



Offer #2024-07458

Post-Doctoral Research Visit F/M [Campagne post-doctorants] - Multi-Agent Reinforcement Learning for Mean-Field Games and Systemic Risk

Contract type : Fixed-term contract

Renewable contract : Yes

Level of qualifications required : PhD or equivalent

Other valued qualifications : PhD thesis

Fonction : Post-Doctoral Research Visit

Context

This Postdoctoral Research Fellowship position is proposed by the Mathrisk INRIA Research team, <https://team.inria.fr/mathrisk/en/>, which is common with INRIA, the Ecole Nationale des Ponts et Chaussées and the University Gustave Eiffel.

The Mathrisk team addresses broad research topics in the area of mathematical handling of risk, embracing risk measurement and risk management, modeling and optimization in quantitative finance and other related domains where risk control is paramount.

It also develops a numerical platform for quantitative finance (<http://www.premia.fr>), supported by a consortium of financial institutions.

Mathematical expertise of the team includes stochastic modeling, stochastic analysis, in particular stochastic (partial) differential equations and various aspects of stochastic control and optimal stopping of these equations, stochastic optimization, dynamic game theory, random graphs, martingale optimal transport and numerical probability. In recent years, systemic risk has emerged as a major focus of research. Unlike traditional risk management approaches that primarily consider risks faced by individual institutions, the emphasis now lies on modeling the intricate interrelationships among institutions and the mechanisms of distress propagation across them. Leveraging a multi-agent reinforcement learning (MARL) approach enables a more detailed examination of systemic risk within financial networks. As evidenced by past crises, effective tools for monitoring stability in large and complex financial systems must accurately account for the diverse interconnections within these systems. In this context, our research proposal builds upon our previous findings on systemic risk using a random graph approach, integrating mean-field games and reinforcement learning strategies. This integration enhances both the depth and precision of our analyses within a dynamic financial network framework.

Academic Partnership : Hamed Amini, Associate Professor, Department of Industrial and Systems Engineering, University of Florida, Gainesville, FL, USA, email: aminil@ufl.edu

Travel expenses are covered within the limits of the scale in force.

Assignment

Assignments

The objective of this project is to develop data-driven stochastic network models for quantifying systemic risk in financial systems using Multi-Agent Reinforcement Learning (MARL) techniques and Mean-Field Games (MFGs). While systemic risk analysis has seen a surge in interest post-crisis, existing models often lack the ability to capture the heterogeneity, variety of contagion channels, and dynamics of financial networks. By integrating MARL and MFGs, we aim to address these limitations and derive forward-looking systemic risk measurement tools that can adapt and learn from continuous changes in financial networks. Through this approach, we seek to provide a more accurate and insightful understanding of potential future crises while identifying key factors contributing to systemic risk.

References:

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 - Amini, Z. Cao, and A. Sulem. Stochastic Graphon Games with Jumps and Approximate Nash Equilibria. SSRN: 4412999, 2023.
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 - Borgs, J. T. Chayes, L. Lovasz, V. T. Sos, and K. Vesztegombi. Convergent sequences of dense graphs i: Subgraph frequencies, metric properties and testing. Advances in Mathematics, 219(6):1801–1851, 2008.
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 - E. Caines and M. Huang. Graphon mean field games and their equations. SIAM Journal on Control and Optimization, 59(6):4373–4399, 2021.
 - Carmona, D. B. Cooney, C. V. Graves, and M. Lauriere. Stochastic graphon games: I. the static case. Mathematics of Operations Research, 47(1):750–778, 2022.
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 - Garnier, G. Papanicolaou, and T.W. Yang. Large deviations for a mean field model of systemic risk, SIAM Journal on Financial Mathematics, 4(1):151–184, 2013.
 - -M. Lasry and P.-L. Lions. Mean field games. Japanese Journal of Mathematics, 2:229–260, 2007.

Collaboration :

The recruited person will work in collaboration with Agnès Sulem, INRIA Paris, agnes.sulem@inria.fr and Hamed Amini, Associate Professor, Department of Industrial and Systems Engineering, University of Florida, Gainesville, FL, USA, email: aminil@ufl.edu

Main activities

Main activities :

It is expected that the successful candidate will conduct novel research in the proposed topic and will be able to valorize it by writing articles and presenting the results in workshops and conferences. The postdoctoral fellow will also participate to the scientific life of the team, in particular by attendance to the seminars. He/she might visit Prof. Hamed Amini in University of Florida for collaboration.

Skills

PhD in applied mathematics or Computer sciences.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking and flexible organization of working hours (after 12 months of contract)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training

Remuneration

According to civil service salary scales

General Information

- **Theme/Domain :** Stochastic approaches
Scientific computing (BAP E)
- **Town/city :** Paris
- **Inria Center :** [Centre Inria de Paris](#)
- **Starting date :** 2024-10-01
- **Duration of contract :** 1 year, 6 months
- **Deadline to apply :** 2024-05-19

Contacts

- Inria Team : [MATHRISK](#)
- Recruiter :
Bialobroda Sulem Agnes / Agnes.Bialobroda_Sulem@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

Skills required:

Specialists in stochastic analysis, reinforcement learning, random graph theory, numerical probability, financial mathematics, operations research, network analysis, game theory are welcome. In particular, skills in the domains of mean-field systems and games, Graphons, backward stochastic differential equations are welcome. Experience in financial modelling and machine learning for complex financial data is highly appreciated.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Application

The candidates must send a letter of motivation explaining how their scientific skills and profile match the research proposal. Their application should also include

- * a CV
- * the list of publications
- * the thesis reports (if the thesis has been already defended)
- * Candidates who have not yet defended their thesis must provide a letter from their PhD adviser certifying that the thesis is ready to be defended, giving a date of defense and the composition of the defense committee.
- * Recommendation letters (at least a letter from the PhD adviser) they can be directed send to Agnes Sulem

Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.