SA305 – Linear Programming Spring 2013
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Lesson 1. Introduction

What is operations research?

- "The most influential academic discipline field you've never heard of" [Boston Globe, 2004]
- **Operations Research (OR)** is the discipline of applying advanced mathematical methods to help make better decisions
- "The Science of Better" [INFORMS slogan]
- "A liberal education in a technological world" [Thomas Magnanti, former Dean of Engineering at MIT]
- Numerous applications
  - manufacturing
  - operating systems
  - logistics
  - airline pricing
  - communications
  - finance
  - marketing

Historical connections between OR and the military

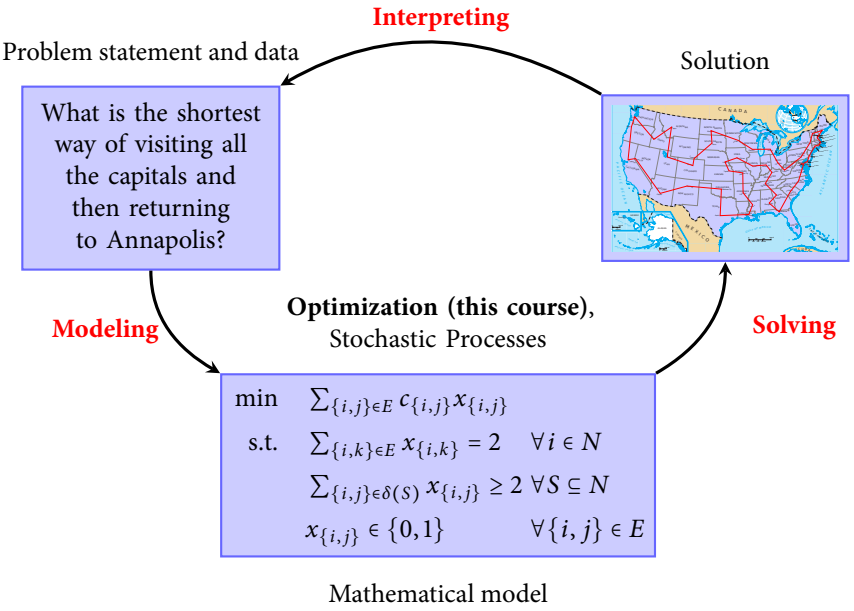
- 1930s: Britain – deployment of radar, aircraft maintenance and inspection, antisubmarine operations
- 1940s: US Navy – Antisubmarine Warfare Operations Research Group, Operations Evaluation Group established
- 1950s: Naval Postgraduate School OR program, *Naval Research Logistics Quarterly* established
- 1962: Center for Naval Analyses established

The traveling salesperson problem

- A saleswoman located in Annapolis wants to visit all 48 state capitals of the continental US sell her wares
- What is shortest way of visiting all the capitals and then returning to Annapolis?
- Entire books have been written on the TSP
- 1962: contest by Proctor and Gamble - best TSP tour through 33 US cities
- 1998: The Florida Sun-Sentinel's Science page ponders Santa Claus's traveling problem

- One of the most popular problems in operations research
- Numerous applications in expected and unexpected places
  - Circuit board manufacturing
  - Genome sequencing
- Your turn! Try to find the shortest way of visiting all the capitals and then returning to Annapolis
- What about 13,509 cities in the US?
- Sophisticated mathematical techniques are our best bet

The OR approach



Goals for this course

- Modeling
  - Recognize opportunities for mathematical optimization
  - Formulate optimization models – linear programs – that capture the essence of the problem
  - Illustrate applications of real-world problems
- Solving
  - Algorithms to solve these mathematical models
- Detailed topic list and schedule is on the syllabus

Optimization is everywhere

- "Minimize" time it takes to get from class to class
- "Maximize" the company's profits
- (Moneyball) "Best" lineup for the Oakland A's
- We are always trying to make **decisions** in a way that meets some **objective** subject to some **constraints**
- Some success stories of optimization helping solve complex real-world decision-making problems ...

Package delivery

- UPS has an air network consisting of 7 hubs, nearly 100 additional airports in the US, 160 aircraft of nine different types
- Decision:
- Objective:
- Constraints:
- UPS credits optimization-based planning tools with identifying operational changes that have saved over $87 million to date, reduced planning times, peak and non-peak costs, fleet requirements

Sports scheduling

- ACC Basketball earns over $30 million in revenue annually, almost all from TV and radio
- TV networks need a steady stream of "high quality" games, NCAA rules, school preferences and traditions
- Decision:
- Objective:

- Constraints:

- Optimization approaches yields reasonable schedules very quickly

Radiation therapy

- High doses of radiation can kill cancer cells and/or prevent them from growing and dividing
- Can also kill healthy cells!
- Radiation can be delivered at different angles and intensities
- Decision:

- Objective:

- Constraints:

- Many successes reported using different types of optimization models

Next time...

- A small example