Team Projects (plus more)
“For me, every day is a new thing. I approach each project with a new insecurity, almost like the first project I ever did. And I get the sweats. I go in and start working, I'm not sure where I'm going. If I knew where I was going I wouldn't do it.”

Frank Gehry (Architect)

“Don't undertake a project unless it is manifestly important and nearly impossible.”

Edwin Land
Overview of Lecture

- Comments on upcoming midterm
- Slack variables vs artificial variables.
- Information on projects
  - Two presentations of projects
    - Brian Chang (from 15.066, Systems opt.)
    - Noa Ben (from 15.066, Systems opt.)
Midterm 1

- Same topics as the review topics for quizzes 1 to 4
- Comparable level of difficulty as the quizzes
- Office hours Monday
- Optional review session  Monday, March 11, 7 PM to 8 PM.  E51-145.
  - covers material requested by students
  - answers questions from students
Slack variables vs. artificial variables

**Slack variables:** added when the original problem has a “≤” constraint.

**Original:** \[ x_1 + 2x_2 + x_3 - x_4 \leq 5 ; \]

**After slack:** \[ x_1 + 2x_2 + x_3 - x_4 + s_1 = 5 ; \]
\[ s_1 \geq 0 \]

**Original:** \[ D + E \leq 32 \]

**After slack:** \[ D + E + s_2 = 32 \]
\[ s_2 \geq 0 \]

**Note:** Slacks are (implicitly) part of the original problem. \[ s_2 = 32 - D - E \] is the “unsatisfied demand for e-readers.”
Slack variables vs. artificial variables

Artificial variables: added to a “=“ constraint of the original problem in creating a Phase 1 problem.

\[
\begin{align*}
\text{max} & \quad z = -3x_1 + x_2 + x_3 \\
\text{s.t.} & \quad x_1 + x_2 + x_3 = 4 \\
& \quad -2x_1 + x_2 - x_3 = 1 \\
& \quad x_1 \geq 0, \ x_2 \geq 0, \ x_3 \geq 0
\end{align*}
\]

Problem P

\[
\begin{align*}
\text{min} & \quad y_1 + y_2 \\
\text{max} & \quad v = -y_1 - y_2 \\
\text{s.t.} & \quad x_1 + x_2 + x_3 + y_1 = 4 \\
& \quad -2x_1 + x_2 - x_3 + y_2 = 1 \\
& \quad x_1 \geq 0, \ x_2 \geq 0, \ x_3 \geq 0, \ y_1 \geq 0, \ y_2 \geq 0
\end{align*}
\]

Problem P*

Note: Artificial variables were created so that they could be part of an initial bfs for P*. (Simplex needs an initial bfs).

The goal of Phase 1 is to find a solution \(x^*, y^*\) with \(y^* = 0\).
Slack variables vs. artificial variables

D + E ≤ 32
D + E + s₂ = 32
s₂ ≥ 0

It is OK for slack variables to be positive.

e.g. D = 25 and E = 5 and s₂ = 7.
The “≤” constraint is satisfied.

min y₁ + y₂
max v = −y₁ − y₂

s.t. x₁ + x₂ + x₃ + y₁ = 4
−2x₁ + x₂ − x₃ + y₂ = 1
x₁ ≥ 0, x₂ ≥ 0, x₃ ≥ 0, y₁ ≥ 0, y₂ ≥ 0

P* and P are different problems

It is OK for artificial variables to be positive in P*, but not P.

e.g. x₁ = x₂ = x₃ = 0, y₁ = 4, y₂ = 1 is feasible for P*.
But it is infeasible for P.
Team Projects
details are available on Stellar

- 3 or 4 person teams
- Project that applies optimization in practice
  - modeling
  - data collection
  - optimization and analysis
- Written presentation: 4 to 6 pages
- Oral presentation: 15 minutes.
Sample (very challenging) topics

- School bus scheduling
- Optimization in radiation therapy
- Exam scheduling at MIT or elsewhere
- Assigning K-12 students to public schools.
- Portfolio optimization
- Scheduling residents in hospitals
- Optimal location of cell phone towers
- Meal selection (and diet) problems.
- Optimal strategies for sports teams
- Optimal location of wind turbines.
- Optimal pricing problems.
- Optimal inventory control.
- Optimal truck routing.
Team Projects: Objectives

- Identify practical applications for concepts learned in class
- Conduct analysis while leveraging course material
- Learn about assorted real-life situations where optimization methods can be used
- Utilize a different approach for learning and mastering 15.053 concepts
- Learn about applying optimization in practice, including learning the difficulties that may be associated with finding the right data and forming a useful model.
Team Projects: Time frames

- 3 or 4 person teams formed by March 13
  - Students can select members of their teams.
  - We will assign students not on a team.

- Brief description of project is due on March 21

- Intermediate deliverables

- Project report due May 7

- Team presentations. May 13 to 17
Additional support: OR Consultants

- There are five OR Center Ph.D. students who have agreed to serve as internal consultants for the projects.

- They will provide limited guidance where needed.
  - suggestions on where to get data
  - advice on modeling
  - suggestions on software

- If you would like to meet with one of them, let us know.