Linnæus University

Jnr: 2019/1454-3.1.2.2

Course syllabus

Faculty of Technology
Department of Computer Science and Media Technology

4DV657 Parallelldatorprogrammering, 5 högskolepoäng
Parallel Computing, 5 credits

Main field of study
Computer Science

Subject Group
Informatics/Computer and Systems Sciences

Level of classification
Second Level

Progression
A1N

Date of Ratification
Approved by Faculty of Technology 2019-04-29
The course syllabus is valid from spring semester 2020

Prerequisites
General entry requirements for second cycle studies and specific entry requirements:

- English B/6 or the equivalent.

Objectives

After completing the course the student shall be able to:

- Explain the main similarities and differences between concurrent and parallel programs,
- describe different types of parallel computers and accelerators, and reason about which type is best for a given problem,
- describe the state of the art of parallel computer and accelerators as well as how these are programmed,
- decompose a problem, formulate a parallel algorithm to solve it, and implement it on a parallel computer and accelerator using, e.g., OpenMP, CUDA, or MPI,
- plan and deploy a (virtual) cluster and software (e.g., MPI) to solve a specific type of problem,
- given a problem and an implementation, reason about expected performance and ways to increase it, and
- reflect on the cost of solving certain types of problems, e.g., with respect to economic costs and energy/environmental costs, as well as how these are impacted by the choice of architecture, algorithm, etc.

Content

The course advances the students knowledge of how problems can be solved by parallel processing and accelerators (e.g., graphic processors), how problems are decomposed into parallel parts, and how programs can be optimized for different computer and accelerator architectures.
The following topics are covered:

- Introduction to homogeneous and heterogeneous parallel computers.
- Introduction to graphics processors and accelerators.
- How problems are decomposed to enable parallel execution.
- OpenMP.
- How to write programs for computer clusters using, e.g., MPI.
- How to write programs for graphics processors using, e.g. CUDA.
- Parallel patterns, such as prefix sum, map-reduce, matrix calculations, merge sort, and graph search.
- Examples of how parallel processing is used within different domains, such as machine learning, image processing, and image analysis.
- How to plan and deploy (virtual) clusters and parallel application in a cloud.
- Common benchmarks and how they are used to evaluate performance.
- Tools to test and debug parallel programs.

Type of Instruction

The instruction consists of lectures, seminars, and teacher-supervised laboratory sessions. The course also contains a series of guest lectures where representatives from industry and research discuss how and why they use parallel computers and accelerators in their work and how they use these to solve problems.

Examination

The course is assessed with the grades A, B, C, D, E, Fx or F.
The grade A constitutes the highest grade on the scale and the remaining grades follow in descending order where the grade E is the lowest grade on the scale that will result in a pass. The grade F means that the student's performance is assessed as a fail (i.e. received the grade F). Assessment of student performance is made through theoretical assignments, programming assignments, and a written exam. Students who do not pass the regular examination will be offered retrials close to the regular examination.
To pass the course, grade E or higher is required for all parts. The final grade is decided from: programming assignments (70%) and written exam (30%).

Repeat examination is offered in accordance with Local regulations for courses and examination at the first and second-cycle level at Linnaeus University.
If the university has decided that a student is entitled to special pedagogical support due to a disability, the examiner has the right to give a customised exam or to have the student conduct the exam in an alternative way.

Course Evaluation

During the implementation of the course or in close conjunction with the course, a course evaluation is to be carried out. Results and analysis of the course evaluation are to be promptly presented as feedback to the students who have completed the course. Students who participate during the next course instance receive feedback at the start of the course. The course evaluation is to be carried out anonymously.

Other

Grade criteria for the A-F scale are communicated to the student through a special document. The student is to be informed about the grade criteria for the course by the start of the course at the latest.

The course is conducted in such a way that the course participants' experiences and knowledge are made visible and developed. This means, for example, that we have an inclusive approach and strive for no one to feel excluded. This can be expressed in

different ways in a course, for example by using the gender-neutral example.

Required Reading and Additional Study Material

Required reading:

- Kirk, David and Hwu, Wen-mei, *Programming Massively Parallel Processors - A Hands-on Approach*, third edition, Morgan Kaufmann, 2016, ISBN: 0124159923. Pages: 500 of 576
- Compendium of scientific articles. Approximately 100 pages.