

# TSE-P - Sébastien Gadat

## I Curriculum Vitae

Sébastien GADAT

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Date of birth : 07/12/1978 - Age : 39 Nationality : French - married, 3 children

### Current professional situation :

**Professor of statistics and applied mathematics Toulouse School of Economics - UMR 5604**

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**Associated member of Institut de Mathématiques de Toulouse - UMR 5219**

Université Toulouse 3, 118 route de Narbonne, 31400 Toulouse.

### A Education

- **2018** : Junior Member IUF – Section mathématiques

- **2018** : Professor chargé de cours – Statistics and machine learning, Ecole Polytechnique.

- **2014** : Professor - Toulouse School of Economics, Université Toulouse 1 Capitole

- **2012** : French “Habilitation à Diriger des Recherches”. Université Paul Sabatier.

Title : “High dimensional statistics. Non reversible optimization.”

Advisor : Patrick Cattiaux.

Reviewers : Pierre Del Moral, Gabor Lugosi, Stéphane Mallat.

Committee : P. Cattiaux, D. Chafaï, P. Del Moral, F. Gamboa, S. Mallat, C. Prieur.

- **2005-2014** : Associate Professor – Université Paul Sabatier

- **2001-2004** : PhD Thesis in Applied mathematics.

CMLA, ENS de Cachan / CIS, Johns Hopkins University, Baltimore.

Title : “Statistical learning of a symbolic vocabulary for object detection”

Advisors : L. Younès, D. Geman.

Reviewers : R. Abraham, M. Benaïm.

Committee: R. Abraham, M. Benaïm, D. Geman, L. Moisan, A. Trouvé, L. Younès.

- **2002-2005** : PhD student – Ecole Normale Supérieure de Cachan.

- **2001** : Agrégation de Mathématiques - Competition for high-school professors in Mathematics.
- **2000** : MsC – Université Paris-Dauphine & ENS Cachan
- **1998-2002** : Fellow of the Ecole Normale Supérieure de Cachan.

## **B PhD and post doc supervision**

### **B.1 Completed PhD Thesis:**

**[1] 2005-2008** : PhD Thesis of K.-A. Lê Cao (joint supervision with P. Besse).

Title : *Statistical method of variable selection and omic integration*. Awarded the Marie-Jeanne Duhamel Price.  
Now researcher in Biostatistics, University of Queensland, Brisbane, Australia.

**[2] 2011-2014** : PhD Thesis of C. Christophe (joint supervision with P. Cattiaux).

Title : *Probabilistic modelling with a prey-predator system of cytotoxic cells and melanoma tumor*  
Now teacher in high school in France

**[3] 2011-2014** : PhD Thesis of M. Champion

Title : *Regulation network inference : modelling, estimation and algorithms in high dimensional statistics*.  
Now Post Doc in Univ. Paris 5

**[4] 2013-2016** : PhD Thesis of S. Saadane (joint supervision with F. Panloup).

Title: *Stochastic algorithms for learning, optimization and approximation of stationary distributions*  
Now : teacher in high school in France

**[5] 2014-2017** : PhD Thesis of C. Bouttier (joint supervision with S. Gerchinovitz).

Title : *Optimization under uncertainty : stochastic algorithms and continuous bandits. Application to trajectories optimization*.  
Now : research engineer at Airbus Group.

**[6] 2014-2017** : PhD Thesis of I. Gavra (joint supervision with L. Miclo).

Title : *Stochastic algorithm under uncertainty with complex structures. Convergence and applications*  
Now ATER at university Toulouse I Capitole

### **B.2 Ongoing PhD Thesis:**

**[7] 2019-** : PhD Thesis of A. Doury (joint supervision with Météo France)

Title : *Machine learning for statistical downscaling. Application to meteorological forecasting and mean field limits*.

### **B.3 Post Doc supervision:**

**[8] 2015-2016** : Post doc of M. Costa (graduated from E. Polytechnique and ENS Paris)

Title : *Biased competition model for CTL/tumor nodule confrontation. Statistical issues and medical forecasting*  
Now : Associate professor at University Toulouse 3.

**[9] 2016-2017** : Post doc of M. Chassan (graduated from Univ. Toulouse 3)

Title : *Hidden Markov Model for CLL dynamics : statistical inference and prediction*  
Now : post doc at the French national center of research in agronomy (INRA)

## **C Financial support and research projects**

Since the beginning of my career in 2005, I have been regularly involved in several research projects. These projects were either academic ones (ANR, foundations, etc) or industrial ones (CIFRE, etc). Some of them are multi-disciplinary and other ones focused on statistics and optimization.

The list of these projects is provided below.

**2019-2023 : Head of Masdol** : Mathematics of Stochastic and Deterministic Optimization for Deep Learning  
Funded by the ANR, 470 000 €.

Members : **TSE** : J. Bolte, J. Renault, S. Gadat,

**IMB** : B. Bercu, J. Bigot, J.F. Aujol, **IMT** : C. Dossal, G. Fort, E. Pauwels, A. Rondepierre, M. Serrurier

**2018-2022: Member among 3 of OpSiMorE** : Head : G. Fort

Funded by the Académie des sciences, prix Del Duca

**2017-2021 : Head of the project COSAL**

*Combining Optimization and Stochastic Algorithms for large scale Learning.*

Funded by the foundation Jacques Hadamard. PGM0 40 K€.

Members : J. Bolte, G. Fort, S. Gadat, A. Juditsky, F. Panloup, M. Rousset, P.A. Zitt

**2015-2019 : Head of the math work package** of the project COMPUTREAT

*Ibrutinib effects on CL leukemia and follicular lymphoma : random modelling, statistical inference and forecasting.*

Funded by Plan Cancer - Systems biology - 20 K€ + 1 Post Doc (80 k€).

Members : M. Costa, S. Gadat, F. Malgouyres, L. Risser

**2014-2018: Head of the project TOXIMATH,**

*TOXicity and MATHematics of immune system.*

Funded by the Fondation Recherche Innovation Thérapeutique Cancérologie (Plan Cancer - Oncopole ). 20 K€ + 1 post doc (80 k€).

Members : M. Costa, S. Gadat, P. Cattiaux

**2011-2014 : Head of the project DEMOS,**

*DEformable MOdels in Statistics.*

Funded by the French National Research Agency ANR. 45 K€.

Members : J. Bigot, S. Gadat, J.M. Loubes, C. Marteau

**2011 : Member of the project** : INTEGRITY - THALES/CNES

*Detecting Ionosphere storm and application to satellite positioning.*

Funded by Thales Alenia Space / CNES. 90 K€.

Members : J.M. Azais, S. Gadat, A. Lagnoux, C. Mercadier - Leader : J.M. Azais .

**2010-2013 : Member of a pluridisciplinary project**

*Mathematical modelling in immunology .*

Funded by the Univ. Toulouse 3. 20 K€ + 1PhD (120 k€) thesis between IMT and INSERM.

Members : S. Gadat, P. Cattiaux, S. Valittutti - Leader P. Cattiaux.

**2009 : Member of the project** : INTEGRITY – THALES/CNES

*Estimation of extreme events and application to satellite positioning.*

Funded by Thales Alenia Space / CNES. 60 K€.

Members : J.M. Azais, S. Gadat, A. Lagnoux, C. Mercadier - Leader : J.M. Azais .

## D Research administrative tasks and scientific animation

I have participated to several research academic tasks in Université Toulouse 3 (when I was assistant professor) and in the Toulouse School of Economics as a professor. In particular, I am involved in a research group direction. I also have been involved in the organization of several workshops and working groups.

### D-1 Research group animation

**2019- :** Head of the **Analyse et économie des Big Data**, Digital Center, TSE-Partenariat

**2017- :** Head of the research group **MADS at TSE** (around 30 researchers and 15 PhD students).  
<https://www.tse-fr.eu/groups/mathematics-decision-making-and-statistics?lang=en>

### D.2 Animation and organization of scientific events

#### Conferences

- **09-2018 : Joint Organization of the international conference : « Optimization and Learning »** with G. Fort, S. Gadat, and C. Févotte.

<http://www.cimi.univ-toulouse.fr/optimisation/en/workshop-optimization-and-machine-learning>

- **06-2018 : Joint Organization of the National workshop : « Aspects fondamentaux et Exploitation de la structure »** with G. Fort and C. Dossal as co-organizers ;

<http://cimi.univ-toulouse.fr/optimisation/fr/workshop-optimisation-aspects-fondamentaux-et-exploitation-de-la-structure>

- **09-2017 : organization** of the workshop « First meeting UT1/UT3 »

<https://www.tse-fr.eu/fr/conferences/2017-rencontre-ut1-ut3>

This small workshop (45 participants) was organized by C. Pellegrini (UT3) and I and took place in TSE on september 2017. He presented during 1 day several fields of research in applied mathematics (statistics, optimization, game theory and P.D.E.)

- **07-2017 : co-organization** of the workshop *Image, Optimization, Probability and Statistics*

<https://sites.google.com/site/journeeslops/home/>

The organization was led by J. Bigot (IMB). We organized this workshop during 3 days at the Teich center of conference, there was around 40 participants. The thematics of the talks was around optimal transport, statistics on manifold ((with two courses of G. Carlier and M. Arnaudon) and stochastic algorithms.

- **2015-2016 : TSE statistical seminar.**

<https://perso.math.univ-toulouse.fr/gadat/tse-statistical-seminar/>

The TSE statistical seminar was planned every week, except during the holidays. The

- **06-2015: co-organization** of the conference

*Journées de Probabilités 2015*

<https://jp2015.sciencesconf.org/>

This big conference occurs every year during one week and gathers probabilists of France. A special place is reserved for young researchers. The number of participants is around 100.

- **11-2014 : co-organization** of an ANR workshop

*Optimal transport application to signal processing and statistics*. Toulouse

<https://sites.google.com/site/anrdemos/events-and-meetings/workshop-imt-17-18-novembre-2014>

This workshop was organized as the ending event of the ANR DEMOS project. We have selected the « optimal transport » research theme as it represents a promising point of view for signal and image deformation. It has gathered more than 50 participants with at least 25 from other universities.

- **08-2014 : organization of one session** of the MAS conference:

*Bayesian high dimensional statistics.*

[www.math.univ-toulouse.fr/MAS2014/](http://www.math.univ-toulouse.fr/MAS2014/)

I selected and invited talks for this big general workshop. One session represents one afternoon of talks (3 sessions in parallel).

- **05-2013 : organization of one session** of the SFDS conference :

*Non parametric statistics*

<http://jds2013.sfds.asso.fr/>

I had only a small influence on this session since the talks were selected by the scientific board.

- **06-2011 : co-organization** of an ANR workshop

*Statistical analysis of deformable signals.*

<https://sites.google.com/site/anrdemos/events-and-meetings/working-day-imt-17-juin-2011>

This workshop was the launching event of the ANR DEMOS project. We have chosen a thematic of research centered around non parametric statistics and signal processing. There was around 30 participants.

- **09-2010 : organization of one session** of the MAS conference :

*Statistics and signal processing*

<https://www.math.u-bordeaux.fr/MAS10/>

I selected and invited talks for this big general workshop. One session represents one afternoon of talks (3 sessions in parallel).

- **06-2009 : organization of one session** of the EMS conference.

*Multiresolution analysis in non parametric statistics*

<http://www.math.univ-toulouse.fr/EMS2009/4-17613-EMS2009.php>

I had only a small influence on this session since the talks were selected by the scientific board.

## Annual Lab Working Groups

These working groups were organized twice a month in the University Paul Sabatier. The members of the team Probability and Statistics were regularly solicited to give talks on their research that was related to the working group.

- **2011-2012** : joint organization (with C. Maugis) of the WG in statistics

*Non parametric Bayesian statistics.*

- **2008-2009** : with J. Bigot of the WG in statistics

*Statistics on manifolds.*

- **2009-2010** : with F. Panloup of the WG in probability

*Non markovian diffusions.*

## Scientific board

My work consisted in selecting talks among a large amount of papers submitted to these two econometrics

conference. As a statistician, I was in charge of the expertise of the statistical technical side of the papers and not really on the econometric approach.

- **2015** : Financial Econometrics Conference.

<https://www.tse-fr.eu/fr/conferences/2015-financial-econometrics-conference>

- **2016** : EC2 Conference on Econometrics and Big Data,

<https://sites.google.com/site/ecpower2/news/ec22016toulousedecember16-17>

### **D.3 Evaluation**

I have participated to several research project evaluations in France and abroad. I also regularly review research papers mainly in the field of statistics, optimization and applied probability.

#### **Research grants :**

- **2014-2017** : Referee (among 4) for the MITT PhD grant attribution

The board of the Doctoral School of Toulouse was involved in the selection of PhD grant applications, Post-Doc grant applications and the control of the choices of the PhD thesis committees.

- **2014-** : Referee for the FNRS grant attributions (PhD and Research projects)

Belgium national research agency

I regularly evaluate projects submitted to the FNRS. These projects are either individuals or with a consortium of researchers. I also serve as a reviewer for the PhD thesis grant attribution funded by the FNRS.

- **2012-2013** : Referee of French national research agency ANR grants.

- **2012** : Referee of CNRS interdisciplinary projects PEPS.

- **2009** : Referee Israel-USA Grants

#### **Referees for journals :**

I regularly serve as a referee for international journals in particular in the field of mathematical statistics, applied probability, optimization and stochastic algorithms. Among the last 10 years, I have reviewed more than 40 papers :

##### Statistics and applied probability :

AOS (1),

PTRF (2),

EJS (5),

ESAIM P & S (2),

JSPI (3),

Bernoulli (3),

Annales de l'IHP (B) (2),

SIAM J. on Numerical Analysis (1),

J. of Mathematical Modelling and Analysis (1).

##### Signal processing journals:

IEEE : Trans. on Automatic and Control (1),

IEEE : Trans. on Image Processing (1),  
IEEE : Transactions on KDD (1),  
IEEE :Trans. on Information Theory (1).  
Journal of mathematical imaging and vision (2),

Optimization journals :

Math. Oper. Research (1),  
Math. Prog B (1),  
Foundation and trends in Machine Learning (1),

International machine learning conferences :

NIPS (3 years),  
COLT (2 years).

**D.4 Councils**

**2019** : Scientific committee Position Associate Professor: Université Paul Sabatier

**2017** : Scientific committee Position Associate Professor: Insa Toulouse.

**2014-2016** : Scientific board doctoral School MITT (PhD grants, Post Doc Labex CIMI)

**2015** : Scientific committee Position Associate Professor Versailles, Marseille, Toulouse I.

**2013-2014** : Scientific board of "Groupe d'Avancement et primes Université Paul Sabatier"

**2012** : Scientific committee Position Associate Professor: Marne la Vallée, Montpellier II, Toulouse I.

**2011-2014** : Scientific Board of the "Institut of Mathématiques of Toulouse."

**2011** : Scientific committee Position Associate Professor IRIT - IMT

**2010** : Scientific committee Position Associate Professor Montpellier II, ISFA – Lyon1

**E Recent invited talks and research visits**

I have been regularly invited to give research talks in generalist seminars of research teams in probability and statistics and to give more specific talks in national and international conferences.

**Workshops and conferences**

**2017**: Non-asymptotic Polyak Ruppert averaging without convexity, Saclay, PGMO Days.

**2017** : *How to calculate the barycenter of a weighted graph* PDMP 2017, ANR PIECE, Paris, France.

**2014** : *L2-boosting on generalized Hoeffding decomposition for dependent variables* Pacific Rim Meeting (IMS - 2014), Taipei.

**2014** : *L2-boosting on generalized Hoeffding decomposition for dependent variables - application to sensitivity analysis*. In Proceedings of the SIAM Conference on Uncertainty Quantification (UQ14), Savannah, Georgia,

2014.

**2013** : *Shape invariant model, a bayesian point of view*. In Workshop on Bayes Non Parametric, Paris, France.

**2012** : *Bayesian consistency for deformable models in image processing*. 3th Conference of Mathematics for Image processing..

**2011** : *Assessment of an ionosphere storm occurrence risk*. Conference ENC GNSS, London, England.

**2011** : *Ionosphere severe storms and occurrence risk estimation*. 7th Conference Extreme Value Analysis, Probabilistic and Statistical Models and their Applications (EVA 2011), Lyon, France, 2011.

**2009** : Gns integrity achievement by using extreme value theory. In Proceedings of the 2009 Conference ION GNSS, San diego, USA, 2009.

## Seminars

**12/2017** : Univ. Paul Sabatier : Stochastic Heavy Ball and Polyak Ruppert averaging

**07/2017** : Univ. Bordeaux: IOPS 2017 Stochastic Heavy Ball and Polyak Ruppert averaging

**10/2016** : TSE : How to calculate the barycenter of a weighted graph

**05/2016** : Univ. Paul Sabatier: How to calculate the barycenter of a weighted graph

**04/2016** : SPOT optimization seminar: How to calculate the barycenter of a weighted graph

**01/2016** : Orsay-Inria : Regret of Narendra Schapiro bandit Algorithms

**09/2015** : MIAT INRA Toulouse: Regret of Narendra Schapiro bandit Algorithms

**06/2015** : SPOT optimization seminar: On stochastic efficiency of second order methods

**06/2015** : INRIA - Univ. Lille: Regret of Narendra Schapiro bandit Algorithms

**04/2015** : Univ. Oxford : Regret of Narendra Schapiro bandit Algorithms

**04/2015** : TSE : Regret of Narendra Schapiro bandit Algorithms

**02/2014** : CPTP (Inserm-CNRS) : Interdisciplinary mathematics with biology

**11/2013** : TSE: K nearest neighbour classification

**05/2013** : Statistical Seminar Orsay Bayesian estimation in deformable inverse problems

**02/2013** : Univ. Paul Sabatier: Active regression

**10/2012** : TSE : Bayesian estimation in deformable inverse problems

**02/2012** : Univ. Paul Sabatier : Bayesian consistency



## Research visits

**2017:** 1 week department of Mathematics, Angers, F. Panloup.

**2017 :** 2 weeks department of Mathematics, Lyon, C. Marteau.

**06-2015 :** Inria Lille, B. Guedj.

**04-2015 :** Department of Statistics, Oxford, A. Doucet.

**2011 :** 1 month Laboratoire de Mathématiques et Physique Théorique, Tours G. Barles.

**2009 :** 2 months invited at Institute of Statistics, Bochum, H. Dette.

**2008-2009 :** 5 months invited at Institut Camille Jordan, Lyon, C. Mercadier.

## II Summary of my research over the past 10 years

My expertise of research concerns statistics, machine learning, applied probability and optimization. I describe below a list of my research interests, grouped in an approximate thematical order.

### **Inverse Problems :**

I had the great opportunity to work with several colleagues on inverse problems in mathematical statistics and signal processing. I mainly worked on inverse problems with J. Bigot using nonparametric statistics and wavelet-based techniques to solve some problems like regression under shape constraints and curve alignment problems under various perturbations (Gaussian or Poisson noise).

We have applied our methods to real signal and images datasets and have developed several softwares available at [http://www.math.u-bordeaux1.fr/~jbigot/Site/Software\\_files/](http://www.math.u-bordeaux1.fr/~jbigot/Site/Software_files/).

### **Optimization and dynamical systems:**

#### *Heavy ball system*

Motivated by a numerical improvement obtained by K.A. Lê Cao (biostatistician) with a modification of a gradient descent type method, I decided to work in the beginning of 2009 on optimization algorithms with inertial methods such as the Polyak heavy ball with friction descent or gradient descent with memory.

I obtained with A. Cabot (Dijon) and H. Engler (Washington) several convergence results on the deterministic O.D.E. associated to these methods. The deterministic results being promising, I then decided to continue to work on memoried stochastic differential systems with several colleagues : with F. Panloup (Angers) and C. Pellegrini, I obtained ergodic and large deviation properties on the gradient descent with memory diffusion.

#### *Langevin dynamical system*

With L. Miclo, I studied the ergodicity of the kinetic Langevin diffusion and obtain the exact L-2 convergence rate of convergence towards its associated Gibbs field.

#### *Speculative behaviour and hypocoercive model*

Lastly, we proposed and studied with L. Miclo and F. Panloup a mathematical model that exploits a memory term for the formation of financial bubbles. Finally, starting from my initial motivation on diffusion reinforced by their memory, I have organized during the year 2009-2010 a bi-mensual working group on the problematic of self-interacting diffusions.

## **Fréchet means and non-Euclidean data analysis :**

A natural follow-up of my works on inverse problems is completely represented by the « ANR Demos » research project I led between 2010 and 2014 : <https://sites.google.com/site/anrdemos/home>.

Following the Grenander's pattern theory of deformable shapes and the recent developments of Trouvé and Younes, I have studied statistical problems where the estimation problem has to handle observations corrupted by a geometrical random warping and an additional noise of measurements. Such situations are encountered in many concrete signal processing issues.

### *Fréchet means*

With my colleagues J. Bigot, D. Bontemps, T. Klein and C. Marteau (Lyon), I have obtained an unexpected link between some inverse problems with noisy operators and the curve alignment problem. We then generalize our study to non-Euclidean and high-dimensional data analysis in the presence of a random deformable process and additive measurement noise and we obtained new results with the nonparametric statistics point of view. Some important advances have been obtained with the help of geometric tools such as the Fréchet mean or the representations of Lie groups that are non-standard in the statistical community.

## **Supervised classification :**

### *Statistical learning*

With T. Klein and C. Marteau, we therefore have been interested in the k-nearest neighbour classifier (kNN for short), which produces a simple decision rule with only metric considerations among the observations. After an important bibliography study, we have decided to extend the existing results on this classifier to the case of non-compactly supported densities in finite dimensional space and we obtained in 2016 the minimal assumptions under which we can assert the consistency of any classification rule. We also proved that the kNN procedure was minimax optimal in many situations, with the help of a suitable choice of the bandwidth parameter  $k$ .

### *Functional classification*

In another paper (2019), we then study the situation of infinite dimensional signals in Sobolev spaces corrupted by a Gaussian noise. We prove that in that case, simple classifiers are much more efficient than the kNN (regardless the choice of  $k$ ).

## **Mixture models :**

### *Contamination models*

With C. Marteau, C. Maugis and J. Kahn (Toulouse), as part of the ANR project led by C. Maugis Mixstatseq <https://perso.math.univ-toulouse.fr/maugis/mixstatseq/mixstatseqpubli/>, we have studied the problem of parameter recovery in a two-component contamination mixture model. We derive optimal minimax rates of convergence in the multi-dimensional situation when we adopt a L2 fitting density criterion. We also characterise the difficulty of the problem in terms of the Wasserstein distance between the mixing distributions.

### *Atomic deconvolution*

In a recent work with M. Costa, L. Risser (IMT Toulouse) and P. Gonnord (immunologist) in 2017, I then studied a mixture model estimation problem that occurs in cytometry data analysis, which is referred to as the *atomic deconvolution problem*. We developed an adaptive estimation of the mixture parameters with the help of the Lepski method and obtained good results on real biological datasets.

### *Super-resolution*

Finally, we have developed with C. Maugis, C. Marteau and Y. De Castro a completely different approach for

estimating mixtures with the help of the super-resolution theory recently introduced by E. Candès. We prove that mixture estimation may be turned into a penalized convex programming that may be solved efficiently. This paper has been accepted last month to the Annals of Statistics journal.

### **Sequential stochastic algorithms :**

My current most active field of research concerns the study of stochastic algorithms for optimization and sampling. In particular, I have been recently interested by second order methods, motivated by the Nesterov acceleration algorithm and his two cousins (heavy ball with friction and Ruppert-Polyak averaging).

#### *Bandits*

During the supervision of the PhD thesis of S. Saadane (joint supervision with F. Panloup) defended in 2016, we studied two on-line methods : the first one is a multi-armed stochastic algorithms. We proposed a penalized version of the seminal Narendro-Shapira algorithm developed in the sixties and prove its optimality in some restrictive situations with respect to the cumulative regret. The second contribution concerns the study of the stochastic heavy ball with friction algorithm for solving the minimization of functions. We identify explicit convergence rate in the strongly convex situation and prove that despite the attractiveness of this method in the deterministic situation, the performances are seriously damaged in the stochastic settings.

#### *Optimization*

In a recent work with F. Panloup in 2017, we then study the Ruppert-Polyak averaging algorithm. We obtained for this algorithm the first non-asymptotic first order optimal result without any convexity assumption, with the help of a weaker Kurdyka-Lojasiewicz inequality. We also improved the state of the art second-order term of Bach & Moulines (2011). These progresses are certainly promising for some future developments in various situations (composite problems for example).

#### *CvaR estimation*

Finally, I developed ad-hoc study for specific estimation problems involved in practical problems : the VaR and CvaR of financial series. I have found with M. Costa and B. Bercu some recent stochastic methods that can estimate VaR and CvaR on-line with a flow of observations without any parametric assumptions. We have successfully applied our methods to Yahoo ! Finance datasets and provide on-line confidence intervals of our predictions. This research has led to two papers.

## **III Teaching and collective administration tasks**

### **III.1 Lectures**

#### **- Master's degree "Academic mathematics"**

2012-2014 : CM - Master 2 Recherche Markov processes (36 HCM).

This course presents a general theory on Markov chains and Markov processes : we introduce the martingale problem approach and the infinitesimal generator. Then we stated the ergodicity of Markov processes through Lyapunov theory. Finally, we describe the L2 theory of reversible processes with Poincaré inequality.

Lecture notes : 124 pages : [http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours\\_m2R1.pdf](http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours_m2R1.pdf)

2016-2018 : CM - Master 2 Recherche Stochastic algorithms (36 HCM).

This course presents a general theory on stochastic algorithms : the Robbins-Monro result of almost sure convergence for stochastic gradient descent We then derive convergence rates in strongly convex situation and central limit theorems with the help of the infinitesimal generators. We also provide a new proof of deviation results of stochastic algorithms. We end with an introduction to simulated annealing procedures.

Lecture notes : 88 pages : [http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours\\_Algo\\_Stos\\_M2R3.pdf](http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours_Algo_Stos_M2R3.pdf)

2015-2018 : CM - M1 - Advanced Analysis (30 HCM).

The objective of this lecture is to propose an introduction to functional analysis and in particular Hilbert spaces and Fixed point theorems. After around 15 hours of theory, I propose several applications in statistics (non parametric estimation, conditional expectation), probability (Brownian motion construction), optimization and economics (minimax theorem, game theory)

Lecture notes : 90 pages: [http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours\\_Analyse\\_M15.pdf](http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours_Analyse_M15.pdf)

2015-2018 : CM - M1 - Optimization on big data problems (15 HCM), practical sessions with Python.

The objective of this course is to introduce convex optimization problems and gradient descent methods. These methods are studied in various situation (convex or strongly convex cases). We also exemplify these methods on practical big data examples (Lasso algorithm with forward backward splitting). Finally, the course ends with an introduction to sequential stochastic methods like stochastic gradient descent.

Lecture notes : 60 pages : [http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours\\_Analyse\\_M16.pdf](http://perso.math.univ-toulouse.fr/gadat/files/2012/12/cours_Analyse_M16.pdf)

### **Master's degree "enseignement"**

2009-2013 : Lectures and practical session for « Agrégation », Analysis, Probability, Statistics (120 - 150 Htd).

I gave a lot of courses for the preparation of the oral defense in modelling, probability and statistics.

The teaching material may be downloaded here : <https://perso.math.univ-toulouse.fr/gadat/page-d-exemple/>

### **Professional Master's degree :**

2014-2018: Lecture M2 Big Data (40 Htd). Master 2 Statistiques et Econométrie. Theoretical introduction, Practical session on computers with Python & R.

I actively contribute to the website <http://wikistat.fr/> that provides free teaching material for students and professors in datascience. In particular, I have written many slides for my M2 Big Data lecture that be downloaded here : <https://perso.math.univ-toulouse.fr/gadat/page-d-exemple/>

I also supervised the students during their participation to big data challenges inside Toulouse and in a national French competition.

2014-2018 : Statistical Consulting M2 Stat-Eco (15 Htd)

Supervision of several case studies of students over the whole year with industrial partners (BVA, Airbus, etc)

### **Professional bachelor :**

2013-2014 : Preparation of « Concours polytechniques ». Mathematics (70 Htd).

2013-2014 : Lecture on Probability theory and integration (80 Htd). Maths for engineering

2014-2016 : CM/TD - L1 Eco-Maths (100 Htd) Linear Algebra.

2014-2016 : CM : L3 Refresher course in mathematics (30 Htd). Magistère Economist and Statistician.

[http://perso.math.univ-toulouse.fr/gadat/files/2014/10/cours\\_MAN\\_L3.pdf](http://perso.math.univ-toulouse.fr/gadat/files/2014/10/cours_MAN_L3.pdf)

### **III.2 Pedagogical duty :**

- **2009-2012:** Head of M2 Preparation "Agrégation de mathématiques" . 20-30 students / year, 20 teachers (Université Paul Sabatier).

<https://www.math.univ-toulouse.fr/agreg/>

This preparation supervises the formation of teachers in mathematics for high school in France. The preparation is intensive and the final competition for the students is very selective. The mathematics involved in this preparation are a nice mix between pure mathematics (algebra, geometry) and applied mathematics (PDE, probability and statistics). The specificity of this year is three oral defenses at the end of the competition, that should be prepared all along the year.

- **2010:** Head of the “Masterisation de la Préparation à l’agrégation de mathématiques”. Now transformed in M2 Pro Enseignement, speciality « Agrégation » (Université Paul Sabatier).

I have been in charge of an (heavy) administrative duty to convert the old form of the preparation to a preparation compatible with the LMD rhythm.

- **2013-2014:** joint with C. Besse. Conversion to a “CMI” of Master Pro IMAT. Now MAPI<sup>3</sup> (Université Paul Sabatier).

<http://departement-math.univ-tlse3.fr/master-mathematiques-appliquees-pour-l-ingenierie-l-industrie-et-l-innovation-mapi3--620692.kjsp?RH=1450190046833&RF=1455381160987>

The Master pro IMAT was a Msc on applied mathematics and we have built a unique mix (in France) on applied mathematics from L1 to M2 with a general formation with courses in numerical analysis, Fourier analysis, probability, statistics and at the end signal and image processing, big data and PDE. The MAPI<sup>3</sup> Msc is a very useful formation for mathematical engineering.

- **2014-2017:** Head of the Magistère d’Economiste Statisticien (TSE) (around 90 students)

<https://www.tse-fr.eu/fr/magistere-deconomiste-statisticien>

The Magistère is a diploma from L3 to M2 that provides a complete formation in mathematics, statistics, econometrics and economics. The objective is to form students for future works in data science, marketing, applied econometrics, etc.

### III.3 Research duty:

2017- . : **Responsible of the MADS research team** (TSE)

<https://www.tse-fr.eu/fr/groups/mathematiques-de-la-decision-et-statistique>

2015-2016 : Responsible of the research seminar in statistics (TSE)

<https://perso.math.univ-toulouse.fr/gadat/tse-statistical-seminar/>

## IV Publications

My publications may be downloaded on my website : <https://perso.math.univ-toulouse.fr/gadat/publications/>

1. Y. De Castro, S. Gadat, C. Marteau and C. Maugis. Supermix: sparse regularization for Mixture, **Annals of Statistics**, to appear 2021.

2. S. Gadat, S. Gerchinovitz and C. Marteau. Optimal functional supervised classification with separation condition, **Bernoulli**, Volume 26, Number 3, 2020.
3. S. Gadat, J. Kahn, C. Marteau, C. Maugis. Parameter recovery in two-component contamination mixtures: the L2 strategy **Annales de l'Institut Henri Poincaré (B)**, Volume 56, Number 2, 2020.
4. P. Gonnord, M. Costa, M. Peres, L. Ysebaert, S. Gadat and S. Valitutti S. Patient clustering reveals CD8<sup>+</sup> T cell central/effector memory dichotomy as an early marker of disease progression in chronic lymphocytic leukemia (2019) **Oncolimmunology**, Volume 8, 2019.
5. M. Costa and S. Gadat and P. Gonnord and L. Risser. Cytometry inference through adaptive atomic deconvolution. **Journal of Nonparametric Statistics**, Volume 3, Number 2, 2019.
6. S. Gadat, F. Panloup and S. Saadane. Stochastic Heavy Ball. **Electronic Journal of Statistics**, Volume 12, Number 1, 2018.
7. S. Gadat, F. Panloup and S. Saadane. Regret bounds for Narendra-Shapiro bandit algorithms. **Stochastics**, Volume 41, Number 1, 2018.
8. S. Gadat, I. Gavra and L. Risser. How to calculate the barycenter of a weighted graph. **Mathematics of Operation Research**, , Volume 43, Number 4, 2018.
9. S. Gadat, T. Klein, and C. Marteau. Classification with the nearest neighbor rule in general finite dimensional spaces. **Annals of Statistics**, (3) :982–1009, 2016.
10. C. Bouttier, S. Gadat, S. Gerchinovitz, and F. Nicol. Adaptive simulated annealing with homogenization for aircraft trajectory optimization. **Operation Research**, 2016.
11. N. Chopin, S. Gadat, B. Guedj, A. Guyader, and E. Vernet. On some recent advances in high dimensional bayesian statistics. **ESAIM Proceedings**, 2015 Vol. 51.
12. S. Gadat, L. Miclo, and F. Panloup. A stochastic model for speculative bubbles. **Alea, Latin American Journal of Probability and Mathematical Statistics**, (12) :491–532, 2015.
13. C. Christophe, M. Rodrigues, S. Muller, L. Dupre, P. Cattiaux, S. Gadat, and S. Valitutti. A biased competition model of dynamical cytotoxic t lymphocytes/tumor nodule interaction., **Plos One**, DOI :10.1371/journal.pone.0120053, 2015.
14. Z. Vasconcelos, S. Muller, Y. Wong, C. Christophe, S. Gadat, S. Valitutti, and L. Dupre. Individual human cytotoxic t lymphocytes exhibit intracloal heterogeneity in cumulative killing. **Cells Reports**, 11 :1474–1485, 2015.
15. G. Chastaing, M. Champion, S. Gadat, and C. Prieur. L2-boosting on a generalized hoeffding decomposition for dependent variables, application to sensitivity analysis. **Statistica Sinica**, 2014.
16. C. Cierco, M. Champion, S. Gadat, and M. Vignes. A boost-boost algorithm for high dimensional multivariate regression. **ournal of Statistical Planning and Inference**, 155(C) :18–40, 2014.
17. S. Gadat and F. Panloup. Long time behavior and stationary regime of memory gradient diffusions. **Annales de l'Institut Henri Poincaré (B)**, 50 :564–601, 2014.
18. D. Bontemps and S. Gadat. Bayesian methods in the shape invariant model : Posterior contraction rates on probability measures. **Electronic Journal of Statistics**, 8 :1522–1568, 2014.
19. D. Dedieu, C. Delpierre, S. Gadat, T. Lang, B. Lepage, and N. Savy. Mixed hidden markov model for heterogeneous longitudinal data with missingness and errors in the outcome variable. **Journal de la Société Française de Statistique**, 105 :73–98, 2014

20. S. Gadat, F. Panloup, and C. Pellegrini. Large deviation principle for invariant distributions of memory gradient diffusions. **Electronic Journal of Probability**, pages 1–34, 2013.
21. J. Bigot, S. Gadat, T. Klein, and C. Marteau. Intensity estimation of non-homogeneous poisson processes from shifted trajectories. **Electronic Journal of Statistics**, 7 :881–931, 2013.
22. S. Gadat and L. Miclo. Spectral decompositions and  $L^2$ -operator norms of toy hypocoercive models. **Kinetic and Related Models**, 6 :317–372, 2012.
23. S. Cohen, S. Déjean, and S. Gadat. Adaptive sequential design for regression on multi-resolution bases. **Statistics and Computing**, 22(2) :753–772, 2012.
24. J. Bigot, C. Christophe, and S. Gadat. Random action of compact lie groups and minimax estimation of a mean pattern. **IEEE, Transactions on Information Theory**, 58 :3509–3520, 2012.
25. N. Villa, T. Dkaki, S. Gadat, J.M. Inglebert, and Q.D. Truong. Recherche et représentation de communautés dans un grand graphe : une approche combinée. **Document Numérique**, 14 :59–80, 2011.
26. J. Bigot, S. Gadat, and C. Marteau. Sharp template estimation in a shifted curves model. **Electronic Journal of Statistics**, 4 :994–1021, 2010.
27. J. Bigot and S. Gadat. A deconvolution approach to estimation of a common shape in a shifted curves model. **Annals of Statistics**, 38 :2422–2464, 2010.
28. J. Bigot and S. Gadat. Smoothing under diffeomorphic constraints with homeomorphic splines. **SIAM, Journal on Numerical Analysis**, 48(1) :224–243, 2010.
29. A. Cabot, H. Engler, and S. Gadat. Second order differential equations with asymptotically small dissipation and piecewise flat potentials. **Electronic Journal of Differential Equations**, 17 :33–38, 2009.
30. A. Cabot, H. Engler, and S. Gadat. On the long time behavior of second order differential equations with asymptotically small dissipation. **Transactions of the American Mathematical Society**, 361 :5983–6017, 2009.
31. J. Bigot, S. Gadat, and J.-M. Loubes. Statistical m-estimation and consistency in large deformable models for image warping. **Journal of Mathematical Imaging and Vision**, 34(3) :270–290, 2009.
32. K.-A. Lê Cao, A. Bonnet, and S. Gadat. Multiclass classification and gene selection with a stochastic algorithm. **Computational Statistics and Data Analysis**, 53 :3601–3615, 2009.
33. S. Gadat. Jump diffusion over feature space for object recognition. **SIAM, Journal on Control and Optimisation**, 47:04– 935, 2008.
34. K.-A. Lê Cao, P. Besse, O. Gonçalves, and S. Gadat. Selection of biologically relevant genes with a wrapper stochastic algorithm. **Statistical Applications in Genetics and Molecular Biology**, 6, 2007.
35. S. Gadat and L. Younes. A stochastic algorithm of features extraction for pattern recognition. **Journal of Machine Learning Research**, 8 :509–547, 2007.

#### Submitted Preprints :

1. S. Gadat, and F. Panloup. Optimal non-asymptotic bound of the Ruppert-Polyak averaging without strong convexity, (2017).
2. B. Bercu, M. Costa and S. Gadat, On-line non-asymptotic estimation of CvaR (2020).
3. B. Bercu, M. Costa and S. Gadat, Stochastic approximation algorithms for superquantile estimation (2020).
4. S. Gadat, F. Panloup and C. Pellegrini. On the cost of Bayesian learning with log-concave models (2020).

