Operations Research

Topics for Self-Study

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Self-study

- We have gone through thirteen lectures.
  - Linear programming.
  - Duality, network flow, integer programming.
  - Nonlinear programming.
- If this course is successful, now you should:
  - Be **able** to learn advanced materials by yourself.
  - Be **willing** to learn advanced materials by yourself.
- One way to test it is to see whether you take relevant courses.
  - Mostly in Business Administration, Industrial Engineering, Economics, and Computer Science.
  - And how well you do in those courses.
- Alternatively, we may leave you one week for **self-study**.

Self-study

- There is no lecture on 5/26.
  - The instructor will show up as usual.
- Three topics are assigned for you to study by yourselves.
- In the final exam on 6/2, there will be one problem for each topic, which counts for 10 bonus points.
- Why don't the instructor teach these topics?
  - We have no time to teach all the three topics.
  - If we choose one, the other two is gone.
  - Now a student may study the topic that interests her/him the most.
  - We may see whether students are able to learn by themselves.
- Each topic is contained in the textbook.
  - Searching for relevant materials by yourselves (libraries, Internet, senior students, etc.) are welcome.
  - The instructor will not talk about them.

Three topics

- Applications: Sensitivity analysis (Sections 7.1 and 7.2).
- Theory: Two-person zero-sum game theory (Sections 15.1–15.5).
- Algorithms: Genetic algorithms (Sections 14.1 and 14.4).

Topic 1: Sensitivity analysis

- Suppose that you have formulated an LP and solved it for a resource allocation problem.
- Then the problem changes:
  - The supply amount of a resource changes.
  - The sales price of a product changes.
  - The consumption of a resource for a product changes.
  - A new product may be produced.
  - A new resource is considered to create a new constraint.
- Goal: Given an original optimal solution, may we obtain a new optimal solution without solving the new LP from scratch?
- **Sensitivity analysis** is the key.
  - Prerequisites: mostly the simplex method; partly LP duality.

Topic 2: Two-person zero-sum game theory

- Game theory, as a branch of economics, offers an analytical framework to analyze the interaction among multiple decision makers.
- One type of game is a **two-person zero-sum game**.
  - There are two decision makers.
  - One's gain is the other's loss.
- Goal: How to find an **equilibrium**, i.e., a prediction on the result of the game?
  - Especially when the players can play mixed (randomized) strategies.
  - May a player's decision be found by solving an optimization problem?
  - What kind of properties do we have?
- Let's study **two-person zero-sum game theory**.
  - Prerequisites: LP duality.

Topic 3: Genetic algorithms

- In this course, most algorithms are not effective for non-convex programs.
  - Simplex, gradient descend, and Newton's methods do not work.
  - Branch-and-bound are quite time-consuming.
- For difficult optimization problems, people design **heuristic algorithms** to find a near-optimal solution in a reasonable time.
  - This is especially important when the feasible region is discrete (e.g., IP) or continuous but non-convex (e.g., general NLP).
- Let's study **genetic algorithms**.
  - Prerequisites: NLP and IP.

Let's try it!

- Select a topic and teach yourself!