Offer #2024-07250

PhD Position F/M Efficient Data Compression within the Task-Based Method for High-Performance Applications

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Context

Position Overview:

This role represents a collaborative opportunity between two Inria teams: CAMUS and TONUS.

Location:

The selected candidate will be positioned within the CAMUS team, based in Illkirch Graffenstaden, within the ICube laboratory.

Team Focus:

- **CAMUS Team:** Specializes in compilation and high-performance computing. The team currently comprises 4 postdoctoral researchers/engineers, 9 PhD students, and 8 permanent researchers.

- **TONUS Team:** Dedicated to mathematical modeling, numerical schemes, and computational challenges in plasma physics simulation.

The research conducted in this position will aim to bridge the gap between high-performance computing (HPC) programming and its applications.

Assignment

The project described in the offer is aimed at bridging the gap between High-Performance Computing (HPC) programming and applications through the innovative use of data compression techniques. The research is grounded in the collaboration between the CAMUS and TONUS teams, bringing together expertise in parallelization, acceleration of computer programs, optimization of compilers, and the development of efficient numerical methods for the approximation of Partial Differential Equations (PDEs), particularly in the context of plasma physics modeling.

The research initiative is inspired by the successful implementation of Wavelet compression in PDE solvers, as demonstrated in Clément Flint's PhD work, and seeks to explore the potential of compression as a generic method in HPC. The project will focus on implementing high-performance compression/decompression kernels, developing new building blocks for integrating compression into task-based applications, investigating the application of compression across various numerical applications, and formulating strategies for the automatic incorporation of compression within the task-based method.

Key aspects of the research include:

- **Enhancing compression kernels**: Optimizing existing kernels for GPU and CPU, exploring efficient storage formats for non-zero values, and creating mechanisms for partial data manipulation.

- **Seamless integration with task-based applications**: Adapting runtime systems to manage compressed data objects, potentially modifying the StarPU runtime system to incorporate compression features, and determining the best strategies for handling compression/decompression tasks within the runtime environment.

- **Application across numerical domains**: The project will test and validate the use of compression in various HPC applications, demonstrating its benefits and identifying any limitations or challenges.

- **Automation of compression in HPC**: Developing methodologies for the automatic integration of compression techniques into HPC applications, aiming to optimize performance by balancing the overhead of compression with the benefits of reduced data movement and storage requirements.

This research project is highly relevant for advancing HPC applications, particularly in fields requiring the simulation of complex phenomena that are computationally intensive and memory-bound. By developing a framework that effectively integrates compression techniques into HPC programming and applications, the project aims to enable more efficient utilization of modern hybrid and multicore computing architectures, potentially leading to breakthroughs in scientific computing and other areas reliant on large-scale numerical simulations.

Main activities

Main activities:

- Imagine new compression methods that work well on accelerators
- Implement high performance code
- Participate to conference and publish the work done

Skills

Technical Skills and Proficiency Required:

- Proficient in CUDA programming and experienced in implementing high-performance computing (HPC) compression kernels.
- Familiarity with HPC environments and compilation processes.

Programming Languages:

- C++ (mandatory)
- CUDA

Interpersonal Skills:

- Capable of collaborative teamwork as well as independent work.

Additional Valued Qualities:

- Creativity.

The applicant must have a MS degree or equivalent.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

2100 € gross/month the 1st year

General Information

- **Theme/Domain :** Distributed and High Performance Computing
- **Town/city :** Illkirch-Graffenstaden
- **Inria Center :** Centre Inria de l'Université de Lorraine
- **Starting date :** 2024-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-04-28

Contacts

- **Inria Team :** CAMUS
- **PhD Supervisor :**
  Bramas Bérenger / Berenger.Bramas@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

The ideal candidate will possess:

- A passion for solving complex algorithmic challenges, with the ability to deliver robust and efficient solutions.

- An enthusiasm for understanding the work of others and proposing innovative improvements.

- The ability to clearly explain methodologies, operational functions, and contribute to scientific publications.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.