Offer #2024-08292

PhD Position F/M Contrat relais-thèse “Simulation of wave propagation problems in complex media using adaptive finite elements” (M/F)

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria University of Lille centre, created in 2008, employs 360 people including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria University of Lille centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region.

For more than 10 years, the Inria University of Lille centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

Context

The accurate simulation of time-dependent wave propagation phenomena is central to many areas of physics. Finite element and discontinuous Galerkin methods are very popular for such simulations, since they are able to take complex propagation media into account. The ANR APOWA project aims to improve the reliability and efficiency of these discretization methods by using error estimators and adaptive mesh refinements.

This thesis is part of the APOWA project, funded by the French National Research Agency (ANR). The aim of the thesis is to familiarize the doctoral student with the key themes of the project before embarking on new theoretical developments.

Assignment

A posteriori error estimation for wave propagation is a delicate subject: [1,3,4] are fundamental contributions that open the way to rigorous numerical analysis. A new approach to a posteriori error estimation of time-dependent wave propagation problems has recently been proposed [2].

The results presented in [2] only take into account the spatial discretization of (1), but for the moment neglect its temporal discretization. The aim of this thesis will be to extend the techniques developed in [2] to take into account the errors associated with temporal discretization.

[1] C. Bernardi, E. Süli, Time and space adaptivity for the second-order wave equation. Math. Models Methods Appl. Sci. 15 (2005), 199-225.
[2] T. Chaumont-Frelet, Asymptotically constant-free and polynomial-degree-robust a posteriori estimates for space discretizations of the wave equation. SIAM J. Sci. Comput. 45 (2023), A1591-A1620.
[3] T. Chaumont-Frelet, A. Ern, M. Vohralı́k, On the derivation of guaranteed and p-robust a posteriori error estimates for the Helmholtz equation, Numer. Math. 148 (2021), 525-573.
[4] W. Dörfler and S.A. Sauter, A posteriori error estimation for highly indefinite Helmholtz problems, Comput. Methods Appl. Math. 13 (2013), 333-347.

Main activities

This thesis project has three objectives. Firstly (i), the PhD student will develop an a posteriori error estimator that takes into account the spatiotemporal discretization of the wave equation. This estimator will be implemented in a one-dimensional toy calculation code. Following (ii), he or she will develop a two-dimensional implementation to evaluate the performance of the error estimator for complex configurations. He or she will empirically use the estimator in adaptive mesh refinement algorithms. Finally (iii), he or she will analyze from a theoretical point of view the adaptive computation algorithms previously implemented from a practical point of view.

Benefits package

- Subsidized catering
- Public transport partially reimbursed
- Vacations: 7 weeks' annual leave + 10 days' RTT (full-time basis) + possibility of exceptional leave (e.g. sick children, moving house)
- Possibility of telecommuting and flexible working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports benefits (Association de gestion des œuvres sociales d'Inria)
- Access to professional training
- Social security benefits

Remuneration

2200€ gross per month

General Information

- **Theme/Domain :** Numerical schemes and simulations
  Scientific computing (BAP E)
- **Town/city :** Villeneuve d'Ascq
- **Inria Center :** Centre Inria de l'Université de Lille
- **Starting date :** 2025-01-01
- **Duration of contract :** 3 months
- **Deadline to apply :** 2024-11-27

Contacts

- **Inria Team :** RAPSODI
- **PhD Supervisor :**
  Chaumont-frelet Theophile / Theophile.Chaumont@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

We are looking for a candidate with a Master's degree or an engineering diploma in applied mathematics. He or she should have knowledge of PDE theory, numerical analysis and the finite element method. We are also particularly interested in candidates who have already worked on wave propagation and/or a posteriori error estimation, as well as those with programming skills.

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

CV + cover letter

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.