2019-01286 - PhD Position F/M Automatic task-based parallelization and scheduling for OO languages by source-to-source transformations [5]

Contexte et atouts du poste
The Inria CAMUS/Cube ICPS research team focuses on automatic parallelization and optimization, profiling, modeling, and compilation. The team has increasing interests in the high-performance community such as the task-based method.

Mission confiée
Scientific Context
The task-based method consists in dividing an application into independent sequential code-based applications using the sequential task-flow (STF) model. In this model, the dependencies allow obtaining valid parallel executions, i.e. with a correct execution order of the tasks and without any race conditions. The method has gained popularity in the high-performance computing community because it allows parallelizing with an abstraction of the hardware by delegating the task distribution and the load balancing to the dynamic schedulers. See [1] for an illustrative application that relies on the method. While all aspects related to the TB parallelization are active research topics, the method is mainly used by HPC experts because parallelizing a code must be done manually. With this in mind, the position aims in solving the challenges to bridge the gap between automatic parallelization and the task-based method.

Missions
The project aims in having an automatic task-based parallelization system for C++ code-based applications using the sequential task-flow (STF) model. In this model, the sequential code (i.e. a code that is originally not designed to run in parallel) is annotated to decide what sections to transform into tasks and how these ones access the data. From this description, a runtime system can build a graph of tasks and execute them in parallel, while respecting the data dependencies.

The transformation from an STF code to a graph of tasks is done by a runtime system. The current project will focus on the transformation from a sequential code to an STF code. To do so, a source-to-source transformation of sequential C++ source code will insert tasks and data accesses. The first step will be to consider one function/method as one task and will manage the data accesses at the “object” level (one object == one data handle). Then, the research work will focus on fighting the successive pitfalls that will arise and increase the performance/degree of parallelism.

Principales activités
We provide here a non-exhaustive list of possible key challenges:

• How to manage the granularity to enable/disable tasking at runtime
• How to split a function/loop into tasks
• How to detect patterns for commutative data accesses to increase the degree of parallelism, such as in [2], or to enable speculative execution, as done manually in [3]
• How to remove/delay/regroup synchronizations
• How to schedule an automatically parallelized application, including on heterogeneous architectures using our own LAHeteroprio scheduler [4]
• How to move to automatic distributed parallelization using a common task declaration strategies, as the one used in [5]

The significant results from past and on-going researches on automatic parallelization will give few hints and will help to parallelize compute loops, see [6,7] for example. The validation of the proposed solutions will be done on large open-source C++ projects that are currently sequential.

Technology
The source-to-source transformation system will be based on clang-LLVM. It will be developed on a modern Gitlab and proposed to the community with an open-source license. We will rely on our in-house runtime system SPETABARU to manage and execute the tasks.

References

Informations générales
• Thème/Domaine : Architecture, langages et compilation
• Ville : Illkirch-Graffenstaden
• Centre Inria : CNRS Nancy - Grand Est
• Date de prise de fonction souhaitée : 2019-10-01
• Durée de contrat : 3 ans
• Date limite pour postuler : 2019-05-01

Contacts
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A propos d’Inria
Inria, l’institut national de recherche dédié aux sciences du numérique, promeut l’excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l’interface d’autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-ups. 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
Application deadline
May 1st, 2019 (Midnight Paris time)

How to apply
Upload your file on jobs.inria.fr in a single pdf or zip file, and send it as well by email to berenger.bramas@inria.fr. Your file should contain the following documents:

• Your CV.
• A cover/motivation letter describing your interest in this topic.
• A short (max one page) description of your Master thesis (or equivalent) or of the work in progress if not yet completed.
• Your degree certificates and transcripts for Bachelor and Master (or the last 5 years).
• Master thesis (or equivalent) if it is already completed and publications if any (it is not expected that you have any). Only the web links to these documents are preferable, if possible.

In addition, one recommendation letter from the person who supervises(d) your Master thesis (or research project or internship) should be sent directly by
Compétences

- C++ (17)
- Knowledge of compilation would be really appreciated
- Knowledge of parallel programming/computing is an asset
- Proactive, high interest in solving problems, interest in learning clang-LLVM

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


Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).