Optimization and Operations Research

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Have you ever wondered...

- ... how airline ticket/hotel prices are determined
- ... how Google Maps gives you the fastest route to get to a desired place
- ... how a hedge fund picks stocks for its portfolio
- ... how FedEx/UPS/DHL ship so many packages around the world in so little time
- ... how Minute Maid orange juice always taste the same
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The answer: Operations Research
What is Operations Research?

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  “the discipline of applying advanced analytical methods to help people make better decisions”

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- Other names: “(Business) Analytics”, “Management Science”
What is Operations Research?

Draws from several areas:

- Business/Management science
- Economics
- Mathematics
- Computer Science

Typical decision-making process in OR entails:

- Gathering available data
- Building an abstract mathematical model
- Solving/analyzing the mathematical problem
- Supplying the results to management
Success stories

**Sears**
Created a vehicle routing system to run its delivery and home service fleets more efficiently.
**Savings** $42M per year

**ups**
Redesigned its overnight shipping network
**Savings:** $87M in 2 years

**Ford**
Optimized the way it designs and tests vehicle prototypes.
**Savings:** $250M

**CSX**
Optimization to minimize use of empty freight cars.
**Savings:** $560M (and avoid $1.4bi in extra expenditure)
Marketing/advertising

- Targeted web advertising

![Google Logo]

- Sales of TV ad slots

From 1996 to 2000:

- Reduced work by 80%
- Increased revenues by $200M
- Improved customer satisfaction

![NBC Logo]
Finance and Risk/Revenue Management

- Portfolio optimization
- Hedge funds
- Revenue Management
  - Hotel rooms
  - Airline seats
  - Rental cars
- Thomson Holidays (UK’s largest tour operator)
  - > 1M web site visitors per week
  - 40% of sales on line
  - 50K to 100K price changes daily
Less Brown left turns

- 95,000 trucks every day
- 3M gallons of gas saved (1 year)
- 62M pounds of CO₂ saved
Logistics, Scheduling and Transportation

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- Dutch railway scheduling (2002)
  - Passenger volume doubled since 1970
  - Timetable stayed the same
  - Better service $\rightarrow$ 15% demand increase
  - Profits rose by 40M Euros in 1 year
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- Airline crew scheduling
Sports

- Sports Scheduling
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- Hollywood!
Memorial Sloan-Kettering Cancer Center:

- Optimization to implement an intra-operative 3D treatment planning system for cancer.
- Quality-of-life is improved through drastic reduction (45-60%) of complications.
Healthcare

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- Sick-Kids Hospital in Toronto is using optimization models to figure how to better perform a surgery in small children (joint project with UW team)
Doing good with good OR

- Humanitarian Logistics is an area that focuses on using OR tools to better plan humanitarian operations
  - How to best provide/plan for disaster relief
  - How to provide aid for very poor regions of the world.

- OR in Policy
  - How to best contain the spread of infectious diseases,
  - What are “good” vaccination policies.

- DNA sequencing: genome projects
Many, many, many more

- Military applications
- O.R. at the Lego Factory
- O.R. at Disney
- Aisle design for warehouses
- Finding optimal piano fingerings
- Optimizing instrument tuning
- Telecommunications
- Forestry
- Mining
- Building cheaper boats and ships
Best Business Jobs

Take a look at the jobs we highlight in the business sector, and you should notice a common theme: money. The people in this list's occupations study us to determine how we like to spend our money, advertise to get us to splurge with our money and advise us on the various ways we should invest and save our money. In the next few years, the Bureau of Labor Statistics foresees close to 3 million openings for our Best Business Jobs of 2014. See which occupations top our list, and read more on how we rank the jobs.

Operations Research Analyst

Like a market research analyst, the No. 2 Business Job is also an advisory position – one that involves helping businesses and organizations operate more efficiently. The BLS projects employment growth of nearly 27 percent for operations research analysts by the year 2022.

Full Review | Salary Details | Available Jobs
References and Acknowledgement

For more info:

- www.informs.org
- www.informs.org/Sites/Getting-Started-With-Analytics
- www.cors.ca

Some material obtained from:

- www.hsor.org
- orchallenge.org

- Thanks to Prof. Tallys Yunes (Univ. of Miami) for some of the material seen in this presentation
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One of many areas of Operations Research methodology.
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**Problems**

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- Is the set of alternatives (solutions) well-defined?
  Person in Waterloo: Born in Waterloo, currently at Waterloo, whose home is Waterloo?
Focus on Optimization problems that have a well-defined set of solutions and each solution gets an associated value (called objective function value) by which it is evaluated.

Goal

Find, among all feasible solutions, the one with highest/lowest objective function value.
A simple optimization problem:
“Who is the tallest person in this classroom?”

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- **Optimal value:** The value of the optimal solution