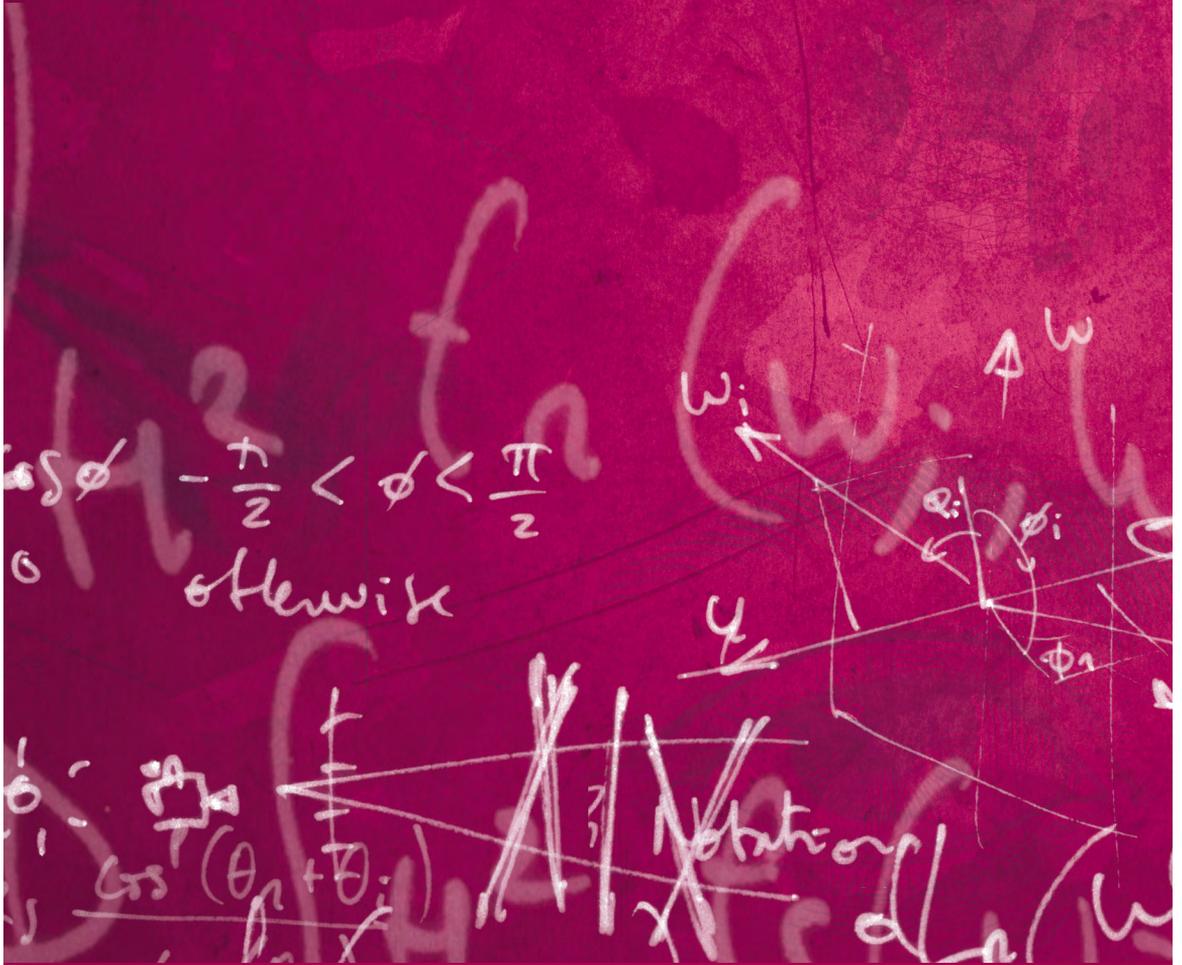




LABORATOIRE  
JEAN KUNTZMANN

MATHÉMATIQUES APPLIQUÉES - INFORMATIQUE



LABORATOIRE JEAN KUNTZMANN

# HIGHLIGHTS

FAITS MARQUANTS

## 2025

— EDITION —

CHAIRMAN  
Jean-Guillaume Dumas

DEPUTY DIRECTORS  
Eric Blayo, Adeline Samson-Leclercq

PROJECT MANAGERS  
Montbonnot site: Peter Sturm – Communication: Brigitte Bidegaray  
Diversity & Parity: Élise Arnaud – Doctoral Students: Kevin Polisano  
Foresight Committee: Clément Pernet – International Relations: Sana Louhichi  
Promotions: Éric Blayo – Quality of Life at Work: Laurence Wazné  
Scientific Support: Vincent Brault – Social & Environmental Responsibility: Franck Pérignon  
Valorisation: Adeline Leclercq Samson



DEPARTMENT  
ALGORITHMS,  
MODELS, ANALYSIS  
& COMPUTATIONS

Valérie Perrier

*Mathematical analysis, PDE's,  
dynamical systems, control and  
optimization, inverse problems,  
numerical analysis, scientific  
and symbolic computing*

AIRSEA

Arthur Vidard

CAS<sup>3</sup>C<sup>3</sup>

Clément Pernet

EDP

Boris Thibert

ELAN

Florence Descoubes-Bertails

STEEP

Peter Sturm

TRIPOP

Vincent Acary



DEPARTMENT  
DATA AND STOCHASTICS:  
THEORY  
& APPLICATIONS

Jean-François Coeurjolly

*Probability, statistics,  
reliability, uncertainty  
modeling, data mining,  
signal processing*

ASAR

Laurent Doyen

DAO

Jérôme Malick

IPS

Sana Louhichi

STATIFY

Florence Forbes

SVH

Julien Chevallier



DEPARTMENT  
GEOMETRY  
& IMAGES

Georges-Pierre Bonneau

*Geometric modeling,  
shape/image analysis,  
computer graphics,  
computer vision*

ANIMA

Rémi Ronfard

CVGI

Luc Biard

MAVERICK

Fabrice Neyret

MORPHEO

Jean-Sébastien Franco

ROBOTLEARN

Xavier Alameda-Pineda

THOTH

Julien Mairal

LABORATOIRE JEAN KUNTZMANN

# HIGHLIGHTS

FAITS MARQUANTS

2025

— EDITION —

[ 2023 - 2024 ]

# FOREWORD



The synergy between computer science and applied mathematics is the essence of the Jean Kuntzmann Laboratory, a joint research unit of Grenoble Alpes University, CNRS, Grenoble INP (Institute of Engineering) and Inria. This multidisciplinary makes it a rich structure, both humanly and scientifically. In a spirit of conviviality and creative enthusiasm, the success of our teams is the result of a joint investment, favoring exchanges, ethics and scientific rigor.

The unit thus brings together more than 300 people particularly mindful to gender equality, sustainable development and quality of business life. We are organized with four support and three scientific departments, the latter comprising seventeen research teams. Our research focuses on analysis, on scientific and high-performance computing, on modeling, on exact and symbolic computation, on cybersecurity, on inverse problems, statistics and probability, on machine learning, signal and image processing, on data mining, optimization, applied geometry, graphic computing or computer vision.

The versatility of the fields of application of the projects is large, ranging from mechanics to health and biology, or from image and cryptology, to economics and finance.

We are happy to present in this 2025 edition of the highlights of the Laboratoire a compendium of our past two years of research that illustrates the pursuit of a common vision.

Among them, we emphasize here many scientific developments, that are at the heart of our activities, as well as portraits of three of our colleagues.

Our results range from theoretical studies to computational modeling and simulation.

We point out, for instance, methodological developments for a robust and efficient digital twin of the ocean, modeling and simulation of natural gravity hazards and protection structures, biomechanically accurate 3d digital humans from skin to skeleton, socially pertinent robots for gerontological healthcare, as well as a unified formulation of the equations representing the two classes of computational decision-making models that are sequential sampling models and dynamic neural fields.

We also have developed a modeler's guide to extreme value software, a long awaited explanation of how the distribution of stochastic gradient explores the solution space, or an open-source initiative in the field of markerless video motion analysis, to apply advances in computer vision to biomechanics.

This is illustrated also by several start-ups, computing platforms and industrial or territorial collaborations that range from Software tools for teaching statistics to Economics, Biology or Psychology students, to a territorial dialogue on energy in the large Briançon territory, or for the production of mirrors and lenses that project a desired light distribution.

Overall, a number of prestigious prizes were awarded to members of the LJK and we organized no less than twenty-one multidisciplinary and international events.

I wish you a pleasant and fruitful journey with us, exploring our most amazing scientific discoveries!

Jean-Guillaume Dumas

## PORTRAITS



## Sophie Achard

› STATIFY team

Sophie Achard is a French statistician and neuroscientist whose research concerns the statistics of the *pattern of connectivity in the brain*. She is a director of research for the CNRS. She joined LJK in 2019 in the Statify team.

She has studied mathematics, statistics, and numerical analysis at Université Jean Monnet in Saint-Etienne, earning a bachelor's degree in 1999. She earned a master's degree and PhD, working on independent component analysis, at Université Joseph Fourier in Grenoble, in 2003.

It is at the Brain Mapping Unit at the University of Cambridge from 2004 to 2007 that she understood the potential of wavelet multivariate time series analysis to determine significant connections between brain regions. This allowed her, together with Ed Bullmore, to establish robust graphs for modelling brain connectivity.

Sophie Achard's research enables the analysis of networks through which signals propagate. By applying graph theory to neuroscience for the first time, she has made an original contribution to our understanding of how the human brain works. Her collaborative research has also advanced our understanding of neurological dysfunctions and the mechanisms that compensate for them. The data she has collected has shown that hyper-connected 'hub' neurons can regenerate, even when there is persistent damage after a coma. The statistical methods she has developed help to identify individual-specific neurological markers with greater precision, paving the way for personalised medicine. The adoption of these techniques by clinicians illustrates the practical value of mathematics in serving society. She received the CNRS Silver Medal in 2023.

She has been involved in various responsibilities for the scientific community. She is currently the scientific director of MIAI Cluster. She is particularly attentive to facilitate interdisciplinary research in a collaborative environment. She is an advocate for diversity and inclusion in all areas of research, with a particular focus on the role of women.

## Karteek Alahari

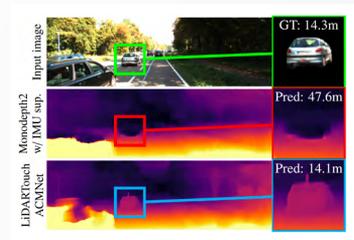
› THOTH team

Karteek Alahari is a research director, and also the deputy scientific director for Artificial Intelligence at Inria. He is a member of the joint Inria, CNRS/LJK, UGA team Thoth. His research is centered around the problem of understanding the visual world, particularly in the context of large-scale and continuously evolving data where not all the samples are labelled.

He obtained his Ph.D. in 2010 from Oxford Brookes University, UK, working on efficient combinatorial optimization solutions for computer vision labelling problems, such as object detection, semantic segmentation. He was a post-doctoral fellow in the joint Inria, CNRS, ENS team WILLOW in Paris from 2010 until 2013. He then moved to Grenoble as a researcher in the LEAR team, which is a prior incarnation of the Thoth team. Karteek's research has been supported by national (ANR JCJC, 2018; several CIFRE PhDs), international (CEFIPRA, 2019; Korean AI research project, 2024), and industrial (Google research award, 2015; Toyota Motor Europe, 2024) grants.

Karteek's recent work is focused around two themes. The first one is on developing efficient learning algorithms, in terms of the quantity of annotated data required to learn. For instance, despite significant advances, the performance of popular approaches that continue to learn over time hinges on the unrealistic scenario of fully labeled data. His work with a PhD student leverages nearest-neighbor classifiers to extend this framework to the challenging case of partially annotated data. Another example is the problem of vision-based depth estimation, which often requires expensive devices such as dense LiDARs to obtain accurate estimation. Their work, LiDARTouch, overcomes this by estimating dense depth maps from monocular images with the help of «touches» of LiDAR, i.e., with only sparse annotations, thus providing inexpensive but effective methods.

The second research theme is on the use of alternative data modalities to learn visual representations. One example is Earth observation problems that leverage satellite and other remotely-sensed data. They introduce a new approach for harnessing metadata (e.g., time and location) in the pretraining phase through a flexible and unified multimodal learning objective. A second example explores the question of whether images generated by models such as Stable Diffusion can be an alternative data modality, and if they can render real images obsolete for training image prediction models.



Comparison of depth estimation with our approach (LiDARTouch) vs ground truth (GT) and a prominent technique (Monodepth2).



## Florian Lemarié

› AIRSEA team

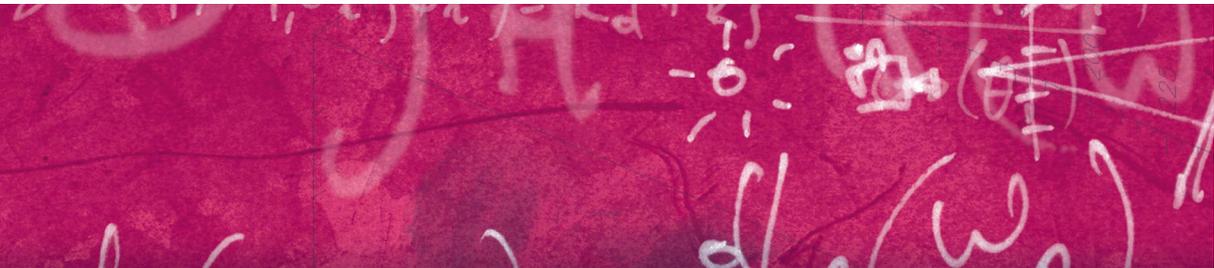
---

Florian Lemarié is a research scientist at Inria and a member of the AIRSEA team at LJK. After his dreams of a basketball career were cut short, he pivoted to academia and earned a PhD from Joseph Fourier University in 2008. He then spent four years as a project scientist in the Department of Atmospheric and Oceanic Sciences at UCLA before joining Inria as a researcher in 2013.

His work lies at the crossroads of applied mathematics, oceanography, and climate science, with a focus on numerical modeling of the ocean and its interactions with the atmosphere. His research centers on developing efficient numerical methods tailored to real-world physical problems. Multidisciplinarity is a constant in his approach: from the mathematical design of algorithms, to their large-scale implementation, to the evaluation of their impact on the physics represented by models. He also values making advances broadly accessible, ensuring that results can be used widely by the geophysics community. A number of his contributions have been integrated into operational and research ocean models. He has long been engaged in national and international initiatives that unite researchers from mathematics, geophysical fluid dynamics, and computer science to advance model development. In 2023, he co-authored a paper on reconciling thermodynamics and conservation principles in Earth System Models, which was recognized with the UCAR Outstanding Accomplishment Award for Publication. This collaborative study highlighted persistent errors in energy budgets within current models and proposed a roadmap for future improvements.

Since January 2024, he has been a member of the international CLIVAR Ocean Model Development Panel, which coordinates efforts to ensure ocean models are scientifically rigorous, validated, and widely shared, while contributing to CLIVAR's overarching mission to understand and predict the climate system.

One of his motivations for contributing to climate research is purely selfish: to know how much longer he'll be able to skate-ski in the Vercors before switching to roller skis.



## The newcomers

---



**Mathilde Boissier**  
› STEEP team / INRIA



**Frédérique Charles**  
› EDP team / UGA



**Jonathan El Methni**  
› STATIFY team / UGA



**Hamza Ennaji**  
› DAO team / G INP



**Lola Etiévant**  
› SVH team / UGA



**Samuel Heidmann**  
› TRIPOP team / INRIA



**Hadrien Hendrikx**  
› THOTH team / INRIA



**Annamaria Iezzi**  
› CAS<sup>3</sup>C<sup>3</sup> team / UGA



**Violaine Louvet**  
› SCALDE / CNRS



**Michaël Nahon**  
› EDP team / UGA



**Thibault Tricard**  
› MAVERICK team / G INP

# MULTI-DISCIPLINARY INTERACTIONS

## MEDIATION: MEthodological Developments for a robust and efficient digital Twin of the Ocean

> Airsea team



MEDIATION is one of the projects of the Priority Research Program (PPR) Ocean and Climate. Its aim is to develop digital tools for in-depth analysis of the impact of global climate change on marine ecosystems, and to provide decision-making tools to guide adaptation policies.

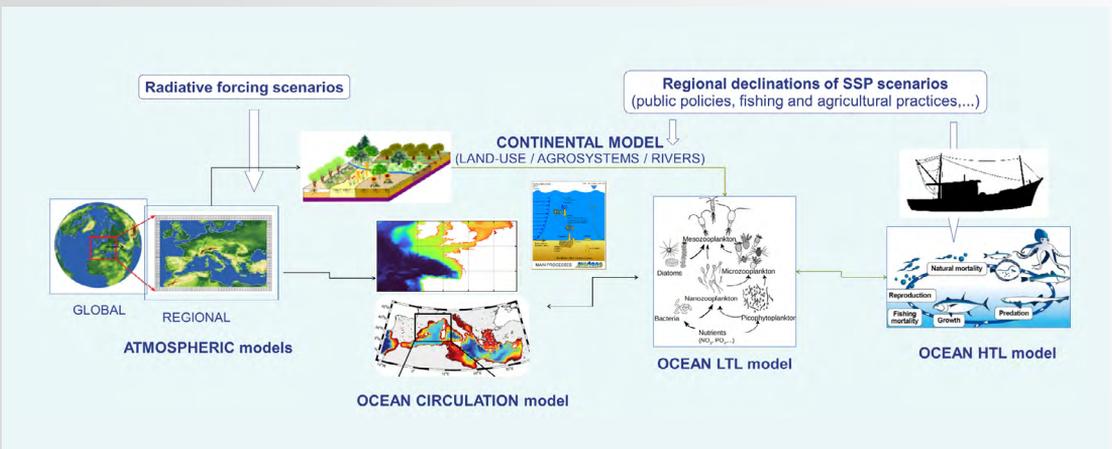
Coordinated by Airsea, this €2.5m project brings together researchers from a wide range of institutions (CNRS, Ifremer, IMT Atlantique, INP Toulouse, Inria, IRD, Météo-France, SHOM, Université Aix-Marseille, UGA), with complementary expertise in applied mathematics, high-performance computing, meteorology, physical and biological oceanography, economics, etc.

MEDIATION aims to develop a complete modeling chain, from the global atmosphere to the modeling of the ocean's high trophic levels (fishes), integrating the physical ocean and marine biogeochemistry (low trophic levels). It also aims to design rapid emulators of this chain, capable of providing precise indicators to facilitate decision-making in terms of management and adaptation to climate change.

A major effort is devoted to quantifying and propagating uncertainties, both in the modeling chain and in the emulators. To achieve this, Airsea is mobilizing all its scientific expertise, covering numerical modeling, sensitivity analysis and experimental design, uncertainty modeling and quantification, machine learning and high-performance computing.

Thanks to this integrated approach, MEDIATION is a unifying project for the Airsea team. Moreover, the partnership with the project's various stakeholders ensures that our scientific advances are rapidly and effectively transferred to concrete applications.

<https://www.ocean-climat.fr/Les-actions-et-projets/Les-projets-de-recherche/MEDIATION>





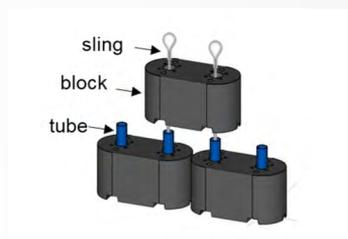
## Modeling and simulation of natural gravity hazards and protection structures

> TRIPOP team

Over the last 4 years, the TRIPOP team has chosen to focus its research in the field of non-smooth dynamic systems on one main application: the modeling of natural gravity hazards in mountains, such as boulder falls, rock flows, mudflows, debris flows, avalanches...

Climate change has numerous consequences for the hazards associated with these risks, both in terms of intensity and frequency. The aim of this research is to apply numerical sciences to the prediction and mitigation of these hazards. Numerical simulation of gravity flows involves numerous mechanical phenomena for which non-smooth modeling is relevant: contact, impact, friction, threshold laws to express the plasticity of geomaterials.

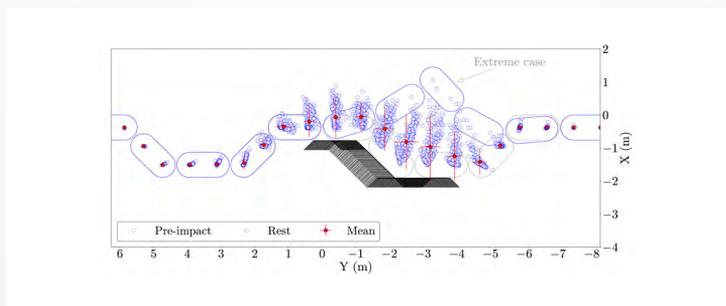
In this project, behavioral models and numerical resolution algorithms are being developed to produce simulations that are as accurate as possible. To improve the predictive capabilities of the models, the team is working on calibrating the models using field data (past events and field experiments) and developing data-driven simulation tools. This work is carried out in close collaboration with the IGE laboratory and INRAE.



*Block connection concept.*



*Structure of a boulder-fall protection structure (front view and top view).*



*Simulation of a boulder-fall protection structure.*

# MULTI-DISCIPLINARY INTERACTIONS

## Computer theatre days

› ANIMA team



Theatrical computing is an emerging disciplinary field, focused on the use of computer science in theatrical creation, and the work of a community that is not yet organized to meet and structure itself.

For this reason Rémi Ronfard (LJK) and Julie Valero (Litt&Arts) have created *Les journées d'informatique théâtrale*, in Grenoble in February 2020. This first conference was co-organized by UGA's IDEX Performance Lab, the LJK, Inria and the Théâtre de l'Hexagone in Meylan, as part of the Arts and Sciences biennial. All 15 presentations were recorded and are available online on the IDEX Performance Lab youtube channel. The conference proceedings have been published on the open science archive HAL.

Given the success of these first days, a second edition was organized by ENSATT in Lyon in October 2022, with a scientific committee chaired by Rémi Ronfard and Mireille Losco.

The event became a recurring event from 2024 onwards. The third event was organized by the University of Avignon in October 2024, with a scientific committee chaired by Rémi Ronfard and Cyrelle Garson. Participation is on the rise (15 papers and 30 registrants in 2020, 26 papers and 50 registrants in 2022, 32 papers and 80 registrants in 2024).

The next edition will be organized by Université Paris 8 Vincennes - Saint-Denis in 2026.



*Posters of the 3 Theatrical informatics days, Grenoble 2020, Lyon 2022, and Avignon 2024.*

<https://hal.science/JIT/>

<https://litt-arts.univ-grenoble-alpes.fr/fr/actualites/journees-dinformatique-theatrale>

<https://ictt.univ-avignon.fr/programme-JIT/>

[https://www.youtube.com/playlist?list=PLtBF5DSKZOPJy-ZuMOvgqxY8aIY\\_d6vgn](https://www.youtube.com/playlist?list=PLtBF5DSKZOPJy-ZuMOvgqxY8aIY_d6vgn)

## From Skin to Skeleton: Towards Biomechanically Accurate 3D Digital Humans

› MORPHEO team

This work focuses on biomechanical modeling of the human body and the relationship between the skeleton and external tissues, in a simplified, low-parameter way. The long-term aim is to be able to estimate an internal model (skeleton) from external observations (images or videos) for clinical purposes.

This work is the fruit of a collaboration between the Morpheo team and Michael Black of the Max-Planck Institute for Intelligent Systems (Tübingen, Germany), and was awarded the “Best Paper Runner Up” prize at the Siggraph Asia 2023 conference. They are representative of Morpheo’s fundamental work to build a foundation for collaborations with digital health players. The previous cycle saw Morpheo forge closer ties with Grenoble University Hospital, for example through collaborations and thesis co-supervision with the Biomecamot team at the TIMC laboratory, and the INSERM/Strobe team; or preparatory work for a joint action/acquisition platform in the new CRESI building at Grenoble University Hospital, due to be completed by the end of 2025.

This work is based on the observation that significant progress has been made in estimating human pose and form in 3D using neural networks trained on models such as SMPL (Multi-Person Linear model), but that these models have simplified kinematic structures, limiting their relevance in biomechanics. On the other hand, current biomechanical models for humans are highly complex and resource-intensive. The SKEL model was proposed with the aim of bridging this gap between the two families of approaches, augmenting the classical SMPL approach with an accurate and easily manipulated biomechanical skeleton.

SKEL is based on a dataset built from optimized skeletons in SMPL meshes derived from AMASS (Archive of Motion Capture As Surface Shapes) sequences. It learns to link the vertices of SMPL meshes to optimized bone articulations and rotations. The result is an animatable model like SMPL, but with reduced, realistic degrees of freedom. SKEL improves the biomechanical accuracy of joints and the fit of bones in the body, and enables existing data to be transformed to include biomechanical parameters. This model provides a tool for biomechanics in the natural environment, and a more realistic joint model for vision and graphics research.

[1] ***From Skin to Skeleton: Towards Biomechanically Accurate 3D Digital Humans***, M. Keller, K. Werling, S. Shin, S. Delp, S. Pujades, C. K. Liu, M.J. Black, *ACM Transactions on Graphics*, 42(6), 1-12, 2023.

[https://youtu.be/RB\\_bNAHjOKg](https://youtu.be/RB_bNAHjOKg)



*Estimate in the volume from the observed area.*

# MULTI-DISCIPLINARY INTERACTIONS

## Socially Pertinent Robots for Gerontological Healthcare

› Robotlearn team

---



The ARI robot

The European H2020 SPRING (Socially Pertinent Robots for Gerontological Healthcare) project, lasting 53 months (January 2020 to May 2024), and with funding of €8.3m, was coordinated by the Robotlearn team. It raised the question of how to evolve robots so that they become capable of non-pre-programmed social interactions, with several people at the same time, as well as the question of their usefulness and acceptability in the waiting room of a gerontological day hospital.

In this context, the robots could take on the repetitive tasks of greeting the public. At the start of the project, existing mediation tools had rudimentary capabilities, or required remote control by an engineer. During the project, the ARI robot was equipped with multi-person interaction capabilities. If two people are talking to each other or both ask it a question, the robot needs to know not only what to answer, but to whom, and in what way.

To provide an answer, during the SPRING project the consortium focused on scientific, technological and experimental objectives. On the scientific side, we developed machine learning methods enabling the robot to adapt to a new environment, to know who to address in a multi-person conversation, and to navigate while respecting social codes. On the technological side, we have developed a platform adapted to these interactions, as well as over fifty software modules implementing the various skills required for social interaction. From an experimental point of view, we have succeeded in organizing interactions with over 150 people at the Broca gerontological day hospital (AP-HP), involving patients, carers and nursing staff. In this project, the RobotLearn team was responsible for social navigation and audio-visual data fusion.

[1] *Socially Pertinent Robots in Gerontological Healthcare*, X. Alameda-Pineda et al., *International Journal on Social Robotics*, arXiv:2404.07560, 2024.

<https://spring-h2020.eu/>

## Why hesitate between two when a continuum is the answer

› SVH team

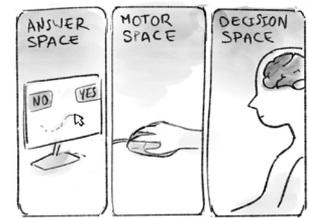
Like the two possible response options separated by design in a forced-choice task, two classes of computational decision-making models have flourished independently in the literature for five decades. While sequential sampling models (SSM) focus on participants' key press times to provide the response in experimental dichotomous decision paradigms, dynamic neural fields (DNF) focus on continuous sensorimotor dimensions and are found in perception and robotics research. Recent attempts have been made to remedy their respective limitations and enable their application to other domains, but the strong similarities and compatibility between the prototypical models of the two classes have hardly been taken into account (e.g., similarity of the stochastic differential equations used).

The gap between these two classes of models, and between disciplines and paradigms that rely on binary or continuous responses is bridged in [1]. A unified formulation of the equations representing SSM and DNF is proposed, varying the number of units that interact and compete to converge on a decision. The physical embodiment of decisions is also taken into account by coupling cognitive and sensorimotor processes, which allows the model to generate realistic decision trajectories on each simulated trial (e.g., via computer mouse or mouse tracking). The resulting model thus adapts to different paradigms (forced choices or continuous response scales) and measures (final responses or response dynamics). The model was statistically evaluated by adjusting it to empirical distributions obtained from human participants on moral decision-making tasks using mouse tracking, for which dichotomous and continuous (more qualified) responses are relevant.

In addition to integrating and comparing equations at the theoretical and formal level, adjusting to empirical data also made it possible to compare optimal parameters for various experimental configurations. To stimulate the interest of empirical researchers, the potential implications for understanding human decision-making processes were discussed, as were the assumptions underlying the paradigms widely used in psychology.

Beyond its value in the context of Flora Gautheron's doctoral thesis on the empirical and computational study of moral decision-making, the publication [1] has led to invitations and integration into a recognized international research community on these topics, as well as the application of these models to other tasks and sub-disciplines.

[1] **Embodied sequential sampling models and dynamic neural fields for decision-making: why hesitate between two when a continuum is the answer**, J.-C. Quinton, F. Gautheron, and A. Smeding, *Neural Networks*, 179, 106526 (2004).



# SCIENTIFIC RESULTS OF THE TEAMS

SCi

## Pose2Sim: an open-source initiative in the field of markerless video motion analysis, to apply advances in computer vision to biomechanics

> CVGI team

The use of optical markers has long been the de facto method in biomechanics for accurately measuring human movements.

It is still widely used, but recent advances in computer vision have opened up prospects for the analysis of markerless movements, enabling a much more ergonomic approach to the analysis of human movements. These methods have given rise to an abundant literature in the field of computer vision.

However, despite this community's habit of providing publicly accessible code, it is generally difficult to install for communities with little computer expertise. Furthermore, the link between computer vision and the requirements of the biomechanics community is not guaranteed, both in terms of anatomical description and accuracy analysis. We therefore proposed the Pose2Sim environment, which bridges the gap between two open-source proposals popular in each community, respectively OpenPose for computer vision and OpenSim for biomechanics.

The highlights of this work are as follows:

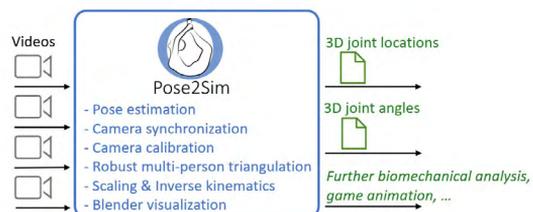
- three open-access publications: two evaluating the accuracy and robustness of the method (Sensors magazine) and one describing the open-source software (Journal of Open Source Software). They currently have over 100 citations.
- an open-source repository on github, with a total of over 300 positive recommendations.

This work was supported by the ANR PerfAnalytics project as part of the Programme Prioritaire de Recherche Sport de Très Haute Performance, and by a thesis funded by the CNRS in collaboration with the PPrime laboratory (UPR 3346) in Poitiers.

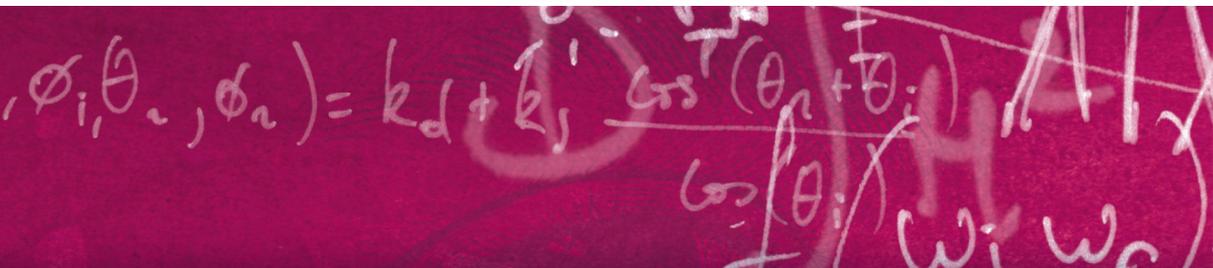
<http://www.perfanalytics.fr>

<https://anr.fr/fr/actualites-de-lanr/details/news/la-valorisation-scientifique-des-donnees-au-service-de-la-performance-sportive/>

<https://github.com/perfanalytics/pose2sim>



Pose2Sim Overview.



## What is the Long-Run Distribution of Stochastic Gradient?

› DAO team

The « Stochastic Gradient Descent » (SGD) algorithm is a fundamental optimization algorithm, variants of which are used to train deep neural networks. Although this algorithm is ultra-simple and has been known for 70 years, its behavior still partly eludes us when used to minimize non-convex functions, such as optimization landscapes in deep learning.

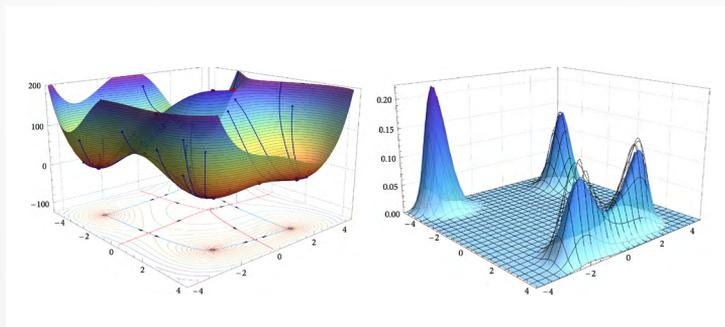
The article [1] helps to demystify the SGD algorithm a little further, explaining how it explores the solution space.

More concretely, we show that the long-term distribution of SGD iterates resembles the Boltzmann-Gibbs distribution in physics, with a time lag equal to the algorithm's step and energy levels determined by the objective function and noise statistics. Concretely, we quantify that

- (a) critical regions are visited exponentially more frequently than non-critical ones;
- (b) iterations are concentrated exponentially around the state of minimum energy;
- (c) other critical points are visited exponentially in proportion to their energy;
- (d) local maximizers and saddle points are visited exponentially less often than local minimizers.

To obtain these results, an approach based on the theory of large deviations is used, and some of the classical results have been generalized to randomly perturbed dynamical systems (a mathematical tour de force by the PhD student Waiss Azizian).

[1] [What is the long-run distribution of stochastic gradient descent? A large deviations analysis](#), W. Azizian, F. Iutzeler, J. Malick, P. Mertikopoulos. In 41<sup>st</sup> International Conference on Machine Learning, Jul 2024, Vienna.



Left: graph of a function with 4 local minima (and some trajectories of SGD iterates).

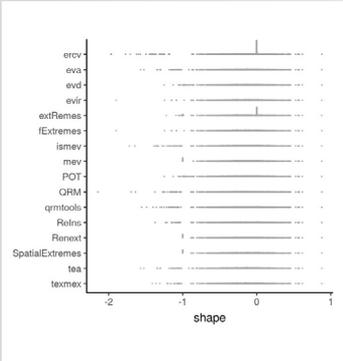
Right: for the same function, we simulate the invariant measure of SGD iterates (in blue) and note that it coincides with the theoretical result (mesh).

# SCIENTIFIC RESULTS OF THE TEAMS

SCi

## A modeler's guide to extreme value software

› ASAR team



Analysis of  $\xi$ .

This work is part of a comprehensive review of extreme value analysis and the implementation of extreme value theory (EVT) models. Previous work by Gilleland et al. (2013) and Stephenson & Gilleland (2006) have highlighted significant gaps in this area.

Over the past two decades, the significant development of computer languages (notably R, Python, Julia, and Matlab) and their package systems has made it possible to cover a wide variety of statistical models. However, the development and implementation of EVT is very uneven. As [1] points out, almost all packages have been developed in R. As such, the CRAN thematic page [2] lists the contributions of the 41 packages listed among the 21,800 packages in CRAN.

In [1], we first study univariate extremes based on two parametric distributions, the GEV and GPD. The sign of the shape parameter  $\xi$  of these distributions defines the domain of attraction of the extremes. Its estimation is complex: instability for  $\xi$  around 0, infinite log-likelihood value for  $\xi < -1$ . Following the review, several packages with numerical instabilities or inconsistencies were corrected. The Bayesian framework or framework with covariates and graphical analysis highlighted the maturity of the packages in this area.

Secondly, [1] reviews multivariate extreme value models, for which a fully parametric representation no longer exists. It turns out that most packages deal with special cases (e.g., bivariate models) or projections (tail dependence coefficients). Some packages also offer innovative approaches to spatial, functional, and/or temporal models, e.g., max-stable processes.

Finally, [1] demonstrates the applicability of EVT to historical fields such as hydrology and climate, or finance and actuarial science, but also to statistical learning methods.

The ASAR team is also very active in digital implementation in R or Julia: this publication fits perfectly with this objective.

[1] [A modeler's guide to extreme value software](#), L. Belzille, C. Dutang, P. J. Northrop, T. Opitz, *Extremes*, 26, 595–638, 2023.

[2] [CRAN Task View: Extreme Value Analysis](#), C. Dutang (2023).

# COMPUTING PLATFORMS AND VALORIZATION

 $g(\phi)$ 

## MATH.en.JEANS 2023

The Auvergne-Rhône-Alpes MATH.en.JEANS 2023 congress was held on June 1 and 2, 2023 on the St Martin d'Hères campus of the Université Grenoble Alpes, mainly on the premises of the Département Licences Sciences et Techniques (DLST). This year's event was attended by 21 workshops (from 9 middle schools and 12 high schools), representing a total of 262 students (110 middle school students, 152 high school students), accompanied by 37 teachers and some 15 researchers.

The congress was organized around 33 student presentations and 34 stands at the forum. Each group presented its findings on the research topic it had been working on throughout the year. An opening plenary lecture, entitled "Modeling and simulating humans", was given by Carole Adam, from the Grenoble Computer Laboratory (LIG), and a closing lecture, "Geo-metry", was presented by Romain Joly, from the Institut Fourier (IF). In addition, participants had access to the "Sophie Germain" exhibition, on loan from the Institut Fourier, and also (for groups having booked a slot) to the "Mission exoplanètes" escape game, on loan and supervised by the "La Grange des Maths" association. At the end of the first day, students in two amphitheatres were able to ask researchers a wide range of questions about their jobs and careers.



<https://www.mathenjeans.fr/Congres2023/Grenoble>



# COMPUTING PLATFORMS AND VALORIZATION

$$g(\phi) =$$

## RayMapr: non-imaging optics and lighting

› EDP team

The RayMapr valorisation project involves the development of software capable of automating the creation of mirrors and lenses that distort the luminous flux emitted by a light source to conform to a desired light distribution.

This project is led by Boris Thibert and Jean-Baptiste Keck of the EDP team, with Quentin Mérigot (professor at Orsay). It has been supported by AMIES and Université Grenoble Alpes since January 2023. It is currently supported by Inria Startup Studio.

The scientific field is non-imaging optics. Quentin and Boris have been working in this field for some fifteen years, developing and adapting optimal transport algorithms to solve the Monge-Ampère equations modeling these problems in the case of ideal light sources. Since 2020, they have been working with Jean-Baptiste (initially a post-doc) on the case of industrial light sources. The approach is based on inverse problem techniques and uses optimal transport as a data fitting term.

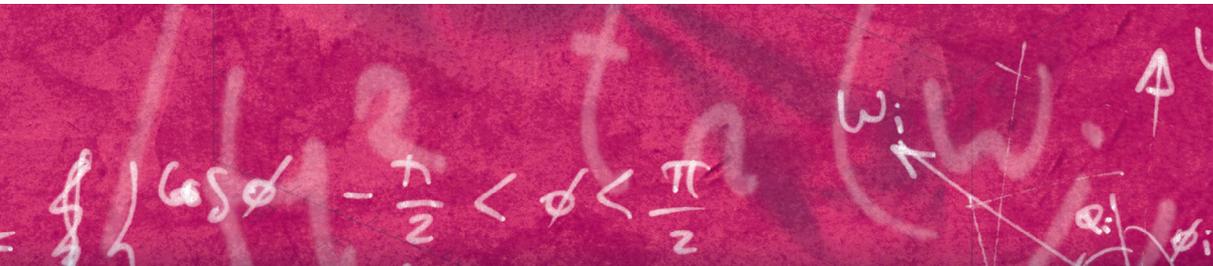
The markets concerned are the automotive industry (headlight design) and street lighting. In most of these applications, the aim is to build the surface of a lens that can precisely redirect the luminous flux emitted by a LED in the desired directions.

The team plans to set up a start-up company to develop the software.

<https://www.raymapr.fr/>



*Uniform parallel light refracted by a lens (built using our approach) to illuminate a Japanese character*



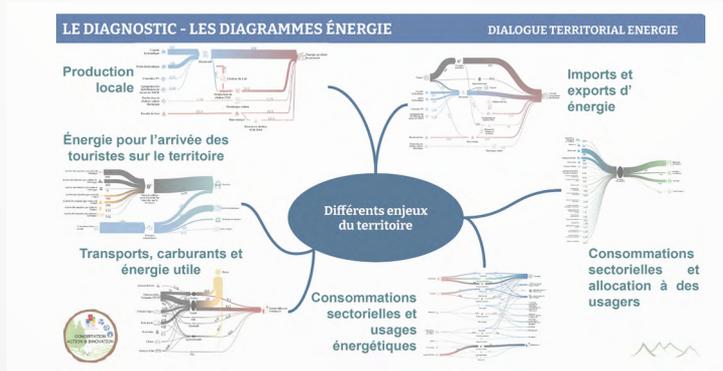
## Territorial Dialogue on Energy in the Large Briançon Territory, from Écrins to Queyras

› STEEP team

Located in the north-east of the Hautes Alpes, the « Pôle d'équilibre territorial et rural du Briançonnais, du Pays des Écrins, du Guillestrois et du Queyras » (PETR) brings together 36 municipalities (3 federations of municipalities) and a population of 36,000. This territory, at the head of the Durance river basin, is at the heart of multiple challenges (biodiversity reserves, energy production, winter tourism, etc.). Reconciling the expectations of the region's various stakeholders (energy producers, environmentalists, local authorities) with regard to these issues presents a number of difficulties. This is why the president of the PETR has asked the Inria STEEP and INRAE G-EAU teams to accompany a research-intervention to support the players. In particular, the aim is to set up and lead a consultation process to define the region's energy policy, combining resource management and environmental impacts. The aim is to involve stakeholders throughout the process: in the construction of a participation plan and in its implementation, including participatory modeling and the creation of an action plan to be implemented subsequently. This collaboration involves a number of challenges, such as a joint search for funding, the mobilization of citizens and the decision-making nature of the process, as well as the scientific production associated with the project. This includes the mobilization of biophysical accounting on territories, one of the STEEP team's specialties.

The project will also enable the STEEP team to step up its involvement in action-research/intervention projects and in the deployment of its models and tools. Until now, these tools were mainly intended for expert users (local authority technicians, economic players, etc.), and one of the team's aims is to make them accessible and actionable for all types of players, including citizens.

<https://www.paysgrandbrianconnais.fr/concertation-politique-energetique>



Energy diagrams

# COMPUTING PLATFORMS AND VALORIZATION

$g(\phi)$

## Software tools for teaching statistics

› DATA department

The faculty members of the DATA department teach in several departments, particularly those where statistics is not the core subject (social sciences, economics, biology, chemistry, life and earth sciences). The DATA department is a place for inter-departmental exchange on our teaching practices. J.-C. Quinton is responsible for the Trainteract training project (2023-2025) funded by IdEx Univ. Grenoble Alpes. This project brings together several members of the DATA department with the aim of developing an online platform allowing students to access statistical resources.

### Psychology students

J.-C. Quinton is developing an online platform (via a R/Shiny server) for:

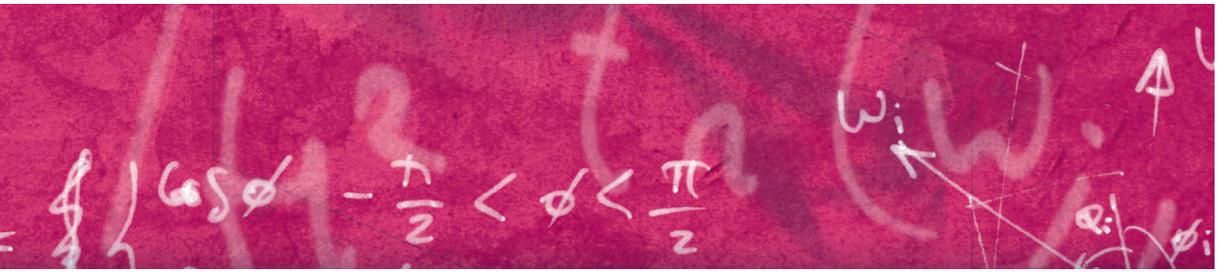
- manipulating key concepts or deepening knowledge through thematic sets of structured guided exercises;
- manipulating real data sets, allowing exercises to be repeated by varying the situation and the results to be obtained;
- obtaining feedback and automatic evaluation of incorrect answers.

Part of the project focuses on the gamification of web interfaces and subjects, in particular through the use of comic book-style visual aids (in partnership with the author of <https://crish.fr>).

### Economics Students

R. Drouilhet and J. El Methni develop an experimental approach to probability based on simulation, <https://cqls.dyndoc.fr/probostat>, with descriptive statistics and a module on statistical data processing using the R software during tutorials without the need for a dedicated computer lab (thanks to the excellent WebR tool). Via an internet connection, this approach allows students to work with R directly on their computers/tablets/mobile phones. In order to make students more active, an online multiple-choice question system allows them to learn/revise (through self-assessment) and finally to be assessed.

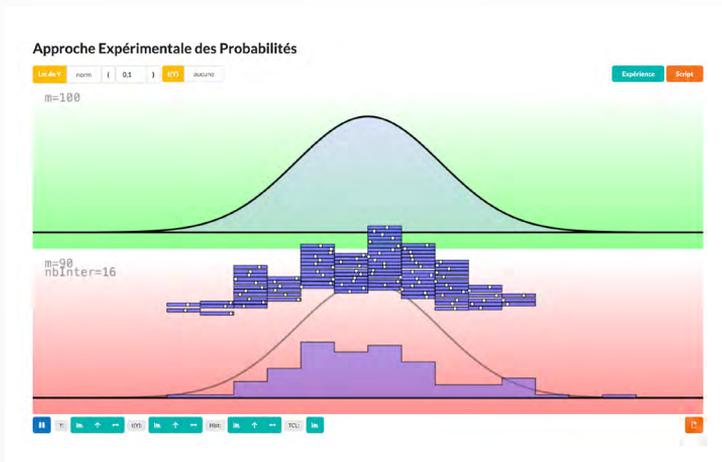
Also for the Faculty of Economics, K. Benhenni is responsible for implementing the program of six courses taught in Mathematics, Statistics, and Econometrics in Years 1, 2, and 3. The investment consists of writing digital Ebooks courses as well as corrected exercises.



## Biology Students

Leclercq-Samson and J.-F. Coeurjolly supervised a master's student in statistics to develop a set of shiny R applications, <https://sites.google.com/site/homepagejfc/software>, for data analysis and visualization, the concept of dispersion, the manipulation of standard probability distributions, confidence intervals, and hypothesis testing.

<https://faculte-h3s.univ-grenoble-alpes.fr/realisations/apprentissage-interactif-et-evaluation-continue-en-sciences-des-donnees--1442066.kjsp?RH=1707216036702>



# AWARDS

## 2023

### Mickaël Ly (ELAN team)

Second PhD award from the French IG-RV GdR for his PhD « Static inverse modelling of cloth »

[https://gdr-igrv.icube.unistra.fr/index.php/Prix\\_de\\_th%C3%A8se\\_du\\_GdR\\_IG-RV](https://gdr-igrv.icube.unistra.fr/index.php/Prix_de_th%C3%A8se_du_GdR_IG-RV)

### Sophie Achard (STATIFY team)

Silver CNRS medal

<https://www.cnrs.fr/fr/personne/sophie-achard>

### Jérôme Malick (DAO team)

Jean-Jacques Moreau Prize

<https://www.academie-sciences.fr/laureat-2023-du-prix-jean-jacques-moreau-jerome-malick>

### Cordelia Schmid (THOTH team)

Körber European Science Prize

<https://koerber-stiftung.de/en/projects/koerber-european-science-prize/all-prizewinners/#s30878>

### Julien Mairal (THOTH team)

Young researchers prize, Inria-Académie des sciences

<https://www.academie-sciences.fr/laureats-2023-des-prix-inria-academie-des-sciences-gilles-dowek-lequipe-cardiologie-numerique>

### Gilles Daviet, Florence Bertails-Descoubes, and Laurence Boissieux (ELAN team)

Test-of-time award at SIGGRAPH Asia 2023

<https://elan.inrialpes.fr/people/bertails/Papiers/hybridIterativeSolverHairDynamicsSiggraphAsia2011.html>

### Sergi Pujades (MORPHEO team)

with Marilyn Keller, Keenon Werling, Soyong Shin, Scott Delp, C. Karen Liu, and Michael J. Black

Honorable mention at SIGGRAPH Asia 2023, for their paper « From Skin to Skeleton: Towards Biomechanically Accurate 3D Digital Humans »

# 2024

## Timothée Darcet et Julien Mairal (THOTH team)

with Maxime Oquab and Piotr Bojanowski

ICRL 2024 Outstanding Paper Award (International Conference on Learning Representations) for « Vision Transformers Need Registers »

<https://blog.iclr.cc/2024/05/06/iclr-2024-outstanding-paper-awards/>

## Clément Pernet (CAS3C3 team)

with Vincent Neiger and Gilles Villard

ISSAC 2024 Distinguished Paper Award (International Symposium on Symbolic and Algebraic Computation) for « Computing Krylov iterates in the time of matrix multiplication »

<https://www.sigsam.org/Awards/ISSACAwards.html>

## Cordelia Schmid (THOTH team)

European Inventor Award 2024

<https://www.youtube.com/live/i7yloUvRVeQ> (timestamp 14:40 to 22:48)

## Stefanie Hahmann (ANIMA team)

John Gregory Memorial Award

<http://www.geometric-modelling.org/>

## Stefanie Hahmann (ANIMA team)

Tosiyasu L. Kunii Award

<https://smiconf.github.io/SMI/>

## Théo Cousino, Laurent Doyen, and Olivier Gaudouin (ASAR team)

with Florent Brissaud and Leïla Marle

Gold  $\lambda\mu$  for the « Best Interactive session » Prize for « Modélisation de maintenances imparfaites et estimation paramétrique à partir de données censurées à gauche »

<https://www.imdr-lambdamu.eu/lambda-mu-dor-lm24>

## Kliment Olechnovič (DAO team)

with Justas Dapkūnas, Darius Kazlauskas, and Česlovas Venclovas

Lithuanian Science Prize 2024 for the cycle of studies « Development and application of protein structural bioinformatics methods (2010–2023) »

<https://www.lma.lt/news/2621/645/Lithuanian-Science-Prizes-2024-Announced>

# CONFERENCES & WORKSHOPS

## 2023



RL@Alpes 2023  
Reinforcement Learning Meeting  
January 3 Grenoble

---

<https://team.inria.fr/robotlearn/rl-alpes-2023/>



Optimization and Statistical Learning  
January 15–20 Les Houches

---

<https://www.di.ens.fr/~aspremon/OSL2023/>



15<sup>th</sup> SSIAB  
Spatial Statistics and Image Analysis in Biology  
May 24–26 Grenoble

---

<https://ssiab15.dyndoc.fr/>

Mathematical Software and High Performance  
Algebraic Computing  
June 26–30 Lyon

---

[https://rtca2023.github.io/pages\\_Lyon/m3.html](https://rtca2023.github.io/pages_Lyon/m3.html)



14<sup>th</sup> International Conference on Monte Carlo  
Methods and Applications  
June 26–30 Paris

---

<https://mcm2023.sciencesconf.org/>

## PDE on the Sphere

July 3–7 Grenoble

<https://pdes2023.sciencesconf.org/>



## GRETSI'23

29<sup>e</sup> Colloque Francophone de Traitement  
du Signal et des Images

August 28–September 1 Grenoble

<https://grets.fr/colloque2023/>



## Autumn school in Bayesian Statistics (Bayes at CIRM)

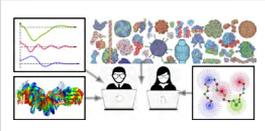
October 30–November 3 Marseille

<https://bayesatcirm.github.io/2023/>



# CONFERENCES & WORKSHOPS

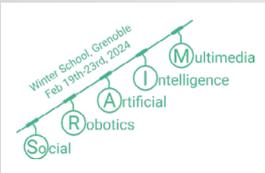
## 2024



Joint Integrative Computational Biology  
workshop and 8<sup>th</sup> CAPRI assessment meeting

February 14–16 Grenoble

<https://www.capri-docking.org/events/>  
<https://workshops.ill.fr/event/392/>



SoRAIM Winter School: Social Robotics Artificial  
Intelligence Multimedia

February 19–23 Grenoble

<https://spring-h2020.eu/soraim/>

JNCF 2024:  
Journées nationales du calcul formel

March 4–8 Marseille

<https://sourcesup.renater.fr/www/orga-jncf/index-2024.html>

Journées des réseaux Mathrice, RNBM et Groupe  
Calcul

March 11–14 Grenoble

<https://indico.math.cnrs.fr/event/10998/>



JNIM'24: Journées Nationales du GDR  
Informatique-Mathématique

March 18–21 Grenoble

<https://jnim2024.sciencesconf.org/>



IABM 2024: Colloque Français d'Intelligence  
Artificielle en Imagerie Biomédicale

March 25–27 Grenoble

<https://iabm2024.sciencesconf.org/>

## Journées du Réseau National pour la Recherche Reproductible

March 26–28 Grenoble

<https://jrfr-2024.sciencesconf.org/>



## Workshop «Spatial Econometrics »

May 23–24 Grenoble

<https://sew2024.sciencesconf.org/>

## Interfaces dans le système climatique

May 27–29 Grenoble

<https://theorie-climat2024.sciencesconf.org/>



## Collective motion of animals and robots

May 27–31 Cargèse

<https://liphy.univ-grenoble-alpes.fr/en/news/collective-motions-animals-and-robots>



## GAP 2024: Grenoble Artificial Intelligence for Physical Sciences

May 29-31 Grenoble

<https://gap2024.sciencesconf.org/>



## Journées EDP Auvergne Rhône Alpes

November 7–8 Grenoble

<https://jeara2024.sciencesconf.org/>



## Spectral Deferred Correction methods

December 17–19 Grenoble

<https://sdc2024.sciencesconf.org/>



## Books

### **Algebraic Number Theory with Elementary Galois Theory**

Rodney Coleman, Laurent Zwald.  
2023.



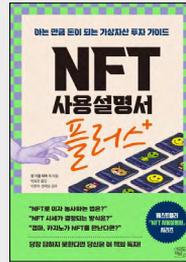
### **Les limites à la croissance. Meadows : questions raisonnées**

Zoé Steep, Sophie Wahnich,  
Louis Delannoy.  
Coll. Voix publiques, Excès, 2023.



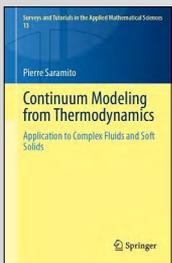
### **Control and Inverse Problems**

Kais Ammari, Chaker  
Jammazi, Faouzi Triki.  
Springer Nature Switzerland,  
Trends in Mathematics, 2023.



### **NFT 사용설명서 플러스**

Jean-Guillaume Dumas, Pascal  
Lafourcade, Étienne Roudéix,  
Ariane Tichit, Sébastien Varrette,  
and Park Hyo-Eun (trad.)  
Yeouido, Séoul, 296 pages, 2023.



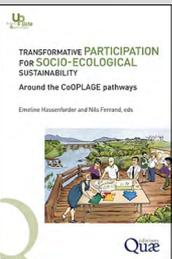
### **Continuum Modeling from Thermodynamics: application to complex fluids and soft solids**

Pierre Saramito.  
Surveys and Tutorials in  
the Applied Mathematical  
Sciences 13, Springer Nature  
Switzerland, 2024.



### **La révolution des sentiments, comment faire une cité. 1789-1794**

Sophie Wahnich.  
Coll. La couleur des  
idées, Seuil, 2024.



### **Transformative Participation for Socio-Ecological Sustainability**

Emeline Hassenforder,  
Nils Ferrand.  
Coll. Update Sciences &  
technologies, Editions Quæ, 2024.

## Some key figures for LJK

---

305 lab members

of which 65 professors and assistant professors

52 researchers

124 doctoral students and postdocs

29 technical and administrative staff members

and around 60 trainees each year

140 publications in peer-reviewed journals per year

80 publications in international conference proceedings per year

7 books in 2023-2024

25 projects sponsored by the French ANR

3 European projects,

including 1 ERC individual grant

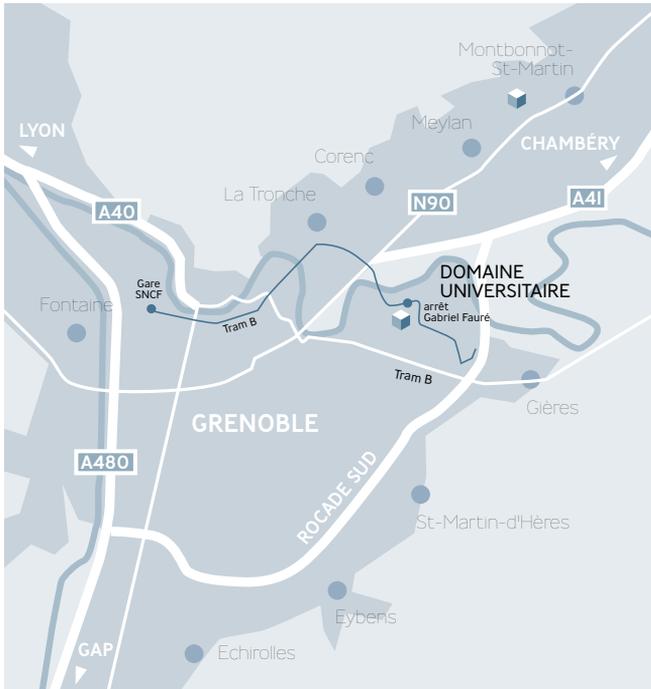
22 PIA (PEPR, MIAI, PUI, PERSYVAL...) contracts

and 19 CIFRE PhD contracts



**LABORATOIRE  
JEAN KUNTZMANN**  
MATHÉMATIQUES APPLIQUÉES - INFORMATIQUE

[ljk.imag.fr](http://ljk.imag.fr)



**CHAIRMAN**

**Jean-Guillaume Dumas**  
tel.: +33 4 57 42 17 32  
Jean-Guillaume.Dumas@univ-  
grenoble-alpes.fr

**COORDINATOR OF GI DEPT.**

**Georges-Pierre Bonneau**  
Tel.: +33 4 76 61 54 06  
Georges-Pierre.Bonneau@inria.fr

**COORDINATOR OF AMAC DEPT.**

**Valérie Perrier**  
Tel.: +33 4 57 42 17 73  
Valerie.Perrier@univ-grenoble-alpes.fr

**COORDINATOR OF DATA DEPT.**

**Jean-François Coeurjolly**  
Tel.: +33 4 57 42 17 17  
Jean-Francois.Coeurjolly@univ-  
grenoble-alpes.fr

**ADMINISTRATIVE MANAGER**

**Delphine Favre-Giraud**  
Tel.: +33 4 57 42 17 36  
Delphine.Favre-Giraud@univ-  
grenoble-alpes.fr

Design vincentmertzt.com



**Site Campus**  
Université Grenoble Alpes  
150 place du torrent  
38401 Domaine Universitaire  
de Saint-Martin-d'Hères

tel.: +33 4 57 42 17 36



**Site Montbonnot**  
655 avenue de l'Europe  
38334 Saint Ismier Cedex

tel.: +33 4 76 61 52 00

