
**Business Analytics
Providing
Actionable Insights**

With Application to Inventory Optimization

Overview

- ◆ About Business Analytics
- ◆ Current Situation in US and the World
- ◆ Statistical Techniques used in Advanced Business Analytics
- ◆ How to web-publish and run your analytics via a web-interface
- ◆ Examples of Analytics providing Actionable Insights:

About Advanced Analytics

- Analytics are tools that allows running of an analytical procedure
- Advanced Analytics
 - ◆ Use advanced Statistical and OR techniques
 - ◆ Provide Actionable Insights
- Analytics are best utilized if web-published enabling users can run them remotely via the Web
 - ◆ without having any data analytical software (e.g. SAS) on desktop
 - ◆ only with business knowledge and with no expertise in Statistics
- Developed working with experts in an organization

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- Almost any business can benefit from web-based analytics

Advanced Business Analytics: Leveraging the power of analytics

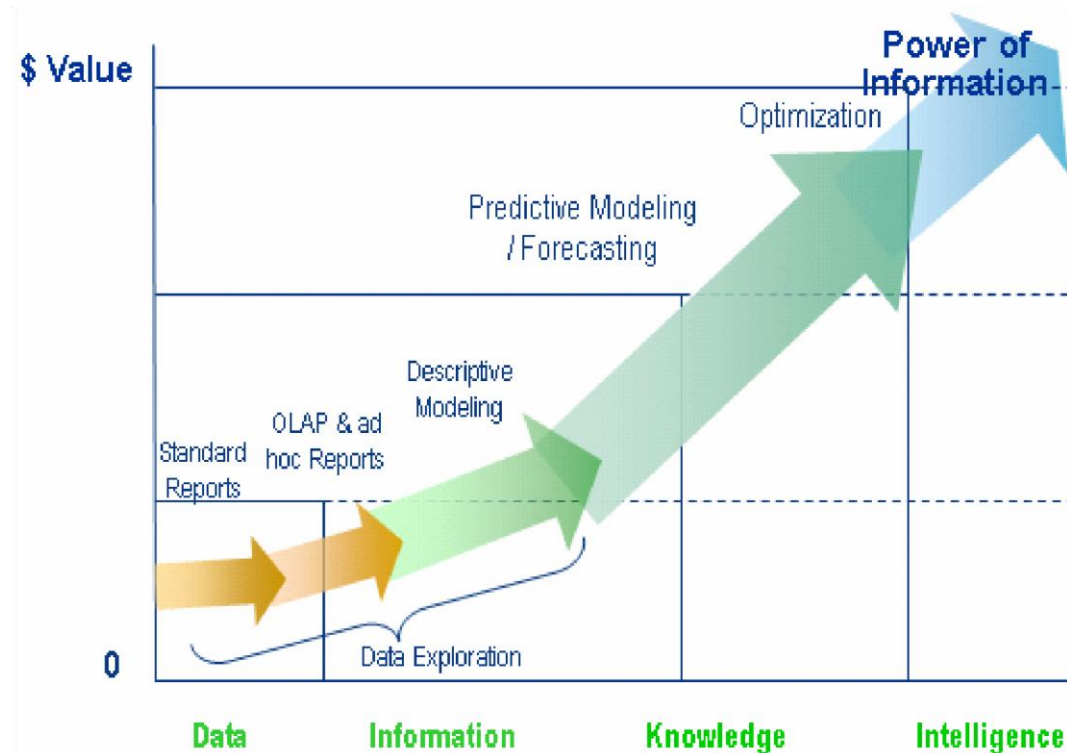
- To get full benefit of your models, go beyond ROI estimation
- Optimize ROI
- Provide Business Insights to take specific actions

- Possible when model parameters are estimated at lowest level of decision making

- Use calibrated model to Optimize

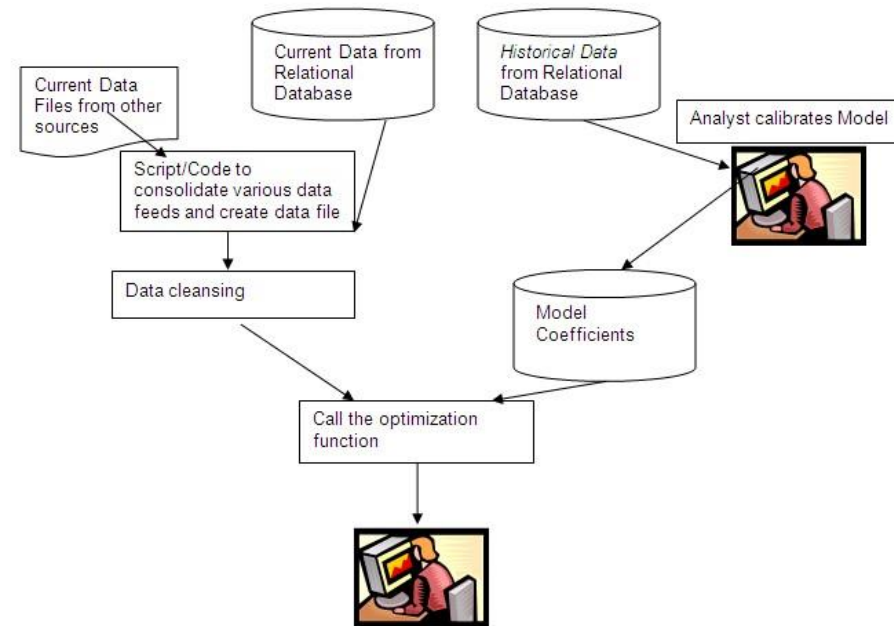
Promotional Tactics and Business Operations

- Web-publish analytics so that Marketing/Sales can run models
- No need to know Stats Techniques or Programming



Current Situation in US and the World

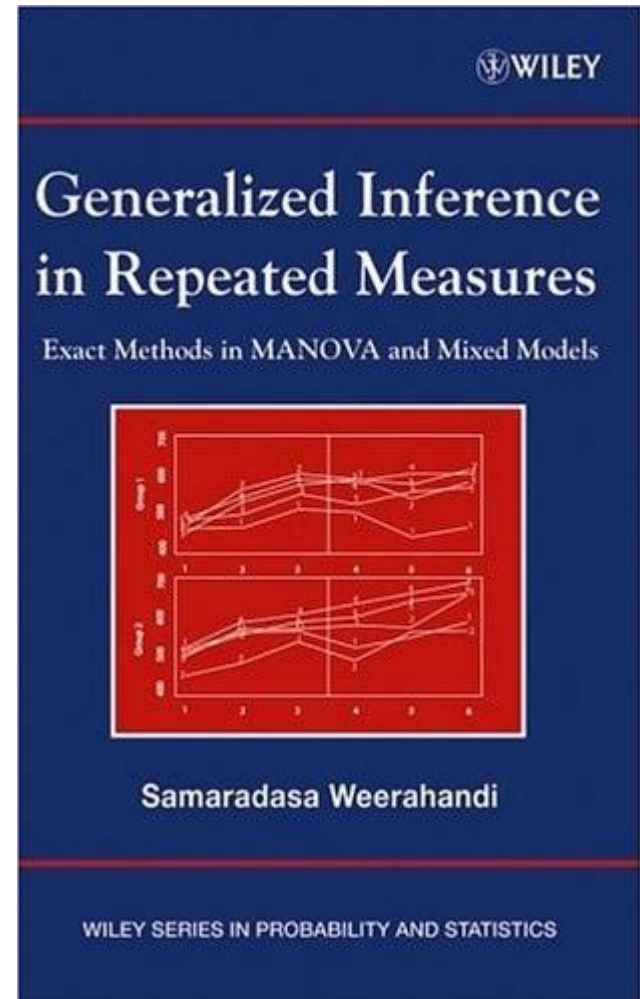
- US Companies are leading in Analytics
- Mostly Technology companies (e.g. Google, Yahoo, Amazon, NetFlix) used to lead in Analytics
- Now most companies use Analytics, but many lacks analytical value
- In-depth Business Analytics require
 - Statisticians
 - BI Developers with analytical knowledge
- Many companies perform simple Business analyses such as Trend, ROI calculations, Market Share



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- Such analyses are of limited use
 - Use Analytics providing Actionable Insights

Statistical Techniques Used in Advanced Analytics

- ◆ Mixed models are now heavily used
 - in Business Analytics
 - In analysis of data from Clinical Trials
- ◆ In Corporate America performing advanced business analytics Hierarchical Mixed Models are heavily used
- ◆ You can read more about Mixed Models from freely distributed Book www.xtechniques.com
- ◆ The most widely used Statistical Techniques in Business Analytics was used to be LSE (Least Squares Estimator)!
- ◆ What is the Most widely used business analytical technique today?



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- ◆ **It is BLUP, the Best Linear Unbiased Predictor**
Statistical Techniques Used in Analytics (ctd.)
 - ◆ In Corporate America performing advanced business analytics
 - **BLUP has replaced LSE as the most widely used statistical technique**
 - ◆ Why? In estimating by large number of segments, estimates you get using
 - BLUP provides more accurate estimates than by LSE
 - BLUP yields shorter prediction intervals
 - Chance of getting wrong sign diminishes
 - ◆ Example: Suppose you were asked to estimate consumer Response to Car Ad by Market (DMA). Then
 - Ad-stock Advertisement GRPs
 - Model sales by market as a function of ad-stocked GRP and other drivers of sales
 - **If you model all covariates as “fixed effects” and use LSE you will not even yield the right sign for some markets**

- So, model response to Car Advertisement as a random effect around the national average
- USE BLUP instead of LSE

Overview of the BLUP



- Suppose certain groups/segments distributed around their parent
- Assumption in Mixed Models: Random effects are Normally distributed around the mean, the parent estimate, say M
- Suppose Regression By Groups yield estimate M_i for Segment i
- Let V_s be the between segment variance and V_e be the error variance, which are known as Variance Components

- It can be shown that the BLUP of Segment i effect is

$$\frac{V_e M \square k V_s M_i}{V_e \square k V_s}$$

a weighted average of the two estimates, and k is a known constant that depends on sample size and group data

- The above is a shrinkage estimate that move extreme estimates towards the parent estimate

The BLUP (ctd): Some Inference Issues



- Recall that BLUP of Segment i effect is $\frac{V_e M \square k V_s M_i}{V_e \square k V_s}$

is a function of variance components (two or more)

- MLE based methods frequently yield 0 (or negative) variance estimates, a drawback of
- Generalized Estimator (GE) and Bayesian Estimator (BE) do not suffer from such drawbacks
- Areas requiring further research:
 - ◆ Extending GE/BE to more complicated mixed models
 - ◆ Improving upon GE/BE using Stein type approach

How to Web-Publish Your Desktop Analytics: BI Software

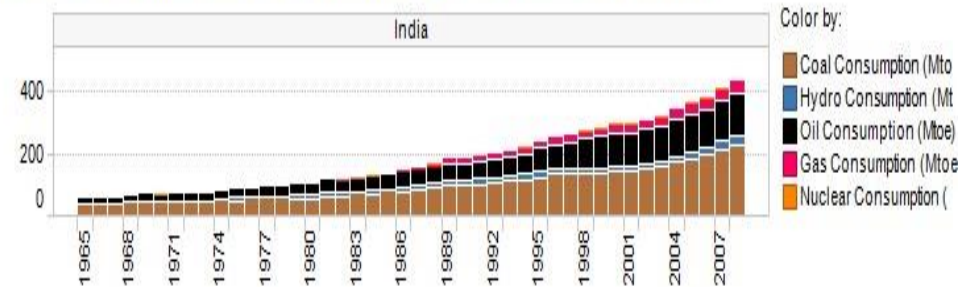
- ◆ Use BI Software to web publish your analytics
- ◆ They provide Drilldown capabilities, Interactive capabilities, etc.

- ◆ BI software for reporting: **Cognos, Business Objects, MicroStrategy, SAP, etc.**
- ◆ **SpotFire (see Image) and Microsoft Power BI allow any analysis with R**
- ◆ Few other BI software allow programming in SAS and SPSS

2008 energy figures



Yearly consumption by energy type (Click on a country to see)



Advanced Analytics Example: Inventory Optimization

- Analysts estimate Model parameters periodically; e.g. Demand Model for consumer products of a Supermarket Chain; e.g. Interface below
- Other parameters and scenarios are specified by users
- Model is applied real-time with latest data

The screenshot shows a web interface for 'Inventory Optimization' at 'Fresh Grocer Mart'. The interface is divided into two columns of input fields. The left column includes 'Item:' (a dropdown menu with 'Apple Juice' selected and a list of options: Apple Juice, Orange Juice, White Bread, Wheat Bread), 'Start Date:', 'Price Per unit:' (input: 2.00), 'Sale Price Per unit:' (input: 1.00), and 'Week of the Year:' (input: 20). The right column includes 'County:' (a dropdown menu with 'Middlesex' selected), 'End Date:' (input: 09/22/2011), 'Cost Per unit:' (input: 0.50), and 'Min units Allowed:' (input: 5). At the bottom left is a 'Home' link, and at the bottom right is a 'Run Analysis' button.

Fresh Grocer Mart		Inventory Optimization	
Item:	Apple Juice	County:	Middlesex
Start Date:		End Date:	09/22/2011
Price Per unit:	2.00	Cost Per unit:	0.50
Sale Price Per unit:	1.00	Min units Allowed:	5
Week of the Year:	20		
Home		<input type="button" value="Run Analysis"/>	

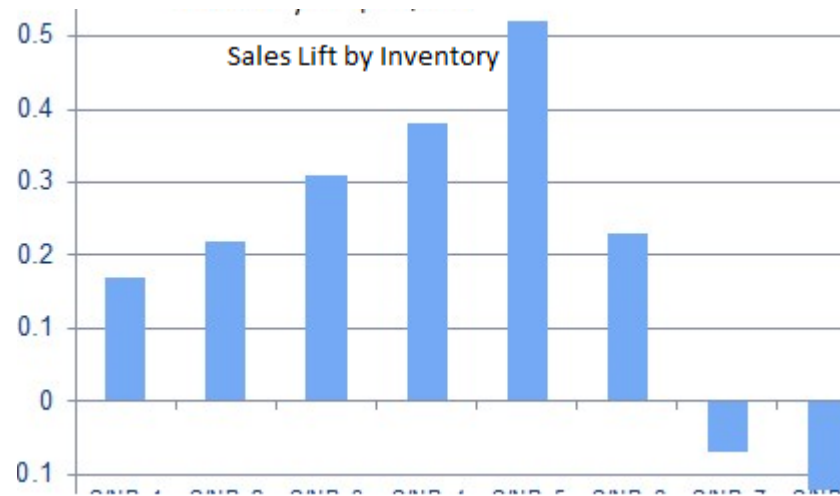
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- Results are displayed or exported in desired format
 - Optimization is done real-time:
 - ◆ Note: Average Demand is NOT the Optimum Inventory
 - ◆ **Optimum Inventory is a Quantile, a function of the Mean and Variance Both:**
Opt Inventory = $m + \sigma F^{-1}(1-c/p)$, where c is the unit cost and p is the unit price

Inventory Optimization: Leveraging to non-flat Demand models

- Preceding Inventory model for “Flat Demand” is called “Newsboy Model”
- Not appropriate even for Magazine Inventory Management, because demand may depend on Display.

Newsboy model is not appropriate also

- when the shape of Demand function, a piece-wise curve as shown in figure
- cannibalize brand sales due to over-inventory



- Develop customized Demand models and Optimize for any type of logistics problems