Math 4630/6630 * Nonlinear Optimization * Spring 2021

Course outline

The course covers theory and techniques for both unconstrained and constrained optimization in a general (nonlinear) setting. The emphasis is on methods that are useful for solving real problems, although important theoretical ideas such as convexity and the Karush-Kuhn-Tucker conditions are also covered. We primarily discuss local optimization methods, although discussion of appropriate global optimization methods can be included in the paper.

The following topics will be covered.

- 1. Introduction
  - Optimization models
  - Conditions for optimality
  - Local versus global optimality
  - Convexity
  - Convergence analysis
- 2. Theory of constrained multi-dimensional optimization
  - Lagrange multipliers
  - Karush-Kuhn-Tucker conditions
- 3. Unconstrained one-dimensional methods
  - A. Derivative-zeroing methods
    - Newton's method
    - Bisection
    - Regula falsi
    - Secant method
  - B. Non-derivative methods
    - Bracketing framework
    - Golden section method
    - Quadratic interpolation
  - C. Cubic interpolation
- 4. Unconstrained multi-dimensional methods
  - A. Smooth functions
    - Line search framework
    - Taylor polynomials
    - Newton's method
    - Steepest descent
    - Quasi-Newton methods
    - Conjugate gradient methods
    - Convergence for line search framework
    - Trust region framework
  - B. Noisy functions
    - Nelder-Mead simplex method
    - Hooke-Jeeves pattern search
- 5. Constrained methods
  - Barrier functions
  - Penalty functions, including augmented Lagrangians
  - Sequential quadratic programming