

# Financial engineering

## Aim

This course deals with numerical methods used in quantitative finance. Emphasis is placed on numerical option pricing methods and their practical implementation in MATLAB, but we also cover numerical methods for portfolio optimization.

## Content

### Part 1: Numerical methods

- Issues in numerical analysis. Computational complexity, convergence, numerical stability, conditioning.
- Numerical linear algebra. Direct and iterative methods to solve systems of linear equations.
- Function approximation. Issues with polynomial interpolation. Splines and their variants.
- Solving nonlinear equations. Bisection, Newton's method, optimization-based approaches.
- Numerical integration. Quadrature methods, Gaussian quadrature, Monte Carlo and quasi-Monte Carlo methods.

### Part 2: Option pricing

- Sample path generation for stochastic processes; stochastic and deterministic approaches to discretization.
- Option pricing by lattices and trees.
- Option pricing and risk measurement by Monte Carlo methods.
- Variance reduction and low-discrepancy sequences.
- Option pricing by finite differences.

### Part 3: Portfolio optimization

- Numerical optimization methods
- Application to portfolio optimization

## Bibliography

- P. Brandimarte *Numerical Methods in Finance and Economics: A MATLAB-Based Introduction* (2nd ed.). Wiley, 2006.
- P. Brandimarte. *Handbook in Monte Carlo Simulation: Applications in Financial Engineering, Risk Management, and Economics*. Wiley, 2014.