Fall 2019 — ORIE 3300/5300
OPTIMIZATION I (Linear programming)
Instructor: Adrian Lewis

Course outline

Planning, scheduling, and design problems in large organizations or engineering systems can often be modeled mathematically using decision variables that must satisfy linear equations and inequalities. Planners seek good solutions by maximizing or minimizing linear objective functions in the variables, often modeling profits or costs. The formulation of these models, and their solution and interpretation, is called *linear programming*. This course introduces the underlying theory (a natural extension of linear algebra), modeling for concrete problems, and computational solution and analysis using the AMPL modeling language.

Core topics

Each lecture topic lasts about one week.

1. Linear programs, graphical solution, optimal solutions, unboundedness, transforming to standard forms.
2. Building linear programming models.
3. Using AMPL to define linear programming models, and to solve and analyze.
4. Linear algebra review: linear independence, bases, matrices, elementary row operations, rank, invertibility. Basic solutions of linear equations, basic feasible solutions, convexity, extreme points.
5. The simplex method (as row operations on linear equations).
6. Recognizing optimality and unboundedness. Finding an initial feasible solution.
7. Degeneracy, finite termination of the simplex method, Bland's rule. The Fundamental Theorem.
8. Modeling using integer programs.
9. Solving integer programs by branch-and-bound. Using AMPL with CPLEX.
10. The simplex method in matrix format: the revised simplex method.
11. The Duality Theorem. Duality for linear programs in general forms.
12. Complementary slackness. Economic interpretations of duality.
13. Analyzing optimal solutions: sensitivity analysis and dual simplex.

Course administration

Instructor

Adrian Lewis (Rhodes 234, `adrian.lewis@cornell.edu`)

Teaching Assistants: to be announced

Prerequisite Linear algebra — MATH 2210 or MATH 2940.

Lectures Tuesdays and Thursdays, 11:40am–12:55pm, in Hollister Hall B14.

After each lecture I will post a summary on Blackboard. However, it is important to attend *all* lectures and to take complete notes — it is easiest to learn during lectures, and the material I present may differ from the summaries. Students should also attend their scheduled recitation each week.

Course material

The course (along with its successor ORIE 3310/5310) makes substantial use of the book *AMPL: A Modeling Language for Mathematical Programming*, 2nd Edition, (2003), by Fourer, Gay and Kernighan. All chapters of the AMPL book are free for download from `ampl.com/resources/the-ampl-book`.

I will place all announcements and other course material on Blackboard: check often.

Grading

Assignments	20%
Recitation attendance and exercises	10%
Prelim Exam 1 (7:30pm, Thursday October 10, rooms to be announced)	20%
Prelim Exam 2 (7:30pm, Tuesday November 12, rooms to be announced)	20%
Final Exam (to be announced)	30%

Email me about any *Prelim Exam conflicts* by Thursday, September 12.

Assignments are *individual* work: no collaboration.

Recitation computing exercises are the work of *declared pairs* or of individuals, and involve no collaboration outside declared pairs. Declare a pair by handing one copy of the first computing exercise with both names on the cover sheet. Normally, pairs should remain together for the semester. To dissolve or change a pair, email me *before* starting the new assignment.

I will discard each student's lowest assignment grade, providing it is at least 50%. The same policy applies to computing exercises. Assignments are typically due at 11am on Tuesdays. I will accept *at most one* late assignment from each student, submitted by 11am the following Friday: use this flexibility only when absolutely necessary.

Students must abide by the Cornell University Code of Academic Integrity. Any work submitted by a student for academic credit must be the student's own work. I allow collaboration only in the computing exercises, as described above.