

Composability and Data Partitioning in High Performance Computing

Master Internship 2024

Keywords: High Performance Computing, Parallel languages, Data Partitioning, Composability.

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Context

Numerical simulation is a key technology for many application domains. Thanks to the democratization of high performance computers (HPC), complex physics and more generally complex systems can now be simulated routinely. Numerical simulation is considered as the third pillar of sciences (with experiment and theory).

While the machines are very powerful, their programming models face several challenges to easily and efficiently exploit the available computing resources. A particular challenge is to ease code composability to improve separation of concerns and code reuse. Code composability appears also more and more required to handle the complexity of hardware and software.

Though composable code is an old dream [3] that is very common in sequential and distributed computing [5], it is an open issue for parallel computing. Several previous works such as CCA [1], L2C [2], Comet [4] have shown that it is achievable on specific parallel patterns.

Internship Objectives

This internship is part of the PEPR NumPEX Exa-soft project that in particular aims at improving parallel code composability.

In cooperation with other partners of the PEPR NumPEX, the objectives of this internship is to propose extensions to current component models to support irregular and dynamic programming patterns extracted from motivating examples such as Aevol that is an open-source digital genetics platform that captures the evolutionary process using genetic algorithms and individual based modeling or Adaptive Mesh Refinement (AMR) codes.

The internship will require good parallel algorithmic skills as well a taste for modeling (meta-models) and programming (Python/C++ and task-based programming).

Comments

The internship will be located at the LIP, ENS Lyon. This subject may lead to a PhD.

References

- [1] B. A. Allan and al. A Component Architecture for High-Performance Scientific Computing. *International Journal of High Performance Computing Applications*, 2006.
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- [3] M. D. McIlroy. Mass-produced Software Components. *Proc. NATO Conf. on Software Engineering, Garmisch, Germany*, 1968.
- [4] Jérôme Richard. *Conception d'un modèle de composants logiciels avec ordonnancement de tâches pour les architectures parallèles multi-coeurs, application au code Gysela*. Theses, Université de Lyon, December 2017.
- [5] Clemens Szyperski. *Component Software: Beyond Object-Oriented Programming*. Addison-Wesley Longman Publishing Co., Inc., 2002.