Course Outline

Lecturers

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Purpose of Module

Software is no longer sequential. Many programs now have to be executed on several computing engines in parallel. At the same time the range of machines that contribute to such parallel computations are getting very diverse, including classical multi-core systems with shared memory, distributed systems, heterogeneous systems building on accelerators such as GPUs, or even mobile systems. This module explores technologies that enable the programming and use of such parallel and distributed systems.

The course starts by reviewing basic concepts of parallel and distributed systems including brief overviews of the need for parallelism, system architectures and programming approaches. Subsequently, the main focus is on parallel programming models including

- explicit accelerator (GPU) programming using OpenCL,
- explicit distribution using MPI with C,
- explicit shared-memory programming using OpenMP,
- functional task parallelism using Glasgow parallel Haskell,
- skeleton programming using Hadoop,
- data parallelism using SaC.

The course also provides revisions of C and Haskell to ensure a sufficient level of background knowledge in these languages and their tools. Students not fluent in these languages will need to allocate extra time for revision.

Tutorials & Labs

During the course there will be tutorial/problem classes. The lab sessions will take place in 2.50 in the normal Friday lecture slot. Lab assistance will be available for at least one and up to two hours.
Structure of Module

The following schedule is a plan that may evolve over the coming months!

Week 1 (HWL)
- Introducing Parallelism (HWL)
- C Revision I
- C Revision II
- C Tutorial

Week 2 (HWL)
- Communication Libraries (MPI) I
- Communication Libraries (MPI) II
- MPI Tutorial

Week 3 (SBS)
- The programming model of OpenCL
- Writing your first OpenCL application
- OpenCL Tutorial

Week 4 (SBS)
- Advanced OpenCL topics I
- Advanced OpenCL topics II
- OpenCL Tutorial II

Week 5 (SBS)
- OpenMP I
- OpenMP II
- OpenMP lab

Week 6 (HWL)
- Haskell I
- Haskell II
- Haskell lab

Coursework Deliverable due

Week 7 (HWL)
- Glasgow parallel Haskell (GpH) I
- Glasgow parallel Haskell (GpH) II
- GpH Lab

Week 8 (SBS)
- Data-Parallel Programming I
- Data-Parallel Programming II
- SaC Tutorial

Week 9 (SBS)
- Thinking arrays I
- Thinking arrays II
- SaC lab
Coursework

Students will undertake two pieces of coursework comparing low-level and high-level parallel software engineering technologies using both the department’s Beowulf cluster, and multicore resources. Each coursework will be done in pairs, with each student picking one implementation technology. The coursework will handed out in weeks 4 and 10 and deliverables are due at the end of weeks 6 and 12.

Course Materials

Vision and Web Support

There are Vision and web pages providing supporting materials, e.g. copies of lecture notes, and tutorial sheets and solution:

http://www.macs.hw.ac.uk/~hwloidl/Courses/F21DP

Reading List

No single book or web resource covers the course, but recommended reading is associated with many lectures, and some resources are listed on the above course web page:

http://www.macs.hw.ac.uk/~hwloidl/Courses/F21DP/#reading