IN PARTNERSHIP WITH:
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Université de Lorraine

Activity Report 2013

Project-Team TOSCA

TO Simulate and CAlibrate stochastic models

IN COLLABORATION WITH: Institut Elie Cartan Nancy (IECN)

RESEARCH CENTERS
Sophia Antipolis - Méditerranée
Nancy - Grand Est

THEME
Stochastic approaches

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Project-Team TOSCA

Keywords: Stochastic Modeling, Numerical Probability, Stochastic Analysis, Monte Carlo Methods, Financial Mathematics, Population Dynamics

Creation of the Project-Team: 2007 January 01.

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2. Overall Objectives

2.1. Overall Objectives

The team develops and analyzes stochastic models and probabilistic numerical methods. The present fields of applications are in fluid mechanics, molecular dynamics, chemical kinetics, neuroscience, population dynamics, and financial mathematics.

The problems where stochastic models arise are numerous, and the critical reasons for which stochastic models are used make analysis and simulations difficult.

The TOSCA team thus aims to develop calibration and simulation methods for stochastic models in cases where **singularities** in the coefficients or **boundary conditions** make them hard to discretize and estimate. For this, we are willing to tackle theoretical and numerical questions which are motivated by real applications.

We are interested in developing **stochastic numerical methods** and **transverse methodologies** that cover several fields of applications, instead of having chosen a particular field of application (e.g., Biology, or Fluid Mechanics, or Chemistry). We justify this way to proceed as follows:

- For a couple of years now, we have attacked singular problems to answer questions coming from economists, meteorologists, biologists and engineers with whom we collaborate within industrial contracts or research programs such as ACI, ANR, GDR. To solve their problems which are so complex that stochastic processes are involved in the modelling, these colleagues need to combine expertise and knowledge in many fields: deterministic computing, computer science, vision, algorithm analysis, etc. We are incompetent in these fields, and therefore we could not pretend to fully treat any of these problems. A contrario, we are requested to bring our expertise in stochastic modelling and simulation to extremely various domains of applications.
- In spite of this diversity, whatever the application is, one has to simulate stochastic processes as solutions to equations of the type

$$\left\{ \begin{array}{rl} X_t(\omega) & = X_0(\omega) + \left(\displaystyle\int_0^t \int_{\mathbb{R}^d} b(X_s, y) \mu_s(dy) ds \right)(\omega) \\ & \quad + \left(\displaystyle\int_0^t \int_{\mathbb{R}^d} \sigma(X_s, y) \mu_s(dy) dZ_s \right)(\omega), \\ \mu_s & = \text{Law of } X_s \text{ for all } s \geq 0, \end{array} \right. \tag{1}$$

in order to compute statistics of the laws of functionals of these solutions. In addition, several fields often produce very similar "pathologies" of the model (1) or of the statistics to compute: for example, Lagrangian stochastic particles in Fluid Mechanics and models in Molecular Dynamics produce the same degeneracy in (1), namely, one has to substitute 'conditional law of components of X_s given the other ones' for 'law of X_s'; as well, when studying chartist strategies in Finance and stochastic resonance in the electrical working of neurons, we encounter close questions on the density functions of the random passage times of processes (X_t) at given thresholds.

- Theory and numerical experiments show that each 'pathology' of the model (1) requires specific analysis and numerical methods. However, they require common abstract tools (Malliavin calculus, propagation of chaos theory, nonlinear PDE analysis, etc.) and common numerical methodologies (stochastic particle systems, Monte Carlo simulations, time discretization of stochastic differential equations, etc.). Thus each application takes benefit from the modelling and numerical knowledge developed for all the others.

The TOSCA team is currently studying models in relation with Geophysics, Neuroscience, Fluid Mechanics, Chemical Kinetics, Meteorology, Molecular Dynamics, Population Dynamics, Evolutionary Dynamics and Finance. We also construct and study stochastic particle systems for Fluid Mechanics, coagulation–fragmentation, stationary nonlinear PDEs, variance reduction techniques for Monte-Carlo computations and numerical methods combining deterministic and stochastic steps to solve nonlinear PDEs in Finance.

3. Research Program

3.1. Research Program

Most often physicists, economists, biologists, engineers need a stochastic model because they cannot describe the physical, economical, biological, etc., experiment under consideration with deterministic systems, either because of its complexity and/or its dimension or because precise measurements are impossible. Then they abandon trying to get the exact description of the state of the system at future times given its initial conditions, and try instead to get a statistical description of the evolution of the system. For example, they desire to compute occurrence probabilities for critical events such as the overstepping of a given thresholds by financial losses or neuronal electrical potentials, or to compute the mean value of the time of occurrence of interesting events such as the fragmentation to a very small size of a large proportion of a given population of particles. By nature such problems lead to complex modelling issues: one has to choose appropriate stochastic models, which require a thorough knowledge of their qualitative properties, and then one has to calibrate them, which requires specific statistical methods to face the lack of data or the inaccuracy of these data. In addition, having chosen a family of models and computed the desired statistics, one has to evaluate the sensitivity of the results to the unavoidable model specifications. The TOSCA team, in collaboration with specialists of the relevant fields, develops theoretical studies of stochastic models, calibration procedures, and sensitivity analysis methods.

In view of the complexity of the experiments, and thus of the stochastic models, one cannot expect to use closed form solutions of simple equations in order to compute the desired statistics. Often one even has no other representation than the probabilistic definition (e.g., this is the case when one is interested in the quantiles of the probability law of the possible losses of financial portfolios). Consequently the practitioners need Monte Carlo methods combined with simulations of stochastic models. As the models cannot be simulated exactly, they also need approximation methods which can be efficiently used on computers. The TOSCA team develops mathematical studies and numerical experiments in order to determine the global accuracy and the global efficiency of such algorithms.

The simulation of stochastic processes is not motivated by stochastic models only. The stochastic differential calculus allows one to represent solutions of certain deterministic partial differential equations in terms of probability distributions of functionals of appropriate stochastic processes. For example, elliptic and parabolic linear equations are related to classical stochastic differential equations, whereas nonlinear equations such as the Burgers and the Navier–Stokes equations are related to McKean stochastic differential equations describing the asymptotic behavior of stochastic particle systems. In view of such probabilistic representations one can get numerical approximations by using discretization methods of the stochastic differential systems under consideration. These methods may be more efficient than deterministic methods when the space dimension of the PDE is large or when the viscosity is small. The TOSCA team develops new probabilistic representations in order to propose probabilistic numerical methods for equations such as conservation law equations, kinetic equations, and nonlinear Fokker–Planck equations.

4. Application Domains

4.1. Application Domains

TOSCA is interested in developing stochastic models and probabilistic numerical methods. Our present motivations come from Finance, Neuroscience and Biology, Fluid Mechanics and Meteorology, Chemical Kinetics, Diffusions in random media, Transverse problems, Software and Numerical experiments.

Finance For a long time now TOSCA has collaborated with researchers and practitioners in various financial institutions and insurance companies. We are particularly interested in calibration problems, risk analysis (especially model risk analysis), optimal portfolio management, Monte Carlo methods for option pricing and risk analysis, asset and liabilities management. We also work on the partial differential equations related to financial issues, for example the stochastic control Hamilton–Jacobi–Bellman equations. We study existence, uniqueness, qualitative properties and appropriate deterministic or probabilistic numerical methods. At the moment we pay special attention to the financial consequences induced by modelling errors and calibration errors on hedging strategies and portfolio management strategies.

Neuroscience and Biology The interest of TOSCA in biology is developing in three main directions: neuroscience, molecular dynamics and population dynamics. In neuroscience, stochastic methods are developed to analyze stochastic resonance effects, to solve inverse problems and to investigate mean-field/McKean-Vlasov equations. For example, we are studying probabilistic interpretations and Monte Carlo methods for divergence form second-order differential operators with discontinuous coefficients, motivated by the 3D MEG inverse problem. Our research in molecular dynamics focuses on the development of Monte Carlo methods for the Poisson-Boltzmann equation which also involves a divergence form operator, and of original algorithms to construct improved simulation techniques for protein folding or interaction. Finally, our interest in population dynamics comes from ecology, evolution and genetics. For example, we are studying the emergence of diversity through the phenomenon of evolutionary branching in adaptive dynamics. Some collaborations in biostatistics on cancer problems are also being initiated.

Fluid Mechanics and Meteorology In Fluid Mechanics we develop probabilistic methods to solve vanishing viscosity problems and to study the behavior of complex flows at the boundary, and their interaction with the boundary. We elaborate and analyze stochastic particle algorithms. Our studies concern the convergence analysis of these methods on theoretical test cases and the design of original schemes for applicative cases. A first example concerns the micro-macro model of polymeric fluids (the FENE model). A second example concerns stochastic Lagrangian modelling of turbulent flows. We are particularly motivated by the meteorological downscaling, and by the computation of characteristic properties of the local wind activity in areas where windmills are built. Our goal is to estimate local potential resources which are subject to meteorological variability (randomness) by developing a stochastic downscaling methodology, that is able to refine wind prevision at large scale, and to compute management strategies of wind resources.

Chemical Kinetics The TOSCA team is studying coagulation and fragmentation models, that have numerous areas of applications (polymerization, aerosols, cement industry, copper industry, population dynamics...). Our current motivation comes from the industrial copper crushers in Chile. We aim to model and calibrate the process of fragmentation of brass particles of copper in industrial crushers, in order to improve their efficiency at a low cost.

Diffusions in random media A *random medium* is a material with a lot of heterogeneity which can be described only statistically. Typical examples are fissured porous media within rocks of different types, turbulent fluids or unknown or deficient materials in which polymers evolve or waves propagate. For the last few years, the TOSCA team has been collaborating with the Geophysics community on problems related to underground diffusions, especially those which concern waste transport or oil extraction. We are extending our previous results on the simulation of diffusion

processes generated by divergence form operators with discontinuous coefficients. Such an operator appears for example in the Darcy law for the behavior of a fluid in a porous media. We are also developing another class of Monte Carlo methods to simulate diffusion phenomena in discontinuous media.

Transverse problems Several of the topics of interest of TOSCA do not only concern a single area of application. This is the case in particular for long time simulation methds of nonlinear McKean-Vlasov PDEs, the problem of simulation of multivalued models, variance reduction techniques or stochastic partial differential equations. For example, multivalued processes have applications in random mechanics or neuroscience, and variance reduction techniques have applications in any situation where Monte Carlo methods are applicable.

Software, numerical experiments TOSCA is interested in designing algorithms of resolution of specific equations in accordance with the needs of practitioners. We benefit from our strong experience of the programming of probabilistic algorithms of various architectures including intensive computation architectures. In particular, our activity will concern the development of grid computing techniques to solve large dimensional problems in Finance. We are also interested in intensively comparing various Monte Carlo methods for PDEs and in the development of open source libraries for our numerical methods in Fluid Mechanics, MEG or Chemical Kinetics.

5. Software and Platforms

5.1. SDM

Participant: Mireille Bossy [correspondant].

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

In 2013, the SDM code became the kernel of the wind farm modelling of the Fundacion Inria Chile. In France, its development is pursuing through the collaborative Modéol project on the evaluation of wind potential.

This is a joint work with Antoine Rousseau from the project-team MOISE.

- Version: 2.0

5.2. CarbonQuant

Participants: Mireille Bossy [correspondant], Selim Karia.

CarbonQuant is a simulator project of CO2 allowances prices on a EU-ETS type market, by an indifference price approach.

It aims to demonstrate the high potentiality of stochastic control solvers, to quantify sensibilities of a carbon market with respect to its design.

Starting in September 2011, CarbonQuant is an ADT [1] Inria.

See also the web page http://carbonvalue.gforge.inria.fr, from where CarbonQuant can be now downloaded for various architectures.

- Version: 2.0

[1] Technology Development Action

6. New Results

6.1. Probabilistic numerical methods, stochastic modelling and applications

Participants: Mireille Bossy, Nicolas Champagnat, Julien Claisse, Madalina Deaconu, Samuel Herrmann, James Inglis, Antoine Lejay, Sylvain Maire, Sebastian Niklitschek Soto, Denis Talay, Etienne Tanré, Denis Villemonais, Laurent Violeau.

6.1.1. Published works and preprints

- M. Bossy and J-F. Jabir (University of Valparaíso) [29], have proved the well-posedness of a conditional McKean Lagrangian stochastic model, endowed with the specular boundary condition, and further the mean no-permeability condition, in a smooth bounded confinement domain $\mathcal{D}$. This result extends their previous work [48], where the confinement domain was the upper-half plane. The extension of the construction to more general confinement domain exhibits difficulties that we handle by combining stochastic calculus and the analysis of kinetic equations. As a prerequisite for the study of the nonlinear case, we construct a Langevin process confined in $\overline{\mathcal{D}}$ and satisfying the specular boundary condition. We then use PDE techniques to construct the time-marginal densities of the nonlinear process from which we are able to exhibit the conditional McKean Lagrangian stochastic model.
- N. Champagnat studied in collaboration with S. Méléard (Ecole Polytechnique, Palaiseau) and P.-E. Jabin (Univ. of Maryland) adaptive dynamics and evolutionary branching in individual-based models of populations competing for resources, where resources consumption is modelled similarly as for chemostat systems of ODEs [13].
- M. Deaconu and S. Herrmann constructed a new procedure for the simulation of the hitting times of nonlinear boundaries for Bessel processes. This method, called the random walk on moving spheres algorithm, is based on two key properties: first, the explicit distribution of the first hitting time of a particular boundary for the Bessel process; second, the connexion between the Bessel process and the Euclidean norm of a Brownian motion having the same dimension. This result can be applied for the hitting time of a given level for the Cox-Ingersoll-Ross process and thus be used in models arising from finance and neurosciences [15].
- J. Inglis and E. Tanré completed their study with F. Delarue and S. Rubenthaler (Univ. Nice – Sophia Antipolis) on the global solvability of a networked system of integrate-and-fire neurons proposed in the neuroscience literature. To do this it was necessary to obtain some general estimates of the first hitting times of barriers by non-homogeneous processes, which have been collected together separately in [40], http://hal.inria.fr/hal-00870991.
- J. Inglis, in collaboration with O. Faugeras (EPI NeuroMathComp), studied the well-posedness of stochastic neural field equations within a rigorous framework. The deterministic versions of these equations have been used to great success for the macroscopic modeling of brain activity. Their stochastic counterparts are non-trivial SPDEs, due to the presence of a nonlocal operator [26], http://hal.inria.fr/hal-00907555.
- A. Lejay and L. Coutin (Université de Toulouse) have continued their work on the sensitivity of the Itô's map in the context of rough paths [37].
- With L. Coutin (Université de Toulouse), A. Lejay has provided a framework for considering linear rough differential equations [49].
- With A. Kohatsu-Higa (Ritsumeikan University) and K. Yasuda (Hosei University), A. Lejay provided bounds on the weak rate of convergence of the Euler scheme when the drift term is discontinuous [41].
- S. Maire and G. Nguyen have developed a Monte Carlo method to deal with Robin and transmission conditions for elliptic diffusion equations in stratified media. It combines walk on spheres techniques and finite differences [44].

- D. Villemonais worked on the empirical distribution of Fleming-Viot type particle systems. Using couplings with reflected diffusion processes, he proved the uniform tightness of such empirical distributions and deduced the non-degeneracy of the law of diffusion processes conditioned not to hit a boundary [19].
- D. Villemonais proved in [18] a general approximation method for Markov processes conditioned not be killed. The method is based on a mean field interacting particles system which is easy to simulate. The study also details the particular case of time/environment dependent diffusion processes.

6.1.2. Other works in progress

- N. Champagnat and B. Henry work on the long-time behaviour of the frequency spectrum for the Splitting Tree models under the infinitly-many alleles model. Specificaly, they want to study the asymptotic behavior of the largests families in the "supercritical clonal" case. Such results could be applied to design statistical methods to detect positive selection of a gene in a growing population.
- N. Champagnat, D. Ritchie (ORPAILLEUR team, Inria Nancy) and B. Henry work on the design of a stochastic model for the evolution of 3D structures of proteins. Using Kpax algorithm [52], which allow to quantify the evolutionary distance between proteins, their goal is to design a statistical method to infer phylogenetic trees with particle systems methods.
- N. Champagnat and D. Villemonais obtained criterions for existence and uniqueness of quasi-stationary distributions and Q-processes for general absorbed Markov processes. A quasi-stationary distribution is a stationary distribution conditionnally on non-absorbtion, and the Q-process is defined as the original Markov process conditionned to never be absorbed. The criterion that they obtain ensures exponential convergence of the conditionned t-marginal of the process conditionned not to be absorbed at time t, to the quasi-stationary distribution and also the exponential ergodicity of the Q-process. This work is currently being written.
- J. Claisse continued his PhD. under the supervision of N. Champagnat and D. Talay on stochastic control of population dynamics. He completed a finite-horizon optimal control problem on branching–diffusion processes. He also created and studied a hybrid model of tumor growth emphasizing the role of acidity. Key therapeutic targets appear in the model to allow investigation of optimal treatment problems.
- M. Deaconu and S. Herrmann are developing a new algorithm for the simulation of Bessel processes hitting times for non-integer dimensions. The idea is to decompose the dimension into its integer part and its fractional part and use the additivity property for squared Bessel processes. Each simulation step is splitted in two parts: one uses the integer dimension case and the other one considers hitting times of a Bessel process starting from zero.
- M. Deaconu in collaboration with L. Beznea (IMAR Bucarest) and O. Lupaşcu (Université Paris 13 and IMAR Bucarest) studies the connexion between the coagulation/fragmentation phenomena and branching processes.
- J. Inglis and D. Talay are developing a mean-field model of a network of neurons, that contains both a spatial element describing the transmission of a signal along dendrites, as well as non-homogenous weights that represent the strength of the synaptic connections. More generally, this leads to the study of the limiting behavior of non-exchangeable mean-field particle systems.
- J. Inglis and E. Tanré are continuing their collaboration with F. Delarue (Univ. Nice – Sophia Antipolis) by developing approximations to a limiting equation describing the behavior of a large network of neurons all behaving according to the integrate-and-fire model. Both a particle system approximation and an approximation involving delays are considered.
- S. Larnier and A. Lejay have worked on nearshore wave analysis and bathymetry identification through the use of a video installed on the shore [42], [43].
- A. Lejay has continued his work with R. Rebolledo (Pontificia Universidad Católica), S. Torres (Universidad de Valparaíso) and E. Mordecki (Universidad de la República) on the parametric estimation of coefficients of diffusion with discontinuous coefficients.

- S. Maire and I. Dimov (Bulgarian academy of sciences) have introduced a new Monte Carlo method to solve real or complex linear systems of equations. Coupled with sequential Monte Carlo this walk on equations method shows a very fast convergence. A similar method is in progress to solve linear integral equations.
- S. Niklitschek Soto and D. Talay have set up and solved a new martingale problem which has allowed them to get a new stochastic representation for solutions of multi-dimensional diffraction parabolic PDEs with general discontinuous coefficients. One of the main difficulties to overcome has been to identify the proper weighted local time process involved in the stochastic dynamics. This work opens the way to innovating Monte Carlo methods for this class of PDEs.
- P. Guiraud (University of Valparaíso) and E. Tanré study the effect of noise in the phenomenon of spontaneous synchronisation in a network of full connected integrate- and-fire neurons. They detail cases in which the phenomenon of synchronization persists in a noisy environment, cases in which noise permits to accelerate synchronization, and cases in which noise permits to observe synchronization while the noiseless model does not show synchronization. (Math Amsud program SIN)
- L. Capietto worked during his internship under the supervision of O. Faugeras (EPI NEUROMATHCOMP) and E. Tanré on extension of [51], in a context with several populations of homogeneous neurons. They study the limit mean field equation of the membrane potential as the number of neurons increase in a network with correlated synaptic weights.
- E. Tanré, in collaboration with O. Faugeras (EPI NEUROMATHCOMP) and the team Inference and Visual Behavior (IViBe) of Institut de Neurosciences de la Timone (INT), studied the motion of eyes, the phenomena of sacades and micro-saccades when monkeys or humans have to fix the center of a picture during a few minutes. They introduce a stochastic model to describe the typical path of the eyes on the picture and evaluate the link between the characteristics of the artificial pictures and the coefficients of the stochastic model.
- L. Violeau continued his PhD. on *Stochastic Lagrangian Models and Applications to Downscaling in Fluid Dynamics* under the supervision of M. Bossy and A. Rousseau (LEMON team, Inria Sophia Antipolis - Méditerranée). Laurent Violeau has obtained a theoretical rate of convergence of the particle approximation of kinetic conditional McKean-Vlasov stochastic models. This result is the first that explicits the complex relationship between the two sources of spacial errors in such kind of algorithm: the smoothing parameter for the conditional expectation estimator and the number of interacting particles. This theoretical convergence rate was confronted with numerical tests in the case of simplified Lagrangian models that confirm the pertinence of the theoretical bound for the error.
- C. Graham and D. Talay are writing the second volume of their series published by Springer on the Mathematical Foundations of Stochastic Simulations.
- In collaboration with N. Touzi (Ecole Polytechnique), D. Talay is studying stochastic differential equations involving local times with stochastic weights, and extensions of classical notions of viscosity solutions to PDEs whose differential operator has discontinuous coefficients and transmission boundary conditions.

6.2. Financial Mathematics

Participants: Mireille Bossy, Nicolas Champagnat, Paul Charton, Madalina Deaconu, Dalia Ibrahim, Antoine Lejay, Khaled Salhi, Denis Talay, Etienne Tanré.

6.2.1. Published works and preprints

- In collaboration with N. Maïzi (CMA - Mines Paristech) and O. Pourtallier (COPRIN team, Inria Sophia Antipolis - Méditerranée), M. Bossy studied the existence result of a Nash equilibrium between electricity producers selling their production on an electricity market and buying CO2

emission allowances on an auction carbon market. The producers' strategies integrate the coupling of the two markets via the cost functions of the electricity production. The authors set out a clear Nash equilibrium that can be used to compute equilibrium prices on both markets as well as the related electricity produced and CO2 emissions covered [30]

- In addition to the internship of K. Salhi, N. Champagnat, M. Deaconu, and A. Lejay have worked on the use of power law to predict risk in financial markets using data from Euronext NSYE stocks exchanges [33].
- P. Charton submitted an article [35] on the optimal operation of a windfarm equipped with a storage unit.

6.2.2. Other works in progress

- D. Ibrahim, D. Talay and E. Tanré worked on a model coming from technical analysis in finance. They study the Bollinger Bands indicator to detect jumps in the volatility in an extension of classical Black and Scholes models. They evaluate the efficiency of such indicators to detect the random time at which the volatility jump from a *small* value to a *large* one. A paper is being written.
- In collaboration with Victor Reutenauer and Christophe Michel (CA-CIB), D. Talay and E. Tanré worked on a model in financial mathematics including bid-ask spread cost. They study the optimal strategy to hedge an interest rate swap that pays a fixed rate against a floating rate. They present a methodology using a stochastic gradient algorithm to optimize strategies. A paper is being submitted.
- In collaboration with J. Bion-Nadal (Ecole Polytechnique and CNRS), D. Talay introduced a new calibration method based on dynamical risk measures and stochastic control PDEs. A paper is being written.

6.3. Stochastic Analysis

Participants: Nicolas Champagnat, Julien Claisse, Denis Talay.

- N. Champagnat studied in collaboration with P.-E. Jabin (Univ. of Maryland) strong existence and pathwise uniqueness for stochastic differential equations driven by a Brownian motion and with rough coefficients [34]. The method is an extension of the one of [50], which studies well-posedness for deterministic dynamical system. Strong existence and pathwise uniqueness can be proved for example if the drift vector is $L^1(W^{1,1})$ and the diffusion matrix is uniformly elliptic and $L^q(W^{1,p})$ with $2/q + d/p = 1$. This improves the previous conditions of [53].
- J. Claisse and D. Talay studied in collaboration with X. Tan (Univ. of Paris Dauphine) a conditioning argument which is often used to prove the dynamic programming principle [36]. Their study of the literature revealed that previous proofs of this argument are incorrect or incomplete. They provided a rigorous and detailed proof by setting up martingale controlled problems in a original way.

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- TOSCA Nancy had a bilateral contract with the SME Alphability on the evaluation of the Value at Risk with applications in portfolio management. This collaboration will be continued in 2014.

7.2. Bilateral Grants with Industry

- Since September 2013, TOSCA Sophia is involved in a Cifre convention with Koris International.

7.3. Promotion of Mathematics in the industry

- D. Talay is the Vice-President of the Fondation d'Entreprise Natixis which aims to contribute to develop research in quantitative finance. He also serves as a member of the Scientific Committee of the Foundation.
- D. Talay is a member of the Scientific Committee of the AMIES National Agency aimed to promote interactions between Mathematics and Industry.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- N. Champagnat, J. Claisse and D. Villemonais are members of the ANR MANEGE (Modèles Aléatoires eN Écologie, Génétique et Évolution, ending in April 2014) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. In addition, the three working groups that operate in each of the three poles of the MANEGE project (Paris, Palaiseau, Marseille) gather all local probabilistic interests in the issues of this project. http://www.cmap.polytechnique.fr/~anr-manege/index_en.html
- A. Lejay is member of the ANR SIMUDMRI (Simulation of diffusion MRI signals in biological tissues) which started in November 2010 (directed by Jing-Rebecca Li, Inria Rocquencourt). http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html
- A. Lejay is member of the ANR H2MNO4 (ANR Cosinus, 2012–2015) on Original Optimized Object Oriented Numerical Model for Heterogeneous Hydrogeology which started in November 2012 (directed by Joceyline Erhel, IRISA, Rennes).

8.1.2. Contract with ADEME

Participant: Mireille Bossy.

Modéol Since April 2013, M. Bossy is the coordinator of the MODÉOL collaboration project funded by the French Environment and Energy Agency (ADEME), and involving the IPSL (CNRS) and the French company Maïa Eolis. The overall goal of the project concerns the modeling and prediction of wind potential in France, in particular the quantification of uncertainties and the analysis of multi-scale variability.

Concerning the Inria workpackage, in collaboration with Antoine Rousseau, from the project-team MOISE, M. Bossy introduced the terrain elevation in the SDM modelling. Selim Kraria is starting to work in MODÉOL. This year we also work on the interface of SDM with the classical and widely used numerical weather prediction solver WRF. For the visualisation purpose with the SDM outputs, we also retained the NUM3SIS platform developed at Inria Sophia Antipolis - Méditerranée.

8.2. International Initiatives

8.2.1. Inria Associate Teams

8.2.1.1. ANESTOC

Title: Stochastic modelling of renewable energies

Inria principal investigator: Denis Talay

International Partner (Institution - Laboratory - Researcher):

Pontificia Universidad Católica de Chile (Chile) - ANESTOC - Denis Talay

Duration: 2011 - 2013

See also: http://www.anestoc.cl/es/?page_id=1112

This associate team complements a CIRIC research program in Chile. We refer to the TOSCA-ANESTOC project on stochastic modelling of renewable energies, especially wind farms, and oceanic resources. Our associate team (”équipe associée Inria”) will conduct its joint research at two different levels. Firstly, the mathematical work on its own which we have called the ”Mathematical Kernel” (MK), motivated by a number of fundamental problems raised by the specific applications in which we are interested. The second level of research concerns two main axes of Applications: (A1) Applications to Engineering (Renewable energies) and (A2) Applications to Neuroscience. The Mathematical Kernel includes a number of fields in the domains of Stochastic Analysis, Statistics and Numerical Analysis. In particular, it is worth mentioning the following: 1. Probabilistic resolution of Boussinesq non-linear partial differential equations; 2. Stochastic Lagrangian modelling for wind simulation at small scale; 3. Open system dynamics as a bridge between Molecular Dynamics and Stochastic Differential Equations; 4. Inference on Stochastic Processes. 5. Algorithms and simulation. The Applications include the stochastic modelling of renewable energy through ocean resources and wind farms (CIRIC-subproject). This subject will be developed with engineers of Fundacion Inria Chile. In addition, applications to ion-channel dynamics through cell membranes will be considered jointly with biophysicists of the CINV (Neuroscience Centre of Valparaíso).

8.2.1.2. Informal International Partners

The TOSCA team project has collaborations with researchers in Japan (Ritsumeikan and Hosei University), Uruguay (Universidad de la República), ...

8.2.2. Inria International Labs

The CIRIC Team on *Stochastic Analysis of Renewable Energies: Ocean Energy and Wind Farms; dynamics and numerics* (2012-2014) is managed by TOSCA and ANESTOC (Univ Catolica, Santiago). It is composed of three main projects.

Mireille Bossy is managing the WINDPOS project, in collaboration with Antoine Rousseau (MOISE team) and three engineers of Inria Chile, Cristian Paris, José Espina Dote and Jacques Morice. Based on the stochastic Lagrangian modeling of the wind at small scale (see SDM SOFTWARE), WINDPOS aims to develop a wind farm simulator software, able to provide fine statistical information for the managing of electricity production.

This year the WINDPOS project focused on the introduction on wind mills modeling in the SDM software. This modeling is based on actuator disk and actuator line models. We also introduced inflow/outflow boundary conditions in SDM and added a CIC averaging in order to refine the input for the projection/pressure computation.

8.2.3. Participation In other International Programs

8.2.3.1. Math Amsud project SIN

Participant: Etienne Tanré.

The Math Amsud project SIN (Stochastic, Inference, Neuroscience) started in 2013. We worked on the part concerned by the stochastic modelling in neuroscience.

It is likely that the stochastic components play an important role in the functions of the neurons and of the networks they form. We describe and study the effect of the noise at different scales of neural activity, such that the level of the ionic channels and the level of neural networks, which are responsible for conveying and processing the information coded in sequences of spikes. The most popular models of this class are integrate and fire (LIF) neural networks. We study the synchronization of neurons in those networks.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- The TOSCA *seminar* organized by J. Inglis in Sophia Antipolis has received the following speakers: Eric Luçon (Technische Universität, Berlin), Julien Reygner (UPMC), Khaled Bahlali (Université du Sud Toulon-Var), Bertrand Cloez (Laboratoire d'Analyse et de Mathématiques Appliquées Université Paris-Est - Marne-la-Vallée), Michael Mascagni (Florida State University), Camillo Garcia Trillos (Laboratoire J.A. Dieudonné Nice), Pierre Guiraud (CIMFAV Facultad de Ingenieria, Universidad de Valparaíso), Laurent Michel (Laboratoire J.A. Dieudonné Nice), François Delarue (Laboratoire J.A. Dieudonné Nice).
- L. Beznea (Simion Stoilow of the Institute of Mathematics of the Romanina Academy) has been visiting TOSCA Nancy for two weeks in May and June.

8.3.1.1. Internships

Jonathan Alif

Subject: Étude des grandes variations du modèle de Heston

Date: from May 2013 until August 2013

Institution: Université de Lorraine

Maimoun Ben Taher

Subject: Real options for electricity production

Date: from Feb 2013 until May 2013

Institution: École Polytechnique de Tunisie (Tunisia)

Louis Capietto

Subject: Networks with several populations of neurons

Date: January-June 2013

Institution: École Centrale de Lyon

Benoît Henry

Subject: Population genetics and ancestral inference for continuous time branching processes

Date: from March 2013 until September 2013

Institution: Université de Lorraine

Alexis Papic

Subject: First Passage Times

Date: March 2013

Institution: PUC (Chile)

Khaled Salhi

Subject: Risk measures: detection of crisis periods and computation of Value-at-Risk

Date: from March 2013 until September 2013

Institution: Université de Lorraine

Shih Hau Tan

Subject: Towards efficient risk quantification using GPUs and variance reduction techniques

Date: from April 2013 until September 2013, in co-advising with Françoise Baude (OASIS team)

Institution: Erasmus Mundus MathMods Program, University of Nice Sophia-Antipolis

8.3.2. Visits to International Teams

- J. Inglis was invited for one week by B. Zegarlinski to Imperial College London in January.

9. Dissemination

9.1. Scientific Animation

- M. Bossy is a member of the Scientific Committee of the *École Doctorale "Sciences Fondamentales et Appliquées"* of the Université de Nice - Sophia Antipolis.
- M. Bossy is a member of the *Collectif Andromede* of the PACA Region council.
- M. Bossy is a elected member of the Inria Evaluation Board.
- M. Bossy served as an Associate Editor of *Annals of Applied Probability*.
- M. Bossy participated to the junior position recruitment committee at the University of Nice - Sophia Antipolis.
- M. Bossy has been a member of the Committee for junior permanent research positions of Inria Nancy - Grand Est.
- N. Champagnat is a member of the *Commission de Développement Technologique* of Inria Nancy - Grand Est, a subsitute member of the *Comité de Centre* of Inria Nancy - Grand Est since October and a member of the *Commission bibliothèque* of IECL.
- N. Champagnat organized the Team Working Group on Probability and Statistics of IECL until January.
- N. Champagnat serves as an Associate Editor of *Stochastic Models* since October.
- N. Champagnat, with T. Lelièvre and A. Nouy, was member of the organizing committee of the *Centre d'Eté de Mathématiques et de Recherche Avancée en Calcul Scientifique* (CEMRACS 2013) held in CIRM, Luminy, from July 22nd until August 30th.
- N. Champagnat, with T. Lelièvre and A. Nouy, was member of the organizing committee of the *Special Event "Mathématiques pour la planète Terre* held at CIRM, Luminy, on the 23rd July.
- N. Champagnat organized with D. Ritchie a *Journée Scientifique de la Fédération Charles Hermite* on *Ancestral Inference and Evolutionary Relationships in Biology* at Inria Nancy - Grand Est in September.
- N. Champagnat organized a mini-symposium on *Quasi-stationary distributions and Q-processes* at the *Congrès SMAI 2013* in Seignosse in May.
- M. Deaconu is member of *Comité des Projets* and *Bureau du Comité des Projets* at Inria Nancy - Grand Est.
- M. Deaconu organized with S. Herrmann the Workshop *Hitting times and exit problems for stochastic models* held in Dijon, 27-29 November.
- M. Deaconu organized with E. Vincent (Inria, Centre de recherche Nancy-Grand Est) a *Journée Scientifique de la Fédération Charles Hermite* on *Uncertainties: approaches and challenges* at IECL in December.
- M. Deaconu and A. Lejay were members of the organizing committee of the *Semaine d'Étude Maths-Entreprises Nancy*, 11-15 February 2013.

- A. Lejay is member of a editorial board of the collection *Séminaire de Probabilités*.
- A. Lejay is member of the scientific committee of the *Journées de Probabilités*.
- A. Lejay is General Secretary of Société des Mathématiques Appliquées et Industrielles (SMAI).
- D. Talay continued to serve as the Head of Science and Chair of the Project-Teams Committee of Inria Sophia Antipolis - Méditerrannée.
- D. Talay, jointly with F. Delarue (Université Nice - Sophia Antipolis) organized the workshop ERGONUM at CIRM (Marseille) in February.
- D. Talay served as an Associate Editor of: *Stochastic Processes and their Applications*, *ESAIM Probability and Statistics*, *Stochastics and Dynamics*, *Journal of Scientific Computing*, *Monte Carlo Methods and Applications*, *Oxford IMA Journal of Numerical Analysis*, *Communications in Applied Mathematics and Computational Science*, *Éditions de l'École Polytechnique*. He also served as the Co-editor in chief of *MathematicS in Action*.
- D. Talay is serving as a member of the Advisory Board of the Centro de Mathematica da Universidade do Porto (Portugal).
- D. Talay participated to Professor position recruitment committees at Paris 6 University and Nice Sophia Antipolis University.
- D. Talay chaired the AERES Evaluation Committee of the Mathematics Department of Paris Descartes University.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Master: M. Bossy, *Continuous time stochastic models for quantitative Finance*, 45h, M2 IMAFA (Informatique et Mathématiques Appliquées à la Finance et à l'Assurance), École Polytechnique Universitaire, Univ. Nice - Sophia Antipolis, France.

Master : M. Bossy, *Risk on energetic financial markets*, 27h, Master Ingénierie et Gestion de l'Énergie, Mine ParisTech, France.

Master : M. Bossy *Stochastic Particle Methods for PDEs*, 18h, M2 Probabilité et Applications, Université Paris 6, France.

Master: N. Champagnat, *Introduction to Quantitative Finance*, 18h, M1, École des Mines de Nancy, France.

Master: N. Champagnat, *Introduction to Quantitative Finance*, 18h, M2, École des Mines de Nancy, France.

Master: N. Champagnat, *Génétique des Population et Généalogies Aléatoires*, 22.5h, M2, École supérieure des sciences et de la technologie de Hammam Sousse, Tunisia.

Master: M. Deaconu, *Simulation de variables aléatoires*, 14h, M1, École des Mines de Nancy, France.

Master: M. Deaconu, *Modélisation stochastique*, 33h, M2, Université de Lorraine, France.

Master: J. Inglis, *Advanced Numerics for Computational Finance*, 15h, M2, UNSA (Mathmods Erasmus Mundus), France.

Master: A. Lejay, *simulation des marchés financiers*, 23h, M2, Université de Lorraine, Metz.

Master : D. Talayy *Stochastic Methods for PDEs with Boundary Conditions*, 18h, M2 Probabilité et Applications, Université Paris 6, France.

Master: E. Tanré, *Advanced Numerics for Computational Finance*, 15h, M2, UNSA (Mathmods Erasmus Mundus), France.

Master: E. Tanré, *Numerical Probability in Finance*, 12h, M2, Ecole PolytechNice (IMAFA), France.

Master: E. Tanré, *Mathematical Methods for Neurosciences*, 25h, M2, ENS - Master MVA / Paris 6 - Master Maths-Bio, France.

Master: L. Violeau, *Continuous Probabilistic Models with Applications in Finance* (exercice classes), 20h, M2 IMAFA (Informatique et Mathématiques Appliquées à la Finance et à l'Assurance), École Polytechnique Universitaire, Univ. Nice - Sophia Antipolis, France.

Licence: L. Violeau, *Probabilty and Statistics* (exercice classes), 20h, L3, Ecole Polytechnique Universitaire, Univ. Nice - Sophia Antipolis, France.

9.2.2. Supervision

- PhD in progress: Maxime Bonelli, *Behavioral finance approach to risk assessment in quantitative portfolio management*, September 2013, M. Bossy.
- PhD in progress: Paul Charton, *Hedging strategies for wind energy prices*, September 2010, M. Deaconu and A. Lejay.
- PhD in progress: Julien Claisse, *Stochastic control of population dynamics*, September 2010, N. Champagnat, D. Talay.
- PhD in progress: Benoît Henry, *Modeling Evolutionary Relationships Between Three-Dimensional Protein Structures*, October 2013, N. Champagnat, D. Ritchie (ORPAILLEUR team).
- PhD : Dalia Ibrahim, *Étude théorique d'indicateurs d'analyse technique*, Université de Nice - Sophia Antipolis, November 2009, D. Talay and E. Tanré.
- PhD in progress; Lionel Lenôtre, *Simulation of processes in discontinuous media*, 2012, J. Erhel (Irisa), A. Lejay and G. Pichot (Irisa). L. Lenôtre has a grant from the MESR and stays at Rennes.
- PhD in progress: Sebastian Niklitschek-Soto, *Discretized stochastic differential equations related to one-dimensional partial differential equations of parabolic type involving a discontinuous drift coefficient*, September 2010, D. Talay.
- PhD in progress: Hernán Mardones, *Numerical Solution of Stochastic Differential Equations with Multiplicative Noise*, 2009, C. Mora (Universidad de Concepción), A. Lejay. H. Mardones spends six months in France (nov. 2013-april 2014) with a grant Becas Chile.
- PhD in progress: Khaled Salhi, *Estimation of Risk in Finance*, October 2013, M. Deaconu, A. Lejay.
- PhD in progress: Laurent Violeau, *Stochastic Lagrangian Models and Applications to Downscaling in Fluid Dynamics*, October 2010, M. Bossy and A. Rousseau.

9.2.3. Juries

- M. Bossy chaired the Committee for the Ph.D. thesis of Paul-Eric Chaudru de Raynal, *Équations différentielles stochastiques : résolubilité forte d'équations singulères dégénérées ; analyse numérique de systèmes progressifs-rétrogrades de McKean-Vlasov*, Université de Nice - Sophia Antipolis, December 2013.
- M. Deaconu served as referee for the Ph.D. thesis of O. Lupaşcu, *Probabilistic and deterministic models for fracture type phenomena*, IMAR Bucarest and Université de Paris 13, Bucarest, December 2013.
- A. Lejay serves as examiner for the Ph.D. thesis of Paul-Éric Chaudru de Raynal, *Équations différentielles stochastiques : résolubilité forte d'équations singulères dégénérées ; analyse numérique de systèmes progressifs-rétrogrades de McKean-Vlasov*, Université de Nice - Sophia Antipolis, December 2013.
- D. Talay chaired the Committees for the Habilitation à Diriger des Recherches de B. de Saporta (université Montesquieu Bordeaux 4), the Ph.D. thesis of O. Aboura (Université Paris 1 Panthéon Sorbonne), the Ph.D. thesis of C.A. Garcia Trillos (Université Nice Sophia Antipolis).
- E. Tanré reported on the Ph.D. thesis of Mauricio Tejo, Pontificia Universidad Católica de Chile (PUC).

9.3. Popularization

- M. Bossy contributed as a Guest Blogger on the Mathematics of Planet Earth 2013 web site.
- D. Talay gave lectures to scholars in Nice.

9.4. Participation to congresses, conferences, invitations...

- M. Bossy gave a seminar talk at the research sessions of the CEMRACS 2013, Luminy in August.
- M. Bossy gave an invited talk at the Focus Program on Commodities, Energy and Environmental Finance of the Fields Institute, Toronto (Canada) in August.
- M. Bossy gave an invited talk at the European Science Foundation OPTPDE Workshop "Modeling and Control of Large Interacting Dynamical Systems" in September at Université Paris-Dauphine.
- M. Bossy gave an invited talk at the workshop METEO, Université d'Orléans in October.
- N. Champagnat gave a plenary talk at the *57th Annual Meeting of the Australian Mathematical Society* in Sydney (Australia) in October.
- N. Champagnat gave talks at the Conference on *Genetic models and quasi-stationarity* at CIRM, Luminy in March, at the Conference on *Biological invasion and evolutionary biology: stochastic and deterministic models* in Lyon in March, at the *Congrès SMAI 2013* in Seignosse in May, at the *Workshop "Mathematics for Planet Earth"* of the *Fédération Charles Hermite* in Nancy in October, and at the *International Conference on Stochastic Models in Ecology, Evolution and Genetics* (SMEEG 2013) in Angers in December.
- N. Champagnat gave seminar talks at the *Mark Kac seminar on Stochastics and Physics* in Utrecht (The Netherlands) in May, and at the *Oberseminar Stochastics* of the Probability Theory and Stochastic Analysis Group of the University of Bonn (Germany) in June.
- P. Charton participated at the *Cinquième Semaine d'Étude Maths-Entreprise* at Nancy, France in February. He and his group studied the asymptotic properties of the process Garch(1,1). A report has been written [32].
- P. Charton made a poster on *Optimal operating of a windfarm equipped with a storage device* at the *Congrès SMAI 2013* in Seignosse in May. A proceeding has been written [21].
- P. Charton gave talk at the *Ninth IMACS seminar* at Annecy-le-Vieux (France) in July. A proceeding is being written.
- M. Deaconu gave a invited talk in a special session at the *Joint International Meeting of the American Mathematical Society and the Romanian Mathematical Society*, in Alba Iulia (Romania) in June.
- M. Deaconu gave a talk at the *Ninth IMACS Seminar on Monte Carlo Methods*, Annecy-le-Vieux (France) in July.
- J. Inglis gave seminar talks at the *analysis and probability seminar*, Imperial College London, in January and at the probability seminar, University of Rennes, in February.
- J. Inglis gave an invited talk at the European project MATHEMACS meeting, held at the Max-Planck Institute, Leipzig, in December.
- A. Lejay gave a 4h30 lecture on *Rough paths* a the *35th Finnish Summer School on Probability Theory and Statistics* in Finland.
- A. Lejay gave talks at the workshop *rough paths* (Berlin) *Interplay of Theory and Numerics for Deterministic and Stochastic Homogenization* (Oberwolfach, Germany) in August and at the international conferences *Stochastic processes and their statistics in Finance* (Naha, Okinawa, Japan) in October, and at the Workshop on *Hitting times and exit problems for stochastic models* (Dijon, France) in December.
- A. Lejay gave a talk at the *COMCA-2013* congress (La Serena, Chile).
- D. Talay gave a series of lectures at the Pauli Institute in June.

- D. Talay gave a talk at the University of Antwerp.
- D. Talay gave a talk at the Workshop on Extreme Events in November in Nice.
- D. Talay gave two lectures at the Conference in the honor of Etienne Pardoux (Marseille) in February.
- E. Tanré gave a talk at the Centro Interdisciplinario de Neurociencia de Valparaíso (Chile) in January.
- E. Tanré gave a talk at the conference on *Mathematical Methods and Modeling of Biophysical Phenomena* in Cabo Frio (Brazil) in March.
- E. Tanré gave a seminar talk at Toulouse in May.
- E. Tanré gave a talks at the workshop on *Hitting times and exit problems for stochastic models* at Dijon in November and at the *First Workshop CIMFAV on Stochastic Analysis and its Applications* at Valparaíso (Chile) in December.
- D. Villemonais gave a 4h lecture at the Conference on *Genetic models and quasi-stationarity* at CIRM, Luminy in March.
- D. Villemonais gave a talk at the *Congrès SMAI 2013* in Seignosse in May.

10. Bibliography

Major publications by the team in recent years

[1] C. BLANCHET-SCALLIET, A. DIOP, R. GIBSON, D. TALAY, E. TANRÉ. *Technical analysis compared to mathematical models based methods under parameters mis-specification*, in "Journal of Banking and Finance", 2007, vol. 31, n^{o} 5, pp. 1351–1373

[2] M. BOSSY, E. GOBET, D. TALAY. *A symmetrized Euler scheme for an efficient approximation of reflected diffusions*, in "J. Appl. Probab.", 2004, vol. 41, n^{o} 3, pp. 877–889

[3] M. BOSSY, B. JOURDAIN. *Rate of convergence of a particle method for the solution of a 1D viscous scalar conservation law in a bounded interval*, in "Ann. Probab.", 2002, vol. 30, n^{o} 4, pp. 1797–1832

[4] N. CHAMPAGNAT. *A microscopic interpretation for adaptive dynamics trait substitution sequence models*, in "Stochastic Process. Appl.", 2006, vol. 116, n^{o} 8, pp. 1127–1160

[5] M. DEACONU, N. FOURNIER, E. TANRÉ. *A pure jump Markov process associated with Smoluchowski's coagulation equation*, in "Ann. Probab.", 2002, vol. 30, n^{o} 4, pp. 1763–1796

[6] S. HERRMANN, P. IMKELLER, D. PEITHMANN. *Transition times and stochastic resonance for multidimensional diffusions with time periodic drift: a large deviations approach*, in "Ann. Appl. Probab.", 2006, vol. 16, n^{o} 4, pp. 1851–1892

[7] A. LEJAY. *An introduction to rough paths*, in "Séminaire de Probabilités XXXVII", Berlin, Lecture Notes in Math., Springer, 2003, vol. 1832, pp. 1–59

[8] A. LEJAY, M. MARTINEZ. *A scheme for simulating one-dimensional diffusion processes with discontinuous coefficients*, in "Ann. Appl. Probab.", 2006, vol. 16, n^{o} 1, pp. 107–139

[9] B. ROYNETTE, P. VALLOIS, M. YOR. *Pénalisations et quelques extensions du théorème de Pitman, relatives au mouvement Brownien et à son maximum unilatère*, in "In memoriam Paul-André Meyer: Séminaire de Probabilités XXXIX", Berlin, Lecture Notes in Math., Springer, 2006, vol. 1874, pp. 305–336

[10] D. TALAY, Z. ZHENG. *Approximation of quantiles of components of diffusion processes*, in "Stochastic Process. Appl.", 2004, vol. 109, n° 1, pp. 23–46

Publications of the year

Doctoral Dissertations and Habilitation Theses

[11] D. IBRAHIM. , *Etude théorique d'indicateurs d'analyse technique*, Université Nice Sophia Antipolis, February 2013, http://hal.inria.fr/tel-00919102

Articles in International Peer-Reviewed Journals

[12] M. BOSSY, J. FONTBONA, P.-E. JABIN, J. F. JABIR. *Local existence of analytical solutions to an incompressible Lagrangian stochastic model in a periodic domain*, in "Communications in Partial Differential Equations", June 2013, vol. 38, n° 7, pp. 1141-1182 [*DOI :* 10.1080/03605302.2013.786727], http://hal.inria.fr/hal-00691712

[13] N. CHAMPAGNAT, P.-E. JABIN, S. MÉLÉARD. *Adaptation in a stochastic multi-resources chemostat model*, in "Journal de Mathématiques Pures et Appliquées", October 2013 [*DOI :* 10.1016/J.MATPUR.2013.10.003], http://hal.inria.fr/hal-00784166

[14] N. CHAMPAGNAT, A. LAMBERT. *Splitting trees with neutral Poissonian mutations II: Largest and Oldest families*, in "Stochastic Processes and their Applications", 2013, vol. 123, n° 4, pp. 1368-1414 [*DOI :* 10.1016/J.SPA.2012.11.013], http://hal.inria.fr/inria-00616765

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[16] A. LEJAY, S. MAIRE. *New Monte Carlo schemes for simulating diffusions in discontinuous media*, in "Journal of Computational and Applied Mathematics", January 2013, http://hal.inria.fr/hal-00689581

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Invited Conferences

[20] A. LEJAY, S. MAIRE, G. PICHOT. *Monte Carlo simulations in media with interfaces*, in "Interplay of Theory and Numerics for Deterministic and Stochastic Homogenization", Oberwolfach, Germany, G. BAIL, B. ENGQUIST, C. LE BRIS, H. OWHADI (editors), Oberwolfach Report, Mathematisches Forschungsinstitut Oberwolfach, May 2013, vol. 14/2013, pp. 38-30 [*DOI :* 10.4171/OWR/2013/14], http://hal.inria.fr/hal-00819900

National Conferences with Proceedings

[21] P. CHARTON. *Gestion optimale d'une ferme éolienne couplée à un dispositif de stockage*, in "Congrès SMAI 2013", Seignosse, France, January 2014, http://hal.inria.fr/hal-00926831

Scientific Books (or Scientific Book chapters)

[22] D. TALAY, C. GRAHAM. , *Stochastic Simulation and Monte Carlo Methods. Mathematical Foundations of Stochastic Simulation*, Stochastic Modelling and Applied Probability, Springer, 2013, vol. 68, 268 p. , http://hal.inria.fr/hal-00954842

Books or Proceedings Editing

[23] C. DONATI-MARTIN, A. LEJAY, A. ROUAULT (editors). , *Séminaire de Probabilités XLV*, Lecture Notes in Mathematics, Springer, June 2013, vol. 2078, 558 p. [*DOI :* 10.1007/978-3-319-00321-4], http://hal.inria.fr/hal-00849019

Research Reports

[24] S. BOUKHEROUAA, N. CHAMPAGNAT, M. DEACONU, A. LEJAY. , *Mesure de risques : calcul de la Value-at-Risk et application a` la gestion de portefeuilles*, January 2013, 77 p. , http://hal.inria.fr/hal-00780460

[25] N. CHAMPAGNAT, M. DEACONU, A. LEJAY, K. SALHI. , *Mesure de risque : detection du regime de crise et calcul de la Value-at-Risk*, November 2013, 67 p. , http://hal.inria.fr/hal-00942009

[26] O. FAUGERAS, J. INGLIS. , *Stochastic neural field equations: A rigorous footing*, November 2013, 40 p. , http://hal.inria.fr/hal-00907555

Other Publications

[27] J. ALIF. , *Une approximation de la queue de la densite du cours de l'actif dans le mode`le de Heston*, Université de LorraineMetz, September 2013, 49 p. , http://hal.inria.fr/hal-00860620

[28] L. BEZNEA, M. DEACONU, O. LUPASCU. , *Branching processes and stochastic fragmentation equation*, February 2014, http://hal.inria.fr/hal-00948876

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[30] M. BOSSY, N. MAIZI, O. POURTALLIER. , *Nash equilibrium for coupling of CO2 allowances and electricity markets*, 2013, http://hal.inria.fr/hal-00913320

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[32] P. CAZEAUX, P. CHARTON, N. PHAM, L. VINCKENBOSCH, R. ZEINEDDINE. , *Semaine d'Etude Mathématiques et Entreprises 5 : Propriétés asymptotiques de processus à volatilité stochastique*, 2013, http://hal.inria.fr/hal-00833375

[33] N. CHAMPAGNAT, M. DEACONU, A. LEJAY, N. NAVET, S. BOUKHEROUAA. , *An empirical analysis of heavy-tails behavior of financial data: The case for power laws*, 2013, http://hal.inria.fr/hal-00851429

[34] N. CHAMPAGNAT, P.-E. JABIN. , *Strong solutions to stochastic differential equations with rough coefficients*, March 2013, http://hal.inria.fr/hal-00799242

[35] P. CHARTON. , *Optimal Operation of a Wind Farm equipped with a Storage Unit*, June 2013, http://hal.inria.fr/hal-00834142

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