

**April 8, 2009**

## **Numerical optimization and nonlinear systems syllabus**

One dimensional case:

Newton method for nonlinear equations and unconstrained minimization. Local quadratic convergence of Newton's method. Secant method.

Several dimensions:

- Newton's method for nonlinear systems  
Local convergence; finite difference derivative method for nonlinear systems
- Newton's method for unconstrained minimization  
Finite difference derivative method for minimization

Globally convergent Newton-type methods

- Quasi-Newton framework; descent directions.
- Line searches; Model-trust region approach and its implementations (hook, double dogleg step)
- Global methods for nonlinear systems.

Scaling and stopping

Secant methods for nonlinear systems

Broyden's methods, its local convergence and implementation of quasi-Newton with Broyden's update

Secant methods for unconstrained minimization

Symmetric secant Powell update; symmetric positive definite (BFGS) updates; local convergence of positive definite secant updates; implementation of quasi-Newton algorithms with positive definite secant updates

Nonlinear least squares

- Gauss-Newton type methods; full Newton's type methods

*Minimization for large scale systems: iterative solution methods for the solution of linear problem.*

*Minimization with bound constraints*

## **References:**

J.E. Dennis and R.B. Schnabel: Numerical methods for Unconstrained Optimization and Nonlinear Equation, SIAM, Philadelphia 1996 (primary reference): Chapters 1-10

C.T. Kelley: Iterative Methods for Linear and Nonlinear Equations, SIAM, Philadelphia, 1995

C.T. Kelley: Iterative Methods for Optimization, SIAM, Philadelphia, 1999 (primary reference for topics in *Italic*)