GCC and LLVM compilers), disseminated (it is installed by default by the main Linux distributions) and considered as the state of the art in polyhedral code generation.

RELEASE FUNCTIONAL DESCRIPTION: It mostly solves building and offers a better OpenScop support.

- Participant: Cédric Bastoul
- Contact: Cédric Bastoul
- URL: <http://www.cloog.org>

6.5. IBB

Iterate-But-Better

FUNCTIONAL DESCRIPTION: IBB is a source-to-source xfor compiler which automatically translates any C source code containing xfor-loops into an equivalent source code where xfor-loops have been transformed into equivalent for-loops.

RELEASE FUNCTIONAL DESCRIPTION: The IBB compiler has been improved in some aspects in 2014: loop bounds can now be min and max functions, IBB uses the OpenScop format to encode statements and iteration domains.

- Participants: Cédric Bastoul, Imèn Fassi and Philippe Clauss
- Contact: Philippe Clauss
- URL: <http://xfor.gforge.inria.fr>

6.6. OpenScop

A Specification and a Library for Data Exchange in Polyhedral Compilation Tools

FUNCTIONAL DESCRIPTION: OpenScop is an open specification that defines a file format and a set of data structures to represent a static control part (SCoP for short), i.e., a program part that can be represented in the polyhedral model. The goal of OpenScop is to provide a common interface to the different polyhedral compilation tools in order to simplify their interaction. To help the tool developers to adopt this specification, OpenScop comes with an example library (under 3-clause BSD license) that provides an implementation of the most important functionalities necessary to work with OpenScop.

- Participant: Cédric Bastoul
- Contact: Cédric Bastoul
- URL: http://icps.u-strasbg.fr/people/bastoul/public_html/development/openscop/

6.7. PolyLib

The Polyhedral Library

KEYWORDS: Rational polyhedra - Library - Polyhedral compilation

SCIENTIFIC DESCRIPTION: A C library used in polyhedral compilation, as a basic tool used to analyze, transform, optimize polyhedral loop nests. Has been shipped in the polyhedral tools Cloog and Pluto.

FUNCTIONAL DESCRIPTION: PolyLib is a C library of polyhedral functions, that can manipulate unions of rational polyhedra of any dimension. It was the first to provide an implementation of the computation of parametric vertices of a parametric polyhedron, and the computation of an Ehrhart polynomial (expressing the number of integer points contained in a parametric polytope) based on an interpolation method. Vincent Loechner is the maintainer of this software.

- Participant: Vincent Loechner
- Contact: Vincent Loechner
- URL: <http://icps.u-strasbg.fr/PolyLib/>

6.8. ORWL

Ordered Read-Write Lock

KEYWORDS: Task scheduling - Deadlock detection

FUNCTIONAL DESCRIPTION: ORWL is a reference implementation of the Ordered Read-Write Lock tools. The macro definitions and tools for programming in C99 that have been implemented for ORWL have been separated out into a toolbox called P99.

- Participants: Jens Gustedt, Mariem Saied and Stéphane Vialle
- Contact: Jens Gustedt
- Publications: [Iterative Computations with Ordered Read-Write Locks - Automatic, Abstracted and Portable Topology-Aware Thread Placement](#) - [Resource-Centered Distributed Processing of Large Histopathology Images](#) - [Automatic Code Generation for Iterative Multi-dimensional Stencil Computations](#)

6.9. P99

KEYWORD: Macro programming

FUNCTIONAL DESCRIPTION: P99 is a suite of macro and function definitions that ease the programming in modern C, minimum C99. By using tools from C99 and C11 we implement default arguments for functions, scope bound resource management, transparent allocation and initialization.

- Participants: Jens Gustedt, Mariem Saied and Stéphane Vialle
- Contact: Jens Gustedt
- URL: <https://gforge.inria.fr/projects/p99/>

6.10. stdatomic

standard atomic library

KEYWORD: Atomic access

SCIENTIFIC DESCRIPTION: We present a new algorithm and implementation of a lock primitive that is based on Linux' native lock interface, the futex system call. It allows us to assemble compiler support for atomic data structures that can not be handled through specific hardware instructions. Such a tool is needed for C11's atomics interface because here an `_Atomic` qualification can be attached to almost any data type. Our lock data structure for that purpose meets very specific criteria concerning its field of operation and its performance. By that we are able to outperform gcc's libatomic library by around 60%.

FUNCTIONAL DESCRIPTION: This implementation builds entirely on the two gcc ABIs for atomics. It doesn't even attempt to go down to assembly level by itself. We provide all function interfaces that the two gcc ABIs and the C standard need. For compilers that don't offer the direct language support for atomics this provides a syntactically reduced but fully functional approach to atomic operations.

- Author: Jens Gustedt
- Contact: Jens Gustedt
- Publications: [Futex based locks for C11's generic atomics](#) - [Futex based locks for C11's generic atomics \(extended abstract\)](#)
- URL: <http://stdatomic.gforge.inria.fr/>

6.11. musl

KEYWORDS: Standards - Library

SCIENTIFIC DESCRIPTION: musl provides consistent quality and implementation behavior from tiny embedded systems to full-fledged servers. Minimal machine-specific code means less chance of breakage on minority architectures and better success with “write once run everywhere” C development.

musl’s efficiency is unparalleled in Linux libc implementations. Designed from the ground up for static linking, musl carefully avoids pulling in large amounts of code or data that the application will not use. Dynamic linking is also efficient, by integrating the entire standard library implementation, including threads, math, and even the dynamic linker itself into a single shared object, most of the startup time and memory overhead of dynamic linking have been eliminated.

FUNCTIONAL DESCRIPTION: We participate in the development of musl, a re-implementation of the C library as it is described by the C and POSIX standards. It is lightweight, fast, simple, free, and strives to be correct in the sense of standards-conformance and safety. Musl is production quality code that is mainly used in the area of embedded device. It gains more market share also in other area, e.g. there are now Linux distributions that are based on musl instead of Gnu LibC.

- Participant: Jens Gustedt
- Contact: Jens Gustedt
- URL: <http://www.musl-libc.org/>

6.12. Modular C

KEYWORDS: Programming language - Modularity

FUNCTIONAL DESCRIPTION: The change to the C language is minimal since we only add one feature, composed identifiers, to the core language. Our modules can import other modules as long as the import relation remains acyclic and a module can refer to its own identifiers and those of the imported modules through freely chosen abbreviations. Other than traditional C include, our import directive ensures complete encapsulation between modules. The abbreviation scheme allows to seamlessly replace an imported module by another one with equivalent interface. In addition to the export of symbols, we provide parameterized code injection through the import of “snippets”. This implements a mechanism that allows for code reuse, similar to X macros or templates. Additional features of our proposal are a simple dynamic module initialization scheme, a structured approach to the C library and a migration path for existing software projects.

- Author: Jens Gustedt
- Contact: Jens Gustedt
- Publications: [Modular C - Arbogast: Higher order AD for special functions with Modular C - Futex based locks for C11’s generic atomics](#)
- URL: <http://cmod.gforge.inria.fr/>

6.13. arbogast

KEYWORD: Automatic differentiation

SCIENTIFIC DESCRIPTION: This high-level toolbox for the calculus with Taylor polynomials is named after L.F.A. Arbogast (1759-1803), a French mathematician from Strasbourg (Alsace), for his pioneering work in derivation calculus. Its modular structure ensures unmatched efficiency for computing higher order Taylor polynomials. In particular it permits compilers to apply sophisticated vector parallelization to the derivation of nearly unmodified application code.

FUNCTIONAL DESCRIPTION: Arbogast is based on a well-defined extension of the C programming language, Modular C, and places itself between tools that proceed by operator overloading on one side and by rewriting, on the other. The approach is best described as contextualization of C code because it permits the programmer to place his code in different contexts – usual math or AD – to reinterpret it as a usual C function or as a differential operator. Because of the type generic features of modern C, all specializations can be delegated to the compiler.

- Author: Jens Gustedt
- Contact: Jens Gustedt
- Publications: **Arbogast: Higher order AD for special functions with Modular C - Arbogast – Origine d’un outil de dérivation automatique**
- URL: <https://gforge.inria.fr/projects/arbo>

6.14. CFML

Interactive program verification using characteristic formulae

KEYWORDS: Coq - Software Verification - Deductive program verification - Separation Logic

FUNCTIONAL DESCRIPTION: The CFML tool supports the verification of OCaml programs through interactive Coq proofs. CFML proofs establish the full functional correctness of the code with respect to a specification. They may also be used to formally establish bounds on the asymptotic complexity of the code. The tool is made of two parts: on the one hand, a characteristic formula generator implemented as an OCaml program that parses OCaml code and produces Coq formulae, and, on the other hand, a Coq library that provides notation and tactics for manipulating characteristic formulae interactively in Coq.

- Participants: Arthur Charguéraud, Armaël Guéneau and François Pottier
- Contact: Arthur Charguéraud
- URL: <http://www.chargueraud.org/softs/cfml/>

6.15. TLC

TLC Coq library

KEYWORDS: Coq - Library

FUNCTIONAL DESCRIPTION: TLC is a general purpose Coq library that provides an alternative to Coq’s standard library. TLC takes as axiom extensionality, classical logic and indefinite description (Hilbert’s epsilon). These axioms allow for significantly simpler formal definitions in many cases. TLC takes advantage of the type class mechanism. In particular, this allows for common operators and lemma names for all container data structures and all order relations. TLC includes the optimal fixed point combinator, which can be used for building arbitrarily-complex recursive and co-recursive definitions. Last, TLC provides a collection of tactics that enhance the default tactics provided by Coq. These tactics help constructing more concise and more robust proof scripts.

- Contact: Arthur Charguéraud
- URL: <http://www.chargueraud.org/softs/tlc/>

CARAMBA Project-Team

6. New Software and Platforms

6.1. Belenios

Belenios - Verifiable online voting system

KEYWORD: E-voting

FUNCTIONAL DESCRIPTION: Belenios is an online voting system that provides confidentiality and verifiability. End-to-end verifiability relies on the fact that the ballot box is public (voters can check that their ballots have been received) and on the fact that the tally is publicly verifiable (anyone can recount the votes). Confidentiality relies on the encryption of the votes and the distribution of the decryption key.

Belenios builds upon Helios, a voting protocol used in several elections. The main design enhancement of Belenios vs Helios is that the ballot box can no longer add (fake) ballots, due to the use of credentials.

- Participants: Pierrick Gaudry, Stéphane Glondou and Véronique Cortier
- Partners: CNRS - Inria
- Contact: Stéphane Glondou
- URL: <http://belenios.gforge.inria.fr/>

6.2. tinygb

KEYWORD: Gröbner bases

FUNCTIONAL DESCRIPTION: Tinygb is a free software which implements tools for computing Gröbner bases with Faugère's F4 algorithm.

NEWS OF THE YEAR: The code has been largely rewritten and optimized. A new release is planned for the beginning of 2018.

- Author: Pierre-Jean Spaenlehauer
- Contact: Pierre-Jean Spaenlehauer
- URL: <https://gforge.inria.fr/projects/tinygb/>

6.3. CADO-NFS

Crible Algébrique: Distribution, Optimisation - Number Field Sieve

KEYWORDS: Cryptography - Number theory

FUNCTIONAL DESCRIPTION: CADO-NFS is a complete implementation in C/C++ of the Number Field Sieve (NFS) algorithm for factoring integers and computing discrete logarithms in finite fields. It consists in various programs corresponding to all the phases of the algorithm, and a general script that runs them, possibly in parallel over a network of computers.

- Participants: Pierrick Gaudry, Emmanuel Thomé and Paul Zimmermann
- Contact: Emmanuel Thomé
- URL: <http://cado-nfs.gforge.inria.fr/>

CARTE Team

6. New Software and Platforms

6.1. Software

6.1.1. *FiatLux*

FiatLux is a simulation program for cellular automata developed by Nazim Fatès. The project is currently available at the Inria GForge. It is under the CeCILL license.

CASCADE Project-Team (section vide)

CELTIQUE Project-Team

3. New Software and Platforms

3.1. Jacal

JavaCard AnaLyseur

KEYWORDS: JavaCard - Certification - Static program analysis - AFSCM

FUNCTIONAL DESCRIPTION: Jacal is a JAvacard AnaLyseur developed on top of the SAWJA platform. This proprietary software verifies automatically that Javacard programs conform with the security guidelines issued by the AFSCM (Association Française du Sans Contact Mobile). Jacal is based on the theory of abstract interpretation and combines several object-oriented and numeric analyses to automatically infer sophisticated invariants about the program behaviour. The result of the analysis is thereafter harvest to check that it is sufficient to ensure the desired security properties.

- Participants: David Pichardie, Delphine Demange, Frédéric Besson and Thomas Jensen
- Contact: Thomas Jensen

3.2. Javalib

FUNCTIONAL DESCRIPTION: Javalib is an efficient library to parse Java .class files into OCaml data structures, thus enabling the OCaml programmer to extract information from class files, to manipulate and to generate valid .class files.

- Participants: David Pichardie, Frédéric Besson, Laurent Guillo, Laurent Hubert, Nicolas Barré, Pierre Vittet and Tiphaine Turpin
- Contact: Frédéric Besson
- URL: <http://sawja.inria.fr/>

3.3. JSCert

Certified JavaScript

FUNCTIONAL DESCRIPTION: The JSCert project aims to really understand JavaScript. JSCert itself is a mechanised specification of JavaScript, written in the Coq proof assistant, which closely follows the ECMAScript 5 English standard. JSRef is a reference interpreter for JavaScript in OCaml, which has been proved correct with respect to JSCert and tested with the Test 262 test suite.

- Participants: Alan Schmitt and Martin Bodin
- Partner: Imperial College London
- Contact: Alan Schmitt
- URL: <http://jscert.org/>

3.4. SAWJA

Static Analysis Workshop for Java

KEYWORDS: Security - Software - Code review - Smart card

SCIENTIFIC DESCRIPTION: Sawja is a library written in OCaml, relying on Javalib to provide a high level representation of Java bytecode programs. Its name comes from Static Analysis Workshop for JAvA. Whereas Javalib is dedicated to isolated classes, Sawja handles bytecode programs with their class hierarchy and with control flow algorithms.

Moreover, Sawja provides some stackless intermediate representations of code, called JBir and A3Bir. The transformation algorithm, common to these representations, has been formalized and proved to be semantics-preserving.

See also the web page <http://sawja.inria.fr/>.

Version: 1.5

Programming language: Ocaml

FUNCTIONAL DESCRIPTION: Sawja is a toolbox for developing static analysis of Java code in bytecode format. Sawja provides advanced algorithms for reconstructing high-level programme representations. The SawjaCard tool dedicated to JavaCard is based on the Sawja infrastructure and automatically validates the security guidelines issued by AFSCM (<http://www.afscm.org/>). SawjaCard can automate the code audit process and automatic verification of functional properties.

- Participants: David Pichardie, Frédéric Besson and Laurent Guillo
- Partners: CNRS - ENS Cachan
- Contact: Frédéric Besson
- URL: <http://sawja.inria.fr/>

3.5. Timbuk

KEYWORDS: Demonstration - Ocaml - Vérification de programmes - Tree Automata

FUNCTIONAL DESCRIPTION: Timbuk is a collection of tools for achieving proofs of reachability over Term Rewriting Systems and for manipulating Tree Automata (bottom-up non-deterministic finite tree automata)

RELEASE FUNCTIONAL DESCRIPTION: This version does no longer include the tree automata library but focuses on reachability analysis and equational approximations.

- Participant: Thomas Genet
- Contact: Thomas Genet
- URL: <http://www.irisa.fr/ceutique/genet/timbuk/>

CIDRE Project-Team

6. New Software and Platforms

6.1. Blare

To detect intrusion using information flows

KEYWORDS: Cybersecurity - Intrusion Detection Systems (IDS) - Data Leakage Protection

SCIENTIFIC DESCRIPTION: Blare implements our approach of illegal information flow detection for a single node (Android and Linux kernel, JVM) and a set of nodes (monitoring of flows between linux machines).

FUNCTIONAL DESCRIPTION: Blare IDS is a set of tools that implements our approach to illegal information flow detection for a single node and a set of nodes.

NEWS OF THE YEAR: During this year, Laurent Georget has modified the implementation of Blare in order to correctly monitor the kernel system calls with LSM hooks. He add also ported this new version of Blare to the Lollipop Android emulator.

- Partner: CentraleSupélec
- Contact: Frédéric Tronel
- Publications: [Information Flow Tracking for Linux Handling Concurrent System Calls and Shared Memory](#) - [Verifying the Reliability of Operating System-Level Information Flow Control Systems in Linux](#) - [Monitoring both OS and program level information flows to detect intrusions against network servers](#) - [Experimenting a Policy-Based HIDS Based on an Information Flow Control Model](#) - [Introducing reference flow control for intrusion detection at the OS level](#) - [Blare Tools: A Policy-Based Intrusion Detection System Automatically Set by the Security Policy](#) - [Diagnosing intrusions in Android operating system using system flow graph](#) - [Intrusion detection in distributed systems, an approach based on taint marking](#) - [BSPL: A Language to Specify and Compose Fine-grained Information Flow Policies](#) - [Information Flow Policies vs Malware](#) - [A taint marking approach to confidentiality violation detection](#) - [Designing information flow policies for Android's operating system](#) - [Information Flow Control for Intrusion Detection derived from MAC Policy](#) - [Flow based interpretation of access control: Detection of illegal information flows](#) - [A taint marking approach to confidentiality violation detection](#)
- URL: <http://www.blare-ids.org/>

6.2. GNG

Security Supervision by Alert Correlation

KEYWORDS: Intrusion Detection Systems (IDS) - SIEM

SCIENTIFIC DESCRIPTION: GNG is an intrusion detection system that correlates different sources (such as different logs) in order to identify attacks against the system. The attack scenarios are defined using the Attack Description Language (ADeLe) proposed by our team, and are internally translated to attack recognition automaton. GNG intends to define time efficient algorithms based on these automaton to recognize complex attack scenarios.

- Partner: CentraleSupélec
- Contact: Eric Totel
- Publication: [A Language Driven Intrusion Detection System for Events and Alerts Correlation](#)
- URL: <http://www.rennes.supelec.fr/ren/perso/etotel/GNG/index.html>

6.3. GroddDroid

KEYWORDS: Android - Detection - Malware

SCIENTIFIC DESCRIPTION: GroddDroid automates the dynamic analysis of a malware. When a piece of suspicious code is detected, groddDroid interacts with the user interface and eventually forces the execution of the identified code. Using Blare (Information Flow Monitor), GroddDroid monitors how an execution contaminates the operating system. The output of GroddDroid can be visualized in a web browser. GroddDroid is used by the Kharon software.

FUNCTIONAL DESCRIPTION: GroddDroid 1 - locates suspicious code in Android application 2 - computes execution paths towards suspicious code 3 - forces executions of suspicious code 4 - automate the execution of a malware or a regular Android application

NEWS OF THE YEAR: In 2017, GroddDroid has integrated the work of Mourad Leslous, who have implemented GPFinder. GPFinder improves the computation of control flow paths by taking into account the Android framework. The end of the year has been used to clean the code and to improve the graphical interface.

- Partners: CentraleSupélec - Insa Centre Val-de-Loire
- Contact: Valérie Viet Triem Tong
- Publications: [Kharon dataset: Android malware under a microscope](#) - [GroddDroid: a Gorilla for Triggering Malicious Behaviors](#) - [GPFinder: Tracking the Invisible in Android Malware](#) - [Information flows at OS level unmask sophisticated Android malware](#)
- URL: <http://kharon.gforge.inria.fr/grodddroid.html>

6.4. Kharon

KEYWORDS: Android - Malware - Dynamic Analysis

FUNCTIONAL DESCRIPTION: Kharon is a software for managing Android application analysis. Kharon uses the results of the GroddDroid software. The user can submit one or several applications to Kharon and get a graph of the information flows that occurred at system level and that have been caused by the application.

Kharon is used in the Kharon platform for the analysis of malicious applications. This platform is deployed at the high security laboratory (LHS) of Rennes.

- Author: Sébastien Campion
- Partners: CentraleSupélec - Insa Centre Val-de-Loire
- Contact: Valérie Viet Triem Tong
- URL: <http://kharon.gforge.inria.fr/>

6.5. StarLord

KEYWORDS: Security - SIEM

FUNCTIONAL DESCRIPTION: In the domain of security event visualisation, we have developed a prototype called StarLord. Basically, this software is able to parse heterogeneous logs, and to extract from each line of logs a set of security objects. Moreover, some of these objects appears in several lines of different logs. These lines are thus linked by the sharing of one or more security objects. When we analyse the lines of logs, we are thus able to generate graphs that represents the links between the different objects discovered in the logs. These graphs are thus displayed in 3D in order for the administrator to investigate easily the relations between the logs and the relations between the logs and some particular indicators of compromise. The tool permits to discover visually the activity of an attacker on the supervised system.

- Authors: Ludovic Mé, Eric Totel, Nicolas Prigent and Laetitia Leichtnam
- Contact: Eric Totel
- Publication: [STARLORD: Linked Security Data Exploration in a 3D Graph](#)

6.6. SpecCert

KEYWORDS: Formal methods - Coq

FUNCTIONAL DESCRIPTION: SpecCert is a framework for specifying and verifying Hardware-based Security Enforcement (HSE) mechanisms against hardware architecture models. HSE mechanisms form a class of security enforcement mechanism such that a set of trusted software components relies on hardware functions to enforce a security policy.

- Participant: Thomas Letan
- Partners: ANSSI - CentraleSupélec
- Contact: Guillaume Hiet
- Publications: [SpecCert: Specifying and Verifying Hardware-based Security Enforcement](#) - [SpecCert: Specifying and Verifying Hardware-based Software Enforcement](#)
- URL: <https://github.com/lethom/speccert>

6.7. HardBlare

KEYWORDS: Intrusion Detection Systems (IDS) - FPGA - Static analysis

FUNCTIONAL DESCRIPTION: HardBlare is a hardware/software framework to implement hardware DIFC on Xilinx Zynq Platform. HardBlare consists of three components : 1) the VHDL code of the coprocessor, 2) a modified LLVM compiler to compute the static analysis, and 3) a dedicated Linux kernel. This last component is a specific version of the Blare monitor.

- Partners: CentraleSupélec - Lab-STICC
- Contact: Guillaume Hiet
- Publications: [ARMHEx: A hardware extension for DIFT on ARM-based SoCs](#) - [ARMHEx: a framework for efficient DIFT in real-world SoCs](#) - [ARMHEx: embedded security through hardware-enhanced information flow tracking](#) - [HardBlare: a Hardware-Assisted Approach for Dynamic Information Flow Tracking](#) - [A portable approach for SoC-based Dynamic Information Flow Tracking implementations](#) - [Towards a hardware-assisted information flow tracking ecosystem for ARM processors](#) - [HardBlare: an efficient hardware-assisted DIFC for non-modified embedded processors](#)

6.8. Conductor

KEYWORDS: Intrusion Detection Systems (IDS) - Static analysis - Instrumentation

FUNCTIONAL DESCRIPTION: Conductor contains three main components: a static analysis to extract the expected behavior of the target, an instrumentation module to add instructions to the target's code in order to send messages to the co-processor, and an intrusion detection engine executed on the co-processor. The latter processes the messages sent by the instrumented target, describing its current behavior. This behavior is then compared against the expected behavior previously extracted by the static analysis.

- Participants: Ronny Chevalier, Guillaume Hiet, Maugan Villatel and David Plaquin
- Partners: CentraleSupélec - HP Labs
- Contact: Ronny Chevalier
- Publication: [Co-processor-based Behavior Monitoring: Application to the Detection of Attacks Against the System Management Mode](#)

6.9. Platforms

6.9.1. Kharon platform

The Kharon platform is under development in the LHS of Rennes and should be ready to use in the beginning of 2018. This experimental platform aims to analyze Android malware using a set of software developed by the CIDRE team. Software that are involved are:

- The Blare IDS <http://www.blare-ids.org/>, and in particular the AndroBlare version, for tracking information flows of malware;
- The GroddDroid software <http://kharon.gforge.inria.fr/grodddroid.html>, for manipulating the malware statically and dynamically;
- The GPFinder software <http://kharon.gforge.inria.fr/gpfinder.html>, for computing paths in the malware's control flow;
- The kharon software that handles the orchestration of a bunch of malware, the server and a set of smartphones.

The Kharon platform will be used for analysing malware as soon as they appear in the wild. The analysis results will be stored for further experiments and statistics.

COMETE Project-Team

5. New Software and Platforms

5.1. Location Guard

KEYWORDS: Privacy - Geolocation - Browser Extensions

SCIENTIFIC DESCRIPTION: The purpose of Location Guard is to implement obfuscation techniques for achieving location privacy, in a an easy and intuitive way that makes them available to the general public. Various modern applications, running either on smartphones or on the web, allow third parties to obtain the user's location. A smartphone application can obtain this information from the operating system using a system call, while web application obtain it from the browser using a JavaScript call.

FUNCTIONAL DESCRIPTION: Websites can ask the browser for your location (via JavaScript). When they do so, the browser first asks your permission, and if you accept, it detects your location (typically by transmitting a list of available wifi access points to a geolocation provider such as Google Location Services, or via GPS if available) and gives it to the website.

Location Guard is a browser extension that intercepts this procedure. The permission dialog appears as usual, and you can still choose to deny. If you give permission, then Location Guard obtains your location and adds "random noise" to it, creating a fake location. Only the fake location is then given to the website.

In 2017 there was a major update to the Firefox version of Location Guard, to make it compatible with the Firefox Quantum. This latest Firefox version discontinued support for the legacy addon API, so Location Guard had to be adapted to the new WebExtensions API.

Moreover, the latest version implements new features requested by users, such as the ability to search for a fixed location, as well as bugfixes.

- Participants: Catuscia Palamidessi, Konstantinos Chatzikokolakis, Marco Stronati, Miguel Andrés and Nicolas Bordenabe
- Contact: Konstantinos Chatzikokolakis
- URL: <https://github.com/chatziko/location-guard>

5.2. libqif - A Quantitative Information Flow C++ Toolkit Library

KEYWORDS: Information leakage - Privacy - C++ - Linear optimization

FUNCTIONAL DESCRIPTION: The goal of libqif is to provide an efficient C++ toolkit implementing a variety of techniques and algorithms from the area of quantitative information flow and differential privacy. We plan to implement all techniques produced by Comète in recent years, as well as several ones produced outside the group, giving the ability to privacy researchers to reproduce our results and compare different techniques in a uniform and efficient framework.

Some of these techniques were previously implemented in an ad-hoc fashion, in small, incompatible with each-other, non-maintained and usually inefficient tools, used only for the purposes of a single paper and then abandoned. We aim at reimplementing those – as well as adding several new ones not previously implemented – in a structured, efficient and maintainable manner, providing a tool of great value for future research. Of particular interest is the ability to easily re-run evaluations, experiments and case-studies from all our papers, which will be of great value for comparing new research results in the future.

The library's development continued in 2017 with several new added features. The project's git repository shows for this year 33 commits by 2 contributors. The new functionality was directly applied to the exeperimental results of several publications of the team (PETS'17, GameSec'17, VALUETOOLS'17).

- Contact: Konstantinos Chatzikokolakis
- URL: <https://github.com/chatziko/libqif>

5.3. dspacenet

Distributed-Spaces Network.

KEYWORDS: Social networks - Distributed programming

FUNCTIONAL DESCRIPTION: DSpaceNet is a tool for social networking based on multi-agent spatial and timed concurrent constraint language.

I - The fundamental structure of DSpaceNet is that of **space**: A space may contain

(1) spatial-mobile-reactive tcc programs, and (2) other spaces.

Furthermore, (3) each space belongs to a given agent. Thus, a space of an agent j within the space of agent i means that agent i allows agent j to use a computation sub-space within its space.

II - The fundamental operation of DSpaceNet is that of **program posting**: In each time unit, agents can post spatial-mobile-reactive tcc programs in the spaces they are allowed to do so (ordinary message posting corresponds to the posting of tell processes). Thus, an agent can for example post a watchdog tcc process to react to messages in their space, e.g. whenever (**happy b*frank**) do tell("thank you!"). More complex mobile programs are also allowed (see below).

The language of programs is a spatial mobile extension of tcc programs:

$$P, Q, \dots := \text{tell}(c) | \text{whencdo } P | | \text{next } P | P | | Q | \text{unlesscnext } P | [P]_i | \uparrow_i P | \text{rec } X.P$$

computation of timed processes proceeds as in tcc. The spatial construct $[P]_i$ runs P in the space of agent i and the mobile process $\uparrow_i P$, extrudes P from the space of i . By combining space and mobility, arbitrary processes can be moved from one space into another. For example, one could send a trojan watchdog to another space for spying for a given message and report back to one's space.

III- Constraint systems can be used to specify advance text message deduction, arithmetic deductions, scheduling, etc.

IV - Epistemic Interpretation of spaces can be used to derive whether they are users with conflicting/inconsistent information, or whether a group of agents may be able to deduce certain message.

V - The scheduling of agent requests for program posts, privacy settings, friendship lists are handled by an external interface. For example, one could use type systems to check whether a program complies with privacy settings (for example checking that the a program does not move other program into a space it is not allowed into).

- Partner: Pontificia Universidad Javeriana Cali
- Contact: Frank Valencia
- URL: <http://www.dspacenet.com>

CONVECS Project-Team

5. New Software and Platforms

5.1. CADP Pro

Construction and Analysis of Distributed Processes

KEYWORDS: Formal methods - Verification

FUNCTIONAL DESCRIPTION: CADP (*Construction and Analysis of Distributed Processes* – formerly known as *CAESAR/ALDEBARAN Development Package*) [4] is a toolbox for protocols and distributed systems engineering.

In this toolbox, we develop and maintain the following tools:

- CAESAR.ADT [30] is a compiler that translates LOTOS abstract data types into C types and C functions. The translation involves pattern-matching compiling techniques and automatic recognition of usual types (integers, enumerations, tuples, etc.), which are implemented optimally.
- CAESAR [36], [35] is a compiler that translates LOTOS processes into either C code (for rapid prototyping and testing purposes) or finite graphs (for verification purposes). The translation is done using several intermediate steps, among which the construction of a Petri net extended with typed variables, data handling features, and atomic transitions.
- OPEN/CAESAR [31] is a generic software environment for developing tools that explore graphs on the fly (for instance, simulation, verification, and test generation tools). Such tools can be developed independently of any particular high level language. In this respect, OPEN/CAESAR plays a central role in CADP by connecting language-oriented tools with model-oriented tools. OPEN/CAESAR consists of a set of 16 code libraries with their programming interfaces, such as:
 - CAESAR_GRAPH, which provides the programming interface for graph exploration,
 - CAESAR_HASH, which contains several hash functions,
 - CAESAR_SOLVE, which resolves Boolean equation systems on the fly,
 - CAESAR_STACK, which implements stacks for depth-first search exploration, and
 - CAESAR_TABLE, which handles tables of states, transitions, labels, etc.

A number of on-the-fly analysis tools have been developed within the OPEN/CAESAR environment, among which:

- BISIMULATOR, which checks bisimulation equivalences and preorders,
- CUNCTATOR, which performs steady-state simulation of continuous-time Markov chains,
- DETERMINATOR, which eliminates stochastic nondeterminism in normal, probabilistic, or stochastic systems,
- DISTRIBUTOR, which generates the graph of reachable states using several machines,
- EVALUATOR, which evaluates MCL formulas,
- EXECUTOR, which performs random execution,
- EXHIBITOR, which searches for execution sequences matching a given regular expression,
- GENERATOR, which constructs the graph of reachable states,
- PROJECTOR, which computes abstractions of communicating systems,
- REDUCTOR, which constructs and minimizes the graph of reachable states modulo various equivalence relations,

- SIMULATOR, XSIMULATOR, and OCIS, which enable interactive simulation, and
- TERMINATOR, which searches for deadlock states.
- BCG (*Binary Coded Graphs*) is both a file format for storing very large graphs on disk (using efficient compression techniques) and a software environment for handling this format. BCG also plays a key role in CADP as many tools rely on this format for their inputs/outputs. The BCG environment consists of various libraries with their programming interfaces, and of several tools, such as:
 - BCG_CMP, which compares two graphs,
 - BCG_DRAW, which builds a two-dimensional view of a graph,
 - BCG_EDIT, which allows the graph layout produced by BCG_DRAW to be modified interactively,
 - BCG_GRAPH, which generates various forms of practically useful graphs,
 - BCG_INFO, which displays various statistical information about a graph,
 - BCG_IO, which performs conversions between BCG and many other graph formats,
 - BCG_LABELS, which hides and/or renames (using regular expressions) the transition labels of a graph,
 - BCG_MIN, which minimizes a graph modulo strong or branching equivalences (and can also deal with probabilistic and stochastic systems),
 - BCG_STEADY, which performs steady-state numerical analysis of (extended) continuous-time Markov chains,
 - BCG_TRANSIENT, which performs transient numerical analysis of (extended) continuous-time Markov chains, and
 - XTL (*eXecutable Temporal Language*), which is a high level, functional language for programming exploration algorithms on BCG graphs. XTL provides primitives to handle states, transitions, labels, *successor* and *predecessor* functions, etc.

For instance, one can define recursive functions on sets of states, which allow evaluation and diagnostic generation fixed point algorithms for usual temporal logics (such as HML [40], CTL [26], ACTL [28], etc.) to be defined in XTL.
- PBG (*Partitioned BCG Graph*) is a file format implementing the theoretical concept of *Partitioned LTS* [34] and providing a unified access to a graph partitioned in fragments distributed over a set of remote machines, possibly located in different countries. The PBG format is supported by several tools, such as:
 - PBG_CP, PBG_MV, and PBG_RM, which facilitate standard operations (copying, moving, and removing) on PBG files, maintaining consistency during these operations,
 - PBG_MERGE (formerly known as BCG_MERGE), which transforms a distributed graph into a monolithic one represented in BCG format,
 - PBG_INFO, which displays various statistical information about a distributed graph.
- The connection between explicit models (such as BCG graphs) and implicit models (explored on the fly) is ensured by OPEN/CAESAR-compliant compilers, e.g.:
 - BCG_OPEN, for models represented as BCG graphs,
 - CAESAR.OPEN, for models expressed as LOTOS descriptions,
 - EXP.OPEN, for models expressed as communicating automata,
 - FSP.OPEN, for models expressed as FSP [46] descriptions,
 - LNT.OPEN, for models expressed as LNT descriptions, and
 - SEQ.OPEN, for models represented as sets of execution traces.

The CADP toolbox also includes TGV (*Test Generation based on Verification*), which has been developed by the VERIMAG laboratory (Grenoble) and the VERTECS project-team at Inria Rennes – Bretagne-Atlantique.

The CADP tools are well-integrated and can be accessed easily using either the EUCALYPTUS graphical interface or the SVL [32] scripting language. Both EUCALYPTUS and SVL provide users with an easy and uniform access to the CADP tools by performing file format conversions automatically whenever needed and by supplying appropriate command-line options as the tools are invoked.

- Participants: Frédéric Lang, Hubert Garavel, Radu Mateescu and Wendelin Serwe
- Contact: Hubert Garavel
- URL: <http://cadp.inria.fr/>

5.2. TRAIAN

KEYWORDS: Compilation - LOTOS NT

FUNCTIONAL DESCRIPTION: TRAIAN is a compiler for translating LOTOS NT descriptions into C programs, which will be used for simulation, rapid prototyping, verification, and testing.

The current version of TRAIAN, which handles LOTOS NT types and functions only, has useful applications in compiler construction [33], being used in all recent compilers developed by CONVECS.

- Participants: Frédéric Lang, Hubert Garavel and Wendelin Serwe
- Contact: Hubert Garavel
- URL: <http://convecs.inria.fr/software/traian/>

CORSE Project-Team

5. New Software and Platforms

5.1. THEMIS

THEMIS: A Tool for Decentralized Monitoring Algorithms

KEYWORDS: Monitoring - Simulation

FUNCTIONAL DESCRIPTION: THEMIS consists of a library and command-line tools. It provides an API, data structures and measures for decentralized monitoring. These building blocks can be reused or extended to modify existing algorithms, design new more intricate algorithms, and elaborate new approaches to assess existing algorithms.

- Participants: Antoine El Hokayem and Ylies Falcone
- Contact: Antoine El Hokayem
- Publications: **THEMIS: A Tool for Decentralized Monitoring Algorithms - Monitoring Decentralized Specifications**
- URL: <https://gitlab.inria.fr/monitoring/themis/>

5.2. Verde

KEYWORDS: Debug - Verification

FUNCTIONAL DESCRIPTION: Interactive Debugging with a traditional debugger can be tedious. One has to manually run a program step by step and set breakpoints to track a bug.

i-RV is an approach to bug fixing that aims to help developpers during their Interactive Debugging sessions using Runtime Verification.

Verde is the reference implementation of i-RV.

- Participants: Kevin Pouget, Ylies Falcone, Raphael Jakse and Jean-François Méhaut
- Contact: Raphael Jakse
- Publication: **Interactive Runtime Verification - When Interactive Debugging meets Runtime Verification**
- URL: <https://gitlab.inria.fr/monitoring/verde>

5.3. Nanvix

KEYWORD: Operating system

SCIENTIFIC DESCRIPTION: Nanvix presents a similar structure to Unix System V, and it has been intentionally designed this way because it is adopted in some successful Operating Systemes, such as Linux. Nanvix is structured in two layers. The kernel (bottom layer), seats on top of the hardware and runs in privileged mode. Its job is to (i) extend the underlying hardware so that an easier-to-program interface is exported to the higher layer, and (ii) multiplex hardware resources among several users. The userland (top layer), relies on Posix system calls exported by the kernel and it is the place where user software run in unprivileged mode.

The kernel presents a tiny monolithic architecture (7k loc), and it is structured in four subsystems: the hardware abstraction layer, the memory management system, the process manager, and the file system. The hardware abstraction layer interacts directly with the hardware and exports to the other subsystems a set of well-defined low-level routines. The job of the hardware abstraction layer is to isolate, as much as possible, all the hardware intricacies, so that the kernel can easily be ported to other compatible platforms.

The memory manager provides a flat virtual memory abstraction. It does so by having two modules working together: the paging and virtual memory allocator. The former deals with paging, keeping in memory those pages that are more frequently used, and swapping out to disk those that are not. The virtual memory allocator, on the other hand, relies on the paging module to create higher-level abstractions called memory regions, and thus enable advanced features such as shared memory regions, on-demand loading and lazy coping.

The process manager handles creation, termination, scheduling, synchronization and communication of processes. Processes are single-threaded entities and are created on demand, either by the system itself or the user. Scheduling is based on preemption, and in userland it happens whenever a process runs out of quantum or blocks awaiting for a resource. In kernel land, processes run in nonpreemptive mode and scheduling occurs when a processes voluntarily goes to sleep. In addition, the process manager exports inter-process communication facilities, such as Posix pipes and shared memory regions.

The file system provides a uniform interface for dealing with hardware resources. It extends the device driver interface and creates on top of it the file abstraction. Files can be accessed through a unique pathname, and may be shared among several processes. The Nanvix file system is compatible with the one present in Minix, it adopts an hierarchical inode structure, and features mounting points and disk block caching.

Investigations on Nanvix concern to a joint collaboration research effort between the CORSE Team (Inria - FRANCE) and CArT (PUC Minas - Brazil). More precisely, a port of Nanvix to low-power embedded many-cores is ongoing, and it consists on the thesis subject of a cotutella student between the two aforementioned research teams.

FUNCTIONAL DESCRIPTION: Nanvix is an Operating System that we designed from scratch to address growing interest on research and education. It originally targets x86-based architectures and features virtual-memory based on paging, a hierarchical Unix file system based on inodes, a uniform device driver interface, and a preemptive priority-based scheduler.

We are currently extending Nanvix to provide a portable OS targetting multiple manycore platforms through the PhD of Pedro Henrique Penna.

- Participants: Pedro Henrique De Mello Morado Penna, François Broquedis, Jean-François Méhaut, Marcio Bastos Castro and Henrique Cota De Freitas
- Partner: Université pontificale catholique du Minas Gerais
- Contact: Pedro Henrique De Mello Morado Penna
- URL: <https://github.com/nanvix/nanvix>

5.4. Mickey

KEYWORDS: Dynamic Analysis - Performance analysis - Profiling - Polyhedral compilation

FUNCTIONAL DESCRIPTION: Mickey is a set of tools for profiling based performance debugging for compiled binaries. It uses a dynamic binary translator to instrument arbitrary programs as they are being run to reconstruct the control flow and track data dependencies. This information is then fed to a polyhedral optimizer that proposes structured transformations for the original code.

Mickey can handle both inter- and intra-procedural control and data flow in a unified way, thus enabling inter-procedural structured transformations. It is based on QEMU to allow for portability, both in terms of targeted CPU architectures, but also in terms of programming environment and the use of third-party libraries for which no source code is available.

- Partner: STMicroelectronics
- Contact: Fabian Gruber

5.5. IPFME

Integer Polynomial Fourier-Motzkin Elimination

KEYWORDS: Fourier–Motzkin Elimination - Quantifier Elimination - System of Inequalities - Mixed Integer Programming - Polynomial or analytical systems

SCIENTIFIC DESCRIPTION: Fourier-Motzkin is a very well known algorithm for performing quantifier (variable) elimination, given a system (or formula) of inequalities. It removes quantified variables by combining all upper and lower bounds of such variables.

It was designed to operate on linear systems, where all coefficients of the variable being eliminated are numeric values, and the inequality can be classified as either a upper or lower bound.

When dealing with polynomials, variable coefficients might be symbolic expressions. In such case, all possible signs of the coefficient (positive, negative, or zero) must be explored.

To avoid this branching we use the positiveness test algorithm, proposed by Markus Schweighofer ([https://doi.org/10.1016/S0022-4049\(01\)00041-X](https://doi.org/10.1016/S0022-4049(01)00041-X)), to retrieve symbolic coefficient signs.

The same positiveness test algorithm is of major importance when resolving system over integer variables, instead of reals. It is used in many other techniques required to preserve the precision of the simplified formula, such as extending the normalization technique (<https://doi.org/10.1145/125826.125848>) to symbolic expressions, performing convex hull detection and removing redundant constraints. Such tester is implemented using GLPK (<https://www.gnu.org/software/glpk>).

FUNCTIONAL DESCRIPTION: Quantifier elimination is the process of removing existential variables of a given formula, obtaining one with less variables and that implies the original formula. This can also be viewed as a projection of the set of points (integer here) that satisfy the original formula onto a sub-vectorial space made up of all the non-eliminated variables. The obtained projection is an over-approximation of the exact projection. The goal of the process is to make it as tight as possible.

IPFME presents extensions to the Fourier-Motzkin quantifier elimination process. The developed techniques allow to derive more precise simplification operations when handling integer valued multivariate polynomial systems.

The implementation, in C++, uses GiNaC (<https://www.ginac.de/>) for the manipulation of symbolic expressions.

- Authors: Diogo Nunes Sampaio, Fabrice Rastello and Alain Ketterlin
- Contact: Diogo Nunes Sampaio
- Publications: [Profile Guided Hybrid Compilation - Simplification and Run-time Resolution of Data Dependence Constraints for Loop Transformations](#)

5.6. mcGDB

Model Centric Debugging with GDB

KEYWORDS: Model debugging - Parallel programming - OpenMP - Multicore

FUNCTIONAL DESCRIPTION: mcGDB defines the concept of “programming-model centric” source-level interactive debugging as an extension of the traditional language-level interactive debugging. The idea is to integrate into debuggers the notion of “programming models”, as abstract machines running over the physical ones. These abstract machines, implemented by runtime libraries and programming frameworks, provide high-level primitives required for the implementation of today’s parallel applications. mcGDB is developed as a Python extension of GDB, the debugger of the GNU project

- Partner: STMicroelectronics
- Contact: Jean-François Méhaut
- URL: <http://dema.gforge.inria.fr/>

5.7. BOAST

Bringing Optimization Through Automatic Source-to-Source Transformations

KEYWORDS: Code generation - Portability - Autotuning - High performance computing - Conformance testing - Productivity

FUNCTIONAL DESCRIPTION: BOAST provides scientific application developers with a framework to develop and test application computing kernels.

The developer starts from an application kernel (either designed or implemented), and writes it in a dedicated language. This language provides enough flexibility for the kernel to be metaprogrammed with several orthogonal optimizations. From this set of optimizations, possible languages targets, and compilation options, the user can design an optimization space to explore. This optimization space can contain rules to remove infeasible candidates. BOAST provides the mechanisms to specify those optimization spaces and enforce the users rules.

BOAST was already used with three real scientific applications: BigDFT (materials, CEA Inac), SPECFEM3D (geophysics, CNRS and Princeton) and GYSELA (plasma physics, CEA Cadarache, ITER). ’

- Partner: CEA INAC LSim
- Contact: Brice Videau
- URL: <https://github.com/Nanosim-LIG/boast>

DATASHAPE Project-Team

6. New Software and Platforms

6.1. GUDHI

Geometric Understanding in Higher Dimensions

KEYWORDS: Computational geometry - Topology

SCIENTIFIC DESCRIPTION: The current release of the GUDHI library includes: – Data structures to represent, construct and manipulate simplicial and cubical complexes. – Algorithms to compute simplicial complexes from point cloud data. – Algorithms to compute persistent homology and multi-field persistent homology. – Simplification methods via implicit representations.

FUNCTIONAL DESCRIPTION: The GUDHI open source library will provide the central data structures and algorithms that underly applications in geometry understanding in higher dimensions. It is intended to both help the development of new algorithmic solutions inside and outside the project, and to facilitate the transfer of results in applied fields.

RELEASE FUNCTIONAL DESCRIPTION: Major new features in 2017: - python interface - bottleneck distance - tangential complex - relaxed witness complex

- Participants: Clément Maria, François Godi, David Salinas, Jean-Daniel Boissonnat, Marc Glisse, Mariette Yvinec, Pawel Dlotko, Siargey Kachanovich and Vincent Rouvreau
- Contact: Jean-Daniel Boissonnat
- URL: <http://gudhi.gforge.inria.fr/>

6.2. dD Triangulations

CGAL module: Triangulations in any dimension

KEYWORDS: 3D modeling - Triangulation - Delaunay triangulation - Voronoi diagram - Regular triangulation

FUNCTIONAL DESCRIPTION: This package of CGAL (Computational Geometry Algorithms Library <http://www.cgal.org>) allows to compute triangulations, Delaunay triangulations and regular triangulations in any dimension. Those triangulations are built incrementally and can be modified by insertion or removal of vertices.

RELEASE FUNCTIONAL DESCRIPTION: Version 4.11 adds the regular triangulations to the package.

- Participants: Clément Jamin, Olivier Devillers and Samuel Hornus
- Contact: Samuel Hornus
- URL: <http://www.cgal.org>

DATASPHERE Team

6. New Software and Platforms

6.1. Platforms

The team participated to the development of the following software platforms.

6.1.1. *DNS data analysis*

Data analytics tools for DNS data analysis were developed in a cooperation with ICT, Chinese Academy of Sciences in the frame of the thesis of Jingxiu SU [9].

6.1.2. *Advokat*

Distributed aggregation mechanisms preserving confidentiality for application such as online voting were developed in the frame of the thesis of Robert Riemann [11].

6.1.3. *BGP Geopolitics*

An observatory of global BGP connectivity has been developed that is used to monitor in real time BGP level attacks. In addition, a set of tools were developed to analyse the structure of information propagation over social networks.

DEDUCTEAM Project-Team

5. New Software and Platforms

5.1. Autotheo

KEYWORD: Automated deduction

SCIENTIFIC DESCRIPTION: Transformation of axiomatic theories into rewriting systems that can be used by iProverModulo.

FUNCTIONAL DESCRIPTION: Autotheo is a tool that transforms axiomatic theories into polarized rewriting systems, thus making them usable in iProverModulo. It supports several strategies to orient the axioms, some of them being proved to be complete, in the sense that ordered polarized resolution modulo the resulting systems is refutationally complete, some others being merely heuristics. In practice, Autotheo takes a TPTP input file and produces an input file for iProverModulo.

NEWS OF THE YEAR: Used by iProverModulo in its participation at the CASC-26 competition.

- Participant: Guillaume Burel
- Partner: ENSIIE
- Contact: Guillaume Burel
- Publication: [Consistency Implies Cut Admissibility](#)
- URL: http://www.ensiie.fr/~guillaume.burel/blackandwhite_autotheo.html.en

5.2. CoLoR

Coq Library on Rewriting and termination

KEYWORDS: Coq - Formalisation

FUNCTIONAL DESCRIPTION: CoLoR is a Coq library on rewriting theory and termination. It provides many definitions and theorems on various mathematical structures (quasi-ordered sets, relations, ordered semi-rings, etc.), data structures (lists, vectors, matrices, polynomials, finite graphs), term structures (strings, first-order terms, lambda-terms, etc.), transformation techniques (dependency pairs, semantic labeling, etc.) and (non-)termination criteria (polynomial and matrix interpretations, recursive path ordering, computability closure, etc.).

NEWS OF THE YEAR: 2017: Port to Coq 8.6 and 8.7.

- Authors: Frédéric Blanqui and Sébastien Hinderer
- Contact: Frédéric Blanqui
- Publications: [CoLoR: a Coq library on well-founded rewrite relations and its application to the automated verification of termination certificates](#) - [Automated Verification of Termination Certificates](#) - [CoLoR: a Coq library on rewriting and termination](#)
- URL: <http://color.inria.fr/>

5.3. Coquine

Coq In dEdukti

KEYWORDS: Higher-order logic - Formal methods - Proof

FUNCTIONAL DESCRIPTION: CoqInE is a plugin for the Coq software translating Coq proofs into Dedukti terms. It provides a Dedukti signature file faithfully encoding the underlying theory of Coq (or a sufficiently large subset of it). Current development is mostly focused on implementing support for Coq universe polymorphism. The generated output is meant to be type-checkable using the latest version of Dedukti.

- Contact: Guillaume Burel
- URL: http://www.ensiie.fr/~guillaume.burel/blackandwhite_coqInE.html.en

5.4. Dedukti

KEYWORD: Logical Framework

FUNCTIONAL DESCRIPTION: Dedukti is a proof-checker for the LambdaPi-calculus modulo. As it can be parametrized by an arbitrary set of rewrite rules, defining an equivalence relation, this calculus can express many different theories. Dedukti has been created for this purpose: to allow the interoperability of different theories.

Dedukti's core is based on the standard algorithm for type-checking semi-full pure type systems and implements a state-of-the-art reduction machine inspired from Matita's and modified to deal with rewrite rules.

Dedukti's input language features term declarations and definitions (opaque or not) and rewrite rule definitions. A basic module system allows the user to organize his project in different files and compile them separately.

Dedukti features matching modulo beta for a large class of patterns called Miller's patterns, allowing for more rewriting rules to be implemented in Dedukti.

- Participants: François Thiré, Gaspard Ferey, Guillaume Genestier and Rodolphe Lepigre
- Contact: François Thiré
- Publications: [Dedukti: un vérificateur de preuves universel - Rewriting Modulo \$\beta\$ in the \$\lambda\Pi\$ -Calculus Modulo - Expressing theories in the \$\lambda\Pi\$ -calculus modulo theory and in the Dedukti system](#)
- URL: <http://dedukti.gforge.inria.fr/>

5.5. Holide

KEYWORD: Proof

FUNCTIONAL DESCRIPTION: Holide translates HOL proofs to Dedukti[OT] proofs, using the OpenTheory standard (common to HOL Light and HOL4). Dedukti[OT] being the encoding of OpenTheory in Dedukti.

- Contact: Guillaume Burel
- URL: <http://deducteam.gforge.inria.fr/holide/>

5.6. HOT

Higher-Order Termination

FUNCTIONAL DESCRIPTION: HOT is an automated termination prover for higher-order rewriting, based on the notion of computability closure.

- Contact: Frédéric Blanqui
- URL: <http://rewriting.gforge.inria.fr/hot.html>

5.7. iProver Modulo

KEYWORDS: Automated deduction - Automated theorem proving

SCIENTIFIC DESCRIPTION: Integration of ordered polarized resolution modulo theory into the prover iProver.

FUNCTIONAL DESCRIPTION: iProver Modulo is an extension of the automated theorem prover iProver originally developed by Konstantin Korovin at the University of Manchester. It implements ordered polarized resolution modulo theory, a refinement of the resolution method based on deduction modulo theory. It takes as input a proposition in predicate logic and a clausal rewriting system defining the theory in which the formula has to be proved. Normalization with respect to the term rewriting rules is performed very efficiently through translation into OCaml code, compilation and dynamic linking. Experiments have shown that ordered polarized resolution modulo dramatically improves proof search compared to using raw axioms.

NEWS OF THE YEAR: Participation at the automated-theorem-prover competition CASC-26 Integration of version 2.5 of iProver, adding support for types (TFF0)

- Participant: Guillaume Burel
- Partner: ENSIIE
- Contact: Guillaume Burel
- Publications: [A Shallow Embedding of Resolution and Superposition Proofs into the \$\lambda\$ -Calculus Modulo - Experimenting with deduction modulo](#)
- URL: http://www.ensiie.fr/~guillaume.burel/blackandwhite_iProverModulo.html.en

5.8. mSAT

KEYWORD: Propositional logic

FUNCTIONAL DESCRIPTION: mSAT is a modular, proof-producing, SAT and SMT core based on Alt-Ergo Zero, written in OCaml. The solver accepts user-defined terms, formulas and theory, making it a good tool for experimenting. This tool produces resolution proofs as trees in which the leaves are user-defined proof of lemmas.

- Contact: Guillaume Bury
- Publication: [mSAT: An OCaml SAT Solver](#)
- URL: <https://github.com/Gbury/mSAT>

5.9. Rainbow

Termination certificate verifier

KEYWORDS: Demonstration - Code generation - Verification

FUNCTIONAL DESCRIPTION: Rainbow is a set of tools for automatically verifying the correctness of termination certificates expressed in the CPF format used in the annual international competition of termination tools. It contains: a tool xsd2coq for generating Coq data types for representing XML files valid with respect to some XML Schema, a tool xsd2ml for generating OCaml data types and functions for parsing XML files valid with respect to some XML Schema, a tool for translating a CPF file into a Coq script, and a standalone Coq certified tool for verifying the correctness of a CPF file.

- Author: Frédéric Blanqui
- Contact: Frédéric Blanqui
- Publications: [Automated verification of termination certificates - Automated verification of termination certificates](#)
- URL: <http://color.inria.fr/rainbow.html>

5.10. Krajono

KEYWORD: Proof

FUNCTIONAL DESCRIPTION: Krajono translates Matita proofs into Dedukti[CiC] (encoding of CiC in Dedukti) terms.

- Contact: François Thiré

5.11. archsat

KEYWORDS: Automated theorem proving - First-order logic - Propositional logic

FUNCTIONAL DESCRIPTION: Archsat is an automated theorem prover aimed at studying the integration of first-order theorem prover technologies, such as rewriting, into SMT solvers.

- Contact: Guillaume Bury
- URL: <https://gforge.inria.fr/projects/archsat>

GALLIUM Project-Team

6. New Software and Platforms

6.1. CompCert

The CompCert formally-verified C compiler

KEYWORDS: Compilers - Formal methods - Deductive program verification - C - Coq

FUNCTIONAL DESCRIPTION: CompCert is a compiler for the C programming language. Its intended use is the compilation of life-critical and mission-critical software written in C and meeting high levels of assurance. It accepts most of the ISO C 99 language, with some exceptions and a few extensions. It produces machine code for the ARM, PowerPC, RISC-V, and x86 architectures. What sets CompCert C apart from any other production compiler, is that it is formally verified to be exempt from miscompilation issues, using machine-assisted mathematical proofs (the Coq proof assistant). In other words, the executable code it produces is proved to behave exactly as specified by the semantics of the source C program. This level of confidence in the correctness of the compilation process is unprecedented and contributes to meeting the highest levels of software assurance. In particular, using the CompCert C compiler is a natural complement to applying formal verification techniques (static analysis, program proof, model checking) at the source code level: the correctness proof of CompCert C guarantees that all safety properties verified on the source code automatically hold as well for the generated executable.

RELEASE FUNCTIONAL DESCRIPTION: Novelties include a formally-verified type checker for CompCert C, a more careful modeling of pointer comparisons against the null pointer, algorithmic improvements in the handling of deeply nested struct and union types, much better ABI compatibility for passing composite values, support for GCC-style extended inline asm, and more complete generation of DWARF debugging information (contributed by AbsInt).

- Participants: Xavier Leroy, Sandrine Blazy, Jacques-Henri Jourdan, Sylvie Boldo and Guillaume Melquiond
- Partner: AbsInt Angewandte Informatik GmbH
- Contact: Xavier Leroy
- URL: <http://compcert.inria.fr/>

6.2. Diy

Do It Yourself

KEYWORD: Parallelism

FUNCTIONAL DESCRIPTION: The diy suite provides a set of tools for testing shared memory models: the litmus tool for running tests on hardware, various generators for producing tests from concise specifications, and herd, a memory model simulator. Tests are small programs written in x86, Power or ARM assembler that can thus be generated from concise specification, run on hardware, or simulated on top of memory models. Test results can be handled and compared using additional tools.

- Participants: Jade Alglave and Luc Maranget
- Partner: University College London UK
- Contact: Luc Maranget
- URL: <http://diy.inria.fr/>

6.3. Menhir

KEYWORDS: Compilation - Context-free grammars - Parsing

FUNCTIONAL DESCRIPTION: Menhir is a LR(1) parser generator for the OCaml programming language. That is, Menhir compiles LR(1) grammar specifications down to OCaml code. Menhir was designed and implemented by François Pottier and Yann Régis-Gianas.

- Contact: François Pottier
- Publications: [A Simple, Possibly Correct LR Parser for C11 - Reachability and Error Diagnosis in LR\(1\) Parsers](#)

6.4. OCaml

KEYWORDS: Functional programming - Static typing - Compilation

FUNCTIONAL DESCRIPTION: The OCaml language is a functional programming language that combines safety with expressiveness through the use of a precise and flexible type system with automatic type inference. The OCaml system is a comprehensive implementation of this language, featuring two compilers (a bytecode compiler, for fast prototyping and interactive use, and a native-code compiler producing efficient machine code for x86, ARM, PowerPC and System Z), a debugger, a documentation generator, a compilation manager, a package manager, and many libraries contributed by the user community.

- Participants: Damien Doligez, Xavier Leroy, Fabrice Le Fessant, Luc Maranget, Gabriel Scherer, Alain Frisch, Jacques Garrigue, Marc Shinwell, Jeremy Yallop and Leo White
- Contact: Damien Doligez
- URL: <https://ocaml.org/>

6.5. PASL

KEYWORD: Parallel computing

FUNCTIONAL DESCRIPTION: PASL is a C++ library for writing parallel programs targeting the broadly available multicore computers. The library provides a high level interface and can still guarantee very good efficiency and performance, primarily due to its scheduling and automatic granularity control mechanisms.

- Participants: Arthur Charguéraud, Michael Rainey and Umut Acar
- Contact: Michael Rainey
- URL: <http://deepsea.inria.fr/pasl/>

6.6. ZENON

FUNCTIONAL DESCRIPTION: Zenon is an automatic theorem prover based on the tableaux method. Given a first-order statement as input, it outputs a fully formal proof in the form of a Coq proof script. It has special rules for efficient handling of equality and arbitrary transitive relations. Although still in the prototype stage, it already gives satisfying results on standard automatic-proving benchmarks.

Zenon is designed to be easy to interface with front-end tools (for example integration in an interactive proof assistant), and also to be retargeted to output scripts for different frameworks (for example, Isabelle and Dedukti).

- Author: Damien Doligez
- Contact: Damien Doligez
- URL: <http://zenon-prover.org/>

6.7. OPAM Builder

KEYWORDS: Ocaml - Continuous integration - Opam

FUNCTIONAL DESCRIPTION: OPAM Builder checks in real-time the installability on a computer of all packages after any modification of the repository. To achieve this result, it uses smart mechanisms to compute incremental differences between package updates, to be able to reuse cached compilations, and switch from a quadratic complexity to a linear complexity.

- Partner: OCamlPro
- Contact: Fabrice Le Fessant
- URL: <http://github.com/OCamlPro/opam-builder>

6.8. TLAPS

TLA+ proof system

KEYWORD: Proof assistant

FUNCTIONAL DESCRIPTION: TLAPS is a platform for developing and mechanically verifying proofs about TLA+ specifications. The TLA+ proof language is hierarchical and explicit, allowing a user to decompose the overall proof into proof steps that can be checked independently. TLAPS consists of a proof manager that interprets the proof language and generates a collection of proof obligations that are sent to backend verifiers. The current backends include the tableau-based prover Zenon for first-order logic, Isabelle/TLA+, an encoding of TLA+ set theory as an object logic in the logical framework Isabelle, an SMT backend designed for use with any SMT-lib compatible solver, and an interface to a decision procedure for propositional temporal logic. NEWS OF THE YEAR: In 2017, we have continued to work on a complete reimplementing of the proof manager. One objective is a cleaner interaction with the TLA⁺ front-ends, in particular SANY, the standard parser and semantic analyzer. The reimplementing is also necessary for extending the scope of the fragment of TLA⁺ that is handled by TLAPS, in particular full temporal logic and module instantiation.

- Participants: Damien Doligez, Stephan Merz and Martin Riener
- Contact: Stephan Merz
- URL: <https://tla.msr-inria.inria.fr/tlaps/content/Home.html>

6.9. CFML

Interactive program verification using characteristic formulae

KEYWORDS: Coq - Software Verification - Deductive program verification - Separation Logic

FUNCTIONAL DESCRIPTION: The CFML tool supports the verification of OCaml programs through interactive Coq proofs. CFML proofs establish the full functional correctness of the code with respect to a specification. They may also be used to formally establish bounds on the asymptotic complexity of the code. The tool is made of two parts: on the one hand, a characteristic formula generator implemented as an OCaml program that parses OCaml code and produces Coq formulae, and, on the other hand, a Coq library that provides notations and tactics for manipulating characteristic formulae interactively in Coq.

- Participants: Arthur Charguéraud, Armaël Guéneau and François Pottier
- Contact: Arthur Charguéraud
- URL: <http://www.chargueraud.org/softs/cfml/>

6.10. ldrngen

Liveness-driven random C code generator

KEYWORDS: Code generation - Randomized algorithms - Static program analysis

FUNCTIONAL DESCRIPTION: The ldrngen program is a generator of C code: On every call it generates a new random C function and prints it to the standard output. The generator is "liveness-driven", which means that it tries to avoid generating dead code: All the computations it generates are (in a certain, limited sense) actually used to compute the function's return value. This is achieved by generating the program backwards, in combination with a simultaneous liveness analysis that guides the random generator's choices.

- Participant: Gergő Barany
- Contact: Gergő Barany
- Publication: [Liveness-Driven Random Program Generation](#)
- URL: <https://github.com/gergo-/ldrgen>

GAMBLE Project-Team

6. New Software and Platforms

6.1. ISOTOP

Topology and geometry of planar algebraic curves

KEYWORDS: Topology - Curve plotting - Geometric computing

FUNCTIONAL DESCRIPTION: Isotop is a Maple software for computing the topology of an algebraic plane curve, that is, for computing an arrangement of polylines isotopic to the input curve. This problem is a necessary key step for computing arrangements of algebraic curves and has also applications for curve plotting. This software has been developed since 2007 in collaboration with F. Rouillier from Inria Paris - Rocquencourt. It is based on the method described in [Cheng, J., Lazard, S., Pe

NEWS OF THE YEAR: In 2017, an ADT FastTrack funded a 6 months engineer contract to port the Maple code to C code. In addition, another local engineer from Inria Nancy (Benjamin Dexheimer) implemented a web server to improve the diffusion of our software.

- Participants: Elias Tsigaridas, Jinsan Cheng, Luis Penaranda, Marc Pouget and Sylvain Lazard
- Contact: Sylvain Lazard
- URL: <http://vegas.loria.fr/isotop/>

6.2. CGAL Package : 3D periodic regular triangulations

KEYWORDS: Flat torus - CGAL - Geometry - Geometric computing - Voronoi diagram - Delaunay triangulation - Triangulation

FUNCTIONAL DESCRIPTION: This class of CGAL (Computational Geometry Algorithms Library <http://www.cgal.org>) allows to build and handle periodic regular triangulations whose fundamental domain is a cube in 3D. Triangulations are built incrementally and can be modified by insertion of weighted points or removal of vertices. They offer location facilities for weighted points. The class offers nearest neighbor queries for the additively weighted distance and primitives to build the dual weighted Voronoi diagrams.

- Participants: Aymeric Pellé, Mael Rouxel-Labbe and Monique Teillaud
- Contact: Monique Teillaud
- URL: <https://doc.cgal.org/latest/Manual/packages.html#PkgPeriodic3Triangulation3Summary>

6.3. CGAL Package : 2D hyperbolic triangulations

KEYWORDS: Geometry - Delaunay triangulation - Hyperbolic space

FUNCTIONAL DESCRIPTION: This package implements the construction of Delaunay triangulations in the Poincaré disk model.

- Authors: Mikhail Bogdanov, Olivier Devillers and Monique Teillaud
- Contact: Monique Teillaud
- Publication: [Hyperbolic Delaunay Complexes and Voronoi Diagrams Made Practical](#)
- URL: https://github.com/CGAL/cgal-public-dev/tree/Hyperbolic_triangulation_2-MBogdanov

6.4. CGAL Package : 2D periodic hyperbolic triangulations

KEYWORDS: Geometry - Delaunay triangulation - Hyperbolic space

FUNCTIONAL DESCRIPTION: This module implements the computation of Delaunay triangulations of the Bolza surface.

- Authors: Iordan Iordanov and Monique Teillaud
- Contact: Monique Teillaud
- Publication: [Implementing Delaunay Triangulations of the Bolza Surface](#)
- URL: https://github.com/CGAL/cgal-public-dev/tree/Periodic_4_hyperbolic_triangulation_2-Iordanov

GRACE Project-Team

5. New Software and Platforms

5.1. ACTIS

Algorithmic Coding Theory in Sage

FUNCTIONAL DESCRIPTION: The aim of this project is to vastly improve the state of the error correcting library in Sage. The existing library does not present a good and usable API, and the provided algorithms are very basic, irrelevant, and outdated. We thus have two directions for improvement: renewing the APIs to make them actually usable by researchers, and incorporating efficient programs for decoding, like J. Nielsen's CodingLib, which contains many new algorithms.

- Partner: Technical University Denmark
- Contact: Daniel Augot

5.2. DECODING

KEYWORD: Algebraic decoding

FUNCTIONAL DESCRIPTION: Decoding is a standalone C library. Its primary goal is to implement Guruswami–Sudan list decoding-related algorithms, as efficiently as possible. Its secondary goal is to give an efficient tool for the implementation of decoding algorithms (not necessarily list decoding algorithms) and their benchmarking.

- Participant: Guillaume Quintin
- Contact: Daniel Augot

5.3. Fast Compact Diffie-Hellman

KEYWORD: Cryptography

FUNCTIONAL DESCRIPTION: A competitive, high-speed, open implementation of the Diffie–Hellman protocol, targeting the 128-bit security level on Intel platforms. This download contains Magma files that demonstrate how to compute scalar multiplications on the x-line of an elliptic curve using endomorphisms. This accompanies the EuroCrypt 2014 paper by Costello, Hisil and Smith, the full version of which can be found here: <http://eprint.iacr.org/2013/692> . The corresponding SUPERCOP-compatible crypto_dh application can be downloaded from <http://hhisil.yasar.edu.tr/files/hisil20140318compact.tar.gz> .

- Participant: Benjamin Smith
- Contact: Benjamin Smith
- URL: <http://research.microsoft.com/en-us/downloads/ef32422a-af38-4c83-a033-a7aafbc1db55/>

5.4. CADO-NFS

Crible Algébrique: Distribution, Optimisation - Number Field Sieve

KEYWORDS: Cryptography - Number theory

FUNCTIONAL DESCRIPTION: CADO-NFS is a complete implementation in C/C++ of the Number Field Sieve (NFS) algorithm for factoring integers and computing discrete logarithms in finite fields. It consists in various programs corresponding to all the phases of the algorithm, and a general script that runs them, possibly in parallel over a network of computers.

- Participants: Pierrick Gaudry, Emmanuel Thomé and Paul Zimmermann
- Contact: Emmanuel Thomé
- URL: <http://cado-nfs.gforge.inria.fr/>

HYCOMES Project-Team

4. New Software and Platforms

4.1. Demodocos

Demodocos (Examples to Generic Scenario Models Generator)

KEYWORDS: Surgical process modelling - Net synthesis - Process mining

SCIENTIFIC DESCRIPTION: Demodocos is used to construct a Test and Flip net (Petri net variant) from a collection of instances of a given procedure. The tool takes as input either standard XES log files (a standard XML file format for process mining tools) or a specific XML file format for surgical applications. The result is a Test and Flip net and its marking graph. The tool can also build a #SEVEN scenario for integration into a virtual reality environment. The scenario obtained corresponds to the generalization of the input instances, namely the instances synthesis enriched with new behaviors respecting the relations of causality, conflicts and competition observed.

Demodocos is a synthesis tool implementing a linear algebraic polynomial time algorithm. Computations are done in the $\mathbb{Z}/2\mathbb{Z}$ ring. Test and Flip nets extend Elementary Net Systems by allowing test to zero, test to one and flip arcs. The effect of flip arcs is to complement the marking of the place. While the net synthesis problem has been proved to be NP hard for Elementary Net Systems, thanks to flip arcs, the synthesis of Test and Flip nets can be done in polynomial time. Test and flip nets have the required expressivity to give concise and accurate representations of surgical processes (models of types of surgical operations). Test and Flip nets can express causality and conflict relations. The tool takes as input either standard XES log files (a standard XML file format for process mining tools) or a specific XML file format for surgical applications. The output is a Test and Flip net, solution of the following synthesis problem: Given a finite input language (log file), compute a net, which language is the least language in the class of Test and Flip net languages, containing the input language.

FUNCTIONAL DESCRIPTION: The tool Demodocos allows to build a generic model for a given procedure from some examples of instances of this procedure. The generated model can take the form of a graph, a Test 'n Flip net or a SEVEN scenario (intended for integration into a virtual reality environment).

The classic use of the tool is to apply the summary operation to a set of files describing instances of the target procedure. Several file formats are supported, including the standard XES format for log events. As output, several files are generated. These files represent the generic procedure in different forms, responding to varied uses.

This application is of limited interest in the case of an isolated use, out of context and without a specific objective when using the model generated. It was developed as part of a research project focusing in particular on surgical procedures, and requiring the generation of a generic model for integration into a virtual reality training environment. It is also quite possible to apply the same method in another context.

- Participants: Aurélien Lamercerie and Benoît Caillaud
- Contact: Benoît Caillaud
- Publication: [Surgical Process Mining with Test and Flip Net Synthesis](#)
- URL: <http://tinyurl.com/oql6f3y>

4.2. MICA

Model Interface Compositional Analysis Library

KEYWORDS: Modal interfaces - Contract-based desing

SCIENTIFIC DESCRIPTION: In Mica, systems and interfaces are represented by extension. However, a careful design of the state and event heap enables the definition, composition and analysis of reasonably large systems and interfaces. The heap stores states and events in a hash table and ensures structural equality (there is no duplication). Therefore complex data-structures for states and events induce a very low overhead, as checking equality is done in constant time.

Thanks to the Inter module and the mica interactive environment, users can define complex systems and interfaces using Ocaml syntax. It is even possible to define parameterized components as Ocaml functions.

FUNCTIONAL DESCRIPTION: Mica is an Ocaml library implementing the Modal Interface algebra. The purpose of Modal Interfaces is to provide a formal support to contract based design methods in the field of system engineering. Modal Interfaces enable compositional reasoning methods on I/O reactive systems.

- Participant: Benoît Caillaud
- Contact: Benoît Caillaud
- URL: <http://www.irisa.fr/s4/tools/mica/>

4.3. TnF-C++

FUNCTIONAL DESCRIPTION: TnF-C++ is a robust and portable re-implementation of Flipflop, developed in 2014 and integrated in the S3PM toolchain. Both software have been designed in the context of the S3PM project on surgical procedure modeling and simulation,

- Contact: Benoît Caillaud

KAIROS Team

5. New Software and Platforms

5.1. Vercors Component Editor (VCE)

VERification of models for distributed communicating COmponents, with safety and Security

FUNCTIONAL DESCRIPTION: The Vercors tools include front-ends for specifying the architecture and behaviour of components in the form of UML diagrams. We translate these high-level specifications, into behavioural models in various formats, and we also transform these models using abstractions. In a final step, abstract models are translated into the input format for various verification toolsets. Currently we mainly use the various analysis modules of the CADP toolset.

RELEASE FUNCTIONAL DESCRIPTION: It includes integrated graphical editors for GCM component architecture descriptions, UML classes, interfaces, and state-machines. The user diagrams can be checked using the recently published validation rules from, then the corresponding GCM components can be executed using an automatic generation of the application ADL, and skeletons of Java files.

- Participants: Antonio Cansado, Bartłomiej Szejna, Eric Madelaine, Ludovic Henrio, Marcela Rivera, Nassim Jibai, Oleksandra Kulankhina and Siqi Li
- Contact: Eric Madelaine
- URL: <http://www-sop.inria.fr/oasis/index.php?page=vercors>

5.2. TimeSquare

KEYWORDS: Profil MARTE - Embedded systems - UML - IDM

SCIENTIFIC DESCRIPTION: TimeSquare offers six main functionalities:

- * graphical and/or textual interactive specification of logical clocks and relative constraints between them,
- * definition and handling of user-defined clock constraint libraries,
- * automated simulation of concurrent behavior traces respecting such constraints, using a Boolean solver for consistent trace extraction,
- * call-back mechanisms for the traceability of results (animation of models, display and interaction with waveform representations, generation of sequence diagrams...).
- * compilation to pure java code to enable embedding in non eclipse applications or to be integrated as a time and concurrency solver within an existing tool.
- * a generation of the whole state space of a specification (if finite of course) in order to enable model checking of temporal properties on it

FUNCTIONAL DESCRIPTION: TimeSquare is a software environment for the modeling and analysis of timing constraints in embedded systems. It relies specifically on the Time Model of the Marte UML profile, and more accurately on the associated Clock Constraint Specification Language (CCSL) for the expression of timing constraints.

- Participants: Benoît Ferrero, Charles André, Frédéric Mallet, Julien Deantoni and Nicolas Chleq
- Contact: Julien Deantoni
- URL: <http://timesquare.inria.fr>

5.3. GEMOC Studio

KEYWORDS: DSL - Language workbench - Model debugging

SCIENTIFIC DESCRIPTION: The language workbench put together the following tools seamlessly integrated to the Eclipse Modeling Framework (EMF):

- Melange, a tool-supported meta-language to modularly define executable modeling languages with execution functions and data, and to extend (EMF-based) existing modeling languages. - MoCCML, a tool-supported meta-language dedicated to the specification of a Model of Concurrency and Communication (MoCC) and its mapping to a specific abstract syntax and associated execution functions of a modeling language. - GEL, a tool-supported meta-language dedicated to the specification of the protocol between the execution functions and the MoCC to support the feedback of the data as well as the callback of other expected execution functions. - BCOoL, a tool-supported meta-language dedicated to the specification of language coordination patterns to automatically coordinates the execution of, possibly heterogeneous, models. - Sirius Animator, an extension to the model editor designer Sirius to create graphical animators for executable modeling languages.

FUNCTIONAL DESCRIPTION: The GEMOC Studio is an eclipse package that contains components supporting the GEMOC methodology for building and composing executable Domain-Specific Modeling Languages (DSMLs). It includes the two workbenches: The GEMOC Language Workbench: intended to be used by language designers (aka domain experts), it allows to build and compose new executable DSMLs. The GEMOC Modeling Workbench: intended to be used by domain designersto create, execute and coordinate models conforming to executable DSMLs. The different concerns of a DSML, as defined with the tools of the language workbench, are automatically deployed into the modeling workbench. They parametrize a generic execution framework that provide various generic services such as graphical animation, debugging tools, trace and event managers, timeline, etc.

- Participants: Didier Vojtisek, Dorian Leroy, Erwan Bousse, Fabien Coulon and Julien Deantoni
- Partners: IRIT - ENSTA - I3S - OBEO - Thales TRT
- Contact: Benoît Combemale
- URL: <http://gemoc.org/studio.html>

5.4. BCOoL

BCOoL

KEYWORDS: DSL - Language workbench - Behavior modeling - Model debugging - Model animation

FUNCTIONAL DESCRIPTION: BCOoL is a tool-supported meta-language dedicated to the specification of language coordination patterns to automatically coordinates the execution of, possibly heterogeneous, models.

- Participants: Julien Deantoni, Matias Vara Larsen, Benoît Combemale and Didier Vojtisek
- Contact: Julien Deantoni
- URL: <http://www.gemoc.org>

5.5. MoCCML

KEYWORDS: DSL - Language workbench - Modeling workbench - Model debugging - Model animation

FUNCTIONAL DESCRIPTION: The MoCCML / Concurrency provides components and engines supporting concurrency and/or time in execution semantics.

- Participants: Julien Deantoni, Didier Vojtisek, Joël Champeau, Benoît Combemale and Stephen Creff
- Partner: ENSTA
- Contact: Benoît Combemale
- URL: <http://www.gemoc.org>

LFANT Project-Team

5. New Software and Platforms

5.1. APIP

Another Pairing Implementation in PARI

SCIENTIFIC DESCRIPTION: Apip , Another Pairing Implementation in PARI, is a library for computing standard and optimised variants of most cryptographic pairings.

The following pairings are available: Weil, Tate, ate and twisted ate, optimised versions (à la Vercauteren–Hess) of ate and twisted ate for selected curve families.

The following methods to compute the Miller part are implemented: standard Miller double-and-add method, standard Miller using a non-adjacent form, Boxall et al. version, Boxall et al. version using a non-adjacent form.

The final exponentiation part can be computed using one of the following variants: naive exponentiation, interleaved method, Avanzi–Mihailescu’s method, Kato et al.’s method, Scott et al.’s method.

Part of the library has been included into Pari/Gp proper.

FUNCTIONAL DESCRIPTION: APIP is a library for computing standard and optimised variants of most cryptographic pairings.

- Participant: Jérôme Milan
- Contact: Jérôme Milan
- URL: <http://www.lix.polytechnique.fr/~milanj/apip/apip.shtml>

5.2. AVIsogenies

Abelian Varieties and Isogenies

FUNCTIONAL DESCRIPTION: AVIsogenies is a Magma package for working with abelian varieties, with a particular emphasis on explicit isogeny computation.

Its prominent feature is the computation of (l,l) -isogenies between Jacobian varieties of genus-two hyperelliptic curves over finite fields of characteristic coprime to l , practical runs have used values of l in the hundreds.

It can also be used to compute endomorphism rings of abelian surfaces, and find complete addition laws on them.

- Participants: Damien Robert, Gaëtan Bisson and Romain Cosset
- Contact: Gaëtan Bisson
- URL: <http://avisogenies.gforge.inria.fr/>

5.3. CM

KEYWORD: Arithmetic

FUNCTIONAL DESCRIPTION: The Cm software implements the construction of ring class fields of imaginary quadratic number fields and of elliptic curves with complex multiplication via floating point approximations. It consists of libraries that can be called from within a C program and of executable command line applications.

RELEASE FUNCTIONAL DESCRIPTION: Features - Precisions beyond 300000 bits are now supported by an addition chain of variable length for the `-function`. Dependencies - The minimal version number of Mpfr has been increased to 3.0.0, that of Mpc to 1.0.0 and that of Pari to 2.7.0.

- Participant: Andreas Enge
- Contact: Andreas Enge
- URL: <http://www.multiprecision.org/>

5.4. CMH

Computation of Igusa Class Polynomials

KEYWORDS: Mathematics - Cryptography - Number theory

FUNCTIONAL DESCRIPTION: Cmh computes Igusa class polynomials, parameterising two-dimensional abelian varieties (or, equivalently, Jacobians of hyperelliptic curves of genus 2) with given complex multiplication.

- Participants: Andreas Enge, Emmanuel Thomé and Regis Dupont
- Contact: Emmanuel Thomé
- URL: <http://cmh.gforge.inria.fr>

5.5. CUBIC

FUNCTIONAL DESCRIPTION: Cubic is a stand-alone program that prints out generating equations for cubic fields of either signature and bounded discriminant. It depends on the Pari library. The algorithm has quasi-linear time complexity in the size of the output.

- Participant: Karim Belabas
- Contact: Karim Belabas
- URL: <http://www.math.u-bordeaux1.fr/~belabas/research/software/cubic-1.2.tgz>

5.6. Euclid

FUNCTIONAL DESCRIPTION: Euclid is a program to compute the Euclidean minimum of a number field. It is the practical implementation of the algorithm described in [38] . Some corresponding tables built with the algorithm are also available. Euclid is a stand-alone program depending on the PARI library.

- Participants: Jean-Paul Cerri and Pierre Lezowski
- Contact: Pierre Lezowski
- URL: <http://www.math.u-bordeaux1.fr/~plezowsk/euclid/index.php>

5.7. KleinianGroups

FUNCTIONAL DESCRIPTION: KleinianGroups is a Magma package that computes fundamental domains of arithmetic Kleinian groups.

- Participant: Aurel Page
- Contact: Aurel Page
- URL: <http://www.normalesup.org/~page/Recherche/Logiciels/logiciels-en.html>

5.8. GNU MPC

KEYWORD: Arithmetic

FUNCTIONAL DESCRIPTION: Mpc is a C library for the arithmetic of complex numbers with arbitrarily high precision and correct rounding of the result. It is built upon and follows the same principles as Mpfr. The library is written by Andreas Enge, Philippe Théveny and Paul Zimmermann.

RELEASE FUNCTIONAL DESCRIPTION: Fixed mpc_pow, see <http://lists.gforge.inria.fr/pipermail/mpc-discuss/2014-October/001315.html> - #18257: Switched to libtool 2.4.5.

- Participants: Andreas Enge, Mickaël Gastineau, Paul Zimmermann and Philippe Théveny
- Contact: Andreas Enge
- URL: <http://www.multiprecision.org/>

5.9. MPFR/CX

KEYWORD: Arithmetic

FUNCTIONAL DESCRIPTION: Mpfrcx is a library for the arithmetic of univariate polynomials over arbitrary precision real (Mpfr) or complex (Mpc) numbers, without control on the rounding. For the time being, only the few functions needed to implement the floating point approach to complex multiplication are implemented. On the other hand, these comprise asymptotically fast multiplication routines such as Toom-Cook and the FFT.

RELEASE FUNCTIONAL DESCRIPTION: - new function `product_and_hecke` - improved memory consumption for unbalanced FFT multiplications

- Participant: Andreas Enge
- Contact: Andreas Enge
- URL: <http://www.multiprecision.org/>

5.10. PARI/GP

KEYWORD: Computational number theory

FUNCTIONAL DESCRIPTION: Pari/Gp is a widely used computer algebra system designed for fast computations in number theory (factorisation, algebraic number theory, elliptic curves, modular forms ...), but it also contains a large number of other useful functions to compute with mathematical entities such as matrices, polynomials, power series, algebraic numbers, etc., and many transcendental functions.

- Participants: Andreas Enge, Hamish Ivey-Law, Henri Cohen and Karim Belabas
- Partner: CNRS
- Contact: Karim Belabas
- URL: <http://pari.math.u-bordeaux.fr/>

MARELLE Project-Team

5. New Software and Platforms

5.1. Coq

The Coq Proof Assistant

KEYWORDS: Proof - Certification - Formalisation

SCIENTIFIC DESCRIPTION: Coq is an interactive proof assistant based on the Calculus of (Co-)Inductive Constructions, extended with universe polymorphism. This type theory features inductive and co-inductive families, an impredicative sort and a hierarchy of predicative universes, making it a very expressive logic. The calculus allows to formalize both general mathematics and computer programs, ranging from theories of finite structures to abstract algebra and categories to programming language metatheory and compiler verification. Coq is organised as a (relatively small) kernel including efficient conversion tests on which are built a set of higher-level layers: a powerful proof engine and unification algorithm, various tactics/decision procedures, a transactional document model and, at the very top an IDE.

FUNCTIONAL DESCRIPTION: Coq provides both a dependently-typed functional programming language and a logical formalism, which, altogether, support the formalisation of mathematical theories and the specification and certification of properties of programs. Coq also provides a large and extensible set of automatic or semi-automatic proof methods. Coq's programs are extractible to OCaml, Haskell, Scheme, ...

RELEASE FUNCTIONAL DESCRIPTION: Version 8.7 features a large amount of work on cleaning and speeding up the code base, notably the work of Pierre-Marie Pédrot on making the tactic-level system insensitive to existential variable expansion, providing a safer API to plugin writers and making the code more robust.

New tactics: Variants of tactics supporting existential variables "eassert", "eenough", etc. by Hugo Herbelin. Tactics "extensionality in H" and "inversion_sigma" by Jason Gross, "specialize with" accepting partial bindings by Pierre Courtieu.

Cumulative Polymorphic Inductive Types, allowing cumulativity of universes to go through applied inductive types, by Amin Timany and Matthieu Sozeau.

The SSReflect plugin by Georges Gonthier, Assia Mahboubi and Enrico Tassi was integrated (with its documentation in the reference manual) by Maxime Dénès, Assia Mahboubi and Enrico Tassi.

The "coq_makefile" tool was completely redesigned to improve its maintainability and the extensibility of generated Makefiles, and to make "_CoqProject" files more palatable to IDEs by Enrico Tassi.

A lot of other changes are described in the CHANGES file.

NEWS OF THE YEAR: Version 8.7 was released in October 2017 and version 8.7.1 in December 2017, development started in January 2017. This is the second release of Coq developed on a time-based development cycle. Its development spanned 9 months from the release of Coq 8.6 and was based on a public road-map. It attracted many external contributions. Code reviews and continuous integration testing were systematically used before integration of new features, with an important focus given to compatibility and performance issues.

The main scientific advance in this version is the integration of cumulative inductive types in the system. More practical advances in stability, performance, usability and expressivity of tactics were also implemented, resulting in a mostly backwards-compatible but appreciably faster and more robust release. Much work on plugin extensions to Coq by the same development team has also been going on in parallel, including work on JSCoq by Emilio JG Arias, Ltac 2 by P.M-Pédrot, which required synchronised changes of the main codebase. In 2017, the construction of the Coq Consortium by Yves Bertot and Maxime Dénès has greatly advanced and is now nearing its completion.

- Participants: Abhishek Anand, C. J. Bell, Yves Bertot, Frédéric Besson, Tej Chajed, Pierre Courtieu, Maxime Denes, Julien Forest, Emilio Jesús Gallego Arias, Gaëtan Gilbert, Benjamin Grégoire, Jason Gross, Hugo Herbelin, Ralf Jung, Matej Kosik, Sam Pablo Kuper, Xavier Leroy, Pierre Letouzey, Assia Mahboubi, Cyprien Mangin, Érik Martin-Dorel, Olivier Marty, Guillaume Melquiond, Pierre-Marie Pédro, Benjamin C. Pierce, Lars Rasmussen, Yann Régis-Gianas, Lionel Rieg, Valentin Robert, Thomas Sibut-Pinote, Michael Soegtrop, Matthieu Sozeau, Arnaud Spiwack, Paul Steckler, George Stelle, Pierre-Yves Strub, Enrico Tassi, Hendrik Tews, Laurent Théry, Amin Timany, Vadim Zaliva and Théo Zimmermann
- Partners: CNRS - Université Paris-Sud - ENS Lyon - Université Paris-Diderot
- Contact: Matthieu Sozeau
- Publication: [The Coq Proof Assistant, version 8.7.1](#)
- URL: <http://coq.inria.fr/>

5.2. EasyCrypt

FUNCTIONAL DESCRIPTION: EasyCrypt is a toolset for reasoning about relational properties of probabilistic computations with adversarial code. Its main application is the construction and verification of game-based cryptographic proofs. EasyCrypt can also be used for reasoning about differential privacy.

- Participants: Benjamin Grégoire, Gilles Barthe and Pierre-Yves Strub
- Contact: Gilles Barthe
- URL: <https://www.easycrypt.info/trac/>

5.3. ELPI

Embeddable Lambda Prolog Interpreter

KEYWORDS: Constraint Programming - Programming language - Higher-order logic

FUNCTIONAL DESCRIPTION: ELPI is a lambdaProlog interpreter written in OCaml, easy to embed in software written in the same language.

- Contact: Enrico Tassi

5.4. Math-Components

Mathematical Components library

FUNCTIONAL DESCRIPTION: The Mathematical Components library is a set of Coq libraries that cover the mechanization of the proof of the Odd Order Theorem.

RELEASE FUNCTIONAL DESCRIPTION: The library includes 16 more theory files, covering in particular field and Galois theory, advanced character theory, and a construction of algebraic numbers.

- Participants: Alexey Solovyev, Andrea Asperti, Assia Mahboubi, Cyril Cohen, Enrico Tassi, François Garillot, Georges Gonthier, Ioana Pasca, Jeremy Avigad, Laurence Rideau, Laurent Théry, Russell O'Connor, Sidi Ould Biha, Stéphane Le Roux and Yves Bertot
- Contact: Assia Mahboubi
- URL: <http://math-comp.github.io/math-comp/>

5.5. Semantics

KEYWORDS: Semantic - Programming language - Coq

FUNCTIONAL DESCRIPTION: A didactical Coq development to introduce various semantics styles. Shows how to derive an interpreter, a verifier, or a program analyser from formal descriptions, and how to prove their consistency.

This is a library for the Coq system, where the description of a toy programming language is presented. The value of this library is that it can be re-used in classrooms to teach programming language semantics or the Coq system. The topics covered include introductory notions to domain theory, pre and post-conditions, abstract interpretation, and the proofs of consistency between all these point of views on the same programming language. Standalone tools for the object programming language can be derived from this development.

- Participants: Christine Paulin and Yves Bertot
- Contact: Yves Bertot
- URL: http://www-sop.inria.fr/members/Yves.Bertot/proofs/semantics_survey.tgz

5.6. Ssreflect

FUNCTIONAL DESCRIPTION: Ssreflect is a tactic language extension to the Coq system, developed by the Mathematical Components team.

- Participants: Assia Mahboubi, Cyril Cohen, Enrico Tassi, Georges Gonthier, Laurence Rideau, Laurent Théry and Yves Bertot
- Contact: Yves Bertot
- URL: <http://math-comp.github.io/math-comp/>

5.7. AutoGnP

KEYWORDS: Formal methods - Security - Cryptography

FUNCTIONAL DESCRIPTION: autoGnP is an automated tool for analyzing the security of padding-based public-key encryption schemes (i.e. schemes built from trapdoor permutations and hash functions). This years we extended the tool to be able to deal with schemes based on cyclic groups and bilinear maps.

- Participants: Benjamin Grégoire, Gilles Barthe and Pierre-Yves Strub
- Contact: Gilles Barthe
- URL: <https://github.com/ZooCrypt/AutoGnP>

MEXICO Project-Team

6. New Software and Platforms

6.1. COSMOS

FUNCTIONAL DESCRIPTION: COSMOS is a statistical model checker for the Hybrid Automata Stochastic Logic (HASL). HASL employs Linear Hybrid Automata (LHA), a generalization of Deterministic Timed Automata (DTA), to describe accepting execution paths of a Discrete Event Stochastic Process (DESP), a class of stochastic models which includes, but is not limited to, Markov chains. As a result HASL verification turns out to be a unifying framework where sophisticated temporal reasoning is naturally blended with elaborate reward-based analysis. COSMOS takes as input a DESP (described in terms of a Generalized Stochastic Petri Net), an LHA and an expression Z representing the quantity to be estimated. It returns a confidence interval estimation of Z , recently, it has been equipped with functionalities for rare event analysis. COSMOS is written in C++

- Participants: Benoît Barbot, Hilal Djafri, Marie DufLOT-Kremer, Paolo Ballarini and Serge Haddad
- Contact: Hilal Djafri
- URL: <http://www.lsv.ens-cachan.fr/~barbot/cosmos/>

6.2. CosyVerif

FUNCTIONAL DESCRIPTION: CosyVerif is a platform dedicated to the formal specification and verification of dynamic systems. It allows to specify systems using several formalisms (such as automata and Petri nets), and to run verification tools on these models.

- Participants: Alban Linard, Fabrice Kordon, Laure Petrucci and Serge Haddad
- Partners: LIP6 - LSV - LIPN (Laboratoire d'Informatique de l'Université Paris Nord)
- Contact: Serge Haddad
- URL: <http://www.cosyverif.org/>

6.3. Mole

FUNCTIONAL DESCRIPTION: Mole computes, given a safe Petri net, a finite prefix of its unfolding. It is designed to be compatible with other tools, such as PEP and the Model-Checking Kit, which are using the resulting unfolding for reachability checking and other analyses. The tool Mole arose out of earlier work on Petri nets.

- Participant: Stefan Schwon
- Contact: Stefan Schwon
- URL: <http://www.lsv.ens-cachan.fr/~schwon/tools/mole/>

PACAP Project-Team

5. New Software and Platforms

5.1. ATMI

KEYWORDS: Analytic model - Chip design - Temperature

SCIENTIFIC DESCRIPTION: Research on temperature-aware computer architecture requires a chip temperature model. General purpose models based on classical numerical methods like finite differences or finite elements are not appropriate for such research, because they are generally too slow for modeling the time-varying thermal behavior of a processing chip.

We have developed an ad hoc temperature model, ATMI (Analytical model of Temperature in Microprocessors), for studying thermal behaviors over a time scale ranging from microseconds to several minutes. ATMI is based on an explicit solution to the heat equation and on the principle of superposition. ATMI can model any power density map that can be described as a superposition of rectangle sources, which is appropriate for modeling the microarchitectural units of a microprocessor.

FUNCTIONAL DESCRIPTION: ATMI is a library for modelling steady-state and time-varying temperature in microprocessors. ATMI uses a simplified representation of microprocessor packaging.

- Participant: Pierre Michaud
- Contact: Pierre Michaud
- URL: <https://team.inria.fr/pacap/software/atmi/>

5.2. HEPTANE

KEYWORDS: IPET - WCET - Performance - Real time - Static analysis - Worst Case Execution Time

SCIENTIFIC DESCRIPTION: WCET estimation

Status: Registered with APP (Agence de Protection des Programmes). Available under GNU General Public License v3, with number IDDN.FR.001.510039.000.S.P.2003.000.10600.

The aim of Heptane is to produce upper bounds of the execution times of applications. It is targeted at applications with hard real-time requirements (automotive, railway, aerospace domains). Heptane computes WCETs using static analysis at the binary code level. It includes static analyses of microarchitectural elements such as caches and cache hierarchies.

For more information, please contact Damien Hardy or Isabelle Puaut.

FUNCTIONAL DESCRIPTION: In a hard real-time system, it is essential to comply with timing constraints, and Worst Case Execution Time (WCET) in particular. Timing analysis is performed at two levels: analysis of the WCET for each task in isolation taking account of the hardware architecture, and schedulability analysis of all the tasks in the system. Heptane is a static WCET analyser designed to address the first issue.

- Participants: Benjamin Lesage, Loïc Besnard, Damien Hardy, François Joulaud, Isabelle Puaut and Thomas Piquet
- Partner: Université de Rennes 1
- Contact: Isabelle Puaut
- URL: <https://team.inria.fr/pacap/software/heptane/>

5.3. tiptop

KEYWORDS: Instructions - Cycles - Cache - CPU - Performance - HPC - Branch predictor

SCIENTIFIC DESCRIPTION: Tiptop is written in C. It can take advantage of libncurses when available for pseudo-graphic display.

Performance, hardware counters, analysis tool.

Status: Registered with APP (Agence de Protection des Programmes). Available under GNU General Public License v2, with number IDDN.FR.001.450006.000.S.P.2011.000.10800. Current version is 2.3.1, released October 2017.

Tiptop has been integrated in major Linux distributions, such as Fedora, Debian, Ubuntu.

Tiptop is a new simple and flexible user-level tool that collects hardware counter data on Linux platforms (version 2.6.31+). The goal is to make the collection of performance and bottleneck data as simple as possible, including simple installation and usage. In particular, we stress the following points.

Installation is only a matter of compiling the source code. No patching of the Linux kernel is needed, and no special-purpose module needs to be loaded.

No privilege is required, any user can run tiptop

FUNCTIONAL DESCRIPTION: Today's microprocessors have become extremely complex. To better understand the multitude of internal events, manufacturers have integrated many monitoring counters. Tiptop can be used to collect and display the values from these performance counters very easily. Tiptop may be of interest to anyone who wants to optimise the performance of their HPC applications.

- Participant: Erven Rohou
- Contact: Erven Rohou
- URL: <http://tiptop.gforge.inria.fr>

5.4. PADRONE

KEYWORDS: Legacy code - Optimization - Performance analysis - Dynamic Optimization

FUNCTIONAL DESCRIPTION: Padrone is new platform for dynamic binary analysis and optimization. It provides an API to help clients design and develop analysis and optimization tools for binary executables. Padrone attaches to running applications, only needing the executable binary in memory. No source code or debug information is needed. No application restart is needed either. This is especially interesting for legacy or commercial applications, but also in the context of cloud deployment, where actual hardware is unknown, and other applications competing for hardware resources can vary. The profiling overhead is minimum.

- Participants: Emmanuel Riou and Erven Rohou
- Contact: Erven Rohou
- URL: <https://team.inria.fr/alf/software/padrone>

5.5. If-memo

KEYWORD: Performance

SCIENTIFIC DESCRIPTION: We propose a linker based technique for enabling software memorizing of any dynamically linked pure function by function interception and we illustrate our framework using a set of computationally expensive pure functions - the transcendental functions. Our technique does not need the availability of source code and thus can even be applied to commercial applications as well as applications with legacy codes. As far as users are concerned, enabling memoization is as simple as setting an environment variable. Our framework does not make any specific assumptions about the underlying architecture or compiler too-chains, and can work with a variety of current architectures.

- Participants: Arjun Suresh and Erven Rohou
- Contact: Erven Rohou
- URL: <https://team.inria.fr/alf/software/if-memo/>

5.6. Simty

KEYWORDS: RISC-V - Multi-threading - SMT - FPGA - Softcore - GPU

FUNCTIONAL DESCRIPTION: Simty is a massively multi-threaded processor core that dynamically assembles SIMD instructions from scalar multi-thread code. It runs the RISC-V (RV32-I) instruction set. Unlike existing SIMD or SIMT processors like GPUs, Simty takes binaries compiled for general-purpose processors without any instruction set extension or compiler changes. Simty is described in synthesizable VHDL.

- Author: Sylvain Collange
- Contact: Sylvain Collange
- URL: <https://gforge.inria.fr/projects/simty>

5.7. Barra

KEYWORDS: Performance - Computer architecture - Debug - Tesla ISA - GPU - Profiling - CUDA - HPC - Simulator - GPGPU

SCIENTIFIC DESCRIPTION: Research on throughout-oriented architectures demands accurate and representative models of GPU architectures in order to be able to evaluate new architectural ideas, explore design spaces and characterize applications. The Barra project is a simulator of the NVIDIA Tesla GPU architecture.

Barra builds upon knowledge acquired through micro-benchmarking, in order to provide a baseline model representative of industry practice. The simulator provides detailed statistics to identify optimization opportunities and is fully customizable to experiment ideas of architectural modifications. Barra incorporates both a functional model and a cycle-level performance model.

FUNCTIONAL DESCRIPTION: Barra is a Graphics Processing Unit (GPU) architecture simulator. It simulates NVIDIA CUDA programs at the assembly language level. Barra is a tool for research on computer architecture, and can also be used to debug, profile and optimize CUDA programs at the lowest level.

RELEASE FUNCTIONAL DESCRIPTION: Timing model Tesla-like architecture model Fermi-like architecture model New per-PC control-flow divergence management Simultaneous branch and warp interweaving Affine vector cache

- Participants: Alexandre Kouyoumdjian, David Defour, Fabrice Mouhartem and Sylvain Collange
- Partners: ENS Lyon - UPVD
- Contact: Sylvain Collange
- URL: <http://barra.gforge.inria.fr/>

PARKAS Project-Team

5. New Software and Platforms

5.1. Cmmtest

FUNCTIONAL DESCRIPTION: Cmmtest is a tool for hunting concurrency compiler bugs. The Cmmtest tool performs random testing of C and C++ compilers against the C11/C++11 memory model. A test case is any well-defined, sequential C program, for each test case, cmmtest:

compiles the program using the compiler and compiler optimisations that are being tested,

runs the compiled program in an instrumented execution environment that logs all memory accesses to global variables and synchronisations,

compares the recorded trace with a reference trace for the same program, checking if the recorded trace can be obtained from the reference trace by valid eliminations, reorderings and introductions.

Cmmtest identified several mistaken write introductions and other unexpected behaviours in the latest release of the gcc compiler. These have been promptly fixed by the gcc developers.

- Participants: Anirudh Kumar, Francesco Zappa Nardelli, Pankaj More, Pankaj Pawan, Pankaj Prateek Kewalramani and Robin Morisset
- Contact: Francesco Zappa Nardelli
- URL: <http://www.di.ens.fr/~zappa/projects/cmmtest/>

5.2. GCC

KEYWORDS: Compilation - Polyhedral compilation

FUNCTIONAL DESCRIPTION: The GNU Compiler Collection includes front ends for C, C++, Objective-C, Fortran, Java, Ada, and Go, as well as libraries for these languages (libstdc++, libgccj,...). GCC was originally written as the compiler for the GNU operating system. The GNU system was developed to be 100

- Participants: Albert Cohen, Feng Li, Nhat Minh Le, Riyadh Baghdadi and Tobias Grosser
- Contact: Albert Cohen
- URL: <http://gcc.gnu.org/>

5.3. Heptagon

KEYWORDS: Compilers - Synchronous Language - Controller synthesis

FUNCTIONAL DESCRIPTION: Heptagon is an experimental language for the implementation of embedded real-time reactive systems. It is developed inside the Synchronics large-scale initiative, in collaboration with Inria Rhones-Alpes. It is essentially a subset of Lucid Synchrone, without type inference, type polymorphism and higher-order. It is thus a Lustre-like language extended with hierarchical automata in a form very close to SCADE 6. The intention for making this new language and compiler is to develop new aggressive optimization techniques for sequential C code and compilation methods for generating parallel code for different platforms. This explains much of the simplifications we have made in order to ease the development of compilation techniques.

The current version of the compiler includes the following features: - Inclusion of discrete controller synthesis within the compilation: the language is equipped with a behavioral contract mechanisms, where assumptions can be described, as well as an "enforce" property part. The semantics of this latter is that the property should be enforced by controlling the behaviour of the node equipped with the contract. This property will be enforced by an automatically built controller, which will act on free controllable variables given by the programmer. This extension has been named BZR in previous works. - Expression and compilation of array values with modular memory optimization. The language allows the expression and operations on arrays (access, modification, iterators). With the use of location annotations, the programmer can avoid unnecessary array copies.

- Participants: Adrien Guatto, Brice Gelineau, Cédric Pasteur, Eric Rutten, Gwenaël Delaval, Léonard Gérard and Marc Pouzet
- Partners: UGA - ENS Paris - Inria - LIG
- Contact: Gwenaël Delaval
- URL: <http://heptagon.gforge.inria.fr>

5.4. isl

FUNCTIONAL DESCRIPTION: isl is a library for manipulating sets and relations of integer points bounded by linear constraints. Supported operations on sets include intersection, union, set difference, emptiness check, convex hull, (integer) affine hull, integer projection, transitive closure (and over-approximation), computing the lexicographic minimum using parametric integer programming. It includes an ILP solver based on generalized basis reduction, and a new polyhedral code generator. isl also supports affine transformations for polyhedral compilation, and increasingly abstract representations to model source and intermediate code in a polyhedral framework.

- Participants: Albert Cohen, Sven Verdoolaege and Tobias Grosser
- Contact: Sven Verdoolaege
- URL: <http://freshmeat.net/projects/isl>

5.5. Lem

lightweight executable mathematics

FUNCTIONAL DESCRIPTION: Lem is a lightweight tool for writing, managing, and publishing large scale semantic definitions. It is also intended as an intermediate language for generating definitions from domain-specific tools, and for porting definitions between interactive theorem proving systems (such as Coq, HOL4, and Isabelle). As such it is a complementary tool to Ott. Lem resembles a pure subset of Objective Caml, supporting typical functional programming constructs, including top-level parametric polymorphism, datatypes, records, higher-order functions, and pattern matching. It also supports common logical mechanisms including list and set comprehensions, universal and existential quantifiers, and inductively defined relations. From this, Lem generates OCaml, HOL4, Coq, and Isabelle code.

- Participants: Francesco Zappa Nardelli, Peter Sewell and Scott Owens
- Contact: Francesco Zappa Nardelli
- URL: <http://www.cl.cam.ac.uk/~pes20/lem/>

5.6. Lucid Synchrone

FUNCTIONAL DESCRIPTION: Lucid Synchrone is a language for the implementation of reactive systems. It is based on the synchronous model of time as provided by Lustre combined with features from ML languages. It provides powerful extensions such as type and clock inference, type-based causality and initialization analysis and allows to arbitrarily mix data-flow systems and hierarchical automata or flows and valued signals.

RELEASE FUNCTIONAL DESCRIPTION: The language is still used for teaching and in our research but we do not develop it anymore. Nonetheless, we have integrated several features from Lucid Sychrone in new research prototypes described below. The Heptagon language and compiler are a direct descendent of it. The new language Zélus for hybrid systems modeling borrows many features originally introduced in Lucid Sychrone.

- Contact: Marc Pouzet
- URL: <http://www.di.ens.fr/~pouzet/lucid-sychrone/>

5.7. Lucy-n

Lucy-n: an n-synchronous data-flow programming language

FUNCTIONAL DESCRIPTION: Lucy-n is a language to program in the n-synchronous model. The language is similar to Lustre with a buffer construct. The Lucy-n compiler ensures that programs can be executed in bounded memory and automatically computes buffer sizes. Hence this language allows to program Kahn networks, the compiler being able to statically compute bounds for all FIFOs in the program.

- Participants: Adrien Guatto, Albert Cohen, Louis Mandel and Marc Pouzet
- Contact: Albert Cohen
- URL: <https://www.lri.fr/~mandel/lucy-n/>

5.8. Ott

FUNCTIONAL DESCRIPTION: Ott is a tool for writing definitions of programming languages and calculi. It takes as input a definition of a language syntax and semantics, in a concise and readable ASCII notation that is close to what one would write in informal mathematics. It generates output:

a LaTeX source file that defines commands to build a typeset version of the definition,

a Coq version of the definition,

an Isabelle version of the definition, and

a HOL version of the definition.

Additionally, it can be run as a filter, taking a LaTeX/Coq/Isabelle/HOL source file with embedded (symbolic) terms of the defined language, parsing them and replacing them by typeset terms.

The main goal of the Ott tool is to support work on large programming language definitions, where the scale makes it hard to keep a definition internally consistent, and to keep a tight correspondence between a definition and implementations. We also wish to ease rapid prototyping work with smaller calculi, and to make it easier to exchange definitions and definition fragments between groups. The theorem-prover backends should enable a smooth transition between use of informal and formal mathematics.

- Participants: Francesco Zappa Nardelli, Peter Sewell and Scott Owens
- Contact: Francesco Zappa Nardelli
- URL: <http://www.cl.cam.ac.uk/~pes20/ott/>

5.9. PPCG

FUNCTIONAL DESCRIPTION: PPCG is our source-to-source research tool for automatic parallelization in the polyhedral model. It serves as a test bed for many compilation algorithms and heuristics published by our group, and is currently the best automatic parallelizer for CUDA and OpenCL (on the Polybench suite).

- Participants: Albert Cohen, Riyadh Baghdadi, Sven Verdoolaege and Tobias Grosser
- Contact: Sven Verdoolaege
- URL: <http://freshmeat.net/projects/ppcg>

5.10. ReactiveML

FUNCTIONAL DESCRIPTION: ReactiveML is a programming language dedicated to the implementation of interactive systems as found in graphical user interfaces, video games or simulation problems. ReactiveML is based on the synchronous reactive model due to Boussinot, embedded in an ML language (OCaml).

The Synchronous reactive model provides synchronous parallel composition and dynamic features like the dynamic creation of processes. In ReactiveML, the reactive model is integrated at the language level (not as a library) which leads to a safer and a more natural programming paradigm.

- Participants: Cédric Pasteur, Guillaume Baudart and Louis Mandel
- Contact: Guillaume Baudart

5.11. SundialsML

Sundials/ML

KEYWORDS: Simulation - Mathematics - Numerical simulations

SCIENTIFIC DESCRIPTION: Sundials/ML is a comprehensive OCaml interface to the Sundials suite of numerical solvers (CVODE, CVODES, IDA, IDAS, KINSOL). Its structure mostly follows that of the Sundials library, both for ease of reading the existing documentation and for adapting existing source code, but several changes have been made for programming convenience and to increase safety, namely:

solver sessions are mostly configured via algebraic data types rather than multiple function calls,

errors are signalled by exceptions not return codes (also from user-supplied callback routines),

user data is shared between callback routines via closures (partial applications of functions),

vectors are checked for compatibility (using a combination of static and dynamic checks), and

explicit free commands are not necessary since OCaml is a garbage-collected language.

FUNCTIONAL DESCRIPTION: Sundials/ML is a comprehensive OCaml interface to the Sundials suite of numerical solvers (CVODE, CVODES, IDA, IDAS, KINSOL, ARKODE).

- Participants: Jun Inoue, Marc Pouzet and Timothy Bourke
- Partner: UPMC
- Contact: Marc Pouzet
- URL: <http://inria-parkas.github.io/sundialsml/>

5.12. Zelus

SCIENTIFIC DESCRIPTION: The Zélus implementation has two main parts: a compiler that transforms Zélus programs into OCaml programs and a runtime library that orchestrates compiled programs and numeric solvers. The runtime can use the Sundials numeric solver, or custom implementations of well-known algorithms for numerically approximating continuous dynamics.

FUNCTIONAL DESCRIPTION: Zélus is a new programming language for hybrid system modeling. It is based on a synchronous language but extends it with Ordinary Differential Equations (ODEs) to model continuous-time behaviors. It allows for combining arbitrarily data-flow equations, hierarchical automata and ODEs. The language keeps all the fundamental features of synchronous languages: the compiler statically ensure the absence of deadlocks and critical races, it is able to generate statically scheduled code running in bounded time and space and a type-system is used to distinguish discrete and logical-time signals from continuous-time ones. The ability to combines those features with ODEs made the language usable both for programming discrete controllers and their physical environment.

- Participants: Marc Pouzet and Timothy Bourke
- Contact: Marc Pouzet

PARSIFAL Project-Team

5. New Software and Platforms

5.1. Abella

FUNCTIONAL DESCRIPTION: Abella is an interactive theorem prover for reasoning about computations given as relational specifications. Abella is particularly well suited for reasoning about binding constructs.

- Participants: Dale Miller, Gopalan Nadathur, Kaustuv Chaudhuri, Mary Southern, Matteo Cimini, Olivier Savary-Bélangier and Yuting Wang
- Partner: Department of Computer Science and Engineering, University of Minnesota
- Contact: Kaustuv Chaudhuri
- URL: <http://abella-prover.org/>

5.2. Bedwyr

Bedwyr - A proof search approach to model checking

FUNCTIONAL DESCRIPTION: Bedwyr is a generalization of logic programming that allows model checking directly on syntactic expressions that possibly contain bindings. This system, written in OCaml, is a direct implementation of two recent advances in the theory of proof search.

It is possible to capture both finite success and finite failure in a sequent calculus. Proof search in such a proof system can capture both may and must behavior in operational semantics. Higher-order abstract syntax is directly supported using term-level lambda-binders, the nabla quantifier, higher-order pattern unification, and explicit substitutions. These features allow reasoning directly on expressions containing bound variables.

The distributed system comes with several example applications, including the finite pi-calculus (operational semantics, bisimulation, trace analyses, and modal logics), the spi-calculus (operational semantics), value-passing CCS, the lambda-calculus, winning strategies for games, and various other model checking problems.

- Participants: Dale Miller, Quentin Heath and Roberto Blanco Martinez
- Contact: Quentin Heath
- URL: <http://slimmer.gforge.inria.fr/bedwyr/>

5.3. Checkers

Checkers - A proof verifier

KEYWORDS: Proof - Certification - Verification

FUNCTIONAL DESCRIPTION: Checkers is a tool in Lambda-prolog for the certification of proofs. Checkers consists of a kernel which is based on LKF and is based on the notion of ProofCert.

- Participants: Giselle Machado Nogueira Reis, Marco Volpe and Tomer Libal
- Contact: Tomer Libal
- URL: <https://github.com/proofcert/checkers>

5.4. Psyche

Proof-Search factorY for Collaborative HEuristics

FUNCTIONAL DESCRIPTION: Psyche is a modular platform for automated or interactive theorem proving, programmed in OCaml and built on an architecture (similar to LCF) where a trusted kernel interacts with plugins. The kernel offers an API of proof-search primitives, and plugins are programmed on top of the API to implement search strategies. This architecture is set up for pure logical reasoning as well as for theory-specific reasoning, for various theories.

RELEASE FUNCTIONAL DESCRIPTION: It is now equipped with the machinery to handle quantifiers and quantifier-handling techniques. Concretely, it uses meta-variables to delay the instantiation of existential variables, and constraints on meta-variables are propagated through the various branches of the search-space, in a way that allows local backtracking. The kernel, of about 800 l.o.c., is purely functional.

- Participants: Assia Mahboubi, Jean-Marc Notin and Stéphane Graham-Lengrand
- Contact: Stéphane Graham-Lengrand
- URL: <http://www.lix.polytechnique.fr/~lengrand/Psyche/>

PESTO Project-Team

6. New Software and Platforms

6.1. Akiss

AKISS: Active Knowledge in Security Protocols

KEYWORDS: Security - Verification

FUNCTIONAL DESCRIPTION: Akiss (Active Knowledge in Security Protocols) is a tool for verifying indistinguishability properties in cryptographic protocols, modelled as trace equivalence in a process calculus. Indistinguishability is used to model a variety of properties including anonymity properties, strong versions of confidentiality and resistance against offline guessing attacks, etc. Akiss implements a procedure to verify equivalence properties for a bounded number of sessions based on a fully abstract modelling of the traces of a bounded number of sessions of the protocols into first-order Horn clauses and a dedicated resolution procedure. The procedure can handle a large set of cryptographic primitives, namely those that can be modeled by an optimally reducing convergent rewrite system.

- Contact: Steve Kremer
- URL: <https://github.com/akiss>

6.2. Belenios

Belenios - Verifiable online voting system

KEYWORD: E-voting

FUNCTIONAL DESCRIPTION: Belenios is an online voting system that provides confidentiality and verifiability. End-to-end verifiability relies on the fact that the ballot box is public (voters can check that their ballots have been received) and on the fact that the tally is publicly verifiable (anyone can recount the votes). Confidentiality relies on the encryption of the votes and the distribution of the decryption key.

Belenios builds upon Helios, a voting protocol used in several elections. The main design enhancement of Belenios vs Helios is that the ballot box can no longer add (fake) ballots, due to the use of credentials.

- Participants: Pierrick Gaudry, Stéphane Glondou and Véronique Cortier
- Partners: CNRS - Inria
- Contact: Stéphane Glondou
- URL: <http://belenios.gforge.inria.fr/>

6.3. CL-AtSe

Constraint Logic based Attack Searcher

KEYWORDS: Security - Verification - Web Services

FUNCTIONAL DESCRIPTION: CL-AtSe is a Constraint Logic based Attack Searcher for security protocols and services. The main idea in CL-AtSe consists in running the protocol or set of services in all possible ways by representing families of traces with positive or negative constraints on the intruder knowledge, on variable values, on sets, etc. Thus, each run of a service step consists in adding new constraints on the current intruder and environment state, reducing these constraints down to a normalized form for which satisfiability is easily decidable, and decide whether some security property has been violated up to this point.

- Participants: Mathieu Turuani and Tigran Avanesov
- Contact: Mathieu Turuani
- URL: <https://cassis.loria.fr/wiki/Wiki.jsp?page=CL-Atse>

6.4. Deepsec

DEciding Equivalence Properties in SECurity protocols

KEYWORDS: Security - Verification

FUNCTIONAL DESCRIPTION: DeepSec (DEciding Equivalence Properties in SECurity protocols) is a tool for verifying indistinguishability properties in cryptographic protocols, modelled as trace equivalence in a process calculus. Indistinguishability is used to model a variety of properties including anonymity properties, strong versions of confidentiality and resistance against offline guessing attacks, etc. DeepSec implements a decision procedure to verify trace equivalence for a bounded number of sessions and cryptographic primitives modeled by a subterm convergent destructor rewrite system. The procedure is based on constraint solving techniques. Several new features are currently being developed including the possibility to verify labelled bisimilarity and session equivalence. Optimizations to improve efficiency and interface improvements are also under development.

- Contact: Vincent Cheval
- URL: <https://github.com/DeepSec-prover/deepsec>

6.5. Tamarin

TAMARIN prover

KEYWORDS: Security - Verification

FUNCTIONAL DESCRIPTION: The TAMARIN prover is a security protocol verification tool that supports both falsification and unbounded verification of security protocols specified as multiset rewriting systems with respect to (temporal) first-order properties and a message theory that models Diffie-Hellman exponentiation, bilinear pairing, multisets, and exclusive-or (XOR), combined with a user-defined convergent rewriting theory. Its main advantages are its ability to handle stateful protocols and its interactive proof mode. Moreover, it has recently been extended to verify equivalence properties. The tool is developed jointly by the PESTO team, the Institute of Information Security at ETH Zurich, and the University of Oxford. In a joint effort, the partners wrote and published a user manual in 2016, available from the Tamarin website.

- Contact: Jannik Dreier
- URL: <http://tamarin-prover.github.io/>

6.6. SAPIC

SAPIC: Stateful Applied Pi Calculus

KEYWORDS: Security - Verification

FUNCTIONAL DESCRIPTION: SAPIC is a tool that translates protocols from a high-level protocol description language akin to the applied pi-calculus into multiset rewrite rules, that can then be analysed using the TAMARIN prover. TAMARIN has also been extended with dedicated heuristics that exploit the form of translated rules and favor termination.

SAPIC offers support for the analysis of protocols that include states, for example Hardware Security Tokens communicating with a possibly malicious user, or protocols that rely on databases. It also allows us to verify liveness properties and a recent extension adds a notion of location and reporting used for modelling trusted execution environments. It has been successfully applied on several case studies including the Yubikey authentication protocol, and extensions of the PKCS#11 standard. SAPIC also includes support for verifying liveness properties, which are for instance important in fair exchange and contract signing protocols, as well as support for constructions useful when modelling isolated execution environments.

SAPIC has been integrated as a plugin in TAMARIN and is now part of the TAMARIN distribution.

- Contact: Steve Kremer
- URL: <http://sapic.gforge.inria.fr/>

6.7. TypeEquiv

A type checker for privacy properties

KEYWORDS: Security - Cryptographic protocol - Privacy

FUNCTIONAL DESCRIPTION: TypeEquiv takes as input the specification of a pair of security protocols, written in a dialect of the applied-pi calculus, together with some type annotations. It checks whether the two protocols are in equivalence or not.

- Partner: Technische Universität Wien
- Contact: Véronique Cortier

PL.R2 Project-Team

5. New Software and Platforms

5.1. Coq

The Coq Proof Assistant

KEYWORDS: Proof - Certification - Formalisation

SCIENTIFIC DESCRIPTION: Coq is an interactive proof assistant based on the Calculus of (Co-)Inductive Constructions, extended with universe polymorphism. This type theory features inductive and co-inductive families, an impredicative sort and a hierarchy of predicative universes, making it a very expressive logic. The calculus allows to formalize both general mathematics and computer programs, ranging from theories of finite structures to abstract algebra and categories to programming language metatheory and compiler verification. Coq is organised as a (relatively small) kernel including efficient conversion tests on which are built a set of higher-level layers: a powerful proof engine and unification algorithm, various tactics/decision procedures, a transactional document model and, at the very top an IDE.

FUNCTIONAL DESCRIPTION: Coq provides both a dependently-typed functional programming language and a logical formalism, which, altogether, support the formalisation of mathematical theories and the specification and certification of properties of programs. Coq also provides a large and extensible set of automatic or semi-automatic proof methods. Coq's programs are extractible to OCaml, Haskell, Scheme, ...

RELEASE FUNCTIONAL DESCRIPTION: Version 8.7 features a large amount of work on cleaning and speeding up the code base, notably the work of Pierre-Marie Pédro on making the tactic-level system insensitive to existential variable expansion, providing a safer API to plugin writers and making the code more robust.

New tactics: Variants of tactics supporting existential variables "eassert", "eenough", etc. by Hugo Herbelin. Tactics "extensionality in H" and "inversion_sigma" by Jason Gross, "specialize with" accepting partial bindings by Pierre Courtieu.

Cumulative Polymorphic Inductive Types, allowing cumulativity of universes to go through applied inductive types, by Amin Timany and Matthieu Sozeau.

The SSReflect plugin by Georges Gonthier, Assia Mahboubi and Enrico Tassi was integrated (with its documentation in the reference manual) by Maxime Dénès, Assia Mahboubi and Enrico Tassi.

The "coq_makefile" tool was completely redesigned to improve its maintainability and the extensibility of generated Makefiles, and to make "_CoqProject" files more palatable to IDEs by Enrico Tassi.

A lot of other changes are described in the CHANGES file.

NEWS OF THE YEAR: Version 8.7 was released in October 2017 and version 8.7.1 in December 2017, development started in January 2017. This is the second release of Coq developed on a time-based development cycle. Its development spanned 9 months from the release of Coq 8.6 and was based on a public road-map. It attracted many external contributions. Code reviews and continuous integration testing were systematically used before integration of new features, with an important focus given to compatibility and performance issues.

The main scientific advance in this version is the integration of cumulative inductive types in the system. More practical advances in stability, performance, usability and expressivity of tactics were also implemented, resulting in a mostly backwards-compatible but appreciably faster and more robust release. Much work on plugin extensions to Coq by the same development team has also been going on in parallel, including work on JSCoq by Emilio JG Arias, Ltac 2 by P.M-Pédrot, which required synchronised changes of the main codebase. In 2017, the construction of the Coq Consortium by Yves Bertot and Maxime Dénès has greatly advanced and is now nearing its completion.

- Participants: Abhishek Anand, C. J. Bell, Yves Bertot, Frédéric Besson, Tej Chajed, Pierre Courtieu, Maxime Denes, Julien Forest, Emilio Jesús Gallego Arias, Gaëtan Gilbert, Benjamin Grégoire, Jason Gross, Hugo Herbelin, Ralf Jung, Matej Kosik, Sam Pablo Kuper, Xavier Leroy, Pierre Letouzey, Assia Mahboubi, Cyprien Mangin, Érik Martin-Dorel, Olivier Marty, Guillaume Melquiond, Pierre-Marie Pédro, Benjamin C. Pierce, Lars Rasmussen, Yann Régis-Gianas, Lionel Rieg, Valentin Robert, Thomas Sibut-Pinote, Michael Soegtrop, Matthieu Sozeau, Arnaud Spiwack, Paul Steckler, George Stelle, Pierre-Yves Strub, Enrico Tassi, Hendrik Tews, Laurent Théry, Amin Timany, Vadim Zaliva and Théo Zimmermann
- Partners: CNRS - Université Paris-Sud - ENS Lyon - Université Paris-Diderot
- Contact: Matthieu Sozeau
- Publication: **The Coq Proof Assistant, version 8.7.1**
- URL: <http://coq.inria.fr/>

5.2. Equations

KEYWORDS: Coq - Dependent Pattern-Matching - Proof assistant - Functional programming

SCIENTIFIC DESCRIPTION: Equations is a tool designed to help with the definition of programs in the setting of dependent type theory, as implemented in the Coq proof assistant. Equations provides a syntax for defining programs by dependent pattern-matching and well-founded recursion and compiles them down to the core type theory of Coq, using the primitive eliminators for inductive types, accessibility and equality. In addition to the definitions of programs, it also automatically derives useful reasoning principles in the form of propositional equations describing the functions, and an elimination principle for calls to this function. It realizes this using a purely definitional translation of high-level definitions to core terms, without changing the core calculus in any way, or using axioms.

FUNCTIONAL DESCRIPTION: Equations is a function definition plugin for Coq (supporting Coq 8.6 and 8.7), that allows the definition of functions by dependent pattern-matching and well-founded, mutual or nested structural recursion and compiles them into core terms. It automatically derives the clauses equations, the graph of the function and its associated elimination principle.

Equations is based on a simplification engine for the dependent equalities appearing in dependent eliminations that is also usable as a separate tactic, providing an axiom-free variant of dependent destruction. The main features of Equations include:

Dependent pattern-matching in the style of Agda/Epigram, with inaccessible patterns, with and where clauses. The use of the K axiom or a proof of K is configurable.

Support for well-founded recursion using by rec annotations, and automatic derivation of the subterm relation for inductive families.

Support for mutual and nested structural recursion using with and where auxiliary definitions, allowing to factor multiple uses of the same nested fixpoint definition. It proves the expected elimination principles for mutual and nested definitions.

Automatic generation of the defining equations as rewrite rules for every definition.

Automatic generation of the unfolding lemma for well-founded definitions (requiring only functional extensibility).

Automatic derivation of the graph of the function and its elimination principle. In case the automation fails to prove these principles, the user is asked to provide a proof.

A new dependent elimination tactic based on the same splitting tree compilation scheme that can advantageously replace dependent destruction and sometimes inversion as well. The `as` clause of dependent elimination allows to specify exactly the patterns and naming of new variables needed for an elimination.

A set of `Derive` commands for automatic derivation of constructions from an inductive type: its signature, no-confusion property, well-founded subterm relation and decidable equality proof, if applicable.

NEWS OF THE YEAR: Equations 1.0 was released in december this year, after 7 years of (non-continuous) development. It provides the first feature-full version of the software. It has been tried and tested on small to medium scale examples (available on the website). Equations was presented at the Type Theory Tools EUTypes meeting in January 2017 in Paris, and another demo/presentation will be given at PEPM 2018 in Los Angeles in January 2018.

- Participants: Matthieu Sozeau and Cyprien Mangin
- Contact: Matthieu Sozeau
- Publications: [Equations reloaded - Equations for Hereditary Substitution in Leivant's Predicative System F: A Case Study](#) - [Equations: A Dependent Pattern-Matching Compiler](#)
- URL: <http://mattam82.github.io/Coq-Equations/>

POLSYS Project-Team

5. New Software and Platforms

5.1. Epsilon

FUNCTIONAL DESCRIPTION: Epsilon is a library of functions implemented in Maple and Java for polynomial elimination and decomposition with (geometric) applications.

- Contact: Dongming Wang
- URL: <http://wang.cc4cm.org/epsilon/index.html>

5.2. FGb

KEYWORDS: Gröbner bases - Nonlinear system - Computer algebra

FUNCTIONAL DESCRIPTION: FGb is a powerful software for computing Gröbner bases. It includes the new generation of algorithms for computing Gröbner bases polynomial systems (mainly the F4, F5 and FGLM algorithms). It is implemented in C/C++ (approximately 250000 lines), standalone servers are available on demand. Since 2006, FGb is dynamically linked with Maple software (version 11 and higher) and is part of the official distribution of this software.

- Participant: Jean Charles Faugère
- Contact: Jean-Charles Faugère
- URL: <http://www-polsys.lip6.fr/~jcf/FGb/index.html>

5.3. FGb Light

FUNCTIONAL DESCRIPTION: Gröbner basis computation modulo p (p is a prime integer of 16 bits).

- Participant: Jean-Charles Faugère
- Contact: Jean-Charles Faugère
- URL: <http://www-polsys.lip6.fr/~jcf/FGb/index.html>

5.4. GBLA

FUNCTIONAL DESCRIPTION: GBLA is an open source C library for linear algebra specialized for eliminating matrices generated during Gröbner basis computations in algorithms like F4 or F5.

- Contact: Jean-Charles Faugère
- URL: <http://www-polsys.lip6.fr/~jcf/GBLA/index.html>

5.5. HFEBoost

FUNCTIONAL DESCRIPTION: Public-key cryptography system enabling an authentication of dematerialized data.

- Authors: Jean-Charles Faugère and Ludovic Perret
- Partner: UPMC
- Contact: Jean-Charles Faugère
- URL: <http://www-polsys.lip6.fr/Links/hfeboost.html>

5.6. RAGlib

Real Algebraic Geometry library

FUNCTIONAL DESCRIPTION: RAGLib is a powerful library, written in Maple, dedicated to solving over the reals polynomial systems. It is based on the FGb library for computing Grobner bases. It provides functionalities for deciding the emptiness and/or computing sample points to real solution sets of polynomial systems of equations and inequalities. This library provides implementations of the state-of-the-art algorithms with the currently best known asymptotic complexity for those problems.

- Contact: Mohab Safey El Din
- URL: <http://www-polsys.lip6.fr/~safey/RAGLib/>

5.7. SLV

FUNCTIONAL DESCRIPTION: SLV is a software package in C that provides routines for isolating (and subsequently refine) the real roots of univariate polynomials with integer or rational coefficients based on subdivision algorithms and on the continued fraction expansion of real numbers. Special attention is given so that the package can handle polynomials that have degree several thousands and size of coefficients hundreds of Megabytes. Currently the code consists of approx. 5000 lines.

- Contact: Elias Tsigaridas
- URL: <http://www-polsys.lip6.fr/~elias/soft>

5.8. SPECTRA

Semidefinite Programming solved Exactly with Computational Tools of Real Algebra

KEYWORD: Linear Matrix Inequalities

FUNCTIONAL DESCRIPTION: SPECTRA is a Maple library devoted to solving exactly Semi-Definite Programs. It can handle rank constraints on the solution. It is based on the FGb library for computing Gröbner bases and provides either certified numerical approximations of the solutions or exact representations thereof.

- Contact: Mohab Safey El Din
- URL: <http://homepages.laas.fr/henrion/software/spectra/>

PRIVATICS Project-Team

5. New Software and Platforms

5.1. FECFRAME

FEC Framework following RFC 6363 specifications (<https://datatracker.ietf.org/doc/rfc6363/>)

KEYWORDS: Error Correction Code - Content delivery protocol - Robust transmission

FUNCTIONAL DESCRIPTION: This software implements the FECFRAME IETF standard (RFC 6363) co-authored by V. Roca, and is compliant with 3GPP specifications for mobile terminals. It enables the simultaneous transmission of multimedia flows to one or several destinations, while being robust to packet erasures that happen on wireless networks (e.g., 4G or Wifi). This software relies on the OpenFEC library (the open-source <http://openfec.org> version or the commercial version) that provides the erasure correction codes (or FEC) and thereby offer robustness in front of packet erasures.

- Participant: Vincent Roca
- Contact: Vincent Roca

5.2. Mobilitics

FUNCTIONAL DESCRIPTION: Mobilitics is a joint project, started in 2012 between Inria and CNIL, which targets privacy issues on smartphones. The goal is to analyze the behavior of smartphones applications and their operating system regarding users private data, that is, the time they are accessed or sent to third party companies usually neither with user's awareness nor consent.

In the presence of a wide range of different smartphones available in terms of operating systems and hardware architecture, Mobilitics project focuses actually its study on the two mostly used mobile platforms, IOS (Iphone) and Android. Both versions of the Mobilitics software: (1) capture any access to private data, any modification (e.g., ciphering or hashing of private data), or transmission of data to remote locations on the Internet, (2) store these events in a local database on the phone for offline analysis, and (3) provide the ability to perform an in depth database analysis in order to identify personal information leakage.

- Authors: Jagdish Achara, James-Douglass Lefruit, Claude Castelluccia, Franck Baudot, Geoffrey Delcroix, Gwendal Le Grand, Stéphane Petitcolas and Vincent Roca
- Contact: Claude Castelluccia

5.3. MyTrackingChoices

KEYWORDS: Privacy - User control

FUNCTIONAL DESCRIPTION: This extension lets you control how you are being tracked on the Internet. It allows you to choose the categories (e.g., health, adult) of the websites where you don't want to be tracked on. When you browse the web, your visited webpages will be categorized on the fly and, depending on your choices, the extension will block the trackers (webpage by webpage) or not.

Existing anti-tracking (Ghostery, Disconnect etc.) and ad-blocking (AdBlock Plus etc.) tools block almost ALL trackers and as a result, ads. This has a negative impact on the Internet economy because free services/content on the Internet are fuelled by ads. As a result, websites are starting to block access to their content if they detect use of Ad-blockers or they ask users to move to a subscription-based model (where users have to pay to get access to the website).

This extension is testing another approach: It is trying to find a trade-off between privacy and economy, that would allow users to protect their privacy while still accessing to free content.

It is based on the assumption that most people are not against advertisements, but want to keep control over their data. We believe that some sites are more sensitive than others. In fact, most people don't want to be tracked on "sensitive" websites (for example related to religion, health,...), but don't see any problem to be tracked on less sensitive ones (such as news, sport,...). This extension allows you to take control and specify which on which categories of sites you don't want to be tracked on! Furthermore, the extension also gives you the option to block the trackers on specific websites.

- Contact: Claude Castelluccia
- URL: <https://addons.mozilla.org/FR/firefox/addon/mytrackingchoices/>

5.4. OMEN+

FUNCTIONAL DESCRIPTION: Omen+ is a password cracker following our previous work. It is used to guess possible passwords based on specific information about the target. It can also be used to check the strength of user password by effectively looking at the similarity of that password with both usual structures and information relative to the user, such as his name, birth date...

It is based on a Markov analysis of known passwords to build guesses. The previous work Omen needs to be cleaned in order to be scaled to real problems and to be distributed or transferred to the security community (maintainability): eventually it will become an open source software. The main challenge of Omen+ is to optimize the memory consumption.

- Participants: Claude Castelluccia and Pierre Rouveyrol
- Contact: Claude Castelluccia

5.5. OPENFEC

KEYWORD: Error Correction Code

FUNCTIONAL DESCRIPTION: OpenFEC is a C-language implementation of several Application-Level Forward Erasure Correction (AL-FEC) codecs, namely: Reed-Solomon (RFC 5510), LDPC-Staircase (RFC 5170) codes, and RLC (<https://datatracker.ietf.org/doc/draft-ietf-tsvwg-rlc-fec-scheme/>). Two versions are available: an open-source, unsupported version (<http://openfec.org/>), and an advanced version commercialized by the Expway SME.

RELEASE FUNCTIONAL DESCRIPTION: Added support of RLC codes (Random Linear Codes), based on a sliding encoding window.

- Participants: Christophe Neumann, Belkacem Teibi, Jérôme Lacan, Jonathan Detchart, Julien Laboure, Kevin Chaumont, Mathieu Cunche and Vincent Roca
- Partner: Expway
- Contact: Vincent Roca
- URL: <http://openfec.org/>

PROSECCO Project-Team

6. New Software and Platforms

6.1. Cryptosense Analyzer

SCIENTIFIC DESCRIPTION: Cryptosense Analyzer (formerly known as Tookan) is a security analysis tool for cryptographic devices such as smartcards, security tokens and Hardware Security Modules that support the most widely-used industry standard interface, RSA PKCS#11. Each device implements PKCS#11 in a slightly different way since the standard is quite open, but finding a subset of the standard that results in a secure device, i.e. one where cryptographic keys cannot be revealed in clear, is actually rather tricky. Cryptosense Analyzer analyses a device by first reverse engineering the exact implementation of PKCS#11 in use, then building a logical model of this implementation for a model checker, calling a model checker to search for attacks, and in the case where an attack is found, executing it directly on the device. It has been used to find at least a dozen previously unknown flaws in commercially available devices.

FUNCTIONAL DESCRIPTION: Cryptosense Analyzer (formerly known as Tookan) is a security analysis tool for cryptographic devices such as smartcards,

- Participants: Graham Steel and Romain Bardou
- Contact: Graham Steel
- URL: <https://cryptosense.com/>

6.2. CryptoVerif

Cryptographic protocol verifier in the computational model

KEYWORDS: Security - Verification - Cryptographic protocol

FUNCTIONAL DESCRIPTION: CryptoVerif is an automatic protocol prover sound in the computational model. In this model, messages are bitstrings and the adversary is a polynomial-time probabilistic Turing machine. CryptoVerif can prove secrecy and correspondences, which include in particular authentication. It provides a generic mechanism for specifying the security assumptions on cryptographic primitives, which can handle in particular symmetric encryption, message authentication codes, public-key encryption, signatures, hash functions, and Diffie-Hellman key agreements. It also provides an explicit formula that gives the probability of breaking the protocol as a function of the probability of breaking each primitives, this is the exact security framework.

NEWS OF THE YEAR: We made several case studies using CryptoVerif (Signal, TLS 1.3 Draft 18, ARINC 823 avionic protocol) and have made a few technical improvements.

- Participants: Bruno Blanchet and David Cadé
- Contact: Bruno Blanchet
- Publications: [Proved Implementations of Cryptographic Protocols in the Computational Model - Proved Generation of Implementations from Computationally Secure Protocol Specifications - Verified Models and Reference Implementations for the TLS 1.3 Standard Candidate - Verified Models and Reference Implementations for the TLS 1.3 Standard Candidate - Symbolic and Computational Mechanized Verification of the ARINC823 Avionic Protocols - Automated Verification for Secure Messaging Protocols and Their Implementations: A Symbolic and Computational Approach](#)
- URL: <http://cryptoverif.inria.fr/>

6.3. F*

FStar

KEYWORDS: Programming language - Software Verification

FUNCTIONAL DESCRIPTION: F* is a new higher order, effectful programming language (like ML) designed with program verification in mind. Its type system is based on a core that resembles System Fw (hence the name), but is extended with dependent types, refined monadic effects, refinement types, and higher kinds. Together, these features allow expressing precise and compact specifications for programs, including functional correctness properties. The F* type-checker aims to prove that programs meet their specifications using an automated theorem prover (usually Z3) behind the scenes to discharge proof obligations. Programs written in F* can be translated to OCaml, F#, or JavaScript for execution.

- Participants: Antoine Delignat-Lavaud, Catalin Hritcu, Cédric Fournet, Chantal Keller, Karthikeyan Bhargavan and Pierre-Yves Strub
- Contact: Catalin Hritcu
- URL: <https://www.fstar-lang.org/>

6.4. miTLS

KEYWORDS: Cryptographic protocol - Software Verification

FUNCTIONAL DESCRIPTION: miTLS is a verified reference implementation of the TLS protocol. Our code fully supports its wire formats, ciphersuites, sessions and connections, re-handshakes and resumptions, alerts and errors, and data fragmentation, as prescribed in the RFCs, it interoperates with mainstream web browsers and servers. At the same time, our code is carefully structured to enable its modular, automated verification, from its main API down to computational assumptions on its cryptographic algorithms.

- Participants: Alfredo Pironti, Antoine Delignat-Lavaud, Cédric Fournet, Jean-Karim Zinzindohoué, Karthikeyan Bhargavan, Pierre-Yves Strub and Santiago Zanella-Béguelin
- Contact: Karthikeyan Bhargavan
- URL: <https://github.com/mitls/mitls-fstar>

6.5. ProVerif

KEYWORDS: Security - Verification - Cryptographic protocol

FUNCTIONAL DESCRIPTION: ProVerif is an automatic security protocol verifier in the symbolic model (so called Dolev-Yao model). In this model, cryptographic primitives are considered as black boxes. This protocol verifier is based on an abstract representation of the protocol by Horn clauses. Its main features are:

It can verify various security properties (secrecy, authentication, process equivalences).

It can handle many different cryptographic primitives, specified as rewrite rules or as equations.

It can handle an unbounded number of sessions of the protocol (even in parallel) and an unbounded message space.

NEWS OF THE YEAR: Marc Sylvestre improved the display of attacks, in particular by showing the computations performed by the attacker to obtain the messages sent in the attack, and by explaining why the found trace breaks the considered security property. He also developed an interactive simulator that allows the user to run the protocol step by step. We also made several case studies using this tool (Signal, TLS 1.3 Draft 18, ARINC 823 avionic protocol).

- Participants: Bruno Blanchet, Marc Sylvestre and Vincent Cheval
- Contact: Bruno Blanchet
- Publications: [Automated Reasoning for Equivalences in the Applied Pi Calculus with Barriers](#) - [Automated reasoning for equivalences in the applied pi calculus with barriers](#) - [Modeling and Verifying Security Protocols with the Applied Pi Calculus and ProVerif](#) - [Automatic Verification of Security Protocols in the Symbolic Model: The Verifier ProVerif](#) - [Verified Models and Reference Implementations for the TLS 1.3 Standard Candidate](#) - [Verified Models and Reference Implementations for the TLS 1.3 Standard Candidate](#) - [Automated Verification for Secure Messaging Protocols and Their Implementations: A Symbolic and Computational Approach](#) - [Symbolic and Computational Mechanized Verification of the ARINC823 Avionic Protocols](#) - [Symbolic and Computational Mechanized Verification of the ARINC823 Avionic Protocols](#)
- URL: <http://proverif.inria.fr/>

6.6. HACL*

High Assurance Cryptography Library

KEYWORDS: Cryptography - Software Verification

FUNCTIONAL DESCRIPTION: HACL* is a formally verified cryptographic library in F*, developed by the Prosecco team at Inria Paris in collaboration with Microsoft Research, as part of Project Everest.

HACL stands for High-Assurance Cryptographic Library and its design is inspired by discussions at the HACS series of workshops. The goal of this library is to develop verified C reference implementations for popular cryptographic primitives and to verify them for memory safety, functional correctness, and secret independence.

- Contact: Karthikeyan Bhargavan
- URL: <https://github.com/mitls/hacl-star>

SECRET Project-Team

6. New Software and Platforms

6.1. CFS

FUNCTIONAL DESCRIPTION: Reference implementation of parallel CFS (reinforced version of the digital signature scheme CFS). Two variants are proposed, one with a « bit-packing » finite field arithmetic and an evolution with a « bit-slicing » finite-field arithmetic (collaboration with Peter Schwabe). For 80 bits of security the running time for producing one signature with the « bit-packing » variant is slightly above one second. This is high but was still the fastest so far. The evolution with the « bit-slicing » arithmetic produces the same signature in about 100 milliseconds.

- Participants: Grégory Landaïs and Nicolas Sendrier
- Contact: Nicolas Sendrier
- URL: <https://gforge.inria.fr/projects/cfs-signature/>

6.2. Collision Decoding

KEYWORDS: Algorithm - Binary linear code

FUNCTIONAL DESCRIPTION: Collision Decoding implements two variants of information set decoding : Stern-Dumer, and MMT. To our knowledge it is the best full-fledged open-source implementation of generic decoding of binary linear codes. It is the best generic attack against code-based cryptography.

- Participants: Grégory Landaïs and Nicolas Sendrier
- Contact: Nicolas Sendrier
- URL: <https://gforge.inria.fr/projects/collision-dec/>

6.3. ISDF

FUNCTIONAL DESCRIPTION: Implementation of the Stern-Dumer decoding algorithm, and of a variant of the algorithm due to May, Meurer and Thomae.

- Participants: Grégory Landaïs and Nicolas Sendrier
- Contact: Anne Canteaut
- URL: <https://gforge.inria.fr/projects/collision-dec/>

SPADES Project-Team

5. New Software and Platforms

5.1. pyCPA_TCA

FUNCTIONAL DESCRIPTION: We are developing pyCPA_TCA , a pyCPA plugin for Typical Worst-Case Analysis as described in Section. pyCPA is an open-source Python implementation of Compositional Performance Analysis developed at TU Braunschweig, which allows in particular response-time analysis. pyCPA_TCA is an extension of this tool that is co-developed by Sophie Quinton and Zain Hammadeh at TU Braunschweig. It allows in particular the computation of weakly-hard guarantees for real-time tasks, i.e. number of deadline misses out of a sequence of executions. So far, pyCPA_TCA is restricted to uniprocessor systems of independent tasks, scheduled according to static priority scheduling.

- Contact: Sophie Quinton

5.2. LDDL

Coq proofs of circuit transformations for fault-tolerance

KEYWORDS: Fault-tolerance - Transformation - Coq - Semantics

FUNCTIONAL DESCRIPTION: We have been developing a Coq-based framework to formally verify the functional and fault-tolerance properties of circuit transformations. Circuits are described at the gate level using LDDL, a Low-level Dependent Description Language inspired from muFP. Our combinator language, equipped with dependent types, ensures that circuits are well-formed by construction (gates correctly plugged, no dangling wires, no combinational loops, . . .). Faults like Single-Event Upsets (SEUs) (i.e., bit-flips in flipflops) and SETs (i.e., glitches propagating in the combinational circuit) and fault-models like "at most 1 SEU or SET within n clock cycles" are described in the operational semantics of LDDL. Fault-tolerance techniques are described as transformations of LDDL circuits.

The framework has been used to prove the correctness of three fault-tolerance techniques: TMR, TTR and DTR. The size of specifications and proofs for the common part (LDDL syntax and semantics, libraries) is 5000 lines of Coq (excluding comments and blank lines), 700 for TMR, 3500 for TTR and 7000 for DTR.

- Authors: Pascal Fradet and Dmitry Burlyaev
- Contact: Pascal Fradet
- URL: <https://team.inria.fr/spades/fthwproofs/>

SPECFUN Project-Team

5. New Software and Platforms

5.1. DynaMoW

Dynamic Mathematics on the Web

FUNCTIONAL DESCRIPTION: Programming tool for controlling the generation of mathematical websites that embed dynamical mathematical contents generated by computer-algebra calculations. Implemented in OCaml.

- Participants: Alexis Darrasse, Frédéric Chyzak and Maxence Guesdon
- Contact: Frédéric Chyzak
- URL: <http://ddmf.msr-inria.inria.fr/DynaMoW/>

5.2. ECS

Encyclopedia of Combinatorial Structures

FUNCTIONAL DESCRIPTION: On-line mathematical encyclopedia with an emphasis on sequences that arise in the context of decomposable combinatorial structures, with the possibility to search by the first terms in the sequence, keyword, generating function, or closed form.

- Participants: Alexis Darrasse, Frédéric Chyzak, Maxence Guesdon and Stéphanie Petit
- Contact: Frédéric Chyzak
- URL: <http://ecs.inria.fr/>

5.3. DDMF

Dynamic Dictionary of Mathematical Functions

FUNCTIONAL DESCRIPTION: Web site consisting of interactive tables of mathematical formulas on elementary and special functions. The formulas are automatically generated by OCaml and computer-algebra routines. Users can ask for more terms of the expansions, more digits of the numerical values, proofs of some of the formulas, etc.

- Participants: Alexandre Benoit, Alexis Darrasse, Bruno Salvy, Christoph Koutschan, Frédéric Chyzak, Marc Mezzarobba, Maxence Guesdon, Stefan Gerhold and Thomas Gregoire
- Contact: Frédéric Chyzak
- URL: <http://ddmf.msr-inria.inria.fr/1.9.1/ddmf>

5.4. Mgfund

multivariate generating functions package

FUNCTIONAL DESCRIPTION: The Mgfund Project is a collection of packages for the computer algebra system Maple, and is intended for the symbolic manipulation of a large class of special functions and combinatorial sequences (in one or several variables and indices) that appear in many branches of mathematics, mathematical physics, and engineering sciences. Members of the class satisfy a crucial finiteness property which makes the class amenable to computer algebra methods and enjoy numerous algorithmic closure properties, including algorithmic closures under integration and summation.

- Contact: Frédéric Chyzak
- URL: <http://specfun.inria.fr/chyzak/mgfund.html>

5.5. Ssreflect

FUNCTIONAL DESCRIPTION: Ssreflect is a tactic language extension to the Coq system, developed by the Mathematical Components team.

- Participants: Assia Mahboubi, Cyril Cohen, Enrico Tassi, Georges Gonthier, Laurence Rideau, Laurent Théry and Yves Bertot
- Contact: Yves Bertot
- URL: <http://math-comp.github.io/math-comp/>

5.6. Math-Components

Mathematical Components library

FUNCTIONAL DESCRIPTION: The Mathematical Components library is a set of Coq libraries that cover the mechanization of the proof of the Odd Order Theorem.

RELEASE FUNCTIONAL DESCRIPTION: The library includes 16 more theory files, covering in particular field and Galois theory, advanced character theory, and a construction of algebraic numbers.

- Participants: Alexey Solovyev, Andrea Asperti, Assia Mahboubi, Cyril Cohen, Enrico Tassi, François Garillot, Georges Gonthier, Ioana Pasca, Jeremy Avigad, Laurence Rideau, Laurent Théry, Russell O'Connor, Sidi Ould Biha, Stéphane Le Roux and Yves Bertot
- Contact: Assia Mahboubi
- URL: <http://math-comp.github.io/math-comp/>

5.7. CoqInterval

Interval package for Coq

KEYWORDS: Interval arithmetic - Coq

FUNCTIONAL DESCRIPTION: CoqInterval is a library for the proof assistant Coq.

It provides several tactics for proving theorems on enclosures of real-valued expressions. The proofs are performed by an interval kernel which relies on a computable formalization of floating-point arithmetic in Coq.

The Marelle team developed a formalization of rigorous polynomial approximation using Taylor models in Coq. In 2014, this library has been included in CoqInterval.

- Participants: Assia Mahboubi, Érik Martin-Dorel, Guillaume Melquiond, Jean-Michel Muller, Laurence Rideau, Laurent Théry, Micaela Mayero, Mioara Joldes, Nicolas Brisebarre and Thomas Sibut-Pinote
- Contact: Guillaume Melquiond
- Publications: [Proving bounds on real-valued functions with computations](#) - [Floating-point arithmetic in the Coq system](#) - [Proving Tight Bounds on Univariate Expressions with Elementary Functions in Coq](#) - [Formally Verified Approximations of Definite Integrals](#) - [Formally Verified Approximations of Definite Integrals](#)
- URL: <http://coq-interval.gforge.inria.fr/>

SUMO Project-Team

6. New Software and Platforms

6.1. Active Workspaces

KEYWORDS: Active workspace - Collaborative systems - Artifact centric workflow system

SCIENTIFIC DESCRIPTION: Tool for computer supported cooperative work where a user's workspace is given by an active structured repository containing the pending tasks together with information needed to perform the tasks. Communication between active workspaces is asynchronous using message passing. The tool is based on the model of guarded attribute grammars.

- Authors: Éric Badouel and Robert Nsaibirni
- Contact: Éric Badouel
- URL: <http://people.rennes.inria.fr/Eric.Badouel/Research/ActiveWorkspaces.html>

6.2. DAXML

KEYWORDS: XML - Web Services - Distributed Software - Active documents

SCIENTIFIC DESCRIPTION: DAXML is an interpreter and implementation of Distributed Active Documents, a formalism for data centric design of Web Services. This implementation is based on a REST framework, and can run on a network of machines connected to internet and equipped with JAVA.

FUNCTIONAL DESCRIPTION: This prototype interprets distributed Active XML documents. It can be used to deploy services defined as active documents over the web.

- Participants: Benoît Masson and Loïc Héluët
- Contact: Loïc Héluët
- URL: <http://www.irisa.fr/sumo/Software/DAXML/>

6.3. Sigali

FUNCTIONAL DESCRIPTION: Sigali is a model-checking tool that operates on ILTS (Implicit Labeled Transition Systems, an equational representation of an automaton), an intermediate model for discrete event systems. It offers functionalities for verification of reactive systems and discrete controller synthesis. The techniques used consist in manipulating the system of equations instead of the set of solutions, which avoids the enumeration of the state space. Each set of states is uniquely characterized by a predicate and the operations on sets can be equivalently performed on the associated predicates. Therefore, a wide spectrum of properties, such as liveness, invariance, reachability and attractivity, can be checked. Algorithms for the computation of predicates on states are also available. Sigali is connected with the Polychrony environment (Tea project-team) as well as the Matou environment (VERIMAG), thus allowing the modeling of reactive systems by means of Signal Specification or Mode Automata and the visualization of the synthesized controller by an interactive simulation of the controlled system.

- Contact: Hervé Marchand

6.4. SIMSTORS

Simulator for stochastic regulated systems

KEYWORDS: Simulation - Public transport - Stochastic models - Distributed systems

FUNCTIONAL DESCRIPTION: SIMSTORS is a software for the simulation of stochastic concurrent timed systems. The heart of the software is a variant of stochastic and timed Petri nets, whose execution is controlled by a regulation policy (a controller), or a predetermined theoretical schedule. The role of the regulation policy is to control the system to realize objectives or a schedule when it exists with the best possible precision. SIMSTORS is well adapted to represent systems with randomness, parallelism, tasks scheduling, and resources. It is currently in use within collaboration P22 with Asltom Transport, where it is used to model metro traffic and evaluate performance of regulation solutions. This software allows for step by step simulation, but also for efficient performance analysis of systems such as production cells or train systems. The initial implementation was released in 2015, and the software is protected by the APP.

In 2017, SIMSTORS has been extended along two main axes: on one hand, SIMSTORS models were extended to handle situations where shared resources can be occupied by more than one object (this is of paramount importance to represent conveyors, roads occupied by cars, or train tracks with smoothed scheduling allowing shared sections among trains) with priorities, constraint on their ordering and individual characteristics. This allows for instance to model vehicles with different speeds on a road, while handling safety distance constraints. On the other hand, SIMSTORS models were extended to allow control of stochastic nets based on decision rules that follow optimization schemes.

- Participants: Abd El Karim Kecir and Loïc Hélouët
- Contact: Loïc Hélouët
- URL: <http://www.irisa.fr/sumo/Software/SIMSTORS/>

6.5. Tipex

Timed Properties Enforcement during eXecution

KEYWORDS: Monitoring - Controller synthesis - Formal methods

FUNCTIONAL DESCRIPTION: We are implementing a prototype tool named Tipex (TImed Properties Enforcement during eXecution) for the enforcement of timed properties. Tipex is based on the theory and algorithms that we develop for the synthesis of enforcement monitors for properties specified by timed automata (TA). The prototype is developed in python, and uses the PyUPPAAL and DBMpyuppaal libraries of the UPPAAL tool . It is currently restricted to safety and co-safety timed property. The property provided as input to the tool is a TA that can be specified using the UPPAAL tool, and is stored in XML format. The tool synthesizes an enforcement monitor from this TA, which can then be used to enforce a sequence of timed events to satisfy the property. Experiments have been conducted on a set of case studies. This allowed to validate the architecture and feasibility of enforcement monitoring in a timed setting and to have a first assessment of performance (and to what extent the overhead induced by monitoring is negligible).

- Participants: Thierry Jéron, Srinivas Pinisetty and Hervé Marchand
- Contact: Thierry Jéron

TAMIS Team

6. New Software and Platforms

6.1. GNUnet

SCIENTIFIC DESCRIPTION: The GNUnet project seeks to answer the question what a modern Internet architecture should look like for a society that care about security and privacy. We are considering all layers of the existing well-known Internet, but are also providing new and higher-level abstractions (such as voting protocols, Byzantine consensus, etc.) that are today solved in application-specific ways. Research questions include the desired functionality of the overall stack, protocol design for the various layers as well as implementation considerations, i.e. how to implement the design securely.

FUNCTIONAL DESCRIPTION: GNUnet is a framework for secure peer-to-peer networking that does not use any centralized or otherwise trusted services. Our high-level goal is to provide a strong free software foundation for a global network that provides security and in particular respects privacy.

GNUnet started with an idea for anonymous censorship-resistant file-sharing, but has grown to incorporate other applications as well as many generic building blocks for secure networking applications. In particular, GNUnet now includes the GNU Name System, a privacy-preserving, decentralized public key infrastructure.

- Participants: Alvaro Garcia Recuero, Florian Dold, Gabor Toth, Hans Grothoff, Jeffrey Paul Burdges and Sree Hrsha Totakura
- Partner: The GNU Project
- Contact: Hans Grothoff
- URL: <https://gnunet.org/>

6.2. MHD

GNU libmicrohttpd

KEYWORDS: Embedded - Web 2.0

SCIENTIFIC DESCRIPTION: We are providing a standards compliant and complete implementation of the HTTP server protocol that allows developers to easily write correct HTTP servers. Key challenges include code size minimization (for IoT devices), performance (zero copy, scalability to 100k concurrent connections), portability and security. MHD is already widely used in production by both academic and industrial users. Ongoing research challenges include formal verification.

FUNCTIONAL DESCRIPTION: GNU libmicrohttpd is a small C library that is supposed to make it easy to run an HTTP server as part of another application.

- Participants: Evgeny Grin, Hans Grothoff and Sree Hrsha Totakura
- Partner: The GNU Project
- Contact: Hans Grothoff
- URL: <http://www.gnu.org/software/libmicrohttpd/>

6.3. PLASMA Lab

KEYWORDS: Energy - Statistics - Security - Runtime Analysis - Model Checker - Statistical - Model Checking - Aeronautics - Distributed systems

SCIENTIFIC DESCRIPTION: Statistical model checking (SMC) is a fast emerging technology for industrial scale verification and optimisation problems. SMC only requires an executable semantics and is not constrained by decidability. Therefore we can easily apply it to different modelling languages and logics. We have implemented in PLASMA Lab several advanced SMC algorithms that combine formal methods with statistical tests, which include techniques for rare events estimation and non-deterministic models.

FUNCTIONAL DESCRIPTION: PLASMA Lab is a compact, efficient and flexible platform for statistical model checking of stochastic models. PLASMA Lab includes simulators for PRISM models (Reactive Modules Language-RML) and Biological models. It also provides plugins that interface external simulators in order to support Matlab/Simulink, SytemC and LLVM . PLASMA Lab can be extended with new plugins to support other external simulators, and PLASMA Lab API can be used to embed the tool in other softwares. PLASMA Lab provide fast SMC algorithms, including advanced techniques for rare events simulation and nondeterministic models. These algorithms are designed in a distributed architecture to run large number of simulations on several computers, either on a local area network or grid. PLASMA Lab is implemented in Java with efficient data structures and low memory consumption

NEWS OF THE YEAR: In 2017 we have extended PLASMA Lab with a new simulator plugin that allows to verify LLVM code.

- Participants: Axel Legay, Jean Quilbeuf, Benoît Boyer, Kevin Corre, Louis-Marie Traonouez, Matthieu Simonin and Sean Sedwards
- Contact: Axel Legay
- URL: <https://project.inria.fr/plasma-lab/>

6.4. Taler

GNU Taler

KEYWORD: Privacy

SCIENTIFIC DESCRIPTION: Taler is a Chaum-style digital payment system that enables anonymous payments while ensuring that entities that receive payments are auditable. In Taler, customers can never defraud anyone, merchants can only fail to deliver the merchandise to the customer, and payment service providers can be fully audited. All parties receive cryptographic evidence for all transactions, still, each party only receives the minimum information required to execute transactions. Enforcement of honest behavior is timely, and is at least as strict as with legacy credit card payment systems that do not provide for privacy.

The key technical contribution underpinning Taler is a new refresh protocol which allows fractional payments and refunds while maintaining untraceability of the customer and unlinkability of transactions. The refresh protocol combines an efficient cut-and-choose mechanism with a link step to ensure that refreshing is not abused for transactional payments.

We argue that Taler provides a secure digital currency for modern liberal societies as it is a flexible, libre and efficient protocol and adequately balances the state's need for monetary control with the citizen's needs for private economic activity.

FUNCTIONAL DESCRIPTION: Taler is a new electronic payment system. It includes an electronic wallet for customers, a payment backend for merchants and the main payment service provider logic called the exchange. Taler offers Chaum-style anonymous payments for citizens, and income-transparency for taxability.

- Participants: Florian Dold, Gabor Toth, Hans Grothoff, Jeffrey Paul Burdges and Marcello Stanisci
- Partner: The GNU Project
- Contact: Hans Grothoff
- URL: <http://taler.net/>

6.5. HyLeak

Hybrid Analysis Tool for Information Leakage

KEYWORD: Information leakage

FUNCTIONAL DESCRIPTION: HyLeak is an evolution of the QUAIL tool, also developed by the TAMIS team. HyLeak divides the input program into (terminal) components and decides for each of them whether to analyze it using precise or statistical analysis, by applying heuristics that evaluate the analysis cost of each component. Then, HyLeak composes the analysis results of all components into an approximate joint probability distribution of the secret and observable variables in the program. Finally, the tool estimates the Shannon leakage and its confidence interval.

- Partner: AIST Tsukuba
- Contact: Fabrizio Biondi

6.6. SimFI

Tool for Simulation Fault injection

KEYWORDS: Fault injection - Fault-tolerance

FUNCTIONAL DESCRIPTION: Fault injections are used to test the robust and security of systems. We have developed SimFI, a tool that can be used to simulate fault injection attacks against binary files. SimFI is lightweight utility designed to be integrated into larger environments as part of robustness testing and fault injection vulnerability detection.

- Contact: Nisrine Jafri
- URL: <https://github.com/nisrine/Fault-Injection-Tool>

6.7. DaD

Data-aware Defense

KEYWORD: Ransomware

FUNCTIONAL DESCRIPTION: DaD is a ransomware countermeasure based on a file system minifilter driver. It is a proof of concept and in its present condition cannot be used as a replacement of the existing antivirus solutions. DaD detects randomness of the data by monitoring the write operations on the file system. We monitor all the userland threads, and also the whole file system (i.e., not restricted to Documents). It blocks the threads that exceed a specific threshold. The malicious thread is not killed, we only block its next I/O operations.

- Contact: Aurélien Palisse

6.8. MASSE

Modular Automated Syntactic Signature Extraction

KEYWORDS: Malware - Syntactic analysis

FUNCTIONAL DESCRIPTION: The Modular Automated Syntactic Signature Extraction (MASSE) architecture is a new integrated open source client-server architecture for syntactic malware detection and analysis based on the YARA, developed with Teclib'. MASSE includes highly effective automated syntactic malware detection rule generation for the clients based on a server-side modular malware detection system. Multiple techniques are used to make MASSE effective at detecting malware while keeping it from disrupting users and hindering reverse-engineering of its malware analysis by malware creators. MASSE integrates YARA in a distributed system able to detect malware on endpoint systems using YARA, analyze malware with multiple analysis techniques, automatically generate syntactic malware detection rules, and deploy the new rules to the endpoints. The MASSE architecture is freely available to companies and institutions as a complete, modular, self-maintained antivirus solution. Using MASSE, a security department can immediately update the rule database of the whole company, stopping an infection on its tracks and preventing future ones.

- Contact: Axel Legay

6.9. Behavioral Malware Analysis

KEYWORDS: Artificial intelligence - Malware - Automatic Learning - Concolic Execution

FUNCTIONAL DESCRIPTION: Our approach is based on artificial intelligence. We extract graphs from programs, that represent their behaviors. Such graphs are called system call dependency graphs (SCDGs). Our software learns to distinguish malware from cleanware on a large set of malwares and cleanwares. Whenever we want to analyze a new program, we extract its graphs and use the result of the training to decide whether the new program to analyze is a malware.

- Partner: Cisco
- Contact: Axel Legay
- URL: <https://team.inria.fr/tamis/>

6.10. VITRAIL - Visualisation Tool

Real-Time, Advanced, Immersive Visualization of Software / Visualizer

KEYWORD: Visualization of software

SCIENTIFIC DESCRIPTION: It is difficult for developers to explore and understand the source code of large programs, for example in objet-oriented languages programs featuring thousands of classes. Visualization methods based on daily life metaphors have thus been proposed. The VITRAIL Visualization tool (or VITRAIL Vizualizer) makes it possible to display, visualize and explore Java programs in a metaphorical way, using the city metaphor. An execution trace of the Java (byte)code provided by VITRAIL JBInstrace tool, is provided as input to VITRAIL Visualizer which displays a city-like metaphorical world showing the static structure of the code as well as some dynamic elements (calls).

FUNCTIONAL DESCRIPTION: This program makes it possible to displays, visualizes and explores Java programs in a metaphorical way (using the city metaphore). Useful for complex application developers/architects.

RELEASE FUNCTIONAL DESCRIPTION: Early release

- Participants: Damien Bodenes, Olivier Demengeon and Olivier Zendra
- Contact: Olivier Zendra
- URL: <http://vitrail.loria.fr>

6.11. VITRAIL 6 JBInsTrace

Real-Time, Advanced, Immersive Visualization of Software / Java Bytecode Instrumenter and Tracer

KEYWORDS: Execution trace - Profiling - Instrumentation - Bytecode - Java - Basic block

SCIENTIFIC DESCRIPTION: VITRAIL JBInsTrace is a program to instrument Java bytecode to trace its execution. The trace contains both static and dynamic information (calls). It is produced by intercepting the JVM class loader and replacing it by ours. Thus Java bytecode file are not modified, since instrumentation is performed on the fly, in memory. This makes it possible to instrument the whole program code, including libraries. Java source code is not needed. The trace which is then fed into our program VITRAIL Visualizer is an XML-like file.

FUNCTIONAL DESCRIPTION: VITRAIL JBInsTrace is a program to instrument Java bytecode files to trace their execution. The trace is then fed into our VITRAIL Visualizer tool.

- Participants: Olivier Zendra and Pierre Caserta
- Contact: Olivier Zendra
- URL: <http://vitrail.loria.fr>

6.12. Platforms

6.12.1. Malware'o'Matic

This LHS platform is dedicated to the collect, the categorization and the analyze of malware. We are currently interested in a specific kind of malware the ransomware. The platform grabs periodically samples of public data bases, executes the ransomware without virtualization on a victim PC and evaluate the implemented detection mechanisms. Once a ransomware has been executed the image of the OS is automatically restored and a new sample is evaluated. The platform is fully automatic and target Windows platforms (seven, W10) in both 32 bits and 64 bits versions. More recent developments can be seen in the LHS Activity Report.

6.12.2. Faustine

This LHS platform is dedicated to the EM fault injection experiments. It is composed of a motion table (XY), a pulse generator, an amplifier and a control PC. It injects EM pulses in a controlled way on a targeted device using an EM probe. It controls with a high precision the timing and the edges of the pulse. A recent development consists in adding a FPGA board to control the trigger in a more convenient and precise way. Then, the pulse can be triggered while a specific information is sent to the board under attack. More recent developments can be seen in the LHS Activity Report.

TEA Project-Team

6. New Software and Platforms

6.1. ADFG

Affine data-flow graphs schedule synthesizer

KEYWORDS: Code generation - Scheduling - Static program analysis

FUNCTIONAL DESCRIPTION: ADFG is a synthesis tool of real-time system scheduling parameters: ADFG computes task periods and buffer sizes of systems resulting in a trade-off between throughput maximization and buffer size minimization. ADFG synthesizes systems modeled by ultimately cyclo-static dataflow (UCSDF) graphs, an extension of the standard CSDF model.

Knowing the WCET (Worst Case Execute Time) of the actors and their exchanges on the channels, ADFG tries to synthesize the scheduler of the application. ADFG offers several scheduling policies and can detect unschedulable systems. It ensures that the real scheduling does not cause overflows or underflows and tries to maximize the throughput (the processors utilization) while minimizing the storage space needed between the actors (i.e. the buffer sizes).

Abstract affine scheduling is first applied on the dataflow graph, that consists only of periodic actors, to compute timeless scheduling constraints (e.g. relation between the speeds of two actors) and buffering parameters. Then, symbolic schedulability policies analysis (i.e., synthesis of timing and scheduling parameters of actors) is applied to produce the scheduler for the actors.

ADFG, initially defined to synthesize real-time schedulers for SCJ/L1 applications, may be used for scheduling analysis of AADL programs.

- Authors: Thierry Gautier, Jean-Pierre Talpin, Adnan Bouakaz, Alexandre Honorat and Loïc Besnard
- Contact: Loïc Besnard

6.2. POLYCHRONY

KEYWORDS: Code generation - AADL - Proof - Optimization - Multi-clock - GALS - Architecture - Cosimulation - Real time - Synchronous Language

FUNCTIONAL DESCRIPTION: Polychrony is an Open Source development environment for critical/embedded systems. It is based on Signal, a real-time polychronous data-flow language. It provides a unified model-driven environment to perform design exploration by using top-down and bottom-up design methodologies formally supported by design model transformations from specification to implementation and from synchrony to asynchrony. It can be included in heterogeneous design systems with various input formalisms and output languages. The Polychrony tool-set provides a formal framework to: validate a design at different levels, by the way of formal verification and/or simulation, refine descriptions in a top-down approach, abstract properties needed for black-box composition, compose heterogeneous components (bottom-up with COTS), generate executable code for various architectures. The Polychrony tool-set contains three main components and an experimental interface to GNU Compiler Collection (GCC):

* The Signal toolbox, a batch compiler for the Signal language, and a structured API that provides a set of program transformations. It can be installed without other components and is distributed under GPL V2 license.

* The Signal GUI, a Graphical User Interface to the Signal toolbox (editor + interactive access to compiling functionalities). It can be used either as a specific tool or as a graphical view under Eclipse. It has been transformed and restructured, in order to get a more up-to-date interface allowing multi-window manipulation of programs. It is distributed under GPL V2 license.

* The POP Eclipse platform, a front-end to the Signal toolbox in the Eclipse environment. It is distributed under EPL license.

- Participants: Loïc Besnard, Paul Le Guernic and Thierry Gautier
- Partners: CNRS - Inria
- Contact: Loïc Besnard
- URL: <https://www.polarsys.org/projects/polarsys.pop>

6.3. Polychrony AADL2SIGNAL

KEYWORDS: Real-time application - Polychrone - Synchronous model - Polarsys - Polychrony - Signal - AADL - Eclipse - Meta model

FUNCTIONAL DESCRIPTION: This polychronous MoC has been used previously as semantic model for systems described in the core AADL standard. The core AADL is extended with annexes, such as the Behavior Annex, which allows to specify more precisely architectural behaviors. The translation from AADL specifications into the polychronous model should take into account these behavior specifications, which are based on description of automata.

For that purpose, the AADL state transition systems are translated as Signal automata (a slight extension of the Signal language has been defined to support the model of polychronous automata).

Once the AADL model of a system transformed into a Signal program, one can analyze the program using the Polychrony framework in order to check if timing, scheduling and logical requirements over the whole system are met.

We have implemented the translation and experimented it using a concrete case study, which is the AADL modeling of an Adaptive Cruise Control (ACC) system, a highly safety-critical system embedded in recent cars.

- Participants: Huafeng Yu, Loïc Besnard, Paul Le Guernic, Thierry Gautier and Yue Ma
- Partner: CNRS
- Contact: Loïc Besnard
- URL: <http://www.inria.fr/equipes/tea>

6.4. POP

Polychrony on Polarsys

KEYWORDS: Synchronous model - Model-driven engineering

FUNCTIONAL DESCRIPTION: The Eclipse project POP is a model-driven engineering front-end to our open-source toolset Polychrony, a major achievement of the ESPRESSO (and now TEA) project-team. The Eclipse project POP is a model-driven engineering front-end to our open-source toolset Polychrony. It was finalised in the frame of project OPEES, as a case study: by passing the POLARSYS qualification kit as a computer aided simulation and verification tool. This qualification was implemented by CS Toulouse in conformance with relevant generic (platform independent) qualification documents. Polychrony is now distributed by the Eclipse project POP on the platform of the POLARSYS industrial working group. Team TEA aims at continuing its dissemination to academic partners, as to its principles and features, and industrial partners, as to the services it can offer.

Project POP is composed of the Polychrony tool set, under GPL license, and its Eclipse framework, under EPL license. SSME (Syntactic Signal-Meta under Eclipse), is the meta-model of the Signal language implemented with Eclipse/Ecore. It describes all syntactic elements specified in Signal Reference Manual ⁰: all Signal operators (e.g. arithmetic, clock synchronization), model (e.g. process frame, module), and construction (e.g. iteration, type declaration). The meta-model primarily aims at making the language and services of the Polychrony environment available to inter-operation and composition with other components (e.g. AADL, Simulink, GeneAuto, P) within an Eclipse-based development tool-chain. Polychrony now comprises the capability to directly import and export Ecore models instead of textual Signal programs, in order to facilitate interaction between components within such a tool-chain. The download site for project POP has opened in 2015 at <https://www.polarsys.org/projects/polarsys.pop>. It should be noted that the Eclipse Foundation does not host code under GPL license. So, the Signal toolbox useful to compile Signal code from Eclipse is hosted on our web server.

- Participants: Jean-Pierre Talpin, Loïc Besnard, Paul Le Guernic and Thierry Gautier
- Contact: Loïc Besnard
- URL: <https://www.polarsys.org/projects/polarsys.pop>

6.5. Sigali

FUNCTIONAL DESCRIPTION: Sigali is a model-checking tool that operates on ILTS (Implicit Labeled Transition Systems, an equational representation of an automaton), an intermediate model for discrete event systems. It offers functionalities for verification of reactive systems and discrete controller synthesis. The techniques used consist in manipulating the system of equations instead of the set of solutions, which avoids the enumeration of the state space. Each set of states is uniquely characterized by a predicate and the operations on sets can be equivalently performed on the associated predicates. Therefore, a wide spectrum of properties, such as liveness, invariance, reachability and attractivity, can be checked. Algorithms for the computation of predicates on states are also available. Sigali is connected with the Polychrony environment (Tea project-team) as well as the Matou environment (VERIMAG), thus allowing the modeling of reactive systems by means of Signal Specification or Mode Automata and the visualization of the synthesized controller by an interactive simulation of the controlled system.

- Contact: Hervé Marchand

⁰

SIGNAL V4-Inria version: Reference Manual. Besnard, L., Gautier, T. and Le Guernic, P.
<http://www.irisa.fr/espresso/Polychrony>, 2010

TOCCATA Project-Team

6. New Software and Platforms

6.1. Alt-Ergo

Automated theorem prover for software verification

KEYWORDS: Software Verification - Automated theorem proving

FUNCTIONAL DESCRIPTION: Alt-Ergo is an automatic solver of formulas based on SMT technology. It is especially designed to prove mathematical formulas generated by program verification tools, such as Frama-C for C programs, or SPARK for Ada code. Initially developed in Toccata research team, Alt-Ergo's distribution and support are provided by OCamlPro since September 2013.

RELEASE FUNCTIONAL DESCRIPTION: the "SAT solving" part can now be delegated to an external plugin, new experimental SAT solver based on mini-SAT, provided as a plugin. This solver is, in general, more efficient on ground problems, heuristics simplification in the default SAT solver and in the matching (instantiation) module, re-implementation of internal literals representation, improvement of theories combination architecture, rewriting some parts of the formulas module, bugfixes in records and numbers modules, new option "-no-Ematching" to perform matching without equality reasoning (i.e. without considering "equivalence classes"). This option is very useful for benchmarks coming from Atelier-B, two new experimental options: "-save-used-context" and "-replay-used-context". When the goal is proved valid, the first option allows to save the names of useful axioms into a ".used" file. The second one is used to replay the proof using only the axioms listed in the corresponding ".used" file. Note that the replay may fail because of the absence of necessary ground terms generated by useless axioms (that are not included in .used file) during the initial run.

- Participants: Alain Mebsout, Évelyne Contejean, Mohamed Iguernelala, Stéphane Lescuyer and Sylvain Conchon
- Partner: OCamlPro
- Contact: Sylvain Conchon
- URL: <http://alt-ergo.lri.fr>

6.2. CFML

Interactive program verification using characteristic formulae

KEYWORDS: Coq - Software Verification - Deductive program verification - Separation Logic

FUNCTIONAL DESCRIPTION: The CFML tool supports the verification of OCaml programs through interactive Coq proofs. CFML proofs establish the full functional correctness of the code with respect to a specification. They may also be used to formally establish bounds on the asymptotic complexity of the code. The tool is made of two parts: on the one hand, a characteristic formula generator implemented as an OCaml program that parses OCaml code and produces Coq formulae, and, on the other hand, a Coq library that provides notations and tactics for manipulating characteristic formulae interactively in Coq.

- Participants: Arthur Charguéraud, Armaël Guéneau and François Pottier
- Contact: Arthur Charguéraud
- URL: <http://www.chargueraud.org/softs/cfml/>

6.3. Coq

The Coq Proof Assistant

KEYWORDS: Proof - Certification - Formalisation

SCIENTIFIC DESCRIPTION: Coq is an interactive proof assistant based on the Calculus of (Co-)Inductive Constructions, extended with universe polymorphism. This type theory features inductive and co-inductive families, an impredicative sort and a hierarchy of predicative universes, making it a very expressive logic. The calculus allows to formalize both general mathematics and computer programs, ranging from theories of finite structures to abstract algebra and categories to programming language metatheory and compiler verification. Coq is organised as a (relatively small) kernel including efficient conversion tests on which are built a set of higher-level layers: a powerful proof engine and unification algorithm, various tactics/decision procedures, a transactional document model and, at the very top an IDE.

FUNCTIONAL DESCRIPTION: Coq provides both a dependently-typed functional programming language and a logical formalism, which, altogether, support the formalisation of mathematical theories and the specification and certification of properties of programs. Coq also provides a large and extensible set of automatic or semi-automatic proof methods. Coq's programs are extractible to OCaml, Haskell, Scheme, ...

RELEASE FUNCTIONAL DESCRIPTION: Version 8.7 features a large amount of work on cleaning and speeding up the code base, notably the work of Pierre-Marie Pédro on making the tactic-level system insensitive to existential variable expansion, providing a safer API to plugin writers and making the code more robust.

New tactics: Variants of tactics supporting existential variables "eassert", "eenough", etc. by Hugo Herbelin. Tactics "extensionality in H" and "inversion_sigma" by Jason Gross, "specialize with" accepting partial bindings by Pierre Courtieu.

Cumulative Polymorphic Inductive Types, allowing cumulativity of universes to go through applied inductive types, by Amin Timany and Matthieu Sozeau.

The SSReflect plugin by Georges Gonthier, Assia Mahboubi and Enrico Tassi was integrated (with its documentation in the reference manual) by Maxime Dénès, Assia Mahboubi and Enrico Tassi.

The "coq_makefile" tool was completely redesigned to improve its maintainability and the extensibility of generated Makefiles, and to make "_CoqProject" files more palatable to IDEs by Enrico Tassi.

A lot of other changes are described in the CHANGES file.

NEWS OF THE YEAR: Version 8.7 was released in October 2017 and version 8.7.1 in December 2017, development started in January 2017. This is the second release of Coq developed on a time-based development cycle. Its development spanned 9 months from the release of Coq 8.6 and was based on a public road-map. It attracted many external contributions. Code reviews and continuous integration testing were systematically used before integration of new features, with an important focus given to compatibility and performance issues.

The main scientific advance in this version is the integration of cumulative inductive types in the system. More practical advances in stability, performance, usability and expressivity of tactics were also implemented, resulting in a mostly backwards-compatible but appreciably faster and more robust release. Much work on plugin extensions to Coq by the same development team has also been going on in parallel, including work on JSCoq by Emilio JG Arias, Ltac 2 by P.M-Pédrot, which required synchronised changes of the main codebase. In 2017, the construction of the Coq Consortium by Yves Bertot and Maxime Dénès has greatly advanced and is now nearing its completion.

- Participants: Abhishek Anand, C. J. Bell, Yves Bertot, Frédéric Besson, Tej Chajed, Pierre Courtieu, Maxime Denes, Julien Forest, Emilio Jesús Gallego Arias, Gaëtan Gilbert, Benjamin Grégoire, Jason Gross, Hugo Herbelin, Ralf Jung, Matej Kosik, Sam Pablo Kuper, Xavier Leroy, Pierre Letouzey, Assia Mahboubi, Cyprien Mangin, Érik Martin-Dorel, Olivier Marty, Guillaume Melquiond, Pierre-Marie Pédro, Benjamin C. Pierce, Lars Rasmusson, Yann Régis-Gianas, Lionel Rieg, Valentin Robert, Thomas Sibut-Pinote, Michael Soegtrop, Matthieu Sozeau, Arnaud Spiwack, Paul Steckler, George Stelle, Pierre-Yves Strub, Enrico Tassi, Hendrik Tews, Laurent Théry, Amin Timany, Vadim Zaliva and Théo Zimmermann
- Partners: CNRS - Université Paris-Sud - ENS Lyon - Université Paris-Diderot
- Contact: Matthieu Sozeau
- Publication: **The Coq Proof Assistant, version 8.7.1**
- URL: <http://coq.inria.fr/>

6.4. CoqInterval

Interval package for Coq

KEYWORDS: Interval arithmetic - Coq

FUNCTIONAL DESCRIPTION: CoqInterval is a library for the proof assistant Coq.

It provides several tactics for proving theorems on enclosures of real-valued expressions. The proofs are performed by an interval kernel which relies on a computable formalization of floating-point arithmetic in Coq.

The Marelle team developed a formalization of rigorous polynomial approximation using Taylor models in Coq. In 2014, this library has been included in CoqInterval.

- Participants: Assia Mahboubi, Érik Martin-Dorel, Guillaume Melquiond, Jean-Michel Muller, Laurence Rideau, Laurent Théry, Micaela Mayero, Mioara Joldes, Nicolas Brisebarre and Thomas Sibut-Pinote
- Contact: Guillaume Melquiond
- Publications: [Proving bounds on real-valued functions with computations - Floating-point arithmetic in the Coq system](#) - [Proving Tight Bounds on Univariate Expressions with Elementary Functions in Coq](#) - [Formally Verified Approximations of Definite Integrals](#) - [Formally Verified Approximations of Definite Integrals](#)
- URL: <http://coq-interval.gforge.inria.fr/>

6.5. Coquelicot

The Coquelicot library for real analysis in Coq

KEYWORDS: Coq - Real analysis

FUNCTIONAL DESCRIPTION: Coquelicot is library aimed for supporting real analysis in the Coq proof assistant. It is designed with three principles in mind. The first is the user-friendliness, achieved by implementing methods of automation, but also by avoiding dependent types in order to ease the stating and readability of theorems. This latter part was achieved by defining total function for basic operators, such as limits or integrals. The second principle is the comprehensiveness of the library. By experimenting on several applications, we ensured that the available theorems are enough to cover most cases. We also wanted to be able to extend our library towards more generic settings, such as complex analysis or Euclidean spaces. The third principle is for the Coquelicot library to be a conservative extension of the Coq standard library, so that it can be easily combined with existing developments based on the standard library.

- Participants: Catherine Lelay, Guillaume Melquiond and Sylvie Boldo
- Contact: Sylvie Boldo
- URL: <http://coquelicot.saclay.inria.fr/>

6.6. Cubicle

The Cubicle model checker modulo theories

KEYWORDS: Model Checking - Software Verification

FUNCTIONAL DESCRIPTION: Cubicle is an open source model checker for verifying safety properties of array-based systems, which corresponds to a syntactically restricted class of parametrized transition systems with states represented as arrays indexed by an arbitrary number of processes. Cache coherence protocols and mutual exclusion algorithms are typical examples of such systems.

- Participants: Alain Mebsout and Sylvain Conchon
- Contact: Sylvain Conchon
- URL: <http://cubicle.lri.fr/>

6.7. Flocq

The Flocq library for formalizing floating-point arithmetic in Coq

KEYWORDS: Floating-point - Arithmetic code - Coq

FUNCTIONAL DESCRIPTION: The Flocq library for the Coq proof assistant is a comprehensive formalization of floating-point arithmetic: core definitions, axiomatic and computational rounding operations, high-level properties. It provides a framework for developers to formally verify numerical applications.

Flocq is currently used by the CompCert verified compiler to support floating-point computations.

- Participants: Guillaume Melquiond, Pierre Roux and Sylvie Boldo
- Contact: Sylvie Boldo
- Publications: [Flocq: A Unified Library for Proving Floating-point Algorithms in Coq](#) - [A Formally-Verified C Compiler Supporting Floating-Point Arithmetic](#) - [Verified Compilation of Floating-Point Computations](#) - [Innocuous Double Rounding of Basic Arithmetic Operations](#) - [Formal Proofs of Rounding Error Bounds](#) - [Computer Arithmetic and Formal Proofs](#)
- URL: <http://flocq.gforge.inria.fr/>

6.8. Gappa

The Gappa tool for automated proofs of arithmetic properties

KEYWORDS: Floating-point - Arithmetic code - Software Verification - Constraint solving

FUNCTIONAL DESCRIPTION: Gappa is a tool intended to help formally verifying numerical programs dealing with floating-point or fixed-point arithmetic. It has been used to write robust floating-point filters for CGAL and it is used to verify elementary functions in CRLibm. While Gappa is intended to be used directly, it can also act as a backend prover for the Why3 software verification platform or as an automatic tactic for the Coq proof assistant.

- Participant: Guillaume Melquiond
- Contact: Guillaume Melquiond
- Publications: [Generating formally certified bounds on values and round-off errors](#) - [Formal certification of arithmetic filters for geometric predicates](#) - [Assisted verification of elementary functions](#) - [From interval arithmetic to program verification](#) - [Formally Certified Floating-Point Filters For Homogeneous Geometric Predicates](#) - [Combining Coq and Gappa for Certifying Floating-Point Programs](#) - [Handbook of Floating-Point Arithmetic](#) - [Certifying the floating-point implementation of an elementary function using Gappa](#) - [Automations for verifying floating-point algorithms](#) - [Automating the verification of floating-point algorithms](#) - [Computer Arithmetic and Formal Proofs](#)
- URL: <http://gappa.gforge.inria.fr/>

6.9. Why3

The Why3 environment for deductive verification

KEYWORDS: Formal methods - Trusted software - Software Verification - Deductive program verification

FUNCTIONAL DESCRIPTION: Why3 is an environment for deductive program verification. It provides a rich language for specification and programming, called WhyML, and relies on external theorem provers, both automated and interactive, to discharge verification conditions. Why3 comes with a standard library of logical theories (integer and real arithmetic, Boolean operations, sets and maps, etc.) and basic programming data structures (arrays, queues, hash tables, etc.). A user can write WhyML programs directly and get correct-by-construction OCaml programs through an automated extraction mechanism. WhyML is also used as an intermediate language for the verification of C, Java, or Ada programs.

- Participants: Andriy Paskevych, Claude Marché, François Bobot, Guillaume Melquiond, Jean-Christophe Filliâtre, Levs Gondelmans and Martin Clochard
- Partners: CNRS - Université Paris-Sud
- Contact: Claude Marché
- URL: <http://why3.lri.fr/>

VERIDIS Project-Team

6. New Software and Platforms

6.1. Redlog

Reduce Logic System

KEYWORDS: Computer algebra system (CAS) - First-order logic - Constraint solving

SCIENTIFIC DESCRIPTION: Redlog is an integral part of the interactive computer algebra system Reduce. It supplements Reduce's comprehensive collection of powerful methods from symbolic computation by supplying more than 100 functions on first-order formulas.

Redlog generally works with interpreted first-order logic in contrast to free first-order logic. Each first-order formula in Redlog must exclusively contain atoms from one particular Redlog-supported theory, which corresponds to a choice of admissible functions and relations with fixed semantics. Redlog-supported theories include Nonlinear Real Arithmetic (Real Closed Fields), Presburger Arithmetic, Parametric QSAT, and many more.

NEWS OF THE YEAR: In 2017, there was a strong focus on applications of Redlog. With the final phase of the ANR-DFG Project SMaRT, Redlog was integrated with the SMT solver veriT. That combination, as well as a stand-alone version of Redlog, participated in the SMT competition SMTCOMP 2017. All configurations performed very well, the stand-alone version won the category NRA (nonlinear real arithmetic).

On the scientific side, we made significant progress with the symbolic bifurcation analysis for biological networks.

Redlog technology for biological network analysis from last year, viz. subtropical solving, has raised considerable attention in the SMT community, where it has been adopted and triggered new research.

- Participant: Thomas Sturm
- Contact: Thomas Sturm
- URL: <http://www.redlog.eu/>

6.2. SPASS

KEYWORD: First-order logic

SCIENTIFIC DESCRIPTION: The classic SPASS is an automated theorem prover based on superposition that handles first-order logic with equality and several extensions for particular classes of theories. With version SPASS 3.9 we have stopped the development of the classic prover and have started the bottom-up development of SPASS 4.0 that will actually be a workbench of automated reasoning tools. Furthermore, we use SPASS 3.9 as a test bed for the development of new calculi.

Meanwhile we have released the second version of SPASS-IQ, our solver for linear integer arithmetic that we are currently extending to real and mixed real-integer arithmetic. We didn't release SPASS-SATT yet, instead we further investigated the use of redundancy elimination in SAT solving and underlying implementation techniques. Our aim is a new approach to SAT solving that needs fewer conflicts (on average) *and* is faster than the current state-of-the-art solvers. Furthermore, we have developed a new calculus and first prototypical implementation of a SAT solver with mixed OR/XOR clauses.

SPASS 3.9 has been used as the basis for SPASS-AR, an new approximation refinement theorem proving approach.

FUNCTIONAL DESCRIPTION: SPASS is an automated theorem prover based on superposition that handles first-order logic with equality and several extensions for particular classes of theories.

- Contact: Christoph Weidenbach
- URL: <http://www.spass-prover.org/>

6.3. TLAPS

TLA+ proof system

KEYWORD: Proof assistant

FUNCTIONAL DESCRIPTION: TLAPS is a platform for developing and mechanically verifying proofs about TLA+ specifications. The TLA+ proof language is hierarchical and explicit, allowing a user to decompose the overall proof into proof steps that can be checked independently. TLAPS consists of a proof manager that interprets the proof language and generates a collection of proof obligations that are sent to backend verifiers. The current backends include the tableau-based prover Zenon for first-order logic, Isabelle/TLA+, an encoding of TLA+ set theory as an object logic in the logical framework Isabelle, an SMT backend designed for use with any SMT-lib compatible solver, and an interface to a decision procedure for propositional temporal logic. NEWS OF THE YEAR: In 2017, we have continued to work on a complete reimplementing of the proof manager. Its objectives are a cleaner interaction with the TLA⁺ front-ends, in particular SANY, the standard parser and semantic analyzer. The reimplementing is also necessary for extending the scope of the fragment of TLA⁺ that is handled by TLAPS, in particular full temporal logic and module instantiation.

- Participants: Damien Doligez, Stephan Merz and Martin Riener
- Contact: Stephan Merz
- URL: <https://tla.msr-inria.inria.fr/tlaps/content/Home.html>

6.4. veriT

KEYWORDS: Automated deduction - Formula solving - Verification

SCIENTIFIC DESCRIPTION: veriT comprises a SAT solver, a decision procedure for uninterpreted symbols based on congruence closure, a simplex-based decision procedure for linear arithmetic, and instantiation-based quantifier handling.

FUNCTIONAL DESCRIPTION: VeriT is an open, trustable and efficient SMT (Satisfiability Modulo Theories) solver, featuring efficient decision procedure for uninterpreted symbols and linear arithmetic, and quantifier reasoning.

NEWS OF THE YEAR: Efforts in 2017 have been focused on non-linear arithmetic reasoning and quantifier handling. The reasoning capabilities of veriT have been significantly improved along those two axes.

The veriT solver participated in the SMT competition **SMT-COMP 2017** with good results.

We target applications where validation of formulas is crucial, such as the validation of TLA⁺ and B specifications, and work together with the developers of the respective verification platforms to make veriT even more useful in practice. The solver is available as a plugin for the Rodin platform, it is integrated within the Atelier B.

- Participants: Haniel Barbosa, Daniel El Ouraoui, Pascal Fontaine and Hans-Jörg Schurr
- Partner: Université de Lorraine
- Contact: Pascal Fontaine
- URL: <http://www.veriT-solver.org>

6.5. Nunchaku

The Nunchaku Higher-Order Model Finder

KEYWORDS: Proof - Higher-order logic

SCIENTIFIC DESCRIPTION: Nunchaku is a model finder for higher-order logic, with dedicated support for various definitional principles. It is designed to work as a backend for various proof assistants (notably Isabelle/HOL and Coq) and to use state-of-the-art model finders and other solvers as backends.

FUNCTIONAL DESCRIPTION: Nunchaku is a model finder (counterexample generator) for higher-order logic.

NEWS OF THE YEAR: A noteworthy development this year is the creation of a backend called SMBC, based on new ideas by Cruanes about how to combine SAT solving and narrowing.

- Participants: Jasmin Christian Blanchette and Simon Cruanes
- Contact: Jasmin Christian Blanchette
- URL: <https://github.com/nunchaku-inria>

ACUMES Project-Team

5. New Software and Platforms

5.1. MGDA

Multiple Gradient Descent Algorithm

KEYWORDS: Descent direction - Multiple gradients - Multi-objective differentiable optimization

SCIENTIFIC DESCRIPTION: The software provides a vector d whose scalar product with each of the given gradients (or directional derivative) is positive provided a solution exists. When the gradients are linearly independent, the algorithm is direct following a Gram-Schmidt orthogonalization. Otherwise, a sub-family of the gradients is identified according to a hierarchical criterion as a basis of the spanned subspace associated with a cone that contains almost all the gradient directions. Then, one solves a quadratic programming problem formulated in this basis.

<https://hal.inria.fr/hal-01139994> <https://hal.inria.fr/hal-01414741>

FUNCTIONAL DESCRIPTION: The utilization of the platform can be made via two modes : – the interactive mode, through a web interface that facilitates the data exchange between the user and an Inria dedicated machine, – the iterative mode, in which the user downloads the object library to be included in a personal optimization software.

- Participant: Jean-Antoine Désidéri
- Contact: Jean-Antoine Désidéri
- URL: <http://mgda.inria.fr>

5.2. Igloo

Iso-Geometric anaLysis using discOntinuOus galerkin methods

KEYWORDS: Numerical simulations - Isogeometric analysis

SCIENTIFIC DESCRIPTION: Igloo contains numerical methods to solve partial differential equations of hyperbolic type, or convection-dominant type, using an isogeometric formulation (NURBS bases) with a discontinuous Galerkin method.

FUNCTIONAL DESCRIPTION: Igloo is composed of a set of C++ libraries and applications, which allow to simulate time-dependent physical phenomena using natively CAD-based geometry descriptions.

- Author: Régis Duvigneau
- Contact: Régis Duvigneau

5.3. BuildingSmart

BuildingSmart interactive visualization

KEYWORDS: Physical simulation - 3D rendering - 3D interaction

SCIENTIFIC DESCRIPTION: The aim of the BuildingSmart project is to develop a software environment for the simulation and interactive visualisation for the design of buildings (structural safety, thermal confort).

FUNCTIONAL DESCRIPTION: The main task of the project is to study and develop solutions dedicated to interactive visualisation of building performances (heat, structural) in relation to the Building Information Modeling BIM framework, using Oculus Rift immersion.

NEWS OF THE YEAR: Demo movies are available from Youtube (see web site)

- Participants: Régis Duvigneau, Jean-Luc Szpyrka, David Rey and Clement Welsch
- Contact: Abderrahmane Habbal
- URL: http://youtu.be/MW_gIF8hUdk

APICS Project-Team (section vide)

ASPI Team (section vide)

BIPOP Project-Team

6. New Software and Platforms

6.1. ACEF

Automatic switched Circuits Equation Formualtion

KEYWORDS: Simulation - Electrical circuit - Switched systems

SCIENTIFIC DESCRIPTION: Nonsmooth Modeling and Simulation for Switched Circuits concerns the modeling and the numerical simulation of switched circuits with the nonsmooth dynamical systems (NSDS) approach, using piecewise-linear and multivalued models of electronic devices like diodes, transistors, switches. Numerous examples (ranging from introductory academic circuits to various types of power converters) are analyzed and many simulation results obtained with the Inria open-source SICONOS software package are presented. Comparisons with SPICE and hybrid methods demonstrate the power of the NSDS approach. Nonsmooth Modeling and Simulation for Switched Circuits is intended to researchers and engineers in the field of circuits simulation and design, but may also attract applied mathematicians interested by the numerical analysis for nonsmooth dynamical systems, as well as researchers from Systems and Control.

References: Nonsmooth Modeling and Simulation for Switched Circuits Authors: Acary, Vincent, Bonnefon, Olivier, Brogliato, Bernard (<http://www.springer.com/fr/book/9789048196807>)

FUNCTIONAL DESCRIPTION: The Automatic Circuit Equations Formulation (ACEF) module is the implementation of the automatic circuit equation extended to general nonsmooth components. From a SPICE netlist, possibly augmented by some nonsmooth components, the ACEF builds a dynamical formulation that can be simulated by SICONOS.

- Participants: Olivier Bonnefon and Vincent Acary
- Contact: Vincent Acary
- URL: <http://bipop.inrialpes.fr/people/acary/>

6.2. Approche

KEYWORD: Geometric computing

- Participants: Alexandre Derouet-Jourdan, Florence Descoubes and Joëlle Thollot
- Contact: Florence Descoubes
- URL: <http://bipop.inrialpes.fr/~bertails/Papiers/floatingTangents3d.html>

6.3. CloC

Super Space Clothoids in C

KEYWORD: Physical simulation

FUNCTIONAL DESCRIPTION: Reference software implementing the paper "Super Space Clothoids", R. Casati and F. Bertails-Descoubes, ACM Transactions on Graphics, 2013

- Participants: Florence Descoubes and Romain Casati
- Partner: UJF
- Contact: Florence Descoubes
- URL: <http://bipop.inrialpes.fr/people/casati/publications/codes/ssc.html>

6.4. MECHE-COSM

Modeling Entangled fiber with frictional Contact in Hair

KEYWORDS: Physical simulation - Frictional contact - Thin elastic rod

FUNCTIONAL DESCRIPTION: Implements super-helices [Bertails et al. 2006] coupled together by a hybrid algorithm for frictional contact [Daviet et al. 2011].

- Participants: Florence Bertails Descoubes, Florent Cadoux and Gilles Daviet
- Contact: Florence Descoubes

6.5. N1cv2

KEYWORDS: Optimization - Decomposition

- Participants: Claude Lemaréchal and Claudia Sagastizabal
- Partners: Université fédérale de Rio de Janeiro - Université de Varsovie - Université de Washington - Université de Pise
- Contact: Jérôme Malick
- URL: <http://www.inrialpes.fr/bipop/>

6.6. SALADYN MULTIBODY

KEYWORDS: Physical simulation - Co-simulation

FUNCTIONAL DESCRIPTION: The project SALADYN aims at designing and implementing a new software platform into Salomé-Méca by coupling three kinds of mechanical models: a) Deformable bodies, mainly through their finite element representation, b) rigid multi-body systems and c) multi-contact systems. The goal is to obtain a close coupling of these models for the modeling and the simulation in a nonsmooth dynamical framework, able to deal rigorously with the unilateral contact and Coulomb's friction. This platform will be composed by the integration of the following components:

Salomé. An OpenSource platform for the pre and post-processing and the coupling of numerical software codes. Code_Aster. An OpenSource Finite Element Application, which has already been integrated in Salomé, under the name of Salomé-méca. LMGC90. An OpenSource software for the modeling and the simulation of multicontact systems. Siconos. An OpenSource software for the modeling, the simulation and the control of nonsmooth Dynamical systems Besides this integration, the main deliverable of this project is a common numerical software which allows the interoperability of the models through a multiple representation of an unique physical object, and a dynamic adaptability in time based on the user needs and the simulation requirements (accuracy, efficiency, abstraction, etc.). The consortium (Schneider Electric, EDF, Inria, LMGC, LAMSID) brings together well-recognized skills of academic laboratories and companies, which possess a strong experience in structural analysis and dynamical analysis in the field of nonsmooth dynamics. The industrial partners will provide the project with effective test-beds and experiments, which will be very reliable element for validation and performance analysis. The expected result of this project should concern a large field of application ranging from transport, energy, micro-mechanical systems to divided materials such as Masonry or granular matter.

More generally, one aim of this project is to federate the national academic and industrial community for the design and the simulation of complex mechanical in non smooth interactions into a common OpenSource software platform.

- Participants: Olivier Bonnefon and Vincent Acary
- Contact: Vincent Acary
- URL: <http://saladyn.gforge.inria.fr>

6.7. SICONOS

Modeling, simulation and control of nonsmooth dynamical systems

KEYWORDS: Friction - Collision - SD - DCDC - MEMS - NSDS - Mechanical multi-body systems

FUNCTIONAL DESCRIPTION: Siconos is an open-source scientific software primarily targeted at modeling and simulating nonsmooth dynamical systems in C++ and in Python: - Mechanical systems (rigid or solid) with unilateral contact and Coulomb friction and impact (nonsmooth mechanics, contact dynamics, multibody systems dynamics or granular materials). - Switched Electrical Circuit such as electrical circuits with ideal and piecewise linear components: power converter, rectifier, Phase-Locked Loop (PLL) or Analog-to-Digital converter. - Sliding mode control systems. - Biology (Gene regulatory network). Other applications are found in Systems and Control (hybrid systems, differential inclusions, optimal control with state constraints), Optimization (Complementarity systems and Variational inequalities), Fluid Mechanics, and Computer Graphics.

- Participants: Franck P rignon, Maurice Br mond, Olivier Bonnefon and Vincent Acary
- Contact: Vincent Acary
- URL: <http://siconos.gforge.inria.fr>

6.8. Platforms: SICONOS

6.8.1. Platform A : SICONOS

Participants: Vincent Acary, Maurice Br mond, Olivier Huber, Franck P rignon.

In the framework of the FP5 European project Siconos (2002-2006), Bipop was the leader of the Work Package 2 (WP2), dedicated to the numerical methods and the software design for nonsmooth dynamical systems. This has given rise to the platform SICONOS which is the main software development task in the team. The aim of this work is to provide a common platform for the simulation, modeling, analysis and control of abstract nonsmooth dynamical systems. Besides usual quality attributes for scientific computing software, we want to provide a common framework for various scientific fields, to be able to rely on the existing developments (numerical algorithms, description and modeling software), to support exchanges and comparisons of methods, to disseminate the know-how to other fields of research and industry, and to take into account the diversity of users (end-users, algorithm developers, framework builders) in building expert interfaces in Python and end-user front-end through Scilab.

After the requirement elicitation phase, the Siconos Software project has been divided into 5 work packages which are identified to software products:

1. SICONOS/NUMERICS This library contains a set of numerical algorithms, already well identified, to solve non smooth dynamical systems. This library is written in low-level languages (C,F77) in order to ensure numerical efficiency and the use of standard libraries (Blas, Lapack, ...)
2. SICONOS/KERNEL This module is an object-oriented structure (C++) for the modeling and the simulation of abstract dynamical systems. It provides the users with a set of classes to describe their nonsmooth dynamical system (dynamical systems, interconnections, nonsmooth laws, ...) and to perform a numerical time integration and solving.
3. SICONOS/FRONT-END. This module is mainly an auto-generated wrapper in Python which provides a user-friendly interface to the Siconos libraries. A scilab interface is also provided in the Front-End module.
4. SICONOS/CONTROL This part is devoted to the implementation of control strategies of non smooth dynamical systems.
5. SICONOS/MECHANICS. This part is dedicated to the modeling and the simulation of multi-body systems with 3D contacts, impacts and Coulomb's friction. It uses the Siconos/Kernel as simulation engine but relies on a industrial CAD library (OpenCascade and pythonOCC) to deal with complex body geometries and to compute the contact locations and distances between B-Rep description and on Bullet for contact detection between meshes.

Further informations may be found at <http://siconos.gforge.inria.fr/>

CAGIRE Project-Team

6. New Software and Platforms

6.1. AeroSol

KEYWORD: Finite element modelling

FUNCTIONAL DESCRIPTION: The AeroSol software is a high order finite element library written in C++. The code has been designed so as to allow for efficient computations, with continuous and discontinuous finite elements methods on hybrid and possibly curvilinear meshes. The work of the team CARDAMOM (previously Bacchus) is focused on continuous finite elements methods, while the team Cagire is focused on discontinuous Galerkin methods. However, everything is done for sharing the largest part of code we can. More precisely, classes concerning IO, finite elements, quadrature, geometry, time iteration, linear solver, models and interface with PaMPA are used by both of the teams. This modularity is achieved by mean of template abstraction for keeping good performances. The distribution of the unknowns is made with the software PaMPA , developed within the team TADAAM (and previously in Bacchus) and the team Castor.

NEWS OF THE YEAR: The following points have been developed in the code

*A postprocessing in the high order GMSH format has been added

*On the Uhaina part, the work has been focused on the entropy viscosity approach for shock limiting, and on the positivity preserving limiters for ensuring positive water height

*On the dealing of low Mach problems -Multidimensional numerical flux accurate for the computation of steady and unsteady low Mach flows. -Test cases at low Mach

*A method for penalizing rigid bodies instead of meshing it has been developed within the postdoc of Marco Lorini. The model was implemented, an improvement of time schemes for steady problems was done. The method has been tested with 2d and 3d tests: bump, flow around a cylinder. These tests allowed to fix bugs, especially for wall boundary conditions. The coupling with adaptation tools has began.

*The library has benefited from the HPCLib Inria Hub, which aims at improving the development environment of HPC libraries within the Bordeaux Sud Ouest Centre. Within this project, a static analysis of the library based on sonarqube has been performed.

*A wiki for gathering the documentation of the different test cases has begun.

- Participants: Benjamin Lux, Damien Genet, Dragan Amenga Mbengoue, Hamza Belkhatat Zougari, Mario Ricchiuto, Maxime Mogé, Simon Delmas and Vincent Perrier
- Contact: Vincent Perrier

CARDAMOM Project-Team

6. New Software and Platforms

6.1. AeroSol

KEYWORD: Finite element modelling

FUNCTIONAL DESCRIPTION: The AeroSol software is a high order finite element library written in C++. The code has been designed so as to allow for efficient computations, with continuous and discontinuous finite elements methods on hybrid and possibly curvilinear meshes. The work of the team CARDAMOM (previously Bacchus) is focused on continuous finite elements methods, while the team Cagire is focused on discontinuous Galerkin methods. However, everything is done for sharing the largest part of code we can. More precisely, classes concerning IO, finite elements, quadrature, geometry, time iteration, linear solver, models and interface with PaMPA are used by both of the teams. This modularity is achieved by mean of template abstraction for keeping good performances. The distribution of the unknowns is made with the software PaMPA , developed within the team TADAAM (and previously in Bacchus) and the team Castor.

NEWS OF THE YEAR: The following points have been developed in the code

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*The library has benefited from the HPCLib Inria Hub, which aims at improving the development environment of HPC libraries within the Bordeaux Sud Ouest Centre. Within this project, a static analysis of the library based on sonarqube has been performed.

*A wiki for gathering the documentation of the different test cases has began.

- Participants: Benjamin Lux, Damien Genet, Dragan Amenga Mbengoue, Hamza Belkhayat Zougari, Mario Ricchiuto, Maxime Mogé, Simon Delmas and Vincent Perrier
- Contact: Vincent Perrier

6.2. Crysa

KEYWORDS: Image analysis - 2D

FUNCTIONAL DESCRIPTION: Analyzes the organization of objects placed in a hexagonal grid in an image and the crystalline structure induced in this image.

- Participants: Cécile Dobrzynski and Jean Mercat
- Partners: LCTS (UMR 5801) - LCPO - ISM
- Contact: Cécile Dobrzynski

6.3. Cut-ANOVA

Cut-ANOVA Global Sensitivity Analysis

KEYWORDS: Stochastic models - Uncertainty quantification

SCIENTIFIC DESCRIPTION: An anchored analysis of variance (ANOVA) method is proposed to decompose the statistical moments. Compared to the standard ANOVA with mutually orthogonal component functions, the anchored ANOVA, with an arbitrary choice of the anchor point, loses the orthogonality if employing the same measure. However, an advantage of the anchored ANOVA consists in the considerably reduced number of deterministic solver's computations, which renders the uncertainty quantification of real engineering problems much easier. Different from existing methods, the covariance decomposition of the output variance is used in this work to take account of the interactions between non-orthogonal components, yielding an exact variance expansion and thus, with a suitable numerical integration method, provides a strategy that converges. This convergence is verified by studying academic tests. In particular, the sensitivity problem of existing methods to the choice of anchor point is analyzed via the Ishigami case, and we point out that covariance decomposition survives from this issue. Also, with a truncated anchored ANOVA expansion, numerical results prove that the proposed approach is less sensitive to the anchor point. The covariance-based sensitivity indices (SI) are also used, compared to the variance-based SI. Furthermore, we emphasize that the covariance decomposition can be generalized in a straightforward way to decompose higher-order moments. For academic problems, results show the method converges to exact solution regarding both the skewness and kurtosis. The proposed method can indeed be applied to a large number of engineering problems.

FUNCTIONAL DESCRIPTION: The Cut-ANOVA code (Fortran 90, MPI + OpenMP) is devoted to the stochastic analysis of numerical simulations. The method implemented is based on the spectral expansion of "anchored ANOVA", allowing the covariance-based sensitivity analysis. Compared to the conventional Sobol method, "Cut-ANOVA" provides three sensitivity indices instead of one, which allows a better analysis of the reliability of the numerical prediction. On the other hand, "Cut-ANOVA" is able to compute the higher order statistical moments such as the Skewness (3-rd order moment) and Kurtosis (4-th order moment). Several dimension reduction techniques have also been implemented to reduce the computational cost. Finally, thanks to the innovative method implemented into the Code Cut-ANOVA, one can obtain a similar accuracy for stochastic quantities by using a considerably less number of deterministic model evaluations, compared with the classical Monte Carlo method.

- Participants: Kunkun Tang and Pietro-Marco Congedo
- Contact: Kunkun Tang

6.4. Fmg

KEYWORD: Mesh adaptation

FUNCTIONAL DESCRIPTION: FMG is a library deforming an input/reference simplicial mesh w.r.t. a given smoothness error monitor (function gradient or Hessian), metric field, or given mesh size distribution. Displacements are computed by solving an elliptic Laplacian type equation with a continuous finite element method. The library returns an adapted mesh with a corresponding projected solution, obtained by either a second order projection, or by an ALE finite element remap. The addition of a new mass conservative approach developed ad-hoc for shallow water flows is under way.

NEWS OF THE YEAR: - Development of the Elasticity model to compute the nodes displacement. - Development of a new model to compute the nodes displacement. This mixed model takes the advantages of the Laplacian model and the Elasticity model: a refined mesh where the solution varies a lot and a smooth gradation of the edges size elsewhere. - Extension in three dimension

- Participants: Cécile Dobrzynski, Leo Nouveau, Luca Arpaia and Mario Ricchiuto
- Contact: Cécile Dobrzynski

6.5. Mmg

Mmg Platform

KEYWORDS: Mesh adaptation - Anisotropic - Mesh generation - Mesh - Isovalue discretization

SCIENTIFIC DESCRIPTION: The Mmg platform gathers open source software for two-dimensional, surface and volume remeshing. The platform software perform local mesh modifications. The mesh is iteratively modified until the user prescriptions satisfaction.

The 3 softwares can be used by command line or using the library version (C, C++ and Fortran API) : - Mmg2d performs mesh generation and isotropic and anisotropic mesh adaptation. - Mmgs allows isotropic and anisotropic mesh adaptation for 3D surface meshes. - Mmg3d is a new version of the MMG3D4 software. It remesh both the volume and surface mesh of a tetrahedral mesh. It performs isotropic and anisotropic mesh adaptation and isovalue discretization of a level-set function.

The platform software allow to control the boundaries approximation: The "ideal" geometry is reconstructed from the piecewise linear mesh using cubic Bezier triangular patches. The surface mesh is modified to respect a maximal Hausdorff distance between the ideal geometry and the mesh.

Inside the volume, the software perform local mesh modifications (such as edge swap, pattern split, isotropic and anisotropic Delaunay insertion...).

FUNCTIONAL DESCRIPTION: The Mmg platform gathers open source software for two-dimensional, surface and volume remeshing. It provides three applications : 1) mmg2d: generation of a triangular mesh , adaptation and optimization of a triangular mesh 2) mmgs: adaptation and optimization of a surface triangulation representing a piecewise linear approximation of an underlying surface geometry 3) mmg3d: adaptation and optimization of a tetrahedral mesh and isovalue discretization

The platform software perform local mesh modifications. The mesh is iteratively modified until the user prescription satisfaction.

NEWS OF THE YEAR: Release 5.3.0 improves: - the mmg3d algorithm for mesh adaptation (better convergence and edge lengths closest to 1) - the software behaviour in case of failure (warnings/error messages are printed only 1 time and there is no more exits in the code) - the mmg2d software that now uses the same structure than mmgs and mmg3d

It adds: - the -hsiz option for mmg2d/s/3d (that allows to generate a uniform mesh of size) - the -nosurf option for mmg2d (that allows to not modify the mesh boundaries) - the -opnbdy option for mmg3d (that allow to preserve an open boundary inside a volume mesh) - the possibility to provide meshes containing prisms to mmg3d (the prisms entities are preserved while the tetra ones are modified)

- Participants: Algiane Froehly, Cécile Dobrzynski, Charles Dapogny and Pascal Frey
- Partners: Université de Bordeaux - CNRS - IPB - UPMC
- Contact: Cécile Dobrzynski
- URL: <http://www.mmgtools.org>

6.6. MMG3D

Mmg3d

KEYWORDS: Mesh - Anisotropic - Mesh adaptation

SCIENTIFIC DESCRIPTION: Mmg3d is an open source software for tetrahedral remeshing. It performs local mesh modifications. The mesh is iteratively modified until the user prescriptions satisfaction.

Mmg3d can be used by command line or using the library version (C, C++ and Fortran API) : - It is a new version of the MMG3D4 software. It remesh both the volume and surface mesh of a tetrahedral mesh. It performs isotropic and anisotropic mesh adaptation and isovalue discretization of a level-set function.

Mmg3d allows to control the boundaries approximation: The "ideal" geometry is reconstructed from the piecewise linear mesh using cubic Bezier triangular patches. The surface mesh is modified to respect a maximal Hausdorff distance between the ideal geometry and the mesh.

Inside the volume, the software perform local mesh modifications (such as edge swap, pattern split, isotropic and anisotropic Delaunay insertion...).

FUNCTIONAL DESCRIPTION: Mmg3d is one of the software of the Mmg platform. Is is dedicated to the modification of 3D volume meshes. It perform the adaptation and the optimization of a tetrahedral mesh and allow to discretize an isovalue.

Mmg3d perform local mesh modifications. The mesh is iteratively modified until the user prescription satisfaction.

- Participants: Algiane Froehly, Cécile Dobrzynski, Charles Dapogny and Pascal Frey
- Partners: Université de Bordeaux - CNRS - IPB - UPMC
- Contact: Cécile Dobrzynski
- URL: <http://www.mmgtools.org>

6.7. NOMESH

KEYWORDS: Mesh - Curved mesh - Tetrahedral mesh

FUNCTIONAL DESCRIPTION: NOMESH is a software allowing the generation of three order curved simplicial meshes. Starting from a "classical" mesh with straight elements composed by triangles and/or tetrahedra, we are able to curve the boundary mesh. Starting from a mesh with some curved elements, we can verify if the mesh is valid, that means there is no crossing elements and only positive jacobian. If the curved mesh is non valid, we modify it using linear elasticity equations until having a valid curved mesh.

- Participants: Algiane Froehly, Ghina El Jannoun and Cécile Dobrzynski
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Cécile Dobrzynski

6.8. ORComp

FUNCTIONAL DESCRIPTION: The ORComp platform is a simulation tool permitting to design an ORC cycle. Starting from the solar radiation, this platform computes the cycle providing the best performance with optimal choices of the fluid and the operating conditions. It includes RobUQ, a simulation block of the ORC cycles, the RealfluidS code for the simulation of the turbine and of the heat exchanger, the software FluidProp (developed at the University of Delft) for computing the fluid thermodynamic properties.

- Participants: Maria-Giovanna Rodio and Pietro-Marco Congedo
- Contact: Maria-Giovanna Rodio
- URL: <https://github.com/Orcomp/Orcomp>

6.9. RealfluidS

KEYWORDS: Compressible flows - Finite element modelling - Residual distribution - Aeronautics

FUNCTIONAL DESCRIPTION: RealfluidS is a software dedicated to the simulation of inert or reactive flows. It is also able to simulate multiphase, multimaterial, MHD flows and turbulent flows (using the SA model). There exist 2D and 3D dimensional versions. The 2D version is used to test new ideas that are later implemented in the 3D one. This software implements the more recent residual distribution schemes. The code has been parallelized with and without overlap of the domains. The uncertainty quantification library RobUQ has been coupled to the software. A partitioning tool exists in the package, which uses Scotch. Recently, the code has been developed for taking into account real-gas effects, in order to use arbitrarily complex equations of state. Further developments concerning multiphase effects are under way.

- Participants: Cécile Dobrzynski, Héloïse Beaugendre, Leo Nouveau, Pietro-Marco Congedo and Quentin Viville
- Contact: Héloïse Beaugendre

6.10. SH-COMP

KEYWORDS: Finite element modelling - Multi-physics simulation - Chemistry - Incompressible flows - 2D

FUNCTIONAL DESCRIPTION: Numerical modelling of the healing process in ceramic matrix composites

- Participants: Gérard Vignoles, Gregory Perrot, Guillaume Couegnat, Mario Ricchiuto and Virginie Drean
- Partner: LCTS (UMR 5801)
- Contact: Guillaume Couegnat

6.11. SLOWS

Shallow-water fLOWS

KEYWORDS: Simulation - Free surface flows - Unstructured meshes

SCIENTIFIC DESCRIPTION: Three different approaches are available, based on conditionally depth-positivity preserving implicit schemes, or on conditionally depth-positivity preserving genuinely explicit discretizations, or on an unconditionally depth-positivity preserving space-time approach. Newton and frozen Newton loops are used to solve the implicit nonlinear equations. The linear algebraic systems arising in the discretization are solved with the MUMPS library. This year implicit and explicit (extrapolated) multistep higher order time integration methods have been implemented, and a mesh adaptation technique based on simple mesh deformation has been also included.

FUNCTIONAL DESCRIPTION: SLOWS is a C-platform allowing the simulation of free surface shallow water flows with friction. It can be used to simulate near shore hydrodynamics, wave transformations processes, etc.

- Participants: Andrea Filippini, Luca Arpaia, Maria Kazolea, Mario Ricchiuto and Nikolaos Pattakos
- Contact: Mario Ricchiuto

6.12. Sparse-PDD

Adaptive sparse polynomial dimensional decomposition for global sensitivity analysis

KEYWORDS: Stochastic models - Uncertainty quantification

SCIENTIFIC DESCRIPTION: The polynomial dimensional decomposition (PDD) is employed in this code for the global sensitivity analysis and uncertainty quantification (UQ) of stochastic systems subject to a moderate to large number of input random variables. Due to the intimate structure between the PDD and the Analysis of Variance (ANOVA) approach, PDD is able to provide a simpler and more direct evaluation of the Sobol' sensitivity indices, when compared to the Polynomial Chaos expansion (PC). Unfortunately, the number of PDD terms grows exponentially with respect to the size of the input random vector, which makes the computational cost of standard methods unaffordable for real engineering applications. In order to address the problem of the curse of dimensionality, this code proposes essentially variance-based adaptive strategies aiming to build a cheap meta-model (i.e. surrogate model) by employing the sparse PDD approach with its coefficients computed by regression. Three levels of adaptivity are carried out in this code: 1) the truncated dimensionality for ANOVA component functions, 2) the active dimension technique especially for second- and higher-order parameter interactions, and 3) the stepwise regression approach designed to retain only the most influential polynomials in the PDD expansion. During this adaptive procedure featuring stepwise regressions, the surrogate model representation keeps containing few terms, so that the cost to resolve repeatedly the linear systems of the least-square regression problem is negligible. The size of the finally obtained sparse PDD representation is much smaller than the one of the full expansion, since only significant terms are eventually retained. Consequently, a much less number of calls to the deterministic model is required to compute the final PDD coefficients.

FUNCTIONAL DESCRIPTION: This code allows an efficient meta-modeling for a complex numerical system featuring a moderate-to-large number of uncertain parameters. This innovative approach involves polynomial representations combined with the Analysis of Variance decomposition, with the objective to quantify the numerical output uncertainty and its sensitivity upon the variability of input parameters.

- Participants: Kunkun Tang and Pietro-Marco Congedo
- Contact: Kunkun Tang

6.13. TUCWave

KEYWORD: Physical simulation

SCIENTIFIC DESCRIPTION: A novel work that advances a step ahead the methodology of the solution of dispersive models. TUCWave uses a high-order well-balanced unstructured finite volume (FV) scheme on triangular meshes for modeling weakly nonlinear and weakly dispersive water waves over varying bathymetries, as described by the 2D depth-integrated extended Boussinesq equations of Nwogu (1993), rewritten in conservation law form. The FV scheme numerically solves the conservative form of the equations following the median dual node-centered approach, for both the advective and dispersive part of the equations. The code developed follows an efficient edge based structured technique. For the advective fluxes, the scheme utilizes an approximate Riemann solver along with a well-balanced topography source term up-winding. Higher order accuracy in space and time is achieved through a MUSCL-type reconstruction technique and through a strong stability preserving explicit Runge-Kutta time stepping. Special attention is given to the accurate numerical treatment of moving wet/dry fronts and boundary conditions. Furthermore, the model is applied to several examples of wave propagation over variable topographies and the computed solutions are compared to experimental data.

FUNCTIONAL DESCRIPTION: Fortran Planform which accounts for the study of near shore processes

- Participants: Argiris Delis, Ioannis Nikolos and Maria Kazolea
- Partner: CNRS
- Contact: Maria Kazolea

COMMANDS Project-Team**6. New Software and Platforms****6.1. BOCOP***Boite à Outils pour le Contrôle Optimal***KEYWORDS:** Dynamic Optimization - Identification - Biology - Numerical optimization - Energy management - Transportation**FUNCTIONAL DESCRIPTION:** Bocop is an open-source toolbox for solving optimal control problems, with collaborations with industrial and academic partners. Optimal control (optimization of dynamical systems governed by differential equations) has numerous applications in transportation, energy, process optimization, energy and biology. Bocop includes a module for parameter identification and a graphical interface, and runs under Linux / Windows / Mac.**RELEASE FUNCTIONAL DESCRIPTION:** Handling of delay systems Alternate automatic differentiation tool: CppAD Update for CMake and MinGW (windows version)

- Participants: Benjamin Heymann, Virgile Andreani, Jinyan Liu, Joseph Frédéric Bonnans and Pierre Martinon
- Contact: Pierre Martinon
- URL: <http://bocop.org>

6.2. Bocop HJB**KEYWORDS:** Optimal control - Stochastic optimization - Global optimization**FUNCTIONAL DESCRIPTION:** Toolbox for stochastic or deterministic optimal control, dynamic programming / HJB approach.**RELEASE FUNCTIONAL DESCRIPTION:** User interface State jumps for switched systems Explicit handling of final conditions Computation of state probability density (fiste step to mean field games)

- Participants: Benjamin Heymann, Jinyan Liu, Joseph Frédéric Bonnans and Pierre Martinon
- Contact: Joseph Frédéric Bonnans
- URL: <http://bocop.org>

6.3. Bocop Avion**KEYWORDS:** Optimization - Aeronautics**FUNCTIONAL DESCRIPTION:** Optimize the climb speeds and associated fuel consumption for the flight planning of civil airplanes.**NEWS OF THE YEAR:** Improved atmosphere model 2D interpolations for temperature and wind data

- Participants: Gregorutti Baptiste, Cindie Andrieu, Anamaria Lupu, Joseph Frédéric Bonnans, Karim Tekkal, Pierre Jouniaux and Pierre Martinon
- Partner: Safety Line
- Contact: Pierre Martinon
- URL: <http://www.safety-line.fr>

6.4. Bocop HJB Avion**KEYWORDS:** Optimization - Aeronautics**FUNCTIONAL DESCRIPTION:** Optimize the climb and cruising trajectory of flight by a HJB approach.**NEWS OF THE YEAR:** First demonstrator for cruise flight deployed at Safety Line

- Participants: Pierre Martinon, Joseph Frédéric Bonnans, Jinyan Liu, Gregorutti Baptiste and Anamaria Lupu
- Partner: Safety Line
- Contact: Pierre Martinon
- URL: <http://www.safety-line.fr>

CQFD Project-Team

6. New Software and Platforms

6.1. biips

Bayesian Inference with Interacting Particle Systems

FUNCTIONAL DESCRIPTION: Biips is a software platform for automatic Bayesian inference with interacting particle systems. Biips allows users to define their statistical model in the probabilistic programming BUGS language, as well as to add custom functions or samplers within this language. Then it runs sequential Monte Carlo based algorithms (particle filters, particle independent Metropolis-Hastings, particle marginal Metropolis-Hastings) in a black-box manner so that to approximate the posterior distribution of interest as well as the marginal likelihood. The software is developed in C++ with interfaces with the softwares R, Matlab and Octave.

- Participants: Adrien Todeschini and François Caron
- Contact: Adrien Todeschini
- URL: <http://biips.gforge.inria.fr>

6.2. PCAmixdata

KEYWORD: Statistic analysis

FUNCTIONAL DESCRIPTION: Mixed data type arise when observations are described by a mixture of numerical and categorical variables. The R package PCAmixdata extends standard multivariate analysis methods to incorporate this type of data. The key techniques included in the package are PCAmix (PCA of a mixture of numerical and categorical variables), PCArot (rotation in PCAmix) and MFAmix (multiple factor analysis with mixed data within a dataset). The MFAmix procedure handles a mixture of numerical and categorical variables within a group - something which was not possible in the standard MFA procedure. We also included techniques to project new observations onto the principal components of the three methods in the new version of the package.

- Contact: Marie Chavent
- URL: <https://cran.r-project.org/web/packages/PCAmixdata/index.html>

6.3. QuantifQuantile

KEYWORD: Regression

FUNCTIONAL DESCRIPTION: QuantifQuantile is an R package that allows to perform quantization-based quantile regression. The different functions of the package allow the user to construct an optimal grid of N quantizers and to estimate conditional quantiles. This estimation requires a data driven selection of the size N of the grid that is implemented in the functions. Illustration of the selection of N is available, and graphical output of the resulting estimated curves or surfaces (depending on the dimension of the covariate) is directly provided via the plot function.

- Contact: Jérôme Saracco

DEFI Project-Team

5. New Software and Platforms

5.1. FVforBlochTorrey

- Participant: Jing Rebecca Li
- Contact: Jing Rebecca Li

5.2. InvGIBC

- Participant: Nicolas Chaulet
- Contact: Housseem Haddar

5.3. RODIN

FUNCTIONAL DESCRIPTION: In the framework of the RODIN project we continue to develop with our software partner ESI the codes Topolev and Geolev for topology and geometry shape optimization of mechanical structures using the level set method.

- Contact: Grégoire Allaire

5.4. samplings-2d

This software solves forward and inverse problems for the Helmholtz equation in 2-D.

FUNCTIONAL DESCRIPTION: This software is written in Fortran 90 and is related to forward and inverse problems for the Helmholtz equation in 2-D. It includes three independent components. * The first one solves to scattering problem using integral equation approach and supports piecewise-constant dielectrics and obstacles with impedance boundary conditions. * The second one contains various samplings methods to solve the inverse scattering problem (LSM, RGLSM(s), Factorization, MuSiC) for near-field or far-field setting. * The third component is a set of post processing functionalities to visualize the results

- Participant: Housseem Haddar
- Contact: Housseem Haddar
- URL: <http://sourceforge.net/projects/samplings-2d/>

5.5. Samplings-3d

FUNCTIONAL DESCRIPTION: This software is written in Fortran 90 and is related to forward and inverse problems for the Helmholtz equation in 3-D. It contains equivalent functionalities to samplings-2d in a 3-D setting.

- Contact: Housseem Haddar

5.6. SCILAB

SCIENTIFIC DESCRIPTION: Scilab includes hundreds of mathematical functions. It has a high level programming language allowing access to advanced data structures, 2-D and 3-D graphical functions.

A large number of functionalities is included in Scilab:

Maths & Simulation For usual engineering and science applications including mathematical operations and data analysis. 2-D & 3-D Visualization Graphics functions to visualize, annotate and export data and many ways to create and customize various types of plots and charts. Optimization Algorithms to solve constrained and unconstrained continuous and discrete optimization problems. Statistics Tools to perform data analysis and modeling Control System Design & Analysis Standard algorithms and tools for control system study Signal Processing Visualize, analyze and filter signals in time and frequency domains. Application Development Increase Scilab native functionalities and manage data exchanges with external tools. Xcos - Hybrid dynamic systems modeler and simulator Modeling mechanical systems, hydraulic circuits, control systems...

FUNCTIONAL DESCRIPTION: Scilab is free and open source software for numerical computation providing a powerful computing environment for engineering and scientific applications.

- Participant: Grégoire Allaire
- Contact: Grégoire Allaire
- URL: <http://www.scilab.org/>

DISCO Project-Team

6. New Software and Platforms

6.1. YALTA

Yet Another LTI TDS Algorithm

FUNCTIONAL DESCRIPTION: The YALTA toolbox is a Matlab toolbox dedicated to the study of classical and fractional systems with delay in the frequency-domain. Its objective is to provide basic but important information such as, for instance, the position of the neutral chains of poles and unstable poles, as well as the root locus with respect to the delay of the system. The corresponding algorithms are based on recent theoretical results and on classical continuation methods exploiting the particularities of the problem.

- Participants: André Fioravanti, Catherine Bonnet, David Avanesoff, Hugo Cavallera, Jim Pioche and Le Ha Vy Nguyen
- Contact: Catherine Bonnet
- URL: <http://yalta-toolbox.gforge.inria.fr/>

DOLPHIN Team

6. New Software and Platforms

6.1. Grid'5000

Grid'5000 experimental platform

FUNCTIONAL DESCRIPTION: The Grid'5000 experimental platform is a scientific instrument to support computer science research related to distributed systems, including parallel processing, high performance computing, cloud computing, operating systems, peer-to-peer systems and networks. It is distributed on 10 sites in France and Luxembourg, including Lyon. Grid'5000 is a unique platform as it offers to researchers many and varied hardware resources and a complete software stack to conduct complex experiments, ensure reproducibility and ease understanding of results.

- Participants: Christian Pérez, David Loup, Frédéric Desprez, Laurent Lefèvre, Laurent Pouilloux, Marc Pinhède and Simon Delamare
- Contact: Frédéric Desprez
- URL: <https://www.grid5000.fr/mediawiki/index.php/Grid5000:Home>

6.2. ParadisEO

KEYWORD: Parallelisation

SCIENTIFIC DESCRIPTION: ParadisEO (PARallel and DIStributed Evolving Objects) is a C++ white-box object-oriented framework dedicated to the flexible design of metaheuristics. Based on EO, a template-based ANSI-C++ compliant evolutionary computation library, it is composed of four modules: * Paradiseo-EO provides tools for the development of population-based metaheuristic (Genetic algorithm, Genetic programming, Particle Swarm Optimization (PSO)...) * Paradiseo-MO provides tools for the development of single solution-based metaheuristics (Hill-Climbing, Tabu Search, Simulated annealing, Iterative Local Search (ILS), Incremental evaluation, partial neighborhood...) * Paradiseo-MOEO provides tools for the design of Multi-objective metaheuristics (MO fitness assignment schemes, MO diversity assignment schemes, Elitism, Performance metrics, Easy-to-use standard evolutionary algorithms...) * Paradiseo-PEO provides tools for the design of parallel and distributed metaheuristics (Parallel evaluation, Parallel evaluation function, Island model) Furthermore, ParadisEO also introduces tools for the design of distributed, hybrid and cooperative models: * High level hybrid metaheuristics: coevolutionary and relay model * Low level hybrid metaheuristics: coevolutionary and relay model

FUNCTIONAL DESCRIPTION: Paradiseo is a software framework for metaheuristics (optimisation algorithms aimed at solving difficult optimisation problems). It facilitates the use, development and comparison of classic, multi-objective, parallel or hybrid metaheuristics.

- Partners: CNRS - Université Lille 1
- Contact: El-Ghazali Talbi
- URL: <http://paradiseo.gforge.inria.fr/>

6.3. VRPsolve

KEYWORDS: C++ - Mobile Computing, Transportation - Optimization

SCIENTIFIC DESCRIPTION: VRPsolve is a software for solving vehicle routing problems dealing with last-mile delivery issues that arise as we approach the final customer. When modeling and solving combinatorial optimization problems, especially problems related to the transport of goods and people, the resulting models are generally subject to a specific development in order to be validated, as industrial needs are highly dependent of the application domain. However, a set of conventional objectives and constraints, such as vehicles capacities, incompatible parcels, time windows, are now commonly encountered. In addition to being efficient and effective, VRPsolve differentiates from other tools by allowing to quickly and conveniently integrate ad-hoc constraints and objectives into a generic software. Indeed, VRPsolve effectively deal with industrial last-mile delivery vehicle routing problems and is able to cope with multiple objectives and a large number of constraints by using advanced optimization algorithms which are usually not available with existing softwares. In addition, VRPsolve allows industrial collaborations to be addressed by solving real-world problems requiring geographic information systems (GIS).

- Participants: Arnaud Liefoghe, Clive Ferret-Canape and Sébastien Vérel
- Contact: Clive Ferret-Canape
- URL: <http://gforge.inria.fr/projects/vrpsolve>

6.4. Platform Grid'5000

The Dolphin project-team has been the Principal Investigator of the Grid5000@Lille project funded (budget: 750K€) within the framework of the CPER. This project consists in building in 2017 a new site of the Grid'5000 platform at Lille. This new site hosted by Inria Lille replaces the old one which was located in the supercomputing center (CRI) of the University of Lille. It consists in a GPU-enhanced computing cluster composed of over 1.000 CPU cores and 60.000 GPU cores corresponding to a 20FLOPS computational power. The Grid5000@Lille project allowed also the recruitment of two engineers for the system and network administration and the software development for two years. Another upgrade with more GPUs is planned for the beginning of 2018.

- Participants: F. Desprez, F. Huet, E. Jeannot, Y. Jegou, A. Lebre, L. Lefevre, F. Loui, D. Margery, N. Melab, J-M. Menaud, P. Neyron, L. Nussbaum, C. Perez, J-M. Pierson, O. Richard., S. Varette.
- Contact: Nouredine Melab
- URL: <https://www.grid5000.fr/mediawiki/index.php/Grid5000:Home>

ECUADOR Project-Team

5. New Software and Platforms

5.1. AIRONUM

KEYWORDS: Computational Fluid Dynamics - Turbulence

FUNCTIONAL DESCRIPTION: Aironum is an experimental software that solves the unsteady compressible Navier-Stokes equations with k-epsilon, LES-VMS and hybrid turbulence modelling on parallel platforms, using MPI. The mesh model is unstructured tetrahedrization, with possible mesh motion.

- Participant: Alain Dervieux
- Contact: Alain Dervieux
- URL: <http://www-sop.inria.fr/tropics/aironum>

5.2. TAPENADE

KEYWORDS: Static analysis - Optimization - Compilation - Gradients

SCIENTIFIC DESCRIPTION: Tapenade implements the results of our research about models and static analyses for AD. Tapenade can be downloaded and installed on most architectures. Alternatively, it can be used as a web server. Higher-order derivatives can be obtained through repeated application.

Tapenade performs sophisticated data-flow analysis, flow-sensitive and context-sensitive, on the complete source program to produce an efficient differentiated code. Analyses include Type-Checking, Read-Write analysis, and Pointer analysis. AD-specific analyses include:

Activity analysis: Detects variables whose derivative is either null or useless, to reduce the number of derivative instructions.

Adjoint Liveness analysis: Detects the source statements that are dead code for the computation of derivatives.

TBR analysis: In adjoint-mode AD, reduces the set of source variables that need to be recovered.

FUNCTIONAL DESCRIPTION: Tapenade is an Algorithmic Differentiation tool that transforms an original program into a new program that computes derivatives of the original program. Algorithmic Differentiation produces analytical derivatives, that are exact up to machine precision. Adjoint-mode AD can compute gradients at a cost which is independent from the number of input variables. Tapenade accepts source programs written in Fortran77, Fortran90, or C. It provides differentiation in the following modes: tangent, vector tangent, adjoint, and vector adjoint.

NEWS OF THE YEAR: - Continued development of multi-language capacity: AD of codes mixing Fortran and C - Creation of a front-end for C++ based on Clang - Improved support for the current frontiers of Source-Transformation AD: Dynamic Memory, and MPI

- Participants: Benoît Dufumier, Louis Becquey, Laurent Hascoët and Valérie Pascual
- Contact: Laurent Hascoët
- URL: <http://www-sop.inria.fr/tropics/tapenade.html>

GAMMA3 Project-Team

3. New Software and Platforms

3.1. ABL4FLO

KEYWORDS: Boundary layers - Hybrid meshes

FUNCTIONAL DESCRIPTION: ABL4FLO is designed to generate 3D adapted boundary layer meshes by using a cavity-based operator.

- Participant: Adrien Loseille
- Contact: Adrien Loseille

3.2. AMA4FLO

Anisotropic Mesh Adaptation 4 FLOW

KEYWORDS: 3D - Mesh adaptation

FUNCTIONAL DESCRIPTION: 3D, surface, 2D anisotropic mesh generation

- Participant: Adrien Loseille
- Contact: Adrien Loseille
- URL: <http://pages.saclay.inria.fr/adrien.loseille/index.php?page=softwares>

3.3. BL2D

KEYWORDS: Abstraction - Meshing - Isotropic - Anisotropic - Delaunay

FUNCTIONAL DESCRIPTION: This software package stems from a former one called BL2D-V1. The meshing method is of controlled Delaunay type, isotropic or anisotropic. The internal point generation follows a frontal logic, and their connection is realised as in a classical Delaunay approach. Quadrilaterals are obtained by a pairing process. The direct construction of degree 2 element has been made possible via the control of the domain boundary mesh, in order to ensure the desired compatibility. The boundary middle nodes are located according to the curvilinear abscissa. The internal middle nodes are, by default, at the middle of the corresponding edges.

RELEASE FUNCTIONAL DESCRIPTION: Par rapport à la version V1, il offre de nombreuses possibilités nouvelles : méthode frontale, triangles quadratiques courbes, quadrilatères de degré 1 ou 2, frontières déformables, allocation dynamique de mémoire, etc

- Participants: Houman Borouchaki and Patrick Laug
- Contact: Patrick Laug
- URL: <http://pages.saclay.inria.fr/patrick.laug/logiciels/bl2d-v2/INDEX.html>

3.4. BL2D-ABAQ

KEYWORDS: Anisotropic - Delaunay - Automatic mesher

FUNCTIONAL DESCRIPTION: The meshing method is the same as BL2D in an adaptive process. An a posteriori error estimation of a solution at the nodes of the current mesh results in a size map. A new mesh satisfying these size specifications (made continuous) is built, and the solution is interpolated on the new mesh.

- Participants: Abel Cherouat, Houman Borouchaki and Patrick Laug
- Contact: Patrick Laug

3.5. BLGEOL

KEYWORDS: Automatic mesher - Geologic structure

FUNCTIONAL DESCRIPTION: BLGEOL-V1 software can generate hex-dominant meshes of geologic structures complying with different geometric constraints: surface topography (valleys, reliefs, rivers), geologic layers and underground workings. First, a reference 2D domain is obtained by projecting all the line constraints into a horizontal plane. Different size specifications are given for rivers, outcrop lines and workings. Using an adaptive methodology, the size variation is bounded by a specified threshold in order to obtain a high quality quad-dominant mesh. Secondly, a hex-dominant mesh of the geological medium is generated by a vertical extrusion, taking into account the surfaces found (interfaces between two layers, top or bottom faces of underground workings). The generation of volume elements follows a global order established on the whole set of surfaces to ensure the conformity of the resulting mesh.

- Participants: Houman Borouchaki and Patrick Laug
- Contact: Patrick Laug
- URL: <https://team.inria.fr/gamma3/project-presentation/gamma-software/>

3.6. BLMOL

KEYWORDS: Mesher - Molecular surface

SCIENTIFIC DESCRIPTION: An increasingly important part of quantum chemistry is devoted to molecular surfaces. To model such a surface, each constituting atom is idealized by a simple sphere. Surface mesh generation techniques are then used either for visualization or for simulation, where mesh quality has a strong influence on solution accuracy. First, a boundary representation (B-rep) of the surface is obtained, i.e. a set of patches and the topological relations between them. Second, an appropriate parameterization and a metric map are computed for each patch. Third, meshes of the parametric domains are generated with respect to an induced metric map, using a combined advancing-front generalized-Delaunay approach. Finally these meshes are mapped onto the entire surface. Several application examples illustrate various capabilities of our method.

FUNCTIONAL DESCRIPTION: BLMOL is a molecular surface mesher.

- Participants: Houman Borouchaki and Patrick Laug
- Contact: Patrick Laug
- URL: <http://pages.saclay.inria.fr/patrick.laug/logiciels/blmol/INDEX.html>

3.7. BLSURF

KEYWORDS: Automatic mesher - Molecular surface

FUNCTIONAL DESCRIPTION: An indirect method for meshing parametric surfaces conforming to a user-specifiable size map is used. First, from this size specification, a Riemannian metric is defined so that the desired mesh is one with unit length edges with respect to the related Riemannian space (the so-called

- Participants: Houman Borouchaki and Patrick Laug
- Partner: Université de Technologie de Troyes
- Contact: Patrick Laug
- URL: <https://team.inria.fr/gamma3/project-presentation/gamma-software/>

3.8. FEFLOA-REMESH

KEYWORDS: Scientific calculation - Anisotropic - Mesh adaptation

FUNCTIONAL DESCRIPTION: FEFLOA-REMESH is intended to generate adapted 2D, surface and volume meshes by using a unique cavity-based operator. The metric-aligned or metric-orthogonal approach is used to generate high quality surface and volume meshes independently of the anisotropy involved.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Adrien Loseille
- URL: <http://pages.saclay.inria.fr/adrien.loseille/index.php?page=softwares>

3.9. GAMANIC 3D

KEYWORDS: Tetrahedral mesh - Delaunay - Anisotropic size and direction control - Automatic mesher

FUNCTIONAL DESCRIPTION: GAMANIC3D is a volume mesher governed by a (anisotropic) size and directional specification metric field.

- Participants: Adrien Loseille, Éric Saltel, Frédéric Alauzet, Frederic Hecht, Houman Borouchaki and Paul Louis George
- Contact: Paul Louis Georges
- URL: <http://www.meshgems.com/volume-meshing.html>

3.10. GAMHIC 3D

KEYWORDS: Tetrahedral mesh - Delaunay - Isotropic - Automatic mesher

FUNCTIONAL DESCRIPTION: GAMHIC3D is a volume mesher governed by a (isotropic) size specification metric field.

- Participants: Adrien Loseille, Éric Saltel, Frédéric Alauzet, Frederic Hecht, Houman Borouchaki and Paul Louis George
- Contact: Paul Louis George
- URL: <http://www.meshgems.com/volume-meshing.html>

3.11. GHS3D

KEYWORDS: Tetrahedral mesh - Delaunay - Automatic mesher

FUNCTIONAL DESCRIPTION: GHS3D is an automatic volume mesher

- Participants: Adrien Loseille, Éric Saltel, Frédéric Alauzet, Frederic Hecht, Houman Borouchaki and Paul Louis George
- Contact: Paul Louis George
- URL: <http://www.meshgems.com/volume-meshing.html>

3.12. HEXOTIC

KEYWORDS: 3D - Mesh generation - Meshing - Unstructured meshes - Octree/Quadtree - Multi-threading - GPGPU - GPU

FUNCTIONAL DESCRIPTION: Input: a triangulated surface mesh and an optional size map to control the size of inner elements.

Output: a fully hexahedral mesh (no hybrid elements), valid (no negative jacobian) and conformal (no dangling nodes) whose surface matches the input geometry.

The software is a simple command line that requires no knowledge on meshing. Its arguments are an input mesh and some optional parameters to control elements sizing, curvature and subdomains as well as some features like boundary layers generation.

- Participant: Loïc Maréchal
- Partner: Distene
- Contact: Loïc Maréchal
- URL: <https://team.inria.fr/gamma3/project-presentation/gamma-software/hexotic/>

3.13. Nimbus 3D

KEYWORDS: Surface reconstruction - Point cloud

FUNCTIONAL DESCRIPTION: Nimbus3D is a surface reconstruction method piece of software

- Participants: Houman Borouchaki and Paul Louis George
- Contact: Paul Louis George
- URL: <http://www.meshgems.com/volume-meshing.html>

3.14. VIZIR

Maillages Clés en Main pour la Simulation Numérique

KEYWORD: Mesh

FUNCTIONAL DESCRIPTION: VIZIR is intended to visualize and modify interactively simplicial, hybrid and high order curved meshes.

- Participants: Adrien Loseille, Alexis Loyer and Julien Castelneau
- Contact: Adrien Loseille
- URL: <http://pages.saclay.inria.fr/adrien.loseille/index.php?page=softwares>

3.15. Wolf

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Numerical solver for the Euler and compressible Navier-Stokes equations with turbulence modelling. ALE formulation for moving domains. Modules of interpolation, mesh optimisation and moving meshes. Wolf is written in C++, and may be later released as an opensource library. FELiScE was registered in July 2014 at the Agence pour la Protection des Programmes under the Inter Deposit Digital Number IDDN.FR.001.340034.000.S.P.2014.000.10000.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.16. Wolf-Bloom

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-Bloom is a structured boundary layer mesh generator using a pushing approach. It start from an existing volume mesh and insert a structured boundary layer by pushing the volume mesh. The volume mesh deformation is solved with an elasticity analogy. Mesh-connectivity optimizations are performed to control volume mesh element quality.

- Participants: Adrien Loseille, David Marcum and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.17. Wolf-Elast

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-Elast is a linear elasticity solver using the P1 Finite-Element method. The Young and Poisson coefficient can be parametrized. The linear system is solved using the Conjugate Gradient method with the LUSGS preconditioner.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.18. Wolf-Interpol

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-Interpol is a tool to transfer scalar, vector and tensor fields from one mesh to another one. Polynomial interpolation (from order 2 to 4) or conservative interpolation operators can be used. Wolf-Interpol also extract solutions along lines or surfaces.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.19. Wolf-MovMsh

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-MovMsh is a moving mesh algorithm coupled with mesh-connectivity optimization. Mesh deformation is computed by means of a linear elasticity solver or a RBF interpolation. Smoothing and swapping mesh optimization are performed to maintain good mesh quality. It handles rigid bodies or deformable bodies, and also rigid or deformable regions of the domain.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Paul Louis George
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.20. Wolf-Nsc

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-Nsc is numerical flow solver solving steady or unsteady turbulent compressible Euler and Navier-Stokes equations. The available turbulent models are the Spalart-Almaras and the Menter SST k-omega. A mixed finite volume - finite element numerical method is used for the discretization. Second order spatial accuracy is reached thanks to MUSCL type methods. Explicit or implicit time integration are available. It also resolved dual (adjoint) problem and compute error estimate for mesh adaptation.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

3.21. Wolf-Spyder

KEYWORD: Scientific calculation

FUNCTIONAL DESCRIPTION: Wolf-Spyder is a metric-based mesh quality optimizer using vertex smoothing and edge/face swapping.

- Participants: Adrien Loseille and Frédéric Alauzet
- Contact: Frédéric Alauzet
- URL: https://www.rocq.inria.fr/gamma/Frederic.Alauzet/code_eng.html

GECO Project-Team

6. New Software and Platforms

6.1. IRHD

Image Reconstruction via Hypoelliptic Diffusion

FUNCTIONAL DESCRIPTION: IRHD is a software for reconstruction of corrupted and damaged images. One of the main features of the algorithm on which the software is based is that it does not require any information about the location and character of the corrupted places. Another important advantage is that this method is massively parallelizable, this allows to work with sufficiently large images. Theoretical background of the presented method is based on the model of geometry of vision due to Petitot, Citti and Sarti. The main step is numerical solution of the equation of 3D hypoelliptic diffusion. IRHD is based on Fortran.

- Contact: Mario Sigalotti

GEOSTAT Project-Team

6. New Software and Platforms

6.1. Fluex

KEYWORDS: Signal - Signal processing

SCIENTIFIC DESCRIPTION: Fluex is a package consisting of the Microcanonical Multiscale Formalism for 1D, 2D 3D and 3D+t general signals.

FUNCTIONAL DESCRIPTION: Fluex is a C++ library developed under Gforge. Fluex is a library in nonlinear signal processing. Fluex is able to analyze turbulent and natural complex signals, Fluex is able to determine low level features in these signals that cannot be determined using standard linear techniques.

- Participants: Hussein Yahia and Rémi Paties
- Contact: Hussein Yahia
- URL: <http://fluex.gforge.inria.fr/>

6.2. FluidExponents

KEYWORDS: Signal processing - Wavelets - Fractal - Spectral method - Complexity

FUNCTIONAL DESCRIPTION: FluidExponents is a signal processing software dedicated to the analysis of complex signals displaying multiscale properties. It analyzes complex natural signals by use of nonlinear methods. It implements the multifractal formalism and allows various kinds of signal decomposition and reconstruction. One key aspect of the software lies in its ability to evaluate key concepts such as the degree of unpredictability around a point in a signal, and provides different kinds of applications. The software can be used for times series or multidimensional signals.

- Participants: Antonio Turiel and Hussein Yahia
- Contact: Hussein Yahia
- URL: <https://fluidexponents@scm.gforge.inria.fr/svn/fluidexponents/FluidExponents>

6.3. classifemo

KEYWORDS: Classification - Audio

FUNCTIONAL DESCRIPTION: Classifies vocal audio signals. Classifemo extracts characteristics from vocal audio signals. These characteristics are extracted from signals of different type: initially these were emotion databases, but it can also process signals recorded from patients with motor speech disorders. The software can train usual classifiers (SVM, random forests, etc) on these databases as well as classify new signals.

- Participants: Khalid Daoudi and Nicolas Brodu
- Contact: Khalid Daoudi
- URL: <https://allgo.inria.fr/app/emotionclassifierprototype>

6.4. superres

Super-Resolution of multi-spectral and multi-resolution images

KEYWORD: Multiscale

SCIENTIFIC DESCRIPTION: This resolution enhancement method is designed for multispectral and multiresolution images, such as these provided by the Sentinel-2 satellites (but not only). Starting from the highest resolution bands, band-dependent information (reflectance) is separated from information that is common to all bands (geometry of scene elements). This model is then applied to unmix low-resolution bands, preserving their reflectance, while propagating band-independent information to preserve the sub-pixel details.

FUNCTIONAL DESCRIPTION: This super-resolution software for multi-spectral images consists of: - A core C++ library, which can be used directly - A Python module interface to this library - A Java JNI interface to the library - An end-user Python script for super-resolving Sentinel-2 images - An end-user plugin for the widely used SNAP software of the ESA.

- Participant: Nicolas Brodu
- Contact: Nicolas Brodu
- URL: <http://nicolas.brodu.net/recherche/superres/index.html>

6.5. EdgeReconstruct

Edge Reconstruction With UPM Manifold

KEYWORDS: 2D - Fractal - Signal processing

FUNCTIONAL DESCRIPTION: EdgeReconstruct is a software that reconstructs a complex signal from the computation of most unpredictable points in the framework of the Microcanonical Multifractal Formalism. The quality of the reconstruction is also evaluated. The software is a companion of a paper published in 2013: <https://hal.inria.fr/hal-00924137>.

- Contact: Suman Kumar Maji
- URL: <https://geostat.bordeaux.inria.fr/index.php/downloads.html>

I4S Project-Team

6. New Software and Platforms

6.1. PEGASE

Plate-forme Experte Générique pour Applications Sans-fil Embarquées

KEYWORD: SHM (Structural Health Monitoring)

FUNCTIONAL DESCRIPTION: PEGASE is a generic high level wireless sensor platform. The main characteristics of PEGASE to reach this genericity are obtained by :

- Software genericity: use of a Linux embedded OS to make any developed application independent from the hardware, and to enable the user to manage the system without any physical operations.
- Hardware genericity: with a principle of daughter and mother boards, each redundant need is embedded (processing, memory, timing, GPS, energy, etc) where each pluggable daughter board implements a specific function (e.g., sensing, 3G, Lora/Sigfox and Ethernet wireless communications, signal processing and relay control).
- Accurate time synchronization: based on an original GPS and PPS algorithm, PEGASE platform is one of few boards able to time-stamp data from sensors or any event with an accuracy of some micro-seconds Universal Time.

After the industrial exploitation of PEGASE 1 (hundreds are sold), PEGASE 2 and the future PEGASE 3 version maintain and extend the previous platform. Focus on main characteristics is subject of electronic research and development:

- embed a "Debian" Linux operating system able to be validated for critical applications (such as SHM applications)
- embed a module dedicated to energy autonomy, to harvest energy from solar cells while considering the dis/charge of Lithium battery
- integrate a 3D accelerometer based on a MEMs to propose motion applications (train detection by vibration for example)
- new original daughter boards for new wireless IOT industrial protocols: LorA and Sigfox
- convert the proposed SDK (Single Development Kit) fully from C to C++ language
- a generic embedded front-end development called Zeus able to manage time control of Linux enslaved to the UTC synchronization, applications manager, network manager (from WiFi, Lora to 3G...), ...

Since 2017, PEGASE 2 platform is also used as the support for some lectures given at University of Nantes.

Associated to PEGASE hardware platform, I4S has also designed and programmed a generic Cloud Supervisor that allows to manage wireless sensors. In 2017 this application has matured, and has been licensed to two companies for industrial exploitation and distribution (Stimio and Power-Lan).

- Participants: Laurent Mevel, Mathieu Le Pen, Michael Doehler and Vincent Le Cam
- Contact: Michael Doehler
- URL: http://www.a3ip.com/joomla/index.php?option=com_content&view=article&id=12&Itemid=8

6.2. TrackingMecaSysEvo

KEYWORDS: Particular filter - Kalman filter - Monte-Carlo - Bayesian estimation - Vibrating system

FUNCTIONAL DESCRIPTION: Based on a IPKF (Interacting Particles and Kalman Filter) implementation, TrackingMecaSysEvo allow mechanical parameters tracking over the time for a 1-2-3D vibrating model. The algorithm insure also, input force and ambient noise estimation

- Participants: Antoine Crinière, Laurent Mevel and Subhamoy Sen
- Partner: IFSTTAR
- Contact: Laurent Mevel

INOCS Team

6. New Software and Platforms

6.1. dapcstp

A dual-ascent-based branch-and-bound framework for the prize-collecting Steiner tree and related problems

KEYWORDS: Mathematical Optimization - Systems Biology

FUNCTIONAL DESCRIPTION: Variants of the Steiner tree problem appear in a broad range of diverse applications, ranging from infrastructure network design to the analysis of biological networks and pattern recognition. In this software, we provide a branch-and-bound (B&B) framework for solving the asymmetric prize-collecting Steiner tree problem (APCSTP). Several well-known network design problems can be transformed to the APCSTP, including the Steiner tree problem (STP), prize-collecting Steiner tree problem (PCSTP), maximum-weight connected subgraph problem (MWCS) and the node-weighted Steiner tree problem (NW-STP).

- Contact: Markus Sinnl
- URL: <https://github.com/mluipersbeck/dapcstp>

6.2. HappyChic-ApproPick

KEYWORDS: Operational research - Optimization - Java

FUNCTIONAL DESCRIPTION: This software is a prototype developed for the bilateral contract with the company HappyChic. This software is a solver for an integrated warehouse order picking problem with manual picking operations. More precisely, the following problems are solved: (1) the assignment of references to storage positions, based on the iterative solving of minimum cost flow problems, (2) the division of clients orders into several parcels, respecting weight and size constraints, using a dynamic programming algorithm based on the split algorithm, (3) the batching of parcels into trolleys to perform picking tours, using a dynamic programming algorithm based on the split algorithm. The objective function is to minimize the total walking distance. This software is designed to deal with the large-sized industrial instances of HappyChic (considering hundreds of clients, thousands of positions and product references) in a short computation time (few minutes).

- Contact: Maxime Ogier

6.3. rcmwcs

A Relax-and-Cut Algorithm for Maximum Weight Connected Subgraph Problems

KEYWORDS: Mathematical Optimization - Systems Biology

FUNCTIONAL DESCRIPTION: Finding maximum weight connected subgraphs within networks is a fundamental combinatorial optimization problem both from a theoretical and a practical standpoint. One of the most prominent applications of this problem appears in Systems Biology and it corresponds to the detection of active subnetworks within gene interaction networks. The software is a framework to solve the model by means of Relax-and-Cut, i.e., Lagrangian relaxation combined with constraint generation.

- Contact: Markus Sinnl
- URL: <https://msinnl.github.io/pages/rcmwcs.html>

6.4. MIBLPsolver

A Solver for Mixed-Integer Bilevel Linear Problems

KEYWORD: Mathematical Optimization

FUNCTIONAL DESCRIPTION: Bilevel optimization problems are very challenging optimization models arising in many important practical contexts, including pricing mechanisms in the energy sector, airline and telecommunication industry, transportation networks, optimal expansion of gas networks, critical infrastructure defense, and machine learning. In this software, we present a new general purpose branch-and-cut framework for the exact solution of mixed-integer bilevel linear programs (MIBLP), which constitute a very significant subfamily of bilevel optimization problems.

- Contact: Markus Sinnl
- URL: <https://msinnl.github.io/pages/bilevel.html>

6.5. PARROT

Planning Adapter Performing ReRouting and Optimization of Timing

KEYWORDS: Decision aid - Railway - Scheduling

FUNCTIONAL DESCRIPTION: This is a decision support system addressing the problem of the rescheduling railway schedules on the Belgian network when maintenance operations are planned in the short term (2-3 weeks in advance). The deliverable is a software tool that will take as input: (1) the schedules initially planned for the different trains, (2) the initial routes of the trains, (3) maintenance operations / changes of elements in the form of constraints (unavailable routes etc.). He then provides in output: (1) the new train schedule, (2) the new routing of the fleet. The modifications must respect the constraints corresponding to the operations of maintenance. For example, in some cases it is common to leave at least a few minutes interval between two trains using the same track in the station. This constraint must then be propagated if a maintenance operation delays the arrival of a train. New schedules and routings have to be created following a specific goal. Changes made to schedules and routings must minimize: (1) variations on the time spent at the station, (2) the number of partially canceled trains (additional correspondence (s) or stations that are no longer served), (2) the number of fully canceled trains (no stations served).

- Contact: Martine Labbe

IPSO Project-Team (section vide)

MATERIALS Project-Team

6. New Software and Platforms

6.1. simol

KEYWORDS: Molecular simulation - Quantum chemistry - Statistical physics - C++ - OpenMP

FUNCTIONAL DESCRIPTION: Molecular simulation software written in C++

- Contact: Gabriel Stoltz

MATHRISK Project-Team

5. New Software and Platforms

5.1. PREMIA

KEYWORDS: Financial products - Computational finance - Option pricing

SCIENTIFIC DESCRIPTION: The Premia project keeps track of the most recent advances in the field of computational finance in a well-documented way. It focuses on the implementation of numerical analysis techniques for both probabilistic and deterministic numerical methods. An important feature of the platform Premia is the detailed documentation which provides extended references in option pricing.

Premia is thus a powerful tool to assist Research and Development professional teams in their day-to-day duty. It is also a useful support for academics who wish to perform tests on new algorithms or pricing methods without starting from scratch.

Besides being a single entry point for accessible overviews and basic implementations of various numerical methods, the aim of the Premia project is: 1 - to be a powerful testing platform for comparing different numerical methods between each other, 2 - to build a link between professional financial teams and academic researchers, 3 - to provide a useful teaching support for Master and PhD students in mathematical finance.

FUNCTIONAL DESCRIPTION: Premia is a software designed for option pricing, hedging and financial model calibration.

- Participants: Agnes Sulem, Antonino Zanette, Aurélien Alfonsi, Benjamin Jourdain, Jacques Printems and Jérôme Lelong
- Partners: Inria - Ecole des Ponts ParisTech - Université Paris-Est
- Contact: Agnes Sulem
- URL: <http://www.premia.fr>

5.2. Platforms

5.2.1. Development of the quantitative platform Premia in 2017

- Premia 18 has been registered at the Agence pour la Protection des Programmes APP (IDDN.FR.001.190010.014.S.C.2001.000.31000)

- Premia 19 has been delivered to the Consortium Premia on March 16th. It contains the following new algorithms : Risk Management, Model Risk, Insurance

- XVA simulation on GPUs using Nested Monte Carlo. L. Abbas Turki
- Model-independent bounds for option prices a mass transport approach. M. Beiglböck, P. H. Labordère, F. Penkner
Finance Stochastics Volume 17, 2013.
- Model-Independent Pricing of Asian Options via Optimal Martingale. F Stebegg
- Pricing and Hedging GMWB in the Heston and in the Black-Scholes with Stochastic Interest Rate Models. L. Goudenege, A. Molent, A. Zanette

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- Quantization meets Fourier: a new technology for pricing options. G. Callegaro, L. Fiorin, M. Grasselli.
- Efficient unbiased simulation scheme for the SABR stochastic volatility model. B. Chen, C.W. Oosterlee J.A.M van der Weide.

International Journal of Theoretical and Applied Finance. Vol. 15, No. 2 (2012)

- An efficient Monte Carlo method for discrete variance contracts. N.Merener L.Vicchi
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- Path-Dependent Volatility. J.Guyon
Risk Magazine, October 2014.
- Cross-Dependent Volatility. J.Guyon
Risk Magazine, March 2016
- Option pricing and implied volatilities in a 2-hypergeometric stochastic volatility model. N. Privault
Q. She
Applied Mathematics Letters, 53, 2016
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C. R. Math. Acad. Sci. Paris, 351(9-10), 2013.
- Application of the improved fast Gauss transform to option pricing under jump-diffusion processes. T. Sakuma and Y. Yamada
The Journal of Computational Finance, Volume 18, Issue 2, 2014.
- Features of the Russian derivatives market volatility index development taking into account possible price jumps. A. Grechko, O. Kudryavtsev
Theory of Probability and Its Applications-SIAM, 2017 61:3 (2017), to appear
- On the application of spectral filters in a Fourier option pricing technique. C.W. Oosterlee M.J. Ruijter, M. Versteegh
The Journal of Computational Finance, Volume 19, Issue 1, 2015.
- Unbiased simulation of stochastic differential equations. P.H. Labordere X. Tan, N. Touzi

We have benefited from the help of the engineer Cedric Doucet, supervised by Jérôme Lelong, for designing non regression tests for Premia.

MCTAO Project-Team

5. New Software and Platforms

5.1. Hampath

KEYWORDS: Optimal control - Second order conditions - Differential homotopy - Ordinary differential equations

FUNCTIONAL DESCRIPTION: Hampath is a software developed to solve optimal control problems by a combination of Hamiltonian et path following methods. Hampath includes shooting and computation of conjugate points. It is an evolution of the software cotcot (apo.enseeiht.fr/cotcot). It has a Fortran kernel, uses Tapenade (www-sop.inria.fr/tropics/tapenade.html) for automatic differentiation and has a Matlab interface.

- Participants: Jean-Baptiste Caillaud, Joseph Gergaud and Olivier Cots
- Contact: Jean-Baptiste Caillaud
- URL: <http://www.hampath.org>

MEMPHIS Project-Team

6. New Software and Platforms

6.1. COCOFLOW

KEYWORDS: 3D - Elasticity - MPI - Compressible multimaterial flows

FUNCTIONAL DESCRIPTION: The code is written in fortran 95 with a MPI parallelization. It solves equations of conservation modeling 3D compressible flows with elastic models as equation of state.

- Contact: Florian Bernard
- URL: <https://gforge.inria.fr/projects/cocoflow>

6.2. KOPPA

Kinetic Octree Parallel PolyAtomic

FUNCTIONAL DESCRIPTION: KOPPA is a C++/MPI numerical code solving a large range of rarefied flows from external to internal flows in 1D, 2D or 3D. Different kind of geometries can be treated such as moving geometries coming from CAO files or analytical geometries. The models can be solved on Octree grids with dynamic refinement.

- Participant: Florian Bernard
- Contact: Florian Bernard
- URL: <https://git.math.cnrs.fr/gitweb/?p=plm/fbernard/KOPPA.git;a=summary>

6.3. NaSCar

Navier-Stokes Cartesian

KEYWORDS: HPC - Numerical analyse - Fluid mechanics - Langage C - PETSc

SCIENTIFIC DESCRIPTION: NaSCar can be used to simulate both hydrodynamic bio-locomotion as fish like swimming and aerodynamic flows such wake generated by a wind turbine.

FUNCTIONAL DESCRIPTION: This code is devoted to solve 3D-flows in around moving and deformable bodies. The incompressible Navier-Stokes equations are solved on fixed grids, and the bodies are taken into account thanks to penalization and/or immersed boundary methods. The interface between the fluid and the bodies is tracked with a level set function or in a Lagrangian way. The numerical code is fully second order (time and space). The numerical method is based on projection schemes of Chorin-Temam's type. The code is written in C language and use Petsc library for the resolution of large linear systems in parallel.

NaSCar can be used to simulate both hydrodynamic bio-locomotion as fish like swimming and aerodynamic flows such wake generated by a wind turbine.

- Participant: Michel Bergmann
- Contact: Michel Bergmann
- URL: <https://gforge.inria.fr/projects/nascar/>

6.4. NS-penal

Navier-Stokes-penalization

KEYWORDS: 3D - Incompressible flows - 2D

FUNCTIONAL DESCRIPTION: The software can be used as a black box with the help of a data file if the obstacle is already proposed. For new geometries the user has to define them. It can be used with several boundary conditions (Dirichlet, Neumann, periodic) and for a wide range of Reynolds numbers.

- Partner: Université de Bordeaux
- Contact: Charles-Henri Bruneau

MEPHYSTO Project-Team (section vide)

MISTIS Project-Team

6. New Software and Platforms

6.1. BOLD model FIT

KEYWORDS: Functional imaging - FMRI - Health

FUNCTIONAL DESCRIPTION: This Matlab toolbox performs the automatic estimation of biophysical parameters using the extended Balloon model and BOLD fMRI data. It takes as input a MAT file and provides as output the parameter estimates achieved by using stochastic optimization

- Authors: Jan M Warnking, Pablo Mesejo Santiago and Florence Forbes
- Contact: Pablo Mesejo Santiago
- URL: <https://hal.archives-ouvertes.fr/hal-01221115v2/>

6.2. MMST

Mixtures of Multiple Scaled Student T distributions

KEYWORDS: Medical imaging - Brain MRI - Statistics - Health - Robust clustering

FUNCTIONAL DESCRIPTION: The package implements mixtures of so-called multiple scaled Student distributions, which are generalisation of multivariate Student T distribution allowing different tails in each dimension. Typical applications include Robust clustering to analyse data with possible outliers. In this context, the model and package have been used on large data sets of brain MRI to segment and identify brain tumors.

- Participants: Alexis Arnaud, Darren Wraith and Florence Forbes
- Contact: Florence Forbes
- URL: <http://mistis.inrialpes.fr/realisations.html>

6.3. PyHRF

KEYWORDS: Health - Brain - IRM - Neurosciences - Statistic analysis - FMRI - Medical imaging

FUNCTIONAL DESCRIPTION: As part of fMRI data analysis, PyHRF provides a set of tools for addressing the two main issues involved in intra-subject fMRI data analysis : (i) the localization of cerebral regions that elicit evoked activity and (ii) the estimation of the activation dynamics also referenced to as the recovery of the Hemodynamic Response Function (HRF). To tackle these two problems, PyHRF implements the Joint Detection-Estimation framework (JDE) which recovers parcel-level HRFs and embeds an adaptive spatio-temporal regularization scheme of activation maps.

- Participants: Aina Frau Pascual, Christine Bakhous, Florence Forbes, Jaime Eduardo Arias Almeida, Laurent Risser, Lotfi Chaari, Philippe Ciuciu, Solveig Badillo, Thomas Perret and Thomas Vincent
- Partners: CEA - NeuroSpin
- Contact: Florence Forbes
- URL: <http://pyhrf.org>

6.4. xLLiM

High dimensional locally linear mapping

KEYWORDS: Clustering - Regression

FUNCTIONAL DESCRIPTION: This is an R package available on the CRAN at <https://cran.r-project.org/web/packages/xLLiM/index.html>

xLLiM provides a tool for non linear mapping (non linear regression) using a mixture of regression model and an inverse regression strategy. The methods include the GLLiM model (Deleforge et al (2015)) based on Gaussian mixtures and a robust version of GLLiM, named SLLiM (see Perthame et al (2016)) based on a mixture of Generalized Student distributions.

- Participants: Antoine Deleforge, Emeline Perthame and Florence Forbes
- Contact: Florence Forbes
- URL: <https://cran.r-project.org/web/packages/xLLiM/index.html>

MODAL Project-Team

6. New Software and Platforms

6.1. MixtComp

Mixture Computation

KEYWORDS: Clustering - Statistics - Missing data

FUNCTIONAL DESCRIPTION: MixtComp (Mixture Computation) is a model-based clustering package for mixed data originating from the Modal team (Inria Lille). It has been engineered around the idea of easy and quick integration of all new univariate models, under the conditional independence assumption. New models will eventually be available from researches, carried out by the Modal team or by other teams. Currently, central architecture of MixtComp is built and functionality has been field-tested through industry partnerships. Three basic models (Gaussian, multinomial, Poisson) are implemented, as well as two advanced models (Ordinal and Rank). MixtComp has the ability to natively manage missing data (completely or by interval). MixtComp is used as an R package, but its internals are coded in C++ using state of the art libraries for faster computation.

- Participants: Christophe Biernacki, Étienne Goffinet, Matthieu Marbac-Lourdelle, Quentin Grimonprez, Serge Iovleff and Vincent Kubicki
- Contact: Christophe Biernacki
- URL: <https://modal-research.lille.inria.fr/BigStat>

6.2. BlockCluster

Block Clustering

KEYWORDS: Statistic analysis - Clustering package

SCIENTIFIC DESCRIPTION: Simultaneous clustering of rows and columns, usually designated by biclustering, co-clustering or block clustering, is an important technique in two way data analysis. It consists of estimating a mixture model which takes into account the block clustering problem on both the individual and variables sets. The blockcluster package provides a bridge between the C++ core library and the R statistical computing environment. This package allows to co-cluster binary, contingency, continuous and categorical data-sets. It also provides utility functions to visualize the results. This package may be useful for various applications in fields of Data mining, Information retrieval, Biology, computer vision and many more.

FUNCTIONAL DESCRIPTION: BlockCluster is an R package for co-clustering of binary, contingency and continuous data based on mixture models.

- Participants: Christophe Biernacki, Gilles Celeux, Parmeet Bhatia, Serge Iovleff, Vincent Brault and Vincent Kubicki
- Partner: Université de Technologie de Compiègne
- Contact: Serge Iovleff
- URL: <http://cran.r-project.org/web/packages/blockcluster/index.html>

6.3. CloHe

Clustering of Mixed data

KEYWORDS: Classification - Clustering - Missing data

FUNCTIONAL DESCRIPTION: Software of classification for mixed data with missing values with application to multispectral satellite image time-series

- Partners: CNRS - INRA
- Contact: Serge Iovleff
- URL: <https://modal.lille.inria.fr/CloHe/>

6.4. PACBayesianNMF

KEYWORDS: Statistics - Machine learning

FUNCTIONAL DESCRIPTION: Implementing NMF with a PAC-Bayesian approach relying upon block gradient descent

- Participants: Benjamin Guedj and Astha Gupta
- Contact: Benjamin Guedj
- URL: <https://github.com/astha736/PACbayesianNMF>

6.5. pycobra

KEYWORDS: Statistics - Data visualization - Machine learning

SCIENTIFIC DESCRIPTION: pycobra is a python library for ensemble learning, which serves as a toolkit for regression, classification, and visualisation. It is scikit-learn compatible and fits into the existing scikit-learn ecosystem.

pycobra offers a python implementation of the COBRA algorithm introduced by Biau et al. (2016) for regression.

Another algorithm implemented is the EWA (Exponentially Weighted Aggregate) aggregation technique (among several other references, you can check the paper by Dalalyan and Tsybakov (2007).

Apart from these two regression aggregation algorithms, pycobra implements a version of COBRA for classification. This procedure has been introduced by Mojirsheibani (1999).

pycobra also offers various visualisation and diagnostic methods built on top of matplotlib which lets the user analyse and compare different regression machines with COBRA. The Visualisation class also lets you use some of the tools (such as Voronoi Tessellations) on other visualisation problems, such as clustering.

- Participants: Bhargav Srinivasa Desikan and Benjamin Guedj
- Contact: Benjamin Guedj
- URL: <https://github.com/bhargavvader/pycobra>

6.6. STK++

Statistical ToolKit

KEYWORDS: Statistics - Linear algebra - Framework - Learning - Statistical learning

FUNCTIONAL DESCRIPTION: STK++ (Statistical ToolKit in C++) is a versatile, fast, reliable and elegant collection of C++ classes for statistics, clustering, linear algebra, arrays (with an API Eigen-like), regression, dimension reduction, etc. The library is interfaced with lapack for many linear algebra usual methods. Some functionalities provided by the library are available in the R environment using rtkpp and rtkore.

STK++ is suitable for projects ranging from small one-off projects to complete data mining application suites.

- Participant: Serge Iovleff
- Contact: Serge Iovleff
- URL: <http://www.stkpp.org>

6.7. rtkore

STK++ core library integration to R using Rcpp

KEYWORDS: C++ - Data mining - Clustering - Statistics - Regression

FUNCTIONAL DESCRIPTION: STK++ (<http://www.stkpp.org>) is a collection of C++ classes for statistics, clustering, linear algebra, arrays (with an Eigen-like API), regression, dimension reduction, etc. The integration of the library to R is using Rcpp. The rtkore package includes the header files from the STK++ core library. All files contain only templated classes or inlined functions. STK++ is licensed under the GNU LGPL version 2 or later. rtkore (the stkpp integration into R) is licensed under the GNU GPL version 2 or later. See file LICENSE.note for details.

- Participant: Serge Iovleff
- Contact: Serge Iovleff
- URL: <https://cran.r-project.org/web/packages/rtkore/index.html>

6.8. Platforms

6.8.1. MASSICCC Platform

MASSICCC is a demonstration platform giving access through a SaaS (service as a software) concept to data analysis libraries developed at Inria. It allows to obtain results either directly through a website specific display (specific and interactive visual outputs) or through an R data object download. It started in October 2015 for two years and is common to the Modal team (Inria Lille) and the Select team (Inria Saclay). In 2016, two packages have been integrated: Mixmod and MixtComp (see the specific section about MixtComp). In 2017, the BlockCluster package has been integrated and also a particular attention to provide meaningful graphical outputs (for Mixmod, MixtComp and BlockCluster) directly in the web platform itself has led to some specific developments.

MOKAPLAN Project-Team

5. New Software and Platforms

5.1. ALG2

FUNCTIONAL DESCRIPTION: ALG2 for Monge Mean-Field Games, Monge problem and Variational problems under divergence constraint. A generalisation of the ALG2 algorithm has been implemented in FreeFem++.

- Contact: Jean-David Benamou
- URL: <https://team.inria.fr/mokaplan/augmented-lagrangian-simulations/>

5.2. Mokabajour

FUNCTIONAL DESCRIPTION: We design a software resolving the following inverse problem: define the shape of a mirror which reflects the light from a source to a defined target, distribution and support of densities being prescribed. Classical applications include the conception of solar oven, public lightning, car headlights. . . Mathematical modeling of this problem, related to the optimal transport theory, takes the form of a nonlinear Monge-Ampere type PDE. The numerical resolution of these models remained until recently a largely open problem. MOKABAJOUR project aims to develop, using algorithms invented especially at Inria and LJK, a reflector design software more efficient than geometrical methods used so far. The final step is to realize and physically test prototype reflectors.

- Participants: Boris Thibert, Jean-David Benamou and Quentin M  rigot
- Contact: Jean-David Benamou
- URL: <https://project.inria.fr/mokabajour/>

5.3. Platforms

5.3.1. MABV2

A 2D Julia implementation of the algorithm described in [25]. https://gforge.inria.fr/scm/browser.php?group_id=9995

NACHOS Project-Team

5. New Software and Platforms

5.1. DIOGENeS

Discontinuous Galerkin Nanoscale Solvers

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin - Computational nanophotonics

FUNCTIONAL DESCRIPTION: DIOGENeS relies on a two layer architecture. The core of the suite is a library of generic software components (data structures and algorithms) for the implementation of high order DG (Discontinuous Galerkin) and HDG (Hybridizable Discontinuous Galerkin) schemes formulated on unstructured tetrahedral and hybrid structured/unstructured (cubic/tetrahedral) meshes. This library is used to develop dedicated simulation software for time-domain and frequency-domain problems relevant to nanophotonics and nanoplasmonics, considering various material models.

- Contact: Stéphane Lanteri
- URL: <http://www-sop.inria.fr/nachos/index.php/Software/DIOGENeS>

5.2. GERShWIN

discontinuous Galerkin Solver for microWave Interaction with biological tissues

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin - Computational bioelectromagnetics

FUNCTIONAL DESCRIPTION: GERShWIN is based on a high order DG method formulated on unstructured tetrahedral meshes for solving the 3D system of time-domain Maxwell equations coupled to a Debye dispersion model.

- Contact: Stéphane Lanteri
- URL: <http://www-sop.inria.fr/nachos/index.php/Software/GERShWIN>

5.3. HORSE

High Order solver for Radar cross Section Evaluation

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin

FUNCTIONAL DESCRIPTION: HORSE is based on a high order HDG (Hybridizable Discontinuous Galerkin) method formulated on unstructured tetrahedral and hybrid structured/unstructured (cubic/tetrahedral) meshes for the discretization of the 3D system of frequency-domain Maxwell equations, coupled to domain decomposition solvers.

- Contact: Stéphane Lanteri
- URL: <http://www-sop.inria.fr/nachos/index.php/Software/HORSE>

NANO-D Project-Team

4. New Software and Platforms

4.1. SAMSON

Software for Adaptive Modeling and Simulation Of Nanosystems

KEYWORDS: Structural Biology - Nanosystems - Simulation - Bioinformatics - Chemistry

SCIENTIFIC DESCRIPTION: Please refer to <https://www.samson-connect.net>

FUNCTIONAL DESCRIPTION: SAMSON is a software platform for real-time modelling and simulation of natural or artificial nanosystems. The objective is to make SAMSON a generic application for computer-aided design of nanosystems, similar to existing applications for macrosystem prototyping (CATIA, SolidWorks, etc.).

- Contact: Stéphane Redon
- URL: <http://nano-d.inrialpes.fr/software/>

4.2. HermiteFit

A new docking algorithm for rapid fitting atomic structures into cryo-EM density maps

FUNCTIONAL DESCRIPTION: HermiteFit is a new docking algorithm for rapid fitting atomic structures into cryo-EM density maps using 3D orthogonal Hermite functions. HermiteFit uses the cross-correlation or the Laplacian-filtered cross-correlation as the fitting criterion. HermiteFit exhaustively rotates the protein density in the Hermite space and then converts the expansion coefficients into the Fourier space for the subsequent fast FFT-based correlation computations.

- Partners: IBS - FZJ Juelich
- Contact: Sergey Grudinin
- URL: <https://team.inria.fr/nano-d/software/hermitefit/>

4.3. Knodle

KNOWledge-Driven Ligand Extractor

FUNCTIONAL DESCRIPTION: KNOWledge-Driven Ligand Extractor is a software library for the recognition of atomic types, their hybridization states and bond orders in the structures of small molecules. Its prediction model is based on nonlinear Support Vector Machines. The process of bond and atom properties perception is divided into several steps. At the beginning, only information about the coordinates and elements for each atom is available :

Connectivity is recognized. A search of rings is performed to find the Smallest Set of Smallest Rings (SSSR). Atomic hybridizations are predicted by the corresponding SVM model. Bond orders are predicted by the corresponding SVM model. Aromatic cycles are found. Atomic types are set in obedience to the functional groups. Some bonds are reassigned during this stage.

- Partner: MIPT Moscow
- Contact: Sergey Grudinin
- URL: <https://team.inria.fr/nano-d/software/Knodle/>

4.4. RigidRMSD

A library for rapid computations of the root mean square deviations (RMSDs) corresponding to a set of rigid body transformations of a coordinate vector

FUNCTIONAL DESCRIPTION: RigidRMSD is a library for rapid computations of the root mean square deviations (RMSDs) corresponding to a set of rigid body transformations of a coordinate vector (which can be a molecule in PDB format, for example). Calculation of the RMSD splits into two steps:

Initialization, which is linear in the number of vector entities (or particles in a rigid body). RMSD computation, which is computed in constant time for a single rigid-body spatial transformation (rotation + translation). This step uses the inertia tensor and the the center of mass computed on the first step. Initialization step is performed only once. It makes RigidRMSD particularly useful when computing multiple RMSDs, since each new RMSD calculation takes only constant time.

- Contact: Sergey Grudinin
- URL: <https://team.inria.fr/nano-d/software/rigidrmsd/>

4.5. DockTrina

A novel protein docking method for modeling the 3D structures of nonsymmetrical triangular trimers

FUNCTIONAL DESCRIPTION: DockTrina is a novel protein docking method for modeling the 3D structures of nonsymmetrical triangular trimers. The method takes as input pair-wise contact predictions from a rigid body docking program. It then scans and scores all possible combinations of pairs of monomers using a very fast root mean square deviation (RMSD) test (see below). Finally, it ranks the predictions using a scoring function which combines triples of pair-wise contact terms and a geometric clash penalty term. The overall approach takes less than 2 min per complex on a modern desktop computer.

- Contact: Sergey Grudinin
- URL: <https://team.inria.fr/nano-d/software/docktrina/>

NECS Project-Team

6. New Software and Platforms

6.1. GTL

Grenoble Traffic Lab

FUNCTIONAL DESCRIPTION: The Grenoble Traffic Lab (GTL) initiative, led by the NeCS team, is a real-time traffic data Center (platform) that collects traffic road infrastructure information in real-time with minimum latency and fast sampling periods. The main elements of the GTL are: a real-time data-base, a show room, and a calibrated micro-simulator of the Grenoble South Ring. Sensed information comes from a dense wireless sensor network deployed on Grenoble South Ring, providing macroscopic traffic signals such as flows, velocities, densities, and magnetic signatures. This sensor network was set in place in collaboration with Inria spin-off Karrus-ITS, local traffic authorities (DIR-CE, CG38, La Metro), and specialized traffic research centers. In addition to real data, the project also uses simulated data, in order to validate models and to test the ramp-metering, the micro-simulator is a commercial software (developed by TSS AIMSUN ©). More details at <http://necs.inrialpes.fr/pages/grenoble-traffic-lab.php>

- Participants: Alain Kibangou, Andres Alberto Ladino Lopez, Anton Andreev, Carlos Canudas-De-Wit, Dominik Pisarski, Enrico Lovisari, Fabio Morbidi, Federica Garin, Hassen Fourati, Iker Bellicot, Maria laura Delle monache, Paolo Frasca, Pascal Bellemain, Pietro Grandinetti, Rémi Piotaix, Rohit Singhal and Vadim Bertrand
- Contact: Carlos Canudas-De-Wit
- URL: <http://necs.inrialpes.fr/pages/grenoble-traffic-lab.php>

6.2. Benchmarks Attitude Smartphones

KEYWORDS: Performance analysis - Sensors - Motion analysis - Experimentation - Smartphone

SCIENTIFIC DESCRIPTION: We investigate the precision of attitude estimation algorithms in the particular context of pedestrian navigation with commodity smartphones and their inertial/magnetic sensors. We report on an extensive comparison and experimental analysis of existing algorithms. We focus on typical motions of smartphones when carried by pedestrians. We use a precise ground truth obtained from a motion capture system. We test state-of-the-art attitude estimation techniques with several smartphones, in the presence of magnetic perturbations typically found in buildings. We discuss the obtained results, analyze advantages and limits of current technologies for attitude estimation in this context. Furthermore, we propose a new technique for limiting the impact of magnetic perturbations with any attitude estimation algorithm used in this context. We show how our technique compares and improves over previous works.

- Participants: Hassen Fourati, Nabil Layaïda, Pierre Genevès and Thibaud Michel
- Partner: GIPSA-Lab
- Contact: Pierre Genevès
- URL: <http://tyrex.inria.fr/mobile/benchmarks-attitude/>

6.3. GreAR

Grenoble AR-Tour based on geolocation.

KEYWORDS: Augmented reality - Geolocation - Smartphone

FUNCTIONAL DESCRIPTION: This application is an AR navigator specifically designed for pedestrians. This application was initially developed during the Venturi FP7 (2011-2015) project and has been updated with our AR framework since then. Between two visually driven AR experiences (at the time, developed by partners), the navigator provides the user with an audio and visual guidance through a pre-defined touristic path in Grenoble. The position of the user is obtained through a fusion of GPS signal (when available), pedometer estimates and a map-matching algorithm exploiting OpenStreetMap. As the GPS signal is poor in several parts of the old city the integration of the pedometer enables the navigator to obtain a sufficiently reliable position estimate, crucial for AR applications and geofencing. Within the application, there are several options given to the user to view the navigation path through the city, ranging from a satellite image of the streets to a vector map. In the navigation pane, the geofences relating to the AR experiences and other points of interest can be seen.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)
- URL: <http://tyrex.inria.fr/projects/mrb.html>

6.4. TyrAr

Geo Augmented Reality on a Smartphone

KEYWORDS: Augmented reality - Smartphone - Geolocation

FUNCTIONAL DESCRIPTION: This application is an AR viewer to name the mountains, cities and historical buildings over the camera feed of the smartphone. The user can turn on himself with his device to discover names and information about Points of Interest (POIs). POIs are directly extracted from the OSM database thanks to the Overpass Turbo API. POIs are displayed on the screen with their name, an icon and an extra information. City POIs exhibit the number of inhabitants, mountains are associated to their altitude and historical buildings display their date of construction.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)
- URL: <http://tyrex.inria.fr/projects/mrb.html>

6.5. AmiAr

Smart Home Augmented Reality on a Smartphone

KEYWORDS: Augmented reality - Smart home - Smartphone - Indoor geolocalisation

FUNCTIONAL DESCRIPTION: This application is a proof of concept of a Geo AR system in a smart apartment. This setup has been conducted in EquipEx Amiquel4Home. The goal here is to control objects in the apartment using widgets over the video feed from the camera. For example, a user points a lamp with his smartphone, a widget appears, then he uses a slider in this widget to modify the light intensity.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)

NON-A Project-Team

6. New Software and Platforms

6.1. Blimp

FUNCTIONAL DESCRIPTION: Scientific research and development on the control of autonomous airship have shown a significant growth in recent years. New applications appear in the areas such as freight carrier, advertising, monitoring, surveillance, transportation, military and scientific research. The control of autonomous airship is a very important problem for the aerial robots research.

The development of Blimp by Non-A is used for experimentation and demonstration of controlling algorithms. The blimp is required to provide some environment information and status of itself, such as surveillance video of surrounding environment, gesture of blimp, altitude of blimp. With these basic information, one could localize blimp with certain algorithm (visual SLAM for example) or implement one controller in order to improve the stability and maneuverability of blimp.

- Contact: Jean-Pierre Richard

6.2. SLIM

FUNCTIONAL DESCRIPTION: Multi-robots cooperation can be found as an application in many domains of science and technology: manufacturing, medical robotics, personal assistance, military/security and spatial robots. The market of robots is quickly developing and its capacity is continuously growing. Concerning cooperation of mobile multi-robots, 3 key issues have to be studied: Localization, path planning and robust control, for which Non-A team has worked and proposed new algorithms. Due to the ADT SLIM, we implement our algorithms (localization, path planning and robust control) and integrate them into ROS (Robotic Operating System) as a package, named SLIM.

- Contact: Jean-Pierre Richard

POEMS Project-Team

6. New Software and Platforms

6.1. COFFEE

FUNCTIONAL DESCRIPTION: COFFEE is a 3D BEM-accelerated FMM solver for linear elastodynamics (full implementation, 30 000 lines of Fortran 90). The 3-D elastodynamic equations are solved with the boundary element method accelerated by the multi-level fast multipole method. The fundamental solutions for the infinite space are used in this implementation. A boundary element-boundary element coupling strategy is also implemented so multi-region problems (strata inside a valley for example) can be solved.

- Contact: Stéphanie Chaillat

6.2. XLiFE++

FUNCTIONAL DESCRIPTION: XLiFE++ is a Finite Element library in C++ based on philosophy of the previous library Melina in Fortran but with new capabilities (boundary elements, discontinuous Galerkin methods, more integrated tools -in particular mesh tools - and high performance computing skills, multithread and GPU computation).

- Contact: Eric Lunéville

QUANTIC Project-Team (section vide)

RANDOPT Team (section vide)

RAPSODI Project-Team (section vide)

REALOPT Project-Team

6. New Software and Platforms

6.1. BaPCod

A generic Branch-And-Price-And-Cut Code

KEYWORDS: Column Generation - Branch-and-Price - Branch-and-Cut - Mixed Integer Programming - Mathematical Optimization - Benders Decomposition - Dantzig-Wolfe Decomposition - Extended Formulation

FUNCTIONAL DESCRIPTION: BaPCod is a prototype code that solves Mixed Integer Programs (MIP) by application of reformulation and decomposition techniques. The reformulated problem is solved using a branch-and-price-and-cut (column generation) algorithms, Benders approaches, network flow and dynamic programming algorithms. These methods can be combined in several hybrid algorithms to produce exact or approximate solutions (primal solutions with a bound on the deviation to the optimum).

- Participants: Artur Alves Pessoa, Boris Detienne, Eduardo Uchoa Barboza, Franck Labat, François Clautiaux, François Vanderbeck, Halil Sen, Issam Tahiri, Michael Poss, Pierre Pesneau, Romain Leguay and Ruslan Sadykov
- Partners: Université de Bordeaux - CNRS - IPB - Universidade Federal Fluminense
- Contact: François Vanderbeck
- URL: <https://wiki.bordeaux.inria.fr/realopt/pmwiki.php/Project/BaPCod>

6.2. WineryPlanning

- Participants: Agnes Le Roux, Alexis Toullat, François Vanderbeck, Issam Tahiri and Ruslan Sadykov
- Contact: François Vanderbeck

6.3. ORTOJ

Operation Research Tools Under Julia

KEYWORDS: Modeling - Processing - Dashboard

FUNCTIONAL DESCRIPTION: This set of tools currently includes : 1) BlockJuMP.jl: extension of JuMP to model decomposable mathematical programs (using either Benders or Dantzig-Wolfe decomposition paradigm) 2) Scanner.jl: a default data parser to ease the reading of the input data in the form that they are often encountered in operational research. 3) BenchmarkUtils.jl: Tools to ease the setup of numerical experiments to benchmark algorithmic feature performances. The test automation permits to quickly calibrate the parameters of an arbitrary algorithm control function.

- Participants: François Vanderbeck, Guillaume Marques, Issam Tahiri and Ruslan Sadykov
- Contact: Issam Tahiri

SELECT Project-Team

5. New Software and Platforms

5.1. BlockCluster

Block Clustering

KEYWORDS: Statistic analysis - Clustering package

SCIENTIFIC DESCRIPTION: Simultaneous clustering of rows and columns, usually designated by biclustering, co-clustering or block clustering, is an important technique in two way data analysis. It consists of estimating a mixture model which takes into account the block clustering problem on both the individual and variables sets. The blockcluster package provides a bridge between the C++ core library and the R statistical computing environment. This package allows to co-cluster binary, contingency, continuous and categorical data-sets. It also provides utility functions to visualize the results. This package may be useful for various applications in fields of Data mining, Information retrieval, Biology, computer vision and many more.

FUNCTIONAL DESCRIPTION: BlockCluster is an R package for co-clustering of binary, contingency and continuous data based on mixture models.

- Participants: Christophe Biernacki, Gilles Celeux, Parmeet Bhatia, Serge Iovleff, Vincent Brault and Vincent Kubicki
- Partner: Université de Technologie de Compiègne
- Contact: Serge Iovleff
- URL: <http://cran.r-project.org/web/packages/blockcluster/index.html>

5.2. MASSICCC

Massive Clustering with Cloud Computing

KEYWORDS: Statistic analysis - Big data - Machine learning - Web Application

SCIENTIFIC DESCRIPTION: The web application let users use several software packages developed by Inria directly in a web browser. Mixmod is a classification library for continuous and categorical data. MixtComp allows for missing data and a larger choice of data types. BlockCluster is a library for co-clustering of data. When using the web application, the user can first upload a data set, then configure a job using one of the libraries mentioned and start the execution of the job on a cluster. The results are then displayed directly in the browser allowing for rapid understanding and interactive visualisation.

FUNCTIONAL DESCRIPTION: The MASSICCC web application offers a simple and dynamic interface for analysing heterogeneous data with a web browser. Various software packages for statistical analysis are available (Mixmod, MixtComp, BlockCluster) which allow for supervised and supervised classification of large data sets.

- Contact: Jonas Renault
- URL: <https://massiccc.lille.inria.fr>

5.3. Mixmod

Many-purpose software for data mining and statistical learning

KEYWORDS: Data modeling - Mixed data - Classification - Data mining - Big data

FUNCTIONAL DESCRIPTION: Mixmod is a free toolbox for data mining and statistical learning designed for large and highdimensional data sets. Mixmod provides reliable estimation algorithms and relevant model selection criteria.

It has been successfully applied to marketing, credit scoring, epidemiology, genomics and reliability among other domains. Its particularity is to propose a model-based approach leading to a lot of methods for classification and clustering.

Mixmod allows to assess the stability of the results with simple and thorough scores. It provides an easy-to-use graphical user interface (mixmodGUI) and functions for the R (Rmixmod) and Matlab (mixmodForMatlab) environments.

- Participants: Benjamin Auder, Christophe Biernacki, Florent Langrognnet, Gérard Govaert, Gilles Celeux, Remi Lebrete and Serge Iovleff
- Partners: CNRS - Université Lille 1 - LIFL - Laboratoire Paul Painlevé - HEUDIASYC - LMB
- Contact: Gilles Celeux
- URL: <http://www.mixmod.org>

SEQUEL Project-Team

6. New Software and Platforms

6.1. BAC

Bayesian Policy Gradient and Actor-Critic Algorithms

KEYWORDS: Machine learning - Incremental learning - Policy Learning

FUNCTIONAL DESCRIPTION: To address this issue, we proceed to supplement our Bayesian policy gradient framework with a new actor-critic learning model in which a Bayesian class of non-parametric critics, based on Gaussian process temporal difference learning, is used. Such critics model the action-value function as a Gaussian process, allowing Bayes' rule to be used in computing the posterior distribution over action-value functions, conditioned on the observed data. Appropriate choices of the policy parameterization and of the prior covariance (kernel) between action-values allow us to obtain closed-form expressions for the posterior distribution of the gradient of the expected return with respect to the policy parameters. We perform detailed experimental comparisons of the proposed Bayesian policy gradient and actor-critic algorithms with classic Monte-Carlo based policy gradient methods, as well as with each other, on a number of reinforcement learning problems.

- Contact: Michal Valko
- URL: <https://team.inria.fr/sequel/Software/BAC/>

6.2. GuessWhat?!

GuessWhat?! Visual object discovery through multi-modal dialogue

KEYWORDS: Deep learning - Dialogue System

FUNCTIONAL DESCRIPTION: This project train a AI to play the GuessWhat?! game. Thus, you can train an AI to ask questions, to answer questions about images. You can also perform basic visual reasoning. This project is a testbed for future interactive dialogue system.

- Partner: Universite de Montreal
- Contact: Florian Strub
- Publications: [GuessWhat?! Visual object discovery through multi-modal dialogue - End-to-end optimization of goal-driven and visually grounded dialogue systems Harm de Vries](#)

6.3. Squeak

Sequential sampling for kernel matrix approximation

KEYWORD: Machine learning

- Contact: Daniele Calandriello
- URL: <http://researchers.lille.inria.fr/~valko/hp/serve.php?what=publications/squeak.py>

6.4. OOR

Optimistic Optimization in R

KEYWORDS: Black-box optimization - Machine learning

- Contact: Mickael Binois
- URL: <https://cran.r-project.org/web/packages/OOR/index.html>

SIERRA Project-Team

5. New Software and Platforms

5.1. ProxASAGA

KEYWORD: Optimization

FUNCTIONAL DESCRIPTION: A C++/Python code implementing the methods in the paper "Breaking the Nonsmooth Barrier: A Scalable Parallel Method for Composite Optimization", F. Pedregosa, R. Leblond and S. Lacoste-Julien, Advances in Neural Information Processing Systems (NIPS) 2017. Due to their simplicity and excellent performance, parallel asynchronous variants of stochastic gradient descent have become popular methods to solve a wide range of large-scale optimization problems on multi-core architectures. Yet, despite their practical success, support for nonsmooth objectives is still lacking, making them unsuitable for many problems of interest in machine learning, such as the Lasso, group Lasso or empirical risk minimization with convex constraints. In this work, we propose and analyze ProxASAGA, a fully asynchronous sparse method inspired by SAGA, a variance reduced incremental gradient algorithm. The proposed method is easy to implement and significantly outperforms the state of the art on several nonsmooth, large-scale problems. We prove that our method achieves a theoretical linear speedup with respect to the sequential version under assumptions on the sparsity of gradients and block-separability of the proximal term. Empirical benchmarks on a multi-core architecture illustrate practical speedups of up to 12x on a 20-core machine.

- Contact: Fabian Pedregosa
- URL: <https://github.com/fabianp/ProxASAGA>

5.2. object-states-action

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: Code for the paper Joint Discovery of Object States and Manipulation Actions, ICCV 2017: Many human activities involve object manipulations aiming to modify the object state. Examples of common state changes include full/empty bottle, open/closed door, and attached/detached car wheel. In this work, we seek to automatically discover the states of objects and the associated manipulation actions. Given a set of videos for a particular task, we propose a joint model that learns to identify object states and to localize state-modifying actions. Our model is formulated as a discriminative clustering cost with constraints. We assume a consistent temporal order for the changes in object states and manipulation actions, and introduce new optimization techniques to learn model parameters without additional supervision. We demonstrate successful discovery of seven manipulation actions and corresponding object states on a new dataset of videos depicting real-life object manipulations. We show that our joint formulation results in an improvement of object state discovery by action recognition and vice versa.

- Contact: Jean-Baptiste Alayrac

SPHINX Project-Team

6. New Software and Platforms

6.1. GetDDM

KEYWORDS: Large scale - 3D - Domain decomposition - Numerical solver

FUNCTIONAL DESCRIPTION: GetDDM combines GetDP and Gmsh to solve large scale finite element problems using optimized Schwarz domain decomposition methods.

- Contact: Xavier Antoine
- URL: <http://onelab.info/wiki/GetDDM>

6.2. GPESLab

Gross-Pitaevskii equations Matlab toolbox

KEYWORDS: 3D - Quantum chemistry - 2D

FUNCTIONAL DESCRIPTION: GPESLab is a Matlab toolbox developed to help physicists for computing ground states or dynamics of quantum systems modeled by Gross-Pitaevskii equations. This toolbox allows the user to define a large range of physical problems (1d-2d-3d equations, general nonlinearities, rotation term, multi-components problems...) and proposes numerical methods that are robust and efficient.

- Contact: Xavier Antoine
- URL: <http://gpelab.math.cnrs.fr/>

TAU Team

6. New Software and Platforms

6.1. io.datascience

Input Output Data Science

KEYWORDS: Open data - Semantic Web - FAIR (Findable, Accessible, Interoperable, and Reusable)

FUNCTIONAL DESCRIPTION: io.datascience (Input Output Data Science) is the instance of the Linked Wiki platform developed specifically in Paris-Saclay University as part of its Center for Data Science.

The goal of io.datascience: to facilitate the sharing and use of scientific data. The technological concept of io.datascience: the exploitation of semantic web advances, and in particular wiki technologies.

One of the grand challenges of data-intensive science is to facilitate knowledge discovery by assisting humans and machines in their discovery of, access to, integration and analysis of, task-appropriate scientific data and their associated algorithms and workflows. The guiding principles for this challenge have been defined: Data should become FAIR (Findable, Accessible, Interoperable, and Reusable) (Wilkinson, M., and The FAIR Guiding Principles for Scientific Data Management and Stewardship, Nature Scientific Data 2016)

io.datascience is both a data sharing platform and a framework for further development. It realizes a practical implementation of FAIR principles through a user-centric approach. • **Share:** Software users can declare the sources of the data they use as well as their query requests. • **Discover:** Using a form, users can link their data sources to each other. The repository used is that of Wikidata. The user can then retrieve his data sources and example queries through a search interface or directly through Google and Wikipedia. • **Reuse:** data is identified and qualified, a simple interface allows the user to provide the desired level of description for the data they refer to, as well as examples of use. • **Analyze:** io.datascience will soon be proposing the creation of RDF databases on the cloud on the cloud of Paris Sud University.

- Partners: Border Cloud - Paris Saclay Center for Data Science - Université Paris-Sud
- Contact: Cécile Germain-Renaud
- Publications: Data acquisition for analytical platforms: Automating scientific workflows and building an open database platform for chemical analysis metadata - A platform for scientific data sharing - TFT, Tests For Triplestores - Une autocomplétion générique de SPARQL dans un contexte multi-services - Certifying the interoperability of RDF database systems - Transforming Wikipedia into an Ontology-based Information Retrieval Search Engine for Local Experts using a Third-Party Taxonomy - The Grid Observatory 3.0 - Towards reproducible research and open collaborations using semantic technologies
- URL: <https://io.datascience-paris-saclay.fr/>

6.2. Codalab

KEYWORDS: Benchmarking - Competition

FUNCTIONAL DESCRIPTION: Challenges in machine learning and data science are competitions running over several weeks or months to resolve problems using provided datasets or simulated environments. Challenges can be thought of as crowdsourcing, benchmarking, and communication tools. They have been used for decades to test and compare competing solutions in machine learning in a fair and controlled way, to eliminate "inventor-evaluator" bias, and to stimulate the scientific community while promoting reproducible science. See our slide presentation.

As of december 2017 there are 145 public competitions on Codalab and over 10000 users. Some of the areas in which Codalab is used include Computer vision and medical image analysis, natural language processing, time series prediction, causality, and automatic machine learning. Codalab was selected for the million Euro challenge See.4C that was awarded a H2020 EU grant for its organization.

TAU is going to continue expanding Codalab to accommodate new needs. One of our current focus is to support use of challenges for teaching (i.e. include a grading system as part of Codalab) and support for hooking up data simulation engines in the backend of Codalab to enable Reinforcement Learning challenges and simulate interactions of machines with an environment. For the third year, **we are using Codalab for student projects**. M2 AIC students create mini data science challenges in teams of 6 students. L2 math and informatics students then solve them as part of their mini projects. We are collaborating with RPI (New York, USA) to use this platform as part of a curriculum of medical students. Our PhD. students are involved in co-organizing challenges to expose the research community at large with the topic of their PhD. This helps them formalizing a task with rigor and allows them to disseminate their research.

- Partner: Microsoft
- Contact: Isabelle Guyon
- URL: <http://competitions.codalab.org>

6.3. Cartolabe

KEYWORD: Information visualization

FUNCTIONAL DESCRIPTION: The goal of Cartolabe is to build a visual map representing the scientific activity of an institution/university/domain from published articles and reports. Using the HAL Database and building upon the AnHALytics processing chain, Cartolabe provides the user with a map of the thematics, authors and articles and their dynamics along time. ML techniques are used for dimensionality reduction, cluster and topics identification, visualisation techniques are used for a scalable 2D representation of the results.

NEWS OF THE YEAR: Improvement of the graphical interface

- Contact: Philippe Caillou
- URL: <http://cartolabe.lri.fr/>

TOSCA Project-Team

6. New Software and Platforms

6.1. MOC

Models Of Chemostat

KEYWORD: Simulator

FUNCTIONAL DESCRIPTION: MOC (for Models of Chemostat) is a Python simulator of four chemostat models: a mass-structured stochastic individual based model, a mass-structured integro-differential model, the Crump-Young model and a system of ordinary differential equations. This software allows to simulate one or several of those models with different parameters, to plot graphics of evolution of biomass concentration, number of bacteria and substrate concentration as well as the phase portrait, to determine the law of the extinction time of the bacterial population in case of population extinction.

- Participants: Coralie Fritsch and Fabien Campillo
- Contact: Coralie Fritsch
- URL: <https://github.com/coraliefritsch/modelsOfChemostat>

6.2. AWFCController

Acoustic Wind Farm Controller

KEYWORDS: Matlab - Noise - Control

SCIENTIFIC DESCRIPTION: AWFCController is a matlab module dedicated to a real time application that performs acoustic control of wind farms based on microphones set near surrounding housings. It computes the optimal command for each wind turbine at each time-step to fulfill the law criteria of acoustic annoyance while maximizing the electric production. It uses local weather measurements (wind speeds and directions) and wind turbines noise estimates computed by an audio source separation algorithm on the acoustic measurements.

FUNCTIONAL DESCRIPTION: Nowadays, wind farm owners have to reduce the velocity of their wind turbines to comply with the regulation on acoustic annoyance. However, the variability of perceived noise due to weather variations makes optimization hard to achieve. AWFCController is developed along with an industrial project in order to improve the optimization by adapting wind turbines speeds in regards to acoustic measurements of permanent sensors. It computes optimal command from acoustic measurements and meteo data.

- Participants: Baldwin Dumortier, Emmanuel Vincent and Madalina Deaconu
- Contact: Baldwin Dumortier

TROPICAL Team

6. New Software and Platforms

6.1. Coq-Polyhedra

KEYWORDS: Coq - Polyhedra - Automated theorem proving - Linear optimization

SCIENTIFIC DESCRIPTION: Coq-Polyhedra is a library providing a formalization of convex polyhedra in the Coq proof assistant. While still in active development, it provides an implementation of the simplex method, and already handles the basic properties of polyhedra such as emptiness, boundedness, membership. Several fundamental results in the theory of convex polyhedra, such as Farkas Lemma, duality theorem of linear programming, and Minkowski Theorem, are also formally proved.

The formalization is based on the Mathematical Components library, and makes an extensive use of the boolean reflection methodology.

FUNCTIONAL DESCRIPTION: Coq-Polyhedra is a library which aims at formalizing convex polyhedra in Coq

- Participants: Xavier Allamigeon, Vasileios Charisopoulos and Ricardo Katz
- Partner: CIFASIS
- Contact: Xavier Allamigeon
- Publication: [A Formalization of Convex Polyhedra Based on the Simplex Method](#)
- URL: <https://github.com/nhojem/Coq-Polyhedra>

ABS Project-Team

4. New Software and Platforms

4.1. SBL

Structural Bioinformatics Library

KEYWORDS: Structural Biology - Biophysics - Software architecture

FUNCTIONAL DESCRIPTION: The SBL is a generic C++/python cross-platform software library targeting complex problems in structural bioinformatics. Its tenet is based on a modular design offering a rich and versatile framework allowing the development of novel applications requiring well specified complex operations, without compromising robustness and performances.

More specifically, the SBL involves four software components (1-4 thereafter). For end-users, the SBL provides ready to use, state-of-the-art (1) applications to handle molecular models defined by unions of balls, to deal with molecular flexibility, to model macro-molecular assemblies. These applications can also be combined to tackle integrated analysis problems. For developers, the SBL provides a broad C++ toolbox with modular design, involving core (2) algorithms, (3) biophysical models, and (4) modules, the latter being especially suited to develop novel applications. The SBL comes with a thorough documentation consisting of user and reference manuals, and a bugzilla platform to handle community feedback.

RELEASE FUNCTIONAL DESCRIPTION: In 2017, major efforts targeted two points. First, the simplification of installation procedures. Second, the development of packages revolving on molecular flexibility at large: representations in internal and Cartesian coordinates, generic representation of molecular mechanics force fields (and computation of gradients), exploration algorithms for conformational spaces.

- Contact: Frédéric Cazals
- Publication: **The Structural Bioinformatics Library: modeling in biomolecular science and beyond**
- URL: <https://sbl.inria.fr/>

AIRSEA Project-Team

6. New Software and Platforms

6.1. AGRIF

Adaptive Grid Refinement In Fortran

KEYWORD: Mesh refinement

SCIENTIFIC DESCRIPTION: AGRIF is a Fortran 90 package for the integration of full adaptive mesh refinement (AMR) features within a multidimensional finite difference model written in Fortran. Its main objective is to simplify the integration of AMR potentialities within an existing model with minimal changes. Capabilities of this package include the management of an arbitrary number of grids, horizontal and/or vertical refinements, dynamic regridding, parallelization of the grids interactions on distributed memory computers. AGRIF requires the model to be discretized on a structured grid, like it is typically done in ocean or atmosphere modelling.

NEWS OF THE YEAR: In 2017, the multiresolution capabilities of the AGRIF software have been extended to be able to treat a much larger number of grids. In particular, the load balancing algorithms have been greatly improved.

- Participants: Roland Patoum and Laurent Debreu
- Contact: Laurent Debreu
- Publications: [Numerical and experimental approach for a better physical description of submesoscale processes : A north-western Mediterranean Sea case - AGRIF: Adaptive Grid Refinement in Fortran](#)
- URL: <http://www-ljk.imag.fr/MOISE/AGRIF>

6.2. BALAISE

Bibliothèque d'Assimilation Lagrangienne Adaptée aux Images Séquencées en Environnement

KEYWORDS: Multi-scale analysis - Data assimilation - Optimal control

FUNCTIONAL DESCRIPTION: BALAISE (Bibliothèque d'Assimilation Lagrangienne Adaptée aux Images Séquencées en Environnement) is a test bed for image data assimilation. It includes a shallow water model, a multi-scale decomposition library and an assimilation suite.

- Contact: Patrick Vidard

6.3. DassFlow

- Participants: Jerome Monnier, Joel Marin and Marc Honnorat
- Contact: Eric Blayo-Nogret

6.4. DiceDesign

Designs of Computer Experiments

FUNCTIONAL DESCRIPTION: This package is useful for conducting design and analysis of computer experiments.

- Contact: Céline Hartweg
- URL: <https://cran.r-project.org/web/packages/DiceDesign/index.html>

6.5. DiceEval

Construction and Evaluation of Metamodels

FUNCTIONAL DESCRIPTION: This package is useful for conducting design and analysis of computer experiments. Estimation, validation and prediction of models of different types : linear models, additive models, MARS, PolyMARS and Kriging.

- Contact: Céline Hartweg
- URL: <https://cran.r-project.org/web/packages/DiceEval/index.html>

6.6. NEMOVAR

Variational data assimilation for NEMO

KEYWORDS: Oceanography - Data assimilation - Adjoint method - Optimal control

FUNCTIONAL DESCRIPTION: NEMOVAR is a state-of-the-art multi-incremental variational data assimilation system with both 3D and 4D var capabilities, and which is designed to work with NEMO on the native ORCA grids. The background error covariance matrix is modelled using balance operators for the multivariate component and a diffusion operator for the univariate component. It can also be formulated as a linear combination of covariance models to take into account multiple correlation length scales associated with ocean variability on different scales. NEMOVAR has recently been enhanced with the addition of ensemble data assimilation and multi-grid assimilation capabilities. It is used operationnaly in both ECMWF and the Met Office (UK)

- Partners: CERFACS - ECMWF - Met Office
- Contact: Patrick Vidard

6.7. Sensitivity

FUNCTIONAL DESCRIPTION: This package is useful for conducting sensitivity analysis of complex computer codes.

- Contact: Laurent Gilquin
- URL: <https://cran.r-project.org/web/packages/sensitivity/index.html>

AMIBIO Team (section vide)

ANGE Project-Team

6. New Software and Platforms

6.1. Freshkiss

FREe Surface Hydrodynamics using KInetic SchemeS

KEYWORDS: Finite volume methods - Hydrostatic Navier-Stokes equations - Free surface flows

FUNCTIONAL DESCRIPTION: Freshkiss3D is a numerical code solving the 3D hydrostatic and incompressible Navier-Stokes equations with variable density.

- Participants: Fabien Souille, Emmanuel Audusse, Jacques Sainte Marie and Marie-Odile Bristeau
- Partners: UPMC - CEREMA
- Contact: Jacques Sainte Marie

6.2. TSUNAMATHS

KEYWORDS: Modeling - Tsunamis

FUNCTIONAL DESCRIPTION: Tsunamaths is an educational platform aiming at simulating historical tsunamis. Real data and mathematical explanations are provided to enable people to better understand the overall process of tsunamis.

- Participants: Emmanuel Audusse, Jacques Sainte Marie and Raouf Hamouda
- Contact: Jacques Sainte Marie
- URL: <http://tsunamath.paris.inria.fr/>

6.3. Verdandi

KEYWORDS: HPC - Model - Software Components - Partial differential equation

FUNCTIONAL DESCRIPTION: Verdandi is a free and open-source (LGPL) library for data assimilation. It includes various such methods for coupling one or several numerical models and observational data. Mainly targeted at large systems arising from the discretization of partial differential equations, the library is devised as generic, which allows for applications in a wide range of problems (biology and medicine, environment, image processing, etc.). Verdandi also includes tools to ease the application of data assimilation, in particular in the management of observations or for a priori uncertainty quantification. Implemented in C++, the library may be used with models implemented in Fortran, C, C++ or Python.

- Participants: Dominique Chapelle, Gautier Bureau, Nicolas Claude, Philippe Moireau and Vivien Mallet
- Contact: Vivien Mallet
- URL: <http://verdandi.gforge.inria.fr/>

6.4. Polyphemus

KEYWORD: Simulation

FUNCTIONAL DESCRIPTION: Polyphemus is a modeling system for air quality. As such, it is designed to yield up-to-date simulations in a reliable framework: data assimilation, ensemble forecast and daily forecasts. Its completeness makes it suitable for use in many applications: photochemistry, aerosols, radionuclides, etc. It is able to handle simulations from local to continental scales, with several physical models. It is divided into three main parts:

- libraries that gather data processing tools (SeldonData), physical parameterizations (AtmoData) and post-processing abilities (AtmoPy),
- programs for physical pre-processing and chemistry-transport models (Polair3D, Castor, two Gaussian models, a Lagrangian model),
- model drivers and observation modules for model coupling, ensemble forecasting and data assimilation.
- Participants: Sylvain Doré and Vivien Mallet
- Contact: Vivien Mallet
- URL: <http://cerea.enpc.fr/polyphemus/>

6.5. Urban noise analysis

KEYWORD: Environment perception

FUNCTIONAL DESCRIPTION: This software processes mobile observations collected by the application Ambiciti (previously known as SoundCity). It can merge simulated noise maps with the mobile observations.

- Authors: Raphaël Ventura, Vivien Mallet and Guillaume ChereI
- Contact: Vivien Mallet

ARAMIS Project-Team

6. New Software and Platforms

6.1. Brain Networks Toolbox

KEYWORDS: Neuroimaging - Medical imaging

FUNCTIONAL DESCRIPTION: Brain Networks Toolbox is an open-source package of documented routines implementing new graph algorithms for brain network analysis. It mainly contains Matlab code of new methods developed by the team and associated to publications (e.g., brain network thresholding, extraction of the information redundancy, node accessibility, etc). It requires, as input, adjacency matrices representing brain connectivity networks. Thus, it is independent on the specific approach used to construct brain networks and it can be used to extract network properties from any neuroimaging modality in healthy and diseased subjects.

- Participants: Fabrizio De Vico Fallani, Jeremy Guillon and Mario Chavez
- Contact: Fabrizio De Vico Fallani
- URL: <https://github.com/brain-network/bnt>

6.2. Deformetrica

KEYWORDS: Anatomy - Mesh - Automatic Learning - C++ - 3D modeling - Image analysis

SCIENTIFIC DESCRIPTION: Deformetrica is a software for the statistical analysis of 2D and 3D shape data. It essentially computes deformations of the 2D or 3D ambient space, which, in turn, warp any object embedded in this space, whether this object is a curve, a surface, a structured or unstructured set of points, or any combination of them.

Deformetrica comes with two applications:

registration, which computes the best possible deformation between two sets of objects, atlas construction, which computes an average object configuration from a collection of object sets, and the deformations from this average to each sample in the collection.

Deformetrica has very little requirements about the data it can deal with. In particular, it does not require point correspondence between objects!

FUNCTIONAL DESCRIPTION: Deformetrica is a software for the statistical analysis of 2D and 3D shape data. It essentially computes deformations of the 2D or 3D ambient space, which, in turn, warp any object embedded in this space, whether this object is a curve, a surface, a structured or unstructured set of points, or any combination of them.

Deformetrica comes with two applications:

- Registration, which computes the optimal deformation between two sets of objects,
- Atlas construction, which computes an average object configuration from a collection of object sets, and the deformations from this average to each sample in the collection.

Deformetrica has very little requirements about the data it can deal with. In particular, it does not require point correspondence between objects!

- Participants: Alexandre Routier, Ana Fouquier, Barbara Gris, Benjamin Charlier, Cédric Doucet, Joan Alexis Glaunès, Marcel Prastawa, Michael Bacci, Pietro Gori and Stanley Durrleman
- Partners: University of Utah - Université de Montpellier 2 - Université Paris-Descartes
- Contact: Stanley Durrleman
- URL: <http://www.deformetrica.org/>

6.3. Clinica

KEYWORDS: Neuroimaging - Brain MRI - MRI - Clinical analysis - Image analysis - Machine learning

SCIENTIFIC DESCRIPTION: Clinica is a software platform for multimodal brain image analysis in clinical research studies. It makes it easy to apply advanced analysis tools to large scale clinical studies. For that purpose, it integrates a comprehensive set of processing tools for the main neuroimaging modalities: currently MRI (anatomical, functional, diffusion) and PET, in the future, EEG/MEG. For each modality, Clinica allows to easily extract various types of features (regional measures, parametric maps, surfaces, curves, networks). Such features are then subsequently used as input of machine learning, statistical modeling, morphometry or network analysis methods. Processing pipelines are based on combinations of freely available tools developed by the community. It provides an integrated data management specification to store raw and processing data. Clinica is written in Python. It uses the Nipype system for pipelining. It combines widely-used software for neuroimaging data analysis (SPM, Freesurfer, FSL, MRtrix...), morphometry (Deformetrica), machine learning (Scikit-learn) and the BIDS standard for data organization.

FUNCTIONAL DESCRIPTION: Clinica is a software platform for multimodal brain image analysis in clinical research studies. It makes it easy to apply advanced analysis tools to large scale clinical studies. For that purpose, it integrates a comprehensive set of processing tools for the main neuroimaging modalities: currently MRI (anatomical, functional, diffusion) and PET, in the future, EEG/MEG. For each modality, Clinica allows to easily extract various types of features (regional measures, parametric maps, surfaces, curves, networks). Such features are then subsequently used as input of machine learning, statistical modeling, morphometry or network analysis methods. Clinica also provides an integrated data management specification to store raw and processing data. Overall, Clinica helps to: i) apply advanced analysis tools to clinical research studies, ii) easily share data and results, iii) make research more reproducible.

- Participants: Junhao Wen, Jorge Samper Gonzalez, Alexandre Routier, Tristan Moreau, Arnaud Marcoux, Pascal Lu, Thomas Jacquemont, Jeremy Guillon, Olivier Colliot, Stanley Durrleman, Michael Bacci, Simona Bottani, Ninon Burgos, Sabrina Fontanella and Pietro Gori
- Partners: Institut du Cerveau et de la Moelle épinière (ICM) - CNRS - INSERM - UPMC
- Contact: Olivier Colliot
- Publications: [Amyloidosis and neurodegeneration result in distinct structural connectivity patterns in mild cognitive impairment - Yet Another ADNI Machine Learning Paper? Paving The Way Towards Fully-reproducible Research on Classification of Alzheimer's Disease](#)
- URL: <http://www.clinica.run>

6.4. Platforms

6.4.1. Platform Brain-computer interface

Our team has coordinated the implementation of the Brain-Computer Interface (BCI) platform at the Centre EEG/MEG of the neuroimaging core facility of the ICM. Several projects, including our NETBCI NSF/NIH/ANR funded project, and demos are currently being run by different researchers of the Institute. Such technological advance contributed to the scientific visibility of Inria and ICM with two TV reports (M6 and France 5).

ASCLEPIOS Project-Team

5. New Software and Platforms

5.1. MedInria

KEYWORDS: Visualization - DWI - Health - Segmentation - Medical imaging

SCIENTIFIC DESCRIPTION: It aims at creating an easily extensible platform for the distribution of research algorithms developed at Inria for medical image processing. This project has been funded by the D2T (ADT MedInria-NT) in 2010, renewed in 2012. A fast-track ADT was awarded in 2017 to transition the software core to more recent dependencies and study the possibility of a consortium creation. The Visages team leads this Inria national project and participates in the development of the common core architecture and features of the software as well as in the development of specific plugins for the team's algorithm.

FUNCTIONAL DESCRIPTION: MedInria is a free software platform dedicated to medical data visualization and processing.

- Participants: Maxime Sermesant, Olivier Commowick and Théodore Papadopoulo
- Partners: HARVARD Medical School - IHU - LIRYC - NIH
- Contact: Olivier Commowick
- URL: <http://med.inria.fr>

5.2. Music

Multi-modality Platform for Specific Imaging in Cardiology

KEYWORDS: Medical imaging - Cardiac Electrophysiology - Computer-assisted surgery - Cardiac - Health

FUNCTIONAL DESCRIPTION: MUSIC is a software developed by the Asclepios research project in close collaboration with the IHU LIRYC in order to propose functionalities dedicated to cardiac interventional planning and guidance. This includes specific tools (algorithms of segmentation, registration, etc.) as well as pipelines. The software is based on the MedInria platform.

- Participants: Florent Collot, Mathilde Merle and Maxime Sermesant
- Partner: IHU- Bordeaux
- Contact: Maxime Sermesant
- URL: <https://team.inria.fr/asclepios/software/music/>

5.3. SOFA

Simulation Open Framework Architecture

KEYWORDS: Real time - Multi-physics simulation - Medical applications

FUNCTIONAL DESCRIPTION: SOFA is an Open Source framework primarily targeted at real-time simulation, with an emphasis on medical simulation. It is mostly intended for the research community to help develop new algorithms, but can also be used as an efficient prototyping tool. Based on an advanced software architecture, it allows : the creation of complex and evolving simulations by combining new algorithms with algorithms already included in SOFA, the modification of most parameters of the simulation (deformable behavior, surface representation, solver, constraints, collision algorithm, etc.) by simply editing an XML file, the building of complex models from simpler ones using a scene-graph description, the efficient simulation of the dynamics of interacting objects using abstract equation solvers, the reuse and easy comparison of a variety of available methods.

- Participants: Christian Duriez, François Faure, Hervé Delingette and Stéphane Cotin
- Partner: IGG
- Contact: Stéphane Cotin
- URL: <http://www.sofa-framework.org>

5.4. VP2HF

KEYWORDS: Health - Cardiac - Medical - Image - Processing - Medical imaging

FUNCTIONAL DESCRIPTION: The VP2HF software is developed by the Asclepios team and brings together all the research produced by the VP2HF's partners. It contains MedInria plugins implemented by teams such as UPF Barcelona, KCL, and specific tools provided by Philips (algorithms of segmentation, scar segmentation, ...). It aims at integrating in a single clinical workflow, tools to improve the therapy selection and treatment optimisation for patients suffering from heart failure.

- Participants: Hakim Fadil, Loic Cadour and Maxime Sermesant
- Contact: Maxime Sermesant

5.5. Longitudinal SVF Framework

Longitudinal Stationary Velocity Field (SVF) Framework

KEYWORDS: Image registration - Image analysis - Medical imaging

SCIENTIFIC DESCRIPTION: The pipeline pre-process the images, and then estimates the longitudinal deformation per patient using the log-demons (or more recently the LCC-log-demons), transports the subject-SVF into a common spatial reference and performs group-wise analyses.

FUNCTIONAL DESCRIPTION: The Longitudinal Stationary Velocity Field (SVF) Framework estimates longitudinal brain deformations from image data series, transport them in a common space and perform statistical group-wise analyses.

It is based on freely available softwares and tools, and consists of three main steps: i) Pre-processing, ii) Position correction, iii) Non-linear deformation analysis.

- Authors: Marco Lorenzi, Xavier Pennec, Giovanni Frisoni and Nicholas Ayache
- Partner: IRCCS San Giovanni di Dio Fatebenefratelli
- Contact: Xavier Pennec

5.6. LCC-LogDemos

KEYWORD: Image registration

SCIENTIFIC DESCRIPTION: LCClogDemos is an accurate and robust diffeomorphic registration framework based on the log-Demons. It implements the symmetric Local Correlation Coefficient (LCC) as a similarity measure, and thus it is unbiased with respect to local linear intensity bias of the images.

LCC-LogDemos is suited for both inter and intra-subject registration, and compares well with respect to state-of-art methods. Thanks to the stable and consistent scheme for the computation of the Jacobian determinant of the transformation, LCClogDemos represents a reliable instrument for Tensor Based Morphometry (TBM).

The average registration time for typical 3D images is around 30 minutes for a single core on a Xeon platform 2.66Ghz quad core, 4Gb RAM.

FUNCTIONAL DESCRIPTION: LCClogDemos is an accurate and robust diffeomorphic registration framework based on the log-Demons. It implements the symmetric Local Correlation Coefficient (LCC) as a similarity measure, and thus it is unbiased with respect to local linear intensity bias of the images.

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The average registration time for typical 3D images is around 30 minutes for a single core on a Xeon platform 2.66Ghz quad core, 4Gb RAM.

- Participants: Marco Lorenzi and Xavier Pennec
- Contact: Xavier Pennec
- URL: <https://team.inria.fr/asclepios/software/lcclogdemos/>

5.7. GP-ProgressionModel

GP progression model

KEYWORDS: Data modeling - Data visualization - Data integration - Machine learning - Biostatistics - Statistical modeling - Medical applications - Evolution - Brain - Uncertainty - Uncertainty quantification - Alzheimer's disease - Probability - Stochastic models - Stochastic process - Trajectory Modeling - Marker selection - Health - Statistic analysis - Statistics - Bayesian estimation

FUNCTIONAL DESCRIPTION: Disease progression modeling (DPM) of Alzheimer's disease (AD) aims at revealing long term pathological trajectories from short term clinical data. Along with the ability of providing a data-driven description of the natural evolution of the pathology, DPM has the potential of representing a valuable clinical instrument for automatic diagnosis, by explicitly describing the biomarker transition from normal to pathological stages along the disease time axis.

In this software we reformulate DPM within a probabilistic setting to quantify the diagnostic uncertainty of individual disease severity in an hypothetical clinical scenario, with respect to missing measurements, biomarkers, and follow-up information. The proposed formulation of DPM provides a statistical reference for the accurate probabilistic assessment of the pathological stage of de-novo individuals, and represents a valuable instrument for quantifying the variability and the diagnostic value of biomarkers across disease stages.

Basic usage:

```
model = GP_progression_model.GP_progression_model(input_X,input_N,N_random_features)
```

X and Y should be A list of biomarkers arrays. Each entry "i" of the list is a list of individuals' observations for the biomarker i The monotonicity is enforced by the parameter self.penalty

- The class comes with an external method for transforming a given .csv file in the required input X and Y:

```
X,Y,list_biomarker = GP_progression_model.convert_csv(file_path)
```

- The method Save(folder_path) saves the model parameters to an external folder, that can be subsequently read with the method Load(folder_path)

- Optimization can be done with the method Optimize:

```
model.Optimize()
```

This software is based on the publication:

Probabilistic disease progression modeling to characterize diagnostic uncertainty: Application to staging and prediction in Alzheimer's disease. Marco Lorenzi, Maurizio Filippone, Daniel C. Alexander, Sebastien Ourselin Neuroimage. 2017 Oct 24. pii: S1053-8119(17)30706-1. doi: 10.1016/j.neuroimage.2017.08.059. HAL Id : hal-01617750 <https://hal.archives-ouvertes.fr/hal-01617750/>

- Authors: Marco Lorenzi and Maurizio Filippone
- Contact: Marco Lorenzi
- URL: <https://team.inria.fr/asclepios/team/marco-lorenzi/>

ATHENA Project-Team

6. New Software and Platforms

6.1. BCI-VIZAPP

BCI visual applications

KEYWORDS: Health - Brain-Computer Interface - GUI (Graphical User Interface)

SCIENTIFIC DESCRIPTION: Bci-Vizapp is a library that allows (in interaction with OpenViBE) to build BCI (Brain Computer Interfaces) applications based on the P300 speller principle. Bci-Vizapp provides a library that allows you to create the BCI's stimulation part as part of the Qt toolkit. Being able to use a standard toolkit to make BCI applications is a strong Bci-Vizapp originality. Indeed, in general the use of such toolkits is prohibited by the need for a very precise control of the display timings, which generally eliminates high-level graphic toolkits such as Qt.

FUNCTIONAL DESCRIPTION: BCI-VIZAPP includes a virtual keyboard for typing text, a photodiode monitoring application for checking timing issues. It communicates with the OpenViBE acquisition server for signal acquisition and with the OpenViBE designer for signal processing. The configuration is performed through a wizard.

This software is a new version following the CoAdapt P300 stimulator software.

NEWS OF THE YEAR: Bci-Vizapp is undergoing a profound transmutation with the help of CRISAM's SED in ADT BciBrowser (part of the AMDT). This change aims at integrating the functionality of Bci-Vizapp in third-party applications such as a web browsers.

- Participants: Nathanaël Foy, Romain Lacroix, Maureen Clerc Gallagher and Théodore Papadopoulos
- Contact: Maureen Clerc Gallagher

6.2. DIPY

Diffusion Imaging in Python

KEYWORDS: MRI - Medical imaging

FUNCTIONAL DESCRIPTION: Diffusion Imaging in Python (Dipy) is a free and open source software project for computational neuroanatomy, focusing mainly on diffusion magnetic resonance imaging (dMRI) analysis. E. Garyfallidis (now Indiana University) is the founder and lead engineer of this open source project in the development of diffusion MRI methods. We continuously collaborate with this global effort and our effort is combined with Université de Sherbrooke, in Canada and Stanford University among others. See for example our registration, denoising, tractography and microstructures tutorials.

- Participants: Demian Wassermann and Rutger Fick
- Partner: Sherbrooke University
- Contact: Demian Wassermann
- URL: <http://nipy.org/dipy/>

6.3. High Performance Diffusion MRI

KEYWORDS: Health - Neuroimaging - Medical imaging

FUNCTIONAL DESCRIPTION: This library has been developed and transferred to the Cie Olea Medical currently in charge of its validation and inclusion in its Olea Sphere platform. We have been closely involved in pushing the frontiers of the diffusion MRI (dMRI) in the recent years, especially in the mathematical modelling and processing of the dMRI signal and have developed state-of-the-art software implementations in the form of a C++ library that can be effectively used to infer the complex microstructure of the cerebral white matter. The algorithms and software transferred to Olea Medical fall into four categories : (i) local tissue modelling, which includes both popular 2nd order models and advanced higher than 2nd order models such as DTI, higher order Cartesian tensors (HOTs), ODF, FOD, EAP, maxima extraction, regularization and segmentation, (ii) generation of scalar indices (or biomarkers), which include DTI biomarkers, Diffusion Kurtosis Imaging (DKI) and invariants of 4th order tensors, (iii) global structure estimation, which includes deterministic and probabilistic tractography, and (iv) data visualisation for scalar indices, local models and global structures.

- Participants: Aurobrata Ghosh, Rachid Deriche and Théodore Papadopoulos
- Partner: Olea Medical
- Contact: Rachid Deriche

6.4. OpenMEEG

KEYWORDS: Health - Neuroimaging - Medical imaging

SCIENTIFIC DESCRIPTION: OpenMEEG provides a symmetric boundary element method (BEM) implementation for solving the forward problem of electromagnetic propagation over heterogeneous media made of several domains of homogeneous and isotropic conductivities. OpenMEEG works for the quasistatic regime (frequencies $< 100\text{Hz}$ and medium diameter $< 1\text{m}$).

FUNCTIONAL DESCRIPTION: OpenMEEG provides state-of-the art tools for modelling bio-electromagnetic propagation in the quasi-static regime. It is based on the symmetric BEM for the EEG/MEG forward problem, with a distributed source model. OpenMEEG has also been used to model the forward problem of ECoG, for modelling nerves or the cochlea. OpenMEEG is a free, open software written in C++ with python bindings. OpenMEEG is used through a command line interface, but is also interfaced in graphical interfaces such as BrainStorm, FieldTrip or SPM.

NEWS OF THE YEAR: OpenMEEG has had a large update including notably the parallelisation of some operators and bug corrections. The new version allows in addition the use of non-nested domains.

- Participants: Alexandre Gramfort, Emmanuel Olivi, Geoffray Adde, Jan Kybic, Kai Dang, Maureen Clerc Gallagher, Perrine Landreau, Renaud Keriven and Théodore Papadopoulos
- Contact: Théodore Papadopoulos
- Publications: [OpenMEEG: opensource software for quasistatic bioelectromagnetics - Forward Field Computation with OpenMEEG.](#) - [Source modeling of ElectroCorticoGraphy \(ECoG\) data: Stability analysis and spatial filtering](#)
- URL: <http://openmeeeg.github.io/>

BEAGLE Project-Team

5. New Software and Platforms

5.1. aevol

Artificial Evolution

FUNCTIONAL DESCRIPTION: Aevol is a digital genetics model: populations of digital organisms are subjected to a process of selection and variation, which creates a Darwinian dynamics. By modifying the characteristics of selection (e.g. population size, type of environment, environmental variations) or variation (e.g. mutation rates, chromosomal rearrangement rates, types of rearrangements, horizontal transfer), one can study experimentally the impact of these parameters on the structure of the evolved organisms. In particular, since Aevol integrates a precise and realistic model of the genome, it allows for the study of structural variations of the genome (e.g. number of genes, synteny, proportion of coding sequences).

The simulation platform comes along with a set of tools for analysing phylogenies and measuring many characteristics of the organisms and populations along evolution.

An extension of the model (R-Aevol), integrates an explicit model of the regulation of gene expression, thus allowing for the study of the evolution of gene regulation networks.

RELEASE FUNCTIONAL DESCRIPTION: Fix compilation error on Mac (tr1 included in std). The new mac compiler includes the tr1 directly in std which caused a compilation error. This issue was specific to aevol-4.4.1

- Participants: Antoine Frénoy, Bérénice Batut, Carole Knibbe, David Parsons, Dusan Misevic, Guillaume Beslon, Jonathan Rouzaud-Cornabas and Vincent Liard
- Partners: UCBL Lyon 1 - INSERM - Université Paris-Descartes - Insa de Lyon
- Contact: Carole Knibbe
- URL: <http://www.aevol.fr/>

5.2. DeCoSTAR

KEYWORDS: Bioinformatics - Evolution

FUNCTIONAL DESCRIPTION: DeCoSTAR reconstructs ancestral genomes and improves the assembly of extant genomes. It takes as input a set of gene trees, a species tree and adjacency relations between extant genes. It outputs ancestral genes, adjacencies between extant and ancestral genes, and a statistical support associated to each inferred adjacency.

NEWS OF THE YEAR: Publication of the software with several test sets in Genome Biology and Evolution

- Participants: Eric Tannier and Wandrille Duchemin
- Contact: Eric Tannier
- Publication: [DeCoSTAR: Reconstructing the ancestral organization of genes or genomes using reconciled phylogenies](#)
- URL: <http://pbil.univ-lyon1.fr/software/DeCoSTAR/>

5.3. EvoEvo

Evolution of Evolution

KEYWORDS: Bioinformatics - Biology - Evolution

FUNCTIONAL DESCRIPTION: In the context of the EvoEvo european project we are developing an integrated model of microorganisms evolution. This model will extend the current evolutionary models developed in the team (Aevol and R-Aevol) by adding a metabolic level and an ecosystem level. In 2014, a first version has been developed and released that includes the genomic, genetic and metabolic levels.

- Participants: Carole Knibbe, Charles Rocabert and Guillaume Beslon
- Contact: Guillaume Beslon
- URL: <http://www.evoevo.eu/>

5.4. evowave

KEYWORDS: Data stream - Clustering - Evolution - Wireless network

FUNCTIONAL DESCRIPTION: This package is a toolbox to analyse signal strength in wifi activity logfiles. It includes three main modules. The first is a preprocessing module to aggregate logfile contents. The second one is a subspace clustering module, based on an evolutionary algorithm, to identify similar wifi activity contexts. This similarity is defined on signal strength of wifi devices and the clusters can change over time. The third module is a visualisation tool to display the cluster modifications over time.

- Participants: Anthony Rossi, Christophe Rigotti, Guillaume Beslon, Jonas Abernot, Leo Lefebvre and Sergio Peignier
- Contact: Christophe Rigotti
- URL: http://evoevo.liris.cnrs.fr/download/4_-_deliverables/wp5/Deliverable_D5.1_software_archive.zip

5.5. FluoBacTracker

KEYWORDS: Bioinformatics - Biology - Biomedical imaging

SCIENTIFIC DESCRIPTION: FluoBacTracker is an ImageJ plugin allowing the segmentation and tracking of growing bacterial cells from time-lapse microscopy movies. The segmentation and tracking algorithms used by FluoBacTracker have been developed by Lionel Moisan and colleagues at Université Paris Descartes.

FUNCTIONAL DESCRIPTION: FluoBacTracker has the following functionalities: 1) Select regions of interest in images of microcolonies 2) Denoise and renormalize the images 3) Identify each cells in each image (segmentation) 4) Follow cells through the whole movie (tracking), including the detection of cells washed out from a microfluidics channel 5) Detect divisions and construct cell lineage of the population

NEWS OF THE YEAR: Version 2 of FluoBacTracker also allows the analysis of microscopy of bacteria growing in a microfluidics device called "mother machine".

- Participants: Hugues Berry, Cyril Dutrieux, Hidde De Jong, Charles Kervrann, David Parsons and Magali Vangkeosay
- Partners: Université Descartes - UGA
- Contact: Hugues Berry
- URL: <http://fluobacktracker.inrialpes.fr>

5.6. Tewep

Simulator of the dynamics of Transposable Elements Within Expanding Populations

KEYWORDS: Simulator - Transposable elements - Population genetics - Geographic expansion

FUNCTIONAL DESCRIPTION: Transposable elements, found in the genomes of most living organisms (including humans), are pieces of DNA able to replicate themselves and to proliferate. Their presence is a source of mutations which are, most of the time, detrimental to their host. As a consequence, natural selection usually limits their spread. There are, however, some conditions where natural selection cannot be efficient enough to remove them, for example when the population size is small. It is also hypothesized that when a population geographically expands, the efficiency of natural selection could be reduced at the expansion front. TEWEP is an individual-based simulator designed to test whether transposable elements could proliferate in large expanding populations. It combines several population genetics models to simulate the evolution of the number of transposable elements in each individual of an expanding population.

- Partner: Laboratoire de Biométrie et Biologie Evolutive (LBBE) - UMR CNRS 5558
- Contact: Carole Knibbe
- URL: <https://gforge.inria.fr/projects/tewep/>

BIGS Project-Team

5. New Software and Platforms

5.1. Angio-Analytics

KEYWORDS: Health - Cancer - Biomedical imaging

SCIENTIFIC DESCRIPTION: This tool allows the pharmacodynamic characterization of anti-vascular effects in anti-cancer treatments. It uses time series of in vivo images provided by intra-vital microscopy. Such in vivo images are obtained owing to skinfold chambers placed on mice skin. The automatized analysis is split up into two steps that were completely performed separately and manually before. The first steps corresponds to image processing to identify characteristics of the vascular network. The last step is the system identification of the pharmacodynamic response and the statistical analysis of the model parameters.

FUNCTIONAL DESCRIPTION: Angio-Analytics allows the pharmacodynamic characterization of anti-vascular effects in anti-cancer treatments.

- Participant: Thierry Bastogne
- Contact: Thierry Bastogne

5.2. In silico

In silico design of nanoparticles for the treatment of cancers by enhanced radiotherapy

KEYWORDS: Bioinformatics - Cancer - Drug development

FUNCTIONAL DESCRIPTION: To speed up the preclinical development of medical engineered nanomaterials, we have designed an integrated computing platform dedicated to the virtual screening of nanostructured materials activated by X-ray making it possible to select nano-objects presenting interesting medical properties faster. The main advantage of this in silico design approach is to virtually screen a lot of possible formulations and to rapidly select the most promising ones. The platform can currently handle the accelerated design of radiation therapy enhancing nanoparticles and medical imaging nano-sized contrast agents as well as the comparison between nano-objects and the optimization of existing materials.

- Participant: Thierry Bastogne
- Contact: Thierry Bastogne

5.3. SesIndexCreator

FUNCTIONAL DESCRIPTION: This package allows computing and visualizing socioeconomic indices and categories distributions from datasets of socioeconomic variables (These tools were developed as part of the EquitArea Project, a public health program).

- Participants: Benoît Lalloué, Jean-Marie Monnez, Nolwenn Le Meur and Severine Deguen
- Contact: Benoît Lalloué
- URL: http://www.equitarea.org/documents/packages_1.0-0/

BIOCORE Project-Team

6. New Software and Platforms

6.1. In@lgae

Numerical simulator of microalgae based processes

KEYWORDS: Simulation - Microalgae system - Productivity

FUNCTIONAL DESCRIPTION: In@lgae simulates the productivity of a microalgae production system, taking into account both the process type and its location and time of the year. The process is mainly defined by its thermal dynamics and by its associated hydrodynamics. For a given microalgal strain, a set of biological parameters describe the response to nitrogen limitation, temperature and light. As a result, the biomass production, CO₂ and nitrogen fluxes, lipid and sugar accumulation are predicted.

RELEASE FUNCTIONAL DESCRIPTION: The In@lgae platform has been optimised to make it faster. Some of the key models have been rewritten in C++ to allow a faster computation. Models have been improved to include, in the growth rate computation, the composition of the light spectrum. The graphical user interface has been enhanced and several sets of parameters describing different microalgal species have been stored.

- Participants: Étienne Delclaux, Francis Mairet, Olivier Bernard and Quentin Béchet
- Contact: Olivier Bernard

6.2. Odin

Platform for advanced monitoring, control and optimisation of bioprocesses

KEYWORDS: Bioinformatics - Biotechnology - Monitoring - Automatic control

SCIENTIFIC DESCRIPTION: This C++ application enables researchers and industrialists to easily develop and deploy advanced control algorithms through the use of a Scilab interpreter. It also contains a Scilab-based process simulator which can be harnessed for experimentation and training purposes. ODIN is primarily developed in the C++ programming language and uses CORBA to define component interfaces and provide component isolation. ODIN is a distributed platform, enabling remote monitoring of the controlled processes as well as remote data acquisition. It is very modular in order to adapt to any plant and to run most of the algorithms, and it can handle the high level of uncertainties that characterises the biological processes through explicit management of confidence indexes.

FUNCTIONAL DESCRIPTION: ODIN is a software framework for bioprocess control and supervision. ODIN is a distributed platform, where algorithms are described with a common structure easy to implement. Finally, ODIN can perform remote data acquisition and process these data to compute the signals to be applied to the actuators, together with estimates of state variables or process state. ODIN can handle the high level of uncertainties that characterises the biological processes through explicit management of confidence indexes.

- Participants: Fabien Dilet, Florian Guenn, Francesco Novellis, Mathieu Lacage, Melaine Gautier, Olivier Bernard, Olivier Calabro, Romain Primet and Serigne Sow
- Contact: Olivier Bernard
- URL: <https://team.inria.fr/biocore/software/odin/>

BIOVISION Team

6. New Software and Platforms

6.1. Virtual Retina

A biological retina modèle with contrast gain control for large scale simulations

KEYWORDS: Neurosciences - Simulation - Biology - Health

SCIENTIFIC DESCRIPTION: Virtual Retina has a variety of biological features implemented such as (i) spatio-temporal linear filter implementing the basic center/surround organization of retinal filtering, (ii) non-linear contrast gain control mechanism providing instantaneous adaptation to the local level of contrast, (iii) spike generation by one or several layers of ganglion cells paving the visual field.

FUNCTIONAL DESCRIPTION: Virtual Retina is a simulation software that allows large-scale simulations of biologically-plausible retinas.

NEWS OF THE YEAR: Virtual Retina software has been integrated into the platform PRANAS allowing to simulate retinal output via a graphical user interface (see paper published in Frontiers in Neuroinformatics, 2017)

- Participants: Adrien Wohrer, Pierre Kornprobst, Bruno Cessac, Maria-Jose Escobar and Thierry Viéville
- Contact: Pierre Kornprobst
- Publication: [Virtual Retina: A biological retina model and simulator, with contrast gain control](#)
- URL: <https://team.inria.fr/biovision/virtualretina/>

6.2. PRANAS

Platform for Retinal Analysis And Simulation

KEYWORDS: Retina - Neural Code - Data management - Statistics - Modeling - Vision

SCIENTIFIC DESCRIPTION: PRANAS was designed as a user-friendly tool dedicated to neuroscientist community in a large sense, i.e., not only experienced computational neuroscientists. It has two main goals : (i) to analyze retina data, especially spatio-temporal correlations, at single cell but also population levels, (ii) to simulate the spike response of the retina to a visual flow with a customizable retina simulator which evolves in synergy with experimental data analysis. In general, PRANAS allows to explore several aspects of retinal image processing such as understanding how to reproduce accurately the statistics of the spiking activity at the population level, or reconciling connectomics and simple computational rules for visual motion detection. This makes this tool a unique platform to better understand how the retina works.

FUNCTIONAL DESCRIPTION: The retina encodes a visual scene by trains of action potentials sent to the brain via the optic nerve. PRANAS brings to neuroscientists and modelers tools to better understand this coding. It integrates a retina simulator allowing large scale simulations while keeping a strong biological plausibility and a toolbox for the analysis of spike trains population statistics. The statistical method (entropy maximization under constraints) takes into account both spatial and temporal correlations as constraints, allowing to analyze the effects of memory on statistics. PRANAS also integrates a tool computing and representing in 3D (time-space) receptive fields. All these tools are accessible through a friendly graphical user interface. The most CPU-costly of them has been implemented to run in parallel. The actual version simulates healthy retinas but the long term goal is to study retinas with a pathology (DMLA, Retinitis Pigmentosa, Glaucoma).

NEWS OF THE YEAR: PRANAS software is described in an article published in Frontiers in Neuroinformatics (2017), and it is available for download.

- Authors: Bruno Cessac, Pierre Kornprobst, Sélim Kraria, Hassan Nasser, Daniela Pamplona, Geoffrey Portelli and Adrien Wohrer
- Contact: Bruno Cessac
- Publication: [PRANAS: A New Platform for Retinal Analysis and Simulation](#)
- URL: <https://team.inria.fr/biovision/pranas-software/>

BONSAI Project-Team

6. New Software and Platforms

6.1. BCALM 2

KEYWORDS: Bioinformatics - NGS - Genomics - Metagenomics - De Bruijn graphs

SCIENTIFIC DESCRIPTION: BCALM 2 is a bioinformatics tool for constructing the compacted de Bruijn graph from sequencing data. It is a parallel algorithm that distributes the input based on a minimizer hashing technique, allowing for good balance of memory usage throughout its execution. It is able to compact very large datasets, such as spruce or pine genome raw reads in less than 2 days and 40 GB of memory on a single machine.

FUNCTIONAL DESCRIPTION: BCALM 2 is an open-source tool for dealing with DNA sequencing data. It constructs a compacted representation of the de Bruijn graph. Such a graph is useful for many types of analyses, i.e. de novo assembly, de novo variant detection, transcriptomics, etc. The software is written in C++ and makes extensive use of the GATB library.

- Participants: Antoine Limasset, Paul Medvedev and Rayan Chikhi
- Contact: Rayan Chikhi
- Publication: [Compacting de Bruijn graphs from sequencing data quickly and in low memory](#)
- URL: <https://github.com/GATB/bcalm>

6.2. NORINE

Nonribosomal peptides resource

KEYWORDS: Drug development - Knowledge database - Chemistry - Graph algorithmics - Genomics - Biology - Biotechnology - Bioinformatics - Computational biology

SCIENTIFIC DESCRIPTION: Since its creation in 2006, Norine remains the unique knowledgebase dedicated to non-ribosomal peptides (NRPs). These secondary metabolites, produced by bacteria and fungi, harbor diverse interesting biological activities (such as antibiotic, antitumor, siderophore or surfactant) directly related to the diversity of their structures. The Norine team goal is to collect the NRPs and provide tools to analyze them efficiently. We have developed a user-friendly interface and dedicated tools to provide a complete bioinformatics platform. The knowledgebase gathers abundant and valuable annotations on more than 1100 NRPs. To increase the quantity of described NRPs and improve the quality of associated annotations, we are now opening Norine to crowdsourcing. We believe that contributors from the scientific community are the best experts to annotate the NRPs they work on. We have developed MyNorine to facilitate the submission of new NRPs or modifications of stored ones.

FUNCTIONAL DESCRIPTION: Norine is a public computational resource with a web interface and REST access to a knowledge-base of nonribosomal peptides. It also contains dedicated tools : 2D graph viewer and editor, comparison of NRPs, MyNorine, a tool allowing anybody to easily submit new nonribosomal peptides, Smiles2monomers (s2m), a tool that deciphers the monomeric structure of polymers from their chemical structure.

- Participants: Areski Flissi, Juraj Michalik, Laurent Noé, Maude Pupin, Stéphane Janot, Valerie Leclère and Yoann Dufresne
- Partners: CNRS - Université Lille 1 - Institut Charles Violette
- Contact: Maude Pupin
- Publications: [Norine, the knowledgebase dedicated to non-ribosomal peptides, is now open to crowdsourcing](#) - [Smiles2Monomers: a link between chemical and biological structures for polymers](#) - [Norine: a powerful resource for novel nonribosomal peptide discovery](#) - [NORINE: a database of nonribosomal peptides](#) - [Bioinformatics Tools for the Discovery of New Nonribosomal Peptides](#)
- URL: <http://bioinfo.lille.inria.fr/NRP>

6.3. Vidjil

High-Throughput Analysis of V(D)J Immune Repertoire

KEYWORDS: Cancer - Indexation - NGS - Bioinformatics - Drug development

SCIENTIFIC DESCRIPTION: Vidjil is made of three components: an algorithm, a visualization browser and a server that allow an analysis of lymphocyte populations containing V(D)J recombinations.

Vidjil high-throughput algorithm extracts V(D)J junctions and gathers them into clones. This analysis is based on a spaced seed heuristics and is fast and scalable, as, in the first phase, no alignment is performed with database germline sequences. Each sequence is put in a cluster depending on its V(D)J junction. Then a representative sequence of each cluster is computed in time linear in the size of the cluster. Finally, we perform a full alignment using dynamic programming of that representative sequence against the germline sequences.

Vidjil also contains a dynamic browser (with D3JS) for visualization and analysis of clones and their tracking along the time in a MRD setup or in an immunological study.

FUNCTIONAL DESCRIPTION: Vidjil is an open-source platform for the analysis of high-throughput sequencing data from lymphocytes. V(D)J recombinations in lymphocytes are essential for immunological diversity. They are also useful markers of pathologies, and in leukemia, are used to quantify the minimal residual disease during patient follow-up. High-throughput sequencing (NGS/HTS) now enables the deep sequencing of a lymphoid population with dedicated Rep-Seq methods and software.

- Participants: Florian Thonier, Marc Duez, Mathieu Giraud, Mikaël Salson, Ryan Herbert and Tatiana Rocher
- Partners: CNRS - Inria - Université de Lille - CHRU Lille
- Contact: Mathieu Giraud
- Publications: [High-Throughput Immunogenetics for Clinical and Research Applications in Immunohematology: Potential and Challenges.](#) - [High-throughput sequencing in acute lymphoblastic leukemia: Follow-up of minimal residual disease and emergence of new clones](#) - [Diagnostic et suivi des leucémies aiguës lymphoblastiques \(LAL\) par séquençage haut-débit \(HTS\)](#) - [Multiclonal Diagnosis and MRD Follow-up in ALL with HTS Coupled with a Bioinformatic Analysis](#) - [A dataset of sequences with manually curated V\(D\)J designations](#) - [Vidjil: A Web Platform for Analysis of High-Throughput Repertoire Sequencing](#) - [Multi-loci diagnosis of acute lymphoblastic leukaemia with high-throughput sequencing and bioinformatics analysis](#) - [Fast multiclonal clusterization of V\(D\)J recombinations from high-throughput sequencing](#) - [The predictive strength of next-generation sequencing MRD detection for relapse compared with current methods in childhood ALL.](#)
- URL: <http://www.vidjil.org>

6.4. MATAM

Mapping-Assisted Targeted-Assembly for Metagenomics

KEYWORDS: Metagenomics - Genome assembling - Graph algorithmics

SCIENTIFIC DESCRIPTION: MATAM relies on the construction of a read overlap graph. Overlaps are computed using SortMeRNA. The overlap graph is simplified into relevant components related to specific and conserved regions. Components are assembled into contigs using SGA and contigs are finally assembled into scaffolds. The process yields nearly full length marker sequences with a very low error rate compared to the state of the art approaches. Taxonomic assignation of the obtained scaffolds is performed using the RDP classifier and is represented using Krona.

FUNCTIONAL DESCRIPTION: MATAM provides targeted genes assembly from the short metagenomic reads issued from environmental samples sequencing. Its default application focuses on the gold standard for species identification, 16S / 18S ribosomal RNA SSU genes. The produced gene scaffolds are highly accurate and suitable for precise taxonomic assignation. The software also provides a RDP classification for the reconstructed scaffolds as well as an estimation of the relative population sizes.

- Participants: H    ne Touzet, Pierre Pericard, Yoann Dufresne, Samuel Blanquart and Lo  c Couderc
- Contact: H    ne Touzet
- Publication: **MATAM: reconstruction of phylogenetic marker genes from short sequencing reads in metagenomes**
- URL: <https://github.com/bonsai-team/matam>

CAMIN Team

5. New Software and Platforms

5.1. Softwares

5.1.1. HILECOP

Participants: Baptiste Colombani, David Andreu.

High Level hardware Component Programming

Functional Description: Our SENIS (Stimulation Electrique Neurale dIStribuee) based FES architecture relies on distributed stimulation units (DSU) which are interconnected by means of a 2-wire based network. A DSU is a complex digital system since it embeds among others a dedicated processor (micro-machine with a specific reduced instruction set), a monitoring module and a 3-layer protocol stack. To face the complexity of the units digital part and to ease its prototyping on programmable digital devices (e.g. FPGA), we developed an approach for high level hardware component programming (HILECOP). To support the modularity and the reusability of sub-parts of complex hardware systems, the HILECOP methodology is based on components. An HILECOP component has: an Interpreted Time Petri Net (ITPN) based behavior [3](#), a set of functions whose execution is controlled by the PN, and a set of variables and signals. Its interface contains places and transitions from which its PN model can be inter-connected as well as signals it exports or imports. The interconnection of those components, from a behavioral point out view, consists in the interconnection of places and/or transitions according to well-defined mechanisms: interconnection by means of oriented arcs or by means of the "merging" operator (existing for both places and transitions).

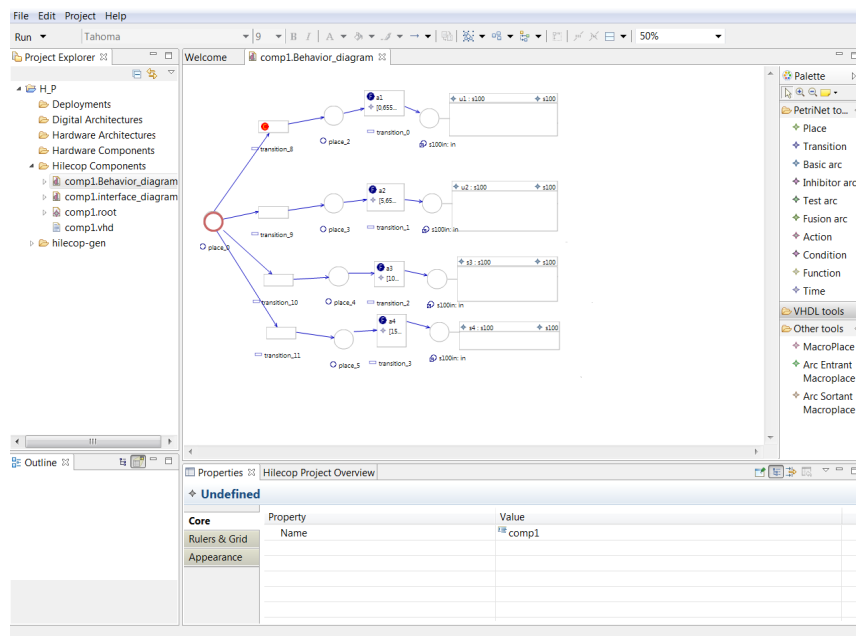


Figure 3. HILECOP screenshot

Several formalism evolutions have been integrated within the HILECOP software, like for instance behavior agregation as well as exception handling, both for analysis and implementation sides. Analysis has also been improved, a new approach for state space generation of synchronously executed ITPN has been designed, validated and then integrated within the software.

The Eclipse-based version of HILECOP (registered at the french Agence de Protection des Programmes (APP)) has been refactored: for instance, the application ECore model, a new Eclipse E4 architecture and a set of new features (new link types and new views to connect components) have been developed.

Specification of GALS systems (Globally Asynchronous Locally Synchronous) and their deployment on the hardware architecture are ongoing works; the aim is to take into account deployment properties like connecting different clocks to HILECOP components within a same FPGA, or on a set of interconnected FPGAs (and thus interconnecting them by means of asynchronous signals).

5.1.2. Sensbiotk

Participants: Christine Azevedo Coste, Roger Pissard-Gibollet, Benoît Sijobert.

Sensbiotk is a toolbox in Python for the calibration, the acquisition, the analysis and visualization of motion capture Inertial Measurement Units (IMU). Motion and Gait parameter reconstruction algorithms are also available. <http://sensbio.github.io/sensbiotk/>

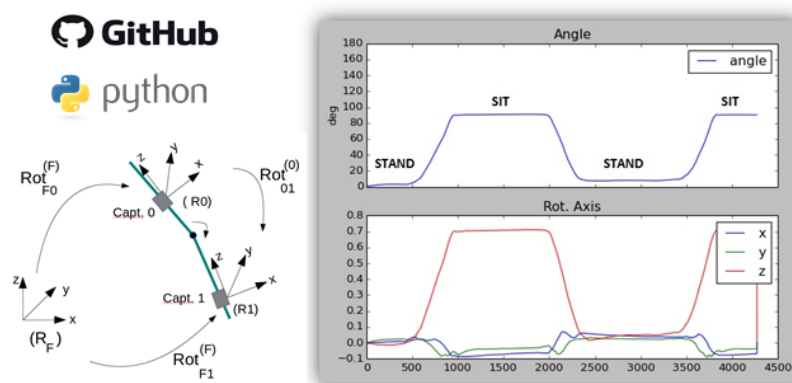


Figure 4. Sensbiotk toolbox for the calibration, the acquisition, the analysis and visualization of motion capture Inertial Measurement Units (IMU)

5.1.3. MOS2SENS

Participants: Mélissa Dali, Olivier Rossel, David Guiraud.

From Model Optimization and Simulation To Selective Electrical Neural Stimulation: it allows to manipulate 3D modeling of nerve and cuff electrodes taking into account anisotropy and the most advanced HH models of the myelinated axons. Based on optimized computing scheme, it allows to predict the activation areas induced by a complex 3D spreading of the current over a multicontact electrodes. Moreover, the tool allows for performing optimization of the needed current to target a specific cross section of the nerve. Version 1.0 (IDDN.FR.001.490036.000.S.P.2014.000.31230) has been released on december 2014 and v2.0 will be released January 2017. The last version includes full interface with OpenMEEG and COMSOL, and many other enhancements concerning both the model itself and the computation scheme.

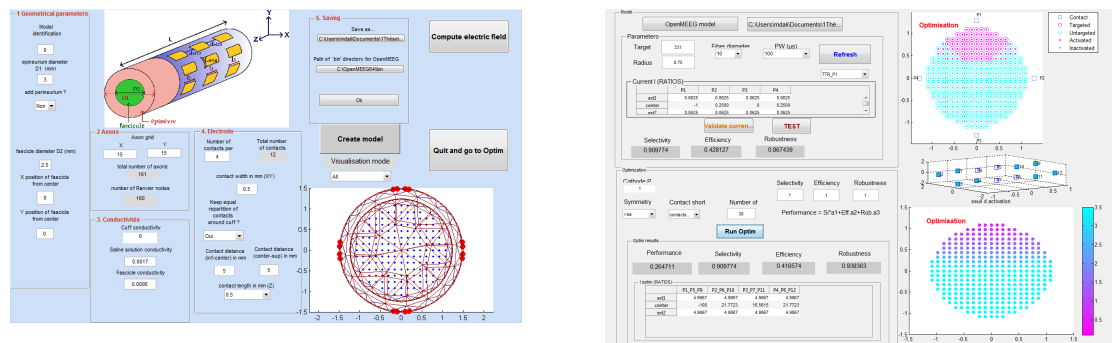


Figure 5. Graphical interface of software MOS2SENS, left: modeling multicuff CUFF electrode, right: optimization for spatial selectivity

CAPSID Project-Team

6. New Software and Platforms

6.1. Hex

KEYWORDS: 3D rendering - Bioinformatics - 3D interaction - Structural Biology

SCIENTIFIC DESCRIPTION: Hex is an interactive protein docking and molecular superposition program for Linux Mac-OS and Windows-XP. Hex understands protein and DNA structures in PDB format, and it can also read small-molecule SDF files. The recent versions now include CUDA support for Nvidia GPUs. On a modern workstation, docking times range from a few minutes or less when the search is constrained to known binding sites, to about half an hour for a blind global search (or just a few seconds with CUDA).

FUNCTIONAL DESCRIPTION: The underlying algorithm uses a novel polar Fourier correlation technique to accelerate the search for close-fitting orientations of the two molecules.

- Participant: David Ritchie
- Contact: David Ritchie
- URL: <http://hex.loria.fr>

6.2. Kbdock

KEYWORD: 3D interaction

SCIENTIFIC DESCRIPTION: Kbdock is a database of 3D protein domain-domain interactions with a web interface.

FUNCTIONAL DESCRIPTION: The Kbdock database is built from a snapshot of the Protein Databank (PDB) in which all 3D structures are cut into domains according to the Pfam domain description. A web interface allows 3D domain-domain interactions to be compared by Pfam family.

- Authors: Anisah Ghoorah, Anisah Ghoorah, David Ritchie and Marie-Dominique Devignes
- Contact: David Ritchie
- URL: <http://kbdock.loria.fr>

6.3. Kpax

KEYWORDS: Bioinformatics - Structural Biology

SCIENTIFIC DESCRIPTION: Kpax is a program for aligning and superposing the 3D structures of protein molecules.

FUNCTIONAL DESCRIPTION: The algorithm uses a Gaussian representation of the protein backbone in order to construct a similarity score based on the 3D overlap of the Gaussians of the proteins to be superposed. Multiple proteins may be aligned together (multiple structural alignment) and databases of protein structures may be searched rapidly.

- Participant: David Ritchie
- Contact: David Ritchie

6.4. Sam

Protein Symmetry Assembler

KEYWORDS: Proteins - Structural Biology

SCIENTIFIC DESCRIPTION: Sam is a program for making symmetrical protein complexes, starting from a single monomer.

FUNCTIONAL DESCRIPTION: The algorithm searches for good docking solutions between protein monomers using a spherical polar Fast Fourier transform correlation in which symmetry restraints are built into the calculation. Thus every candidate solution is guaranteed to have the desired symmetry.

- Authors: David Ritchie and Sergey Grudinin
- Partner: CNRS
- Contact: David Ritchie
- URL: <http://sam.loria.fr>

6.5. gEMfitter

KEYWORDS: 3D reconstruction - Cryo-electron microscopy - Fitting

SCIENTIFIC DESCRIPTION: A program for fitting high resolution 3D protein structures into low resolution cryo-EM density maps.

FUNCTIONAL DESCRIPTION: A highly parallel fast Fourier transform (FFT) EM density fitting program which can exploit the special hardware properties of modern graphics processor units (GPUs) to accelerate both the translationnal and rotational parts of the correlation search.

- Authors: Van-Thai Hoang and David Ritchie
- Contact: David Ritchie
- URL: <http://gem.loria.fr/gEMfitter/>

6.6. ECDM

ECDomainMiner

KEYWORD: Functional annotation

SCIENTIFIC DESCRIPTION: EC-DomainMiner uses a recommender-based approach for associating EC (Enzyme Commission) numbers with protein Pfam domains from EC-sequence relationships that have been annotated previously in the SIFTS and Uniprot databases.

FUNCTIONAL DESCRIPTION: A program to associate protein Enzyme Commission numbers with Pfam domains

- Contact: David Ritchie
- URL: <http://ecdm.loria.fr>

6.7. GODM

GO-DomainMiner

KEYWORD: Functional annotation

FUNCTIONAL DESCRIPTION: GO-DomainMiner is a graph-based approach for associating GO (gene ontology) terms with protein Pfam domains.

- Contact: David Ritchie
- URL: <http://godm.loria.fr>

6.8. BLADYG

A Block-centric graph processing framework for LArge Dynamic Graphs

KEYWORDS: Distributed computing - Dynamic graph processing

FUNCTIONAL DESCRIPTION: BLADYG is a block-centric framework that addresses the issue of dynamism in large-scale graphs. BLADYG starts its computation by collecting the graph data from various data sources. After collecting the graph data, BLADYG partitions the input graph into multiple partitions. Each BLADYG worker loads its block/partition and performs both local and remote computations, after which the status of the blocks is updated. The BLADYG coordinator orchestrates the execution of the considered graph operation in order to deal with graph updates.

- Partner: University of Trento
- Contact: Sabeur Aridhi

6.9. Platforms

6.9.1. The MBI Platform

The MBI (Modeling Biomolecular Interactions) platform (<http://bioinfo.loria.fr>) was established to support collaborations between Inria Nancy – Grand Est and other research teams associated with the University of Lorraine. The platform is a research node of the Institut Français de Bioinformatique (IFB), which is the French national network of bioinformatics platforms (<http://www.france-bioinformatique.fr>). In 2017, a Galaxy portal (<https://galaxyproject.org/>) for structural bioinformatics software was added to the platform thanks to funding for an engineer (Antoine Chemardin) from the IFB.

- Contact: Marie-Dominique Devignes

CARMEN Project-Team

6. New Software and Platforms

6.1. CEPS

Cardiac ElectroPhysiology Simulation

KEYWORDS: 3D - Cardiac - Mesh - Health - Simulation - Cardiac Electrophysiology

SCIENTIFIC DESCRIPTION: As compared to other existing softwares, CEPS aims at providing a more general framework of integration for new methods or models and a better efficiency in parallel. CEPS is designed to run on massively parallel architectures, and to make use of state-of-the-art and well known computing libraries to achieve realistic and complex heart simulations. CEPS also includes software engineering and validation tools.

FUNCTIONAL DESCRIPTION: CEPS is a numerical simulation tool focused on the modeling of cardiac electrophysiology. The goal of CEPS is to easily allow the development of new numerical methods and new physical models.

- Participants: Mehdi Juhoor and Nejib Zemzemi
- Partners: Université de Bordeaux - CNRS - INP Bordeaux - IHU - LIRYC
- Contact: Yves Coudière
- URL: <https://gforge.inria.fr/projects/ceps/>

6.2. Platforms

6.2.1. CEMPACK

CEMPACK is a new collection of software that was previously archived in different places. It includes the high-performance simulation code Propag and a suite of software for the creation of geometric models, preparing inputs for Propag, and analysing its outputs. In the course of 2017 the code was collected in an archive on Inria's GitLab platform, and a public website was created where documentation will be placed (<http://cempack.gforge.inria.fr>).

The main components of CEMPACK are the following.

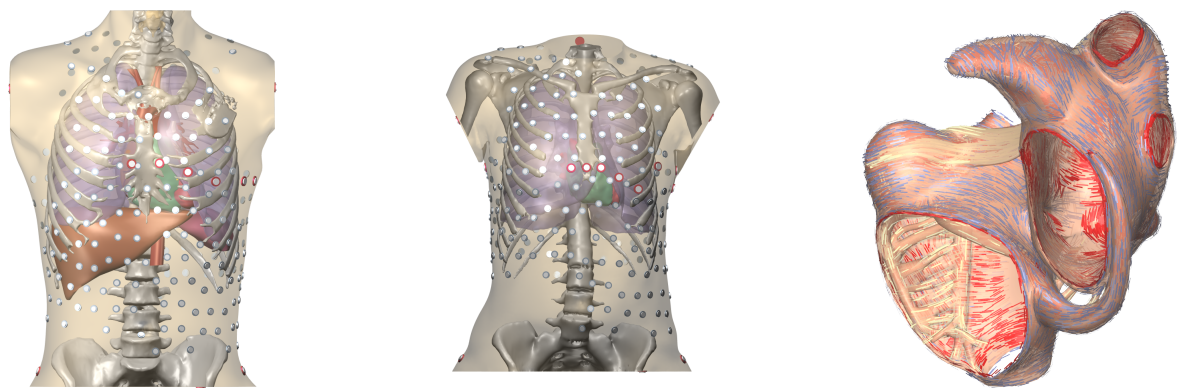
Propag-5.1 Applied modeling studies performed by the Carmen team, especially M. Potse and M. Kania, in collaboration with IHU Liryc and foreign partners [17] [7] [61], [51] [43] rely to a great extent on high-performance computations on the national supercomputers Curie, Occigen, and Turing. The Propag-5 code is optimized for these systems. It is the result of a decades-long development first at the *Université de Montréal* in Canada, then at Maastricht University in the Netherlands, and finally at the Institute of Computational Science of the *Università della Svizzera italiana* in Lugano, Switzerland. Since 2016 most of the development on Propag has been done by M. Potse at the Carmen team. The code scales excellently to large core counts and, as it is controlled completely with command-line flags and configuration files, it can be used by non-programmers. It also features

- a plugin system for membrane models,
- a completely parallel workflow, including the initial anatomy input and mesh partitioning, which allows it to work with meshes of more than 10^9 nodes,
- a flexible output scheme allowing hundreds of different state variables and transient variables to be output to file, when desired, using any spatial and temporal subsampling,
- a configurable, LUSTRE-aware parallel output system in which groups of processes write HDF5/netCDF files, and
- CWEB documentation of the entire code base.

The code has been stable and reliable for several years, and only minor changes are being made currently. It can be considered the workhorse for our HPC work until CEPS takes over.

Gepetto The Gepetto suite, named after a famous model maker, transforms a surface mesh of the heart into a set of (semi-)structured meshes for use by the Propag software or others. It creates the different fiber orientations in the model, including the transmurally rotating ventricular fibers and the various bundle structures in the atria (figure 2), and creates layers with possibly different electrophysiological properties across the wall. A practically important function is that it automatically builds the matching heart and torso meshes that Propag uses to simulate potentials in the torso (at a resolution of 1 mm) after projecting simulation results from the heart model (at 0.1 to 0.2 mm) on the coarser torso mesh [60]. Like Propag, the Gepetto software results from a long-term development that started in Montreal, Canada, around 2002. The code for atrial fiber structure was developed by our team.

Blender plugins Blender (<https://www.blender.org>) is a free software package for the production of 3-D models, renderings, and animations, comparable to commercial software such as Cinema4D. CEMPACK includes a set of plugins for Blender that facilitate the production of anatomical models and the visualization of data. It uses the MMG remeshing library, which is developed by the CARDAMOM team at Inria Bordeaux.



A **B** **C**
Figure 2. **A and B:** Complete heart-torso geometries created with CEMPACK tools. **C:** Bundle structures and different layers of fiber orientation created by the Gepetto software.

6.2.2. MUSIC

MUSIC is a multimodal platform for cardiac imaging developed by the imaging team at IHU LIRYC in collaboration with the Inria team Asclepios (<https://bil.inria.fr/fr/software/view/1885/tab>). It is based on the medInria software also developed by the Asclepios team. MUSIC is a cross-platform software for segmentation of medical imaging data, meshing, and ultimately also visualization of functional imaging data and model results.

Several members of the Carmen team use MUSIC for their work, and the team contributes to the software through the IDAM project.

CASTOR Project-Team

6. New Software and Platforms

6.1. CEDRES++

KEYWORDS: 2D - Magnetic fusion - Plasma physics

FUNCTIONAL DESCRIPTION: In Tokamaks, at the slow resistive diffusion time scale, the magnetic configuration in the plasma can be described by the MHD equilibrium equations inside the plasma and the Maxwell equations outside. Moreover, the magnetic field is often supposed not to depend on the azimuthal angle.

Under this assumption of axisymmetric configuration, the equilibrium in the whole space reduces to solving a 2D problem in which the magnetic field in the plasma is described by the well known Grad Shafranov equation. The unknown of this problem is the poloidal magnetic flux. The P1 finite element code CEDRES++ solves this free boundary equilibrium problem in direct and inverse mode. The direct problem consists in the computation of the magnetic configuration and of the plasma boundary, given a plasma current density profile and the total current in each poloidal field coils (PF coils). The aim of the inverse problem is to find currents in the PF coils in order to best fit a given plasma shape.

- Participants: Blaise Faugeras, Cédric Boulbe, Holger Heumann and Jacques Blum
- Partners: CNRS - CEA - Université de Nice Sophia Antipolis (UNS)
- Contact: Cédric Boulbe

6.2. Equinox

KEYWORDS: 2D - Problem inverse

FUNCTIONAL DESCRIPTION: EQUINOX is a code dedicated to the numerical reconstruction of the equilibrium of the plasma in a Tokamak. The problem solved consists in the identification of the plasma current density, a non-linear source in the 2D Grad-Shafranov equation which governs the axisymmetric equilibrium of a plasma in a Tokamak. The experimental measurements that enable this identification are the magnetics on the vacuum vessel, but also polarimetric and interferometric measures on several chords, as well as motional Stark effect measurements. The reconstruction can be obtained in real-time and the numerical method implemented involves a finite element method, a fixed-point algorithm and a least-square optimization procedure.

- Participants: Blaise Faugeras, Cédric Boulbe and Jacques Blum
- Contact: Blaise Faugeras

6.3. FBGKI

Full Braginskii

FUNCTIONAL DESCRIPTION: The Full Braginskii solver considers the equations proposed by Braginskii (1965), in order to describe the plasma turbulent transport in the edge part of tokamaks. These equations rely on a two fluid (ion - electron) description of the plasma and on the electroneutrality and electrostatic assumptions. One has then a set of 10 coupled non-linear and strongly anisotropic PDEs. FBGKI makes use in space of high order methods: Fourier in the toroidal periodic direction and spectral elements in the poloidal plane. The integration in time is based on a Strang splitting and Runge-Kutta schemes, with implicit treatment of the Lorentz terms (DIRK scheme). The spectral vanishing viscosity (SVV) technique is implemented for stabilization. Static condensation is used to reduce the computational cost. In its sequential version, a matrix free solver is used to compute the potential. The parallel version of the code is under development.

- Contact: Sebastian Minjeaud

6.4. FEEQS.M

Finite Element Equilibrium Solver in MATLAB

KEYWORDS: Finite element modelling - Optimal control - Plasma physics

FUNCTIONAL DESCRIPTION: FEEQS.M (Finite Element Equilibrium Solver in Matlab) is a MATLAB implementation of the numerical methods in [Heumann2015] to solve equilibrium problems for toroidal plasmas. Direct and inverse problems for both the static and transient formulations of plasma equilibrium can be solved. FEEQS.M exploits MATLAB's evolved sparse matrix methods and uses heavily the vectorization programming paradigm, which results in running times comparable to C/C++ implementations. FEEQS.M complements the production code CEDRES++ in being considered as fast prototyping test bed for computational methods for equilibrium problems. This includes aspects of numerics such as improved robustness of the Newton iterations or optimization algorithms for inverse problems. The latest developments aim at incorporating the resistive diffusion equation.

[Heumann2015]: Heumann, H., Blum, J., Boulbe, C., Faugeras, B., Selig, G., Ané, J.-M., Brémond, S., Grandgirard, V., Hertout, P., Nardon, E.: Quasi-static free-boundary equilibrium of toroidal plasma with CEDRES++: Computational methods and applications. In: Journal of Plasma Physics 81 (2015)

- Participant: Holger Heumann
- Contact: Holger Heumann
- URL: <https://scm.gforge.inria.fr/svn/holgerheumann/Matlab/FEEQS.M>

6.5. Fluidbox

FUNCTIONAL DESCRIPTION: FluidBox is a software dedicated to the simulation of inert or reactive flows. It is also able to simulate multiphase, multi-material and MDH flows. There exist 2D and 3D dimensional versions. The 2D version is used to test new ideas that are later implemented in 3D. Two classes of schemes are available : a classical finite volume scheme and the more recent residual distribution schemes. Several low Mach number preconditioning are also implemented. The code has been parallelized with and without domain overlapping.

- Participants: Boniface Nkonga, Mario Ricchiuto, Michael Papin and Rémi Abgrall
- Contact: Boniface Nkonga

6.6. Jorek-Inria

FUNCTIONAL DESCRIPTION: Jorek-Inria is a new version of the JOREK software, for MHD modeling of plasma dynamic in tokamaks geometries. The numerical approximation is derived in the context of finite elements where 3D basic functions are tensor products of 2D basis functions in the poloidal plane by 1D basis functions in the toroidal direction. More specifically, Jorek uses curved bicubic isoparametric elements in 2D and a spectral decomposition (sine, cosine) in the toroidal axis. Continuity of derivatives and mesh alignment to equilibrium surface fluxes are enforced. Resulting linear systems are solved by the PASTIX software developed at Inria-Bordeaux.

RELEASE FUNCTIONAL DESCRIPTION: The new formulation of the Jorek-Inria code extends this approximation strategy by introducing more flexibility and a variety of finite elements used in the poloidal plane and in the toroidal direction. It also proposes a sparse matrix interface SPM (Sparse Matrix Manager) that allows to develop clean code without a hard dependency on any linear solver library (i.e. PetSc, Pastix, Mumps, ...).

- Participants: Ahmed Ratnani, Boniface Nkonga, Emmanuel Franck and Hervé Guillard
- Contact: Hervé Guillard
- URL: <https://gforge.inria.fr/projects/jorek/>

6.7. Plato

A platform for Tokamak simulation

FUNCTIONAL DESCRIPTION: PlaTo (A platform for Tokamak simulation) is a suite of data and softwares dedicated to the geometry and physics of Tokamaks. Plato offers interfaces for reading and handling distributed unstructured meshes, numerical templates for parallel discretizations, interfaces for distributed matrices and linear and non-linear equation solvers. Plato provides meshes and solutions corresponding to equilibrium solutions that can be used as initial data for more complex computations as well as tools for visualization using Visit or Paraview.

- Participants: Afeintou Sangam, Boniface Nkonga, Elise Estibals, Giorgio Giorgiani and Hervé Guillard
- Contact: Hervé Guillard

6.8. VacTH

KEYWORD: Problem inverse

FUNCTIONAL DESCRIPTION: VacTH implements a method based on the use of toroidal harmonics and on a modelization of the poloidal field coils and divertor coils to perform the 2D interpolation and extrapolation of discrete magnetic measurements in a tokamak and the identification of the plasma boundary. The method is generic and can be used to provide the Cauchy boundary conditions needed as input by a fixed domain equilibrium reconstruction code like EQUINOX. It can also be used to extrapolate the magnetic measurements in order to compute the plasma boundary itself. The method is foreseen to be used in the real-time plasma control loop on the WEST tokamak.

- Contact: Blaise Faugeras

6.9. NICE

Newton direct and Inverse Computation for Equilibrium

KEYWORDS: 2D - C++ - Scientific computing - Finite element modelling - Plasma physics - Optimal control - Optimization - Identification

FUNCTIONAL DESCRIPTION: The NICE code is under development. Its goal is to gather in a single modern, modular and evolutionary C++ code, the different numerical methods and algorithms from VACTH, EQUINOX and CEDRES++ which share many common features. It also integrates new methods as for example the possibility to use the Stokes model for equilibrium reconstruction using polarimetry measurements.

- Contact: Blaise Faugeras

COFFEE Project-Team

5. New Software and Platforms

5.1. AP_PartFlow

FUNCTIONAL DESCRIPTION: We are developing experimental codes, mainly based on Finite Differences, for the simulation of particulate flows. A particular attention is paid to guaranty the asymptotic properties of the scheme, with respect to relaxation parameters.

- Contact: Thierry Goudon

5.2. Compass

Computing Architecture to Speed up Simulation

KEYWORDS: Finite volume methods - Porous media - High performance computing

FUNCTIONAL DESCRIPTION: Compass is a parallel code initiated in 2012 and co-developed by LJAD-Inria Coffee and BRGM since 2015. It is devoted to the simulation of multiphase flows in porous media, it accounts for non isothermal and compositional flows and includes complex network of fractures or faults represented as interfaces of co-dimension one coupled to the surrounding matrix. The discretization is based on vertex and cell unknowns and is adapted to polyhedral meshes and heterogeneous media. The ComPASS code is co-developed since december 2016 by the partners of the ANR CHARMS project including BGRM, LJAD-Inria Coffee, Storengy, MdS and LJLL with the objective to develop a new generation simulator for geothermal systems focusing on fluids and accounting for complex fault networks and wells.

- Participants: Chang Yang, Cindy Guichard, Robert Eymard, Roland Masson and Thierry Goudon
- Partners: Université de Nice Sophia Antipolis (UNS) - BRGM
- Contact: Roland Masson

5.3. NS2DDV

2D Navier-Stokes equations with variable density

KEYWORDS: Partial differential equation - Finite volume methods - Finite element modelling

FUNCTIONAL DESCRIPTION: The NS2DDV Matlab toolbox is an open-source program written in Matlab for simulating 2D viscous, incompressible and inhomogeneous flows. The computation kernel of the code is based on Finite Elements - Finite Volumes hybrid methods applied on the 2D Navier-Stokes equations. It works on unstructured meshes and can include mesh refinements strategies. We develop and freely distribute a new version of the Matlab code NS2DDV-M (equipped with a graphic interface and an accurate documentation) to promote new collaborations in the domain, allow some easy comparisons with concurrent codes on the same benchmark cases, and compare alternative numerical solution methods.

- Partner: Laboratoire Paul Painlevé
- Contact: Creusé Emmanuel
- URL: <https://wikis.univ-lille1.fr/painleve/ns2ddv>

5.4. SimBiof

KEYWORDS: Bioinformatics - Chemistry

FUNCTIONAL DESCRIPTION: We are developing numerical methods, currently by using Finite Differences approaches, for the simulation of biofilms growth. The underlying system of PDEs takes the form of multiphase flows equations with conservation constraints and vanishing phases. The numerical experiments have permitted to bring out the influence of physical parameters on the multidimensional growth dynamics.

- Contact: Thierry Goudon

5.5. CELIA3D

KEYWORDS: Fluid mechanics - Multi-physics simulation

FUNCTIONAL DESCRIPTION: The CELIA3D code simulates the coupling between a compressible fluid flow and a deformable structure. The fluid is handled by a Finite Volume method on a structured Cartesian grid. The solid is handled by a Discrete Element method (Mka3d scheme). The solid overlaps the fluid grid and the coupling is carried out with immersed boundaries (cut cells) in a conservative way.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/CELIA3D/>

5.6. Mka3d

KEYWORDS: Scientific computing - Elasticity - Elastodynamic equations

FUNCTIONAL DESCRIPTION: The Mka3d method simulates an elastic solid by discretizing the solid into rigid particles. An adequate choice of forces and torques between particles allows to recover the equations of elastodynamics.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/Mka3D/>

DRACULA Project-Team

4. New Software and Platforms

4.1. CelDyn

KEYWORDS: Modeling - Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: Software "Celdyn" is developed in order to model cell population dynamics for biological applications. Cells are represented either as soft spheres or they can have more complex structure. Cells can divide, move, interact with each other or with the surrounding medium. Different cell types can be introduced. When cells divide, the types of daughter cells are specified. A user interface is developed.

- Participants: Alen Tosenberger, Laurent Pujo-Menjouet, Nikolai Bessonov and Vitaly Volpert
- Contact: Vitaly Volpert

4.2. SiMuScale

We have developed within the team the *SiMuScale* platform, a software dedicated to exploring multi-scale population models ("SiMuScale" on researchgate, <https://gforge.inria.fr/projects/simuscale>). Coded in C++, *SiMuScale* is in active development since 2014. *SiMuScale* has been primarily developed to answer the need for an all-purpose, fast and flexible modeling tool for multiscale cell population dynamics. Biological agents (cells) are modeled by visco-elastic spheres, which are subject to mechanical constraints. Each cell possesses its own intracellular dynamics, coupled to other cells through bimolecular signals expressed at the surface of the cell. The internal state of the cell is also coupled to a behavioral state of the cell, which control the macroscopic fate: motility, growth, proliferation, death, etc. Mechanical interactions provide a 3D environment in which cells interact locally. *SiMuScale* is based on a core containing the simulator, and on plug-ins that contain the biological specifications of each cell. The core+plug-ins architecture makes it easier for the researcher to focus on the model and to capitalise on existing models, which all share the same framework and are compatible with each other. That way, *SiMuScale* makes the work of model writing and re-writing minimal and fits into reproducible research.

DYLISS Project-Team

6. New Software and Platforms

6.1. AskOmics

KEYWORDS: RDF - SPARQL - Querying - Graph - LOD - Linked open data

FUNCTIONAL DESCRIPTION: AskOmics allows to load heterogeneous bioinformatics data (formatted as tabular files) into a Triple Store system using a user-friendly web interface. AskOmics also provides an intuitive graph-based user interface supporting the creation of complex queries that currently require hours of manual searches across tens of spreadsheet files. The elements of interest selected in the graph are then automatically converted into a SPARQL query that is executed on the users' data.

NEWS OF THE YEAR: Several functionalities have been developed: 1) capacity of integrating genomics data (import of GFF and BED files and generation of RDF compliant with the FALDO ontology), 2) integration of data and knowledge in the OWL format to exploit biological information from external repositories, particularly from EBI and NCBI. Notably, this functionality allows AskOmics to support the Gene Ontology, the Taxonomy ontology as well as BioPAX biological networks. 3) improved user interface expressivity for generating SPARQL queries, 4) implementation of a support for multiple concurrent user sessions, with the distinction between public and user-specific datasets 5) deployment of AskOmics on the GenOuest cloud infrastructure to facilitate its release and diffusion 6) interoperability between AskOmics and the Galaxy workflow environment.

- Authors: Charles Bettembourg, Xavier Garnier, Anthony Bretaudeau, Fabrice Legeai, Olivier Dameron, Olivier Filangi and Yvonne Chaussin
- Partners: Université de Rennes 1 - CNRS - INRA
- Contact: Fabrice Legeai
- URL: <https://github.com/askomics/askomics>

6.2. PADMet-utils

KEYWORDS: Metabolic networks - Bioinformatics - Workflow - Omic data - Toolbox - Data management - LOD - Linked open data

FUNCTIONAL DESCRIPTION: The main concept underlying padmet-utils is to provide solutions that ensure the consistency, the internal standardization and the reconciliation of the information used within any workflow that combines several tools involving metabolic networks reconstruction or analysis.

NEWS OF THE YEAR: In 2017, Padmet-utils was enriched with a RDF export to allow the interoperability of the AuReMe workspace for the reconstruction of metabolic networks with the Askomics Tool for querying heterogeneous data. Padmet-utils was also extended to handle metabolic networks in the SBML3 format.

- Participants: Alejandro Maass, Meziane Aite and Anne Siegel
- Partner: University of Chile
- Contact: Anne Siegel
- URL: <https://gitlab.inria.fr/maite/padmet-utils>

6.3. CADBIOM

Computer Aided Design of Biological Models

KEYWORDS: Health - Biology - Biotechnology - Bioinformatics - Systems Biology

FUNCTIONAL DESCRIPTION: Based on Guarded transition semantic, this software provides a formal framework to help the modeling of biological systems such as cell signaling network. It allows investigating synchronization events in biological networks. Software development has been restarted since November 2016. The source code is available at the following address: <https://gitlab.irisa.fr/0000B8EG/Cadbiom>

- Participants: Geoffroy Andrieux, Michel Le Borgne, Nathalie Theret, Nolwenn Le Meur and Pierre Vignet
- Contact: Anne Siegel
- URL: <http://cadbiom.genouest.org>

6.4. conquests

Crossroads in Metabolic Network from Stoichiometric and Topologic Studies

KEYWORDS: Bioinformatics - ASP - Answer Set Programming - Constraint-based programming

FUNCTIONAL DESCRIPTION: This Python package in systems biology allows the identification of essential metabolites with respect to the production of targeted elements in a metabolic network, by comparing flux and graph-based analysis. Conquests's inputs are a sbml file corresponding to a metabolic network and the biomass reaction name. The outputs are three sets of essential metabolites. They are computed according to three complementary criteria: graph-based accessibility of targeted metabolites, the presence of flux in the biomass reaction and the maximisation of flux in the biomass reaction.

NEWS OF THE YEAR: Conquest was released in 2017.

- Contact: Julie Laniau

ERABLE Project-Team

5. New Software and Platforms

5.1. C3Part/Isofun

KEYWORDS: Bioinformatics - Genomics

FUNCTIONAL DESCRIPTION: The C3PART / ISOFUN package implements a generic approach to the local alignment of two or more graphs representing biological data, such as genomes, metabolic pathways or protein-protein interactions, in order to infer a functional coupling between them.

- Participants: Alain Viari, Anne Morgat, Frédéric Boyer, Marie-France Sagot and Yves-Pol Deniérou
- Contact: Alain Viari
- URL: <http://www.inrialpes.fr/helix/people/viari/lxgraph/index.html>

5.2. Cassis

KEYWORDS: Bioinformatics - Genomics

FUNCTIONAL DESCRIPTION: Implements methods for the precise detection of genomic rearrangement breakpoints.

- Participants: Christian Baudet, Christian Gautier, Claire Lemaitre, Eric Tannier and Marie-France Sagot
- Contact: Marie-France Sagot
- URL: <http://pbil.univ-lyon1.fr/software/Cassis/>

5.3. Coala

CO-evolution Assessment by a Likelihood-free Approach

KEYWORDS: Bioinformatics - Evolution

SCIENTIFIC DESCRIPTION: Despite an increasingly vaster literature on cophylogenetic reconstructions for studying host-parasite associations, understanding the common evolutionary history of such systems remains a problem that is far from being solved. Many of the most used algorithms do the host-parasite reconciliation analysis using an event-based model, where the events include in general (a subset of) cospeciation, duplication, loss, and host-switch. All known event-based methods then assign a cost to each type of event in order to find a reconstruction of minimum cost. The main problem with this approach is that the cost of the events strongly influence the reconciliation obtained.

To deal with this problem, we developed an algorithm, called Coala, for estimating the frequency of the events based on an approximate Bayesian computation approach.

FUNCTIONAL DESCRIPTION: COALA stands for “COevolution Assessment by a Likelihood-free Approach”. It is thus a likelihood-free method for the co-phylogeny reconstruction problem which is based on an Approximate Bayesian Computation (ABC) approach.

- Participants: Beatrice Donati, Blerina Sinimeri, Catherine Matias, Christian Baudet, Christian Gautier, Marie-France Sagot and Pierluigi Crescenzi
- Contact: Blerina Sinimeri
- URL: <http://coala.gforge.inria.fr/>

5.4. CSC

KEYWORDS: Genomics - Algorithm

FUNCTIONAL DESCRIPTION: Given two sequences x and y , CSC (which stands for Circular Sequence Comparison) finds the cyclic rotation of x (or an approximation of it) that minimises the blockwise q -gram distance from y .

- Contact: Nadia Pisanti
- URL: <https://github.com/solonas13/csc>

5.5. Cycads

KEYWORDS: Systems Biology - Bioinformatics

FUNCTIONAL DESCRIPTION: Annotation database system to ease the development and update of enriched BIOCYC databases. CYCADS allows the integration of the latest sequence information and functional annotation data from various methods into a metabolic network reconstruction. Functionalities will be added in future to automate a bridge to metabolic network analysis tools, such as METEXPLORE. CYCADS was used to produce a collection of more than 22 arthropod metabolism databases, available at ACYPICYC (<http://acypicyc.cycadsys.org>) and ARTHROPODACYC (<http://arthropodacyc.cycadsys.org>). It will continue to be used to create other databases (newly sequenced organisms, Aphid biotypes and symbionts...).

- Participants: Augusto Vellozo, Hubert Charles, Marie-France Sagot and Stefano Colella
- Contact: Hubert Charles

5.6. Eucalypt

KEYWORDS: Bioinformatics - Evolution

FUNCTIONAL DESCRIPTION: EUCALYPT stands for “EnUmerator of Coevolutionary Associations in PoLYnomial-Time delay”. It is an algorithm for enumerating all optimal (possibly time-unfeasible) mappings of a symbiont tree unto a host tree.

- Participants: Beatrice Donati, Blerina Sinimeri, Christian Baudet, Marie-France Sagot and Pierluigi Crescenzi
- Contact: Blerina Sinimeri
- URL: <http://eucalypt.gforge.inria.fr/>

5.7. Fast-SG

KEYWORDS: Genomics - Algorithm - NGS

FUNCTIONAL DESCRIPTION: FAST-SG enables the optimal hybrid assembly of large genomes by combining short and long read technologies.

- Contact: Alex Di Genova
- URL: <https://github.com/adigenova/fast-sg>

5.8. Gobbolino-Touché

KEYWORDS: Bioinformatics - Graph algorithmics - Systems Biology

FUNCTIONAL DESCRIPTION: Designed to solve the metabolic stories problem, which consists in finding all maximal directed acyclic subgraphs of a directed graph G whose sources and targets belong to a subset of the nodes of G , called the black nodes.

- Participants: Etienne Birmelé, Fabien Jourdan, Ludovic Cottret, Marie-France Sagot, Paulo Vieira Milreu, Pierluigi Crescenzi, Vicente Acuna Aguayo and Vincent Lacroix
- Contact: Marie-France Sagot
- URL: <http://gforge.inria.fr/projects/gobbolino>

5.9. HapCol

KEYWORDS: Bioinformatics - Genomics

FUNCTIONAL DESCRIPTION: A fast and memory-efficient DP approach for haplotype assembly from long reads that works until 25x coverage and solves a constrained minimum error correction problem exactly.

- Contact: Nadia Pisanti
- URL: <http://hapcol.algolab.eu/>

5.10. HgLib

KEYWORD: Graph algorithmics

FUNCTIONAL DESCRIPTION: The open-source library hglib is dedicated to model hypergraphs, which are a generalisation of graphs. In an **undirected** hypergraph, an hyperedge contains any number of vertices. A **directed** hypergraph has hyperarcs which connect several tail and head vertices. This library, which is written in C++, allows to associate user defined properties to vertices, to hyperedges/hyperarcs and to the hypergraph itself. It can thus be used for a wide range of problems arising in operations research, computer science, and computational biology.

- Contact: Arnaud Mary
- URL: <https://gitlab.inria.fr/kirikomics/hglib>

5.11. KissDE

KEYWORDS: Bioinformatics - NGS

FUNCTIONAL DESCRIPTION: KISSDE is an R Package enabling to test if a variant (genomic variant or splice variant) is enriched in a condition. It takes as input a table of read counts obtained from an NGS data pre-processing and gives as output a list of condition-specific variants.

RELEASE FUNCTIONAL DESCRIPTION: This new version improved the recall and made more precise the size of the effect computation.

- Participants: Camille Marchet, Aurélie Siberchicot, Audric Cologne, Clara Benoît-Pilven, Janice Kielbassa, Lilia Brinza and Vincent Lacroix
- Contact: Vincent Lacroix
- URL: <http://kisssplice.prabi.fr/tools/kissDE/>

5.12. KisSplice

KEYWORDS: Bioinformatics - Bioinformatics search sequence - Genomics - NGS

FUNCTIONAL DESCRIPTION: Enables to analyse RNA-seq data with or without a reference genome. It is an exact local transcriptome assembler, which can identify SNPs, indels and alternative splicing events. It can deal with an arbitrary number of biological conditions, and will quantify each variant in each condition.

RELEASE FUNCTIONAL DESCRIPTION: Improvements : KissReads module has been modified and sped up, with a significant impact on run times. Parameters : `-timeout` default now at 10000: in big datasets, recall can be increased while run time is a bit longer. Bugs fixed : Reads containing only 'N': the graph construction was stopped if the file contained a read composed only of 'N's. This was a silence bug, no error message was produced. Problems compiling with new versions of MAC OSX (10.8+): KisSplice is now compiling with the new default C++ compiler of OSX 10.8+.

- Participants: Alice Julien-Laferrrière, Leandro Ishi Soares De Lima, Vincent Miele, Rayan Chikhi, Pierre Peterlongo, Camille Marchet, Gustavo Akio Tominaga Sacomoto, Marie-France Sagot and Vincent Lacroix
- Contact: Vincent Lacroix
- URL: <http://kisssplice.prabi.fr/>

5.13. KisSplice2RefGenome

KEYWORDS: Bioinformatics - NGS - Transcriptomics

FUNCTIONAL DESCRIPTION: KISSPLICE identifies variations in RNA-seq data, without a reference genome. In many applications however, a reference genome is available. KISSPLICE2REFGENOME enables to facilitate the interpretation of the results of KISSPLICE after mapping them to a reference genome.

- Participants: Audric Cologne, Camille Marchet, Camille Sessegolo, Alice Julien-Laferrrière and Vincent Lacroix
- Contact: Vincent Lacroix
- URL: <http://kissplice.prabi.fr/tools/kiss2refgenome/>

5.14. KisSplice2RefTranscriptome

KEYWORDS: Bioinformatics - NGS - Transcriptomics

FUNCTIONAL DESCRIPTION: KISSPLICE2REFTRANSCRIPTOME enables to combine the output of KISSPLICE with the output of a full length transcriptome assembler, thus allowing to predict a functional impact for the positioned SNPs, and to intersect these results with condition-specific SNPs. Overall, starting from RNA-seq data only, we obtain a list of condition-specific SNPs stratified by functional impact.

- Participants: Helene Lopez Maestre, Mathilde Boutigny and Vincent Lacroix
- Contact: Vincent Lacroix
- URL: <http://kissplice.prabi.fr/tools/kiss2rt/>

5.15. MetExplore

KEYWORDS: Systems Biology - Bioinformatics

SCIENTIFIC DESCRIPTION: MetExplore stores metabolic networks of 160 organisms into a relational database. Information about metabolic networks mainly come from BioCyc-like databases. Two BioCyc-like databases contain information about several organisms: PlantCyc and MetaCyc. MetExplore contains also the information about metabolites stored in Metabolome.jp. Note that there is no information about reactions in this database and is only useful to identify compounds from masses. Several genome-scale models designed for Flux Balance Analysis have also been imported into MetExplore. The table below gives details about the sources of the metabolic networks present in MetExplore.

FUNCTIONAL DESCRIPTION: Web-server that allows to build, curate and analyse genome-scale metabolic networks. METEXPLORE is also able to deal with data from metabolomics experiments by mapping a list of masses or identifiers onto filtered metabolic networks. Finally, it proposes several functions to perform Flux Balance Analysis (FBA). The web-server is mature, it was developed in PHP, JAVA, Javascript and Mysql. METEXPLORE was started under another name during Ludovic Cottret's PhD in Bamboo, and is now maintained by the METEXPLORE group at the Inra of Toulouse.

- Participants: Fabien Jourdan, Hubert Charles, Ludovic Cottret and Marie-France Sagot
- Contact: Fabien Jourdan
- URL: <http://metexplore.toulouse.inra.fr/metexplore/>

5.16. Mirinho

KEYWORDS: Bioinformatics - Computational biology - Genomics - Structural Biology

FUNCTIONAL DESCRIPTION: Predicts, at a genome-wide scale, microRNA candidates.

- Participants: Christian Gautier, Christine Gaspin, Cyril Fournier, Marie-France Sagot and Susan Higashi
- Contact: Marie-France Sagot
- URL: <http://mirinho.gforge.inria.fr/>

5.17. MultiPus

KEYWORDS: Systems Biology - Algorithm - Graph algorithmics - Metabolic networks - Computational biology

SCIENTIFIC DESCRIPTION: Synthetic biology has boomed since the early 2000s when it started being shown that it was possible to efficiently synthesise compounds of interest in a much more rapid and effective way by using other organisms than those naturally producing them. However, to thus engineer a single organism, often a microbe, to optimise one or a collection of metabolic tasks may lead to difficulties when attempting to obtain a production system that is efficient, or to avoid toxic effects for the recruited microorganism. The idea of using instead a microbial consortium has thus started being developed in the last decade. This was motivated by the fact that such consortia may perform more complicated functions than could single populations and be more robust to environmental fluctuations. Success is however not always guaranteed. In particular, establishing which consortium is best for the production of a given compound or set thereof remains a great challenge. The algorithm MultiPus is based on an initial model that enables to propose a consortium to synthetically produce compounds that are either exogenous to it, or are endogenous but where interaction among the species in the consortium could improve the production line.

FUNCTIONAL DESCRIPTION: MULTIPUS (for “MULTIple species for the synthetic Production of Useful biochemical Substances”) is an algorithm that, given a microbial consortium as input, identifies all optimal sub-consortia to synthetically produce compounds that are either exogenous to it, or are endogenous but where interaction among the species in the sub-consortia could improve the production line.

- Participants: Alberto Marchetti-Spaccamela, Alice Julien-Laferrière, Arnaud Mary, Delphine Parrot, Laurent Bulteau, Leen Stougie, Marie-France Sagot and Susana Vinga
- Contact: Marie-France Sagot
- URL: <http://multipus.gforge.inria.fr/>

5.18. Pitufolandia

KEYWORDS: Bioinformatics - Graph algorithmics - Systems Biology

FUNCTIONAL DESCRIPTION: The algorithms in PITUFOLANDIA (PITUFO / PITUFINA / PAPAPITUFO) are designed to solve the minimal precursor set problem, which consists in finding all minimal sets of precursors (usually, nutrients) in a metabolic network that are able to produce a set of target metabolites.

- Contact: Marie-France Sagot
- URL: <http://gforge.inria.fr/projects/pitufo/>

5.19. Sasita

KEYWORDS: Bioinformatics - Graph algorithmics - Systems Biology

FUNCTIONAL DESCRIPTION: SASITA is a software for the exhaustive enumeration of minimal precursor sets in metabolic networks.

- Contact: Marie-France Sagot
- URL: <http://sasita.gforge.inria.fr/>

5.20. Savage

KEYWORDS: Algorithm - Genomics

FUNCTIONAL DESCRIPTION: Reconstruction of viral quasi species without using a reference genome.

- Contact: Alexander Schonhuth
- URL: <https://bitbucket.org/jbaaijens/savage>

5.21. Smile

KEYWORDS: Bioinformatics - Genomic sequence

FUNCTIONAL DESCRIPTION: Motif inference algorithm taking as input a set of biological sequences.

- Participant: Marie-France Sagot
- Contact: Marie-France Sagot

5.22. Rime

KEYWORDS: Bioinformatics - Genomics - Sequence alignment

FUNCTIONAL DESCRIPTION: Detects long similar fragments occurring at least twice in a set of biological sequences.

- Contact: Nadia Pisanti

5.23. Totoro & Kotoura

KEYWORDS: Bioinformatics - Graph algorithmics - Systems Biology

FUNCTIONAL DESCRIPTION: Both TOTORO and KOTOURA decipher the reaction changes during a metabolic transient state, using measurements of metabolic concentrations. These are called metabolic hyperstories. TOTORO (for TOPological analysis of Transient metabOlic RespOnse) is based on a qualitative measurement of the concentrations in two steady-states to infer the reaction changes that lead to the observed differences in metabolite pools in both conditions. In the currently available release, a pre-processing and a post-processing steps are included. After the post-processing step, the solutions can be visualised using DINGHY (<http://dinghy.gforge.inria.fr>). KOTOURA (for Kantitative analysis Of Transient metabOlic and regUlatory Response And control) infers quantitative changes of the reactions using information on measurement of the metabolite concentrations in two steady-states.

- Contact: Marie-France Sagot
- URL: <http://hyperstories.gforge.inria.fr/>

5.24. WhatsHap

KEYWORDS: Bioinformatics - Genomics

FUNCTIONAL DESCRIPTION: WHATSHAP is a DP approach for haplotype assembly from long reads that works until 20x coverage and solves the minimum error correction problem exactly. PWHATSHAP is a parallelisation of the core dynamic programming algorithm of WHATSHAP.

- Contact: Nadia Pisanti
- URL: <https://bitbucket.org/whatschap/whatschap>

FLUMINANCE Project-Team

6. New Software and Platforms

6.1. 2DLayeredMotion

Estimation of 2D independent mesoscale layered atmospheric motion fields

FUNCTIONAL DESCRIPTION: This software enables to estimate a stack of 2D horizontal wind fields corresponding to a mesoscale dynamics of atmospheric pressure layers. This estimator is formulated as the minimization of a global energy function. It relies on a vertical decomposition of the atmosphere into pressure layers. This estimator uses pressure data and classification clouds maps and top of clouds pressure maps (or infra-red images). All these images are routinely supplied by the EUMETSAT consortium which handles the Meteosat and MSG satellite data distribution. The energy function relies on a data model built from the integration of the mass conservation on each layer. The estimator also includes a simplified and filtered shallow water dynamical model as temporal smoother and second-order div-curl spatial regularizer. The estimator may also incorporate correlation-based vector fields as additional observations. These correlation vectors are also routinely provided by the Eumetsat consortium.

- Participant: Étienne Mémin
- Contact: Étienne Mémin
- URL: <http://fluid.irisa.fr/index.html>

6.2. 3DLayeredMotion

Estimation of 3D interconnected layered atmospheric motion fields

FUNCTIONAL DESCRIPTION: This software extends the previous 2D version. It allows (for the first time to our knowledge) the recovery of 3D wind fields from satellite image sequences. As with the previous techniques, the atmosphere is decomposed into a stack of pressure layers. The estimation relies also on pressure data and classification clouds maps and top of clouds pressure maps. In order to recover the 3D missing velocity information, physical knowledge on 3D mass exchanges between layers has been introduced in the data model. The corresponding data model appears to be a generalization of the previous data model constructed from a vertical integration of the continuity equation.

- Contact: Étienne Mémin
- URL: <http://fluid.irisa.fr>

6.3. DenseMotion

Estimation of 2D dense motion fields

FUNCTIONAL DESCRIPTION: This code allows the computation from two consecutive images of a dense motion field. The estimator is expressed as a global energy function minimization. The code enables the choice of different data models and different regularization functionals depending on the targeted application. Generic motion estimators for video sequences or fluid flows dedicated estimators can be set up. This software allows in addition the users to specify additional correlation based matching measurements. It enables also the inclusion of a temporal smoothing prior relying on a velocity vorticity formulation of the Navier-Stoke equation for Fluid motion analysis applications.

- Participant: Étienne Mémin
- Contact: Étienne Mémin
- URL: <http://fluid.irisa.fr/index.html>

6.4. Low-Order-Motion

Estimation of low order representation of fluid motion

FUNCTIONAL DESCRIPTION: This code enables the estimation of a low order representation of a fluid motion field from two consecutive images. The fluid motion representation is obtained using a discretization of the vorticity and divergence maps through regularized Dirac measure. The irrotational and solenoidal components of the motion fields are expressed as linear combinations of basis functions obtained through the Biot-Savart law. The coefficient values and the basis function parameters are formalized as the minimizer of a functional relying on an intensity variation model obtained from an integrated version of the mass conservation principle of fluid mechanics.

- Participants: Anne Cuzol and Étienne Mémin
- Contact: Étienne Mémin
- URL: <http://fluid.irisa.fr>

6.5. TYPHOON

- Participants: Christopher Mauzey, Étienne Mémin and Pierre Dérian
- Partner: CSU Chico
- Contact: Étienne Mémin
- URL: <http://phys.csuchico.edu/lidar/typhoon/>

6.6. H2OLab

KEYWORDS: Energy - Contamination - Groundwater - Hydrogeology - Heterogeneity - Uncertainty - Multi-scale - Simulation

SCIENTIFIC DESCRIPTION: The software platform contains a database which is interfaced through the web portal H2OWeb. It contains also software modules which can be used through the interface H2OGuide. The platform H2OLab is an essential tool for the dissemination of scientific results. Currently, software and database are shared by the partners of the h2mno4 project.

FUNCTIONAL DESCRIPTION: The software platform H2OLab is devoted to stochastic simulations of groundwater flow and contaminant transport in highly heterogeneous porous and fractured geological media.

-Modeling and numerical simulation of aquifers -Porous and fractured heterogeneous media -Flow with mixed finite elements -Solute transport with a Lagrangian method -Stochastic modeling for data uncertainty.

- Participants: Géraldine Pichot, Grégoire Lecourt, Jean-Raynald De Dreuzy and Jocelyne Erhel
- Partners: Université de Rennes 1 - CNRS - Université de Lyon - Université de Poitiers
- Contact: Jocelyne Erhel
- URL: <http://h2olab.inria.fr/>

6.7. PALMTREE

KEYWORD: Monte-Carlo

FUNCTIONAL DESCRIPTION: We present an easy-to-use package for the parallelization of Lagrangian methods for partial differential equations. In addition to the reduction of computation time, the code aims at satisfying three properties:

simplicity: the user just has to add the algorithm governing the behaviour of the particles. portability: the possibility to use the package with any compiler and OS. action-replay: the ability of the package to replay a selected batch of particles.

The last property allows the user to replay and capture the whole sample path for selected particles of a batch. This feature is very useful for debugging and catching some relevant information.

- Authors: Lionel Lenôtre, Géraldine Pichot, Lionel Lenôtre and Lionel Lenôtre
- Contact: Géraldine Pichot

6.8. GRT3D

KEYWORDS: Geochemistry - Dispersion - Scientific calculation - Simulation - Advection

SCIENTIFIC DESCRIPTION: Participants : Édouard Canot, Jocelyne Erhel [correspondant] .

Version: version 2.0, April 2014

APP: registered

Programming language: C

Abstract: Reactive transport modeling has become an essential tool for understanding complex environmental problems. It is an important issue for MoMaS and C2S@EXA partners (see sections 8.2.5 , 8.2.3), in particular Andra. We have developed a method coupling transport and chemistry, based on a method of lines such that spatial discretization leads to a semi-discrete system of algebraic differential equations (DAE system). The main advantage is to use a complex DAE solver, which controls simultaneously the timestep and the convergence of Newton algorithm. The approach SIA uses a fixed-point method to solve the nonlinear system at each timestep, whereas the approach SNIA uses an explicit scheme.

The software suite GRT3D has four executable modules:

SIA1D: Sequential Iterative Approach for 1D domains,

GDAE1D: Global DAE approach for 1D domains,

SNIA3D: Sequential Non Iterative Approach for 1D, 2D or 3D domains.

GDAE3D: Global DAE approach for 1D, 2D or 3D domains. This module has three variants: the original one with logarithms, an optimized one still with logarithms, an optimized one which does not use logarithms.

Current work: extension of the chemistry module and parallelization.

FUNCTIONAL DESCRIPTION: Reactive transport modeling has become an essential tool for understanding complex environmental problems. It is an important issue for MoMaS and C2S@EXA partners, in particular Andra. We have developed a method coupling transport and chemistry, based on a method of lines such that spatial discretization leads to a semi-discrete system of algebraic differential equations (DAE system). The main advantage is to use a complex DAE solver, which controls simultaneously the timestep and the convergence of Newton algorithm. The approach SIA uses a fixed-point method to solve the nonlinear system at each timestep, whereas the approach SNIA uses an explicit scheme.

The software suite GRT3D has four executable modules:

SIA1D: Sequential Iterative Approach for 1D domains,

GDAE1D: Global DAE approach for 1D domains,

SNIA3D: Sequential Non Iterative Approach for 1D, 2D or 3D domains.

GDAE3D: Global DAE approach for 1D, 2D or 3D domains. This module has three variants: the original one with logarithms, an optimized one still with logarithms, an optimized one which does not use logarithms.

- Participants: Caroline De Dieuleveult, Édouard Canot, Jocelyne Erhel, Nadir Soualem and Souhila Sabit
- Partner: ANDRA
- Contact: Jocelyne Erhel

GALEN Project-Team

6. New Software and Platforms

6.1. DISD

Dense Image and Surface Descriptors

FUNCTIONAL DESCRIPTION: Scale-Invariant Descriptor, Scale-Invariant Heat Kernel Signatures DISD implements the SID, SI-HKS and ISC descriptors. SID (Scale-Invariant Descriptor) is a densely computable, scale- and rotation- invariant descriptor. We use a log-polar grid around every point to turn rotation/scalings into translation, and then use the Fourier Transform Modulus (FTM) to achieve invariance. SI-HKS (Scale-Invariant Heat Kernel Signatures) extract scale-invariant shape signatures by exploiting the fact that surface scaling amounts to multiplication and scaling of a properly sampled HKS descriptor. We apply the FTM trick on HKS to achieve invariance to scale changes. ISC (Intrinsic Shape Context) constructs a net-like grid around every surface point by shooting outwards and tracking geodesics. This allows us to build a meta-descriptor on top of HKS/SI-HKS that takes neighborhood into account, while being invariant to surface isometries.

- Participants: Eduard Trulls and Iasonas Kokkinos
- Contact: Iasonas Kokkinos
- URL: <http://vision.mas.ecp.fr/Personnel/iasonas/descriptors.html>

6.2. DPMS

FUNCTIONAL DESCRIPTION: Dpms implements branch-and-bound object detection, cutting down the complexity of detection from linear in the number of pixels to logarithmic.

- Participant: Iasonas Kokkinos
- Contact: Iasonas Kokkinos

6.3. DROP

KEYWORDS: Health - Merging - Registration of 2D and 3D multimodal images - Medical imaging

FUNCTIONAL DESCRIPTION: Drop is a software programme that registers images originating from one or more modes by quickly and efficiently calculating a non-rigid / deformable field of deformation. Drop is a new, quick and effective registration tool based on new algorithms that do not require a cost function derivative.

- Partner: Centrale Paris
- Contact: Nikolaos Paragios
- URL: <http://campar.in.tum.de/Main/Drop>

6.4. FastPD

KEYWORD: Medical imaging

FUNCTIONAL DESCRIPTION: FastPD is an optimization platform in C++ for the computer vision and medical imaging community.

- Contact: Nikolaos Paragios
- URL: <http://www.csd.uoc.gr/~komod/FastPD/>

6.5. GraPeS

Grammar Parser for Shapes

FUNCTIONAL DESCRIPTION: It is a software for parsing facade images using shape grammars. Grapes implement a parsing methods based on Reinforcement Learning principles. It optimizes simultaneously the topology of the parse tree as well as the associated parameters. GraPeS comes along with predefined shape grammars as XML files and defines three kinds of rewards. However, it also offers the possibility to create new grammars and to provide custom rewards in text files, widening the scope of potential applications. The name of the software comes from the aspect of the parse tree of the binary split grammars involved in the process.

RELEASE FUNCTIONAL DESCRIPTION: Supports jpg and gif file formats.

- Participant: Iasonas Kokkinos
- Contact: Iasonas Kokkinos

6.6. HOAP-SVM

High-Order Average Precision SVM

SCIENTIFIC DESCRIPTION: We consider the problem of using high-order information (for example, persons in the same image tend to perform the same action) to improve the accuracy of ranking (specifically, average precision). We develop two learning frameworks. The high-order binary SVM (HOB-SVM) optimizes a convex upper bound of the surrogate 0-1 loss function. The high-order average precision SVM (HOAP-SVM) optimizes a difference-of-convex upper bound on the average precision loss function.

Authors of the research paper: Puneet K. Dokania, A. Behl, C. V. Jawahar and M. Pawan Kumar

FUNCTIONAL DESCRIPTION: The software provides a convenient API for learning to rank with high-order information. The samples are ranked according to a score that is proportional to the difference of max-marginals of the positive and the negative class. The parameters of the score function are computed by minimizing an upper bound on the average precision loss. The software also provides an instantiation of the API for ranking samples according to their relevance to an action, using the poselet features. The following learning algorithms are included in the API:

(1) Multiclass-SVM (2) AP-SVM (3) High Order Binary SVM (HOB-SVM) (4) High Order AP-SVM (HOAP-SVM) (5) M4 Learning (unpublished work)

The API is developed in C/C++ by Puneet K. Dokania.

- Participants: Pawan Kumar and Puneet Dokania
- Contact: Puneet Dokania
- URL: <http://puneetkdokania.github.io/projects/ranking-highorder/ranking-highorder.html>

6.7. LBSD

Learning-Based Symmetry Detection

FUNCTIONAL DESCRIPTION: LBSD implements the learning-based approach to symmetry detection. It includes the code for running a detector, alongside with the ground-truth symmetry annotations that we have introduced for the Berkeley Segmentation Dataset (BSD) benchmark.

- Participant: Stavros Tsogkas
- Contact: Stavros Tsogkas
- URL: https://github.com/tsogkas/oid_1.0

6.8. mrf-registration

KEYWORDS: Health - Medical imaging

FUNCTIONAL DESCRIPTION: Deformable image and volume registration, is a deformable registration platform in C++ for the medical imaging community. This is the first publicly available platform which contains most of the existing metrics to perform registration under the same concept. The platform is used for clinical research from approximately 3,000 users worldwide.

RELEASE FUNCTIONAL DESCRIPTION: Bugfix in image resampling Resampling of binary mask is now w.r.t. to target image Added adjustable sigma for Gaussian image pyramid Added level dependent scaling of maximum displacement when linkMax is disabled Changed approximation method for computation of the inverse displacement field (less memory demanding) Bugfix in grid and quiver visualization Added support for compressed MHD Bugfix in 3D thin-plate splines in landmark-based registration

- Participant: Nikolaos Paragios
- Contact: Nikolaos Paragios
- URL: <http://www.mrf-registration.net/>

6.9. TeXMeG

FUNCTIONAL DESCRIPTION: Texture, modulation, generative models, segmentation, TeXMeG is a front-end for texture analysis and edge detection platform in Matlab that relies on Gabor filtering and image demodulation. Includes frequency- and time- based definition of Gabor- and other Quadrature-pair filterbanks, demodulation with the Regularized Energy Separation Algorithm and Texture/Edge/Smooth classification based on MDL criterion.

- Participant: Iasonas Kokkinos
- Contact: Iasonas Kokkinos
- URL: <http://cvsp.cs.ntua.gr/software/texture/>

6.10. Platforms

6.10.1. The Proximity Operator Repository

Participants: Emilie Chouzenoux and Jean-Christophe Pesquet (in collaboration with Giovanni Chierchia, Univ. Paris Est, and Patrick Combettes, North Carolina State University).

link: <http://proximity-operator.net/>

Proximity operators have become increasingly important tools as basic building blocks of proximal splitting algorithms, a class of algorithms that decompose complex composite convex optimization methods into simple steps involving one of the functions present in the model. This website provides formulas for efficiently computing the proximity operator of various functions, along with the associated codes.

GENSCALE Project-Team

6. New Software and Platforms

6.1. GATB-Core

Genome Assembly and Analysis Tool Box

KEYWORDS: Bioinformatics - NGS - Genomics - Genome assembling

FUNCTIONAL DESCRIPTION: The GATB-Core library aims to lighten the design of NGS algorithms. It offers a panel of high-level optimized building blocks to speed-up the development of NGS tools related to genome assembly and/or genome analysis. The underlying data structure is the de Bruijn graph, and the general parallelism model is multithreading. The GATB library targets standard computing resources such as current multicore processor (laptop computer, small server) with a few GB of memory. From high-level API, NGS programming designers can rapidly elaborate their own software based on domain state-of-the-art algorithms and data structures. The GATB-Core library is written in C++.

RELEASE FUNCTIONAL DESCRIPTION: speed up from x2 to x4 for kmer counting and graph construction phases (optimizations based on minimizers and improved Bloom filters). GATB's k-mer counter has been improved using techniques from KMC2, to achieve competitive running times compared to KMC2. ability to store arbitrary information associated to each kmer of the graph, enabled by a minimal perfect hash function (costs only 2.61 bits/kmer of memory) improved API with new possibilities (banks and kmers management) many new snippets showing how to use the library.

- Participants: Charles Deltel, Claire Lemaitre, Dominique Lavenier, Guillaume Rizk, Patrick Durand and Pierre Peterlongo
- Contact: Dominique Lavenier
- URL: <http://gatb.inria.fr/>

6.2. DiscoSnpRad

DISCOVering Single Nucleotide Polymorphism, Indels in RAD seq data

KEYWORD: RAD-seq

FUNCTIONAL DESCRIPTION: Software discoSnpRad is designed for discovering Single Nucleotide Polymorphism (SNP) and insertions/deletions (indels) from raw set(s) of RAD-seq data. Note that number of input read sets is not constrained, it can be one, two, or more. Note also that no other data as reference genome or annotations are needed. The software is composed of several modules. First module, kissnp2, detects SNPs from read sets. A second module, kissreads2, enhances the kissnp2 results by computing per read set and for each variant found i/ its mean read coverage and ii/ the (phred) quality of reads generating the polymorphism. Then, variants are grouped by RAD locus, and a VCF file is finally generated. We also provide several scripts to further filter and select informative variants for downstream population genetics studies.

This tool relies on the GATB-Core library.

- Contact: Pierre Peterlongo
- URL: <https://github.com/GATB/DiscoSnp>

6.3. GWASDM

Genome Wide Association Study using Data Mining strategy

KEYWORDS: GWAS - Data mining

FUNCTIONAL DESCRIPTION: From two cohorts of genotyped individuals (case and control), the GWASDM software performs a Genome Wide Association Study based on data mining techniques and generates several patterns of SNPs that correlate with a given phenotype. The algorithm implemented in GWASDM directly uses relative risk measures such as risk ratio, odds ratio and absolute risk reduction combined with confidence intervals as anti-monotonic properties to efficiently prune the search space. The algorithm discovers a complete set of discriminating patterns with regard to given thresholds or applies heuristic strategies to extract the largest statistically significant discriminating patterns in a given dataset.

- Contact: Dominique Lavenier

6.4. bcool

de Bruijn graph cOrrectiOn from graph aLignment

KEYWORDS: De Bruijn graphs - Reads correction - Short reads - Read mapping

FUNCTIONAL DESCRIPTION: BCool includes two steps. As a first step, Bcool constructs a corrected compacted de Bruijn graph from the reads. This graph is then used as a reference and the reads are corrected according to their mapping on the graph. This approach yields a better correction than kmer-spectrum techniques, while being scalable, making it possible to apply it to human-size genomic datasets and beyond. The implementation is open source and available at github.com/Malfoy/BCOOL

- Partner: Université libre de Bruxelles
- Contact: Pierre Peterlongo
- URL: <http://github.com/Malfoy/BCOOL>

6.5. CARNAC-LR

Clustering coefficient-based Acquisition of RNA Communities in Long Reads

KEYWORDS: Transcriptomics - Clustering - Bioinformatics

FUNCTIONAL DESCRIPTION: Carnac-LR is a clustering method for third generation sequencing data. Used on RNA sequences it retrieves all sequences that describes a gene and put them in a cluster. CARNAC-LR is an efficient implementation of a novel clustering algorithm for detecting communities in a graph of reads from Third Generation Sequencing. It is a part of a pipeline that allows to retrieve expressed variants from each gene de novo (without reference genome/transcriptome), for transcriptomic sequencing data.

- Contact: Camille Marchet

IBIS Project-Team

5. New Software and Platforms

5.1. WellFARE

KEYWORDS: Bioinformatics - Statistics - Data visualization - Data modeling

SCIENTIFIC DESCRIPTION: WellFARE is a Python library implementing linear inversion methods for the reconstruction of gene expression profiles from fluorescent or luminescent reporter gene data.

FUNCTIONAL DESCRIPTION: As input, WellFARE reads the primary data file produced by a 96-well microplate reader, containing time-series measurements of the absorbance (optical density) as well as the fluorescence and luminescence intensities in each well (if available). Various functions exist to analyze the data, in particular for detecting outliers, subtracting background, estimating growth rates, promoter activities and protein concentrations, visualizing expression profiles, synchronizing replicate profiles, etc. WellFARE is the computational core of the web application WellInverter.

NEWS OF THE YEAR: New version 2.0 with correction of several bugs.

- Participants: Delphine Ropers, Hans Geiselmann, Hidde De Jong, Michel Page, Valentin Zulkower and Yannick Martin
- Partner: UGA
- Contact: Hidde De Jong
- Publication: [Robust reconstruction of gene expression profiles from reporter gene data using linear inversion](#)
- URL: <https://github.com/ibis-inria/wellfare>

5.2. WellInverter

KEYWORDS: Bioinformatics - Statistics - Data visualization - Data modeling

SCIENTIFIC DESCRIPTION: WellInverter is a web application that implements linear inversion methods for the reconstruction of gene expression profiles from fluorescent or luminescent reporter gene data.

FUNCTIONAL DESCRIPTION: As input, WellInverter reads the primary data file produced by a 96-well microplate reader, containing time-series measurements of the absorbance (optical density) as well as the fluorescence and luminescence intensities in each well (if available). Various modules exist to analyze the data, in particular for detecting outliers, subtracting background, estimating growth rates, promoter activities and protein concentrations, visualizing expression profiles, synchronizing replicate profiles, etc. The computational core of the web application consists of the Python library WellFARE.

NEWS OF THE YEAR: New version developed this year, making the tool accessible to a broader audience of biologists and bioinformaticians. In particular, we have put in place a parallel computing architecture with a load balancer to distribute the analysis queries over several back-end servers, redesigned the graphical user interface, and developed a plug-in system for defining high-level routines for parsing data files produced by microplate readers from different manufacturers.

- Participants: Delphine Ropers, Hans Geiselmann, Hidde De Jong, Johannes Geiselmann, Michel Page, Valentin Zulkower and Yannick Martin
- Partner: UGA
- Contact: Hidde De Jong
- Publication: [Robust reconstruction of gene expression profiles from reporter gene data using linear inversion](#)
- URL: <https://team.inria.fr/ibis/wellinverter/>

5.3. FluoBacTracker

KEYWORDS: Bioinformatics - Biology - Biomedical imaging

SCIENTIFIC DESCRIPTION: FluoBacTracker is an ImageJ plugin allowing the segmentation and tracking of growing bacterial cells from time-lapse microscopy movies. The segmentation and tracking algorithms used by FluoBacTracker have been developed by Lionel Moisan and colleagues at Université Paris Descartes.

FUNCTIONAL DESCRIPTION: FluoBacTracker has the following functionalities: 1) Select regions of interest in images of microcolonies 2) Denoise and renormalize the images 3) Identify each cells in each image (segmentation) 4) Follow cells through the whole movie (tracking), including the detection of cells washed out from a microfluidics channel 5) Detect divisions and construct cell lineage of the population

NEWS OF THE YEAR: Version 2 of FluoBacTracker also allows the analysis of microscopy of bacteria growing in a microfluidics device called "mother machine".

- Participants: Hugues Berry, Cyril Dutrieux, Hidde De Jong, Charles Kervrann, David Parsons and Magali Vangkeosay
- Partners: Université Descartes - UGA
- Contact: Hugues Berry
- URL: <http://fluobacktracker.inrialpes.fr>

5.4. GNA

Genetic Network Analyzer

KEYWORDS: Model Checking - Bioinformatics - Gene regulatory networks - Qualitative simulation

SCIENTIFIC DESCRIPTION: Genetic Network Analyzer (GNA) is the implementation of methods for the qualitative modeling and simulation of gene regulatory networks developed in the IBIS project-team.

FUNCTIONAL DESCRIPTION: The input of GNA consists of a model of the regulatory network in the form of a system of piecewise-linear differential equations (PLDEs), supplemented by inequality constraints on the parameters and initial conditions. From this information, GNA generates a state transition graph summarizing the qualitative dynamics of the system. In order to analyze large graphs, GNA allows the user to specify properties of the qualitative dynamics of a network in temporal logic, using high-level query templates, and to verify these properties on the state transition graph by means of standard model-checking tools, either locally installed or accessible through a remote web server.

RELEASE FUNCTIONAL DESCRIPTION: (1) it supports the editing and visualization of regulatory networks, in an SBGN-compatible format, (2) it semi-automatically generates a prototype model from the network structure, thus accelerating the modeling process, and (3) it allows models to be exported in the SBML Qual standard.

NEWS OF THE YEAR: Use for the modeling of the osmotic stress response network in *E. coli*.

- Participants: François Rechenmann, Hidde De Jong and Michel Page
- Partner: UGA
- Contact: Hidde De Jong
- Publications: [Genetic Network Analyzer: A Tool for the Qualitative Modeling and Simulation of Bacterial Regulatory Networks - Piecewise linear approximations to model the dynamics of adaptation to osmotic stress by food-borne pathogens](#)
- URL: <http://www-helix.inrialpes.fr/gna>

LEMON Team

5. New Software and Platforms

5.1. Action Dépollution

FUNCTIONAL DESCRIPTION: Action Dépollution is a serious game made for learning how to purify fast and well a water reservoir, such as lakes. In the scope of the international initiative Mathematics of Planet Earth, this game shows an application of mathematics related to environmental education and sustainable development. The player can act as a researcher, that compares different strategies and looks for the best solution.

- Participants: Alain Rapaport, Alexis Pacholik and Antoine Rousseau
- Contact: Antoine Rousseau
- URL: <https://depollution.inria.fr/>

5.2. SW2D

Shallow Water 2 Dimensions

KEYWORDS: Numerical simulations - Shallow water equations

FUNCTIONAL DESCRIPTION: Urban floods are usually simulated using two-dimensional shallow water models. A correct representation of the urban geometry and hydraulics would require that the average computational cell size be between 0.1 m and 1 m. The meshing and computation costs make the simulation of entire districts/conurbations impracticable in the current state of computer technology.

An alternative approach consists in upscaling the shallow water equations using averaging techniques. This leads to introducing storage and conveyance porosities, as well as additional source terms, in the mass and momentum balance equations. Various versions of porosity-based shallow water models have been proposed in the literature. The Shallow Water 2 Dimensions (SW2D) computational code embeds various finite volume discretizations of these models. It uses fully unstructured meshes with arbitrary numbers of edges. The key features of the models and numerical techniques embedded in SW2D are :

- specific momentum/energy dissipation models that are active only under transient conditions. Such models, that are not present in classical shallow water models, stem from the upscaling of the shallow water equations and prove essential in modeling the features of fast urban flow transients accurately
- modified HLLC solvers for an improved discretization of the momentum source terms stemming from porosity gradients
- higher-order reconstruction techniques that allow for faster and more stable calculations in the presence of wetting/drying fronts.

- Participant: Vincent Guinot
- Contact: Vincent Guinot

5.3. WindPoS-SDM-LAM

KEYWORDS: Numerical simulations - 3D - Fluid mechanics

FUNCTIONAL DESCRIPTION: Software platform for wind modeling.

- Authors: Antoine Rousseau, Cristian Paris Ibarra, Jacques Morice, Mireille Bossy and Sélim Kraria
- Contact: Mireille Bossy
- URL: <https://windpos.inria.fr>

LIFEWARE Project-Team

6. New Software and Platforms

6.1. BIOCHAM

The Biochemical Abstract Machine

KEYWORDS: Systems Biology - Bioinformatics

FUNCTIONAL DESCRIPTION: The Biochemical Abstract Machine (BIOCHAM) is a software environment for modeling, analyzing and synthesizing biochemical reaction networks (CRNs) with respect to a formal specification of the observed or desired behavior of a biochemical system. BIOCHAM is compatible with the Systems Biology Markup Language (SBML) and contains some unique features about formal specifications in quantitative temporal logic, sensitivity and robustness analyses and parameter search in high dimension w.r.t. behavioral specifications, static analyses, and synthesis of CRNs.

RELEASE FUNCTIONAL DESCRIPTION: influence networks with forces – PAC learning of influence networks from time series data – synthesis of continuous reaction networks for mathematical functions defined by polynomial differential equations – complete modular rewriting of Biocham in SWI-Prolog

- Participants: François Fages, David Coudrin, Sylvain Soliman and Thierry Martinez
- Contact: François Fages
- URL: <http://lifeware.inria.fr/biocham/>

M3DISIM Project-Team

6. New Software and Platforms

6.1. FELiScE

Finite Elements for Life Sciences and Engineering problems

KEYWORDS: Finite element modelling - Cardiac Electrophysiology - Cardiovascular and respiratory systems

FUNCTIONAL DESCRIPTION: FELiScE is a finite element code which the M3DISIM and REO project-teams have decided to jointly develop in order to build up on their respective experiences concerning finite element simulations. One specific objective of this code is to provide in a unified software environment all the state-of-the-art tools needed to perform simulations of the complex respiratory and cardiovascular models considered in the two teams – namely involving fluid and solid mechanics, electrophysiology, and the various associated coupling phenomena. FELISCE is written in C++, and may be later released as an opensource library. FELiScE was registered in July 2014 at the Agence pour la Protection des Programmes under the Inter Deposit Digital Number IDD.N.FR.001.350015.000.S.P.2014.000.10000.

- Participants: Axel Fourmont, Benoit Fabreges, Damiano Lombardi, Dominique Chapelle, Faisal Amlani, Irène Vignon-Clementel, Jean-Frédéric Gerbeau, Marina Vidrascu, Matteo Aletti, Miguel Angel Fernandez Varela, Mikel Landajuela Larma, Philippe Moireau and Sébastien Gilles
- Contact: Jean-Frédéric Gerbeau
- URL: <http://felisce.gforge.inria.fr>

6.2. HeartLab

KEYWORDS: Computational geometry - Image analysis - Cardiac - Health - Simulation

SCIENTIFIC DESCRIPTION: The heartLab software is a library designed to perform both simulation and estimation of the heart mechanical behavior (based on various types of measurements, e.g. images).

Also included are geometric data and tools in the code to define cardiac anatomical models compatible with the simulation requirements in terms of mesh quality, fiber direction data defined within each element, and the referencing necessary for handling boundary conditions and estimation, in particular. These geometries are analytical or come from computerized tomography (CT) or magnetic resonance (MR) image data of humans or animals.

FUNCTIONAL DESCRIPTION: The heartLab software is a library designed to perform both simulation and estimation of the heart mechanical behavior (based on various types of measurements, e.g. images).

Also included are geometric data and tools in the code to define cardiac anatomical models compatible with the simulation requirements in terms of mesh quality, fiber direction data defined within each element, and the referencing necessary for handling boundary conditions and estimation, in particular. These geometries are analytical or come from computerized tomography (CT) or magnetic resonance (MR) image data of humans or animals.

- Participants: Radomir Chabiniok, Gautier Bureau, Martin Genet, Federica Caforio, Ustim Khris-tenko, Dominique Chapelle and Philippe Moireau
- Contact: Philippe Moireau
- URL: <https://raweb.inria.fr/rapportsactivite/RA2013/m3disim/uid14.html>

6.3. Verdandi

KEYWORDS: HPC - Model - Software Components - Partial differential equation

FUNCTIONAL DESCRIPTION: Verdandi is a free and open-source (LGPL) library for data assimilation. It includes various such methods for coupling one or several numerical models and observational data. Mainly targeted at large systems arising from the discretization of partial differential equations, the library is devised as generic, which allows for applications in a wide range of problems (biology and medicine, environment, image processing, etc.). Verdandi also includes tools to ease the application of data assimilation, in particular in the management of observations or for a priori uncertainty quantification. Implemented in C++, the library may be used with models implemented in Fortran, C, C++ or Python.

- Participants: Dominique Chapelle, Gautier Bureau, Nicolas Claude, Philippe Moireau and Vivien Mallet
- Contact: Vivien Mallet
- URL: <http://verdandi.gforge.inria.fr/>

6.4. CardiacLab

KEYWORDS: Cardiovascular and respiratory systems - Matlab - Real time

FUNCTIONAL DESCRIPTION: CardiacLab is a MATLAB toolbox allowing to perform “real-time” cardiac simulations using 0D models of the cardiovascular systems. Its modular development includes (1) a module integrating the mechanical dynamics of the cavity taking into account its particular geometry, (2) a module allowing to choose a micro-model of the cardiac contraction, (3) a module of phase management, (4) a circulation module based on Windkessel models or more advanced 1D flows models, and (5) a perfusion module. The objective of this code is threefold: (1) demonstrate to students, engineers, medical doctors, the interest of modeling in cardiac applications, (2) unify our original modeling developments with the possibility to evaluate them with previous team developments before integrating them into 3D complex formulations, and (3) explore some avenues pertaining to real-time simulat

- Participants: Sebastien Impériale, Martin Genet, Federica Caforio, Ustim Khristenko, Peter Baumgartner, Radomir Chabiniok, François Kimmig and Arthur Le Gall
- Contact: Philippe Moireau
- URL: <https://gitlab.inria.fr/M3DISIM/CardiacLab>

MAGIQUE-3D Project-Team

5. New Software and Platforms

5.1. Elasticus

KEYWORDS: Discontinuous Galerkin - Acoustic equation - Elastodynamic equations - Elastoacoustic - 2D - 3D - Time Domain

SCIENTIFIC DESCRIPTION: Elasticus simulate acoustic and elastic wave propagation in 2D and in 3D, using Discontinuous Galerkin Methods. The space discretization is based on two kind of basis functions, using Lagrange or Jacobi polynomials. Different kinds of fluxes (upwind and centered) are implemented, coupled with RK2 and RK4 time schemes.

FUNCTIONAL DESCRIPTION: Elasticus is a sequential library, independent of Total platform and developed in Fortran, to simulate wave propagation in geophysical environment, based on a DG method. It is meant to help PhD students and post-doctoral fellows to easily implement their algorithms in the library. Thus, readability of the code is privileged to optimization of its performances. Developed features should be easily transferred in the computing platform of Total. Elasticus manages arbitrary orders for the spatial discretization with DG method.

NEWS OF THE YEAR: In 2017, we implemented the coupling between triangles and quadrangles, and we started the implementation of coupling between Discontinuous Galerkin methods and Spectral Element methods

- Participants: Julien Diaz, Lionel Boillot and Simon Ettouati
- Partner: TOTAL
- Contact: Julien Diaz

5.2. Hou10ni

KEYWORDS: 2D - 3D - Elastodynamic equations - Acoustic equation - Elastoacoustic - Frequency Domain - Time Domain - Discontinuous Galerkin

SCIENTIFIC DESCRIPTION: Hou10ni simulates acoustic and elastic wave propagation in time domain and in harmonic domain, in 2D and in 3D. It is also able to model elasto acoustic coupling. It is based on the second order formulation of the wave equation and the space discretization is achieved using Interior Penalty Discontinuous Galerkin Method. Recently, the harmonic domain solver has been extended to handle Hybridizable Discontinuous Galerkin Methods.

FUNCTIONAL DESCRIPTION: This software simulates the propagation of waves in heterogeneous 2D and 3D media in time-domain and in frequency domain. It is based on an Interior Penalty Discontinuous Galerkin Method (IPDGM) and allows for the use of meshes composed of cells of various order (p-adaptivity in space).

NEWS OF THE YEAR: In 2017, we have completed the implementation of hybridizable DG for 3D anisotropic elastic, and we have coupled Hou10ni with Maphys (developed by Inria team project Hiepac). We have begun scalability tests and performance comparison of Hou10ni/Mumps vs Hou10ni/Maphys, in the framework of the european project HPC4E.

- Participants: Conrad Hillairet, Elodie Estecahandy, Julien Diaz, Lionel Boillot and Marie Bonnasse Gahot
- Contact: Julien Diaz
- Publications: Hybridizable discontinuous Galerkin method for the two-dimensional frequency-domain elastic wave equations - Convergence of seismic full waveform inversion and extension to Cauchy data - Convergence Analysis for Seismic Full Waveform Inversion - Stability and convergence analysis for seismic depth imaging using FWI - On the use of a laser ablation as a laboratory seismic source - Towards Energy-Efficient Storage Servers - Equivalent Robin Boundary Conditions for Acoustic and Elastic Media - Comparison of solvers performance when solving the 3D Helmholtz elastic wave equations over the Hybridizable Discontinuous Galerkin method - Comparison of solvers performance when solving the 3D Helmholtz elastic wave equations using the Hybridizable Discontinuous Galerkin method - Resolution strategy for the Hybridizable Discontinuous Galerkin system for solving Helmholtz elastic wave equations - Seismic imaging in laboratory trough laser Doppler vibrometry - Absorbing Boundary Conditions for 3D Elastic TTI Modeling, Application to Time-Based and Time-Harmonic Simulations - Shape and material parameter reconstruction of an isotropic or anisotropic solid immersed in a fluid - Modelling and advanced simulation of wave propagation phenomena in 3D geophysical media. - Multi-level explicit local time-stepping methods for second-order wave equations - Absorbing Boundary Conditions for 3D elastic TTI modeling - Modeling of elastic Helmholtz equations by hybridizable discontinuous Galerkin method (HDG) for geophysical applications - Performance Assessment on Hybridizable Dg Approximations for the Elastic Wave Equation in Frequency Domain - High-Order IPDG Approximations for Elasto-Acoustic Problems - High-order Discontinuous Galerkin approximations for elasto-acoustic scattering problems - Modelling of seismic waves propagation in harmonic domain by hybridizable discontinuous Galerkin method (HDG) - Absorbing Boundary Conditions for 3D Tilted Transverse Isotropic media - Performance comparison between hybridizable DG and classical DG methods for elastic waves simulation in harmonic domain - Polynomial speeds in a Discontinuous Galerkin code - Hybridizable Discontinuous Galerkin method for the simulation of the propagation of the elastic wave equations in the frequency domain - Discontinuous Galerkin methods for the simulation of the propagation of the elastic wave equations in the frequency domain - High order discontinuous Galerkin methods for time-harmonic elastodynamics - Hybridizable discontinuous Galerkin method for the two-dimensional frequency-domain elastic wave equations - Efficient DG-like formulation equipped with curved boundary edges for solving elasto-acoustic scattering problems - Numerical schemes for the simulation of seismic wave propagation in frequency domain - Performance analysis of DG and HDG methods for the simulation of seismic wave propagation in harmonic domain - Hybridizable Discontinuous Galerkin method for solving Helmholtz elastic wave equations - Discontinuous Galerkin methods for solving Helmholtz elastic wave equations for seismic imaging - Performance comparison of HDG and classical DG method for the simulation of seismic wave propagation in harmonic domain - Contributions to the mathematical modeling and to the parallel algorithmic for the optimization of an elastic wave propagator in anisotropic media - Contribution to the mathematical analysis and to the numerical solution of an inverse elasto-acoustic scattering problem
- URL: <https://team.inria.fr/magique3d/software/hou10ni/>

5.3. MONTJOIE

KEYWORDS: High order finite elements - Edge elements - Aeroacoustics - High order time schemes

SCIENTIFIC DESCRIPTION: Montjoie is designed for the efficient solution of time-domain and time-harmonic linear partial differential equations using high-order finite element methods. This code is mainly written for quadrilateral/hexahedral finite elements, partial implementations of triangular/tetrahedral elements are provided. The equations solved by this code, come from the "wave propagation" problems, particularly acoustic, electromagnetic, aeroacoustic, elastodynamic problems.

FUNCTIONAL DESCRIPTION: Montjoie is a code that provides a C++ framework for solving partial differential equations on unstructured meshes with finite element-like methods (continuous finite element, discontinuous Galerkin formulation, edge elements and facet elements). The handling of mixed elements (tetrahedra, prisms, pyramids and hexahedra) has been implemented for these different types of finite elements methods. Several applications are currently available : wave equation, elastodynamics, aeroacoustics, Maxwell's equations.

- Participants: Gary Cohen, Juliette Chabassier, Marc Duruflé and Morgane Bergot
- Contact: Marc Duruflé
- URL: <http://montjoie.gforge.inria.fr/>

5.4. tmodeling-DG

Time-domain Wave-equation Modeling App

KEYWORDS: 2D - 3D - Elastoacoustic - Elastodynamic equations - Discontinuous Galerkin - Time Domain

SCIENTIFIC DESCRIPTION: tmodeling-DG simulate acoustic and elastic wave propagation in 2D and in 3D, using Discontinuous Galerkin Methods. The space discretization is based on two kind of basis functions, using Lagrange or Jacobi polynomials. Different kinds of fluxes (upwind and centered) are implemented, coupled with RK2 and RK4 time schemes.

FUNCTIONAL DESCRIPTION: tmodelling-DG is the follow up to DIVA-DG that we develop in collaboration with our partner Total. Its purpose is more general than DIVA-DG and should contains various DG schemes, basis functions and time schemes. It models wave propagation in acoustic media, elastic (isotropic and TTI) media and elasto-acoustic media, in two and three dimensions.

NEWS OF THE YEAR: In 2017, we have completed the implementation of Lagrange and Jacobi polynomials and we have released the 3D elastodynamic version and the 3D elasto-acoustic coupling.

- Participants: Julien Diaz, Lionel Boillot and Simon Ettouati
- Partner: TOTAL
- Contact: Julien Diaz

5.5. fmodeling

Frequency-domain Wave-equation Modeling App (fModeling)

KEYWORDS: Discontinuous Galerkin - Frequency Domain - 2D - 3D - Elastodynamic equations - Acoustic equation

SCIENTIFIC DESCRIPTION: FModelling simulates acoustic and elastic wave propagation in frequency domain, in 2D and in 3D, using Discontinuous Galerkin Methods and Hybridizable Discontinuous Galerkin Methods. The space discretization is based on Lagrange or Jacobi polynomials. Different kinds of fluxes (upwind and centered) are implemented, coupled with two linear solvers (Mumps and Maphys).

FUNCTIONAL DESCRIPTION: fmodeling is developed in partnership with Total in the context of the Depth Imaging Partnership (DIP). It is the equivalent of Tmodeling for frequency domain. The software deals with wave equation in the frequency domain and solves the forward problem using Discontinuous Galerkin methods or Hybridizable Discontinuous Galerkin Methods. In particular, acoustic and elastic (isotropic and TTI) media are considered in two and three dimensions. It is planned to implement and to test various kind of basis function and to couple the code with various linear solvers (such as Mumps or Maphys). The software is coupled to the Inversion solver of Total to conduct Seismic Imaging using iterative minimization with the Full Waveform Inversion method.

NEWS OF THE YEAR: In 2017, we completed the implementation of Hybridizable Discontinuous Galerkin Methods and we started the validation of the code in an industrial context. We have also coupled the code with the Full Waveform Inversion solver of Total.

- Partner: TOTAL
- Contact: Julien Diaz

MAMBA Project-Team

5. New Software and Platforms

5.1. TiQuant

Tissue Quantifier

KEYWORDS: Systems Biology - Bioinformatics - Biology - Physiology

FUNCTIONAL DESCRIPTION: Systems biology and medicine on histological scales require quantification of images from histological image modalities such as confocal laser scanning or bright field microscopy. The latter can be used to calibrate the initial state of a mathematical model, and to evaluate its explanatory value, which hitherto has been little recognized. We generated a software for image analysis of histological material and demonstrated its use in analysing liver confocal micrografts, called TiQuant (Tissue Quantifier). The software is part of an analysis chain detailing protocols of imaging, image processing and analysis in liver tissue, permitting 3D reconstructions of liver lobules down to a resolution of less than a micrometer.

- Author: Dirk Drasdo
- Contact: Dirk Drasdo

5.2. TiSim

Tissue Simulator

KEYWORDS: Systems Biology - Bioinformatics - Biology - Physiology

SCIENTIFIC DESCRIPTION: TiSim (Tissue Simulator) is a versatile and efficient simulation environment for tissue models. TiSim is a software for agent-based models of multicellular systems. It permits model development with center-based models and deformable cell models, it contains modules for monolayer and multicellular spheroid simulations as well as for simulations of liver lobules. Besides agent-based simulations, the flow of blood and the transport of molecules can be modelled in the extracellular space, intracellular processes such as signal transduction and metabolism can be simulated, for example over an interface permitting integration of SBML-formulated ODE models. TiSim is written in modern C++ , keeping central model constituents in modules to be able to reuse them as building blocks for new models. For user interaction, the GUI Framework Qt is used in combination with OpenGL for visualisation. The simulation code is in the process of being published. The modeling strategy and approaches slowly reach systems medicine and toxicology. The diffusion of software is a fundamental component as it provides the models that are complex and difficult to implement (implementing a liver lobule model from scratch takes about 2-2.5yrs) in form of a software to the developer and users who like to build upon them. This increases significantly the speed of implementing new models. Moreover, standardization is indispensable as it permits coupling different software tools that may have implemented models at different scales / levels.

FUNCTIONAL DESCRIPTION: TiSim is a software that permits agent-based simulations of multicellular systems. - center-based lattice-free agent-based model - modular - C++, Qt, OpenGL, GUI, batch mode - permits multiscale simulations by integration of molecular pathways (for signaling, metabolisms, drug) into each individual cell - applications so far: monolayer growth, multicellular spheroids - Boolean networks (development time = coding time (60 MMs) + model development time (264 MMs)) - in follow-up version 1: - liver lobule regeneration - SBML interface - in follow-up version 2: - deformable cell model (by triangulation of cell surface) - deformable rod models - extracellular matrix - vascular flow and transport TiSim can be directly fed by processed image data from TiQuant.

- Participants: Andreas Buttenschoen, Dirk Drasdo, Eugenio Lella, Géraldine Cellière, Johannes Neitsch, Margaretha Palm, Nick Jagiella, Noémie Boissier, Paul Van Liedekerke, Stefan Hoehme and Tim Johann
- Partner: IZBI, Université de Leipzig
- Contact: Dirk Drasdo

5.3. Platforms

TiQuant and TiSim The software for tissue image analysis (**Tissue Quantifier**) and simulation (**Tissue Simulator**) has been enriched. In more details,

5.3.1. *TiQuant*

TiQuant [94], [91] is implemented in portable object-oriented ISO C++. The GUI is based on QT and supports real-time visualisation using OpenGL. TiQuant is embedded in the tissue modelling framework CellSys and thus is tightly linked with TiSim, a versatile and efficient simulation environment for tissue models. TiQuant provides an interface to VolView and further complements its functionality by linking to the open-source libraries ITK and VTK (itk/vtk.org). The image/volume processing chains currently implemented in TiQuant for example include techniques to segment conduit and cell segmentation from 3D confocal micrographs of liver tissue based on the Adaptive Otsu Thresholding method and a number of morphological operators. TiQuant was currently extended by a machine-learning component, largely replacing the manual image-processing pipeline.

5.3.2. *TiSim*

TiSim permits agent-based simulations of multicellular systems. It is modular, in object-oriented ISO C++, the GUI based on Qt and OpenGL, while also allowing for batch mode runs. The software permits multi-scale simulations by integration of molecular pathways (for signalling, metabolisms, drug) into each individual cell. Applications so far are monolayer growth, multicellular spheroids, liver regeneration, TRAIL-treatment simulations. It has an SBML interface. In a largely finished follow-up version it will integrate a deformable cell model by triangulation of cell surface, deformable rod models, extracellular matrix and vascular flow and transport. TiSim can be directly fed by structures synthesised from processed image data from TiQuant.

Impact: The tool is used by our collaborators in liver biology, medicine and toxicology. We recently trained a PhD student from P. Segers (Ghent Univ.) on TiQuant and from T. Hillen (Univ. Alberta, Ca) on TiSim and organised a workshop on benchmarking and comparing agent-based models and tools (workshop Leipzig, volet 5).

MATHNEURO Team (section vide)

MIMESIS Team

6. New Software and Platforms

6.1. SOFA

Simulation Open Framework Architecture

KEYWORDS: Real time - Multi-physics simulation - Medical applications

FUNCTIONAL DESCRIPTION: SOFA is an Open Source framework primarily targeted at real-time simulation, with an emphasis on medical simulation. It is mostly intended for the research community to help develop new algorithms, but can also be used as an efficient prototyping tool. Based on an advanced software architecture, it allows : the creation of complex and evolving simulations by combining new algorithms with algorithms already included in SOFA, the modification of most parameters of the simulation (deformable behavior, surface representation, solver, constraints, collision algorithm, etc.) by simply editing an XML file, the building of complex models from simpler ones using a scene-graph description, the efficient simulation of the dynamics of interacting objects using abstract equation solvers, the reuse and easy comparison of a variety of available methods.

- Participants: Christian Duriez, François Faure, Hervé Delingette and Stéphane Cotin
- Partner: IGG
- Contact: Stéphane Cotin
- URL: <http://www.sofa-framework.org>

6.2. SofaPardisoSolver

KEYWORDS: Simulation - Linear Systems Solver - Direct solvers - Collision - Numerical simulations

SCIENTIFIC DESCRIPTION: The SofaPardisoSolver allows for fast direct solution of sparse systems of linear equations, using a decomposition (such as LU, LDL and Cholesky) according to the type of the matrix. Moreover, the wrapper allows for employing a partial factorization which brings a significant improvement when solving augmented systems, usually resulting in problems involving collisions and/or domain decomposition. FUNCTIONAL DESCRIPTION: The SofaPardisoSolver plugin contains a wrapper allowing for an efficient direct solution of a system of linear equations. It also contains an advanced feature which exploits an algorithm of partial decomposition available in Pardiso. This feature significantly accelerates the computation of Schur complement, typically needed to solve linear complementarity problems (LCP). Example of use: collision and contacts.

- Author: Igor Peterlik
- Contact: Igor Peterlik

6.3. SOFA Xray rendering

KEYWORDS: Simulation - Realistic rendering - Real-time rendering - Medical imaging - Medical applications

FUNCTIONAL DESCRIPTION: This work allows to emulate a X-ray scan image within the simulation platform SOFA. By defining the position of an emitter and receptor in the 3D space, an image is rendered. A realistic medical image of organs can thus be obtained from surface meshes (triangulated or quadrangulated) in real-time.

Version compatible with SOFA v17.06

- Authors: Stéphane Cotin and Frédérick Roy
- Contact: Stéphane Cotin

MNEMOSYNE Project-Team

6. New Software and Platforms

6.1. DANA

Distributed Asynchronous Numerical and Adaptive computing framework

KEYWORD: Neural networks

FUNCTIONAL DESCRIPTION: DANA is a python framework whose computational paradigm is grounded on the notion of a unit that is essentially a set of time dependent values varying under the influence of other units via adaptive weighted connections. The evolutions of a unit's value are defined by a set of differential equations expressed in standard mathematical notation which greatly ease their definition. The units are organized into groups that form a model. Each unit can be connected to any other unit (including itself) using a weighted connection. The DANA framework offers a set of core objects needed to design and run such models. The modeler only has to define the equations of a unit as well as the equations governing the training of the connections. The simulation is completely transparent to the modeler and is handled by DANA. This allows DANA to be used for a wide range of numerical and distributed models as long as they fit the proposed framework (e.g. cellular automata, reaction-diffusion system, decentralized neural networks, recurrent neural networks, kernel-based image processing, etc.).

- Participant: Nicolas Rougier
- Contact: Nicolas Rougier
- URL: <http://dana.loria.fr/>

6.2. ENAS

Event Neural Assembly Simulation

KEYWORDS: Neurosciences - Health - Physiology

SCIENTIFIC DESCRIPTION: As one gains more intuitions and results on the importance of concerted activity in spike trains, models are developed to extract potential canonical principles underlying spike coding. These methods shed a new light on spike train dynamics. However, they require time and expertise to be implemented efficiently, making them hard to use in a daily basis by neuroscientists or modelers. To bridge this gap, we developed the license free multiplatform software ENAS (<https://enas.inria.fr>) integrating tools for individual and collective spike analysis and simulation, with some specificities devoted to the retina. The core of ENAS is the statistical analysis of population codes. One of its main strength is to provide statistical analysis of spike trains using Maximum Entropy-Gibbs distributions taking into account both spatial and temporal correlations as constraints, allowing to introduce causality and memory in statistics. ENAS also generates simulated spike trains. On one hand, one can draw a population raster from an user-specified Gibbs distribution. On the other hand, we have integrated in ENAS our retina simulator VIRTUAL RETINA, extended here to include lateral connections in the IPL. We hope that ENAS will become a useful tool for neuroscientists to analyse spike trains and we hope to improve it thanks to user feedback. Our goal is to progressively enrich it with the latest research results, in order to facilitate transfer of new methods to the community.

FUNCTIONAL DESCRIPTION: As one gains more intuitions and results on the importance of concerted activity in spike trains, models are developed to extract potential canonical principles underlying spike coding. These methods shed a new light on spike train dynamics. However, they require time and expertise to be implemented efficiently, making them hard to use in a daily basis by neuroscientists or modelers. To bridge this gap, we developed the license free multiplatform software ENAS integrating tools for spike trains analysis and simulation. These tools are accessible through a friendly Graphical User Interface that avoids any scripting or writing code from the user. Most of them have been implemented to run in parallel to reduce the time and memory consumption. ENAS offers basic visualizations and classical analysis for statistics of spike trains analysis. It also proposes statistical analysis with Maximum Entropy-Gibbs distributions taking into account both spatial and temporal correlations as constraints, allowing to introduce causality and memory in statistics. ENAS also includes specific tools dedicated to the retina: Receptive Field computation and a virtual retina simulator. Finally, ENAS generates synthetic rasters, either from known statistics or from the VIRTUAL RETINA simulator. We expect ENAS to become a useful tool for neuroscientists to analyse spike trains and we hope to improve it thanks to users feedback. From our perspective, our goal is to progressively enrich ENAS with the latest research results, in order to facilitate transfer of new methods to the community.

- Participants: Bruno Cessac, Daniela Pamplona, Geoffrey Portelli, Hassan Nasser, Pierre Kornprobst, Rodrigo Cofre Torres, Sélim Kraria, Theodora Karvouniari and Thierry Viéville
- Contact: Bruno Cessac
- URL: <https://enas.inria.fr>

6.3. Virtual Enaction

KEYWORDS: Neurosciences - Simulation - Health

FUNCTIONAL DESCRIPTION: VirtualEnaction: A Platform for Systemic Neuroscience Simulation. The computational models studied in this project have applications that extend far beyond what is possible to experiment yet in human or non-human primate subjects. Real robotics experimentations are also impaired by rather heavy technological constraints, for instance, it is not easy to dismantle a given embedded system in the course of emerging ideas. The only versatile environment in which such complex behaviors can be studied both globally and at the level of details of the available modeling is a virtual environment, as in video games. Such a system can be implemented as “brainy-bot” (a programmed player based on our knowledge of the brain architecture) which goal is to survive in a complete manipulable environment.

In order to attain this rather ambitious objective we both (i) deploy an existing open-source video game middleware in order to be able to shape the survival situation to be studied and (ii) revisit the existing models in order to be able to integrate them as an effective brainy-bot. It consists of a platform associated to a scenario that is the closest possible to a survival situation (foraging, predator-prey relationship, partner approach to reproduction) and in which it is easy to integrate an artificial agent with sensory inputs (visual, touch and smell), emotional and somatosensory cues (hunger, thirst, fear, ..) and motor outputs (movement, gesture, ..) connected to a “brain” whose architecture will correspond to the major anatomical regions involved in the issues of learning and action selection (cortex areas detailed here, basal ganglia, hippocampus, and areas dedicated to sensorimotor processes). The internal game clock can be slowed down enough to be able to run non trivial brainy-bot implementations. This platform has already been used by two students of the team and is now a new deliverable of the KEOpS project.

- Participants: André Garenne, Frédéric Alexandre, Nicolas Rougier and Thierry Viéville
- Contact: Frédéric Alexandre

MONC Project-Team (section vide)

MORPHEME Project-Team

4. New Software and Platforms

4.1. BioLib

KEYWORD: Biomedical imaging

FUNCTIONAL DESCRIPTION: Library of image analysis for biology: object detection, tracking

- Participants: Étienne Delclaux, Grégoire Malandain, Sylvain Prigent and Xavier Descombes
- Contact: Xavier Descombes

4.2. PIB

Biological imaging platform

FUNCTIONAL DESCRIPTION: This platform, based on the DTK meta-platform, aims at gathering the team software development, and at providing a visual development tool.

- Participants: Étienne Delclaux, Grégoire Malandain and Xavier Descombes
- Contact: Xavier Descombes

4.3. Stracking

KEYWORDS: Bioinformatics - Biology - Biomedical imaging

SCIENTIFIC DESCRIPTION: Head Tracking and Flagellum Tracing for Sperm Motility Analysis : Sperm quality assessment plays an essential role in human fertility and animal breeding. Manual analysis is time-consuming and subject to intra- and inter-observer variability. To automate the analysis process, as well as to offer a means of statistical analysis that may not be achieved by visual inspection, we present a computational framework that tracks the heads and traces the tails for analyzing sperm motility, one of the most important attributes in semen quality evaluation. Our framework consists of 3 modules: head detection, head tracking, and flagellum tracing. The head detection module detects the sperm heads from the image data, and the detected heads are the inputs to the head tracking module for obtaining the head trajectories. Finally, a flagellum tracing algorithm is proposed to obtain the flagellar beat patterns.

FUNCTIONAL DESCRIPTION: This software is developed within the ANR project MOTIMO. It allows to segment and track spermatozoons from confocal microscopy image sequences.

- Participants: Grégoire Malandain, Huei Fang Yang, Sylvain Prigent and Xavier Descombes
- Contact: Xavier Descombes

MYCENAE Project-Team

6. New Software and Platforms

6.1. DynPeak

KEYWORDS: Biology - Health - Physiology

SCIENTIFIC DESCRIPTION: DynPeak is an algorithm for pulse detection and frequency analysis in hormonal time series.

- Participants: Alexandre Vidal, Claire Médigue, Frédérique Clément, George Rosca, Qinghua Zhang and Serge Steer
- Partner: INRA
- Contact: Frédérique Clément
- URL: <https://team.inria.fr/mycenae/en/software/>

NEUROSYS Project-Team

6. New Software and Platforms

6.1. BrianModel

Library of Brian Neuron Models

KEYWORDS: Spiking neural networks - Neurosciences - Numerical simulations

FUNCTIONAL DESCRIPTION: BrianModel is a library of neuron models and ionic currents for the BRIAN simulator. The purpose of BrianModel is to speed up simulation set-up and reduce code duplication across simulation scripts. Template neurons are defined by the ionic currents that flow through their membrane. Implemented templates include: Hodgkin-Huxley pyramidal neuron, Hodgkin-Huxley pyramidal neuron with CAN receptors, Hodgkin-Huxley fast-spiking inhibitory hippocampal. The current library is easily extensible by third-party users due to its hierarchical design. The template neurons and their currents are defined as YAML files, which are conveniently parsed by a Python library which acts as an interface to the BRIAN simulator API's.

- Contact: Francesco Giovannini
- URL: <https://github.com/JoErNanO/brianmodel>

6.2. OpenViBE

KEYWORDS: Neurosciences - Interaction - Virtual reality - Health - Real time - Neurofeedback - Brain-Computer Interface - EEG - 3D interaction

FUNCTIONAL DESCRIPTION: OpenViBE is a free and open-source software platform devoted to the design, test and use of Brain-Computer Interfaces (BCI). The platform consists of a set of software modules that can be integrated easily and efficiently to design BCI applications. The key features of OpenViBE software are its modularity, its high-performance, its portability, its multiple-users facilities and its connection with high-end/VR displays. The designer of the platform enables to build complete scenarios based on existing software modules using a dedicated graphical language and a simple Graphical User Interface (GUI). This software is available on the Inria Forge under the terms of the AGPL licence, and it was officially released in June 2009. Since then, the OpenViBE software has already been downloaded more than 40000 times, and it is used by numerous laboratories, projects, or individuals worldwide. More information, downloads, tutorials, videos, documentations are available on the OpenViBE website.

- Participants: Cédric Riou, Thierry Gaugry, Anatole Lécuyer, Fabien Lotte, Jussi Tapio Lindgren, Laurent Bougrain, Maureen Clerc Gallagher and Théodore Papadopoulo
- Partners: INSERM - CEA-List - GIPSA-Lab
- Contact: Anatole Lécuyer
- URL: <http://openvibe.inria.fr>

6.3. Platforms

6.3.1. EEG experimental room

A room at Inria Nancy - Grand Est is dedicated to electroencephalographic recordings. An umbrella agreement and several additional experiment descriptions have been approved by the Inria Operational Legal and Ethical Risk Assessment Committee (COERLE). Our Biosemi EEG amplifier has been extended this year to record 128 channels (Regional initiative *Contrat de Projet État Région (CPER) IT2MP* see section 8.1).



Figure 1. Electroencephalographic Experimental room at Inria Nancy-Grand Est

NUMED Project-Team

4. New Software and Platforms

4.1. Bingham flows

FUNCTIONAL DESCRIPTION: A 1D and 2D code with a new method for the computation of viscoplastic flows with free-surface. It essentially couples Optimization methods and Well-Balanced Finite-Volumes schemes for viscous shallow-water equations (induced by the viscoplastic nature of the fluid). Currently applied to avalanches of dense snow, it is a private code currently actively developed (in C++). One of the key feature is that its well-balanced property allows to obtained the stationary states which are linked to the stopping of the snow avalanche for this highly non-linear type of fluid.

- Contact: Emmanuel Grenier

4.2. OptimChemo

FUNCTIONAL DESCRIPTION: OptimChemo is a userfriendly software designed to study numerically the effect of multiple chemotherapies on simple models of tumour growth and to optimize chemotherapy schedules.

- Participants: Ehouarn Maguet, Emmanuel Grenier, Paul Vigneaux and Violaine Louvet
- Contact: Emmanuel Grenier

4.3. SETIS

KEYWORDS: Health - DICOM - Medical imaging - Drug development

FUNCTIONAL DESCRIPTION: SETIS software is a GUI allowing to treat DICOM medical images to extract pathological data. These data can then be exported and used in a SAEM software (including Monolix (Inria & Lixoft)) for the parameters' estimation of models in the context of population approaches. As an example SETIS can be used to segment and compute the tumor size of a patients from MRI scans taken at different times. The software is sufficiently general to be used in various situations by clinicians (already done by colleagues in Lyon Hospital).

- Participants: Ehouarn Maguet and Paul Vigneaux
- Partner: ENS Lyon
- Contact: Paul Vigneaux

4.4. SIMPHYT

KEYWORDS: Bioinformatics - Cancer - Drug development

FUNCTIONAL DESCRIPTION: SimPHYt is an implementation in Python of the low grad glioma model. The aim is to predict the evolution of the glioma size of patients.

- Participant: Benjamin Ribba
- Contact: Benjamin Ribba

4.5. SITLOG

- Participants: Benjamin Ribba and Morgan Martinet
- Contact: Emmanuel Grenier

4.6. VAXSIMSTAB

KEYWORDS: Bioinformatics - Health - Drug development

FUNCTIONAL DESCRIPTION: VAXSIMSTAB is a modeler stability prediction of vaccine software.

- Participants: Benjamin Ribba, Emmanuel Grenier and Vincent Calvez
- Contact: Benjamin Ribba

PARIETAL Project-Team

6. New Software and Platforms

6.1. Mayavi

FUNCTIONAL DESCRIPTION: Mayavi is the most used scientific 3D visualization Python software. Mayavi can be used as a visualization tool, through interactive command line or as a library. It is distributed under Linux through Ubuntu, Debian, Fedora and Mandriva, as well as in PythonXY and EPD Python scientific distributions. Mayavi is used by several software platforms, such as PDE solvers (fipy, sfepy), molecule visualization tools and brain connectivity analysis tools (connectomeViewer).

- Contact: Gaël Varoquaux
- URL: <http://mayavi.sourceforge.net/>

6.2. MedInria

KEYWORDS: Visualization - DWI - Health - Segmentation - Medical imaging

SCIENTIFIC DESCRIPTION: It aims at creating an easily extensible platform for the distribution of research algorithms developed at Inria for medical image processing. This project has been funded by the D2T (ADT MedInria-NT) in 2010, renewed in 2012. A fast-track ADT was awarded in 2017 to transition the software core to more recent dependencies and study the possibility of a consortium creation. The Visages team leads this Inria national project and participates in the development of the common core architecture and features of the software as well as in the development of specific plugins for the team's algorithm.

FUNCTIONAL DESCRIPTION: MedInria is a free software platform dedicated to medical data visualization and processing.

- Participants: Maxime Sermesant, Olivier Commowick and Théodore Papadopoulos
- Partners: HARVARD Medical School - IHU - LIRYC - NIH
- Contact: Olivier Commowick
- URL: <http://med.inria.fr>

6.3. Nilearn

NeuroImaging with scikit learn

KEYWORDS: Health - Neuroimaging - Medical imaging

FUNCTIONAL DESCRIPTION: NiLearn is the neuroimaging library that adapts the concepts and tools of scikit-learn to neuroimaging problems. As a pure Python library, it depends on scikit-learn and nibabel, the main Python library for neuroimaging I/O. It is an open-source project, available under BSD license. The two key components of NiLearn are i) the analysis of functional connectivity (spatial decompositions and covariance learning) and ii) the most common tools for multivariate pattern analysis. A great deal of efforts has been put on the efficiency of the procedures both in terms of memory cost and computation time.

- Participants: Alexandre Abraham, Alexandre Gramfort, Bertrand Thirion, Elvis Dohmatob, Fabian Pedregosa Izquierdo, Gaël Varoquaux, Loïc Estève, Michael Eickenberg and Virgile Fritsch
- Contact: Bertrand Thirion
- URL: <http://nilearn.github.io/>

6.4. PyHRF

KEYWORDS: Health - Brain - IRM - Neurosciences - Statistic analysis - FMRI - Medical imaging

FUNCTIONAL DESCRIPTION: As part of fMRI data analysis, PyHRF provides a set of tools for addressing the two main issues involved in intra-subject fMRI data analysis : (i) the localization of cerebral regions that elicit evoked activity and (ii) the estimation of the activation dynamics also referenced to as the recovery of the Hemodynamic Response Function (HRF). To tackle these two problems, PyHRF implements the Joint Detection-Estimation framework (JDE) which recovers parcel-level HRFs and embeds an adaptive spatio-temporal regularization scheme of activation maps.

- Participants: Aina Frau Pascual, Christine Bakhous, Florence Forbes, Jaime Eduardo Arias Almeida, Laurent Risser, Lotfi Chaari, Philippe Ciuciu, Solveig Badillo, Thomas Perret and Thomas Vincent
- Partners: CEA - NeuroSpin
- Contact: Florence Forbes
- URL: <http://pyhrf.org>

6.5. Scikit-learn

KEYWORDS: Regression - Clustering - Learning - Classification - Medical imaging

SCIENTIFIC DESCRIPTION: Scikit-learn is a Python module integrating classic machine learning algorithms in the tightly-knit scientific Python world. It aims to provide simple and efficient solutions to learning problems, accessible to everybody and reusable in various contexts: machine-learning as a versatile tool for science and engineering.

FUNCTIONAL DESCRIPTION: Scikit-learn can be used as a middleware for prediction tasks. For example, many web startups adapt Scikitlearn to predict buying behavior of users, provide product recommendations, detect trends or abusive behavior (fraud, spam). Scikit-learn is used to extract the structure of complex data (text, images) and classify such data with techniques relevant to the state of the art.

Easy to use, efficient and accessible to non datascience experts, Scikit-learn is an increasingly popular machine learning library in Python. In a data exploration step, the user can enter a few lines on an interactive (but non-graphical) interface and immediately sees the results of his request. Scikitlearn is a prediction engine . Scikit-learn is developed in open source, and available under the BSD license.

- Participants: Alexandre Gramfort, Bertrand Thirion, Fabian Pedregosa Izquierdo, Gaël Varoquaux, Loïc Estève, Michael Eickenberg and Olivier Grisel
- Partners: CEA - Logilab - Nuxeo - Saint Gobain - Tinyclues - Telecom Paris
- Contact: Olivier Grisel
- URL: <http://scikit-learn.org>

6.6. MODL

Massive Online Dictionary Learning

KEYWORDS: Pattern discovery - Machine learning

FUNCTIONAL DESCRIPTION: Matrix factorization library, usable on very large datasets, with optional sparse and positive factors.

- Participants: Arthur Mensch, Gaël Varoquaux, Bertrand Thirion and Julien Mairal
- Contact: Arthur Mensch
- Publications: [Subsampled online matrix factorization with convergence guarantees](#) - [Stochastic Subsampling for Factorizing Huge Matrices](#)
- URL: <http://github.com/arthurmensch/modl>

6.7. MNE

MNE-Python

KEYWORDS: Neurosciences - EEG - MEG - Signal processing - Machine learning

FUNCTIONAL DESCRIPTION: Open-source Python software for exploring, visualizing, and analyzing human neurophysiological data: MEG, EEG, sEEG, ECoG, and more.

- Contact: Alexandre Gramfort
- URL: <http://martinos.org/mne/>

PLEIADE Team

5. New Software and Platforms

5.1. Magus

KEYWORDS: Bioinformatics - Genomic sequence - Knowledge database

SCIENTIFIC DESCRIPTION: MAGUS can be used on small installations with a web server and a relational database on a single machine, or scaled out in clusters or elastic clouds using Apache Cassandra for NoSQL data storage and Apache Hadoop for Map-Reduce.

FUNCTIONAL DESCRIPTION: The MAGUS genome annotation system integrates genome sequences and sequences features, in silico analyses, and views of external data resources into a familiar user interface requiring only a Web navigator. MAGUS implements annotation workflows and enforces curation standards to guarantee consistency and integrity. As a novel feature the system provides a workflow for simultaneous annotation of related genomes through the use of protein families identified by in silico analyses this has resulted in a three-fold increase in curation speed, compared to one-at-a-time curation of individual genes. This allows us to maintain standards of high-quality manual annotation while efficiently using the time of volunteer curators.

NEWS OF THE YEAR: Magus is now available as a Docker image, and can be integrated with other containerized services using Pleiade's Alcyon system.

- Participants: David Sherman, Florian Lajus, Natalia Golenetskaya, Pascal Durrens and Xavier Calcas
- Partners: Université de Bordeaux - CNRS - INRA
- Contact: David James Sherman
- Publication: [High-performance comparative annotation](#)
- URL: <http://magus.gforge.inria.fr>

5.2. Pantograph

KEYWORDS: Systems Biology - Bioinformatics - Genomics - Gene regulatory networks

SCIENTIFIC DESCRIPTION: Pantograph requires a template model in SMBL format, where every reaction is annotated with a gene association that describes its gene-protein-reaction dependencies as a boolean formula over the genes of the organism.

Pantograph uses a consensus procedure to infer relationships between metabolic models, based on several sources of orthology between genomes. These inter-genome relations are used to rewrite the gene associations. Every successful rewrite is used as evidence that the corresponding reaction should be present in the inferred model.

The resulting models can be validated with respect to phenotypic information obtained from experimental results.

FUNCTIONAL DESCRIPTION: Pantograph is a software toolbox to reconstruct, curate and validate genome-scale metabolic models. It uses existing metabolic models as templates, to start a reconstructions process in which new, species-specific reactions are added. Pantograph uses an iterative approach to improve reconstructed models, facilitating manual curation and comparisons between reconstructed model's predictions and experimental evidence.

Pantograph uses a consensus procedure to infer relationships between metabolic models, based on several sources of orthology between genomes. This allows for a very detailed rewriting of reaction's genome associations between template models and the model you want to reconstruct.

NEWS OF THE YEAR: Work is in progress to integrate Razanne Issa's Ab-Pantograph modules into Pantograph. Ab-Pantograph uses abductive logic to invert the inference process: a reaction explains the presence of the genes in its gene-protein-reaction formula, rather than the genes justify the reaction. Ab-Pantograph is driven by the goal of explaining all of the genes in the target organism.

- Participants: Anna Zhukova, David James Sherman, Nicolas Loira and Pascal Durrens
- Partner: University of Chile
- Contact: Nicolas Loira
- Publication: **Pantograph: A template-based method for genome-scale metabolic model reconstruction**
- URL: <http://pathtastic.gforge.inria.fr/>

5.3. Mimoza

KEYWORDS: Systems Biology - Bioinformatics - Biotechnology

FUNCTIONAL DESCRIPTION: Mimoza uses metabolic model generalization and cartographic paradigms to allow human experts to explore a metabolic model in a hierarchical manner. Mimoza generalizes genome-scale metabolic models, by factoring equivalent reactions and metabolites while preserving reaction consistency. The software creates a zoomable representation of a model submitted by the user in SBML format. The most general view represents the compartments of the model, the next view shows the visualization of generalized versions of reactions and metabolites in each compartment, and the most detailed view visualizes the initial model with the generalization-based layout (where similar metabolites and reactions are placed next to each other). The resulting map can be explored on-line, or downloaded in a COMBINE archive. The zoomable representation is implemented using the Leaflet JavaScript library for mobile-friendly interactive maps. Users can click on reactions and compounds to see the information about their annotations.

NEWS OF THE YEAR: Mimoza is now available as a Docker image, and can be integrated with other containerized services using Pleiade's Alcyon system.

- Participants: Anna Zhukova and David James Sherman
- Contact: David James Sherman
- Publications: **Knowledge-based generalization of metabolic models - Knowledge-based zooming for metabolic models - Knowledge-based generalization of metabolic networks: a practical study**
- URL: <http://mimoza.bordeaux.inria.fr/>

5.4. Declic

FUNCTIONAL DESCRIPTION: Declic is a Python library that provides several tools for data analysis in the domains of multivariate data analysis, machine learning, and graph based methods. It can be used to study in-depth the accuracy of the dictionary between molecular based and morphological based taxonomy.

Declic includes an interpreter for a Domain Specific Language (DSL) to make its Python library easy to use for scientists familiar with environments such as R.

- Partner: INRA
- Contact: Alain Franc

5.5. Diagno-Syst

diagno-syst: a tool for accurate inventories in metabarcoding

KEYWORDS: Biodiversity - Clustering - Ecology

FUNCTIONAL DESCRIPTION: Diagno-syst builds accurate inventories for biodiversity. It performs supervised clustering of reads obtained from a next-generation sequencing experiment, mapping onto an existing reference database, and assignment of taxonomic annotations.

- Participants: Alain Franc, Jean-Marc Frigerio, Philippe Chaumeil and Franck Salin
- Partner: INRA
- Contact: Alain Franc
- Publication: [diagno-syst: a tool for accurate inventories in metabarcoding](#)

5.6. Alcyone

Alcyone instantiates bioinformatics environments from specifications committed to a Git repository

KEYWORDS: Docker - Orchestration - Bioinformatics - Microservices - Versioning

SCIENTIFIC DESCRIPTION: Alcyone conceives the user's computing environment as a microservices architecture, where each bioinformatics tool in the specification is a separate containerized Docker service. Alcyone builds a master container for the specified environment that is responsible for building, updating, deploying and stopping these containers, as well as recording and sharing the environment in a Git repository. The master container can be manipulated using a command-line interface.

FUNCTIONAL DESCRIPTION: Alcyone defines a file structure for the specifying bioinformatics analysis environments, including tool choice, interoperability, and sources of raw data. These specifications are recorded in a Git repository. Alcyone compiles a specification into a master Docker container that deploys and orchestrates containers for each of the component tools. Alcyone can restore any version of an environment recorded in the Git repository.

NEWS OF THE YEAR: Alcyone was designed and implemented this year.

- Participants: Louise-Amelie Schmitt and David Sherman
- Contact: David Sherman
- URL: <https://team.inria.fr/pleiade/alcyone/>

REO Project-Team

6. New Software and Platforms

6.1. FELiScE

Finite Elements for Life Sciences and Engineering problems

KEYWORDS: Finite element modelling - Cardiac Electrophysiology - Cardiovascular and respiratory systems

FUNCTIONAL DESCRIPTION: FELiScE is a finite element code which the M3DISIM and REO project-teams have decided to jointly develop in order to build up on their respective experiences concerning finite element simulations. One specific objective of this code is to provide in a unified software environment all the state-of-the-art tools needed to perform simulations of the complex respiratory and cardiovascular models considered in the two teams – namely involving fluid and solid mechanics, electrophysiology, and the various associated coupling phenomena. FELiScE is written in C++, and may be later released as an opensource library. FELiScE was registered in July 2014 at the Agence pour la Protection des Programmes under the Inter Deposit Digital Number IDD.N.FR.001.350015.000.S.P.2014.000.10000.

- Participants: Axel Fourmont, Benoit Fabreges, Damiano Lombardi, Dominique Chapelle, Faisal Amlani, Irène Vignon-Clementel, Jean-Frédéric Gerbeau, Marina Vidrascu, Matteo Aletti, Miguel Angel Fernandez Varela, Mikel Landajuela Larma, Philippe Moireau and Sébastien Gilles
- Contact: Jean-Frédéric Gerbeau
- URL: <http://felisce.gforge.inria.fr>

6.2. MODULEF

FUNCTIONAL DESCRIPTION: The numerical method to approximate the constitutive laws for rubber elasticity derived from polymer physics are implemented in the Inria software Modulef.

It is based on : - algorithms from stochastic geometry to generate suitable polymer networks, - Delaunay tessellation algorithms to deal with steric effects (courtesy of the Inria project-team GAMMA2), - the introduction of 1-dimensional finite elements for the polymer-chains in Modulef.

- Participants: Antoine Gloria and Marina Vidrascu
- Contact: Marina Vidrascu
- URL: <https://www.rocq.inria.fr/modulef/>

6.3. SHELDDON

SHELLs and structural Dynamics with DOnain decomposition in Nonlinear analysis

FUNCTIONAL DESCRIPTION: SHELDDON is a finite element library based on the Modulef package which contains shell elements, nonlinear procedures and PVM subroutines used in domain decomposition or coupling methods, in particular fluid-structure interaction.

- Participants: Dominique Chapelle, Marina Vidrascu and Patrick Le Tallec
- Contact: Marina Vidrascu
- URL: <https://gforge.inria.fr/projects/shelldon/>

SERENA Project-Team

6. New Software and Platforms

6.1. GEOFRAC

GEOFRACFLOW

KEYWORDS: Hydrogeology - Numerical simulations - 3D

SCIENTIFIC DESCRIPTION: GEOFRACFLOW is a Matlab software for the simulation of steady state single phase flow in Discrete Fracture Networks (DFNs) using the Mixed Hybrid Finite Element (MHFEM) method for conforming and non conforming discretizations.

FUNCTIONAL DESCRIPTION: The software GEOFRACFLOW solves the problem of an incompressible fluid flowing through a network of fractures. The software is interfaced with different mesh generators, among which BLSURF from the GAMMA3 team. A mixed hybrid finite element method is implemented.

RELEASE FUNCTIONAL DESCRIPTION: The last version includes optimisations of the code, mainly with an efficient upload of the mesh data generated with BLSURF and vectorization of the operations.

- Participants: Géraldine Pichot, Jean-Raynald De Dreuzy and Jocelyne Erhel
- Contact: Géraldine Pichot
- Publication: [A mixed hybrid Mortar method for solving flow in discrete fracture networks](#)

6.2. Ref-indic

Refinement indicators

KEYWORD: Inverse problem

SCIENTIFIC DESCRIPTION: The refinement indicator algorithm is suited for the estimation of a distributed parameter occurring in a mathematical simulation model, typically a set of partial differential equations. When the numerical simulation model must be solved on a fine grid, the refinement indicator algorithm provides an adaptive parameterization of the sought parameter that avoids overparameterization difficulties. In each grid cell, the estimated parameter may be of dimension greater than one, i.e. the algorithm is able to estimate several scalar distributed parameters.

Ref-indic implements a generic version of the refinement indicator algorithm that can dock specific programs provided they conform to the generic algorithm API.

The API of Ref-indic requires four main functionalities (called tasks) for the user specific program, it must be able: * to initialize, i.e. to open all necessary data files, to perform all necessary preliminary computation, and to return an initial coarse parameterization (giving a zone number between 0 and the initial number of zones minus one for each cell of the fine grid), * to compute the gradient on the fine grid for a given fine parameterization, * to optimize the problem for a given coarse parameterization, * and to finalize, i.e. to store the resulting coarse parameterization.

Given any such user specific program, the inversion platform automatically provides a program that solves the corresponding user inverse problem using the refinement indicator algorithm.

FUNCTIONAL DESCRIPTION: Ref-indic is an adaptive parameterization platform using refinement indicators. Slogan is “invert details only where they are worth it”. Ref-indic implements a generic version of the refinement indicator algorithm that can dock specific programs provided they conform to the generic algorithm API.

NEWS OF THE YEAR: In its current implementation, the inversion platform can only build coarse parameterizations for a distributed parameter defined on a fine rectangular grid. From version 1.5+pl0, the user has the possibility to specify masked cells in the fine rectangular grid that will be ignored by the algorithm (with the use of the specific zone number -1 in the initial coarse parameterization). This allows for the treatment of inverse problems defined on unstructured meshes. The handling of both-way interpolations must be taken care of by the gradient computation and optimization tasks. The masked cells must be the same for all components of the parameter.

- Contact: François Clément
- Publications: [Image Segmentation with Multidimensional Refinement Indicators](#) - [The Multidimensional Refinement Indicators Algorithm for Optimal Parameterization](#)
- URL: <http://refinement.inria.fr/ref-indic/>

6.3. Sklml

The OCaml parallel skeleton system

KEYWORDS: Parallel programming - Functional programming

SCIENTIFIC DESCRIPTION: Writing parallel programs is not easy, and debugging them is usually a nightmare. To cope with these difficulties, the skeleton programming approach uses a set of predefined patterns for parallel computations. The skeletons are higher order functional templates that describe the program underlying parallelism.

Sklml is a new framework for parallel programming that embeds an innovative compositional skeleton algebra into the OCaml language. Thanks to its skeleton algebra, Sklml provides two evaluation regimes to programs: a regular sequential evaluation (merely used for prototyping and debugging) and a parallel evaluation obtained via a recompilation of the same source program in parallel mode.

Sklml was specifically designed to prove that the sequential and parallel evaluation regimes coincide.

FUNCTIONAL DESCRIPTION: Sklml is a functional parallel skeleton compiler and programming system for OCaml programs. Slogan is “easy coarse grain parallelization”.

NEWS OF THE YEAR: Caml preprocessors are no longer needed.

- Participants: François Clément and Pierre Weis
- Contact: François Clément
- URL: <http://sklml.inria.fr>

6.4. GENFIELD

KEYWORDS: Hydrogeology - Algorithm - Heterogeneity

FUNCTIONAL DESCRIPTION: GENFIELD allows the generation of gaussian correlated fields. It is based on the circulant embedding method. Parallelism is implemented using MPI communications. GENFIELD is used in hydrogeology to model natural fields, like hydraulic conductivity or porosity fields.

RELEASE FUNCTIONAL DESCRIPTION: The new version includes: - The use of the FFTW3-mpi library for discrete Fourier transform - Non regression tests (and continuous integration through gitlab.inria.fr) - Debugging of the parallel algorithm

- Participants: Géraldine Pichot, Simon Legrand, Grégoire Lecourt, Jean-Raynald De Dreuzy and Jocelyne Erhel
- Contact: Géraldine Pichot
- Publication: [Algorithms for Gaussian random field generation](#)
- URL: https://gitlab.inria.fr/slegrand/Genfield_dev

6.5. DiSk++

KEYWORDS: High order methods - Polyhedral meshes - C++

SCIENTIFIC DESCRIPTION: Discontinuous Skeletal methods approximate the solution of boundary-value problems by attaching discrete unknowns to mesh faces (hence the term skeletal) while allowing these discrete unknowns to be chosen independently on each mesh face (hence the term discontinuous). Cell-based unknowns, which can be eliminated locally by a Schur complement technique (also known as static condensation), are also used in the formulation. Salient examples of high-order Discontinuous Skeletal methods are Hybridizable Discontinuous Galerkin methods and the recently-devised Hybrid High-Order methods. Some major benefits of Discontinuous Skeletal methods are that their construction is dimension-independent and that they offer the possibility to use general meshes with polytopal cells and non-matching interfaces. The mathematical flexibility of Discontinuous Skeletal methods can be efficiently replicated in a numerical software: by using generic programming, the DiSk++ library offers an environment to allow a programmer to code mathematical problems in a way completely decoupled from the mesh dimension and the cell shape.

FUNCTIONAL DESCRIPTION: The software provides a numerical core to discretize partial differential equations arising from the engineering sciences (mechanical, thermal, diffusion). The discretization is based on the "Hybrid high-order" or "Discontinuous Skeletal" methods, which use as principal unknowns polynomials of arbitrary degree on each face of the mesh. An important feature of these methods is that they make it possible to treat general meshes composed of polyhedral cells. The DiSk ++ library, using generic programming techniques, makes it possible to write a code for a mathematical problem independently of the mesh. When a user writes the code for his problem using the basic operations offered by DiSk ++, that code can be executed without modifications on all types of mesh already supported by the library and those that will be added in the future.

- Author: Matteo Cicuttin
- Partner: CERMICS
- Contact: Matteo Cicuttin
- Publication: [Implementation of Discontinuous Skeletal methods on arbitrary-dimensional, polytopal meshes using generic programming](#)
- URL: <https://github.com/datafl4sh/diskpp>

6.6. CELIA3D

KEYWORDS: Fluid mechanics - Multi-physics simulation

FUNCTIONAL DESCRIPTION: The CELIA3D code simulates the coupling between a compressible fluid flow and a deformable structure. The fluid is handled by a Finite Volume method on a structured Cartesian grid. The solid is handled by a Discrete Element method (Mka3d scheme). The solid overlaps the fluid grid and the coupling is carried out with immersed boundaries (cut cells) in a conservative way.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/CELIA3D/>

6.7. Mka3d

KEYWORDS: Scientific computing - Elasticity - Elastodynamic equations

FUNCTIONAL DESCRIPTION: The Mka3d method simulates an elastic solid by discretizing the solid into rigid particles. An adequate choice of forces and torques between particles allows to recover the equations of elastodynamics.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/Mka3D/>

SERPICO Project-Team

6. New Software and Platforms

6.1. ATLAS

KEYWORDS: Image segmentation - Object detection - Photonic imaging - Image analysis - Fluorescence microscopy

FUNCTIONAL DESCRIPTION: The ATLAS software enables to detect spots in 2D fluorescence images. The spot size is automatically selected and the detection threshold adapts to the local image contrasts. ATLAS relies on the Laplacian of Gaussian (LoG) filter, which both reduces noise and enhances spots. A multiscale representation of the image is built to automatically select the optimal LoG variance. Local statistics of the LoG image are estimated in a Gaussian window, and the detection threshold is pointwise inferred from a probability of false alarm (PFA). The user only has to specify: i/ size of the Gaussian window, ii/ PFA value. The Gaussian window must be about the size of the background structures, increasing the PFA increases the number of detections.

- Participants: Patrick Bouthemy, Charles Kervrann, Jean Salamero, Jérôme Boulanger and Antoine Basset
- Partner: UMR 144 CNRS - Institut Curie
- Contact: Patrick Bouthemy
- Publication: [Adaptive spot detection with optimal scale selection in fluorescence microscopy images](#)
- URL: <http://mobyly-serpico.rennes.inria.fr/cgi-bin/portal.py#forms::ATLAS>

6.2. C-CRAFT

KEYWORDS: Fluorescence microscopy - Photonic imaging - Image analysis - Detection - 3D - Health - Biology - Segmentation

FUNCTIONAL DESCRIPTION: The C-CRAFT software enables to jointly segment small particles and estimate background in 2D or 3D fluorescence microscopy image sequences. The vesicle segmentation and background estimation problem is formulated as a global energy minimization problem in the Conditional Random Field framework. A patch-based image representation is used to detect spatial irregularity in the image. An iterative scheme based on graph-cut algorithm is proposed for energy minimization.

- Participants: Patrick Bouthemy, Jean Salamero, Charles Kervrann and Thierry Pécot
- Partner: UMR 144 CNRS - Institut Curie
- Contact: Charles Kervrann
- Publication: [Background Fluorescence Estimation and Vesicle Segmentation in Live Cell Imaging with Conditional Random Fields](#)
- URL: <http://mobyly-serpico.rennes.inria.fr/cgi-bin/portal.py#forms::C-CRAFT>

6.3. F2D-SAFIR

KEYWORDS: Biomedical imaging - Photonic imaging - Fluorescence microscopy - Image processing

FUNCTIONAL DESCRIPTION: The F2D-SAFIR software removes mixed Gaussian-Poisson noise in large 2D images, typically 10000 x 10000 pixels, in a few seconds. The method is unsupervised and is a simplified version of the method related to the ND-SAFIR software. The software is dedicated to microarrays image denoising for disease diagnosis and multiple applications (gene expression, genotyping, aCGH, ChIP-chip, microRNA, ...).

- Participant: Charles Kervrann
- Partner: INRA
- Contact: Charles Kervrann

6.4. GcoPS

KEYWORDS: Photonic imaging - Fluorescence microscopy - Image processing - Statistic analysis

FUNCTIONAL DESCRIPTION: The GCOPS (Geo-Co-Positioning System) software is dedicated to the co-localization of fluorescence image pairs for both conventional and super-resolution microscopy. The procedure is only controlled by a p-value and tests whether the Pearson correlation between two binary images is significantly positive. It amounts to quantifying the interaction strength by the area/volume of the intersection between the two binary images viewed as random distributions of geometrical objects. Under mild assumptions, it turns out that the appropriately normalized Pearson correlation follows a standard normal distribution under the null hypothesis if the number of image pixels is large. Unlike previous methods, GcoPS handles 2D and 3D images, variable SNRs and any kind of cell shapes. It is able to co-localize large regions with small dots, as it is the case in TIRF-PALM experiments and to detect negative co-localization. The typical processing time is two milliseconds per image pair in 2D and a few seconds in 3D, with no dependence on the number of objects per image. In addition, the method provides maps to geo-co-localize molecule interactions in specific image regions.

- Participants: Frédéric Lavancier, Thierry Pécot and Liu Zengzhen
- Partners: Université de Nantes - UMR 144 CNRS - Institut Curie
- Contact: Charles Kervrann
- Publication: [A Fast Automatic Colocalization Method for 3D Live Cell and Super-Resolution Microscopy](#)
- URL: <http://icy.bioimageanalysis.org/plugin/GcoPS>

6.5. Hullkground

KEYWORDS: Biomedical imaging - Photonic imaging - Fluorescence microscopy - Image processing

FUNCTIONAL DESCRIPTION: The HullkGround software decomposes a fluorescence microscopy image sequence into two dynamic components: i) an image sequence showing mobile objects, ii) an image sequence showing the slightly moving background. Each temporal signal of the sequence is processed individually and analyzed with computational geometry tools. The convex hull is estimated automatically for each pixel and subtracted to the original signal. The method is unsupervised, requires no parameter tuning and is a simplified version of the shapes-based scale-space method.

- Participants: Anatole Chessel, Charles Kervrann and Jean Salamero
- Partner: UMR 144 CNRS - Institut Curie
- Contact: Charles Kervrann
- URL: <http://mobyte-serpico.rennes.inria.fr/cgi-bin/portal.py#forms::Hullkground>

6.6. Motion2D

KEYWORDS: Image sequence - Motion model - 2D

FUNCTIONAL DESCRIPTION: The Motion2D software is a multi-platform object-oriented library to estimate 2D parametric motion models in an image sequence. It can handle several types of motion models, namely, constant (translation), affine, and quadratic models. Moreover, it includes the possibility of accounting for a global variation of illumination and more recently for temporal image intensity decay (e.g. due to photobleaching decay in fluorescence microscopy). The use of such motion models has been proved adequate and efficient for solving problems such as optic flow computation, motion segmentation, detection of independent moving objects, object tracking, or camera motion estimation, and in numerous application domains (video surveillance, visual servoing for robots, video coding, video indexing), including biological imaging (image stack registration, motion compensation in videomicroscopy). Motion2D is an extended and optimized implementation of the robust, multi-resolution and incremental estimation method (exploiting only the spatio-temporal derivatives of the image intensity function). Real-time processing is achievable for motion models involving up to six parameters. Motion2D can be applied to the entire image or to any pre-defined window or region in the image.

RELEASE FUNCTIONAL DESCRIPTION: Modifications and improvements in the PNG image file support. Support RAW and Mpeg2 video format as input (see CReader). The available video format which can be handled by the motion estimator are given by CReader::EReaderFormat. For the results, video sequences can be written using the format specified by CWriter::EWriterFormat. Support Fedora 3 (g++ 3.4.2).

- Participants: Charles Kervrann, Fabien Spindler, Jean Marc Odobez, Patrick Bouthemy and Thierry Pécot
- Contact: Patrick Bouthemy
- URL: <http://www.irisa.fr/vista/Motion2D/>

6.7. ND-SAFIR

KEYWORDS: Fluorescence microscopy - Photonic imaging - Image analysis - Health - Biomedical imaging

SCIENTIFIC DESCRIPTION: ND-SAFIR is a software for denoising n-dimensionnal images especially dedicated to microscopy image sequence analysis. It is able to deal with 2D, 3D, 2D+time, 3D+time images have one or more color channel. It is adapted to Gaussian and Poisson-Gaussian noise which are usually encountered in photonic imaging. Several papers describe the detail of the method used in ndsafir to recover noise free images (see references).

- Participants: Charles Kervrann, Patrick Bouthemy, Jean Salamero and Jérôme Boulanger
- Partners: INRA - PiCT - UMR 144 CNRS - Institut Curie
- Contact: Charles Kervrann
- URL: <http://serpico.rennes.inria.fr/doku.php?id=software:nd-safir:index>

6.8. OWF

KEYWORDS: Image filter - Image processing - Statistics

FUNCTIONAL DESCRIPTION: The OWF software enables to denoise images corrupted by additive white Gaussian noise. In the line of work of the Non-Local means and ND-SAFIR algorithms, this adaptive estimator is based on the weighted average of observations taken in a neighborhood with weights depending on the similarity of local patches. The idea is to compute adaptive weights that best minimize an upper bound of the pointwise L2 risk. The spatially varying smoothing parameter is automatically adjusted to the image context. The proposed algorithm is fast and easy to control and is competitive when compared to the more sophisticated NL-means filters.

- Participants: Ion Grama, Quansheng Liu and Qiyu Jin
- Partner: University of Bretagne-Sud
- Contact: Charles Kervrann
- Publication: [Non-local means and optimal weights for noise removal](#)
- URL: <http://serpico.rennes.inria.fr/doku.php?id=software:owf>

6.9. QuantEv

KEYWORDS: Photonic imaging - Fluorescence microscopy - Biomedical imaging - Image analysis - Image sequence - Statistic analysis

FUNCTIONAL DESCRIPTION: The QUANTEV software analyzes the spatial distribution of intracellular events represented by any static or dynamical descriptor, provided that the descriptors are associated with spatial coordinates. QUANTEV first computes 3D histograms of descriptors in a cylindrical coordinate system with computational cell shape normalization, enabling comparisons between cells of different shape. Densities are obtained via adaptive kernel density estimation, and we use the Circular Earth Mover's Distance to measure the dissimilarity between densities associated to different experimental conditions. A statistical analysis on these distances reliably takes into account the biological variability over replicated experiments.

- Participants: Jean Salamero, Jérôme Boulanger and Liu Zengzhen
- Partner: UMR 144 CNRS - Institut Curie
- Contact: Charles Kervrann
- Publication: [QuantEv: quantifying the spatial distribution of intracellular events](#)
- URL: <http://mobyale-serpico.rennes.inria.fr/cgi-bin/portal.py#forms::QuantEv-Densities>

6.10. TMA-Lib

KEYWORDS: Photonic imaging - Fluorescence microscopy - Biomedical imaging - Image processing

FUNCTIONAL DESCRIPTION: The TMA-LIB enables to jointly detect using adaptive wavelet transform, segment with parametric active contours and restore (i.e., artifact correction and deconvolution) TMA (Tissue MicroArrays) images.

- Participants: Cyril Cauchois, Vincent Paveau and Hoai Nam Nguyen
- Partner: Innopsys
- Contact: Charles Kervrann
- Publications: [A variational method for dejittering large fluorescence line scanner images](#) - [Generalized Sparse Variation Regularization for Large Fluorescence Image Deconvolution](#) - [ATMAD : robust image analysis for Automatic Tissue MicroArray De-arraying](#)

6.11. TOTH

KEYWORDS: Photonic imaging - Fluorescence microscopy - Biomedical imaging - Classification - Statistical categorisation techniques - Statistics - Image sequence - Visual tracking

FUNCTIONAL DESCRIPTION: The TOTH software classifies trajectories of biomolecules computed with tracking algorithms. Trajectories in living cells are generally modelled with three types of diffusion processes: (i) free diffusion, (ii) subdiffusion or (iii) superdiffusion. We used a test approach with the Brownian motion as the null hypothesis, and developed a non-parametric three-decision test whose alternatives are subdiffusion and superdiffusion. First, we built a single test procedure for testing a single trajectory. Second, we proposed a multiple test procedure for testing a collection of trajectories. These procedures control respectively the type I error and the false discovery rate. Our approach can be considered as an alternative to the Mean Square Displacement (MSD) method commonly used to address this issue. It gives more reliable results as confirmed by our Monte Carlo simulations and evaluations on real sequences of images depicting protein dynamics acquired with TIRF or SPT-PALM microscopy.

- Participants: Vincent Briane and Myriam Vimond
- Partner: ENSAI
- Contact: Charles Kervrann
- Publication: [A Statistical Analysis of Particle Trajectories in Living Cells](#)
- URL: <http://serpico.rennes.inria.fr/doku.php?id=software:thot:index>

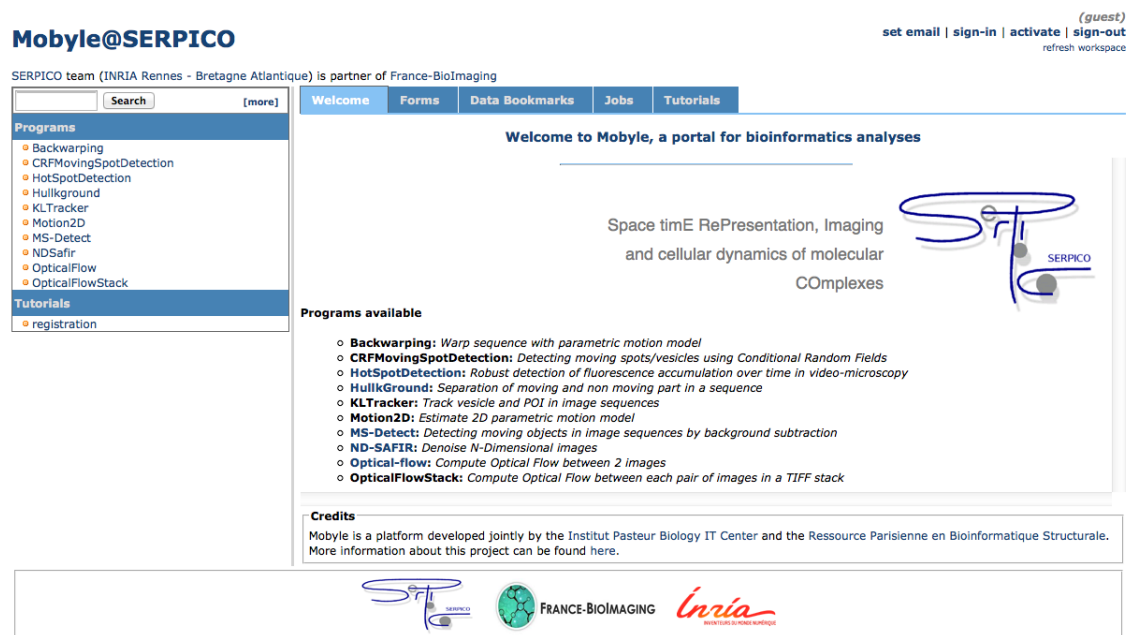


Figure 2. Mobyle@SERPICO web portal.

6.12. Platforms

6.12.1. Mobyle@Serpico platform and software distribution

The objective is to disseminate the distribution of SERPICO image processing software in the community of cell biology and cell imaging.

Free binaries: software packages have been compiled for the main operating systems (Linux, MacOS, Windows) using CMake (see <http://www.cmake.org/>). They are freely available on the team website under a proprietary license (e.g. ND-SAFIR and HULLKGROUND are distributed this way at <http://serpico.rennes.inria.fr/doku.php?id=software:index>).

Mobyle@Serpico web portal: An on-line version (<http://mobyle-serpico.rennes.inria.fr>) of the image processing algorithms has been developed using the Mobyle framework (Institut Pasteur, see <http://mobyle.pasteur.fr/>). The main role of this web portal (see Fig. 2) is to demonstrate the performance of the programs developed by the team: QUANTEV, C-CRAFT[14], ATLAS[1], HULLKGROUND[40], KLTRACKER[44], MOTION2D[43], MS-DETECT[41], ND-SAFIR[6], OPTICALFLOW and FLUX ESTIMATION [14]. The web interface makes our image processing methods available for biologists at Mobyle@SERPICO (<http://mobyle-serpico.rennes.inria.fr/cgi-bin/portal.py#welcome>) without any installation or configuration on their own. The size of submitted images is limited to 200 MegaBytes per user and all the results are kept 15 days. The web portal and calculations run on a server with 2 CPU x 8 cores, 64 GigaBytes of RAM (500 MegaBytes for each user / Data is saved for 3 months).

ImageJ plugins: IMAGEJ (see <http://rsb.info.nih.gov/ij/>) is a widely used image visualization and analysis software for biologist users. We have developed IMAGEJ plug-in JAVA versions of the following software: ND-SAFIR [6], HULLKGROUND [40], MOTION2D [43], ATLAS [1]. The C-CRAFT algorithm [14] has been developed for the image processing ICY platform (<http://icy.bioimageanalysis.org/>).

- **Contact:** Charles Kervrann, Charles Deltel (Inria Rennes SED).
- **Partner:** UMR 144 CNRS-Institut Curie and France-BioImaging.

6.12.2. IGRIDA-Serpico cluster

The IGRIDA-Serpico cluster of 200 nodes is opened for end-users for large scale computing and data sets processing (200 TeraBytes).

- **Batch Scheduler:** OAR
- **File management:** Puppet / Git / Capistrano
- **OS:** Linux Debian 7
- **User connexion:** public ssh key
- **Contact:** Charles Kervrann, Charles Deltel (Inria Rennes SED).

SISTM Project-Team

6. New Software and Platforms

6.1. marqLevAlg

KEYWORDS: Optimization - Biostatistics

FUNCTIONAL DESCRIPTION: An R package for function optimization. Available on CRAN, this package performs a minimization of function based on the Marquardt-Levenberg algorithm. This package is really useful when the surface to optimize is non-strictly convex or far from a quadratic function. A new convergence criterion, the relative distance to maximum (RDM), allows the user to have a better confidence in the stopping points, other than basic algorithm stabilization.

- Contact: Melanie Prague
- URL: <https://cran.r-project.org/web/packages/marqLevAlg/index.html>

6.2. VSURF

Variable Selection Using Random Forests

KEYWORDS: Classification - Statistics - Machine learning - Regression

FUNCTIONAL DESCRIPTION: An R package for Variable Selection Using Random Forests. Available on CRAN, this package performs an automatic (meaning completely data-driven) variable selection procedure. Originally designed to deal with high dimensional data, it can also be applied to standard datasets.

- Contact: Robin Genuer
- URL: <https://github.com/robingenuer/VSURF>

6.3. NPflow

Bayesian Nonparametrics for Automatic Gating of Flow-Cytometry Data

KEYWORDS: Bayesian estimation - Bioinformatics - Biostatistics

FUNCTIONAL DESCRIPTION: Dirichlet process mixture of multivariate normal, skew normal or skew t-distributions modeling oriented towards flow-cytometry data pre-processing applications.

- Contact: Boris Hejblum
- URL: <https://cran.r-project.org/web/packages/NPflow/>

6.4. COVVSURF

Combination of Clustering Of Variables and Variable Selection Using Random Forests

KEYWORDS: Classification - Statistics - Cluster - Machine learning - Regression

- Contact: Robin Genuer
- URL: <https://github.com/robingenuer/CoVVSURF>

6.5. clogitLasso

KEYWORDS: Biostatistics - Bioinformatics - Machine learning - Regression

FUNCTIONAL DESCRIPTION: R package to fit a sequence of conditional logistic regression models with lasso, for small to large sized samples.

- Partner: DRUGS-SAFE
- Contact: Marta Avalos Fernandez
- URL: <https://cran.r-project.org/web/packages/clogitLasso/index.html>

6.6. TcGSA

Time-course Gene Set Analysis

KEYWORDS: Bioinformatics - Genomics

FUNCTIONAL DESCRIPTION: An R package for the gene set analysis of longitudinal gene expression data sets. This package implements a Time-course Gene Set Analysis method and provides useful plotting functions facilitating the interpretation of the results.

- Contact: Boris Hejblum
- URL: <https://cran.r-project.org/web/packages/TcGSA/index.html>

6.7. NIMROD

Normal approximation Inference in Models with Random effects based on Ordinary Differential equations

KEYWORDS: Ordinary differential equations - Statistical modeling

FUNCTIONAL DESCRIPTION: We have written a specific program called NIMROD for estimating parameter of ODE based population models.

- Contact: Melanie Prague
- URL: <http://etudes.isped.u-bordeaux2.fr/BIOSTATISTIQUE/NIMROD/documentation/html/index.html>

6.8. tcgsaseq

Time-Course Gene Set Analysis for RNA-Seq Data

KEYWORDS: Genomics - Biostatistics - Statistical modeling - RNA-seq - Gene Set Analysis

FUNCTIONAL DESCRIPTION: Gene set analysis of longitudinal RNA-seq data with variance component score test accounting for data heteroscedasticity through precision weights.

- Contact: Boris Hejblum
- URL: <https://cran.r-project.org/web/packages/tcgsaseq/index.html>

6.9. cytometree

KEYWORDS: Clustering - Biostatistics - Bioinformatics

FUNCTIONAL DESCRIPTION: Given the hypothesis of a bimodal distribution of cells for each marker, the algorithm constructs a binary tree, the nodes of which are subpopulations of cells. At each node, observed cells and markers are modeled by both a family of normal distributions and a family of bimodal normal mixture distributions. Splitting is done according to a normalized difference of AIC between the two families.

- Contact: Boris Hejblum
- URL: <https://cran.r-project.org/web/packages/cytometree/index.html>

6.10. CRTgeeDR

KEYWORDS: Missing data - Statistics - Regression

FUNCTIONAL DESCRIPTION: The CRTgeeDR package allows you to estimates parameters in a regression model (with possibly a link function). It allows treatment augmentation and IPW for missing outcome. It is particularly of use when the goal is to estimate the intervention effect of a prevention strategy against epidemics in cluster randomised trials.

- Contact: Melanie Prague
- URL: <https://cran.r-project.org/web/packages/CRTgeeDR/index.html>

6.11. ludic

KEYWORDS: Probability - Biostatistics

FUNCTIONAL DESCRIPTION: An R package to perform probabilistic record Linkage Using only DIagnosis Codes without direct identifiers, using C++ code to speed up computations. Available on CRAN, development version on github.

- Contact: Boris Hejblum
- URL: <https://cran.r-project.org/web/packages/ludic/index.html>

STEPP Project-Team

6. New Software and Platforms

6.1. Software tools for the TRANUS LUTI Model

KEYWORDS: Urban planning - Transport model - LUTI

FUNCTIONAL DESCRIPTION: This year, we have consolidated and extended our software tools for the TRANUS LUTI model, thanks to support by Inria allowing to hire an engineer for one year Emna Jribi (ADT TRACAV project). Various tasks have been accomplished, concerning three types of functionality, these are as follows. First, calibration of TRANUS. The software implementation of our methods for calibrating the TRANUS land-use component has been cleaned up. It has been encapsulated such as to be seamlessly integrated within the TRANUS workflow (consisting of a sequence of executables, exchanging data through binary and other files). Second, graphical user interfaces to facilitate the repeated execution of TRANUS executables, for generating reports on results or for the exploration of the space of some critical model parameters. Third, we have continued to work on the embedding of TRANUS within the open source QGIS platform (a widely used Geographic Information System).

- Participants: Emna Jribi, Thomas Capelle and Peter Sturm
- Contact: Peter Sturm
- URL: <https://gitlab.inria.fr/tranus>

6.2. USAT

Urban Sprawl Analysis Toolkit

KEYWORDS: Urban sprawl - Urban planning

FUNCTIONAL DESCRIPTION: This software allows to calculate and analyse indices of urban sprawl from open data (OpenStreetMap), aimed to be used by urban scientists and urban planners. A spatialized version of indices measuring the accessibility, dispersion and land use mix is calculated. The implemented methods are described in [14].

- Participants: Luciano Gervasoni, Serge Fenet and Peter Sturm
- Partner: LIRIS
- Contact: Peter Sturm
- URL: <https://github.com/lgervasoni/urbansprawl>

6.3. USAT WEB

Urban Sprawl Analysis Toolkit Web-service

KEYWORDS: Urban planning - Urban sprawl

FUNCTIONAL DESCRIPTION: This is a web-service on top of the software USAT described above. The web-service will allow any user to select a region of interest and to launch the calculation and display of sprawl indices using USAT. It is in the process of being hosted on the HPC platform of IN2P3, after which it will be made open to the public. The source code for this web-service is already available at the below site.

The web-service is described in [15].

- Participants: Lucas Rezakhanlou, Peter Sturm, Luciano Gervasoni and Serge Fenet
- Contact: Peter Sturm
- Publication: [USAT \(Urban Sprawl Analysis Toolkit\) : une plateforme web d'analyse de l'étalement urbain à partir de données massives ouvertes](#)
- URL: <https://gitlab.inria.fr/lrezakha/usat-web>

6.4. InterfacesTRANUS

FUNCTIONAL DESCRIPTION: This software contains two interfaces dedicated to facilitating the usage of the TRANUS integrated land use and transport model+software. The first interface is dedicated to enabling the execution of the TRANUS binary programs without the need to use the console or the TRANUS GUI. The second interface provides an aid for calibrating a TRANUS model, by interactively exploring ranges of different parameters of a TRANUS model and visualising model outputs across these ranges.

- Participants: Julien Armand, Peter Sturm and Thomas Capelle
- Contact: Peter Sturm
- URL: https://gitlab.inria.fr/tranus/TRANUS_Interfaces

6.5. LUM_OSM

Land Use Mix calculation from OpenStreepMap data

FUNCTIONAL DESCRIPTION: The software uses Mapzen Metro Extracts to retrieve the OpenStreetMap data of a given region in the PostgreSQL format. Afterwards, a continuous representation of residential and activity land uses is created. Finally, a GIS output containing the degree of land use mixture is calculated by means of using the land uses maps. The implemented approach is documented in the paper "A framework for evaluating urban land use mix from crowd-sourcing data", <http://hal.inria.fr/hal-01396792>

- Participants: Luciano Gervasoni, Marti Bosch Padros, Peter Sturm and Serge Fenet
- Partners: EPFL - Ecole Polytechnique Fédérale de Lausanne - LIRIS
- Contact: Peter Sturm
- URL: <http://github.com/martibosch/landusemix>

6.6. QGIS_Tranus_Reports

FUNCTIONAL DESCRIPTION: This software allows to graphically visualise data output by the TRANUS LUTI model (and possibly, of any other data of the same structure). In particular, this concerns any data items defined per zone of a modelled territory (productions, indicators, etc.). The software is designed as a plugin for the geographical information system platform QGIS and can be run interactively as well as by the command line or by a call from within another software. The interactive mode (within QGIS) allows the user to define graphical outputs to be generated from TRANUS output files (type of graphs to be generated – 2D or 3D – color coding to be used, choice of data to be displayed, etc.). Visualisation of data is done in the form of 2D graphs or 3D models defined using java-script.

- Participants: Fausto Lo Feudo, Huu Phuoc Nguyen, Patricio Inzaghi, Peter Sturm and Thomas Capelle
- Contact: Peter Sturm
- URL: https://gitlab.inria.fr/tranus/QGIS_Tranus_Reports

6.7. Comptabilité Ecologique

FUNCTIONAL DESCRIPTION: Databases, database handling tools and data visualization tools (on the web-site). Databases include socio-economic and environmental datasets. Visualization tools include interactive piecharts, maps and Sankey diagrams.

- Participants: Jean-Yves Courtonne and Pierre-Yves Longaretti
- Contact: Jean-Yves Courtonne
- URL: <http://www.eco-data.fr>

TAPDANCE Team

5. New Software and Platforms

5.1. Sanakirja

KEYWORD: Databases

FUNCTIONAL DESCRIPTION: Sanakirja is a fully transactional (all operations are atomic) key-value dictionary stored in a file (usable at the low-level layer of a more full-featured database engine), with a zero-copy fork operation (fork is in time and space $O(\log n)$, where n is the number of keys in the file). This project is written in Rust.

- Contact: Pierre-Etienne Meunier
- URL: https://nest.pijul.com/pijul_org/sanakirja

5.2. Thrush

KEYWORD: Security

FUNCTIONAL DESCRIPTION: Purely asynchronous SSH library in Rust.

- Contact: Pierre-Etienne Meunier

5.3. Pijul

KEYWORDS: Data structures - Distributed systems

FUNCTIONAL DESCRIPTION: Patch-based distributed version control system using category theory. This solves a number of problems in other systems (such as Git), like:

- Scaling up to giant repositories (as used by Facebook, Google and Mozilla). - Being easy to understand and use, because based on a solid theory.

- Contact: Pierre-Etienne Meunier
- URL: <https://pijul.org>

5.4. SeqDesign

KEYWORDS: Chemistry - Molecular simulation

FUNCTIONAL DESCRIPTION: SeqDesign is a free energy calculation tool for DNA secondary structures. We use it to design sequences capable of self-assembling in a designed way.

- Contact: Pierre-Etienne Meunier

TONUS Team

6. New Software and Platforms

6.1. CLAC

Conservation Laws Approximation on many Cores

SCIENTIFIC DESCRIPTION: It is clear now that future computers will be made of a collection of thousands of interconnected multicore processors. Globally it appears as a classical distributed memory MIMD machine. But at a lower level, each of the multicore processors is itself made of a shared memory MIMD unit (a few classical CPU cores) and a SIMD unit (a GPU). When designing new algorithms, it is important to adapt them to this kind of architecture. Our philosophy will be to program our algorithms in such a way that they can be run efficiently on this kind of computers. Practically, we will use the MPI library for managing the coarse grain parallelism, while the OpenCL library will efficiently operate the fine grain parallelism.

We have invested for several years until now into scientific computing on GPUs, using the open standard OpenCL (Open Computing Language). We were recently awarded a prize in the international AMD OpenCL innovation challenge thanks to an OpenCL two-dimensional Vlasov-Maxwell solver that fully runs on a GPU. OpenCL is a very interesting tool because it is an open standard now available on almost all brands of multicore processors and GPUs. The same parallel program can run on a GPU or a multicore processor without modification.

Because of the envisaged applications of CLAC, which may be either academic or commercial, it is necessary to conceive a modular framework. The heart of the library is made of generic parallel algorithms for solving conservation laws. The parallelism can be both fine-grained (oriented towards GPUs and multicore processors) and coarse-grained (oriented towards GPU clusters). The separate modules allow managing the meshes and some specific applications. In this way, it is possible to isolate parts that should be protected for trade secret reasons.

FUNCTIONAL DESCRIPTION: CLAC is a generic Discontinuous Galerkin solver, written in C/C++, based on the OpenCL and MPI frameworks.

- Partner: AxesSim
- Contact: Philippe Helluy
- URL: <http://clac.gforge.inria.fr/>

6.2. Selalib

SEmi-LAgrangian LIBrary

KEYWORDS: Plasma physics - Semilagrangian method - Parallel computing - Plasma turbulence

SCIENTIFIC DESCRIPTION: The objective of the Selalib project (SEmi-LAgrangian LIBrary) is to develop a well-designed, organized and documented library implementing several numerical methods for kinetic models of plasma physics. Its ultimate goal is to produce gyrokinetic simulations.

Another objective of the library is to provide to physicists easy-to-use gyrokinetic solvers, based on the semi-lagrangian techniques developed by Eric Sonnendrücker and his collaborators in the past CALVI project. The new models and schemes from TONUS are also intended to be incorporated into Selalib.

FUNCTIONAL DESCRIPTION: Selalib is a collection of modules conceived to aid in the development of plasma physics simulations, particularly in the study of turbulence in fusion plasmas. Selalib offers basic capabilities from general and mathematical utilities and modules to aid in parallelization, up to pre-packaged simulations.

- Partners: Max Planck Institute - Garching - Université de Strasbourg
- Contact: Philippe Helluy
- URL: <http://selalib.gforge.inria.fr/>

6.3. SCHNAPS

Solver for Conservative Hyperbolic Nonlinear Applications for PlasmaS

KEYWORDS: Discontinuous Galerkin - StarPU - Kinetic scheme

FUNCTIONAL DESCRIPTION: Generic systems of conservation laws. Specific models: fluids, Maxwell, Vlasov, acoustics (with kinetic representation). Multitasking with StarPU. Explicit solvers (RK2, RK3, RK4): accelerated with OpenCL Implicit solvers: through kinetic representations and palindromic time integration.

- Contact: Philippe Helluy
- URL: <http://schnaps.gforge.inria.fr/>

VIRTUAL PLANTS Project-Team

5. New Software and Platforms

5.1. OpenAlea

KEYWORDS: Bioinformatics - Biology

RELEASE FUNCTIONAL DESCRIPTION: OpenAlea 2.0 adds to OpenAlea 1.0 a high-level formalism dedicated to the modeling of morphogenesis that makes it possible to use several modeling paradigms (Blackboard, L-systems, Agents, Branching processes, Cellular Automata) expressed with different languages (Python, L-Py, R, Visual Programming, ...) to analyse and simulate shapes and their development.

- Participants: Christian Fournier, Christophe Godin, Christophe Pradal, Frédéric Boudon, Guillaume Baty, Julien Coste and Samuel Dufour Kowalski
- Contact: Christophe Pradal

5.2. OpenAlea.Visualea

KEYWORDS: Bioinformatics - Biology

- Participants: Christophe Pradal and Samuel Dufour Kowalski
- Contact: Christophe Pradal

5.3. VPlants

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: Computer algorithms and tools developed by the Virtual Plants team are integrated in the common software suite V-Plants, dedicated to the modeling and analysis of plant development at different scales (e.g. cellular tissue, whole plant, stand). The VPlants packages are integrated into OpenAlea as Python components. General-purpose components (such as PlantGL, MTGs, L-Py) are distributed with the OpenAlea platform and usable through the visual programming environment VisuAlea.

- Contact: Christophe Pradal

VISAGES Project-Team

6. New Software and Platforms

6.1. Anima

KEYWORDS: Registration - Diffusion imaging - Medical imaging - Filtering - Relaxometry

SCIENTIFIC DESCRIPTION: Anima is a set of libraries and tools developed by the team as a common repository of research algorithms. As of now, it contains tools for image registration, statistical analysis (group comparison, patient to group comparison), diffusion imaging (model estimation, tractography, etc.), quantitative MRI processing (quantitative relaxation times estimation, MR simulation), image denoising and filtering, and segmentation tools. All of these tools are based on stable libraries (ITK, VTK), making it simple to maintain.

- Participants: Aymeric Stamm, Fang Cao, Florent Leray, Guillaume Pasquier, Laurence Catanese, Olivier Commowick, Renaud Hedouin and René-Paul Debroize
- Contact: Olivier Commowick
- URL: <https://github.com/Inria-Visages/Anima-Public/wiki>

6.2. autoMRI

KEYWORDS: FMRI - MRI - ASL - FASL - SPM - Automation

SCIENTIFIC DESCRIPTION: This software is highly configurable in order to fit to a wide range of needs. Pre-processing includes segmentation of anatomical data, as well as co-registration, spatial normalization and atlas building of all data types. The analysis pipelines perform either within-group analysis or between-group or one subject-versus-group comparison and produce statistical maps of regions with significant differences. These pipelines can be applied to structural data to exhibit patterns of atrophy or lesions, to ASL (both pulsed or pseudo-continuous sequences) or PET data to detect perfusion or metabolic abnormalities, to relaxometry data to detect deviations from a template, to functional data - either BOLD or ASL - to outline brain activations related to block or event-related paradigms. In addition to the standard General Linear Model approach, the ASL pipelines implement an a contrario approach and, for patient-specific perfusion study, an heteroscedastic variance model. Besides, the vascular pipeline processes 4D MRA data and enables accurate assessment of hemodynamic patterns.

FUNCTIONAL DESCRIPTION: AutoMRI Based on MATLAB and the SPM8 toolbox, autoMRI provides complete pipelines to pre-process and analyze various types of images (anatomical, functional, perfusion, metabolic, relaxometry, vascular).

- Participants: Camille Maumet, Cédric Meurée, Elise Bannier, Fang Cao, Isabelle Corouge and Pierre Maurel
- Contact: Isabelle Corouge
- URL: <http://www.irisa.fr/visages/>

6.3. MedInria

KEYWORDS: Visualization - DWI - Health - Segmentation - Medical imaging

SCIENTIFIC DESCRIPTION: It aims at creating an easily extensible platform for the distribution of research algorithms developed at Inria for medical image processing. This project has been funded by the D2T (ADT MedInria-NT) in 2010, renewed in 2012. A fast-track ADT was awarded in 2017 to transition the software core to more recent dependencies and study the possibility of a consortium creation. The Visages team leads this Inria national project and participates in the development of the common core architecture and features of the software as well as in the development of specific plugins for the team's algorithm.

FUNCTIONAL DESCRIPTION: MedInria is a free software platform dedicated to medical data visualization and processing.

- Participants: Maxime Sermesant, Olivier Commowick and Théodore Papadopoulos
- Partners: HARVARD Medical School - IHU - LIRYC - NIH
- Contact: Olivier Commowick
- URL: <http://med.inria.fr>

6.4. QtShanoir

KEYWORDS: Webservices - Soap - C++ - Health - DICOM - Plug-in - Medical imaging - Qt - Shanoir - Nifti

SCIENTIFIC DESCRIPTION: QtShanoir is based on Qt/C++ librairie. It interacts with the Shanoir server using SOAP web services provided. This application queries the server and displays hierarchical data extracted in tree view. Data could also be easily downloaded or uploaded on the server. In order to extend the Shanoir environment, QtShanoir is developed to contain two shared libraries: - « GUI » that represents all user interfaces. - « DAO » that takes in charge the data model. This library assures the connection to the server and provides all QtShanoir services : research, download and upload of Processed Dataset (NIfTI). QtShanoir dynamic libraries are already reused and integrated in other projects: in the software medInria and in an under development command line program.

FUNCTIONAL DESCRIPTION: QtShanoir is a graphical client application of the medical imaging database Shanoir. This application provides various functionalities to satisfy researchers' needs. It allows users to: - explore neuroimaging data derived from multicenter research trials. Through an intuitive user interface, users could easily visualize voluminous amount of structured data: studies, patients and datasets extracted from Shanoir - download and to upload data from the server. This application is available on Windows, UNIX, MacOS X. It is integrated as a plugin in medInria, a multi-plateform for medical image processing and visualization.

- Participants: Alexandre Abadie, Guillaume Renard, Nicolas Wiest Daessle, Olivier Commowick and Wefa Hakem
- Contact: Christian Barillot
- URL: <http://qtshanoir.gforge.inria.fr>

6.5. Shanoir

SHaring NeuroImaging Resources

KEYWORDS: Neuroimaging - Medical imaging - PACS - Nifti - Data Sharing - DICOM - Health - Shanoir - Webservices - Data base - Biology - Web Application

FUNCTIONAL DESCRIPTION: SHaring NeuroImaging Resources (Shanoir, Previously InriaNeuroTk) is an open source software platform designed to structure, manage, archive, visualize and share neuroimaging data with an emphasis on multi-centric collaborative research projects. It provides common features of neuroimaging data management systems along with research-oriented data organization and enhanced accessibility.

Shanoir is a secured J2EE application running on a JBoss server, reachable via graphical interfaces in a browser or by third party programs via web services. It behaves as a repository of neuroimaging files coupled with a relational database hoding meta-data. The data model, based on OntoNeurolog, an ontology devoted to the neuroimaging field, is structured around research studies where of involved patients have examinations which either produce image acquisitions or clinical scores. Each image acquisition is composed of datasets represented by their acquisition parameters and image files. The system only keeps anonymous data.

Image files imports are possible from various sources (DICOM CDs, PACs, image files in NIfTI / Analyze format) using either online wizards, with completions of related meta-data, or commande line tools. Once de-identified during the import phase, DICOM header's customizable feature. Shanoir can also record any executed processing allowing to retrieve workflows applied to a particular dataset along with the intermediate data.

The clinical scores resulting from instrument based assessments (e.g. neuropsychological tests) can also be entered and easily retrieved and exported in different formats (Excel, CSV, Xml). Scores and image acquisitions are bound together which makes relationship analysis possible. The instrument database is scalable and new measures can be added in order to meet specific project needs, by use of intuitive graphical interfaces.

Using cross-data navigation and advanced search criteria, the users can quickly point to a subset of data of data to be downloaded. Client side applications have as well been developed to illustrate how to locally access and exploit data through the available web services. With regards to security, the system requires authentication and user rights are tunable for each hosted studies. A study responsible can thereby define the users allowed to see, download or import data into his study or simply make it public.

Shanoir serves neuroimaging researchers in organizing efficiently their studies while cooperating with other laboratories. By managing patient privacy, Shanoir allows the exploitation of clinical data in a research context. It is finally a handy solution to publish and share data with a broader community.

Shanoir integrates the enterprise search platform, Apache Solr, to provide the users a vast array of advanced features such as near real-time indexing and queries, full-text search, faceted navigation, autosuggestion and autocomplete.

- Participants: Adrien Férial, Anthony Baire, Bernard Gibaud, Christian Barillot, Guillaume Renard, Justine Guillaumont, Michael Kain and Yao Yao
- Partners: Université de Rennes 1 - CNRS - INSERM
- Contact: Christian Barillot
- URL: <http://shanoir.gforge.inria.fr>

6.6. ShanoirUploader

KEYWORDS: PACS - Medical imaging - Neuroimaging - DICOM - Health - Biology - Java - Webservices - Shanoir

SCIENTIFIC DESCRIPTION: ShanoirUploader is a desktop application on base of JavaWebStart (JWS). The application can be downloaded and installed using an internet browser. It interacts with a PACS to query and retrieve the data stored on it. After this ShanoirUploader sends the data to a Shanoir server instance in order to import these data. This application bypasses the situation, that in most of the clinical network infrastructures a server to server connection is complicated to set up between the PACS and a Shanoir server instance.

FUNCTIONAL DESCRIPTION: ShanoirUploader is a Java desktop application that transfers data securely between a PACS and a Shanoir server instance (e.g., within a hospital). It uses either a DICOM query/retrieve connection or a local CD/DVD access to search and access images from a local PACS or the local CD/DVD. After having retrieved the data, the DICOM files are locally anonymized and then uploaded to the Shanoir server. A possible integration of a hash creation application for patient identifiers is provided as well. The primary goals of that application are to enable mass data transfers between different remote server instances and therefore reduce the waiting time of the users, when importing data into Shanoir. Most of the time during import is spent with data transfers.

- Participants: Christian Barillot, Ines Fakhfakh, Justine Guillaumont, Michael Kain and Yao Yao
- Contact: Christian Barillot
- URL: <http://shanoir.gforge.inria.fr>

6.7. Platforms

6.7.1. The Neurinfo Platform

VisAGeS is the founding actor of an experimental research platform which was installed in August 2009 at the University Hospital of Rennes. The University of Rennes 1, Inria, Inserm for the academic side, and the University Hospital of Rennes and the Cancer Institute “Eugene Marquis” for the clinical side, are partners of this neuroinformatics platform called Neurinfo⁰. This platform has been supported under the “Contrat de Projets Etat-Région” (Christian Barillot is the PI) and has received a total amount of 4.01 M€ for the period 2007–2014. European (FEDER), National (through Ministry of research, Inria, Inserm and ANR) and local councils (Brittany Region, Ille et Vilaine, and Rennes Metropole) have joined their effort to support this operation for a total amount of 4 010 k€ (600 k€ for the infrastructures, 2 850 k€ for the equipments and 560 k€ for the functioning). This application was set up through the Regional PIMATGI initiative coordinated by INSERM in Brittany (C. Roux). The overall PIMATGI initiative served for the financing of three distinct, but complementary, platforms: Neurinfo, TheraFONC as a technical platform dedicated to therapy guided by functional imaging especially in the oncology domain (Inserm U650 - LaTIM, Dir. Ch. Roux, Brest), and Thera-Image as a platform dedicated to image guided mini-invasive surgery and therapy especially in the domain of cardio-vascular diseases (U642 -LTSI, Dir. L. Senhadji, Rennes).

Concerning the Neurinfo Platform, the activity domain is a continuum between methodological and technological research built around specific clinical research projects. The ambition is to do innovation in science, technology and medical technology transfer for the implementation on the clinical field. On the medical field, the translational research domain mainly concerns medical imaging and more specifically the clinical neurosciences. Among them are multiple sclerosis, epilepsy, neurodegenerative, neurodevelopmental and psychiatric diseases, surgical procedures of brain lesions, neuro-oncology and radiotherapy planning. Beyond these CNS applications, the platform is also open to alternative applications. Neurinfo ambitions to support the emergence of research projects based on their level of innovation, their pluri-disciplinarity and their ability to foster collaborations between different actors (public and private research entities, different medical specialties, different scientific profiles).

In this context, a research 3T MRI system (Siemens Verio) was acquired in summer 2009 in order to develop the clinical research in the domain of morphological, functional, structural and cellular in-vivo imaging. In 2014 a new equipment for simultaneous recording of EEG and MRI images was acquired from Brain Product. In 2015, a mock scanner for experimental set-up was acquired as well as a new High Performance Computing environment made of one large computing cluster and a data center that is shared and operated by the Inria center at IRISA (UMR CNRS 6074). The computation cluster (240 cores) and the data center (up to 50 TB) are dedicated to host and process imaging data produced by the Neurinfo platform, but also by other research partners that share their protocols on the Neurinfo neuroinformatics system (currently more than 30 sites).

VisAGeS and its partners in the Neurinfo project are committed to use this new research platform for developing new regional, national and international collaborations around fundamental and applied clinical research projects dealing with in-vivo medical imaging.

In 2016, VisAGeS has been awarded by IBISA as a “Plateforme d’excellence”.

In 2017, funding was collected to replace the 3T Siemens Verio MRI. A 3T Siemens Prisma will be installed early 2018.

⁰<http://www.neurinfo.org>

XPOP Project-Team

6. New Software and Platforms

6.1. mlxR

KEYWORDS: Simulation - Data visualization - Clinical trial simulator

FUNCTIONAL DESCRIPTION: The models are encoded using the model coding language 'Mlxtran', automatically converted into C++ codes, compiled on the fly and linked to R using the 'Rcpp' package. That allows one to implement very easily complex ODE-based models and complex statistical models, including mixed effects models, for continuous, count, categorical, and time-to-event data.

- Contact: Marc Lavielle
- URL: <http://simulx.webpopix.org/>

AGORA Team

6. New Software and Platforms

6.1. TAPASCologne

Travel and Activity PAtterns Simulation Cologne

KEYWORDS: Mobility - Traces

FUNCTIONAL DESCRIPTION: TAPASCologne is an initiative by the Institute of Transportation Systems at the German Aerospace Center (ITS-DLR), aimed at reproducing, with the highest level of realism possible, car traffic in the greater urban area of the city of Cologne, in Germany.

To that end, different state-of-art data sources and simulation tools are brought together, so to cover all of the specific aspects required for a proper characterization of vehicular traffic:

The street layout of the Cologne urban area is obtained from the OpenStreetMap (OSM) database, The microscopic mobility of vehicles is simulated with the Simulation of Urban Mobility (SUMO) software, The traffic demand information on the macroscopic traffic flows across the Cologne urban area (i.e., the O/D matrix) is derived through the Travel and Activity PAtterns Simulation (TAPAS) methodology, The traffic assignment of the vehicular flows described by the TAPASCologne O/D matrix over the road topology is performed by means of Gawron's dynamic user assignment algorithm.

- Participants: Marco Fiore and Razvan Stanica
- Contact: Marco Fiore
- URL: <http://kolntrace.project.citi-lab.fr/#download>

6.2. Sense in the City

KEYWORDS: Sensors - Sensors network - Wireless Sensor Networks

FUNCTIONAL DESCRIPTION: Sense in the city is a lightweight experimentation platform for wireless sensor networks in development. The main objective of this platform is to be easily transferable and deployable on the field. It allows a simplified deployment of the code running on the sensors and the collection of logs generated by the instrumentation of the code on a centralized database. In the early stage of the platform, the sensors are powered by small PCs, e.g. Raspberry Pis, but we are investigating the integration of energy harvesting capabilities such as solar panels.

- Participants: Hervé Rivano and Khaled Boussetta
- Contact: Khaled Boussetta

6.3. PrivaMovApp

KEYWORD: Crowd-sensing

FUNCTIONAL DESCRIPTION: Agora is leading the development of an Android application for user data collection purposes. The application is based on the Funf framework, and is currently available on Google Play.

- Participants: Stéphane D'alu, Hervé Rivano and Razvan Stanica
- Contact: Razvan Stanica

6.4. WSNet

KEYWORD: Network simulator

FUNCTIONAL DESCRIPTION: WSN_{et} is a modular event-driven simulator targeted to Wireless Sensor Networks. Its main goals are to offer scalability, extensibility and modularity for the integration of new protocols/hardware models and a precise radio medium simulation. We still hope to find the proper resource to make WSN_{et} evolve into a wireless capillary network simulator suitable for conducting simulations at the urban scale.

- Participants: Rodrigue Domga Komguem and Fabrice Valois
- Partner: CEA-LETI
- Contact: Guillaume Chelius
- URL: <https://gforge.inria.fr/projects/wsnet-3/>

ALPINES Project-Team

6. New Software and Platforms

6.1. FreeFem++

SCIENTIFIC DESCRIPTION: FreeFem++ is a partial differential equation solver. It has its own language. freefem scripts can solve multiphysics non linear systems in 2D and 3D.

Problems involving PDE (2d, 3d) from several branches of physics such as fluid-structure interactions require interpolations of data on several meshes and their manipulation within one program. FreeFem++ includes a fast 2d-tree-based interpolation algorithm and a language for the manipulation of data on multiple meshes (as a follow up of bamg (now a part of FreeFem++)).

FreeFem++ is written in C++ and the FreeFem++ language is a C++ idiom. It runs on Macs, Windows, Unix machines. FreeFem++ replaces the older freefem and freefem+.

FUNCTIONAL DESCRIPTION: FreeFem++ is a PDE (partial differential equation) solver based on a flexible language that allows a large number of problems to be expressed (elasticity, fluids, etc) with different finite element approximations on different meshes.

- Partner: UPMC
- Contact: Frederic Hecht
- URL: <http://www.freefem.org/ff++/>

6.2. HPDDM

SCIENTIFIC DESCRIPTION: HPDDM is an efficient implementation of various domain decomposition methods (DDM) such as one- and two-level Restricted Additive Schwarz methods, the Finite Element Tearing and Interconnecting (FETI) method, and the Balancing Domain Decomposition (BDD) method. This code has been proven to be efficient for solving various elliptic problems such as scalar diffusion equations, the system of linear elasticity, but also frequency domain problems like the Helmholtz equation. A comparison with modern multigrid methods can be found in the thesis of Pierre Jolivet.

FUNCTIONAL DESCRIPTION: HPDDM is an efficient implementation of various domain decomposition methods (DDM) such as one- and two-level Restricted Additive Schwarz methods, the Finite Element Tearing and Interconnecting (FETI) method, and the Balancing Domain Decomposition (BDD) method.

- Participants: Frédéric Nataf and Pierre Jolivet
- Contact: Pierre Jolivet
- URL: <https://github.com/hpddm>

6.3. LORASC

LORASC preconditioner

KEYWORD: Preconditioner

- Participants: Laura Grigori and Rémi Lacroix
- Contact: Laura Grigori

6.4. Platforms

6.4.1. HTOOL

KEYWORD: Hierarchical Matrices

FUNCTIONAL DESCRIPTION: HTOOL is a C++ header-only library implementing compression techniques (e.g. Adaptive Cross Approximation) using hierarchical matrices. The library uses MPI and OpenMP for parallelism, and is interfaced with HPDDM for the solution of linear systems.

- Partners: CNRS - UPMC - ANR NonlocalDD
- Contact: Pierre Marchand
- URL: <https://github.com/PierreMarchand20/htool>

6.4.2. BemTool

KEYWORD: Boundary Element Method

FUNCTIONAL DESCRIPTION: BemTool is a C++ header-only library implementing the boundary element method for the discretisation of the Laplace, Helmholtz and Maxwell equations, in 2D and 3D. Its main purpose is the assembly of classic boundary element matrices, which can be compressed and inverted through its interface with HTOOL.

- Partners: UPMC - ANR NonlocalDD
- Contact: Xavier Claeys
- URL: <https://github.com/xclaeys/BemTool>

ASAP Project-Team

5. New Software and Platforms

5.1. WebGC

Web-based Gossip Communication

KEYWORDS: WebRTC - Recommendation systems - Decentralized architectures - Personalized systems - Web - Peer-to-peer - Gossip protocols - Epidemic protocols - Decentralized web

SCIENTIFIC DESCRIPTION: The library currently includes the implementation of two peer sampling protocols, Cyclon and the generic peer-sampling protocol from, as well as a clustering protocol. All protocols implement a common GossipProtocol “interface”

FUNCTIONAL DESCRIPTION: WebGC consists of a WebRTC-based library that supports gossip-based communication between web browsers and enables them to operate with Node-JS applications. WebGC comprises the implementation of standard gossip protocols such as Peer Sampling or Clustering, and simplifies the development of new protocols. It comprises a decentralized signaling service that makes it easier to build completely decentralized browser-based applications.

- Participants: Anne-Marie Kermarrec, Davide Frey, Matthieu Simonin and Raziel Carvajal Gomez
- Contact: Davide Frey

5.2. Asapknn (MediEgo)

KEYWORDS: Widget web - Social network - Recommendation

FUNCTIONAL DESCRIPTION: Asapknn (MediEgo) is a solution for content recommendation based on the users navigation history. The solution 1) collects the usages of the Web users and store them in a profile, 2) uses this profile to associate to each user her most similar users, 3) leverages this implicit network of close users in order to infer their preferences and recommend advertisements and recommendations. MediEgo achieves scalability using a sampling method, which provides very good results at a drastically reduced cost.

- Participants: Anne Marie Kermarrec, Antoine Boutet, Arnaud Jegou, Davide Frey, Jacques Falcou, Jean-Francois Verdonck, Rachid Guerraoui and Sébastien Campion
- Partner: EPFL - Ecole Polytechnique Fédérale de Lausanne
- Contact: Sébastien Campion

5.3. YALPS

KEYWORDS: Simulator - Peer-to-peer - Experimentation - Nat traversal - Traffic-shaping - Deployment

FUNCTIONAL DESCRIPTION: YALPS is an open-source Java library designed to facilitate the development, deployment, and testing of distributed applications. Applications written using YALPS can be run both in simulation and in real-world mode without changing a line of code or even recompiling the sources. A simple change in a configuration file will load the application in the proper environment. A number of features make YALPS useful both for the design and evaluation of research prototypes and for the development of applications to be released to the public. Specifically, YALPS makes it possible to run the same application as a simulation or in a real deployment. Applications communicate by means of application-defined messages which are then routed either through UDP/TCP or through YALPS’s simulation infrastructure. In both cases, YALPS’s communication layer offers features for testing and evaluating distributed protocols and applications. Communication channels can be tuned to incorporate message losses or to constrain their outgoing bandwidth. Finally, YALPS includes facilities to support operation in the presence of NATs and firewalls using relaying and NAT-traversal techniques. The implementation of YALPS includes approximately 16K lines of code, and is used in several projects by ASAP, including HEAP, AllYours-P2P, and Behave.

- Participants: Anne Marie Kermarrec, Arnaud Jegou, Davide Frey, Heverson Borba Ribeiro and Maxime Monod
- Contact: Davide Frey
- URL: <http://yalps.gforge.inria.fr/>

5.4. GossipLib

KEYWORDS: Nat traversal - Epidemic protocols - Gossip protocols - Overlay maintenance - Peer-to-peer - Dissemination

FUNCTIONAL DESCRIPTION: GossipLib is a library consisting of a set of Java classes aimed to facilitate the development of gossip-based application in a large-scale setting. It provides developers with a set of support classes that constitute a solid starting point for building any gossip-based application. GossipLib is designed to facilitate code reuse and testing of distributed application and as thus also provides the implementation of a number of standard gossip protocols that may be used out of the box or extended to build more complex protocols and applications. These include for example the peer-sampling protocols for overlay management.

GossipLib also provides facility for the configuration and deployment of applications as final-product but also as research prototype in environments like PlanetLab, clusters, network emulators, and even as event-based simulation. The code developed with GossipLib can be run both as a real application and in simulation simply by changing one line in a configuration file.

RELEASE FUNCTIONAL DESCRIPTION: Library for gossip-based applications and experiments

- Participants: Anne Marie Kermarrec, Davide Frey, Ilham Ikbali, Imane Al Ifdal and Ribeiro Heverson
- Contact: Davide Frey
- URL: <http://gossiplib.gforge.inria.fr/>

ASCOLA Project-Team

6. New Software and Platforms

6.1. btrCloud

KEYWORDS: Cloud computing - Data center - Cluster - Placement - Autonomic system - Orchestration - Energy - Grid - Virtualization - Scheduler

FUNCTIONAL DESCRIPTION: Orchestration, virtualization, energy, autonomic system, placement, cloud computing, cluster, data center, scheduler, grid

btrCloud is a virtual machine manager for clusters and provides a complete solution for the management and optimization of virtualized data centers. btrCloud (acronym of better cloud) is composed of three parts.

The analysis function enables operatives and people in charge to monitor and analyze how a data-center works - be it on a daily basis, on the long run, or in order to predict future trends. This feature includes boards for performance evaluation and analysis as well as trends estimation.

btrCloud, by the integration of btrScript, provides (semi-)automated VM lifecycle management, including provisioning, resource pool management, VM tracking, cost accounting, and scheduled deprovisioning. Key features include a thin client interface, template-based provisioning, approval workflows, and policy-based VM placement.

Finally, several kinds of optimizations are currently available, such as energy and load balancing. The former can help save up to around 20

- Participants: Frédéric Dumont, Guillaume Le Louët and Jean-Marc Menaud
- Contact: Guillaume Le Louët
- URL: http://www.btrcloud.org/btrCloud/index_EN.html

6.2. SimGrid

KEYWORDS: Large-scale Emulators - Grid Computing - Distributed Applications

SCIENTIFIC DESCRIPTION: SimGrid is a toolkit that provides core functionalities for the simulation of distributed applications in heterogeneous distributed environments. The simulation engine uses algorithmic and implementation techniques toward the fast simulation of large systems on a single machine. The models are theoretically grounded and experimentally validated. The results are reproducible, enabling better scientific practices.

Its models of networks, cpus and disks are adapted to (Data)Grids, P2P, Clouds, Clusters and HPC, allowing multi-domain studies. It can be used either to simulate algorithms and prototypes of applications, or to emulate real MPI applications through the virtualization of their communication, or to formally assess algorithms and applications that can run in the framework.

The formal verification module explores all possible message interleavings in the application, searching for states violating the provided properties. We recently added the ability to assess liveness properties over arbitrary and legacy codes, thanks to a system-level introspection tool that provides a finely detailed view of the running application to the model checker. This can for example be leveraged to verify both safety or liveness properties, on arbitrary MPI code written in C/C++/Fortran.

RELEASE FUNCTIONAL DESCRIPTION:

- Four releases in 2017. Major changes:
 - S4U: many progress, toward SimGrid v4.0. About 80% of the features offered by SimDag and MSG are now integrated, along with examples. Users can now write plugins to extend SimGrid.
 - SMPI: Support MPI 2.2, RMA support, Convert internals to C++.
 - Java: Massive memleaks and performance issues fixed.
 - New models: Multi-core VMs, Energy consumption due to the network
 - All internals are now converted to C++, and most of our internally developed data containers were replaced with std::* constructs.
 - (+ bug fixes, cleanups and documentation improvements)
- Participants: Adrien Lèbre, Arnaud Legrand, Augustin Degomme, Florence Perronnin, Frédéric Suter, Jean-Marc Vincent, Jonathan Pastor, Jonathan Rouzaud-Cornabas, Luka Stanisic, Mario Südholt and Martin Quinson
- Partners: CNRS - ENS Rennes
- Contact: Martin Quinson
- URL: <http://simgrid.gforge.inria.fr/>

6.3. VMPlaces

FUNCTIONAL DESCRIPTION: VMPlaces is a dedicated framework to evaluate and compare VM placement algorithms. This framework is composed of two major components: the injector and the VM placement algorithm. The injector is the generic part of the framework (i.e. the one you can directly use) while the VM placement algorithm is the part you want to study (or compare with available algorithms). Currently, the VMPlaceS is released with three algorithms:

Entropy, a centralized approach using a constraint programming approach to solve the placement/reconfiguration VM problem

Snooze, a hierarchical approach where each manager of a group invokes Entropy to solve the placement/reconfiguration VM problem. Note that in the original implementation of Snooze, it is using a specific heuristic to solve the placement/reconfiguration VM problem. As the sake of simplicity, we have simply reused the entropy scheduling code.

DVMS, a distributed approach that dynamically partitions the system and invokes Entropy on each partition.

- Participants: Adrien Lèbre, Flavien Quesnel, Jonathan Pastor, Mario Südholt and Takahiro Hirofuchi
- Contact: Adrien Lèbre
- URL: <http://beyondtheclouds.github.io/VMPlaceS/>

6.4. ENOS

Experimental eNvironment for OpenStack

KEYWORDS: OpenStack - Experimentation - Reproducibility

FUNCTIONAL DESCRIPTION: Enos workflow :

A typical experiment using Enos is the sequence of several phases:

- enos up : Enos will read the configuration file, get machines from the resource provider and will prepare the next phase - enos os : Enos will deploy OpenStack on the machines. This phase rely highly on Kolla deployment. - enos init-os : Enos will bootstrap the OpenStack installation (default quotas, security rules, ...) - enos bench : Enos will run a list of benchmarks. Enos support Rally and Shaker benchmarks. - enos backup : Enos will backup metrics gathered, logs and configuration files from the experiment.

- Partner: Orange Labs
- Contact: Adrien Lèbre

AVALON Project-Team

5. New Software and Platforms

5.1. Kwapi

FUNCTIONAL DESCRIPTION: Kwapi is a software framework dealing with energy monitoring of large scale infrastructures through heterogeneous energy sensors. Kwapi has been designed inside the FSN XLCloud project for Openstack infrastructures. Through the support of Hemera Inria project, kwapi has been extended and deployed in production mode to support easy and large scale energy profiling of the Grid5000 resources.

- Participants: François Rossigneux, Jean-Patrick Gelas, Laurent Lefèvre and Laurent Pouilloux
- Contact: Laurent Lefèvre
- URL: <https://launchpad.net/kwapi>

5.2. DIET

Distributed Interactive Engineering Toolbox

KEYWORDS: Scheduling - Clusters - Grid - Cloud - HPC - Middleware - Data management.

FUNCTIONAL DESCRIPTION: Middleware for grids and clouds. Toolbox for the use and porting of intensive computing applications on heterogeneous architectures.

RELEASE FUNCTIONAL DESCRIPTION: - Upgrade to support Cmake 3.3 and later - Update workflow unit tests to take the results of the execution into account - DIET workflow engine was improved

NEWS OF THE YEAR: New release (DIET 2.10) DIET at SC'17 Rutgers University Collaboration

- Participants: Joel Faubert, Hadrien Croubois, Abdelkader Amar, Arnaud Lefray, Aurélien Bouteiller, Benjamin Isnard, Daniel Balouek, Eddy Caron, Eric Bois, Frédéric Desprez, Frédéric Lombart, Gaël Le Mahec, Guillaume Verger, Huaxi Zhang, Jean-Marc Nicod, Jonathan Rouzaud-Cornabas, Lamiel Toch, Maurice Faye, Peter Frauenkron, Philippe Combes, Philippe Laurent, Raphaël Bolze and Yves Caniou
- Partners: CNRS - ENS Lyon - UCBL Lyon 1 - Sysfera
- Contact: Eddy Caron
- URL: <http://graal.ens-lyon.fr/diet/>

5.3. Sam4C

Security-Aware Models for Clouds

SCIENTIFIC DESCRIPTION: This editor is generated in Java from an EMF -Eclipse Modeling Framework- metamodel to simplify any modifications or extensions. The application model and the associated security policy are compiled in a single XML file which serves as input for an external Cloud security-aware scheduler. Alongside with this editor, Cloud architecture models and provisioning algorithms are provided for simulation (in the current version) or real deployments (in future versions).

FUNCTIONAL DESCRIPTION: Sam4C (<https://gforge.inria.fr/projects/sam4c/>) -Security-Aware Models for Clouds- is a graphical and textual editor to model Cloud applications (as virtual machines, processes, files and communications) and describe its security policy. Sam4C is suitable to represent any static application without deadline or execution time such as n-tiers or parallel applications.

- Participants: Arnaud Lefray, Eddy Caron and Jonathan Rouzaud-Cornabas
- Contact: Eddy Caron
- URL: <https://gforge.inria.fr/projects/sam4c/>

5.4. L2C

Low Level Components

KEYWORDS: Software Components - HPC

FUNCTIONAL DESCRIPTION: L2C (<http://hlcm.gforge.inria.fr>) is a Low Level Component model implementation targeting at use-cases where overhead matters such as High-Performance Computing. L2C does not offer network transparency neither language transparency. Instead, L2C lets the user choose between various kinds of interactions between components, some with ultra low overhead and others that support network transport. L2C is extensible as additional interaction kinds can be added quite easily. L2C currently supports C++, FORTRAN 2013, MPI and CORBA interactions.

- Participants: Christian Pérez, Hélène Coullon, Jérôme Richard and Vincent Lanore
- Partner: Maison de la simulation
- Contact: Christian Pérez
- URL: <http://hlcm.gforge.inria.fr/l2c:start>

5.5. Halley

KEYWORDS: Software Components - HPC

SCIENTIFIC DESCRIPTION: Halley is an implementation of the COMET component model that enable to efficiently compose independent parallel code using task graph for multi-core shared-memory machines.

NEWS OF THE YEAR: First operational version.

- Participants: Jérôme Richard and Christian Pérez
- Contact: Christian Pérez
- Publications: [Conception of a software component model with task scheduling for many-core based parallel architecture, application to the Gysela5D code](#) - [Combining Both a Component Model and a Task-based Model for HPC Applications: a Feasibility Study on GYSELA](#) - [COMET: A High-Performance Model for Fine-Grain Composition](#)

5.6. SimGrid

KEYWORDS: Large-scale Emulators - Grid Computing - Distributed Applications

SCIENTIFIC DESCRIPTION: SimGrid is a toolkit that provides core functionalities for the simulation of distributed applications in heterogeneous distributed environments. The simulation engine uses algorithmic and implementation techniques toward the fast simulation of large systems on a single machine. The models are theoretically grounded and experimentally validated. The results are reproducible, enabling better scientific practices.

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The formal verification module explores all possible message interleavings in the application, searching for states violating the provided properties. We recently added the ability to assess liveness properties over arbitrary and legacy codes, thanks to a system-level introspection tool that provides a finely detailed view of the running application to the model checker. This can for example be leveraged to verify both safety or liveness properties, on arbitrary MPI code written in C/C++/Fortran.

RELEASE FUNCTIONAL DESCRIPTION:

- Four releases in 2017. Major changes:
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 - New models: Multi-core VMs, Energy consumption due to the network
 - All internals are now converted to C++, and most of our internally developed data containers were replaced with std::* constructs.
 - (+ bug fixes, cleanups and documentation improvements)
- Participants: Adrien Lèbre, Arnaud Legrand, Augustin Degomme, Florence Perronnin, Frédéric Suter, Jean-Marc Vincent, Jonathan Pastor, Jonathan Rouzaud-Cornabas, Luka Stanisic, Mario Südholt and Martin Quinson
- Partners: CNRS - ENS Rennes
- Contact: Martin Quinson
- URL: <http://simgrid.gforge.inria.fr/>

5.7. execo

KEYWORDS: Toolbox - Deployment - Orchestration - Python

FUNCTIONAL DESCRIPTION: Execo offers a Python API for asynchronous control of local or remote, standalone or parallel, unix processes. It is especially well suited for quickly and easily scripting workflows of parallel/distributed operations on local or remote hosts: automate a scientific workflow, conduct computer science experiments, perform automated tests, etc. The core python package is execo. The execo_g5k package provides a set of tools and extensions for the Grid5000 testbed. The execo_engine package provides tools to ease the development of computer sciences experiments.

- Participants: Florent Chuffart, Laurent Pouilloux and Matthieu Imbert
- Contact: Matthieu Imbert
- URL: <http://execo.gforge.inria.fr>

5.8. Grid'5000

Participants: Laurent Lefèvre, Simon Delamare, David Loup, Christian Perez.

FUNCTIONAL DESCRIPTION

The Grid'5000 experimental platform is a scientific instrument to support computer science research related to distributed systems, including parallel processing, high performance computing, cloud computing, operating systems, peer-to-peer systems and networks. It is distributed on 10 sites in France and Luxembourg, including Lyon. Grid'5000 is a unique platform as it offers to researchers many and varied hardware resources and a complete software stack to conduct complex experiments, ensure reproducibility and ease understanding of results. In 2016, a new cluster financially supported by Inria has been deployed on the Grid'5000 Lyon site.

- Contact: Laurent Lefèvre
- URL: <https://www.grid5000.fr/>

5.9. Leco

Participants: Thierry Gautier, Laurent Lefèvre, Christian Perez.

FUNCTIONAL DESCRIPTION

The LECO experimental platform is a new medium size scientific instrument funded by DRRT to investigate research related to BigData and HPC. It is located in Grenoble as part of the the HPCDA computer managed by UMS GRICAD. The installation starts in December 2017.

- Contact: Thierry Gautier

COAST Project-Team

4. New Software and Platforms

4.1. BeGood

FUNCTIONAL DESCRIPTION: BeGood is a generic system for managing non-regression tests on knowledge bases. BeGood allows to define test plans in order to monitor the evolution of knowledge-bases. Any system answering queries by providing results in the form of set of strings can be tested with BeGood. BeGood has been developed following a REST architecture and is independent of any application domain. BeGood is a part of the Kolflow infrastructure.

- Participant: G r me Canals
- Contact: G r me Canals
- URL: <https://github.com/kolflow/begood>

4.2. MUTE

Multi-User Text Editor

FUNCTIONAL DESCRIPTION: MUTE (Multi-User Text Editor) is a web-based text editing tool that allows to edit documents collaboratively in real-time. It implements our recent work on collaborative editing algorithms and more specifically the LogootSplit+ approach. Compared to existing web-based collaborative text editing tool this editor does not require a powerful central server since the server is not performing any computation and acts as a simple broadcast server. Our editor offers support for working offline while still being able to reconnect at a later time.

- Participants: Claudia-Lavinia Ignat, Fran ois Charoy, G r ald Oster and Luc Andr 
- Contact: G r ald Oster
- URL: <https://github.com/coast-team/mute-demo/>

4.3. Replication Benchmark

FUNCTIONAL DESCRIPTION: The Replication Benchmark is a performance evaluation framework for optimistic replication mechanisms used in collaborative applications. It contains a library of implementation of several CRDT (Commutative Replicated Data Type) and OT (Operational Transformation) algorithms for different data types: text, set, trees. The framework is able to evaluate the performance of comparable algorithms on different corpus of events traces. These events traces can be produced randomly according to different parameters, can be extracted from real real-time editing session that have been recorded, or can be automatically extracted from distributed version control repositories such as the one produced with Git. Performances of the algorithms are measured in term of execution time, memory footprint and merge result quality (compared to manual merge history stored in git repositories).

- Participants: G r ald Oster, Mehdi Ahmed-Nacer and Pascal Urso
- Contact: Pascal Urso
- URL: <https://github.com/score-team/replication-benchmark/>

4.4. Rivage

Real-time Vector graphic Group Editor

FUNCTIONAL DESCRIPTION: Rivage is a real-time collaborative graphical editor. Several users can edit at the same time and in real-time a graphical document, user changes being immediately seen by the other users. The editor relies on a peer-to-peer architecture where users can join and leave the group at any time. Each user has a copy of the shared document and user changes on the document copies are merged in real-time by using a CRDT (Commutative Replicated Data Type) algorithm.

- Participant: Claudia-Lavinia Ignat
- Contact: Claudia-Lavinia Ignat
- URL: <https://github.com/stephanemartin/rivage/>

COATI Project-Team

6. New Software and Platforms

6.1. BigGraphs

KEYWORDS: Graph algorithmics - Distributed computing - Java - Graph processing

FUNCTIONAL DESCRIPTION: The objective of BigGraphs is to provide a distributed platform for very large graphs processing. A typical data set for testing purpose is a sample of the Twitter graph : 240GB on disk, 398M vertices, 23G edges, average degree of 58 and max degree of 24635412.

We started the project in 2014 with the evaluation of existing middlewares (GraphX / Spark and Giraph / Hadoop). After having tested some useful algorithms (written according to the BSP model) we decided to develop our own platform.

This platform is based on the existing BIGGRPH library and we are now in the phasis where we focus on the quality and the improvement of the code. In particular we have designed strong test suites and some non trivial bugs have been fixed. We also have solved problems of scalability, in particular concerning the communication layer with billions of messages exchanged between BSP steps. We also have implemented specific data structures for BSP and support for distributed debugging. This comes along with the implementation of algorithms such as BFS or strongly connected components that are run on the NEF cluster.

In 2017 we have developed a multi-threaded shared-memory parallel version of the Bulk Synchronous Parallel framework. This new version uses advanced synchronization mechanisms and strategies to minimize the congestion of multiple threads working on the same graph. Using the NEF cluster (Inria Sophia Antipolis), this parallel version exhibits speed-ups up to 6.5 using 8 nodes (16 cores each) when computing a BFS on the 23 G edges Twitter graph sample.

- Participants: Luc Hogie, Michel Syska and Nicolas Chleq
- Partner: CNRS
- Contact: Luc Hogie

6.2. GRPH

The high performance graph library for Java

KEYWORDS: Graph - Graph algorithmics - Java

FUNCTIONAL DESCRIPTION: Grph is an open-source Java library for the manipulation of graphs. Its design objectives are to make it portable, simple to use/extend, computationally/memory efficient, and, according to its initial motivation: useful in the context of graph experimentation and network simulation. Grph also has the particularity to come with tools like an evolutionary computation engine, a bridge to linear programming solvers, a framework for distributed computing, etc.

Grph offers a very general model of graphs. Unlike other graph libraries which impose the user to first decide if he wants to deal with directed, undirected, hyper (or not) graphs, the model offered by Grph is unified in a general class that supports mixed graphs made of undirected and directed simple and hyper edges. Grph achieves great efficiency through the use of multiple code optimization techniques such as multi-core parallelism, caching, adequate data structures, use of primitive objects, exploitation of low-level processor caches, on-the-fly compilation of specific C/C++ code, etc. Grph attempts to access the Internet in order to check if a new version is available and to report who is using it (login name and hostname). This has no impact whatsoever on performance and security.

- Participants: Aurélien Lancin, David Coudert, Issam Tahiri, Luc Hogie and Nathann Cohen
- Contact: Luc Hogie
- URL: <http://www.i3s.unice.fr/~hogie/grph/>

6.3. Sage

SageMath

SCIENTIFIC DESCRIPTION: SageMath is a free open-source mathematics software system. It builds on top of many existing open-source packages: NumPy, SciPy, matplotlib, Sympy, Maxima, GAP, FLINT, R and many more. Access their combined power through a common, Python-based language or directly via interfaces or wrappers.

FUNCTIONAL DESCRIPTION: SageMath is an open-source mathematics software initially created by William Stein (Professor of mathematics at Washington University). We contribute the addition of new graph algorithms along with their documentations and the improvement of underlying data structures.

- Contact: David Coudert
- URL: <http://www.sagemath.org/>

CTRL-A Project-Team

5. New Software and Platforms

5.1. Heptagon

KEYWORDS: Compilers - Synchronous Language - Controller synthesis

FUNCTIONAL DESCRIPTION: Heptagon is an experimental language for the implementation of embedded real-time reactive systems. It is developed inside the Synchronics large-scale initiative, in collaboration with Inria Rhones-Alpes. It is essentially a subset of Lucid Sychrone, without type inference, type polymorphism and higher-order. It is thus a Lustre-like language extended with hierchical automata in a form very close to SCADE 6. The intention for making this new language and compiler is to develop new aggressive optimization techniques for sequential C code and compilation methods for generating parallel code for different platforms. This explains much of the simplifications we have made in order to ease the development of compilation techniques.

The current version of the compiler includes the following features: - Inclusion of discrete controller synthesis within the compilation: the language is equipped with a behavioral contract mechanisms, where assumptions can be described, as well as an "enforce" property part. The semantics of this latter is that the property should be enforced by controlling the behaviour of the node equipped with the contract. This property will be enforced by an automatically built controller, which will act on free controllable variables given by the programmer. This extension has been named BZR in previous works. - Expression and compilation of array values with modular memory optimization. The language allows the expression and operations on arrays (access, modification, iterators). With the use of location annotations, the programmer can avoid unnecessary array copies.

- Participants: Adrien Guatto, Brice Gelineau, Cédric Pasteur, Eric Rutten, Gwenaël Delaval, Léonard Gérard and Marc Pouzet
- Partners: UGA - ENS Paris - Inria - LIG
- Contact: Gwenaël Delaval
- URL: <http://heptagon.gforge.inria.fr>

DANTE Project-Team

6. New Software and Platforms

6.1. GraSP

Graph Signal Processing

KEYWORDS: Signal processing - Graph visualization - Graph - LaTeX - Matlab - GNU Octave

FUNCTIONAL DESCRIPTION: Matlab / GNU Octave toolbox to manipulate and visualize signals on graphs. LaTeX package to draw signals.

- Contact: Benjamin Girault

6.2. IoT-LAB aggregation-tools

KEYWORD: Internet of things

FUNCTIONAL DESCRIPTION: IoT-LAB aggregation-tools allow aggregating data results from many nodes at a time. It connects to several tcp connections and handle the received data.

- Participant: Gaetan Harter
- Contact: Eric Fleury
- URL: <https://github.com/iot-lab/aggregation-tools>

6.3. IoT-LAB cli-tools

KEYWORD: Internet of things

FUNCTIONAL DESCRIPTION: IoT-LAB cli-tools provide a basic set of operations for managing IoT-LAB experiments from the command-line.

- Participants: Frédéric Saint-Marcel and Gaetan Harter
- Contact: Eric Fleury
- URL: <https://github.com/iot-lab/cli-tools>

6.4. IoT-LAB gateway

KEYWORD: Internet of things

FUNCTIONAL DESCRIPTION: IoT-LAB software embedded on a IoT-LAB gateway node new generation provides the local management of the experiment on that node. It is a software bridge between the IoT-LAB server, the user open node and the control node.

- Contact: Frédéric Saint-Marcel
- URL: <https://github.com/iot-lab/iot-lab-gateway>

6.5. IoT-LAB robots

KEYWORDS: Internet of things - Robotics

FUNCTIONAL DESCRIPTION: IoT-LAB robots is an embedded robot controller on a Turtlebot2 providing the IoT-LAB node mobility fonctionnality

- Partner: Université de Strasbourg
- Contact: Julien Vandaële
- URL: <https://github.com/iot-lab/>

6.6. Queueing Systems

FUNCTIONAL DESCRIPTION: This tool aims at providing a simple web interface to promote the use of our proposed solutions to numerically solve classical queueing systems.

- Participants: Alexandre Brandwajn and Thomas Begin
- Contact: Thomas Begin
- URL: <http://queueing-systems.ens-lyon.fr/>

6.7. WSNet

KEYWORD: Network simulator

FUNCTIONAL DESCRIPTION: WSNet is a modular event-driven simulator targeted to Wireless Sensor Networks. Its main goals are to offer scalability, extensibility and modularity for the integration of new protocols/hardware models and a precise radio medium simulation. We still hope to find the proper resource to make WSNet evolve into a wireless capillary network simulator suitable for conducting simulations at the urban scale.

- Participants: Rodrigue Domga Komguem and Fabrice Valois
- Partner: CEA-LETI
- Contact: Guillaume Chelius
- URL: <https://gforge.inria.fr/projects/wsnet-3/>

6.8. Platforms

6.8.1. FIT IoT-LAB

FUNCTIONAL DESCRIPTION

IoT-LAB provides full control of network IoT nodes and direct access to the gateways to which nodes are connected, allowing researchers to monitor nodes energy consumption and network-related metrics, e.g. end-to-end delay, throughput or overhead. The facility offers quick experiments deployment, along with easy evaluation, results collection and analysis. Defining complementary testbeds with different node types, topologies and environments allows for coverage of a wide range of real-life use-cases.

- Partner: FIT is one of 52 winning projects from the first wave of the French Ministry of Higher Education and Research (Équipement d'Excellence (Equipex) research grant programme. The FIT consortium is composed of: Université Pierre et Marie Curie (UPMC), Inria, Université de Strasbourg, Institut Mines Télécom and CNRS
- Contact: Éric Fleury
- URL: <https://www.iot-lab.info/>

DATAMOVE Project-Team

6. New Software and Platforms

6.1. FlowVR

SCIENTIFIC DESCRIPTION: FlowVR adopts the "data-flow" paradigm, where your application is divided as a set of components exchanging messages (think of it as a directed graph). FlowVR enables to encapsulate existing codes in components, interconnect them through data channels, and deploy them on distributed computing resources. FlowVR takes care of all the heavy lifting such as application deployment and message exchange.

The base entity, called a module or component, is an autonomous process, potentially multi-threaded with tools like OpenMP, TBB, or deferring computations to a GPU or Xeon Phi. This module processes data coming from input ports and write data on output ports. A module has no global insight on where the data comes from or goes to. The programming interface is designed to limit code refactoring, easing turning an existing code into a FlowVR component. The three main functions are:

`wait()`: Blocking function call that waits for the availability of new messages on input ports. `get()`: Retrieve a handle to access the message received at the previous `wait()` call on a given input port. `put()`: Notify FlowVR that a new message on a given output port is ready for dispatch. FlowVR manages data transfers. Intra-node communications between two components take place through a shared memory segment, avoiding copies. Once the sender has prepared the data in a shared memory segment, it simply handles a pointer to the destination that can directly access them. Inter-node communications extend this mechanism, FlowVR taking care of packing and transferring the data from the source shared memory segment to the destination shared memory segment.

Assembling components to build an application consists in writing a Python script, instantiate it according to the target machine. FlowVR will process it and prepare everything so that in one command line you can deploy and start your application.

FUNCTIONAL DESCRIPTION: FlowVR adopts the "data-flow" paradigm, where your application is divided as a set of components exchanging messages (think of it as a directed graph). FlowVR enables to encapsulate existing codes in components, interconnect them through data channels, and deploy them on distributed computing resources. FlowVR takes care of all the heavy lifting such as application deployment and message exchange.

- Participants: Bruno Raffin, Clément Ménier, Emmanuel Melin, Jean Denis Lesage, Jérémie Allard, Jérémy Jaussaud, Matthieu Dreher, Sébastien Limet, Sophie Robert and Valérie Gourantou
- Contact: Bruno Raffin
- URL: <http://flowvr.sf.net>

6.2. OAR

KEYWORDS: Resource manager - Clusters - Cloud - HPC - Light grid

SCIENTIFIC DESCRIPTION: This batch system is based on a database (PostgreSQL (preferred) or MySQL), a script language (Perl) and an optional scalable administrative tool (e.g. Taktuk). It is composed of modules which interact mainly via the database and are executed as independent programs. Therefore, formally, there is no API, the system interaction is completely defined by the database schema. This approach eases the development of specific modules. Indeed, each module (such as schedulers) may be developed in any language having a database access library.

FUNCTIONAL DESCRIPTION: OAR is a versatile resource and task manager (also called a batch scheduler) for HPC clusters, and other computing infrastructures (like distributed computing experimental testbeds where versatility is a key).

- Participants: Bruno Bzeznik, Olivier Richard and Pierre Neyron
- Partners: LIG - CNRS - Grid'5000 - CIMENT
- Contact: Olivier Richard
- URL: <http://oar.imag.fr>

6.3. MELISSA

Modular External Library for In Situ Statistical Analysis

KEYWORD: Sensitivity Analysis

FUNCTIONAL DESCRIPTION: Melissa is an in situ solution for sensitivity analysis. It implements iterative algorithms to compute spatio-temporal statistic fields over results of large scale sensitivity studies. Melissa relies on a client/server architecture, composed of three main modules:

Melissa Server: an independent parallel executable. It receives data from the simulations, updates iterative statistics as soon as possible, then throw data away. Melissa API: a shared library to be linked within the simulation code. It mainly transmit simulation data to Melissa Server at each timestep. The simulations of the sensitivity analysis become the clients of Melissa Server. Melissa Launcher: A Python script in charge of generating and managing the whole global sensitivity analysis.

- Authors: Théophile Terraz, Bruno Raffin, Alejandro Ribes and Bertrand Iooss
- Partner: Edf
- Contact: Bruno Raffin
- Publications: [In Situ Statistical Analysis for Parametric Studies - Melissa: Large Scale In Transit Sensitivity Analysis Avoiding Intermediate Files](#)
- URL: <https://melissa-sa.github.io>

6.4. Platforms

6.4.1. Grid'5000 (<https://www.grid5000.fr/>) and Meso Center Ciment (<https://ciment.ujf-grenoble.fr>)

We have been very active in promoting the factorization of compute resources at a regional and national level. We have a three level implication, locally to maintain a pool of very flexible experimental machines (hundreds of cores), regionally through the CIMENT meso center (Equipex Grant), and nationally by contributing to the Grid'5000 platform, our local resources being included in this platform. Olivier Richard is member of Grid'5000 scientific committee and Pierre Neyron is member of the technical committee. The OAR scheduler in particular is deployed on both infrastructures. We are currently preparing proposals for the next generation machines within the context of the new university association (Univ. Grenoble-Alpes).

DIANA Project-Team

5. New Software and Platforms

5.1. ACQUAmobile

KEYWORDS: Android - Internet access - Performance measure - Quality of Experience

FUNCTIONAL DESCRIPTION: ACQUA is an Application for prediCting QQuality of Experience (QoE) at Internet Access. It is developed by the Diana team at Inria Sophia Antipolis – Méditerranée and is supported by Inria under the ADT ACQUA grant. The scientific project around ACQUA is supported by Inria Project Lab BetterNet and the French National Project ANR BottleNet. ACQUA presents a new way for the evaluation of the performance of Internet access. Starting from network-level measurements as the ones we often do today (bandwidth, delay, loss rates, jitter, etc), ACQUA targets the estimated Quality of Experience (QoE) related to the different applications of interest to the user without the need to run them (e.g., estimated Skype quality, estimated video streaming quality).

An application in ACQUA is a function, or a model, that links the network-level and device-level measurements to the expected Quality of Experience. Supervised machine learning techniques are used to establish such link between measurements both at the network level and the device level, and estimations of the Quality of Experience for different Internet applications. The required data for such learning can be obtained either by controlled experiments as we did in [19] on YouTube Quality of Experience, or by soliciting the crowd (i.e. crowdsourcing) for combinations (i.e. tuples) of measurements and corresponding application-level Quality of Experience. Our current work is concentrating on using the ACQUA principle in the estimation and prediction of the Quality of Experience for main user's applications. We refer to the web site of the project for further details.

The ACQUA Android application is supposed to be on one hand the reference application for QoE forecasting and troubleshooting for end users at their Internet access, and on the other hand, the feedback channel that allows end users to report to us (if they are willing) on their experience together with the corresponding network measurements so as to help us calibrating better and more realistic models. For this calibration, we are currently performing extensive, efficient and automatic measurements in the laboratory, we will count on end users to help us completing this dataset with further applications and more realistic network and user conditions.

ACQUA is mainly meant for end users, but it is also of interest to (mobile) network operators and to content providers to estimate the QoE of their customers and their networks without each time having to run expensive application-level traffic and to involve real users.

- Authors: Thierry Spetebroot and Chadi Barakat
- Contact: Chadi Barakat
- URL: <http://project.inria.fr/acqua/>

5.2. ElectroSmart

KEYWORDS: Crowd-sourcing - UMTS - GSM - Bluetooth - Wi-Fi - 4G - 3G - 2G - Electromagnetic waves - Android - LTE

FUNCTIONAL DESCRIPTION: The Internet and new devices such as smartphones have fundamentally changed the way people communicate, but this technological revolution comes at the price of a higher exposition of the general population to microwave electromagnetic fields (EMF). This exposition is a concern for health agencies and epidemiologists who want to understand the impact of such an exposition on health, for the general public who wants a higher transparency on its exposition and the health hazard it might represent, but also for cellular operators and regulation authorities who want to improve the cellular coverage while limiting the exposition, and for computer scientists who want to better understand the network connectivity in order to optimize communication protocols. Despite the fundamental importance to understand the exposition of the general public to EMF, it is poorly understood because of the formidable difficulty to measure, model, and analyze this exposition.

The goal of the ElectroSmart project is to develop the instrument, methods, and models to compute the exposition of the general public to microwave electromagnetic fields used by wireless protocols and infrastructures such as Wi-Fi, Bluetooth, or cellular. Using a pluri-disciplinary approach combining crowd-based measurements, in-lab experiments, and modeling using sparse and noisy data, we address challenges such as designing and implementing a measuring instrument leveraging on crowd-based measurements from mobile devices such as smartphones, modeling the exposition of the general public to EMF to compute the most accurate estimation of the exposition, and analyzing the evolution of the exposition to EMF with time. This technological breakthrough will have scientific, technical, and societal applications, notably on public health politics, by providing the scientific community and potential users with a unique measuring instrument, methods, and models to exploit the invaluable data gathered by the instrument.

This project is supported by the UCN@Sophia Labex in 2016/2017/2018 (funding the engineer Mondri Ravi), by an Inria ADT (funding the engineer Abdelhakim Akodadi) 2017/2018, by and Inria ATT (funding the business developer David Migliacci) in 2017/2018, and by the academy 1 of UCAJedi (funding a Ph.D. student Yanis Boussad) 2017/2020.

In August 2016, we released the first stable public release of ElectroSmart. On the 22th December 2017 we have 35 836 downloads in Google Play, an average score of 4,6/5, 10 538 active users, 350 millions measured signals.

We are in a process of creating a startup to commercialize the exposition maps we can build with the data we are collecting.

- Participants: Arnaud Legout, Hackob Melconian, Inderjeet Singh and Mondri Ravi
- Contact: Arnaud Legout
- URL: https://es.inria.fr/home/index?path_prefix=en

5.3. OpenLISP

KEYWORDS: LISP - Routing - Control-plane

FUNCTIONAL DESCRIPTION: Among many options tackling the scalability issues of the current Internet routing architecture, the Locator/Identifier Separation Protocol (LISP) appears as a viable solution. LISP improves a network's scalability, flexibility, and traffic engineering, enabling mobility with limited overhead. As for any new technology, implementation and deployment are essential to gather and master the real benefits that it provides. We propose a complete open source implementation of the LISP control plane. Our implementation is deployed in the worldwide LISP Beta Network and the French LISP-Lab testbed, and includes the key standardized control plane features. Our control plane software is the companion of the existing OpenLISP dataplane implementation, allowing the deployment of a fully functional open source LISP network compatible with any implementation respecting the standards.

- Contact: Damien Saucez
- URL: <http://www.openlisp.org/downloads>

5.4. nepi-ng

KEYWORDS: Wireless network - Experimentation

FUNCTIONAL DESCRIPTION: In the specific context of R2lab, we have created a tool suite for orchestrating network experiments, that for historical reasons we refer to collectively as `nepi-ng`, for NEPI new generation. An umbrella website is available at <https://nepi-ng.inria.fr/>.

At this point, `nepi-ng` has a much smaller scope than its NEPI ancestor used to have, in that it only supports remote control of network experiments over `ssh`. As a matter of fact, in practice, this is the only access mechanism that we need to have for running experiments on both R2lab, and PlanetLab Europe.

The design of `nepi-ng` of course is modular, so that it will be perfectly possible to add other control mechanisms to this core if and when it becomes necessary.

`nepi-ng` is currently made of 2 separate python libraries :

- `asynciojobs`:
 - URL: <http://asynciojobs.readthedocs.io/en/latest/>
 - Version: `asynciojobs` v0.5.4
 - Keywords: networking experimentation, orchestration
 - License: CC BY-SA 4.0
 - Type of human computer interaction: python library
 - OS/Middleware: Linux
 - Required library or software: python-3.5 / `asyncio`
 - Programming language: python3
- `apssh`:
 - URL: <http://apssh.readthedocs.io/en/latest/>
 - Version: `apssh` v0.7.1
 - Keywords: networking experimentation, orchestration
 - License: CC BY-SA 4.0
 - Type of human computer interaction: python library
 - OS/Middleware: Linux
 - Required library or software: python-3.5 / `asyncio`
 - Programming language: python3
- Contact: Thierry Parmentelat
- URL: <http://nepi-ng.inria.fr>

5.5. Platforms

5.5.1. Reproducible research laboratory (R²lab)

Scientific evaluation of network protocols requires for experiments to be reproducible before they can be deemed valid. This is particularly difficult to obtain in the wireless networking area, where characteristics of wireless channels are known to be variable, unpredictable and hardly controllable.

The R²lab wireless testbed is built around an isolated and anechoic chamber, featuring RF absorbers preventing radio waves reflections and a Faraday cage blocking external interferences. This lab, named R²lab, represents an ideal environment for experiments reproducibility.

It represents a perfect facility for making wireless experiments reproducible. It has been operated for 3 years now, in the context of the FIT Equipment of Excellence project, and as such, it is now federated with the other testbeds that are part of the FIT initiative. This testbed is for the long-haul, and is scheduled to remain operational until at least 2020.

During 2017, our focus regarding R²lab has been set on deploying more, and more diverse USRPs (Universal Software Radio Peripherals). The chamber now offers more Ettus-based devices, as well as a couple of lime-sdr devices, and a couple of E3372 LTE dongles. An apple iphone will soon be available, in addition to the first nexus phone. All these additions aim at widening even further the spectrum of experiments that the testbed can support.

For more details see <http://r2lab.inria.fr>.

DIONYSOS Project-Team

6. New Software and Platforms

6.1. IPv6 Test Toolkit

FUNCTIONAL DESCRIPTION: These test suites are developed using the TTCN-3 environment.

The packages contains the full Abstract Test Suites written in TTCN-3 and the source files for building the codecs and adapters with the help of T3DevKit.

- Participants: Annie Floch, Anthony Baire, Ariel Sabiguero, Bruno Deniaud, César Viho and Frédéric Roudaut
- Contact: César Viho

6.2. Passive Test Tool

- Participants: Anthony Baire and César Viho
- Contact: Anthony Baire

6.3. T3DevKit

KEYWORDS: IPv6 - Conformance testing - TTCN-3

SCIENTIFIC DESCRIPTION: We have built a toolkit for easing executing tests written in the standardized TTCN-3 test specification language. This toolkit is made of a C++ library together with a highly customizable CoDec generator that allows fast development of external components (that are required to execute a test suite) such as CoDec (for message Coding/Decoding), System and Platform Adapters. It also provides a framework for representing and manipulating TTCN-3 events so as to ease the production of test reports. The toolkit addresses issues that are not yet covered by ETSI standards while being fully compatible with the existing standard interfaces: TRI (Test Runtime Interfaces) and TCI (Test Control Interfaces), it has been tested with four TTCN-3 environments (IBM, Elvior, Danet and Go4IT) and on three different platforms (Linux, Windows and Cygwin).

FUNCTIONAL DESCRIPTION: T3DevKit is a free open source toolkit to ease the development of test suites in the TTCN-3 environment. It provides:

a CoDec generator (t3cdgen) that automates the development process of the CoDec needed for coding TTCN-3 values into physically transmittable messages and decoding incoming messages a library (t3devlib) that provides an object oriented framework to manipulate TTCN-3 entities (values, ports, timers, external functions. . .) an implementation of the TRI and TCI standard interfaces default implementations for the system adapter (SA), platform adapter (PA), test management (TM), test logging (TL) and component handling (CH) modules default codecs build scripts for the generation of executable test suites, these are tool-independent and facilitate the distribution of test suite sources

- Participants: Annie Floch, Anthony Baire, Ariel Sabiguero, César Viho and Frédéric Roudaut
- Contact: Federico Sismondi

6.4. ttproto

Testing Tool Prototype

KEYWORDS: Interoperability - Conformance testing - TTCN-3

FUNCTIONAL DESCRIPTION: ttproto is an experimental tool for implementing testing tools, for conformance and interoperability testing.

It was first implemented to explore new features and concepts for the TTCN-3 standard, but we also used it to implement a passive interoperability test suite we provided for the CoAP interoperability event held in Paris in March 2012.

This tool is implemented in python3 and its design was influenced mainly by TTCN-3 (abstract model, templates, snapshots, behaviour trees, communication ports, logging) and by Scapy (syntax, flexibility, customisability)

Its purpose is to facilitate rapid prototyping rather than experimentations (rather than production use). We choosed to maximise its modularity and readability rather than performances and real-time considerations.

Now you should have a look at the Features page: https://www.irisa.fr/tipi/wiki/doku.php/testing_tool_prototype:features

- Contact: Federico Sismondi
- URL: https://www.irisa.fr/tipi/wiki/doku.php/testing_tool_prototype

6.5. CoAP Testing Tool

KEYWORDS: Test - Interoperability - Conformance testing - Plugtests

FUNCTIONAL DESCRIPTION: The software helps developers of the CoAP protocol assessing if their implementations (either CoAP clients or CoAP servers) are conformant to protocol specifications, and interoperable with other implementations. It encompasses:

- Coordination of CoAP interoperability tests
- Analysis of CoAP traces & issuing verdicts
- Automation of open source CoAP implementations for based reference interop testing
- Authors: Federico Sismondi and César Viho
- Contact: Federico Sismondi

6.6. ioppytest

Interoperability testing

KEYWORDS: Interoperability - Conformance testing - CoAP - 6LoWPAN - OneM2M

FUNCTIONAL DESCRIPTION: The software is a framework for developing interoperability tests. The interoperability tests help developers of network protocol assessing if their implementations are conformant to protocol specifications, and interoperable with other implementations.

The software already integrates interoperability tests for CoAP, OneM2M and 6LoWPAN The framework provides the following features to the users:

- Coordination of the interoperability tests (enabling remote testing)
- VPN-like connectivity between users' implementations (enabling remote testing)
- Analysis of exchanged network traces & issuing verdicts
- Automation of open source implementations for based reference interop testing

This framework is the evolution of the CoAP Testing Tool (<https://bil.inria.fr/fr/software/view/2937/tab>)

- Contact: Federico Sismondi
- URL: <https://gitlab.f-interop.eu/f-interop-contributors/ioppytest>

6.7. AdaComp

Participants: Corentin Hardy, Bruno Sericola

Our recent works, in collaboration with Technicolor, on deep learning and distributed learning led us to study a kind of data parallelism called the Parameter Server model. This model consists in sharing the learning of a deep neural network between many devices (called the workers) via a centralized Parameter Server (PS). We deployed a platform which allow us to experiment different state-of-the-art algorithms based on the PS model. The platform is composed of a unique powerful machine where many Linux containers (LXC) are running. Each LXC executes a Tensorflow session and can be a worker or a PS. The first experimentations were used to validate the correct functioning of the platform, to better understand its limitations and to determine what can be measured in an unbiased way. Others experimentations helped us to understand the role of different parameters of the overall model, mainly those related to the distribution on user-devices, and their impact on the learning (accuracy of the model, number of iterations to learn the model). During these experimentations, we noted that the main bottleneck is the ingress traffic of PS during the learning phase. To reduce this ingress traffic, we chose to compress the messages sent by the workers to the PS. We proposed in [43] a method to reduce up to 2 orders of magnitude this ingress traffic, keeping a good accuracy on the learned model. This new method, called AdaComp, is available in github (<https://github.com/Hardy-c/AdaComp>).

6.8. DNN-withRNL

Participants: Corentin Hardy, Gerardo Rubino, Bruno Sericola

The extension of the AdaComp method, presented in 6.7 , to Random Neural Networks started with the introduction of Random Neural Layers, see [65]. Concerning the associated software, see <https://github.com/Hardy-c/DNN-with-RNL>.

DIVERSE Project-Team

6. New Software and Platforms

6.1. amiunique

KEYWORDS: Privacy - Browser fingerprinting

SCIENTIFIC DESCRIPTION: The amiunique web site has been deployed in the context of the DiverSE's research activities on browser fingerprinting and how software diversity can be leveraged in order to mitigate the impact of fingerprinting on the privacy of users. The construction of a dataset of genuine fingerprints is essential to understand in details how browser fingerprints can serve as unique identifiers and hence what should be modified in order to mitigate its impact privacy. This dataset also supports the large-scale investigation of the impact of web technology advances on fingerprinting. For example, we can analyze in details the impact of the HTML5 canvas element or the behavior of fingerprinting on mobile devices.

The whole source code of amiunique is open source and is distributed under the terms of the MIT license.

Similar sites: Panopticlick <https://panopticlick.eff.org/> BrowserSpy <http://browserspy.dk/> <http://noc.to/> Main innovative features: canvas fingerprinting WebGL fingerprinting advanced JS features (platform, DNT, etc.)

Impact: The website has been showcased in several professional forums in 2014 and 2015 (Open World Forum 2014, FOSSA'14, FIC'15, ICT'15) and it has been visited by more than 100000 unique visitors in one year.

FUNCTIONAL DESCRIPTION: This web site aims at informing visitors about browser fingerprinting and possible tools to mitigate its effect, as well as at collecting data about the fingerprints that can be found on the web. It collects browser fingerprints with the explicit agreement of the users (they have to click on a button on the home page). Fingerprints are composed of 17 attributes, which include regular HTTP headers as well as the most recent state of the art techniques (canvas fingerprinting, WebGL information).

- Participants: Benoit Baudry and Pierre Laperdrix
- Partner: INSA Rennes
- Contact: Benoit Baudry
- URL: <https://amiunique.org/>

6.2. FAMILIAR

KEYWORDS: Software line product - Configurators - Customisation

SCIENTIFIC DESCRIPTION: FAMILIAR (for FeAture Model scrIpt Language for manIpulation and Automatic Reasoning) is a language for importing, exporting, composing, decomposing, editing, configuring, computing "diffs", refactoring, reverse engineering, testing, and reasoning about (multiple) feature models. All these operations can be combined to realize complex variability management tasks. A comprehensive environment is proposed as well as integration facilities with the Java ecosystem.

FUNCTIONAL DESCRIPTION: Familiar is an environment for large-scale product customisation. From a model of product features (options, parameters, etc.), Familiar can automatically generate several million variants. These variants can take many forms: software, a graphical interface, a video sequence or even a manufactured product (3D printing). Familiar is particularly well suited for developing web configurators (for ordering customised products online), for providing online comparison tools and also for engineering any family of embedded or software-based products.

- Participants: Aymeric Hervieu, Benoit Baudry, Didier Vojtisek, Edward Mauricio Alferez Salinas, Guillaume Bécan, Joao Bosco Ferreira-Filho, Julien Richard-Foy, Mathieu Acher, Olivier Barais and Sana Ben Nasr
- Contact: Mathieu Acher
- URL: <http://familiar-project.github.com>

6.3. GEMOC Studio

KEYWORDS: DSL - Language workbench - Model debugging

SCIENTIFIC DESCRIPTION: The language workbench put together the following tools seamlessly integrated to the Eclipse Modeling Framework (EMF):

- Melange, a tool-supported meta-language to modularly define executable modeling languages with execution functions and data, and to extend (EMF-based) existing modeling languages. - MoCCML, a tool-supported meta-language dedicated to the specification of a Model of Concurrency and Communication (MoCC) and its mapping to a specific abstract syntax and associated execution functions of a modeling language. - GEL, a tool-supported meta-language dedicated to the specification of the protocol between the execution functions and the MoCC to support the feedback of the data as well as the callback of other expected execution functions. - BCOoL, a tool-supported meta-language dedicated to the specification of language coordination patterns to automatically coordinates the execution of, possibly heterogeneous, models. - Sirius Animator, an extension to the model editor designer Sirius to create graphical animators for executable modeling languages.

FUNCTIONAL DESCRIPTION: The GEMOC Studio is an eclipse package that contains components supporting the GEMOC methodology for building and composing executable Domain-Specific Modeling Languages (DSMLs). It includes the two workbenches: The GEMOC Language Workbench: intended to be used by language designers (aka domain experts), it allows to build and compose new executable DSMLs. The GEMOC Modeling Workbench: intended to be used by domain designersto create, execute and coordinate models conforming to executable DSMLs. The different concerns of a DSML, as defined with the tools of the language workbench, are automatically deployed into the modeling workbench. They parametrize a generic execution framework that provide various generic services such as graphical animation, debugging tools, trace and event managers, timeline, etc.

- Participants: Didier Vojtisek, Dorian Leroy, Erwan Bousse, Fabien Coulon and Julien Deantoni
- Partners: IRT - ENSTA - I3S - OBEO - Thales TRT
- Contact: Benoît Combemale
- URL: <http://gemoc.org/studio.html>

6.4. Kevoree

Kevoree Core

KEYWORDS: M2M - Dynamic components - Iot - Heterogeneity - Smart home - Cloud - Software architecture - Dynamic deployment

SCIENTIFIC DESCRIPTION: Kevoree is an open-source models@runtime platform (<http://www.kevoree.org>) to properly support the dynamic adaptation of distributed systems. Models@runtime basically pushes the idea of reflection [132] one step further by considering the reflection layer as a real model that can be uncoupled from the running architecture (e.g. for reasoning, validation, and simulation purposes) and later automatically resynchronized with its running instance.

Kevoree has been influenced by previous work that we carried out in the DiVA project [132] and the Entimid project [135]. With Kevoree we push our vision of models@runtime [131] farther. In particular, Kevoree provides a proper support for distributed models@runtime. To this aim we introduced the Node concept to model the infrastructure topology and the Group concept to model semantics of inter node communication during synchronization of the reflection model among nodes. Kevoree includes a Channel concept to allow for multiple communication semantics between remoteComponents deployed on heterogeneous nodes. All Kevoree concepts (Component, Channel, Node, Group) obey the object type design pattern to separate deployment artifacts from running artifacts. Kevoree supports multiple kinds of very different execution node technology (e.g. Java, Android, MiniCloud, FreeBSD, Arduino, ...).

Kevoree is distributed under the terms of the LGPL open source license.

Main competitors:

- the Fractal/Frascati eco-system (<http://frascati.ow2.org>).
- SpringSource Dynamic Module (<http://spring.io/>)

GCM-Proactive (<http://proactive.inria.fr/>)

OSGi (<http://www.osgi.org>)

Chef

Vagran (<http://vagrantup.com/>)

Main innovative features:

distributed models@runtime platform (with a distributed reflection model and an extensible models@runtime dissemination set of strategies).

Support for heterogeneous node type (from Cyber Physical System with few resources until cloud computing infrastructure).

Fully automated provisioning model to correctly deploy software modules and their dependencies.

Communication and concurrency access between software modules expressed at the model level (not in the module implementation).

Impact:

Several tutorials and courses have been performed this year at EJCP for French PhD student, at ECNU summer school for 82 chinese PhD students. See also the web page <http://www.kevoree.org> .

In 2015, we mainly created a new implementation in C# and we created an implementation for system containers for driving resources using Kevoree. We also use Kevoree in the context of Mohammed's PhD to create testing infrastructure on-demand.

FUNCTIONAL DESCRIPTION: Kevoree is an open-source models@runtime platform to properly support the dynamic adaptation of distributed systems. Models@runtime basically pushes the idea of reflection one step further by considering the reflection layer as a real model that can be uncoupled from the running architecture (e.g. for reasoning, validation, and simulation purposes) and later automatically resynchronized with its running instance.

- Participants: Aymeric Hervieu, Benoit Baudry, Francisco-Javier Acosta Padilla, Inti Gonzalez Herrera, Ivan Paez Anaya, Jacky Bourgeois, Jean Emile Dartois, Johann Bourcier, Manuel Leduc, Maxime Tricoire, Mohamed Boussaa, Noël Plouzeau and Olivier Barais
- Contact: Olivier Barais
- URL: <http://kevoree.org/>

6.5. Melange

KEYWORDS: Modeling language - Meta-modelisation - Language workbench - Dedicated langage - Model-driven software engineering - DSL - MDE - Meta model - Model-driven engineering - Meta-modeling

SCIENTIFIC DESCRIPTION: Melange is a follow-up of the executable metamodeling language Kermeta, which provides a tool-supported dedicated meta-language to safely assemble language modules, customize them and produce new DSMLs. Melange provides specific constructs to assemble together various abstract syntax and operational semantics artifacts into a DSML. DSMLs can then be used as first class entities to be reused, extended, restricted or adapted into other DSMLs. Melange relies on a particular model-oriented type system that provides model polymorphism and language substitutability, i.e. the possibility to manipulate a model through different interfaces and to define generic transformations that can be invoked on models written using different DSLs. Newly produced DSMLs are correct by construction, ready for production (i.e., the result can be deployed and used as-is), and reusable in a new assembly.

Melange is tightly integrated with the Eclipse Modeling Framework ecosystem and relies on the meta-language Ecore for the definition of the abstract syntax of DSLs. Executable meta-modeling is supported by weaving operational semantics defined with Xtend. Designers can thus easily design an interpreter for their DSL in a non-intrusive way. Melange is bundled as a set of Eclipse plug-ins.

FUNCTIONAL DESCRIPTION: Melange is a language workbench which helps language engineers to mashup their various language concerns as language design choices, to manage their variability, and support their reuse. It provides a modular and reusable approach for customizing, assembling and integrating DSMLs specifications and implementations.

- Participants: Arnaud Blouin, Benoît Combemale, David Mendez Acuna, Didier Vojtisek, Dorian Leroy, Erwan Bousse, Fabien Coulon, Jean-Marc Jézéquel, Olivier Barais and Thomas Degueule
- Contact: Benoît Combemale
- URL: <http://melange-lang.org>

6.6. Opencompare

KEYWORD: Software Product Line

FUNCTIONAL DESCRIPTION: Product comparison matrices (PCMs) are tabular data: supported and unsupported features are documented for both describing the product itself and for discriminating one product compared to another. PCMs abound – we are all using PCMs – and constitute a rich source of knowledge for easily comparing and choosing product. Yet the current practice is suboptimal both for humans and computers, mainly due to unclear semantics, heterogeneous forms of data, and lack of dedicated support.

OpenCompare.org is an ambitious project for the collaborative edition, the sharing, the standardisation, and the open exploitation of PCMs. The goal of OpenCompare.org is to provide an integrated set of tools (e.g., APIs, visualizations, configurators, editors) for democratizing their creation, import, maintenance, and exploitation.

- Participants: Guillaume Bécane, Mathieu Acher and Sana Ben Nasr
- Contact: Mathieu Acher
- URL: <http://opencompare.org>

DYOGENE Project-Team

6. New Software and Platforms

6.1. CloNES

CLOsed queueing Networks Exact Sampling

FUNCTIONAL DESCRIPTION: Clones is a Matlab toolbox for exact sampling of closed queueing networks.

- Participant: Christelle Rovetta
- Contact: Christelle Rovetta
- URL: <http://www.di.ens.fr/~rovetta/Clones/index.html>

6.2. Platforms

6.2.1. CapRadio

Cellular network dimensioning toolbox *CapRadio* is being developed by Orange in a long-term collaboration between TREC/DYOGENE represented by B. Blaszczyzyn, and Orange Labs, represented by M. K. Karray. This year it has been enriched by the results of the contract titled “Scheduling effect on the distribution of QoS over cells in 4G wireless cellular networks”; cf [8.1.1](#) .

EVA Project-Team

6. New Software and Platforms

6.1. OpenWSN

KEYWORDS: Internet of things - 6TiSCH - 6LoWPAN - CoAP

FUNCTIONAL DESCRIPTION: OpenWSN is an open-source implementation of a fully standards-based protocol stack for the Internet of Things. It has become the de-facto implementation of the IEEE802.15.4e TSCH standard, has a vibrant community of academic and industrial users, and is the reference implementation of the work we do in the IETF 6TiSCH standardization working group.

- Partner: University of California Berkeley
- Contact: Thomas Watteyne
- URL: <http://www.openwsn.org/>

6.2. 6TiSCH Simulator

High-level simulator of a 6TiSCH network

KEYWORDS: Network simulator - 6TiSCH

FUNCTIONAL DESCRIPTION: The simulator is written in Python. While it doesn't provide a cycle-accurate emulation, it does implement the functional behavior of a node running the full 6TiSCH protocol stack. This includes RPL, 6LoWPAN, CoAP and 6P. The implementation work tracks the progress of the standardization process at the IETF.

- Contact: Malisa Vucinic

6.3. Argus

KEYWORDS: Cloud - Low-Power Wireless - Sniffer

FUNCTIONAL DESCRIPTION: There are three pieces to the Argus:

The Argus Probe is the program which attaches to your low-power wireless sniffer and forwards its traffic to the Argus Broker.

The Argus Broker sits somewhere in the cloud. Based on MQTT, it connects Argus Probes with Argus Clients based on a pub-sub architecture.

Several Argus Clients can be started at the same time. It is a program which subscribes to the Argus Broker and displays the frames in Wireshark.

- Contact: Rémy Leone

6.4. SolSystem

Sensor Object Library System

KEYWORDS: Low-Power Wireless - Back-End System - SmartMesh IP

FUNCTIONAL DESCRIPTION: The source code is composed of the definition of the SOL structure (<https://github.com/realms-team/sol>), the code that runs on the manager (<https://github.com/realms-team/solmanager>, written in Python) and the code that runs on the server receiving the data (<https://github.com/realms-team/solserver>, written in Python)

- Contact: Keoma Brun-Laguna
- URL: <http://www.solssystem.io/>

6.5. 6TiSCH Wireshark Dissector

KEYWORDS: 6TiSCH - Wireshark

FUNCTIONAL DESCRIPTION: Implementation on the dissectors is done through an open-source repository, stable code is regularly contributed back to the main Wireshark code base.

- Contact: Jonathan Munoz

6.6. F-Interop

Remote Conformance and Interoperability Tests for the Internet of Thing

KEYWORDS: Interoperability - Iot - Conformance testing - Standardization

- Partners: UPMC - IMEC - ETSI - EANTC - Mandat International - Digital Catapult - University of Luxembourg - Device Gateway
- Contact: Rémy Leone

6.7. Mercator

KEYWORDS: Deployment - Low-Power Wireless - Testbeds - Connectivity

FUNCTIONAL DESCRIPTION: The firmware is written as part of the OpenWSN project. Scripts and analysis tools are written in Python.

- Contact: Keoma Brun-Laguna

6.8. Platforms

6.8.1. SolSystem

In collaboration with University College London and IBM, we have designed a cloud-based low-power network management solution called SolSystem. It serves as a “control tower” for the networks we deploy, allowing us to manage both the network and data produced by those networks. It is architected following the micro-service principle, and we are in the process of switching all of our deployments to that interface. Fig. 1 gives an example of the visualization the SolSystem web interface gives us.

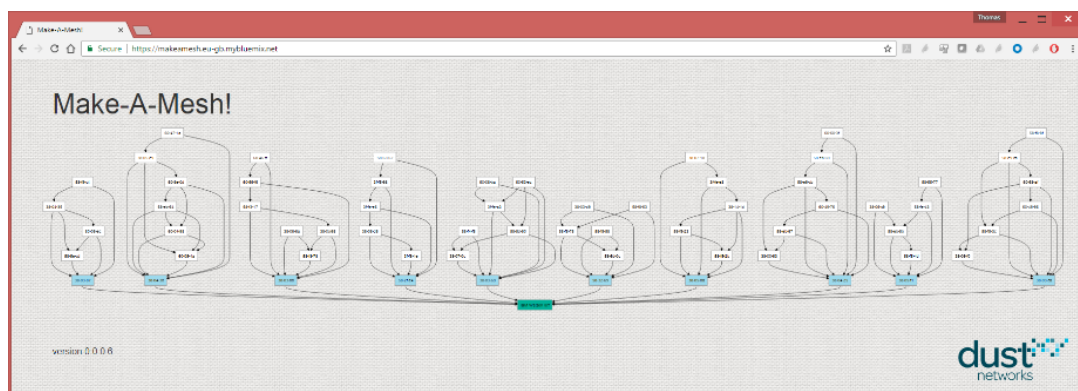


Figure 1. Topological view of the canopy network deployed across the Robert's building at University College London from February to April 2017, using SolSystem.

6.8.2. OpenMote B

In collaboration with OpenMote (<http://www.openmote.com/>), we have designed the OpenMote B platform. This board contains both a CC2538 IEEE802.15.4 radio, and an AT86RF215 IEEE802.15.4g radio, offering communication on both 2.4 GHz and sub-GHz frequency bands, 4 modulations schemes, and data rates from 50 kbps to 800 kbps. The first prototypes (shown in Fig. 2) started being tested in December 2017.

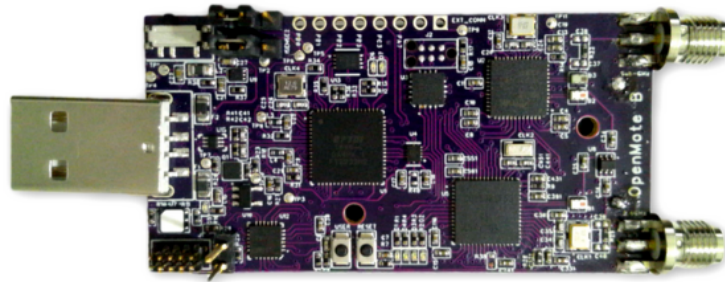


Figure 2. The OpenMote B. sub-GHz radio (and antenna connector) on top, 2.4 GHz radio on the bottom.

FOCUS Project-Team

6. New Software and Platforms

6.1. HoCA

Higher-Order Complexity Analysis

KEYWORDS: Ocaml - Verification - Runtime Complexity Analysis

SCIENTIFIC DESCRIPTION: Over the last decade, various tools for the static analysis of resource properties of programs have emerged. In particular, the rewriting community has recently developed several tools for the time complexity analysis of term rewrite systems. These tools have matured and are nowadays able to treat non-trivial programs, in a fully automatic setting. However, none of these automatic complexity analysers can deal with higher-order functions, a pervasive feature of functional programs. HoCA (Higher-Order Complexity Analyser) overcomes this limitation by translating higher-order programs – in the form of side-effect free OCaml programs - into equivalent first-order rewrite systems. At the heart of our tool lies Reynold's defunctionalization technique. Defunctionalization however is not enough. Resulting programs have a recursive structure too complicated to be analysed automatically in all but trivial cases. To overcome this issue, HoCA integrates a handful of well established program transformation techniques, noteworthy dead-code elimination, inlining, instantiation and uncurrying. A complexity bound on the resulting first-order program can be relayed back reliably to the higher-order program of interest. A detailed description of HoCA is available on <http://arxiv.org/abs/1506.05043>.

FUNCTIONAL DESCRIPTION: HoCA is an abbreviation for Higher-Order Complexity Analysis, and is meant as a laboratory for the automated complexity analysis of higher-order functional programs. Currently, HoCA consists of one executable `pcf2trs` which translates a pure subset of OCaml to term rewrite systems, in a complexity reflecting manner. As a first step, HoCA desugars the given program to a variation of Plotkin's PCF with data-constructors. Via Reynold's defunctionalization, the PCF program is turned into an applicative term rewrite system (ATRS for short), call-by-value reductions of the PCF program are simulated by the ATRS step-by-step, on the ATRS, and various complexity reflecting transformations are performed: inlining, dead-code-elimination, instantiation of higher-order variables through a call-flow-analysis and finally uncurrying. This results finally in a first-order rewrite system, whose runtime-complexity reflects the complexity of the initial program, asymptotically.

- Participants: Martin Avanzini and Ugo Dal Lago
- Contact: Ugo Dal Lago
- URL: <http://cbr.uibk.ac.at/tools/hoca/>

6.2. JOLIE

Java Orchestration Language Interpreter Engine

KEYWORD: Microservices

SCIENTIFIC DESCRIPTION: Jolie is a service-oriented programming language. Jolie can be used to program services that interact over the Internet using different communication protocols.

Differently from other Web Services programming languages such as WS-BPEL, Jolie is based on a user-friendly C/Java-like syntax (more readable than the verbose XML syntax of WS-BPEL) and, moreover, the language is equipped with a formal operational semantics. This language is used for the *proof of concepts* developed around Focus activities. For instance, contract theories can be exploited for checking the conformance of a Jolie program with respect to a given contract.

FUNCTIONAL DESCRIPTION: Developments in 2017: 2017 has seen many efforts around the language to increase its usage in industry. These include:

- Organisation of two events. One in Italy, called Meeting on Microservices, organised by italianaSoftware and Monrif SpA in December 2016. The second one in Denmark, organised by Southern Denmark University and Università di Bologna in October 2017. Common aim of both events was presenting the language from a practical, industrial point of view, to illustrate with real-world cases how its abstractions can increase productivity of companies. Both venues contributed in growing the community of companies that have adopted the language or plan to adopt it in the near future.

- Revision of the language documentation, migrating it to GitBook. In this way, Jolie users can access its documentation as HTML pages, as a PDF, and as an eBook. The choice of GitBook has been guided by the need to give a proper tool to users to collaborate, discuss, and request fixes and extensions on the documentation.

- Development of several tools, frameworks, and libraries to ease the management of architectures of microservices. The main ones are:

- the publication of libraries to interact with and orchestrate the Docker containerisation technology. This work, called Jocker, has been the fulcrum of other projects that streamline the creation and management of container-based microservice architectures,

- the publication of a fundamental companion for any industrial-grade language: a packing system. The project, called jpm, automatises the process of publishing, installing, upgrading, configuring, and removing libraries in Jolie software projects,

- the inclusion in the language interpreter of hooks for modular, distributed tracing, a renowned problem of microservices and distributed systems. Developed to output program traces in JSON, this work maintained an open perspective on both output formats and logging deployment, which can be extended in a modular way. The project also includes a visualiser of several distributed traces for debugging purposes,

- the publication of a unit testing framework for microservices, a fundamental building block for continuous integration processes. This framework includes also functionalities to automatically test microservices within a distributed, sandboxed environment, thanks to its integration with Jocker. The framework is also the first step towards a more comprehensive suite to test complete microservice architectures,

- the creation of a deployment framework that automatises the deployment of microservice architectures. This is an important issue in microservice and distributed system deployment, where correctly installing programs on execution nodes and making sure they are properly linked to each other is a daunting and time-consuming task. The framework, given a deployment schema, i) automatises the creation of containers where one or more microservices coexist, ii) deploys the containers into assigned machines, and iii) binds the deployed containers so that microservices within different containers can communicate,

- the creation of the Jiot project, aimed at integrating IoT-related technologies into the Jolie language. The final goal is to provide easy-to-use and flexible communication abstractions to interconnect and make interact disparate IoT islands. Work in 2017 comprised the inclusion of the CoAP/UDP and MQTT/TCP protocols among the communication technologies supported by the language.

Jolie also transitioned from version 1.6 to 1.6.2, which are minor releases, however they contain many performance optimisations and bug fixes.

RELEASE FUNCTIONAL DESCRIPTION: There are many fixes to the HTTP extension, improvements to the embedding engine for Javascript programs, and improvements to the support tools jolie2java and wsdl2jolie.

- Participants: Claudio Guidi, Fabrizio Montesi, Maurizio Gabbrielli and Saverio Giallorenzo
- Contact: Fabrizio Montesi
- URL: <http://www.jolie-lang.org/>

6.3. NightSplitter

KEYWORD: Constraint-based programming

FUNCTIONAL DESCRIPTION: Nightsplitter deals with the group preference optimization problem. We propose to split users into subgroups trying to optimize members' satisfaction as much as possible. In a large city with a huge volume of activity information, designing subgroup activities and avoiding time conflict is a challenging task. Currently, the Demo is available only for restaurant and movie activities in the city of Paris.

- Contact: Tong Liu
- URL: <http://cs.unibo.it/t.liu/nightsplitter/>

6.4. AIOCJ

Adaptive Interaction-Oriented Choreographies in Jolie

SCIENTIFIC DESCRIPTION: AIOCJ is a framework for programming adaptive distributed systems based on message passing. AIOCJ comes as a plugin for Eclipse, AIOCJ-ecl, allowing to edit descriptions of distributed systems as adaptive interaction-oriented choreographies (AIOC). From interaction-oriented choreographies the description of single participants can be automatically derived. Adaptation is specified by rules allowing to replace predetermined parts of the AIOC with a new behaviour. A suitable protocol ensures that all the participants are updated in a coordinated way. As a result, the distributed system follows the specification given by the AIOC under all changing sets of adaptation rules and environment conditions. In particular, the system is always deadlock-free. AIOCJ can interact with external services, seen as functions, by specifying their URL and the protocol they support (HTTP, SOAP, ...). Deadlock-freedom guarantees of the application are preserved provided that those services do not block.

FUNCTIONAL DESCRIPTION: AIOCJ is an open-source choreography programming language for developing adaptive systems.

- Participants: Ivan Lanese, Jacopo Mauro, Maurizio Gabbrielli, Mila Dalla Preda and Saverio Giallorenzo
- Contact: Saverio Giallorenzo
- URL: <http://www.cs.unibo.it/projects/jolie/aioj.html>

6.5. CauDER

Causal-consistent Debugger for Erlang

KEYWORDS: Debug - Reversible computing

SCIENTIFIC DESCRIPTION: The reversible debugger is based on the theory of causal-consistent reversibility, which states that any action can be undone provided that its consequences, if any, are undone beforehand. This theory relies on a causal semantic for the target language, and can be used even if different processes have different notions of time

FUNCTIONAL DESCRIPTION: CauDER is a debugger allowing one to explore the execution of concurrent Erlang programs both forward and backward. Notably, when going backward, any action can be undone provided that its consequences, if any, are undone beforehand. This enables one to find a bug by following the causality links from the visible misbehaviour to the bug. The debugger takes an Erlang program but debugging is done on its translation into Core Erlang.

- Partner: Universitat Politècnica de València
- Contact: Ivan Lanese
- URL: <https://github.com/mistupv/cauder>

6.6. SUNNY-AS

SUNNY FOR ALGORITHM SELECTION

KEYWORDS: Optimisation - Machine learning

FUNCTIONAL DESCRIPTION: SUNNY-AS is a portfolio solver derived from SUNNY-CP for Algorithm Selection Problems (ASLIB). The goal of SUNNY-AS is to provide a flexible, configurable, and usable portfolio solver that can be set up and executed just like a regular individual solver.

- Contact: Tong Liu
- URL: <https://github.com/lteu/oasc>

FUN Project-Team

6. New Software and Platforms

6.1. AspireRFID ALE

FUNCTIONAL DESCRIPTION: AspireRFID middleware is a modular OW2 open source RFID middleware. It is compliant with EPC Global standards. This new module integrates the modifications of the new standard release, including new RP and LLRP definitions and fixing bugs. This module has been implemented in the framework of the MIAOU project.

- Participants: Ibrahim Amadou, Julien Vandaële, Nathalie Mitton and Rim Driss
- Contact: Nathalie Mitton

6.2. ETINODE-CONTIKI-PORT

FUNCTIONAL DESCRIPTION: Contiki is an open source embedded OS for Internet of Things (IoT). It is light and portable to different hardware architectures. It embeds communication stacks for IoT. Il embarque aussi des piles de communication pour l'internet des objets. This driver allows the running of Contiki OS over Etinode-MSP430. The code also allows the use of radio chip and embedded sensors. This module has been implemented in the framework of the ETIPOPS project.

- Participants: Nathalie Mitton, Roudy Dagher and Salvatore Guzzo Bonifacio
- Contact: Salvatore Guzzo Bonifacio

6.3. ETINODE-DRIVERS

FUNCTIONAL DESCRIPTION: These drivers for Etinode-MSP430 control the different embedded sensors and hardware components available on an Etinode-MSP430 node such as gyroscope, accelerometer and barometric sensor. This module has been implemented in the framework of the ETIPOPS project.

- Participants: Nathalie Mitton, Roudy Dagher and Salvatore Guzzo Bonifacio
- Contact: Salvatore Guzzo Bonifacio

6.4. EVe-TCF

Embedded Verifier for Transitive Control Flow

KEYWORDS: Security - Embedded - Embedded systems - JavaCard - Control Flow - Code analysis

FUNCTIONAL DESCRIPTION: Verification of transitive control flow policies on JavaCard 2.x bytecode. Control flow policies expressed using a DSL language are embedded in JavaCard packages (CAP files) using EVe-TCF convert tool. Control flow policies are then statically verified on-device at loading-time thanks to an embedded verifier (designed for smart cards in EVe-TCF). EVe-TCF (Embedded Verifier for Transitive Control Flow) also contains an off-device (i.e. PC tool) to simulate on-device loading process of JavaCard 2.x platforms with GlobalPlatform 2.x installed.

- Participants: Arnaud Fontaine and Isabelle Simplot Ryl
- Contact: Nathalie Mitton

6.5. GOLIATH

Generic Optimized Lightweight communication stack for Ambient Technologies

KEYWORDS: WSN - WSN430

FUNCTIONAL DESCRIPTION: GOLIATH (Generic Optimized LIghtweight communication stack for Ambient TecHnologies) is a full protocol stack for wireless sensor networks. This module has been implemented in the framework of the ETIPOPS project.

- Participants: David Simplot Ryl, Fadila Khadar, Nathalie Mitton and Salvatore Guzzo Bonifacio
- Contact: Nathalie Mitton
- URL: <https://gforge.inria.fr/projects/goliath/>

6.6. IoT-LAB robots

KEYWORDS: Internet of things - Robotics

FUNCTIONAL DESCRIPTION: IoT-LAB robots is an embedded robot controller on a Turtlebot2 providing the IoT-LAB node mobility fonctionnality

- Partner: Université de Strasbourg
- Contact: Julien Vandaële
- URL: <https://github.com/iot-lab/>

6.7. T-SCAN

KEYWORDS: Rfid - RFID Middleware

FUNCTIONAL DESCRIPTION: T-Scan is an interface ensuring the translation from a SGTIN tag format to an ONS hostname format according to the EPCGlobal standards. It allows the sending of a DNS request to look up the EPC-IS aides to which the product belongs in order to access the data relative to that product. This module has been implemented in the framework of the TRACAVERRÉ project.

- Participants: Gabriele Sabatino and Nathalie Mitton
- Contact: Gabriele Sabatino

6.8. FIT IoT-Lab

Participants: Nathalie Mitton [correspondant], Julien Vandaele, Matthieu Berthome.

FIT IoT-LAB is a very large scale open testbed that features over 2700 wireless sensor nodes and more than 200 robots spread across six different sites in France. Nodes are either fixed or mobile and can be allocated in various topologies throughout all sites. A variety of wireless sensors are available, with different processor architectures (MSP430, STM32 and Cortex-A8) and different wireless chips (802.15.4 PHY at 800 MHz or 2.4 GHz). In addition, "open nodes" can receive custom wireless sensors for inclusion in IoT-LAB testbed. This platform is completely open and can be used by any one wishing to run experiment on wireless sensors and robots.

The Lille site displays 3 subsets of the platforms:

- Euratechnologies: this site features 256 WSN430 sensor nodes operating in the 2.4GHz band. 64 nodes are mobile, embedded on mobile trains.
- Haute Borne: this site features 256 M3 sensor nodes operating in the 2.4GHz band and 64 mobile robots (32 turtlebots and 32 wifibots) completely remotely programmable.
- Opennodes: this site will feature (opening beginning 2015) 64 hardware open slots to allow any one to plug his own hardware and benefits from the platform debugging and monitoring tools.

GANG Project-Team

5. New Software and Platforms

5.1. big-graph-tools

FUNCTIONAL DESCRIPTION: Gang is developping a software for big graph manipulation. A preliminary library offering diameter and skeleton computation is available at <https://who.rocq.inria.fr/Laurent.Viennot/dev/big-graph-tools/>. This library was used to compute the diameters of the worldwide road network (200M edges) and the largest strongly connected component of the Twitter follower-followee graph (23G edges).

- Contact: Laurent Viennot
- URL: <https://who.rocq.inria.fr/Laurent.Viennot/dev/big-graph-tools/>

5.2. GRPH

The high performance graph library for Java

KEYWORDS: Graph - Graph algorithmics - Java

FUNCTIONAL DESCRIPTION: Grph is an open-source Java library for the manipulation of graphs. Its design objectives are to make it portable, simple to use/extend, computationally/memory efficient, and, according to its initial motivation: useful in the context of graph experimentation and network simulation. Grph also has the particularity to come with tools like an evolutionary computation engine, a bridge to linear programming solvers, a framework for distributed computing, etc.

Grph offers a very general model of graphs. Unlike other graph libraries which impose the user to first decide if he wants to deal with directed, undirected, hyper (or not) graphs, the model offered by Grph is unified in a general class that supports mixed graphs made of undirected and directed simple and hyper edges. Grph achieves great efficiency through the use of multiple code optimization techniques such as multi-core parallelism, caching, adequate data structures, use of primitive objects, exploitation of low-level processor caches, on-the-fly compilation of specific C/C++ code, etc. Grph attempts to access the Internet in order to check if a new version is available and to report who is using it (login name and hostname). This has no impact whatsoever on performance and security.

- Participants: Aurélien Lancin, David Coudert, Issam Tahiri, Luc Hogue and Nathann Cohen
- Contact: Luc Hogue
- URL: <http://www.i3s.unice.fr/~hogie/grph/>

HIEPACS Project-Team

6. New Software and Platforms

6.1. Chameleon

KEYWORDS: Runtime system - Task-based algorithm - Dense linear algebra - HPC - Task scheduling

SCIENTIFIC DESCRIPTION: Chameleon is part of the MORSE (Matrices Over Runtime Systems @ Exascale) project. The overall objective is to develop robust linear algebra libraries relying on innovative runtime systems that can fully benefit from the potential of those future large-scale complex machines.

We expect advances in three directions based first on strong and closed interactions between the runtime and numerical linear algebra communities. This initial activity will then naturally expand to more focused but still joint research in both fields.

1. Fine interaction between linear algebra and runtime systems. On parallel machines, HPC applications need to take care of data movement and consistency, which can be either explicitly managed at the level of the application itself or delegated to a runtime system. We adopt the latter approach in order to better keep up with hardware trends whose complexity is growing exponentially. One major task in this project is to define a proper interface between HPC applications and runtime systems in order to maximize productivity and expressivity. As mentioned in the next section, a widely used approach consists in abstracting the application as a DAG that the runtime system is in charge of scheduling. Scheduling such a DAG over a set of heterogeneous processing units introduces a lot of new challenges, such as predicting accurately the execution time of each type of task over each kind of unit, minimizing data transfers between memory banks, performing data prefetching, etc. Expected advances: In a nutshell, a new runtime system API will be designed to allow applications to provide scheduling hints to the runtime system and to get real-time feedback about the consequences of scheduling decisions.

2. Runtime systems. A runtime environment is an intermediate layer between the system and the application. It provides low-level functionality not provided by the system (such as scheduling or management of the heterogeneity) and high-level features (such as performance portability). In the framework of this proposal, we will work on the scalability of runtime environment. To achieve scalability it is required to avoid all centralization. Here, the main problem is the scheduling of the tasks. In many task-based runtime environments the scheduler is centralized and becomes a bottleneck as soon as too many cores are involved. It is therefore required to distribute the scheduling decision or to compute a data distribution that impose the mapping of task using, for instance the so-called “owner-compute” rule. Expected advances: We will design runtime systems that enable an efficient and scalable use of thousands of distributed multicore nodes enhanced with accelerators.

3. Linear algebra. Because of its central position in HPC and of the well understood structure of its algorithms, dense linear algebra has often pioneered new challenges that HPC had to face. Again, dense linear algebra has been in the vanguard of the new era of petascale computing with the design of new algorithms that can efficiently run on a multicore node with GPU accelerators. These algorithms are called “communication-avoiding” since they have been redesigned to limit the amount of communication between processing units (and between the different levels of memory hierarchy). They are expressed through Direct Acyclic Graphs (DAG) of fine-grained tasks that are dynamically scheduled. Expected advances: First, we plan to investigate the impact of these principles in the case of sparse applications (whose algorithms are slightly more complicated but often rely on dense kernels). Furthermore, both in the dense and sparse cases, the scalability on thousands of nodes is still limited, new numerical approaches need to be found. We will specifically design sparse hybrid direct/iterative methods that represent a promising approach.

Overall end point. The overall goal of the MORSE associate team is to enable advanced numerical algorithms to be executed on a scalable unified runtime system for exploiting the full potential of future exascale machines.

FUNCTIONAL DESCRIPTION: Chameleon is a dense linear algebra software relying on sequential task-based algorithms where sub-tasks of the overall algorithms are submitted to a Runtime system. A Runtime system such as StarPU is able to manage automatically data transfers between not shared memory area (CPUs-GPUs, distributed nodes). This kind of implementation paradigm allows to design high performing linear algebra algorithms on very different type of architecture: laptop, many-core nodes, CPUs-GPUs, multiple nodes. For example, Chameleon is able to perform a Cholesky factorization (double-precision) at 80 TFlop/s on a dense matrix of order 400 000 (e.i. 4 min).

RELEASE FUNCTIONAL DESCRIPTION: Chameleon includes the following features:

- BLAS 3, LAPACK one-sided and LAPACK norms tile algorithms - Support QUARK and StarPU runtime systems - Exploitation of homogeneous and heterogeneous platforms through the use of BLAS/LAPACK CPU kernels and cuBLAS/MAGMA CUDA kernels - Exploitation of clusters of interconnected nodes with distributed memory (using OpenMPI)

- Participants: Cédric Castagnede, Samuel Thibault, Emmanuel Agullo, Florent Pruvost and Mathieu Faverge
- Partners: Innovative Computing Laboratory (ICL) - King Abdulla University of Science and Technology - University of Colorado Denver
- Contact: Emmanuel Agullo
- URL: <https://project.inria.fr/chameleon/>

6.2. Fabulous

Fast Accurate Block Linear krylOv Solver

KEYWORDS: Numerical algorithm - Block Krylov solver

SCIENTIFIC DESCRIPTION: Versatile and flexible numerical library that implements Block Krylov iterative schemes for the solution of linear systems of equations with multiple right-hand sides

FUNCTIONAL DESCRIPTION: Versatile and flexible numerical library that implements Block Krylov iterative schemes for the solution of linear systems of equations with multiple right-hand sides. The library implements block variants of minimal norm residual variants with partial convergence management and spectral information recycling. The package already implements regular block-GMRES (BGMRES), Inexact Breakdown BGMRES (IB-BMGRES), Inexact Breakdown BGMRES with Deflated Restarting (IB-BGMRES-DR), Block Generalized Conjugate Residual with partial convergence management. The C++ library relies on call-back mechanisms to implement the calculations (matrix-vector, dot-product, ...) that depend on the parallel data distribution selected by the user.

- Participants: Emmanuel Agullo, Luc Giraud and Cyrille Piacibello
- Contact: Luc Giraud
- Publication: [Block GMRES method with inexact breakdowns and deflated restarting](#)
- URL: <https://gitlab.inria.fr/solverstack/fabulous/>

6.3. HIPS

Hierarchical Iterative Parallel Solver

KEYWORDS: Simulation - HPC - Parallel calculation - Hybrid direct iterative method

SCIENTIFIC DESCRIPTION: The key point of the methods implemented in HIPS is to define an ordering and a partition of the unknowns that relies on a form of nested dissection ordering in which cross points in the separators play a special role (Hierarchical Interface Decomposition ordering). The subgraphs obtained by nested dissection correspond to the unknowns that are eliminated using a direct method and the Schur complement system on the remaining of the unknowns (that correspond to the interface between the subgraphs viewed as sub-domains) is solved using an iterative method (GMRES or Conjugate Gradient at the time being). This special ordering and partitioning allows for the use of dense block algorithms both in the direct and iterative part of the solver and provides a high degree of parallelism to these algorithms. The code provides a hybrid method which blends direct and iterative solvers. HIPS exploits the partitioning and multistage ILU techniques to enable a highly parallel scheme where several subdomains can be assigned to the same process. It also provides a scalar preconditioner based on the multistage ILUT factorization.

HIPS can be used as a standalone program that reads a sparse linear system from a file, it also provides an interface to be called from any C, C++ or Fortran code. It handles symmetric, unsymmetric, real or complex matrices. Thus, HIPS is a software library that provides several methods to build an efficient preconditioner in almost all situations.

FUNCTIONAL DESCRIPTION: HIPS (Hierarchical Iterative Parallel Solver) is a scientific library that provides an efficient parallel iterative solver for very large sparse linear systems.

- Participants: Jérémie Gaidamour, Pascal Hénon and Yousef Saad
- Contact: Pierre Ramet
- URL: <http://hips.gforge.inria.fr/>

6.4. MAPHYS

Massively Parallel Hybrid Solver

KEYWORD: Parallel hybrid direct/iterative solution of large linear systems

FUNCTIONAL DESCRIPTION: MaPHyS is a software package that implements a parallel linear solver coupling direct and iterative approaches. The underlying idea is to apply to general unstructured linear systems domain decomposition ideas developed for the solution of linear systems arising from PDEs. The interface problem, associated with the so called Schur complement system, is solved using a block preconditioner with overlap between the blocks that is referred to as Algebraic Additive Schwarz. A fully algebraic coarse space is available for symmetric positive definite problems, that insures the numerical scalability of the preconditioner.

The parallel implementation is based on MPI+thread. Maphys relies on state-of-the art sparse and dense direct solvers.

MaPHyS is essentially a preconditioner that can be used to speed-up the convergence of any Krylov subspace method and is coupled with the ones implemented in the Fabulous package.

- Participants: Emmanuel Agullo, Luc Giraud, Matthieu Kuhn, Gilles Marait and Louis Poirel
- Contact: Emmanuel Agullo
- Publications: [Hierarchical hybrid sparse linear solver for multicore platforms](#) [Robust coarse spaces for Abstract Schwarz preconditioners via generalized eigenproblems](#)
- URL: <https://gitlab.inria.fr/solverstack/maphys>

6.5. MetaPart

KEYWORDS: High performance computing - HPC - Parallel computing - Graph algorithmics - Graph - Hypergraph

FUNCTIONAL DESCRIPTION: MetaPart is a framework for graph or hypergraph manipulation that addresses different problems, like partitioning, repartitioning, or co-partitioning, ... MetaPart is made up of several projects, such as StarPart, LibGraph or CoPart. StarPart is the core of the MetaPart framework. It offers a wide variety of graph partitioning methods (Metis, Scotch, Zoltan, Patoh, ParMetis, Kahip, ...), which makes it easy to compare these different methods and to better adjust the parameters of these methods. It is built upon the LibGraph library, that provides basic graph & hypergraph routines. The Copart project is a library used on top of StarPart, that provides co-partitioning algorithms for the load-blancing of parallel coupled simulations.

- Participant: Aurélien Esnard
- Contact: Aurélien Esnard
- URL: <https://gitlab.inria.fr/metapart>

6.6. MPICPL

MPI CouPLing

KEYWORDS: MPI - Coupling software

FUNCTIONAL DESCRIPTION: MPICPL is a software library dedicated to the coupling of parallel legacy codes, that are based on the well-known MPI standard. It proposes a lightweight and comprehensive programming interface that simplifies the coupling of several MPI codes (2, 3 or more). MPICPL facilitates the deployment of these codes thanks to the mpicplrun tool and it interconnects them automatically through standard MPI inter-communicators. Moreover, it generates the universe communicator, that merges the world communicators of all coupled-codes. The coupling infrastructure is described by a simple XML file, that is just loaded by the mpicplrun tool.

- Participant: Aurélien Esnard
- Contact: Aurélien Esnard
- URL: <https://gitlab.inria.fr/esnard/mpicpl>

6.7. OptiDis

KEYWORDS: Dislocation dynamics simulation - Fast multipole method - Large scale - Collision

FUNCTIONAL DESCRIPTION: OptiDis is a new code for large scale dislocation dynamics simulations. Its purpose is to simulate real life dislocation densities (up to 5.1022 dislocations/m-2) in order to understand plastic deformation and study strain hardening. The main application is to observe and understand plastic deformation of irradiated zirconium. Zirconium alloys are the first containment barrier against the dissemination of radioactive elements. More precisely, with neutron irradiated zirconium alloys we are talking about channeling mechanism, which means to stick with the reality, more than tens of thousands of induced loops, i. e. 100 million degrees of freedom in the simulation. The code is based on Numodis code developed at CEA Saclay and the ScalFMM library developed in H/14iePACS project. The code is written in C++ language and using the last features of C++11. One of the main aspects is the hybrid parallelism MPI/OpenMP that gives the software the ability to scale on large cluster while the computation load rises. In order to achieve that, we use different levels of parallelism. First of all, the simulation box is distributed over MPI processes, then we use a thinner level for threads, dividing the domain by an Octree representation. All these parts are controlled by the ScalFMM library. On the last level, our data are stored in an adaptive structure that absorbs the dynamics of this type of simulation and manages the parallelism of tasks..

- Participant: Olivier Coulaud
- Contact: Olivier Coulaud
- URL: <http://optidis.gforge.inria.fr/>

6.8. PaStiX

Parallel Sparse matrix package

KEYWORDS: Sparse Matrices - Factorisation - High-performance calculation - Linear algebra - Linear Systems Solver

SCIENTIFIC DESCRIPTION: PaStiX is based on an efficient static scheduling and memory manager, in order to solve 3D problems with more than 50 million of unknowns. The mapping and scheduling algorithm handle a combination of 1D and 2D block distributions. A dynamic scheduling can also be applied to take care of NUMA architectures while taking into account very precisely the computational costs of the BLAS 3 primitives, the communication costs and the cost of local aggregations.

FUNCTIONAL DESCRIPTION: PaStiX is a scientific library that provides a high performance parallel solver for very large sparse linear systems based on block direct and block ILU(k) methods. It can handle low-rank compression techniques to reduce the computation and the memory complexity. Numerical algorithms are implemented in single or double precision (real or complex) for LLt, LDLt and LU factorization with static pivoting (for non symmetric matrices having a symmetric pattern). The PaStiX library uses the graph partitioning and sparse matrix block ordering packages Scotch or Metis.

The PaStiX solver is suitable for any heterogeneous parallel/distributed architecture when its performance is predictable, such as clusters of multicore nodes with GPU accelerators or KNL processors. In particular, we provide a high-performance version with a low memory overhead for multicore node architectures, which fully exploits the advantage of shared memory by using an hybrid MPI-thread implementation.

- Participants: Grégoire Pichon, Mathieu Faverge and Pierre Ramet
- Partner: Université Bordeaux 1
- Contact: Pierre Ramet
- URL: <http://pastix.gforge.inria.fr/>

6.9. ScalFMM

Scalable Fast Multipole Method

KEYWORDS: N-body - Fast multipole method - Parallelism - MPI - OpenMP

SCIENTIFIC DESCRIPTION: ScalFMM is a software library to simulate N-body interactions using the Fast Multipole Method. The library offers two methods to compute interactions between bodies when the potential decays like $1/r$. The first method is the classical FMM based on spherical harmonic expansions and the second is the Black-Box method which is an independent kernel formulation (introduced by E. Darve @ Stanford). With this method, we can now easily add new non oscillatory kernels in our library. For the classical method, two approaches are used to decrease the complexity of the operators. We consider either matrix formulation that allows us to use BLAS routines or rotation matrix to speed up the M2L operator.

ScalFMM intends to offer all the functionalities needed to perform large parallel simulations while enabling an easy customization of the simulation components: kernels, particles and cells. It works in parallel in a shared/distributed memory model using OpenMP and MPI. The software architecture has been designed with two major objectives: being easy to maintain and easy to understand. There is two main parts:

the management of the octree and the parallelization of the method the kernels. This new architecture allow us to easily add new FMM algorithm or kernels and new paradigm of parallelization.

FUNCTIONAL DESCRIPTION: Compute N-body interactions using the Fast Multipole Method for large number of objects

- Participants: Bramas Bérenger and Olivier Coulaud
- Contact: Olivier Coulaud
- URL: <https://gitlab.inria.fr/solverstack/ScalFMM>

6.10. VITE

Visual Trace Explorer

KEYWORDS: Visualization - Execution trace

FUNCTIONAL DESCRIPTION: ViTE is a trace explorer. It is a tool made to visualize execution traces of large parallel programs. It supports Pajé, a trace format created by Inria Grenoble, and OTF and OTF2 formats, developed by the University of Dresden and allows the programmer a simpler way to analyse, debug and/or profile large parallel applications.

- Participant: Mathieu Faverge
- Contact: Mathieu Faverge
- URL: <http://vite.gforge.inria.fr/>

6.11. PlaFRIM

Plateforme Fédérative pour la Recherche en Informatique et Mathématiques

KEYWORDS: High-Performance Computing - Hardware platform

FUNCTIONAL DESCRIPTION: PlaFRIM is an experimental platform for research in modeling, simulations and high performance computing. This platform has been set up from 2009 under the leadership of Inria Bordeaux Sud-Ouest in collaboration with computer science and mathematics laboratories, respectively Labri and IMB with a strong support in the region Aquitaine.

It aggregates different kinds of computational resources for research and development purposes. The latest technologies in terms of processors, memories and architecture are added when they are available on the market. It is now more than 1,000 cores (excluding GPU and Xeon Phi) that are available for all research teams of Inria Bordeaux, Labri and IMB. This computer is in particular used by all the engineers who work in HiePACS and are advised by F. Rue from the SED.

- Contact: Olivier Coulaud
- URL: <https://www.plafrim.fr/en/home/>

INDES Project-Team

4. New Software and Platforms

4.1. Bigloo

KEYWORD: Compilers

FUNCTIONAL DESCRIPTION: Bigloo is a Scheme implementation devoted to one goal: enabling Scheme based programming style where C(++) is usually required. Bigloo attempts to make Scheme practical by offering features usually presented by traditional programming languages but not offered by Scheme and functional programming. Bigloo compiles Scheme modules. It delivers small and fast stand alone binary executables. Bigloo enables full connections between Scheme and C programs, between Scheme and Java programs.

RELEASE FUNCTIONAL DESCRIPTION: modification of the object system (language design and implementation), new APIs (alsa, flac, mpg123, avahi, csv parsing), new library functions (UDP support), new regular expressions support, new garbage collector (Boehm's collection 7.3alpha1).

- Participant: Manuel Serrano
- Contact: Manuel Serrano
- URL: <http://www-sop.inria.fr/teams/indes/fp/Bigloo/>

4.2. Camloo

KEYWORD: Compilers

FUNCTIONAL DESCRIPTION: Camloo is a caml-light to bigloo compiler, which was developed a few years ago to target bigloo 1.6c. New major releases 0.4.x of camloo have been done to support bigloo 3.4 and bigloo 3.5. Camloo makes it possible for the user to develop seamlessly a multi-language project, where some files are written in caml-light, in C, and in bigloo. Unlike the previous versions of camloo, 0.4.x versions do not need a modified bigloo compiler to obtain good performance. Currently, the only supported backend for camloo is bigloo/C. We are currently rewriting the runtime of camloo in bigloo to get more portability and to be able to use HOP and camloo together.

- Contact: Manuel Serrano

4.3. Hop

KEYWORDS: Programming language - Multimedia - Iot - Web 2.0 - Functional programming

SCIENTIFIC DESCRIPTION: The Hop programming environment consists in a web broker that intuitively combines in a single architecture a web server and a web proxy. The broker embeds a Hop interpreter for executing server-side code and a Hop client-side compiler for generating the code that will get executed by the client.

An important effort is devoted to providing Hop with a realistic and efficient implementation. The Hop implementation is validated against web applications that are used on a daily-basis. In particular, we have developed Hop applications for authoring and projecting slides, editing calendars, reading RSS streams, or managing blogs.

FUNCTIONAL DESCRIPTION: Multitier web programming language and runtime environment.

- Participant: Manuel Serrano
- Contact: Manuel Serrano
- URL: <http://hop.inria.fr>

4.4. IFJS

Information Flow monitor inlining for JavaScript

FUNCTIONAL DESCRIPTION: The IFJS compiler is applied to JavaScript code. The compiler generates JavaScript code instrumented with checks to secure code. The compiler takes into account special features of JavaScript such as implicit type coercions and programs that actively try to bypass the inlined enforcement mechanisms. The compiler guarantees that third-party programs cannot (1) access the compiler internal state by randomizing the names of the resources through which it is accessed and (2) change the behaviour of native functions that are used by the enforcement mechanisms inlined in the compiled code.

- Contact: Manuel Serrano
- URL: <http://www-sop.inria.fr/index/ifJS/>

4.5. ifflowsigs.js

KEYWORDS: Compilers - Monitoring

FUNCTIONAL DESCRIPTION: ifflowsigs.js is a JavaScript library designed to inline an information flow monitor into JavaScript code. ifflowsigs.js support is able to track information flow even in programs that interact with arbitrary Web APIs.

- Participants: José Frago Santos and Tamara Rezk
- Contact: Tamara Rezk
- URL: <http://j3fsantos.github.io/PersonalPage/IFMonitor/>

4.6. iflowTYPES.js

FUNCTIONAL DESCRIPTION: iflowtypes.js is a JavaScript library designed to type secure information flow in JavaScript. iflowtypes.js has two main modes of operation: fully static and hybrid. In the hybrid mode, the program to be typed is instrumented with runtime assertions that are verified at runtime. By deferring rejection to runtime, the hybrid type system is able to type more programs than fully static mechanisms.

- Contact: Tamara Rezk
- URL: <http://j3fsantos.github.io/PersonalPage/TypeSystem/>

4.7. Mashic

FUNCTIONAL DESCRIPTION: The Mashic compiler is applied to mashups with untrusted scripts. The compiler generates mashups with sandboxed scripts, secured by the same origin policy of the browsers. The compiler is written in Bigloo.

- Contact: Manuel Serrano
- URL: <http://web.ist.utl.pt/~ana.matos/Mashic/mashic.html>

4.8. scheme2JS

Scheme to JavaScript

KEYWORD: Compilers

FUNCTIONAL DESCRIPTION: Scm2JS is a Scheme to JavaScript compiler distributed under the GPL license. Even though much effort has been spent on being as close as possible to R5rs, we concentrated mainly on efficiency and interoperability. Usually Scm2JS produces JavaScript code that is comparable (in speed) to hand-written code. In order to achieve this performance, Scm2JS is not completely R5rs compliant. In particular it lacks exact numbers.

Interoperability with existing JavaScript code is ensured by a JavaScript-like dot-notation to access JavaScript objects and by a flexible symbol-resolution implementation.

Scm2JS is used on a daily basis within Hop, where it generates the code which is sent to the clients (web-browsers).

- Contact: Manuel Serrano
- URL: <http://www-sop.inria.fr/indes/scheme2js/>

4.9. Hiphop.js

KEYWORDS: Web 2.0 - Synchronous Language

FUNCTIONAL DESCRIPTION: Hiphop.js is a DSL which extends JavaScript with temporal constructions. It makes easier the orchestration of asynchronous Web applications.

- Contact: Colin Vidal
- URL: <http://www-sop.inria.fr/members/Colin.Vidal/hiphop/>

4.10. Server-Side Protection against Third Party Web Tracking

KEYWORDS: Privacy - Web Application - Web - Architecture - Security by design - Program rewriting techniques

FUNCTIONAL DESCRIPTION: We present a new web application architecture that allows web developers to gain control over certain types of third party content. In the traditional web application architecture, a web application developer has no control over third party content. This allows the exchange of tracking information between the browser and the third party content provider.

To prevent this, our solution is based on the automatic rewriting of the web application in such a way that the third party requests are redirected to a trusted third party server, called the Middle Party Server. It may be either controlled by a trusted party, or by a main site owner and automatically eliminates third-party tracking cookies and other technologies that may be exchanged by the browser and third party server

- Contact: Doliere Some
- URL: <http://www-sop.inria.fr/members/Doliere.Some/essos/>

4.11. BELL

Browser fingerprinting via Extensions and Login-Leaks

KEYWORDS: Browser Extensions - Security and Privacy in Web Services - Social Networks Security and Privacy

FUNCTIONAL DESCRIPTION: Recent studies show that users can be tracked based on their web browser properties. This software is designed to conduct an experiment on such kinds of user tracking. In this experiment, we demonstrate that a Web user can also be tracked by

- her browser extensions (such as Adblock, Pinterest, or Ghostery), and
- the websites she has logged in (such as Facebook, Gmail, or Twitter).

In the experiment, we collect user's browser fingerprint, together with the browser extensions installed and a list of websites she has logged in. We only collect anonymous data during the experiment (more details in our Privacy Policy ⁰), we will securely store the data on an Inria server, use it only for research purposes and not share it with anyone outside of Inria.

- Contact: Gabor Gulyas
- URL: <https://extensions.inrialpes.fr/>

4.12. webstats

Webstats

⁰<https://extensions.inrialpes.fr/privacy.php>

KEYWORDS: Web Usage Mining - Statistic analysis - Security

FUNCTIONAL DESCRIPTION: The goal of this tool is to perform a large-scale monthly crawl of the top Alexa sites, collecting both inline scripts (written by web developers) and remote scripts, and establishing the popularity of remote scripts (such as Google Analytics and jQuery). With this data, we establish whether the collected scripts are actually written in a subset of JavaScript by analyzing the different constructs used in those scripts. Finally, we collect and analyze the HTTP headers of the different sites visited, and provide statistics about the usage of HTTPOnly and Secure cookies, and the Content Security Policy in top sites.

- Contact: Doliere Some
- URL: <https://webstats.inria.fr>

INFINE Project-Team

5. New Software and Platforms

5.1. Gardinet

KEYWORD: Distributed networks

FUNCTIONAL DESCRIPTION: Gardinet (previously DragonNet) is a generic framework for network coding in wireless networks. It is a initially result of the GETRF project of the Hipercom2 team.

It is based on intra-flow coding where the source divides the flow in a sequence of payloads of equal size (padding may be used). The design keys of DragonNet are simplicity and universality, DragonNet does not use explicit or implicit knowledge about the topology (such as the direction or distance to the source, the loss rate of the links, ...). Hence, it is perfectly suited to the most dynamic wireless networks. The protocol is distributed and requires minimal coordination. DragonNet architecture is modular, it is based on 5 building blocks (LIB, SIG, Protocol, SEW and DRAGON). Each block is almost independent. This makes DragonNet generic and hence adaptable to many application scenarios. DragonNet derives from a prior protocol called DRAGONCAST. Indeed, DragonNet shares the same principles and theoretical overview of DRAGONCAST. It enriches DRAGONCAST by the information base and signaling required to perform broadcast in wireless networks and in wireless sensor networks in particular.

- Participants: Antonia Masucci, Cédric Adjih, Hana Baccouch and Ichrak Amdouni
- Contact: Cédric Adjih
- URL: <http://gitlab.inria.fr/gardinet>

5.2. MACACO

Mobile context-Adaptive Caching for COntent-centric networking

FUNCTIONAL DESCRIPTION: MACACOapp is developped in the context of the EU CHIST-ERA MACACO project. It consists in a mobile phone application that periodically samples phone's information on the mobility (through, e.g., GPS sensor, accelerometer and WiFi/Bluetooth/Cellular environment, connectivity type) and on the data traffic it generates (through, e.g., Internet browser history and applications data consumption). The information collected will be time-stamped and will be periodically sent to the central servers for analysis and visualization. We expect that (1) the collected information will allow us studying the correlation between mobility and content demand patterns and that (2) the results of this analysis will allow us inferring the best times and places to transfer content from/to users' phones location and/or from/to the wireless infrastructure closest to the users' phones location. Users will be also invited to fill a non-mandatory questionnaire relevant to this study. Our questionnaire collects information about the personality traits and application preferences of people. We expect that the information collected from questionnaire will allow us to analyse the correlation between users personality traits and their application preferences and interests. User's application preferences and interests will be inferred from the Internet browsing history and running app information obtained from the MACACO App.

- Participants: Aline Carneiro Viana, Katia Jaffres and Marco Fiore
- Contact: Aline Carneiro Viana
- URL: <https://macaco.inria.fr/macacoapp/>

5.3. RIOT

KEYWORDS: Internet of things - Wireless Sensor Networks - Iot - Sensors - Operating system - Internet protocols

SCIENTIFIC DESCRIPTION: While requiring as low as 1,5kB of RAM and 5kB of ROM, RIOT offers real time and energy efficiency capabilities, as well as a single API (partially POSIX compliant) across heterogeneous 8-bit, 16-bit and 32-bit low-hardware. This API is developer-friendly in that it enables multi-threading, standard C and C++ application programming and the use of standard debugging tools (which was not possible so far for embedded programming). On top of this, RIOT includes several network stacks, such as a standard IPv6/6LoWPAN stack and an information-centric network stack (based on CCN).

FUNCTIONAL DESCRIPTION: RIOT is an Open Source operating system that provides standard protocols for embedded systems. RIOT allows, for example, the development of applications that collect sensor data and transmit it to a central node (e.g. a server). This data can then be used for smart energy management for instance.

RIOT is specially designed for embedded systems, which are strongly constrained in memory and energy. Further, RIOT can easily be ported to different hardware devices and follows the latest evolution of IP standards.

RIOT applications can readily be tested in the FIT IoT-Lab, which provides a large-scale infrastructure facility with 3000 nodes for testing remotely small wireless devices.

- Participants: Emmanuel Baccelli and Oliver Hahm
- Partner: Freie Universität Berlin
- Contact: Emmanuel Baccelli
- URL: <http://www.riot-os.org>

KERDATA Project-Team

5. New Software and Platforms

5.1. BlobSeer

BlobSeer : A Storage System For The Exascale Era

KEYWORDS: Versioning - HPC - Cloud storage - Distributed metadata - MapReduce

SCIENTIFIC DESCRIPTION: BlobSeer is a large-scale distributed storage service that addresses advanced data management requirements resulting from ever-increasing data sizes. It is centered around the idea of leveraging versioning for concurrent manipulation of binary large objects in order to efficiently exploit data-level parallelism and sustain a high throughput despite massively parallel data access.

FUNCTIONAL DESCRIPTION: BlobSeer is a large-scale distributed storage service for advanced management of massive data. Validated on Nimbus, OpenNebula and Microsoft Azure cloud platforms.

- Participants: Bogdan Nicolae, Gabriel Antoniu and Luc Bougé
- Partners: Université de Rennes 1 - ENS Cachan
- Contact: Gabriel Antoniu
- URL: <http://blobseer.gforge.inria.fr/>

5.2. Damaris

KEYWORDS: Big data - Visualization - I/O - HPC - Exascale

SCIENTIFIC DESCRIPTION: Damaris is a middleware for multicore SMP nodes enabling them to efficiently handle data transfers for storage and visualization. The key idea is to dedicate one or a few cores of each SMP node to the application I/O. It is developed within the framework of a collaboration between KerData and the Joint Laboratory for Petascale Computing (JLPC). The current version enables efficient asynchronous I/O, hiding all I/O related overheads such as data compression and post-processing, as well as direct (in situ) interactive visualization of the generated data.

Damaris has been preliminarily evaluated at NCSA (Urbana-Champaign) with the CM1 tornado simulation code. CM1 is one of the target applications of the Blue Waters supercomputer in production at NCSA/UIUC (USA), in the framework of the Inria-UIUC-ANL Joint Lab (JLPC). Damaris now has external users, including (to our knowledge) visualization specialists from NCSA and researchers from the France/Brazil Associated research team on Parallel Computing (joint team between Inria/LIG Grenoble and the UFRGS in Brazil). Damaris has been successfully integrated into three large-scale simulations (CM1, OLAM, Nek5000). Works are in progress to evaluate it in the context of several other simulations including HACC (cosmology code) and GTC (fusion).

FUNCTIONAL DESCRIPTION: Damaris is a middleware for data management targeting large-scale HPC simulations: • «In-situ» data analysis by some dedicated cores of the simulation platform • Asynchronous and fast data transfer from HPC simulations to Damaris • Semantic-aware dataset processing through Damaris plug-ins

- Participants: Gabriel Antoniu, Lokman Rahmani, Luc Bougé, Matthieu Dorier and Orçun Yildiz
- Partner: ENS Rennes
- Contact: Matthieu Dorier
- URL: <https://project.inria.fr/damaris/>

5.3. iHadoop

FUNCTIONAL DESCRIPTION: iHadoop is a Hadoop simulator developed in Java on top of SimGrid to simulate the behavior of Hadoop and therefore accurately predict the performance of Hadoop in normal scenarios and under failures.

iHadoop is an internal software prototype, which was initially developed to validate our idea for exploring the behavior of Hadoop under failures. iHadoop has preliminarily evaluated within our group and it has shown very high accuracy when predicating the execution time of a Map-Reduce application. We intend to integrate iHadoop within the SimGrid distribution and make it available to the SimGrid community.

- Participants: Shadi Ibrahim and Tien Dat Phan
- Contact: Shadi Ibrahim

5.4. JetStream

FUNCTIONAL DESCRIPTION: JetStream is a middleware solution for batch-based, high-performance streaming across cloud data centers. JetStream implements a set of context-aware strategies for optimizing batch-based streaming, being able to self-adapt to changing conditions. Additionally, the system provides multi-route streaming across cloud data centers for aggregating bandwidth by leveraging the network parallelism. It enables easy deployment across .Net frameworks and seamless binding with event processing engines such as StreamInsight.

JetStream is currently used at Microsoft Research ATLE Munich for the management of the Azure cloud infrastructure.

- Participants: Alexandru Costan, Gabriel Antoniu and Radu Marius Tudoran
- Contact: Alexandru Costan

5.5. OverFlow

FUNCTIONAL DESCRIPTION: OverFlow is a uniform data management system for scientific workflows running across geographically distributed sites, aiming to reap economic benefits from this geo-diversity. The software is environment-aware, as it monitors and models the global cloud infrastructure, offering high and predictable data handling performance for transfer cost and time, within and across sites. OverFlow proposes a set of pluggable services, grouped in a data-scientist cloud kit. They provide the applications with the possibility to monitor the underlying infrastructure, to exploit smart data compression, deduplication and geo-replication, to evaluate data management costs, to set a tradeoff between money and time, and optimize the transfer strategy accordingly.

Currently, OverFlow is used for data transfers by the Microsoft Research ATLE Munich team as well as for synthetic benchmarks at the Politehnica University of Bucharest.

- Participants: Alexandru Costan, Gabriel Antoniu and Radu Marius Tudoran
- Contact: Alexandru Costan

MADYNES Team

6. New Software and Platforms

6.1. Distem

KEYWORDS: Large scale - Experimentation - Virtualization - Emulation

FUNCTIONAL DESCRIPTION: Distem is a distributed systems emulator. When doing research on Cloud, P2P, High Performance Computing or Grid systems, it can be used to transform an homogenous cluster (composed of identical nodes) into an experimental platform where nodes have different performance, and are linked together through a complex network topology, making it the ideal tool to benchmark applications targetting such environments, or aiming at tolerating performance degradations or variations which are frequent in the Cloud or in other applications distributed at large scale (P2P for example).

- Participants: Luc Sarzyniec, Lucas Nussbaum and Tomasz Buchert
- Partners: CNRS - Université de Lorraine - Loria - Grid'5000 - Inria
- Contact: Lucas Nussbaum
- URL: <http://distem.gforge.inria.fr>

6.2. Grid'5000 testbed

FUNCTIONAL DESCRIPTION: Grid'5000 is a scientific instrument designed to support experiment-driven research in all areas of computer science related to parallel, large-scale or distributed computing and networking. It gathers 10 sites, 25 clusters, 1200 nodes, for a total of 8000 cores. It provides its users with a fully reconfigurable environment (bare metal OS deployment with Kadeploy, network isolation with KaVLAN) and a strong focus on enabling high-quality, reproducible experiments.

- Participants: Arthur Garnier, Clement Parisot, Émile Morel, Emmanuel Jeanvoine, Jérémie Gaidamour, Luc Sarzyniec and Lucas Nussbaum
- Contact: Lucas Nussbaum
- URL: <https://www.grid5000.fr/>

6.3. Kadeploy

KEYWORD: Operating system provisioning

FUNCTIONAL DESCRIPTION: Kadeploy is a scalable, efficient and reliable deployment (provisioning) system for clusters and grids. It provides a set of tools for cloning, configuring (post installation) and managing cluster nodes. It can deploy a 300-nodes cluster in a few minutes, without intervention from the system administrator. It plays a key role on the Grid'5000 testbed, where it allows users to reconfigure the software environment on the nodes, and is also used on a dozen of production clusters both inside and outside Inria.

- Participants: Emmanuel Jeanvoine, Luc Sarzyniec and Lucas Nussbaum
- Partners: CNRS - Université de Lorraine - Loria - Grid'5000 - Inria
- Contact: Lucas Nussbaum
- URL: <http://kadeploy3.gforge.inria.fr>

6.4. MECSYCO-RE-C++

en Multi-agent Environment for Complex SYstems COsimulation. Coeur C++

KEYWORDS: Agent - Multi-agent - Multi-model - Simulator - Simulation - Modeling - Artefact

FUNCTIONAL DESCRIPTION: MECSYCO is a project aiming at the modeling and simulation of complex systems. It provides concepts and tools to describe and then simulate a system as a set of heterogeneous models (namely a multi-model). MECSYCO-RE-C++ is the C++ implementation of the central part (core) of MECSYCO. It can be complemented by mecsyco-com (a communication package for distributed execution) and mecsyco-visu (a set of tools for visualizing simulations).

- Participants: Benjamin Camus, Benjamin Segault, Julien Vaubourg, Laurent Ciarletta, Nicolas Kirchner, Victorien Elvinger, Vincent Chevrier and Yannick Presse
- Partners: Université de Lorraine - Inria
- Contact: Vincent Chevrier

6.5. MECSYCO-RE-java

Multi-agent Environment for Complex Systems COsimulation. Coeur java

KEYWORDS: Agent - Multi-agent - Co-simulation - Multi-model - Simulator - Simulation - Modeling - Artefact

FUNCTIONAL DESCRIPTION: MECSYCO is a project aiming at the modeling and simulation of complex systems. It provides concepts and tools to describe and then simulate a system as a set of heterogeneous models (namely a multi-model). MECSYCO-RE-java is the Java implementation of the central part (core) of MECSYCO. It can be complemented by mecsyco-com (a communication package for distributed execution) and mecsyco-visu (a set of tools for visualizing simulations).

- Participants: Benjamin Camus, Christine Bourjot, Julien Siebert, Julien Vaubourg, Laurent Ciarletta, Victorien Elvinger, Vincent Chevrier and Yannick Presse
- Partners: Université de Lorraine - Inria
- Contact: Vincent Chevrier
- URL: <http://www.mecsyco.com>

6.6. Ruby-cute

KEYWORDS: Experimentation - HPC - Cloud

FUNCTIONAL DESCRIPTION: Ruby-Cute is a set of Commonly Used Tools for Experiments, or Critically Useful Tools for Experiments, depending on who you ask. It is a library aggregating various Ruby snippets useful in the context of (but not limited to) development of experiment software on distributed systems testbeds such as Grid'5000.

- Contact: Lucas Nussbaum
- URL: <http://ruby-cute.github.io/>

6.7. Platforms

6.7.1. CPS Security Assessment Platform

This year, we have extended our Cyber-Physical systems security assessment platform with new hardware components including multiple types of Programmable Logic Controllers (PLS) and a small scale distribution and sorting testbed. The physical platform is also extended with several IoT devices dedicated to residential networks (heating control, lightning system, home gateways, etc). The platform will be mainly used for building security assessment and evaluation experimentation on the available devices to identify and validate their associated attack patterns and discover new vulnerabilities.

MIMOVE Team

6. New Software and Platforms

6.1. SoundCity - Ambiciti

KEYWORDS: Crowd-sensing - Mobile application

FUNCTIONAL DESCRIPTION: Is your exposure to noise too high on certain days? How is air pollution in your street? Will air quality improve in the next hours? Do you want to measure the noise pollution on the way between your home and your office? What pollution levels are considered harmful for your health? Ambiciti (previously SoundCity) provides answers to these questions and many others.

Noise pollution. Ambiciti (previously called SoundCity) measures the actual noise levels to which you are exposed. Ambiciti can monitor noise levels throughout the day and inform you about your instantaneous, hourly and daily exposures. If you want to contribute to the improvement of the noise map in your city, you can anonymously send your measurements.

Air pollution. Ambiciti computes the air quality index in your region or at the exact location where you stand. You can also access to forecasts and find information about the main pollutants. Depending on your location, you may have access to hourly air quality maps, at street resolution, in real time and for the next two days. Currently, only Paris (France) enjoys such fine maps, but other cities are on the way to be included.

Since 2017, the software is exclusively licensed to the Ambiciti start-up company.

- Authors: Fadwa Rebhi, Pierre-Guillaume Raverdy, Cong Kinh Nguyen, Rajiv Bhatia, Valérie Issarny and Vivien Mallet
- Partners: Ambientic - The Civic Engine
- Contact: Valérie Issarny

6.2. SocialBus

Universal Social Network Bus

KEYWORDS: Middleware - Interoperability - Social networks - Software Oriented Service (SOA)

FUNCTIONAL DESCRIPTION: Online social network services (OSNSs) have become an integral part of our daily lives. At the same time, the aggressive market competition has led to the emergence of multiple competing siloed OSNSs that cannot interoperate. As a consequence, people face the burden of creating and managing multiple OSNS accounts and learning how to use them, to stay connected. The goal of the Universal Social Network Bus (USNB) is to relieve users from such a burden, letting them use their favorite applications to communicate.

Social Entities. Social entities can be humans or systems. They can create a profile in the USNB and link it with their OSNSs identities. Social entities can also choose the OSNS identity they want to use when contacted through the USNB or specify one or more OSNS identities for message reception concerning specific events or senders.

Personae. Personae are USNB entities interacting with users within concrete OSNSs or systems, achieving interoperability between heterogeneous OSNSs. New personae can be developed, registered in the USNB, discovered and used to include additional OSNSs.

Privacy & Security. The USNB is designed to be as less intrusive as possible. It does not ask users their credentials nor any kind of authorization concerning their OSNS accounts.

- Authors: Rafael Angarita Arocha, Nikolaos Georgantas and Valérie Issarny
- Contact: Valérie Issarny
- URL: <https://gitlab.inria.fr/usnb/universal-social-network-bus>

6.3. WeBrowse

KEYWORDS: Web Usage Mining - Content analysis - Recommendation systems

FUNCTIONAL DESCRIPTION: The amount of information available on the web today, and the fast rate with which new information appears, overwhelm most users. The goal of our research is to assist Web users in discovering content. One of the most powerful means today to help people discover new web content is sharing between members of online communities. In the case of communities of a place (e.g., people who live, study, or work together) people share common interests, but often fail to actively share content. To address this problem, we have developed WeBrowse, a passive crowdsourced content discovery system for communities of a place.

WeBrowse leverages the passive observation of web-clicks (i.e., the URLs users intentionally visit) as an indication of users' interest in a piece of content. Intuitively, the more users click on a URL, the higher the interest in the content on the corresponding page. Our approach is then to leverage the collective clicks in a community to automatically discover relevant content to promote to users of the community.

To implement passive crowdsourcing, one must be in a position to observe the aggregated web-clicks of the community. Luckily, in many communities of a place, users will connect to the Internet from the same network, such as, e.g., the campus/enterprise network or the network of a residential Internet Service Provider (ISP) in a neighborhood. WeBrowse (i) observes web packets flowing through a network link, (ii) passively extracts HTTP logs (i.e., streams recording the headers of HTTP requests), and (iii) detects and decides on-the-fly the set of URLs to show to users.

- Contact: Renata Cruz Teixeira
- URL: <https://team.inria.fr/muse/webbrowse-info-page/>

6.4. TA

TA - Traffic Analysis

KEYWORDS: Quality of Experience - Network monitoring - Video analysis

FUNCTIONAL DESCRIPTION: System running at the home getaway that analyzes traffic generated by DASH on-demand and live video streams. The system tracks traffic patterns to infer key video QoE metrics such as average bitrate and re-buffering events. Moreover, the system exploits novel algorithms that use probing techniques, i.e. lightweight pings and traceroutes, to detect possible congestion location.

- Participants: Francesco Bronzino and Renata Cruz Teixeira
- Contact: Francesco Bronzino

6.5. HostView

KEYWORDS: Quality of Experience - Network monitoring

FUNCTIONAL DESCRIPTION: End-host performance monitoring and user feedback reporting.

- Participants: Anna-Kaisa Pietilainen, Francesco Bronzino, George Rosca and Renata Cruz Teixeira
- Contact: Renata Cruz Teixeira
- URL: <https://github.com/inria-muse/hostview-win>

6.6. VSB

eVolution Service Bus

KEYWORDS: Service and Thing choreographies - Middleware protocol interoperability - Enterprise service bus

FUNCTIONAL DESCRIPTION: VSB is a development and runtime environment dedicated to complex distributed applications of the Future Internet. Such applications are open, dynamic choreographies of extremely heterogeneous services and Things, including lightweight embedded systems (e.g., sensors, actuators and networks of them), mobile systems (e.g., smartphone applications), and resource-rich IT systems (e.g., systems hosted on enterprise servers and Cloud infrastructures). VSB's objective is to seamlessly interconnect, inside choreographies, services and Things that employ heterogeneous interaction protocols at the middleware level, e.g., SOAP Web services, REST Web services, Things using CoAP. This is based on runtime conversions between such protocols, with respect to their primitives and data type systems, while properly mapping between their semantics. This also includes mapping between the public interfaces of services/Things, regarding their operations and data, from the viewpoint of the middleware: the latter means that operations and data are converted based on their middleware-level semantics, while their business semantics remains transparent to the conversion. VSB follows the well-known Enterprise Service Bus (ESB) paradigm. We propose a generic interface description, which we call GIDL, for application components that employ VSB. Based on GIDL, we enable automated synthesis of binding components for connecting heterogeneous services and Things onto VSB.

- Participants: Georgios Bouloukakakis, Nikolaos Georgantas and Patient Ntumba
- Contact: Nikolaos Georgantas
- URL: <https://github.com/sidutta/vsb>

MYRIADS Project-Team

6. New Software and Platforms

6.1. ConPaaS

KEYWORDS: Cloud computing - PaaS

SCIENTIFIC DESCRIPTION: Contact:

Guillaume Pierre, Guillaume.Pierre@irisa.fr URL:

<http://www.conpaas.eu/> Status:

Version 1.4.2 License:

BSD Presentation:

ConPaaS [60] is a runtime environment for hosting applications in the cloud. It aims at offering the full power of the cloud to application developers while shielding them from the associated complexity of the cloud. ConPaaS is designed to host both high-performance scientific applications and online Web applications. It automates the entire life-cycle of an application, including collaborative development, deployment, performance monitoring, and automatic scaling. This allows developers to focus their attention on application-specific concerns rather than on cloud-specific details. Active contributors (from the Myriads team):

Eliya Buyukkaya, Ancuta Iordache, Morteza Neishaboori, Guillaume Pierre, Dzenan Softic, Genc Tato, Teodor Crivat. Impact:

ConPaaS is recognized as one of the major open-source PaaS environments. It is being developed by teams in Rennes, Amsterdam, Berlin and Ljubljana. Technology transfer of ConPaaS technology is ongoing in the context of the MC-DATA EIT ICT Labs project.

FUNCTIONAL DESCRIPTION: ConPaaS is a runtime environment for hosting applications in the cloud. It aims at offering the full power of the cloud to application developers while shielding them from the associated complexity of the cloud. ConPaaS is designed to host both high-performance scientific applications and online Web applications. It automates the entire life-cycle of an application, including collaborative development, deployment, performance monitoring, and automatic scaling. This allows developers to focus their attention on application-specific concerns rather than on cloud-specific details.

- Participants: Ancuta Iordache, Dzenan Softic, Eliya Buyukkaya, Genc Tato, Guillaume Pierre, Morteza Neishaboori and Teodor Crivat
- Contact: Guillaume Pierre
- URL: <http://www.conpaas.eu/>

6.2. GinFlow

KEYWORDS: Dynamic adaptation - Distributed Applications - Distributed - Distributed computing - Workflow - Framework

FUNCTIONAL DESCRIPTION: GinFlow decentralizes the coordination of the execution of workflow-based applications. GinFlow relies on an architecture where multiple service agents (SA) coordinate each others through a shared space containing the workflow description and current status. GinFlow allows the user to define several variants of a workflow and to switch from one to the other during run time.

- Participants: Cédric Tedeschi, Hector Fernandez, Javier Rojas Balderrama, Matthieu Simonin and Thierry Priol
- Partner: Université de Rennes 1
- Contact: Cédric Tedeschi
- URL: <http://ginflow.inria.fr>

6.3. Merkat

FUNCTIONAL DESCRIPTION: Merkat is a platform that allows users of an organization to automatically manage and scale their applications while maximizing the infrastructure's utilization. Merkat is generic and extensible, allowing users to automate the application deployment and management process. Users have the flexibility to control how many resources are allocated to their applications and to define their own resource demand adaptation policies. Merkat applies an unique approach to multiplex the infrastructure capacity between the applications, by implementing a proportional-share market and allowing applications to adapt autonomously to resource price and their given performance objectives. The price of the acquired resources acts as a control mechanism to ensure that resources are distributed to applications according to the user's value for them. Merkat was evaluated on Grid'5000 with several scientific applications.

- Participants: Christine Morin, Nikolaos Parlavantzas and Stefania Costache
- Contact: Nikolaos Parlavantzas
- URL: <http://www.irisa.fr/myriads/software/Merkat/>

6.4. PaaSage Adapter

KEYWORDS: Cloud computing - Dynamic adaptation - Cloud applications management

FUNCTIONAL DESCRIPTION: The purpose of the Adapter is to transform the current configuration of a cloud application into a target configuration in an efficient and safe way. The Adapter is part of PaaSage, an open-source platform for modeling, deploying and executing applications on different clouds in an optimal manner. The Adapter has the following responsibilities: (1) validating reconfiguration plans, (2) applying the plans to the running system, and (3) maintaining an up-to-date representation of the current system state.

- Contact: Nikolaos Parlavantzas
- URL: <https://team.inria.fr/myriads/software-and-platforms/paasage-adapter/>

6.5. SAIDS

self-adaptable intrusion detection system

KEYWORDS: Cloud - Security

FUNCTIONAL DESCRIPTION: SAIDS is a self-adaptable intrusion detection system for IaaS clouds. To maintain an effective level of intrusion detection, SAIDS monitors changes in the virtual infrastructure of a Cloud environment and reconfigures its components (security probes) accordingly. SAIDS can also reconfigure probes in the case of a change in the list of running services.

- Authors: Anna Giannakou and Jean-Léon Cusinato
- Contact: Christine Morin

6.6. SimGrid

KEYWORDS: Large-scale Emulators - Grid Computing - Distributed Applications

SCIENTIFIC DESCRIPTION: SimGrid is a toolkit that provides core functionalities for the simulation of distributed applications in heterogeneous distributed environments. The simulation engine uses algorithmic and implementation techniques toward the fast simulation of large systems on a single machine. The models are theoretically grounded and experimentally validated. The results are reproducible, enabling better scientific practices.

Its models of networks, cpus and disks are adapted to (Data)Grids, P2P, Clouds, Clusters and HPC, allowing multi-domain studies. It can be used either to simulate algorithms and prototypes of applications, or to emulate real MPI applications through the virtualization of their communication, or to formally assess algorithms and applications that can run in the framework.

The formal verification module explores all possible message interleavings in the application, searching for states violating the provided properties. We recently added the ability to assess liveness properties over arbitrary and legacy codes, thanks to a system-level introspection tool that provides a finely detailed view of the running application to the model checker. This can for example be leveraged to verify both safety or liveness properties, on arbitrary MPI code written in C/C++/Fortran.

RELEASE FUNCTIONAL DESCRIPTION:

- Four releases in 2017. Major changes:
 - S4U: many progress, toward SimGrid v4.0. About 80% of the features offered by SimDag and MSG are now integrated, along with examples. Users can now write plugins to extend SimGrid.
 - SMPI: Support MPI 2.2, RMA support, Convert internals to C++.
 - Java: Massive memleaks and performance issues fixed.
 - New models: Multi-core VMs, Energy consumption due to the network
 - All internals are now converted to C++, and most of our internally developed data containers were replaced with std::* constructs.
 - (+ bug fixes, cleanups and documentation improvements)
- Participants: Adrien Lèbre, Arnaud Legrand, Augustin Degomme, Florence Perronnin, Frédéric Suter, Jean-Marc Vincent, Jonathan Pastor, Jonathan Rouzaud-Cornabas, Luka Stanisic, Mario Südholt and Martin Quinson
- Partners: CNRS - ENS Rennes
- Contact: Martin Quinson
- URL: <http://simgrid.gforge.inria.fr/>

6.7. DiFFuSE

Distributed framework for cloud-based epidemic simulations

KEYWORDS: Simulation - Cloud

FUNCTIONAL DESCRIPTION: The DiFFuSE framework enables simulations of epidemics to take full advantage of cloud environments. The framework provides design support, reusable code, and tools for building and executing epidemic simulations. Notably, the framework automatically handles failures and supports elastic allocation of resources from multiple clouds.

- Contact: Nikolaos Parlavantzas
- URL: <https://team.inria.fr/myriads/software-and-platforms/diffuse/>

NEO Project-Team

6. New Software and Platforms

6.1. marmoteCore

Markov Modeling Tools and Environments - the Core

KEYWORDS: Modeling - Stochastic models - Markov model

FUNCTIONAL DESCRIPTION: marmoteCore is a C++ environment for modeling with Markov chains. It consists in a reduced set of high-level abstractions for constructing state spaces, transition structures and Markov chains (discrete-time and continuous-time). It provides the ability of constructing hierarchies of Markov models, from the most general to the particular, and equip each level with specifically optimized solution methods.

This software is developed within the ANR MARMOTE project: ANR-12-MONU-00019.

- Participants: Alain Jean-Marie, Hlib Mykhailenko, Benjamin Briot, Franck Quessette, Issam Rabhi, Jean-Marc Vincent and Jean-Michel Fourneau
- Partner: UVSQ
- Contact: Alain Jean-Marie
- Publications: [marmoteCore: a Markov Modeling Platform](#) - [marmoteCore: a software platform for Markov modeling](#)
- URL: <http://marmotecore.gforge.inria.fr/>

6. New Software and Platforms

6.1. College

KEYWORDS: Neurosciences - Health - Autism - Mobile application

FUNCTIONAL DESCRIPTION: College+ is an iPad app gathering an assistance module and a training module for school inclusion in of children with autism spectrum disorders and children with intellectual disabilities in mainstream classrooms. The assistance module, used in mainstream classroom, comprises 3 functionalities: - emotion regulation - classroom routines - verbal communication. The training module, used on a daily basis at home or in special education classroom, comprises two functionalities, presented as serious games: - attention training - emotion identification training. All contents of College+ app can be modified, to fit the unique needs of each student.

- Participants: Alexandre Spriet, Charles Consel, Charles Fage, Damien Martin Guillerez and H  l  ne Sauz  on
- Partners: Universit   de Bordeaux - CNRS - IPB
- Contact: Charles Consel
- URL: <http://phoenix.inria.fr/research-projects/school>

6.2. College +

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- Participants: Alexandre Spriet, Charles Fage, Damien Martin Guillerez and H  l  ne Sauz  on
- Contact: Charles Consel
- URL: <http://phoenix.inria.fr/research-projects/school>

6.3. DiaSuite

KEYWORDS: Pervasive computing - Code generation - Specification language

SCIENTIFIC DESCRIPTION: DiaSuite is a suite of tools covering the development life-cycle of a pervasive computing application:

Defining an application area. First, an expert defines a catalog of entities, whether hardware or software, that are specific to a target area. These entities serve as building blocks to develop applications in this area. They are gathered in a taxonomy definition, written in the taxonomy layer of the DiaSpec language.

Designing an application. Given a taxonomy, the architect can design and structure applications. To do so, the DiaSpec language provides an application design layer. This layer is dedicated to an architectural pattern commonly used in the pervasive computing domain. Describing the architecture application allows to further model a pervasive computing system, making explicit its functional decomposition.

Implementing an application. We leverage the taxonomy definition and the architecture description to provide dedicated support to both the entity and the application developers. This support takes the form of a Java programming framework, generated by the DiaGen compiler. The generated programming framework precisely guides the developer with respect to the taxonomy definition and the architecture description. It consists of high-level operations to discover entities and interact with both entities and application components. In doing so, it abstracts away from the underlying distributed technologies, providing further separation of concerns.

Testing an application. DiaGen generates a simulation support to test pervasive computing applications before their actual deployment. An application is simulated in the DiaSim tool, without requiring any code modification. DiaSim provides an editor to define simulation scenarios and a 2D-renderer to monitor the simulated application. Furthermore, simulated and actual entities can be mixed. This hybrid simulation enables an application to migrate incrementally to an actual environment.

Deploying a system. Finally, the system administrator deploys the pervasive computing system. To this end, a distributed systems technology is selected. We have developed a back-end that currently targets the following technologies: Web Services, RMI, SIP and OSGI. This targeting is transparent for the application code. The variety of these target technologies demonstrates that our development approach separates concerns into well-defined layers.

FUNCTIONAL DESCRIPTION: DiaSuite is developed as a research project by the Inria/LaBRI Phoenix research group. The DiaSuite approach covers the development life-cycle of a pervasive computing application. It takes the form of a methodology, supported by (1) a high-level design language and (2) a suite of tools covering the development life-cycle of a pervasive computing application. Specifically, we have developed a design language dedicated to describing pervasive computing systems and a suite of tools providing customized support for each development stage of a pervasive computing system, namely, implementation (e.g., programming support), testing (e.g., unit test, 2D simulator), and deployment (e.g., distribution platforms like SIP and Web Services).

- Participants: Adrien Carteron, Alexandre Spriet, Charles Consel, Milan Kabac, Paul Van Der Walt and Quentin Barlas
- Contact: Charles Consel
- URL: <http://phoenix.inria.fr/software/diasuite>

6.4. DiaSuiteBOX

KEYWORDS: Dedicated langage - Iot - Orchestration - Toolbox - Development tool suite

FUNCTIONAL DESCRIPTION: DiaSuiteBOX proposes an application store that gathers the devices deployed at home. This store is open and available online such as an application store for Smartphone.

- Participants: Adrien Carteron, Amélie Marzin, Bertran Benjamin, Bruneau Julien, Consel Charles, Damien Cassou, Damien Martin Guillerez, Emilie Balland, Eugène Volanschi, Hélène Sauzéon, Joan Rieu, Julien Durand, Ludovic Fornasari, Milan Kabac, Quentin Barlas and Quentin Enard
- Contact: Charles Consel
- URL: <https://domassist.bordeaux.inria.fr/>

6.5. DomAssist

KEYWORDS: Health - Mobile application - Persons attendant - Home care

FUNCTIONAL DESCRIPTION: 3 mobile applications for assistive living : - DiAndroid : Interface for the main tablet with the DiaSuiteBox applications including those for the daily activities, the meetings scheduling, etc. and for home and personal safety - Accueil : home screen restraining the use of a secondary tablet and offering communications and social activities applications with simplified communication means (ie. eMail), collaborative games, etc. - eMail : mail client made for older people

Other Vera gateway tools : - Controlling connected objects to the Vera home automation gateway from Android
- Vera push plugin to domassist cloud: vera plugin to communicate sensor information associated with the gateway directly to DomAssist servers - Vera HeartBeat Plugin: Regular sending of a frame to know that the gateway is still online

- Participants: Alexandre Spriet, Quentin Barlas, Charles Consel, Hélène Sauzéon and Julien Durand
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Charles Consel
- URL: <http://phoenix.inria.fr/research-projects/homeassist>

POLARIS Team

6. New Software and Platforms

6.1. Framesoc

FUNCTIONAL DESCRIPTION: Framesoc is the core software infrastructure of the SoC-Trace project. It provides a graphical user environment for execution-trace analysis, featuring interactive analysis views as Gantt charts or statistics views. It provides also a software library to store generic trace data, play with them, and build other analysis tools (e.g., Ocelotl).

- Participants: Arnaud Legrand and Jean-Marc Vincent
- Contact: Guillaume Huard
- URL: <http://soctrace-inria.github.io/framesoc/>

6.2. GameSeer

FUNCTIONAL DESCRIPTION: GameSeer is a tool for students and researchers in game theory that uses Mathematica to generate phase portraits for normal form games under a variety of (user-customizable) evolutionary dynamics. The whole point behind GameSeer is to provide a dynamic graphical interface that allows the user to employ Mathematica's vast numerical capabilities from a simple and intuitive front-end. So, even if you've never used Mathematica before, you should be able to generate fully editable and customizable portraits quickly and painlessly.

- Contact: Panayotis Mertikopoulos
- URL: <http://mescal.imag.fr/membres/panayotis.mertikopoulos/publications.html>

6.3. marmoteCore

Markov Modeling Tools and Environments - the Core

KEYWORDS: Modeling - Stochastic models - Markov model

FUNCTIONAL DESCRIPTION: marmoteCore is a C++ environment for modeling with Markov chains. It consists in a reduced set of high-level abstractions for constructing state spaces, transition structures and Markov chains (discrete-time and continuous-time). It provides the ability of constructing hierarchies of Markov models, from the most general to the particular, and equip each level with specifically optimized solution methods.

This software is developed within the ANR MARMOTE project: ANR-12-MONU-00019.

- Participants: Alain Jean-Marie, Hlib Mykhailenko, Benjamin Briot, Franck Quessette, Issam Rabhi, Jean-Marc Vincent and Jean-Michel Fourneau
- Partner: UVSQ
- Contact: Alain Jean-Marie
- Publications: [marmoteCore: a Markov Modeling Platform](#) - [marmoteCore: a software platform for Markov modeling](#)
- URL: <http://marmotecore.gforge.inria.fr/>

6.4. Moca

Memory Organisation Cartography and Analysis

KEYWORDS: High-Performance Computing - Performance analysis

- Contact: David Beniamine
- URL: <https://github.com/dbeniamine/MOCA>

6.5. Ocelotl

Multidimensional Overviews for Huge Trace Analysis

FUNCTIONAL DESCRIPTION: Ocelotl is an innovative visualization tool, which provides overviews for execution trace analysis by using a data aggregation technique. This technique enables to find anomalies in huge traces containing up to several billions of events, while keeping a fast computation time and providing a simple representation that does not overload the user.

- Participants: Arnaud Legrand and Jean-Marc Vincent
- Contact: Jean-Marc Vincent
- URL: <http://soctrace-inria.github.io/ocelotl/>

6.6. PSI

Perfect Simulator

FUNCTIONAL DESCRIPTION: Perfect simulator is a simulation software of markovian models. It is able to simulate discrete and continuous time models to provide a perfect sampling of the stationary distribution or directly a sampling of functional of this distribution by using coupling from the past. The simulation kernel is based on the CFTP algorithm, and the internal simulation of transitions on the Aliasing method.

- Contact: Jean-Marc Vincent
- URL: <http://psi.gforge.inria.fr/>

6.7. SimGrid

KEYWORDS: Large-scale Emulators - Grid Computing - Distributed Applications

SCIENTIFIC DESCRIPTION: SimGrid is a toolkit that provides core functionalities for the simulation of distributed applications in heterogeneous distributed environments. The simulation engine uses algorithmic and implementation techniques toward the fast simulation of large systems on a single machine. The models are theoretically grounded and experimentally validated. The results are reproducible, enabling better scientific practices.

Its models of networks, cpus and disks are adapted to (Data)Grids, P2P, Clouds, Clusters and HPC, allowing multi-domain studies. It can be used either to simulate algorithms and prototypes of applications, or to emulate real MPI applications through the virtualization of their communication, or to formally assess algorithms and applications that can run in the framework.

The formal verification module explores all possible message interleavings in the application, searching for states violating the provided properties. We recently added the ability to assess liveness properties over arbitrary and legacy codes, thanks to a system-level introspection tool that provides a finely detailed view of the running application to the model checker. This can for example be leveraged to verify both safety or liveness properties, on arbitrary MPI code written in C/C++/Fortran.

RELEASE FUNCTIONAL DESCRIPTION:

- Four releases in 2017. Major changes:
 - S4U: many progress, toward SimGrid v4.0. About 80% of the features offered by SimDag and MSG are now integrated, along with examples. Users can now write plugins to extend SimGrid.
 - SMPI: Support MPI 2.2, RMA support, Convert internals to C++.
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 - New models: Multi-core VMs, Energy consumption due to the network
 - All internals are now converted to C++, and most of our internally developed data containers were replaced with std::* constructs.
 - (+ bug fixes, cleanups and documentation improvements)
- Participants: Adrien Lèbre, Arnaud Legrand, Augustin Degomme, Florence Perronnin, Frédéric Suter, Jean-Marc Vincent, Jonathan Pastor, Jonathan Rouzaud-Cornabas, Luka Stanisic, Mario Südholt and Martin Quinson
- Partners: CNRS - ENS Rennes
- Contact: Martin Quinson
- URL: <http://simgrid.gforge.inria.fr/>

6.8. Tabarnac

Tool for Analyzing the Behavior of Applications Running on NUMA Architecture

KEYWORDS: High-Performance Computing - Performance analysis - NUMA

- Contact: David Beniamine
- URL: <https://dbeniamine.github.io/Tabarnac/>

RAP2 Team (section vide)

REGAL Project-Team

4. New Software and Platforms

4.1. Antidote

KEYWORDS: Distributed computing - Distributed Data Management - Cloud storage - Large scale

FUNCTIONAL DESCRIPTION: Antidote is the flexible cloud database platform currently under development in the SyncFree and LightKone European projects. Antidote aims to be both a research platform for studying replication and consistency at the large scale, and an instrument for exploiting research results. The platform supports replication of CRDTs, in and between sharded (partitioned) data centres (DCs). The current stable version supports strong transactional consistency inside a DC, and causal transactional consistency between DCs. Ongoing research includes support for explicit consistency, for elastic version management, for adaptive replication, for partial replication, and for reconfigurable sharding.

- Participants: Marc Shapiro, Paolo Viotti, Alejandro Tomsic, Ilyas Toumlilt and Dimitrios Vasilas
- Partners: Université Catholique de Louvain (UCL), Louvain-la-Neuve, Belgium - Universidade NOVA de Lisboa, Portugal - Technische Universität Kaiserslautern (UniKL), Allemagne
- Contact: Marc Shapiro
- Publications: [Bringing the cloud closer to users](#) - [Write Fast, Read in the Past: Causal Consistency for Client-side Applications](#) - [Extending Eventually Consistent Cloud Databases for Enforcing Numeric Invariants](#) - [Designing a causally consistent protocol for geo-distributed partial replication](#) - [Towards Fast Invariant Preservation in Geo-replicated Systems](#) - [Putting Consistency back into Eventual Consistency](#) - [The Case for Fast and Invariant-Preserving Geo-Replication](#) - [Improving the scalability of geo-replication with reservations](#) - [Conflict-free Replicated Data Types](#) - [An encounter with Marc Shapiro and his SyncFree European project](#) - [PhysiCS-NMSI: efficient consistent snapshots for scalable snapshot isolation](#) - [Geo-Replication: Fast If Possible, Consistent If Necessary](#) - [Cure: Strong semantics meets high availability and low latency](#) - [Cure: Strong semantics meets high availability and low latency](#)

4.2. CISE Tool

KEYWORDS: Distributed Applications - Program verification

FUNCTIONAL DESCRIPTION: Static analysis of the model of a distributed application, to prove (under the assumption of causal consistency) whether the invariants of the application are always satisfied, and to provide a counterexample if not.

- Participants: Sreeja Nair and Marc Shapiro
- Contact: Marc Shapiro
- Publications: [Evaluation of the CEC \(Correct Eventual Consistency\) Tool](#) - [The CISE Tool: Proving Weakly-Consistent Applications Correct](#) - [The CISE Tool: Proving Weakly-Consistent Applications Correct](#) - [CISE Safety Tool](#) - ['Cause I'm Strong Enough: Reasoning about Consistency Choices in Distributed Systems](#) - [Putting Consistency back into Eventual Consistency](#)

4.3. PUMA

Puma: pooling unused memory in virtual machines

KEYWORDS: Virtualization - Operating system - Distributed systems - Linux kernel

FUNCTIONAL DESCRIPTION: PUMA is a system that is based on a kernel-level remote caching mechanism that provides the ability to pool VMs memory at the scale of a data center. An important property while lending memory to another VM, is the ability to quickly retrieve memory in case of need. Our approach aims at lending memory only for clean cache pages: in case of need, the VM which lent the memory can retrieve it easily. We use the system page cache to store remote pages such that: (i) if local processes allocate memory the borrowed memory can be retrieved immediately, and (ii) if they need cache the remote pages have a lower priority than the local ones.

- Participants: Maxime Lorrillere, Julien Sopena and Pierre Sens
- Partner: LIP6
- Contact: Julien Sopena
- Publications: *Conception et évaluation d'un système de cache réparti adapté aux environnements virtualisés - Puma: pooling unused memory in virtual machines for I/O intensive applications*
- URL: <https://github.com/mlorrillere/puma>

RMOD Project-Team

6. New Software and Platforms

6.1. Moose

Moose: Software and Data Analysis Platform

KEYWORDS: Software engineering - Meta model - Software visualisation

FUNCTIONAL DESCRIPTION: Moose is an extensive platform for software and data analysis. It offers multiple services ranging from importing and parsing data, to modeling, to measuring, querying, mining, and to building interactive and visual analysis tools. The development of Moose has been evaluated to 200 man/year.

Mots-cles : MetaModeling, Program Visualization, Software metrics, Code Duplication, Software analyses, Parsers

- Participants: Anne Etien, Nicolas Anquetil, Olivier Auverlot and Stéphane Ducasse
- Partners: Université de Berne - Sensus - Synectique - Pleiad - USI - Vrije Universiteit Brussel
- Contact: Stéphane Ducasse
- URL: <http://www.moosetechnology.org>

6.2. Pharo

KEYWORDS: Live programming objet - Reflective system - Web Application

FUNCTIONAL DESCRIPTION: Pharo is a pure object reflective and dynamic language inspired by Smalltalk. In addition, Pharo comes with a full advanced programming environment developed under the MIT License. It provides a platform for innovative development both in industry and research. By providing a stable and small core system, excellent developer tools, and maintained releases, Pharo's goal is to be a platform to build and deploy mission critical applications, while at the same time continue to evolve. Pharo 60 got 100 contributors world-wide. It is used by around 30 universities, 15 research groups and around 40 companies.

RELEASE FUNCTIONAL DESCRIPTION: Inspector/Playground/Spotter are new moldable development tools for inspecting, coding and searching objects. Slots model instance variables as first class entities and enable meta-programming on this level. ShoreLine reporter introduces a way to report system errors and collect statistics, that we will use for future improvements Dark theme.

- Participants: Christophe Demarey, Clement Bera, Damien Pollet, Esteban Lorenzano, Marcus Denker and Stéphane Ducasse
- Partners: Université de Berne - Cadence - Inceptive - Netstyle - Feenk - ObjectProfile - GemstoneSystems - Greyc Université de Caen - Basse-Normandie - BetaNine - Yesplan - RMod - Pleiad - Synectique - Sensus - Université de Bretagne Occidentale - École des Mines de Douai - Reveal
- Contact: Marcus Denker
- URL: <http://www.pharo.org>

6.3. Pillar

KEYWORDS: HTML - LaTeX - HTML5

FUNCTIONAL DESCRIPTION: Pillar is a markup syntax and associated tools to write and generate documentation and books. Pillar is currently used to write several books and other documentation. Two platforms have already been created on top of Pillar: PillarHub and Marina.

- Contact: Stéphane Ducasse
- URL: <https://github.com/Pillar-markup/pillar>

ROMA Project-Team

6. New Software and Platforms

6.1. DCC

DPN C Compiler

KEYWORDS: Polyhedral compilation - Automatic parallelization - High-level synthesis

FUNCTIONAL DESCRIPTION: Dcc (Data-aware process network C compiler) analyzes a sequential regular program written in C and generates an equivalent architecture of parallel computer as a communicating process network (Data-aware Process Network, DPN). Internal communications (channels) and external communications (external memory) are automatically handled while fitting optimally the characteristics of the global memory (latency and throughput). The parallelism can be tuned. Dcc has been registered at the APP ("Agence de protection des programmes") and transferred to the XtremLogic start-up under an Inria license.

- Participants: Alexandru Plesco and Christophe Alias
- Contact: Christophe Alias

6.2. MUMPS

A Multifrontal Massively Parallel Solver

KEYWORDS: High-Performance Computing - Direct solvers - Finite element modelling

FUNCTIONAL DESCRIPTION: MUMPS is a software library to solve large sparse linear systems ($AX=B$) on sequential and parallel distributed memory computers. It implements a sparse direct method called the multifrontal method. It is used worldwide in academic and industrial codes, in the context numerical modeling of physical phenomena with finite elements. Its main characteristics are its numerical stability, its large number of features, its high performance and its constant evolution through research and feedback from its community of users. Examples of application fields include structural mechanics, electromagnetism, geophysics, acoustics, computational fluid dynamics. MUMPS is developed by INPT(ENSEEIH)-IRIT, Inria, CERFACS, University of Bordeaux, CNRS and ENS Lyon. In 2014, a consortium of industrial users has been created (<http://mumps-consortium.org>).

RELEASE FUNCTIONAL DESCRIPTION: MUMPS versions 5.1.0, 5.1.1 and 5.1.2, all released in 2017 include many new features and improvements. The two main new features are Block Low-Rank compression, decreasing the complexity of sparse direct solvers for various types of applications, and selective 64-bit integers, allowing to process matrices with more than 2 billion entries.

- Participants: Gilles Moreau, Abdou Guermouche, Alfredo Buttari, Aurélia Fevre, Bora Uçar, Chiara Puglisi, Clément Weisbecker, Emmanuel Agullo, François-Henry Rouet, Guillaume Joslin, Jacko Koster, Jean-Yves L'excellent, Marie Durand, Maurice Bremond, Mohamed Sid-Lakhdar, Patrick Amestoy, Philippe Combes, Stéphane Pralet, Theo Mary and Tzvetomila Slavova
- Partners: Université de Bordeaux - CNRS - CERFACS - ENS Lyon - INPT - IRIT - Université de Lyon - Université de Toulouse - LIP
- Contact: Jean-Yves L'excellent
- URL: <http://mumps-solver.org/>

6.3. PoCo

Polyhedral Compilation Library

KEYWORDS: Polyhedral compilation - Automatic parallelization

FUNCTIONAL DESCRIPTION: PoCo (Polyhedral Compilation Library) is a compilation framework allowing to develop parallelizing compilers for regular programs. PoCo features many state-of-the-art polyhedral program analysis and a symbolic calculator on execution traces (represented as convex polyhedra). PoCo has been registered at the APP (“agence de protection des programmes”) and transferred to the XtremLogic start-up under an Inria licence.

- Participant: Christophe Alias
- Contact: Christophe Alias

SOCRATE Project-Team

5. New Software and Platforms

5.1. fftweb

KEYWORDS: Experimentation - Data visualization - SDR (Software Defined Radio)

FUNCTIONAL DESCRIPTION: fftweb is a real-time spectral (FFT) visualization of one or several signal, embedded in a web page. The FFT is computed in a GNURadio block, then sent to a gateway server, which serves the web page, associated javascripts, and signal websockets. The end user only has to use the GNURadio block and the web page, and doesn't need to bother about the internal details of the system. fftweb has been developed specially for the CorteXlab testbed but with minor adaptations, it can be used in other contexts, and also can be used to draw more generic real-time graphs, not only FFTs. Technologies: GNURadio, python, python-gevent, Javascript, D3JS

- Contact: Matthieu Imbert

5.2. FloPoCo

Floating-Point Cores, but not only

KEYWORD: Synthesizable VHDL generator

FUNCTIONAL DESCRIPTION: The purpose of the open-source FloPoCo project is to explore the many ways in which the flexibility of the FPGA target can be exploited in the arithmetic realm.

- Participants: Antoine Martinet, Florent Dupont De Dinechin, Matei Istioan and Nicolas Brunie
- Partners: CNRS - ENS Lyon - UCBL Lyon 1 - UPVD
- Contact: Florent Dupont De Dinechin
- URL: <http://flopoco.gforge.inria.fr/>

5.3. minus

KEYWORDS: Experimentation - SDR (Software Defined Radio)

FUNCTIONAL DESCRIPTION: Minus is an experiment control system able to control, the whole lifecycle of a radio experiment in CorteXlab or any other testbed inspired by it. Minus controls and automates the whole experiment process starting from node power cycling, experiment deployment, experiment start and stop, and results collection and transfer. Minus is also capable of managing multiple queues of experiments which are executed simultaneously in the testbed.

- Contact: Matthieu Imbert

5.4. WiPlan

FUNCTIONAL DESCRIPTION: Wiplan is a software including an Indoor propagation engine and a wireless LAN optimization suite, which has been registered by INSA-Lyon. The heart of this software is the propagation simulation core relying on an original method, MR-FDPF (multi-resolution frequency domain ParFlow), proposed by JM Gorce in 2001 and further extended. The discrete ParFlow equations are translated in the Fourier domain providing a large linear system, solved in two steps taking advantage of a multi-resolution approach. The first step computes a cell-based tree structure referred to as the pyramid. In the second phase, a radiating source is simulated, taking advantage of the pre-processed pyramidal structure. Using of a full-space discrete simulator instead of classical ray-tracing techniques is a challenge due to the inherent high computation requests. However, we have shown that the use of a multi-resolution approach allows the main computational load to be restricted to a pre-processing phase. Extensive works have been done to make predictions more realistic.

- Contact: Tanguy Risset

5.5. Sytare

KEYWORDS: Embedded systems - Operating system - Non volatile memory

FUNCTIONAL DESCRIPTION: Sytare is an embedded operating system targeting tiny platforms with intermittent power. In order to make power failures transparent for the application, the system detects imminent failures and saves a checkpoint of program state to non-volatile memory. Hardware peripherals are also made persistent without requiring developer attention.

- Authors: Gautier Berthou, Tristan Delizy, Kevin Marquet and Guillaume Salagnac
- Contact: Guillaume Salagnac
- Publication: [Peripheral State Persistence For Transiently Powered Systems](#)
- URL: <https://hal.inria.fr/hal-01460699>

5.6. Platform - FIT/CortexLab

FIT (Future Internet of Things) is a french Equipex (Équipement d'excellence) which aims to develop an experimental facility, a federated and competitive infrastructure with international visibility and a broad panel of customers. FIT is composed of four main parts: a Network Operations Center (FIT NOC), a set of IoT test-beds (FIT IoT-Lab), a set of wireless test-beds (FIT-Wireless) which includes the FIT/CortexLab platform deployed by the Socrate team in the Citi lab, and finally a set of Cloud test-beds (FIT-Cloud). In 2014 the construction of the room was finished see Figure 5. SDR nodes have installed in the room, 42 industrial PCs (Aplus Nuvo-3000E/P), 22 NI radio boards (USRP) and 18 Nutaq boards (PicoSDR, 2x2 and 4X4) can be programmed from internet now.

A very successfully inauguration took place in 2014⁰, with the noticable venue of Vincent Poor, Dean of School of Engineering and Applied Science of Princeton University. Since that date, the platform is open to public experiments. CortexLab has been used for innovative experiments such as Interference Alignment in Cellular Networks for Energy Efficiency Improvement demonstrated in the [GreenTouch Consortium](#).



Figure 5. Photo of the FIT/CortexLab experimentation room installed and a snapshot of the inauguration meeting

⁰<http://www.inria.fr/centre/grenoble/actualites/inauguration-reussie-de-la-plateforme-cortexlab-equipex-fit>

SPIRALS Project-Team

6. New Software and Platforms

6.1. APISENSE

KEYWORDS: Mobile sensing - Crowd-sensing - Mobile application - Crowd-sourcing - Android

FUNCTIONAL DESCRIPTION: APISENSE platform is a software solution to collect various contextual information from Android devices (client application) and automatically upload collected data to a server (deployed as a SaaS). APISENSE is based on a Cloud computing infrastructure to facilitate datasets collection from significant populations of mobile users for research purposes.

- Participants: Antoine Veuiller, Christophe Ribeiro, Julien Duribreux, Nicolas Haderer and Romain Rouvoy
- Partner: Université Lille 1
- Contact: Romain Rouvoy
- URL: <http://apisense.io>

6.2. Nopol

KEYWORD: Automatic software repair

FUNCTIONAL DESCRIPTION: Nopol is an automatic software repair tool for buggy conditional statements (i.e., if-then-else statements) in Java programs. Nopol takes a buggy program as well as a test suite as input and generates a patch with a conditional expression as output. The test suite is required to contain passing test cases to model the expected behavior of the program and at least one failing test case that reveals the bug to be repaired. The process of Nopol consists of three major phases. First, Nopol employs angelic fix localization to identify expected values of a condition during the test execution. Second, runtime trace collection is used to collect variables and their actual values, including primitive data types and objected-oriented features (e.g., nullness checks), to serve as building blocks for patch generation. Third, Nopol encodes these collected data into an instance of a Satisfiability Modulo Theory (SMT) problem, then a feasible solution to the SMT instance is translated back into a code patch.

- Contact: Martin Monperrus
- URL: <https://github.com/SpoonLabs/nopol/>

6.3. PowerAPI

KEYWORDS: Energy efficiency - Energy management

FUNCTIONAL DESCRIPTION: PowerAPI is a library for monitoring the energy consumption of software systems.

PowerAPI differs from existing energy process-level monitoring tool in its software orientation, with a fully customizable and modular solution that let the user to precisely define what he/she wants to monitor. PowerAPI is based on a modular and asynchronous event-driven architecture using the Akka library. PowerAPI offers an API which can be used to define requests about energy spent by a process, following its hardware resource utilization (in term of CPU, memory, disk, network, etc.).

- Participants: Adel Noureddine, Loïc Huertas, Maxime Colmant and Romain Rouvoy
- Contact: Romain Rouvoy
- URL: <http://powerapi.org>

6.4. Saloon

KEYWORDS: Feature Model - Software Product Line - Cloud computing - Model-driven engineering - Ontologies

FUNCTIONAL DESCRIPTION: Saloon is a framework for the selection and configuration of Cloud providers according to application requirements. The framework enables the specification of such requirements by defining ontologies. Each ontology provides a unified vision of provider offers in terms of frameworks, databases, languages, application servers and computational resources (i.e., memory, storage and CPU frequency). Furthermore, each provider is related to a Feature Model (FM) with attributes and cardinalities, which captures its capabilities. By combining the ontology and FMs, the framework is able to match application requirements with provider capabilities and select a suitable one. Specific scripts to the selected provider are generated in order to enable its configuration.

- Participants: Clément Quinton, Daniel Romero Acero, Laurence Duchien, Lionel Seinturier and Romain Rouvoy
- Partner: Université Lille 1
- Contact: Lionel Seinturier
- URL: <https://gitlab.irisa.fr/drome00A/saloon>

6.5. SPOON

KEYWORDS: Java - Code analysis

FUNCTIONAL DESCRIPTION: Spoon is an open-source library that enables you to transform (see below) and analyze Java source code (see example) . Spoon provides a complete and fine-grained Java metamodel where any program element (classes, methods, fields, statements, expressions...) can be accessed both for reading and modification. Spoon takes as input source code and produces transformed source code ready to be compiled.

- Participants: Gérard Paligot, Lionel Seinturier, Martin Monperrus and Nicolas Petitprez
- Contact: Martin Monperrus
- URL: <http://spoon.gforge.inria.fr>

STORM Project-Team

5. New Software and Platforms

5.1. Chameleon

KEYWORDS: Runtime system - Task-based algorithm - Dense linear algebra - HPC - Task scheduling

SCIENTIFIC DESCRIPTION: Chameleon is part of the MORSE (Matrices Over Runtime Systems @ Exascale) project. The overall objective is to develop robust linear algebra libraries relying on innovative runtime systems that can fully benefit from the potential of those future large-scale complex machines.

We expect advances in three directions based first on strong and closed interactions between the runtime and numerical linear algebra communities. This initial activity will then naturally expand to more focused but still joint research in both fields.

1. Fine interaction between linear algebra and runtime systems. On parallel machines, HPC applications need to take care of data movement and consistency, which can be either explicitly managed at the level of the application itself or delegated to a runtime system. We adopt the latter approach in order to better keep up with hardware trends whose complexity is growing exponentially. One major task in this project is to define a proper interface between HPC applications and runtime systems in order to maximize productivity and expressivity. As mentioned in the next section, a widely used approach consists in abstracting the application as a DAG that the runtime system is in charge of scheduling. Scheduling such a DAG over a set of heterogeneous processing units introduces a lot of new challenges, such as predicting accurately the execution time of each type of task over each kind of unit, minimizing data transfers between memory banks, performing data prefetching, etc. Expected advances: In a nutshell, a new runtime system API will be designed to allow applications to provide scheduling hints to the runtime system and to get real-time feedback about the consequences of scheduling decisions.

2. Runtime systems. A runtime environment is an intermediate layer between the system and the application. It provides low-level functionality not provided by the system (such as scheduling or management of the heterogeneity) and high-level features (such as performance portability). In the framework of this proposal, we will work on the scalability of runtime environment. To achieve scalability it is required to avoid all centralization. Here, the main problem is the scheduling of the tasks. In many task-based runtime environments the scheduler is centralized and becomes a bottleneck as soon as too many cores are involved. It is therefore required to distribute the scheduling decision or to compute a data distribution that impose the mapping of task using, for instance the so-called “owner-compute” rule. Expected advances: We will design runtime systems that enable an efficient and scalable use of thousands of distributed multicore nodes enhanced with accelerators.

3. Linear algebra. Because of its central position in HPC and of the well understood structure of its algorithms, dense linear algebra has often pioneered new challenges that HPC had to face. Again, dense linear algebra has been in the vanguard of the new era of petascale computing with the design of new algorithms that can efficiently run on a multicore node with GPU accelerators. These algorithms are called “communication-avoiding” since they have been redesigned to limit the amount of communication between processing units (and between the different levels of memory hierarchy). They are expressed through Direct Acyclic Graphs (DAG) of fine-grained tasks that are dynamically scheduled. Expected advances: First, we plan to investigate the impact of these principles in the case of sparse applications (whose algorithms are slightly more complicated but often rely on dense kernels). Furthermore, both in the dense and sparse cases, the scalability on thousands of nodes is still limited, new numerical approaches need to be found. We will specifically design sparse hybrid direct/iterative methods that represent a promising approach.

Overall end point. The overall goal of the MORSE associate team is to enable advanced numerical algorithms to be executed on a scalable unified runtime system for exploiting the full potential of future exascale machines.

FUNCTIONAL DESCRIPTION: Chameleon is a dense linear algebra software relying on sequential task-based algorithms where sub-tasks of the overall algorithms are submitted to a Runtime system. A Runtime system such as StarPU is able to manage automatically data transfers between not shared memory area (CPUs-GPUs, distributed nodes). This kind of implementation paradigm allows to design high performing linear algebra algorithms on very different type of architecture: laptop, many-core nodes, CPUs-GPUs, multiple nodes. For example, Chameleon is able to perform a Cholesky factorization (double-precision) at 80 TFlop/s on a dense matrix of order 400 000 (e.i. 4 min).

RELEASE FUNCTIONAL DESCRIPTION: Chameleon includes the following features:

- BLAS 3, LAPACK one-sided and LAPACK norms tile algorithms - Support QUARK and StarPU runtime systems - Exploitation of homogeneous and heterogeneous platforms through the use of BLAS/LAPACK CPU kernels and cuBLAS/MAGMA CUDA kernels - Exploitation of clusters of interconnected nodes with distributed memory (using OpenMPI)

- Participants: Cédric Castagnede, Samuel Thibault, Emmanuel Agullo, Florent Pruvost and Mathieu Faverge
- Partners: Innovative Computing Laboratory (ICL) - King Abdulla University of Science and Technology - University of Colorado Denver
- Contact: Emmanuel Agullo
- URL: <https://project.inria.fr/chameleon/>

5.2. hwloc

Hardware Locality

KEYWORDS: NUMA - Multicore - GPU - Affinities - Open MPI - Topology - HPC - Locality

FUNCTIONAL DESCRIPTION: Hardware Locality (hwloc) is a library and set of tools aiming at discovering and exposing the topology of machines, including processors, cores, threads, shared caches, NUMA memory nodes and I/O devices. It builds a widely-portable abstraction of these resources and exposes it to applications so as to help them adapt their behavior to the hardware characteristics. They may consult the hierarchy of resources, their attributes, and bind task or memory on them.

hwloc targets many types of high-performance computing applications, from thread scheduling to placement of MPI processes. Most existing MPI implementations, several resource managers and task schedulers, and multiple other parallel libraries already use hwloc.

- Participants: Brice Goglin and Samuel Thibault
- Partners: Open MPI consortium - Intel - AMD
- Contact: Brice Goglin
- Publications: [hwloc: a Generic Framework for Managing Hardware Affinities in HPC Applications](#) - [Managing the Topology of Heterogeneous Cluster Nodes with Hardware Locality \(hwloc\)](#) - [A Topology-Aware Performance Monitoring Tool for Shared Resource Management in Multicore Systems](#) - [Exposing the Locality of Heterogeneous Memory Architectures to HPC Applications](#) - [Towards the Structural Modeling of the Topology of next-generation heterogeneous cluster Nodes with hwloc](#) - [On the Overhead of Topology Discovery for Locality-aware Scheduling in HPC](#)
- URL: <http://www.open-mpi.org/projects/hwloc/>

5.3. KaStORS

The KaStORS OpenMP Benchmark Suite

KEYWORDS: OpenMP - Task scheduling - Task-based algorithm - HPC - Benchmarking - Data parallelism

FUNCTIONAL DESCRIPTION: The KaStORS benchmarks suite has been designed to evaluate implementations of the OpenMP dependent task paradigm, introduced as part of the OpenMP 4.0 specification.

- Participants: François Broquedis, Nathalie Furmento, Olivier Aumage, Philippe Virouleau, Pierrick Brunet, Samuel Thibault and Thierry Gautier
- Contact: Thierry Gautier
- URL: <http://kastors.gforge.inria.fr/#!/index.md>

5.4. KStar

The KStar OpenMP Compiler

KEYWORDS: Source-to-source compiler - OpenMP - Task scheduling - Compilers - Data parallelism

FUNCTIONAL DESCRIPTION: The KStar software is a source-to-source OpenMP compiler for languages C and C++. The KStar compiler translates OpenMP directives and constructs into API calls from the StarPU runtime system or the XKaapi runtime system. The KStar compiler is virtually fully compliant with OpenMP 3.0 constructs. The KStar compiler supports OpenMP 4.0 dependent tasks and accelerated targets.

- Participants: Nathalie Furmento, Olivier Aumage, Samuel Pitoiset and Samuel Thibault
- Contact: Olivier Aumage
- URL: <http://kstar.gforge.inria.fr/#!/index.md>

5.5. MAQAO

SCIENTIFIC DESCRIPTION: MAQAO relies on binary codes for Intel x86 and ARM architectures. For x86 architecture, it can insert probes for instrumentation directly inside the binary. There is no need to recompile. The static/dynamic approach of MAQAO analysis is the main originality of the tool, combining performance model with values collected through instrumentation.

MAQAO has a static performance model for x86 and ARM architectures. This model analyzes performance of the codes on the architectures and provides some feed-back hints on how to improve these codes, in particular for vector instructions.

The dynamic collection of data in MAQAO enables the analysis of thread interactions, such as false sharing, amount of data reuse, runtime scheduling policy, ...

FUNCTIONAL DESCRIPTION: MAQAO is a performance tuning tool for OpenMP parallel applications. It relies on the static analysis of binary codes and the collection of dynamic information (such as memory traces). It provides hints to the user about performance bottlenecks and possible workarounds.

- Participants: Christopher Haine, Denis Barthou, James Tombi A Mba and Olivier Aumage
- Contact: Denis Barthou

5.6. StarPU

The StarPU Runtime System

KEYWORDS: Multicore - GPU - Scheduling - HPC - Performance

SCIENTIFIC DESCRIPTION: Traditional processors have reached architectural limits which heterogeneous multicore designs and hardware specialization (eg. coprocessors, accelerators, ...) intend to address. However, exploiting such machines introduces numerous challenging issues at all levels, ranging from programming models and compilers to the design of scalable hardware solutions. The design of efficient runtime systems for these architectures is a critical issue. StarPU typically makes it much easier for high performance libraries or compiler environments to exploit heterogeneous multicore machines possibly equipped with GPGPUs or Cell processors: rather than handling low-level issues, programmers may concentrate on algorithmic concerns. Portability is obtained by the means of a unified abstraction of the machine. StarPU offers a unified offloadable task abstraction named "codelet". Rather than rewriting the entire code, programmers can encapsulate existing functions within codelets. In case a codelet may run on heterogeneous architectures, it is possible to specify one function for each architectures (eg. one function for CUDA and one function for CPUs). StarPU takes care to schedule and execute those codelets as efficiently as possible over the entire machine. In order to relieve programmers from the burden of explicit data transfers, a high-level data management library enforces memory coherency over the machine: before a codelet starts (eg. on an accelerator), all its data are transparently made available on the compute resource. Given its expressive interface and portable scheduling policies, StarPU obtains portable performances by efficiently (and easily) using all computing resources at the same time. StarPU also takes advantage of the heterogeneous nature of a machine, for instance by using scheduling strategies based on auto-tuned performance models.

StarPU is a task programming library for hybrid architectures

The application provides algorithms and constraints: - CPU/GPU implementations of tasks - A graph of tasks, using either the StarPU's high level GCC plugin pragmas or StarPU's rich C API

StarPU handles run-time concerns - Task dependencies - Optimized heterogeneous scheduling - Optimized data transfers and replication between main memory and discrete memories - Optimized cluster communications

Rather than handling low-level scheduling and optimizing issues, programmers can concentrate on algorithmic concerns!

FUNCTIONAL DESCRIPTION: StarPU is a runtime system that offers support for heterogeneous multicore machines. While many efforts are devoted to design efficient computation kernels for those architectures (e.g. to implement BLAS kernels on GPUs), StarPU not only takes care of offloading such kernels (and implementing data coherency across the machine), but it also makes sure the kernels are executed as efficiently as possible.

- Participants: Corentin Salingue, Andra Hugo, Benoît Lize, Cédric Augonnet, Cyril Roelandt, François Tessier, Jérôme Clet-Ortega, Ludovic Courtes, Ludovic Stordeur, Marc Sergent, Mehdi Juhoor, Nathalie Furmento, Nicolas Collin, Olivier Aumage, Pierre-André Wacrenier, Raymond Namyst, Samuel Thibault, Simon Archipoff and Xavier Lacoste
- Contact: Olivier Aumage
- URL: <http://starpu.gforge.inria.fr/>

5.7. PARCOACH

PARallel Control flow Anomaly CHecker

KEYWORDS: High-Performance Computing - Program verification - Debug - MPI - OpenMP - Compilation

SCIENTIFIC DESCRIPTION: PARCOACH verifies programs in two steps. First, it statically verifies applications with a data- and control-flow analysis and outlines execution paths leading to potential deadlocks. The code is then instrumented, displaying an error and synchronously interrupting all processes if the actual scheduling leads to a deadlock situation.

FUNCTIONAL DESCRIPTION: Supercomputing plays an important role in several innovative fields, speeding up prototyping or validating scientific theories. However, supercomputers are evolving rapidly with now millions of processing units, posing the questions of their programmability. Despite the emergence of more widespread and functional parallel programming models, developing correct and effective parallel applications still remains a complex task. As current scientific applications mainly rely on the Message Passing Interface (MPI) parallel programming model, new hardware designed for Exascale with higher node-level parallelism clearly advocate for an MPI+X solutions with X a thread-based model such as OpenMP. But integrating two different programming models inside the same application can be error-prone leading to complex bugs - mostly detected unfortunately at runtime. PARallel CONTROL flow Anomaly CHecker aims at helping developers in their debugging phase.

- Participants: Emmanuelle Saillard, Denis Barthou and Pierre Huchant
- Partner: CEA
- Contact: Emmanuelle Saillard
- URL: <https://esaillar.github.io/PARCOACH/>

5.8. AFF3CT

A Fast Forward Error Correction Tool

KEYWORDS: High-Performance Computing - Signal processing - Error Correction Code

FUNCTIONAL DESCRIPTION: AFF3CT proposes high performance Error Correction algorithms for Polar, Turbo, LDPC, RSC (Recursive Systematic Convolutional), Repetition and RA (Repeat and Accumulate) codes. These signal processing codes can be parameterized in order to optimize some given metrics, such as Bit Error Rate, Bandwidth, Latency, ...using simulation. For the designers of such signal processing chain, AFF3CT proposes also high performance building blocks so to develop new algorithms. AFF3CT compiles with many compilers and runs on Windows, Mac OS X, Linux environments and has been optimized for x86 (SSE, AVX instruction sets) and ARM architectures (NEON instruction set).

- Authors: Adrien Cassagne, Bertrand Le Gal, Camille Leroux, Denis Barthou and Olivier Aumage
- Partner: IMS
- Contact: Adrien Cassagne
- URL: <https://aff3ct.github.io/>

5.9. MORSE

KEYWORDS: High performance computing - Matrix calculation - Fast multipole method - Runtime system

FUNCTIONAL DESCRIPTION: MORSE (Matrices Over Runtime Systems @ Exascale) is a scientific project, its objectives are to solve matrix problems on complex architectures, using runtime systems. More specifically, the goal is to write codes that reach a high level of performance for all architectures. The algorithms are written independently of the architecture, and the runtime system dispatches the different computational parts to the different computing units. This methodology has been validated on three classes of problems: dense linear algebra, sparse and dense, and fast multipole methods. The corresponding codes have been incorporated into several softwares, MAGMA, Pastix and ScalFMM.

- Contact: Emmanuel Agullo
- URL: <http://icl.cs.utk.edu/morse/>

TACOMA Team

5. New Software and Platforms

5.1. THEGAME

SCIENTIFIC DESCRIPTION: Context-aware applications have to sense the environment in order to adapt themselves and provide with contextual services. This is the case of Smart Homes equipped with sensors and augmented appliances. However, sensors can be numerous, heterogeneous and unreliable. Thus the data fusion is complex and requires a solid theory to handle those problems. The aim of the data fusion, in our case, is to compute small pieces of context we call context attributes. Those context attributes are diverse and could be for example the presence in a room, the number of people in a room or even that someone may be sleeping in a room. For this purpose, we developed an implementation of the belief functions theory (BFT). THE GAME (THeory of Evidence in a lanGuage Adapted for Many Embedded systems) is made of a set of C-Libraries. It provides the basics of belief functions theory, computations are optimized for an embedded environment (binary representation of sets, conditional compilation and diverse algorithmic optimizations).

THE GAME is published under apache licence (<https://github.com/bpietropaoli/THEGAME/>). It is maintained and experimented by Aurélien Richez within a sensor network platform developed by TACOMA since June 2013.

FUNCTIONAL DESCRIPTION: THEGAME is a set of software services for detecting different types of situation in a building (presence in a room, activity level, etc.) based on a set of raw data sourced from all sorts of sensors. Written in C or Java, it can be integrated in an embedded computer: tablet, smartphone, box, etc., and can be connected to different sensor networks. It can be used to implement context-aware services: for example, to alert the user if s/he forgets to close a window when leaving the building, or to turn off the heating in an empty room, etc.

- Participants: Aurélien Richez and Bastien Pietropaoli
- Contact: Frédéric Weis
- URL: <https://github.com/bpietropaoli/THEGAME/>

5.2. Platform Pervasive_RFID

KEYWORDS: Composite objects - RFID

- Participants: Paul Couderc and Anthony Blair (Univ. Rennes 1)
- Partner: Univ. Rennes 1 (IETR)
- Contact: Paul Couderc

SCIENTIFIC DESCRIPTION

The RFID experiment testbed has been designed and deployed in collaboration with IETR (see Figure 2). This system allows both interactive testing as well as long running experiments of RFID reading protocols. It comprises a software platform allowing fine control over all dynamic aspects influencing RFID readings: movements for target and antenna, RFID reader configuration, and smart antenna configuration (diversity and power control).

5.3. Metamorphic Housing platform and Software - On-demand room

KEYWORDS: Smart Home - Metamorphic House - Sharing

- Participants: Ghislain Nouvel (Univ. Rennes 1), Guillermo Andrade Barroso and Michele Dominici
- Partner: Univ. Rennes 1
- Partner: Delta Dore - Néotoa⁰
- Contact: Michele Dominici and Frédéric Weis

⁰<http://www.neotoa.fr/>

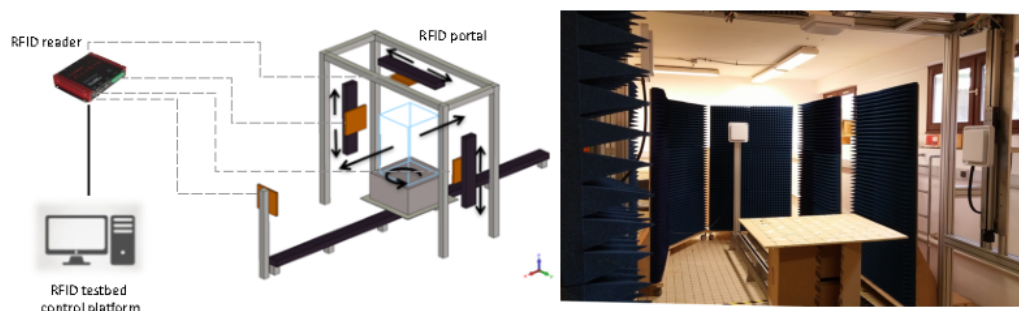


Figure 2. RFID testbed

SCIENTIFIC DESCRIPTION- SOFTWARE

As part of the experimentation of the On-demand room, we have developed a software system that will be used to manage the room and provide functionalities to end users and building managers (access control, electrical and time consumption monitoring and report, room state display...). The software has been deployed in the building that hosts the experimentation. This software is co-developed by Michele Dominici (Univ. Rennes 1), Guillermo Andrade (SED Inria) and Ghislain Nouvel (MobBI platform⁰). Contributions are provided by members of the Diverse project-team. Intellectual protection is expected to be applied on such software.

SCIENTIFIC DESCRIPTION- PLATFORM

We realized a prototype of the on-demand room as an immersive interactive virtual-reality application, leveraging the Immersia platform (see <https://raweb.inria.fr/rapportsactivite/RA2015/tacoma/uid29.html>), with real domestic appliances connected to Immersa. In 2016-2017, the experimentation of the On-demand room is organized in the following steps: modification of the original building to create a common, On-demand room between two apartments; deployment of the computer and hardware and software that we are developing; rental of the apartments to two households, for an estimated duration of one year. The building that hosted the experimentation is showed in Figure 3. During the rental of the apartments, data has been collected and stored about the use of the room by households. Data included time of occupation, mode (private or shared), consumptions, errors etc. The On-demand room thus constitutes an experimentation platform, where real people live and produce data that can be analyzed for statistical purposes. Produced data could also be used in combination with interviews of the occupants to improve the functionalities of the On-demand room, evaluate acceptance and appropriation.

5.4. ISO/IEC 15118-2 Open source Implementation

KEYWORDS: Smart Grid - Intelligent Transport System

- Partner: IMT Atlantique
- Participants: Guillaume Le Gall
- Contact: Jean-Marie Bonnin

SCIENTIFIC DESCRIPTION

⁰<https://mobbi.univ-rennes1.fr/>



Figure 3. On-demand room real experimentation

The ISO/IEC 15118 standard, named "Road vehicles – Vehicle-to-Grid Communication Interface", defines how an electric vehicle and a charging station should communicate. It enables the Smart Charging of electric vehicles by allowing them to plan their charging sessions. As we want to be able to manage the charge of electric vehicles in our micro Smart Grid systems, we decided to implement the protocol defined by this standard. The goal is also to participate actively in the design of the new version of this protocol. During a charging session the charging station provides the vehicle with the status of the electric power grid. The vehicle is then able to plan its sharing session accordingly. It sends back its charge plan to the charging station, so that the Smart Grid is aware of it. The protocol also provides security and authentication features.

This software platform was implemented onto small PCs, and was used to control the charge in a small and portable demonstration platform, to demonstrate how it is possible to interconnect this high level decision and communication software with low level components, such as a Battery Management System (BMS), and a battery charger. In 2016, in the context of the Greenfeed project our software has been demonstrated to control the charge of the electric vehicle during the final demonstration of the project. The integration work has been done in collaboration with VeDeCom⁰.

⁰<http://www.vedecom.fr/>

TADaaM Project-Team

6. New Software and Platforms

6.1. Hsplit

Hierarchical communicators split

KEYWORDS: MPI communication - Topology - Hardware platform

SCIENTIFIC DESCRIPTION: Hsplit is a library that implements an abstraction allowing the programmer using MPI in their parallel applications to access the underlying hardware structure through a hierarchy of communicators. Hsplit is based on the MPI_Comm_split_type routine and provides a new value for the split_type argument that specifically creates a hierarchy of subcommunicators where each new subcommunicator corresponds to a meaningful hardware level. The important point is that only the structure of the hardware is exploited and the number of levels or the levels names are not fixed so as to propose a solution independent from future hardware evolutions (such as new levels for instance). Another flavor of this MPI_Comm_split_type function is provided that creates a roots communicators at the same time a subcommunicator is produced, in order to ease the collective communication and/or synchronization among subcommunicators.

FUNCTIONAL DESCRIPTION: Hsplit implements an abstraction that allows the programmer using MPI in their parallel applications to access the underlying hardware structure through a hierarchy of communicators. Hsplit is based on the MPI_Comm_split_type routine and provides a new value for the split_type argument that specifically creates a hierarchy of subcommunicators where each new subcommunicator corresponds to a meaningful hardware level. The important point is that only the structure of the hardware is exploited and the number of levels or the levels names are not fixed so as to propose a solution independent from future hardware evolutions (such as new levels for instance). Another flavor of this MPI_Comm_split_type function is provided that creates a roots communicators at the same time a subcommunicator is produced, in order to ease the collective communication and/or synchronization among subcommunicators.

NEWS OF THE YEAR: A new working group in the MPI Forum to champion the integration of this proposal in the MPI standard has been created. This working group includes Inria, CEA, Atos/Bull, Paratools, the University of Tennessee - Knoxville and many other institutions/companies are interested to join in.

- Participants: Guillaume Mercier, Brice Goglin, Emmanuel Jeannot and Farouk Mansouri
- Contact: Guillaume Mercier
- Publications: [A hierarchical model to manage hardware topology in MPI applications - A Hierarchical Model to Manage Hardware Topology in MPI Applications](#)
- URL: <http://mpi-topology.gforge.inria.fr/>

6.2. hwloc

Hardware Locality

KEYWORDS: NUMA - Multicore - GPU - Affinities - Open MPI - Topology - HPC - Locality

FUNCTIONAL DESCRIPTION: Hardware Locality (hwloc) is a library and set of tools aiming at discovering and exposing the topology of machines, including processors, cores, threads, shared caches, NUMA memory nodes and I/O devices. It builds a widely-portable abstraction of these resources and exposes it to applications so as to help them adapt their behavior to the hardware characteristics. They may consult the hierarchy of resources, their attributes, and bind task or memory on them.

hwloc targets many types of high-performance computing applications, from thread scheduling to placement of MPI processes. Most existing MPI implementations, several resource managers and task schedulers, and multiple other parallel libraries already use hwloc.

- Participants: Brice Goglin and Samuel Thibault
- Partners: Open MPI consortium - Intel - AMD
- Contact: Brice Goglin
- Publications: [hwloc: a Generic Framework for Managing Hardware Affinities in HPC Applications](#) - [Managing the Topology of Heterogeneous Cluster Nodes with Hardware Locality \(hwloc\)](#) - [A Topology-Aware Performance Monitoring Tool for Shared Resource Management in Multicore Systems](#) - [Exposing the Locality of Heterogeneous Memory Architectures to HPC Applications](#) - [Towards the Structural Modeling of the Topology of next-generation heterogeneous cluster Nodes with hwloc](#) - [On the Overhead of Topology Discovery for Locality-aware Scheduling in HPC](#)
- URL: <http://www.open-mpi.org/projects/hwloc/>

6.3. NetLoc

Network Locality

KEYWORDS: Topology - Locality - Distributed networks - HPC - Parallel computing - MPI communication

FUNCTIONAL DESCRIPTION: netloc (Network Locality) is a library that extends hwloc to network topology information by assembling hwloc knowledge of server internals within graphs of inter-node fabrics such as Infiniband, Intel OmniPath or Cray networks.

Netloc builds a software representation of the entire cluster so as to help applications properly place their tasks on the nodes. It may also help communication libraries optimize their strategies according to the wires and switches.

Netloc targets the same challenges as hwloc but focuses on a wider spectrum by enabling cluster-wide solutions such as process placement. It interoperates with the Scotch graph partitioner to do so.

Netloc is distributed within hwloc releases starting with hwloc 2.0.

- Participants: Brice Goglin, Clement Foyer and Cyril Bordage
- Contact: Brice Goglin
- Publications: [netloc: Towards a Comprehensive View of the HPC System Topology](#) - [Netloc: a Tool for Topology-Aware Process Mapping](#)
- URL: <http://www.open-mpi.org/projects/netloc/>

6.4. NewMadeleine

KEYWORDS: High-performance calculation - MPI communication

FUNCTIONAL DESCRIPTION: NewMadeleine is the fourth incarnation of the Madeleine communication library. The new architecture aims at enabling the use of a much wider range of communication flow optimization techniques. Its design is entirely modular: drivers and optimization strategies are dynamically loadable software components, allowing experimentations with multiple approaches or on multiple issues with regard to processing communication flows.

The optimizing scheduler SchedOpt targets applications with irregular, multi-flow communication schemes such as found in the increasingly common application conglomerates made of multiple programming environments and coupled pieces of code, for instance. SchedOpt itself is easily extensible through the concepts of optimization strategies (what to optimize for, what the optimization goal is) expressed in terms of tactics (how to optimize to reach the optimization goal). Tactics themselves are made of basic communication flows operations such as packet merging or reordering.

The communication library is fully multi-threaded through its close integration with PIOMan. It manages concurrent communication operations from multiple libraries and from multiple threads. Its MPI implementation Mad-MPI fully supports the MPI_THREAD_MULTIPLE multi-threading level.

- Participants: Alexandre Denis, Clement Foyer, Nathalie Furmento and Raymond Namyst
- Contact: Alexandre Denis
- URL: <http://pm2.gforge.inria.fr/newmadeleine/>

6.5. PaMPA

Parallel Mesh Partitioning and Adaptation

KEYWORDS: Dynamic load balancing - Unstructured heterogeneous meshes - Parallel remeshing - Subdomain decomposition - Parallel numerical solvers

SCIENTIFIC DESCRIPTION: PaMPA is a parallel library for handling, redistributing and remeshing unstructured meshes on distributed-memory architectures. PaMPA dramatically eases and speeds-up the development of parallel numerical solvers for compact schemes. It provides solver writers with a distributed mesh abstraction and an API to: - describe unstructured and possibly heterogeneous meshes, on the form of a graph of interconnected entities of different kinds (e.g. elements, faces, edges, nodes), - attach values to the mesh entities, - distribute such meshes across processing elements, with an overlap of variable width, - perform synchronous or asynchronous data exchanges of values across processing elements, - describe numerical schemes by means of iterators over mesh entities and their connected neighbors of a given kind, - redistribute meshes so as to balance computational load, - perform parallel dynamic remeshing, by applying adequately a user-provided sequential remesher to relevant areas of the distributed mesh.

PaMPA runs concurrently multiple sequential remeshing tasks to perform dynamic parallel remeshing and redistribution of very large unstructured meshes. E.g., it can remesh a tetrahedral mesh from 43Melements to more than 1Belements on 280 Broadwell processors in 20 minutes.

FUNCTIONAL DESCRIPTION: Parallel library for handling, redistributing and remeshing unstructured, heterogeneous meshes on distributed-memory architectures. PaMPA dramatically eases and speeds-up the development of parallel numerical solvers for compact schemes.

NEWS OF THE YEAR: PaMPA has been used to remesh an industrial mesh of a helicopter turbine combustion chamber, up to more than 1 billion elements.

- Participants: Cécile Dobrzynski, Cedric Lachat and François Pellegrini
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Cedric Lachat
- URL: <http://project.inria.fr/pampa/>

6.6. TreeMatch

KEYWORDS: Intensive parallel computing - High-Performance Computing - Hierarchical architecture - Placement

SCIENTIFIC DESCRIPTION: TreeMatch embeds a set of algorithms to map processors/cores in order to minimize the communication cost of the application.

Important features are : the number of processors can be greater than the number of applications processes , it assumes that the topology is a tree and does not require valuation of the topology (e.g. communication speeds) , it implements different placement algorithms that are switched according to the input size.

Some core algorithms are parallel to speed-up the execution. Optionally embeds scotch for fix-vertex mapping. enable exhaustive search if required. Several metric mapping are computed. Allow for oversubscribing of ressources. multithreaded.

TreeMatch is integrated into various software such as the Charm++ programming environment as well as in both major open-source MPI implementations: Open MPI and MPICH2.

FUNCTIONAL DESCRIPTION: TreeMatch is a library for performing process placement based on the topology of the machine and the communication pattern of the application.

- Participants: Adele Villiermet, Emmanuel Jeannot, François Tessier, Guillaume Mercier and Pierre Celor
- Partners: Université de Bordeaux - CNRS - IPB
- Contact: Emmanuel Jeannot
- URL: <http://treematch.gforge.inria.fr/>

6.7. SCOTCH

KEYWORDS: Mesh partitioning - Domain decomposition - Graph algorithmics - High-performance calculation - Sparse matrix ordering

FUNCTIONAL DESCRIPTION: Scotch is a graph partitioner. It helps optimise the division of a problem, by means of a graph, into a set of independent sub-problems of equivalent sizes. These sub-problems can also be solved at the same time.

RELEASE FUNCTIONAL DESCRIPTION: Version 6.0 offers many new features:

sequential graph repartitioning

sequential graph partitioning with fixed vertices

sequential graph repartitioning with fixed vertices

new, fast, direct k-way partitioning and mapping algorithms

multi-threaded, shared memory algorithms in the (formerly) sequential part of the library

exposure in the API of many distributed graph handling routines

embedded pseudo-random generator for improved reproducibility

and even more...

NEWS OF THE YEAR: In the context of the PhD of Rémi Barat, the sequential version of Scotch has been extended so as to manage graphs with multiple vertex weights, and multi-constraint graph partitioning algorithms have been implemented as prototypes.

- Participants: Sébastien Fourestier, François Pellegrini and Cédric Chevalier
- Partners: CNRS - IPB - Region Aquitaine
- Contact: François Pellegrini
- Publications: [Process Mapping onto Complex Architectures and Partitions Thereof](#) - [Contributions au partitionnement de graphes parallèle multi-niveaux](#) - [Adaptation au repartitionnement de graphes d'une méthode d'optimisation globale par diffusion](#) - [A parallelisable multi-level banded diffusion scheme for computing balanced partitions with smooth boundaries](#) - [PT-Scotch: A tool for efficient parallel graph ordering](#) - [Design and implementation of efficient tools for parallel partitioning and distribution of very large numerical problems](#) - [PT-Scotch : Un outil pour la renumérotation parallèle efficace de grands graphes dans un contexte multi-niveaux](#) - [PT-Scotch: A tool for efficient parallel graph ordering](#) - [Improvement of the Efficiency of Genetic Algorithms for Scalable Parallel Graph Partitioning in a Multi-Level Framework](#)
- URL: <http://www.labri.fr/~pelegri/scotch/>

WHISPER Project-Team

6. New Software and Platforms

6.1. Coccinelle

KEYWORDS: Code quality - Evolution - Infrastructure software

FUNCTIONAL DESCRIPTION: Coccinelle is a tool for code search and transformation for C programs. It has been extensively used for bug finding and evolutions in Linux kernel code.

- Participants: Gilles Muller, Julia Lawall, Nicolas Palix, Rene Rydhof Hansen and Thierry Martinez
- Partners: LIP6 - IRILL
- Contact: Julia Lawall
- URL: <http://coccinelle.lip6.fr>

6.2. Prequel

KEYWORDS: Code search - Git

SCIENTIFIC DESCRIPTION: The commit history of a code base such as the Linux kernel is a gold mine of information on how evolutions should be made, how bugs should be fixed, etc. Nevertheless, the high volume of commits available and the rudimentary filtering tools provided mean that it is often necessary to wade through a lot of irrelevant information before finding example commits that can help with a specific software development problem. To address this issue, we propose Prequel (Patch Query Language), which brings the descriptive power of code matching to the problem of querying a commit history.

FUNCTIONAL DESCRIPTION: Prequel is a tool for searching for complex patterns in the commits of software managed using git.

- Participants: Gilles Muller and Julia Lawall
- Partners: LIP6 - IRILL
- Contact: Julia Lawall
- URL: <http://prequel-pql.gforge.inria.fr/>

ALICE Project-Team

6. New Software and Platforms

6.1. Graphite

Graphite: The Numerical Geometry Workbench

KEYWORDS: 3D modeling - Numerical Geometry - Texturing - Lighting - CAD - Visualization

SCIENTIFIC DESCRIPTION: Graphite is an experimental 3D modeler, built in top of the Geogram programming library. It has data structures and efficient OpenGL visualization for pointsets, surfacic meshes (triangles and polygons), volumetric meshes (tetrahedra and hybrid meshes). It has state-of-the-art mesh repair, remeshing, reconstruction algorithms. It also has an interface to the Tetgen tetrahedral mesh generator (by Hang Si). This year, Graphite3 was released. It is a major rewrite, based on Geogram, with increased software quality standards (zero warnings on all platforms, systematic documentation of all classes / all functions / all parameters, dramatically improved performances). It embeds Geogram (and optionally Vorpaline) with an easy-to-use Graphic User Interface.

FUNCTIONAL DESCRIPTION: Graphite is a dedicated software platform in numerical geometry that enables, among other things, 3D modelling and texture baking.

- Participants: Bruno Lévy, David Lopez, Dobrina Boltcheva, Jeanne Pellerin, Nicolas Ray and Samuel Hornus
- Contact: Bruno Lévy
- URL: <http://alice.loria.fr/software/graphite>

6.2. GEOGRAM

GEOGRAM : A functions library for geometric programming

KEYWORD: 3D modeling

FUNCTIONAL DESCRIPTION: GEOGRAM is a programming library with a set of basic geometric algorithms, such as search data structures (AABB tree, Kd tree), geometric predicates, triangulations (Delaunay triangulation, Regular triangulation), intersection between a simplicial mesh and a Voronoi diagram (restricted Voronoi diagram). GEOGRAM also includes a code generator for predicates (PCK: Predicate Construction Kit) and an efficient implementation of expansion arithmetics in arbitrary precision. GEOGRAM is shipped with WARP-DRIVE, the first program that computes semi-discrete optimal transport in 3D.

- Participant: Bruno Lévy
- Contact: Bruno Lévy
- URL: <http://alice.loria.fr>

6.3. OpenNL

Open Numerical Library

KEYWORDS: 3D modeling - Numerical algorithm

SCIENTIFIC DESCRIPTION: Open Numerical Library is a library for solving sparse linear systems, especially designed for the Computer Graphics community. The goal for OpenNL is to be as small as possible, while offering the subset of functionalities required by this application field. The Makefiles of OpenNL can generate a single .c + .h file, very easy to integrate in other projects. The distribution includes an implementation of the Least Squares Conformal Maps parameterization method.

FUNCTIONAL DESCRIPTION: Open Numerical Library is a library for solving sparse linear systems, especially designed for the Computer Graphics community. The goal for OpenNL is to be as small as possible, while offering the subset of functionalities required by this application field.

RELEASE FUNCTIONAL DESCRIPTION: * OpenMP parallel solver * more compact data structures, X2 acceleration * SuperLU weak coupling (dynamically loads SuperLU .so if available) (latest version available as part of geogram <http://alice.loria.fr/software/geogram/doc/html/index.html>)

- Participants: Bruno Lévy, Nicolas Ray and Rhaleb Zayer
- Contact: Bruno Lévy
- URL: <http://alice.loria.fr/index.php/software/4-library/23-opennl.html>

6.4. IceSL

KEYWORD: Additive manufacturing

FUNCTIONAL DESCRIPTION: IceSL allows to model complex shapes through CSG boolean operations. Objects can be directly prepared and sent to a 3d printer for fabrication, without the need to compute an intermediate 3D mesh.

- Participants: Frédéric Claux, Jean Hergel, Jérémie Dumas, Jonas Martinez-Bayona, Samuel Hornus and Sylvain Lefebvre
- Contact: Sylvain Lefebvre
- URL: <http://shapeforge.loria.fr/icesl/>

6.5. LibSL

Simple Library For Graphics

KEYWORDS: 3D - Graphics

FUNCTIONAL DESCRIPTION: LibSL is a toolbox for rapid prototyping of computer graphics algorithms, under both OpenGL, DirectX 9 - 10, Windows and Linux.

- Participant: Sylvain Lefebvre
- Contact: Sylvain Lefebvre

6.6. 3DPrintScaffoldings

KEYWORDS: 3D - 3D modeling - Additive manufacturing

FUNCTIONAL DESCRIPTION: Support generation for additive manufacturing. Optimizes scaffolding made of vertical pillars and horizontal bars that are optimized to use minimal material, be easily removed and support the part at all stages of the fabrication process.

- Participants: Jean Hergel, Jérémie Dumas and Sylvain Lefebvre
- Partner: Université de Lorraine
- Contact: Sylvain Lefebvre
- URL: <http://shapeforge.loria.fr/icesl/>

6.7. VORPALINE

VORPALINE mesh generator

KEYWORDS: 3D modeling - Unstructured heterogeneous meshes

FUNCTIONAL DESCRIPTION: VORPALINE is a surfacic and volumetric mesh generator, for simplicial meshes (triangles and tetrahedra), for quad-dominant and hex-dominant meshes.

- Participant: Bruno Lévy
- Contact: Bruno Lévy
- URL: <http://alice.loria.fr/index.php/erc-vorpaline.html>

ALMANACH Team

6. New Software and Platforms

6.1. Enqi

- Author: Benoît Sagot
- Contact: Benoît Sagot

6.2. SYNTAX

KEYWORD: Parsing

FUNCTIONAL DESCRIPTION: Syntax system includes various deterministic and non-deterministic CFG parser generators. It includes in particular an efficient implementation of the Earley algorithm, with many original optimizations, that is used in several of Alpage's NLP tools, including the pre-processing chain Sx Pipe and the LFG deep parser SxLfg. This implementation of the Earley algorithm has been recently extended to handle probabilistic CFG (PCFG), by taking into account probabilities both during parsing (beam) and after parsing (n-best computation).

- Participants: Benoît Sagot and Pierre Boullier
- Contact: Pierre Boullier
- URL: <http://syntax.gforge.inria.fr/>

6.3. FRMG

KEYWORDS: Parsing - French

FUNCTIONAL DESCRIPTION: FRMG is a large-coverage linguistic meta-grammar of French. It can be compiled (using MGCOMP) into a Tree Adjoining Grammar, which, in turn, can be compiled (using DyALog) into a parser for French.

- Participant: Éric Villemonte De La Clergerie
- Contact: Éric De La Clergerie
- URL: <http://mgkit.gforge.inria.fr/>

6.4. MELt

Maximum-Entropy lexicon-aware tagger

KEYWORD: Part-of-speech tagger

FUNCTIONAL DESCRIPTION: MELt is a freely available (LGPL) state-of-the-art sequence labeller that is meant to be trained on both an annotated corpus and an external lexicon. It was developed by Pascal Denis and Benoît Sagot within the Alpage team, a joint Inria and Université Paris-Diderot team in Paris, France. MELt allows for using multiclass Maximum-Entropy Markov models (MEMMs) or multiclass perceptrons (multitrons) as underlying statistical devices. Its output is in the Brown format (one sentence per line, each sentence being a space-separated sequence of annotated words in the word/tag format).

MELt has been trained on various annotated corpora, using Alexina lexicons as source of lexical information. As a result, models for French, English, Spanish and Italian are included in the MELt package.

MELt also includes a normalization wrapper aimed at helping processing noisy text, such as user-generated data retrieved on the web. This wrapper is only available for French and English. It was used for parsing web data for both English and French, respectively during the SANCL shared task (Google Web Bank) and for developing the French Social Media Bank (Facebook, twitter and blog data).

- Contact: Benoît Sagot
- URL: <https://team.inria.fr/almanach/melt/>

6.5. dyalog-sr

KEYWORDS: Parsing - Deep learning - Natural language processing

FUNCTIONAL DESCRIPTION: DyALog-SR is a transition-based dependency parser, built on top of DyALog system. Parsing relies on dynamic programming techniques to handle beams. Supervised learning exploits a perceptron and aggressive early updates. DyALog-SR can handle word lattice and produce dependency graphs (instead of basic trees). It was tested during several shared tasks (SPMRL'2013 and SEMEVAL'2014). It achieves very good accuracy on French TreeBank, alone or by coupling with FRMG parser. In 2017, DyALog-SR has been extended into DyALog-SRNN by adding deep neuronal layers implemented with the Dynet library. The new version has participated to the evaluation campaigns CONLL UD 2017 (on more than 50 languages) and EPE 2017.

- Contact: Éric De La Clergerie

6.6. Crapbank

French Social Media Bank

KEYWORDS: Treebank - User-generated content

FUNCTIONAL DESCRIPTION: The French Social Media Bank is a treebank of French sentences coming from various social media sources (Twitter(c), Facebook(c)) and web forums (JeuxVidéos.com(c), Doctissimo.fr(c)). It contains different kind of linguistic annotations: - part-of-speech tags - surface syntactic representations (phrase-based representations) as well as normalized form whenever necessary.

- Contact: Djamé Seddah

6.7. DyALog

KEYWORD: Logic programming

FUNCTIONAL DESCRIPTION: DyALog provides an environment to compile and execute grammars and logic programs. It is essentially based on the notion of tabulation, i.e. of sharing computations by tabulating traces of them. DyALog is mainly used to build parsers for Natural Language Processing (NLP). It may nevertheless be used as a replacement for traditional PROLOG systems in the context of highly ambiguous applications where sub-computations can be shared.

- Participant: Éric Villemonte De La Clergerie
- Contact: Éric Villemonte De La Clergerie
- URL: <http://dyalog.gforge.inria.fr/>

6.8. SxPipe

KEYWORD: Surface text processing

SCIENTIFIC DESCRIPTION: Developed for French and for other languages, Sx Pipe includes, among others, various named entities recognition modules in raw text, a sentence segmenter and tokenizer, a spelling corrector and compound words recognizer, and an original context-free patterns recognizer, used by several specialized grammars (numbers, impersonal constructions, quotations...). It can now be augmented with modules developed during the former ANR EDyLex project for analysing unknown words, this involves in particular (i) new tools for the automatic pre-classification of unknown words (acronyms, loan words...) (ii) new morphological analysis tools, most notably automatic tools for constructional morphology (both derivational and compositional), following the results of dedicated corpus-based studies. New local grammars for detecting new types of entities and improvement of existing ones, developed in the context of the PACTE project, will soon be integrated within the standard configuration.

FUNCTIONAL DESCRIPTION: SxPipe is a modular and customizable processing chain dedicated to applying to raw corpora a cascade of surface processing steps (tokenisation, wordform detection, non-deterministic spelling correction. . .). It is used as a preliminary step before ALMANACH's parsers (e.g., FRMG) and for surface processing (named entities recognition, text normalization, unknown word extraction and processing...).

- Participants: Benoît Sagot, Djamé Seddah and Éric Villemonte De La Clergerie
- Contact: Benoît Sagot
- URL: <http://lingwb.gforge.inria.fr/>

6.9. Mgwiki

KEYWORDS: Parsing - French

FUNCTIONAL DESCRIPTION: Mgwiki is a linguistic wiki that may be used to discuss linguistic phenomena with the possibility to add annotated illustrative sentences. The work is essentially devoted to the construction of an instance for documenting and discussing FRMG, with the annotations of the sentences automatically provided by parsing them with FRMG. This instance also offers the possibility to parse small corpora with FRMG and an interface of visualization of the results. Large parsed corpora (like French Wikipedia or Wikisource) are also available. The parsed corpora can also be queried through the use of the DPath language.

- Participant: Éric Villemonte De La Clergerie
- Contact: Éric Villemonte De La Clergerie
- URL: <http://alpage.inria.fr/frmgwiki/>

6.10. WOLF

WORDnet Libre du Français (Free French Wordnet)

KEYWORDS: WordNet - French - Semantic network - Lexical resource

FUNCTIONAL DESCRIPTION: The WOLF (Wordnet Libre du Français, Free French Wordnet) is a free semantic lexical resource (wordnet) for French.

The WOLF has been built from the Princeton WordNet (PWN) and various multilingual resources.

- Contact: Benoît Sagot
- URL: <http://alpage.inria.fr/~sagot/wolf-en.html>

6.11. vera

KEYWORD: Text mining

FUNCTIONAL DESCRIPTION: Automatic analysis of answers to open-ended questions based on NLP and statistical analysis and visualisation techniques (vera is currently restricted to employee surveys).

- Participants: Benoît Sagot and Dimitri Tcherniak
- Partner: Verbatim Analysis
- Contact: Benoît Sagot

6.12. Alexina

Atelier pour les LEXiques INformatiques et leur Acquisition

KEYWORD: Lexical resource

FUNCTIONAL DESCRIPTION: Alexina is ALMANACH's framework for the acquisition and modeling of morphological and syntactic lexical information. The first and most advanced lexical resource developed in this framework is the Lefff, a morphological and syntactic lexicon for French.

- Participant: Benoît Sagot
- Contact: Benoît Sagot
- URL: <http://gforge.inria.fr/projects/alexina/>

6.13. FQB

French QuestionBank

KEYWORD: Treebank

FUNCTIONAL DESCRIPTION: The French QuestionBanks is a corpus of around 2000 questions coming from various domains (TREC data set, French governmental organisation, NGOs, etc..) it contains different kind of annotations - morpho-syntactic ones (POS, lemmas) - surface syntaxe (phrase based and dependency structures) with long-distance dependency annotations.

The TREC part is aligned with the English QuestionBank (Judge et al, 2006).

- Contact: Djamé Seddah

6.14. Sequoia corpus

KEYWORD: Treebank

FUNCTIONAL DESCRIPTION: The Sequoia corpus contains French sentences, annotated with various linguistic information: - parts-of-speech - surface syntactic representations (both constituency trees and dependency trees) - deep syntactic representations (which are deep syntactic dependency graphs)

- Contact: Djamé Seddah

AVIZ Project-Team

5. New Software and Platforms

5.1. Cartolabe

KEYWORD: Information visualization

FUNCTIONAL DESCRIPTION: The goal of Cartolabe is to build a visual map representing the scientific activity of an institution/university/domain from published articles and reports. Using the HAL Database and building upon the AnHALytics processing chain, Cartolabe provides the user with a map of the thematics, authors and articles and their dynamics along time. ML techniques are used for dimensionality reduction, cluster and topics identification, visualisation techniques are used for a scalable 2D representation of the results.

NEWS OF THE YEAR: Improvement of the graphical interface

- Contact: Philippe Caillou
- URL: <http://cartolabe.lri.fr/>

5.2. BitConduite

BitConduite Bitcoin explorer

KEYWORDS: Data visualization - Clustering - Financial analysis - Cryptocurrency

FUNCTIONAL DESCRIPTION: BitConduite is a web-based visual tool that allows for a high level explorative analysis of the Bitcoin blockchain. It offers a data transformation back end that gives us an entity-based access to the blockchain data and a visualization front end that supports a novel high-level view on transactions over time. In particular, it facilitates the exploration of activity through filtering and clustering interactions. This gives analysts a new perspective on the data stored on the blockchain.

- Contact: Petra Isenberg

CEDAR Team

6. New Software and Platforms

6.1. RDF-Commons

KEYWORDS: Data management - RDF

FUNCTIONAL DESCRIPTION: RDF-Commons is a set of modules providing the abilities to: - load and store RDF data in a DBMS - parse RDF conjunctive queries - encode URIs and literals into integers - encode RDF conjunctive queries - build statistics on RDF data - estimate the cost of the evaluation of a conjunctive query - saturate the RDF data, with respect to an RDF Schema - reformulate a conjunctive query with respect to an RDF Schema - propose algebraic plans

- Contact: Ioana Manolescu

6.2. RDFSummary

FUNCTIONAL DESCRIPTION: RDF Summary is a standalone Java software capable of building summaries of RDF graphs. Summaries are compact graphs (typically several orders of magnitude smaller than the original graph), which can be used to get acquainted quickly with a given graph, they can also be used to perform static query analysis, infer certain things about the answer of a query on a graph, just by considering the query and the summary.

- Contact: Sejla Cebiric

6.3. Tatooine

KEYWORDS: Data integration - Databases - Knowledge database - JSon - RDF - Polystore

FUNCTIONAL DESCRIPTION: Tatooine allows to jointly query data sources of heterogeneous formats and data models (relations, RDF graphs, JSON documents etc.) under a single interface. It is capable of evaluating conjunctive queries over several such data sources, distributing computations between the underlying single-data model systems and a Java-based integration layer based on nested tuples.

- Participants: François Goasdoué, Ioana Manolescu, Javier Letelier Ruiz, Michaël Thomazo, Oscar Santiago Mendoza Rivera, Raphael Bonaque, Swen Ribeiro, Tien Duc Cao and Xavier Tannier
- Contact: Ioana Manolescu

CHROMA Project-Team

6. New Software and Platforms

6.1. CUDA-HSBOF

FUNCTIONAL DESCRIPTION: Ce logiciel est une implémentation du filtre d'Occupation Bayésien à Echantillonnage Hybride (HSBOF) sur GPU. Cette version favorise l'intégration dans un système embarqué sur puce.

- Participants: Amaury Nègre, Christian Laugier and Lukas Rummelhard
- Contact: Christian Laugier

6.2. E.R.C.I.

Estimation du risque de collision aux intersections

- Participants: Christian Laugier, Javier Ibanez-Guzman and Stéphanie Lefevre
- Contact: Christian Laugier

6.3. Embedded Perception

FUNCTIONAL DESCRIPTION: The method for computing occupancy grids from a stereoscopic sensor, developed in the e-motion team, has been implemented on GPU, using NVIDIA CUDA. This allows a real time implementation and an online processing within the Lexus experimental platform.

- Participants: Amaury Nègre, Christian Laugier and Mathias Perrollaz
- Contact: Christian Laugier

6.4. kinetics

FUNCTIONAL DESCRIPTION: Software computing decision support strategies and decision-making

- Contact: Jilles Dibangoye

6.5. VI-SFM

FUNCTIONAL DESCRIPTION: Experimentary the closed Form Solution for usual-initial data fusion against real and simulated fusion

- Authors: Agostino Martinelli and Jacques Kaiser
- Contact: Agostino Martinelli

6.6. Ground Elevation and Occupancy Grid Estimator (GEOG - Estimator)

KEYWORDS: Robotics - Environment perception

FUNCTIONAL DESCRIPTION: GEOG-Estimator is a system of joint estimation of the shape of the ground, in the form of a Bayesian network of constrained elevation nodes, and the ground-obstacle classification of a pointcloud. Starting from an unclassified 3D pointcloud, it consists of a set of expectation-maximization methods computed in parallel on the network of elevation nodes, integrating the constraints of spatial continuity as well as the influence of 3D points, classified as ground-based or obstacles. Once the ground model is generated, the system can then construct a occupation grid, taking into account the classification of 3D points, and the actual height of these impacts. Mainly used with lidars (Velodyne64, Quanergy M8, IBEO Lux), the approach can be generalized to any type of sensor providing 3D pointclouds. On the other hand, in the case of lidars, free space information between the source and the 3D point can be integrated into the construction of the grid, as well as the height at which the laser passes through the area (taking into account the height of the laser in the sensor model). The areas of application of the system spread across all areas of mobile robotics, it is particularly suitable for unknown environments. GEOG-Estimator was originally developed to allow optimal integration of 3D sensors in systems using 2D occupancy grids, taking into account the orientation of sensors, and indefinite forms of grounds. The ground model generated can be used directly, whether for mapping or as a pre-calculation step for methods of obstacle recognition or classification. Designed to be effective (real-time) in the context of embedded applications, the entire system is implemented on Nvidia graphics card (in Cuda), and optimized for Tegra X2 embedded boards. To ease interconnections with the sensor outputs and other perception modules, the system is implemented using ROS (Robot Operating System), a set of opensource tools for robotics.

- Authors: Amaury Nègre, Lukas Rummelhard, Lukas Rummelhard, Jean-Alix David and Christian Laugier
- Contact: Christian Laugier

6.7. CMCDOT

KEYWORDS: Robotics - Environment perception

FUNCTIONAL DESCRIPTION: CMCDOT is a Bayesian filtering system for dynamic occupation grids, allowing parallel estimation of occupation probabilities for each cell of a grid, inference of velocities, prediction of the risk of collision and association of cells belonging to the same dynamic object. Last generation of a suite of Bayesian filtering methods developed in the Inria eMotion team, then in the Inria Chroma team (BOF, HSBOF, ...), it integrates the management of hybrid sampling methods (classical occupancy grids for static parts, particle sets for parts dynamics) into a Bayesian unified programming formalism, while incorporating elements resembling the Dempster-Shafer theory (state "unknown", allowing a focus of computing resources). It also offers a projection system of the estimated scene in the near future, to reference potential collisions with the ego-vehicle or any other element of the environment, as well as very low cost pre-segmentation of coherent dynamic spaces (taking into account speeds). It takes as input instantaneous occupation grids generated by sensor models for different sources, the system is composed of a ROS package, to manage the connectivity of I / O, which encapsulates the core of the embedded and optimized application on GPU Nvidia (Cuda), allowing real-time analysis of the direct environment on embedded boards (Tegra X1, X2). ROS (Robot Operating System) is a set of open source tools to develop software for robotics. Developed in an automotive setting, these techniques can be exploited in all areas of mobile robotics, and are particularly suited to highly dynamic and uncertain environment management (eg urban scenario, with pedestrians, cyclists, cars, buses, etc.).

- Authors: Amaury Nègre, Amaury Nègre, Lukas Rummelhard, Lukas Rummelhard, Jean-Alix David and Christian Laugier
- Contact: Olivier Simonin

6.8. cuda_grid_fusion

KEYWORDS: Robotics - Environment perception

FUNCTIONAL DESCRIPTION: This module, directly implemented in ROS / Cuda, performs the merge of occupancy grids, defined in the format proposed in CMCDOT (probabilities integrating the "visibility" information of the cell, via the coefficients "unknown") thanks to an original method, allowing not only consistency with the rest of the system, but also a nuanced consideration of confidence criteria towards the various sources of information.

- Authors: Lukas Rummelhard and Jean-Alix David
- Contact: Olivier Simonin

6.9. cuda_laser_grid

KEYWORDS: Robotics - Environment perception

FUNCTIONAL DESCRIPTION: This module generates occupation grids from "almost" planar lidar. The sensor model, as well as the outputs, have been modified, in order to be fully consistent with the CMCDOT and grid fusion module formats.

- Authors: Amaury Nègre, Amaury Nègre, Lukas Rummelhard, Lukas Rummelhard and Jean-Alix David
- Contact: Olivier Simonin

6.10. CMCDOT-Tools

KEYWORD: Robotics

FUNCTIONAL DESCRIPTION: Tools for CMCDOT Software

- Authors: Amaury Nègre, Lukas Rummelhard, Lukas Rummelhard, Jean-Alix David, Mathias Perrollaz, Procopio Silveira-Stein, Jérôme Lussereau and Nicolas Vignard
- Contact: Olivier Simonin

6.11. DWA Planner on occupancy grid

Dynamic Window Approach Planner based on occupancy grid

KEYWORD: Navigation

FUNCTIONAL DESCRIPTION: This program considers : - a given target - an occupancy grid which represents the environment - the odometry of the vehicle With these data, it computes the commands for a safe navigation towards the target.

- Authors: Christian Laugier and Thomas Genevois
- Partner: CEA
- Contact: Olivier Simonin

6.12. Zoe Simulation

Simulation of Inria's Renault Zoe in Gazebo environment

KEYWORD: Simulation

FUNCTIONAL DESCRIPTION: This simulation represents the Renault Zoe vehicle considering the realistic physical phenomena (friction, sliding, inertia, ...). The simulated vehicle embeds sensors similar to the ones of the actual vehicle. They provide measurement data under the same format. Moreover the software input/output are identical to the vehicle's. Therefore any program executed on the vehicle can be used with the simulation and reciprocally.

- Authors: Christian Laugier, Nicolas Turro and Thomas Genevois
- Contact: Olivier Simonin

6.13. PedSim-ROS

FUNCTIONAL DESCRIPTION: Simulation of moving people and mobile robots that can detect agents around them. Integration of ROS mobile robots with the PedSim simulator.

- Contact: Jacques Saraydaryan

COML Team

6. New Software and Platforms

6.1. abkhazia

KEYWORDS: Speech recognition - Speech-text alignment

FUNCTIONAL DESCRIPTION: The Abkhazia software makes it easy to obtain simple baselines for supervised ASR (using Kaldi) and ABX tasks (using ABXpy) on the large corpora of speech recordings typically used in speech engineering, linguistics or cognitive science research.

- Contact: Emmanuel Dupoux
- URL: <https://github.com/bootphon/abkhazia>

6.2. TDE

Term Discovery Evaluation

KEYWORDS: NLP - Speech recognition - Speech

SCIENTIFIC DESCRIPTION: This toolbox allows the user to judge of the quality of a word discovery algorithm. It evaluates the algorithms on these criteria : - Boundary : efficiency of the algorithm to found the actual boundaries of the words - Group : efficiency of the algorithm to group similar words - Token/Type: efficiency of the algorithm to find all words from the corpus (types), and to find all occurrences (token) of these words. - NED : Mean of the edit distance across all the word pairs found by the algorithm - Coverage : efficiency of the algorithm to find every discoverable phone in the corpus

FUNCTIONAL DESCRIPTION: Toolbox to evaluate algorithms that segment speech into words. It allows the user to evaluate the efficiency of algorithms to segment speech into words, and create clusters of similar words.

- Contact: Emmanuel Dupoux
- URL : <https://github.com/bootphon/TDE>

6.3. ABXpy

KEYWORDS: Evaluation - Speech recognition - Machine learning

FUNCTIONAL DESCRIPTION: The ABX package gives a performance score to speech recognition systems by measuring their capacity to discriminate linguistic contrasts (accents, phonemes, speakers, etc...)

- Contact: Emmanuel Dupoux
- URL : <https://github.com/bootphon/ABXpy>

6.4. h5features

KEYWORD: File format

FUNCTIONAL DESCRIPTION: The h5features python package provides easy to use and efficient storage of large features data on the HDF5 binary file format.

- Contact: Emmanuel Dupoux
- URL : <https://github.com/bootphon/h5features>

DEFROST Project-Team

6. New Software and Platforms

6.1. Simulation de neurochirurgie

Vascular neurosurgery simulation based on SOFA Framework

KEYWORDS: Simulation - Health - Computer-assisted surgery

- Participants: Christian Duriez, Eulalie Coevoet, Jérémie Dequidt and Laurent Thines
- Partners: Université de Lille - CHRU Lille
- Contact: Christian Duriez

6.2. SOFA

Simulation Open Framework Architecture

KEYWORDS: Real time - Multi-physics simulation - Medical applications

FUNCTIONAL DESCRIPTION: SOFA is an Open Source framework primarily targeted at real-time simulation, with an emphasis on medical simulation. It is mostly intended for the research community to help develop new algorithms, but can also be used as an efficient prototyping tool. Based on an advanced software architecture, it allows : the creation of complex and evolving simulations by combining new algorithms with algorithms already included in SOFA, the modification of most parameters of the simulation (deformable behavior, surface representation, solver, constraints, collision algorithm, etc.) by simply editing an XML file, the building of complex models from simpler ones using a scene-graph description, the efficient simulation of the dynamics of interacting objects using abstract equation solvers, the reuse and easy comparison of a variety of available methods.

- Participants: Christian Duriez, François Faure, Hervé Delingette and Stéphane Cotin
- Partner: IGG
- Contact: Stéphane Cotin
- URL: <http://www.sofa-framework.org>

6.3. SoftRobots

SoftRobots plugin for Sofa

KEYWORDS: Numerical simulations - Problem inverse - Soft robotics

FUNCTIONAL DESCRIPTION: This framework is based on a mechanical modeling of the robot elements combined with fast real-time direct/inverse FEM solvers. The keypoint of our approach is that the same modeling is used for interactive simulation of its behavior and interactive control of the fabricated robots.

- Participants: Christian Duriez, Olivier Goury, Jérémie Dequidt, Damien Marchal, Eulalie Coevoet, Erwan Douaille and Félix Vanneste
- Contact: Christian Duriez
- URL: <https://project.inria.fr/softrobot/>

EX-SITU Project-Team

6. New Software and Platforms

6.1. Platforms

6.1.1. WildOS

Participant: Michel Beaudouin-Lafon [correspondant].

WildOS is middleware designed to support applications that run in an interactive room, such as our WILD and WILDER rooms, with various interaction resources, including a tiled wall display, a motion tracking system, interactive tabletops, tablets, smartphones and custom-made or 3d printed interactive devices. The conceptual model of *WildOS* is a *platform*, such as the WILD or WILDER room, that can be described as a set of devices on which one or more applications can be run.

WildOS consists of a server running on a machine that has network access to all the machines involved in the platform, and a set of clients running on the various interaction resources, such as a display cluster or a tablet. Once *WildOS* is running, applications can be started and stopped and devices can be added to or removed from the platform.

WildOS relies on Web technologies, most notably Javascript and node.js, as well as node-webkit and HTML5. This makes it inherently portable (it is currently tested on Mac OS X and Linux). While applications can be developed only with these Web technologies, it is also possible to bridge to existing applications developed in other environments if they provide sufficient access for remote control. Sample applications include a web browser, an image viewer, a window manager, and the BrainTwister application developed in collaboration with neuroanatomists at NeuroSpin.

WildOS is used for several research projects at ExSitu and by other partners of the Digiscope project. It was also deployed on several of Google's interactive rooms in Mountain View, Dublin and Paris. It is available under on Open Source licence at <https://bitbucket.org/mblinsitu/wildos>.

- ACM: H.5.2 [User Interfaces]: Graphical user interfaces (GUI)
- Software benefit: helps development of multisurface applications.
- OS/Middleware: Crossplatform
- Required library or software: node.js, node-webkit
- Programming language: Javascript

6.1.2. Unity Cluster

Participants: Cédric Fleury [correspondant], Olivier Gladin.

Unity Cluster is middleware to distribute any Unity 3D (<https://unity3d.com/>) application on a cluster of computers that run in interactive rooms, such as our WILD and WILDER rooms, or immersive CAVES (Computer-Augmented Virtual Environments). Users can interact the the application with various interaction resources.

Unity Cluster provides an easy solution for running existing Unity 3D applications on any display that requires a rendering cluster with several computers. *Unity Cluster* is based on a master-slave architecture: The master computer runs the main application and the physical simulation as well as manages the input; the slave computers receive updates from the master and render small parts of the 3D scene. *Unity Cluster* manages data distribution and synchronization among the computers to obtain a consistent image on the entire wall-sized display surface.

Unity Cluster can also deform the displayed images according to the user's position in order to match the viewing frustum defined by the user's head and the four corners of the screens. This respects the motion parallax of the 3D scene, giving users a better sense of depth.

Unity Cluster is composed of a set of C Sharp scripts that manage the network connection, data distribution, and the deformation of the viewing frustum. In order to distribute an existing application on the rendering cluster, all scripts must be embedded into a Unity package that is included in an existing Unity project.

- ACM: C.2.4 [Distributed Systems]: Distributed applications, I.3.7 [3D Graphics and Realism]: Virtual reality
- Software benefit: adapts existing Unity 3D application to a rendering cluster of an interactive room.
- OS/Middleware: Crossplatform
- Required library or software: Unity 3D
- Programming language: C Sharp

6.1.3. WILDER

Participants: Michel Beaudouin-Lafon [correspondant], Cédric Fleury, Olivier Gladin.

WILDER (Figure 1) is our second experimental ultra-high-resolution interactive environment, which follows the WILD platform developed in 2009. It features a wall-sized display with seventy-five 20" LCD screens, i.e. a 5m50 x 1m80 (18' x 6') wall displaying 14 400 x 4 800 = 69 million pixels, powered by a 10-computer cluster and two front-end computers. The platform also features a camera-based motion tracking system that lets users interact with the wall, as well as the surrounding space, with various mobile devices. The display uses a multitouch frame (the largest of its kind in the world) to make the entire wall touch sensitive.

WILDER was inaugurated in June, 2015. It is one of the ten platforms of the Digiscope Equipment of Excellence and, in combination with WILD and the other Digiscope rooms, provides a unique experimental environment for collaborative interaction.

In addition to using WILD and WILDER for our research, we have also developed software architectures and toolkits, such as WildOS and Unity Cluster, that enable developers to run applications on these multi-device, cluster-based systems.

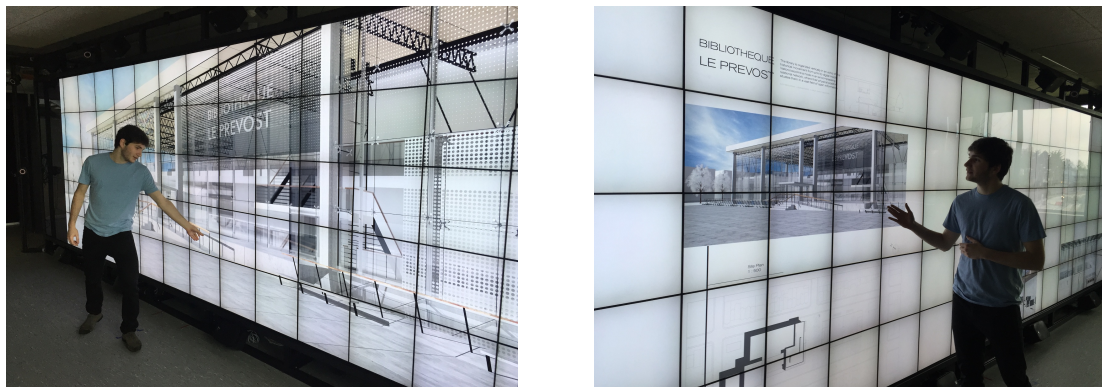


Figure 1. The WILDER platform.

FLOWERS Project-Team

6. New Software and Platforms

6.1. 3rd hand infrastructure

KEYWORDS: Interaction - Robotics - Infrastructure software - Framework - Robot Operating System (ROS)

FUNCTIONAL DESCRIPTION: The infrastructure is predicate-based to handle relational actions and covers perception (scene description generation, human actions recognition), decision making (teleoperated, scripted or learning from demonstrations), interaction with end users (GUI, voice, gestures) and parallel executions of robotic actions (hold, pick, grasp, bring, ...).

- Contact: Yoan Mollard
- URL: https://github.com/3rdHand-project/thr_infrastructure

6.2. Aversive++

FUNCTIONAL DESCRIPTION: Aversive++ is a C++ library that eases micro-controller programming. Its aim is to provide an interface simple enough to be able to create complex applications, and optimized enough to enable small micro-controllers to execute these applications. The other aspect of this library is to be multiplatform. Indeed, it is designed to provide the same API for a simulator (named SASIAE) and for AVR-based and ARM-based micro-controllers.

- Contact: Loïc Dauphin
- URL: <http://aversiveplusplus.com/>

6.3. DMP-BBO

Black-Box Optimization for Dynamic Movement Primitives

FUNCTIONAL DESCRIPTION: The DMP-BBO Matlab library is a direct consequence of the insight that black-box optimization outperforms reinforcement learning when using policies represented as Dynamic Movement Primitives. It implements several variants of the PIBB algorithm for direct policy search. The dmp-bbo C++ library has been extended to include the “unified model for regression”. The implementation of several of the function approximators have been made real-time compatible.

- Participant: Freek Stulp
- Partner: ENSTA
- Contact: Freek Stulp
- URL: <https://github.com/stulp/dmpbbo>

6.4. Explauto

an autonomous exploration library

SCIENTIFIC DESCRIPTION: An important challenge in developmental robotics is how robots can be intrinsically motivated to learn efficiently parametrized policies to solve parametrized multi-task reinforcement learning problems, i.e. learn the mappings between the actions and the problem they solve, or sensory effects they produce. This can be a robot learning how arm movements make physical objects move, or how movements of a virtual vocal tract modulates vocalization sounds. The way the robot will collect its own sensorimotor experience have a strong impact on learning efficiency because for most robotic systems the involved spaces are high dimensional, the mapping between them is non-linear and redundant, and there is limited time allowed for learning. If robots explore the world in an unorganized manner, e.g. randomly, learning algorithms will be often ineffective because very sparse data points will be collected. Data are precious due to the high dimensionality and the limited time, whereas data are not equally useful due to non-linearity and redundancy. This is why learning has to be guided using efficient exploration strategies, allowing the robot to actively drive its own interaction with the environment in order to gather maximally informative data to optimize the parametrized policies. In the recent year, work in developmental learning has explored various families of algorithmic principles which allow the efficient guiding of learning and exploration.

Explauto is a framework developed to study, model and simulate curiosity-driven learning and exploration in real and simulated robotic agents. Explauto's scientific roots trace back from Intelligent Adaptive Curiosity algorithmic architecture [51], which has been extended to a more general family of autonomous exploration architectures by [3] and recently expressed as a compact and unified formalism [40]. The library is detailed in [41]. In Explauto, interest models are implementing the strategies of active selection of particular problems / goals in a parametrized multi-task reinforcement learning setup to efficiently learn parametrized policies. The agent can have different available strategies, parametrized problems, models, sources of information, or learning mechanisms (for instance imitate by mimicking vs by emulation, or asking help to one teacher or to another), and chooses between them in order to optimize learning (a processus called strategic learning [47]). Given a set of parametrized problems, a particular exploration strategy is to randomly draw goals/ RL problems to solve in the motor or problem space. More efficient strategies are based on the active choice of learning experiments that maximize learning progress using bandit algorithms, e.g. maximizing improvement of predictions or of competences to solve RL problems [51]. This automatically drives the system to explore and learn first easy skills, and then explore skills of progressively increasing complexity. Both random and learning progress strategies can act either on the motor or on the problem space, resulting in motor babbling or goal babbling strategies.

- Motor babbling consists in sampling commands in the motor space according to a given strategy (random or learning progress), predicting the expected effect, executing the command through the environment and observing the actual effect. Both the parametrized policies and interest models are finally updated according to this experience.
- Goal babbling consists in sampling goals in the problem space and to use the current policies to infer a motor action supposed to solve the problem (inverse prediction). The robot/agent then executes the command through the environment and observes the actual effect. Both the parametrized policies and interest models are finally updated according to this experience. It has been shown that this second strategy allows a progressive solving of problems much more uniformly in the problem space than with a motor babbling strategy, where the agent samples directly in the motor space [3].

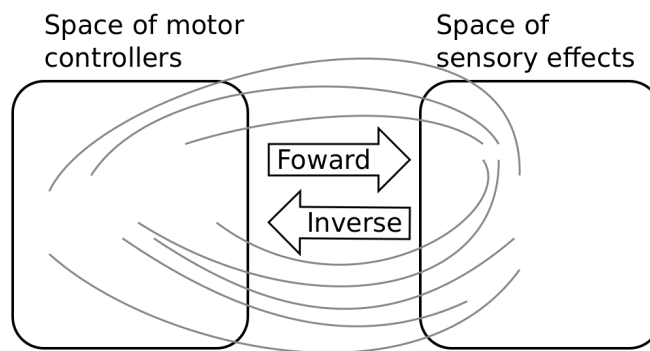


Figure 1. Complex parametrized policies involve high dimensional action and effect spaces. For the sake of visualization, the motor M and sensory S spaces are only 2D each in this example. The relationship between M and S is non-linear, dividing the sensorimotor space into regions of unequal stability: small regions of S can be reached very precisely by large regions of M , or large regions in S can be very sensitive to variations in M : s as well as a non-linear and redundant relationship. This non-linearity can imply redundancy, where the same sensory effect can be attained using distinct regions in M .

FUNCTIONAL DESCRIPTION: This library provides high-level API for an easy definition of:

- Real and simulated robotic setups (Environment level),
- Incremental learning of parametrized policies (Sensorimotor level),
- Active selection of parametrized RL problems (Interest level).

The library comes with several built-in environments. Two of them corresponds to simulated environments: a multi-DoF arm acting on a 2D plan, and an under-actuated torque-controlled pendulum. The third one allows to control real robots based on Dynamixel actuators using the Pypot library. Learning parametrized policies involves machine learning algorithms, which are typically regression algorithms to learn forward models, from motor controllers to sensory effects, and optimization algorithms to learn inverse models, from sensory effects, or problems, to the motor programs allowing to reach them. We call these sensorimotor learning algorithms sensorimotor models. The library comes with several built-in sensorimotor models: simple nearest-neighbor look-up, non-parametric models combining classical regressions and optimization algorithms, online mixtures of Gaussians, and discrete Lidstone distributions. Explauto sensorimotor models are online learning algorithms, i.e. they are trained iteratively during the interaction of the robot in the environment in which it evolves. Explauto provides also a unified interface to define exploration strategies using the InterestModel class. The library comes with two built-in interest models: random sampling as well as sampling maximizing the learning progress in forward or inverse predictions.

Explauto environments now handle actions depending on a current context, as for instance in an environment where a robotic arm is trying to catch a ball: the arm trajectories will depend on the current position of the ball (context). Also, if the dynamic of the environment is changing over time, a new sensorimotor model (Non-Stationary Nearest Neighbor) is able to cope with those changes by taking more into account recent experiences. Those new features are explained in Jupyter notebooks.

This library has been used in many experiments including:

- the control of a 2D simulated arm,
- the exploration of the inverse kinematics of a poppy humanoid (both on the real robot and on the simulated version),
- acoustic model of a vocal tract.

Explauto is cross-platform and has been tested on Linux, Windows and Mac OS. It has been released under the GPLv3 license.

- Contact: Sébastien Forestier
- URL: <https://github.com/flowersteam/explauto>

6.5. HiPi Board

FUNCTIONAL DESCRIPTION: Hipi is a board to control robots on Raspberry Pi. It is an extension of the Pixl board with the following features:

- A DC/DC power converter from 12V (motor) to 5V (Raspberry Pi) at 3A.
- A stereo audio amplifier 3W.
- A MPU9250 central motion unit .
- A RS232 and a RS485 bus connected to the Raspberry Pi by SPI for driving MX and RX Dynamixel motor series.

This board will be integrated soon in the new head of the Poppy Humanoid and Poppy Torso.

Using the Raspberry Pi for every Poppy robots will simplify the hardware complexity (we maintain 4 types of embedded boards, with different Linux kernel and configurations) and improve the usage and installation of new robots.

- Contact: Theo Segonds
- URL: <https://forum.poppy-project.org/t/poppy-1-1-hipi/2137>

6.6. IKPy

Inverse Kinematics Python Library

FUNCTIONAL DESCRIPTION: IKPy is a Python Inverse Kinematics library, designed to be simple to use and extend. It provides Forward and Inverse kinematics functionality, bundled with helper tools such as 3D plotting of the kinematics chains. Being written entirely in Python, IKPy is lightweight and is based on numpy and scipy for fast optimization. IKPy is compatible with many robots, by automatically parsing URDF files. It also supports other (such as DH-parameters) and custom representations. Moreover, it provides a framework to easily implement new Inverse Kinematics strategies. Originally developed for the Poppy project, it can also be used as a standalone library.

- Contact: Pierre Manceron
- URL: <https://github.com/Phylliade/ikpy>

6.7. KERAS-QR

KERAS with Quick Reset

KEYWORDS: Library - Deep learning

- Participant: Florian Golemo
- Contact: Florian Golemo
- URL: <https://github.com/fgolemo/keras>

6.8. KidBreath

FUNCTIONAL DESCRIPTION: KidBreath is a web responsive application composed by several interactive contents linked to asthma and displayed to different forms: learning activities with quiz, short games and videos. There are profil creation and personalization, and a part which describes historic and scoring of learning activities, to see evolution of Kidreath use. To test Kidlearn algorithm, it is iadapted and integrated on this platform. Development in PHP, HTML-5, CSS, MySQL, JQuery, Javascript. Hosting in APACHE, LINUX, PHP 5.5, MySQL, OVH.

- Partner: ItWell SAS
- Contact: Alexandra Delmas
- URL: <http://www.kidbreath.fr>

6.9. Kidlearn: money game application

FUNCTIONAL DESCRIPTION: The games is instantiated in a browser environment where students are proposed exercises in the form of money/token games (see Figure 2). For an exercise type, one object is presented with a given tagged price and the learner has to choose which combination of bank notes, coins or abstract tokens need to be taken from the wallet to buy the object, with various constraints depending on exercises parameters. The games have been developed using web technologies, HTML5, javascript and Django.

- Contact: Benjamin Clement
- URL: <https://flowers.inria.fr/research/kidlearn/>

6.10. Kidlearn: script for Kidbreath use

FUNCTIONAL DESCRIPTION: A new way to test Kidlearn algorithms is to use them on Kidbreath Platform. The Kidbreath Platform use apache/PHP server, so to facilitate the integration of our algorithm, a python script have been made to allow PHP code to use easily the python library already made which include our algorithms.

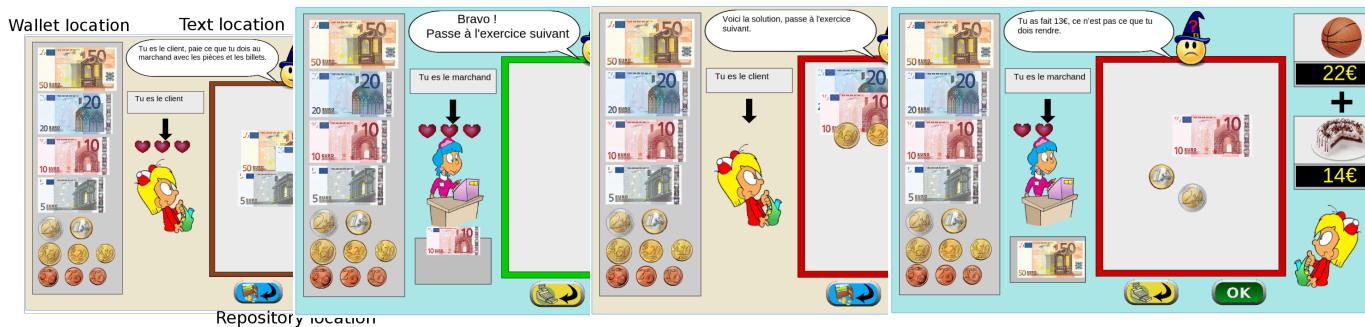


Figure 2. Four principal regions are defined in the graphical interface. The first is the wallet location where users can pick and drag the money items and drop them on the repository location to compose the correct price. The object and the price are present in the object location. Four different types of exercises exist: M : customer/one object, R : merchant/one object, MM : customer/two objects, RM : merchant/two objects.

Github link to explanation about it : <https://github.com/flowersteam/kidlearn/>.

- Contact: Benjamin Clement

6.11. KidLearn

KEYWORD: Automatic Learning

FUNCTIONAL DESCRIPTION: KidLearn is a software which adaptively personalize sequences of learning activities to the particularities of each individual student. It aims at proposing to the student the right activity at the right time, maximizing concurrently his learning progress and its motivation.

- Participants: Benjamin Clement, Didier Roy, Manuel Lopes and Pierre Yves Oudeyer
- Contact: Manuel Lopes
- URL: <https://flowers.inria.fr/research/kidlearn/>

6.12. Kinect 2 Server

Kinect 2 server

KEYWORDS: Depth Perception - Speech recognition - Gesture recognition - Kinect

FUNCTIONAL DESCRIPTION: The server written in C# uses the Kinect SDK v2 to get the RGBD raw image, skeleton tracking information, recognized speech. It also uses the text-to-speech from Microsoft. Then it streams JSON data over the network using the Publisher/Subscriber pattern from the ZeroMQ network library. A Linux client has been written in Python but it can be written in any other language that is compatible with ZeroMQ. Features are controllable through a Graphical User Interface on Windows, or through the code from any Linux/Windows client. The clients can for instance enable features (speech recognition on, skeleton tracking off, ...) and parameters (set new speech to recognize, change language, ...) from remote.

- Contact: Yoan Mollard
- URL: https://github.com/baxter-flowers/kinect_2_server/

6.13. Multimodal

FUNCTIONAL DESCRIPTION: The python code provides a minimum set of tools and associated libraries to reproduce the experiments in [98] , together with the choreography datasets. The code is primarily intended for reproduction of the multimodal learning experiment mentioned above. It has already been reused in several experimentations by other member of the team and is expected to play an important role in further collaborations. It is also expected that the public availability of the code encourages further experimentation by other scientists with data coming from other domains, thus increasing both the impact of the aforementioned publication and the knowledge on the algorithm behaviors.

- Participant: Olivier Mangin
- Contact: Olivier Mangin
- URL: <https://github.com/omangin/multimodal>

6.14. OptiTrack

FUNCTIONAL DESCRIPTION: This python library allows you to connect to an OptiTrack from NaturalPoint. This camera permits the tracking of 3D markers efficiently and robustly. With this library, you can connect to the Motive software used by the OptiTrack and retrieve the 3D position and orientation of all your tracked markers directly from python.

- Participant: Pierre Rouanet
- Contact: Pierre Rouanet
- URL: <http://www.optitrack.com/>

6.15. Pixl Board

FUNCTIONAL DESCRIPTION: Pixl is a tiny board used to create low cost robots based on Raspberry Pi board and Dynamixel XL-320 motors. This board has 2 main features:

- The power part, allowing the user to plug a 7.5V AC/DC converter or a battery directly into the Pixl. This power is distributed to all XL320 motors and is converted to 5V for the Raspberry Pi board.
- The communication part, which converts full duplex to half duplex and vice-versa. The half duplex part switch between RX and TX automatically. Another connector allows the user to connect his XL320 network.

The board is used in the Poppy Ergo Jr robot.

- Contact: Theo Segonds
- URL: <https://github.com/poppy-project/pixl>

6.16. Poppy

FUNCTIONAL DESCRIPTION: The Poppy Project team develops open-source 3D printed robots platforms based on robust, flexible, easy-to-use and reproduce hardware and software. In particular, the use of 3D printing and rapid prototyping technologies is a central aspect of this project, and makes it easy and fast not only to reproduce the platform, but also to explore morphological variants. Poppy targets three domains of use: science, education and art.

In the Poppy project we are working on the Poppy System which is a new modular and open-source robotic architecture. It is designed to help people create and build custom robots. It permits, in a similar approach as Lego, building robots or smart objects using standardized elements.

Poppy System is a unified system in which essential robotic components (actuators, sensors...) are independent modules connected with other modules through standardized interfaces:

- Unified mechanical interfaces, simplifying the assembly process and the design of 3D printable parts.
- Unified communication between elements using the same connector and bus for each module.
- Unified software, making it easy to program each module independently.

Our ambition is to create an ecosystem around this system so communities can develop custom modules, following the Poppy System standards, which can be compatible with all other Poppy robots.

- Participants: Jonathan Grizou, Matthieu Lapeyre, Pierre Rouanet and Pierre-Yves Oudeyer
- Contact: Pierre-Yves Oudeyer
- URL: <https://www.poppy-project.org/>

6.17. Poppy Ergo Jr

FUNCTIONAL DESCRIPTION: Poppy Ergo Jr is an open hardware robot developed by the Poppy Project to explore the use of robots in classrooms for learning robotic and computer science.

It is available as a 6 or 4 degrees of freedom arm designed to be both expressive and low-cost. This is achieved by the use of FDM 3D printing and low cost Robotis XL-320 actuators. A Raspberry Pi camera is attached to the robot so it can detect object, faces or QR codes.

The Ergo Jr is controlled by the Pypot library and runs on a Raspberry pi 2 or 3 board. Communication between the Raspberry Pi and the actuators is made possible by the Pixl board we have designed.

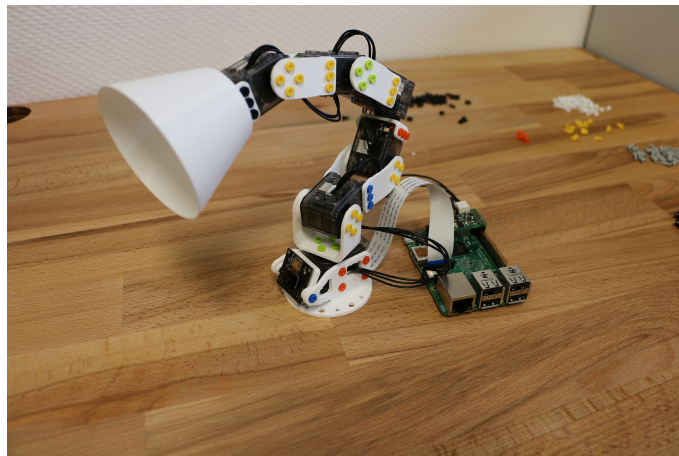


Figure 3. Poppy Ergo Jr; 6-DoFs arm robot for education

The Poppy Ergo Jr robot has several 3D printed tools extending its capabilities. There are currently the lampshade, the gripper and a pen holder.

With the release of a new Raspberry Pi board early 2016, the Poppy Ergo Jr disk image was updated to support Raspberry Pi 2 and 3 boards. The disk image can be used seamlessly with a board or the other.

- Contact: Theo Segonds
- URL: <https://github.com/poppy-project/poppy-ergo-jr>

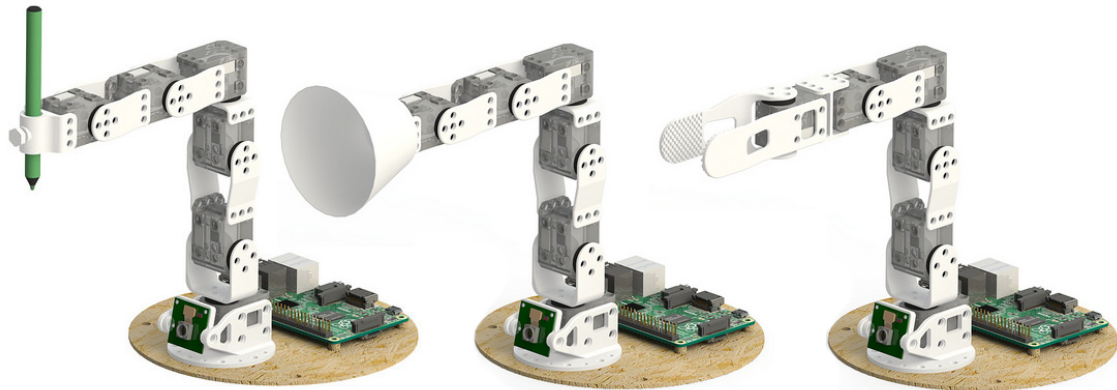


Figure 4. The available Ergo Jr tools: a pen holder, a lampshade and a gripper

6.18. Poppy Ergo Jr Installer

FUNCTIONAL DESCRIPTION: An alternative way to install the Ergo Jr robot software is made available using containers.

Users can own their own operating system installation, then add the Ergo Jr required software in a sandboxed environment. This results in a non-intrusive installation on the host system.

Docker containers implementation were used, and image is hosted at Docker Hub.

- Contact: Damien Caselli
- URL: <https://hub.docker.com/r/poppycommunity/ergo-jr/>

6.19. Poppy Ergo Jr Simulator

FUNCTIONAL DESCRIPTION: Poppy Project, through Poppy Education, wants users to get used to robotics, even without owning a physical robot.

For that purpose, Poppy Project team created a dummy robot in Pypot that is meant to be used in conjunction with a consumer application. We choose to develop a web hosted application using a 3D engine (Threejs) to render the robot.

Our ambition is to have a completely standalone simulated robot with physics. Some prototypes were created to benchmark possible solutions.

- Contact: Damien Caselli
- URL: <https://github.com/poppy-project/poppy-simu>

6.20. ProMP

Probabilistic Movement Primitives

KEYWORDS: Interaction - Robotics - Probability - Motion model - Robot Operating System (ROS)

FUNCTIONAL DESCRIPTION: Joint-space primitives with a task-space constraint: The primitives are stored in joint-space but demonstrations are provided both in joint space and task space, context. Thanks to this context, task-space goals can be requested to these joint-space primitives. The benefit is that requesting a new task-space goal does not require to call an IK method which would return demonstrations-agnostic joint configurations.

Vocal interactive learning and clustering: This work includes an interactive learning aspect which allows to automatically cluster motor primitives based on the standard deviation of their demonstrations. A new primitive is created automatically if the provided demonstration is out of 2 standard deviation of the existing primitives, otherwise the demonstration is distributed to an existing one.

- Contact: Yoan Mollard
- URL: <https://github.com/baxter-flowers/promplib>

6.21. PyPot

SCIENTIFIC DESCRIPTION: Pypot is a framework developed to make it easy and fast to control custom robots based on Dynamixel motors. This framework provides different levels of abstraction corresponding to different types of use. Pypot can be used to:

- control Robotis motors through a USB2serial device,
- define the structure of a custom robot and control it through high-level commands,
- define primitives and easily combine them to create complex behavior.

Pypot is part of the Poppy project. It is the core library used by the Poppy robots. This abstraction layer allows to seamlessly switch from a given Poppy robot to another. It also provides a common set of tools, such as forward and inverse kinematics, simple computer vision, recording and replaying moves, or easy access to the autonomous exploration library Explauto.

To extend pypot application domains and connection to outside world, it also provides an HTTP API. On top of providing an easy way to connect to smart sensors or connected devices, it is notably used to connect to Snap!, a variant of the well-known Scratch visual programming language.

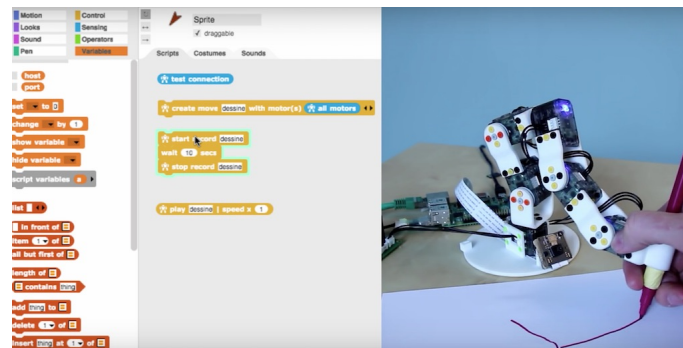


Figure 5. Example of using pypot to program a robot to reproduce a drawn shape

FUNCTIONAL DESCRIPTION: Pypot is entirely written in Python to allow for fast development, easy deployment and quick scripting by non-expert developers. It can also benefit from the scientific and machine learning libraries existing in Python. The serial communication is handled through the standard library and offers high performance (10ms sensorimotor loop) for common Poppy uses. It is cross-platform and has been tested on Linux, Windows and Mac OS.

Pypot is also compatible with the V-REP simulator. This allows the transparent switch from a real robot to its simulated equivalent with a single code base.

Finally, it has been developed to be easily and quickly extended for other types of motors and sensors.

It works with Python 2.7 or Python 3.3 or later, and has also been adapted to the Raspberry Pi board.

Pypot has been connected to Snap!, a variant of the famous Scratch visual language, developed to teach computer science to children. It is based on a drag-and-drop blocks interface to write scripts by assembling those blocks.

Thanks to the Snap! HTTP block, a connection can be made to pypot allowing users to directly control robots through their visual interfaces. A set of dedicated Snap! blocks have been designed, such as **set motor position** or **get motor temperature**. Thanks to the Snap! HTTP block, users can control robots through this visual interfaces connecting to Pypot. A set of dedicated Snap! blocks has been designed, such as **set motor position** or **get motor temperature**.



Figure 6. Using Snap! to program a robot by demonstration and create complex choreographies

Snap! is also used as a tool to program the robot by demonstration. Using the **record** and **play** blocks, users can easily trigger kinesthetic recording of the whole robot or only a specific subpart, such as an arm. These records can then be played or "mixed" - either played in sequence or simultaneously - with other recordings to compose complex choreographies. The moves are encoded as a model of mixture of gaussians (GMM) which allows the definition of clean mathematical operators for combining them.

This recording tool has been developed and used in collaboration with artists who show interest in the concept of robotic moves.

- Participants: Damien Caselli, Matthieu Lapeyre, Pierre Rouanet, Steve Nguyen and Theo Segonds
- Contact: Theo Segonds
- URL: <https://github.com/poppy-project/pypot>

6.22. PyQMC

Python library for Quasi-Metric Control

FUNCTIONAL DESCRIPTION: PyQMC is a python library implementing the control method described in <http://dx.doi.org/10.1371/journal.pone.0083411> It allows to solve discrete markovian decision processes by computing a Quasi-Metric on the state space. This model based method has the advantage to be goal independant and thus can produce a policy for any goal with relatively few recomputation. New addition to this method is the possibility of online learning of the transition model and the Quasi-Metric.

- Participant: Steve Nguyen
- Contact: Steve Nguyen
- URL: <https://github.com/SteveNguyen/pyqmc>

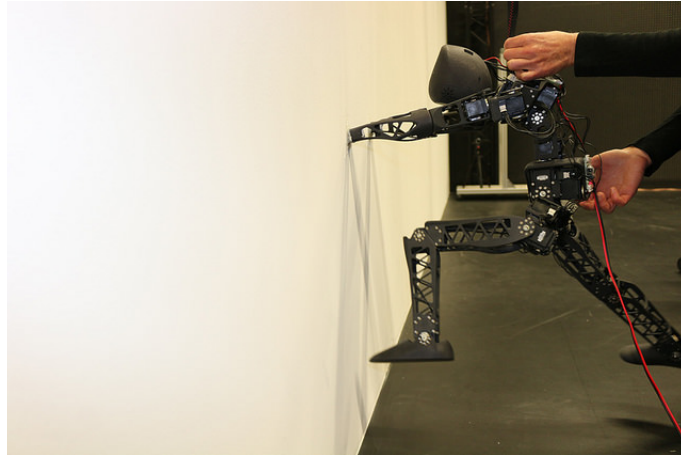


Figure 7. Artistic project exploring the concept of robotic move.

6.23. ROS Optitrack Publisher

KEYWORDS: Target tracking - Robot Operating System (ROS)

FUNCTIONAL DESCRIPTION: This package allows to publish optitrack markers declared as rigid bodies as TF transforms. Data is gathered through the embedded VRPN server of Motive/Arena. Only rigid bodies are requested to the server, thus single points in 2D/3D are ignored. VRPN server can be enable in View > Data streaming in Motive.

- Contact: Yoan Mollard
- URL: https://github.com/baxter-flowers/optitrack_publisher

6.24. ThifloNet

KEYWORDS: Deep learning - Policy Learning

SCIENTIFIC DESCRIPTION: We created a software architecture that combines a state-of-the-art computer vision system with a policy learning framework. This system is able to perceive a visual scene, given by a still image, extract facts ("predicates"), and propose an optimal action to achieve a given goal. Both systems are chained into a pipeline that is trained by presenting images and demonstrating an optimal action. By providing this information, both the predicate recognition model and the policy learning model are updated.

Our architecture is based on the recent works of Lerer, A., Gross, S., & Fergus, R., 2016 ("Learning Physical Intuition of Block Towers by Example"). They created a large network able to identify physical properties of stacked blocks. Analogously our vision system utilizes the same network layout (without the image prediction auxiliary output), with an added output layer for predicates, based on the expected number and arity of predicates. The vision subsystem is not trained with a common cross-entropy or MSE loss function, but instead receives its loss from the policy learning subsystem. The policy learning module calculates the loss as optimal combination of predicates for the given expert action.

By using this combination of systems, the architecture as a whole requires significantly fewer data samples than other systems (which exclusively utilize neural networks). This makes the approach more feasible to real-life application with actual live demonstration.

FUNCTIONAL DESCRIPTION: The neural network consists of ResNet-50 (the currently best-performing computer vision system), with 50 layers, 2 layers for converting the output of ResNet to predicates and a varying amount of output neurons, corresponding to the estimated number of n-arity predicates. The network was pretrained on the ImageNet dataset. The policy learning module incorporates the ACE tree learning tool and a wrapper in Prolog.

Our example domain consists of 2-4 cubes colored in red, blue, green, and yellow and randomly stacked on top of each other in a virtual 3D environment. The dataset used for training and testing contains a total of 30000 elements, each with an image of the scene, the correct predicates, a list of blocks that are present and the corresponding expert action, that would lead to stacking the blocks to a tower.

- Participants: Florian Golemo, Manuel Lopes and Thibaut Munzer
- Contact: Florian Golemo

GRAPHDECO Project-Team

5. New Software and Platforms

5.1. SGTDP

Synthetic Ground Truth Data Generation Platform

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: The goal of this platform is to render large numbers of realistic synthetic images for use as ground truth to compare and validate image-based rendering algorithms and also to train deep neural networks developed in our team.

This pipeline consists of three major elements that are:

- Scene exporter
- Assisted point of view generation
- Distributed rendering on Inria's high performance computing cluster

The scene exporter is able to export scenes created in the widely-used commercial modeler 3DSMAX to the Mitsuba open-source renderer format. It handles the conversion of complex materials and shade trees from 3DSMAX including materials made for V-Ray. The overall quality of the produced images with exported scenes has been improved thanks to a more accurate material conversion. The initial version of the exporter was extended and improved to provide better stability and to avoid any manual intervention.

From each scene we can generate a large number of images by placing multiple cameras. Most of the time those points of view have to be placed with a certain coherency. This task could be long and tedious. In the context of image-based rendering, cameras have to be placed in a row with a specific spacing. To simplify this process we have developed a set of tools to assist the placement of hundreds of cameras along a path.

The rendering is made with the open-source renderer Mitsuba. The rendering pipeline is optimised to render a large number of points of view for a single scene. We use a path tracing algorithm to simulate the light interaction in the scene and produce high dynamic range images. It produces realistic images but it is computationally demanding. To speed up the process we set up an architecture that takes advantage of the Inria cluster to distribute the rendering on hundreds of CPU cores.

The scene data (geometry, textures, materials) and the cameras are automatically transferred to remote workers and HDR images are returned to the user.

We already use this pipeline to export tens of scenes and to generate several thousands of images, which have been used for machine learning and for ground-truth image production.

- Contact: George Drettakis

5.2. Unity IBR

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: Unity IBR (for Image-Based Rendering in Unity) This is a software module that proceeds the development of IBR algorithms in Unity. In this case, algorithms are developed for the context of EMOTIVE EU project. The rendering technique was changed during the year to evaluate and compare which one produces better results suitable for Game Development with Unity (improvement of image quality and faster rendering). New features were also added such as rendering of bigger datasets and some debugging utilities. Software was also updated to keep compatibility with new released versions of Unity game engine.

- Contact: George Drettakis

5.3. SIBR

Simple Image-Based Rendering

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: This is a framework containing libraries and tools used internally for research projects based on Image-Base Rendering. It includes both preprocessing tools (computing data used for rendering) and rendering utilities and serves as the basis for many research projects in the group.

It includes basic support for a large set of computer graphics and computer vision functionalities and includes implementations of several image-based rendering algorithms. The code base has become quite mature and is in the process of being used for tech transfer.

- Contact: George Drettakis

GRAPHIK Project-Team

6. New Software and Platforms

6.1. GRAAL

KEYWORDS: Knowledge database - Ontologies - Querying - Data management

SCIENTIFIC DESCRIPTION: Graal is a Java toolkit dedicated to querying knowledge bases within the framework of existential rules, aka Datalog+/-.

FUNCTIONAL DESCRIPTION: Graal has been designed in a modular way, in order to facilitate software reuse and extension. It should make it easy to test new scenarios and techniques, in particular by combining algorithms. The main features of Graal are currently the following: (1) a data layer that provides generic interfaces to store various kinds of data and query them with (union of) conjunctive queries, currently: MySQL, PostgreSQL, Sqlite, in memory graph and linked list structures, (2) an ontological layer, where an ontology is a set of existential rules, (3) a knowledge base layer, where a knowledge base is composed of a fact base (abstraction of the data via generic interfaces) and an ontology, (4) algorithms to process ontology-mediated queries, based on query rewriting and/or forward chaining (or chase), (5) a rule analyzer, which performs a syntactic and structural analysis of an existential rule set, (6) several IO formats, including imports from OWL 2.

RELEASE FUNCTIONAL DESCRIPTION: The new version (1.3.0) apport some bug fixes, makes the dlqp parser more flexible (dlqp being our serialization format for existential rules) and improves the efficiency of the forward chaining (chase) algorithms.

NEWS OF THE YEAR: A new stable version (1.3.0) has been delivered. Moreover, the Graal website has been deeply restructured and enriched with new tools, available online or for download, and documentation including tutorials, examples of use, and technical documentation about all Graal modules.

- Participants: Marie-Laure Mugnier, Clément Sipieter, Jean-François Baget, Mélanie König, Michel Leclère and Swan Rocher
- Contact: Marie-Laure Mugnier
- Publications: [Gaal: A Toolkit for Query Answering with Existential Rules - Datalog+, RuleML and OWL 2: Formats and Translations for Existential Rules](#)
- URL: <https://github.com/graphik-team>

6.2. Cogui

KEYWORDS: Knowledge database - Ontologies - GUI (Graphical User Interface)

SCIENTIFIC DESCRIPTION: Cogui is a visual tool for building and verifying graphical knowledge bases (KB). Knowledge bases are represented under graphical form (close to conceptual graphs). There is a complete correspondence with the logical existential rule (or Datalog+) framework.

FUNCTIONAL DESCRIPTION: Cogui is a freeware written in Java. It allows to graphically create a KB, to handle its structure and content, and to control it. Currently, it supports Conceptual Graphs and import/export in RDFS and Datalog+. Wizards allow to analyze and check facts with respect to some constraints, as well as to query them while taking into account inferences enabled by the ontology.

NEWS OF THE YEAR: Cogui is currently under heavy refactoring to benefit from NetBeans graphical libraries, as well as the plugin-based architecture and Java 9 Jigsaw.

- Participants: Alain Gutierrez, Michel Chein, Marie-Laure Mugnier, Michel Leclère and Madalina Croitoru
- Partner: LIRMM
- Contact: Michel Chein
- URL: <http://www.lirmm.fr/cogui/>

6.3. CoGui-Capex

KEYWORD: Ontologies

SCIENTIFIC DESCRIPTION: CoGui-Capex is a decision support tool dedicated to food industry based on the CoGui editor. Its knowledge base represents the causal links between food descriptors and actions which can be undertaken by operators to control food quality on the line. Since 2016, the version of CoGui-Capex for Neatbeans environnement is coupled with the so-called "Knowledge book" developed by INRA I2M team in Bordeaux.

FUNCTIONAL DESCRIPTION: CoGui-Capex is a decision support tool dedicated to food industry.

RELEASE FUNCTIONAL DESCRIPTION: The new version of Cogui-Capex has been coupled with the tool "MakeBook".

NEWS OF THE YEAR: CoGui-Capex has been delivered to the industrial partner Régilait, a powder milk producer.

- Participants: Jérôme Fortin, Patrice Buche, Alain Gutierrez and Clément Sipieter
- Partners: INRA - LIRMM
- Contact: Jérôme Fortin

6.4. NoAWVote

KEYWORD: Social choice

SCIENTIFIC DESCRIPTION: NoAWVote is a decision-making system which relies on the fair aggregation of individual preferences, i.e. the preference profile. It allows to: - Compute collective preferences according to different voting methods such as, among others, k-approval, Borda, Kemeny-Young, - Filter the individual preferences according to the voters characteristics (categories such as age, location, etc.), - Cluster individual preferences into group preferences according to some given categories, these groups' preferences being then aggregated themselves, - Format the aggregation result (single winner, k-top alternatives, full ranking)

FUNCTIONAL DESCRIPTION: NoAWVote is a software providing a decision-making mechanism which relies on the fair aggregation of individual preferences which is developed within the context of the H2020 Projects NoAW project.

RELEASE FUNCTIONAL DESCRIPTION: The first release of the tool contains the described functionalities.

NEWS OF THE YEAR: The development of the tool started this year.

- Participants: Pierre Bisquert, Madalina Croitoru, Patrice Buche, Rallou Thomopoulos and Nikolaos Karanikolas
- Partner: INRA
- Contact: Pierre Bisquert
- Publication: [Selection of agro-waste valorisation routes based on a computational social choice and argumentation decision support tool](#)

6.5. Genetix

KEYWORDS: Biological sequences - Propositional logic

SCIENTIFIC DESCRIPTION: Genetix is a design assistant for biologists. The tool allows experts to precompute biological designs (corresponding to DNA sequences) implementing an intended boolean function. The software includes a parallel generator of sequences running on HPC clusters which is able to manage functions with up to 4 input variables. An open database allows biologists to explore and query available designs.

FUNCTIONAL DESCRIPTION: Genetix is a tool for generating biological sequences implementing boolean functions.

RELEASE FUNCTIONAL DESCRIPTION: The first version of the tool is able to generate biological implementations of boolean functions with up to 4-inputs.

NEWS OF THE YEAR: The development of Genetix started this year.

- Participants: Michel Leclère, Federico Ulliana and Guillaume Perution Kihli
- Contact: Michel Leclère
- Publication: [Scalable composition frameworks for multicellular logic](#)
- URL: <http://genetix.lirmm.fr/>

HEPHAISTOS Project-Team

6. New Software and Platforms

6.1. ALIAS

Algorithms Library of Interval Analysis for Systems

FUNCTIONAL DESCRIPTION: The ALIAS library whose development started in 1998, is a collection of procedures based on interval analysis for systems solving and optimization.

ALIAS is made of two parts:

ALIAS-C++ : the C++ library (87 000 code lines) which is the core of the algorithms

ALIAS-Maple : the Maple interface for ALIAS-C++ (55 000 code lines). This interface allows one to specify a solving problem within Maple and get the results within the same Maple session. The role of this interface is not only to generate the C++ code automatically, but also to perform an analysis of the problem in order to improve the efficiency of the solver. Furthermore, a distributed implementation of the algorithms is available directly within the interface.

- Participants: Jean-Pierre Merlet and Odile Pourtallier
- Contact: Jean-Pierre Merlet

6.2. PALGate

KEYWORDS: Health - Home care - Handicap

- Contact: David Daney

6.3. Platforms

6.3.1. ALIAS, *Algorithms Library of Interval Analysis for Systems*

The ALIAS library whose development started in 1998, is a collection of procedures based on interval analysis for systems solving and optimization.

ALIAS is made of two parts:

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- Participants: Odile Pourtallier and Jean-Pierre Merlet
- Contact: Jean-Pierre Merlet
- URL: <http://www-sop.inria.fr/hephaistos/developpements/main.html>

6.3.2. *Hardware platforms*

We describe here only the new platforms that have been developed in 2017 while we maintain a very large number of platforms (e.g. the cable-driven parallel robots of the MARIONET family, the ANG family of walking aids or our experimental flat).

6.3.2.1. GMSIVE ADT: virtual reality and rehabilitation

Inria has agreed to fund us for developing the platform GMSIVE whose purpose is to introduce end-user motion and their analysis in a virtual reality environment in order to make rehabilitation exercises more attractive and more appropriate for the rehabilitation process. For example we have developed an active treadmill whose slope will change according to the user place in the virtual world while the lateral inclination may be changed in order to regulate the load between the left and right leg. Such a system may be used in rehabilitation to simulate a walk in the mountain while increasing on-demand the load on an injured leg (that is usually avoided by the user) for a shorter rehabilitation time. At the same time the walking pattern is analyzed in order to assess the efficiency of the rehabilitation exercise.

The motion system is composed of two vertical columns whose height may be adjusted (they are used for actuating the treadmill), a 6 d.o.f motion base and a cable-driven parallel robot which may lift the user (in the walking experiment this robot may be used to support partly the user while he is walking allowing frail people to start the rehabilitation earlier). We intend to develop sailing and ski simulators as additional rehabilitation environment. Currently the columns and motion base are effective while the robot has been installed but not tested yet and we have started to study the coupling between the motion generators and the 3D visualization.

6.3.2.2. Activities detection platform

For non intrusive activities detection we use low cost distance and motion sensors that are incorporated in a 3D printed box (figure 1) and constitute a detection station. Several such station are implemented at appropriate place in the location that has to be monitored (e.g. the Valrose EHPAD where 15 such stations has been deployed at the end of 2016 while 17 stations have been deployed at Institut Claude Pompidou at the end of 2017). Although the information provided by each station is relatively poor an appropriate network of such station allow us to provide the information requested by the medical community.

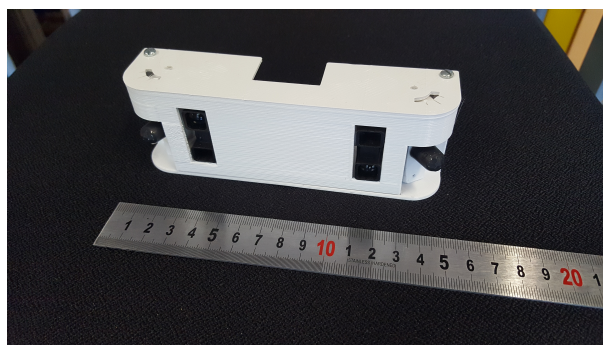


Figure 1. A station for activities detection. The 4 sensors allow to determine the presence of the subject in a given zone, his/her direction of motion and speed even at night

6.3.2.3. Instrumented cane

An alternate to the walker is using a cane for elderly support and for rehabilitation. We have developed two cane prototypes instrumented with accelerometers and force sensor (figure 2) with the purpose of monitoring the walking pattern and assess rehabilitation exercises in a more objective way. These canes have also led lights that are automatically activated at night when the cane is in motion while the ambient lightning is low with the purpose of decreasing the fall risk and to help for navigation.

6.3.2.4. Instrumented gloves

An important part of a rehabilitation process is to assess, on a regular basis, the motricity of the patient. The standard protocol for this assessment is to ask the patient to perform standardized motion while a therapist



Figure 2. Instrumented cane

puts the palm of his/her hand in opposition to measure the pressure exerted by the patient. This intuitive measurement is converted into a simplified ranking from 0 to 5 but, as mentioned by therapists, the subjectivity of this ranking is high. We have developed a glove that is able to measure the pressure and may provide a more objective assessment.



Figure 3. Instrumented glove for rehabilitation assessment

HYBRID Project-Team

6. New Software and Platforms

6.1. #FIVE

Framework for Interactive Virtual Environments

KEYWORDS: Virtual reality - 3D - 3D interaction - Behavior modeling

SCIENTIFIC DESCRIPTION: #FIVE (Framework for Interactive Virtual Environments) is a framework for the development of interactive and collaborative virtual environments. #FIVE was developed to answer the need for an easier and a faster design and development of virtual reality applications. #FIVE provides a toolkit that simplifies the declaration of possible actions and behaviours of objects in a VE. It also provides a toolkit that facilitates the setting and the management of collaborative interactions in a VE. It is compliant with a distribution of the VE on different setups. It also proposes guidelines to efficiently create a collaborative and interactive VE. The current implementation is in C# and comes with a Unity3D engine integration, compatible with MiddleVR framework.

FUNCTIONAL DESCRIPTION: #FIVE contains software modules that can be interconnected and helps in building interactive and collaborative virtual environments. The user can focus on domain-specific aspects for his/her application (industrial training, medical training, etc) thanks to #FIVE's modules. These modules can be used in a vast range of domains using virtual reality applications and requiring interactive environments and collaboration, such as in training for example.

- Participants: Florian Noviale, Valérie Gouranton, Bruno Arnaldi, Thomas Boggini, Guillaume Claude, Thomas Lopez and Quentin Petit
- Contact: Valérie Gouranton
- Publication: [#FIVE : High-Level Components for Developing Collaborative and Interactive Virtual Environments](#)
- URL: <https://bil.inria.fr/fr/software/view/2527/tab>

6.2. #SEVEN

Sensor Effector Based Scenarios Model for Driving Collaborative Virtual Environments

KEYWORDS: Virtual reality - Interactive Scenarios - 3D interaction

SCIENTIFIC DESCRIPTION: #SEVEN (Sensor Effector Based Scenarios Model for Driving Collaborative Virtual Environments) is a model and an engine based on petri nets extended with sensors and effectors, enabling the description and execution of complex and interactive scenarios

FUNCTIONAL DESCRIPTION: #SEVEN enables the execution of complex scenarios for driving Virtual Reality applications. #SEVEN's scenarios are based on an enhanced Petri net model which is able to describe and solve intricate event sequences. #SEVEN comes with an editor for creating, editing and remotely controlling and running scenarios. #SEVEN is implemented in C# and can be used as a stand-alone application or as a library. An integration to the Unity3D engine, compatible with MiddleVR, also exists.

- Participants: Florian Noviale, Valérie Gouranton, Bruno Arnaldi, Guillaume Claude, Thomas Boggini and Rozenn Bouville Berthelot
- Contact: Valérie Gouranton
- Publications: [Actions sequencing incollaborative virtual environment - Short Paper: #SEVEN, a Sensor Effector Based Scenarios Model for Driving Collaborative Virtual Environment](#)
- URL: <https://bil.inria.fr/fr/software/view/2528/tab>

6.3. OpenViBE

KEYWORDS: Neurosciences - Interaction - Virtual reality - Health - Real time - Neurofeedback - Brain-Computer Interface - EEG - 3D interaction

FUNCTIONAL DESCRIPTION: OpenViBE is a free and open-source software platform devoted to the design, test and use of Brain-Computer Interfaces (BCI). The platform consists of a set of software modules that can be integrated easily and efficiently to design BCI applications. The key features of OpenViBE software are its modularity, its high-performance, its portability, its multiple-users facilities and its connection with high-end/VR displays. The designer of the platform enables to build complete scenarios based on existing software modules using a dedicated graphical language and a simple Graphical User Interface (GUI). This software is available on the Inria Forge under the terms of the AGPL licence, and it was officially released in June 2009. Since then, the OpenViBE software has already been downloaded more than 40000 times, and it is used by numerous laboratories, projects, or individuals worldwide. More information, downloads, tutorials, videos, documentations are available on the OpenViBE website.

- Participants: Cédric Riou, Thierry Gaugry, Anatole Lécuyer, Fabien Lotte, Jussi Tapio Lindgren, Laurent Bougrain, Maureen Clerc Gallagher and Théodore Papadopoulo
- Partners: INSERM - CEA-List - GIPSA-Lab
- Contact: Anatole Lécuyer
- URL: <http://openvibe.inria.fr>

6.4. Platforms

6.4.1. Immerstar

- Participants : Florian Nouviale, Ronan Gaugne

With the two platforms of virtual reality, Immersia and Immermove, grouped under the name Immerstar, the team has access to high level scientific facilities. This equipment benefits the research teams of the center and has allowed them to extend their local, national and international collaborations. The Immerstar platform is granted by a Inria CPER funding for 20152019 that enables important evolutions of the equipment. In 2017, WQXGA laser projectors were installed in Immersia as well as a new tracking system and a new cluster of computers, improving the quality, homogeneity and latency of the platform

ILDA Project-Team

6. New Software and Platforms

6.1. Smarties

FUNCTIONAL DESCRIPTION: The Smarties system provides an easy way to add mobile interactive support to collaborative applications for wall displays.

It consists of (i) a mobile interface that runs on mobile devices for input, (ii) a communication protocol between the mobiles and the wall application, and (iii) libraries that implement the protocol and handle synchronization, locking and input conflicts. The library presents the input as an event loop with callback functions and handles all communication between mobiles and wall application. Developers can customize the mobile interface from the wall application without modifying the mobile interface code.

On each mobile we find a set of cursor controllers associated with keyboards, widgets and clipboards. These controllers (pucks) can be shared by multiple collaborating users. They can control simple cursors on the wall application, or specific content (objects or groups of them). The developer can decide the types of widgets associated to pucks from the wall application side.

- Contact: Olivier Chapuis
- URL: <http://smarties.lri.fr/>

6.2. ZVTM

Zoomable Visual Transformation Machine

KEYWORDS: Big data - Visualization - Data visualization - Information visualization - Graph visualization

FUNCTIONAL DESCRIPTION: ZVTM is a toolkit enabling the implementation of multi-scale interfaces for interactively navigating in large datasets displayed as 2D graphics.

ZVTM is used for browsing large databases in multiple domains: geographical information systems, control rooms of complex facilities, astronomy, power distribution systems.

The toolkit also enables the development of applications running on ultra-high-resolution wall-sized displays.

- Participants: Arnaud Prouzeau, Can Liu, Caroline Appert, Hande Gozukan, Maria Jesus Lobo Gunther and Olivier Chapuis
- Contact: Emmanuel Pietriga
- URL: <http://zvtm.sf.net>

6.3. Platforms

6.3.1. Platform: WILDER

Ultra-high-resolution wall-sized displays [33] feature a very high pixel density over a large physical surface. Such platforms have properties that make them well-suited to the visualization of very large datasets. They can represent the data with a high level of detail while at the same time retaining context: users can transition from an overview of the data to a detailed view simply by physically moving in front of the wall display. Wall displays also offer good support for collaborative work, enabling multiple users to simultaneously visualize and interact with the displayed data. To make them interactive, wall-sized displays are increasingly coupled with input devices such as touch frames, motion-tracking systems and wireless multitouch devices, in order to enable multi-device and multi-user interaction with the displayed data. Application areas for such visualization platforms range from the monitoring of complex infrastructures and crisis management situations to tools for the exploratory visualization of scientific data.

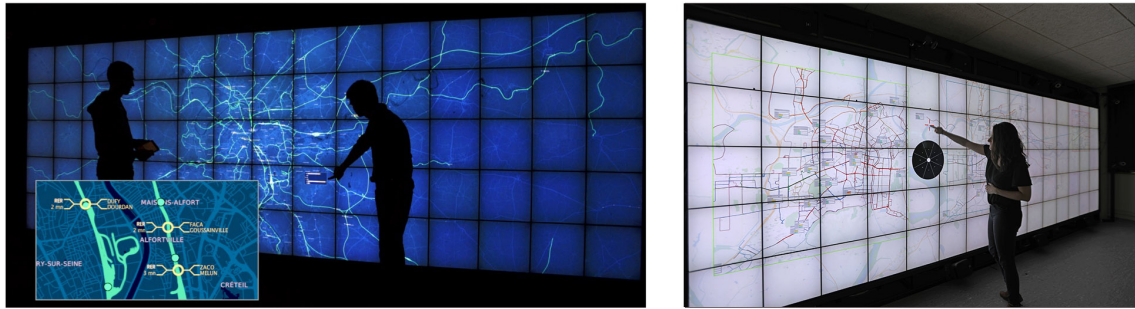


Figure 2. Geovisualization applications running on the WILDER platform. Real-time monitoring of railroad traffic in France (left), real-time monitoring of mobile sensors measuring air quality in Korean cities (right).

WILDER is the latest ultra-high-resolution wall-sized display set up at Inria Saclay, and is one of the nodes of the Digiscope EquipEx. We use this platform for multiple projects, both fundamental HCI research, and research and development activities for specific application areas such as geographical informations systems (Figure 2) and astronomy.

WILDER was used in the projects that led to the following publications this year: [22], [24], [18].

IMAGINE Project-Team

5. New Software and Platforms

5.1. Expressive

KEYWORDS: 3D modeling - 3D - 3D interaction - 2D - Procedural - Terrain - Sketching

FUNCTIONAL DESCRIPTION: Expressive is a new C++ library created in 2013 for gathering and sharing the models and algorithms developed within the ERC Expressive project. It enables us to make our latest research results on new creative tools - such as high level models with intuitive, sketching or sculpting interfaces - soon available to the rest of the group and easily usable for our collaborators, such as Evelyne Hubert (Inria, Galaad) or Loic Barthe (IRIT, Toulouse). The most advanced part is a new version of Convol, a library dedicated to implicit modeling, with a main focus on integral surfaces along skeletons. Convol incorporates all the necessary material for constructive implicit modeling, a variety of blending operators and several methods for tessellating an implicit surface into a mesh, and for refining it in highly curved regions. The creation of new solid geometry can be performed by direct manipulation of skeletal primitives or through sketch-based modeling and multi-touch deformations.

- Participants: Antoine Begault, Cédric Zanni, Guillaume Cordonnier, Marie-Paule Cani, Maxime Garcia, Maxime Quiblier, Rémi Brouet and Ulysse Vimont
- Partner: INPG
- Contact: Marie-Paule Cani

5.2. MyCF

My Corporis Fabrica

KEYWORDS: Patientspecific - Anatomy - Ontologies - Health - Simulation - 3D modeling - Medical imaging

FUNCTIONAL DESCRIPTION: Knowledge-based 3D anatomical modeling using MyCF The MyCF software eases the creation of 3D anatomical models for visualization and mechanical simulation. As input, the user provides a list of anatomical entities or functions to simulate, using keywords or navigating in reference 3D model. As output, she gets a 3D model ready to visualize, or to simulate.

- Participants: Ali Hamadi Dicko, Federico Ulliana, François Faure and Olivier Palombi
- Partner: Université Joseph-Fourier
- Contact: Olivier Palombi
- URL: <http://www.mycorporisfabrica.org>

5.3. Natron

KEYWORDS: Computer vision - Image analysis - Video sequences

FUNCTIONAL DESCRIPTION: Compositing consists in combining computer-generated images and live-action videos, editing them, and adding visual effects. The applications range from green-screen compositing to the insertion of real characters in a virtual set. Natron performs all these tasks, with a professional quality user interface.

- Authors: Alexandre Gauthier-Foichat, Alexandre Gauthier-Foichat and Frédéric Devernay
- Contact: Frédéric Devernay
- URL: <http://natron.fr/>

5.4. Kino AI

Artificial intelligence for cinematography

KEYWORDS: Video analysis - Post-production

FUNCTIONAL DESCRIPTION: Kino AI is an implementation of the method described in our patent "automatic generation of cinematographic rushes using video processing". Starting from a single ultra high definition (UltraHD) recording of a live performance, we track and recognize all actors present on stage and generate one or more rushes suitable for cinematographic editing of a movie.

- Partner: IIIT Hyderabad
- Contact: Rémi Ronfard
- Publications: **Multi-Clip Video Editing from a Single Viewpoint - Zooming On All Actors: Automatic Focus+Context Split Screen Video Generation**

LACODAM Project-Team

6. New Software and Platforms

6.1. EcoMata

KEYWORD: Environment perception

FUNCTIONAL DESCRIPTION: The EcoMata toolbox provides means for qualitative modeling and exploration of ecosystems in order to aid the design of environmental guidelines. We have proposed a new qualitative approach for ecosystem modeling based on the timed automata (TA) formalism combined to a high-level query language for exploring scenarios.

- Participants: Christine Largouët, Marie-Odile Cordier, Thomas Guyet and Yulong Zhao
- Contact: Christine Largouët
- URL: <https://team.inria.fr/dream/fr/ecomata/>

6.2. PATURMATA

KEYWORDS: Bioinformatics - Biology

SCIENTIFIC DESCRIPTION: The Paturmata tool-box provides means for qualitative modeling and the exploration of agrosystems, specifically management of herd based on pasture. The system is modeled using a hierarchical hybrid model described in the timed automata formalism.

FUNCTIONAL DESCRIPTION: In the PaturMata software, users can create a pasture system description by entering herds and plots information. For each herd, the only parameter is the number of animals. For each plot, users should enter the surface, the density, the herb height, the distance to the milking shed, a herb growth profile and an accessibility degree. Users then specify pasturing and fertilization strategies. Finally, users can launch a pasture execution. PaturMata displays the results and a detailed trace of pasture. Users can launch a batch of different strategies and compare the results in order to find the best pasture strategy. PaturMata is developed in Java (Swing for the GUI) and the model-checker that is called for the timed properties verification is UPPAAL.

- Participants: Christine Largouët and Marie-Odile Cordier
- Contact: Christine Largouët

6.3. Promise

KEYWORDS: Data mining - Monitoring

FUNCTIONAL DESCRIPTION: Promise is a software that predicts rare events in industrial production systems from data analysis of energy consumption data. The data is represented as a time series. The program takes as input the temporal series of energy consumption, an abnormal pattern (rare event) and a temporal dilatation, and outputs a set of sub-series similar (according to a similarity metric) to the abnormal pattern.

- Participants: Véronique Masson, Laurence Rozé and Mael Guilleme
- Contact: Véronique Masson

6.4. GWASDM

Genome Wide Association Study using Data Mining strategy

KEYWORDS: GWAS - Data mining

FUNCTIONAL DESCRIPTION: From two cohorts of genotyped individuals (case and control), the GWASDM software performs a Genome Wide Association Study based on data mining techniques and generates several patterns of SNPs that correlate with a given phenotype. The algorithm implemented in GWASDM directly uses relative risk measures such as risk ratio, odds ratio and absolute risk reduction combined with confidence intervals as anti-monotonic properties to efficiently prune the search space. The algorithm discovers a complete set of discriminating patterns with regard to given thresholds or applies heuristic strategies to extract the largest statistically significant discriminating patterns in a given dataset.

- Contact: Dominique Lavenier

6.5. DCM

Discriminant Chronicle Mining

KEYWORDS: Pattern extraction - Sequence - Classification

FUNCTIONAL DESCRIPTION: DCM is a temporal sequences analysis tool. It extracts discriminant chronicles from a large set of labeled sequences. A sequence is made of timestamped events. Each sequence of events is associated to a label (e.g. positive and negative sequences). A chronicle is a temporal model that characterizes a behavior by a set of events linked by temporal constraints. The DCM algorithm extracts chronicles that occurs more in positive sequences than in negative sequences.

- Participants: Yann Dauxais and Thomas Guyet
- Partners: REPERES - Université de Rennes 1
- Contact: Yann Dauxais
- Publications: [Discriminant chronicles mining: Application to care pathways analytics - Extraction de chroniques discriminantes](#)
- URL: <https://gitlab.inria.fr/ydauxais/DCM>

6.6. NTGSP

Negative Time-Gap Sequential Patterns

KEYWORDS: Pattern discovery - Sequence

FUNCTIONAL DESCRIPTION: The NTGSP algorithm is a sequential pattern mining algorithm. It analyses a large database of temporal sequences, i.e., events with timestamps, by extracting its regularities (the patterns). A pattern describes the behavior as a sequence of events that frequently occurred in sequences. What makes NTGSP novel is its ability to handle patterns with negations, i.e., the description of a behavior that specifies the absence of an event. More precisely, it extracts frequent sequences with positive and negative events, as well as temporal information about the delay between these events.

- Participants: Thomas Guyet and René Quiniou
- Partner: Edf
- Contact: René Quiniou
- Publication: [Fouille de motifs temporels négatifs](#)

6.7. Relevant Interval Rules Miner

KEYWORDS: Association rule - Pattern discovery - Formal concept analysis

FUNCTIONAL DESCRIPTION: This software extracts relevant rules from a dataset of labeled numerical attributes (tabular datasets). A rule is an interval-based pattern associated to a predicted label. The tool extracts a subset of rules based on the accuracy and relevance criteria where most of the algorithms are simply based on accuracy. This allow us to extract the best rules that capture the data behavior.

- Participants: René Quiniou, Véronique Masson and Thomas Guyet
- Contact: Thomas Guyet
- Publication: [Mining relevant interval rules](#)

6.8. OCL

One click learning

KEYWORDS: Data mining - Interactivity

FUNCTIONAL DESCRIPTION: This pattern mining software builds a user model preference from implicit feedback of the user in order to automatically choice the type of patterns and algorithms used. The principle builds upon the algorithm introduced by M. Boley et al, "One click mining: interactive local pattern discovery through implicit preference and performance learning". In addition OCL integrates algorithms dealing with temporal series.

- Contact: Laurence Rozé
- URL: <https://github.com/Gremarti/OneClickLearning>

LAGADIC Project-Team

6. New Software and Platforms

6.1. bib2html

Latex bibliography generator

KEYWORDS: LaTeX - Bibliography

FUNCTIONAL DESCRIPTION: The purpose of this software is to automatically produce html pages from BibTEX files, and to provide access to the BibTEX entries by several criteria: year of publication, category of publication, keywords, author name. Moreover cross-linking is generating between pages to provide an easy navigation through the pages without going back to the index.

- Contact: Éric Marchand
- URL: <http://www.irisa.fr/lagadic/soft/bib2html/bib2html.html>

6.2. DESlam

Dense Egocentric SLAM

KEYWORDS: Depth Perception - Robotics - Localisation

FUNCTIONAL DESCRIPTION: This software proposes a full and self content solution to the dense Slam problem. Based on a generic RGB-D representation valid for various type of sensors (stereovision, multi-cameras, RGB-D sensors...), it provides a 3D textured representation of complex large indoor and outdoor environments and it allows localizing in real time (45Hz) a robot or a person carrying out a mobile camera.

- Participants: Andrew Ian Comport, Maxime Meilland and Patrick Rives
- Contact: Patrick Rives

6.3. HandiViz

Driving assistance of a wheelchair

KEYWORDS: Health - Persons attendant - Handicap

FUNCTIONAL DESCRIPTION: The HandiViz software proposes a semi-autonomous navigation framework of a wheelchair relying on visual servoing.

It has been registered to the APP ("Agence de Protection des Programmes") as an INSA software (IDDN.FR.001.440021.000.S.P.2013.000.10000) and is under GPL license.

- Participants: François Pasteau and Marie Babel
- Contact: Marie Babel

6.4. Perception360

Robot vision and 3D mapping with omnidirectional RGB-D sensors.

KEYWORDS: Depth Perception - Localization - 3D reconstruction - Realistic rendering - Sensors - Image registration - Robotics - Computer vision - 3D rendering

FUNCTIONAL DESCRIPTION: This software is a collection of libraries and applications for robot vision and 3D mapping with omnidirectional RGB-D sensors or standard perspective cameras. This project provides the functionality to do image acquisition, semantic annotation, dense registration, localization and 3D mapping. The omnidirectional RGB-D sensors used within this project have been developed in Inria Sophia-Antipolis by the team LAGADIC.

- Contact: Patrick Rives

6.5. SINATRACK

Model-based visual tracking of complex objects

KEYWORDS: Computer vision - Robotics

FUNCTIONAL DESCRIPTION: Sinatrack is a tracking software that allows the 3D localization (translation and rotation) of an object with respect to a monocular camera. It allows to consider object with complex shape. The underlying approach is a model-based tracking techniques. It has been developed for satellite localization and on-orbit service applications but is also suitable for augmented reality purpose.

- Participants: Antoine Guillaume Petit, Éric Marchand and François Chaumette
- Contact: Éric Marchand

6.6. UsTk

Ultrasound toolkit for medical robotics applications guided from ultrasound images

KEYWORDS: Echographic imagery - Image reconstruction - Medical robotics - Visual tracking - Visual servoing (VS)

FUNCTIONAL DESCRIPTION: UsTk, standing for Ultrasound Toolkit, is a cross-platform extension of ViSP software dedicated to two- and three-dimensional ultrasound image processing and visual servoing based on ultrasound images. Written in C++, UsTk architecture provides a core module that implements all the data structures at the heart of UsTk, a grabber module that allows to acquire ultrasound images from an Ultrasonix or a Sonosite device, a GUI module to display data, an IO module for providing functionalities to read/write data from a storage device, and a set of image processing modules to compute the confidence map, to track a needle, and to track an image template. All these modules could be used to control the motion of an ultrasound probe by ultrasound visual servoing.

- Participants: Alexandre Krupa, Marc Pouliquen, Fabien Spindler and Pierre Chatelain
- Partners: Université de Rennes 1 - IRSTEA
- Contact: Alexandre Krupa
- URL: <https://team.inria.fr/lagadic/>

6.7. ViSP

Visual servoing platform

KEYWORDS: Augmented reality - Computer vision - Robotics - Visual servoing (VS)

SCIENTIFIC DESCRIPTION: Since 2005, we develop and release ViSP [1], an open source library available from <https://visp.inria.fr>. ViSP standing for Visual Servoing Platform allows prototyping and developing applications using visual tracking and visual servoing techniques at the heart of the Lagadic research. ViSP was designed to be independent from the hardware, to be simple to use, expandable and cross-platform. ViSP allows to design vision-based tasks for eye-in-hand and eye-to-hand visual servoing that contains the most classical visual features that are used in practice. It involves a large set of elementary positioning tasks with respect to various visual features (points, segments, straight lines, circles, spheres, cylinders, image moments, pose...) that can be combined together, and image processing algorithms that allow tracking of visual cues (dots, segments, ellipses...) or 3D model-based tracking of known objects or template tracking. Simulation capabilities are also available.

[1] E. Marchand, F. Spindler, F. Chaumette. ViSP for visual servoing: a generic software platform with a wide class of robot control skills. IEEE Robotics and Automation Magazine, Special Issue on "Software Packages for Vision-Based Control of Motion", P. Oh, D. Burschka (Eds.), 12(4):40-52, December 2005.

FUNCTIONAL DESCRIPTION: ViSP provides simple ways to integrate and validate new algorithms with already existing tools. It follows a module-based software engineering design where data types, algorithms, sensors, viewers and user interaction are made available. Written in C++, ViSP is based on open-source cross-platform libraries (such as OpenCV) and builds with CMake. Several platforms are supported, including OSX, iOS, Windows and Linux. ViSP online documentation allows to ease learning. More than 280 fully documented classes organized in 17 different modules, with more than 300 examples and 64 tutorials are proposed to the user. ViSP is released under a dual licensing model. It is open-source with a GNU GPLv2 license. A professional edition license that replaces GNU GPLv2 is also available.

- Participants: Aurélien Yol, Éric Marchand, Fabien Spindler, François Chaumette and Souriya Trinh
- Partner: Université de Rennes 1
- Contact: Fabien Spindler
- URL: <http://visp.inria.fr>

6.8. Platforms

6.8.1. Robot Vision Platform

Participant: Fabien Spindler [contact].

We exploit two industrial robotic systems built by Afma Robots in the nineties to validate our researches in visual servoing and active vision. The first one is a 6 DoF Gantry robot, the other one is a 4 DoF cylindrical robot (see Fig. 2 .a). These robots are equipped with cameras. The Gantry robot also allows embedding grippers on its end-effector.

We are also using a haptic Virtuouse 6D device from Haption company (see Fig. 2 .b). This device is used as master device in many of our shared control activities (see Sections 9.3.1.3 , 7.3.3 , and 7.3.4).

Note that eight papers published by Lagadic in 2017 enclose results validated on this platform [35], [37], [15], [63], [58], [48], [51], [52].

6.8.2. Mobile Robots

Participants: Fabien Spindler [contact], Marie Babel, Patrick Rives.

6.8.2.1. Indoor Mobile Robots

For fast prototyping of algorithms in perception, control and autonomous navigation, the team uses Hannibal in Sophia Antipolis, a cart-like platform built by Neobotix (see Fig. 3 .a), and, in Rennes, a Pioneer 3DX from Adept (see Fig. 3 .b). These platforms are equipped with various sensors needed for SLAM purposes, autonomous navigation, and sensor-based control.

Moreover, to validate the researches in personally assisted living topic (see Section 7.5.3), we have three electric wheelchairs in Rennes, one from Permobil, one from Sunrise and the last from YouQ (see Fig. 3 .c). The control of the wheelchair is performed using a plug and play system between the joystick and the low level control of the wheelchair. Such a system lets us acquire the user intention through the joystick position and control the wheelchair by applying corrections to its motion. The wheelchairs have been fitted with cameras and ultrasound sensors to perform the required servoing for assisting handicapped people.

Note that five papers exploiting the indoors mobile robots were published this year [15], [30], [31], [53], [60].

6.8.2.2. Outdoor Vehicles

A camera rig has been developed in Sophia Antipolis. It can be fixed to a standard car (see Fig. 4), which is driven at a variable speed depending on the road/traffic conditions, with an average speed of 30 km/h and a maximum speed of 80 km/h. The sequences are recorded at a frame rate of 20 Hz, with a synchronization of the six global shutter cameras of the stereo system, producing spherical images with a resolution of 2048x665 pixels (see Fig. 4). Such sequences are fused offline to obtain maps that can be used later for localization or for scene rendering (in a similar fashion to Google Street View) as shown in the video <http://www-sop.inria.fr/members/Renato-Jose.Martins/iros15.html>.

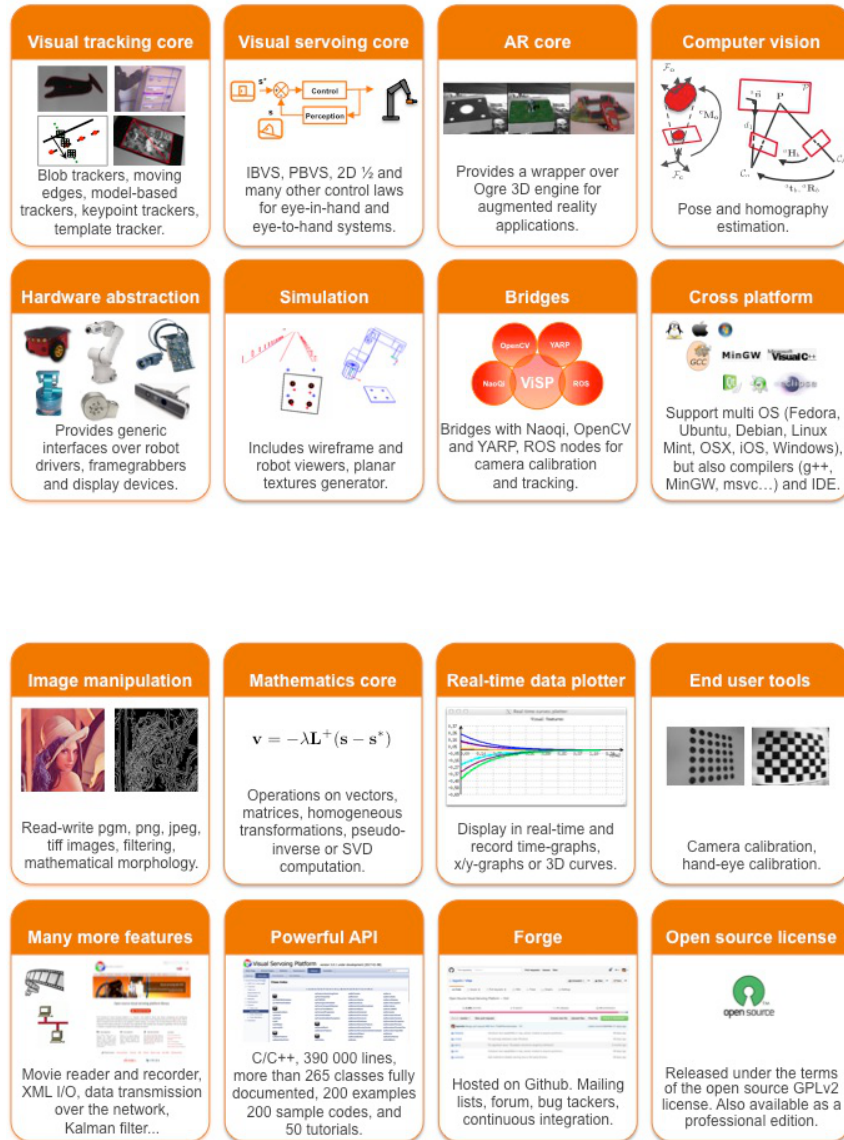
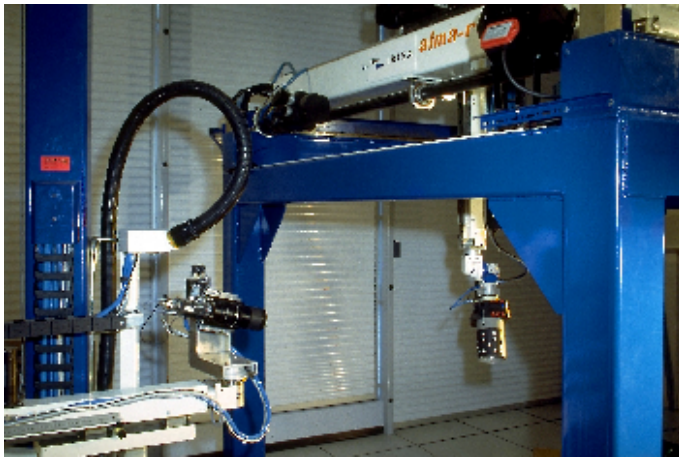


Figure 1. This figure highlights ViSP main capabilities for visual tracking, visual servoing, and augmented reality that may benefit from computer vision algorithms. ViSP allows controlling specific platforms through hardware abstraction or in simulation. ViSP provides also bridges over other frameworks such as OpenCV and ROS. All these capabilities are cross-platform. Moreover, for easing the prototyping of applications, ViSP provides tools for image manipulation, mathematics, data plotting, camera calibration, and many other features. ViSP powerful API is fully documented and available on Github as an open source software under GPLv2 license.



(a)



(b)

Figure 2. a) Lagadic robotics platform for vision-based manipulation, b) Virtuose 6D haptic device

6.8.3. Medical Robotic Platform

Participants: Marc Pouliquen, Fabien Spindler [contact], Alexandre Krupa.

This platform is composed by two 6 DoF Adept Viper arms (see Fig. 5 .a). Ultrasound probes connected either to a SonoSite 180 Plus or an Ultrasonix SonixTouch imaging system can be mounted on a force torque sensor attached to each robot end-effector. The haptic Virtuose 6D device (see Fig. 2 .b) can also be used within this platform.

This testbed is of primary interest for researches and experiments concerning ultrasound visual servoing applied to probe positioning, soft tissue tracking, elastography or robotic needle insertion tasks (see Section 7.3).

Note that seven papers published this year include experimental results obtained with this platform [56], [57], [72], [33], [19], [48], [37]

6.8.4. Humanoid Robots

Participants: Giovanni Claudio, Fabien Spindler [contact].

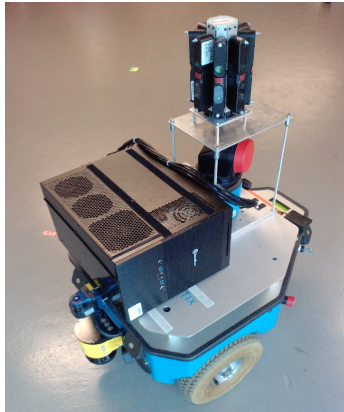
Romeo is a humanoid robot from SoftBank Robotics which is intended to be a genuine personal assistant and companion. Only the upper part of the body (trunk, arms, neck, head, eyes) is working. This research platform is used to validate our researches in visual servoing and visual tracking for object manipulation (see Fig. 6 .a).

Last year, this platform was extended with Pepper, another human-shaped robot designed by SoftBank Robotics to be a genuine day-to-day companion (see Fig. 6 .b). It has 17 DoF mounted on a wheeled holonomic base and a set of sensors (cameras, laser, ultrasound, inertial, microphone) that makes this platform interesting for researches in vision-based manipulation, and visual navigation (see Section 7.5.1).

Note that two papers published this year include experimental results obtained with these platforms [13], [60].

6.8.5. Unmanned Aerial Vehicles (UAVs)

Participants: Thomas Bellavoir, Pol Mordel, Paolo Robuffo Giordano [contact].



(a)



(b)

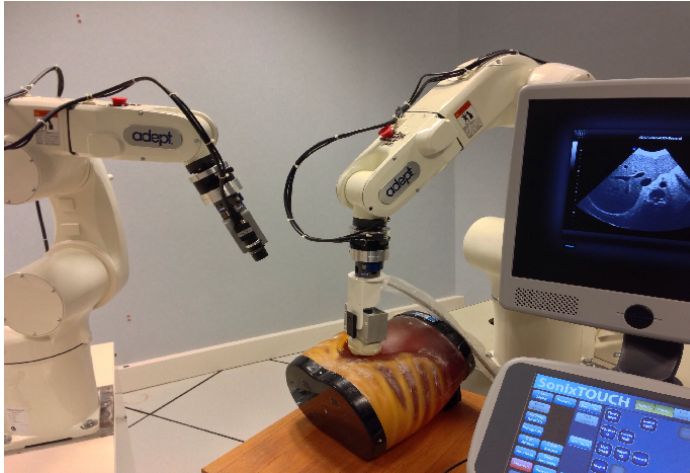


(c)

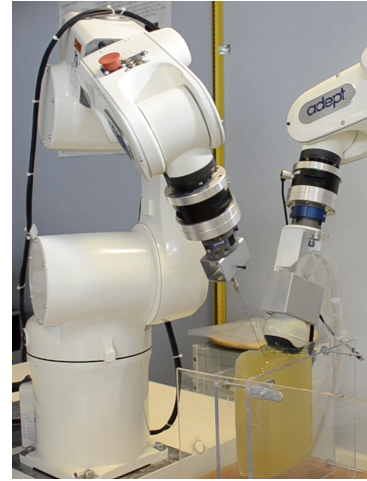
Figure 3. a) Hannibal platform, b) Pioneer P3-DX robot, c) wheelchairs from Permobil, Sunrise and YouQ.



Figure 4. Globeye stereo sensor and acquisition system.

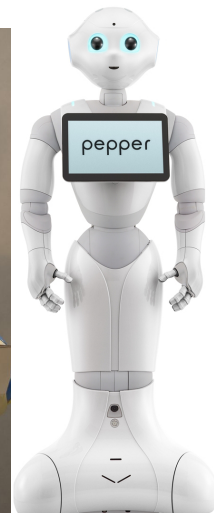
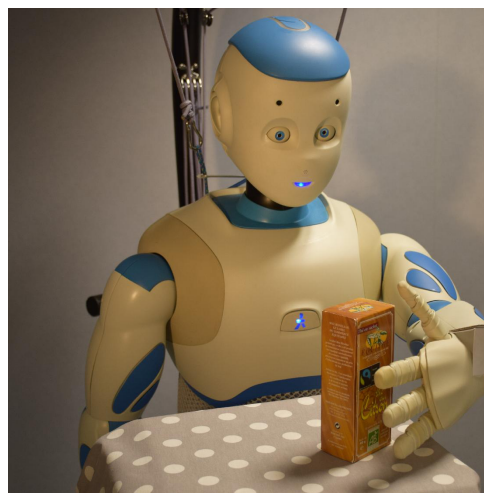


(a)



(b)

Figure 5. a) Lagadic medical robotic platforms. On the right Viper S850 robot arm equipped with a SonixTouch 3D ultrasound probe. On the left Viper S650 equipped with a tool changer that allows to attach a classical camera or biopsy needles. b) Robotic setup for autonomous needle insertion by visual servoing.



(a)

(b)

Figure 6. a) Romeo experimental platform, b) Pepper human-shaped robot

From 2014, Lagadic also started some activities involving perception and control for single and multiple quadrotor UAVs, especially thanks to a grant from “Rennes Métropole” (see Section 9.1.4) and the ANR project “SenseFly” (see Section 9.2.5). To this end, we purchased four quadrotors from Mikrokopter GmbH, Germany (see Fig. 7 .a), and one quadrotor from 3DRobotics, USA (see Fig. 7 .b). The Mikrokopter quadrotors have been heavily customized by: (i) reprogramming from scratch the low-level attitude controller onboard the microcontroller of the quadrotors, (ii) equipping each quadrotor with an Odroid XU4 board (see Fig. 7 .d) running Linux Ubuntu and the TeleKyb software (the middleware used for managing the experiment flows and the communication among the UAVs and the base station), and (iii) purchasing the Flea Color USB3 cameras together with the gimbal needed to mount them on the UAVs (see Fig. 7 .c). The quadrotor group is used as robotic platforms for testing a number of single and multiple flight control schemes with a special attention on the use of onboard vision as main sensory modality.

This year four papers published enclose experimental results obtained with this platform [49], [50], [42], [62].



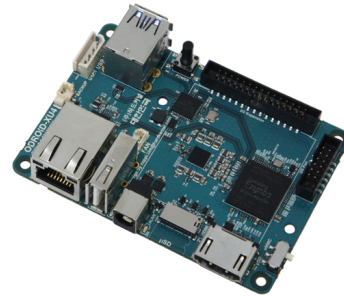
(a)



(b)



(c)



(d)

Figure 7. a) Quadrotor XLI from Mikrokopter, b) Quadrotor Iris from 3DRobotics, c) Flea Color USB3 camera, d) Odroid XU4 board

LARSEN Project-Team

6. New Software and Platforms

6.1. ProMP_iCub

iCub Learning Trajectories with ProMP

KEYWORDS: Gaussian processes - Robotics

FUNCTIONAL DESCRIPTION: A set of matlab modules to learn, replay and infer the continuation of trajectories in robotics using Probabilistic Movement Primitives (ProMP).

- Contact: Serena Ivaldi
- Publication: [Prediction of Intention during Interaction with iCub with Probabilistic Movement Primitives](#)
- URL: <https://github.com/inria-larsen/icubLearningTrajectories>

6.2. Limbo

Library for Model-based Bayesian Optimization

KEYWORDS: Black-box optimization - C++ - Global optimization - Machine learning - Policy Learning - Bayesian optimization - Gaussian processes

FUNCTIONAL DESCRIPTION: Limbo is an open-source C++11 library for Gaussian processes and Bayesian Optimization which is designed to be both highly flexible and very fast. It can be used to optimize functions for which the gradient is unknown, evaluations are expensive, and where runtime cost matters (e.g., on embedded systems or robots). Benchmarks on standard functions show that Limbo is about 2 times faster than BayesOpt (another C++ library) for a similar accuracy.

NEWS OF THE YEAR: Release 2.0 (2017) with: - serialization of Gaussian process models - new architecture for kernel and mean functions - automatic and extensive benchmarks for Gaussian processes regression and Bayesian optimization (generated weekly) - better random generator (thread-safe, c++11) - generation of the documentation for each release

- Partners: UPMC - Imperial College London
- Contact: Jean-Baptiste Mouret
- URL: <http://www.resibots.eu/limbo>

6.3. xsens_driver

KEYWORD: IMU driver

FUNCTIONAL DESCRIPTION: This is a driver for the third and fourth generation of Xsens IMU devices. The driver is in two parts, a small implementation of most of the MT protocol in Python and a ROS node. It works both on serial and USB interfaces.

These MT* devices can store their configuration and will retrieve it at each boot and then stream data according to this configuration. The node only forwards the data streamed onto ROS topics. In order to configure your device, you can use the mtdevice.py script (or the vendor tool on Windows).

RELEASE FUNCTIONAL DESCRIPTION: Support of fourth generation of devices. Support of ubuntu 16.04. Support of ROS Jade and ROS Kinetic.

NEWS OF THE YEAR: version 2.1.0 (2017-04-14) - several bugfixes and a new option.

- Contact: Francis Colas
- URL: https://github.com/ethz-asl/ethzasl_xsens_driver

6.4. sferes2

A lightweight generic C++ framework for evolutionary computation

FUNCTIONAL DESCRIPTION: Sferes2 is a high-performance, multi-core, lightweight, generic C++98 framework for evolutionary computation. It is intently kept small to stay reliable and understandable.

Sferes2 relies heavily on template-based meta-programming in C++ to get both abstraction and execution speed.

- Partner: UPMC
- Contact: Jean-Baptiste Mouret
- URL: <http://github.com/sferes2/sferes2/>

6.5. libdynamixel

KEYWORD: Robotics

FUNCTIONAL DESCRIPTION: The libdynamixel is a high-performance C++11 interface to the Dynamixel actuators (including the Dynamixel Pro range). It provides a high-level interface (designed to be easy to sue), a low-level interface (designed to add no overhead on top of the protocol), and a command-line tool for scripting and maintenance operations. The main emphasis is on performance and compatibility with modern C++.

- Contact: Jean-Baptiste Mouret
- URL: <http://github.com/resibots/libdynamixel>

LINKMEDIA Project-Team

6. New Software and Platforms

6.1. Platforms

6.1.1. AllGO multimedia web services

Participants: Vincent Claveau, Clément Dalloux, Guillaume Gravier [correspondent], Gabriel Sargent.

Available at <http://allgo.irisa.fr>, the AllGO platform allows for the easy deployment of the technology developed in the team as web services. Based on the AllGO infrastructure, LINKMEDIA has continued making available a number of web services related to multimedia content analysis. In 2017, we continued our effort towards the interoperability of the services available (silence detection, face detection, text-based fragmentation) and added speaker diarization and negative sentence detection services.

LINKS Project-Team

6. New Software and Platforms

6.1. ShEx validator

Validation of Shape Expression schemas

KEYWORDS: Data management - RDF

FUNCTIONAL DESCRIPTION: Shape Expression schemas is a formalism for defining constraints on RDF graphs. This software allows to check whether a graph satisfies a Shape Expressions schema.

- Contact: Iovka Boneva
- URL: <https://gforge.inria.fr/projects/shex-impl/>

6.2. gMark

gMark: schema-driven graph and query generation

KEYWORDS: Semantic Web - Data base

FUNCTIONAL DESCRIPTION: gMark allow the generation of graph databases and an associated set of query from a schema of the graph. gMark is based on the following principles: - great flexibility in the schema definition - ability to generate big size graphs - ability to generate recursive queries - ability to generate queries with a desired selectivity

- Contact: Aurélien Lemay
- URL: <https://github.com/graphMark/gmark>

6.3. SmartHal

KEYWORD: Bibliography

FUNCTIONAL DESCRIPTION: SmartHal is a better tool for querying the HAL bibliography database, while is based on Haltool queries. The idea is that a Haltool query returns an XML document that can be queried further. In order to do so, SmartHal provides a new query language. Its queries are conjunctions of Haltool queries (for a list of laboratories or authors) with expressive Boolean queries by which answers of Haltool queries can be refined. These Boolean refinement queries are automatically translated to XQuery and executed by Saxon. A java application for extraction from the command line is available. On top of this, we have build a tool for producing the citation lists for the evaluation report of the LIFL, which can be easily adapter to other Labs.

- Contact: Joachim Niehren
- URL: <http://smarthal.lille.inria.fr/>

6.4. QuiXPath

KEYWORDS: XML - NoSQL - Data stream

SCIENTIFIC DESCRIPTION: The QuiXPath tools supports a very large fragment of XPath 3.0. The QuiXPath library provides a compiler from QuiXPath to FXP, which is a library for querying XML streams with a fragment of temporal logic.

FUNCTIONAL DESCRIPTION: QuiXPath is a streaming implementation of XPath 3.0. It can query large XML files without loading the entire file in main memory, while selecting nodes as early as possible.

- Contact: Joachim Niehren
- URL: <https://project.inria.fr/quix-tool-suite/>

6.5. X-FUN

KEYWORDS: Programming language - Compilers - Functional programming - Transformation - XML

FUNCTIONAL DESCRIPTION: X-FUN is a core language for implementing various XML, standards in a uniform manner. X-Fun is a higher-order functional programming language for transforming data trees based on node selection queries.

- Participants: Joachim Niehren and Pavel Labath
- Contact: Joachim Niehren

MAGNET Project-Team

6. New Software and Platforms

6.1. CoRTex

Python library for noun phrase COreference Resolution in natural language TEXTs

KEYWORD: Natural language processing

FUNCTIONAL DESCRIPTION: CoRTex is a LGPL-licensed Python library for Noun Phrase coreference resolution in natural language texts. This library contains implementations of various state-of-the-art coreference resolution algorithms, including those developed in our research. In addition, it provides a set of APIs and utilities for text pre-processing, reading the main annotation formats (ACE, CoNLL and MUC), and performing evaluation based on the main evaluation metrics (MUC, B-CUBED, and CEAF). As such, CoRTex provides benchmarks for researchers working on coreference resolution, but it is also of interest for developers who want to integrate a coreference resolution within a larger platform.

- Participant: Pascal Denis
- Contact: Pascal Denis
- URL: <https://gforge.inria.fr/projects/cortex/>

6.2. Mangoes

MAgnet liNGuistic wOrd vEctorS

KEYWORDS: Word embeddings - NLP

FUNCTIONAL DESCRIPTION: Process textual data and compute vocabularies and co-occurrence matrices. Input data should be raw text or annotated text. Compute word embeddings with different state-of-the art unsupervised methods. Propose statistical and intrinsic evaluation methods, as well as some visualization tools.

- Contact: Nathalie Vauquier
- URL: <https://gitlab.inria.fr/magnet/mangoes>

MAGRIT Project-Team

6. New Software and Platforms

6.1. Ltrack

KEYWORDS: Augmented reality - Visual tracking

FUNCTIONAL DESCRIPTION: The Inria development action LTrack aims at developing an Android platform in order to facilitate the transfer of some of our algorithms onto mobile devices. For the moment, the tracking-by-synthesis algorithm has been implemented (up to our knowledge, for the first time on a mobile device) in order to rigidly track a real object in real time assuming that a CAD model of this object is available. The design and implementation of the platform have been guided by the need to enable easy integration of any tracking algorithm based on combining video data and other sensor information.

NEWS OF THE YEAR: A recovery procedure based on key-frames has been designed when the number of inliers tracked keypoints is too small.

- Contact: Marie-Odile Berger

6.2. PoLAR

Portable Library for Augmented Reality

FUNCTIONAL DESCRIPTION: PoLAR (Portable Library for Augmented Reality) is a framework which aims to help creating graphical applications for augmented reality, image visualization and medical imaging. PoLAR was designed to offer powerful visualization functionalities without the need to be a specialist in Computer Graphics. The framework provides an API to state-of-the-art libraries: Qt to build GUIs and OpenSceneGraph for high-end visualization, for researchers and engineers with a background in Computer Vision to be able to create beautiful AR applications, with little programming effort. The framework is written in C++ and published under the GNU GPL license

- Contact: Erwan Kerrien
- URL: <http://polar.inria.fr>

6.3. Fast>VP

KEYWORDS: Vanishing points - Image rectification

FUNCTIONAL DESCRIPTION: Fast>VP is a fast and effective tool to detect vanishing points in uncalibrated images of urban or indoor scenes.

This tool also allows automatic rectification of the vertical planes in the scene, namely generating images where these planes appear as if they were observed from a fronto-parallel view.

It is the Matlab implementation of the algorithm described in [6].

- Contact: Gilles Simon
- URL: <https://members.loria.fr/GSimon/fastvp/>

6.4. TheGridMethod

The grid method toolbox

KEYWORD: Experimental mechanics

FUNCTIONAL DESCRIPTION: This Matlab toolbox implements several efficient and state-of-the art algorithms to estimate displacement and strain fields from grid images deposited on the surface of a specimen submitted to mechanical testing.

- Contact: Frédéric Sur
- URL: <http://www.thegridmethod.net/>

MANAO Project-Team

6. New Software and Platforms

6.1. Eigen

KEYWORD: Linear algebra

FUNCTIONAL DESCRIPTION: Eigen is an efficient and versatile C++ mathematical template library for linear algebra and related algorithms. In particular it provides fixed and dynamic size matrices and vectors, matrix decompositions (LU, LLT, LDLT, QR, eigenvalues, etc.), sparse matrices with iterative and direct solvers, some basic geometry features (transformations, quaternions, axis-angles, Euler angles, hyperplanes, lines, etc.), some non-linear solvers, automatic differentiations, etc. Thanks to expression templates, Eigen provides a very powerful and easy to use API. Explicit vectorization is performed for the SSE, AltiVec and ARM NEON instruction sets, with graceful fallback to non-vectorized code. Expression templates allow to perform global expression optimizations, and to remove unnecessary temporary objects.

RELEASE FUNCTIONAL DESCRIPTION: In 2017, we released three revisions of the 3.3 branch with few fixes of compilation and performance regressions, some doxygen documentation improvements, and the addition of transpose, adjoint, conjugate methods to SelfAdjointView to ease writing generic code.

- Participant: Gaël Guennebaud
- Contact: Gaël Guennebaud
- URL: <http://eigen.tuxfamily.org/>

6.2. Elasticity Skinning

KEYWORD: 3D animation

FUNCTIONAL DESCRIPTION: Geometric skinning techniques are very popular in the industry for their high performances, but fail to mimic realistic deformations. With elastic implicit skinning the skin stretches automatically (without skinning weights) and the vertices distribution is more pleasing. Our approach is more robust, for instance the angle's range of joints is larger than implicit skinning.

This software has been ported as a plugin for the Modo software (The Foundry) in collaboration with Toulouse Tech Transfer. This plugin has been bought by The Foundry, which maintains and sells it.

- Participants: Brian Wyvill, Damien Rohmer, Florian Canezin, Gaël Guennebaud, Loïc Barthe, Marie-Paule Cani, Mathias Paulin, Olivier Gourmel and Rodolphe Vaillant
- Partners: Université de Bordeaux - CNRS - INP Bordeaux - Université de Toulouse - Institut Polytechnique de Grenoble - Ecole Supérieure de Chimie Physique Electronique de Lyon
- Contact: Gaël Guennebaud

MAVERICK Project-Team

6. New Software and Platforms

6.1. Diffusion curves

KEYWORDS: Vector-based drawing - Shading

FUNCTIONAL DESCRIPTION: Diffusion Curves is a vector-based design tool for creating complex shaded images. This prototype is composed of the Windows binary, along with the required shader programs (ie. in source code).

- Participants: Adrien Bousseau, Alexandrina Orzan, David Salesin, Holger Winnemoeller, Joëlle Thollot and Pascal Barla
- Partners: CNRS - LJK - INP Grenoble - Université Joseph-Fourier
- Contact: Joëlle Thollot
- URL: <http://maverick.inria.fr/Publications/2008/OBWBTS08/index.php>

6.2. Freestyle

FUNCTIONAL DESCRIPTION: Freestyle is a software for Non-Photorealistic Line Drawing rendering from 3D scenes. It is designed as a programmable interface to allow maximum control over the style of the final drawing: the user "programs" how the silhouettes and other feature lines from the 3D model should be turned into stylized strokes using a set of programmable operators dedicated to style description. This programmable approach, inspired by the shading languages available in photorealistic renderers such as Pixar's RenderMan, overcomes the limitations of integrated software with access to a limited number of parameters and permits the design of an infinite variety of rich and complex styles. The system currently focuses on pure line drawing as a first step. The style description language is Python augmented with our set of operators. Freestyle was developed in the framework of a research project dedicated to the study of stylized line drawing rendering from 3D scenes.

- Participants: Emmanuel Turquin, François Sillion, Frédo Durand and Stéphane Grabli
- Contact: François Sillion

6.3. GigaVoxels

FUNCTIONAL DESCRIPTION: Gigavoxel is a software platform which goal is the real-time quality rendering of very large and very detailed scenes which couldn't fit memory. Performances permit showing details over deep zooms and walk through very crowded scenes (which are rigid, for the moment). The principle is to represent data on the GPU as a Sparse Voxel Octree which multiscale voxels bricks are produced on demand only when necessary and only at the required resolution, and kept in a LRU cache. User defined producer lays across CPU and GPU and can load, transform, or procedurally create the data. Another user defined function is called to shade each voxel according to the user-defined voxel content, so that it is user choice to distribute the appearance-making at creation (for faster rendering) or on the fly (for storageless thin procedural details). The efficient rendering is done using a GPU differential cone-tracing using the scale corresponding to the 3D-MIPmapping LOD, allowing quality rendering with one single ray per pixel. Data is produced in case of cache miss, and thus only whenever visible (accounting for view frustum and occlusion). Soft-shadows and depth-of-field is easily obtained using larger cones, and are indeed cheaper than unblurred rendering. Beside the representation, data management and base rendering algorithm themselves, we also worked on realtime light transport, and on quality prefiltering of complex data. Ongoing researches are addressing animation. GigaVoxels is currently used for the quality real-time exploration of the detailed galaxy in ANR RTIGE. Most of the work published by Cyril Crassin (and al.) during his PhD (see <http://maverick.inria.fr/Members/Cyril.Crassin/>) is related to GigaVoxels. GigaVoxels is available for Windows and Linux under the BSD-3 licence.

- Participants: Cyril Crassin, Eric Heitz, Fabrice Neyret, J  r  my Sinoir, Pascal Guehl and Prashant Goswami
- Contact: Fabrice Neyret
- URL: <http://gigavoxels.inrialpes.fr>

6.4. GRATIN

FUNCTIONAL DESCRIPTION: Gratin is a node-based compositing software for creating, manipulating and animating 2D and 3D data. It uses an internal direct acyclic multi-graph and provides an intuitive user interface that allows to quickly design complex prototypes. Gratin has several properties that make it useful for researchers and students. (1) it works in real-time: everything is executed on the GPU, using OpenGL, GLSL and/or Cuda. (2) it is easily programmable: users can directly write GLSL scripts inside the interface, or create new C++ plugins that will be loaded as new nodes in the software. (3) all the parameters can be animated using keyframe curves to generate videos and demos. (4) the system allows to easily exchange nodes, group of nodes or full pipelines between people.

- Participants: Pascal Barla and Romain Vergne
- Partner: UJF
- Contact: Romain Vergne
- URL: <http://gratin.gforge.inria.fr/>

6.5. HQR

High Quality Renderer

KEYWORDS: Lighting simulation - Materials - Plug-in

FUNCTIONAL DESCRIPTION: HQR is a global lighting simulation platform. HQR software is based on the photon mapping method which is capable of solving the light balance equation and of giving a high quality solution. Through a graphical user interface, it reads X3D scenes using the X3DToolKit package developed at Maverick, it allows the user to tune several parameters, computes photon maps, and reconstructs information to obtain a high quality solution. HQR also accepts plugins which considerably eases the developpement of new algorithms for global illumination, those benefiting from the existing algorithms for handling materials, geometry and light sources.

- Participant: Cyril Soler
- Contact: Cyril Soler
- URL: <http://artis.imag.fr/~Cyril.Soler/HQR>

6.6. libylm

LibYLM

KEYWORD: Spherical harmonics

FUNCTIONAL DESCRIPTION: This library implements spherical and zonal harmonics. It provides the means to perform decompositions, manipulate spherical harmonic distributions and provides its own viewer to visualize spherical harmonic distributions.

- Author: Cyril Soler
- Contact: Cyril Soler
- URL: <https://launchpad.net/~csoler-users/+archive/ubuntu/ylm>

6.7. MobiNet

KEYWORDS: Co-simulation - Education - Programmation

FUNCTIONAL DESCRIPTION: The MobiNet software allows for the creation of simple applications such as video games, virtual physics experiments or pedagogical math illustrations. It relies on an intuitive graphical interface and language which allows the user to program a set of mobile objects (possibly through a network). It is available in public domain for Linux, Windows and MacOS.

- Participants: Fabrice Neyret, Franck Hétroy-Wheeler, Joëlle Thollot, Samuel Hornus and Sylvain Lefebvre
- Partners: CNRS - LJK - INP Grenoble - Inria - IREM - Cies - GRAVIR
- Contact: Fabrice Neyret
- URL: <http://mobinet.imag.fr/index.en.html>

6.8. PLANTRAD

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: PlantRad is a software program for computing solutions to the equation of light equilibrium in a complex scene including vegetation. The technology used is hierarchical radiosity with clustering and instantiation. Thanks to the latter, PlantRad is capable of treating scenes with a very high geometric complexity (up to millions of polygons) such as plants or any kind of vegetation scene where a high degree of approximate self-similarity permits a significant gain in memory requirements.

- Participants: Cyril Soler, François Sillion and George Drettakis
- Contact: Cyril Soler

6.9. PROLAND

PROcedural LANDscape

KEYWORDS: Atmosphere - Masses of data - Realistic rendering - 3D - Real time - Ocean

FUNCTIONAL DESCRIPTION: The goal of this platform is the real-time quality rendering and editing of large landscapes. All features can work with planet-sized terrains, for all viewpoints from ground to space. Most of the work published by Eric Bruneton and Fabrice Neyret (see <http://evasion.inrialpes.fr/Membres/Eric.Bruneton/>) has been done within Proland and integrated in the main branch. Proland is available under the BSD-3 licence.

- Participants: Antoine Begault, Eric Bruneton, Fabrice Neyret and Guillaume Piolet
- Contact: Fabrice Neyret
- URL: <https://proland.inrialpes.fr/>

6.10. ShwarpIt

KEYWORD: Warping

FUNCTIONAL DESCRIPTION: ShwarpIt is a simple mobile app that allows you to manipulate the perception of shapes in images. Slide the ShwarpIt slider to the right to make shapes appear rounder. Slide it to the left to make shapes appear more flat. The Scale slider gives you control on the scale of the warping deformation.

- Contact: Georges-Pierre Bonneau
- URL: <http://bonneau.meylan.free.fr/ShwarpIt/ShwarpIt.html>

6.11. Vrender

FUNCTIONAL DESCRIPTION: The VRender library is a simple tool to render the content of an OpenGL window to a vectorial device such as Postscript, XFig, and soon SVG. The main usage of such a library is to make clean vectorial drawings for publications, books, etc.

In practice, VRender replaces the z-buffer based hidden surface removal of OpenGL by sorting the geometric primitives so that they can be rendered in a back-to-front order, possibly cutting them into pieces to solve cycles.

VRender is also responsible for the vectorial snapshot feature of the QGLViewer library.

- Participant: Cyril Soler
- Contact: Cyril Soler
- URL: <http://artis.imag.fr/Software/VRender/>

6.12. X3D TOOLKIT

X3D Development platform

FUNCTIONAL DESCRIPTION: X3DToolkit is a library to parse and write X3D files, that supports plugins and extensions.

- Participants: Gilles Debunne and Yannick Le Goc
- Contact: Cyril Soler
- URL: <http://artis.imag.fr/Software/X3D/>

MIMETIC Project-Team

6. New Software and Platforms

6.1. AsymGait

Asymmetry index for clinical gait analysis based on depth images

KEYWORDS: Motion analysis - Kinect - Clinical analysis

SCIENTIFIC DESCRIPTION: The system uses depth images delivered by the Microsoft Kinect to retrieve the gait cycles first. To this end it is based on analyzing the knees trajectories instead of the feet to obtain more robust gait event detection. Based on these cycles, the system computes a mean gait cycle model to decrease the effect of noise of the system. Asymmetry is then computed at each frame of the gait cycle as the spatial difference between the left and right parts of the body. This information is computed for each frame of the cycle.

FUNCTIONAL DESCRIPTION: AsymGait is a software package that works with Microsoft Kinect data, especially depth images, in order to carry-out clinical gait analysis. First it identifies the main gait events using the depth information (footstrike, toe-off) to isolate gait cycles. Then it computes a continuous asymmetry index within the gait cycle. Asymmetry is viewed as a spatial difference between the two sides of the body.

- Participants: Edouard Auvinet and Franck Multon
- Contact: Franck Multon

6.2. Cinematic Viewpoint Generator

KEYWORD: 3D animation

FUNCTIONAL DESCRIPTION: The software, developed as an API, provides a mean to automatically compute a collection of viewpoints over one or two specified geometric entities, in a given 3D scene, at a given time. These viewpoints satisfy classical cinematographic framing conventions and guidelines including different shot scales (from extreme long shot to extreme close-up), different shot angles (internal, external, parallel, apex), and different screen compositions (thirds, fifths, symmetric or di-symmetric). The viewpoints allow to cover the range of possible framings for the specified entities. The computation of such viewpoints relies on a database of framings that are dynamically adapted to the 3D scene by using a manifold parametric representation and guarantee the visibility of the specified entities. The set of viewpoints is also automatically annotated with cinematographic tags such as shot scales, angles, compositions, relative placement of entities, line of interest.

- Participants: Christophe Lino, Emmanuel Badier and Marc Christie
- Partners: Université d'Udine - Université de Nantes
- Contact: Marc Christie

6.3. Directors Lens Motion Builder

KEYWORDS: Previzualisation - Virtual camera - 3D animation

FUNCTIONAL DESCRIPTION: Directors Lens Motion Builder is a software plugin for Autodesk's Motion Builder animation tool. This plugin features a novel workflow to rapidly prototype cinematographic sequences in a 3D scene, and is dedicated to the 3D animation and movie previzualization industries. The workflow integrates the automated computation of viewpoints (using the Cinematic Viewpoint Generator) to interactively explore different framings of the scene, proposes means to interactively control framings in the image space, and proposes a technique to automatically retarget a camera trajectory from one scene to another while enforcing visual properties. The tool also proposes to edit the cinematographic sequence and export the animation. The software can be linked to different virtual camera systems available on the market.

- Participants: Christophe Lino, Emmanuel Badier and Marc Christie
- Partner: Université de Rennes 1
- Contact: Marc Christie

6.4. Kimea

Kinect Improvement for Ergonomics Assessment

KEYWORDS: Biomechanics - Motion analysis - Kinect

SCIENTIFIC DESCRIPTION: Kimea consists in correcting skeleton data delivered by a Microsoft Kinect in an ergonomics purpose. Kimea is able to manage most of the occlusions that can occur in real working situation, on workstations. To this end, Kimea relies on a database of examples/poses organized as a graph, in order to replace unreliable body segments reconstruction by poses that have already been measured on real subject. The potential pose candidates are used in an optimization framework.

FUNCTIONAL DESCRIPTION: Kimea gets Kinect data as input data (skeleton data) and correct most of measurement errors to carry-out ergonomic assessment at workstation.

- Participants: Franck Multon, Hubert Shum and Pierre Plantard
- Partner: Faurecia
- Contact: Franck Multon
- Publications: Usability of corrected Kinect measurement for ergonomic evaluation in constrained environment - Validation of an ergonomic assessment method using Kinect data in real workplace conditions - Ergonomics Measurements using Kinect with a Pose Correction Framework - Filtered Pose Graph for Efficient Kinect Pose Reconstruction - Reliability of Kinect measurements for assessing the movement of operators in ergonomic studies

6.5. Populate

KEYWORDS: Behavior modeling - Agent - Scheduling

SCIENTIFIC DESCRIPTION: The software provides the following functionalities:

- A high level XML dialect that is dedicated to the description of agents activities in terms of tasks and sub activities that can be combined with different kind of operators: sequential, without order, interlaced. This dialect also enables the description of time and location constraints associated to tasks.
- An XML dialect that enables the description of agent's personal characteristics.
- An informed graph describes the topology of the environment as well as the locations where tasks can be performed. A bridge between TopoPlan and Populate has also been designed. It provides an automatic analysis of an informed 3D environment that is used to generate an informed graph compatible with Populate.
- The generation of a valid task schedule based on the previously mentioned descriptions.

With a good configuration of agents characteristics (based on statistics), we demonstrated that tasks schedules produced by Populate are representative of human ones. In conjunction with TopoPlan, it has been used to populate a district of Paris as well as imaginary cities with several thousands of pedestrians navigating in real time.

FUNCTIONAL DESCRIPTION: Populate is a toolkit dedicated to task scheduling under time and space constraints in the field of behavioral animation. It is currently used to populate virtual cities with pedestrian performing different kind of activities implying travels between different locations. However the generic aspect of the algorithm and underlying representations enable its use in a wide range of applications that need to link activity, time and space. The main scheduling algorithm relies on the following inputs: an informed environment description, an activity an agent needs to perform and individual characteristics of this agent. The algorithm produces a valid task schedule compatible with time and spatial constraints imposed by the activity description and the environment. In this task schedule, time intervals relating to travel and task fulfillment are identified and locations where tasks should be performed are automatically selected.

- Participants: Carl-Johan Jorgensen and Fabrice Lamarche
- Contact: Fabrice Lamarche

6.6. The Theater

KEYWORDS: 3D animation - Interactive Scenarios

FUNCTIONAL DESCRIPTION: The Theater is a software framework to develop interactive scenarios in virtual 3D environments. The framework provides means to author and orchestrate 3D character behaviors and simulate them in real-time. The tools provides a basis to build a range of 3D applications, from simple simulations with reactive behaviors, to complex storytelling applications including narrative mechanisms such as flashbacks.

- Participant: Marc Christie
- Contact: Marc Christie

6.7. CusToM

Customizable Toolbox for Musculoskeletal simulation

KEYWORDS: Biomechanics - Dynamic Analysis - Kinematics - Simulation - Mechanical multi-body systems

SCIENTIFIC DESCRIPTION: The present toolbox aims at performing a motion analysis thanks to an inverse dynamics method.

Before performing motion analysis steps, a musculoskeletal model is generated. Its consists of, first, generating the desire anthropometric model thanks to models libraries. The generated model is then kinematical calibrated by using data of a motion capture. The inverse kinematics step, the inverse dynamics step and the muscle forces estimation step are then successively performed from motion capture and external forces data. Two folders and one script are available on the toolbox root. The Main script collects all the different functions of the motion analysis pipeline. The Functions folder contains all functions used in the toolbox. It is necessary to add this folder and all the subfolders to the Matlab path. The Problems folder is used to contain the different study. The user has to create one subfolder for each new study. Once a new musculoskeletal model is used, a new study is necessary. Different files will be automatically generated and saved in this folder. All files located on its root are related to the model and are valuable whatever the motion considered. A new folder will be added for each new motion capture. All files located on a folder are only related to this considered motion.

FUNCTIONAL DESCRIPTION: Inverse kinematics Inverse dynamics Muscle forces estimation External forces prediction

- Participants: Antoine Muller, Charles Pontonnier and Georges Dumont
- Contact: Antoine Muller

6.8. MotionGraphVR

KEYWORDS: Virtual reality - Motion capture - Movement analysis

FUNCTIONAL DESCRIPTION: MotionGraphVR is a tool enabling users to automatically create motion graphs in Unity. It is particularly targeting Virtual Reality applications, where with the development of Head Mounted Displays users are now unable to see their real body unless they use expensive motion capture system, or animation techniques (e.g., Inverse Kinematics) which suffer from a lack of visual realism. To lever these limitations, MotionGraphVR automatically builds a graph of human motions from a set of examples captured on a real actor, and identify which motion path is the graph is closest to the user's actions. Additionally, this plugin also provides analysing tools to allow developers of VR applications to visualise similarities between movements to use in their applications before seamlessly connecting them in Motion Graphs.

- Participants: Tiffany Luong, Ludovic Hoyet and Fernando Argelaguet Sanz
- Contact: Ludovic Hoyet

6.9. Platforms

6.9.1. Immerstar Platform

Participants: Georges Dumont [contact], Ronan Gaugne, Anthony Sorel, Richard Kulpa.

With the two platforms of virtual reality, Immersia and Immermove, grouped under the name Immerstar, the team has access to high level scientific facilities. This equipment benefits the research teams of the center and has allowed them to extend their local, national and international collaborations. The Immerstar platform is granted by a Inria CPER funding for 2015-2019 that enables important evolutions of the equipment. In 2016, the first technical evolutions have been decided and, in 2017, these evolutions have been implemented. On one side, for Immermove, the addition of a third face to the immersive space, and the extension of the Vicon tracking system have been realized. And, on the second side, for Immersia, the installation of WQXGA laser projectors with augmented global resolution, of a new tracking system with higher frequency and of new computers for simulation and image generation.

MINT2 Team (section vide)

Mjolnir Team

6. New Software and Platforms

6.1. InspectorWidget

An opensource suite to track and analyze users behaviors in their applications

KEYWORD: Instrumentation

FUNCTIONAL DESCRIPTION: InspectorWidget is a set of opensource tools to track and analyze users' behaviors in interactive software. It works with closed applications that do not provide source code nor scripting capabilities, covers the whole pipeline of software analysis and does not require programming skills. To achieve this, InspectorWidget combines low-level event logging (e.g. mouse and keyboard events) and high-level screen features (e.g. interface widgets) captured through computer vision techniques, or through accessibility hooks when exposed by applications.

NEWS OF THE YEAR: InspectorWidget now supports the collection and annotation of User Interface accessibility features.

- Participants: Christian Frisson, Sylvain Malacria, Stéphane Huot and Gilles Bailly
- Contact: Sylvain Malacria
- Publication: [InspectorWidget: a System to Analyze Users Behaviors in Their Applications](#)
- URL: <https://github.com/InspectorWidget/InspectorWidget>

6.2. WhichFingers

WhichFingers: Identifying Fingers on Touch Surfaces and Keyboards using Vibration Sensors

KEYWORDS: Interaction - HCI

SCIENTIFIC DESCRIPTION: HCI researchers lack low-latency and robust systems to support the design and development of interaction techniques using finger identification. We developed a low-cost prototype using piezo-based vibration sensors attached to each finger. By combining the events from an input device with the information from the vibration sensors we demonstrate how to achieve low-latency and robust finger identification. Our prototype was evaluated in a controlled experiment, using two keyboards and a touchpad, showing single-touch recognition rates of 98.2% for the keyboard and 99.7% for the touchpad, and 94.7% for two simultaneous touches. These results were confirmed in an additional laboratory-style experiment with ecologically valid tasks. Last we present new interaction techniques made possible using this technology.

FUNCTIONAL DESCRIPTION: WhichFingers consists in a hardware and a software components.

The hardware component consists of five Minisense 100 vibration sensors attached to each finger. The sensors use flexible PVDF piezoelectric polymer film loaded by a mass to offer high sensitivity to detect contact vibrations. They produce a voltage as large as 90V depending on the intensity of the shock or vibration. The five sensors are plugged into a micro-controller and sends the raw values to the host computer at 1000 Hz.

The software component monitors low-level interaction touch and key events, and declares the vibration sensor that created the highest voltage as the finger that produced the input event.

- Participants: Géry Casiez and Sylvain Malacria
- Contact: Géry Casiez
- Publication: [WhichFingers: Identifying Fingers on Touch Surfaces and Keyboards using Vibration Sensors](#)

6.3. Lagmeters

Systems to measure end-to-end latency in interactive systems

KEYWORDS: Interaction - Latency

FUNCTIONAL DESCRIPTION: The first method works with most optical mice and allows accurate and real time latency measures up to 5 times per second. In addition, the technique allows easy insertion of probes at different places in the system – i.e. mouse events listeners – to investigate the sources of latency.

The second method relies on a vibration sensor attached to a finger and a photo-diode to detect the screen response. Both are connected to a micro-controller connected to a host computer using a low-latency USB communication protocol in order to combine software and hardware probes to help determine where the latency comes from. We provide source code and materials to replicate both the hardware and software.

- Participants: G ry Casiez, Nicolas Roussel, St phane Huot, Thomas Pietrzak, S bastien Poulmane, St phane Conversy, Damien Marchal and Matthieu Falce
- Partners: Universit  Lille 1 - Inria
- Contact: G ry Casiez
- Publications: [Characterizing Latency in Touch and Button-Equipped Interactive Systems - Looking through the Eye of the Mouse: A Simple Method for Measuring End-to-end Latency using an Optical Mouse](#)
- URL: <http://ns.inria.fr/mjolnir/lagmeter/>

6.4. libParamTuner

Cross-platform library to ease the interactive tuning of parameters at run time and without the need to recompile code.

KEYWORD: Interaction

FUNCTIONAL DESCRIPTION: libParamTuner provides a lightweight syntax to bind some variables of an application to the parameters defined in an XML file. Each modification of the XML file updates in real time the associated parameters in the application. A graphical interface allows editing the XML file, using interactive controls dynamically created for each parameter.

- Participants: G ry Casiez, Marc Baloup and Veis Oudjail
- Partners: Universit  Lille 1 - Inria
- Contact: G ry Casiez
- Publication: [libParamTuner : interactive tuning of parameters without code recompilation](#)
- URL: <https://github.com/casiez/libparamtuner>

6.5. liblag

Library implementing latency compensation techniques for interactive systems

KEYWORDS: Interaction - Latency

FUNCTIONAL DESCRIPTION: The library comprises the management of a set of multitouch input devices, the implementation of latency compensation techniques from the state-of-the-art and new latency compensation techniques developed in the project, and a system to handle artificial latency.

The library is developed in C++ using the Qt framework to allow compiling the same code on a wide range of devices and platforms.

- Contact: G ry Casiez
- Publication: [Dispositif   affichage pr dictif](#)
- URL: <http://mjolnir.lille.inria.fr/turbotouch/>

MOEX Project-Team (section vide)

MORPHEO Project-Team

6. New Software and Platforms

6.1. 4D repository

KEYWORDS: 4D - Dynamic scene

FUNCTIONAL DESCRIPTION: This website hosts dynamic mesh sequences reconstructed from images captured using a multi-camera set up. Such mesh-sequences offer a new promising vision of virtual reality, by capturing real actors and their interactions. The texture information is trivially mapped to the reconstructed geometry, by back-projecting from the images. These sequences can be seen from arbitrary viewing angles as the user navigates in 4D (3D geometry + time) . Different sequences of human / non-human interaction can be browsed and downloaded from the data section.

- Contact: Edmond Boyer
- URL: <http://4drepository.inrialpes.fr/>

6.2. Lucy Viewer

KEYWORDS: Data visualization - 4D - Multi-Cameras

SCIENTIFIC DESCRIPTION: Lucy Viewer is an interactive viewing software for 4D models, i.e, dynamic three-dimensional scenes that evolve over time. Each 4D model is a sequence of meshes with associated texture information, in terms of images captured from multiple cameras at each frame. Such data is available from the 4D repository website hosted by Inria Grenoble.

With Lucy Viewer, the user can use the mouse to zoom in onto the 4D models, zoom out, rotate, translate and view from an arbitrary angle as the 4D sequence is being played. The texture information is read from the images at each frame in the sequence and applied onto the meshes. This helps the user visualize the 3D scene in a realistic manner. The user can also freeze the motion at a particular frame and inspect a mesh in detail. Lucy Viewer lets the user to also select a subset of cameras from which to apply texture information onto the meshes. The supported formats are meshes in .OFF format and associated images in .PNG or .JPG format.

FUNCTIONAL DESCRIPTION: Lucy Viewer is an interactive viewing software for 4D models, i.e, dynamic three-dimensional scenes that evolve over time. Each 4D model is a sequence of meshes with associated texture information, in terms of images captured from multiple cameras at each frame.

- Participants: Edmond Boyer, Jean-Sébastien Franco and Matthieu Armando
- Contact: Edmond Boyer
- URL: <https://kinovis.inria.fr/lucyviewer/>

6.3. Shape Tracking

FUNCTIONAL DESCRIPTION: We are developing a software suite to track shapes over temporal sequences. The motivation is to provide temporally coherent 4D Models, i.e. 3D models and their evolutions over time , as required by motion related applications such as motion analysis. This software takes as input a temporal sequence of 3D models in addition to a template and estimate the template deformations over the sequence that fit the observed 3D models.

- Contact: Edmond Boyer

6.4. QuickCSG V2

KEYWORDS: 3D modeling - CAD - 3D reconstruction - Geometric algorithms

SCIENTIFIC DESCRIPTION: See the technical report "QuickCSG: Arbitrary and Faster Boolean Combinations of N Solids", Douze, Franco, Raffin.

The extension of the algorithm to self-intersecting meshes is described in "QuickCSG with self-intersections", a document inside the package.

FUNCTIONAL DESCRIPTION: QuickCSG is a library and command-line application that computes Boolean operations between polyhedra. The basic algorithm is described in the research report "QuickCSG: Arbitrary and Faster Boolean Combinations of N Solids", Douze, Franco, Raffin. The input and output polyhedra are defined as indexed meshes. In version 2, that was developed for Pixologic, the meshes can be self-intersecting, in which case the inside and outside are defined by the non-zero winding rule. The operation can be any arbitrary Boolean function, including one that is defined as a CSG tree. The focus of QuickCSG is speed. Robustness to degeneracies is obtained by carefully applied random perturbations.

- Authors: Matthys Douze, Jean-Sébastien Franco and Bruno Raffin
- Contact: Jean-Sébastien Franco
- URL: <https://kinovis.inria.fr/quickcsg/>

6.5. CVTGenerator

KEYWORDS: Mesh - Centroidal Voronoi tessellation - Implicit surface

FUNCTIONAL DESCRIPTION: CVTGenerator is a program to build Centroidal Voronoi Tessellations of any 3D meshes and implicit surfaces.

- Partner: INP Grenoble
- Contact: Li Wang
- URL: <http://cvt.gforge.inria.fr/>

6.6. Platforms

6.6.1. Platform Kinovis

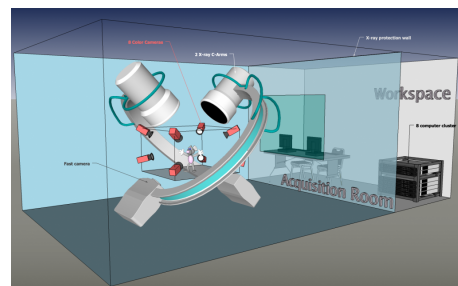
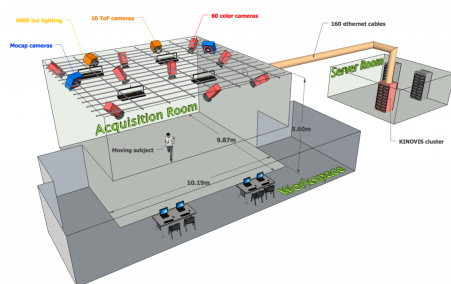


Figure 3. Kinovis platforms: on the left the Inria platform; on the right Grenoble Hospital platform.

Kinovis (<http://kinovis.inrialpes.fr/>) is a multi-camera acquisition project that was selected within the call for proposals "Equipements d'Excellence" of the program "Investissement d'Avenir" funded by the French government. The project involves 2 institutes: the Inria Grenoble Rhône-Alpes, the université Joseph Fourier and 4 laboratories: the LJK (laboratoire Jean Kuntzmann - applied mathematics), the LIG (laboratoire d'informatique de Grenoble - Computer Science), the Gipsa lab (Signal, Speech and Image processing) and the LADAF (Grenoble Hospitals - Anatomy). The Kinovis environment is composed of 2 complementary platforms (see Figure 3). A first platform located at Inria Grenoble with a 10mx10m acquisition surface is equipped with 68 color cameras and 20 IR motion capture (mocap) cameras. It is the evolution of the Grimage platform towards the production of better models of more complex dynamic scenes. A second platform located at Grenoble Hospitals, within the LADAF anatomy laboratory, is equipped with 10 color and 2 X-ray cameras to enable combined analysis of internal and external shape structures, typically skeleton and bodies of animals. Both platforms have already demonstrated their potential through a range of projects lead by the team and externally. Members of Morpheo are highly involved in this project. Edmond Boyer is coordinating this project, and Julien Pansiot is managing the technical resources of both platforms.

MULTISPEECH Project-Team

6. New Software and Platforms

6.1. dnnsep

Multichannel audio source separation with deep neural networks

KEYWORDS: Audio - Source Separation - Deep learning

SCIENTIFIC DESCRIPTION: dnnsep is the only source separation software relying on multichannel Wiener filtering based on deep learning. Deep neural networks are used to initialize and reestimate the power spectrum of the sources at every iteration of an expectation-maximization (EM) algorithm. This results in state-of-the-art separation quality for both speech and music.

FUNCTIONAL DESCRIPTION: Combines deep neural networks and multichannel signal processing for speech enhancement and separation of musical recordings.

NEWS OF THE YEAR: In 2017, we changed the type of multichannel filter used and modified the software so that it runs online in real time.

- Participants: Aditya Nugraha, Laurent Pierron, Emmanuel Vincent, Antoine Liutkus, Romain Serizel and Floris Fournier
- Contact: Emmanuel Vincent

6.2. KATS

Kaldi-based Automatic Transcription System

KEYWORD: Speech recognition

FUNCTIONAL DESCRIPTION: KATS is a multipass system for transcribing audio data, and in particular radio or TV shows in French, English or Arabic. It is based on the Kaldi speech recognition tools. It relies on Deep Neural Network (DNN) modeling for speech detection and acoustic modeling of the phones (speech sounds). Higher order statistical language models and recurrent neural network language models can be used for improving performance through rescoring of multiple hypotheses.

NEWS OF THE YEAR: Better acoustic models have been developed for French, English and Arabic languages. An NN-based speech detection module has been included, as well as rescoring with RNN language models.

- Contact: Dominique Fohr

6.3. SOJA

Speech Synthesis platform in JAVa

KEYWORDS: Speech Synthesis - Audio

SCIENTIFIC DESCRIPTION: SOJA relies on a non uniform unit selection algorithm. Phonetic and linguistic features are extracted and computed from the text to drive selection of speech units in a recorded corpus. The selected units are concatenated to obtain the speech signal corresponding to the input text.

FUNCTIONAL DESCRIPTION: SOJA is a software for Text-To-Speech synthesis (TTS). It performs all steps from text input to speech signal output. A set of associated tools is available for elaborating a corpus for a TTS system (transcription, alignment, . . .). Currently, the corpus contains about 3 hours of speech recorded by a female speaker. Most of the modules are in Java, some are in C. The SOJA software runs under Windows and Linux. It can be launched with a graphical user interface or directly integrated in a Java code or by following the client-server paradigm.

NEWS OF THE YEAR: SOJA now supports the unit selection with emotion tags.

- Participants: Alexandre Lafosse and Vincent Colotte
- Contact: Vincent Colotte

6.4. Xarticulators

KEYWORD: Medical imaging

FUNCTIONAL DESCRIPTION: The Xarticulators software is intended to delineate contours of speech articulators in X-ray and MR images, construct articulatory models and synthesize speech from X-ray films. This software provides tools to track contours automatically, semi-automatically or by hand, to make the visibility of contours easier, to add anatomical landmarks to speech articulators and to synchronize images with the sound. In addition we also added the possibility of processing digitized manual delineation results made on sheets of papers when no software is available. Xarticulators also enables the construction of adaptable linear articulatory models from the X-ray or MR images and incorporates acoustic simulation tools to synthesize speech signals from the vocal tract shape. Recent work was on the possibility of synthesizing speech from 2D-MRI films, and on the construction of better articulatory models for the velum, lips and epiglottis.

NEWS OF THE YEAR: New models of the lips, velum and epiglottis have been added. Xarticulators generates area functions from an MRI film annotated in terms of articulators.

- Contact: Yves Laprie
- Publication: [Articulatory model of the epiglottis](#)

6.5. Platforms

6.5.1. Platform MultiMod: Multimodal Acquisition Data Platform

We have set up an acquisition hardware platform to acquire multimodal data in speech communication context. The system was previously composed of the articulograph Carstens AG501 (which was acquired as part of the EQUIPEX ORTOLANG), 4 Vicon cameras (a motion capture system), and an Intel RealSense camera which contains four components: a video camera, an infrared laser projector, an infrared camera, and a microphone array. With such heterogeneous hardware the synchronization is essential; this is achieved through a trigger device. All the data processing is performed with the PLAVIS software.

This year, we have replaced the 4 Vicon cameras by 8 optitrack cameras. The new motion capture system allows acquiring higher spatial and temporal resolution data, and allows faster acquisition and processing.

We are currently using the system to acquire expressive audiovisual data to build an expressive audiovisual speech synthesis in addition to a lipsync system.

- Participants: Slim Ouni, Vincent Colotte, Valerian Girard, Sara Dahmani
- Contact: Slim Ouni

ORPAILLEUR Project-Team

6. New Software and Platforms

6.1. ARPEntAge

Analyse de Régularités dans les Paysages : Environnement, Territoires, Agronomie

KEYWORDS: Stochastic process - Hidden Markov Models

FUNCTIONAL DESCRIPTION: ARPEntAge is a software based on stochastic models (HMM2 and Markov Field) for analyzing spatio-temporal data-bases. ARPEntAge is built on top of the CarottAge system to fully take into account the spatial dimension of input sequences. It takes as input an array of discrete data in which the columns contain the annual land-uses and the rows are regularly spaced locations of the studied landscape. It performs a Time-Space clustering of a landscape based on its time dynamic Land Uses (LUS). Displaying tools and the generation of Time-dominant shape files have also been defined.

- Partner: INRA
- Contact: Jean-François Mari
- URL: http://carottage.loria.fr/index_in_english.html

6.2. CarottAge

KEYWORDS: Stochastic process - Hidden Markov Models

FUNCTIONAL DESCRIPTION: The system CarottAge is based on Hidden Markov Models of second order and provides a non supervised temporal clustering algorithm for data mining and a synthetic representation of temporal and spatial data. CarottAge is currently used by INRA researchers interested in mining the changes in territories related to the loss of biodiversity (projects ANR BiodivAgrim and ACI Ecoger) and/or water contamination. CarottAge is also used for mining hydromorphological data. Actually a comparison was performed with three other algorithms classically used for the delineation of river continuum and CarottAge proved to give very interesting results for that purpose.

- Participants: Florence Le Ber and Jean-François Mari
- Partner: INRA
- Contact: Jean-François Mari
- URL: http://carottage.loria.fr/index_in_english.html

6.3. CORON

KEYWORDS: Data mining - Closed itemset - Frequent itemset - Generator - Association rule - Rare itemset

FUNCTIONAL DESCRIPTION: The Coron platform is a KDD toolkit organized around three main components: (1) Coron-base, (2) AssRuleX, and (3) pre- and post-processing modules.

The Coron-base component includes a complete collection of data mining algorithms for extracting itemsets such as frequent itemsets, closed itemsets, generators and rare itemsets. In this collection we can find APriori, Close, Pascal, Eclat, Charm, and, as well, original algorithms such as ZART, Snow, Touch, and Talky-G. AssRuleX generates different sets of association rules (from itemsets), such as minimal non-redundant association rules, generic basis, and informative basis. In addition, the Coron system supports the whole life-cycle of a data mining task and proposes modules for cleaning the input dataset, and for reducing its size if necessary.

- Participants: Adrien Coulet, Aleksey Buzmakov, Amedeo Napoli, Florent Marcuola, Jérémie Bourseau, Laszlo Szathmary, Mehdi Kaytoue, Victor Codocedo and Yannick Toussaint
- Contact: Amedeo Napoli
- URL: <http://coron.loria.fr/site/index.php>

6.4. Tuuurbine

KEYWORD: Semantic Web

FUNCTIONAL DESCRIPTION: Tuuurbine: a Generic Ontology Guided Case-Based Inference Engine. The experience acquired since 5 years with the Taaable system conducted to the creation of a generic case-based reasoning system, whose reasoning procedure is based on a domain ontology. This new system, called Tuuurbine, takes into account the retrieval step, the case base organization, and also an adaptation procedure which is not addressed by other generic case-based reasoning tools. Moreover, Tuuurbine is built over semantic web standards that will ensure facilities for being plugged over data available on the web. The domain knowledge is represented in an RDF store, which can be interfaced with a semantic wiki, for collaborative edition and management of the knowledge involved in the reasoning system (cases, ontology, adaptation rules).

- Contact: Emmanuel Nauer
- URL: <http://tuuurbine.loria.fr/>

6.5. LatViz: Visualization of Concept Lattices

- Contact: Amedeo Napoli
- URL: <http://latviz.loria.fr/>
- KEYWORDS: Formal Concept Analysis, Pattern Structures, Concept Lattice, Implications, Visualization

FUNCTIONAL DESCRIPTION.

LatViz is a tool allowing the construction, the display and the exploration of concept lattices. LatViz proposes some noticeable improvements over existing tools and introduces various functionalities focusing on interaction with experts, such as visualization of pattern structures for dealing with complex non-binary data, AOC-poset which is composed of the core elements of the lattice, concept annotations, filtering based on various criteria and a visualization of implications [70]. This way the user can effectively perform interactive exploratory knowledge discovery as often needed in knowledge engineering.

The Latviz platform can be associated with the Coron platform and extends its visualization capabilities (see <http://coron.loria.fr>). Recall that the Coron platform includes a complete collection of data mining algorithms for extracting itemsets and association rules.

6.6. OrphaMine: Data Mining Platform for Orphan Diseases

- Contact: Chedy Raïssi
- URL: <http://orphamine.inria.fr/>
- KEYWORDS: Bioinformatics, data mining, biology, health, data visualization, drug development.

FUNCTIONAL DESCRIPTION.

The OrphaMine platform enables visualization, data integration and in-depth analytics in the domain of “orphan diseases”, where data is extracted from the OrphaData ontology (<http://www.orpha.net/consor/cgi-bin/index.php>). At present, we aim at building a true collaborative portal that will serve different actors: (i) a general visualization of OrphaData data for physicians working, maintaining and developing this knowledge database about orphan diseases. (ii) the integration of analytics (data mining) algorithms developed by the different academic actors. (iii) the use of these algorithms to improve our general knowledge of rare diseases.

6.7. Siren: Interactive and Visual Redescription Mining

- Contact: Esther Catherine Galbrun
- URL: <http://siren.gforge.inria.fr/main/>
- KEYWORDS: Redescription mining, Interactivity, Visualization.

FUNCTIONAL DESCRIPTION.

Siren is a tool for interactive mining and visualization of redescription. Redescription mining aims to find distinct common characterizations of the same objects and, vice versa, to identify sets of objects that admit multiple shared descriptions. The goal is to provide domain experts with a tool allowing them to tackle their research questions using redescription mining. Merely being able to find redescription is not enough. The expert must also be able to understand the redescription found, adjust them to better match his domain knowledge and test alternative hypotheses with them, for instance. Thus, Siren allows mining redescription in an anytime fashion through efficient, distributed mining, to examine the results in various linked visualizations, to interact with the results either directly or via the visualizations, and to guide the mining algorithm toward specific redescription.

New features, such as a visualization of the contribution of individual literals in the queries and the simplification of queries as a post-processing, have been added to the tool, during the internship of IUT student Laëticia Lemièrè.

PANAMA Project-Team

6. New Software and Platforms

6.1. VoiceHome Corpus

KEYWORDS: Audio - Source Separation

FUNCTIONAL DESCRIPTION: This corpus includes reverberated, noisy speech signals spoken by native French talkers in a lounge and recorded by an 8-microphone device at various angles and distances and in various noise conditions. Room impulse responses and noise-only signals recorded in various real rooms and homes and baseline speaker localization and enhancement software are also provided.

- Participants: Ewen Camberlein, Romain Lebarbenchon, Nancy Bertin and Frédéric Bimbot
- Contact: Nancy Bertin
- URL: http://voice-home.gforge.inria.fr/voiceHome_corpus.html

6.2. FAuST

KEYWORDS: Learning - Sparsity - Fast transform - Multilayer sparse factorisation

SCIENTIFIC DESCRIPTION: FAuST allows to approximate a given dense matrix by a product of sparse matrices, with considerable potential gains in terms of storage and speedup for matrix-vector multiplications.

FUNCTIONAL DESCRIPTION: Faust 1.x contains Matlab routines to reproduce experiments of the PANAMA team on learned fast transforms.

Faust 2.x contains a C++ implementation with Matlab / Python wrappers (work in progress).

NEWS OF THE YEAR: In 2017, new Matlab code for fast approximate Fourier Graph Transforms have been included, based on the approach described in the papers:

-Luc Le Magoarou, Rémi Gribonval, "Are There Approximate Fast Fourier Transforms On Graphs?", ICASSP 2016 .

-Luc Le Magoarou, Rémi Gribonval, Nicolas Tremblay, "Approximate fast graph Fourier transforms via multi-layer sparse approximations", IEEE Transactions on Signal and Information Processing over Networks, 2017.

- Participants: Luc Le Magoarou, Nicolas Tremblay, Rémi Gribonval, Nicolas Bellot and Adrien Leman
- Contact: Rémi Gribonval
- Publications: [Approximate fast graph Fourier transforms via multi-layer sparse approximations](#) - [Analyzing the Approximation Error of the Fast Graph Fourier Transform](#) - [Flexible Multi-layer Sparse Approximations of Matrices and Applications](#) - [Are There Approximate Fast Fourier Transforms On Graphs?](#) - [Efficient matrices for signal processing and machine learning](#) - [FA \$\mu\$ ST: speeding up linear transforms for tractable inverse problems](#) - [Chasing butterflies: In search of efficient dictionaries](#) - [Multi-layer Sparse Matrix Factorization](#)
- URL: <http://faust.inria.fr/>

6.3. SketchMLBox

KEYWORD: Clustering

SCIENTIFIC DESCRIPTION: The SketchMLbox is a Matlab toolbox for fitting mixture models to large collections of training vectors using sketching techniques. The collection is first compressed into a vector called sketch, then a mixture model (e.g. a Gaussian Mixture Model) is estimated from this sketch using greedy algorithms typical of sparse recovery. The size of the sketch does not depend on the number of elements in the collection, but rather on the complexity of the problem at hand [2,3]. Its computation can be massively parallelized and distributed over several units. It can also be maintained in an online setting at low cost. Mixtures of Diracs ("K-means") and Gaussian Mixture Models with diagonal covariance are currently available, the toolbox is structured so that new mixture models can be easily implemented

FUNCTIONAL DESCRIPTION: Matlab toolbox for fitting mixture models to large databases using sketching techniques.

- Authors: Nicolas Keriven, Nicolas Tremblay and Rémi Gribonval
- Partner: Université de Rennes 1
- Contact: Rémi Gribonval
- Publications: *Sketching for Large-Scale Learning of Mixture Models - Compressive K-means - Spikes super-resolution with random Fourier sampling - Sketching for large-scale learning of mixture models - Blind Source Separation Using Mixtures of Alpha-Stable Distributions - Sketching for Large-Scale Learning of Mixture Models - Compressive Gaussian Mixture Estimation by Orthogonal Matching Pursuit with Replacement*
- URL: <http://sketchml.gforge.inria.fr>

6.4. SPADE

Sparse Audio Declipper

KEYWORDS: Audio - Sparse regularization - Declipping

SCIENTIFIC DESCRIPTION: SPADE (the Sparse Audio Declipper) allows to reproduce audio declipping experiments from the papers:

- Srđan Kitic, Nancy Bertin, Remi Gribonval. Audio Declipping by Cosparsity Hard Thresholding. iTwist - 2nd international - Traveling Workshop on Interactions between Sparse models and Technology, Aug 2014, Namur, Belgium.

- Srđan Kitic, Nancy Bertin, Remi Gribonval. Sparsity and cosparsity for audio declipping: a flexible non-convex approach. LVA/ICA 2015 - The 12th International Conference on Latent Variable Analysis and Signal Separation, Aug 2015, Liberec, Czech Republic.

FUNCTIONAL DESCRIPTION: SPADE is a declipping algorithm developed by the PANAMA project-team. To the best of our knowledge SPADE achieves state-of-the-art audio declipping quality. Real-time processing of audio streams is possible.

The web site <http://spade.inria.fr> provides example audio files and allows users to test SPADE on their own files, either by downloading Matlab routines or using Inria's software demonstration platform, Allgo, to test it on the web.

NEWS OF THE YEAR: In 2017, a web interface to demonstrate the potential of SPADE has been setup using the Allgo platform.

- Participants: Nancy Bertin, Clement Gaultier, Ewen Camberlein, Romain Lebarbenchon, Rémi Gribonval and Srđan Kitic
- Contact: Rémi Gribonval
- Publications: *Audio Declipping by Cosparsity Hard Thresholding - Sparsity and cosparsity for audio declipping: a flexible non-convex approach*
- URL: <http://spade.inria.fr/>

6.5. FASST

Flexible Audio Source Separation Toolbox

KEYWORD: Audio signal processing

SCIENTIFIC DESCRIPTION: FASST is a Flexible Audio Source Separation Toolbox, designed to speed up the conception and automate the implementation of new model-based audio source separation algorithms.

FASST 1.0 development was achieved by the METISS team in Rennes and is now deprecated.

FASST 2.1 (current version) development was jointly achieved by the PAROLE team in Nancy and the (former) TEXMEX team in Rennes through an Inria funded ADT (Action de Développement Technologique). PANAMA contributed to the development by coordinating and performing user tests, and to the dissemination in a Show-and-Tell ICASSP poster [58]. While the first implementation was in Matlab, the new implementation is in C++ (for core functions), with Matlab and Python user scripts. Version 2, including speedup and new features was released in 2014 and can be downloaded from <http://bass-db.gforge.inria.fr/fasst/>.

A new version is currently under development in the PANAMA team through the Inria funded ADT "FFWD" (FASST For Wider Dissemination) and will be released in 2018.

FUNCTIONAL DESCRIPTION: FASST is a Flexible Audio Source Separation Toolbox designed to speed up the conception and automate the implementation of new model-based audio source separation algorithms. It is the only audio source separation software available to the public (QPL licence) which simultaneously exploits spatial and spectral cues on the sources to separate.

- Participants: Alexey Ozerov, Nancy Bertin, Ewen Camberlein, Romain Lebarbenchon, Emmanuel Vincent, Frédéric Bimbot and Yann Salaun
- Contact: Emmanuel Vincent
- URL: <http://bass-db.gforge.inria.fr/fasst/>

6.6. PHYSALIS

KEYWORDS: Source localization - Cosparsity

SCIENTIFIC DESCRIPTION: PHYSALIS (Physics-Driven Cosparsity Analysis) gathers algorithms for (joint) source localization and estimation, expressed as inverse problems and addressed with co-sparse regularization. A particular emphasis is put on the acoustic and EEG settings.

FUNCTIONAL DESCRIPTION: PHYSALIS is distributed as a set of Matlab routines to reproduce experimental results from the Ph.D. thesis of Srdan Kitic.

NEWS OF THE YEAR: In 2017, the code of PHYSALIS has been packaged at the occasion of the writing of an overview chapter on co-sparse source localization.

- Participants: Laurent Albera, Nancy Bertin, Rémi Gribonval and Srdan Kitic
- Contact: Rémi Gribonval
- Publications: [Physics-driven inverse problems made tractable with cosparsity regularization](#) - [Cosparsity regularization of physics-driven inverse problems](#) - [Versatile and scalable cosparsity methods for physics-driven inverse problems](#) - [Hearing behind walls: localizing sources in the room next door with cosparsity](#) - [Sparse Acoustic Source Localization with Blind Calibration for Unknown Medium Characteristics](#) - [The best of both worlds: synthesis-based acceleration for physics-driven cosparsity regularization](#)
- URL: <http://cosoloc.gforge.inria.fr/>

PERCEPTION Project-Team

5. New Software and Platforms

5.1. ECMPR

Expectation Conditional Maximization for the Joint Registration of Multiple Point Sets

FUNCTIONAL DESCRIPTION: Rigid registration of two or several point sets based on probabilistic matching between point pairs and a Gaussian mixture model

- Participants: Florence Forbes, Manuel Yguel and Radu Horaud
- Contact: Patrice Horaud
- URL: <https://team.inria.fr/perception/research/jrmpr/>

5.2. Mixcam

Reconstruction using a mixed camera system

KEYWORDS: Computer vision - 3D reconstruction

FUNCTIONAL DESCRIPTION: We developed a multiple camera platform composed of both high-definition color cameras and low-resolution depth cameras. This platform combines the advantages of the two camera types. On one side, depth (time-of-flight) cameras provide coarse low-resolution 3D scene information. On the other side, depth and color cameras can be combined such as to provide high-resolution 3D scene reconstruction and high-quality rendering of textured surfaces. The software package developed during the period 2011-2014 contains the calibration of TOF cameras, alignment between TOF and color cameras, TOF-stereo fusion, and image-based rendering. These software developments were performed in collaboration with the Samsung Advanced Institute of Technology, Seoul, Korea. The multi-camera platform and the basic software modules are products of 4D Views Solutions SAS, a start-up company issued from the PERCEPTION group.

- Participants: Clément Ménier, Georgios Evangelidis, Michel Amat, Miles Hansard, Patrice Horaud, Pierre Arquier, Quentin Pelorson, Radu Horaud, Richard Broadbridge and Soraya Arias
- Contact: Patrice Horaud
- URL: <https://team.inria.fr/perception/mixcam-project/>

5.3. NaoLab

Distributed middleware architecture for interacting with NAO

FUNCTIONAL DESCRIPTION: This software provides a set of libraries and tools to simplify the control of NAO robot from a remote machine. The main challenge is to make easy prototyping applications for NAO using C++ and Matlab programming environments. Thus NaoLab provides a prototyping-friendly interface to retrieve sensor data (video and sound streams, odometric data...) and to control the robot actuators (head, arms, legs...) from a remote machine. This interface is available on Naoqi SDK, developed by Aldebarab company, Naoqi SDK is needed as it provides the tools to access the embedded NAO services (low-level motor command, sensor data access...)

- Authors: Fabien Badeig, Quentin Pelorson and Patrice Horaud
- Contact: Patrice Horaud
- URL: <https://team.inria.fr/perception/research/naolab/>

5.4. Stereo matching and recognition library

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: Library providing stereo matching components to rectify stereo images, to retrieve faces from left and right images, to track faces and method to recognise simple gestures

- Participants: Jan Cech, Jordi Sanchez-Riera, Radu Horaud and Soraya Arias
- Contact: Soraya Arias
- URL: <https://code.humavips.eu/projects/stereomatch>

5.5. Platforms

5.5.1. Audio-Visual Head Popeye+

In 2016 our audio-visual platform was upgraded from Popeye to Popeye+. Popeye+ has two high-definition cameras with a wide field of view. We also upgraded the software libraries that perform synchronized acquisition of audio signals and color images. Popeye+ has been used for several datasets.

Websites:

<https://team.inria.fr/perception/projects/popeye/>

<https://team.inria.fr/perception/projects/popeye-plus/>

<https://team.inria.fr/perception/avtrack1/>

<https://team.inria.fr/perception/avdiar/>

5.5.2. NAO Robots

The PERCEPTION team selected the companion robot NAO for experimenting and demonstrating various audio-visual skills as well as for developing the concept of social robotics that is able to recognize human presence, to understand human gestures and voice, and to communicate by synthesizing appropriate behavior. The main challenge of our team is to enable human-robot interaction in the real world.



Figure 2. The Popeye+ audio-visual platform (left) delivers high-quality, high-resolution and wide-angle images at 30FPS. The NAO prototype used by PERCEPTION in the EARS STREP project has a twelve-channel spherical microphone array synchronized with a stereo camera pair.

The humanoid robot NAO is manufactured by SoftBank Robotics Europe. Standing, the robot is roughly 60 cm tall, and 35cm when it is sitting. Approximately 30 cm large, NAO includes two CPUs. The first one, placed in the torso, together with the batteries, controls the motors and hence provides kinematic motions with 26 degrees of freedom. The other CPU is placed in the head and is in charge of managing the proprioceptive sensing, the communications, and the audio-visual sensors (two cameras and four microphones, in our case). NAO's on-board computing resources can be accessed either via wired or wireless communication protocols.

NAO's commercially available head is equipped with two cameras that are arranged along a vertical axis: these cameras are neither synchronized nor a significant common field of view. Hence, they cannot be used in combination with stereo vision. Within the EU project HUMAVIPS, Aldebaran Robotics developed a binocular camera system that is arranged horizontally. It is therefore possible to implement stereo vision algorithms on NAO. In particular, one can take advantage of both the robot's cameras and microphones. The cameras deliver VGA sequences of image pairs at 12 FPS, while the sound card delivers the audio signals arriving from all four microphones and sampled at 48 kHz. Subsequently, Aldebaran developed a second binocular camera system to go into the head of NAO v5.

In order to manage the information flow gathered by all these sensors, we implemented our software on top of the Robotics Services Bus (RSB). RSB is a platform-independent event-driven middleware specifically designed for the needs of distributed robotic applications. Several RSB tools are available, including real-time software execution, as well as tools to record the event/data flow and to replay it later, so that application development can be done off-line. RSB events are automatically equipped with several time stamps for introspection and synchronization purposes. RSB was chosen because it allows our software to be run on a remote PC platform, neither with performance nor deployment restrictions imposed by the robot's CPUs. Moreover, the software packages can be easily reused for other robots.

Recently (2015-2016) the PERCEPTION team started the development of NAOLab, a middleware for hosting robotic applications in C, C++, Python and Matlab, using the computing power available with NAO, augmented with a networked PC. More recently, NAOLab was renamed RMP (Robotics Middleware for Perception).

Websites:

<https://team.inria.fr/perception/nao/>

<https://team.inria.fr/perception/research/naolab/>

PERSVASIVE INTERACTION Project-Team

5. New Software and Platforms

5.1. DomiCube

- Participant: Rémi Pincent
- Contact: Rémi Pincent

5.2. EmoPRAMAD

KEYWORDS: Health - Home care

FUNCTIONAL DESCRIPTION: Within the Pramad project, we want to offer a full affective loop between the companion robot and the elderly people at home. This affective loop is necessary within the context of everyday interaction of elderly and the companion robot. A part of this loop is to make the robot express emotions in response to the emotional state of the user. To do that, we need to test our working hypothesis about the visual representation of emotions with the 3D face of robot. EmoPRAMAD is an evaluation tool designed to conduct comparative studies between human faces and the 3D faces expressing a defined set of emotions.

The evaluation conducted though EmoPRAMAD concerns both unimodal (facial only) and bimodal conditions (facial/sound). The emotions set is composed of 4 basic emotions (joy, fear, anger, sadness) and a neutral state. While experimenting, the software collects several parameters in order to evaluate more than correctness of the answers: time to respond, length of mouse moves, etc.

- Contact: Dominique Vaufreydaz

5.3. Online Movie Director

- Participants: Dominique Vaufreydaz, James Crowley and Patrick Reignier
- Contact: Dominique Vaufreydaz

5.4. PALGate

KEYWORDS: Health - Home care - Handicap

- Contact: David Daney

5.5. PrimaCV

- Participants: Amaury Nègre, Claudine Combe, James Crowley, Lukas Rummelhard, Rémi Baraquand and Sergi Pujades-Rocamora
- Contact: Amaury Nègre

5.6. SmartEnergy

FUNCTIONAL DESCRIPTION: Inhabitants play a key role in buildings global energy consumption but it is difficult to involve them in energy management. Our objective is to make energy consumption visible by simulating inside a serious game the energy impact of inhabitants behaviours. A serious game is currently under development, coupling a 3D virtual environment and a building energy simulator. The 3D virtual environment is based on the JMonkey 3D engine. New houses can be easily imported using SweetHome 3D and Blender. The building energy simulator is EnergyPlus. The 3D engine and the energy engine are coupled using the Functional Mock-up Interface (FMI) standard. Using this standard will allow to easily switch between existing building energy simulators.

- Participant: Patrick Reignier
- Contact: Patrick Reignier

5.7. SmartServoFramework

- Participants: Dominique Vaufreydaz and Eméric Grange
- Contact: James Crowley

5.8. Unix Interface for InfraRed Sensor

- Author: Pierre Baret
- Contact: James Crowley

5.9. Platforms

The AmiQual4Home Innovation Factory is an open research facility for innovation and experimentation with human-centered services based on the use of large-scale deployment of interconnected digital devices capable of perception, action, interaction and communication. The Innovation Factory is composed of a collection of workshops for rapid creation of prototypes, surrounded by a collection of living labs and supported by an industrial innovation and transfer service. Creation of the Innovation Factory has been made possible by a grant from French National programme Investissement d'avenir, together with substantial contributions of resources by Grenoble INP, Univ Joseph Fourier, UPMF, CNRS, Schneider Electric and the Communauté de Communes de Montbonnot. The objective is to provide the academic and industrial communities with an open platform to enable research on design, integration and evaluation of systems and services for smart habitats.

The AmiQual4Home Innovation Factory is a unique combination of three different innovation instruments:

1. Workshops for rapid prototyping of devices that embed perception, action, interaction and communication in ordinary objects based on the MIT FabLab model,
2. Facilities for real-world test and evaluation of devices and services organized as open Living Labs,
3. Resources for assisting students, researchers, entrepreneurs and industrial partners in creating new economic activities.

The AmiQual4Home Innovation Factory works with the Inovallee TARMAC technology incubator as well as the SAT Linksium to provide innovation and transfer services to enable students, researchers and local entrepreneurs to create and grow new commercial activities based on smart objects and services.

PETRUS Project-Team

5. New Software and Platforms

5.1. PLUG-DB ENGINE

KEYWORDS: Databases - Personal information - Privacy - Hardware and Software Platform

FUNCTIONAL DESCRIPTION: PlugDB is a complete platform dedicated to a secure and ubiquitous management of personal data. It aims at providing an alternative to a systematic centralization of personal data. The PlugDB engine is a personal database server capable of storing data (tuples and documents) in tables and BLOBs, indexing them, querying them in SQL, sharing them through assertional access control policies and enforcing transactional properties (atomicity, integrity, durability). The PlugDB engine is embedded in a tamper-resistant hardware device combining the security of smartcard with the storage capacity of NAND Flash. The personal database is hosted encrypted in NAND Flash and the PlugDB engine code runs in the microcontroller. Complementary modules allow to pre-compile SQL queries for the applications, communicate with the DBMS from a remote Java program, synchronize local data with remote servers (typically used for recovering the database in the case of a broken or lost devices) and participate in distributed computation (e.g., global queries). PlugDB runs both on secure devices provided by Gemalto and on specific secure devices designed by PETRUS and assembled by electronic SMEs. Mastering the hardware platform opens up new research and experiment opportunities (e.g., we have recently integrated a Bluetooth module to communicate wirelessly with PlugDB and a fingerprint module to strongly authenticate users). PlugDB engine has been registered first at APP (Agence de Protection des Programmes) in 2009 - a new version being registered every two years and the hardware datasheets in 2015. PlugDB has been experimented in the field, notably in the healthcare domain. We also recently set up an educational platform on top of PlugDB, named SIPD (Système d'Information privacy-by-Design) and used at ENSIIE, INSA CVL and UVSQ through the Versailles Sciences Lab fablab, to raise students awareness of privacy protection problems and embedded programming. As a conclusion, PlugDB combines several research contributions from the team, at the crossroads of flash data management, embedded data processing and secure distributed computations. It then strongly federates all members of our team (permanent members, PhD students and engineers). It is also a vector of visibility, technological transfer and dissemination and gives us the opportunity to collaborate with researchers from other disciplines around a concrete privacy-enhancing platform. PlugDB is now being industrialized in the context of the OwnCare Inria Innovation Lab (II-Lab).

- Participants: Aydogan Ersoz, Laurent Schneider, Luc Bouganim, Nicolas Anciaux and Philippe Pucheral
- Contact: Nicolas Anciaux
- URL: <https://project.inria.fr/plugdb/>

6. New Software and Platforms

6.1. Aïana

KEYWORD: Multimedia player

FUNCTIONAL DESCRIPTION: This software aims to make accessible the playing of a MOOC composed of various information flows (boards, videos, subtitles ...). It is not intended to be "reserved" for people with disabilities but rather to be open to as many as possible by allowing each user to adapt the interface, and therefore the use, to its users own capabilities and needs.

- Authors: Marc Chambon, Julien Grynberg, H    e Sauz    on, Pascal Guitton and Pierre-Antoine Cinquin
- Partner: Universit     de Bordeaux
- Contact: Pascal Guitton

6.2. HybridOptics : Hybrid Optical Platform

KEYWORDS: Augmented reality - Education - Tangible interface

FUNCTIONAL DESCRIPTION: The software platform - gets the values of the sensors - computes in real-time the result of the simulation - generates pedagogical supports that are directly linked to the simulation (projected on the work table) - allows the user to control several parameters from a dedicated application on a tablet

- Participants: Benoît Coulais, Lionel Canioni, Bruno Bousquet, Martin Hachet and Jean-Paul Guillet
- Contact: Martin Hachet
- URL : <https://project.inria.fr/hobit/fr/>

RITS Project-Team

5. New Software and Platforms

5.1. PML-SLAM

KEYWORD: Localization

SCIENTIFIC DESCRIPTION: Simultaneous Localization and Mapping method based on 2D laser data.

- Participants: Fawzi Nashashibi and Zayed Alsayed
- Contact: Fawzi Nashashibi

5.2. V2Provue

Vehicle-to-Pedestrian

FUNCTIONAL DESCRIPTION: It is a software developed for the Vehicle-to-Pedestrian (V2P) communications, risk calculation, and alarming pedestrians of collision risk. This software is made of an Android application dedicated to pedestrians and RtMaps modules for the vehicles.

On the pedestrian side, the application is relying on GPS data to localize the user and Wi-Fi communications are used to receive messages about close vehicles and send information about the pedestrian positioning. Besides, a service has been developed to evaluate the collision risk with the vehicles near the pedestrian and an HMI based on OpenStreetMap displays all the useful information such as pedestrian and vehicles localization and, collision risk.

On the vehicle side, RtMaps modules allowing V2X communications have been developed. These modules contain features such as TCP/UDP socket transmissions, broadcast, multicast, unicast communications, routing, forwarding algorithms, and application specific modules. In the V2ProVu software, a particular application module has been implemented to create data packets containing information about the vehicle state (position, speed, yaw rate,...) and the V2X communication stack is used to broadcast these packets towards pedestrians. Moreover, the V2proVu application can also receive data from pedestrians and create objects structures that can be shared with the vehicle perception tools.

- Contact: Fawzi Nashashibi

5.3. SimConVA

Connected Autonomous Vehicles Simulator

FUNCTIONAL DESCRIPTION: The software provides an interface between the network simulator ns-3 (<https://www.nsnam.org/>) and the modular prototyping framework RTMaps (<https://intempora.com/>).

This code allows to create an RTMaps component which activates and controls the ns-3 simulator. The component handles the sending and reception of data packets between ns-3 and RTMaps for each vehicle. It also handles the mobility of vehicles in ns-3 using their known position in RTMaps.

- Authors: Pierre Merdrignac, Oyunchimeg Shagdar and Jean-Marc Lasgouttes
- Contact: Jean-Marc Lasgouttes

SEMAGRAMME Project-Team

5. New Software and Platforms

5.1. ACGtk

Abstract Categorical Grammar Development Toolkit

KEYWORDS: Natural language processing - NLP - Syntactic analysis - Semantics

FUNCTIONAL DESCRIPTION: ACGtk provides softwares for developing and using Abstract Categorical Grammars (ACG).

- Participants: Philippe De Groote, Jiri Marsik, Sylvain Pogodalla and Sylvain Salvati
- Contact: Sylvain Pogodalla
- Publications: [A syntax-semantics interface for Tree-Adjoining Grammars through Abstract Categorical Grammar - ACGTK: un outil de développement et de test pour les grammaires catégorielles abstraites](#) - [Discourse Modeling with Abstract Categorical Grammars](#) - [On the expressive power of Abstract Categorical Grammars: Representing context-free formalisms](#) - [Towards abstract categorical grammars](#)
- URL: <http://calligramme.loria.fr/acg/>

5.2. Dep2pict

KEYWORDS: Syntactic analysis - Semantics

FUNCTIONAL DESCRIPTION: Dep2pict is a program for drawing graphical representation of dependency structures of natural language sentences. Dep2pict takes into account the modified format mixing surface and deep syntactic information used in deep-sequoia.

- Contact: Bruno Guillaume
- URL: <http://dep2pict.loria.fr/>

5.3. Grew

Graph Rewriting

KEYWORDS: Semantics - Syntactic analysis - Natural language processing - Graph rewriting

FUNCTIONAL DESCRIPTION: Grew is a Graph Rewriting tool dedicated to applications in NLP. Grew takes into account confluent and non-confluent graph rewriting and it includes several mechanisms that help to use graph rewriting in the context of NLP applications (built-in notion of feature structures, parametrization of rules with lexical information).

- Contact: Bruno Guillaume
- URL: <http://grew.loria.fr/>

5.4. LEOPAR

KEYWORD: Parsing

FUNCTIONAL DESCRIPTION: Parser for natural language based on interaction grammars

- Participants: Bruno Guillaume, Guillaume Bonfante and Guy Perrier
- Contact: Bruno Guillaume

5.5. ZombiLingo

KEYWORDS: Syntactic analysis - Natural language processing - Lexical resource - Collaborative science

FUNCTIONAL DESCRIPTION: ZombiLingo is a prototype of a GWAP where gamers have to give linguistic information about the syntax of natural language sentence, currently in French, and later to other languages.

- Authors: Bruno Guillaume, Karën Fort, Nicolas Lefebvre and Valentin Stern
- Contact: Karën Fort
- URL: <http://zombilingo.org/>

5.6. Platforms

5.6.1. SLAMtk

SLAMtk is a processing chain of transcriptions of interviews for the SLAM project (see Section 7.1.1). In particular, it products of a full anonymized and randomized version of the resources. Some extensions, based on Distagger (tagging of disfluencies) and MElt (tagging of part-of-speech and lemmas), have been implemented in order to run linguistic analyses. The tool was reimplemented in order to propose generic treatments for the different corpora.

- Contact: Maxime Amblard
- URL: <http://slam.loria.fr>

SIROCCO Project-Team

6. New Software and Platforms

6.1. SaccadicModel

Saccadic model of visual attention

KEYWORDS: Visual saliency maps - Visual scanpath

FUNCTIONAL DESCRIPTION: Saliency models compute a saliency map from an input image. Saliency maps are a 2D map encoding the ability of every location to attract our gaze. There exist many models in the literature and tremendous progresses have been made. However, they remain quite limited when applied to natural scene exploration. Indeed, the vast majority of these models ignore fundamental properties of our visual system. The most important one is that they overlook the sequential and time-varying aspects of overt attention. Saccadic models aim to predict the visual scanpath itself, i.e. the series of fixations and saccades an observer would perform to sample the visual environment. We propose a new and efficient method to simulate the visual scanpath. It provides scanpaths in close agreement with human behavior and the model can be tailored to simulate scanpaths in specific conditions and for various observer profiles.

- Author: Olivier Le Meur
- Contact: Olivier Le Meur

6.2. QuantizationAE

KEYWORDS: Compression - Machine learning

FUNCTIONAL DESCRIPTION: This code learns an autoencoder to compress images. The learning is performed under a rate-distortion criterion, and jointly learns a transform (the autoencoder) and the quantization step for target rate points. The code is organized as follows. It first builds a set of luminance images (B1) for the auto-encoder training, a set of luminance images (B2) to analyze how the auto-encoder training advances and a set of luminance images (B3) to evaluate the auto-encoders in terms of rate-distortion. It then trains several auto-encoders using a rate-distortion criterion on the set B1. The quantization can be either fixed or learned during this training stage. The set B2 enables to periodically compute indicators to detect overfitting. It finally compares the auto-encoders in terms of rate-distortion on the set B3. The quantization can be either fixed or variable during this test.

- Participants: Aline Roumy, Christine Guillemot and Thierry Dumas
- Contact: Aline Roumy

6.3. LF-Inpainting

Light field inpainting based on a low rank model

KEYWORDS: Light fields - Low rank models - Inpainting

FUNCTIONAL DESCRIPTION: This code implements a method for propagating the inpainting of the central view of a light field to all the other views. To this end, it also implements a new matrix completion algorithm, better suited to the inpainting application than existing methods. A first option does not require any depth prior, unlike most existing light field inpainting algorithms. The code also implements an extended version to better handle the case where the area to inpaint contains depth discontinuities.

- Participants: Mikael Le Pendu and Christine Guillemot
- Contact: Christine Guillemot

6.4. LF-HLRA

Light fields homography-based low rank approximation

KEYWORDS: Compression - Light fields - Low rank models - Dimensionality reduction

FUNCTIONAL DESCRIPTION: This code jointly searches for homographies to align the views of an input light field together with the components of its low rank approximation model. The code either uses a global homography per view or multiple homographies, one per region, the region being extracted using depth information.

- Participants: Xiaoran Jiang, Mikael Le Pendu and Christine Guillemot
- Contact: Christine Guillemot

6.5. GBR-MVimages

Graph-based Representation for multi-view and light field images

KEYWORDS: Light fields - Multi-View reconstruction - Graph

FUNCTIONAL DESCRIPTION: Graph-Based Representation (GBR) describes color and geometry of multiview or light field image content using a graph. The graph vertices represent the color information, while the edges represent the geometry information, i.e. the disparity, by connecting corresponding pixels in neighboring images.

- Participants: Xin Su and Thomas Maugey
- Contact: Thomas Maugey

6.6. Platforms

6.6.1. Light field editor

Participants: Pierre Allain, Laurent Guillo, Christine Guillemot.

As part of the ERC Clim project, the EPI Sirocco is developing a light field editor, a tool analogous to traditional image editors such as the GNU image manipulation program Gimp or the raster graphic editor Photoshop but dedicated to light fields. As input data, this tool accepts for instance sparse light fields acquired with High Density Camera Arrays (HDCA) or denser light fields captured with microlens array (MLA). Two kinds of features are provided. Traditional features such as changing the angle of view, refocusing or depth map extraction are or will be soon supported. More advanced features are being integrated in our tool as libraries we have developed, such as segmentation or inpainting. For instance, a segmentation on a specific subaperture/view of light fields can be propagated to all subapertures/views. Thus, the so-segmented objects or zones can be colorized or even removed, the emptied zone being then inpainted. The tool and libraries are developed in C++ and the graphical user interface relies on Qt.

6.6.2. Acquisition of multi-view sequences for Free viewpoint Television

Participants: Cédric Le Cam, Laurent Guillo, Thomas Maugey.

The scientific and industrial community is nowadays exploring new multimedia applications using 3D data (beyond stereoscopy). In particular, Free Viewpoint Television (FTV) has attracted much attention in the recent years. In those systems, user can choose in real time its view angle from which he wants to observe the scene. Despite the great interest for FTV, the lack of realistic and ambitious datasets penalizes the research effort. The acquisition of such sequences is very costly in terms of hardware and working effort, which explains why no multi-view videos suitable for FTV has been proposed yet.

In 2017, in the context of the project ADT ATeP (funded by Inriahub), such datasets have been acquired and some calibration tools have been developed. First 40 omnidirectional cameras and their associated equipments have been acquired by the team (thanks to Rennes Metropole funding). We have first focused on the calibration of this camera, i.e., the development of the relationship between a 3D point and its projection in the omnidirectional image. In particular, we have shown that the unified spherical model fits the acquired omnidirectional cameras. Second, we have developed tools to calibrate the cameras in relation to each other. Finally, we have made a capture of 3 multiview sequences that are currently in preparation for a sharing with the community (Fig. 1). This work has been published in [41].



Figure 1. The 40 omnidirectional cameras positioned for an indoor scene capture.

6.6.3. Light fields datasets

Participants: Pierre Allain, Christine Guillemot, Laurent Guillo.

The EPI Sirocco makes extensive use of light field datasets with sparse or dense contents provided by the scientific community to run tests. However, it has also generated its own natural and synthetic contents.

Natural content has been created with Lytro cameras (the original first generation Lytro and the Lytro Illum) and is already available to the community (<https://www.irisa.fr/temics/demos/lightField/CLIM/DataSoftware.html>). The team also owns a R8 Raytrix plenoptic cameras with which still and video contents have been captured. Applications taking advantage of the Raytrix API have been developed to extract views from the Raytrix lightfield. The number of views per frame is configurable and can be set for instance to 3x3 or 9x9 according to the desired sparsity.

Synthetic content has been generated from the Sintel film (<https://durian.blender.org/download/>), which is a short computer animated film by the Blender institute, part of the Blender Foundation. A specific Blender add-on is used to extract views from a frame. As previously, the number of views is configurable. Synthetic contents present the advantage to provide a ground truth useful to evaluate how efficient our algorithms are to compute, for instance, the depth maps.

STARS Project-Team

6. New Software and Platforms

6.1. EGMM-BGS

KEYWORD: 2D

FUNCTIONAL DESCRIPTION: This algorithm allows to distinguish between the mobile pixels (except shadows) and pixels belonging to the background of the image.

- Participants: Anh Tuan Nghiem, François Brémond and Vasanth Bathrinarayanan
- Contact: François Brémond

6.2. MTS

Multi camera Tracking System

KEYWORD: Vision

FUNCTIONAL DESCRIPTION: This tool allows to find an appearance of interest in a following system with multi cameras.

- Participants: François Brémond and Slawomir Bak
- Contact: François Brémond

6.3. PALGate

KEYWORDS: Health - Home care - Handicap

- Contact: David Daney

6.4. PrintFoot Tracker

KEYWORD: Video analysis

FUNCTIONAL DESCRIPTION: Following of mobile object moving from single camera video streams.

- Participants: Duc Phu Chau, François Brémond and Monique Thonnat
- Contact: François Brémond

6.5. Proof Of Concept Néosensys (Poc-NS)

KEYWORD: Video analysis

FUNCTIONAL DESCRIPTION: This software is composed of 3 applications dedicated to show the techniques that will be applied by Néosensys Stars start-up. The software PoC-NS is a graphical interface allowing switching between these 3 applications. These applications are dedicated to help videosurveillance operators in stores, in the fight against theft. There are the following: 1. Auto-side swith: allows to swith from a camera to another one by a single translation moving (left-riht) in a set of cameras in parallel. 2. Re-identification: Based on EGMM-BGS and PrintFoot Tracker software (both registred at APP), this application allows to find a person in several camera registrations, during a specific time, by clicking once on the person in a video. 3. Assisted following: allows (by hand) to follow a person in a camera network, with the feature of an automatic switch from a camera to another one when the person moves in a controlled area.

- Participants: Annunziato Polimeni, Bernard Boulay, François Brémond, Julien Gueytat, Slawomir Bak, Sofia Zaidenberg and Yves Pichon
- Partner: Neosensys
- Contact: François Brémond

6.6. py_ad

py action detection

FUNCTIONAL DESCRIPTION: Action Detection framework Allows user to detect action in video stream. It uses model trained in py_ar.

- Participants: François Brémond and Michal Koperski
- Contact: Michal Koperski

6.7. py_ar

py action recognition

FUNCTIONAL DESCRIPTION: Action Recognition training/evaluation framework. It allows user do define action recognition experiment (on clipped videos). Train, test model, save the results and print the statistics.

- Participants: François Brémond and Michal Koperski
- Contact: Michal Koperski

6.8. py_sup_reader

FUNCTIONAL DESCRIPTION: This is a library which allows to read video saved in SUP format in Python.

- Participant: Michal Koperski
- Contact: Michal Koperski

6.9. py_tra3d

py trajectories 3d

KEYWORD: Videos

SCIENTIFIC DESCRIPTION: New video descriptor which fuses trajectory information with 3D information from depth sensor.

FUNCTIONAL DESCRIPTION: 3D Trajectories descriptor. Compute 3D trajectories descriptor proposed in <http://hal.inria.fr/docs/01/05/49/49/PDF/koperski-icip.pdf>.

- Participants: François Brémond and Michal Koperski
- Contact: Michal Koperski

6.10. SUP

Scene Understanding Platform

KEYWORDS: Activity recognition - 3D - Dynamic scene

FUNCTIONAL DESCRIPTION: SUP is a software platform for perceiving, analyzing and interpreting a 3D dynamic scene observed through a network of sensors. It encompasses algorithms allowing for the modeling of interesting activities for users to enable their recognition in real-world applications requiring high-throughput.

- Participants: Etienne Corvée, François Brémond, Thanh Hung Nguyen and Vasanth Bathrinathan
- Partners: CEA - CHU Nice - USC Californie - Université de Hamburg - I2R
- Contact: François Brémond
- URL: <https://team.inria.fr/stars/software>

6.11. sup_ad

sup action detection

SCIENTIFIC DESCRIPTION: This software introduces the framework for online/real-time action recognition using state-of-the-art features and sliding window technique.

FUNCTIONAL DESCRIPTION: SUP Action Detection Plugin Plugin for SUP platform which performs action detection using sliding window and Bag of Words. It uses an input data model trained in py_ar project.

- Participants: François Brémond and Michal Koperski
- Contact: Michal Koperski

6.12. VISEVAL

FUNCTIONAL DESCRIPTION: ViSEval is a software dedicated to the evaluation and visualization of video processing algorithm outputs. The evaluation of video processing algorithm results is an important step in video analysis research. In video processing, we identify 4 different tasks to evaluate: detection, classification and tracking of physical objects of interest and event recognition.

- Participants: Bernard Boulay and François Brémond
- Contact: François Brémond
- URL: http://www-sop.inria.fr/teams/pulsar/EvaluationTool/ViSEvAl_Description.html

6.13. bomotech

KEYWORDS: 3D - Video analysis - Kinect - 2D

FUNCTIONAL DESCRIPTION: Software dedicated to walking analysis using a Kinect deep camera.

- Authors: Melaine Gautier and Baptiste Fosty
- Partner: Mélaine Gautier
- Contact: Melaine Gautier

6.14. BMC_1

- Authors: Anaïs Ducoffe, Julien Badie, Manikandan Bakthavatchalam, Vasanth Bathrinarayanan, Anh Tuan Nghiem, Duc Phu Chau, Slawomir Bak, Ghada Bahloul and Nicolas Chleq
- Contact: François Brémond

6.15. CLEM

FUNCTIONAL DESCRIPTION: The Clem Toolkit is a set of tools devoted to design, simulate, verify and generate code for LE programs. LE is a synchronous language supporting a modular compilation. It also supports automata possibly designed with a dedicated graphical editor and implicit Mealy machine definition.

- Participants: Annie Ressouche and Daniel Gaffé
- Contact: Annie Ressouche
- URL: <http://www-sop.inria.fr/teams/pulsar/projects/Clem/>

6.16. Person Manual Tracking in a Static Camera Network (PMT-SCN)

- Participants: Anaïs Ducoffe, Annunziato Polimeni, Bernard Boulay, Julien Gueytat and Sofia Zaidenberg
- Partner: Neosensys
- Contact: Anaïs Ducoffe

6.17. sup_ad_ont

SUP Activity detection with ontologies

KEYWORD: Activity recognition

FUNCTIONAL DESCRIPTION: SUP plugin for activity detection, with manually defined ontologies.

- Participants: François Brémond, Michal Koperski and Dario Dotti
- Contact: Michal Koperski

THOTH Project-Team

6. New Software and Platforms

6.1. ACT-detector

Action Tubelet Detector for Spatio-Temporal Action Localization

KEYWORDS: Spatio-temporal - Localisation - Video analysis - Motion detection - Object detection

FUNCTIONAL DESCRIPTION: Current state-of-the-art approaches for spatio-temporal action detection rely on detections at the frame level that are then linked or tracked across time. In this paper, we leverage the temporal continuity of videos instead of operating at the frame level. We propose the ACTION Tubelet detector (ACT-detector) that takes as input a sequence of frames and outputs tubelets, ie., sequences of bounding boxes with associated scores. The same way state-of-the-art object detectors rely on anchor boxes, our ACT-detector is based on anchor cuboids. We build upon the state-of-the-art SSD framework. Convolutional features are extracted for each frame, while scores and regressions are based on the temporal stacking of these features, thus exploiting information from a sequence. Our experimental results show that leveraging sequences of frames significantly improves detection performance over using individual frames. The gain of our tubelet detector can be explained by both more relevant scores and more precise localization. Our ACT-detector outperforms the state of the art methods for frame-mAP and video-mAP on the J-HMDB and UCF-101 datasets, in particular at high overlap thresholds.

- Participants: Philippe Weinzaepfel, Vittorio Ferrari, Cordelia Schmid and Vasiliki Kalogeiton
- Contact: Vasiliki Kalogeiton
- Publication: [Action Tubelet Detector for Spatio-Temporal Action Localization](#)
- URL: <http://thoth.inrialpes.fr/src/ACTdetector/>

6.2. Joint object-action learning

Joint learning of object and action detectors

KEYWORDS: Detection - Video sequences - Zero-shot

SCIENTIFIC DESCRIPTION: we propose to jointly detect object-action instances in uncontrolled videos, e.g. cat eating, dog running or car rolling. We build an end-to-end two stream network architecture for joint learning of objects and actions. We cast this joint learning problem by leveraging a multitask objective. We compare our proposed end-to-end multitask architecture with alternative ones: (i) treating every possible combination of actions and objects as a separate class (Cartesian) and (ii) considering a hierarchy of objects-actions: the first level corresponds to objects and the second one to the valid actions for each object (hierarchical). We show that our method performs as well as these two alternatives while (a) requiring fewer parameters and (b) enabling zero-shot learning of the actions performed by a specific object, i.e., when training for an object class alone without its actions, our multitask network is able to predict actions for that object class by leveraging actions performed by other objects. our multitask objective not only allows to effectively detect object-action pairs but also leads to performance improvements on each individual task (i.e., detection of either objects or actions). We compare to the state of the art for object-action detection on the Actor-Action (A2D) dataset and we outperform it.

FUNCTIONAL DESCRIPTION: While most existing approaches for detection in videos focus on objects or human actions separately, we aim at jointly detecting objects performing actions, such as cat eating or dog jumping. We introduce an end-to-end multitask objective that jointly learns object-action relationships. We compare it with different training objectives, validate its effectiveness for detecting objects-actions in videos, and show that both tasks of object and action detection benefit from this joint learning. Moreover, the proposed architecture can be used for zero-shot learning of actions: our multitask objective leverages the commonalities of an action performed by different objects, e.g. dog and cat jumping, enabling to detect actions of an object without training with these object-actions pairs. In experiments on the A2D dataset, we obtain state-of-the-art results on segmentation of object-action pairs. We finally apply our multitask architecture to detect visual relationships between objects in images of the VRD dataset.

- Participants: Vasiliki Kalogeiton, Philippe Weinzaepfel, Vittorio Ferrari and Cordelia Schmid
- Contact: Vasiliki Kalogeiton
- Publication: [Joint learning of object and action detectors](#)
- URL: <https://github.com/vkalogeiton/joint-object-action-learning>

6.3. BlitzNet

A Real-Time Deep Network for Scene Understanding

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: Real-time scene understanding has become crucial in many applications such as autonomous driving. This deep architecture, called BlitzNet, jointly performs object detection and semantic segmentation in one forward pass, allowing real-time computations. Besides the computational gain of having a single network to perform several tasks, object detection and semantic segmentation benefit from each other in terms of accuracy.

- Participants: Mikita Dvornik, Konstantin Shmelkov, Julien Mairal and Cordelia Schmid
- Contact: Mikita Dvornik
- Publication: [BlitzNet: A Real-Time Deep Network for Scene Understanding](#)
- URL: <https://github.com/dvornikita/blitznet>

6.4. LCR-Net

Localization-Classification-Regression Network for Human Pose

KEYWORDS: Object detection - Recognition of human movement

FUNCTIONAL DESCRIPTION: We propose an end-to-end architecture for joint 2D and 3D human pose estimation in natural images. Key to our approach is the generation and scoring of a number of pose proposals per image, which allows us to predict 2D and 3D pose of multiple people simultaneously. Our architecture contains 3 main components: 1) the pose proposal generator that suggests potential poses at different locations in the image, 2) a classifier that scores the different pose proposals, and 3) a regressor that refines pose proposals both in 2D and 3D.

- Participants: Grégory Rogez, Philippe Weinzaepfel and Cordelia Schmid
- Contact: Grégory Rogez
- Publication: [LCR-Net: Localization-Classification-Regression for Human Pose](#)
- URL: <https://thoth.inrialpes.fr/src/LCR-Net/>

6.5. CKN-seq

Convolutional Kernel Networks for Biological Sequences

KEYWORD: Bioinformatics

SCIENTIFIC DESCRIPTION: The growing amount of biological sequences available makes it possible to learn genotype-phenotype relationships from data with increasingly high accuracy. By exploiting large sets of sequences with known phenotypes, machine learning methods can be used to build functions that predict the phenotype of new, unannotated sequences. In particular, deep neural networks have recently obtained good performances on such prediction tasks, but are notoriously difficult to analyze or interpret. Here, we introduce a hybrid approach between kernel methods and convolutional neural networks for sequences, which retains the ability of neural networks to learn good representations for a learning problem at hand, while defining a well characterized Hilbert space to describe prediction functions. Our method outperforms state-of-the-art convolutional neural networks on a transcription factor binding prediction task while being much faster to train and yielding more stable and interpretable results.

FUNCTIONAL DESCRIPTION: CKN-Seq is a software package for predicting transcription factor binding sites. It was shipped with the BiorXiv preprint

D. Chen, L. Jacob, and J. Mairal. Predicting Transcription Factor Binding Sites with Convolutional Kernel Networks. 2017.

The software is implemented in PyTorch.

- Participants: Laurent Jacob, Dexiong Chen and Julien Mairal
- Partners: CNRS - UGA
- Contact: Julien Mairal
- Publication: [Predicting Transcription Factor Binding Sites with Convolutional Kernel Networks](#)
- URL: <https://gitlab.inria.fr/dchen/CKN-seq>

6.6. CKN-TensorFlow

Convolutional Kernel Networks in TensorFlow

KEYWORD: Machine learning

SCIENTIFIC DESCRIPTION: This software package implements a new image representation based on a multilayer kernel machine. Unlike traditional kernel methods where data representation is decoupled from the prediction task, we learn how to shape the kernel with supervision. We proceed by first proposing improvements of the recently-introduced convolutional kernel networks (CKNs) in the context of unsupervised learning, then, we derive backpropagation rules to take advantage of labeled training data. The resulting model is a new type of convolutional neural network, where optimizing the filters at each layer is equivalent to learning a linear subspace in a reproducing kernel Hilbert space (RKHS).

FUNCTIONAL DESCRIPTION: This is the implementation in TensorFlow of the Convolutional Kernel Networks method for image classification, described in the paper J. Mairal. End-to-End Kernel Learning with Supervised Convolutional Kernel Networks. Adv. Neural Information Processing Systems (NIPS), 2016.

- Participants: Ghislain Durif and Julien Mairal
- Contact: Ghislain Durif
- Publication: [End-to-End Kernel Learning with Supervised Convolutional Kernel Networks](#)

6.7. Stochs

fast stochastic solvers for machine learning

KEYWORD: Machine learning

FUNCTIONAL DESCRIPTION: The stochs library provides efficient C++ implementations of stochastic optimization algorithms for common machine learning settings, including situations with finite datasets augmented with random perturbations (e.g. data augmentation or dropout). The library is mainly used from Python through a Cython extension. Currently, SGD, (S-)MISO and (N-)SAGA are supported, for dense and sparse data. See the following reference for details:

A. Bietti and J. Mairal. Stochastic Optimization with Variance Reduction for Infinite Datasets with Finite-Sum Structure. arXiv 1610.00970, 2017.

- Participants: Alberto Bietti and Julien Mairal
- Contact: Alberto Bietti
- Publication: [Stochastic Optimization with Variance Reduction for Infinite Datasets with Finite-Sum Structure](#)
- URL: <https://github.com/albietz/stochs>

6.8. MODL

Massive Online Dictionary Learning

KEYWORDS: Pattern discovery - Machine learning

FUNCTIONAL DESCRIPTION: Matrix factorization library, usable on very large datasets, with optional sparse and positive factors.

- Participants: Arthur Mensch, Gaël Varoquaux, Bertrand Thirion and Julien Mairal
- Contact: Arthur Mensch
- Publications: [Subsampled online matrix factorization with convergence guarantees](#) - [Stochastic Subsampling for Factorizing Huge Matrices](#)
- URL: <http://github.com/arthurmensch/modl>

6.9. Loter

Loter: A software package to infer local ancestry for a wide range of species

KEYWORDS: Local Ancestry Inference - Bioinformatics

SCIENTIFIC DESCRIPTION: Admixture between populations provides opportunity to study biological adaptation and phenotypic variation. Admixture studies can rely on local ancestry inference for admixed individuals, which consists of computing at each locus the number of copies that originate from ancestral source populations. Loter is a software package that does not require any biological parameter besides haplotype data in order to make local ancestry inference available for a wide range of species.

FUNCTIONAL DESCRIPTION: Loter is a Python package for haplotype phasing and local ancestry inference. NEWS OF THE YEAR: The software package was shipped with the biorxiv preprint T. Dias-Alves, J. Mairal, and M. Blum. Loter: A Software Package to Infer Local Ancestry for a Wide Range of Species. preprint BiorXiv. 2017

- Participants: Thomas Dias-Alves, Michael Blum and Julien Mairal
- Partners: UGA - CNRS
- Contact: Julien Mairal
- Publication: [Loter: A software package to infer local ancestry for a wide range of species](#)
- URL: <https://github.com/bcm-uga/Loter>

6.10. SPAMS

SPArse Modeling Software

KEYWORDS: Signal processing - Machine learning

FUNCTIONAL DESCRIPTION: SPAMS is an open-source software package for sparse estimation

NEWS OF THE YEAR: The version 2.6.1 of the software package is now compatible with Python v3, R v3, comes with pre-compiled Matlab packages, and is now available on the conda and PyPi package managers.

- Participants: Ghislain Durif and Julien Mairal
- Contact: Julien Mairal
- URL: <http://spams-devel.gforge.inria.fr/>

6.11. MP-Net

KEYWORD: Motion analysis

FUNCTIONAL DESCRIPTION: This is a public implementation of the method described in the following paper: Learning Motion Patterns in Videos [CVPR 2017].

The problem of determining whether an object is in motion, irrespective of the camera motion, is far from being solved. We address this challenging task by learning motion patterns in videos. The core of our approach is a fully convolutional network, which is learnt entirely from synthetic video sequences, and their ground-truth optical flow and motion segmentation. This encoder-decoder style architecture first learns a coarse representation of the optical flow field features, and then refines it iteratively to produce motion labels at the original high-resolution. The output label of each pixel denotes whether it has undergone independent motion, i.e., irrespective of the camera motion. We demonstrate the benefits of this learning framework on the moving object segmentation task, where the goal is to segment all the objects in motion. To this end we integrate an objectness measure into the framework. Our approach outperforms the top method on the recently released DAVIS benchmark dataset, comprising real-world sequences, by 5.6

- Participants: Pavel Tokmakov, Karteek Alahari and Cordelia Schmid
- Contact: Pavel Tokmakov
- Publication: [Learning Motion Patterns in Videos](#)
- URL: <http://thoth.inrialpes.fr/research/mpnet/>

6.12. LVO

Learning Video Object Segmentation with Visual Memory

KEYWORD: Video analysis

FUNCTIONAL DESCRIPTION: This is a public implementation of the method described in the following paper: Learning Video Object Segmentation with Visual Memory [ICCV 2017].

This paper addresses the task of segmenting moving objects in unconstrained videos. We introduce a novel two-stream neural network with an explicit memory module to achieve this. The two streams of the network encode spatial and temporal features in a video sequence respectively, while the memory module captures the evolution of objects over time. The module to build a "visual memory" in video, i.e., a joint representation of all the video frames, is realized with a convolutional recurrent unit learned from a small number of training video sequences. Given a video frame as input, our approach assigns each pixel an object or background label based on the learned spatio-temporal features as well as the "visual memory" specific to the video, acquired automatically without any manually-annotated frames. The visual memory is implemented with convolutional gated recurrent units, which allows to propagate spatial information over time. We evaluate our method extensively on two benchmarks, DAVIS and Freiburg-Berkeley motion segmentation datasets, and show state-of-the-art results. For example, our approach outperforms the top method on the DAVIS dataset by nearly 6

- Participants: Karteek Alahari, Cordelia Schmid and Pavel Tokmakov
- Contact: Pavel Tokmakov
- Publication: [Learning Video Object Segmentation with Visual Memory](#)
- URL: <http://lear.inrialpes.fr/research/lvo/>

6.13. SURREAL

Learning from Synthetic Humans

KEYWORDS: Synthetic human - Segmentation - Neural networks

FUNCTIONAL DESCRIPTION: The SURREAL dataset consisting of synthetic videos of humans, and models trained on this dataset are released in this package. The code for rendering synthetic images of people and for training models is also included in the release.

- Participants: Gül Varol Simsekli, Xavier Martin, Ivan Laptev and Cordelia Schmid
- Contact: Gül Varol Simsekli
- Publication: [Learning from Synthetic Humans](#)
- URL: <http://www.di.ens.fr/willow/research/surreal/>

TITANE Project-Team

6. New Software and Platforms

6.1. CGAL Barycentric_coordinates_2

Module CGAL : Barycentric coordinates 2D

KEYWORD: Computational geometry

FUNCTIONAL DESCRIPTION: This package offers an efficient and robust implementation of two-dimensional closed-form generalized barycentric coordinates defined for simple two-dimensional polygons.

- Participants: Dmitry Anisimov and Pierre Alliez
- Contact: Pierre Alliez

6.2. dtk-nurbs-probing

KEYWORDS: Algorithm - CAD - Numerical algorithm - Geometric algorithms

FUNCTIONAL DESCRIPTION: This library offers tools for computing intersection between linear primitives and the constitutive elements of CAD objects (curves and surfaces). It is thus possible to compute intersections between a linear primitive with a trimmed or untrimmed NURBS surface, as well with Bezier surfaces. It is also possible, in the xy plane, to compute the intersections between linear primitives and NURBS curves as well as Bezier curves.

- Participants: Come Le Breton, Laurent Busé and Pierre Alliez
- Contact: Come Le Breton

6.3. MeshMantics

KEYWORDS: Classification - 3D modeling

FUNCTIONAL DESCRIPTION: This software component enables the classification of surface meshes in accordance to common outdoor urban classes such as ground, facades, walls, roofs and vegetation.

- Participants: Florent Lafarge, Pierre Alliez and Yannick Verdié
- Contact: Pierre Alliez

6.4. Module CGAL : Point Set Processing

KEYWORD: Geometry Processing

FUNCTIONAL DESCRIPTION: This CGAL component implements methods to analyze and process unorganized point sets. The input is an unorganized point set, possibly with normal attributes (unoriented or oriented). The point set can be analyzed to measure its average spacing, and processed through functions devoted to the simplification, outlier removal, smoothing, normal estimation, normal orientation and feature edges estimation.

- Participants: Clément Jamin, Laurent Saboret and Pierre Alliez
- Contact: Pierre Alliez
- URL: http://doc.cgal.org/latest/Point_set_processing_3/index.html#Chapter_Point_Set_Processing

6.5. Module CGAL : Scale space surface reconstruction

KEYWORD: Geometric algorithms

SCIENTIFIC DESCRIPTION: This CGAL package implements a surface reconstruction method which takes as input an unordered point set and computes a triangulated surface mesh interpolating the point set. We assume that the input points were sampled from the surface of an object. The method can also process point sets sampled from the interior of the object, although we cannot provide guarantees on the output. This method can handle a decent amount of noise and outliers. The point set may greatly undersample the object in occluded regions, although no surface will be reconstructed to fill these regions.

FUNCTIONAL DESCRIPTION: This method allows to reconstruct a surface that interpolates a set of 3D points. This method provides an efficient alternative to the Poisson surface reconstruction method. The main difference in output is that this method reconstructs a surface that interpolates the point set (as opposed to approximating the point set). How the surface connects the points depends on a scale variable, which can be estimated semi-automatically.

- Participants: Pierre Alliez and Thijs Van Lankveld
- Contact: Pierre Alliez

6.6. Skeleton-Blockers

Skeleton-Blockers data-structure

KEYWORDS: Topology - Triangulation - Mesh - C++ - 3D

FUNCTIONAL DESCRIPTION: Skeleton-Blockers is a compact, efficient and generic data-structure that can represent any simplicial complex. The implementation is in C++11.

- Participant: David Salinas
- Contact: David Salinas
- URL: <https://project.inria.fr/gudhi/software/>

6.7. Structure-preserving decimation

KEYWORDS: Mesh - 3D - Multi-View reconstruction

FUNCTIONAL DESCRIPTION: Structure-preserving decimation is a software that can simplify 3D meshes while preserving some of their structure. Simplification can be done either with a command line or with a graphical user interface that allows to combine several operations including several simplification methods.

- Participants: David Salinas, Florent Lafarge and Pierre Alliez
- Contact: David Salinas

TYREX Project-Team

5. New Software and Platforms

5.1. sparqlgx

KEYWORDS: RDF - SPARQL - Distributed computing

SCIENTIFIC DESCRIPTION: SPARQL is the W3C standard query language for querying data expressed in RDF (Resource Description Framework). The increasing amounts of RDF data available raise a major need and research interest in building efficient and scalable distributed SPARQL query evaluators.

In this context, we propose and share SPARQLGX: our implementation of a distributed RDF datastore based on Apache Spark. SPARQLGX is designed to leverage existing Hadoop infrastructures for evaluating SPARQL queries. SPARQLGX relies on a translation of SPARQL queries into executable Spark code that adopts evaluation strategies according to (1) the storage method used and (2) statistics on data. Using a simple design, SPARQLGX already represents an interesting alternative in several scenarios.

FUNCTIONAL DESCRIPTION: Distributed SPARQL query evaluator

RELEASE FUNCTIONAL DESCRIPTION: - Faster load routine which widely improves this phase performances by reading once the initial triple file and by partitioning data in the same time into the correct predicate files. - Improving the generated Scala-code of the translation process with mapValues. This technic allows not to break the partitioning of KeyValueRDD while applying transformations to the values instead of the traditional map that was done prior. - Merging and cleaning several scripts in bin/ such as for example sgx-eval.sh and sde-eval.sh - Improving the compilation process of compile.sh - Cleaner test scripts in tests/ - Offering the possibility of an easier deployment using Docker.

- Participants: Damien Graux, Thomas Calmant, Louis Jachiet, Nabil Layaïda and Pierre Genevès
- Contact: Pierre Genevès
- Publications: [Optimizing sparql query evaluation with a worst-case cardinality estimation based on statistics on the data - The SPARQLGX System for Distributed Evaluation of SPARQL Queries](#)
- URL: <https://github.com/tyrex-team/sparqlgx>

5.2. musparql

KEYWORDS: SPARQL - RDF - Property paths

FUNCTIONAL DESCRIPTION: reads a SPARQL request and translates it into an internal algebra. Rewrites the resulting term into many equivalent versions, then choses one of them and executes it on a graph.

- Participant: Louis Jachiet
- Contact: Nabil Layaïda
- Publication: [Extending the SPARQL Algebra for the optimization of Property Paths](#)
- URL: <https://gitlab.inria.fr/tyrex/musparql>

5.3. SPARUB

SPARQL UPDATE Benchmark generator.

KEYWORDS: SPARQL - RDF

SCIENTIFIC DESCRIPTION: One aim of the RDF data model, as standardized by the W3C, is to facilitate the evolution of data over time without requiring all the data consumers to be changed. To this end, one of the latest addition to the SPARQL standard query language is an update language for RDF graphs. The research on efficient and scalable SPARQL evaluation methods increasingly relies on standardized methodologies for benchmarking and comparing systems. However, current RDF benchmarks do not support graphs updates. We propose and share SPARUB: a benchmark for the SPARQL update language on RDF graphs. The aim of SPARUB is not to be yet another rdf benchmark. Instead it provides the mean to automatically extend and improve existing RDF benchmarks along a new dimension of data updates, while preserving their structure and query scenarios.

FUNCTIONAL DESCRIPTION: SPARUB is a simple tool to generate additional scenarios of test from an already existing N-Triples dataset and some SPARQL queries while focusing on the SPARQL UPDATE fragment (which is part of SPARQL 1.1). It simply extends already existing benchmarking methods taking an RDF dataset and (optionally) SPARQL queries to provide a complete scenario of test. Moreover, a list of predefined metrics is also available to extract interesting figures of the tests.

Technically, SPARUB is a bash script `sparub.sh` which takes a triple file and an optional list of SPARQL queries as arguments. It will then generate a scenario divided into several steps to benchmark an RDF storage system allowing the SPARQL evaluation on the various functionalities of the SPARQL UPDATE standard extension.

- Participants: Damien Graux, Pierre Genevès and Nabil Layaïda
- Contact: Pierre Genevès
- Publication: [SPARUB: SPARQL UPDATE Benchmark](#)
- URL: <https://github.com/tyrex-team/sparub>

5.4. MRB

Mixed Reality Browser

KEYWORDS: Augmented reality - Geolocation - Indoor geolocalisation - Smartphone

FUNCTIONAL DESCRIPTION: MRB displays PoI (Point of Interest) content remotely through panoramics with spatialized audio, or on-site by walking to the corresponding place, it can be used for indoor-outdoor navigation, with assistive audio technology for the visually impaired. It is the only browser of geolocalized data to use XML as a native format for PoIs, panoramics, 3D audio and to rely on HTML5 both for the iconic and full information content of PoIs. Positioning in MRB is based on a PDR library, written in C++ and Java and developed by the team, which provides the user's location in real time based on the interpretation of sensors. Three main modules have been designed to build this positioning system: (i) a pedometer that estimates the distance the user has walked and his speed, (ii) a motion manager that enables data set recording and simulation but also the creation of virtual sensors or filters (e.g gyroscope drift compensation, linear acceleration, altimeter), and (iii) a map-matching algorithm that provides a new location based on a given OpenStreetMap file description and the current user's trajectory.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publications: [On Mobile Augmented Reality Applications based on Geolocation - Attitude Estimation with Smartphones](#)
- URL: <http://tyrex.inria.fr/projects/mrb.html>

5.5. TyrAr

Geo Augmented Reality on a Smartphone

KEYWORDS: Augmented reality - Smartphone - Geolocation

FUNCTIONAL DESCRIPTION: This application is an AR viewer to name the mountains, cities and historical buildings over the camera feed of the smartphone. The user can turn on himself with his device to discover names and information about Points of Interest (POIs). POIs are directly extracted from the OSM database thanks to the Overpass Turbo API. POIs are displayed on the screen with their name, an icon and an extra information. City POIs exhibit the number of inhabitants, mountains are associated to their altitude and historical buildings display their date of construction.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)
- URL: <http://tyrex.inria.fr/projects/mrb.html>

5.6. AmiAr

Smart Home Augmented Reality on a Smartphone

KEYWORDS: Augmented reality - Smart home - Smartphone - Indoor geolocalisation

FUNCTIONAL DESCRIPTION: This application is a proof of concept of a Geo AR system in a smart apartment. This setup has been conducted in EquipEx Amiqual4Home. The goal here is to control objects in the apartment using widgets over the video feed from the camera. For example, a user points a lamp with his smartphone, a widget appears, then he uses a slider in this widget to modify the light intensity.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)

5.7. GreAR

Grenoble AR-Tour based on geolocation.

KEYWORDS: Augmented reality - Geolocation - Smartphone

FUNCTIONAL DESCRIPTION: This application is an AR navigator specifically designed for pedestrians. This application was initially developed during the Venturi FP7 (2011-2015) project and has been updated with our AR framework since then. Between two visually driven AR experiences (at the time, developed by partners), the navigator provides the user with an audio and visual guidance through a pre-defined touristic path in Grenoble. The position of the user is obtained through a fusion of GPS signal (when available), pedometer estimates and a map-matching algorithm exploiting OpenStreetMap. As the GPS signal is poor in several parts of the old city the integration of the pedometer enables the navigator to obtain a sufficiently reliable position estimate, crucial for AR applications and geofencing. Within the application, there are several options given to the user to view the navigation path through the city, ranging from a satellite image of the streets to a vector map. In the navigation pane, the geofences relating to the AR experiences and other points of interest can be seen.

- Participant: Thibaud Michel
- Contact: Nabil Layaïda
- Publication: [On Mobile Augmented Reality Applications based on Geolocation](#)
- URL: <http://tyrex.inria.fr/projects/mrb.html>

5.8. Benchmarks Attitude Smartphones

KEYWORDS: Performance analysis - Sensors - Motion analysis - Experimentation - Smartphone

SCIENTIFIC DESCRIPTION: We investigate the precision of attitude estimation algorithms in the particular context of pedestrian navigation with commodity smartphones and their inertial/magnetic sensors. We report on an extensive comparison and experimental analysis of existing algorithms. We focus on typical motions of smartphones when carried by pedestrians. We use a precise ground truth obtained from a motion capture system. We test state-of-the-art attitude estimation techniques with several smartphones, in the presence of magnetic perturbations typically found in buildings. We discuss the obtained results, analyze advantages and limits of current technologies for attitude estimation in this context. Furthermore, we propose a new technique for limiting the impact of magnetic perturbations with any attitude estimation algorithm used in this context. We show how our technique compares and improves over previous works.

- Participants: Hassen Fourati, Nabil Layaïda, Pierre Genevès and Thibaud Michel
- Partner: GIPSA-Lab
- Contact: Pierre Genevès
- URL: <http://tyrex.inria.fr/mobile/benchmarks-attitude/>

5.9. MedAnalytics

KEYWORDS: Big data - Predictive analytics - Distributed systems

FUNCTIONAL DESCRIPTION: We implemented a method for the automatic detection of at-risk profiles based on a fine-grained analysis of prescription data at the time of admission. The system relies on an optimized distributed architecture adapted for processing very large volumes of medical records and clinical data. We conducted practical experiments with real data of millions of patients and hundreds of hospitals. We demonstrated how the various perspectives of big data improve the detection of at-risk patients, making it possible to construct predictive models that benefit from volume and variety. This prototype implementation is described in the 2017 preprint available at: <https://hal.inria.fr/hal-01517087/document>.

- Participants: Pierre Genevès and Thomas Calmant
- Partner: CHU Grenoble
- Contact: Pierre Genevès
- Publication: [Predicting At-Risk Patient Profiles from Big Prescription Data](#)

Valda Team

5. New Software and Platforms

5.1. ProvSQL

KEYWORDS: Databases - Provenance - Probability

FUNCTIONAL DESCRIPTION: The goal of the ProvSQL project is to add support for (m-)semiring provenance and uncertainty management to PostgreSQL databases, in the form of a PostgreSQL extension/module/plugin.

NEWS OF THE YEAR: ProvSQL becomes usable for a large range of queries. Support for semirings and m-semirings is present, support for probability computation has been added through a variety of techniques, including knowledge compilation, support for where-provenance is currently being implemented.

- Participants: Pierre Senellart and Yann Ramusat
- Contact: Pierre Senellart
- Publication: [Provenance and Probabilities in Relational Databases: From Theory to Practice](#)
- URL: <https://github.com/PierreSenellart/provsql>

5.2. Thymeflow

KEYWORD: Personal information

FUNCTIONAL DESCRIPTION: ThymeFlow allows in particular the development of plugins for both interacting with existing Web sources and presenting users with rich interfaces and query facilities over their personal information. A preliminary version of ThymeFlow tools has also been deployed on the Cozy Cloud personal cloud system. The model allows the open-source community to contribute individual plugins while we focus on providing users with useful ways to exploit their personal information.

NEWS OF THE YEAR: Minor maintenance.

- Participants: David Montoya, Pierre Senellart, Serge Abiteboul and Su Yang
- Partner: ENGIE
- Contact: Pierre Senellart
- Publication: [Personal Knowledge Base Systems](#)
- URL: <https://github.com/thymeflow/thymeflow/>

5.3. apxproof

KEYWORD: LaTeX

FUNCTIONAL DESCRIPTION: apxproof is a LaTeX package facilitating the typesetting of research articles with proofs in appendix, a common practice in database theory and theoretical computer science in general. The appendix material is written in the LaTeX code along with the main text which it naturally complements, and it is automatically deferred. The package can automatically send proofs to the appendix, can repeat in the appendix the theorem environments stated in the main text, can section the appendix automatically based on the sectioning of the main text, and supports a separate bibliography for the appendix material.

RELEASE FUNCTIONAL DESCRIPTION: Ability to specify a sectioning counter, Compilation fix of proofs-ketch in inline mode

NEWS OF THE YEAR: Overall software maintenance. Support for more document classes. Some new features.

- Participant: Pierre Senellart
- Contact: Pierre Senellart
- URL: <https://github.com/PierreSenellart/apxproof>

WILLOW Project-Team

6. New Software and Platforms

6.1. LOUPE

Learnable mOdUle for Pooling fEatures

KEYWORDS: Video analysis - Computer vision

FUNCTIONAL DESCRIPTION: LOUPE (Learnable mOdUle for Pooling fEatures) is a Tensorflow toolbox that implements several modules for pooling features such as NetVLAD, NetRVLAD, NetFV and Soft-DBoW. It also allows to use their Gated version. This toolbox was mainly use in the winning approach of the Youtube 8M Large Scale Video Understanding challenge

- Participants: Antoine Miech, Ivan Laptev and Josef Sivic
- Contact: Antoine Miech
- Publication: [Learning from Video and Text via Large-Scale Discriminative Clustering](#)
- URL: <https://github.com/antoine77340/LOUPE>

6.2. object-states-action

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: Code for the paper Joint Discovery of Object States and Manipulation Actions, ICCV 2017: Many human activities involve object manipulations aiming to modify the object state. Examples of common state changes include full/empty bottle, open/closed door, and attached/detached car wheel. In this work, we seek to automatically discover the states of objects and the associated manipulation actions. Given a set of videos for a particular task, we propose a joint model that learns to identify object states and to localize state-modifying actions. Our model is formulated as a discriminative clustering cost with constraints. We assume a consistent temporal order for the changes in object states and manipulation actions, and introduce new optimization techniques to learn model parameters without additional supervision. We demonstrate successful discovery of seven manipulation actions and corresponding object states on a new dataset of videos depicting real-life object manipulations. We show that our joint formulation results in an improvement of object state discovery by action recognition and vice versa.

- Participants: Jean-Baptiste Alayrac, Josef Sivic, Ivan Laptev and Simon Lacoste-Julien
- Contact: Jean-Baptiste Alayrac
- Publication: [Joint Discovery of Object States and Manipulation Actions](#)
- URL: <https://github.com/jalayrac/object-states-action>

6.3. SURREAL

Learning from Synthetic Humans

KEYWORDS: Synthetic human - Segmentation - Neural networks

FUNCTIONAL DESCRIPTION: The SURREAL dataset consisting of synthetic videos of humans, and models trained on this dataset are released in this package. The code for rendering synthetic images of people and for training models is also included in the release.

- Participants: Gül Varol Simsekli, Xavier Martin, Ivan Laptev and Cordelia Schmid
- Contact: Gül Varol Simsekli
- Publication: [Learning from Synthetic Humans](#)
- URL: <http://www.di.ens.fr/willow/research/surreal/>

6.4. UNREL

Weakly-supervised learning of visual relations

KEYWORDS: Recognition - Computer vision

FUNCTIONAL DESCRIPTION: Open source release of the software package for the ICCV17 paper by Peyre et al. "Weakly-supervised learning of visual relations". The package provides a full implementation of the method (training and evaluation) and the release of the UnRel dataset. Links to all of these are available at the project page <http://www.di.ens.fr/willow/research/unrel/>

- Participants: Julia Peyre, Ivan Laptev, Cordelia Schmid and Josef Sivic
- Contact: Julia Peyre
- Publication: [Weakly-supervised learning of visual relations](#)
- URL: <http://www.di.ens.fr/willow/research/unrel/>

6.5. BIOGAN

GANs for Biological Image Synthesis

KEYWORDS: Computer vision - Biology

FUNCTIONAL DESCRIPTION: This software package implements the method in the ICCV 2017 paper by Osokin et al. "GANs for Biological Image Synthesis".

- Participants: Federico Vaggi, Anton Osokin and Anatole Chessel
- Contact: Anton Osokin
- Publication: [GANs for Biological Image Synthesis](#)

6.6. KernelImageRetrieval

Kernel square-loss exemplar machines for image retrieval

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: This software package contains the code for the CVPR'17 paper by Rezende et al. "Kernel square-loss exemplar machines for image retrieval". It provides the implementation of all variants of the pipeline as well as the trained parameters for each of the tested base features.

- Participants: Jean Ponce, Francis Bach, Patrick Pérez and Rafael Sampaio De Rezende
- Contact: Rafael Sampaio De Rezende
- Publication: [Kernel Square-Loss Exemplar Machines for Image Retrieval](#)
- URL: <https://github.com/rafarez/slem/>

6.7. SCNet

SCNet: Learning semantic correspondence

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: This software package implements the method for the ICCV'17 paper by Han et al. "SCNet: Learning Semantic Correspondence". The package provides the code, the training and testing subsets and the trainable architecture.

- Participants: Rafael Sampaio De Rezende, Bumsub Ham, Minsu Cho, Cordelia Schmid and Jean Ponce
- Contact: Rafael Sampaio De Rezende
- Publication: [SCNet: Learning Semantic Correspondence](#)
- URL: <https://github.com/k-han/SCNet/>

6.8. CNNGeometric

Convolutional neural network architecture for geometric matching

KEYWORD: Computer vision

FUNCTIONAL DESCRIPTION: Open source release of the software package for the CVPR'17 paper by Rocco et al. "Convolutional neural network architecture for geometric matching". This release provides a full implementation of the method, including code for training models, and testing on standard datasets, as well as trained models.

- Participants: Ignacio Rocco Spremolla, Relja Arandjelovic and Josef Sivic
- Contact: Ignacio Rocco Spremolla
- Publication: [Convolutional neural network architecture for geometric matching](#)
- URL: <http://www.di.ens.fr/willow/research/cnngeometric/>

6.9. LSDClustering

Large-Scale Discriminative Clustering

KEYWORDS: Video analysis - Computer vision

FUNCTIONAL DESCRIPTION: This software package implements the method in the ICCV'17 paper by Miech et al. "Learning from Video and Text via Large-Scale Discriminative Clustering".

- Participants: Antoine Miech, Jean-Baptiste Alayrac, Piotr Bojanowski, Ivan Laptev and Josef Sivic
- Contact: Antoine Miech
- Publication: [Learning from Video and Text via Large-Scale Discriminative Clustering](#)
- URL: <http://www.di.ens.fr/willow/research/learningvideotext/>

WIMMICS Project-Team

6. New Software and Platforms

6.1. CORESE

COncceptual REsource Search Engine

KEYWORDS: Semantic Web - Search Engine - RDF - SPARQL

FUNCTIONAL DESCRIPTION: Corese is a Semantic Web Factory, it implements W3C RDF, RDFS, SPARQL 1.1 Query and Update as well as RDF Inference Rules.

Furthermore, Corese query language integrates original features such as approximate search and extended Property Path. It provides STTL: SPARQL Template Transformation Language for RDF graphs. It also provides LDScript: a Script Language for Linked Data. Corese provides distributed federated query processing.

- Participants: Erwan Demairy, Fabien Gandon, Fuqi Song, Olivier Corby, Olivier Savoie and Virginie Bottollier
- Partners: I3S - Mnemotix
- Contact: Olivier Corby
- URL: <http://wimmics.inria.fr/corese>

6.2. DBpedia

KEYWORDS: RDF - SPARQL

FUNCTIONAL DESCRIPTION: DBpedia is an international crowd-sourced community effort to extract structured information from Wikipedia and make this information available on the semantic Web as linked open data. The DBpedia triple stores then allow anyone to solve sophisticated queries against Wikipedia extracted data, and to link the different data sets on these data. The French chapter of DBpedia was created and deployed by Wimmics and is now an online running platform providing data to several projects such as: QAKIS, Izipedia, zone47, Sépage, HdA Lab., JocondeLab, etc.

RELEASE FUNCTIONAL DESCRIPTION: The new release is based on updated Wikipedia dumps and the inclusion of the DBpedia history extraction of the pages.

- Participants: Fabien Gandon and Elmahdi Korfed
- Contact: Fabien Gandon
- URL: <http://wiki.dbpedia.org/>

6.3. Discovery Hub

Discovery Hub Exploratory Search Engine

KEYWORD: Search Engine

FUNCTIONAL DESCRIPTION: Recommendation system on top of DBpedia

- Participants: Alain Giboin, Emilie Palagi, Fabien Gandon and Nicolas Marie
- Partner: Alcatel-Lucent
- Contact: Fabien Gandon
- URL: <http://discoveryhub.co/>

6.4. Fuzzy labelling argumentation module

Fuzzy labelling algorithm for abstract argumentation

KEYWORDS: Artificial intelligence - Multi-agent - Knowledge representation - Algorithm

FUNCTIONAL DESCRIPTION: The goal of the algorithm is to compute the fuzzy acceptability degree of a set of arguments in an abstract argumentation framework. The acceptability degree is computed from the trustworthiness associated with the sources of the arguments.

- Participant: Serena Villata Milanesio
- Contact: Serena Villata Milanesio

6.5. Qakis

Question-Answering wiki framework based system

KEYWORD: Natural language

FUNCTIONAL DESCRIPTION: The QAKiS system implements question answering over DBpedia. QAKiS allows end users to submit a query to an RDF triple store in English and obtain the answer in the same language, hiding the complexity of the non-intuitive formal query languages involved in the resolution process. At the same time, the expressiveness of these standards is exploited to scale to the huge amounts of available semantic data. Its major novelty is to implement a relation-based match for question interpretation, to convert the user question into a query language (e.g. SPARQL). English, French and German DBpedia chapters are the RDF data sets to be queried using a natural language interface.

- Participants: Alessio Palmero Aprosio, Amine Hallili, Elena Cabrio, Fabien Gandon, Julien Cojan and Serena Villata Milanesio
- Contact: Elena Cabrio
- URL: <http://www.qakis.org/>

ZENITH Project-Team

6. New Software and Platforms

6.1. LogMagnet

KEYWORDS: Data mining - Data stream

FUNCTIONAL DESCRIPTION: LogMagnet is a software for analyzing streaming data, and in particular log data. Log data usually arrive in the form of lines containing activities of human or machines. In the case of human activities, it may be the behavior on a Web site or the usage of an application. In the case of machines, such log may contain the activities of software and hardware components (say, for each node of a computing cluster, the calls to system functions or some hardware alerts). Analyzing such data is often difficult and crucial in the meanwhile. LogMagnet allows to summarize this data, and to provide a first analysis as a clustering. This summary may also be exploited as easily as the original data.

- Participants: Florent Masseglia and Julien Diener
- Contact: Florent Masseglia
- URL: <https://team.inria.fr/zenith/?s=LogMagnet>

6.2. Pl@ntNet - Mobile - Android

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: This is the Android front-end of the Pl@ntNet platform, publicly available on Google play: <https://play.google.com/store/apps/details?id=org.plantnet&hl=fr> The main feature of the app is to identify plant species from photographs, through a visual recognition software making use of deep learning technologies. The number of species and the number of images used by the application evolve with the contributions of the Pl@ntNet community.

- Participant: Julien Champ
- Partners: INRA - CIRAD - IRD
- Contact: Alexis Joly
- URL: <https://play.google.com/store/apps/details?id=org.plantnet&hl=en>

6.3. Pl@ntNet - Mobile -IOS

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: This is the iOS front-end of the Pl@ntNet platform, publicly available on Apple store: <https://itunes.apple.com/fr/app/plantnet/id600547573?mt=8> The main feature of the app is to identify plant species from photographs, through a visual recognition software making use of deep learning technologies. The number of species and the number of images used by the application evolve with the contributions of the Pl@ntNet community.

- Participant: Hervé Goëau
- Partners: INRA - CIRAD - IRD
- Contact: Alexis Joly
- URL: <https://itunes.apple.com/fr/app/plantnet/id600547573?mt=8>

6.4. Pl@ntNet - Web - Angular

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: This is the web front-end of the Pl@ntNet platform, publicly available at: <http://identify.plantnet-project.org/> The main feature of the app is to identify plant species from photographs, through a visual recognition software making use of deep learning technologies. The number of species and the number of images used by the application evolve with the contributions of the Pl@ntNet community.

- Participant: Alexis Joly
- Partners: INRA - CIRAD - IRD
- Contact: Alexis Joly
- URL: <https://identify.plantnet-project.org/>

6.5. Pl@ntNet - DataStore

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: Datastore of the Pl@ntNet platform dedicated to the management of botanical data (observations + taxonomy) based on Apache CouchDB, Node.JS, Angular.JS, Apache Lucene.

- Participant: Hervé Goëau
- Partners: INRA - CIRAD - IRD
- Contact: Alexis Joly
- URL: <https://plantnet.org/>

6.6. Pl@ntNet - API

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: REST API of the Pl@ntNet platform. It provides services for data access, authentication, logging, contribution management, etc. It is mainly based on Node.JS + CouchDB.

- Authors: Samuel Dufour Kowalski, Alexis Joly, Pierre Bonnet and Antoine Affouard
- Partners: INRA - CIRAD - IRD
- Contact: Alexis Joly
- URL: <https://plantnet.org/>

6.7. Snoop

FUNCTIONAL DESCRIPTION: Snoop is a C++ framework dedicated to large-scale content-based image retrieval. Its main features are (i) the extraction and efficient indexing of visual features (hand-crafted or learned through deep learning), (ii) the search of similar images through approximate k-nearest neighbors and (iii), the supervised recognition of trained visual concepts. The framework can be used either as a set of C++ libraries or as a set of web services through a RESTFUL API.

- Participants: Alexis Joly, Jean-Christophe Lombardo and Olivier Buisson
- Partner: INA (Institut National de l'Audiovisuel)
- Contact: Alexis Joly

6.8. PlantRT

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: PlantRT is a distributed gossip-based platform for content sharing enabling plants observation keywords search and GPS position based recommendation. It combines advantages from centralized and P2P systems.

- Participants: Alexis Joly, Esther Pacitti, Julien Champ, Maximilien Servajean and Miguel Liroz-Gistau
- Contact: Maximilien Servajean

6.9. SciFloware

Scientific Workflow Middleware

KEYWORDS: Bioinformatics - Distributed Data Management

FUNCTIONAL DESCRIPTION: SciFloware is a middleware for the execution of scientific workflows in a distributed and parallel way. It capitalizes on our experience with SON and an innovative algebraic approach to the management of scientific workflows. SciFloware provides a development environment and a runtime environment for scientific workflows, interoperable with existing systems. We validate SciFloware with workflows for analyzing biological data provided by our partners CIRAD, INRA and IRD.

- Participants: Didier Parigot and Dimitri Dupuis
- Contact: Didier Parigot
- URL: <http://www-sop.inria.fr/members/Didier.Parigot/pmwiki/Scifloware>

6.10. CloudMdsQL Compiler

FUNCTIONAL DESCRIPTION: CloudMdsQL (Cloud Multidastore Query Language) is a functional SQL-like language, capable of querying multiple cloud data stores (SQL, NoSQL, HDFS, etc.). The compiler parses a CloudMdsQL query and generates an optimized query execution plan to be processed by a query operator engine.

- Authors: Boyan Kolev and Patrick Valduriez
- Contact: Patrick Valduriez

6.11. Triton Server

End-to-end Graph Mapper

KEYWORD: Web Application

FUNCTIONAL DESCRIPTION: A server for managing graph data and applications for mobile social networks. The server is built on top of the OrientDB graph database system and a distributed middleware. It provides an End-to-end Graph Mapper (EGM) for modeling the whole application as (i) a set of graphs representing the business data, the in-memory data structure maintained by the application and the user interface (tree of graphical components), and (ii) a set of standardized mapping operators that maps these graphs with each other.

- Participants: Didier Parigot, Patrick Valduriez and Benjamin Billet
- Contact: Didier Parigot
- Publication: [End-to-end Graph Mapper](#)

6.12. Hadoop_g5k

FUNCTIONAL DESCRIPTION: Apache Hadoop provides an open-source framework for reliable, scalable, parallel computing. It can be deployed and used in large-scale platforms such as Grid 5000. However, its configuration and management is very difficult, specially under the dynamic nature of clusters. Therefore, we built Hadoop_g5k (Hadoop easy deployment in clusters), a tool that makes it easier to manage Hadoop clusters and prepare reproducible experiments. Hadoop_g5k offers a set of scripts to be used in command-line interfaces and a Python interface. It is actually used by Grid5000 users, and helps them saving much time when doing their experiments with MapReduce.

- Participants: Miguel Liroz-Gistau, Patrick Valduriez and Reza Akbarinia
- Contact: Patrick Valduriez
- URL: https://www.grid5000.fr/mediawiki/index.php/Hadoop_On_Execo