Module 1
Introduction to Business Analytics
Business Analytics is the use of:

- data
- information technology
- statistical analysis
- quantitative methods
- mathematical or computer-based models

...to help managers gain improved insight about their business operations and make better, fact-based decisions.
Examples of Applications

- **Pricing**
  - setting prices for consumer and industrial goods, government contracts, and maintenance contracts

- **Customer segmentation**
  - identifying and targeting key customer groups in retail, insurance, and credit card industries

- **Merchandising**
  - determining brands to buy, quantities, and allocations

- **Location**
  - finding the best location for bank branches and ATMs, or where to service industrial equipment

- **Social Media**
  - understand trends and customer perceptions; assist marketing managers and product designers
Benefits
- reduced costs
- better risk management
- faster decision
- better productivity
- enhanced profitability & customer satisfaction

Challenges
- lack of understanding of how to use analytics
- insufficient analytical skills
- competing business priorities
- difficulty in getting good data and sharing information
- lack of understanding of benefits vs perceived costs of analytics
Scope of Business Analytics

- **Descriptive analytics**: the use of data to understand past and current business performance and make informed decisions
  - “How much did we sell in each region?”
  - “What was our revenue and profit last quarter?”
  - “How many and what types of complaints did we resolve?”
  - “Which factory has the lowest productivity?”
  - how to classify customers into different segments, to develop specific marketing campaigns and advertising strategies.

- **Predictive analytics**: predict the future by examining historical data, detecting patterns & relationships in these data, then extrapolating these relationships forward in time.
  - “What will happen if demand falls by 10% or if supplier prices go up 5%?”
  - “What do we expect to pay for fuel over the next several months?”
  - “What is the risk of losing money in a new business venture?”

- **Prescriptive analytics**: identify the best alternatives to minimize or maximize some objective
  - determine the best pricing and advertising strategy to maximize revenue, the optimal amount of cash to store in ATMs, or the best mix of investments in a retirement portfolio to manage risk.
Tools

- Database queries and analysis
- Dashboards to report key performance measures
- Data visualization
- Statistical methods
- Spreadsheets and predictive models
- Scenario and “what-if” analyses
- Simulation
- Forecasting
- Data and text mining
- Optimization
- Social media, web, and text analytics
Most department stores clear seasonal inventory by reducing prices.

Question: When to reduce the price and by how much to maximize revenue?

Potential applications of analytics:
- **Descriptive analytics**: examine historical data for similar products (prices, units sold, advertising, …)
- **Predictive analytics**: predict sales based on price
- **Prescriptive analytics**: find the best sets of pricing and advertising to maximize sales revenue
Data

- **Data**: numerical or textual facts and figures that are collected through a measurement process.
- **Information**: result of analyzing data; extracting meaning from data to support evaluation & decisions.
- **Data set**: a collection of data.
  - Marketing survey responses, historical stock prices, dimensions of a manufactured item.
- **Big data**: massive amounts of business data from a wide variety of sources, much of which is available in real time, and much of which is uncertain or unpredictable.
Examples of Data Sources and Uses

- Annual reports
- Accounting audits
- Financial profitability analysis
- Economic trends
- Marketing research
- Operations management performance
- Human resource measurements
- Web behavior
  - page views, visitor’s country, time of view, length of time, origin and destination paths, products they searched for and viewed, products purchased, what reviews they read, and many others.
Categorical (nominal) data - sorted into categories according to specified characteristics (gender, zip code, color).

Ordinal data - can be ordered or ranked according to some relationship to one another (how happy are you with our service 1-5).

Interval/ratio data – continuous or constant differences between observations and have arbitrary zero points (time, temperature, sales).
# Classifying Data Elements

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
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<td>Supplier</td>
<td>Order No.</td>
<td>Item No.</td>
<td>Item Description</td>
<td>Item Cost</td>
<td>Quantity</td>
<td>Cost per order</td>
<td>A/P Terms (Months)</td>
<td>Order Date</td>
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<td>Hulkey Fasteners</td>
<td>Aug11001</td>
<td>1122</td>
<td>Airframe fasteners</td>
<td>$4.25</td>
<td>19,500</td>
<td>$82,875.00</td>
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<td>08/05/11</td>
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<td>1243</td>
<td>Airframe fasteners</td>
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<td>Shielded Cable/ft.</td>
<td>$1.05</td>
<td>23,000</td>
<td>$24,150.00</td>
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<td>22,500</td>
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</table>

- **Fields or Attributes**
  - Categorical
  - Ordinal
  - Categorical
  - Categorical
  - Ratio
  - Ratio
  - Ratio
  - Ratio
  - Interval
  - Interval
3 Forms of a Model

Model - an abstraction or representation of a real system, idea, or object.

Sales of a new product (a first-generation iPad or 3D television) often follow a common pattern.

1. **Verbal description**: Sales starts small as early adopters begin to evaluate a new product, then begin to grow at an increasing rate as positive customer feedback spreads. Eventually, the market begins to become saturated and sales begin to decrease.

2. **Visual model**: A sketch of sales as an S-shaped curve over time.

3. **Mathematical model**: \( S = ae^{b et} \)
   where \( S \) is sales, \( t \) is time, \( e \) is the base of natural logarithms, and \( a, b \) and \( c \) are constants.
Influence Diagram

- a visual representation of a descriptive model that shows how the elements of the model relate to others
- An influence diagram is a useful approach for conceptualizing the structure of a model and can assist in building a mathematical or spreadsheet model.

An Influence Diagram for Total Cost

[Diagram showing the basic and expanded influence diagram for total cost]
Building a Mathematical Model

- total cost = fixed cost + variable cost
- variable cost = unit variable cost × quantity produced
- total cost = fixed cost + variable cost
  = fixed cost + unit variable cost × quantity produced

Mathematical model:

- \( TC = \text{Total Cost} \)
- \( F = \text{Fixed cost} \)
- \( V = \text{Variable unit cost} \)
- \( Q = \text{Quantity produced} \)
- \( TC = F + VQ \)
A Break-Even Decision Model

- **Decision model** – a mathematical representation of a business situation that can be used to understand, analyze, or facilitate making a decision.

\[ TC(\text{manufacturing}) = 50,000 + 125Q \]
\[ TC(\text{outsourcing}) = 175Q \]

**Breakeven Point:** \( TC(\text{manufacturing}) = TC(\text{outsourcing}) \)

\[ 50,000 + 125Q = 175Q \]
\[ 50,000 = 50Q \]
\[ Q = 1,000 \]

- **General Formula**
\[ F + VQ = CQ \]
\[ Q = F/(C - V) \]
How do sales respond to coupons and advertising?

Sales = 500 - 0.05*Price + 30*Coupon + 0.08*Advertising + 0.25*Price*Advertising

If the price is $6.99, no coupons are offered, and no advertising is done, estimate sales

Sales = 500 - 0.05 * $6.99 + 30 * 0 + 0.08 * 0 + 0.25 * $6.99 * 0 = 500 units
Model of Demand for a Product

A Linear Demand Prediction Model

\[ D = 20,000 - 10P \]

A Nonlinear Demand Prediction Model

\[ D = 20,000P^{-0.0111382} \]
A firm wishes to determine the best pricing for one of its products in order to maximize revenue. Analysts determined the following model:

\[
\text{Sales} = -2.9485 \times \text{price} + 3240.9 \\
\text{Total revenue} = (\text{price})(\text{sales}) \\
= \text{price} \times (-2.9485 \times \text{price} + 3240.9) \\
= 22.9485 \times \text{price}^2 + 3240.9 \times \text{price}
\]

Identify the price that maximizes total revenue, subject to any constraints that might exist.

Prescriptive decision models help decision makers identify the best solution.

Optimization - finding values of decision variables that minimize cost or maximize profit.