Approximations in Scientific Computations

- Concepts
  - Absolute error, relative error
  - Computational error, propagated data error
  - Truncation error, rounding error
  - Forward error, backward error
  - Condition number, stability
  - Cancellation
Solutions of Nonlinear Equations

- Concepts
  - Multiplicity
  - Sensitivity
  - Convergence rate

- Basic methods
  - Interval bisection method
  - Fixed-point iteration
  - Newton’s method
  - Secant method, Broyden’s method
  - Other Newton-like method
Numerical Optimization

- Concepts
  - Unconstrained optimization, constrained optimization (linear vs. nonlinear programming)
  - Global vs. local minimum
  - First- and second-order optimality condition
  - Coercive, convex, unimodality

- Methods for unconstrained optimization
  - Golden section search
  - Newton’s method, Quasi-Newton methods (basic ideas)
  - Steepest descent, conjugate gradient (basic ideas)

- Methods for constrained optimization (especially equality-constrained optimization)
  - Lagrange multiplier for constrained optimization
  - Lagrange function and its solution
  - Linear programming
Polynomial interpolation

Concepts
- Existence and uniqueness
- Interpolation vs. approximation
- Accuracy; Runge’s phenomena

Methods
- Monomial basis
- Lagrange interpolant
- Newton interpolation and divided difference
- Orthogonal polynomials