Numerical Methods (5CFU)

(PhD Program in Natural Risks Assessment and Management (NRAM))

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Program

Lesson 1 (3h - Laboratory) *Matlab.* Operations with scalars and arrays. Mathematical functions: definition, evaluation, plot. Fundamentals of graphics in Matlab. Matlab statements: for-loop, while-loop, if-statements. Programming in Matlab: scripts, functions. Input and Output: read and write data files.

Lesson 2 (3h) *Fundamentals of numerical analysis and scientific computing.* Floating point arithmetic: the floating point system, rounding errors, machine precision, propagation of rounding errors. Stability, consistency and convergence of numerical methods. Approximation (truncation) errors. About computational costs.

Lesson 3 (3h) *Linear systems.* Direct methods: Gauss Elimination, LU and Cholesky factorizations. Iterative methods: Gradient and Conjugate Gradient methods. Condition number and stability analysis.

Lesson 4 (3h Laboratory) Exercises and programming: propagation of rounding errors, linear systems

Lesson 5 (3h) *Approximation of derivatives.* Finite differences for the 1D Poisson equation. Approximation of the 1st-order Cauchy problem: Euler methods, Crank-Nicolson method. Convergence, consistency and stability in approximating ordinary differential equations.

Lesson 6 (3h Laboratory) Exercises and programming: approximation of derivatives. Poisson equation, 1st-order Cauchy problem.

Lesson 7 (3h Laboratory) Theory: high order numerical methods for ODEs, the 1d heat equation. Programming: the heat equation