Domain decomposition and intelligent parallelization for flood modeling

Executive summary:

Apply FIFO management of parallel data access to real world flood modeling based on effective domain decompositions.

Key skills required:

good familiarity with C or `Fortran` programming and/or numerical methods and models, knowledge of parallel computing and algorithms

Research teams: ICPS

Research Unit: ICube & LHyGeS

Intern tutors: Jens Gustedt[1], Sylvain Weill, Isabelle Charpentier

Intern level: Master or Engineering student

Internship location: Strasbourg/Illkirch, France

Internship duration: 4 to 6 months

Followed by a PhD: possible

Context

In the framework of the Prim'Eau project of the University of Strasbourg, we study surface runoff for hydrological periods of several days. We use an efficient domain decomposition method that we apply to a real world example of Mutterbach (Moselle) with geological and flood data from the years 1920, 1940 and 2017. As the time and memory usage for these computations is important, we aim to parallelize them.

With our work on *ordered read-write locks* (ORWL), we proposed a framework for a large set of applications, so-called iterative computations, that has interesting properties, namely equity of all compute tasks and deadlock freeness. To ease the parallelization, this framework is applied to the efficient domain decomposition. Thereby we aim to treat real world examples faster (speed up) and to increase the data range and precision (size up).

Description

Our goal is to integrate parallelism into the already existing `Fortran` application. A first step of such a parallelization has already been achieved by using ORWL on a process level. By that, the parallelized code can now run on a cluster of compute nodes. Nevertheless a more fine grained parallelization on the level of threads is in order, such that it better uses the resources that are available inside a typical modern machine.

In particular, this internship comprises the following tasks:

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[1] http://icube-icps.unistra.fr/index.php/Jens_Gustedt

1. The data handling of the exisiting code has to be redefined, such that several components of the decomposition can be dealt with independently within the same process.
2. The existing parallelization will be extended to the thread-level.
3. A task distribution algorithm that is based on the tree-like structure of the decomposition will be designed and implemented.
4. The parallel application will be verified for correctness.
5. Rigorous benchmarking will be used to assess possible improvements experimentally.

Framework

The internship will start as soon as convenient for a period of 4 to 6 months.

It will take place on the Illkirch university campus, which has a direct tram connection to downtown Strasbourg.

We will establish an internship convention with the student and their home university.

The internship will be paid at the level of the French legal gratuity for interships of about 525 € / month.

Applications

Applications should comprise a short CV and a specific motivation letter, but may additionally contain other information that you think useful for us to appreciate your skils, e.g your grades in relevant courses, work that you have written or letters from actual or former teachers. They should be mailed to Jens Gustedt[2].

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[2] jens dot gustedt at inria dot fr