Business Analytics: The Past, Present and Future of Operations Research

BCSI 2013
Michael Trick
Tepper School of Business, Carnegie Mellon University
The Past

Package Delivery

Internet Search

Mail Delivery
The Past

Package Delivery

Internet Search

Mail Delivery
The Past

Package Delivery

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Package Delivery

Internet Search

Mail Delivery
Key Idea

Operations Research

Business Analytics!
Analytics Landscape

Operations Research

- Stochastic Optimization: How can we achieve the best outcome including the effects of variability?
- Optimization: How can we achieve the best outcome?
- Predictive modeling: What will happen next if?
- Forecasting: What if these trends continue?
- Simulation: What could happen....?
- Alerts: What actions are needed?
- Query/drill down: What exactly is the problem?
- Ad hoc reporting: How many, how often, where?
- Standard Reporting: What happened?

Based on: Competing on Analytics, Davenport and Harris, 2007
Business Analytics is a Hot Topic

"Business analytics"
…. Maybe

**Interest over time**
The number 100 represents the peak search interest

- Management science
- Operations research
- Business analytics
Business Analytics

Using **data** to make better **decisions**

*(what the best operations research has always been)*

Change in emphasis: more about data
The Past

Package Delivery

Internet Search

Mail Delivery
Google: Treat web pages as data; treat search as optimization.
US Postal Service closing half its distribution centers

The US Postal Service announced today that it will close 223 of its 461 mail-processing plants by February 2013 in order to cut costs, Bloomberg Businessweek reported.

USPS is facing an annual loss of $18.2 billion by 2015, and the closings will save the agency about $2.5 billion a year, Postmaster General Patrick Donahoe told Bloomberg Businessweek. Some 35,000 jobs will be shed through the process.
The Present

Data

Computer Speed

Algorithms
The Present

Data

Computer Speed

Algorithms

2013: $587
From BestBuy
The Present

Data

Computer Speed

Algorithms

Total speedup of OR Methods in 15 years: 1 billion times
Illustration: TSP with 2392 nodes

1987: Padberg and Rinaldi

when using OSL as the LP solver: While the CYBER 205 runs of the two largest problems TK1002 and TK2392 of our study required about 7 hrs., 18 mins. and 27 hrs., 20 mins., respectively, the IBM 3090/600 runs required about 3 hrs., 10 mins.

2011: Bill Cook and Concorde with iPhone

pr2392
#Nodes 2392
Start 2010-12-31 17:00:10 +0000
LP Value 1: 364121.1667
LP Value 2: 373969.5024
LP Value 3: 376771.0902
LP Value 4: 377525.3060
LP Value 5: 377770.3091
LP Value 6: 377884.7570
LP Value 7: 377968.8068
LP Value 8: 378018.5065
LP Value 9: 378030.2600
LP Value 10: 378032.0000
New lower Bound: 378032.0000
LP Value 1: 378032.0000
New lower Bound: 378032.0000
Found the optimal tour: 378032
Stop 2010-12-31 17:06:13 +0000
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**Assignments**

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**Total Distance**

=SUMPRODUCT(B4:M17:B20:M33)

**Solver Parameters**

Set Target Cell: $B$38

Equal To: Max

By Changing Cells: $B$20:$M$33

Subject to the Constraints:

- $B$34:M$34 = $B$36:M$36
- $M$20:M$33 <= $P$20:M$33

Constraints:

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Future: The OR Process

- Identify a Problem
- Formulate a Model
- Determine Decisions
- Objectives
- Constraints
- Get Data
- Estimate Missing Data
- Find Solution to Model using Mathematical Tools
- Validate Solution
  - Is it reasonable?
  - Sensitivity
- Implement Solution
The Business Analytics Process

Identify a Problem

Formulate a Model
Determine Decisions
Objectives
Constraints

Get Data
Estimate Missing Data

Find Solution to Model using Mathematical Tools

Validate Solution
Is it reasonable?
Sensitivity

Implement Solution

Get Data
Estimate Missing Data
Future is bright!

Business Analytics

$16 billion in revenue by 2015

**Opportunity:**
Global data volumes are predicted to increase by 29 times over the next 10 years to 35 zettabytes.* (A zettabyte is a 1 followed by 21 zeros.)

**2015 Road Map Objective:**
Business analytics revenue is expected to be $16 billion by 2015.

Enterprises need a way to manage and mine the deluge of potentially valuable information, and the key is advanced data analytics. IBM spotted this emerging need early, building the world’s leading analytics practice—with 7,800 expert consultants, the world’s premier nonacademic mathematics function and the acquisition of 25 companies, for $14 billion in gross spending, to deepen our capabilities.

Our scientists have received more than 500 analytics patents. They are expanding technology frontiers through breakthroughs like the powerful new computer named Watson, which competed and won on the television quiz show *Jeopardy!* Applying Watson’s use of advanced analytics to decipher natural language, IBM is working to identify better healthcare diagnoses, potential drug interactions and “what if” scenarios in finance and compliance.

IBM 2010 Annual report; contrast “cloud” at $7 b and smarter planet $10 b
The Future

Linking Predictive and Prescriptive

Handling Uncertainty

Parallelism

Adversaries
The Future

Linking Predictive and Prescriptive

Handling Uncertainty

Parallelism

Adversaries

Based on: Competing on Analytics, Davenport and Harris, 2007
The Future

Linking Predictive and Prescriptive

Handling Uncertainty

Parallelism

Adversaries

How is data helping the organization make better decisions?
The Future

Linking Predictive and Prescriptive

Handling Uncertainty

Parallelism

Adversaries
The Future

Linking Predictive and Prescriptive Handling Uncertainty

Parallelism

Adversaries
The Future

Linking Predictive and Prescriptive Handling Uncertainty

Parallelism

Adversaries
Summarize: Business Analytics and...

- OR Past
  - Fedex
  - Google
  - USPS
  All examples of key role of data

- OR Present
  - More Data
  - Faster computers
  - Better algorithms
  - Lower fixed Costs

- OR Future
  - Predictive Analytics
  - Robustness
  - Parallelism
  - Adversaries

More at http://mat.tepper.cmu.edu/blog