Activity Report 2013

Section highlights of the Team

ALEA Project-Team

2.2. Highlights of the Year

- Pierrick Legrand was finalist of the Humies award (Human-Competitive Results Produced by Genetic and Evolutionary Computation) for his work on "Evolving estimators of the pointwise Holder exponent with Genetic Programming" at Genetic and Evolutionary Computation Conference (GECCO) July 6-10, 2013 In Amsterdam. The jugging committee was:
    – Erik Goodman
    – Una-May O'Reilly
    – Wolfgang Banzhaf
    – Darrell Whitley
    – Lee Spector

  The regularity of a signal can be numerically expressed using Holder exponents, which characterize the singular structures a signal contains. In particular, within the domains of image processing and image understanding, regularity-based analysis can be used to describe local image shape and appearance. However, estimating the Holder exponent is not a trivial task, and current methods tend to be computationally slow and complex. This work presents an approach to automatically synthesize estimators of the pointwise Holder exponent for digital images. This task is formulated as an optimization problem and Genetic Programming (GP) is used to search for operators that can approximate a traditional estimator, the oscillations method. Experimental results show that GP can generate estimators that achieve a low error and a high correlation with the ground truth estimation. Furthermore, most of the GP estimators are faster than traditional approaches, in some cases their runtime is orders of magnitude smaller. This result allowed us to implement a real-time estimation of the Holder exponent on a live video signal, the first such implementation in current literature. Moreover, the evolved estimators are used to generate local descriptors of salient image regions, a task for which a stable and robust matching is achieved, comparable with state-of-the-art methods. In conclusion, the evolved estimators produced by GP could help expand the application domain of Holder regularity within the fields of image analysis and signal processing.

- The IRSES FP7 Marie Curie project ACOBSEC presented by the team ALEA was accepted.

  Over the last decade, Human-Computer Interaction (HCI) has grown and matured as a field. Gone are the days when only a mouse and keyboard could be used to interact with a computer. The most ambitious of such interfaces are Brain-Computer Interaction (BCI) systems. The goal in BCI is to allow a person to interact with an artificial system using only brain activity. The most common approach towards BCI is to analyse, categorize and interpret Electroencephalography (EEG) signals, in such a way that they alter the state of a computer. The objective of the present project is to study the development of computer systems for the automatic analysis and classification of mental states of vigilance; i.e., a person's state of alertness. Such a task is relevant to diverse domains, where a person is expected or required to be in a particular state. However, this problem is by no means a trivial one. In fact, EEG signals are known to be highly noisy, irregular and tend to vary significantly from person to person, making the development of general techniques a very difficult scientific endeavour.
  List of Beneficiaries
    – Beneficiary 1 (coordinator) Institut National de Recherche en Informatique et Automatique Inria France
    – Beneficiary 2 Universite Victor Segalen Bordeaux II UB2 France
    – Beneficiary 3 Instituto de Engenharia de Sistemas e Computadores, Investigacao e Desenvolvimento em Lisboa INESC-ID Portugal
    – Beneficiary 4 Universidad de Extremadura UNEX Spain
    – Partner 5 Instituto Tecnologico de Tijuana ITT Mexico
    – Partner 6 Centro de Investigacion Cientifica y educacion Superior de Ensenada, Baja California CICESE Mexico

BACCHUS Team

2.2. Highlights of the Year

- In the context of the first contract supported by European Space Agency on uncertainty quantification (UQ), we applied some innovative UQ techniques in the challenging issue of predicting phenomena associated to the atmospheric reentry. In particular, we focused on the characterization of free-stream conditions in flight experiments, and the prediction of the radiative heat flux in high enthalpy facilities.

- In 2013 we have organized or contributed to the organization of three international conferences held at Inria or on the applied science campus of the Université de Bordeaux I : the Second ECCOMAS Young Investigators Conference (http://yic2013.sciencesconf.org), the EUROPEAN WORKSHOP on High Order Nonlinear Numerical Methods for Evolutionary PDEs (http://honom2013.bordeaux.inria.fr/), and the International Workshop on Uncertainty Quantification in fluids Simulation (http://boquse2013.bordeaux.inria.fr/) ;

- We have finally succeded in proposing Residual Distribution schemes that are *uniformly* accurate independently of the Reynolds number laminar, and turbulent compressible flow equations, with a stunning convergence to steady state down to machine zero ;

- We have shown the applicability of stabilized finite elements to the simulation of free surface water waves described by Boussinesq modes. We have demonstrated that residual based stabilization operators do not degrade the accuracy of the underlying finite element scheme, and used this to construct non oscillatory schemes for wave propagation, breaking, and runup ;

- We have developed an algorithm for the robust construction of curved simplicial meshes in two and three dimensions. Starting from a classical (straight) mesh, we are able to curve the boundary elements then the volumic ones and keep the boundary layer structures, even for meshes designed for turbulent simulations ;

- We developed a multiresolution strategy applied to a semi-intrusive scheme recently introduced in the context of uncertainty quantification (UQ) analysis for compressible fluids problems. This is one of the first global schemes in literature permitting an adaptive refinement in the coupled physical/stochastic space .

- `PaMPA` remeshed a coarse mesh of 27 millions of elements up to a fine mesh comprising more than 600 millions of elements, in 34 minutes, on 240 processors of the Avakas cluster at MCIA Bordeaux.

- François Pellegrini published a book on software law ; co-authored with Sébastien Canevet, associate professor at Université de Poitiers.

CAGIRE Team

2.2. Highlights of the Year

AeroSol has been successfully tested on the Turing machine of the IDRIS computing center. This was a pre-requisite for the subsequent simulation of the targeted flow configuration.

CARMEN Team

2.2. Highlights of the Year

- Simon Labarthe was awarded the « prix de THESAQT », during the « Forum NOVAQT » on innovation organized by the region Aquitaine. The price was awarded for his scientific achievements during his PhD.

CEPAGE Project-Team (section vide)

CONCHA Project-Team

2.2. Highlights of the Year

CQFD Project-Team

2.2. Highlights of the Year

The paper *Optimal stopping for predictive maintenance of a structure subject to corrosion* [7] was nominated winner of the 2012 SAGE Best Paper Award by the editorial board of Journal of Risk and Reliability.

FLOWERS Project-Team

2.2. Highlights of the Year

In April 2013 at the International Conference on Robotics and Automation in Karlsruhe, Freek Stulp received the "King-Sun Fu Best Paper Award of the IEEE Transactions on Robotics". As T-RO has on of the highest impact factors, this is considered to be the highest paper prize in robotics. It is the first time this prize has been awarded to an article on machine learning.

The team has announced in october 2013 the open-source release of the Poppy humanoid robot. Poppy is to our knowledge the first humanoid robot in the world to be at the same time open-source (hardware and software) and based on 3D printing techniques. It is based on robust, flexible, easy-to-use hardware and software. Its development aims at providing an affordable and hackable humanoid robot for science, education, art and geeks. Poppy was initially made for our research project about understanding the role of morphology in biped locomotion, and full-body physical and social interaction in robots and humans. The robot has generated a huge enthusiasm from geeks, academic laboratories, and educational institutions, and within the first two months already 200 beta-testers registered to rebuild their own copy of the robot. Dozens of articles appeared on the internet and printed press, and the Poppy videos was viewed nearly 40k times. Web site: http://www.poppy-project.org.

The Flowers team made major achievements in diffusing science and technology towards the general public. Pierre-Yves Oudeyer published a popular science book entitled "Aux sources de la parole" at Odile Jacob, and was invited to talk about our research on major radio channels (e.g. France Inter, France Culture, France Info). http://www.pyoudeyer.com/AuxSourcesDeLaParole.htm

The team also initiated the development of educational activities in "écoles primaires" and "collèges" to have kids discover robotics and programming, as well as ran experiments in "école primaires" in Aquitaine to test novel educational software to help children learn mathematics, and developped within the KidLearn ADT project. This was achieved thanks to the arrival of Didier Roy, former math teacher in college, in the team.

The Flowers team is now coordinating the European project "Semi-autonomous 3rdHand" (coord. Manuel Lopes). The goal is to develop a semi-autonomous robot assistant that acts as a third hand of a human worker in factories, which may be a transformative technology for industry in the coming years. It aims to elaborate techniques allowing to instruct even by an untrained layman worker, allow for efficient knowledge transfer between tasks and enable a effective collaboration between a human worker with a robot third hand. http://3rdhandrobot.eu

The Flowers team started the work on Intelligent Tutoring Systems. The project Kidlearn is a research project studying how machine learning can be applied to intelligent tutoring systems. It aims at developing methodologies and software which adaptively personalize sequences of learning activities to the particularities of each individual student. First experiments were realized in elementary schools of Région Aquitaine, where 6-7 year old kids learnt elements of mathematics with our software. https://flowers.inria.fr/research/kidlearn/

An associated team, called Neurocuriosity, was created between Flowers and the Cognitive Neuroscience lab of Jacqueline Gottlieb at Univ. Columbia, NY. The goal of this associated team is to investigate mechanisms of spontaneous exploration and learning in humans by setting up experiments allowing to confirm or falsify predictions made by computational models previously developped by the team. This constitutes a crucial collaboration between developmental robotics and cognitive neuroscience. This joint work already led to a major publication on curiosity and information seeking, in the prestigious Trends in Cognitive Science journal (impact factor: 16.5).[10]

Thomas Cederborgs PhD thesis "A Formal Approach to Social Learning: Exploring Language Acquisition Through Imitation" won the "ThesAqt" prize, awarded by Region Aquitaine who gives this awards to excellent theses in the region.

GEOSTAT Project-Team

2.2. Highlights of the Year

- Hicham Badri, PhD student in GEOSTAT (thesis under way cosupervised by H. Yahia and D. Aboutajdine) received the University Mohammed V best Master student award.

- The paper *Reconstructing an image from its edge representation* by Suman K. Maji, H. Yahia and H. Badri [19] is ranked in the top ten entries in the list of most downloaded papers of Elsevier's Digital Signal Processing journal.

- The paper *An efficient solution to sparse linear prediction analysis of speech* by V. Khanagha and K. Daoudi [15] is ranked in the top ten entries, 13th over 100, in the list of most downloaded papers in 2013 of the EURASIP Journal on Audio, Speech, and Music Processing.

- GEOSTAT and DYNBIO (LEGOS, CNRS UMR 5566, Toulouse) teams have computed daily ocean dynamics at super resolution over a large area around the Algunas current near South Africa using low resolution altimetry data and high resolution Sea Surface Temperature (SST) data for the year 2006. The computed ocean dynamics over a one year time interval is the result of the propagation of low resolution ocean dynamics derived from altimetry across the scales of a multiresolution analysis computed on the SST singularity exponents. The resulting turbulent ocean dynamics has been made into a movie with the help of Inria DIRCOM team (C. Blonz, P.-O. Gaumin) [1].

- Researchers of GEOSTAT have been invited to two speaker sessions, firstly in one of the best international conference in computational biomedecine: EMBC 2013, [21], and second during the India-CEFIPRA workshop in ICST "Challenges in overcoming complexity, from big data to cyberphysical systems", April 4 - 5, 2013, New Delhi- India [22].

- Paper *Fast Multi-Scale Detail Decomposition via Accelerated Iterative Shrinkage* [24] accepted at SIGGRAPH ASIA 2013 conference (technical brief).

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[1] http://geostat.bordeaux.inria.fr/exj1309/annee2006_SHORTER_2ipj.mov (size $\sim$ 800 Mo).

HIEPACS Project-Team

2.2. Highlights of the Year

The `PaStiX` solver is now able to handle efficiently multiple GPU accelerators using runtime systems (`StarPU` or `PaRSEC`). On the Plafrim machine, one GPU card can provide almost the same performance than 12 cores and we get a good scalability while mixing multicores and upto 3 GPUs accelerators.

The first implementation of the Fast Multipole method over a runtime system has been developed in the context of the FASTLA associated team. The main outcome of this work will be published in a paper to appear in the SIAM SISC journal.

LFANT Project-Team

2.2. Highlights of the Year

V. Verneuil's PhD thesis work, co-supervised by K. Belabas and carried out in the company Inside Secure, has been awarded the "Prix de thèse AMIES 2013" of AMIES, l'Agence pour les Mathématiques en Interaction avec l'Entreprise et la Société. The prize recognises outstanding work securing elliptic curve cryptographic systems against side-channel attacks on smartcards and an exceptional integration into the company, see http://www.agence-maths-entreprises.fr/a/?q=fr/node/292.

After two years of development, version 2.6.0 of the Pari/GP computer algebra system has been released, incorporating numerous improvements related to the programming language and the implementation of number fields, finite fields and elliptic curves. The new release maintains Pari/GP as the world leader for number theoretic computations.

MAGIQUE-3D Project-Team (section vide)

MAGNOME Project-Team (section vide)

MANAO Team

2.3. Highlights of the Year

The first highlight of the year was the team's strong participation at SIGGRAPH: three full technical papers, one talk, and the organization of Inria booth at the exhibition. As a result, the projects got major media coverage (100 000 views of paper videos, publications in internet media) and strong industrial interest (Zeiss, Schneider-Kreuznach, Blender, The Foundry, 3DS).

As a second highlight, the *Eigen* library – whose main contributors include Gaël Guennebaud and Desiré Nuentsa – has received the "High Quality Software in Geometry Processing Award 2013" at the Symposium on Geometry Processing (SGP), a prestigious prize for software development. This prize shows that the library has become a quasi-standard in the field.

The third hightlight is shared with our partners of the ANR SeARCH project (see Section 7.2.1). The results of our collaborative work on the Isis statue was one of the key events of a 6 months exhibition at the "Musée Royal de Mariemont" in Brussels. We also had a major success with our interactive installation "The Revealing Flashlight" (cf. Figure 3). These results were made possible by the new visualization and re-assembly tools developed in our team.

../../../../projets/manao/IMG/amsterdam1.png ../../../projets/manao/IMG/amsterdam2.p

Figure 3. The installation "The Revealing Flashlight" lets visitors explore ancient artifacts interactively.

MC2 Project-Team

2.2. Highlights of the Year

- In collaboration with the Bordeaux cancer therapy of Bordeaux (Bergonie) the MC2 team has developped an adaptive radiotherapy technique to follow automatically organs using the low resolution control scanners. This method is helpful in order to avoid the overdose in high risk organs. Thanks to image processing it was shown that the movement of organs is much more important than predicted before and a better control is necessary. This work continues with the design of automatic tools to follow organ movements.

- In collaboration with Rajat Mittal (John Hopkins) accurate numerical simulations were performed using the NaSCar code to improve the energetic efficiency of underwater submarine robots. As these robots are propelled in the water using fish like models, the used flippers were modified maximizing their energy and therefore minimizing their energy consumption.

- As the final step of the PREDIT Caravaje, the optimized form of an actuator was designed using adjoint methods. It should be implemented in a car body in order to reduce drag forces and consequently the fuel consumption/pollution. The results are published.

- Numerical simulations were performed to reproduce the soap bubbles experiments performed by Hamid Kellay team (Loma). Simulations are allowed by a change of metrics between a plane and an hemisphere using a stereographic projection. The results in accordance with the experiments were published in Nature scientific reports.

MNEMOSYNE Team (section vide)

PHOENIX Project-Team

2.2. Highlights of the Year

- Charles Consel was on sabbatical in Montreal at McGill Unversity for the academic year of 2012-2013. This sabbatical year has allowed us to strenghten our academic collaborations in the domain of assistive technology (e.g., Institut universitaire de gériatrie de Montréal, Université du Québec à Trois-Rivières).

- iQSpot, our technology-transfer project, has been rewarded by OSEO (15e édition du Concours national d'aide à la création d'entreprises de technologies innovantes, catégorie "En émergence") and accepted to the startup incubation program of the IRA (Incubateur Régional d'Aquitaine).

- David Daney, a researcher in Robotics, left the COPRIN project-team of CRI Sophia Antipolis-Méditerranée to join the PHOENIX project-team in September 2013. He will be investigating research topics such as system design, sensor deployment and data analysis.

POTIOC Team

2.2. Highlights of the Year

- Potioc has organized IHM 2013, the French conference on Human-Computer Interaction, in cooperation with the AFIHM association. This conference gathered about 125 participants. A dedicated collection has been created on HAL.

- A tutorial about interaction techniques for 3D environments was presented at Eurographics 2013 [13] and Web3D 2013 [14].

REALOPT Project-Team

2.2. Highlights of the Year

Our scientific contributions have been recognized by prestigious journals such as Mathematical Programming, EURO Journal on Computational Optimization, INFORMS Journal on Computing, European Journal of Operational Research, Transportation Science, European Journal of Combinatorics, and Combinatorica, as well as by our participations to prime scientific meetings. In particular, François Vanderbeck was invited as a keynote speaker at the European/American Operations Research Conference in Rome (his presentation was "Extended formulations, Column Generation, and stabilization: synergies in the benefit of large scale applications" which is a subject central to our team work this year); Arnaud Pêcher was invited speaker at the International Conference in Discrete Mathematics, India.

Our methodology of combining an extended formulation approach with Dantzig-Wolfe decomposition has proved able to handle the very large scale instances of railway fret transportation applications (as shown by the very competitive results obtained by Ruslan Sadykov) as well as power production planning at EDF (Jinil Han has managed to solve the Roadef Challenge Instances in a few minutes, while Boris Detienne develops a robust approach on that basis). The Samba associated-team project with Brasil has been at the core of our methodological research effort with a one-month-visit of Professor Uchoa, and a one-year-stay of his PhD student, Hugo Kramer. New industrial collaborative project have started: working on the dimensioning of a logistic fleet with Exeo-Solution (Pierre Pesneau is leading this project), on planning operations in wineries with Ertus Consulting, and on packing and cutting problems with Renault and Saint-Gobain (Francois Clautiaux is an expert on those).

The team is very fortunate to have made very successful appointments: a university professor, Francois Clautiaux, an assistant professor, Boris Detienne and an expert engineer, Issam Tahiri, to be appointed by the center of excellence - labex CPU. Let us also mention that the team is organizing the annual conference of the French Operation Research society (ROADEF) taking place in Bordeaux in February 2014.

RUNTIME Project-Team

2.2. Highlights of the Year

- The hwloc software 5.2 is used for node topology discovery and process binding by the most popular MPI implementations, including MPICH2 and OPEN MPI and all their derivatives such as Intel MPI.

- The StarPU software 5.6 is used for dynamic scheduling by EADS for his hmatrix solver.