ISE 631: Linear Programming
Fall 2016

Time: T, Th 11am-12:20pm
Location: KAP 164

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Catalogue Description

To be taught with rigor, this is the first doctoral course in the field of optimization that serves as the foundation for all subsequent courses in the broad area of mathematical programming. As such, the course is intended for first-year Ph.D. students and advanced M.S. students who intend to pursue a doctoral degree and who are ready for the course.

Expanded Course Description

Modern-day optimization provides a versatile modeling framework and a powerful computational toolset for solving a host of planning problems in operations research, decision making problems in management science, design problems in engineering, investment problems in finance, and equilibrium problems in economics. Lying at the heart of all optimal planning problems under constraints, linear programming provides the entry to the field of optimization, forms the foundation for understanding all optimization problems with constraints, and allows for extensions to the treatment of problems involving nonlinearity, uncertainty, discrete variables, and logical constraints, as well as for multi-agent non-cooperative games and hierarchical problems. Topics covered in this course include linear programs as a modeling tool, the simplex method and its extensions, duality theory, sensitivity and parametric programming, theory of polyhedra, theorems of the alternatives, Dantzig-Wolfe decomposition, interior-point methods, a touch of stochastic and integer programs, and if time permits, some network flow problems.

Learning Objectives

The purpose of this course is to lay down the foundation for students interested in optimization. It begins with an introduction of linear programs as a modeling tool and gives examples of applied problems in diverse disciplines that can be formulated as linear problems. This is followed by a rigorous treatment of the theory of polyhedra that leads to the basic simplex method for solving a linear program and the many variants of this method. The role of these pivoting methods in sensitivity and parametric analysis is explained. Theorems of the alternatives are demonstrated that provide a deeper understanding of the theory of linear inequalities. Relying on a basic resolution theorem of polyhedra, the Dantzig-Wolfe decomposition method is introduced for solving large-scale specially structured linear programs. Interior-point methods are briefly described that provide an efficient alternative to the simplex method. Together, simplex and interior-point methods are implemented in modern-day computer softwares for solving linear programs that are capable of very efficiently and robustly handling problems of huge size. The lectures will be supplemented by many exercises ranging from easy applications to challenging extensions of the presented materials.

Prerequisite(s)

One-year of calculus; and one semester of linear and matrix algebra.

Course Notes

Additional readings and notes beyond the main texts used in the lectures will be provided by the instructor as needed.

Required Text

Dimitris Bertsimas and John N. Tsitsiklis. *Introduction to Linear Optimization.* Athena Scientific, Boston (1997).

Throughout the course, we refer to this book as "BT".

Description and Assessment of Assignments

Exercises will be mostly drawn from the required text with some exceptions.

Grading Breakdown

Students will be graded based on bi-weekly homework assignments (30%), one mid-term exam (30%), and one final exam (40%).

Course Schedule (tentative)
Please turn over.

Lec.	Date	Topic	Read BT	Homework
1	T, 08/23	Introduction to Linear Optimization	Ch. 1	
2	Th, 08/25			1 out
3	T, 08/30			
4	Th, 09/01	Geometry of Linear Optimization	Ch. 2	
5	T, 09/06			1 due, 2 out
6	Th, 09/08			
7	T, 09/13			
8	Th, 09/15	The Simplex Method	Ch. 3	
9	T, 09/20			2 due, 3 out
10	Th, 09/22			
11	T, 09/27			
12	Th, 09/29	Julia/JuMP	online material	
13	T, 10/04	Duality Theory	Ch. 4	3 due
14	Th, 10/06			
15	T, 10/11	MIDTERM EXAM		
16	Th, 10/13	Duality Theory, cont'd	Ch. 4	4 out
17	T, 10/18			
18	Th, 10/20			
19	T, 10/25	Sensitivity Analysis	Ch. 5	
20	Th, 10/27			
21	T, 11/01			
22	Th, 11/03	Large Scale Optimization	Ch. 6	4 due, 5 out
23	T, 11/08			
24	Th, 11/10	Integer Programming	Ch. 9	
25	T, 11/15	Integer Programming (INFORMS conference?)		
26	Th, 11/17	Integer Programming, cont'd	Ch. 9	5 due, 6 out
27	T, 11/22	Interior Point Methods	Ch. 10	
28	Th, 11/24	Thanksgiving Day - No class		
29	T, 11/29	Interior Point Methods, cont'd	Ch. 10	6 due
30	Th, 12/01	Review Lecture		

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism –– presenting someone else's ideas as your own, either verbatim or recast in your own words –– is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* and consult https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* provides certification for students with disabilities and helps arrange the relevant accommodations; consult http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.