Internship / Ph.D. thesis  
(master 2 or 3rd year level of engineering school) 
Inria Paris

Context: Inria Paris project-team SERENA
Subject: Adaptive algorithms for nonlinear PDEs

Contents of the internship / Ph.D. thesis

The aim of this internship / Ph.D. thesis is to contribute to the development of novel adaptive numerical algorithms for the approximation of nonlinear partial differential equations (PDEs).

Even for linear PDEs, the corresponding solution typically exhibits singularities which have to be resolved by local refinement of the underlying finite element mesh. For nonlinear PDEs, an additional challenge is that the computation of the associated finite element approximation naturally leads to nonlinear discrete systems. These cannot be solved exactly, so that suitable iterative solvers are required. To efficiently approximate the solution of a nonlinear PDE, one thus has to balance the discretization error via local mesh-refinement and the linearization error via a suitable stopping criterion for the employed iteration.

For certain classes of nonlinear PDEs, adaptive algorithms that realize such a balance already exist, and it has been rigorously proven that they are optimal with respect to the overall cost (computational time) [1]. This means that the performance of the practical adaptive algorithm compares, up to a generic constant, to the best-possible hypothetical one. Recently, even the algebraic error, which results from solving also the involved large systems of linear algebraic equations iteratively, has been taken into account [2].

In this internship / Ph.D. thesis, these results will be further improved and generalized. The focus will be on the robustness of the algorithms, i.e., on uniformly good quality for all possible PDE data (including the strength of the nonlinearity) as well the polynomial degree of the approximation.

Funding for a consequent Ph.D. thesis after the internship, in which the research can be consolidated and potentially applied for the numerical simulation of environmental problems, is available.

The work will be carried out in the SERENA project-team of Inria Paris, in collaboration with the CERMICS laboratory at Ecole des Ponts ParisTech. The project advisors will be Gregor Gantner (Inria starting faculty position, Inria Paris) and Martin Vohralík (directeur de recherche, Inria Paris).

References


Candidate profile

Master 2 or 3rd year level of engineering school student with interest as well as very good level in functional analysis, numerical methods, and programming (C++, Julia, Matlab, or Python).

Practicalities

Timing: 6 months, starting spring 2023 (the internship). 3 years, starting autumn 2023 (the Ph.D. thesis). The knowledge of the French language is welcome but by no means compulsory.

Application

To apply, send your CV highlighting your background in numerical analysis, scientific computing, and programming, a list of courses and notes, and a short motivation letter to the internship / Ph.D. supervisors Gregor Gantner (gregor.gantner@inria.fr) and Martin Vohralík (martin.vohralik@inria.fr).