RESEARCH CENTER
Nancy - Grand Est

FIELD

Activity Report 2019

Section Software

ALGORITHMICS, PROGRAMMING, SOFTWARE AND ARCHITECTURE

APPLIED MATHEMATICS, COMPUTATION AND SIMULATION

DIGITAL HEALTH, BIOLOGY AND EARTH

NETWORKS, SYSTEMS AND SERVICES, DISTRIBUTED COMPUTING

PERCEPTION, COGNITION AND INTERACTION

CAMUS Project-Team

6. New Software and Platforms

6.1. CLooG

Code Generator in the Polyhedral Model

KEYWORDS: Polyhedral compilation - Optimizing compiler - Code generator

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

6.2. OpenScop

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

KEYWORDS: Polyhedral compilation - Optimizing compiler

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/

6.3. 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

6.4. 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 devices. It gains more market share also in other areas, 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/

6.5. 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 an 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 automatic differentiation for special functions with Modular C - Futex based locks for C11's generic atomics
- URL: http://cmod.gforge.inria.fr/

6.6. 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 automatic differentiation for special functions with Modular C - Arbogast – Origine d'un outil de dérivation automatique
- URL: https://gforge.inria.fr/projects/arbo

6.7. 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/

6.8. SPETABARU

SPEculative TAsk-BAsed RUntime system

KEYWORDS: HPC - Parallel computing - Task-based algorithm

FUNCTIONAL DESCRIPTION: SPETABARU is a task-based runtime system for multi-core architectures that includes speculative execution models. It is a pure C++11 product without external dependency. It uses advanced meta-programming and allows for an easy customization of the scheduler. It is also capable to generate execution traces in SVG to better understand the behavior of the applications.

- Contact: Bérenger Bramas
- URL: https://gitlab.inria.fr/bramas/spetabaru

6.9. APAC

KEYWORDS: Source-to-source compiler - Automatic parallelization - Parallelisation - Parallel programming

SCIENTIFIC DESCRIPTION: APAC is a compiler for automatic parallelization that transforms C++ source code to make it parallel by inserting tasks. It uses the tasks+dependencies paradigm and relies on OpenMP or SPETABARU as runtime system. Internally, it is based on Clang-LLVM.

FUNCTIONAL DESCRIPTION: Automatic task-based parallelization compiler

- Participants: Bérenger Bramas, Stéphane Genaud and Garip Kusoglu
- Contact: Bérenger Bramas
- URL: https://gitlab.inria.fr/bramas/apac

6.10. Dagpar

KEYWORDS: Graph algorithmics - Clustering - Partitioning

SCIENTIFIC DESCRIPTION: This library is a clustering algorithm to create macro-tasks in a DAG of tasks. It extends a clustering/partitioning strategy proposed by Rossignon et al. to speed up the parallel execution of a task-based application. In this package, we provide two additional heuristics to this algorithm, which have been validated on a large graph set. The objective of clustering the nodes of task graphs is to increase the granularity of the tasks and thus obtain faster execution by mitigating the overhead from the management of the dependencies. An important asset of this approach is that working at the graph level allows us to create a generic method independent of the application and of what is done at the user level, but also independent of the task-based runtime system that could be used underneath.

FUNCTIONAL DESCRIPTION: Acyclic Dag Partitioning.

- Participants: Bérenger Bramas and Alain Ketterlin
- Contact: Bérenger Bramas
- URL: https://gitlab.inria.fr/bramas/dagpar

6.11. LetItBench

Lenient to Errors, Transformations, Irregularities and Turbulence Benchmarks

KEYWORDS: Approximate computing - Benchmarking

FUNCTIONAL DESCRIPTION: LetItBench is a benchmark set to help evaluating works on approximate compilation techniques. We propose a set of meaningful applications with an iterative kernel, that is not too complex for automatic analysis and can be analyzed by polyhedral tools. The benchmark set called LetItBench (Lenient to Errors, Transformations, Irregularities and Turbulence Benchmarks) is composed of standalone applications written in C, and a benchmark runner based on CMake. The benchmark set includes fluid simulation, FDTD, heat equations, game of life or K-means clustering. It spans various kind of applications that are resilient to approximation.

- Contact: Cédric Bastoul
- URL: https://github.com/Syllo/LetItBench

6.12. ACR

Adaptive Code Refinement

KEYWORDS: Approximate computing - Optimizing compiler

FUNCTIONAL DESCRIPTION: ACR is to approximate programming what OpenMP is to parallel programming. It is an API including a set of language extensions to provide the compiler with pertinent information about how to approximate a code block, a high-level compiler to automatically generate the approximated code, and a runtime library to exploit the approximation information at runtime according to the dataset properties. ACR is designed to provide approximate computing to non experts. The programmer may write a trivial code without approximation, provide approximation information thanks to pragmas, and let the compiler generate an optimized code based on approximation.

- Contact: Cédric Bastoul
- URL: https://github.com/Syllo/acr

6.13. 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

CARAMBA Project-Team

6. New Software and Platforms

6.1. Belenios

Belenios - Verifiable online voting system

KEYWORD: E-voting

FUNCTIONAL DESCRIPTION: Belenios is an open-source 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. Moreover, Belenios includes a practical threshold decryption system that allows splitting the decryption key among several authorities.

NEWS OF THE YEAR: Since 2015, it has been used by CNRS for remote election among its councils (more than 30 elections every year) and since 2016, it has been used by Inria to elect representatives in the "comités de centre" of each Inria center. In 2018, it has been used to organize about 250 elections (not counting test elections). Belenios is typically used for elections in universities as well as in associations. This goes from laboratory councils (e.g. Irisa, Cran), scientific societies (e.g. SMAI) to various associations (e.g. FFBS - Fédération Française de Baseball et Softball, or SRFA - Société du Rat Francophone et de ses Amateurs).

In 2019, a threshold encryption mode has been added that makes the system more robust to the case where (say) one trustee among three loses her part of the decryption key.

- Participants: Pierrick Gaudry, Stéphane Glondu and Véronique Cortier
- Partners: CNRS - Inria
- Contact: Stéphane Glondu
- URL: http://www.belenios.org/

6.2. 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.

NEWS OF THE YEAR: The main program for relation collection now supports composite "special-q". The memory footprint of the central step of linear algebra was reduced. Parallelism of many of the Cado-NFS programs was improved considerably (sieving, relation filtering, as well as the central step of linear algebra).

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

6.3. Platforms

6.3.1. Platform: computational resources

Since 2018, the CARAMBA team has been using in particular a computer cluster called `grvingt`, acquired in 2018. This equipment was funded by the CPER «CyberEntreprises» (French Ministry of Research, Région Grand Est, Inria, CNRS) and comprises a 64-node, 2,048-core cluster. This cluster is installed in the Inria facility. Other slightly older hardware (a medium-size cluster called `grcinq` from 2013, funded by ANR, and a special machine funded by the aforementioned CPER grant) is also installed in the same location, to form a coherent platform with about 3,000 cpu cores, 100 TB of storage, and specific machines for RAM-demanding computations. As a whole, this platform provides an excellent support for the computational part of the work done in CARAMBA. This platform is also embedded in the larger Grid'5000/Silecs platform (and accessible as a normal resource within this platform). Technical administration is done by the Grid'5000 staff.

This equipment has played a key role in the record factorization of RSA-240 as well as the computation of discrete logarithms modulo a 240-digit prime, completed in the end of 2019.

GAMBLE Project-Team

6. New Software and Platforms

6.1. 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.

NEWS OF THE YEAR: Integration into CGAL 4.14

- Authors: Iordan Iordanov and Monique Teillaud
- Contact: Monique Teillaud
- Publication: Implementing Delaunay Triangulations of the Bolza Surface
- URL: https://doc.cgal.org/latest/Manual/packages.html#PkgPeriodic4HyperbolicTriangulation2

6.2. 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.

NEWS OF THE YEAR: Integration into CGAL 4.14

- Participants: Mikhail Bogdanov, Olivier Devillers, Iordan Iordanov and Monique Teillaud
- Contact: Monique Teillaud
- Publication: Hyperbolic Delaunay Complexes and Voronoi Diagrams Made Practical
- URL: https://doc.cgal.org/latest/Manual/packages.html#PkgHyperbolicTriangulation2

6.3. clenshaw

KEYWORDS: Numerical solver - Visualization - Polynomial equations

FUNCTIONAL DESCRIPTION: Clenshaw is a mixed C and python library that provides computation and plotting functions for the solutions of polynomial equations in the Taylor or the Chebyshev basis. The library is optimized for machine double precision and for numerically well-conditioned polynomials. In particular, it can find the roots of polynomials with random coefficients of degree one million.

- Contact: Guillaume Moroz
- URL: https://gitlab.inria.fr/gmoro/clenshaw

6.4. voxelize

KEYWORDS: Visualization - Curve plotting - Implicit surface - Polynomial equations

FUNCTIONAL DESCRIPTION: Voxelize is a C++ software to visualize the solutions of polynomial equations and inequalities. The software is optimized for high degree curves and surfaces. Internally, polynomials and sets of boxes are stored in the Compressed Sparse Fiber format. The output is either a mesh or a union of boxes written in the standard 3D file format ply.

RELEASE FUNCTIONAL DESCRIPTION: This is the first published version.

- Contact: Guillaume Moroz
- URL: https://gitlab.inria.fr/gmoro/voxelize

<p style="text-align:center; color:red">MOCQUA Team</p>

6. New Software and Platforms

6.1. FiatLux

KEYWORDS: Cellular automaton - Multi-agent - Distributed systems

SCIENTIFIC DESCRIPTION: FiatLux is a discrete dynamical systems simulator that allows the user to experiment with various models and to perturb them. It includes 1D and 2D cellular automata, moving agents, interacting particle systems, etc. Its main feature is to allow users to change the type of updating, for example from a deterministic parallel updating to an asynchronous random updating. FiatLux has a Graphical User Interface and can also be launched in a batch mode for the experiments that require statistics.

FUNCTIONAL DESCRIPTION: FiatLux is a cellular automata simulator in Java specially designed for the study of the robustness of the models. Its main distinctive features is to allow to perturb the updating of the system (synchrony rate) and to perturb the topology of the grid.

- Participants: Nazim Fatès and Olivier Boure
- Partners: ENS Lyon - Université de Lorraine
- Contact: Nazim Fatès
- URL: http://fiatlux.loria.fr/

6.2. ComplexityParser

KEYWORDS: Complexity - Static typing - Parsing

FUNCTIONAL DESCRIPTION: ComplexityParser is a static complexity analyzer of Java programs written in Java (approximatively 5000 lines of code). The program consists in a type inference and checking program based on the data tiering principle. It allows the program to certify that the typed program has a polynomial time complexity.

- Participants: Olivier Zeyen, Emmanuel Hainry, Romain Péchoux and Emmanuel Jeandel
- Contact: Emmanuel Hainry

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, as well as the exclusive or (xor) operator.

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

6.2. Belenios

Belenios - Verifiable online voting system

KEYWORD: E-voting

FUNCTIONAL DESCRIPTION: Belenios is an open-source 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. Moreover, Belenios includes a practical threshold decryption system that allows splitting the decryption key among several authorities.

NEWS OF THE YEAR: Since 2015, it has been used by CNRS for remote election among its councils (more than 30 elections every year) and since 2016, it has been used by Inria to elect representatives in the "comités de centre" of each Inria center. In 2018, it has been used to organize about 250 elections (not counting test elections). Belenios is typically used for elections in universities as well as in associations. This goes from laboratory councils (e.g. Irisa, Cran), scientific societies (e.g. SMAI) to various associations (e.g. FFBS - Fédération Française de Baseball et Softball, or SRFA - Société du Rat Francophone et de ses Amateurs).

In 2019, a threshold encryption mode has been added that makes the system more robust to the case where (say) one trustee among three loses her part of the decryption key.

- Participants: Pierrick Gaudry, Stéphane Glondu and Véronique Cortier
- Partners: CNRS - Inria
- Contact: Stéphane Glondu
- URL: http://www.belenios.org/

6.3. Deepsec

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. The tool also implements state-of-the-art partial order reductions and allows to distribute the computation on multiple cores and multiple machines.

NEWS OF THE YEAR: In 2019, to improve efficiency for non-determinate processes, we developed new optimisation techniques. This is achieved through a new, stronger equivalence for which partial-order reductions are sound even for non-determinate processes, as well as new symmetry reductions. We demonstrated that these techniques provide a significant (several orders of magnitude) speed-up in practice, thus increasing the size of the protocols that can be analysed fully automatically. Even though the new equivalence is stronger, it is nevertheless coarse enough to avoid false attacks on most practical examples.

- Participants: Steve Kremer, Itsaka Rakotonirina and Vincent Cheval
- Contact: Vincent Cheval
- Publications: Exploiting Symmetries When Proving Equivalence Properties for Security Protocols - Exploiting symmetries when proving equivalence properties for security protocols (Technical report) - DEEPSEC: Deciding Equivalence Properties in Security Protocols Theory and Practice - DEEPSEC: Deciding Equivalence Properties in Security Protocols - Theory and Practice - The DEEPSEC prover
- URL: https://deepsec-prover.github.io/

6.4. 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 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/

6.5. SAPIC

SAPIC: Stateful Applied Pi Calculus

KEYWORDS: Security - Verification

FUNCTIONAL DESCRIPTION: SAPIC is a plugin of the TAMARIN 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 by 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 notion of location and reporting used for modelling trusted execution environments. It has been successfully applied to 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.

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

6.6. TypeEquiv

A type checker for privacy properties

KEYWORDS: Security - Cryptographic protocol - Privacy

FUNCTIONAL DESCRIPTION: TypeEquiv provides a (sound) type system for proving equivalence of protocols (to analyse privacy properties such as vote privacy, anonymity, unlinkability), for both a bounded or an unbounded number of sessions and for the standard cryptographic primitives. 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. The tool provides a significant speed-up compared with tools that decide equivalence of security protocols for a bounded number of sessions.

- Partner: Technische Universität Wien
- Contact: Véronique Cortier

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: Parts of the Redlog code are 25 years old now. Version 1 of the underlying computer algebra system Reduce has been published even 50 years ago. In 2018 we therefore started to go for major revisions and improvements of Redlog's software architecture, which are still under way.

Redlog, as well as the underlying Reduce, depends on a quite minimalistic Lisp 1 dialect called Standard Lisp. Today, there are two independent implementations of Standard Lisp left, which are supported only on the basis of private commitment of essentially one individual per Lisp. With the large code base of Redlog plus the necessary algebraic algorithms from Reduce, a migration to a different language or computer algebra system is not feasible. We are therefore experimenting with the realization of a Standard Lisp on the basis of ANSI Common Lisp.

Scientifically we are currently improving on Parametric Gaussian Elimination in Reduce/Redlog, which has various applications in our bilateral interdisciplinary ANR/DFG project SYMBIONT (Symbolic Methods for Biological Networks), e.g., classification of real singularities of systems of implicit ordinary differential equations.

- 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.

SPASS 3.9 has been used as the basis for SPASS-AR, a 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. SPASS-SATT

KEYWORDS: Automated deduction - Decision

SCIENTIFIC DESCRIPTION: SPASS -SATT is an SMT solver for the theories of linear integer arithmetic, linear rational arithmetic and mixed linear arithmetic. It features new tests for the satisfiability of unbounded systems, as well as new algorithms for the detection of integer solutions.

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.

FUNCTIONAL DESCRIPTION: SPASS-SATT is an SMT solver for linear integer arithmetic, mixed linear arithmetic and rational linear arithmetic.

NEWS OF THE YEAR: SPASS-SATT participated in the SMT competition 2019 in the quantifier free integer and rational linear arithmetic categories. It scored first on rational linear arithmetic and second on integer linear arithmetic. (The winner of the latter category was a portfolio solver that includes SPASS-SATT.) The main improvements are due to an advanced translation to clause normal form, a close interaction between the theory and the SAT solvers, and a new transformation turning unbounded integer problems into bounded integer problems.

- Participants: Martin Bromberger, Mathias Fleury and Christoph Weidenbach
- Contact: Martin Bromberger
- URL: https://www.mpi-inf.mpg.de/departments/automation-of-logic/software/spass-workbench/spass-satt/

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 2019 have been focused on quantifier handling, higher logic, and proof production.

The veriT solver participated in the SMT competition SMT-COMP 2019 with good results. In particular, it took the bronze medal in the QF_UF division, solving as many problems as the two leading solvers but taking somewhat more time.

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, and it is integrated within *Atelier B*.

veriT is also a prototype platform for ideas developed within the Matryoshka project, aiming at greater availability of automated reasoning for proof assistants.

- 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. SPIKE

KEYWORDS: Proof - Automated deduction - Automated theorem proving - Term Rewriting Systems - Formal methods

SCIENTIFIC DESCRIPTION: SPIKE, an automatic induction-based theorem prover built to reason on conditional theories with equality, is one of the few formal tools able to perform automatically mutual and lazy induction. Designed in the 1990s, it has been successfully used in many non-trivial applications and served as a prototype for different proof experiments and extensions.

FUNCTIONAL DESCRIPTION: Automated induction-based theorem prover

RELEASE FUNCTIONAL DESCRIPTION: Proof certification with Coq, cyclic induction, decision procedures

- Participant: Sorin Stratulat
- Contact: Sorin Stratulat
- URL: https://github.com/sorinica/spike-prover/wiki

6.6. TLAPS

TLA+ proof system

KEYWORD: Proof assistant

SCIENTIFIC 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.

FUNCTIONAL DESCRIPTION: TLAPS is a proof assistant for the TLA+ specification language.

NEWS OF THE YEAR: Work in 2019 focused on providing support for reasoning about TLA+'s ENABLED and action composition constructs. We also prepared a minor release, fixing some issues and switching to Z3 as the default SMT back-end solver.

- Participants: Damien Doligez, Stephan Merz and Ioannis Filippidis
- Contact: Stephan Merz
- URL: https://tla.msr-inria.inria.fr/tlaps/content/Home.html

6.7. Apalache

Abstraction-based Parameterized TLA+ Checker

KEYWORD: Model Checker

SCIENTIFIC DESCRIPTION: Apalache is a symbolic model checker that works under the following assumptions:

(1) As in TLC, all specification parameters are fixed and finite, e.g., the system is initialized integers, finite sets, and functions of finite domains and co-domains. (2) As in TLC, all data structures evaluated during an execution are finite, e.g., a system specification cannot operate on the set of all integers. (3) Only finite executions up to a given bound are analysed.

Apalache translates bounded executions of a TLA+ specifications into a set of quantifier-free SMT constraints. By querying the SMT solver, the model checker either finds a counterexample to an invariant, or proves that there is no counterexample up to given computation length.

FUNCTIONAL DESCRIPTION: The first version implements a symbolic bounded model checker for TLA$^+$ that runs under the same assumptions as the explicit-state model checker TLC. It checks whether a TLA$^+$ specification satisfies an invariant candidate by checking satisfiability of an SMT formula that encodes: (1) an execution of bounded length, and (2) preservation of the invariant candidate in every state of the execution. Our tool is still in the experimental phase, due to a number of challenges posed by the semantics of TLA$^+$ to SMT solvers.

NEWS OF THE YEAR: In 2019, we have simplified the set of rewriting rules, which are used in the translation from TLA+ to SMT. We have shown that the rules are sound, that is, that the translator produces a set of SMT constraints that are equisatisfiable to the given TLA+ formula. We have conducted the experiments on 10 TLA+ specifications of distributed algorithms. When running bounded model checking, Apalache outperforms TLC in some cases. When checking inductive invariants, Apalache runs significantly faster than TLC. These results were reported at ACM OOPSLA 2019.

- Partner: Technische Universität Wien
- Contact: Igor Konnov
- Publications: hal-01899719v1 - hal-01871131v1 - hal-02280888v1
- URL: https://forsyte.at/research/apalache/

6.8. IMITATOR

KEYWORDS: Verification - Parametric model - Parameter synthesis - Model Checking - Model Checker - Timed automata

FUNCTIONAL DESCRIPTION: IMITATOR is a software tool for parametric verification and robustness analysis of real-time systems with parameters. It relies on the formalism of networks of parametric timed automata, augmented with integer variables and stopwatches.

- Participants: Etienne Andre and Jaime Eduardo Arias Almeida
- Partner: Loria
- Contact: Etienne Andre
- Publications: The Inverse Method - Formalizing Time4sys using parametric timed automata - Minimal-Time Synthesis for Parametric Timed Automata - A benchmark library for parametric timed model checking
- URL: https://www.imitator.fr/

6.9. ByMC

Byzantine Model Checker

KEYWORDS: Model Checker - Distributed computing - Verification

SCIENTIFIC DESCRIPTION: In recent work, we have introduced a series of techniques for automatic verification of threshold-guarded distributed algorithms that have the following features: (1) up to t of n processes may exhibit crash or Byzantine failures, (2) the correct processes count messages and progress when they receive sufficiently many messages, e.g., at least $t + 1$, (3) the number n of processes in the system is a parameter, as well as t, (4) and the parameters are restricted by a resilience condition, e.g., $n > 3t$.

ByMC supports a parallel mode, which allows one to run verification experiments in an MPI cluster such as Grid5000 and Vienna Scientific Cluster.

FUNCTIONAL DESCRIPTION: ByMC implements several techniques for the parameterized verification of threshold-guarded distributed algorithms such as reliable broadcast, one-step Byzantine consensus, non-blocking atomic commit, condition-based consensus, and randomized consensus. The tool accepts two kinds of inputs: (i) threshold automata (the framework of our verification techniques) and (ii) Parametric Promela (which is similar to the way in which the distributed algorithms are presented in the distributed computing literature). Internally, the tool analyzes representative executions by querying an SMT solver. Apart from verification, ByMC also implements a technique for the automatic synthesis of threshold guards.

The tool can run on a single computer as well as in an MPI cluster, e.g., Grid5000 or Vienna Scientific Cluster.

NEWS OF THE YEAR: In 2019, we have shown how to apply ByMC to randomized fault-tolerant consensus algorithms such as randomized consensus by Ben-Or and RS-BOSCO. This result was presented at CONCUR 2019.

- Partner: Technische Universität Wien
- Contact: Igor Konnov
- Publications: ByMC: Byzantine Model Checker - Reachability in Parameterized Systems: All Flavors of Threshold Automata - Model Checking of Fault-Tolerant Distributed Algorithms: from Classics towards Contemporary - Verification of Randomized Distributed Algorithms under Round-Rigid Adversaries
- URL: https://forsyte.at/software/bymc/

<h2 style="text-align:center">SPHINX Project-Team</h2>

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. GPELab

Gross-Pitaevskii equations Matlab toolbox

KEYWORDS: 3D - Quantum chemistry - 2D

FUNCTIONAL DESCRIPTION: GPELab 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/

5. New Software and Platforms

5.1. diamss

KEYWORDS: High-performance calculation - Computation - Stochastic process

FUNCTIONAL DESCRIPTION: Numerical resolution of Keller-Segel equations and everal numerical tests.

- Participants: Denis Talay, Hector Olivero-Quinteros and Milica Tomasevic
- Contact: Denis Talay

5.2. ExitBM

FUNCTIONAL DESCRIPTION: The exitbm library provides methods to simulate random variables related to the first exit time and position of the Brownian motion from simple domains, namely intervals, squares and rectangles.

- Participants: Antoine Lejay and Madalina Deaconu
- Contact: Antoine Lejay
- URL: http://exitbm.gforge.inria.fr/

5.3. 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

5.4. SDM

Stochastic Downsaling Method

FUNCTIONAL DESCRIPTION: The computation of the wind at small scale and the estimation of its uncertainties is of particular importance for applications such as wind energy resource estimation. To this aim, starting in 2005, we have developed a new method based on the combination of an existing Numerical Weather Prediction model providing a coarse prediction, and a Lagrangian Stochastic Model for turbulent flows. This Stochastic Downscaling Method (SDM) requires a specific modeling of the turbulence closure, and involves various simulation techniques whose combination is totally original (such as Poisson solvers, optimal transportation mass algorithm, original Euler scheme for confined Langevin stochastic processes, and stochastic particle methods).

- Participants: Antoine Rousseau, Antoine Rousseau, Claire Chauvin, Frederic Bernardin and Mireille Bossy
- Contact: Mireille Bossy

5.5. SDM-Log

- Participants: Antoine Rousseau, Claire Chauvin, Frederic Bernardin, Jacques Morice and Mireille Bossy
- Contact: Mireille Bossy

5.6. 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

5.7. WindPoS-ATM

KEYWORDS: 3D - Co-simulation - Fluid mechanics

- Authors: Philippe Drobinski, Antoine Rousseau, Mireille Bossy, Jacques Morice and Thomas Dubos
- Partners: Ecole Polytechnique - Laboratoire de Météorologie Dynamique
- Contact: Mireille Bossy
- URL: https://windpos.inria.fr/projects/windpos/

5.8. WindPoS-CIV

WinsPoS-CIV (Configuration Interface and Visualization)

- Authors: Sélim Kraria, Antoine Rousseau and Mireille Bossy
- Contact: Mireille Bossy

5.9. SBM

Skew Brownian Motion

KEYWORDS: Monte-Carlo methods - Skew Brownian Motion

FUNCTIONAL DESCRIPTION: SBM is a code allowing exact or approximated simulations of the Skew Brownian Motion. This code is used for the simulation, with a Monte-Carlo approach, of a 1D diffusion process with a discontinuous diffusion coefficient. Several benchmark tests are also implemented.

NEWS OF THE YEAR: - Refactoring and Cmake compilation - Automatic non regression tests on ci-inria.fr - Full documentation - Open source project on gitlab-inria

- Authors: Antoine Lejay and Géraldine Pichot
- Contact: Antoine Lejay
- Publication: Simulating diffusion processes in discontinuous media: Benchmark tests
- URL: https://gitlab.inria.fr/lejay/sbm

BIGS Project-Team

6. New Software and Platforms

6.1. 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

6.2. ARMADA

A Statistical Methodology to Select Covariates in High-Dimensional Data under Dependence

KEYWORDS: Biostatistics - Aggregated methods - High Dimensional Data - Personalized medicine - Variable selection

FUNCTIONAL DESCRIPTION: Two steps variable selection procedure in a context of high-dimensional dependent data but few observations. First step is dedicated to eliminate dependence between variables (clustering of variables, followed by factor analysis inside each cluster). Second step is a variable selection using by aggregation of adapted methods. https://hal.archives-ouvertes.fr/hal-02173568

NEWS OF THE YEAR: This package is a new one.

- Participants: Aurélie Muller and Anne Gégout-Petit
- Contact: Aurélie Muller
- Publication: Package 'armada' : A Statistical Methodology to Select Covariates in High-Dimensional Data under Dependence
- URL: https://cran.r-project.org/web/packages/armada/

6.3. kosel

Variable Selection by Revisited Knockoffs Procedures

KEYWORDS: Variable selection - Regression

FUNCTIONAL DESCRIPTION: Performs variable selection for many types of L1-regularised regressions using the revisited knockoffs procedure. This procedure uses a matrix of knockoffs of the covariates independent from the response variable Y. The idea is to determine if a covariate belongs to the model depending on whether it enters the model before or after its knockoff. The procedure suits for a wide range of regressions with various types of response variables. Regression models available are exported from the R packages 'glmnet' and 'ordinalNet'. Based on the paper linked to via the URL below: Gegout A., Gueudin A., Karmann C. (2019) https://arxiv.org/abs/1907.03153

NEWS OF THE YEAR: This package is a new one.

- Participants: Clémence Karmann, Aurélie Muller and Anne Gégout-Petit
- Contact: Aurélie Muller
- Publication: The revisited knockoffs method for variable selection in L_1-penalised regressions.
- URL: https://cran.r-project.org/web/packages/kosel/kosel.pdf

6.4. 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/

6.5. 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

6.6. HSPOR

Hidden Smooth Polynomial Regression for Rupture Detection

KEYWORDS: Polynomial regression - Rupture detection

FUNCTIONAL DESCRIPTION: Several functions that allow by different methods to infer a piecewise polynomial regression model under regularity constraints, namely continuity or differentiability of the link function. The implemented functions are either specific to data with two regimes, or generic for any number of regimes, which can be given by the user or learned by the algorithm.

NEWS OF THE YEAR: This package is a new one

- Participants: Florine Greciet, Romain Azais and Anne Gégout-Petit
- Contact: Florine Greciet
- URL: https://cran.r-project.org/web/packages/HSPOR/

CAPSID Project-Team

6. New Software and Platforms

6.1. lib3Dmol

Library in Rust for manipulating 3D representations of molecules

KEYWORDS: 3D modeling - Proteins - Molecules - Rust

FUNCTIONAL DESCRIPTION: The lib3Dmol library can be called by programs written in Rust for 3D modelling of biomolecules and their interactions.

RELEASE FUNCTIONAL DESCRIPTION: The 0.2.0 version can be used with any type of biomolécule.

- Contact: Philippe Noel
- URL: http://mbi.loria.fr

6.2. QRMSDmap

Parallelized computation of RMSD map of molecular structures after 3D alignment based on the quaternion method.

KEYWORDS: Molecules - RMSD - Rust - Bioinformatics

FUNCTIONAL DESCRIPTION: This program allows fast computing of 3D alignments and 3D distances on a large number of biomolecular structures.

RELEASE FUNCTIONAL DESCRIPTION: This 2.3.2 version improves CPU parallelization and decreases memory consumption.

- Contact: Philippe Noel
- URL: http://mbi.loria.fr

6.3. EROS-DOCK

Exhaustive Rotational Search using Branch-and-Bound algorithm for rigid docking

KEYWORDS: 3D modeling - Proteins - Docking

FUNCTIONAL DESCRIPTION: EROS-DOCK is a protein-protein docking program for Linux. It takes in input the 3D structures of two proteins in PDB format, and gives as output a list of transformation matrices describing the most probable relative positions of the two proteins in nature, together with a score (approximation of their binding energy for that position). On a modern workstation, docking times is in the order of few hours for a blind global search. The user can also provide nowledge of particular contact points at the surface of each protein, which accelerates the pruning of the solutions space. The underlying algorithm uses a pi-ball representation of the rotational 3D space, to accelerate the search for close-fitting orientations of the two molecules by a branch-and-bound technique.

- Contact: Isaure Chauvot de Beauchêne
- URL: https://erosdock.loria.fr

6.4. NAFRAGDB

Databases of nucleic acids fragments bound to proteins

KEYWORDS: Structural Biology - Nucleic Acids - Data base

FUNCTIONAL DESCRIPTION: NAfragDB is a python-based software for (i) the automated parsing, correction and annotation of all protein - nucleic acid structures in the public Protein Data Bank, (ii) the creation of libraries of non-redundant RNA/DNA structural fragments, (iii) the selection of sets of structures by customized queries, and (iv) the computation of statistics on sets of RNA/DNA - protein structures.

- Contact: Isaure Chauvot de Beauchêne

6.5. RNA-PDBComplete

Completing RNA structures in PDB files

KEYWORDS: Nucleic Acids - Structural Biology

FUNCTIONAL DESCRIPTION: PDBcomplete is a software and a webserver for the completion of missing atoms in an RNA structure provided in PDB format. PDBcomplete is capable of taking into account the presence of other molecules in the overall PDB structure to avoid atoms collisions. It uses as template an in-house library of mono-nucleotide libraries created with the NAfragDB tool.

- Contact: Isaure Chauvot de Beauchêne
- URL: https://pdbcomplete.loria.fr/

6.6. MBI platform for structural bioinformatics

Initiated during the previous CPER projects Intelligence Logicielle (1999-2005) and MISN: Modelisation, Interactions et Systèmes Numériques (2006-2013), the MBI platform (MBI = Modelling Biomolecules and their Interactions) is today part of the SMEC platform coordinated by MD Devignes and M Smaïl-Tabbone (SMEC: Simulation, Modélisation et Extraction de Connaissances), in the frame of the ongoing CPER projet ITM2P (Innovations Technologiques et Modélisation pour la Médecine Personnalisée ; 2015-2020). The MBI platform is composed of several HPC and storage servers that are shared between users mostly for structural bioinformatics usages. The MBI platform is part of the bioinformatic platform network of the French Institute of Bioinformatics (IFB ; http://www.france-bioinformatique.fr.

- Participants: Marie-Dominique Devignes [contact person], Isaure Chauvot de Beauchêne, Sjoerd de Vries, Antoine Moniot, Emmanuel Bresso, Philippe Noel, Patrice Ringot.
- URL: https://mbi.loria.fr

<p align="center" style="color:red">**MIMESIS Team**</p>

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: Hugo Talbot
- URL: http://www.sofa-framework.org

6.2. SofaNeedleInsertion

Needle Insertion Plugin

KEYWORD: Simulation

FUNCTIONAL DESCRIPTION: This plugin contains needle/tissue interaction models for real-time simulations of needle insertion in deformable objects using the open-source sofa frame-work. This allows for modeling the different forces playing a role during the insertion process (penetration forces, friction along the shaft...) using a constrained-based formulation. This formulation provides a fast and stable solution for the simulation of complex insertions (and reinsertion) of the needle in deformations Finite Element models

- Contact: Hadrien Courtecuisse

6.3. SOFA Optimus

Optimization methods in SOFA: stochastic filtering and data assimilation.

KEYWORDS: Data assimilation - Kalman filter - Stochastic optimization

FUNCTIONAL DESCRIPTION: Optimus is a plugin to work with advanced methods of state estimation and parameter identification. It was created to provide a testing environment for data-driven physics-based modeling (typically finite elements). While currently the plugin implements only stochastic methods based on Kalman filtering, its architecture allows for the implementation of generic prediction–correction schemes where the model is employed as a predictor and correction is performed using given observation data.

- Contact: Stéphane Cotin
- URL: https://gitlab.inria.fr/mimesis/Optimus

<p style="text-align:center; color:red;">**NEUROSYS Project-Team**</p>

6. New Software and Platforms

6.1. 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 60000 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: Cedric Riou, Thierry Gaugry, Anatole Lécuyer, Fabien Lotte, Jussi Tapio Lindgren, Laurent Bougrain, Maureen Clerc and Théodore Papadopoulo
- Partners: INSERM - GIPSA-Lab
- Contact: Anatole Lécuyer
- URL: http://openvibe.inria.fr

TONUS Project-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 Insitute - 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.

- Participants: Philippe Helluy, Matthieu Boileau and Bérenger Bramas
- Contact: Philippe Helluy
- URL: http://schnaps.gforge.inria.fr/

6.4. Slappy

KEYWORDS: Python - Opencl

FUNCTIONAL DESCRIPTION: The code Slappy solves the advection equations on multi-patch and non-conform complex geometries with the Semi-Lagrangian method. Using this we can also treat some hyperbolic/parabolic PDE with the Approximate BGK method which, allows to write a PDE as a transport plus a local relaxation step. The code is written in PyOpcenCL and can be used on CPU/GPU.

- Contact: Emmanuel Franck

6.5. Patapon

Parallel Task in Python

KEYWORDS: Python - Parallel computing - High order time schemes

FUNCTIONAL DESCRIPTION: Patapon is a code in PyOpenCL which allows to solve PDE like MHD using the vectorial Lattice Boltzmann method on Cartesian grids.

- Participant: Philippe Helluy
- Contact: Philippe Helluy

6.6. tofu

Tomography for Fusion

KEYWORDS: 3D - Data visualization - Visualization - Magnetic fusion - Tomography - Diagnostics - Plasma physics - Ray-tracing - Python

FUNCTIONAL DESCRIPTION: tofu aims at providing the fusion and plasma community with an object-oriented, transparent and documented tool for designing tomography diagnostics, computing synthetic signal (direct problem) as well as tomographic inversions (inverse problem). It gives access to a full 3D description of the diagnostic geometry, thus reducing the impact of geometrical approximations on the direct and, most importantly, on the inverse problem.

RELEASE FUNCTIONAL DESCRIPTION: Python 2.7 is not supported anymore Python 3.6 and 3.7 are supported Several changes to try and make installation easier (on clusters, windows, mac....) and less verbose for users More explicit names for default saved configurations Major bug fix in one of the methods for computing synthetic signal Minor bug fixes in interactive figures Minor bug fixes in Plasma2D interpolation New configuration (ITER) available First version of a class handling 2D XRay bragg spectrometers First tools for magnetic field line tracing available on WEST Better documentation, more ressources More informative error messages extra tools for computing LOS length, closest point to magnetic axis... Better PEP8 compliance

- Partner: CEA
- Contact: Laura Mendoza
- URL: https://github.com/ToFuProject/tofu

<div style="text-align:center">**COAST Project-Team**</div>

6. New Software and Platforms

6.1. MUTE

Multi-User Text Editor

KEYWORD: Collaborative systems

SCIENTIFIC DESCRIPTION: MUTE is a peer 2 peer collaborative editing platform that is used to evaluate replication algorithms in editing situations regarding their performances and to understand how it affects user experience.

FUNCTIONAL DESCRIPTION: Existing collaborative systems generally rely on a service provider that stores and has control over user data which is a threat for privacy. MUTE (Multi-User Text Editor) is a web-based real-time collaborative editor that overcomes this limitation by using a peer-to-peer architecture relying on WebRTC. Several users may edit in real-time a shared document and their modifications are immediately sent to the other users without transiting through a central server. Our editor offers support for working offline while still being able to reconnect at a later time, which gives it a unique feature. Data synchronisation is achieved by using the LogootSplit algorithm developed by team Coast.

NEWS OF THE YEAR: In 2019 we implemented a new algorithm, dotted logoot-split. We integrated a group key management algorithm to evaluate a secure version of the algorithm in dynamic situation. We also incorporated probes to evaluate collaboration situation.

- Participants: Claudia Ignat, François Charoy, Gérald Oster, Luc André, Matthieu Nicolas and Victorien Elvinger
- Contact: Gérald Oster
- URL: https://github.com/coast-team/mute

<p style="text-align:center; color:red">**RESIST Team**</p>

6. New Software and Platforms

6.1. Distem

KEYWORDS: Large scale - Experimentation - Virtualization - Emulation

FUNCTIONAL DESCRIPTION: Distem is a distributed systems emulator. When conducting research on Cloud, P2P, High Performance Computing or Grid systems, it can be used to transform an homogenenous 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).

RELEASE FUNCTIONAL DESCRIPTION: New features in Distem 1.3 include: (1) New network emulation parameters: loss, duplication, corruption, reordering and jitter, (2) Support for Debian Stretch, (3) Added many tests, (4) Moved project from GForge to GitHub (https://github.com/madynes/distem).

NEWS OF THE YEAR: New version 1.3

- 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

Grid'5000 testbed

KEYWORDS: HPC - Cloud - Big data - Testbeds

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. 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.

NEWS OF THE YEAR: This year's highlights include the TILECS workshop, and various improvements (update to Debian 10, several new clusters including the addition of 72 GPUs, etc.). More information on https://www.grid5000.fr/w/News

- Participants: Christian Pérez, David Loup, Frédéric Desprez, Laurent Lefèvre, Laurent Pouilloux, Marc Pinhède, Simon Delamare, Lucas Nussbaum, Teddy Valette and Alexandre Merlin
- Contact: Lucas Nussbaum
- URL: https://www.grid5000.fr/

6.3. SCUBA

A Tool Suite for the automated security assessment of IoT environments

KEYWORDS: Cybersecurity - Internet of things - Machine learning - Artificial intelligence

FUNCTIONAL DESCRIPTION: IoT devices are used in different fields of application, not only for the general public, but also in industrial environments. SCUBA is tool suite for the security assessment of industrial and general public IoT devices. It mainly relies on collected information through passive and active scanning of a running IoT device in its exploitation environment to build its Security Knowledge Base (SKB). The knowledge base contains all relevant information of the device regarding its network communications extracted from PCAP files, the enumeration of its used hardware and software represented in the CPE (Common Platform Enumeration) format, the list of its known vulnerabilities in the CVE (Common Vulnerabilities and Exposures) format associated to their CWE (Common Weakness Enumeration) and CAPEC (Common Attack Pattern Enumeration and Classification) descriptions. The SKB is used by SCUBA to predict the intrusion chains associated to an IoT device and its environment. SCUBA tries to be as automated as possible to face the large scale and the great heterogeneity of IoT networks.

NEWS OF THE YEAR: First release

- Participants: Abdelkader Lahmadi, Frédéric Beck, Thomas Lacour and Jérôme François
- Contact: Abdelkader Lahmadi

6.4. Platforms

6.4.1. *CPS Security Assessment Platform*

NEWS OF THE YEAR :

During 2019, we have extended our IoT (Internet of Things) and CPS (Cyber-Physical Systems) security assessment platform with more IoT devices dedicated to home networks (Alexa and Google Home voice assistants, smart door bell, smart door lock, alarm system). The platform is used for several demonstrations and it is extensively used for the development carried on the SCUBA (see 6.3) tool suite to automate the assessment of the security of IoT and SCADA systems by using ML/AI methods.

- Participants: Abdelkader Lahmadi, Frédéric Beck, Thomas Lacour and Jérôme François
- Contact: Abdelkader Lahmadi

ALICE Team

6. New Software and Platforms

6.1. VORPALINE

VORPALINE mesh generator

KEYWORDS: 3D modeling - Unstructured heterogeneous meshes

SCIENTIFIC DESCRIPTION: This software is the result of the team's work on the parameterization of surfaces and volumes, on the generation of Voronoi diagrams and mesh generation.

FUNCTIONAL DESCRIPTION: VORPALINE is a surfacic and volumetric mesh generator, for simplicial meshes (triangles and tetrahedra), for quad-dominant and hex-dominant meshes. It also contains surfacic and volumic parameterization modules.

RELEASE FUNCTIONAL DESCRIPTION: Computer vision algorithms allow us to reconstruct surfaces in a 3d scene. The colours associated with these surfaces can be stored in textures, but these are often incomplete due to a lack of reliable data. For example, some points on the surface are not present in the images, are insufficiently illuminated or, on the contrary, in a reflection that does not give the true color of the object. We have developed in Vorpaline an algorithm capable of generating these missing colors from those present in their vicinity. The originality of our approach is the optimization according to the neighbourhoods defined on the surface and not in the texture space.

- Participants: Bruno Lévy, Dmitry Sokolov and Nicolas Ray
- Contact: Bruno Lévy
- URL: http://alice.loria.fr/index.php/erc-vorpaline.html

<p style="text-align:center; color:red">LARSEN Project-Team</p>

6. New Software and Platforms

6.1. ROS Qt Control

KEYWORDS: Control - Robot Operating System (ROS) - 2D

SCIENTIFIC DESCRIPTION: This ROS module allows to easily develop different controllers for wheeled mobile robots: Controller class just has to be inherited, the new class only needing a constructor and a chooseVelocities method. A graphical user interface using Qt makes it easy to choose a controller and to set its parameters, and it displays odometric data sent by ROS and the velocities sent to ROS by the controller.

NEWS OF THE YEAR: The code structure has been modified in order to propose a class hierarchy, with controllers aiming to reach a given state and others built to follow a selected trajectory.

- Participant: Alexis Scheuer
- Contact: Alexis Scheuer

6.2. ISeeML

Introducing a Smooth, Efficient and Easy-to-use Motion Library

KEYWORDS: Mobile Computing, Transportation - Optimal control - Planning

SCIENTIFIC DESCRIPTION: The main interest of this library is to offer smooth (continuous-curvature) efficient (close to the optimal) motions for mobile robots. Obtained paths correspond to locally optimal motions with constant velocity for wheeled mobile robots, either car-like or with differential-wheels (e.g. Thymio or Turtlebot). Classical paths (with a discontinuous curvature profile) are also provided. Both paths can also be used for aerial robots, as the motion constraints of those are similar to those of wheeled mobile robots.

RELEASE FUNCTIONAL DESCRIPTION: Additionnal functionnalities for optimal control using ROS.

NEWS OF THE YEAR: Additionnal functionnalities for optimal control using ROS.

- Participant: Alexis Scheuer
- Contact: Alexis Scheuer
- Publication: inria-00527913v1
- URL: http://iseeml.loria.fr

<p style="text-align:center">**MAGRIT Team**</p>

6. New Software and Platforms

6.1. 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

6.2. 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 [5].

- Contact: Gilles Simon
- URL: https://members.loria.fr/GSimon/fastvp/

6.3. NoLoDuDoCT

A non-local dual-domain cartoon and texture decomposition

KEYWORDS: Image analysis - Cartoon and texture decomposition

FUNCTIONAL DESCRIPTION: This is an algorithm decomposing images into cartoon and texture components. Spectrum components of textures are detected on the basis of a statistical hypothesis test, the null hypothesis modeling a purely cartoon patch. Statistics are estimated in a non-local way.

- Contact: Frédéric Sur
- Publication: A non-local dual-domain approach to cartoon and texture decomposition
- URL: https://members.loria.fr/FSur/software/NoLoDuDoCT/

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.

NEWS OF THE YEAR: Informal contacts told us that this library is used in academia and industry.

- Contact: Frédéric Sur
- Publication: The grid method for in-plane displacement and strain measurement: a review and analysis
- URL: http://www.thegridmethod.net/

6.5. BSpeckleRender

A Boolean model for deformed speckle rendering

KEYWORDS: Boolean model - Monte Carlo estimation - Experimental mechanics - Displacement fields

FUNCTIONAL DESCRIPTION: This library implements a new method for synthesizing speckle images deformed by an arbitrary deformation field set by the user. Such images are very useful for assessing the different methods based on digital image correlation (DIC) for estimating displacement fields in experimental mechanics. Since the deformations are very small, it is necessary to ensure that no additional bias is introduced by the image synthesis algorithm. The proposed method is based on the Monte Carlo evaluation of images generated by a Boolean model.

- Contact: Frédéric Sur
- Publication: Rendering Deformed Speckle Images with a Boolean Model
- URL: https://members.loria.fr/FSur/software/BSpeckleRender/

MFX Project-Team

6. New Software and Platforms

6.1. Chill

Chill, node-based graphical interface for IceSL

KEYWORDS: 3D - Additive manufacturing

SCIENTIFIC DESCRIPTION: ChiLL is an effort to explore visual modeling tools for IceSL. The core idea behind Chill is to propose a node-based modeling interface, which is a popular way to facilitate the design of 3D objects without going directly through code. Our approach creates a bridge between nodes-based editing and scripting, as the syntax for creating a new node is identical to the scripting language used in IceSL.

FUNCTIONAL DESCRIPTION: In Chill a user creates 3D shapes by connecting various nodes arranged in a directed graph. The shape visualization is updated instantly as the graph is modified.

NEWS OF THE YEAR: Chill was publicly released during the summer of 2019. We will broadly communicate about it in 2020.

- Participants: Jimmy Etienne, Pierre Bedell, Thibault Tricard, Yamil Salim Perchy and Sylvain Lefebvre
- Contact: Sylvain Lefebvre

6.2. IceSL

KEYWORD: Additive manufacturing

SCIENTIFIC DESCRIPTION: IceSL is the software developed within MFX, that serves as a research platform, a showcase of our research results, a test bed for comparisons and a vector of collaborations with both academic and industry partners. The software is freely available both as a desktop (Windows/Linux) and an online version.

FUNCTIONAL DESCRIPTION: IceSL allows users 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.

NEWS OF THE YEAR: In 2019, IceSL has been featured in news, exhibitions and fairs as a well-established tool for 3D printing. Additionally, since its inception, IceSL's community has grown significantly together with the number of new features included in it for slicing and modeling.

Regarding new features and additions to the software in 2019, IceSL has gone through many changes, primarily focused on improving the user experience and scalability/stability of algorithms. The most visible change is the complete rework of the slicing parameters GUI, with the addition of category-icons to allow for a quick access to settings. We can also note the upgrade of the renderer to support wide and high resolution screens, and the possibility to choose an experimental renderer (based on HCSG, published last year).

On the slicing front, we added new features, long requested, from the community: ironing, automatic spiralization, selection of different nozzle diameters, minimum time per layer, etc. A new GUI to customize the supports points was also added to help with the generation of supports.

The social community of IceSL has been growing steadily. Our twitter account has around 338 followers, 187 users frequently interacting in its Google forum (respectively, a progress of 69% and 25% since last year). Downloads have increased by 78% from last year (55K downloads total). In addition, Slicecrafter, the online version, has a cumulative of around 15K sliced objects.

- Participants: Frédéric Claux, Jean Hergel, Jérémie Dumas, Jonas Martinez-Bayona, Samuel Hornus, Sylvain Lefebvre, Pierre Bedell, Cédric Zanni, Noemie Vennin, Thibault Tricard, Jimmy Etienne, Yamil Salim Perchy and Pierre-Alexandre Hugron
- Contact: Sylvain Lefebvre
- URL: https://icesl.loria.fr

6.3. Platforms

Participants: Pierre Bedell, Noémie Vennin, Pierre-Alexandre Hugron.

We continued our active participation within the Creativ'Lab, a common experimental platform funded by Inria, Loria, CNRS and Région Grand Est. We added novel machines (DLP resin printers and large format printers) to explore new problems related to the specificity of each technology. We are also in the process of revisiting some of our techniques in the context of resin 3D printing.

This year we kept developing our custom-made hardware, in particular our color filament 3D printers. In this context we also elaborated our own colored PLA filament (using a filament extrusion device, PLA pellets and pigments). This was instrumental to the success of the corresponding research [15]. Finally, we started the assembly of a 3D printer based on a robotic arm, in the context of our research on curved 3D printing.

We are making these installations available to industrial partners and other research teams.

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.

FUNCTIONAL DESCRIPTION: Combines deep neural networks and multichannel signal processing for speech enhancement and separation of musical recordings.

NEWS OF THE YEAR: Version 1.1 was slightly modified in order to issue a test license to the French Ministry of Interior.

- Participants: Aditya Nugraha, Emmanuel Vincent and Antoine Liutkus
- 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: New models have been trained for German, as well as two bilingual models: one combining French and German phones, and one combining French and English phones. Also, a web server has been set up for on line real-time speech recognition.

- Participants: Dominique Fohr, Odile Mella, Mathieu Hu, Denis Jouvet and Irina Illina
- 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 the 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, etc.). 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.

RELEASE FUNCTIONAL DESCRIPTION: Version 3.0 integrates a phonetization based on a deep learning algorithm. In addition, the phonetization step is managed by API REST (client/server mode). The NLP part provides an output of descriptors in the format that can be used by HTS and Merlin systems.

NEWS OF THE YEAR: The latest version can use the LORIA-PHON deep learning based grapheme-to-phoneme converter through a web API.

- Participants: Alexandre Lafosse and Vincent Colotte
- Contact: Vincent Colotte

6.4. LORIA-PHON

LORIA grapheme-to-phoneme converter

KEYWORDS: Grapheme-to-phoneme converter - Neural networks

FUNCTIONAL DESCRIPTION: LORIA-PHON is a deep-learning based software for grapheme-to-phoneme conversion. It currently works for French. A web API is available for using it in a client/server mode. It properly interfaces with the SOJA software used for speech synthesis.

NEWS OF THE YEAR: new software

- Participants: Mathieu Hu, Denis Jouvet, Vincent Colotte and Louis Delebecque
- Contact: Vincent Colotte

6.5. Dynalips-Player

High realistic lip synchronization for 3d animated characters

KEYWORDS: 3D animation - Graphics - Speech Synthesis

FUNCTIONAL DESCRIPTION: Dynalips provides a solution to synchronize precisely and automatically the movements of the lips of a 3D character with speech (we address 3D animation movies and video games). We have developed a demonstrator that illustrates the whole process: from audio + text to the generation of the animation trajectory, and controlling the animation of a 3D model (e.g. an avatar). The demonstrator is composed mainly by the player developed in Unity 3D (but can be used with any other system) and plays the animation synchronously with speech in realtime. It is possible to generate an animation for Autodesk Maya 3D.

NEWS OF THE YEAR: The player has been extended to be multilingual thanks to two developments within two projects. In fact, within the METAL project, a lipsync for German has been developed. In addition, within the ATT Dynalips, we have built a lipsync for English.

- Partners: Université de Lorraine - Sayens (SATT Grand Est)
- Contact: Slim Ouni
- URL: http://www.dynalips.com

6.6. VisArtico

Visualization of multimodal speech data

KEYWORDS: Data visualization - 3D movement - Speech processing - Videos

SCIENTIFIC DESCRIPTION: VisArtico is a visualization software of multimodal data. It is possible to visualize the positions of real or virtual sensors and to animate them simultaneously with acoustics. This software can be useful for researchers in speech production, audiovisual speech synthesis or articulatory speech analysis.

FUNCTIONAL DESCRIPTION: VisArtico is a user-friendly software which allows visualizing multimodal data acquired by several systems: an articulograph, motion capture system, depth camera. This visualization software has been designed so that it can directly use the data provided by the different systems to display the spatial and temporal positions of the sensors (real and virtual). Moreover, VisArtico allows viewing the sensors augmented with visual information by indicating graphically the data for the tongue, lips and jaw.

RELEASE FUNCTIONAL DESCRIPTION: The current version allows the user to manage different modalities (articulatory, gestural, acoustic and video). It is possible to do automatic alignment, or even speech recognition. Several spatial data processing tools have been added (referential change, head movement suppression, merging data from multiple sources, ...).

NEWS OF THE YEAR: The software has undergone several improvements. Mainly, several branches have been merged in order to have as many features as possible available within the master branch.

- Participants: Ilef Ben Farhat, Loïc Mangeonjean, Slim Ouni and Louis Abel
- Partners: CNRS - Université de Lorraine
- Contact: Slim Ouni
- Publication: VisArtico: a visualization tool for articulatory data
- URL: http://visartico.loria.fr

6.7. Xarticulators

KEYWORDS: Medical imaging - Natural language processing

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.

RELEASE FUNCTIONAL DESCRIPTION: The new version allows MRI films to be processed and, above all, it offers a better transition from the shape of the vocal tract to the area function, which corresponds to an approximation of the vocal tract using a series of elementary tubes from the glottis to the lips.

NEWS OF THE YEAR: This year we completed the software to evaluate the articulatory model built from static images on dynamic images and we added a module to monitor the contour of the language using deep learning.

- Contact: Yves Laprie
- Publication: Articulatory model of the epiglottis

6.8. DCASE 2019 baseline

Baseline system for the task 4 of DCASE 2019 Challenge

KEYWORDS: Audio signal processing - Audio source classification - Machine learning - Smart home

FUNCTIONAL DESCRIPTION: This is the baseline system for the task 4 of the challenge on Detection and Classification of Acoustic Scenes and Events (DCASE) 2019. The algorithm performs sound events detection and classification. From an audio recording, the target of the system is to provide not only the event class but also the event time boundaries given that multiple events can be present in an audio recording. The baseline approach relies on convolutionnal and recurrent neural networks (CRNN) and a mean-teacher model to exploit a large amount of unbalanced and unlabeled training data together with a small weakly annotated (without timestamps) training set and a strongly annotated (with timestamps) synthetic set to improve system performance.

RELEASE FUNCTIONAL DESCRIPTION: This version includes a mean teacher model to exploit the various training sets with that have different levels of annotations, as provided in the task 4 of the DCASE 2019 challenge.

- Participants: Nicolas Turpault and Romain Serizel
- Contact: Nicolas Turpault
- Publication: Sound event detection in domestic environments with weakly labeled data and soundscape synthesis
- URL: https://github.com/turpaultn/DCASE2019_task4/tree/public/baseline

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. 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 [75]. 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.

6.5. OrphaMine: Data Mining Platform for Orphan Diseases

- Contact: Laureline Nevin
- 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.

6.6. 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 redescriptions. 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 redescriptions is not enough. The expert must also be able to understand the redescriptions found, adjust them to better match his domain knowledge and test alternative hypotheses with them, for instance. Thus, Siren allows mining redescriptions 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 redescriptions.

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.

SEMAGRAMME Project-Team

5. New Software and Platforms

5.1. ACGtk

Abstract Categorial Grammar Development Toolkit

KEYWORDS: Natural language processing - NLP - Syntactic analysis - Semantics

SCIENTIFIC DESCRIPTION: Abstract Categorial Grammars (ACG) are a grammatical formalism in which grammars are based on typed lambda-calculus. A grammar generates two languages: the abstract language (the language of parse structures), and the object language (the language of the surface forms, e.g., strings, or higher-order logical formulas), which is the realization of the abstract language.

ACGtk provides two software tools to develop and to use ACGs: acgc, which is a grammar compiler, and acg, which is an interpreter of a command language that allows one, in particular, to parse and realize terms.

FUNCTIONAL DESCRIPTION: ACGtk provides softwares for developing and using Abstract Categorial Grammars (ACG).

RELEASE FUNCTIONAL DESCRIPTION: This version removes the dependency to obsolete packages. It also provides a better handling of the command line interface.

NEWS OF THE YEAR: The new version removes dependencies to obsolete libraries. It improves the command line interface and prepares the integration of new functionalities and optimizations.

- 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 Categorial Grammars - ACGTK: un outil de développement et de test pour les grammaires catégorielles abstraites - Discourse Modeling with Abstract Categorial Grammars - On the expressive power of Abstract Categorial Grammars: Representing context-free formalisms - Towards abstract categorial grammars
- URL: http://acg.loria.fr/

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).

NEWS OF THE YEAR: In 2019, the Grew software was enriched with a new syntax for edges (it is now possible to use feature structures as edge labels).

The Grew-match tool (http://match.grew.fr) is an online service available where a user can query different corpora with graph matching requests. All UD corpora (157 in 90 different languages in v2.5) are available and data from several other projects can also be queried. In the last 12 months (December 2018 to November 2019), 32,465 requests were received on the Grew-match server. The number of requests has increased in the last months (7,948 in November 2019).

An experiment was conducted to test the usage of the matching part of Grew on larger graphs. In the internship of Axel Didier, we experiment graph query on the French lexical network, RL-Fr.

- Participants: Bruno Guillaume, Guy Perrier and Guillaume Bonfante

- Contact: Bruno Guillaume

- Publications: Application de la réécriture de graphes au traitement automatique des langues - Application of Graph Rewriting to Natural Language Processing

- URL: http://grew.fr/

5.4. ZombiLingo

KEYWORDS: Syntactic analysis - Natural language processing - Lexical resource - Collaborative science

FUNCTIONAL DESCRIPTION: ZombiLingo is a prototype of a GWAP (Game With A Purpose) where gamers have to give linguistic information about the syntax of natural language sentences, currently in French, and later to other languages.

NEWS OF THE YEAR: Karën Fort and Bruno Guillaume proposed a new version of ZombiLingo this year. It is named ZombiLudik (https://zombiludik.org) and the main difference is that the linguistic data used are now based on the Universal Dependencies (UD) framework. Due to the recent success of the UD project, this format is now used for data in 90 different languages and we hope to find new collaborations to work on a similar games for some foreign languages. A first demonstration version was built on English data (https://en.zombiludik.org). Karën Fort and Bruno Guillaume presented the English version of the game in June during the NIEUW consortium meeting in London.

- Authors: Bruno Guillaume, Karën Fort, Nicolas Lefebvre and Valentin Stern

- Contact: Karën Fort

- URL: http://zombilingo.org/