



RESEARCH CENTER
Sophia Antipolis - Méditerranée

FIELD

Activity Report 2018

Section Software

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AROMATH Project-Team

5. New Software and Platforms

5.1. Platforms

5.1.1. Axl

KEYWORDS: Algorithm , CAD , Numerical algorithm , Geometric algorithms

SCIENTIFIC DESCRIPTION

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

FUNCTIONAL DESCRIPTION

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

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- Contact: Bernard Mourrain
- URL: <http://axl.inria.fr/>

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

5.1.2. Skelton

KEYWORDS: Algorithm, Numerical algorithm, Geometric algorithm, Scaffolding, Implicit surface, Mesh generation

SCIENTIFIC DESCRIPTION

Skelton is a C++ library for skeleton-based modeling with convolution surfaces. It supports skeletons made of line segments and arcs of circle, including circular splines, and features an anisotropic extension to circular splines. The library can generate a quad dominant mesh that surrounds, and follows, the structure of the skeleton. The mesh is generated with an advanced scaffolding algorithm that works for skeletons of any topology.

FUNCTIONAL DESCRIPTION

Skelton is a multi-platform C++ library distributed as source code. It provides a class hierarchy for creating and manipulating geometric objects generated with anisotropic convolution. It can take the skeleton as an input file or defined directly by the user. The library supports an improved version of convolution surfaces and permits the design of anisotropic surfaces. The scaffolding algorithm can be used independently of the implicit surface definition. The library has a command line interface that controls most of the functionality. The user can subclass elements of the library for extended behavior.

- Participants: Alvaro Fuentes, Evelyne Hubert.
- Contacts: Alvaro Fuentes, Evelyne Hubert.
- URL: <https://gitlab.inria.fr/afuentes/Skelton>

DATASHAPE Project-Team

6. New Software and Platforms

6.1. GUDHI

Geometric Understanding in Higher Dimensions

KEYWORDS: Computational geometry - Topology

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

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

NEWS OF THE YEAR: - Cover complex - Representation of persistence diagrams - Cech complex - weighted periodic 3d alpha-complex - sparse Rips complex - debian / docker / conda-forge packages

- Participants: Clément Maria, François Godi, David Salinas, Jean-Daniel Boissonnat, Marc Glisse, Mariette Yvinec, Pawel Dlotko, Siargey Kachanovich and Vincent Rouvreau
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KAIROS Team

6. New Software and Platforms

6.1. VerCors

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

KEYWORDS: Software Verification - Specification language - Model Checking

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

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

Experimental version (2018) also includes algorithm for computing the symbolic semantics of Open Systems

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- URL: <https://team.inria.fr/scale/software/vercors/>

6.2. TimeSquare

KEYWORDS: Profil MARTE - Embedded systems - UML - IDM

SCIENTIFIC DESCRIPTION: TimeSquare offers six main functionalities:

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

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

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

6.3. GEMOC Studio

KEYWORDS: DSL - Language workbench - Model debugging

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

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

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

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

6.4. BCOoL

BCOoL

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

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

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- Contact: Julien Deantoni
- URL: <http://www.gemoc.org>

6.5. myMed

Framework for building social networks executable on web browsers, android and apple platforms

KEYWORDS: Framework - Peer-to-peer. - NoSQL - Mobile application - Social network - Publish-subscribe

SCIENTIFIC DESCRIPTION: [EN] myMed : an ad hoc framework to execute homogeneous social networks. The explosion of different Open Social Networks (OSN) "running" in the internet arena has changed the habits of mostly all of us. There are OSN almost for everything, from cooperative work, car pooling, healthcare, friendship, love, affairs, healthcare, information, gaming, etc. In almost all of the cases, there are no two OSN that are built by the same software producer, and - quite often - mostly of them work on a competitive basis, and - for many different reasons (business, privacy, politics, etc.) - they are not open source and they are hosted by their private servers. The interactions between those OSN is very little, since the Application Programming Interfaces (API) - if existing - are very weak and limited to access to the friends lists or to access OSN X with the password of OSN Y. Even worst, the possibility of programming or at least interconnecting common features (e.g. search on different data bases, link user names and passwords, chat, access to common data bases etc.) between different OSN advance slowly. The most used practice of interconnecting OSN is based on a form of "asymmetric viral communication" where one can relay (or post or publish) a duplicated copy or a pointer of a record published by user A in OSN X into another OSN Y, provided user A have also an account on OSN Y, and de facto forbidding in mostly cases the inverse operation, aka subscribing for a different user B on OSN Y to any publication of user A on OSN X even if user B does not have an account on OSN X. As such, the well know paradigm of Publish/Subscribe at the basis of many CSCW applications cannot be fully exploited inter social networks, leaving only their use intra social network, the latter use being of less impact in coordination and cooperation. Beside of the "business needs" of OSNs, the myMed (www.mymed.fr) meta-social network represents an important step toward the natural interconnections of social applications. This paper introduce the concept and the original structure of the myMed experimental system, as it was conceived as a common effort between five academic sites (Inria, Polytechnic of Turin, University of Turin, University of Piedmont Oriental, University of Nice Sophia Antipolis) and few local startups. myMed is an open source project, which facilitate and accelerate the development of ad hoc social applications (called in myMed jargon "sociapps") running over an heterogeneous "Plateau" of platforms, such as PCs, Smartphones and Tablets running iOS and Android. myMed provides a rich framework for publishing, searching and subscribing to content: the engine is built on top of a distributed noSQL database. In its current version, it provides high scalability and fault tolerance. The myMed framework allows you to easily build social web applications: it features geolocalization, points of interest in charts, buddy lists, profile management, content/user reputation, built-in cooperation and coordination among different OSN running on it, proto OSN store, etc. A short description of the framework can be found in the appendix of this paper. In a nutshell the myMed framework is composed of:

- a Software Development Kit (SDK) to develop fixed and mobile web sociapps, running on many Web browsers but also natively on Smartphones and Tablets equipped with Android or iOS. Sociapps, by their name, must have a strong social flavor (open social networks, closed social networks, enterprise social networks, micro/nano social networks and so on). Thanks to the rich, general-purpose, catalog of modules in the framework, every module can be freely used without interfering with other sociapps, in a true "Lego" fashion. The program is distributed under the Apache V2 free license. The TTM ("Time To Market") envisaged to develop a sociapp using the myMed SDK can be estimated from 1 to 3 months employing 1 or 2 senior programmers.
- A "cloud" to execute the "sociapps" represented by a "backbone" of 50PCs, distributed through the "AlpMed" EuroRegion following some precise efficiency criteria (as example the presence of Internet running on optical fibers). Part of those PCs have a double function: o ensure the good behavior of all the running sociapps, and o offer services other than those offered by myMed, such as a web browser, an open-source Office suite, a private disk of little size, logically separated from the noSQL space that can be used by others users (we call this "an elastic usage of the myMed cloud PC"). Those PCs can be accessed via a private login and password generated by the framework on demand. The operating systems running on those PC (Ubuntu myMed Edition, UME) is also open source and it is based on a customized version of the Ubuntu operating system. To guarantee the quality of the execution of the sociapps, we require that all machines belonging to the backbone are constantly running (on state).
- A little collection of "proof of concept" sociapps to validate, experiment, and testing the development kit and the execution cloud. These sociapps have been conceived with the precious help of the "Civil society" of the EuroRegion "AlpMed" (States, Regions, Prefectures, Associations, Chambers of Commerce, Municipalities, Universities, etc.) that have played a role of "maitre d'oeuvre" (or experts) in a given "applicative domain". The quasi totality of the sociapps are available on the myMed web platform at the address <http://www.mymed.fr/?action=login> but also

on the most common mobile application stores, such as the Apple Store and the Google Play Store Markets. The myMed system is naturally divided into a backend and a frontend permitting a natural separation of concerns. The present and the future features of the myMed architecture together with the many open questions left open are:

- myMed is distributed by construction and could be decentralized. The myMed backbone is based on a well-tested noSQL database, Cassandra, which can accommodate any number of users without any code changes. Machines can be classically concentrated on a data-center or – more interestingly – fully decentralized modulo a decent internet connection. Failures of one or many machines do not affect the running of the system, thanks to replication of the data on several servers.
- myMed (should be) Easy to use. Start from the template, add or remove features, play with the design and the interface and you have an application ready to deploy on the myMed cloud and accessible to all myMed users via the proto store.
- myMed is Extensible. myMed provides a modular architecture, since developers can easily install new modules and users can add or remove all the sociapps they like using the proto store.
- myMed as a distributed Social Operating system? for many aspects myMed looks like an social operating system installed on a distributed and decentralize pull of PCs. Modifications of internal myMed modules would not affect the behavior of all sociapps using those modules.
- myMed promotes collaboration and cooperation between OSN. The sharing of all social modules have the positive effect of greatly facilitate OSN interconnection
- myMed users feature a two level profile. Having a myMed "basic profile" just give access to the store and to a "read only view" of each OSN X. For a full experience the user must fill the, so called, "extended profile" for OSN X which allows a full read/write access.
- myMed and myMed sociapps can feature an ad hoc economical model? It is well know that economical models for OSN are quite often related to advertising, or buying intra OSN features. The myMed interconnectivity by construction, open a way to novel business models, like "the more you open the more you earn?"
- myMed should feature an unique Human Computer Interface? a common template is provided to expert users that want to implement a proper OSN. Do they need to be compliant with some graphical chart?
- myMed can run on different instances. Can different instances cooperate? As in higher-order languages, the same cooperation level featured between different OSNs running on one myMed instance can be applied on different myMed instances running on different hardware. This would be subject of a further evolution of inter-cooperation and connection of myMed instances and their OSN running inside it. A lot of care must be given in building coherent "meta basic profiles".

FUNCTIONAL DESCRIPTION: myMed is an experimental framework for implementing and deploying, on the top of a built-in cloud platform, many Open Social Networks (OSN) that could take advantage of sharing common software modules, hardware resources, making inter-communication and inter-interaction simpler and improving rapid development and deployment. myMed OSN are either accessible on web browsers and mobile platforms (android, ios). myMed is based on a peer-to-peer architecture and noSQL database technology. A number of experimental OSN are experimentally implemented and deployed to validate the framework : among them we mention myRiviera, myPaysduPaillon, mioConsolato, myBenevolat, myFondationSophiaAntipolis, myEurocin, myEurope, myAngel, ...

- Participants: Claudio Casetti, Luigi Liquori, Mariangiola Dezani and Mino Anglano
- Partners: Politecnico di Torino - Université de Nice Sophia Antipolis (UNS) - Università di Torino - Università del Piemonte Orientale
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- URL: <http://www.mymed.fr>

6.6. JMaxGraph

KEYWORDS: Java - HPC - Graph algorithmics

FUNCTIONAL DESCRIPTION: JMaxGraph is a collection of techniques for the computation of large graphs on one single computer. The motivation for such a centralized computing platform originates in the constantly increasing efficiency of computers which now come with hundred gigabytes of RAM, tens of cores and fast drives. JMaxGraph implements a compact adjacency-table for the representation of the graph in memory. This data structure is designed to 1) be fed page by page, à-la GraphChi, 2) enable fast iteration, avoiding memory

jumps as much as possible in order to benefit from hardware caches, 3) be tackled in parallel by multiple-threads. Also, JMaxGraph comes with a flexible and resilient batch-oriented middleware, which is suited to executing long computations on shared clusters. The first use-case of JMaxGraph allowed F. Giroire, T. Trollet and S. Pérennes to count $K_{2,2}$ s, and various types of directed triangles in the Twitter graph of users (23G arcs, 400M vertices). The computation campaign took 4 days, using up to 400 cores in the NEF Inria cluster.

- Contact: Luc Hogie
- URL: <http://www.i3s.unice.fr/~hogie/software/?name=jmaxgraph>

MARELLE Project-Team

5. New Software and Platforms

5.1. Coq

The Coq Proof Assistant

KEYWORDS: Proof - Certification - Formalisation

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

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

RELEASE FUNCTIONAL DESCRIPTION: Coq version 8.8.2 contains the result of refinements and stabilization of features and deprecations, cleanups of the internals of the system along with a few new features.

Summary of changes:

Kernel: fix a subject reduction failure due to allowing fixpoints on non-recursive values (#407), by Matthieu Sozeau. Handling of evars in the VM (#935) by Pierre-Marie Pédro.

Notations: many improvements on recursive notations and support for destructuring patterns in the syntax of notations by Hugo Herbelin.

Proof language: tacticals for profiling, timing and checking success or failure of tactics by Jason Gross. The focusing bracket { supports single-numbered goal selectors, e.g. 2:{, (#6551) by Théo Zimmermann.

Vernacular: cleanup of definition commands (#6653) by Vincent Laporte and more uniform handling of the Local flag (#1049), by Maxime Dénès. Experimental Show Extraction command (#6926) by Pierre Letouzey. Coercion now accepts Prop or Type as a source (#6480) by Arthur Charguéraud. Export modifier for options allowing to export the option to modules that Import and not only Require a module (#6923), by Pierre-Marie Pédro.

Universes: many user-level and API level enhancements: qualified naming and printing, variance annotations for cumulative inductive types, more general constraints and enhancements of the minimization heuristics, interaction with modules by Gaëtan Gilbert, Pierre-Marie Pédro and Matthieu Sozeau.

Library: Decimal Numbers library (#6599) by Pierre Letouzey and various small improvements.

Documentation: a large community effort resulted in the migration of the reference manual to the Sphinx documentation tool. The new documentation infrastructure (based on Sphinx) is by Clément Pit-Claudel. The migration was coordinated by Maxime Dénès and Paul Steckler, with some help of Théo Zimmermann during the final integration phase. The 14 people who ported the manual are Calvin Beck, Heiko Becker, Yves Bertot, Maxime Dénès, Richard Ford, Pierre Letouzey, Assia Mahboubi, Clément Pit-Claudel, Laurence Rideau, Matthieu Sozeau, Paul Steckler, Enrico Tassi, Laurent Théry, Nikita Zyuizin.

Tools: experimental -mangle-names option to coqtop/coqc for linting proof scripts (#6582), by Jasper Hugunin. Main changes:

Critical soundness bugs were fixed between versions 8.8.0 and 8.8.2, and a PDF version of the reference manual was made available. The Windows installer also includes many more external packages that can be individually selected for installation.

On the implementation side, the `dev/doc/changes.md` file documents the numerous changes to the implementation and improvements of interfaces. The file provides guidelines on porting a plugin to the new version.

More information can be found in the CHANGES file. Feedback and bug reports are extremely welcome.

Distribution Installers for Windows 32 bits (i686), Windows 64 bits (x8_64) and macOS are available. They come bundled with CoqIDE. Windows binaries now include the Bignum library.

Complete sources of the files installed by the Windows installers are made available, to comply with license requirements.

NEWS OF THE YEAR: Version 8.8.0 was released in April 2018 and version 8.8.2 in September 2018. This is the third release of Coq developed on a time-based development cycle. Its development spanned 6 months from the release of Coq 8.7 and was based on a public road-map. It attracted many external contributions. Code reviews and continuous integration testing were systematically used before integration of new features, with an important focus given to compatibility and performance issues.

The main advances in this version are cleanups and fixes in the many different components of the system, ranging from low level kernel fixes to advances in the support of notations and tacticals for selecting goals. A large community effort was made to move the documentation to the Sphinx format, providing a more accessible online resource to users.

- Participants: Abhishek Anand, C. J. Bell, Yves Bertot, Frédéric Besson, Tej Chajed, Pierre Courtieu, Maxime Denes, Julien Forest, Emilio Jesús Gallego Arias, Gaëtan Gilbert, Benjamin Grégoire, Jason Gross, Hugo Herbelin, Ralf Jung, Matej Kosik, Sam Pablo Kuper, Xavier Leroy, Pierre Letouzey, Assia Mahboubi, Cyprien Mangin, Érik Martin-Dorel, Olivier Marty, Guillaume Melquiond, Pierre-Marie Pédro, Benjamin C. Pierce, Lars Rasmusson, Yann Régis-Gianas, Lionel Rieg, Valentin Robert, Thomas Sibut-Pinote, Michael Soegtrop, Matthieu Sozeau, Arnaud Spiwack, Paul Steckler, George Stelle, Pierre-Yves Strub, Enrico Tassi, Hendrik Tews, Laurent Théry, Amin Timany, Vadim Zaliva and Théo Zimmermann
- Partners: CNRS - Université Paris-Sud - ENS Lyon - Université Paris-Diderot
- Contact: Matthieu Sozeau
- Publication: [The Coq Proof Assistant, version 8.8.0](#)
- URL: <http://coq.inria.fr/>

5.2. Easycrypt

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

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

5.3. ELPI

Embeddable Lambda Prolog Interpreter

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

SCIENTIFIC DESCRIPTION: The programming language has the following features

- Native support for variable binding and substitution, via an Higher Order Abstract Syntax (HOAS) embedding of the object language. The programmer needs not to care about De Bruijn indexes.

- Native support for hypothetical context. When moving under a binder one can attach to the bound variable extra information that is collected when the variable gets out of scope. For example when writing a type-checker the programmer needs not to care about managing the typing context.

- Native support for higher order unification variables, again via HOAS. Unification variables of the meta-language (lambdaProlog) can be reused to represent the unification variables of the object language. The programmer does not need to care about the unification-variable assignment map and cannot assign to a unification variable a term containing variables out of scope, or build a circular assignment.

- Native support for syntactic constraints and their meta-level handling rules. The generative semantics of Prolog can be disabled by turning a goal into a syntactic constraint (suspended goal). A syntactic constraint is resumed as soon as relevant variables gets assigned. Syntactic constraints can be manipulated by constraint handling rules (CHR).

- Native support for backtracking. To ease implementation of search.

- The constraint store is extensible. The host application can declare non-syntactic constraints and use custom constraint solvers to check their consistency.

- Clauses are graftable. The user is free to extend an existing program by inserting/removing clauses, both at runtime (using implication) and at "compilation" time by accumulating files.

Most of these feature come with lambdaProlog. Constraints and propagation rules are novel in ELPI.

FUNCTIONAL DESCRIPTION: ELPI implements a variant of lambdaProlog enriched with Constraint Handling Rules, a programming language well suited to manipulate syntax trees with binders and unification variables.

ELPI is a research project aimed at providing a programming platform for the so called elaborator component of an interactive theorem prover.

ELPI is designed to be embedded into larger applications written in OCaml as an extension language. It comes with an API to drive the interpreter and with an FFI for defining built-in predicates and data types, as well as quotations and similar goodies that come in handy to adapt the language to the host application.

RELEASE FUNCTIONAL DESCRIPTION: First public release

NEWS OF THE YEAR: First public release

- Participant: Claudio Sacerdoti Coen
- Contact: Enrico Tassi
- Publications: [ELPI: fast, Embeddable, \$\lambda\$ Prolog Interpreter - Implementing Type Theory in Higher Order Constraint Logic Programming](#)
- URL: <https://github.com/lpicic/elpi/>

5.4. Math-Components

Mathematical Components library

KEYWORD: Proof assistant

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

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

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

5.5. Semantics

KEYWORDS: Semantic - Programming language - Coq

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

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

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

5.6. Ssreflect

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

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

5.7. AutoGnP

KEYWORDS: Formal methods - Security - Cryptography

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

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

ACUMES Project-Team

6. New Software and Platforms

6.1. MGDA

Multiple Gradient Descent Algorithm

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

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

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

FUNCTIONAL DESCRIPTION: Concerning Chapter 1, the utilization of the platform can be made via two modes : – the interactive mode, through a web interface that facilitates the data exchange between the user and an Inria dedicated machine, – the iterative mode, in which the user downloads the object library to be included in a personal optimization software. Concerning Chapters 2 and 3, the utilizer specifies cost and constraint functions by providing procedures compatible with Fortran 90. Chapter 3 does not require the specification of gradients, but only the functions themselves that are approximated by the software by quadratic meta-models.

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

6.2. Igloo

Iso-Geometric anaLysis using discOntinuOus galerkin methods

KEYWORDS: Numerical simulations - Isogeometric analysis

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

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

- Author: Régis Duvigneau
- Contact: Régis Duvigneau

6.3. BuildingSmart

BuildingSmart interactive visualization

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

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

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

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

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

ECUADOR Project-Team

5. New Software and Platforms

5.1. AIRONUM

KEYWORDS: Computational Fluid Dynamics - Turbulence

FUNCTIONAL DESCRIPTION: Aironum is an experimental software that solves the unsteady compressible Navier-Stokes equations with k-epsilon, LES-VMS and hybrid turbulence modelling on parallel platforms, using MPI. The mesh model is unstructured tetrahedrization, with possible mesh motion.

- Participant: Alain Dervieux
- Contact: Alain Dervieux
- URL: <http://www-sop.inria.fr/tropics/aironum>

5.2. TAPENADE

KEYWORDS: Static analysis - Optimization - Compilation - Gradients

SCIENTIFIC DESCRIPTION: Tapenade implements the results of our research about models and static analyses for AD. Tapenade can be downloaded and installed on most architectures. Alternatively, it can be used as a web server. Higher-order derivatives can be obtained through repeated application.

Tapenade performs sophisticated data-flow analysis, flow-sensitive and context-sensitive, on the complete source program to produce an efficient differentiated code. Analyses include Type-Checking, Read-Write analysis, and Pointer analysis. AD-specific analyses include:

Activity analysis: Detects variables whose derivative is either null or useless, to reduce the number of derivative instructions.

Adjoint Liveness analysis: Detects the source statements that are dead code for the computation of derivatives.

TBR analysis: In adjoint-mode AD, reduces the set of source variables that need to be recovered.

FUNCTIONAL DESCRIPTION: Tapenade is an Algorithmic Differentiation tool that transforms an original program into a new program that computes derivatives of the original program. Algorithmic Differentiation produces analytical derivatives, that are exact up to machine precision. Adjoint-mode AD can compute gradients at a cost which is independent from the number of input variables. Tapenade accepts source programs written in Fortran77, Fortran90, or C. It provides differentiation in the following modes: tangent, vector tangent, adjoint, and vector adjoint.

NEWS OF THE YEAR: - Continued development of multi-language capacity: AD of codes mixing Fortran and C - Continued front-end for C++ based on Clang - Experimental support for building Abs-Normal Form tangent of non-smooth codes

- Participants: Laurent Hascoët and Valérie Pascual
- Contact: Laurent Hascoët
- URL: <http://www-sop.inria.fr/tropics/tapenade.html>

FACTAS Team

5. New Software and Platforms

5.1. pisa

KEYWORDS: Electrical circuit - Stability

FUNCTIONAL DESCRIPTION: To minimise prototyping costs, the design of analog circuits is performed using computer-aided design tools which simulate the circuit's response as accurately as possible.

Some commonly used simulation tools do not impose stability, which can result in costly errors when the prototype turns out to be unstable. A thorough stability analysis is therefore a very important step in circuit design. This is where pisa is used.

pisa is a Matlab toolbox that allows designers of analog electronic circuits to determine the stability of their circuits in the simulator. It analyses the impedance presented by a circuit to determine the circuit's stability. When an instability is detected, pisa can estimate location of the unstable poles to help designers fix their stability issue.

RELEASE FUNCTIONAL DESCRIPTION: First version

- Authors: Adam Cooman, David Martinez Martinez, Fabien Seyfert and Martine Olivi
- Contact: Fabien Seyfert
- Publications: [Model-Free Closed-Loop Stability Analysis: A Linear Functional Approach - On Transfer Functions Realizable with Active Electronic Components](#)
- URL: <https://project.inria.fr/pisa>

5.2. PUMA-HF

PUMA-HF: Passive Uniform Matching

KEYWORD: Transfer functions

FUNCTIONAL DESCRIPTION: PUMA computes a passive rational 2-port filtering function presenting a reference impedance (i.e. 50 Ohm) at the first port, and the conjugate of the given load impedance within a frequency band at the second port.

- Authors: David Martinez Martinez, Adam Cooman, Martine Olivi and Fabien Seyfert
- Partners: Xlim - DGA-MI - CNES
- Contact: Fabien Seyfert
- Publication: [Synthesis Method for Matching Filters](#)
- URL: <https://project.inria.fr/puma/>

MCTAO Project-Team

6. New Software and Platforms

6.1. Hampath

KEYWORDS: Optimal control - Second order conditions - Differential homotopy - Ordinary differential equations

FUNCTIONAL DESCRIPTION: Hampath is a software developed to solve optimal control problems by a combination of Hamiltonian et path following methods. Hampath includes shooting and computation of conjugate points. It is an evolution of the software cotcot (apo.enseeiht.fr/cotcot). It has a Fortran kernel, uses Tapenade (www-sop.inria.fr/tropics/tapenade.html) for automatic differentiation and has a Matlab interface.

- Participants: Jean-Baptiste Caillaud, Joseph Gergaud and Olivier Cots
- Contact: Jean-Baptiste Caillaud
- URL: <http://www.hampath.org>

NACHOS Project-Team

5. New Software and Platforms

5.1. DIOGENeS

Discontinuous Galerkin Nanoscale Solvers

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin - Computational nanophotonics

FUNCTIONAL DESCRIPTION: The DIOGENeS software suite provides several tools and solvers for the numerical resolution of light-matter interactions at nanometer scales. A choice can be made between time-domain (DGTD solver) and frequency-domain (HDGFD solver) depending on the problem. The available sources, material laws and observables are very well suited to nano-optics and nano-plasmonics (interaction with metals). A parallel implementation allows to consider large problems on dedicated cluster-like architectures.

- Authors: Stéphane Lanteri, Nikolai Schmitt, Alexis Gobe and Jonathan Viquerat
- Contact: Stéphane Lanteri
- URL: <https://diogenes.inria.fr/>

5.2. GERShWIN

discontinuous Galerkin Solver for microWave Interaction with biological tissues

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin - Computational bioelectromagnetics

FUNCTIONAL DESCRIPTION: GERShWIN is based on a high order DG method formulated on unstructured tetrahedral meshes for solving the 3D system of time-domain Maxwell equations coupled to a Debye dispersion model.

- Contact: Stéphane Lanteri
- URL: <http://www-sop.inria.fr/nachos/index.php/Software/GERShWIN>

5.3. HORSE

High Order solver for Radar cross Section Evaluation

KEYWORDS: High-Performance Computing - Computational electromagnetics - Discontinuous Galerkin

FUNCTIONAL DESCRIPTION: HORSE is based on a high order HDG (Hybridizable Discontinuous Galerkin) method formulated on unstructured tetrahedral and hybrid structured/unstructured (cubic/tetrahedral) meshes for the discretization of the 3D system of frequency-domain Maxwell equations, coupled to domain decomposition solvers.

- Contact: Stéphane Lanteri
- URL: <http://www-sop.inria.fr/nachos/index.php/Software/HORSE>

TOSCA Project-Team (section vide)

ABS Project-Team

4. New Software and Platforms

4.1. SBL

Structural Bioinformatics Library

KEYWORDS: Structural Biology - Biophysics - Software architecture

FUNCTIONAL DESCRIPTION: The SBL is a generic C++/python cross-platform software library targeting complex problems in structural bioinformatics. Its tenet is based on a modular design offering a rich and versatile framework allowing the development of novel applications requiring well specified complex operations, without compromising robustness and performances.

More specifically, the SBL involves four software components (1-4 thereafter). For end-users, the SBL provides ready to use, state-of-the-art (1) applications to handle molecular models defined by unions of balls, to deal with molecular flexibility, to model macro-molecular assemblies. These applications can also be combined to tackle integrated analysis problems. For developers, the SBL provides a broad C++ toolbox with modular design, involving core (2) algorithms, (3) biophysical models, and (4) modules, the latter being especially suited to develop novel applications. The SBL comes with a thorough documentation consisting of user and reference manuals, and a bugzilla platform to handle community feedback.

RELEASE FUNCTIONAL DESCRIPTION: In 2018, major efforts targeted two points. First, the simplification of installation procedures – now possible with conda/python. Second, the development of packages revolving on molecular flexibility at large: representations in internal and Cartesian coordinates, generic representation of molecular mechanics force fields (and computation of gradients), exploration algorithms for conformational spaces.

- Contact: Frédéric Cazals
- Publication: [The Structural Bioinformatics Library: modeling in biomolecular science and beyond](#)
- URL: <https://sbl.inria.fr/>

ATHENA Project-Team

5. New Software and Platforms

5.1. BCI-VIZAPP

BCI visual applications

KEYWORDS: Health - Brain-Computer Interface - GUI (Graphical User Interface)

SCIENTIFIC DESCRIPTION: Bci-Vizapp is a library that allows (in interaction with OpenViBE) to build BCI (Brain Computer Interfaces) applications based on the P300 speller principle. Bci-Vizapp provides a library that allows you to create the BCI's stimulation part as part of the Qt toolkit. Being able to use a standard toolkit to make BCI applications is a strong Bci-Vizapp originality. Indeed, in general the use of such toolkits is prohibited by the need for a very precise control of the display timings, which generally eliminates high-level graphic toolkits such as Qt.

FUNCTIONAL DESCRIPTION: BCI-VIZAPP includes a virtual keyboard for typing text, a photodiode monitoring application for checking timing issues. It communicates with the OpenViBE acquisition server for signal acquisition and with the OpenViBE designer for signal processing. The configuration is performed through a wizard.

This software is a new version following the CoAdapt P300 stimulator software.

NEWS OF THE YEAR: Bci-Vizapp is undergoing a profound transmutation with the help of CRISAM's SED in ADT BciBrowser (part of the AMDT). This change aims at integrating the functionality of Bci-Vizapp in third-party applications such as a web browsers.

- Participants: Nathanaël Foy, Romain Lacroix, Maureen Clerc and Théodore Papadopoulo
- Contact: Maureen Clerc

5.2. DIPY

Diffusion Imaging in Python

KEYWORDS: MRI - Medical imaging

FUNCTIONAL DESCRIPTION: Diffusion Imaging in Python (Dipy) is a free and open source software project for computational neuroanatomy, focusing mainly on diffusion magnetic resonance imaging (dMRI) analysis. E. Garyfallidis (now Indiana University) is the founder and lead engineer of this open source project in the development of diffusion MRI methods. We continuously collaborate with this global effort and our effort is combined with Université de Sherbrooke, in Canada and Stanford University among others. See for example our registration, denoising, tractography and microstructures tutorials.

- Participants: Demian Wassermann and Rutger Fick
- Partner: Sherbrooke University
- Contact: Demian Wassermann
- URL: <http://nipy.org/dipy/>

5.3. High Performance Diffusion MRI

KEYWORDS: Health - Neuroimaging - Medical imaging

FUNCTIONAL DESCRIPTION: This library has been developed and transferred to the Cie Olea Medical currently in charge of its validation and inclusion in its Olea Sphere platform. We have been closely involved in pushing the frontiers of the diffusion MRI (dMRI) in the recent years, especially in the mathematical modelling and processing of the dMRI signal and have developed state-of-the-art software implementations in the form of a C++ library that can be effectively used to infer the complex microstructure of the cerebral white matter. The algorithms and software transferred to Olea Medical fall into four categories : (i) local tissue modelling, which includes both popular 2nd order models and advanced higher than 2nd order models such as DTI, higher order Cartesian tensors (HOTs), ODF, FOD, EAP, maxima extraction, regularization and segmentation, (ii) generation of scalar indices (or biomarkers), which include DTI biomarkers, Diffusion Kurtosis Imaging (DKI) and invariants of 4th order tensors, (iii) global structure estimation, which includes deterministic and probabilistic tractography, and (iv) data visualisation for scalar indices, local models and global structures.

- Participants: Aurobrata Ghosh, Rachid Deriche and Théodore Papadopoulo
- Partner: Olea Medical
- Contact: Rachid Deriche

5.4. OpenMEEG

KEYWORDS: Health - Neuroimaging - Medical imaging

SCIENTIFIC DESCRIPTION: OpenMEEG provides a symmetric boundary element method (BEM) implementation for solving the forward problem of electromagnetic propagation over heterogeneous media made of several domains of homogeneous and isotropic conductivities. OpenMEEG works for the quasistatic regime (frequencies < 100Hz and medium diameter < 1m).

FUNCTIONAL DESCRIPTION: OpenMEEG provides state-of-the art tools for modelling bio-electromagnetic propagation in the quasi-static regime. It is based on the symmetric BEM for the EEG/MEG forward problem, with a distributed source model. OpenMEEG has also been used to model the forward problem of ECoG, for modelling nerves or the cochlea. OpenMEEG is a free, open software written in C++ with python bindings. OpenMEEG is used through a command line interface, but is also interfaced in graphical interfaces such as BrainStorm, FieldTrip or SPM.

RELEASE FUNCTIONAL DESCRIPTION: OpenMEEG has had a large update including notably the parallelisation of some operators and bug corrections. The new version allows in addition the use of non-nested domains.

NEWS OF THE YEAR: OpenMEEG has had a large update including notably the parallelisation of some operators and bug corrections. The new version allows in addition the use of non-nested domains. These improvements have been distributed with the two new releases (2.4.0 and 2.4.1) made in 2018.

- Participants: Alexandre Gramfort, Emmanuel Olivi, Geoffray Adde, Jan Kybic, Kai Dang, Maureen Clerc, Perrine Landreau, Renaud Keriven and Théodore Papadopoulo
- Contact: Théodore Papadopoulo
- Publications: [OpenMEEG: opensource software for quasistatic bioelectromagnetics - Forward Field Computation with OpenMEEG.](#) - [Source modeling of ElectroCorticoGraphy \(ECoG\) data: Stability analysis and spatial filtering](#)
- URL: <http://openmeeg.github.io/>

BIOCORE Project-Team

6. New Software and Platforms

6.1. In@lgae

Numerical simulator of microalgae based processes

KEYWORDS: Simulation - Microalgae system - Productivity

FUNCTIONAL DESCRIPTION: In@lgae simulates the productivity of a microalgae production system, taking into account both the process type and its location and time of the year. The process is mainly defined by its thermal dynamics and by its associated hydrodynamics. For a given microalgal strain, a set of biological parameters describe the response to nitrogen limitation, temperature and light. As a result, the biomass production, CO₂ and nitrogen fluxes, lipid and sugar accumulation are predicted.

RELEASE FUNCTIONAL DESCRIPTION: The In@lgae platform has been optimised to make it faster. Some of the key models have been rewritten in C++ to allow a faster computation. Models have been improved to include, in the growth rate computation, the composition of the light spectrum. The graphical user interface has been enhanced and several sets of parameters describing different microalgal species have been stored.

- Participants: Étienne Delclaux, Francis Mairet, Olivier Bernard and Quentin Béchet
- Contact: Olivier Bernard

6.2. Odin

Platform for advanced monitoring, control and optimisation of bioprocesses

KEYWORDS: Bioinformatics - Biotechnology - Monitoring - Automatic control

SCIENTIFIC DESCRIPTION: This C++ application enables researchers and industrials to easily develop and deploy advanced control algorithms through the use of a Scilab interpreter. It also contains a Scilab-based process simulator which can be harnessed for experimentation and training purposes. ODIN is primarily developed in the C++ programming language and uses CORBA to define component interfaces and provide component isolation. ODIN is a distributed platform, enabling remote monitoring of the controlled processes as well as remote data acquisition. It is very modular in order to adapt to any plant and to run most of the algorithms, and it can handle the high level of uncertainties that characterises the biological processes through explicit management of confidence indexes.

FUNCTIONAL DESCRIPTION: ODIN is a software framework for bioprocess control and supervision. ODIN is a distributed platform, where algorithms are described with a common structure easy to implement. Finally, ODIN can perform remote data acquisition and process these data to compute the signals to be applied to the actuators, together with estimates of state variables or process state. ODIN can handle the high level of uncertainties that characterises the biological processes through explicit management of confidence indexes.

- Participants: Fabien Dilet, Florian Guenn, Francesco Novellis, Mathieu Lacage, Melaine Gautier, Olivier Bernard, Olivier Calabro, Romain Primet and Serigne Sow
- Contact: Olivier Bernard
- URL: <https://team.inria.fr/biocore/software/odin/>

BIOVISION Project-Team

5. New Software and Platforms

5.1. Virtual Retina

A biological retina model with contrast gain control for large scale simulations

KEYWORDS: Neurosciences - Simulation - Biology - Health

SCIENTIFIC DESCRIPTION: Virtual Retina has a variety of biological features implemented such as (i) spatio-temporal linear filter implementing the basic center/surround organization of retinal filtering, (ii) non-linear contrast gain control mechanism providing instantaneous adaptation to the local level of contrast, (iii) spike generation by one or several layers of ganglion cells paving the visual field.

FUNCTIONAL DESCRIPTION: Virtual Retina is a simulation software that allows large-scale simulations of biologically-plausible retinas.

- Participants: Adrien Wohrer, Pierre Kornprobst, Bruno Cessac, Maria-Jose Escobar and Thierry Viéville
- Contact: Pierre Kornprobst
- Publication: [Virtual Retina: A biological retina model and simulator, with contrast gain control](#)
- URL: <https://team.inria.fr/biovision/virtualretina/>

5.2. PRANAS

Platform for Retinal ANalysis And Simulation

KEYWORDS: Retina - Neural Code - Data management - Statistics - Modeling - Vision

SCIENTIFIC DESCRIPTION: PRANAS was designed as a user-friendly tool dedicated to neuroscientist community in a large sense, i.e., not only experienced computational neuroscientists. It has two main goals : (i) to analyze retina data, especially spatio-temporal correlations, at single cell but also population levels, (ii) to simulate the spike response of the retina to a visual flow with a customizable retina simulator which evolves in synergy with experimental data analysis. In general, PRANAS allows to explore several aspects of retinal image processing such as understanding how to reproduce accurately the statistics of the spiking activity at the population level, or reconciling connectomics and simple computational rules for visual motion detection. This makes this tool a unique platform to better understand how the retina works.

FUNCTIONAL DESCRIPTION: The retina encodes a visual scene by trains of action potentials sent to the brain via the optic nerve. PRANAS brings to neuroscientists and modelers tools to better understand this coding. It integrates a retina simulator allowing large scale simulations while keeping a strong biological plausibility and a toolbox for the analysis of spike trains population statistics. The statistical method (entropy maximization under constraints) takes into account both spatial and temporal correlations as constraints, allowing to analyze the effects of memory on statistics. PRANAS also integrates a tool computing and representing in 3D (time-space) receptive fields. All these tools are accessible through a friendly graphical user interface. The most CPU-costly of them has been implemented to run in parallel. The actual version simulates healthy retinas but the long term goal is to study retinas with a pathology (DMLA, Retinitis Pigmentosa, Glaucoma).

- Authors: Bruno Cessac, Pierre Kornprobst, Sélim Kraria, Hassan Nasser, Daniela Pamplona, Geoffrey Portelli and Adrien Wohrer
- Contact: Bruno Cessac
- Publication: [PRANAS: A New Platform for Retinal Analysis and Simulation](#)
- URL: <https://team.inria.fr/biovision/pranas-software/>

5.3. Platforms

5.3.1. VRead

We are currently developing the VRead platform, a reading platform for digital content. We are now in the phase of building and testing prototypes with low-vision patients. We have started to conduct a qualitative Market research with patients to get a continuous feedback from them, discover their needs and thus better drive the developments. A special care is taken for ergonomics to optimize user experience in virtual reality. This is a crucial aspect in this project, especially because we primarily target a more fragile population so that we have to take into account their vision loss and cognitive skills. As for the technical aspect, we are using the Unity game engine along with the Oculus SDK, allowing us to deploy and test early on the Samsung GearVR mobile platform. For scripting the engine we code in C# using the proprietary directives of Unity. We ship the VRead Viewer with an operator application which allows for supervision and tuning of parameters of the reader in realtime. This application is written using the Unity SDK and is deployable under macOS, Windows and Linux.

This project received financial support from Université Côte d'Azur (France) (duration: 18 months, period: Aug. 2017– Jan. 2019 and Inria (via InriaHUB programme). It is done in collaboration with Aix-Marseille Université (CNRS, Laboratoire de Psychologie Cognitive, Marseille, France), Centre hospitalier Pasteur 2 (service d'ophtalmologie, Nice, France) and University of Genoa (DIBRIS, Genoa, Italy).

5.3.2. Macular

We are currently developing the platform Macular, a large-scale simulations platform of impaired retinas, allowing to mimic specific degeneracies or pharmacologically induced impairments, as well as to emulate electric stimulation by prostheses. With this tool scientists will be able to design a simulation gui adapted to their need, so as to test hypotheses, make in-silico experiments prior to real experiments, test models, change the equations of a model and look at the impact of the dynamics. We hope it will become a standard for the community of modelers, experimentalists in the academic word, as well as for companies doing research and development. Macular will also help to better understand how to design algorithms to help visually impaired individuals. Especially, the Biovision team wants to develop computer algorithms for retinal prostheses that reproduce the functions performed by the bypassed parts of the eye: these algorithms can then be used as a “camera to eye translator” in retinal prosthetics.

CAMIN Team

5. New Software and Platforms

5.1. RT_Stim

Real-Time simulation for functional electrical Stimulation

KEYWORDS: Real time - Biomechanics - Control - Co-simulation

FUNCTIONAL DESCRIPTION: Hybrid simulation architecture gathering in a single framework and consistent time scales both the numerical integration of the continuous model of a bio-mechanical system (bones, joints and muscles) and a model of the hardware and software control architecture, including control tasks, communication protocols and real-time schedulers. Simulation run in real-time when possible, and otherwise consistent time scales are generated. The framework is intended to seamlessly evolve from purely software models to hardware-in-the-loop simulation.

- Contact: Daniel Simon

5.2. Platforms

5.2.1. *Modular embedded architecture for real time control of a FES system*

Participants: Christine Azevedo Coste, Benoît Sijobert, Ronan Le Guillou.

The results presented in section 6.2 and 6.3 have led to the development of a new hardware and software architecture embedding a network of sensors and actuators interfaced to a controller, as part of Benoît Sijobert's PhD work and ADT STIMBIO (Ronan Le Guillou). In order to solve numerous issues and constraints observed during experiments, a new hardware and software architecture has been elaborated. The decision was made to decentralize the controller (i.e. the computer) directly on the participant, thereby relocating the essential wireless links around the user. For this purpose, a mini low-cost single board computer (Raspberry Pi3) was embedded in a 3D-printed case strapped around the waist of the subject. Using wireless inertial sensors connected as a WBAN, the sink node gets the data from all the IMUs, therefore highly decreasing the data flow when multiple IMUs were transmitting inside the network. To get rid of this limitation and guarantee an overall 100 Hz sampling rate no matter the number of IMUs, the wireless inertial sensors can be replaced by wired ones, low-cost with a high speed ARM Cortex-M0 based processor and a Kalman Filter directly providing quaternion estimation at 100 Hz for each IMU. The use of a multiplexer connected through an I2C interface (Inter Integrated Circuit) enabled to keep a 100 Hz rate using 4 IMUs.

The stimulator used in the experiments was a wireless programmable and controllable device. Latency issues and communication losses were observed when the computer sending the command to the stimulator was too far or if an obstacle was present between the computer and the participant wearing the stimulator. Taking advantage of the FES controller located on the subject to control the stimulator nearby has enabled us to solve this issue.

In this configuration, this autonomous FES controller is able to acquire the data, process them, execute control algorithms and send the appropriate stimulation command to the stimulator. For safety reasons, in order to access to the FES controller and to enable a remote access to the stimulation from a computer, an ad-hoc Wi-Fi network is automatically provided by the Raspberry on start-up. The ad-hoc network enables to be independent of a network infrastructure where the connection is not always possible (e.g. Wi-Fi network from the hospital).

This scalable architecture (Figure 3), developed as a modular system, now allows us to implement various new commands laws for Real Time closed loop control as well as giving us the ability to switch sensors and stimulators to meet the needs of specific applications. As part of making this system available for future projects in the team, the ability to easily change stimulators depending of the requirements was needed. To achieve this and in order for the FES architecture to directly control them, Application Programming Interfaces (APIs) were developed for 3 main commercial stimulators in the team. They each corresponds to a specific need and use case. The Vivaltis Phoenix Stimulator allows for low-weight embedding, wireless network control, but only 2 stimulation channels by pod, while being scalable. The BerkelBike Stimulator v2.0 presents a cumbersome but extended control compromise with 8 independent stimulation channels, which is an ideal solution for recumbent FES-assisted cycling. And finally the Hasomed Rehasim v1.0 allowing fine control but isn't battery powered in its commercial version and is not produced anymore.

This new architecture is currently used in clinical experiments and will continue to evolve with a goal of being easy to use, even by untrained clinicians. A funding (EDF Foundation) has been obtained by our clinical partner "CRF La Châtaigneraie" to perform a clinical protocol including 6 patients from which one will participate in the Cyathlon 2020 using this hardware and software architecture. The inclusions will begin in January 2019.

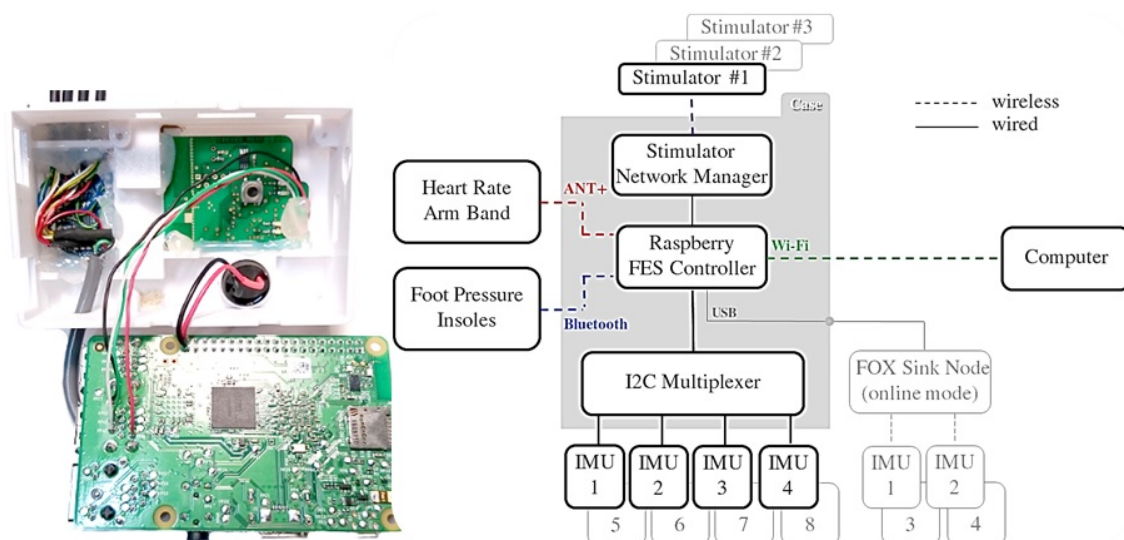


Figure 3. Experimental protocols have led to the development of a scalable hardware architecture decentralized on the subject.

5.2.2. Tremor monitoring system based on acceleration detection in Parkinson's Disease

Participants: Christine Azevedo Coste, Ronan Le Guillou.

As part of a preliminary study on the effects of Mindfulness meditation for patients with Parkinson's Disease (PD), an application was developed to monitor the accelerometer of a wrist worn device. The hypothesis being that reducing the cognitive load of a PD patient might reduce the severity of the tremors. We investigated a few devices that might correspond to our requirements : smartwatches, Myo armbands, Inertial Measurement Units,...Having already a Thalmic Myo Armband (Figure 4) we developed a program acquiring the accelerometer data in Real Time and logging it, as well as doing pre-processing and displaying it on the

screen of the clinician to allow him to monitor the session. While this system was ready and already tested, we had to search for another solution due to the termination of the commercial product. We then selected the smartwatch Samsung Gear S3 as a possible alternative and the dedicated application is currently under development.

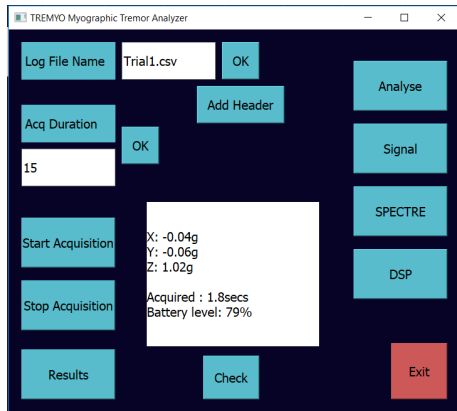


Figure 4. i) Graphical User Interface of the TREMYO Armband monitoring application during acquisition ii) Baseline test with straight extended arm for temporal comparison of the tremors severity.

CASTOR Project-Team

6. New Software and Platforms

6.1. CEDRES++

KEYWORDS: 2D - Magnetic fusion - Plasma physics

FUNCTIONAL DESCRIPTION: In Tokamaks, at the slow resistive diffusion time scale, the magnetic configuration in the plasma can be described by the MHD equilibrium equations inside the plasma and the Maxwell equations outside. Moreover, the magnetic field is often supposed not to depend on the azimuthal angle.

Under this assumption of axisymmetric configuration, the equilibrium in the whole space reduces to solving a 2D problem in which the magnetic field in the plasma is described by the well known Grad Shafranov equation. The unknown of this problem is the poloidal magnetic flux. The P1 finite element code CEDRES++ solves this free boundary equilibrium problem in direct and inverse mode. The direct problem consists in the computation of the magnetic configuration and of the plasma boundary, given a plasma current density profile and the total current in each poloidal field coils (PF coils). The aim of the inverse problem is to find currents in the PF coils in order to best fit a given plasma shape.

- Participants: Blaise Faugeras, Cédric Boulbe, Holger Heumann and Jacques Blum
- Partners: CNRS - CEA - Université de Nice Sophia Antipolis (UNS)
- Contact: Cédric Boulbe

6.2. Equinox

KEYWORDS: 2D - Problem inverse

FUNCTIONAL DESCRIPTION: EQUINOX is a code dedicated to the numerical reconstruction of the equilibrium of the plasma in a Tokamak. The problem solved consists in the identification of the plasma current density, a non-linear source in the 2D Grad-Shafranov equation which governs the axisymmetric equilibrium of a plasma in a Tokamak. The experimental measurements that enable this identification are the magnetics on the vacuum vessel, but also polarimetric and interferometric measures on several chords, as well as motional Stark effect measurements. The reconstruction can be obtained in real-time and the numerical method implemented involves a finite element method, a fixed-point algorithm and a least-square optimization procedure.

- Participants: Blaise Faugeras, Cédric Boulbe and Jacques Blum
- Contact: Blaise Faugeras

6.3. FBGKI

Full Braginskii

FUNCTIONAL DESCRIPTION: The Full Braginskii solver considers the equations proposed by Braginskii (1965), in order to describe the plasma turbulent transport in the edge part of tokamaks. These equations rely on a two fluid (ion - electron) description of the plasma and on the electroneutrality and electrostatic assumptions. One has then a set of 10 coupled non-linear and strongly anisotropic PDEs. FBGKI makes use in space of high order methods: Fourier in the toroidal periodic direction and spectral elements in the poloidal plane. The integration in time is based on a Strang splitting and Runge-Kutta schemes, with implicit treatment of the Lorentz terms (DIRK scheme). The spectral vanishing viscosity (SVV) technique is implemented for stabilization. Static condensation is used to reduce the computational cost. In its sequential version, a matrix free solver is used to compute the potential. The parallel version of the code is under development.

- Contact: Sebastian Minjeaud

6.4. FEEQS.M

Finite Element Equilibrium Solver in MATLAB

KEYWORDS: Finite element modelling - Optimal control - Plasma physics

FUNCTIONAL DESCRIPTION: FEEQS.M (Finite Element Equilibrium Solver in Matlab) is a MATLAB implementation of the numerical methods in [Heumann2015] to solve equilibrium problems for toroidal plasmas. Direct and inverse problems for both the static and transient formulations of plasma equilibrium can be solved. FEEQS.M exploits MATLAB's evolved sparse matrix methods and uses heavily the vectorization programming paradigm, which results in running times comparable to C/C++ implementations. FEEQS.M complements the production code CEDRES++ in being considered as fast prototyping test bed for computational methods for equilibrium problems. This includes aspects of numerics such as improved robustness of the Newton iterations or optimization algorithms for inverse problems. The latest developments aim at incorporating the resistive diffusion equation.

[Heumann2015]: Heumann, H., Blum, J., Boulbe, C., Faugas, B., Selig, G., Ané, J.-M., Brémond, S., Grandgirard, V., Hertout, P., Nardon, E.: Quasi-static free-boundary equilibrium of toroidal plasma with CEDRES++: Computational methods and applications. In: Journal of Plasma Physics 81 (2015)

- Participant: Holger Heumann
- Contact: Holger Heumann
- URL: <https://scm.gforge.inria.fr/svn/holgerheumann/Matlab/FEEQS.M>

6.5. Fluidbox

FUNCTIONAL DESCRIPTION: FluidBox is a software dedicated to the simulation of inert or reactive flows. It is also able to simulate multiphase, multi-material and MDH flows. There exist 2D and 3D dimensional versions. The 2D version is used to test new ideas that are later implemented in 3D. Two classes of schemes are available : a classical finite volume scheme and the more recent residual distribution schemes. Several low Mach number preconditioning are also implemented. The code has been parallelized with and without domain overlapping.

- Participants: Boniface Nkonga, Mario Ricchiuto, Michael Papin and Rémi Abgrall
- Contact: Boniface Nkonga

6.6. Jorek-Inria

FUNCTIONAL DESCRIPTION: Jorek-Inria is a new version of the JOREK software, for MHD modeling of plasma dynamic in tokamaks geometries. The numerical approximation is derived in the context of finite elements where 3D basic functions are tensor products of 2D basis functions in the poloidal plane by 1D basis functions in the toroidal direction. More specifically, Jorek uses curved bicubic isoparametric elements in 2D and a spectral decomposition (sine, cosine) in the toroidal axis. Continuity of derivatives and mesh alignment to equilibrium surface fluxes are enforced. Resulting linear systems are solved by the PASTIX software developed at Inria-Bordeaux.

RELEASE FUNCTIONAL DESCRIPTION: The new formulation of the Jorek-Inria code extends this approximation strategy by introducing more flexibility and a variety of finite elements used in the poloidal plane and in the toroidal direction. It also proposes a sparse matrix interface SPM (Sparse Matrix Manager) that allows to develop clean code without a hard dependency on any linear solver library (i.e. PetSc, Pastix, Mumps, ...).

- Participants: Ahmed Ratnani, Boniface Nkonga, Emmanuel Franck and Hervé Guillard
- Contact: Hervé Guillard
- URL: <https://gforge.inria.fr/projects/jorek/>

6.7. Plato

A platform for Tokamak simulation

FUNCTIONAL DESCRIPTION: PlaTo (A platform for Tokamak simulation) is a suite of data and softwares dedicated to the geometry and physics of Tokamaks. Plato offers interfaces for reading and handling distributed unstructured meshes, numerical templates for parallel discretizations, interfaces for distributed matrices and linear and non-linear equation solvers. Plato provides meshes and solutions corresponding to equilibrium solutions that can be used as initial data for more complex computations as well as tools for visualization using Visit or Paraview.

- Participants: Afeintou Sangam, Boniface Nkonga, Elise Estibals, Giorgio Giorgiani and Hervé Guillard
- Contact: Hervé Guillard

6.8. VacTH

KEYWORD: Problem inverse

FUNCTIONAL DESCRIPTION: VacTH implements a method based on the use of toroidal harmonics and on a modelization of the poloidal field coils and divertor coils to perform the 2D interpolation and extrapolation of discrete magnetic measurements in a tokamak and the identification of the plasma boundary. The method is generic and can be used to provide the Cauchy boundary conditions needed as input by a fixed domain equilibrium reconstruction code like EQUINOX. It can also be used to extrapolate the magnetic measurements in order to compute the plasma boundary itself. The method is foreseen to be used in the real-time plasma control loop on the WEST tokamak.

- Contact: Blaise Faugeras

6.9. NICE

Newton direct and Inverse Computation for Equilibrium

KEYWORDS: 2D - C++ - Scientific computing - Finite element modelling - Plasma physics - Optimal control - Optimization - Identification

FUNCTIONAL DESCRIPTION: The NICE code is under development. Its goal is to gather in a single modern, modular and evolutionary C++ code, the different numerical methods and algorithms from VACTH, EQUINOX and CEDRES++ which share many common features. It also integrates new methods as for example the possibility to use the Stokes model for equilibrium reconstruction using polarimetry measurements.

- Contact: Blaise Faugeras

COFFEE Project-Team

6. New Software and Platforms

6.1. AP_PartFlow

FUNCTIONAL DESCRIPTION: We are developing experimental codes, mainly based on Finite Differences, for the simulation of particulate flows. A particular attention is paid to guaranty the asymptotic properties of the scheme, with respect to relaxation parameters.

- Contact: Thierry Goudon

6.2. Mka3d

KEYWORDS: Scientific computing - Elasticity - Elastodynamic equations

FUNCTIONAL DESCRIPTION: The Mka3d method simulates an elastic solid by discretizing the solid into rigid particles. An adequate choice of forces and torques between particles allows to recover the equations of elastodynamics.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/Mka3D/>

6.3. Compass

Computing Architecture to Speed up Simulation

KEYWORDS: Finite volume methods - Porous media - High performance computing

FUNCTIONAL DESCRIPTION: Compass is a parallel code initiated in 2012 and co-developed by LJAD-Inria Coffee and BRGM since 2015. It is devoted to the simulation of multiphase flows in porous media, it accounts for non isothermal and compositional flows and includes complex network of fractures or faults represented as interfaces of co-dimension one coupled to the surrounding matrix. The discretization is based on vertex and cell unknowns and is adapted to polyhedral meshes and heterogeneous media. The ComPASS code is co-developed since december 2016 by the partners of the ANR CHARMS project including BGRM, LJAD-Inria Coffee, Storengy, MdS and LJLL with the objective to develop a new generation simulator for geothermal systems focusing on fluids and accounting for complex fault networks and wells.

- Participants: Simon Lopez, Farid Smai, Michel Kern, Yacine Ould Rouis, Nabil Birgile, Laurence Beaude, Konstantin Brenner and Roland Masson
- Partners: Université de Nice Sophia Antipolis (UNS) - BRGM
- Contact: Roland Masson
- URL: <http://www.anr-charms.org/page/compass-code>

6.4. NS2DDV-M

2D Navier-Stokes equations with variable density

KEYWORDS: Partial differential equation - Finite volume methods - Finite element modelling

FUNCTIONAL DESCRIPTION: The NS2DDV Matlab toolbox is an open-source program written in Matlab for simulating 2D viscous, incompressible and inhomogeneous flows. The computation kernel of the code is based on Finite Elements - Finite Volumes hybrid methods applied on the 2D Navier-Stokes equations. It works on unstructured meshes and can include mesh refinements strategies. We develop and freely distribute a new version of the Matlab code NS2DDV-M (equipped with a graphic interface and an accurate documentation) to promote new collaborations in the domain, allow some easy comparisons with concurrent codes on the same benchmark cases, and compare alternative numerical solution methods.

- Partner: Laboratoire Paul Painlevé
- Contact: Caterina Calgaro-Zotto
- URL: <https://wikis.univ-lille1.fr/painleve/ns2ddv>

6.5. SimBiof

KEYWORDS: Bioinformatics - Chemistry

FUNCTIONAL DESCRIPTION: We are developing numerical methods, currently by using Finite Differences approaches, for the simulation of biofilms growth. The underlying system of PDEs takes the form of multiphase flows equations with conservation constraints and vanishing phases. The numerical experiments have permitted to bring out the influence of physical parameters on the multidimensional growth dynamics.

- Contact: Thierry Goudon

6.6. CELIA3D

KEYWORDS: Fluid mechanics - Multi-physics simulation

FUNCTIONAL DESCRIPTION: The CELIA3D code simulates the coupling between a compressible fluid flow and a deformable structure. The fluid is handled by a Finite Volume method on a structured Cartesian grid. The solid is handled by a Discrete Element method (Mka3d scheme). The solid overlaps the fluid grid and the coupling is carried out with immersed boundaries (cut cells) in a conservative way.

- Partners: Ecole des Ponts ParisTech - CEA
- Contact: Laurent Monasse
- URL: <http://cermics.enpc.fr/~monassel/CELIA3D/>

EPIONE Project-Team

5. New Software and Platforms

5.1. CardiacSegmentationPropagation

KEYWORDS: 3D - Segmentation - Cardiac - MRI - Deep learning

FUNCTIONAL DESCRIPTION: Training of a deep learning model which is used for cardiac segmentation in short-axis MRI image stacks.

- Authors: Qiao Zheng, Hervé Delingette, Nicolas Duchateau and Nicholas Ayache
- Contact: Qiao Zheng
- Publication: [hal-01753086, version 1](#)

5.2. CardiacMotionFlow

KEYWORDS: 3D - Deep learning - Cardiac - Classification

FUNCTIONAL DESCRIPTION: Creation of a deep learning model for the motion tracking of the heart, extraction of characteristic quantities of the movement and shape of the heart to classify a sequence of cine-MRI cardiac images in terms of the types of pathologies (infarcted heart, dilated, hypertrophied, abnormality of the right ventricle).

- Contact: Qiao Zheng

5.3. MedInria

KEYWORDS: Visualization - DWI - Health - Segmentation - Medical imaging

SCIENTIFIC DESCRIPTION: medInria aims at creating an easily extensible platform for the distribution of research algorithms developed at Inria for medical image processing. This project has been funded by the D2T (ADT MedInria-NT) in 2010, renewed in 2012. A fast-track ADT was awarded in 2017 to transition the software core to more recent dependencies and study the possibility of a consortium creation. The Visages team leads this Inria national project and participates in the development of the common core architecture and features of the software as well as in the development of specific plugins for the team's algorithm.

FUNCTIONAL DESCRIPTION: MedInria is a free software platform dedicated to medical data visualization and processing.

- Participants: Maxime Sermesant, Olivier Commowick and Théodore Papadopoulos
- Partners: HARVARD Medical School - IHU - LIRYC - NIH
- Contact: Olivier Commowick
- URL: <http://med.inria.fr>

5.4. GP-ProgressionModel

GP progression model

KEYWORDS: Data modeling - Data visualization - Data integration - Machine learning - Biostatistics - Statistical modeling - Medical applications - Evolution - Brain - Uncertainty - Uncertainty quantification - Alzheimer's disease - Probability - Stochastic models - Stochastic process - Trajectory Modeling - Marker selection - Health - Statistical analysis - Statistics - Bayesian estimation

FUNCTIONAL DESCRIPTION: Disease progression modeling (DPM) of Alzheimer's disease (AD) aims at revealing long term pathological trajectories from short term clinical data. Along with the ability of providing a data-driven description of the natural evolution of the pathology, DPM has the potential of representing a valuable clinical instrument for automatic diagnosis, by explicitly describing the biomarker transition from normal to pathological stages along the disease time axis.

In this software we reformulate DPM within a probabilistic setting to quantify the diagnostic uncertainty of individual disease severity in an hypothetical clinical scenario, with respect to missing measurements, biomarkers, and follow-up information. The proposed formulation of DPM provides a statistical reference for the accurate probabilistic assessment of the pathological stage of de-novo individuals, and represents a valuable instrument for quantifying the variability and the diagnostic value of biomarkers across disease stages.

This software is based on the publication:

Probabilistic disease progression modeling to characterize diagnostic uncertainty: Application to staging and prediction in Alzheimer's disease. Marco Lorenzi, Maurizio Filippone, Daniel C. Alexander, Sebastien Ourselin *Neuroimage*. 2017 Oct 24. pii: S1053-8119(17)30706-1. doi: 10.1016/j.neuroimage.2017.08.059. HAL Id : hal-01617750 <https://hal.archives-ouvertes.fr/hal-01617750/>

- Authors: Marco Lorenzi and Maurizio Filippone
- Contact: Marco Lorenzi
- URL: <http://gpprogressionmodel.inria.fr>

5.5. Music

Multi-modality Platform for Specific Imaging in Cardiology

KEYWORDS: Medical imaging - Cardiac Electrophysiology - Computer-assisted surgery - Cardiac - Health
FUNCTIONAL DESCRIPTION: MUSIC is a software developed by the Asclepios research project in close collaboration with the IHU LIRYC in order to propose functionalities dedicated to cardiac interventional planning and guidance. This includes specific tools (algorithms of segmentation, registration, etc.) as well as pipelines. The software is based on the MedInria platform.

- Participants: Florent Collot, Mathilde Merle and Maxime Sermesant
- Partner: IHU- Bordeaux
- Contact: Maxime Sermesant
- URL: <https://team.inria.fr/asclepios/software/music/>

5.6. SOFA

Simulation Open Framework Architecture

KEYWORDS: Real time - Multi-physics simulation - Medical applications

FUNCTIONAL DESCRIPTION: SOFA is an Open Source framework primarily targeted at real-time simulation, with an emphasis on medical simulation. It is mostly intended for the research community to help develop new algorithms, but can also be used as an efficient prototyping tool. Based on an advanced software architecture, it allows : the creation of complex and evolving simulations by combining new algorithms with algorithms already included in SOFA, the modification of most parameters of the simulation (deformable behavior, surface representation, solver, constraints, collision algorithm, etc.) by simply editing an XML file, the building of complex models from simpler ones using a scene-graph description, the efficient simulation of the dynamics of interacting objects using abstract equation solvers, the reuse and easy comparison of a variety of available methods.

- Participants: Christian Duriez, François Faure, Hervé Delingette and Stéphane Cotin
- Partner: IGG
- Contact: Stéphane Cotin
- URL: <http://www.sofa-framework.org>

5.7. geomstats

Computations and statistics on manifolds with geometric structures

KEYWORD: Geometry

FUNCTIONAL DESCRIPTION: Geomstats is a python package that performs computations on manifolds such as hyperspheres, hyperbolic spaces, spaces of symmetric positive definite matrices and Lie groups of transformations. It provides efficient and extensively unit-tested implementations of these manifolds, together with useful Riemannian metrics and associated Exponential and Logarithm maps. The corresponding geodesic distances provide a range of intuitive choices of Machine Learning loss functions. We also give the corresponding Riemannian gradients. The operations implemented in geomstats are available with different computing backends such as numpy, tensorflow and keras. Geomstats manifold computations have are integrated into keras deep learning framework thanks to GPU-enabled implementations.

- Partner: Stanford Department of Statistics
- Contact: Nina Miolane
- URL: <https://github.com/geomstats/>

LEMON Team

6. New Software and Platforms

6.1. SW2D

Shallow Water 2 Dimensions

KEYWORDS: Numerical simulations - Shallow water equations

FUNCTIONAL DESCRIPTION: Urban floods are usually simulated using two-dimensional shallow water models. A correct representation of the urban geometry and hydraulics would require that the average computational cell size be between 0.1 m and 1 m. The meshing and computation costs make the simulation of entire districts/conurbations impracticable in the current state of computer technology.

An alternative approach consists in upscaling the shallow water equations using averaging techniques. This leads to introducing storage and conveyance porosities, as well as additional source terms, in the mass and momentum balance equations. Various versions of porosity-based shallow water models have been proposed in the literature. The Shallow Water 2 Dimensions (SW2D) computational code embeds various finite volume discretizations of these models. It uses fully unstructured meshes with arbitrary numbers of edges. The key features of the models and numerical techniques embedded in SW2D are :

- specific momentum/energy dissipation models that are active only under transient conditions. Such models, that are not present in classical shallow water models, stem from the upscaling of the shallow water equations and prove essential in modeling the features of fast urban flow transients accurately
- modified HLLC solvers for an improved discretization of the momentum source terms stemming from porosity gradients
- higher-order reconstruction techniques that allow for faster and more stable calculations in the presence of wetting/drying fronts.
 - Participant: Vincent Guinot
 - Contact: Vincent Guinot

6.2. 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>

6.3. SDM

Stochastic Downscaling 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

6.4. OceaPoS-SDM

KEYWORDS: 3D - Turbulence - Oceanography - Numerical simulations - Stochastic models - Marine Energies

FUNCTIONAL DESCRIPTION: Simulation platform for ocean turbulence and interaction with hydroturbines

- Partner: MERIC
- Contact: Mireille Bossy

MATHNEURO Team (section vide)

MORPHEME Project-Team

5. New Software and Platforms

5.1. Obj.MPP

KEYWORDS: Object detection - Marked Point Process - Parametric model

FUNCTIONAL DESCRIPTION: Obj.MPP implements the detection of parametric objects using a Marked Point Process (MPP). A parametric object is an n-dimensional piece of signal defined by a finite set of parameters. Detecting an object in a signal amounts to finding a position at which the signal can be described well enough by a specific set of parameters (unknowns of the detection problem). The detection task amounts to finding all such objects. Typically, the signal is a 2-dimensional grayscale image and the parametric objects are bright disks on a dark background. In this case, each object is defined by a single parameter: the disk radius. Note however that the core function of Obj.MPP is not tied to a particular context (2-dimensional imaging is just an example).

- Author: Eric Debreuve
- Contact: Eric Debreuve
- Publications: [Stochastic geometry for image analysis - Multiple objects detection in biological images using a marked point process framework - An efficient optimizer for simple point process models - Multiple Birth and Cut Algorithm for Multiple Object Detection](#)
- URL: <https://team.inria.fr/morpheme/obj-mpp-object-detection-using-a-marked-point-process/>

5.2. ATOLS

Adaptative Threshold Operator based on Level Sets

KEYWORDS: Object detection - Level Set

FUNCTIONAL DESCRIPTION: Atols is a Python script allowing to detect features on images using a contrast scoring. Thus, it's possible to detect features at different levels of intensity unlike a simple threshold which would only keep features above its value.

- Authors: Kevin Giulietti and Guillaume Lavis
- Contact: Xavier Descombes
- URL: <https://team.inria.fr/morpheme/software/>

5.3. Small particle detection

KEYWORDS: Image processing - Image segmentation - Object detection - Computational biology - Fluorescence microscopy - Biomedical imaging

FUNCTIONAL DESCRIPTION: An algorithm primarily design to detect objects whose sizes aren't larger a few pixels (particles) on fluorescence microscopy images.

It is an simplified version of marked point process.

- Contact: Nicolas Cedilnik
- Publications: [SPADE: A Small Particle Detection Method Using A Dictionary Of Shapes Within The Marked Point Process Framework - SPADE: A Small Particle Detection Method Using A Dictionary Of Shapes Within The Marked Point Process Framework](#)
- URL: <https://gitlab.inria.fr/ncedilni/spade>

COATI Project-Team

6. New Software and Platforms

6.1. GRPH

The high performance graph library for Java

KEYWORDS: Graph - Graph algorithmics - Java

FUNCTIONAL DESCRIPTION: Grph is an open-source Java library for the manipulation of graphs. Its design objectives are to make it portable, simple to use/extend, computationally/memory efficient, and, according to its initial motivation: useful in the context of graph experimentation and network simulation. Grph also has the particularity to come with tools like an evolutionary computation engine, a bridge to linear programming solvers, a framework for distributed computing, etc.

Grph offers a very general model of graphs. Unlike other graph libraries which impose the user to first decide if he wants to deal with directed, undirected, hyper (or not) graphs, the model offered by Grph is unified in a general class that supports mixed graphs made of undirected and directed simple and hyper edges. Grph achieves great efficiency through the use of multiple code optimization techniques such as multi-core parallelism, caching, adequate data structures, use of primitive objects, exploitation of low-level processor caches, on-the-fly compilation of specific C/C++ code, etc. Grph attempts to access the Internet in order to check if a new version is available and to report who is using it (login name and hostname). This has no impact whatsoever on performance and security.

- Participants: Aurélien Lancin, David Coudert, Issam Tahiri, Luc Hogue and Nathann Cohen
- Contact: Luc Hogue
- URL: <http://www.i3s.unice.fr/~hogie/grph/>

6.2. BigGraphs

KEYWORDS: Graph algorithmics - Distributed computing - Java - Graph processing

FUNCTIONAL DESCRIPTION: The objective of BigGraphs is to provide a distributed platform for very large graphs processing. A typical data set for testing purpose is a sample of the Twitter graph : 240GB on disk, 398M vertices, 23G edges, average degree of 58 and max degree of 24635412.

We started the project in 2014 with the evaluation of existing middlewares (GraphX / Spark and Giraph / Hadoop). After having tested some useful algorithms (written according to the BSP model) we decided to develop our own platform.

This platform is based on the existing BIGGRPH library and we are now in the phasis where we focus on the quality and the improvement of the code. In particular we have designed strong test suites and some non trivial bugs have been fixed. We also have solved problems of scalability, in particular concerning the communication layer with billions of messages exchanged between BSP steps. We also have implemented specific data structures for BSP and support for distributed debugging. This comes along with the implementation of algorithms such as BFS or strongly connected components that are run on the NEF cluster.

In 2017 we have developed a multi-threaded shared-memory parallel version of the Bulk Synchronous Parallel framework. This new version uses advanced synchronization mechanisms and strategies to minimize the congestion of multiple threads working on the same graph. Using the NEF cluster (Inria Sophia Antipolis), this parallel version exhibits speed-ups up to 6.5 using 8 nodes (16 cores each) when computing a BFS on the 23 G edges Twitter graph sample.

- Participants: Luc Hogue, Michel Syska and Nicolas Chleq
- Partner: CNRS
- Contact: Luc Hogue
- URL: <http://www.i3s.unice.fr/~hogie/software/?name=biggrph>

6.3. JMaxGraph

KEYWORDS: Java - HPC - Graph algorithmics

FUNCTIONAL DESCRIPTION: JMaxGraph is a collection of techniques for the computation of large graphs on one single computer. The motivation for such a centralized computing platform originates in the constantly increasing efficiency of computers which now come with hundred gigabytes of RAM, tens of cores and fast drives. JMaxGraph implements a compact adjacency-table for the representation of the graph in memory. This data structure is designed to 1) be fed page by page, à-la GraphChi, 2) enable fast iteration, avoiding memory jumps as much as possible in order to benefit from hardware caches, 3) be tackled in parallel by multiple-threads. Also, JMaxGraph comes with a flexible and resilient batch-oriented middleware, which is suited to executing long computations on shared clusters. The first use-case of JMaxGraph allowed F. Giroire, T. Trollet and S. Pérennes to count K_{2,2}s, and various types of directed triangles in the Twitter graph of users (23G arcs, 400M vertices). The computation campaign took 4 days, using up to 400 cores in the NEF Inria cluster.

- Contact: Luc Hogue
- URL: <http://www.i3s.unice.fr/~hogie/software/?name=jmaxgraph>

6.4. Sagemath

SageMath

KEYWORDS: Graph algorithmics - Graph - Combinatorics - Probability - Matroids - Geometry - Numerical optimization

SCIENTIFIC DESCRIPTION: SageMath is a free open-source mathematics software system. It builds on top of many existing open-source packages: NumPy, SciPy, matplotlib, Sympy, Maxima, GAP, FLINT, R and many more. Access their combined power through a common, Python-based language or directly via interfaces or wrappers.

FUNCTIONAL DESCRIPTION: SageMath is an open-source mathematics software initially created by William Stein (Professor of mathematics at Washington University). We contribute the addition of new graph algorithms along with their documentations and the improvement of underlying data structures.

RELEASE FUNCTIONAL DESCRIPTION: See <http://www.sagemath.org/changelogs/sage-8.4.txt>

NEWS OF THE YEAR: 1) Implementation of a linear time algorithm for partitioning a graph into 3-connected components. Done in the context of Google Summer of Code 2018. 2) Main contributor for making the graph module (more than 100,000 lines of code) of SageMath compatible with Python3 (ongoing, already more than 100 patches)

- Participant: David Coudert
- Contact: David Coudert
- URL: <http://www.sagemath.org/>

DIANA Project-Team

5. New Software and Platforms

5.1. ACQUAmobile

KEYWORDS: Android - Internet access - Performance measure - Quality of Experience

FUNCTIONAL DESCRIPTION: ACQUA is an Application for predicting Quality of Experience (QoE) at Internet Access. It is developed by the Diana team at Inria Sophia Antipolis – Méditerranée and was supported by Inria under the ADT ACQUA grant. The scientific project around ACQUA is supported by Inria Project Lab BetterNet and the French National Project ANR BottleNet. The project also got the approval of Inria COERLE and French CNIL for the part on experimentation with real users. ACQUA presents a new way for the evaluation of the performance of Internet access. Starting from network-level measurements as the ones we often do today (bandwidth, delay, loss rates, jitter, etc), ACQUA targets the estimated Quality of Experience (QoE) related to the different applications of interest to the user without the need to run them (e.g., estimated Skype quality, estimated video streaming quality).

An application in ACQUA is a function, or a model, that links the network-level and device-level measurements to the expected Quality of Experience. Supervised machine learning techniques are used to establish such link between measurements both at the network level and the device level, and estimations of the Quality of Experience for different Internet applications. The required data for such learning can be obtained either by controlled experiments as we did in [22], [21] on YouTube Quality of Experience, or by soliciting the crowd (i.e. crowdsourcing) for combinations (i.e. tuples) of measurements and corresponding application-level Quality of Experience. Our current work is concentrating on using the ACQUA principle in the estimation and prediction of the Quality of Experience for main user's applications. We refer to the web site of the project for further details.

The ACQUA Android application is supposed to be on one hand the reference application for QoE forecasting and troubleshooting for end users at their Internet access, and on the other hand, the feedback channel that allows end users to report to us (if they are willing) on their experience together with the corresponding network measurements so as to help us calibrating better and more realistic models. For this calibration, we are currently performing extensive, efficient and automatic measurements in the laboratory, we will count on end users to help us completing this dataset with further applications and more realistic network and user conditions.

ACQUA is mainly meant for end users, but it is also of interest to (mobile) network operators and to content providers to estimate the QoE of their customers and their networks without each time having to run expensive application-level traffic and to involve real users.

- Authors: Thierry Spetebroot and Chadi Barakat
- Contact: Chadi Barakat
- URL: <http://project.inria.fr/acqua/>

5.2. ElectroSmart

KEYWORDS: Crowd-sourcing - UMTS - GSM - Bluetooth - Wi-Fi - 4G - 3G - 2G - Electromagnetic waves - Android - LTE

FUNCTIONAL DESCRIPTION: The Internet and new devices such as smartphones have fundamentally changed the way people communicate, but this technological revolution comes at the price of a higher exposition of the general population to microwave electromagnetic fields (EMF). This exposition is a concern for health agencies and epidemiologists who want to understand the impact of such an exposition on health, for the general public who wants a higher transparency on its exposition and the health hazard it might represent, but also for cellular operators and regulation authorities who want to improve the cellular coverage while limiting the exposition, and for computer scientists who want to better understand the network connectivity in order to optimize communication protocols. Despite the fundamental importance to understand the exposition of the general public to EMF, it is poorly understood because of the formidable difficulty to measure, model, and analyze this exposition.

The goal of the ElectroSmart project is to develop the instrument, methods, and models to compute the exposition of the general public to microwave electromagnetic fields used by wireless protocols and infrastructures such as Wi-Fi, Bluetooth, or cellular. Using a pluri-disciplinary approach combining crowd-based measurements, in-lab experiments, and modeling using sparse and noisy data, we address challenges such as designing and implementing a measuring instrument leveraging on crowd-based measurements from mobile devices such as smartphones, modeling the exposition of the general public to EMF to compute the most accurate estimation of the exposition, and analyzing the evolution of the exposition to EMF with time. This technological breakthrough will have scientific, technical, and societal applications, notably on public health politics, by providing the scientific community and potential users with a unique measuring instrument, methods, and models to exploit the invaluable data gathered by the instrument.

This project is supported by the UCN@Sophia Labex in 2016/2017/2018 (funding the engineer Mondri Ravi), by an Inria ADT (funding the engineer Abdelhakim Akodadi) 2017/2018, by and Inria ATT (funding the business developer David Migliacci) in 2017/2018, and by the academy 1 of UCAJedi (funding a Ph.D. student Yanis Boussad) 2017/2020.

In August 2016, we released the first stable public release of ElectroSmart. On the 13th July 2018 we have 84 000 downloads in Google Play, an average score of 4.4/5, 30 000 active users, 850 millions measured signals.

We are in a process of creating a startup to commercialize the exposition maps we can build with the data we are collecting.

- Participants: Arnaud Legout, Abdelhakim Akodadi, Hackob Melconian, Inderjeet Singh and Mondri Ravi
- Contact: Arnaud Legout
- URL: https://es.inria.fr/home/index?path_prefix=en

5.3. OpenLISP

KEYWORDS: LISP - Routing - Control-plane

FUNCTIONAL DESCRIPTION: Among many options tackling the scalability issues of the current Internet routing architecture, the Locator/Identifier Separation Protocol (LISP) appears as a viable solution. LISP improves a network's scalability, flexibility, and traffic engineering, enabling mobility with limited overhead. As for any new technology, implementation and deployment are essential to gather and master the real benefits that it provides. We propose a complete open source implementation of the LISP control plane. Our implementation is deployed in the worldwide LISP Beta Network and the French LISP-Lab testbed, and includes the key standardized control plane features. Our control plane software is the companion of the existing OpenLISP dataplane implementation, allowing the deployment of a fully functional open source LISP network compatible with any implementation respecting the standards.

- Contact: Damien Saucez
- URL: <http://www.openlisp.org/downloads>

5.4. nepi-ng

KEYWORDS: Wireless network - Experimentation

FUNCTIONAL DESCRIPTION: In the specific context of R2lab, we have created a tool suite for orchestrating network experiments, that for historical reasons we refer to collectively as `nepi-ng`, for NEPI new generation. An umbrella website is available at <https://nepi-ng.inria.fr/>.

At this point, `nepi-ng` has a much smaller scope than its NEPI ancestor used to have, in that it only supports remote control of network experiments over `ssh`. As a matter of fact, in practice, this is the only access mechanism that we need to have for running experiments on both R2lab, and PlanetLab Europe.

The design of `nepi-ng` of course is modular, so that it will be perfectly possible to add other control mechanisms to this core if and when it becomes necessary.

`nepi-ng` is currently made of two separate python libraries:

- `asynciojobs`:
 - URL: <http://asynciojobs.readthedocs.io/en/latest/>
 - Version: `asynciojobs` v0.5.4
 - Keywords: networking experimentation, orchestration
 - License: CC BY-SA 4.0
 - Type of human computer interaction: python library
 - OS/Middleware: Linux
 - Required library or software: python-3.5 / `asyncio`
 - Programming language: python3
- `apssh`:
 - URL: <http://apssh.readthedocs.io/en/latest/>
 - Version: `apssh` v0.7.1
 - Keywords: networking experimentation, orchestration
 - License: CC BY-SA 4.0
 - Type of human computer interaction: python library
 - OS/Middleware: Linux
 - Required library or software: python-3.5 / `asyncio`
 - Programming language: python3
- Contact: Thierry Parmentelat
- URL: <http://nepi-ng.inria.fr>

5.5. Platforms

5.5.1. Reproducible research Lab - R2lab

Scientific evaluation of network protocols requires for experiments to be reproducible before they can be deemed valid. This is particularly difficult to obtain in the wireless networking area, where characteristics of wireless channels are known to be variable, unpredictable and hardly controllable.

The R2lab wireless testbed is built around an isolated and anechoic chamber, featuring RF absorbers preventing radio waves reflections and a Faraday cage blocking external interferences. This lab, named R2lab, represents an ideal environment for experiments reproducibility.

It represents a perfect facility for making wireless experiments reproducible. It has been operated for 3 years now, in the context of the FIT (Future Internet of Things) Equipment of Excellence project, and as such, it is now federated with the other testbeds that are part of the FIT initiative. This testbed is for the long-haul, and is scheduled to remain operational until at least 2020.

During 2018, our focus regarding R2lab has been set on enhancing the `nepi-ng` software toolkit, extending the set of tutorials and on deploying more network devices such as LoRa and Ettus USRP devices. The chamber now offers 19 USRP devices, as well as a couple of `lime-sdr` devices and a couple of E3372 LTE dongles. Moreover, two remotely controllable iPhone are available. All these additions aim at widening even further the spectrum of experiments that the testbed can support.

Access to R2lab is open 24/7. We currently have around 150 active users from all over the world among them 45 new users registered in 2018. For more details see <http://r2lab.inria.fr>.

5.5.2. *Network simulator for aircrafts*

- Keywords: network, simulation, real-time
- Functional Description: In collaboration with Safran Electrical and Power we produced a network design tool for aircrafts. This tool simulates aircraft networks. The tool is about 10,000 lines of code, out of which we produced 2,000.
- Assessment: A-2up,SO-3,SM-2up,EM-4,SDL-3,OC-DA-CD-TPM
- Licence: confidential
- URL: confidential
- Contact: Damien Saucez

FOCUS Project-Team

5. New Software and Platforms

5.1. HoCA

Higher-Order Complexity Analysis

KEYWORDS: Ocaml - Verification - Runtime Complexity Analysis

SCIENTIFIC DESCRIPTION: Over the last decade, various tools for the static analysis of resource properties of programs have emerged. In particular, the rewriting community has recently developed several tools for the time complexity analysis of term rewrite systems. These tools have matured and are nowadays able to treat non-trivial programs, in a fully automatic setting. However, none of these automatic complexity analysers can deal with higher-order functions, a pervasive feature of functional programs. HoCA (Higher-Order Complexity Analyser) overcomes this limitation by translating higher-order programs – in the form of side-effect free OCaml programs - into equivalent first-order rewrite systems. At the heart of our tool lies Reynold's defunctionalization technique. Defunctionalization however is not enough. Resulting programs have a recursive structure too complicated to be analysed automatically in all but trivial cases. To overcome this issue, HoCA integrates a handful of well established program transformation techniques, noteworthy dead-code elimination, inlining, instantiation and uncurrying. A complexity bound on the resulting first-order program can be relayed back reliably to the higher-order program of interest. A detailed description of HoCA is available on <http://arxiv.org/abs/1506.05043>.

FUNCTIONAL DESCRIPTION: HoCA is an abbreviation for Higher-Order Complexity Analysis, and is meant as a laboratory for the automated complexity analysis of higher-order functional programs. Currently, HoCA consists of one executable `pcf2trs` which translates a pure subset of OCaml to term rewrite systems, in a complexity reflecting manner. As a first step, HoCA desugars the given program to a variation of Plotkin's PCF with data-constructors. Via Reynold's defunctionalization, the PCF program is turned into an applicative term rewrite system (ATRS for short), call-by-value reductions of the PCF program are simulated by the ATRS step-by-step, on the ATRS, and various complexity reflecting transformations are performed: inlining, dead-code-elimination, instantiation of higher-order variables through a call-flow-analysis and finally uncurrying. This results finally in a first-order rewrite system, whose runtime-complexity reflects the complexity of the initial program, asymptotically.

- Participants: Martin Avanzini and Ugo Dal Lago
- Contact: Ugo Dal Lago
- URL: <http://cbr.uibk.ac.at/tools/hoca/>

5.2. JOLIE

Java Orchestration Language Interpreter Engine

KEYWORD: Microservices

SCIENTIFIC DESCRIPTION: Jolie enforces a strict separation of concerns between behaviour, describing the logic of the application, and deployment, describing the communication capabilities. The behaviour is defined using the typical constructs of structured sequential programming, communication primitives, and operators to deal with concurrency (parallel composition and input choice). Jolie communication primitives comprise two modalities of interaction typical of Service-Oriented Architectures (SOAs), namely one-way (sends an asynchronous message) and request-response (sends a message and waits for an answer). A main feature of the Jolie language is that it allows one to switch among many communication media and data protocols in a simple, uniform way. Since it targets the field of SOAs, Jolie supports the main communication media (TCP/IP sockets, Bluetooth L2CAP, Java RMI, and Unix local sockets) and data protocols (HTTP, JSON-RPC, XML-RPC, SOAP and their respective SSL versions) from this area.

FUNCTIONAL DESCRIPTION: Jolie is a language for programming service-oriented and microservice applications. It directly supports service-oriented abstractions such as service, port, and session. Jolie allows to program a service behaviour, possibly obtained by composing existing services, and supports the main communication protocols and data formats used in service-oriented architectures. Differently from other service-oriented programming languages such as WS-BPEL, Jolie is based on a user-friendly Java-like syntax (more readable than the verbose XML syntax of WS-BPEL). Moreover, the kernel of Jolie is equipped with a formal operational semantics. Jolie is used to provide proof of concepts around Focus activities.

RELEASE FUNCTIONAL DESCRIPTION: There are many fixes to the HTTP extension, improvements to the embedding engine for Javascript programs, and improvements to the support tools `jolie2java` and `wsdl2jolie`.

NEWS OF THE YEAR: During 2018 Jolie was complemented by the creation of the JIoT project, aimed at integrating IoT-related technologies into the Jolie language. The final goal is to provide easy-to-use and flexible communication abstractions to interconnect and make interact disparate IoT islands. Jolie currently supports some of the main technologies used in SOAs (e.g., HTTP). However, only a limited amount of IoT devices uses the media and protocols already supported by Jolie. Indeed, protocols such as CoAP and MQTT, which are widely used in IoT scenarios, are not implemented in Jolie. Integrating these protocols, as we have done, is essential in order to allow Jolie programs to directly interact with the majority of IoT devices. We note that emerging frameworks for interoperability, such as the Web of Things, rely on the same protocols we mentioned for IoT, thus JIoT is also compliant with them. Concretely, work in 2018 comprised the inclusion of the CoAP/UDP and MQTT/TCP protocols among the communication technologies supported by the language. The Jolie implementation of MQTT and CoAP, as well as the UDP transport protocol used by CoAP, are based on the JAVA framework Netty.

- Participants: Claudio Guidi, Fabrizio Montesi, Maurizio Gabrielli, Saverio Giallorenzo and Ivan Lanese
- Contact: Fabrizio Montesi
- URL: <http://www.jolie-lang.org/>

5.3. NightSplitter

KEYWORD: Constraint-based programming

FUNCTIONAL DESCRIPTION: Nightsplitter deals with the group preference optimization problem. We propose to split users into subgroups trying to optimize members' satisfaction as much as possible. In a large city with a huge volume of activity information, designing subgroup activities and avoiding time conflict is a challenging task. Currently, the Demo is available only for restaurant and movie activities in the city of Paris.

- Contact: Tong Liu
- URL: <http://cs.unibo.it/t.liu/nightsplitter/>

5.4. AIOCJ

Adaptive Interaction-Oriented Choreographies in Jolie

KEYWORD: Dynamic adaptation

SCIENTIFIC DESCRIPTION: AIOCJ is an open-source choreographic programming language for developing adaptive systems. It allows one to describe a distributed system as an AIOC, to generate code for each role avoiding by construction errors such as deadlocks. Furthermore, it supports dynamic adaptation of the distributed system via adaptation rules.

FUNCTIONAL DESCRIPTION: AIOCJ is a framework for programming adaptive distributed systems based on message passing. AIOCJ comes as a plugin for Eclipse, AIOCJ-ecl, allowing to edit descriptions of distributed systems written as adaptive interaction-oriented choreographies (AIOC). From interaction-oriented choreographies the description of single participants can be automatically derived. Adaptation is specified by rules allowing one to replace predetermined parts of the AIOC with a new behaviour. A suitable protocol ensures that all the participants are updated in a coordinated way. As a result, the distributed system follows the specification given by the AIOC under all changing sets of adaptation rules and environment conditions. In particular, the system is always deadlock free. AIOCJ can interact with external services, seen as functions, by specifying their URL and the protocol they support (HTTP, SOAP, ...). Deadlock-freedom guarantees of the application are preserved provided that those services do not block.

NEWS OF THE YEAR: In 2018 we did minor changes to AIOCJ, including the possibility of generating code only for a few roles, thus avoiding the need for deployment information for other roles.

- Participants: Ivan Lanese, Jacopo Mauro, Maurizio Gabbrielli, Mila Dalla Preda and Saverio Giallorenzo
- Contact: Saverio Giallorenzo
- URL: <http://www.cs.unibo.it/projects/jolie/aioj.html>

5.5. CauDEr

Causal-consistent Debugger for Erlang

KEYWORDS: Debug - Reversible computing

SCIENTIFIC DESCRIPTION: The reversible debugger is based on the theory of causal-consistent reversibility, which states that any action can be undone provided that its consequences, if any, are undone beforehand. This theory relies on a causal semantic for the target language, and can be used even if different processes have different notions of time

FUNCTIONAL DESCRIPTION: CauDEr is a debugger allowing one to explore the execution of concurrent Erlang programs both forward and backward. Notably, when going backward, any action can be undone provided that its consequences, if any, are undone beforehand. The debugger also provides commands to automatically find and undo consequences of a given action. Forward computation can be driven by a log taken from a computation in the standard Erlang/OTP environment. An action in the log can be selected and replayed together with all and only its causes. The debugger enables one to find a bug by following the causality links from the visible misbehaviour to the bug. The debugger takes an Erlang program but debugging is done on its translation into Core Erlang.

- Partner: Universitat Politècnica de València
- Contact: Ivan Lanese
- URL: <https://github.com/mistupv/cauder>

5.6. SUNNY-AS

SUNNY FOR ALGORITHM SELECTION

KEYWORDS: Optimisation - Machine learning

FUNCTIONAL DESCRIPTION: SUNNY-AS is a portfolio solver derived from SUNNY-CP for Algorithm Selection Problems (ASLIB). The goal of SUNNY-AS is to provide a flexible, configurable, and usable portfolio solver that can be set up and executed just like a regular individual solver.

- Contact: Tong Liu
- URL: <https://github.com/lteu/oasc>

INDES Project-Team

4. New Software and Platforms

4.1. Bigloo

KEYWORD: Compilers

FUNCTIONAL DESCRIPTION: Bigloo is a Scheme implementation devoted to one goal: enabling Scheme based programming style where C(++) is usually required. Bigloo attempts to make Scheme practical by offering features usually presented by traditional programming languages but not offered by Scheme and functional programming. Bigloo compiles Scheme modules. It delivers small and fast stand alone binary executables. Bigloo enables full connections between Scheme and C programs, between Scheme and Java programs.

RELEASE FUNCTIONAL DESCRIPTION: modification of the object system (language design and implementation), new APIs (alsa, flac, mpg123, avahi, csv parsing), new library functions (UDP support), new regular expressions support, new garbage collector (Boehm's collection 7.3alpha1).

- Participant: Manuel Serrano
- Contact: Manuel Serrano
- URL: <http://www-sop.inria.fr/teams/indes/fp/Bigloo/>

4.2. Hop

KEYWORDS: Programming language - Multimedia - Iot - Web 2.0 - Functional programming

SCIENTIFIC DESCRIPTION: The Hop programming environment consists in a web broker that intuitively combines in a single architecture a web server and a web proxy. The broker embeds a Hop interpreter for executing server-side code and a Hop client-side compiler for generating the code that will get executed by the client.

An important effort is devoted to providing Hop with a realistic and efficient implementation. The Hop implementation is validated against web applications that are used on a daily-basis. In particular, we have developed Hop applications for authoring and projecting slides, editing calendars, reading RSS streams, or managing blogs.

FUNCTIONAL DESCRIPTION: Multitier web programming language and runtime environment.

- Participant: Manuel Serrano
- Contact: Manuel Serrano
- URL: <http://hop.inria.fr>

4.3. IFJS

Information Flow monitor inlining for JavaScript

KEYWORD: Cybersecurity

FUNCTIONAL DESCRIPTION: The IFJS compiler is applied to JavaScript code. The compiler generates JavaScript code instrumented with checks to secure code. The compiler takes into account special features of JavaScript such as implicit type coercions and programs that actively try to bypass the inlined enforcement mechanisms. The compiler guarantees that third-party programs cannot (1) access the compiler internal state by randomizing the names of the resources through which it is accessed and (2) change the behaviour of native functions that are used by the enforcement mechanisms inlined in the compiled code.

- Contact: Tamara Rezk
- URL: <http://www-sop.inria.fr/indes/ifJS/>

4.4. iflowsigs.js

KEYWORDS: Compilers - Monitoring

FUNCTIONAL DESCRIPTION: iflowsigs.js is a JavaScript library designed to inline an information flow monitor into JavaScript code. iflowsigs.js support is able to track information flow even in programs that interact with arbitrary Web APIs.

- Participants: José Fragoso Santos and Tamara Rezk
- Contact: Tamara Rezk
- URL: <http://j3fsantos.github.io/PersonalPage/IFMonitor/>

4.5. iflowTYPES.js

FUNCTIONAL DESCRIPTION: iflowtypes.js is a JavaScript library designed to type secure information flow in JavaScript. iflowtypes.js has two main modes of operation: fully static and hybrid. In the hybrid mode, the program to be typed is instrumented with runtime assertions that are verified at runtime. By deferring rejection to runtime, the hybrid type system is able to type more programs than fully static mechanisms.

- Contact: Tamara Rezk
- URL: <http://j3fsantos.github.io/PersonalPage/TypeSystem/>

4.6. Mashic

KEYWORD: Security

FUNCTIONAL DESCRIPTION: The Mashic compiler is applied to mashups with untrusted scripts. The compiler generates mashups with sandboxed scripts, secured by the same origin policy of the browsers. The compiler is written in Bigloo.

- Contact: Tamara Rezk
- URL: <http://web.ist.utl.pt/~ana.matos/Mashic/mashic.html>

4.7. Hiphop.js

KEYWORDS: Web 2.0 - Synchronous Language - Programming language

FUNCTIONAL DESCRIPTION: HipHop.js is an Hop.js DLS for orchestrating web applications. HipHop.js helps programming and maintaining Web applications where the orchestration of asynchronous tasks is complex.

- Contact: Manuel Serrano
- URL: <http://hop-dev.inria.fr/hiphop>

4.8. Server-Side Protection against Third Party Web Tracking

KEYWORDS: Privacy - Web Application - Web - Architecture - Security by design - Program rewriting techniques

FUNCTIONAL DESCRIPTION: We present a new web application architecture that allows web developers to gain control over certain types of third party content. In the traditional web application architecture, a web application developer has no control over third party content. This allows the exchange of tracking information between the browser and the third party content provider.

To prevent this, our solution is based on the automatic rewriting of the web application in such a way that the third party requests are redirected to a trusted third party server, called the Middle Party Server. It may be either controlled by a trusted party, or by a main site owner and automatically eliminates third-party tracking cookies and other technologies that may be exchanged by the browser and third party server

- Contact: Doliere Some
- URL: <http://www-sop.inria.fr/members/Doliere.Some/essos/>

4.9. BELL

Browser fingerprinting via Extensions and Login-Leaks

KEYWORDS: Browser Extensions - Security and Privacy in Web Services - Social Networks Security and Privacy

FUNCTIONAL DESCRIPTION: Recent studies show that users can be tracked based on their web browser properties. This software is designed to conduct an experiment on such kinds of user tracking. In this experiment, we demonstrate that a Web user can also be tracked by

- her browser extensions (such as AdBlock, Pinterest, or Ghostery), and
- the websites she has logged in (such as Facebook, Gmail, or Twitter).

In the experiment, we collect user's browser fingerprint, together with the browser extensions installed and a list of websites she has logged in. We only collect anonymous data during the experiment (more details in our Privacy Policy ⁰), we will securely store the data on an Inria server, use it only for research purposes and not share it with anyone outside of Inria.

- Contact: Gabor Gulyas
- URL: <https://extensions.inrialpes.fr/>

4.10. webstats

Webstats

KEYWORDS: Web Usage Mining - Statistic analysis - Security

FUNCTIONAL DESCRIPTION: The goal of this tool is to perform a large-scale monthly crawl of the top Alexa sites, collecting both inline scripts (written by web developers) and remote scripts, and establishing the popularity of remote scripts (such as Google Analytics and jQuery). With this data, we establish whether the collected scripts are actually written in a subset of JavaScript by analyzing the different constructs used in those scripts. Finally, we collect and analyze the HTTP headers of the different sites visited, and provide statistics about the usage of HTTPOnly and Secure cookies, and the Content Security Policy in top sites.

- Contact: Doliere Some
- URL: <https://webstats.inria.fr>

4.11. Platforms

4.11.1. Skini

Skini is a distributed system for composing and producing live performances with audience participation using HTML5 devices. Skini is developed in Hop and HipHop. It proposes a framework for composing music based on patterns and dynamic control of the orchestration for either synthesizers or musicians.

The system has two basic concepts, "Pattern" and "Orchestration" which can be modulated as much as the composer wants in terms of complexity, duration, etc. The platform is meant for interaction with the audience during the show. Each participant can interact with the platform as well as with other participants. According to our experience during the Golem show in MANCA 2017, we implemented five levels of interaction, which allowed theoretically 120 possible combinations.

⁰<https://extensions.inrialpes.fr/privacy.php>

Neo Project-Team

6. New Software and Platforms

6.1. marmoteCore

Markov Modeling Tools and Environments - the Core

KEYWORDS: Modeling - Stochastic models - Markov model

FUNCTIONAL DESCRIPTION: marmoteCore is a C++ environment for modeling with Markov chains. It consists in a reduced set of high-level abstractions for constructing state spaces, transition structures and Markov chains (discrete-time and continuous-time). It provides the ability of constructing hierarchies of Markov models, from the most general to the particular, and equip each level with specifically optimized solution methods.

This software is developed within the ANR MARMOTE project: ANR-12-MONU-00019.

- Participants: Alain Jean-Marie, Hlib Mykhailenko, Benjamin Briot, Franck Quessette, Issam Rabhi, Jean-Marc Vincent and Jean-Michel Fourneau
- Partner: UVSQ
- Contact: Alain Jean-Marie
- Publications: [marmoteCore: a Markov Modeling Platform](#) - [marmoteCore: a software platform for Markov modeling](#)
- URL: <http://marmotecore.gforge.inria.fr/>

GRAPHDECO Project-Team

5. New Software and Platforms

5.1. SGTDP

Synthetic Ground Truth Data Generation Platform

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: The goal of this platform is to render large numbers of realistic synthetic images for use as ground truth to compare and validate image-based rendering algorithms and also to train deep neural networks developed in our team.

This pipeline consists of three major elements that are:

- Scene exporter
- Assisted point of view generation
- Distributed rendering on Inria's high performance computing cluster

The scene exporter is able to export scenes created in the widely-used commercial modeler 3DSMAX to the Mitsuba opensource renderer format. It handles the conversion of complex materials and shade trees from 3DSMAX including materials made for V-Ray. The overall quality of the produced images with exported scenes have been improved thanks to a more accurate material conversion. The initial version of the exporter was extended and improved to provide better stability and to avoid any manual intervention.

From each scene we can generate a large number of images by placing multiple cameras. Most of the time those points of view has to be placed with a certain coherency. This task could be long and tedious. In the context of image-based rendering, cameras have to be placed in a row with a specific spacing. To simplify this process we have developed a set of tools to assist the placement of hundreds of cameras along a path.

The rendering is made with the open source renderer Mitsuba. The rendering pipeline is optimised to render a large number of point of view for single scene. We use a path tracing algorithm to simulate the light interaction in the scene and produce high dynamic range images. It produces realistic images but it is computationally demanding. To speed up the process we setup an architecture that takes advantage of the Inria cluster to distribute the rendering on hundreds of CPU's cores.

The scene data (geometry, textures, materials) and the cameras are automatically transferred to remote workers and HDR images are returned to the user.

We already use this pipeline to export tens of scenes and to generate several thousands of images, which have been used for machine learning and for ground-truth image production.

We have recently integrated the platform with the SIBR software library, allowing us to read mitsuba scenes. We have written a tool to allow camera placement to be used for rendering and for reconstruction of synthetic scenes, including alignment of the exact and reconstructed version of the scenes. This dual-representation scenes can be used for learning and as ground truth. We can also perform various operations on the ground truth data within SIBR, e.g., compute shadow maps of both exact and reconstructed representations etc.

- Contact: George Drettakis

5.2. Unity IBR

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: Unity IBR (for Image-Based Rendering in Unity) This is a software module that proceeds the development of IBR algorithms in Unity. In this case, algorithms are developed for the context of EMOTIVE EU project. The rendering technique was changed during the year to evaluate and compare which one produces better results suitable for Game Development with Unity (improvement of image quality and faster rendering). New features were also added such as rendering of bigger datasets and some debugging utilities. Software was also updated to keep compatibility with new released versions of Unity game engine. In addition, in order to develop a demo showcasing the technology, a multiplayer VR scene was created proving the integration of IBR with the rest of the engine.

- Contact: George Drettakis

5.3. SIBR

Simple Image-Based Rendering

KEYWORD: Graphics

FUNCTIONAL DESCRIPTION: This is a framework containing libraries and tools used internally for research projects based on Image-Base Rendering. It includes both preprocessing tools (computing data used for rendering) and rendering utilities and serves as the basis for many research projects in the group.

It includes basic support for a large set of computer graphics and computer vision functionalities and includes implementations of several image-based rendering algorithms. The code base has become quite mature and is in the process of being used for tech transfer.

- Contact: George Drettakis

5.4. SynthDraw

KEYWORDS: Non-photorealistic rendering - Vector-based drawing

FUNCTIONAL DESCRIPTION: The SynthDraw library extracts occluding contours and sharp features over a 3D shape, computes all their intersections using a binary space partitioning algorithm, and finally makes a raycast to determine each sub-contour visibility. The resulting lines can then be exported as an SVG file for subsequent processing, for instance to stylize the drawing with different brush strokes. The library can also export various attributes for each line, such as its visibility and type. SynthDraw is based on the geometry processing library libIGL.

RELEASE FUNCTIONAL DESCRIPTION: This first version extracts occluding contours and creases, and computes their visibility with brute-force ray casting.

- Contact: Bastien Wailly

5.5. DeepSketch

KEYWORDS: 3D modeling - Sketching - Deep learning

FUNCTIONAL DESCRIPTION: DeepSketch is a sketch-based modeling system that runs in a web browser. It relies on deep learning to recognize geometric shapes in line drawings. The system follows a client/server architecture, based on the Node.js and WebGL technology. The application's main targets are iPads or Android tablets equipped with a digital pen, but it can also be used on desktop computers.

RELEASE FUNCTIONAL DESCRIPTION: This first version is built around a client/server Node.js application whose job is to transmit a drawing from the client's interface to the server where the deep networks are deployed, then transmit the results back to the client where the final shape is created and rendered in a WebGL 3D scene thanks to the THREE.js JavaScript framework. Moreover, the client is able to perform various camera transformations before drawing an object (change position, rotate in place, scale on place) by interacting with the touch screen. The user also has the ability to draw the shape's shadow to disambiguate depth/height. The deep networks are created, trained and deployed with the Caffe framework.

- Contact: Adrien Bousseau

GRAPHIK Project-Team

6. New Software and Platforms

6.1. Cogui

KEYWORDS: Knowledge database - Ontologies - GUI (Graphical User Interface)

SCIENTIFIC DESCRIPTION: Cogui is a visual tool for building and verifying graphical knowledge bases (KB). Knowledge bases are represented under graphical form (close to conceptual graphs). There is a complete correspondence with the logical existential rule (or Datalog+) framework.

FUNCTIONAL DESCRIPTION: Cogui is a freeware written in Java. It allows to graphically create a KB, to handle its structure and content, and to control it. Currently, it supports Conceptual Graphs and import/export in RDFS and Datalog+. Wizards allow to analyze and check facts with respect to some constraints, as well as to query them while taking into account inferences enabled by the ontology.

RELEASE FUNCTIONAL DESCRIPTION: Plugin-extensible architecture, multi-project management, automatic construction of a web documentation of the ontology, adoption of semantic web conventions (IRIs and namespaces), integration of some Graal functionalities (homomorphisms and OWL 2 import), improvement of the import/export between Cogui knowledge bases and Graal dlgp format.

NEWS OF THE YEAR: Release of a new version (V3) resulting from heavy refactoring to benefit from NetBeans plugin-extensible platform architecture and graphical libraries (total replacement of the graphical editors).

This new version requires to completely revise the user documentation, which is in progress.

- Participants: Alain Gutierrez, Michel Chein, Marie-Laure Mugnier, Michel Leclère and Madalina Croitoru
- Partner: LIRMM
- Contact: Michel Chein
- URL: <http://www.lirmm.fr/cogui/>

6.2. DAGGER

KEYWORDS: Graph algorithmics - Logic programming

FUNCTIONAL DESCRIPTION: We introduce DAGGER: a generator for logic based argumentation frameworks instantiated from inconsistent knowledge bases expressed using Datalog. The tool allows to import a knowledge base in DLGP format and the generation and visualisation of the corresponding argumentation graph. Furthermore, the argumentation framework can also be exported in the Aspartix format.

- Contact: Madalina Croitoru
- URL: <http://www.lirmm.fr/~yun/tools.html>

6.3. Eldr

Existential Logic for Defeasible Reasoning

KEYWORDS: Knowledge representation - Logic programming

FUNCTIONAL DESCRIPTION: Eldr is an open source defeasible reasoning tool that allows the use of different semantics (ambiguity blocking/propagating with or without team defeat) in order to reason with incoherent or inconsistent knowledge. It allows the reasoning about preferences and their justification between different agents with a final aim of producing justified preferences on different outcomes (alternatives). These preferences are then used with a voting module (given certain voting strategy) to break ties and establish the chosen alternative. It is applied within the GLOPACK and NOAW projects.

- Contact: Madalina Croitoru
- URL: <https://github.com/hamhec/graal-elder>

6.4. GRAAL

KEYWORDS: Knowledge database - Ontologies - Querying - Data management

SCIENTIFIC DESCRIPTION: Graal is a Java toolkit dedicated to querying knowledge bases within the framework of existential rules, aka Datalog+/-.

FUNCTIONAL DESCRIPTION: Graal has been designed in a modular way, in order to facilitate software reuse and extension. It should make it easy to test new scenarios and techniques, in particular by combining algorithms. The main features of Graal are currently the following: (1) a data layer that provides generic interfaces to store various kinds of data and query them with (union of) conjunctive queries, currently: MySQL, PostgreSQL, Sqlite, in memory graph and linked list structures, (2) an ontological layer, where an ontology is a set of existential rules, (3) a knowledge base layer, where a knowledge base is composed of a fact base (abstraction of the data via generic interfaces) and an ontology, (4) algorithms to process ontology-mediated queries, based on query rewriting and/or forward chaining (or chase), (5) a rule analyzer, which performs a syntactic and structural analysis of an existential rule set, (6) several IO formats, including imports from OWL 2.

RELEASE FUNCTIONAL DESCRIPTION: Version 1.3.0 (2017) fixes some bugs, makes the dlgp parser more flexible (dlgp being our serialization format for existential rules) and improves the efficiency of the forward chaining (chase) algorithms.

Version 1.3.1 (2018) provides minor optimizations and small bug fixes.

NEWS OF THE YEAR: 2018: Version 1.3.1, with small bug fixes and minor improvements. Several new functionalities were developed by internships in 2018 but the code is not integrated to Graal yet. **2017:** New stable version (1.3.0) realised. Moreover, Graal website has been deeply restructured and enriched with new tools, available online or for download, and documentation including tutorials, examples of use, and technical documentation about all Graal modules.

- Participants: Marie-Laure Mugnier, Clément Sipieter, Jean-François Baget, Mélanie König, Michel Leclère and Swan Rocher
- Contact: Marie-Laure Mugnier
- Publications: [Gaal: A Toolkit for Query Answering with Existential Rules - Datalog+, RuleML and OWL 2: Formats and Translations for Existential Rules](#)
- URL: <https://github.com/graphik-team>

HEPHAISTOS Project-Team

6. New Software and Platforms

6.1. ALIAS

Algorithms Library of Interval Analysis for Systems

FUNCTIONAL DESCRIPTION: The ALIAS library whose development started in 1998, is a collection of procedures based on interval analysis for systems solving and optimization.

ALIAS is made of two parts:

ALIAS-C++ : the C++ library (87 000 code lines) which is the core of the algorithms

ALIAS-Maple : the Maple interface for ALIAS-C++ (55 000 code lines). This interface allows one to specify a solving problem within Maple and get the results within the same Maple session. The role of this interface is not only to generate the C++ code automatically, but also to perform an analysis of the problem in order to improve the efficiency of the solver. Furthermore, a distributed implementation of the algorithms is available directly within the interface.

- Participants: Jean-Pierre Merlet and Odile Pourtallier
- Contact: Jean-Pierre Merlet

6.2. PALGate

KEYWORDS: Health - Home care - Handicap

- Contact: David Daney

6.3. Platforms

6.3.1. ALIAS, *Algorithms Library of Interval Analysis for Systems*

Participants: Hiparco Lins Vieira, Jean-Pierre Merlet [correspondant], Yves Papegay.

URL: <http://www-sop.inria.fr/hephaistos/developpements/main.html>

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6.3.2. *Hardware platforms*

We describe here only the new platforms that have been developed or improved in 2018 while we maintain a very large number of platforms (e.g. the cable-driven parallel robots of the MARIONET family, the ANG family of walking aids or our experimental flat).

6.3.2.1. REVMED: virtual reality and rehabilitation

Inria and Université Côte d'Azur have agreed to fund us for developing the platform REVMED whose purpose is to introduce end-user motion and their analysis in a virtual reality environment in order to make rehabilitation exercises more attractive and more appropriate for the rehabilitation process. For example we have developed an active treadmill whose slope change according to the user place in the virtual world while the lateral inclination may be changed in order to regulate the load between the left and right leg. Such a system may be used in rehabilitation to simulate a walk in the mountain while increasing on-demand the load on an injured leg (that is usually avoided by the user) for a shorter rehabilitation time. At the same time the walking pattern is analyzed by using lidar, kinect and distance sensor in order to assess the efficiency of the rehabilitation exercise.

The motion system is composed of two vertical columns whose height may be adjusted (they are used for actuating the treadmill), a 6 d.o.f motion base and a cable-driven parallel robot which may lift the user (in the walking experiment this robot may be used to support partly the user while he is walking allowing frail people to start the rehabilitation earlier). We intend to develop sailing and ski simulators as additional rehabilitation environment. Currently the columns and instrumented treadmill are effective and we have completed at the end of this year the coupling between the subject motion and the 2D visualization of a walk in a nice-looking environment, including basic sound (figure 1). Walking analysis is performed using a lidar, a kinect and a distance sensor at the head of the treadmill.



Figure 1. Our rehabilitation station in a configuration with a treadmill, 2 columns for changing its slope and inclination and lidar and kinect for motion analysis

6.3.2.2. Activities detection platform

For non intrusive activities detection we use low cost distance and motion sensors that are incorporated in a 3D printed box and constitute a detection station. Several such station are implemented at appropriate place in the location that has to be monitored. Currently we have 15 such stations deployed at Valrose EHPAD since end of 2016 and 17 (which amount to 77 different sensors) deployed at Institut Claude Pompidou since the end of 2017.

STARS Project-Team

6. New Software and Platforms

6.1. SUP

Scene Understanding Platform

KEYWORDS: Activity recognition - 3D - Dynamic scene

FUNCTIONAL DESCRIPTION: SUP is a software platform for perceiving, analyzing and interpreting a 3D dynamic scene observed through a network of sensors. It encompasses algorithms allowing for the modeling of interesting activities for users to enable their recognition in real-world applications requiring high-throughput.

- Participants: Etienne Corvée, François Brémond, Thanh Hung Nguyen and Vasanth Bathrinathan
- Partners: CEA - CHU Nice - USC Californie - Université de Hamburg - I2R
- Contact: François Brémond
- URL: <https://team.inria.fr/stars/software>

6.2. VISEVAL

FUNCTIONAL DESCRIPTION: ViSEval is a software dedicated to the evaluation and visualization of video processing algorithm outputs. The evaluation of video processing algorithm results is an important step in video analysis research. In video processing, we identify 4 different tasks to evaluate: detection, classification and tracking of physical objects of interest and event recognition.

- Participants: Bernard Boulay and François Brémond
- Contact: François Brémond
- URL: http://www-sop.inria.fr/teams/pulsar/EvaluationTool/ViSEvAl_Description.html

TITANE Project-Team

6. New Software and Platforms

6.1. CGAL Barycentric_coordinates_2

Module CGAL : Barycentric coordinates 2D

KEYWORD: Computational geometry

FUNCTIONAL DESCRIPTION: This package offers an efficient and robust implementation of two-dimensional closed-form generalized barycentric coordinates defined for simple two-dimensional polygons.

- Participants: Dmitry Anisimov and Pierre Alliez
- Contact: Pierre Alliez

6.2. dtk-nurbs-probing

KEYWORDS: Algorithm - CAD - Numerical algorithm - Geometric algorithms

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

- Participants: Come Le Breton, Laurent Busé and Pierre Alliez
- Contact: Come Le Breton

6.3. MeshMantics

KEYWORDS: Classification - 3D modeling

FUNCTIONAL DESCRIPTION: This software component enables the classification of surface meshes in accordance to common outdoor urban classes such as ground, facades, walls, roofs and vegetation.

- Participants: Florent Lafarge, Pierre Alliez and Yannick Verdié
- Contact: Pierre Alliez

6.4. Module CGAL : Point Set Processing

KEYWORD: Geometry Processing

FUNCTIONAL DESCRIPTION: This CGAL component implements methods to analyze and process unorganized point sets. The input is an unorganized point set, possibly with normal attributes (unoriented or oriented). The point set can be analyzed to measure its average spacing, and processed through functions devoted to the simplification, outlier removal, smoothing, normal estimation, normal orientation and feature edges estimation.

- Participants: Clément Jamin, Laurent Saboret and Pierre Alliez
- Contact: Pierre Alliez
- URL: http://doc.cgal.org/latest/Point_set_processing_3/index.html#Chapter_Point_Set_Processing

6.5. Module CGAL : Scale space surface reconstruction

KEYWORD: Geometric algorithms

SCIENTIFIC DESCRIPTION: This CGAL package implements a surface reconstruction method which takes as input an unordered point set and computes a triangulated surface mesh interpolating the point set. We assume that the input points were sampled from the surface of an object. The method can also process point sets sampled from the interior of the object, although we cannot provide guarantees on the output. This method can handle a decent amount of noise and outliers. The point set may greatly undersample the object in occluded regions, although no surface will be reconstructed to fill these regions.

FUNCTIONAL DESCRIPTION: This method allows to reconstruct a surface that interpolates a set of 3D points. This method provides an efficient alternative to the Poisson surface reconstruction method. The main difference in output is that this method reconstructs a surface that interpolates the point set (as opposed to approximating the point set). How the surface connects the points depends on a scale variable, which can be estimated semi-automatically.

- Participants: Pierre Alliez and Thijs Van Lankveld
- Contact: Pierre Alliez

6.6. Skeleton-Blockers

Skeleton-Blockers data-structure

KEYWORDS: C++ - Mesh - Triangulation - Topology - 3D

FUNCTIONAL DESCRIPTION: Skeleton-Blockers is a compact, efficient and generic data-structure that can represent any simplicial complex. The implementation is in C++11.

- Participant: David Salinas
- Contact: David Salinas
- URL: <https://project.inria.fr/gudhi/software/>

6.7. Structure-preserving decimation

KEYWORDS: Mesh - 3D - Multi-View reconstruction

FUNCTIONAL DESCRIPTION: Structure-preserving decimation is a software that can simplify 3D meshes while preserving some of their structure. Simplification can be done either with a command line or with a graphical user interface that allows to combine several operations including several simplification methods.

- Participants: David Salinas, Florent Lafarge and Pierre Alliez
- Contact: David Salinas

WIMMICS Project-Team

6. New Software and Platforms

6.1. CORESE

COnceptual REsource Search Engine

KEYWORDS: Semantic Web - Search Engine - RDF - SPARQL

FUNCTIONAL DESCRIPTION: Corese is a Semantic Web Factory, it implements W3C RDF, RDFS, SPARQL 1.1 Query and Update as well as RDF Inference Rules.

Furthermore, Corese query language integrates original features such as approximate search and extended Property Path. It provides STTL: SPARQL Template Transformation Language for RDF graphs. It also provides LDScript: a Script Language for Linked Data. Corese provides distributed federated query processing.

- Participants: Erwan Demairy, Fabien Gandon, Fuqi Song, Olivier Corby, Olivier Savoie and Virginie Bottollier
- Partners: I3S - Mnemotix
- Contact: Olivier Corby
- URL: <http://wimmics.inria.fr/corese>

6.2. DBpedia

KEYWORDS: RDF - SPARQL

FUNCTIONAL DESCRIPTION: DBpedia is an international crowd-sourced community effort to extract structured information from Wikipedia and make this information available on the semantic Web as linked open data. The DBpedia triple stores then allow anyone to solve sophisticated queries against Wikipedia extracted data, and to link the different data sets on these data. The French chapter of DBpedia was created and deployed by Wimmics and is now an online running platform providing data to several projects such as: QAKIS, Izipedia, zone47, S epage, HdA Lab., JocondeLab, etc.

RELEASE FUNCTIONAL DESCRIPTION: The new release is based on updated Wikipedia dumps and the inclusion of the DBpedia history extraction of the pages.

- Participants: Fabien Gandon and Elmahdi Korfed
- Contact: Fabien Gandon
- URL: <http://wiki.dbpedia.org/>

6.3. Discovery Hub

Discovery Hub Exploratory Search Engine

KEYWORD: Search Engine

FUNCTIONAL DESCRIPTION: Recommendation system on top of DBpedia

- Participants: Alain Giboin, Emilie Palagi, Fabien Gandon and Nicolas Marie
- Partner: Alcatel-Lucent
- Contact: Fabien Gandon
- URL: <http://discoveryhub.co/>

6.4. Fuzzy labelling argumentation module

Fuzzy labelling algorithm for abstract argumentation

KEYWORDS: Artificial intelligence - Multi-agent - Knowledge representation - Algorithm

FUNCTIONAL DESCRIPTION: The goal of the algorithm is to compute the fuzzy acceptability degree of a set of arguments in an abstract argumentation framework. The acceptability degree is computed from the trustworthiness associated with the sources of the arguments.

- Participant: Serena Villata Milanesio
- Contact: Serena Villata Milanesio

6.5. Qakis

Question-Answering wiki framework based system

KEYWORD: Natural language

FUNCTIONAL DESCRIPTION: The QAKiS system implements question answering over DBpedia. QAKiS allows end users to submit a query to an RDF triple store in English and to obtain the answer in the same language, hiding the complexity of the non-intuitive formal query languages involved in the resolution process. At the same time, the expressiveness of these standards is exploited to scale to the huge amounts of available semantic data. Its major novelty is to implement a relation-based match for question interpretation, to convert the user question into a query language (e.g. SPARQL). English, French and German DBpedia chapters are the RDF data sets to be queried using a natural language interface.

- Participants: Alessio Palmero Aprosio, Amine Hallili, Elena Cabrio, Fabien Gandon, Julien Cojan and Serena Villata Milanesio
- Contact: Elena Cabrio
- URL: <http://www.qakis.org/>

ZENITH Project-Team

6. New Software and Platforms

6.1. PI@ntNet

KEYWORDS: Plant identification - Deep learning - Citizen science

FUNCTIONAL DESCRIPTION: PI@ntNet is a participatory platform and information system dedicated to the production of botanical data through deep learning-based plant identification. It includes 3 main front-ends, an Android app (the most advanced and the most used one), an iOS app (being currently re-developed) and a web version. The main feature of the application is to return the ranked list of the most likely species providing an image or an image set of an individual plant. In addition, PI@ntNet's search engine returns the images of the dataset that are the most similar to the queried observation allowing interactive validation by the users. The back-office running on the server side of the platform is based on Snoop visual search engine (a software developed by ZENITH) and on NewSQL technologies for the data management. The application is distributed in more than 180 countries (10M downloads) and allows identifying about 20K plant species at present time.

- Participants: Antoine Affouard, Jean-Christophe Lombardo, Pierre Bonnet, Hervé Goëau, Mathias Chouet and Julien Champ
- Contact: Alexis Joly
- Publication: [PI@ntNet app in the era of deep learning](#)

6.2. ThePlantGame

KEYWORD: Crowd-sourcing

FUNCTIONAL DESCRIPTION: ThePlantGame is a participatory game whose purpose is the production of big taxonomic data to improve our knowledge of biodiversity. One major contribution is the active training of the users based on innovative sub-task creation and assignment processes that are adaptive to the increasing skills of the user. Thousands of players are registered and produce on average about tens new validated plant observations per day. The accuracy of the produced taxonomic tags is very high (about 95

- Participants: Maximilien Servajean and Alexis Joly
- Contact: Alexis Joly
- Publication: [Crowdsourcing Thousands of Specialized Labels: A Bayesian Active Training Approach](#)

6.3. Snoop

KEYWORDS: Content-based Image Retrieval - Deep learning

FUNCTIONAL DESCRIPTION: Snoop is a C++ framework dedicated to large-scale content-based image retrieval. Its main features are (i) the extraction and efficient indexing of visual features (hand-crafted or learned through deep learning), (ii) the search of similar images through approximate k-nearest neighbors and (iii), the supervised recognition of trained visual concepts. The framework can be used either as a set of C++ libraries or as a set of web services through a RESTFUL API. Snoop is the visual search engine used by the PI@ntNet applications (very large audience).

- Participants: Alexis Joly, Jean-Christophe Lombardo and Olivier Buisson
- Partner: INA (Institut National de l'Audiovisuel)
- Contact: Alexis Joly
- Publication: [Random Maximum Margin Hashing](#)

6.4. Chiaroscuro

KEYWORDS: Privacy - P2P - Data mining

FUNCTIONAL DESCRIPTION: Chiaroscuro is a complete solution for clustering personal data with strong privacy guarantees. The execution sequence produced by Chiaroscuro is massively distributed on personal devices, coping with arbitrary connections and disconnections. Chiaroscuro builds on our novel data structure, called Diptych, which allows the participating devices to collaborate privately by combining encryption with differential privacy. Our solution yields a high clustering quality while minimizing the impact of the differentially private perturbation.

- Participants: Tristan Allard, Georges Hebrail, Florent Masegla and Esther Pacitti
- Contact: Florent Masegla
- Publication: [Chiaroscuro: Transparency and Privacy for Massive Personal Time-Series Clustering](#)

6.5. DfAnalyzer

Dataflow Analysis

KEYWORDS: Data management - Monitoring - Runtime Analysis

FUNCTIONAL DESCRIPTION: DfAnalyzer is a tool for monitoring, debugging, steering, and analysis of dataflows while being generated by scientific applications. It works by capturing strategic domain data, registering provenance and execution data to enable queries at runtime. DfAnalyzer provides lightweight dataflow monitoring components to be invoked by high performance applications. It can be plugged in scripts, or Spark applications, in the same way users already plug visualization library components.

- Participants: Vítor Sousa Silva, Daniel De Oliveira, Marta Mattoso and Patrick Valduriez
- Partners: COPPE/UFRJ - Uff
- Contact: Patrick Valduriez
- Publication: [DfAnalyzer: Runtime Dataflow Analysis of Scientific Applications using Provenance](#)
- URL: <https://github.com/vssousa/dfanalyzer-spark>

6.6. CloudMdsQL Compiler

KEYWORDS: Optimizing compiler - NoSQL - Data integration

FUNCTIONAL DESCRIPTION: The CloudMdsQL (Cloud Multi-datastore Query Language) polystore transforms queries expressed in a common SQL-like query language into an optimized query execution plan to be executed over multiple cloud data stores (SQL, NoSQL, HDFS, etc.) through a query engine. The compiler/optimizer is implemented in C++ and uses the Boost.Spirit framework for parsing context-free grammars. CloudMdsQL has been validated on relational, document and graph data stores in the context of the CoherentPaaS European project.

- Participants: Boyan Kolev, Oleksandra Levchenko and Patrick Valduriez
- Contact: Patrick Valduriez
- Publication: [CloudMdsQL: Querying Heterogeneous Cloud Data Stores with a Common Language](#)

6.7. Savime

Simulation And Visualization IN-Memory

KEYWORDS: Data management. - Distributed Data Management

FUNCTIONAL DESCRIPTION: SAVIME is a multi-dimensional array DBMS for scientific applications. It supports a novel data model called TARS (Typed ARray Schema), which extends the basic array data model with typed arrays. In TARS, the support of application dependent data characteristics is provided through the definition of TAR objects, ready to be manipulated by TAR operators. This approach provides much flexibility for capturing internal data layouts through mapping functions, which makes data ingestion independent of how simulation data has been produced, thus minimizing ingestion time.

- Participants: Hermano Lustosa, Fabio Porto and Patrick Valduriez
- Partner: LNCC - Laboratório Nacional de Computação Científica
- Contact: Patrick Valduriez
- Publication: [TARS: An Array Model with Rich Semantics for Multidimensional Data](#)

6.8. OpenAlea

KEYWORDS: Bioinformatics - Biology

FUNCTIONAL DESCRIPTION: OpenAlea is an open source project primarily aimed at the plant research community. It is a distributed collaborative effort to develop Python libraries and tools that address the needs of current and future works in Plant Architecture modeling. It includes modules to analyze, visualize and model the functioning and growth of plant architecture. It was formally developed in the Inria VirtualPlants team.

RELEASE FUNCTIONAL DESCRIPTION: OpenAlea 2.0 adds to OpenAlea 1.0 a high-level formalism dedicated to the modeling of morphogenesis that makes it possible to use several modeling paradigms (Blackboard, L-systems, Agents, Branching processes, Cellular Automata) expressed with different languages (Python, L-Py, R, Visual Programming, ...) to analyse and simulate shapes and their development.

- Participants: Christian Fournier, Christophe Godin, Christophe Pradal, Frédéric Boudon, Patrick Valduriez, Esther Pacitti and Yann Guedon
- Partners: CIRAD - INRA
- Contact: Christophe Pradal
- Publications: [OpenAlea: Scientific Workflows Combining Data Analysis and Simulation](#) - [OpenAlea: A visual programming and component-based software platform for plant modeling](#)

6.9. FP-Hadoop

Fast Parallel Hadoop

KEYWORDS: Hadoop - Data parallelism

FUNCTIONAL DESCRIPTION: FP-Hadoop makes the reduce side of Hadoop MapReduce more parallel and efficiently deals with the problem of data skew in the reduce side. In FP-Hadoop, there is a new phase, called intermediate reduce (IR), in which blocks of intermediate values, constructed dynamically, are processed by intermediate reduce workers in parallel. Our experiments using FP-Hadoop using synthetic and real benchmarks have shown excellent performance gains compared to native Hadoop, e.g. more than 10 times in reduce time and 5 times in total execution time.

- Participants: Reza Akbarinia, Miguel Liroz-Gistau and Patrick Valduriez
- Contact: Reza Akbarinia
- Publication: [FP-Hadoop: Efficient Execution of Parallel Jobs Over Skewed Data](#)

6.10. Hadoop_g5k

KEYWORD: Cluster

FUNCTIONAL DESCRIPTION: Hadoop_g5k is a tool that makes it easier to manage Hadoop and Spark clusters and prepare reproducible experiments in the Grid 5000 platform. Hadoop_g5k offers a set of scripts to be used in command-line interfaces and a Python API to interact with the clusters. It is currently active within the G5k community, facilitating the preparation and execution of experiments in the platform.

- Participants: Reza Akbarinia, Miguel Liroz-Gistau and Patrick Valduriez
- Contact: Reza Akbarinia
- URL: https://www.grid5000.fr/mediawiki/index.php/Hadoop_On_Execo

6.11. Triton Server

End-to-end Graph Mapper

KEYWORD: Web Application

FUNCTIONAL DESCRIPTION: A server for managing graph data and applications for mobile social networks. The server is built on top of the OrientDB graph database system and a distributed middleware. It provides an End-to-end Graph Mapper (EGM) for modeling the whole application as (i) a set of graphs representing the business data, the in-memory data structure maintained by the application and the user interface (tree of graphical components), and (ii) a set of standardized mapping operators that maps these graphs with each other.

- Participants: Didier Parigot, Patrick Valduriez and Benjamin Billet
- Contact: Didier Parigot
- Publication: [End-to-end Graph Mapper](#)

6.12. SON

Shared-data Overlay Network

KEYWORDS: Sharing - Ibuted exchange - Peer-to-peer.

FUNCTIONAL DESCRIPTION: SON is a development platform for P2P networks using web services, JXTA and OSGi. The development of a SON application is done through the design and implementation of a set of components. Each component includes a technical code that provides the component services and a code component that provides the component logic (in Java). The complex aspects of asynchronous distributed programming are separated from code components and automatically generated from an abstract description of services for each component by the component generator.

- Participants: Didier Parigot, Esther Pacitti and Patrick Valduriez
- Contact: Didier Parigot
- Publication: [A Lightweight Middleware for developing P2P Applications with Component and Service-Based Principles](#)
- URL: <http://www-sop.inria.fr/members/Didier.Parigot/pmwiki/SON/index.php>

6.13. SciFloware

Scientific Workflow Middleware

KEYWORDS: Bioinformatics - Distributed Data Management

FUNCTIONAL DESCRIPTION: SciFloware is a middleware for the execution of scientific workflows in a distributed and parallel way. It capitalizes on our experience with the Shared-Data Overlay Network and an innovative algebraic approach to the management of scientific workflows. SciFloware provides a development environment and a runtime environment for scientific workflows, interoperable with existing systems. We validate SciFloware with workflows for analyzing biological data provided by our partners CIRAD, INRA and IRD.

- Participants: Didier Parigot, Dimitri Dupuis and Patrick Valduriez
- Contact: Didier Parigot
- Publication: [InfraPhenoGrid: A scientific workflow infrastructure for Plant Phenomics on the Grid](#)
- URL: <http://www-sop.inria.fr/members/Didier.Parigot/pmwiki/Scifloware>

6.14. WebSmatch

Web Schema Matching

KEYWORD: Data integration

FUNCTIONAL DESCRIPTION: WebSmatch is a flexible, open environment for discovering and matching complex schemas from heterogeneous Web data sources. It provides three basic functions: (1) metadata extraction from data sources, (2) schema matching, (3) schema clustering to group similar schemas together. WebSmatch is delivered through Web services, to be used directly by data integrators or other tools with RIA clients. It is implemented in Java, delivered as Open Source Software (under LGPL). WebSmatch has been used by Data Publica and CIRAD to integrate public and private data sources.

- Participants: Emmanuel Castanier, Patrick Valduriez and Rémi Coletta
- Contact: Patrick Valduriez
- Publication: [WebSmatch: a tool for Open Data](#)
- URL: <http://websmatch.gforge.inria.fr/>