

Course Outline for MATH 4653, Numerical Optimization

MATH 4653 Numerical Optimization (3 units)

Prerequisite: Graduate standing in Mathematics, MATH 451, or [MATH 3651](#). Recommended: MATH 306 or [MATH 3152](#).

Algorithms for solving constrained and unconstrained optimization problems. Line searches, gradient methods, Newton's method; conjugate gradient, backpropagation, and global search methods. Linear programming and nonlinear constrained optimization methods including simplex and non-simplex methods. 3 lectures. Formerly MATH 453.

Course Learning Objectives	
1	Analyze and implement line-search methods, gradient methods, Newton's method, and the method of conjugate gradients.
2	Implement the backpropagation algorithm for training a neural network.
3	Analyze and implement global search methods such as the Nelder-Mead simplex algorithm, simulated annealing, particle swarm, and genetic algorithms.
4	Implement and analyze linear programs using row operations and the Simplex method.
5	Construct and solve the dual problem associated with a linear programming problem using Simplex and non-Simplex methods.
6	Formulate and solve nonlinear constrained optimization problems.

Expanded Course Content

Textbooks, materials, and/or other resources
Edwin K. P. Chong and Stanislaw H. Zak. "An Introduction to Optimization", Wiley (2013).

Week	Readings	Topics of Discussion
1	Chapters 1 - 5	Mathematical review
2	Sections 6.1, 6.2	Basics of set-constrained and unconstrained optimization
3	Sections 7.2, 7.5, 7.6, 7.8	One-dimensional search methods
4	Sections 8.2 - 9.2	Gradient methods; Newton's method

Week	Readings	Topics of Discussion
5	Sections 10.2, 10.3, 10.4	Conjugate direction methods
6	Sections 11.3, 11.4, 1.5	Quasi-Newton methods
7	Sections 12.1, 12.2	Solving linear equations
8	Sections 13.2, 13.3	Unconstrained optimization and neural networks
9	Chapter 14	Global search algorithms
10	Chapter 15	Introduction to linear programming
11	Sections 16.1, 16.4	Simplex method
12	Sections 17.1 - 18.2	Duality and nonsimplex methods
13	Sections 19.2, 19.3	Integer linear programming
14	Sections 20.2, 20.4, 21.1	Problems with equality and inequality constraints
15	Sections 22.3, 23.3, 23.4, 23.5	Convex optimization problems and algorithms for constrained optimization

Method of Assessment

The possible methods of assessment are written individual examinations, quizzes, in-class worksheets and presentations, projects, and homework. One or more midterms and a cumulative final exam are required.

Instructional Mode

The instructional mode for this class is face-to-face. This designation means that the essential academic standards of the course require in-class student engagement, and thus remote instruction is not appropriate.