5BUIS019W Business Analytics

Lecture 1

Introduction to Business Analytics

Content

- What is Business analytics?
- Problem solving approach
- Dataset: basic concepts
- Module content

PART 1

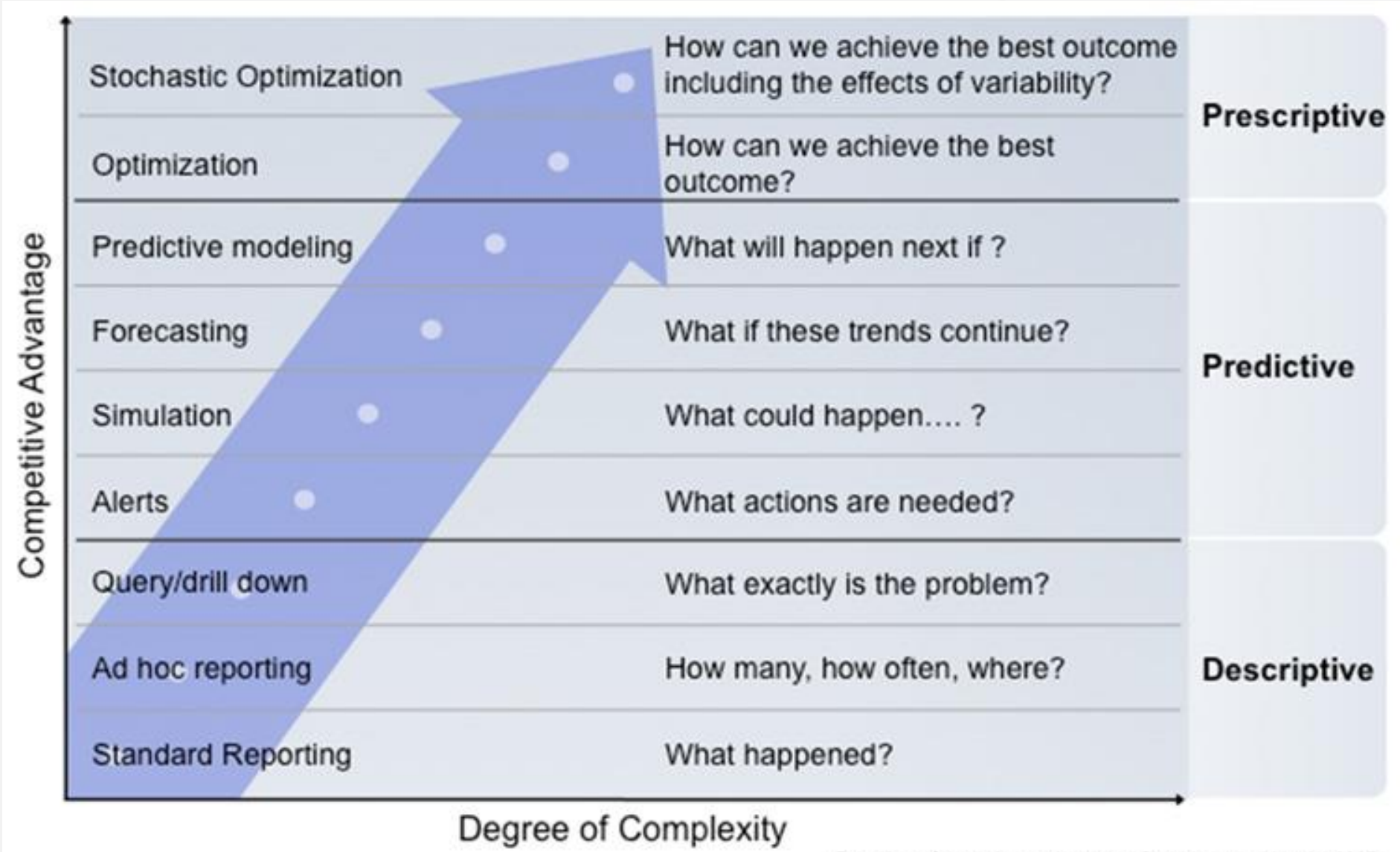
EXPLORING BUSINESS ANALYTICS

What is Business Analytics?

- Business analytics (BA) consists in the continuous iterative **exploration and analysis of business data** in order to measure business **performance** and drive an appropriate **planning**.
- It refers to **quantitative methods and techniques** that help making informed decisions to meet defined business objectives, i.e. **achieve desired outcomes**.
- Business analytics is used to understand the system by evaluating business operations, identify weaknesses, define solution alternatives and predict future states.

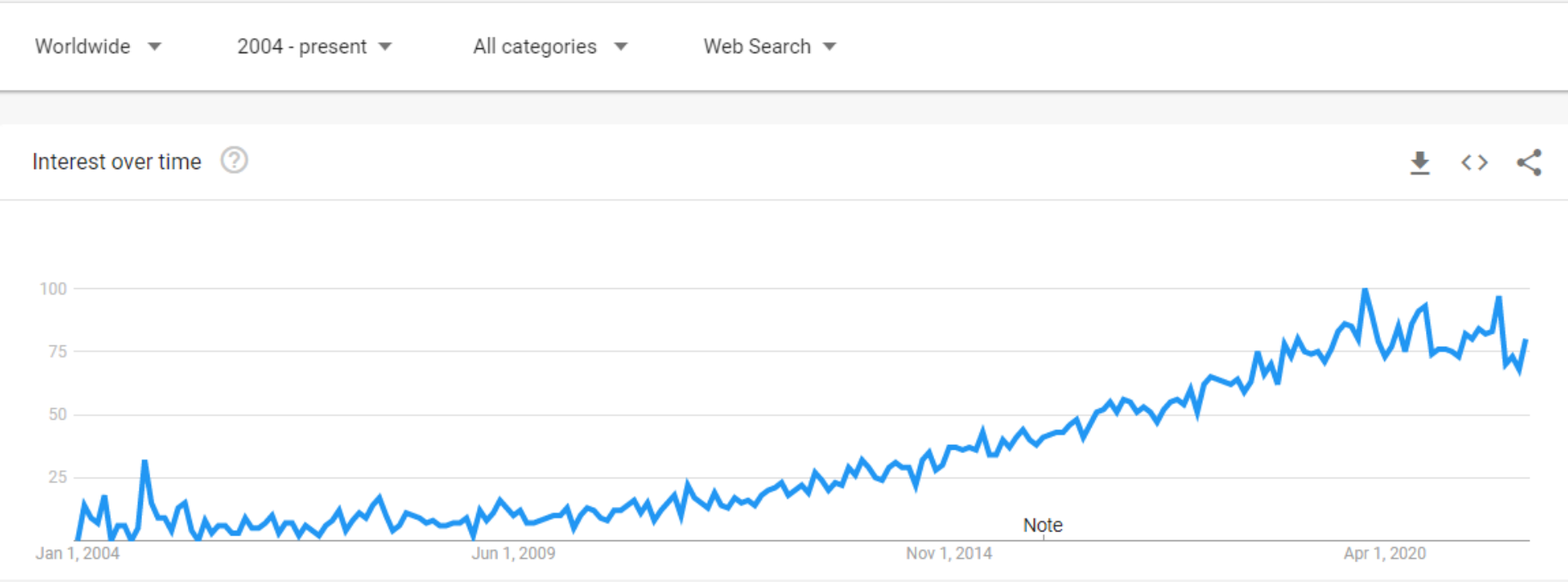
- Business Analytics Includes Statistics; Management Science/Operations Research techniques; Data Mining

What is Business Analytics?



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

Business Analytics popularity
using Google Trends

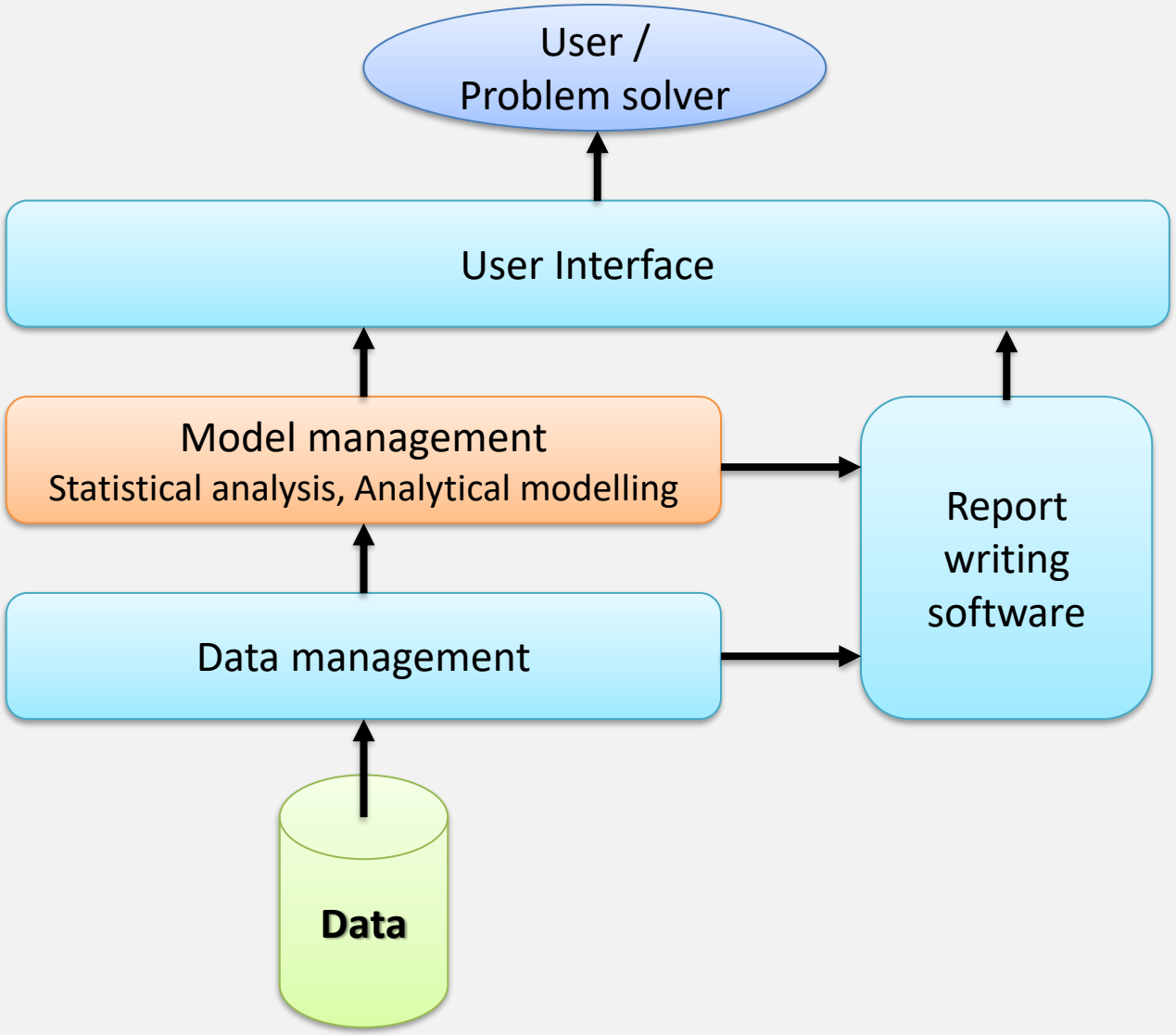


Business Analytics & Decision Support systems

- **Decision support system** (DSS) is a computer-based information system that aids the process of decision making.

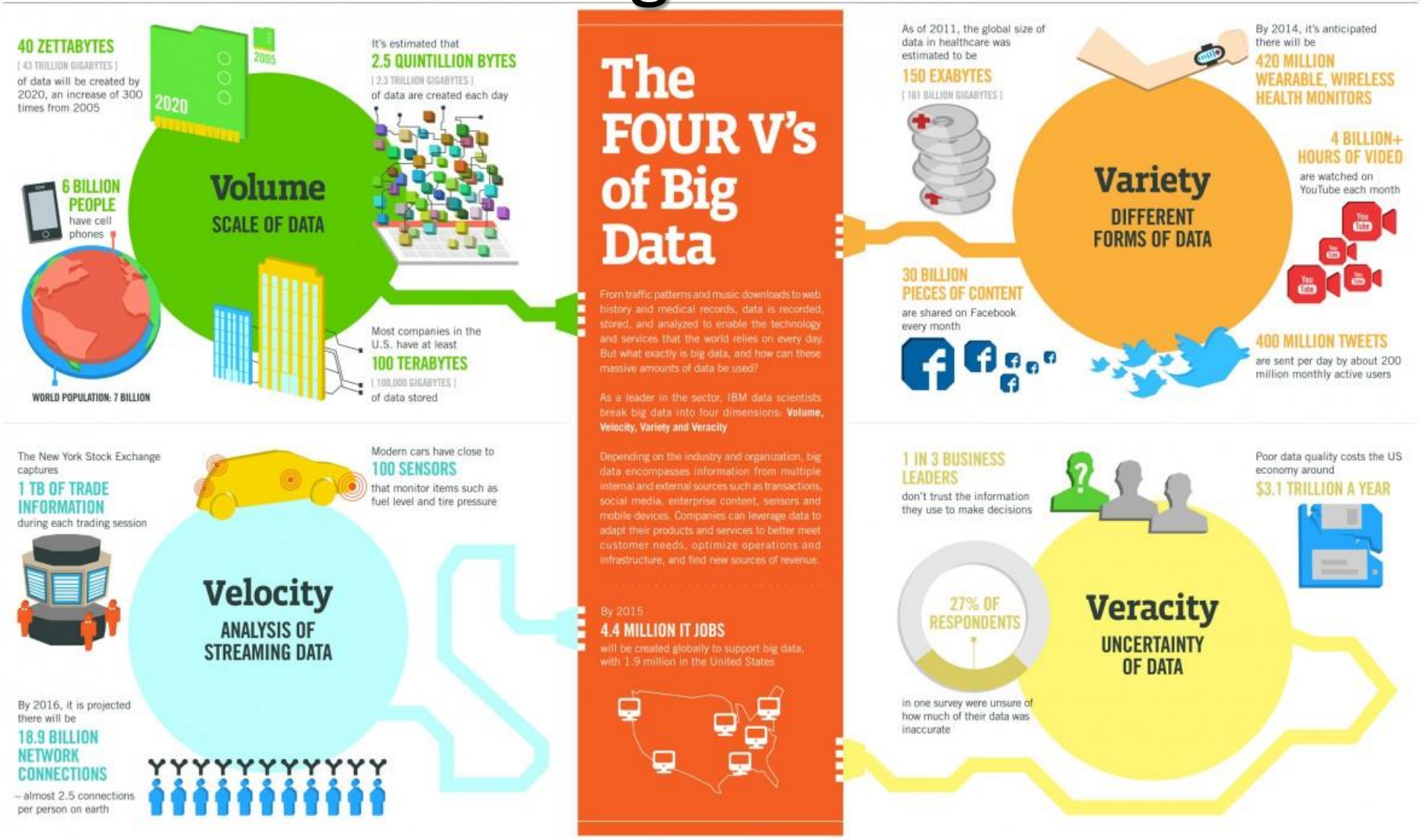
- A DSS should
  - **Assist** users in making decisions to solve problems
  - **Support** their judgement rather than replace it
  - **Improve** their decision making effectiveness rather than its efficiency.

Business Analytics & Decision Support systems



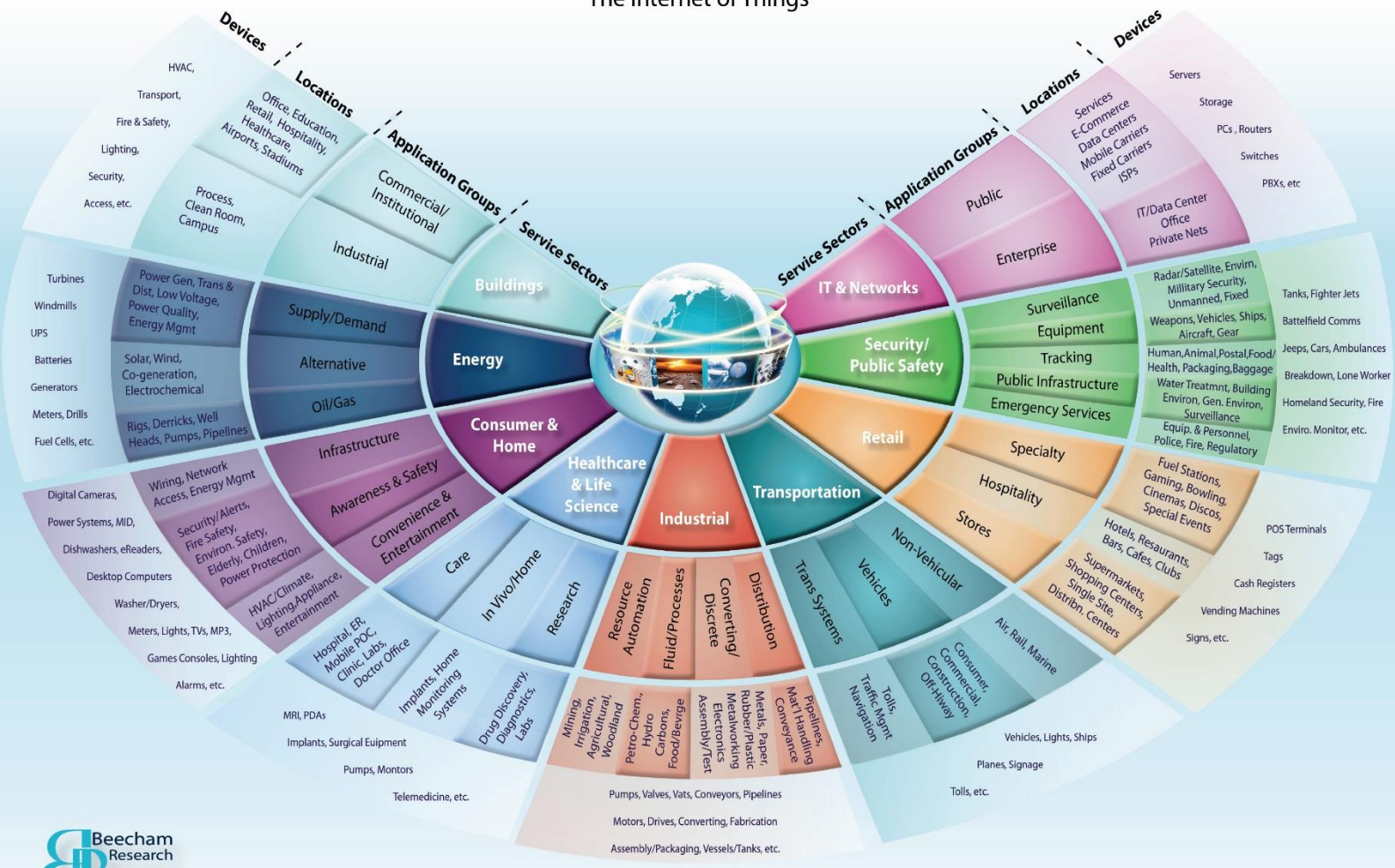
Emerging Trends:

Big Data



Emerging Trends:

The Internet of Things



Beecham Research

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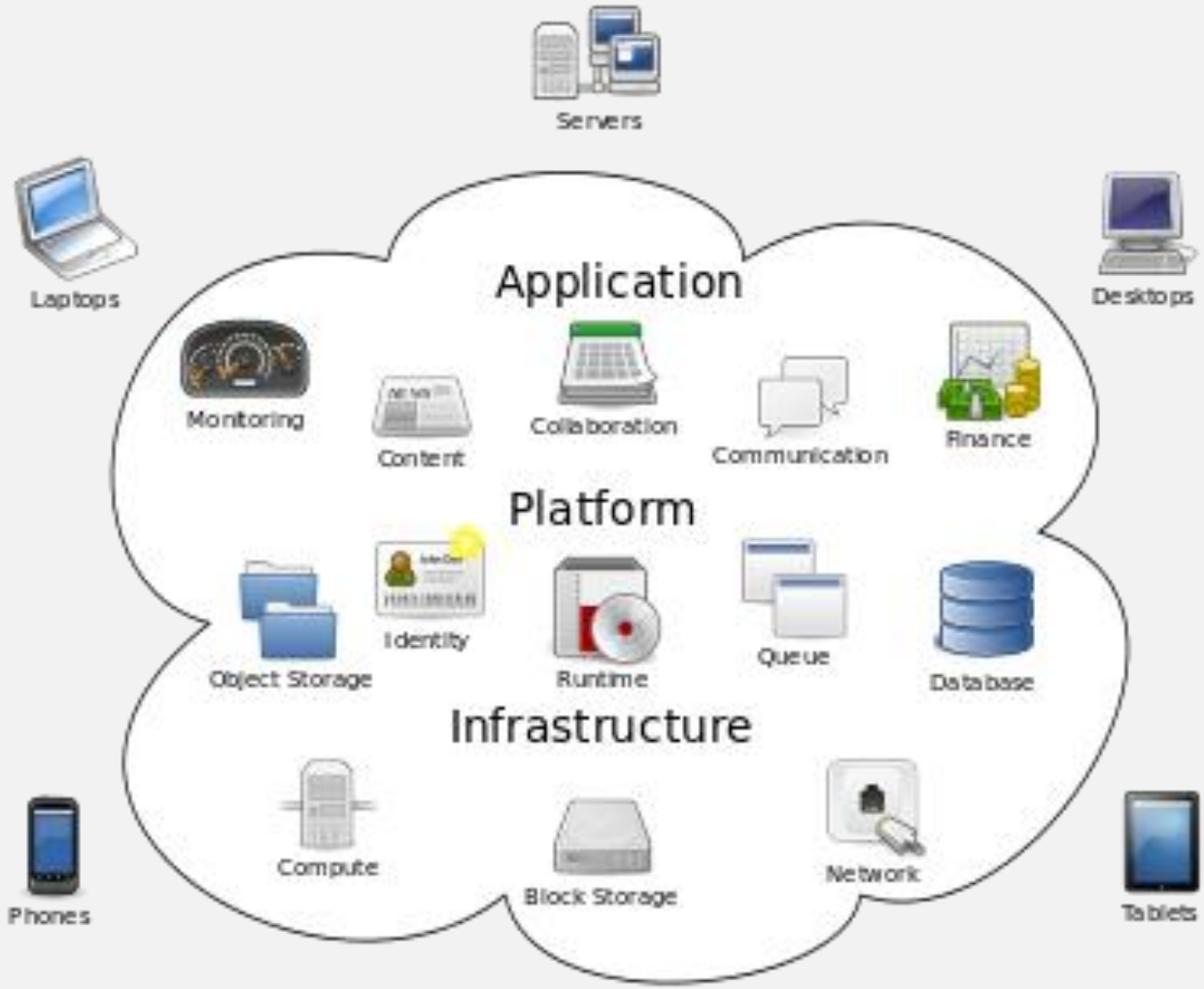
Emerging Trends:

Cloud Computing



What career path?

- A **Data Scientist** use **Data Analytics** to solve business problems.
- Examples of related job titles:
  - Data analyst/manager, Operation Research analyst/manager, Business Intelligence analyst/manager, Insight analyst/manager, Performance analyst/manager…

- To find out more on Business Analytics career paths:
  - "*Data scientist: the sexiest job of the 21st century*" by T.H. Davenport and D.J. Patil
  - "Career paths in Business Analytics – Plan your Next Best Role in the Data Science World" by T. Srivastava
  - "Dynamics of Data Science skills: how can all sectors benefit from data science talent?" The Royal Society

PART 2

PROBLEM SOLVING APPROACH

Basic concepts

- What is a **system**?
  - It is a **group of elements or objects** that interact to accomplish a specified purpose.
- What is a **model**?
  - It is a representation of a system;
  - A model usually takes the form of a **set of assumptions** concerning the operation of the system.
  - Advantages of models (compared to experimenting with the real situation) → requires less time, is less expensive, involves less risk.
- A **mathematical model**
  - Represent real world problems through a system of **mathematical formulas and expressions** based on key assumptions, estimates, or statistical analyses.

Problem Solving

- Main Steps:
  - Understand the system;
  - Define the problem and the objectives;
  - Collect and Prepare the data;
  - Develop a model;
  - Model solution;
  - Model testing/validation;
  - Result analysis and discussion;
  - Generate report;
  - Implement the selected solution.

Data Preparation

- Data preparation is not a trivial step, due to the time required and the possibility of data collection errors.
- A model with 50 decision variables and 25 constraints could have over 1300 data elements!
- Often, a fairly large data base is needed.
- Information systems specialists might be needed.

Model Solution

- The analyst attempts to **identify the alternative** (the set of decision variable values) that **provides the "best" output** for the model.
- The "best" output is the **optimal solution**.
- If the alternative does not satisfy all of the model constraints, it is rejected as being **infeasible**, regardless of the objective function value.
- If the alternative satisfies all of the model constraints, it is **feasible** and a candidate for the "best" solution.

Model Solution

- One solution approach is **trial-and-error**.
  - Might not provide the best solution

- Special solution procedures have been developed for specific mathematical models.
  - Most practical applications require using a computer

Computer Software

- A variety of computer tools are available for solving statistical and mathematical models:
  - Matlab, AIMMS, Mathematica, Maple, LINDO/LINGO, CPLEX…
  - SIMUL8, AnyLogic, Arena, Flexsim, ExtendSim…
  - Palisade Decision tools (@Risk, StatTools…)…
  - R, Python…

- In this module we will be using
  - Microsoft Excel
  - R (Statistical programming language)

Model Testing and Validation

- Often, goodness/accuracy of a model cannot be assessed until solutions are generated.
- Small test problems having known, or at least expected, solutions can be used for model testing and validation.
- If the model generates expected solutions, use the model on the full-scale problem.
- If inaccuracies or potential shortcomings inherent in the model are identified, take corrective action such as:
  - Collection of more-accurate input data
  - Modification of the model

Report Generation

- A managerial report, based on the results of the model, should be prepared.
- The report should be easily understood by the decision maker.
- The report should include:
  - the **recommended decision**
  - other pertinent information about the results (for example, how sensitive the model solution is to the assumptions and data used in the model)

Implementation and Follow-Up

- Successful implementation of model results is of critical importance.
- Secure as much **user involvement** as possible **throughout the modeling process**.
- Continue to monitor the contribution of the model.
- It might be necessary to refine or expand the model.

PART 3

DATASET: BASIC CONCEPTS

Dataset

- A **data set** is usually a rectangular array of data, with variables in columns and observations in rows.
- A **variable** (or **field** or **attribute**) is a characteristic of members of a population, such as height, gender, or salary.
- An **observation** (or **case** or **record**) is a list of all variable values for a single member of a population.

Person	Age	Gender	Regions	Children	Salary
1	30	Male	South East	1	£ 65,400
2	56	Female	London	2	£ 62,000
3	39	Male	North West	0	£ 63,200
4	32	Male	West Midlands	2	£ 52,000
5	30	Female	South West	3	£ 81,400
6	35	Female	East of England	3	£ 46,300
7	68	Female	Yorkshire	2	£ 49,600
8	48	Male	North East	1	£ 45,900
9	42	Male	London	3	£ 47,700
10	33	Female	East Midlands	1	£ 59,900

Types of Data

- A **numerical** variable can represent:
  - A **measurement**, e.g. individual's weight, waiting time.
  - A **count**, e.g. number of pages you read from the textbook, number of transactions per day.
- A **categorical** variable can take on a finite number of values. It can be:
  - **Ordinal** if there is a natural ordering of its possible values, e.g. degree award.
  - **Nominal** if there is no natural ordering, e.g. gender, marital status.

  Binary variable (or **dichotomous** variable) can take on exactly two values.
- There is also a third data type, a **date** variable.

Person	Age	Gender	Regions	Children		Salary
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2	56	Female	London	2	£	62,000
3	39	Male	North West	0	£	63,200
4	32	Male	West Midlands	2	£	52,000

Types of Data

- A numerical variable is
  - **discrete** if it results from a count, e.g. number of children.
  - **continuous** if it is the result of an essentially continuous measurement, e.g. weight or height.

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Types of Data

- **Cross-sectional** data are data on a cross section of a population at a distinct point in time.
- **Time series** data are data collected over time.

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1	30	Male	South East	1	£ 65,400
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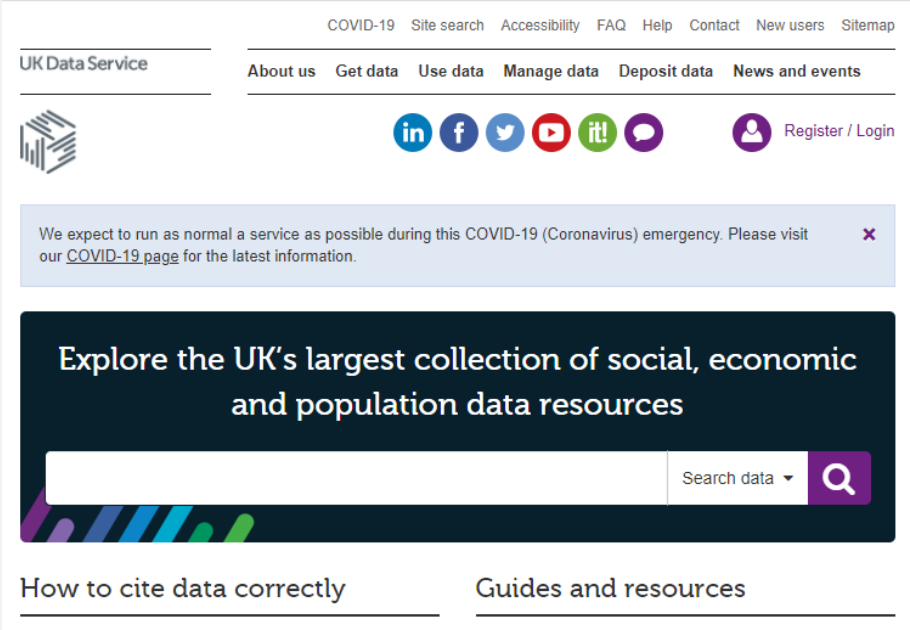
Cross-sectional data

Quarter	Revenue (in 000s)
Q1-2010	£1,333.80
Q2-2010	£1,372.80
Q3-2010	£1,536.60
Q4-2010	£3,719.30
Q1-2011	£1,523.60
Q2-2011	£1,623.70
Q3-2011	£1,749.80
Q4-2011	£4,422.60
Q1-2012	£1,671.80
Q2-2012	£1,712.10
Q3-2012	£1,883.70
Q4-2012	£5,060.90
Q1-2013	£1,900.60
Q2-2013	£1,887.60
Q3-2013	£2,120.30
Q4-2013	£5,460.00

Time series data

Data Sources

- **Primary data**: Data collected first-hand for a specific purpose.
  - Through surveys, interviews, experiments …
- **Secondary data**: collected by a third party for a different purpose.
  - Available online freely or through a subscription
  - Official statistics, technical reports, scholarly journals, online platform …



PART 4

MODULE CONTENT

In this module, we will focus on

- Forecasting
- Simulation
- Decision making
- Linear programming

Forecasting

Met Office MENU

UK Climate Projections (UKCP)

The UK Climate Projections (UKCP) provides the most up-to-date assessment of how the climate of the UK may change over the 21st century. Find information to help with your climate change risk assessments and adaptation plans.

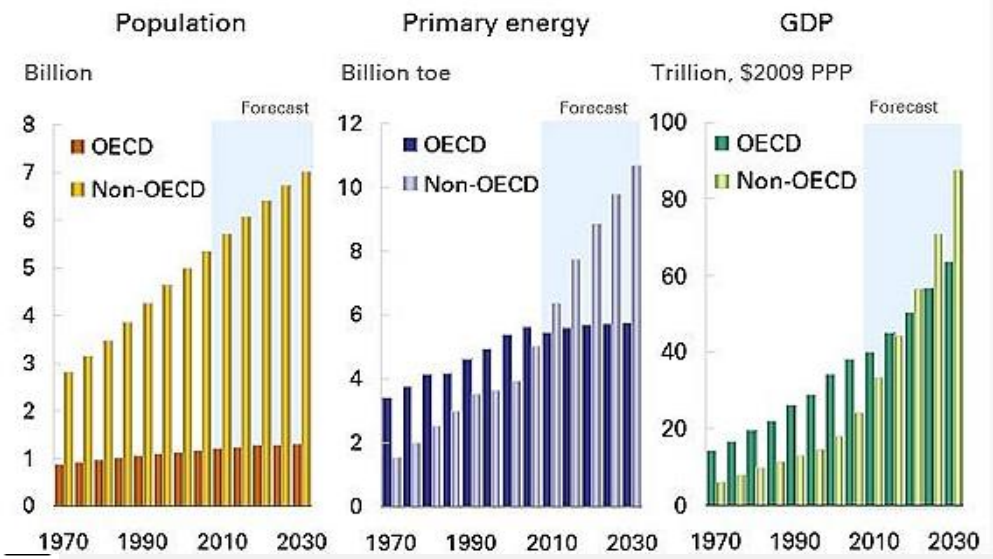
The Health Foundation

Home > News and comment > Blogs and long reads

How can the NHS make the most of risk prediction tools?

bp

The world we live in...



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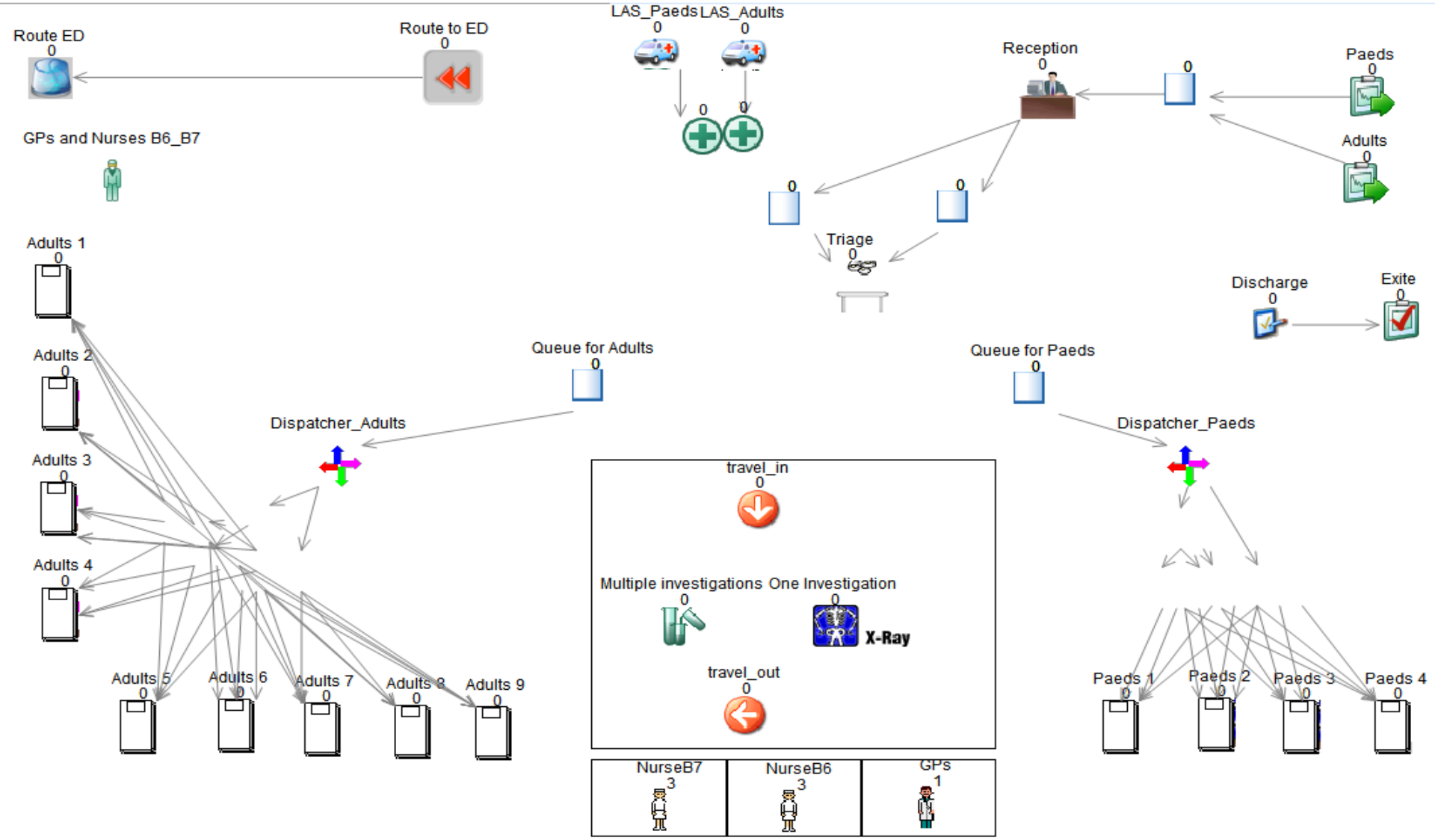
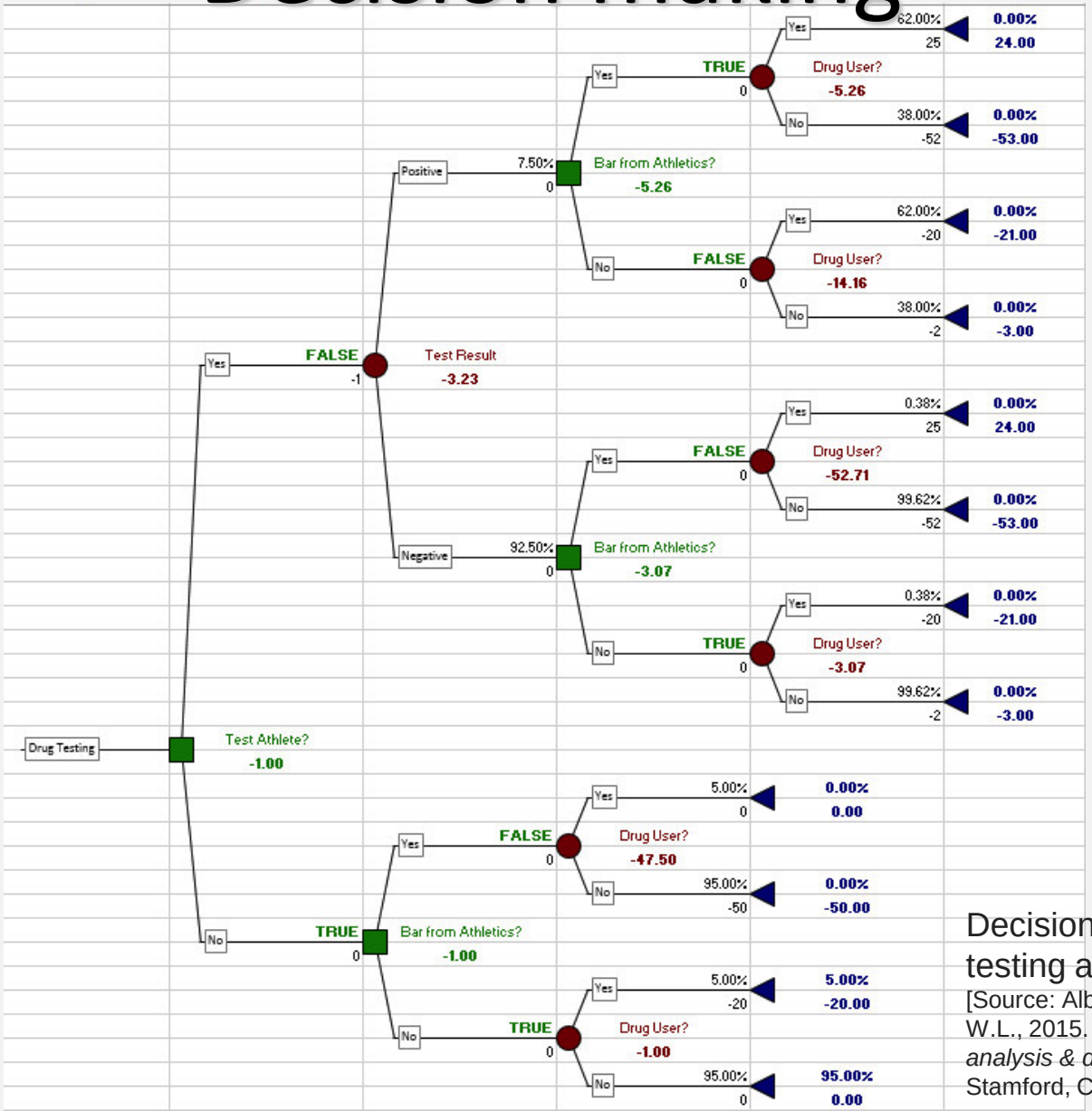
Simulation



[Source: Tadjer, M., Chaussalet, T.J., Fouladinajed, F. and Chahed, S., 2012. Using data mining and simulation for health system understanding and capacity planning: an application to urgent care. In *High Tech Human Touch: Proceedings of the 38th ORAHS conference*.]

Decision making



Decision Tree for Drug testing athletes

[Source: Albright, S.C. and Winston, W.L., 2015. *Business analytics: Data analysis & decision making*. 5th Edition. Stamford, CT, USA: Cengage Learning.]

Linear Programming (LP)

Maximise $Z = c_1 x_1 + c_2 x_2 + \ldots + c_k x_k$

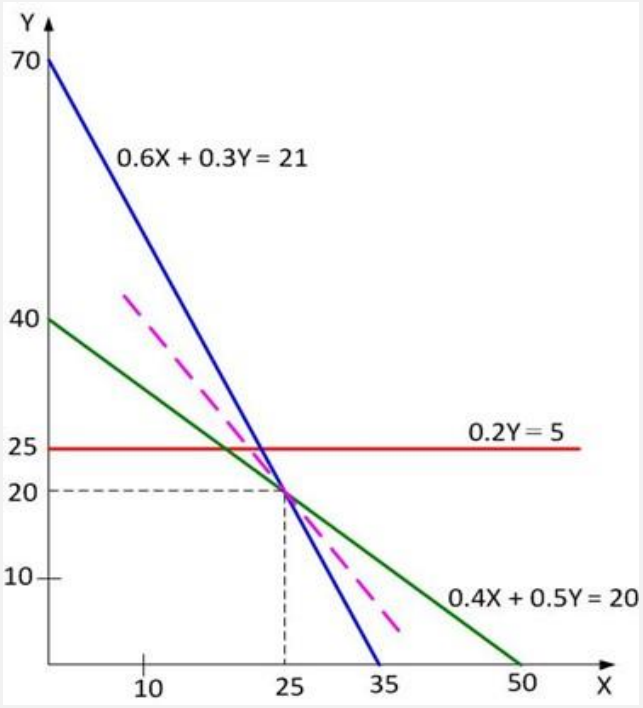
subject to $a_{11} x_1 + a_{12} x_2 + \ldots + a_{1k} x_k \leq b_1$

$a_{21} x_1 + a_{22} x_2 + \ldots + a_{2k} x_k \leq b_2$

$\vdots$

$a_{n1} x_1 + a_{n2} x_2 + \ldots + a_{nk} x_k \leq b_n$

$x_1, x_2, \ldots x_k \geq 0$



A steam and electric power plant example by Alan Weiss, MathWorks

[https://uk.mathworks.com/videos/mathematical-modeling-with-optimization-part-1-68973.html]