

Optimization Topics List

Revised August, 2013

Starting in Fall 2013, we will adopt the reading list below. The format of the exam will be to answer 4 questions drawn from material in the courses CS525, CS720, CS726, and CS730.

Linear Programming

- Primal simplex method
- Dual simplex method
- Duality theory
- Parametric programming and sensitivity analysis
- Degeneracy
- Linear complementarity problems
- Interior point methods

Primary references

1. M. C. Ferris, O. L. Mangasarian & S. J. Wright, *Linear Programming with MATLAB*, SIAM, 2007
2. D. Bertsimas and J. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, 1997
3. R. J. Vanderbei, *Linear Programming: Foundations and Extensions*, Kluwer, 1996

Integer Programming

- Modeling
- Branch and bound methods
- Cutting plane methods
- Decomposition: Lagrangian relaxation and column generation. Benders decomposition.
- Polyhedral theory
- Valid inequalities

Primary references

1. G. Nemhauser and L.A. Wolsey, *Integer and Combinatorial Optimization*, Wiley, 1988.
2. L. A. Wolsey, *Integer Programming*, Wiley, 1998

Nonlinear Programming

- Optimality conditions:
 - first-order conditions (including Karush-Kuhn-Tucker conditions for constrained optimization)
 - second-order necessary and sufficient conditions
 - constraint qualifications
- Theorems of the alternative
- Geometry of convex sets
- Convex functions and their conjugates
- Duality
- Unconstrained optimization theory and algorithms:
 1. first-order methods
 2. line search and trust-region approaches
 3. Newton's method and variants
 4. quasi-Newton methods
 5. conjugate-gradient
 6. derivative-free optimization
 7. least-squares problems
 8. stochastic gradient methods
- Constrained optimization theory and algorithms
 1. Gradient projection methods
 2. Penalty and merit functions
 3. Augmented Lagrangian
 4. Sequential quadratic programming
 5. Interior-point methods
 6. Stability and sensitivity
 7. Semidefinite programming

Primary references

1. J. Nocedal and S. J. Wright, *Numerical Optimization*, 2d Ed., Springer, 2006
2. A. Ruszczyński, *Nonlinear Optimization*, Princeton, 2005.
3. S. Boyd and L. Vandenberghe, *Convex Optimization*, Cambridge University Press, 2004. (Available for download at <http://www.stanford.edu/~boyd/cvxbook/>)
4. R.T. Rockafellar, *Convex Analysis*, Princeton, 1970