Two post-doctoral positions in computational Civil and Environmental Engineering

Location: Université Paris-Saclay, France

Position description

Two postdoctoral positions are available at Laboratoire de Mécanique Paris-Saclay (LMPS), Université Paris-Saclay, focused on natural hazards (flood, landslide, soil deformation) and infrastructure vulnerability assessment in the context of the MINERVE project.

This MINERVE project is leading the ongoing transition towards designing, constructing, operating, maintaining, and decommissioning the French rail infrastructure assets in a way that is efficient, reliable, and with limited negative environmental impacts. MINERVE has assembled 4 industrial partners (SNCF, RATP, Colas Rail, and Kayrros), 1 private research institute (IREX), and 1 academic institution (Université Paris-Saclay) and is financially supported by the French government in the framework of the *Recovery Plan and of the Investing for the Future* program.

The selected postdocs will be members of the MINERVE team conducting research on developing efficient computational models for vulnerability assessment of Civil Engineering assets and natural hazard modelling for MINERVE, and will be employed at LMPS

Research description

The French railway network is 28,000 km long and exposed to various natural hazards. Considering that climate change perturbs the average climate trends (for instance, floods becoming more frequent and higher in intensity than 10 years ago), there is a need to continuously reassess natural hazard effects and the vulnerability of infrastructures.

Conducting regionally large-scale simulations is essential for the rigorous investigation of the models involved in the planning and disaster management of natural hazards. Such large-scale numerical models can be mathematically complex and computationally expensive. Existing empirical data can be sparse, often unable to encompass or capture the full range of possible outcomes in natural hazard assessments. The paucity or lack of region-specific data/measurements encourages researchers to develop surrogate models based on empirical and simulated (synthetic) data in order to circumvent the large-scale simulation burden and provide sensible bases for reliable decision-making.

Many surrogate models are statistical in nature, and hence machine learning (ML) or more general artificial intelligence (AI) approaches are becoming increasingly popular. The aim of this project is to utilise data-driven and physics-based numerical simulations to generate ensembles of hazard scenarios (spanning various parameter spaces) and use the corresponding outcomes to build improved surrogate models via statistical and/or ML-based methodologies.

Multi-modal data (i.e., satellite images, local time series from monitoring points, climate forecasts, etc.) is a key aspect of the data-driven part of this research, with an aim of creating models capable of adapting to different hazards while investigating different kinds of sparse and dense observations. AI and ML models will be trained on multi-modal data to operate across relevant hazards

The following high-level focal points are considered for this research:

1) Hazards description: collection of data about the occurrence frequency and the intensity of considered natural events that can impact railways (floods, landslides, soil deformations).

2) Hazards factors: identification of parameters that significantly impact hazards in space and time (topography, vegetation, geology, hydrology, climatology).

3) Historic hazards maps: development of machine-learning approaches for multi-hazard modelling/mapping in specific regions along the French railway network from historic data.

4) Dynamic hazard maps: development of hazard evolution models for the prediction of multi-hazard maps in the next decades.

5) Vulnerability assessment: damage and loss assessment for the railway infrastructure using simulation and surrogate models to improve the conventional models.

6) Decision metrics: Providing decision support metrics based on the obtained results to pass to stakeholders.

Candidate background

Candidates with the following research backgrounds are highly relevant to this project:

- Machine learning / statistical analysis
- Flood, landslide, and geotechnical hazard modelling via data-driven and/or physics-based simulation methodologies
- Engineering vulnerability assessment
- Geographic data processing

Workplace

The selected researchers will be appointed in the Laboratoire de Mécanique Paris-Saclay (LMPS) at Université Paris-Saclay. The LMPS (UMR 9026, Université Paris-Saclay / CentraleSupélec / ENS Paris-Saclay / CNRS) is dedicated to research on natural hazards and all aspects of solid mechanics (mechanics of materials and structures, civil engineering, fine experimentation, and efficient numerical modelling). The LMPS has about 220 members, including 110 PhD students and postdocs and 35 engineers, technicians and administrative staff on two sites of Paris-Saclay University: CentraleSupélec and ENS Paris-Saclay, both in Gif-sur-Yvette. The LMPS hosts four research teams. COMMET: Behaviour of Materials, Modeling, Experimentation and Theory; STAN: Science and Advanced Techniques in Computational Mechanics; MILA: Architectured Materials; OMEIR: Structures, Materials, Environment: Interactions and Risks.

The cadidates will join the OMEIR team. The team contributes to the energy, ecological, and digital transitions of all fields related to cities and infrastructures. It brings together the expertise of research groups specializing in construction and materials, modelling of various physical phenomena (mechanical, thermal, hydric, chemical), advanced experimental studies, natural risks, large-scale and advanced numerical simulations, and data-driven model developments.

Contacts

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