JOB OFFER – STAGE

High level programming for the next generation of parallel architectures (CPU/GPU): how to solve PDE in Julia

OFFER INFORMATION

Reference: AAM-2024-AC-01
Team: AAM

Location: 42 Avenue Gaspard Coriolis – 31057 Toulouse

Supervisors:

- Arthur Colombié, colombie@cerfacs.fr
- Jean-François Boussuge, boussuge@cerfacs.fr

Gratification : 700€ net per month - M2 level or last year at engineering school
Period : 6 months – from Février 2025 (adaptative)

Mots-clés : Julia, CPU, GPU, MPI, CFD

CERFACS

CERFACS is a private research, development, transfer and training center for modeling, simulation and high-performance computing. CERFACS designs, develops and proposes innovative software methods and solutions to meet the needs of its partners in the aeronautics, space, climate, environment and energy sectors. CERFACS trains students, researchers and engineers in simulation and high-performance computing.
CERFACS works closely with its seven partners: Airbus, CNES, EDF, Météo France, ONERA, Safran et TotalEnergies.

HOSTING TEAM - AAM

The Advanced Aerodynamic & Multiphysics (AAM) team is dedicated to developing cutting-edge numerical methods, physical modeling, and High-Performance Computing (HPC) techniques for new Computational Fluid Dynamics (CFD) solvers. The work focuses on fluid dynamics simulations for aircraft, rockets, and turbomachinery, in close collaboration with CERFACS partners.

CONTEXT

The evolution of aeronautical requirements in terms of performance, fuel consumption and environmental impact (emissions, noise), has led to a need for optimization of industrial applications/processes. Unsteady numerical simulations are a central asset to face these new challenges. Current calculation programs are CPU-oriented but nowadays supercomputers architectures promote GPU-oriented computations to take advantage of their high performance and low energy consumption. This recent changes in supercomputer architecture requires computational portability to run calculations on hybrid systems. This need for flexibility has led to a rethink of programming languages and methods, in order to maintain optimum performance on each computing machine, while remaining user-friendly. Indeed, most of users are not meant for continuous developments of the code. It is therefore essential to ensure that the sources are as readable as possible while maintaining maximum achievable performance.

MISSION

In this context, the aim of this internship is to evaluate the possibilities of using a high-level language for scientific computing. The aim is to achieve maximum card performance, whether on CPU or GPU architecture, while maintaining a sufficient level of code readability. Clarity of source code is a major challenge and should enable users (PhD students/post-docs) to understand and develop quickly within the code. Current research [1,2,3] suggests that Julia programming language is a good choice to fulfil these requirements.

Thus, the intern will be asked to demonstrate the feasibility of a computational code, based on Julia, that allows for ease of development without sacrificing performances. The first mission will be to develop a parallel computational kernel which is able to work indifferently on both CPU and GPU architectures, for the resolution of partial differential equations. This preliminary work will allow to create the programming framework and to check its consistency with the stated objective of readability. The skills developed will then be put to good use for the development of unstructured grid parallel algorithm. This code will include some methods for the reading and partitioning of meshes. Finally, the portability of the program will be assessed as well as its performances. These validation steps will be carried out on current available in-house or external resources.

[1] Julia as a unifying end-to-end workflow language on the Frontier exascale system, Godoy et al., 202
[2] Scalability and HPC Readiness of Julia's AMD GPU Stack | L. Räss | JuliaCon 2023
[3] Scaling Trixi.jl to more than 10,000 cores using MPI. | M. Schlottke-Lakemper & H. Ranocha | JuliaCon 2023

DESIRED PROFILE

- Currently in the final year of an engineering degree or equivalent, specializing in high performance computing (HPC – MPI)
- Experience and knowledge in parallel programming is required.
- Some knowledge in computational fluid dynamics is an advantage.
- As this is a research-oriented internship, the candidate, who is preparing for a Research Master's degree, will be required to present his/her work both orally and in writing in English, in line with the standards expected in an international research laboratory.

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HOW TO APPLY ?

To apply, please send your CV and cover letter to colombie@cerfacs.fr (cc to boussuge@cerfacs.fr), applications are open until the 20th of December of the current year.

See you soon at CERFACS!