IS1240
High Performance Computing for Engineering and Finance

Professor: Frédéric Magoulès

Language of instruction: English* – **Number of hours**: 36 – **ECTS**: 3

Prerequisites: Basic knowledge in linear algebra (matrix, vector), numerical analysis (direct methods, iterative methods), and programming.

Period: S8 Elective 09 February to April IN28IE2, SEP8IE2

Course Objectives

To provide an overview of the state of the art of high performance computing as applied to engineering and finance. Special references will be given to parallel and distributed computing and how serial or sequential algorithms problems may be parallelized for the efficient solution of large scale problems in computational engineering, financial engineering, analysis, simulation and design.

On completion of the course, students should be able to

- understand modern computer architecture
- have good knowledge of numerical methods well suited for parallel and distributed computing
- be familiar with parallel and distributed programming

Course Contents

- Architecture of scientific computer: type of parallelism, memory architecture.
- Parallelism and programming models: parallelization, performance criteria, data parallelism, vectorization, message passing.
- Parallel algorithm: recursive parallel algorithm, matrix-matrix product, spatial distribution
- Direct methods for large linear systems: LU factorization, Gauss algorithm, Gauss-Jordan algorithm, Crout and Cholesky factorization for symetric matrices
- Parallel factorization of dense and sparse matrices: block factorization, implement of the block factorization in a message passing environment, symbolic factorization, renimbering, elimination tree, bissection methods.
- Iterative methods for large linear systems: Lanczos method, conjugate gradient method, GMRES method, ORTHODIR method, etc.
- Parallelization of Krylov's methods: parallelization of dense matrix-vector product, parallelisation of sparse matrix-vector product

Course Organization

Lectures: 18 hr, Tutorials: 9 hr, Labwork: 9 hr

Evaluation

Project with written report and oral defense + final written exam_