Module Description

Parallel computation and algorithms

General Information

Number of ECTS Credits

3

Module code

TSM_ProgAlg

Responsible of module

Pierre Kuonen, HES-SO

Language

Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Berne	Lausanne		Lugano	Zurich		
Instruction	☐ E 100%	☐ E 100%	☑ F 100%	☐ E 100%	☑ E 100%		☐ D 100%
Documentation	☐ E 100%	☐ E 100%	☑ E 50% ☑ F 50%	☐ E 100%	☑ E 100%	☐ E %	☐ D %
Examination	☐ E 100%	☐ E 100%	☐ E 100% ☑ F 100%	☐ E 100%	☑ E 100%	☐ E 100%	☐ D 100%

Module category

- ☐ FTP Fundamental theoretical principles
- ☑ TSM Technical/scientific specialization module
- ☐ CM Context module

Lessons

2 lecture periods and 1 tutorial period per week

Entry-level competencies

Prerequisites, previous knowledge

- ☐ Procedural and object oriented programming
- ☐ Software engineering (UML or other)
- ☐ Basic notion of algorithms and complexity

Brief course description of module objectives and content

The objective of this module is to provide the student with an introduction to parallel computing and algorithms. The first part of the course will be dedicated to the architectures of parallel infrastructures, the different theoretical models for these architectures and the different programming models and tools for programming such architectures. The second part will be dedicated to the study of a number of classical parallel algorithms. This course includes practical work to train the student in the use of parallel computing.

Aims, content, methods

Learning objectives and acquired competencies

At the end of the course the student knows:

- The most common heterogeneous parallel hardware infrastructures
- The different ways to model and efficiently program these architectures
- How to choose the proper parallel algorithm to write an application for solving a specific problem on a specific architecture
- How to efficiently program this application
- How to assess the performance of this application

Contents of module with emphasis on teaching content

Introduction

- Different architectures of parallel infrastructures
- Communications models and communication costs
- Performance metrics for parallel systems
- Scalability of parallel systems

Heterogeneous shared memory systems

- Architecture of widely used multi-core systems
- Parallel programming models (OpenMP)
  Distributed memory systems
- Communication operations and their costs
- Message passing paradigm (MPI)
- Distributed object paradigm
  Parallel algorithms
- Asymptotic analysis of parallel programs
- Decomposition techniques
- Mapping techniques for load balancing
- Matrix-vector and matrix-matrix multiplication
- Parallel sorting algorithms
- Parallel Graph and optimization algorithms

Teaching and learning methods

This course involves theoretical presentations and practical exercises or laboratories. Some of the exercises or laboratories are programming exercises that can be done at home by accessing a parallel infrastructure made available through the internet.

Literature

A. Introduction to Parallel Computing, Zbigniew J. Czech, Cambridge University Press, 2017

B. An Introduction to Parallel Programming, 1st edition, Peter Pacheco , Morgan Kaufmann Publishers Inc, 2011

Assessment

Certification requirements for final examinations (conditions for attestation)

Some exercises or laboratories could be mandatory.

Basic principle for exams:
All the standard final exams for modules are written exams.
The repetition exams can be either written or oral.

Standard final exam for a module and written repetition exam

Kind of Exam	written
Duration of exam	120 minutes
Permissible aids	☐ no aids
	☑ permissible aids:
	☐ Electronical aids: _____
	☐ Hardcopy form: _____
	☑ A handwritten summary of a fixed number of pages given by the lecturer.

Special case: Repetition exam as an oral exam

If an oral exam is set (only possible for ≤ 4 students), the following applies:

Kind of Exam	oral
Duration of exam	30 minutes
Permissible aids	no aids