Activity Report 2012

Computer Science Department
Faculty of Sciences
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Dear Colleagues,

This report highlights the intensive scientific activities of the research groups of the Computer Science Department during the year 2012.

The Department was founded in 1993 within the Faculty of Sciences, and will thus celebrate its 20th anniversary in 2013. We are currently 15 academics and more than 50 researchers.

The research activities inside our department are multidisciplinary and organized in six research areas: algorithms, cryptography and computer security, formal methods and verification, graphs and mathematical optimization, scheduling, and stochastic modelling.

- Our researchers have produced more than 160 research papers, often published in the best journals and international conferences of applied and theoretical computer science. Many of those publications are the result of intense and fruitful international collaborations with foreign researchers from world renowned institutions.

- Our research groups were involved in plenty of international and national research projects, among which the “inVEST - Foundations for a Shift from Verification to Synthesis” European Research Council StG Consolidator grant of Jean-François Raskin, the ComPoSe project, part of the EUROCORES Eurogiga Programme, the EU FP7 project CASSTING, the COMEX inter-university attraction pole coordinated by Bernard Fortz, the CRAFTERS project financed by the ARTEMIS EU consortium and by the Brussels NFA Innoviris.

- Well-renowned computer scientists visited our department for short and mid-term stays.

- One PhD thesis was successfully defended: High level software composition (F. Pluquet).

I hope this report will bring further interest in our research. Do not hesitate to contact us!

Bernard Fortz
President of the Computer Science Department
Algorithms

Topics

- Graph algorithms
- Computational geometry
- Data structures
- Information theory
- Complexity

People

Permanent staff

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Visitors

Dimitrios Thilikos
University of Athens

Remy Belmonte
University of Bergen

Pim van ‘t Hof
University of Bergen
Publications


[19] P. Bose, V. Dujmovic, F. Hurtado, J. Iacono, S. Langerman, H. Meijer, V. Sacristán, M. Saumell, and D. Wood. Proximity graphs: $E$, $\delta$, $\Delta$, and $\chi$ and...


V. Dujmovic and S. Langerman. A center transversal theorem for hyperplanes and applications to graph drawing. Discrete & Computational Geometry, to appear. Special issue of selected papers from the 2011 Symposium on Computational Geometry (SoCG’11).


Lectures

February 2012
• Obtaining a bipartite graph by contracting few edges
  Pim van’t Hof (University of Bergen, Norway)

March 2012
• Dynamic programming in sparse graphs
  Ignasi Sau (CNRS, LIRMM, Montpellier)

May 2012
• Search Tree Mysteries
  Robert E. Tarjan (Princeton U. and HP Labs)

June 2012
• Perfect matchings in cubic graphs
  Louis Esperet (CNRS, G-SCOP, Grenoble)

November 2012
• Triangle-free intersection graphs of line segments with large chromatic number
  Piotr Micek (Jagiellonian University)

Academic Visits and Invited Conferences

January 2012
• MIT and Tufts University, Boston, U.S.A.
  G. Aloupis

January–February 2012
• Polytechnic Institute of NYU, Brooklyn, U.S.A.
  G. Aloupis, S. Langerman

January–March 2012
• University of Melbourne, Australia
  G. Joret

February–March 2012
• Universidad Nacional de General Sarmiento, Buenos Aires, Argentina
  S. Langerman

April 2012
• Jagiellonian University, Krakow, Poland
  G. Joret

April–May 2012
• ETH Zürich
  J. Cardinal

July 2012
• Polytechnic Institute of NYU, Brooklyn, USA
  G. Aloupis

August 2012
• Tsinghua University, Beijing, China
  S. Langerman

September 2012
• American University of Armenia, Yerevan, Armenia
  G. Aloupis, S. Langerman

September–December 2012
• McGill University, Montreal, Canada
  G. Joret

October 2012
• Tel-Aviv University and Ben-Gurion University of the Negev, Be’er Sheva, Israel
  S. Langerman

• Polytechnic Institute of NYU, Brooklyn, USA
  G. Aloupis

November 2012
• University of Ottawa, and Carleton University, Ottawa, Canada
  G. Joret

December 2012
• Université de Montréal, Canada
  G. Joret

• Simon Fraser University, Vancouver, Canada
  G. Joret

• POSTECH, Pohang, South Korea
  S. Langerman

• University of Ljubljana, Slovenia
  M. Šaumell

International Conferences and Meetings

January 2012
• ACM-SIAM Symposium on Discrete Algorithms (SODA), Kyoto, Japan
  S. Langerman

• Dutch Computational Geometry Day, Utrecht, Netherlands
  J. Cardinal

• Iberian Workshop on Computational Geometry (IWCG), Palencia, Spain
  J. Cardinal

February 2012
• Bernoulli Reunion Conference on Discrete and Computational Geometry, Lausanne, Switzerland
  L. Barba

• BIRS Workshop on Models of sparse graphs and network algorithms, Banff, AB, Canada
  S. Langerman

• Bellairs Workshop on Computational Geometry, Holetown, Barbados
  G. Aloupis

March 2012
• Journées ALEA, Luminy, France
  G. Louchard

• European Workshop on Computational Geometry, Assisi, Italy
  G. Aloupis, J. Cardinal, L. Barba

April 2012
• Graph Theory @ Georgia Tech, Conference honoring the 50th birthday of Robin Thomas, Atlanta, United States
  G. Joret

April 2012
• ComPoSe Workshop on the Erdős-Szekeres Theorem, Graz, Austria
  J. Cardinal

June 2012
• Sixth International conference on Fun with Algorithms (FUN 2012), Venice, Italy
August 2012
- 21st International Symposium on Mathematical Programming (ISMP 2012), Berlin, Germany
  G. Joret
- 24th Canadian Conference on Computational Geometry (CCCG), Charlottetown, Canada
  G. Aloupis, L. Barba, S. Langerman
- Workshop on Applications of Computational Geometry, Thira, Greece
  G. Aloupis, L. Barba, S. Langerman
- Korean Workshop on Computational Geometry, Ottawa, Canada
  G. Aloupis, L. Barba

September 2012
- Mons Days on Theoretical Computer Science, Louvain-la-Neuve, Belgium (Invited speaker)
  J. Cardinal
- European Symposium on Algorithms (ESA), Ljubljana, Slovenia
  J. Cardinal

December 2012
- Thailand-Japan Joint Conference on Computational Geometry and Graphs, Bangkok, Thailand
  G. Aloupis, J. Cardinal, S. Langerman

Research Projects
- Understanding Proximity Structures, PDR FNRS
  S. Langerman
- ComPoSe project, Part of the EUROCORES Eurogiga Programme
  O. Aichholzer, J. Cardinal, S. Felsner, F. Hurtado, J. Pach, P. Valtr, E. Welzl
  This CRP focuses on combinatorial properties of discrete sets of points and other simple geometric objects primarily in the plane. More information can be found at http://www.eurogiga-compose.eu/

Editorial and Conference Organization Activities
- S. Langerman
  PC member of
  - EuroCG’12 – European Workshop on Computational Geometry
  - FUN’12 – Fun with Algorithms
- G. Aloupis
  Organizer and PC chair of
  - CCCG’12 – Canadian Conference on Computational Geometry
  PC member of
  - ISAAC’12 – International Symposium on Algorithms and Computation
  Guest editor of two special issues of the journal
  - Computational Geometry: Theory and Applications
  for papers of CCCG’11 and CCCG’12. Organizer of
  - Workshop on Applications of Computational Geometry, Thira, Greece.

Web
http://www.ulb.ac.be/di/algo
Cryptography and Computer Security (QualSec)

Topics

• Electronic voting protocols
• Side channel attacks
• Wireless security
• Non-repudiation protocols and fair exchange protocols
• Certified e-mail protocols
• Design and analysis of cryptographic protocols
• Digital signature schemes
• Security in Cloud computing
• Security in Grid computing
• Cryptographic primitives composition
• Security based on aspect-oriented programming
• Quantum cryptography
• Trust in security protocols

People

Permanent staff

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Frédéric Lafitte (Researcher)
Composition of cryptographic primitives
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Machine learning, cryptanalysis, side channel attack, template based DPA
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Publications


November 2012
- Crypto Group, Université Catholique de Louvain
  Stéphane Fernandes Medeiros
- Crypto Group, Université Catholique de Louvain
  Olivier Markowitch

International Conferences and Meetings

January 2012
- Conference on Cyber Defence, Brussels, Belgium
  Helena Bruyninckx

April 2012
- Eurocrypt 2012, Cambridge, United-Kingdom
  Frédéric Lafitte

May 2012
- 4e Journées de Statistique, Brussels, Belgium
  Liran Lerman

July 2012
- Conference on Electronic Voting 2012, Bregenz, Austria
  Jérôme Dossogne
- International Conference on Security and Cryptography 2012, Rome, Italy
  Jorge Nakahara Jr

September 2012
- Workshop on Cryptographic Hardware and Embedded Systems 2012, Leuven, Belgium
  Stéphane Fernandes Medeiros, Liran Lerman and Nikita Veshchikov
- Brucon, Gent, Belgium
  Jérôme Dossogne

October 2012
- Ecrypt AES Day, Brugge, Belgium
  Helena Bruyninckx, Stéphane Fernandes Medeiros and Frédéric Lafitte

November 2012
- International Conference on Security, Privacy, and Applied Cryptography Engineering 2012, Chennai, India
  Stéphane Fernandes Medeiros
- Workshop on Cryptography for the Internet of Things, Antwerp, Belgium
  Helena Bruyninckx and Frédéric Lafitte
- ADM’s conference, Vilvoorde, Belgium
  Jérôme Dossogne
- Workshop on applied probability, Brussels, Belgium
  Liran Lerman

December 2012
- New Journey to Security Transformation, Brussels, Belgium
  Jérôme Dossogne
- IEEE International Conference on Data Mining Series, Brussels, Belgium
  Liran Lerman
- International Conference on Cryptology and Network Security 2012, Darmstadt, Germany
  Jorge Nakahara Jr

Academic Visits

January 2012
- Unité de Recherche MACCLIA, Saint Cyr Coëtquidan, France
  Helena Bruyninckx and Frédéric Lafitte

February 2012
- Université du Luxembourg
  Jérôme Dossogne and Frédéric Lafitte

Juin 2012
- Information Security Group, Université Catholique de Louvain
  Olivier Markowitch
Research Projects

- **Cryptasc: Advanced ICT Solutions to Cryptography, Authentication and Secure Communication**
  Olivier Markowitch, Jorge Nakahara Jr. and Yves Roggeman
  CRYPTASC aims at the design of an integrated practical toolbox of cryptographic and security primitives based on the promising results obtained over the last decade in the area of quantum information, in particular in quantum cryptography. The project is anticipated to provide a strong impulse to the development and valorization of a potentially revolutionary ICT solutions to secure networks, by joining the efforts of the academic teams of the Brussels region, expert in cryptography, computer science, and quantum technologies, which will closely collaborate with a founded spin-off company. CRYPTASC aims also at the design of a high-speed cryptographic key distribution system based on a fast quantum random number generator, of a software toolbox for monitoring the quality of generated random series and of a set of cryptographic primitives and protocols that exploit the local high-rate supply of random bits. CRYPTASC is funded by the Brussels Institute for Research and Innovation

Editorial and Conference Organization Activities

- **H. Bruyninckx**
  Reviews made for
  - International Conference on Security and Cryptography (SECURITY 2012)

- **J. Dossogne**
  Reviews made for
  - International Conference on Security and Cryptography (SECURITY 2012)

- **S. Fernandes-Medeiros**
  Reviews made for
  - International Conference on Security and Cryptography (SECURITY 2012)
  - Netherlands Organisation for Scientific Research

- **L. Lerman**
  Reviews made for
  - Data Mining Conference (DMIN12)
  - International Conference on Security and Cryptography (SECURITY 2012)
  - Netherlands Organisation for Scientific Research

- **O. Markowitch**
  Program committee member of
  - International Conference on Security and Cryptography (SECURITY 2012)
  - International Conference on Trust and Privacy in Digital Business 2012
  - IEEE International Conference on Cloud Computing Technology and Science 2012
  Reviewer for
  - International Journal of Information Security
  - Advances in Software Engineering
  - International Journal of Quantum Information
  - Transactions on Information Forensics and Security
  - Netherlands Organisation for Scientific Research

- **J. Nakahara Jr**
  Reviews made for
  - Fast Software Encryption 2013
  - Workshop on Coding and Cryptography 2013
  - Journal of Computational and Applied Mathematics
  - 5th International Conference on Information Security and Cryptology
  - International Conference on Applied and Computational Mathematics

- **N. Veshchikov**
  Reviews made for
  - Electronic Letters

Web

http://qualsec.ulb.ac.be
Formal Methods and Verification

Topics

- Models of computation and verification:
  - timed automata;
  - hybrid automata;
  - well-structured transition systems;
  - Game models for controller synthesis.
- Design and synthesis of distributed industrial control systems.
- Code distribution and optimization algorithms.

People

Permanent staff

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Publications

Lectures

January 2012

- Automata, LMIs, and stability of hybrid systems
  Raphaël Jungers (UCLouvain)

- Markov processes with denumerably infinite state spaces
  Giang Nguyen (ULB)
• A Local Greibach Normal Form for Hyperedge Replacement Grammars
  Christina Jansen (RWTH Aachen)

• Selected Topics in Controller Synthesis
  Marco Faella (U Napoli)

February 2012
• Weighted Timed Automata
  Karin Quaas (Universität Leipzig)

• Energy and Mean-Payoff Parity Markov Decision Processes
  Laurent Doyen (ENS Cachan)

March 2012
• Bounded Phase Analysis of Message-Passing Programs
  Michael Emmi (LIAFA)

April 2012
• Streaming string transducers
  Pavol Cerny (IST Austria)

• Verification and Synthesis by Sciduction
  Sanjit A. Seshia (UC Berkeley)

• Strategy Synthesis for Multi-dimensional Quantitative Objectives
  Michael Emmi (LIAFA)

May 2012
• End-to-end arguments in embedded control systems
  Rupak Majumdar (MPI for Software Systems - UCLA)

June 2012
• The Expressiveness of Metric Temporal Logic
  James Worrell (University of Oxford)

July 2012
• Coarse abstractions make Zeno behaviors difficult to detect
  Frédéric Herbreteau (LaBRI)

September 2012
• Streaming Transducers
  Rajeel Ahur (U Penn)

October 2012
• p-Automata and Obligation Games
  Nir Piterman (U Leceister)

November 2012
• Verification of Concurrent Programs under Relaxed Memory Models
  Roland Meyer (U Kaiserslautern)

• Open Problems on Counter Machines
  Laurent Doyen (ENS Cachan)

• Decision Problems for Linear Recurrence Sequences
  Joel Ouaknine (Oxford University)

• Playing with tag systems: experimental and theoretical results in Post's game of tag
  Liesbeth De Mol (Ghent University)

• Robust Reachability in Timed Automata: A Game-based approach
  Ocan Sankur (ENS Cachan)

December 2012
• Banach-Mazur Games on Graphs
  Erich Grädel (RWTH)

• Quantifying Opacity
  Mathieu Sassolas (ULB)

Academic Visits and Invited Conferences

January 2012
• Generalized Mean-payoff and Energy Games, Invited speaker, GDR Mathématique-Informatique, Paris, France
  Jean-François Raskin

February 2012
• Generalized Mean-payoff and Energy Games, Invited speaker, 15th anniversary of LSV, Cachan, France
  Jean-François Raskin

• Channel Synthesis for Finite Transducers, seminar at LSV-ENS Cachan, France
  Mathieu Sassolas

March 2012
• Seminar at GT-VMT 12
  Alexander Heussner

• Seminar at LABRI, U. Bordeaux, France.
  Romain Brenguier

• Presentation at FOSSACS.
  Romain Brenguier
April 2012
- Seminar at LSV-ENS Cachan
  Alexander Heussner
- Departmental Seminar, Department of Computer Science, Oxford UK
  Paul Hunter

May 2012
- Seminar at Universität Saarbrücken
  Alexander Heussner

July 2012
- Seminar at Universität Erlangen-Nurnberg
  Alexander Heussner
- EURO conference, Vilnius Lithuania
  Paul Hunter
- Acacia+: a tool for LTL synthesis, presentation at CAV’12, Berkeley, USA.
  Aaron Bohy

September 2012
- Multi-dimensional Quantitative Games: Complexity and Strategy Synthesis, joint invited speaker of GAMES’12 and GANDALF’12, Naples
  Jean-François Raskin
- Presentation at INFINITY’12
  Alexander Heussner
- Presentation at AVOCS’12
  Alexander Heussner
- Concurrent Games on VASS with Inhibition, presentation at CONCUR 2012, Newcastle, UK.
  Mathieu Sassolas
- Strategy Synthesis for Multi-Dimensional Quantitative Objectives, presentation at CONCUR 2012, Newcastle, UK.
  Mickael Randour
- Automated synthesis of reliable and efficient systems through game theory: a case study, presentation at ECCS’12, Brussels, Belgium.
  Mickael Randour
- Synthesis from LTL specifications with mean-payoff objectives, Workshop "GT Jeux 2012", ENS Cachan, France.
  Aaron Bohy

November 2012
- Multi-dimensional Quantitative Games: Complexity and Strategy Synthesis, Seminar, Max-Planck Institute for Computer Science, Saarbrücken, Germany.
  Jean-François Raskin
- An Introduction to the Automatic Synthesis of Reactive Systems, Seminar, NICTA, Sydney, Australia.
  Jean-François Raskin
- Quantifying Opacity, Dagstuhl seminar on "Quantitative Security Analysis", Dagstuhl, Germany.
  Mathieu Sassolas

December 2012
- Multi-dimensional Quantitative Games: Complexity and Strategy Synthesis, seminar at Université de Bordeaux, France.
  Jean-François Raskin
- Presentation at FSTTCS’12, India.
  Alexander Heussner
- Visibly pushdown automata on trees: universality and u-universality, Mons Days of Theoretical Computer Science, Louvain-La-Neuve, Belgium.
  Marc Ducobu

International Conferences and Meetings

March 2012
- ETAPS12 - Tallinn, Estonia
  T. Massart, A. Heussner, J.-F. Raskin, R. Brenguier

June 2012
- ERC Workshop on Games for the Synthesis of Reactive Systems, Brussels, Belgium
  J.-F. Raskin, G. Geeraerts, E. Filiot, M. Sassolas, M. Randour, M. Shirmohammadi
- CP meets CAV, Tiranç, Turkey
  J.-F. Raskin

July 2012
- CAV 2012, Berkeley, USA
  J.-F. Raskin, M. Randour, A. Bohy.

August 2012
- INFINITY - Paris
  A. Heussner

September 2012
- CONCUR’12, Newcastle, UK
  M. Randour, J.-F. Raskin, R. Brenguier, M. Sassolas
- ECCS’12, Brussels, Belgium
  M. Randour
- Mons Days of Theoretical Computer Science, Louvain-La-Neuve, Belgium
  M. Ducobu, E. Filiot
- AVOCS, Bamberg, Germany
  A. Heussner
- GAMES’12, Naples, Italy
  M. Randour, J.-F. Raskin, T. Massart, M. Shirmohammadi

October 2012
- ESWEEK, Tampere, Finland
  G. Perez

December 2012
- FSTTCS - Hyderabad
  A. Heussner
- MOVEP school, Marseille, France
  G. Perez

Research Projects

- CASSTING (EU FP7 Project)
  G. Geeraerts and J.-F. Raskin
  The objective of Cassting is to develop a novel approach for analysing and designing collective adaptive systems in their totality, by setting up a game theoretic framework.
  - Partners: LSV, Aalborg, RWTH Aachen, UMons, Energinord, Seluxit
  - Total budget 2.700 kEuro (277 kEuro for ULB)

- FOREST (Projet de Recherche FNRS)

13
G. Geeraerts and J. Goossens

The main goal of FOREST is to advance the current knowledge on multiprocessor real-time scheduling, in particular, by defining efficient, sound and complete algorithms for typical problems (such as schedulability and online feasibility problems on multiprocessor platforms). These problems are particularly hard in the multiprocessor case, as there is no worst-case (contrary to the uniprocessor case). In order to obtain efficient algorithms that are applicable in practice, the project will rely on techniques and heuristics that have been developed in the field of formal verification. Thus, a secondary goal of the project it to demonstrate the applicability of specific techniques that have been developed in the setting of formal verification, to multiprocessor scheduling problems. There are strong links between these two rather separate fields, and we see there a unique opportunity for cross-fertilisation of these two domains of fundamental computer science. Total budget: about 250 kâ€”n (funding for 4 years of post-doc).

- **European Research Council StG Consolidator: in-VEST - Foundations for a Shift from Verification to Synthesis**
  J.-F. Raskin,

  Reactive systems are computer systems that maintain a continuous interaction with the environment in which they execute. Examples of reactive systems are controllers embedded in cars or planes, system level software, device drivers, communication protocols, etc. On the one hand, those systems are notoriously difficult to develop correctly (because of characteristics like concurrency, real-time constraints, parallelism, etc). And on the other hand, their correctness is often critical as they are used in contexts where safety is an issue, or because of economical reasons related to mass production.

  To ensure reliability of reactive systems, advanced verification techniques have been developed. One particularly successful approach is model-checking. Nevertheless, model-checking is used to find bugs in designs but it does not support the design itself.

  In this project, we want to develop new algorithms and tools to support the automatic synthesis of modern reactive systems (instead of their verification a posteriori). We aim at a shift from verification to synthesis. To allow this shift, we need new foundations: we propose to generalize transition systems and automata – models of computation in the classical approach to verification – by the more flexible and richer game-theoretic framework. Our work will be of fundamental nature but will also aim at the development of algorithms and prototypes of tools. Those new foundations will allow for the development of a new generation of computer-aided design tools that will support the automatic synthesis of modern reactive systems and ensure correctness by construction.

  - Start date: January 1st, 2012.
  - Duration: 5 years.
  - Budget: 1.415.255EUR.

- **Centre Fédéré en Vérification**
  J.-F. Raskin, T. Massart, G. Geeraerts

  This project is supported by the Belgian National Fund for Scientific Research. The Fédère en Vérification is a working group supported since 2002 by the Belgian National Scientific Research Fund and federates the following teams: the team of Prof. Massart and Raskin at ULB, the team of Prof. Wolper and Boigelot at ULg, the team of Prof. Bruyère at UMH, the team of Prof. Schobbens at FUNDP, and the team of Prof. Le Charlier at UCL. The working group organizes seminars and gives the opportunity for tighter cooperation between the teams of the working group (From January 2006 until December 2009).

- **Vérification et Synthèse temps réel**
  G. Geeraerts

  This project is a Crédit aux chercheurs of the FRS/FNRS, supporting Gilles Geeraerts. The project aims at defining efficient algorithms and heuristics for real-time verification and synthesis, in order to be able to apply those techniques to systems of realistic size.

- **GAMES: Games for Design and Verification (ESF Network)**
  J.-F. Raskin

  As computing systems become larger, more complex, and increasingly distributed and interactive, there is a pressing need for formal methods that guarantee their reliability, correctness, and efficiency. This network proposes a research and training programme for the design and verification of computing systems, using a methodological framework that is based on the interplay of finite and infinite games, mathematical logic and automata theory.

### Editorial and Conference Organization Activities

- **Thierry Massart**
  PC Member of

  - PDCS 2012: IASTED International Conference on Parallel and Distributed Computing and Networks, LAs Vegas, USA, 12-14 novembre 2012 (PC-member)
  - MSR'13: 9eme Colloque Francophone sur la Modélisation des Systèmes réactifs, INRIA Rennes - Bretagne Atlantique, France, du 13 au 15 novembre 2013 (PC-member)

- **Jean-François Raskin**

  Games, Automata, Logic, and Formal Languages (GANDALF’13), Italy, 2013.
  40th International Colloquium on Automata, Languages and Programming (ICALP’13), Riga, Litunanie, 2013.
  Modélisation des Systèmes Réactifs (MSR’13), Nantes, France, 2013.
  24th International Conference on Concurrency Theory (CONCUR’13),
Graphs and Mathematical Optimization

Topics
- Combinatorial optimization
- Graph theory
- Integer programming

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Combinatorial optimization, graphs, location and network design.
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• 12th International Conference on Application of Concurrency to System Design (ACSD’13), Barcelona, Spain, 2013.
• 7th International Conference on Language and Automata Theory and Applications (LATA’13), Bilbao, Spain, 2013.
• 6th Workshop on Reachability Problems (RP’12), Bordeaux, France, PC Member, 2012.
• 12th International Conference on Application of Concurrency to System Design (ACSD’12), Hambourg, Germany, PC Member, 2012.
• 23rd International Conference on Concurrency Theory (CONCUR’12), Newcastle, UK, PC Member, 2012.
• 2nd International Workshop on Interactions, Games and Protocols (iWIGP’12), Talin, Estonia, PC Member, 2012.
Alessia Violin (FRIA Researcher)
Bilevel programming, combinatorial optimization, pricing problems, transportation
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Associated Researchers

Hadrien Mélot (Scientific Collaborator)
Graph theory, computer assisted and automated conjectures.
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Visitors

Publications


Lectures

Academic Visits and Invited Conferences

April, August and November 2012
- University of Trieste, Italy
  A. Violin

May 2012
- Departamento Estadística e Investigación Operativa, Universidad de Sevilla, Spain
  M. Labbé

May 2012 – August 2012
- Carnegie Mellon University
  D. Catanzaro

June 2012
- Departamento Estadística e Investigación Operativa, Universidad de Sevilla, Spain
  M. Labbé

September 2012
- Departamento Estadística e Investigación Operativa, Universidad de Sevilla, Spain
  M. Labbé

November 2012
- Instituto Sistemas Complejos de Ingeniería, Universidad de Chile, Santiago, Chile
  M. Labbé
- UPC Barcelona, Spain
  B. Fortz
- University of Linköping, Sweden
  B. Fortz

December 2012
- Instituto Sistemas Complejos de Ingeniería, Universidad de Chile, Santiago, Chile
  M. Labbé
- University of Lisbon
  B. Fortz
International Conferences and Meetings

January 2012
- 16th Combinatorial Optimization Workshop, Aussois, France
  B. Fortz, M. Labbé

February 2012
  D. Catanzaro, A. Violin, L. Porretta, B. Fortz, M. Labbé
- Journées Graphes et Algorithmes 2012 (JGA), speaker,
  D. Catanzaro, M. Labbé
- EURO 25, Vilnius, Lithuania
- ROADEF 2012, Angers, France

March 2012
- 18th Belgian Mathematical Programming meeting, La Roche en Ardenne, Belgium, on March 2-3, 2012.
  B. Fortz, L. Porretta, A. Violin
- HPSC conference, Hanoi, Vietnam
  M. Labbé

April 2012
- 3rd Student Conference in Operational Research (SCOR 2012), committee member, Nottingham, United Kingdom, April 20-22, 2012.
  A. Violin
- ROADEF 2012, Angers, France
  B. Fortz

May 2012
- International Symposium on Bioinformatics Research and Applications (ISBRA 2012), speaker, Dallas, Texas, on May 21-23, 2012.
  D. Catanzaro
- CORAL, Benicassim, Spain
  M. Labbé
- Workshop on Locational Analysis and Related Problems, Granada, Spain
  M. Labbé (plenary speaker)

July 2012
- EURO 25, Vilnius, Lithuania
  B. Fortz, M. Labbé

August 2012
- International Symposium on Mathematical Programming, Berlin, Germany
  D. Catanzaro, B. Fortz, M. Labbé

September 2012
- Computational Biology, Bioinformatics and Medicine (EURO-CBBM), University of Nottingham, speaker, Nottingham, United Kingdom, on September 13-15, 2012.
  D. Catanzaro, L. Porretta
  D. Catanzaro, M. Labbé

November 2012
- Journées Graphes et Algorithmes 2012 (JGA), speaker, Clermont-Ferrand, France, on November 14-16, 2012.
  D. Catanzaro, M. Labbé

December 2012
- Mini Workshop on Stochastic Optimization, Renaca, Vina del Mar, Chile
  M. Labbé

Research Projects

- Mathematical programming approaches to pricing problems, FRIA Ph. D. fellowship (Fonds pour la Formation à la recherche dans l’industrie et dans l’agriculture, Communauté Française de Belgique)
  Alessia Violin, supervisor M. Labbé
  In many real cases a company faces a best price strategy problem. These problems, typically bilevel, have been proposed during the 90s and turn out to be NP-hard, even though there exist polynomial algorithms for some particular cases. A lot of questions are still open on this subject. In this context, after studying in depth the literature to survey existing results and identify aspects to be studied, the first aim of my PhD research will be to investigate mathematical properties of pricing problems in order to define the boundary between easy (polynomial) and difficult (NP-hard) problems. Then, I will select a few different cases and study them in depth (for instance the case of a per unit tax), in order to reveal structural properties, formulations (if possible in mixed integer variables) and solution methods as efficient as possible. The second aim of my project will be to consider competition, e.g. when more than one company wants to fix the best prices simultaneously. I will search for any condition guaranteeing the existence of Nash equilibriums, and propose alternative solution concepts if no such condition exists. I will therefore search for a MILP formulation to model such problems and develop solution methods. Finally, if time will allow it, the third part of my research will be about a sensitivity analysis and the introduction of uncertainty on the parameters of these problems.

- Models and Methods in Molecular Phylogenetics, FNRS Research Fellowship
  Daniele Catanzaro, supervisor M. Labbé
  Biologists indicate with the term evolution the change, from generation to generation, of inherited traits of a population. These traits are the expression of genes that are copied and passed on to offspring during reproduction. Mutations and other random changes in these genes can produce new or altered traits, resulting in heritable differences (genic variation) between organisms. Evolution then occurs when such heritable differences become more common or rare in a population, either non-randomly (through natural selection) or randomly (through genetic drift). Molecular phylogenetics is the reconstruction and analysis of phylogenetic (evolutionary) trees and networks based on inherited characteristics. It is a flourishing area of interaction between mathematics, statistics, computer science and molecular biology. Its foundations, dating back to the pioneering works by Peter Buneman, David Sankoff, Robert Sokal, Antony Edwards, and Luca Cavalli-Sforza, are at the core of the following project. Specifically, our aim is to provide a critic of the mathematical models used to describe molecular evolution; to propose some mixed integer programming models for the most important methods of phylogenetic reconstruction; to provide efficient approximate algorithms to estimate phylogenies from molecular data; and finally, to characterize the application fields of the most used phylogenetic estimation methods.

- FRFC - Mathematical Programming Group (2008-2013)
  Bernard Fortz
  Development of models and exact and approximate solution methods for linear and non-linear,
continuous, mixed and integer optimization problems.


  Bernard Fortz

  Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

### Editorial and Conference Organization Activities

- **M. Labbé**

  Member of the Program Committee for the following conference:
  - ICORES 2012, Vilamoura, Portugal, February 2012.

  Editor in Chief of
  - EURO Journal on computational Optimization

  Member of the Advisory board of
  - Transportation Science

  Member of the Editorial board of
  - EURO Journal on Transportation and Logistics

  Member of the selection committee for the
  - Transportation Science and Logistics Society’s Dissertation Prize (INFORMS)

  Reviewer for the Einstein Foundation Berlin for the proposal to establish an Einstein Center for Mathematics, March 2012.

  Member of the review panel in mathematics for the DFG in the framework of their excellence initiative program, February 2012.

  Member of the Comité d’orientation scientifique (COS) du Centre interuniversitaire de recherche sur les réseaux d’entreprise, la logistique et le transport (CIRRELT), Canada.

  Member of the CISIT (International Campus on Safety and Intermodality in Transportation)International Scientific Committee, Université de Valenciennes et du Haut - Cambresis.

  Member of the panel for ex-post evaluation of research projects founded by the program "Mathematics and ..." of the WWTF, Vienna, Austria, October 2012.

- **B. Fortz**

  Associate editor of
  - INFORMS Journal on Computing

  Organizer of
  - ORBEL 26, Brussels, Belgium

  Member of the Program Committee of
  - ICORES 2012, Vilamoura, Portugal

  Coordinator of the European Network Optimization Group

  Member of Council of INFORMS Telecommunications Section

  Administrator and treasurer of ORBEL
Parallel Architectures for Real-Time Systems (PARTS)

Topics
- Real-time scheduling theory
- Parallel real-time systems
- Petri nets
- Real-time operating systems
- Stochastic low-power real-time scheduling
- Computer integrated manufacturing
- Grid brokering
- Multiprocessor systems-on-chip
- Networks-on-chip
- Integrated 3D circuits
- Hardware development
- Embedded electronics

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Publications


Academic Visits and Invited Conferences

February 2012
- Airbus Operations, Toulouse, France
  B. Rodriguez

March 2012
- University of York, UK
  J. Goossens, V. Berten
- University of Poitiers, France
  J. Goossens

April 2012
- Wayne State University, MI, USA
  J. Goossens
- Universidad de Cantabria, Santander, Spain
  B. Rodriguez

May 2012
- Wayne State University, MI, USA
  J. Goossens
- Infineon Technologies, Munich, Germany
  B. Rodriguez

September 2012
- École Normale Supérieure, Cachan, France
  R. Devillers
- Université d’Evry val d’Essonne, France
  R. Devillers

November 2012
- University of Göteborg, Sweden
  J. Goossens
**International Conferences and Meetings**

**February 2012**
- Embedded World, Munich, Germany
  - B. Rodriguez

**June 2012**
- 40 ans de recherche en ordonnancement temps réel, Nantes, France
  - B. Rodriguez, J. Goossens, V. Berten
- CRAFTERS Project Workshop, Copenhagen, Denmark
  - B. Rodriguez

**July 2012**
- ECRTS 2012, Pisa, Italy
  - B. Rodriguez, J. Goossens, V. Berten, F. Santy

**November 2012**
- Journée ACTRISS : “Outils pour le temps réel”, INRIA, Nancy, France
  - B. Rodriguez, J. Goossens, V. Berten
- RTNS 2012, Pont-à-Mousson, France
  - J. Goossens, V. Berten

**Research Projects**

- **FOREST**: Formal verification techniques for real-time scheduling problems (4 years project financed by the FNRS)
  - G. Geeraerts and J. Goossens
  
  Computer systems are nowadays ubiquitous, and are often found embedded in other applications (for instance: plane autopilots, ABS braking systems, controller embedded in home appliances, and so forth). Because the failure of such systems could have catastrophic consequences, their correctness is often regarded as critical. However, ensuring the correctness of complex computer systems is a notoriously difficult task. This task is even more difficult with modern computing devices that are often multiprocessor or multicore platforms. On those platforms, several tasks can be executed in parallel, which can produce hard-to-predict interactions between them. Thus, rigorous and efficient methods must be made available to engineers and developers, to help them developing reliable critical embedded systems.

  For many of those systems, the correctness criterion does not only depend on the correct result of the computation that is performed, but also on the time delay to ensure that a given computation will be completed. In this setting, each task is equipped with a strict deadline, that must be enforced. For instance, an ABS system must react correctly when the wheels of the car lose traction, but it must also be able to perform the necessary computations to react within a given time delay. Such systems are collectively referred to as (hard) real-time systems. The key component of a real-time system is the scheduler, which is a module of the operating system that is responsible for attributing the CPU(s) to the different running jobs, in such a way that no job ever misses a deadline. In this project, we consider online schedulers, that take a decision depending only on the current state of the system.

  The main goal of this project is to advance the current knowledge on multiprocessor real-time scheduling, in particular, by defining efficient, sound and complete algorithms for typical problems (such as schedulability and online feasibility problems on multiprocessor platforms). These problems are particularly hard in the multiprocessor case, as there is no worst-case (contrary to the uniprocessor case). In order to obtain efficient algorithms that are applicable in practice, the project will rely on techniques and heuristics that have been developed in the field of formal verification. Thus, a secondary goal of the project is to demonstrate the applicability of specific techniques that have been developed in the setting of formal verification, to multiprocessor scheduling problems. There are strong links between these two rather separate fields, and we see there a unique opportunity for cross-fertilisation of these two domains of fundamental computer science.

- **CRAFTERS**: ConstRaint and Application driven Framework for Tailoring Embedded Real-time Systems (3 years project financed by the ARTEMIS EU consortium and by the Brussels NFA innoviris)
  - J. Goossens and D. Milojevic

  ICT-based service and product innovation is curtailed by the growing vertical chain of dependence on poorly interoperable proprietary technologies in Europe. This issue was identified to have high impact on European innovation productivity by the Report of the Independent Expert Group on R&D and Innovation, commonly known as the Aho-report. The report demanded incentives for the convergence of shared technologies and markets as a remedy. Actions creating standardized, commercially exploitable yet widely accessible ecosystems in European priority areas should be publicly supported. Real-time applications for heterogeneous, networked, embedded many-core systems suffer from the lack of trusted pathways to system realization and application deployment. Service and product development efforts are high with many uncertainties discouraging such ventures. This project brings to bear a holistically designed ecosystem from application to silicon. The ecosystem is realized as a tightly integrated multi-vendor solution and tool chain complementing existing standards. Feature-limited releases of reference tools and platforms are made available under favorable licensing conditions to support the evaluation and adoption of the results. Full-fledged versions are retained for commercial exploitation and standardization of the overall ecosystem is pursued. As direct effects of the project results 30% reduction of the total cost of ownership, 50% shorter time-to-market, and 30% decrease of the number of development assets are expected. Marketable lead applications driving ecosystem development and benchmarking on the fields of industrial and intelligent transport systems, video and image processing, and wireless communications are produced. Key challenges include guaranteeing secure, reliable, and timely operation, back-annotation based forward system governance, Tool-tool, tool-middleware, and middleware-hardware exchange interfaces, and energy management with minimal run-time overhead.

  In this project, PARTS will concentrate on making scheduling policies aware of the thermal issues of MPSoC such as hot spots that make it necessary to optimize the distribution of work among the processors. Then the new algorithms will be integrated in the RTOS currently under development. Together with the company UEG, the joint partner located in Brussels, PARTS will also work on middleware and tools for embedded systems design, and making them compliant with the CRAFTERS framework.

- **PAPARETO**: Parallel Architecture Power Aware Real-time Embedded Technology for Operating Systems (Formation et impulsion la recherche scientifique et technologique...)
  - B. Rodriguez, J. Goossens, V. Berten

  There are strong links between these two rather separate fields, and we see there a unique opportunity for cross-fertilisation of these two domains of fundamental computer science.

- **RTNS**: Real-time Technology for Operating Systems
  - B. Rodriguez, J. Goossens, V. Berten

  The main goal of this project is to advance the current knowledge on multiprocessor real-time scheduling, in particular, by defining efficient, sound and complete algorithms for typical problems (such as schedulability and online feasibility problems on multiprocessor platforms). These problems are particularly hard in the multiprocessor case, as there is no worst-case (contrary to the uniprocessor case). In order to obtain efficient algorithms that are applicable in practice, the project will rely on techniques and heuristics that have been developed in the field of formal verification. Thus, a secondary goal of the project is to demonstrate the applicability of specific techniques that have been developed in the setting of formal verification, to multiprocessor scheduling problems. There are strong links between these two rather separate fields, and we see there a unique opportunity for cross-fertilisation of these two domains of fundamental computer science.
Hardware services for Multi-Processor System-on-Chip platforms with Real-Time Operating System (FIRST) – Spin Off, Region wallonne)
B. Rodriguez, supervisors J. Goossens and D. Milojevic

The PAPARETO project is an R&D valorization project, combining scientific, technological and business aspects. Applications for embedded multi-processor real-time systems are a fast growing area. Improving their efficiency, while reducing development and implementation time and costs, remains challenge. Creating operating systems for platforms that are embedded, multi-processor, power aware and real-time still leaves many theoretical and technological issues unsolved. No satisfactory solutions exist today. New designs are also required to satisfy material constraints and exploit new technologies. The main innovation in the project is to consider operating system design as a co-design process that benefits from new paradigms for parallel scheduling of various task models, while designing parallel platforms to implement key operating system services in hardware. The R&D goal, and expected results, of the project is to design and implement a prototype scheduler for such operating systems, or even the complete operating system. The organizational goal is to coordinate and integrate various research results of the PARTS research unit. The valorization goal of the project is to create a spin-off company to prove the soundness of the concept in real industrial applications and to bring those results to the market.

- Hardware services for Multi-Processor System-on-Chip platforms with Real-Time Operating System, FRIA Ph.D. fellowship (Fonds pour la Formation la recherche dans l’industrie et dans l’agriculture, Communauté Française de Belgique)
  G. Nelissen, supervisors D. Milojevic and J. Goossens

  In recent years we have witnessed a paradigm shift in computer systems. Increasing the frequency has given way to multi-core architectures exploiting the parallelism. In the field of embedded systems, such a vision is seen in the form of Multi-Processor System-on-Chip — MP-SoC. The advantages of such a platform in comparison with a uni-processor one are multiples in several domains like power consumption, scalability, reusability, etc.

  In the same time, a lot of existing systems need Real-Time Operating Systems not only to guarantee a given treatment capacity but also to guarantee a deadline for multiple tasks.

  To break with the sub-optimality of the actual philosophy consisting to see the design of software and hardware as two worlds apart, the aim of this thesis is, through a co-design methodology, to design a configurable MPSoC environment with services tailored directly for high level real-time scheduling algorithms.

- Intégration, évaluation et caractérisation des systèmes temps réel multi-processeur sur plate-formes reconfigurables Assistant – chercheur
Y. Allard, supervisors D. Milojevic and J. Goossens

  To the concept of simultaneous software/hardware co-design, we append the aspects of technology used for integrated circuit manufacturing (ASIC) or implementation in the FPGA circuits. By exploiting software/hardware/technology co-design triplet, the goal is to holistically design predictable, optimized and efficient real-time systems.

  This thesis focuses on hardware part and more specifically on the design and implementation of Multi-Processor Systems-on-Chip (MPSoC) platforms. Considered MPSoCs are based on existing processing elements like open source COFFE processor developed at Tampere University of Technology – TUT

  In order to enhance the performance of the system as a whole, that is the MPSoC platform running an Operating System with its scheduler and an application, dedicated hardware services are developed and integrated into the MPSoC platform. These specific hardware services are also used as constraints for the design of dedicated scheduling algorithms in an iterative and collaborative manner.

- The Energy-conscious 3D Server-on-Chip for Green Cloud Services Project (Project No: 247779 EuroCloud)
  imec, D. Milojevic

  This is a project funded by European Commission FP7 Computing Systems Program that brings together multiple partners that are focused on demonstrating a step function improvement in system density and energy efficiency for data center applications compared to current state-of-the-art platforms using incumbent processor architectures. The goal is to scale the platform to support hundreds cores in a single server and show the path that will make a data centre featuring 1 million cores viable. At the heart of this program is the efficient coupling of high performance ARM CortexTM processors with 3D memory technology targeting the Mobile Cloud services from Nokia ovi.com, which will serve millions of AJM-mobile handsets. By validating this path, companies across the world will be able to construct super-efficient, environmentally clean and compact data centers for the deployment of green Cloud Computing services. Pioneering the pursuit of green data centers further strengthens Europe’s leadership and excellence in green computing. The project started in Jan-2010 and will complete in Dec-2012. It has a significant impact on the society, environment and European IT sector. Please read our Strategic Impact.

Editorial and Conference Organization Activities

- J. Goossens
  Member of the Steering Committee of
  - International Conference on Real-Time and Network

  Member of the Program Committee of
  - The 20th International Conference on Real-Time and Network Systems.
  - The 18th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications
  - IEEE Conference on Design, Automation and Test in Europe

  Reviewer of
  - Information Processing Letters (Elsevier)
  - Journal of Scheduling (Springer)
  - Journal of System Architecture (Elsevier)
• V. Berten

Member of the Program Committee of
• IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2012)
• IEEE International Conference on Emerging Technologies and Factory Automation, Work in Progress and Industry Practice (ETFA-WiP 2012)
• 24th Euromicro Conference on Real-Time Systems (ECRTS 2012)

Reviewer of
• IEEE Conference on Design, Automation and Test in Europe (DATE 2013)
• The 20th International Conference on Real-Time and Network Systems (RTNS 2012).
• CSUR (ACM Computing Survey)
• Journal of Real-Time Systems

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Stochastic Modelling

Topics
• Algorithmic analysis of stochastic processes
• Fluid models
• Branching processes
• Markov binary trees
• Analysis of algorithms
• Machine learning
• Bio-informatics
• Biomedical engineering
• Time series prediction
• Wireless sensor networks
• Time series classification

People

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Guy Latouche (Full Professor)
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The Anh Han (Postdoc)
evolution of cooperation, evolutionary game theory, Intention/Plan recognition, evolution of cognition, knowledge representation and reasoning, logic programming
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Visitors

Sophie Hautphenne (28/05–5/07 and 29/10–31/10)
University of Melbourne, Australia

Masakiyo Miyazawa (08/05–05/06)
Tokyo University of Science

Peter Taylor (29/10–31/10)
University of Melbourne, Australia

Publications


### Lectures

#### Academic Visits and Invited Conferences

**January 2012**
- Validity and accuracy of allosteric predictions in protein domains. VIB Department of Structural Biology, Brussels, Belgium
- T. Lenaerts

**March 2012**
- Game theory and the evolution of cooperation. Presentation in het kader van het vak Wiskunde voor biologen. Universiteit Antwerpen, Antwerp, Belgium
- T. Lenaerts

**May 2012**
International Conferences and Meetings

February 2012

- ORBEL26, ULB, Belgium  
  S. Dendievel
- Actuarial and Financial Mathematics Conference, Belgium  
  S. Dendievel and M. Govorun and G. Latouche

March 2012

- 10th German Probability and Statistics Days, Mainz, Germany  
  M. Govorun and G. T. Nguyen and Y. Liu

April 2012

- Time for Causality workshop, University of Bristol, UK  
  M. Gagliolo

May 2012

- Belgian-Dutch Conference on Machine Learning and Workshop on Predictive Modeling for the Life Sciences (Benelearn), Ghent, Belgium  
  M. Lopes
- IBM’s Academic Days Conference, Frankfurt, Germany  
  G. Bontempi
- AquaVIT 2012 (Internal Symposium of the Max Planck Institute for Evolutionary Biology), Plön, Germany  
  E. Cilia
- 44e Journées de Statistique, ULB, Belgique  
  L. Lerman

June 2012

- International Symposium on Forecasting 2012, Boston, USA  
  S. Ben Taieb
- Multilevel Social Networks symposium, Manchester, UK  
  M. Gagliolo
- Third International Conference on Sensor Systems and Software (S-Cube 2012), Lisbon, Portugal  
  Y.-A. LeBorgne
- 1st Conference of the International Society for Non-Parametric Statistics, Chalkidiki, Greece  
  M. Jansen
- Workshops “When Probability Meets Computation”, Italy  
- 2012 SIAM Conference on Applied Linear Algebra Webpage, Spain  
  G. Latouche
- International Conference “Probability Theory and Its Applications” in Commemoration of the 100th Anniversary of Borys Gnedenko, Moscow, Russia  
  M. Govorun
- 16th International Congress on Insurance Mathematics and Economics (IME), Hong Kong  
  M. Govorun
July 2012
- Workshop on Recent Developments in Statistical Multiscale Methods, Göttingen, Germany
  M. Jansen
- Brussels Summer School of Mathematics, ULB, Belgium
  S. Dendievel

August 2012
- 5th European meeting on Python in Science, EuroSciPy, ULB, Brussels
  M. Gagliolo
- European Conference on Artificial Intelligence 2012, Montpellier, France
  T. Lenaerts, I. Zisis

September 2012
- European Conference on Complex Systems, Brussels, Belgium
  T. Lenaerts
- Next Generation Sequencing conference, SMI, London, UK
  G. Bontempi
- AIMM 2012 (Annotation, Interpretation and Management of Mutations Workshop) held in conjunction with ECCB 2012 (11th European Conference of Computational Biology), Basil, Switzerland.
  E. Cilia
- ECCB 2012 (11th European Conference of Computational Biology), Basil, Switzerland.
  E. Cilia
- BIOCOMP 2012 (International Conference on Bioinformatics and Computational Biology), Varna, Bulgaria.
  E. Cilia
- Workshop on Cryptographic Hardware and Embedded Systems (CHES), KUL, Belgium
  L. Lerman
- 1st European Actuarial Journal Conference, Lausanne, Switzerland
  S. Dendievel and M. Govorun
  S. Dendievel and M. Govorun

October 2012
- Strata conference, New York, USA
  G. Bontempi, A. Dal Pozzolo
- Swiss Re Conference - The future of human longevity: focusing on you, Zurich, Switzerland
  M. Govorun

November 2012
- NSBM (Netherlands Society on Biomolecular Modelling) Fall Meeting 2012, Utrecht, Netherlands.
  E. Cilia
- Workshop on Cryptographic Hardware and Embedded Systems (CHES), KUL, Belgium
  L. Lerman
- Colloque des Mathématiques Appliquées à la Gestion des Risques, Lyon, France
  S. Dendievel and M. Govorun
- Workshop on applied probability, ULB, Belgium

December 2012
- BBC (Benelux Bioinformatics Conference) 2012, Nijmegen, Netherlands
  E. Cilia and T. Lenaerts
- IEEE International Conference on Data Mining series (ICDM 2012), Belgium
  G. Bontempi, L. Lerman, Y.-A. LeBorgne, M. Gagliolo, I. Zisis, C. Olsen

Research Projects
  I. Zisis
  The goal of this project is to investigate the interplay of preference formation and group formation in strategic situations when agents have to learn about the preferences of their potential co-players. For this purpose three experiments will take place regarding the Dictator game, the first in February 2013 in Tilburg. It is a joint collaboration with the ECARES (European Center for Advanced Research in Economics and Statistics).
- "Network dynamics of social capital", Innoviris (2012-2013)
  M. Gagliolo
  Partners: GERME - Institute of Sociology, Department of Political Sciences, ULB and Machine Learning Group, Computer Science Department, ULB
  Social capital is always embedded in social networks. Such networks are inherently dynamic. Their dynamics is affected in various ways by endogenous and exogenous effects. The study of analogous dynamic networks is being carried out in various other fields, ranging from epidemics to telecommunications. With this cross-disciplinary project, we intend to study the interplay of social capital and network dynamics, using advanced modeling tools from research on complex networks to analyze and interpret available social network data.
- Participation in PAI-IAP (Interuniversity attraction Pole), phase VII, P7/06 (Belspo — Belgian Federal Science Office; 2012-2017)
  M. Jansen
  Developing crucial Statistical methods for Understanding major complex Dynamic Systems in natural, biomedical and social sciences
- "Unravelling the information processing patterns of SH2 domains participating in the JAK/STAT signaling pathway", FRFC (2011-2014)
  E. Cilia
  This project aims to provide the structural basis for the different allosteric properties of several SH2 domains, which participate in the common JAK-STAT signaling pathway. On a broad level, we aim to grasp the functional relevance, evolutionary importance and the effect of artificial or disease-related mutations in this class of SH2-containing proteins. To achieve these general goals, we focus here on the three SH2 domains belonging to the proteins SOCS3 and SHP2, which are both implicated in the attenuation of the JAK/STAT pathway. After the in silico identification of those residues implicated in the long-range communication through the SH2 structures,
these dynamics will be validated using NMR relaxation experiments and functional assays in living cells. The residues implicated in signal transmission are expected to correspond to a particular sequence pattern, whose conservation within the family of SH2 domains will be evaluated. These new insights will provide a novel perspective on the existing classifications of this family and, in addition, a validation of alternative methods to multiple sequence alignments to predict the allosteric patterns within that family. Finally, the knowledge derived from the previous steps will be used to design an algorithm to create artificial members of the SH2 family with communication patterns similar to the one(s) previously analyzed. These artificial versions will be examined for folding and binding and their dynamics will be compared with their natural counterparts using NMR. Once they behave correctly, chimeras of the SOCS3 and SHP2 proteins will be tested within living cells. Overall, we aim not only to provide insight into the allosteric nature of SH2 domains, but also to decipher the intimate mechanism of SOCS3 and SHP2 function in modulation of JAK/STAT signaling.

- "Discovery of the molecular pathways regulating pancreatic beta cell dysfunction and apoptosis in diabetes using functional genomics and bioinformatics" ARC project funded by the Communauté Française de Belgique (2010-2015)
  M. Lopes
  The incidence of diabetes mellitus (in its two main forms type 1 and type 2) is currently a matter of great concern: it affects 30 million people in Europe only and this number is expected to double in the next two decades. These two main types of diabetes are characterized by a reduction in the number of functional pancreatic beta cells (a beta cell is a type of cell that is present in the pancreas, in areas called the islets of Langerhans, and which is responsible for the production and release of insulin). The reduction in the number of functional beta cells is caused by an increase of beta cell apoptosis (apoptosis is a programmed, natural process that leads to the death of the cell). The molecular mechanisms responsible for the increase of beta cell apoptosis remain unclear and it is unknown how the candidate genes for diabetes affect beta cell function and survival. The objectives of the project are to use functional genomics, advanced molecular biology and bioinformatics tools to identify gene signatures and regulatory molecular pathways that are responsible for the induction of beta cell apoptosis and to characterize the role of candidate genes for diabetes at the beta cell level.

- "Multi-step ahead spatio-temporal time series forecasting". FNRS (2010-2014)
  S. Ben Taleb
  (abstract) In this project, we propose a machine learning approach to predict the evolution of spatio-temporal processes in long-term horizons from historical data. Spatiotemporal processes, i.e. processes that develop simultaneously in space and time, are object of study in many areas of science and applied science, e.g. economy, biology, physics, hydrology.
  State-of-the-art forecasting methodologies take a reductionist approach where prediction is typically decomposed into a set of low-level and independent tasks. Reductionist approaches strive for accuracy at specific time points or locations without caring for the global properties of the returned prediction. The objective of our project is to shift the focus of forecasting from the reductionist approach to a system-level approach. In other words, our goal is to design, implement and assess forecasting techniques which are able to 1) learn the main properties of the system underlying the historical data and 2) use these properties to select among alternative predictors the most consistent and compliant with the system dynamics.

- "ICT4REHAB - Advanced ICT Platform for Rehabilitation" Innoviris project funded by the Région Bruxelles-Capitale (2011-2014)
  Y.-A. LeBorgne
  (abstract) The ICT4Rehab project addresses a new rehabilitation paradigm in the domain of muscle spasticity rehabilitation. It will require the integration of various data sources, the development of novel algorithms and putting into practice several ICT tools supporting 2D/3D user interaction. Two important aspects of clinical spasticity management will be combined (i) maintaining optimal patient motivation during her/his physical therapy and (ii) data handling and processing of the spasticity-related clinical data. The project’s main results will be the ICT4Rehab platform that will include the developed technology in several demonstrators (a Serious Gaming demonstrator and a Clinical Analysis demonstrator). Developments will be guided by the goals of generalising the methodology to other pathologies requiring motivational sustainability and clinical analysis, and to lead to a technological platform for future developments in diverse areas.

- "Contribution to the analysis of high-throughput biological data linked to skin cancers and heart embryonic development." FNRS (2010-2013)
  S. Brohée
  (abstract) The research activities concern two related fields of bioinformatics. In a first part, I help biologists working at the bench with the huge amount of data they are confronted to (i.e. mainly microarray and next-generation sequencing data analysis). I implemented small, user friendly and documented tool to make their life easier: functional classes enrichment analysis, gene set comparisons, etc.
  The second part of my work consists in developing a new efficient web tool allowing the analysis of genes of similar functions among the up- and down-regulated genes obtained via RNA-seq or microarray experiment.

- "The Effect of Infinity on Matrix-Analytic Models". ARC grant (Action de Recherche Concertée) funded by the Communauté Française de Belgique
  (abstract) The behaviour and properties of Quasi-Birth-and-Death (QBD) processes with infinitely many phases can be markedly different to those of the traditional QBDs with finitely many phases. The main theme of the project is to study in greater depth these differences and to extend the analysis to related processes such as fluid queues. The research will proceed along three directions. One is about the further development of the theory of stochastic fluid queues, which currently deals for the most part with systems of finitely many phases. The second is to study questions about decay rates in QBDs as well as processes of M/G/1 and GI/M/1 type. The third aims at constructing a large deviations principle for the probability that a QBD reaches a high level. This work will be conducted in cooperation with P. Taylor at Melbourne University.
“Adaptive real-time machine learning for credit card fraud detection”, Doctiris, Innoviris, Brussels Region (2012-2014, renewable for other two more years)

A. Dal Pozzolo

(abstract) Nowadays, enterprises and public institutions have to face a growing presence of frauds and consequently need automatic systems able to support fraud detection and fight.

These systems are essential since it is not always possible or easy for a human analyst to detect fraudulent patterns in transaction datasets, often characterized by a large number of samples, many dimensions and online update.

Project Objectives:
Design, assess and validate a machine learning framework able to calibrate in an automatic, real-time and adaptive manner the ATOS Worldline fraud detection strategy.

The goal is to provide the industrial partner with a set of learning tools to be integrated within the credit card fraud detection process daily run by ATOS Worldline in order to improve its robustness, performance and accuracy.

“Epigenomic and Transcriptomic Analysis of Breast Cancer”, Televie FNRS (2012-14)

M. Bizet

(abstract) The aim of this project is a better understanding of the role of epigenetic modifications in breast cancer. More specifically we want to focus on modifications of the DNA methylome.

For this purpose DNA methylation data were acquired from almost 250 tissues samples (236 carcinoma and 12 normal) using the Illumina Infinium 450K Bead Chip technology. Because it is a recent technology there is not any consensus on the way to normalize the data. So we are first going to develop a pipeline for the preprocessing of our data in a way that maximize biological significance. Then we want to use the CpG methylation pattern to cluster patients. To confirm and refine our results we also plan to realize a whole genome DNA methylation analysis on a few samples using MethylCap-Seq technology. An RNA-Seq analysis is also planned on a few samples of each cluster obtained during the DNA methylation analysis. The aim is on one hand to refine breast cancer taxonomy for better survival predictions. On the other hand we also want to get a better understanding of the link between DNA methylation and gene expression. For this purpose we are going to infer causal models from methylation and expression data. In conclusion we want to use power of bioinformatics and machine learning to extract biological information from methylation data. The aims are on one hand to refine breast cancer taxonomy and on the other hand to get a better understanding of the link between DNA methylation modifications and cancer.

Editorial and Conference Organization Activities

G. Bontempi

Local chair
- International Conference on Data Mining, ICDM2012, Brussels, Belgium

Steering committee member of
- ESANN 2012

Program committee member of
- ICPRAM 2012 (International Conference on Pattern Recognition Applications and Methods),
- Benelearn 2012
- WAITS 2012

Reviewer of
- European Research Council (ERC)
- IEEE Transactions on Industrial Informatics, Journal on Data Semantics, ICDM12, PLOS One, Int. J. of Renewable Energy Technology, Neurocomputing

Program committee
- ITBAM 2012

T. Lenaerts

Reviewer for

Program committee
- July 2012, 13th International Conference on the simulation & synthesis of living systems, Michigan, USA.
- December 2012, Benelux Bioinformatics Conference, Nijmegen, Nederland.

Editorial Board
- Computational Biology Journal, Hindawi Publishing Cooperation
- ISRN Computational Biology, Hindawi Publishing Cooperation

Conference organization

M. Jansen

Associate editor
- Signal Processing

Reviewer for
- IEEE transactions on image processing
- IEEE transactions on signal processing
- Journal of Computational and Graphical Statistics, Numerical Algorithms

Member of local committee
- Journées de Statistique, Brussels, 2012

Member of international program committee
- Signal Processing, Pattern Recognition and Applications Conference, SPPRA 2013, Innsbruck, Austria
• Y.-A. LeBorgne
  Reviewer for
  • SensorComm, ESANN, Transactions on Mobile Computing, Transactions on Industrial Informatics, Transactions on Knowledge and Data Engineering, Sensors Journal, ETRI Journal
  Co-chair
  • PhD Forum at ICDM 2012
  Program Committee
  • SensorDevices 2012

• P. Meyer
  Session chair
  • PhD Forum at ICDM 2012

• S. Ben Taieb
  Reviewer for
  • Neurocomputing journal, DMIN 2011, IJCNN 2011

• M. Govorun
  Reviewer of
  • European Actuarial Journal

• S. Dendievel
  Organisation of
  • Séminaires des Doctorants de Mathématique de l’ULB
  • Workshop “When Probability Meets Computation”, University of Insubria, Italie, 6-8 June 2012.

• G. Nguyen
  Reviewer of
  • Stochastic Models, Stochastic Processes and Applications
  Member of organizing committee
  • workshop “When probability meets computation”, Italy, June 6 - 8.

• L. Lerman
  Reviewer of
  • Data Mining Conference (DMIN12)
  • SECRIPT2012
  • Advances in Software Engineering Journal
  Local Organization Member of
  • ICDM 2012 Ð International Conference on Data Mining

• E. Cilia
  Reviewer of
  • BMC Bioinformatics and Bioinformatics (Oxford Journals)
  Local Organization Member of
  • ICDM 2012 Ð International Conference on Data Mining

• A. Dal Pozzolo
  Local Organization Member of
  • ICDM 2012 Ð International Conference on Data Mining

• M. Gagliolo
  Reviewer for
  • IEEE TNNLS (Trans. on Neural Networks and Learning Systems), Journal of Heuristics (Springer), ACM Computing Surveys
  • 2013 IEEE SSCI (Symposium Series on Computational Intelligence), 2012 Winter Simulation Conference (WSC)
  Program committee
  • ACO-SI track of Genetic and Evolutionary Computation Conference (GECCO-2013)
  • NIPS Workshop on Bayesian Optimization and Decision Making
  • BNAIC 2012 (24th Benelux Conference on Artificial Intelligence)

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