Offer #2022-05100

Post-Doctoral Research Visit F/M Numerical methods (MPM and DEM) for gravity flows in mountains

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

Level of experience : Recently graduated

About the research centre or Inria department

The Inria Grenoble - Rhône-Alpes research center groups together almost 600 people in 22 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (University Grenoble Alpes, CNRS, CEA, INRAE, ...), but also with key economic players in the area.

Inria Grenoble - Rhône-Alpes is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Context

Climate change has many consequences on natural gravity hazards in mountainous areas, in particular by increasing their intensity and frequency.
The objective of this exploratory action concerns the application of digital sciences for the prediction and mitigation of these risks. Numerical simulation of gravity flows (rock falls, rock flows, debris flows, ice, etc.) has certainly reached a certain level of maturity, but its use in a prediction and prevention framework is still in its infancy.

In the context of the GRANIER exploratory action, the so-called "data-driven modelling" methods will be explored for gravity flows and prevention structures. The aim will be to make the most of laboratory and observatory data in order to build and calibrate models, evaluate their sensitivity, improve their predictive character, i.e. control and take into account uncertainties, thanks to variational, statistical and AI methods. In turn, it is hoped that this will lead to improved data generation and sustainability. These methods, which have already been tried and tested in the context of climate modelling, have hardly been employed for gravity flows and complex frictional cohesive rheologies, which are inherently non-smooth. This constitutes the highly exploratory nature of this research.

The TRIPOP team is a joint research team of Inria Grenoble Rhône-Alpes and the Laboratoire Jean Kuntzmann (LJK), which is a continuation of the BIPOP team (2003-2017).
The team is mainly interested in the modelling, mathematical analysis, simulation and control of non-smooth dynamic systems. Non-smooth dynamics concerns the study of the temporal evolution of systems that are not smooth in the mathematical sense of the term, i.e. systems that are characterised by a lack of differentiability, either of the mappings in their formulations or of their solutions with respect to time. The team is one of the few in the world to have brought together researchers in applied mathematics, control theory, computational mechanics, and scientific computing in the field of non-smooth dynamics. In mechanics, the main examples of non-smooth dynamical systems are multi-body systems with one-sided Signorini contact, fixed-value friction (Coulomb type) and impacts, or plasticity.

Assignment

Different modelling approaches are used at INRAE/ETNA/ECRINS depending on the type of hazard. For the study of unitary rock falls and the physical phenomena at play during the propagation of rockfalls and dense snow avalanches, methods that explicitly model the constituent particles of granular materials (notably the Discrete Element Methods - DEM) are favoured, whereas to model flows (debris flows, avalanches and large-scale rockfalls), methods that assimilate materials to fluids with complex rheology are more traditionally used (in particular Material Point Method - MPM, Smooth Particles Hydrodynamics - SPH, Shallow Water models - SWM). It should be noted that these methods are most often explicit and regularise the inequality constraints and thresholds

The aim of this post-doc is to work on the development of an MPM method, coupled with a discrete

element method in a non-smooth context.

Main activities

The post-doc will develop the following points:

a) Rethinking the Material Point Method MPM in the non-smooth framework. This will allow a simple and efficient modelling of threshold and unilateral phenomena (one-sided contact, impact with Coulomb friction, threshold behaviour laws such as plasticity, damage or fracture, viscoplastic fluids of the Bingham and Herschel-Bulkley type) in order to develop new, implicit and robust numerical methods, where the most important physical features of frictional cohesive materials are well modelled while neglecting second order phenomena.

b) Couple this method with discrete element method to integrate the multi-scale (micro/meso/macro) character of these problems or, more simply, to spatially couple at the same scale several physical phenomena that are better taken into account by different methods, for example with large particles within the discrete element method (DEM).

c) Use data-driven mechanics approaches in cases where behavioural models are not reliable and faithful to the observed physical phenomena. These techniques make it possible to replace the laws of behaviour of materials with experimental data or data from smaller-scale simulations in order to model "sub-mesh" phenomena, which are not or only slightly taken into account in large-scale phenomenological models.

Skills

Theoretical and computational mechanics, software development, modeling of constitutive laws of continuous media.

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 (90 days / year) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage under conditions

Remuneration

2653€ gross salary / month

General Information

- **Theme/Domain :** Optimization and control of dynamic systems
  Scientific computing (BAP E)
- **Town/city :** Montbonnot
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2022-09-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2022-10-31

Contacts

- **Inria Team :** TRIPOP
- **Recruiter :**
  Acary Vincent / vincent.acary@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

A strong interest in mechanical modelling and the development of numerical methods in a high performance computing context is essential. The candidate will have to demonstrate skills in this field through scientific publications and technical achievements of computational code.

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

Applications must be submitted online on the Inria website.

Processing of applications sent by other channels is not guaranteed.

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.