Team Projects (plus more)

Quotes of the Day

"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.

$$\begin{aligned}
\max \quad & z = -3x_1 + x_2 + x_3 \\
\text{s.t.} \quad & x_1 + x_2 + x_3 = 4 \qquad \boxed{\textbf{Problem P}} \\
& -2x_1 + x_2 - x_3 = 1 \\
& x_1 \geq 0, \; x_2 \geq 0, \; x_3 \geq 0
\end{aligned}$$

$$\begin{aligned}
\min \quad & y_1 + y_2 \qquad \boxed{\max \quad v = -y_1 - y_2} \\
\text{s.t.} \quad & x_1 + x_2 + x_3 + y_1 \quad = 4 \qquad \boxed{\textbf{Problem P*}} \\
& -2x_1 + x_2 - x_3 + \quad y_2 = 1 \\
& x_1 \geq 0, \; x_2 \geq 0, \; x_3 \geq 0, \; y_1 \geq 0, \; y_2 \geq 0
\end{aligned}$$

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.

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Slack variables vs. artificial variables

$$D + E \leq 32$$

$$D + E + s_2 = 32$$

$$s_2 \geq 0$$

It is OK for slack variables to be positive.

e.g.   D = 25 and E = 5 and s_2 = 7.

The "≤" constraint is satisfied.

$$\min \quad y_1 + y_2 \qquad \boxed{\max \quad v = -y_1 - y_2}$$

$$\text{s.t.} \quad x_1 + x_2 + x_3 + y_1 = 4$$

$$-2x_1 + x_2 - x_3 + y_2 = 1$$

Problem P*

$$x_1 \geq 0, \ x_2 \geq 0, \ x_3 \geq 0, \ y_1 \geq 0, \ y_2 \geq 0$$

P* and P are different problems

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

e.g. $x_1 = x_2 = x_3 = 0$, $y_1 = 4$, $y_2 = 1$ 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.**

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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.**

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