Phd Position in Applied Mathematics/Statistics

Applicants are encouraged from areas of applied mathematics and mathematical statistics, data science, signal processing and machine learning. Interest in point process modelling is of particular relevance.

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Location: Laboratoire de Mathématiques Blaise Pascal (http://recherche.math.univ-bpclermont.fr/)
Université Clermont Auvergne, Campus des Cézeaux, 63178 Aubière, FRANCE

Salary: The pre-tax salary is 2100 euros.
Starting date: between March and September 2024.
Duration: 3 years.

PhD in applied mathematics (specialty in statistics)

Language Requirements: French or English and free support given for learning French in UCA for non-native french speaking.

Possibility to perform teaching duties for an additional salary in the latter years of the PhD if desired, up to 64 hours per year.

Supervision Committee:

- Prof. N. Azzaoui (co-director)
- Prof. G.W. Peters(UCSB co-director)
- Prof.L. Chupin, (co-supervisor)
- Prof. O. Roche (co-supervisor)

Required qualification: either master or equivalent (honors) in areas such as applied maths, applied probability, statistics, signal processing engineering, computer science with relevant mathematical background.

Computing skills: expectations that proficiency in R and python are required at intermediate level. Libraries such as Pandas, Pytorch, TensorFlow, and Docker are favoured

Mobility: The position includes travel facilities in Europe to collaborate with partner teams LMV, UCSB, participation to international conferences and visit to collaboration in University of California, Santa Barbara.

Application Process:

- Applications are accepted on a rolling basis until 10 June 2024 and interviews will be performed as suitable applications are received.
- Application submission (In English): - cover letter (motivation letter), cv with description of university performance, and relevant working experience.
- Interview process: two interviews will be performed for shortlisted candidates. Firstly background discussions. Secondly, technical interview on research skills and knowledge from provided research reading.

The university can support the foreign visa process where it is relevant for international candidates.

Research project.

The application domain is methodological work in spatial-temporal models with self-excitation structures. These can include links between stochastic differential equation methods for physical models and stochastic point process models such as Hawkes' processes or various other self-excitation structures. The focus will be on developing new model specifications, calibration and estimation challenges, simulation based and computational approaches, and challenges associated with real data contexts in volcanic eruption and seismic activity settings. This will involve the treatment of real problems such as missing data contexts, historical catalogs, and scenario generation methods. Defining relevant scenarios and stress testing methods in this context will be of practical focus.

The main idea of our project is to utilize data on volcanic eruptions and to validate the model that best describes them. The robustness of the proposed models will also be tested using Monte-Carlo type simulations. To achieve this goal, a detailed understanding and adaptation of the results concerning spatio-temporal Hawkes processes are necessary. The following points will be addressed in the context of this thesis:

- Propose a realistic mathematical model describing the spatio-temporal dynamics of volcanic eruptions in a given geographical area on the surface of the globe. The method will particularly use point process models ranging from the more classical Poisson process to Hawkes or Cox processes.
- Propose a model describing the recurrence time of the largest eruptions (magnitude > 7) on a global scale.
- Collect as much data as possible on eruptions in the concerned area (dates, locations, etc.) as well as all covariables that might influence the eruptive dynamics (such as volume, chemical composition, etc.).
- Based on the observations, use appropriate statistical learning techniques to calibrate the parameters of these models.
- Validate the proposed model through simulation techniques of scenarios regenerating the known data. Compare these results to recent machine learning techniques.
- Use these models to predict potential eruptions in a probabilistic manner: probability of an eruption in the short term, medium term, its location, type, etc.
- By finely quantifying error analyses, possibly provide maps to visualize future probable eruptions.

Outputs should include: research journal publications 2-3 papers, conference presentations at international conferences and seminar presentations/mini lectures on core material developed. In addition, a software library on the models will be prepared on GitHub as part of deliverables for the projects