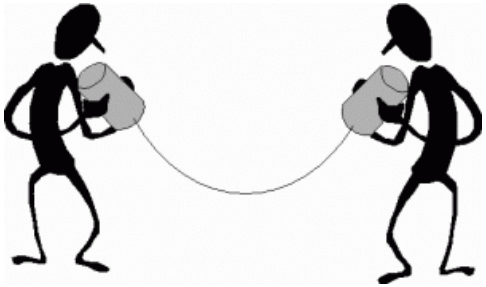
Communication matters



Try to think at one sentence definition for:

- Analytics
  - Descriptive
  - Predictive
  - Prescriptive
- Decision making
- Decision model
- Optimization

Analytics

Analytics is the **discovery**, **interpretation**, and **communication** of meaningful **patterns in data**. Especially valuable in areas rich with recorded information, analytics relies on the simultaneous application of **statistics, computer programming and operations research** to quantify performance.

https://en.wikipedia.org/wiki/Analytics

The systematic **computational** analysis of data or **statistics**

https://en.oxforddictionaries.com/definition/analytics

A process in which a computer examines information using **mathematical** methods in order to find useful patterns

https://dictionary.cambridge.org/dictionary/english/analytics

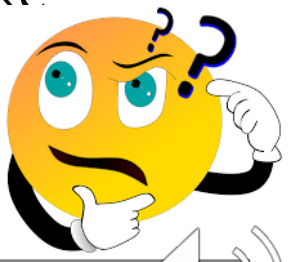
Analytics

Analytics has emerged as a **catch-all term** for a variety of different business intelligence (BI)- and application-related initiatives.

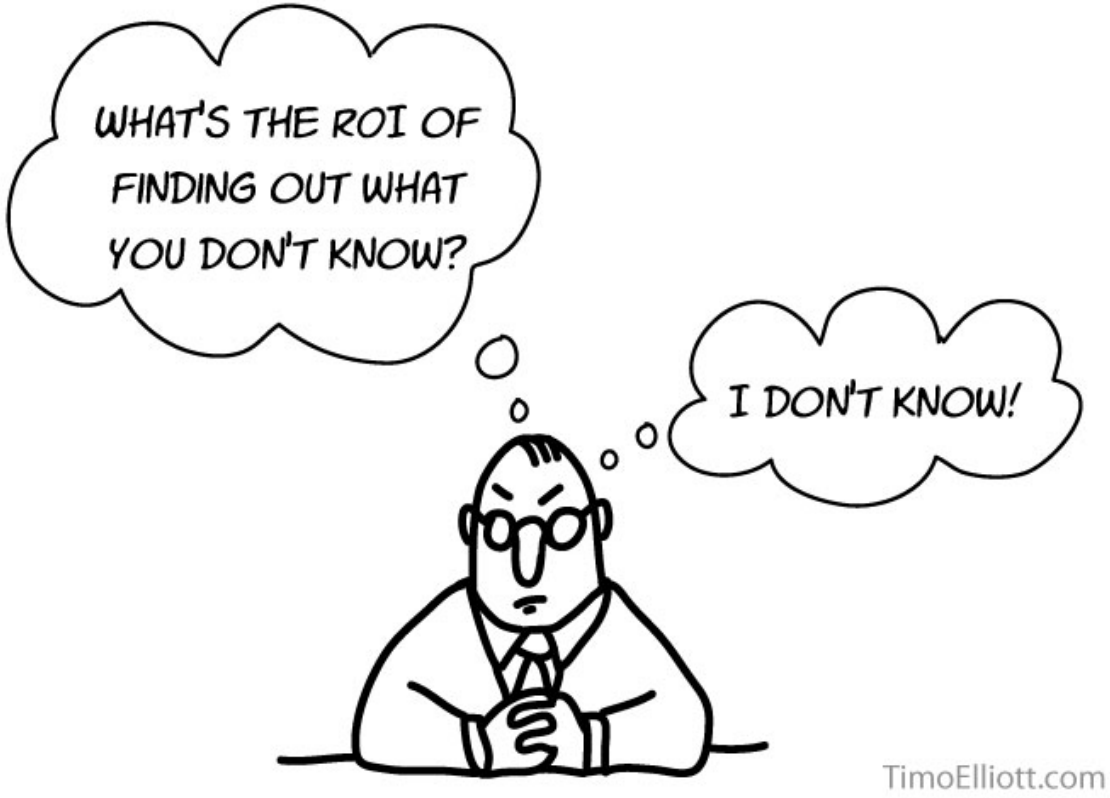
https://www.gartner.com/it-glossary/analytics/

The field of data analysis. Analytics often involves studying **past** historical data to research potential **trends**, to analyze the **effects** of certain decisions or events, or to evaluate the performance of a given tool or scenario. The goal of analytics is to improve the business by **gaining knowledge** which can be used to make **improvements** or changes

http://www.businessdictionary.com/definition/analytics.html



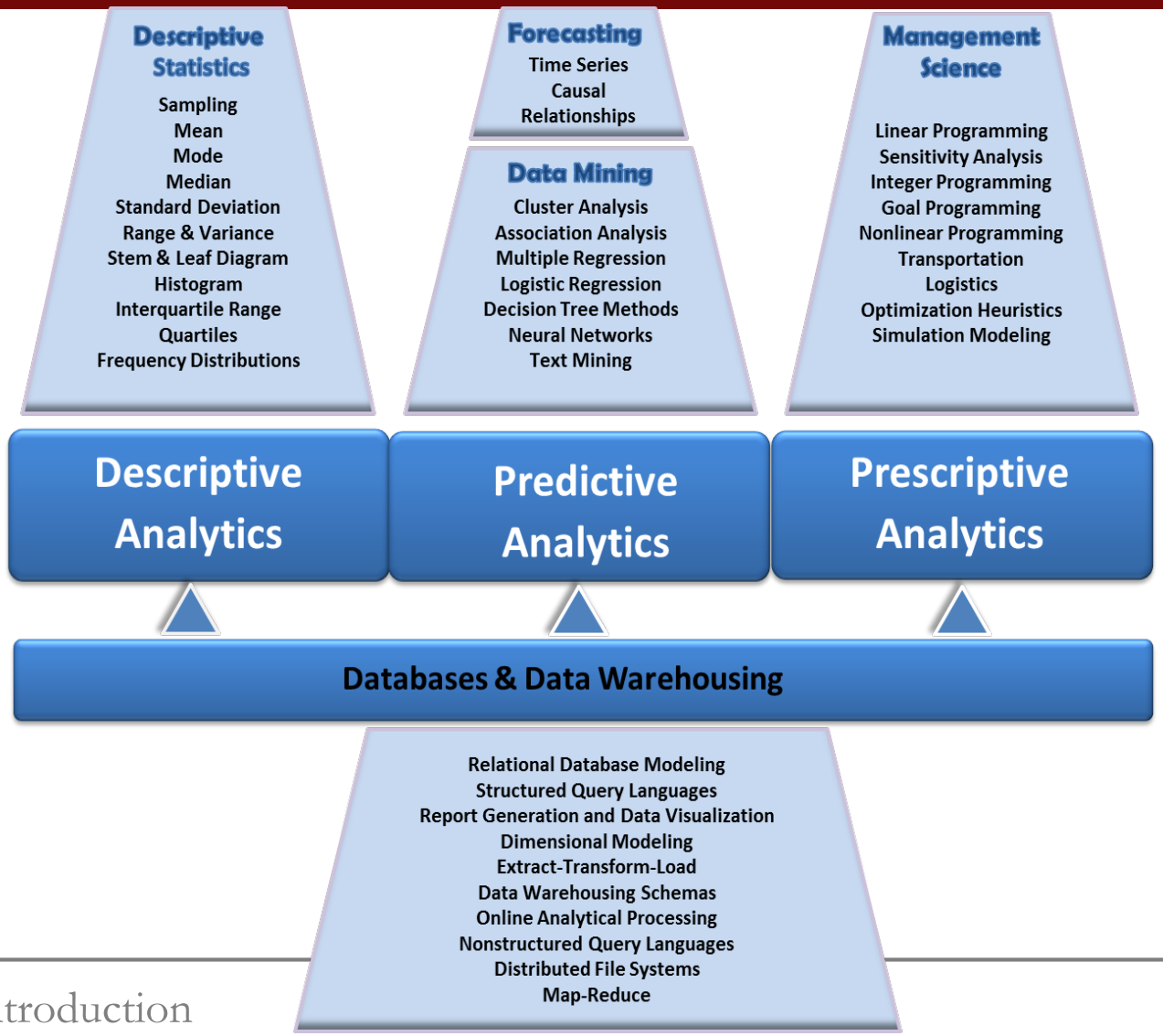
Analytics


WHAT'S THE ROI OF FINDING OUT WHAT YOU DON'T KNOW?
I DON'T KNOW!
TimoElliott.com

What is Analytics?

- Using **data** to build **models** that lead to better **decisions**
- Ultimately create **value**
- Can use big data or "small" data

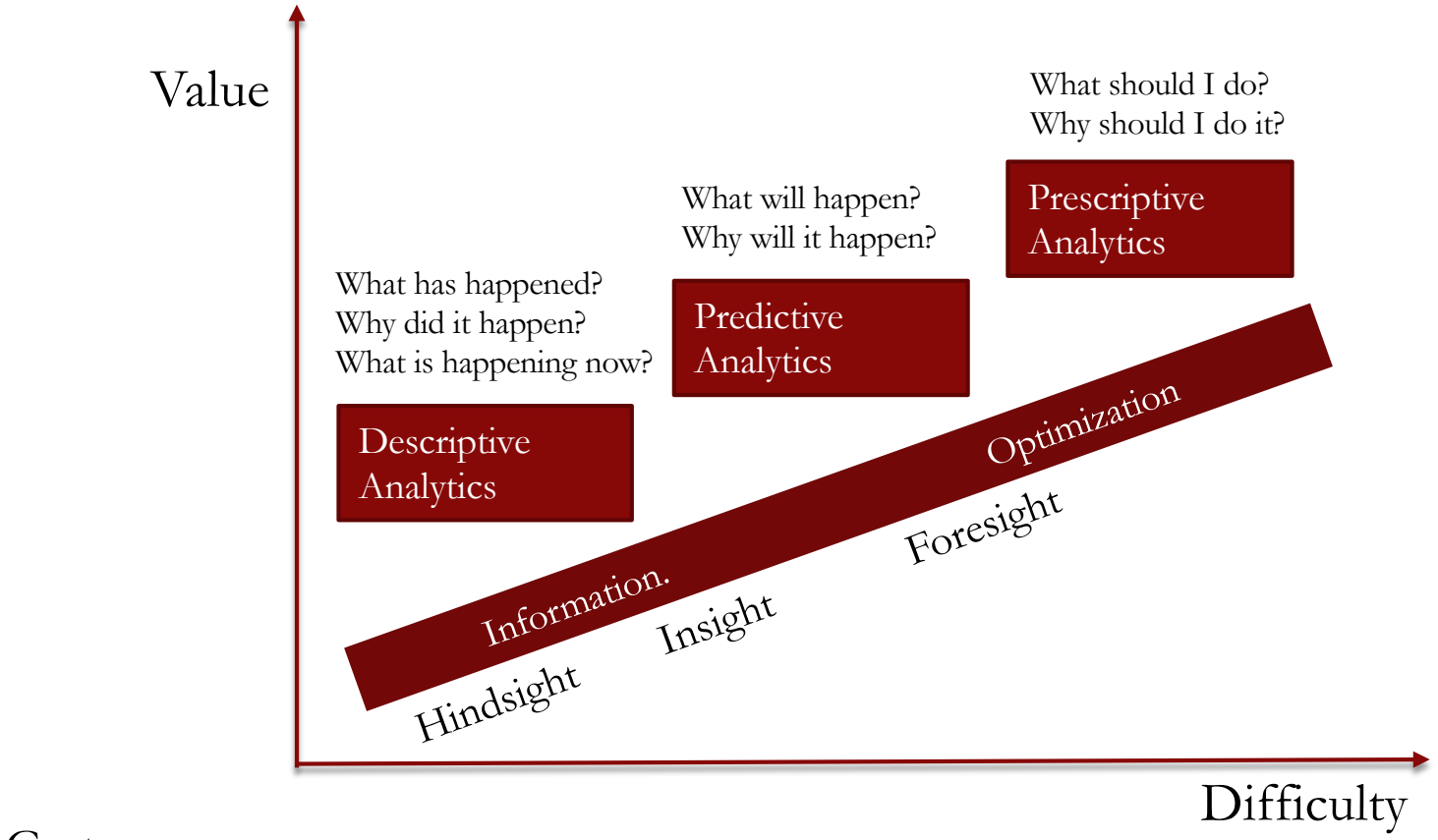
Analytics


Descriptive Statistics
Sampling
Mean
Mode
Median
Standard Deviation
Range & Variance
Stem & Leaf Diagram
Histogram
Interquartile Range
Quartiles
Frequency Distributions
Forecasting
Time Series
Causal
Relationships
Data Mining
Cluster Analysis
Association Analysis
Multiple Regression
Logistic Regression
Decision Tree Methods
Neural Networks
Text Mining
Management Science
Linear Programming
Sensitivity Analysis
Integer Programming
Goal Programming
Nonlinear Programming
Transportation
Logistics
Optimization Heuristics
Simulation Modeling
Descriptive Analytics
Predictive Analytics
Prescriptive Analytics
Databases & Data Warehousing
Relational Database Modeling
Structured Query Languages
Report Generation and Data Visualization
Dimensional Modeling
Extract-Transform-Load
Data Warehousing Schemas
Online Analytical Processing
Nonstructured Query Languages
Distributed File Systems
Map-Reduce

What is Analytics?

- Descriptive – finds patterns in the data
  - Summary statistics
  - Visualizations
  - Clustering etc.
- Predictive – predict different outcomes
  - Linear Regression
  - Logistic Regression, CART, Random Forests, ML etc
- Prescriptive – gives advice on actions to take
  - Optimization

What is Analytics?



Gartner

Descriptive Analytics

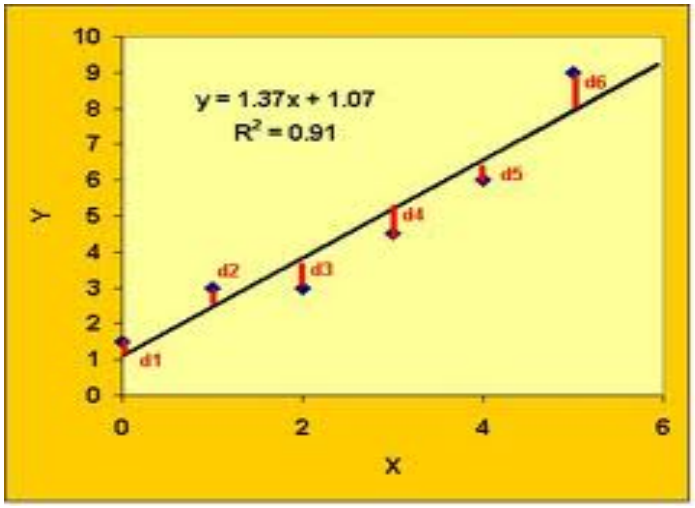
- Function:
  - describe the main features of available data
- Common tools:
  - sampling, mean, mode, median, standard deviation, range, variance, stem and leaf diagram, histogram, interquartile range, quartiles, and frequency distributions
- Displaying results:
  - graphics/charts, tables, and summary statistics such as single numbers

"Data don't make any sense,
we will have to resort to statistics."

Predictive Analytics

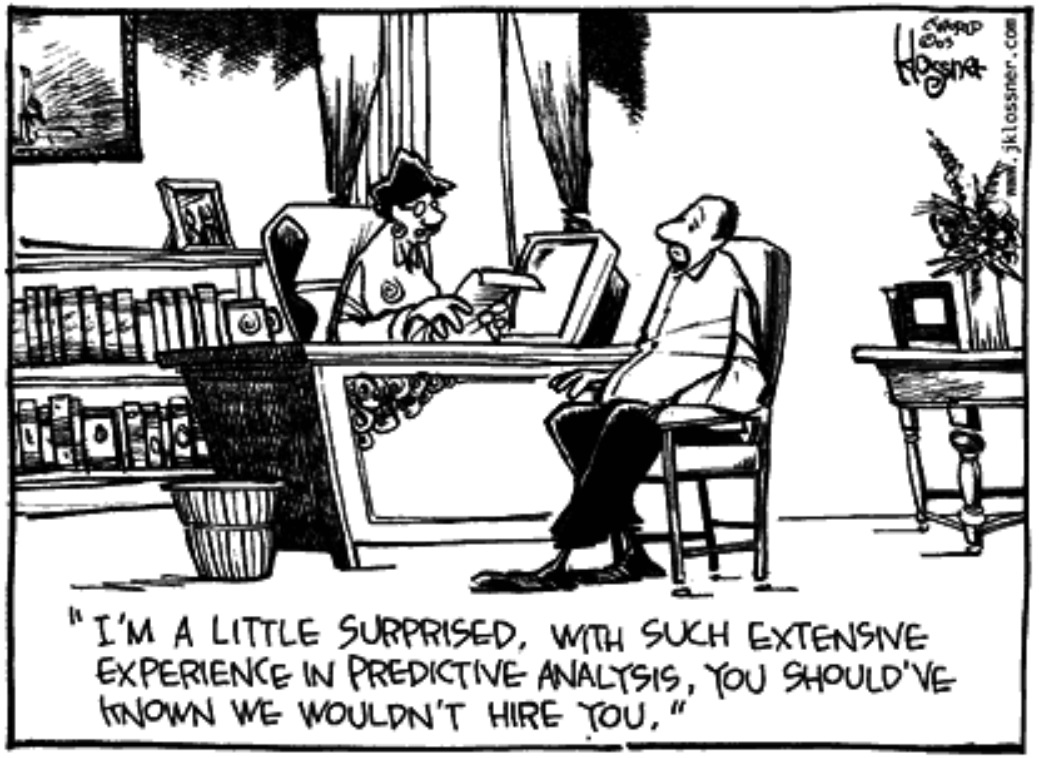
- Process:
  - Begin with descriptive analytics
  - Extract patterns from large data quantities
  - Correlate data types for explanation of near-term behavior – past and present
  - Estimate linear/non-linear behavior

- Example: by classifying past insurance claims, estimate the number of future claims to flag for investigation with a high probability of being fraudulent.



Predictive Analytics

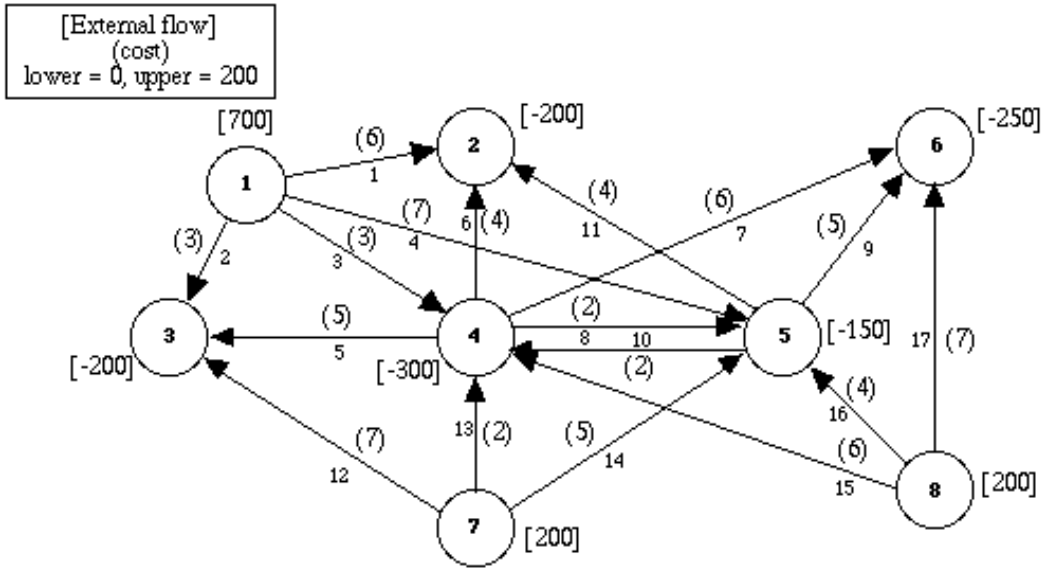
- Function:
  - draw conclusions and predict future behavior



Prescriptive Analytics

- **Process**:
  - Begin with predictive analytics
  - Determine what should occur and how to make it so
  - Identify the mitigating factors that lead to desirable/undesirable outcomes
  - "What-if" analysis with local or global **optimization**

  Ex: Find the best set of prices and advertising frequency to maximize revenue and, the right set of business moves to make to achieve that goal



"Make it so"

Prescriptive Analytics

- Function:
  - make decisions based on data
- Common models:
  - linear programming
  - sensitivity analysis
  - integer programming
  - goal programming
  - nonlinear programming
  - simulation modeling

"What it comes down to is this thing is capable of telling us a lot more than we really want to know."

Example: Industry 4.0

Industry 4.0 indicates the current trend of automation and data exchange in manufacturing technologies in order to facilitate manufacturing.

For example, consider the case of **predictive maintenance** in which sensors generate a multitude of data dealing with indicators of equipment's degradation.

Descriptive analytics algorithms monitor the current condition of the manufacturing system and provide alerts in cases of abnormal behaviours. This is achieved by comparing the actual measurements of several parameters that constitute indicators of degradation.

When they vary from the normal values, an alert triggers the **predictive analytics** algorithms. The alert is evaluated and, if it indicates a potentially hazardous state of the manufacturing equipment, the predictive analytics algorithms generate predictions about the future health state of the manufacturing system, e.g. a prediction about the time-to-failure.

On the basis on this prediction, **prescriptive analytics** algorithms are able to provide recommendations about the optimal mitigating actions and the optimal time for their implementation in a way that the expected loss and the risk are minimized.

Example: Transportation

The **traffic congestion control** attempts to release the city centers from the traffic jams.

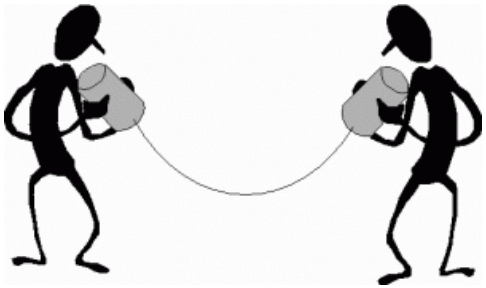
Currently, sensors can detect vehicles in corresponding areas.

Applying **descriptive analytics** we can use this data along with historical data from traffic monitoring network to derive outcomes such as level of traffic in different areas at tifferent times in an aggregated form and describe traffic flow.

These results feed into the **predictive analytics** algorithms can provide predictions about the traffic flow (congestion level) of the system by taking into account contextual information (e.g. peak times).

Then these predictions trigger the **prescriptive analytics** algorithms which can suggest real time reactions with the aim to reduce the congestion level proactively (e.g. traffic lights control), or also take strategic decisions on the network viability in order to reduce congestions.

Communication matters



Try to re-think at one sentence definition for:

- Analytics
  - Descriptive
  - Predictive
  - Prescriptive

Would you changed your definitions now ?

Decision making

The thought **process** of selecting a logical **choice** from the available options.

When trying to make a good **decision**, a person must consider all the **alternatives** and **weight** the positives and negatives of each option.

For **effective** decision making, a person must be able to **forecast** the outcome of each option as well, and based on all these items, determine which option is the best for that particular situation

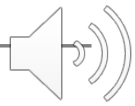
http://www.businessdictionary.com/definition/decision-making.html

Decision making

Decision-making is a **goal-oriented** process.

Decisions are usually made to achieve some purpose or goal.

To make informed decisions we can use Analytics



Types of Decision Making Problems

- Unstructured problems

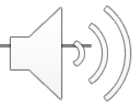
  * Problems that are new or unusual and for which information is ambiguous or incomplete.

  * Problems that will require custom-made solutions.

- Non-programmed decisions

  * Decision that are unique and nonrecurring.

  * Decision that generate unique responses.



Types of Decision Making Problems

- Structured problems

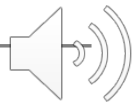
  * Their goals are clear.

  * Are familiar (have occurred before)

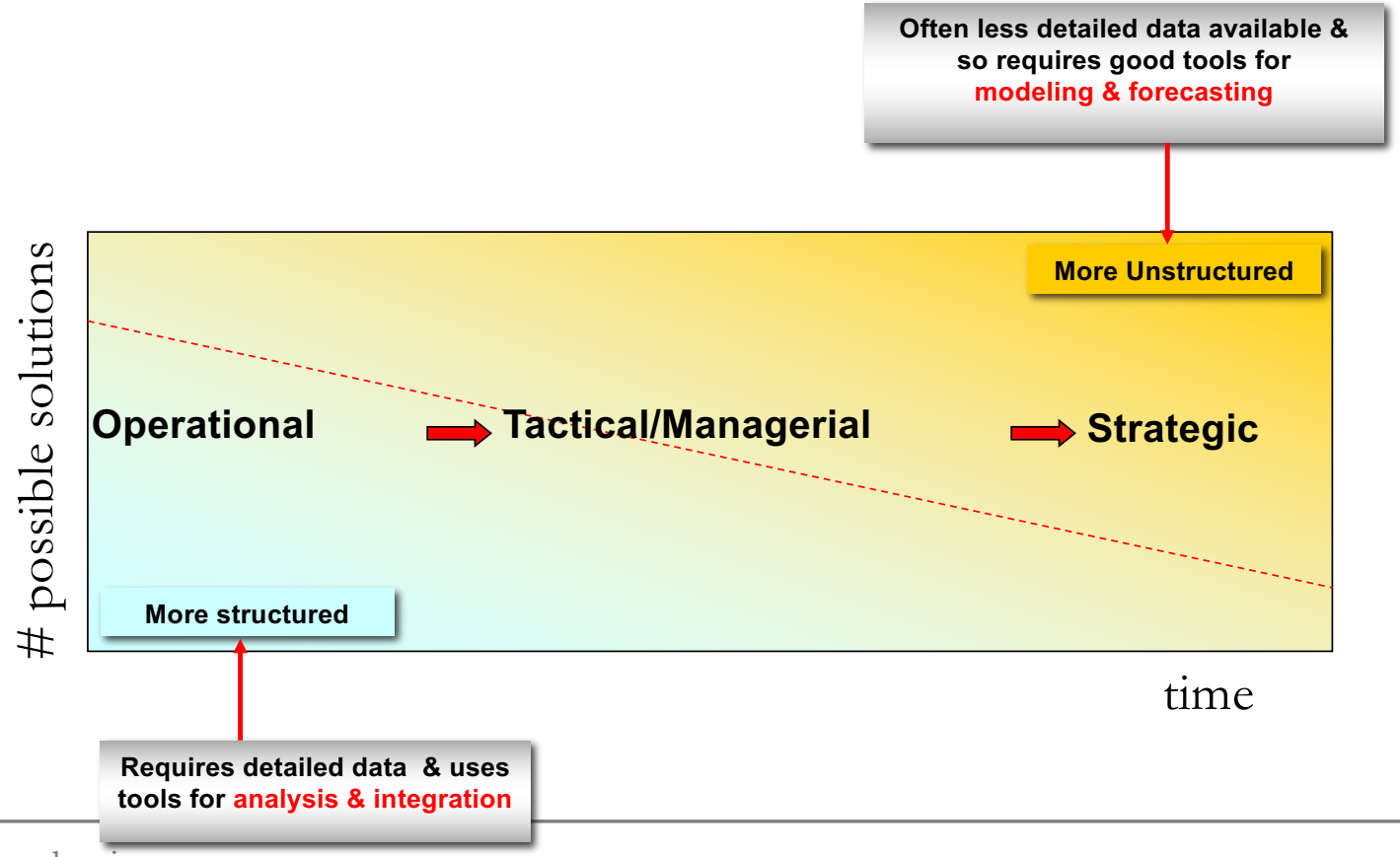
  * Are easily and completely defined (information about the problem is available and complete)

- Programmed decision

  * A repetitive decision that can be handled by a routine approach.



Types of Decision Making Problems



Decision Making Conditions

Certainty

- A situation in which the outcomes of all possible decisions are known and therefore the we can make accurate decisions.

Uncertainty

- A situation in which there is no certainty of the outcomes of the possible decisions
- When a probability estimation of the outcome is known then we might be able to estimate the likelihood of certain outcomes (this condition is also referred to as Risk)

Decision model

A model refers to some form of symbolic representation of our assumptions about the reality

A **Decision Model** must be able to **predict** the **outcomes** of **decisions**.

It mappes the **relationships between elements** of the decision and the forecasted results in order to **understand or control** the problem.

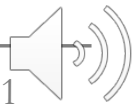
The decision model predicts what will happen if a certain action is taken.

Why do we use models?

Enhance our understanding of the world to improve our decision making

Elaborate a scientific method to solve a problem

Duplicable (repeatable) Reduce bias



Optimization

Optimization is at the heart of almost all machine learning and statistical techniques used in data science.

Optimization is at the heart of every major business, social, economic, and personal decision, that is taken by an individual person, collective representation of people, or intelligent machines and software agents.

https://towardsdatascience.com/a-quick-overview-of-optimization-models-for-machine-learning-and-statistics-38e3a7d13138

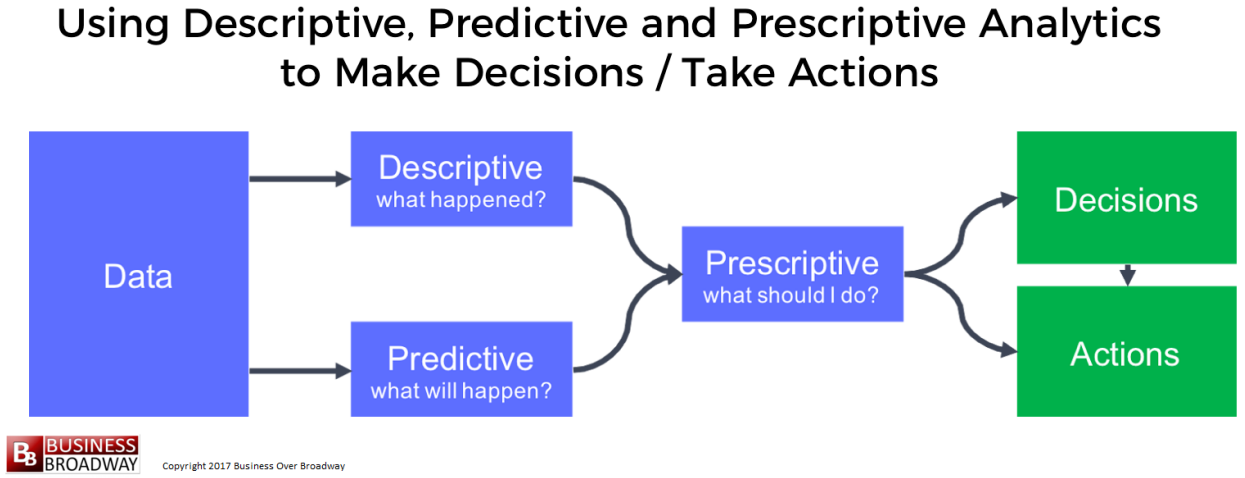
Optimization

Optimization : Maximizing or minimizing some performance function relative to some set of possible solutions meeting a set of possible constraints.

The function allows comparison of the different choices for determining which might be "best."

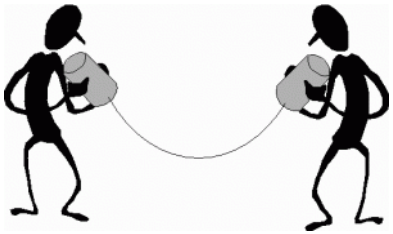
Optimization is achieved usually by using techniques of operations research.

In conclusion… the course objective is…



- Inspire you to use all kinds of analytics in your career
- Not just hearing about analytics, but acquire competences for creating your own models
- Throughout this course we will study how various mathematical models can be implemented and analyzed

Communication matters



Try to re-think at one sentence definition for:

- Decision making
- Decision model
- Optimization

Have you changed your definitions ?