ML/FIN EXCHANGE RATE:
MATHEMATICAL INSIGHTS FROM MARKETS, CONTROL, AND LEARNING.
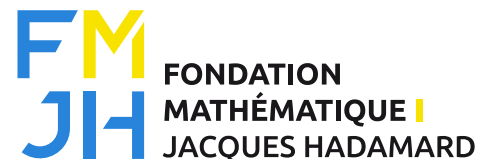
ML/FIN

Abstract

Capturing the complexity of modern financial markets often require knowledge of the parameters of a model which is often lacking in practice. The use of machine learning (ML) offers immense potential to enable more accurate modelling of financial markets and more informed decision-making, under constraints imposed by increasing regulation.

On the other hand, the wide range of problems studied in financial mathematics, such as optimal execution and portfolio management, has begun attracting the interest of researchers in learning theory. The advanced mathematical tools traditionally used in financial mathematics are now contributing to several notable advances in learning theory and its recent applications, such as mean-field interpretations of neural networks and use signatures in statistical learning.

This workshop aims to bring together young researchers from these two fields to promote interdisciplinary sharing of ideas, challenges, and methods, to open exciting new perspectives in the fields of mathematical finance and machine learning.

Sponsors

Chaire Futures of Quantitative Finance

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QRT

1. Dates

From Monday 23rd September 2024 to Friday 27th September 2024.

2. Venue

The workshop will take place at the Centre Paul Langevin, in Aussois, in the French Alps. (It is accessible by trains up to Modane Station on the French side or Bardonecchia on the Italian side, then by taxi).

3. Participants

We aim to welcome 30 participants at an early stage of their academic career (PhD, Postdoc, and young permanent researchers) from a range of backgrounds.

4. Applications

We will take applications from prospective attendees on the basis of the call for contributions below. Priority will be given to selected speakers.

5. Call for contributions

The *mathematical insights from markets, control, and learning* workshop aims to be an interdisciplinary workshop for young researchers in financial mathematics, machine learning and adjacent fields within mathematics, computer science, and economics.

We invite applications from researchers of all backgrounds at early stages in their careers (PhD, postdoc, recent faculty/researchers). Applicants are encouraged to submit a contribution to the conference (talk and/or poster) in the form of an abstract, and priority will be given to contributing applicants within the limits of capacity.

Gender equality will be taken into account in the selection process.

Contributions may present original or published research on topics related to Financial mathematics, machine learning, the economic theory of markets, etc. Examples include

- Theoretical study of markets (e.g. auction theory, matching, market design)
- Empirical study of markets (e.g. market microstructure, volatility models, non-standard markets)
- Financial decision problems (e.g. portfolio management, optimal execution)
- General theory of decision problems (e.g. optimisation, control, game theory)

- General theory of stochastic analysis (e.g. SDEs, Hawkes processes, rough path)
- Applications of machine learning methods to financial problems
- General theory of learning (e.g. reinforcement learning, algorithms with predictions)
- Issues of fairness, privacy, or transparency or other social and economic considerations regarding markets (e.g. dark pools, financial data privacy)
- Theory of fairness and privacy.

6. Organisation Committee

- Lorenzo Croissant, postdoc, CREST, ENSAE, and Inria, FairPlay team.
- Antonio Ocello, postdoc, CMAP, Ecole Polytechnique.
- Grégoire Szymanski, PhD student, CMAP, Ecole Polytechnique.

7. Scientific Committee

- Samuel Cohen, Professor, University of Oxford.
- Christa Cuchiero, Professor, Universität Wien.
- Charles-Albert Lehalle, Global Head of Quantitative R&D, Abu Dhabi Investment Authority.
- Eric Moulines, Professor, CMLA, Ecole Polytechnique.
- Vianney Perchet, Professor, CREST, ENSAE.
- Huyên Pham, Professor, LPSM, Université Paris Cité.

SCIENTIFIC PROGRAM

Overview

The workshop focuses on interdisciplinary contributions welcoming both theoretical and empirical work. To realise this vision, we have centred the scientific program around 5 sessions each of which straddles disciplinary boundaries while also engaging in a dialogue with other sessions. A brief introduction on them is provided further below.

Program

We will host three types of talks broken up by many short breaks, namely:

- 5 Introductory courses each consisting of 3 lectures of 45 minutes each.
- 7 Spotlight talks lasting 45 minutes each (35m talk, 10m questions).
- 20 Short talks (posters encouraged), lasting 20 minutes each (15m talk, 5m questions).

Below is a draft schedule of the arrangement of the talks. Specific talks will be placed in the schedule based on speaker constraints, and wherever possible lectures in a session will precede the spotlights and short talks associated.

	Monday	Tuesday	Wednesday	Thursday	Friday
8:30-9:15	Opening Course 1 Lecture 1	Course 2 Lecture 1	Course 3 Lecture 2	Course 4 Lecture 2	Course 5 Lecture 3
9:15-9:30	Break				
9:30-10:15	Course 1 Lecture 2	Course 2 Lecture 2	Course 3 Lecture 3	Course 4 Lecture 3	Spotlight
10:15-10:45	Break				
10:45-11:30	Spotlight	Spotlight	Short Talks	Spotlight	Short Talks
11:30-11:45	Break				
11:45-12:30	Short Talks	Short Talks	Course 4 Lecture 1	Short Talks	Short Talks Closing
12:30-14:00	Lunch				
14:00-14:45	Course 1 Lecture 3	Course 2 Lecture 3	Left free for activities	Course 5 Lecture 1	Left free for return travel
14:45-15:00	Break			Break	
15:00-15:45	Spotlight	Spotlight		Course 5 Lecture 2	
15:45-16:15	Break			Break	
16:15-17:00	Short Talks	Short Talks		Spotlight	
17:00-17:15	Break			Break	
17:15-18:00	Short Talks	Course 3 Lecture 1		Short Talks	

1. Economic theory of markets,

Simon Mauras is a permanent researcher at INRIA, in the FAIRPLAY team, working on topics of Mechanism Design, auctions and Fairness. Prior to this position, he was a postdoctoral Fellow at Tel Aviv University, working on algorithmic Mechanism Design. He holds a Ph.D. in Computer Science from IRIF and Université Paris Cité, under the supervision of Claire Mathieu.

Flore Sentenac is an Assistant Professor in the Information Systems and Operations Management department at HEC Paris. Her research focuses on online learning algorithms and matching with applications in digital advertising. She holds a Ph.D. in Applied Mathematics from ENSAE, under the supervision of Vianney Perchet.

2. Markets in the real-world,

Timothée Fabre is a third-year Ph.D. student at the MICS Lab in CentraleSupelec, part of Université Paris-Saclay, where he is supervised by Damien Challet and Ionae Muni-Toke. His research focuses on market microstructure and machine learning applied to optimal execution and detection of price manipulation. As part of his PhD is also a quantitative researcher at SUN ZU Lab.

3. Learning to control,

Lorenzo Croissant is currently a postdoctoral researcher at ENSAE working on topics in control and learning theory, as part of the FAIRPLAY INRIA team. He holds a Ph.D. in Applied Mathematics from Université Paris-Dauphine, under the supervision of Bruno Bouchard and Marc Abeille.

4. Mean-field games and learning,
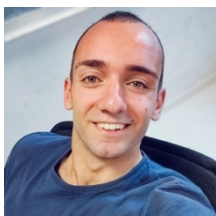
Antonio Ocello is currently a postdoctoral researcher at École Polytechnique in the OCEAN team working on mean field games for machine learning and generative models under the supervision of Eric Moulines. He holds a PhD in Probability from Sorbonne Université, under the supervision of Idris Kharroubi.

5. Fairness, privacy, transparency in markets,

Felipe Garrido-Lucero is currently a postdoctoral researcher in Market design & Fairness at FAIRPLAY, joint team between INRIA, IP Paris (ENSAE and Ecole Polytechnique), and Criteo. He defended his Ph.D. in Computer Science in 2022 at Université Paris-Dauphine, under the supervision of Rida Laraki.

Solenne Gaucher is currently a postdoctoral researcher in sequential learning, sequential decision-making problems, and fair machine learning at CREST, as part of the FAIRPLAY INRIA team. She holds a Ph.D. in Statistics from Université Paris-Saclay, under the supervision of Christophe Giraud and Olga Klopp.

1. Economic theory of markets

This session delves into the foundational theories underpinning market dynamics, including auction theory, market design, and matching algorithms. Researchers will explore the theoretical frameworks governing market equilibrium, price discovery mechanisms, and allocation efficiency in various market structures. Discussions will encompass the intricacies of auction mechanisms, the design of market platforms, and the role of matching algorithms in optimizing resource allocation. Through mathematical analyses of theoretical models, participants will uncover insights into market efficiency, liquidity provision, and the impact of market microstructure on price formation. These theoretical insights, leveraging mostly Economics and Computer Science tools should provide the basis of comparison with real-world market situations.

2. Markets in the real world

This session focuses on the empirical realities and statistical phenomena observed in real-world markets, encompassing diverse financial instruments as well as markets lying outside traditional financial domains. Topics include market microstructure dynamics, statistical properties of asset returns, and the influence of exogenous factors on market behaviour. Case studies will explore the intricacies of trading in non-financial markets, such as commodities, energy, and advertising, and shed light on the challenges posed by various aspects of market structure (auction format, regulatory environments, etc.). Traditional mathematical finance will find new, exotic markets which welcome its mature tools, while also shedding new light on the influence of the market format via comparative analysis.

3. Learning to Control

This session, dedicated to control problems, explores innovative approaches to resolving control problems in dynamic environments with imperfect knowledge or uncertain models. Researchers will discuss advancements in control theory, reinforcement learning theory, and adaptive control strategies. Topics range from theory to applications within the context of financial decision-making and may include the resolution of control problems under model uncertainty, reinforcement learning techniques for trading algorithms, and the development of robust control policies in uncertain market conditions. This session aims for the mutually beneficial convergence of expertise between theoreticians and practitioners of both control theory and reinforcement learning.

4. Mean-field games and learning

This session on mean-field game theory showcases methodologies for modelling and analysing the strategic interactions among a large population of agents. The mean-field setting is a classical tool for the economic study of the behaviour of agents in large markets. Traditional work in probability theory provides tools, solution concepts, as well as results on existence and characterization of such solutions. In contrast, modern work, under the influence of Machine Learning methods, has showcased new avenue for numerical simulation and resolution. This session will allow researchers to exchange on topics from the modelling of real phenomena using mean-field models to the use of Reinforcement Learning to solve them numerically, and many topics in between.

5. Fairness, privacy, and transparency in markets

Ensuring fairness, privacy, and transparency in financial markets is paramount for maintaining market integrity and public trust. This session examines the ethical, policy, and regulatory considerations surrounding data privacy, algorithmic bias, and market transparency in financial markets, in both theoretical and real-world markets. Researchers will discuss methodologies for detecting and mitigating biases in algorithmic decision-making, safeguarding sensitive financial information, and promoting equitable market access. Through interdisciplinary discussions, participants will explore the implications of emerging technologies on market fairness and transparency, and the role of regulatory frameworks in fostering trust and accountability in financial markets.