Postdoc position in HPC/NLA

We are inviting applications for a postdoctoral position at Sorbonne Université, LIP6 laboratory, in Paris, France (https://www.lip6.fr/?LANG=en) in the field of high performance computing and numerical linear algebra. The position is a two-year contract funded by the French National Agency for Research (ANR). The start date is January 2024 or later. The gross salary follows the standard grid of Sorbonne University and ranges between 2643€ and 3647€ per month, depending on experience.

To apply please send your CV and cover letter to theo.mary@lip6.fr. For full consideration, applications should be sent before October 31st, 2023, although the position will remain open until filled.

Position details The emergence of low precision floating-point arithmetic on modern computer hardware provides new opportunities for High Performance Computing (HPC). Indeed, low precisions can be used to reduce the time, storage, and communications costs of many important Numerical Linear Algebra (NLA) computations, such as matrix multiplication and the solution of linear systems. However, it is also paramount to evaluate and control the loss of accuracy and stability resulting from these low precisions. This motivates the development of mixed precision algorithms, which combine different precisions in order to achieve both high performance and high accuracy [3].

The postdoc will work in a team project investigating important topics in mixed precision HPC/NLA, covering both fundamental questions about the design and error analysis of new algorithms, and practical questions about their efficient implemention on modern parallel supercomputers. In particular, an exciting recent development in the field has been the design of *adaptive precision* algorithms [3, sect. 14], which dynamically adapt the precisions of each operation at runtime. This class of algorithms benefits both from the mathematical fact that several NLA algorithms can actually exploit a *continuum* of precisions, and from the increasing availability and efficiency of customized floating-point formats.

Promising research directions include in particular the use of adaptive precision block low-rank approximations [1] to accelerate sparse direct methods, and adaptive precision matrix–vector product [2] and preconditioners [4] to accelerate sparse iterative methods. The proposed methods will be benchmarked and validated in close collaboration with application and industrial partners, in particular the MUMPS solver (https://mumps-solver.org/) team for the direct methods and IFPEN and ONERA for the iterative methods.

Candidate profile The ideal candidate is expert in both HPC and NLA, although candidates experts in one field and with an interest to learn about the other will also be given full consideration. All methods will be developed in either C/C++ or Fortran, so programming expertise in at least one of these languages is required. Knowledge of NLA algorithms, in particular direct and iterative methods for the solution of sparse linear systems would be appreciated but is not necessary, as long as the candidate is keen to learn about them.

[1] Patrick Amestoy, Olivier Boiteau, Alfredo Buttari, Matthieu Gerest, Fabienne Jézéquel, Jean-Yves L'Excellent, and Theo Mary. Mixed Precision Low Rank Approximations and their Application to Block Low Rank LU Factorization. *IMA J. Numer. Anal.*, August 2022.

[2] Stef Graillat, Fabienne Jézéquel, Theo Mary, and Roméo Molina. Adaptive precision sparse matrix-vector product and its application to Krylov solvers. *To appear in SIAM J. Sci. Comput.*, 2023. https://hal.archives-ouvertes.fr/hal-03561193.

[3] Nicholas J. Higham and Theo Mary. Mixed precision algorithms in numerical linear algebra. *Acta Numerica*, 31:347–414, May 2022.

[4] Noaman Khan and Erin Carson. Mixed precision iterative refinement with adaptive precision sparse approximate inverse preconditioning. 2023. https://arxiv.org/abs/2307.03914.