6.215/6.255J/15.093J/IDS.200J
Optimization Methods

4-0-8 units

Fall 2021, updated draft, 9/7/2021

Instructor:	Patrick Jaillet
TAs:	Amine Bennouna, Moise Blanchard, Victor Gonzalez, Tetiana Guzak, Yi-Lun Liao
Lectures:	TR 1-2:30pm (**32-123**)
Canvas:	https://canvas.mit.edu/courses/11155
Piazza:	https://piazza.com/mit/fall2021/6255
Recitations:	**F 10-11am (32-141), or F 1-2pm (32-155)**
Staff e-mail:	6.255@mit.edu (for personal issues, not related to the content of the subject)

Summary description

This course introduces the principal algorithms for linear, network, discrete, robust, nonlinear, and dynamic optimization. It emphasizes methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton's method, heuristic methods, and dynamic programming. At the end of the course you should be able to:

1. understand in detail the different classes of optimization problems discussed in class, as well as the relative advantages among different formulations,
2. be able to identify what optimization methodologies are the most appropriate when faced with a concrete problem,
3. be familiar with the geometric, algebraic, and computational aspects of linear optimization problems, and their associated duality and sensitivity properties.

Prerequisites

Calculus, Linear algebra (18.06 or equivalent), some familiarity with computational tools (e.g., Julia) and mathematical maturity.

Required Text

The required textbook is: D. Bertsimas and J. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, Belmont, MA, 1997.

Course Requirements

Problem sets (approximately handed out on a bi-weekly basis with two-week deadlines) one midterm examination, and one final examination. Grades will be determined by performance on the above requirements weighted as 30% problem sets, 30% midterm exam, and 40% final exam. Problem sets are due at the beginning of the lectures on the respective due dates. These are hard deadlines, with no extensions granted, as solutions are posted at the end of the lectures on these due dates.

Collaboration policy

In the case of the written homework assignments, your assignment write-up may be done in pairs. If you can not find a team mate the TAs will be happy to help you along. You may also interact with other fellow students (not in your pair) when preparing your homework solutions. However, at the end, each pair must write up solutions on their own. Duplicating a solution that someone else has written (verbatim or edited), or providing solutions for another pair to copy is not acceptable.

During the midterm and the final examination, any student who either receives or knowingly gives assistance or information concerning the examination will be in violation of the policy on individual work.

Tentative Schedule

Lec.	Time	Topic	Readings in BT	Homework
1.	Th, 9/9	Applications of Linear Optimization	Ch. 1	
2.	T, 9/14	Geometry	Ch. 2	1 out
3.	Th, 9/16	Simplex Method I	Ch. 3	
4.	T, 9/21	Simplex Method II	Ch. 3	
5.	Th, 9/23	Duality Theory I	Ch. 4	
6.	T, 9/28	Duality Theory II	Ch. 4	1 due, 2 out
7.	Th, 9/30	Sensitivity Analysis	Ch. 5	
8.	T, 10/5	Large Scale Optimization	Ch. 6	
9.	Th, 10/7	Network Flows I	Ch. 7	
10.	T, 10/12	Network Flows II	Ch. 7	2 due
11.	Th, 10/14	Applications/Review/Recap		
	F, 10/15	Midterm Exam, 1.5-hr	Lec. 1-10	
12.	T, 10/19	Robust Optimization	Lecture note	3 out
13.	Th, 10/21	Applications of Discrete Optimization	Ch. 10	
14.	T, 10/26	Branch and Bound and Cutting Planes	Ch. 11	
15.	Th, 10/28	Lagrangean Methods	Ch. 11	
16.	T, 11/2	Heuristics and Approximation Algorithms	Ch. 11	3 due, 4 out
17.	Th, 11/4	Dynamic Programming	Ch. 11	
18.	T, 11/9	Applications of Nonlinear Optimization	Lecture note	
	Th, 11/11	No class		
19.	T, 11/16	Optimality Conditions	Lecture note	4 due, 5 out
20.	Th, 11/18	Gradient Methods	Lecture note	
21.	T, 11/23	Newton Methods	Lecture note	
	Th, 11/25	No class		
22.	T, 11/30	Interior Point Methods I	Ch. 9	5 due
23.	Th, 12/2	Interior Point Methods II	Ch. 9	
24.	T, 12/7	Semidefinite Optimization	Lecture note	
25.	Th, 12/9	Review/Additional topics		
	12/13-12/17 (TBD)	Final Exam, 3-hr	Lec. 1-24	