Post-doctoral position

Towards highly scalable domain decomposition methods for the time domain.

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The Laboratory of Numerical Methods for Reactor Studies of CEA-Saclay (DM2S/SERMA/LLPR) is inviting applications for a post-doctoral position in the field of domain decomposition methods for the *time* domain. Research interests should lie within Parallel and Scientific Computing or a closely related area. The position is for one year with the possibility of extending it for a second year. The work will be in close collaboration with Laboratoire Jacques Louis Lions (Paris VI University) and CEREMADE (Paris Dauphine University).

Review of applications will begin in April 2016 and will continue until the position is filled.

General context and goals: In the search of new approaches for the efficient exploitation of massively parallel computers, the parallelization of the time domain for solving PDEs is a promising idea. However, its competitiveness is pulled down by the major parallel efficiency limitations that the existing methods present. In this context, a promising approach to improve efficiency has recently been proposed in [1]. It is based on the combination of the parareal in time algorithm (one of the most widespread methods to parallelize time) with fixed-point iterative schemes.

In [1], the idea was applied to a very simple numerical example: a 1D heat equation implemented in Matlab. The aim of the postdoc is to apply the new algorithm to an involved non-academic problem in order to quantify the improvement on parallel efficiency in a real context of application. In this respect, the solution of the neutron transport equation for nuclear studies turns out to be a very good candidate. Indeed, nuclear safety studies require the solution of highly accurate models with numerical methods that must be at the same time very accurate and very fast. In particular, when it comes to the study of the behavior of the neutrons in a reactor core, there is particular interest in solving quickly and accurately a time dependent Boltzmann-type equation on very large spatial domains. We could say that the parallelization of the variables other that the time is saturated in the sense that the problem has been extensively explored. Therefore, the search for additional speed-ups through the parallelization of time could bring a dramatic improvement in the performances of R&D neutronic codes. In this context, the candidate will examine the performance of the algorithm of [1] through computations in MINARET, a neutronics solver developed at CEA-Saclay used for real nuclear safety calculations (see [2]). Depending on the candidate's personal research interests, improvements of the algorithm at the theoretical level could be searched. It could also be possible to extend the application to a multi-physics problem coupling neutronics and thermal-hydraulics on a second part of the work.

Candidate profile:

- Ph.D. in Applied Mathematics, Scientific Computing, Nuclear Engineering or Physics.
- Strong background in scientific computing and numerical methods.
- Skills in C++ programming.

Application process: Please, send a resume to Jean-Jacques Lautard (jean-jacques.lautard@cea.fr) or Olga Mula (mula@ceremade.dauphine.fr).

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Salary: Net salary: around 2000 €/month (gross around 2600 €/month).

References

[1] Y. Maday, O. Mula, and M. K. Riahi. Towards a Fully Scalable Balanced Parareal Algorithm: an application to neutronics. 2015. Preprint, https://hal.archives-ouvertes.fr/hal-01184303.

[2] A.-M. Baudron, J.-J. Lautard, Y. Maday, and O. Mula. MINARET: Towards a parallel 3D time-dependent neutron transport solver. In *SNA + MC 2013 - Joint International Conference on Supercomputing in Nuclear Applications + Monte Carlo*. 2014.