



Offre n°2024-07250

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

Type de contrat : Fixed-term contract

Niveau de diplôme exigé : Graduate degree or equivalent

Fonction : PhD Position

Contexte et atouts du poste

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.

Mission confiée

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.

Principales activités

Main activities:

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

Compétences

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.

Avantages

- 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

Rémunération

2100 € gross/month the 1st year

Informations générales

- **Thème/Domaine** : Distributed and High Performance Computing
- **Ville** : Illkirch-Graffenstaden
- **Centre Inria** : [Centre Inria de l'Université de Lorraine](#)
- **Date de prise de fonction souhaitée** : 2024-10-01
- **Durée de contrat** : 3 years
- **Date limite pour postuler** : 2024-04-28

Contacts

- **Équipe Inria** : [CAMUS](#)
- **Directeur de thèse** :
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A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

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.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Sécurité défense :

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux

personnes en situation de handicap.