Introduction to Business Analytics

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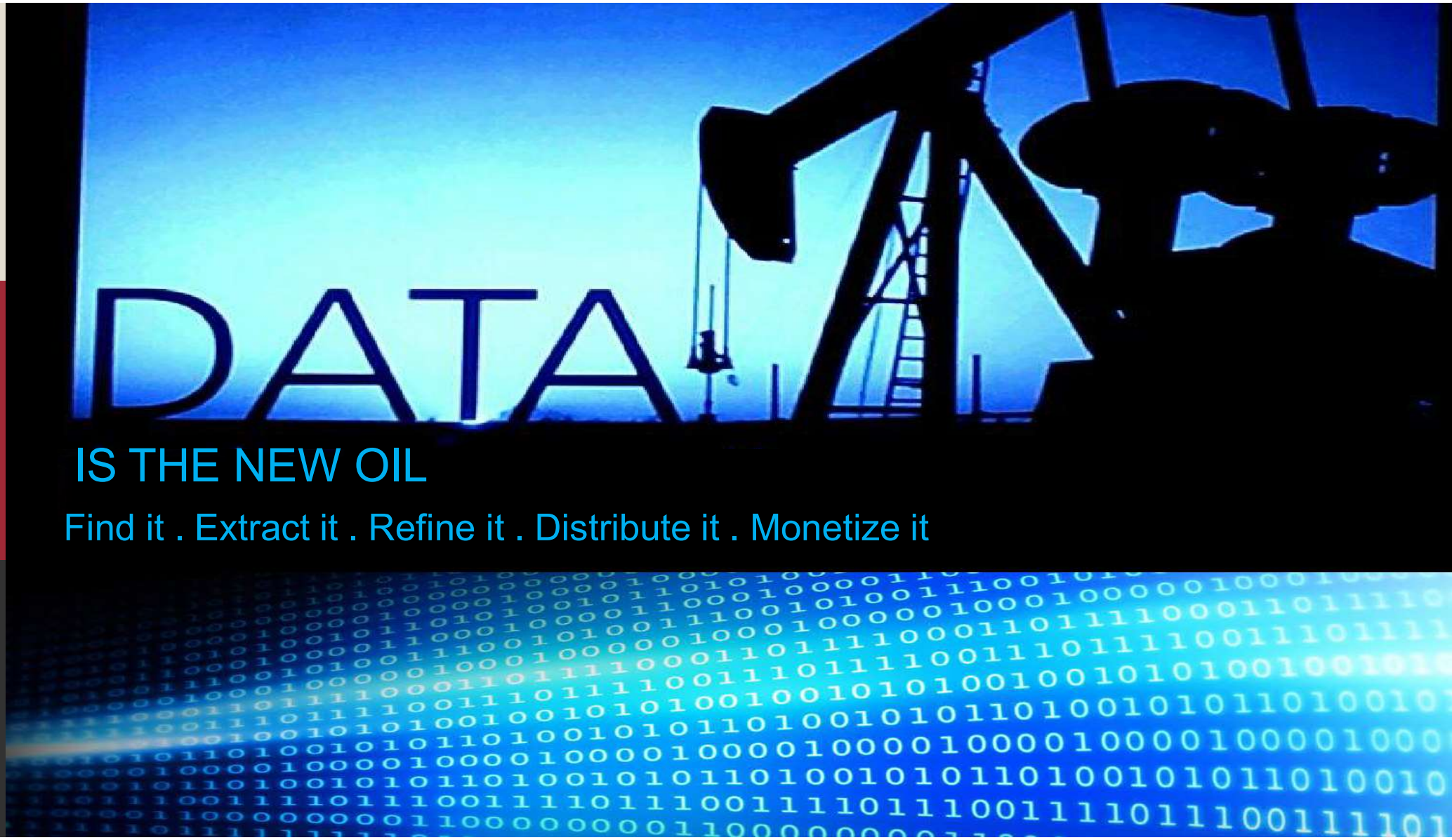


IS THE NEW OIL

Find it . Extract it . Refine it . Distribute it . Monetize it

What is Data Analytics?

The vast reservoir of data is the next big thing

Real impetus is the derived potential insights

DEFINITION:

Data analytics (DA) is the science of examining raw data with the purpose of drawing conclusions about that information.

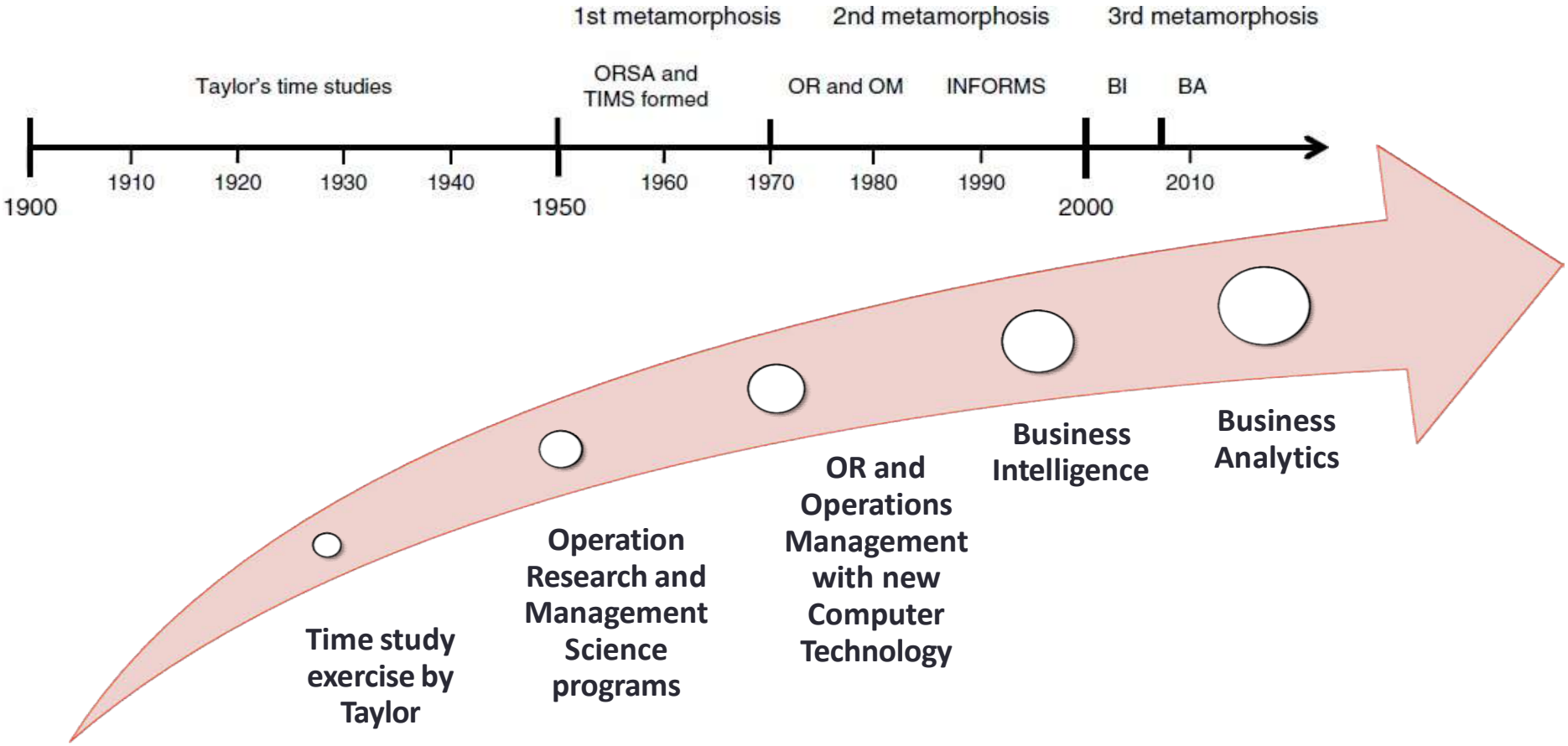
INFORMS: Analytics is the scientific process of transforming data into insight for making better decisions.

DATA → INFORMATION → KNOWLEDGE → WISDOM

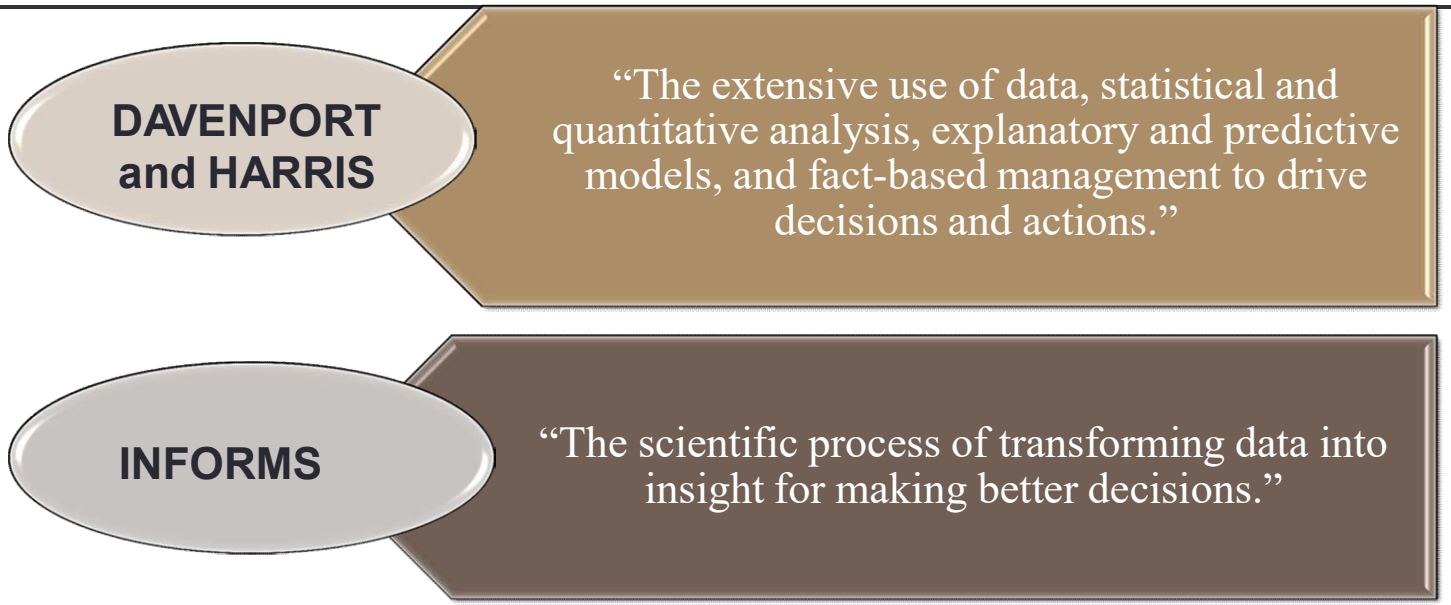
Companies and organization use it to make better business decisions

In sciences it is used to verify/ disprove existing models or theories.

History of Business Analytics



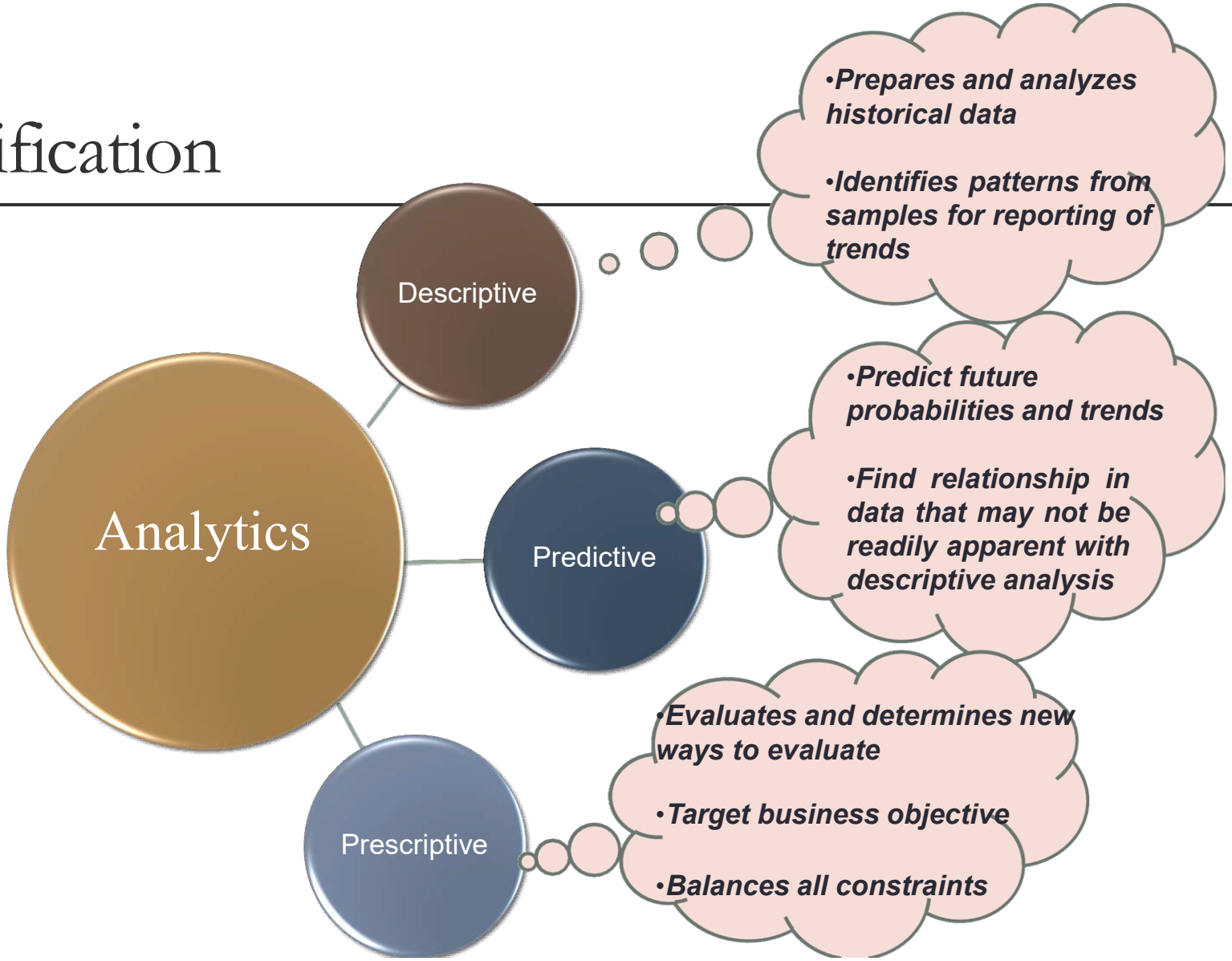
What is Business Analytics



INFORMS defines OR as '*A discipline that deals with the application of advanced analytical methods to help make better decisions'.*

BA extends OR by more broadly including the critical data transformation process to support OR models and decision making.

Classification

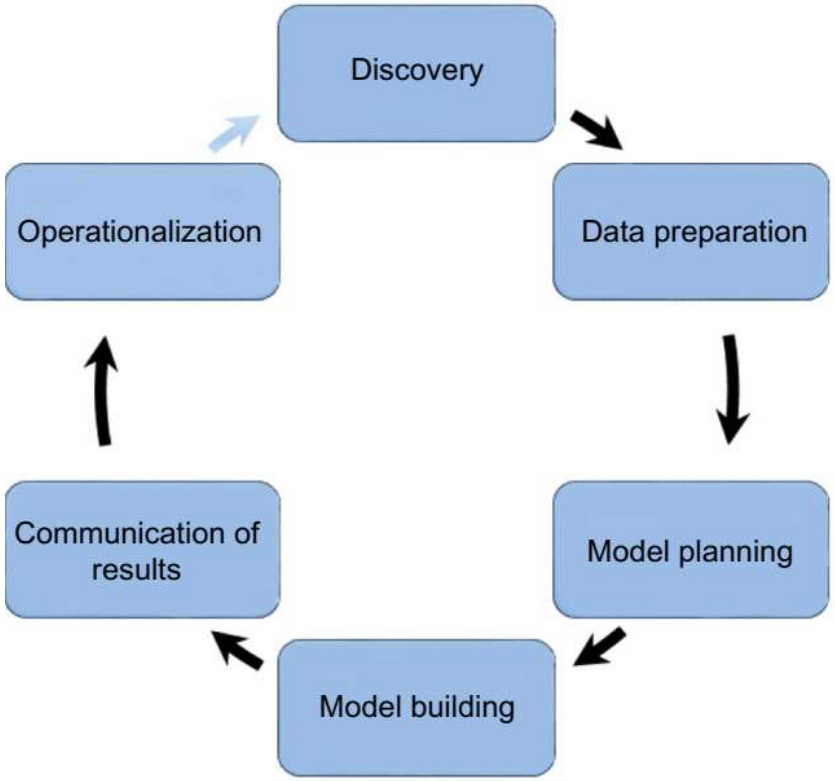


Business Analytics

- Descriptive Analytics
  - Describes what happened in the past
  - Used for reporting and dashboards, and for preliminary exploratory data analysis to understand the data
  - Customer segmentation, Clustering
- Diagnostic Analytics
  - "Why did it happen?"
  - examines data or content to answer the question
- Predictive Analytics
  - Uses models and data from the past to forecast the future
  - Causal Relationship not assumed
  - Churn Prediction, Customer Scoring
- Prescriptive Analytics
  - Prescribes actions to perform
  - Two approaches – Experimental Design, Optimization
  - Scenario Analysis, Decision Analytics

Classification	Questions	Examples from Business
Prescriptive	What is the best outcome? What if?	Optimisations Scenario testing Randomised tests
Predictive	What could happen? What is happening next? Why is this happening?	Statistical modelling Forecasting
Descriptive	What happened? How many, how often? What action is needed?	Standard and ad hoc reports Queries Alerts

The Business Analytics Lifecycle

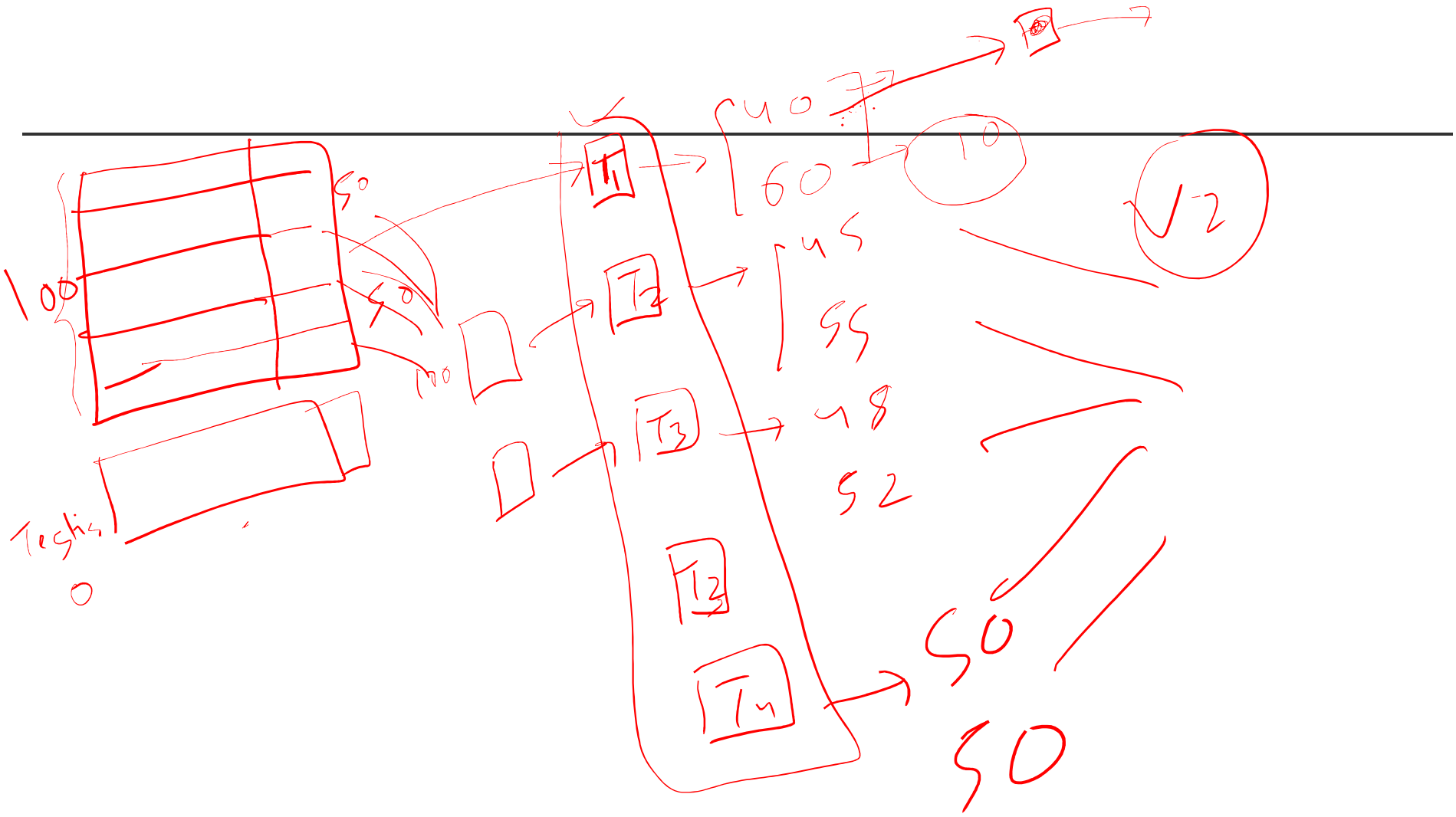


The Business Analytics Lifecycle

1. **Discovery**
   - This stage covers learning about the business problem and the approaches that have been attempted in the past (if any)
   - Assessment of the available data and resources, identification of the important stakeholders, and formulation of the initial hypotheses are included
2. **Data Preparation**
   - This stage involves collection of the data necessary to address the problem and reformatting it to facilitate successful analysis (from DataBase, API, Web Scrapping, Survey, etc.)
   - It often takes 60%–80% of the project time
3. **Model Planning**
   - This stage covers preliminary data analysis, e.g., exploration of the relationships between different variables to assess which variables appear to be most important
     - Visualization, Univariate/Bivariate, Class Imbalance, Feature Selection, etc.)
   - Determination of possible models that may be applicable for addressing the business problem is included

The Business Analytics Lifecycle

4. **Model Building, Evaluation and Selection**
   - This stage covers the implementation and fine-tuning of the models
5. **Communication of Results**
   - This stage includes the determination of whether the project has accomplished its goals, assessment of the business value of the proposed approach, and summary reports and presentations of key findings to the different stakeholders
6. **Operationalization**
   - This stage covers delivery of the technical documents and code, implementation of the model in a production environment, and a pilot project run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Why Analytics?

Deciding to buy a car

Analytical Approach	Non-Analytical approach
Nailing down constraints- time, money, five feature requirement and five wish-lists	Process may start by test driving a car irrespective of any criteria
Prioritize on requirements and wishes Eg: good mileage is high priority while emission low priority;	
Based on must haves and constraints, shortlist cars for test-drive	You either begin creating your own criteria as you go along- may be rejecting some car and loving others based on what you “feels” good.
Grade each vehicle with a 1-5 score on each requirement and wish. Requirement graded with an extra point .	
Take average of requirement and wish list	

A year later after buying a car, XYZ started complaining about his expenditure on fuel/mileage.

To this ABC asked him :

1)Did your office is farther now than one year earlier (job change if any)?

2) If the car is giving lower mileage than expected or advertised?

3)Didn't you buy a car with higher mileage at first place knowing long travels?

(XYZ answered NO to all the above questions)

XYZ: He didn't know the cost would be this high and burden some to him. He really liked the car when he drove it.

ADVANTAGE: Using data to drive decisions deliver a significantly higher chance of making a good, long-lasting decision over non data-driven approach.

Broad Applications of Business Analytics

Industry Specific

Optimize Funnel Conversion

Business analytics allows companies to track leads through the entire sales conversion process, from a click on an adword ad to the final transaction, in order to uncover insights on how the conversion process can be improved.

EXAMPLE:

CREDEM uses Businesss Analytics to predict which financial products or services a customer would appreciate, so it can better target consumers during the sales process. With these insights, the bank increased average revenue by 22 % and reduced costs by 9 %.

CREDEM BANCA

La forma e la sostanza.

Company	Industry
Credem	Finance

Behavioral Analytics:

With access to data on consumer behavior, companies can learn what prompts a customer to stick around longer, as well as learn more about their customer's characteristics and purchasing habits in order to improve marketing efforts and boost profits.

EXAMPLE:

McDonalds tracks vast amounts of data in order to improve operations and boost the customer experience. The company looks at factors such as the design of the drive-thru, information provided on the menu, wait times, the size of orders and ordering patterns in order to optimize each restaurant to its particular market

Company	Industry
McDonalds	Food & Beverages

Customer Segmentation

By accessing data about the consumer from multiple sources, such as social media data and transaction history, companies can better segment and target their customers and start to make personalized offers to those customers.

EXAMPLE:

Walmart combines public data, social data and internal data to monitor what customers and friends of customers are saying about a particular product online. The retailer uses this data to send targeted messages about the product, and to share discount offers. Walmart also uses data analysis to identify the context of an online message, such as if a reference to "salt" is about the movie or the condiment.

Walmart
Save money. Live better.

Company	Industry
Walmart	Retail

Predictive Support

Through sensors and other machine-generated data, companies can identify when a malfunction is likely to occur. The company can then pre-emptively order parts and make repairs in order to avoid downtime and lost profits.

EXAMPLE:

Southwest analyses sensor data on their planes in order to identify patterns that indicate a potential malfunction or safety issue. This allows the airline to address potential problems and make necessary repairs without interrupting flights or putting passengers in danger.

Company	Industry
Southwest airlines	Travel

Predict Security Threats

Big data analytics can track trends in security breaches and allow companies to proactively go after threats before they strike.

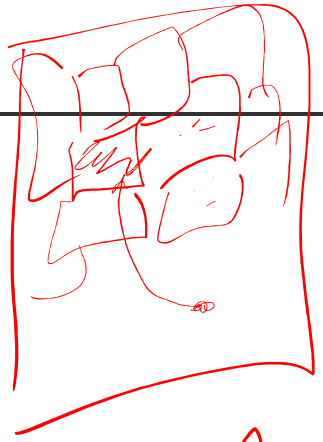
EXAMPLE:

amazon.com

With more than 1.5 billion items in its catalog, Amazon has a lot of product to keep track of and protect. It uses its cloud system, S3, to predict which items are most likely to be stolen, so it can better secure its warehouses.

Company	Industry
Amazon	Online Retail

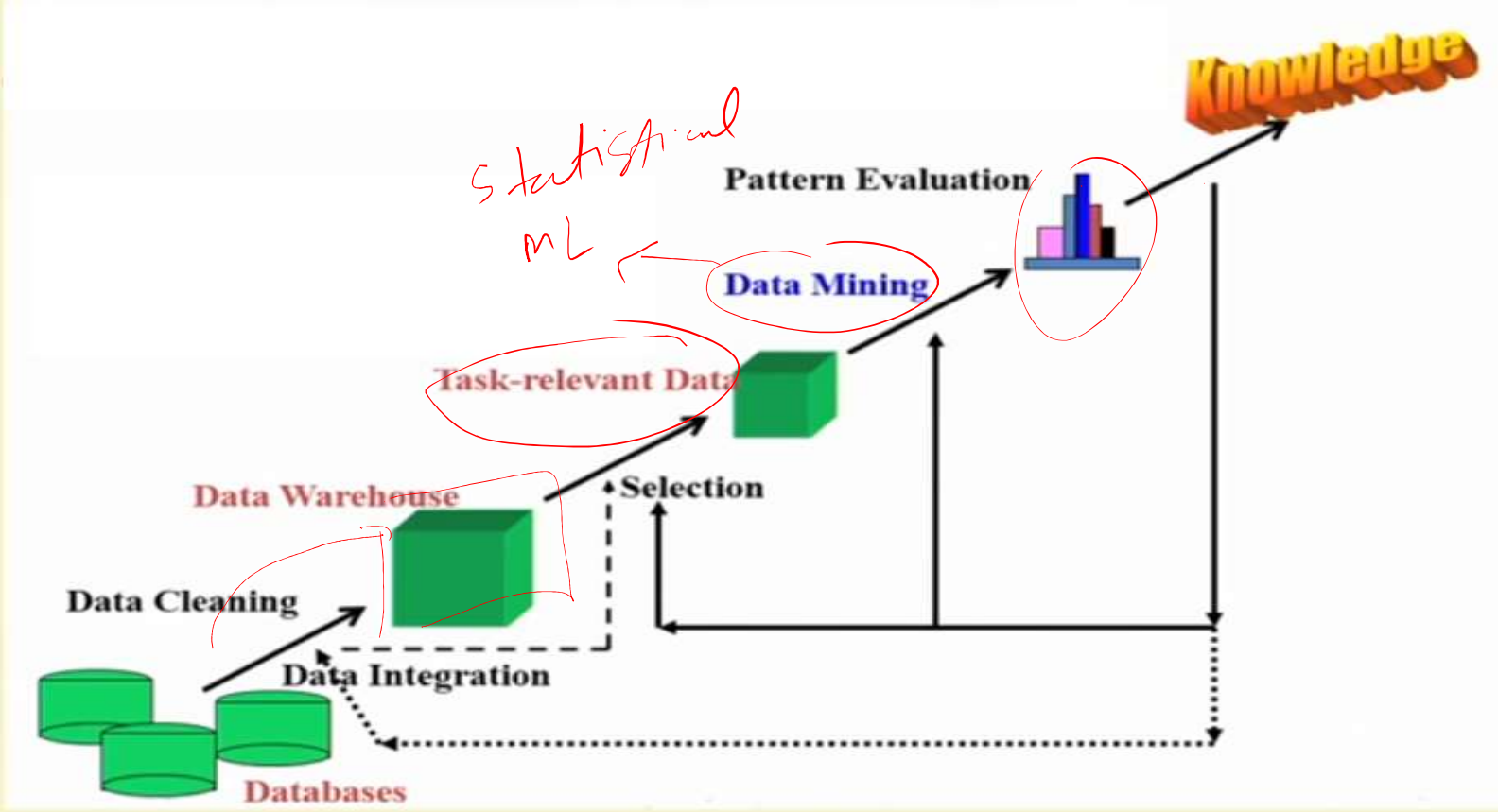
Tour spot - OLA/Uber



Twitter - X

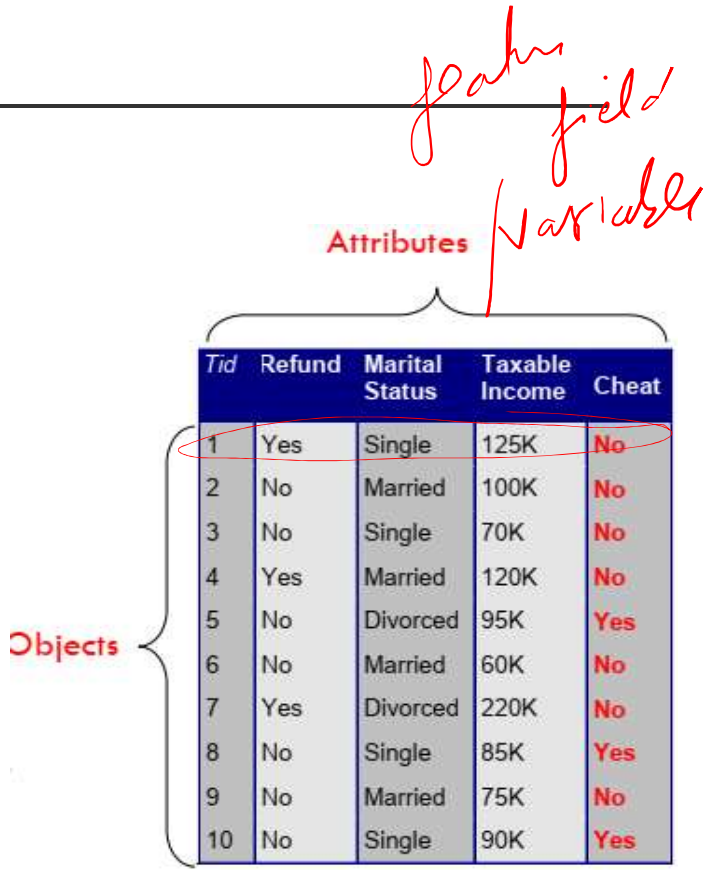
Sentiment Analysis

Knowledge Discovery in Data: Process



What is Data?

- a collection of number assigned as value to quantitative variable and/ or characters assigned as value to qualitative variables, or
- collection of records and their attributes
- An attribute is a characteristic of an object
  - Example: Colours of eyes, temperature, etc.
  - Attribute is also known as variable, feature, characteristics, fields, etc.
- A collection of attributes describe an object
  - Object is also known as record, point, case, sample, entity or instances



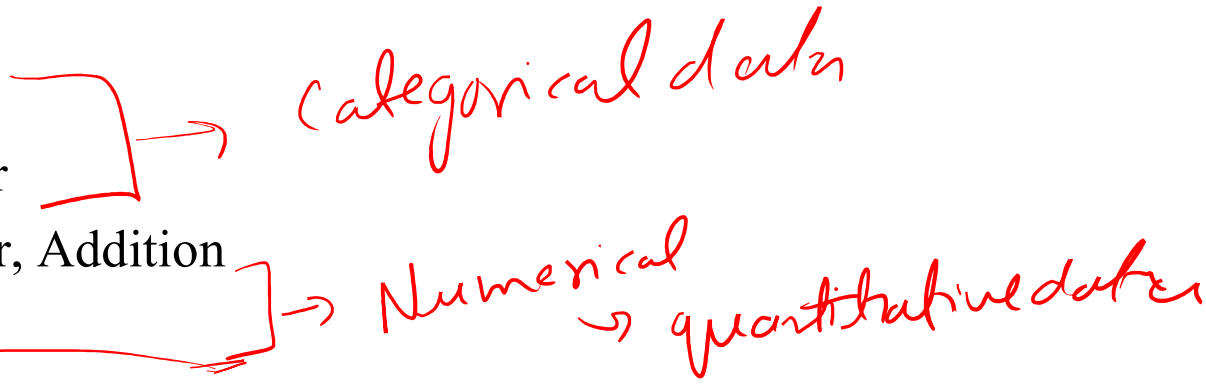
Types of Attributes

- **Nominal**
  - Used to assign individual cases to categories
  - Example: eye colour, ID number, Zip code, etc
- **Ordinal**
  - Used to rank order cases
  - Example: ranking (eg. movie on scale of 1-10), height (tall, medium, short), grades
- **Interval**
  - Example: Calendar dates, longitude, latitude
- **Ratio**
  - Same as interval variable but they have a “true zero”
  - Example: time, length, population, age

Properties of Attribute values

- The type of an attributes depends on which of the following properties it possess:
  - Distinctness: = ≠
  - Order: < >
  - Addition: + -
  - Multiplication: * /

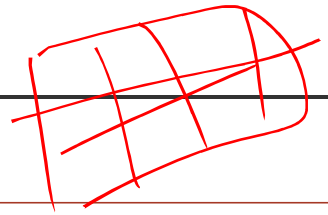
- Nominal: Distinctness
- Ordinal: Distinctness, Order
- Interval: Distinctness, Order, Addition
- Ratio: all 4 properties



Discrete and Continuous Attributes

- **Discrete Attribute**
  - Has only a finite or countable infinite set of values
  - Examples: zip codes, counts, or the set of words in a collection of documents
  - Often represented as integer variables.
  - Note: Binary attributes are special cases of discrete attributes

- **Continuous Attribute**
  - Has real numbers as attribute values
  - Examples: temperature, height, or weight.
  - Practically, real values can only be measured and represented using a finite number of digits.
  - Continuous attributes are typically represented as floating-point variable



***STRUCTURED DATA*:**

A data structure is a particular way of storing and organizing data in a computer so that so that it can be used efficiently.

data types: boolean, chart, float, double, array, set, queue, graph, etc.

UNSTRUCTURED DATA:

Unstructured data refers to information that either does not have a predefined data model or is not organized in a predefined manner.

Type of data sets

- Record Data
  - Data Matrix
  - Transaction data
- Graph Data
  - World wide web
  - Molecular structure
- Ordered
  - Spatial data
  - Temporal data
  - Sequential data
  - Genetic sequence data

Record Data

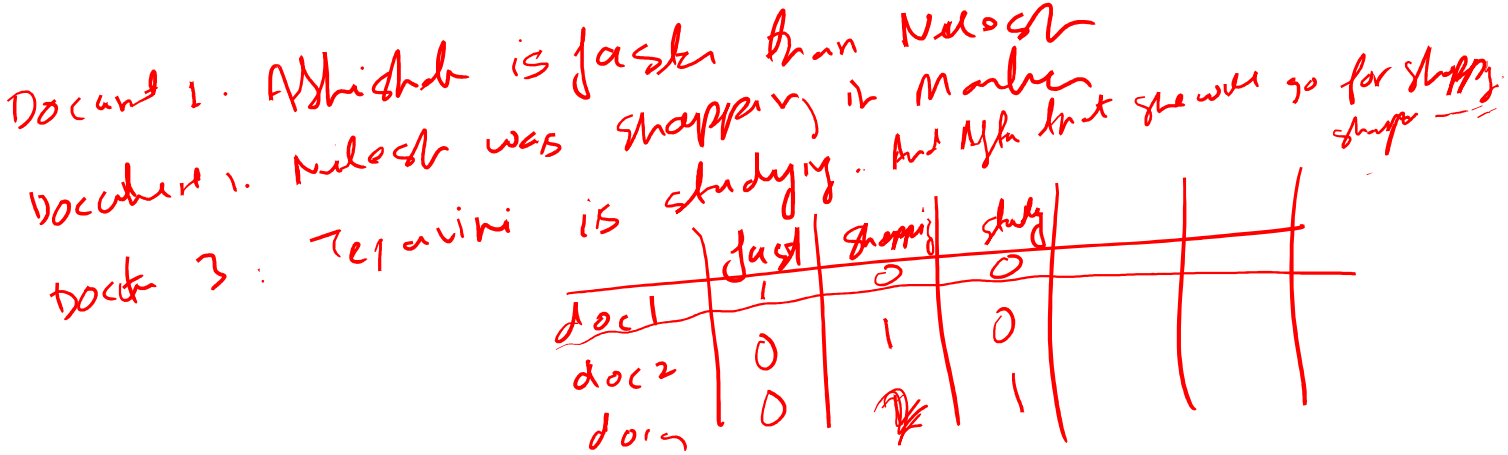
- Data that consists of a collection of records, each of which consists of fixed set of attributes

Tid	Refund	Marital Status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

Data Matrix

- If data objects have the same fixed set of numeric attributes, then the data objects can be thought of as points in a multidimensional space, where each dimension represents a distinct attribute

- Such data set can be represented by an m by n matrix, where there are m rows, one for each object, and n columns, one for each attribute



Data Matrix Example for Documents

- Each document becomes a `term' vector,
  - each term is a component (attribute) of the vector,
  - the value of each component is the number of times the corresponding term occurs in the document.

	team	coach	play	ball	score	game	win	lost	timeout	season
Document 1	3	0	5	0	2	6	0	2	0	2
Document 2	0	7	0	2	1	0	0	3	0	0
Document 3	0	1	0	0	1	2	2	0	3	0

Transaction Data

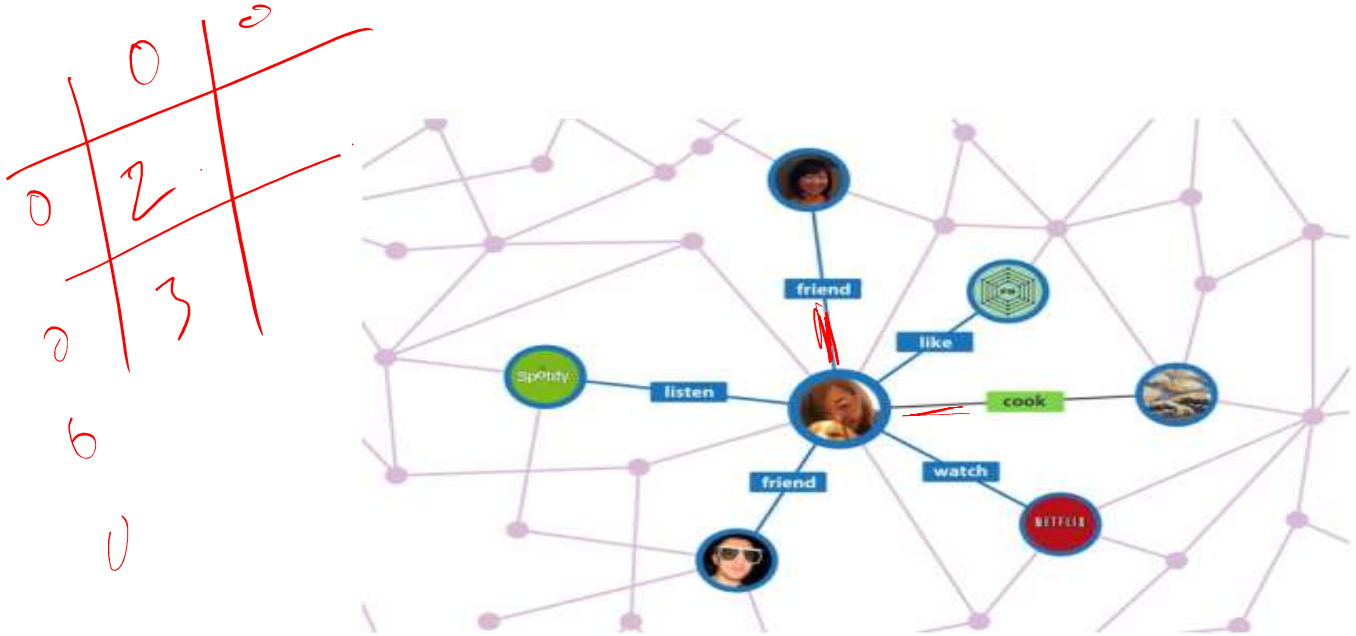
- A typical type of record data, then
  - Each record (transaction) involves a set of items

TID	*Items*
1	Bread, Coke, Milk
2	Beer, Bread
3	Beer, Coke, Diaper, Milk
4	Beer, Bread, Diaper, Milk
5	Coke, Diaper, Milk

Market-Basket Dataset

Graph data

- Example: Facebook graph and HTML links



Ordered data

- Genetic sequence data

Species	Alignment of Amino Acid Sequences of β-globin
Human	1 VHLTPEEKSA VTALWGKVNV DEVGGEALGR LLVVYPWTQR FFESFGDLST
Monkey	1 VHLTPEEKNA VTTLWGKVNV DEVGGEALGR LLLVYPWTQR FFESFGDLSS
Gibbon	1 VHLTPEEKSA VTALWGKVNV DEVGGEALGR LLVVYPWTQR FFESFGDLST
Human	51 PDAVMGNPKV KAHGKKVLGA FSDGLAHLDN LKGTFATLSE LHCDKLHVDP
Monkey	51 PDAVMGNPKV KAHGKKVLGA FSDGLNHLDN LKGTFAQLSE LHCDKLHVDP
Gibbon	51 PDAVMGNPKV KAHGKKVLGA FSDGLAHLDN LKGTFAQLSE LHCDKLHVDP
Human	101 ENFRLLGNVL VCVLAHHFGK EFTPPVQAAY QKVVAGVANA LAHKYH
Monkey	101 ENFKLLGNVL VCVLAHHFGK EFTPQVQAAY QKVVAGVANA LAHKYH
Gibbon	101 ENFRLLGNVL VCVLAHHFGK EFTPQVQAAY QKVVAGVANA LAHKYH

Data Quality

- What kind of data quality problems?
- How can we detect the problem with the data?
- What can we do about these problem?
- Examples of data quality problems:
  - Missing values
  - Noise and outliers
  - Duplicate data

A mistake or a millionaire?

Missing values

Inconsistent duplicate entries

Tid	Refund	Marital Status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	10000K	Yes
6	No	NULL	60K	No
7	Yes	Divorced	220K	NULL
8	No	Single	85K	Yes
9	No	Married	90K	No
9	No	Single	90K	No

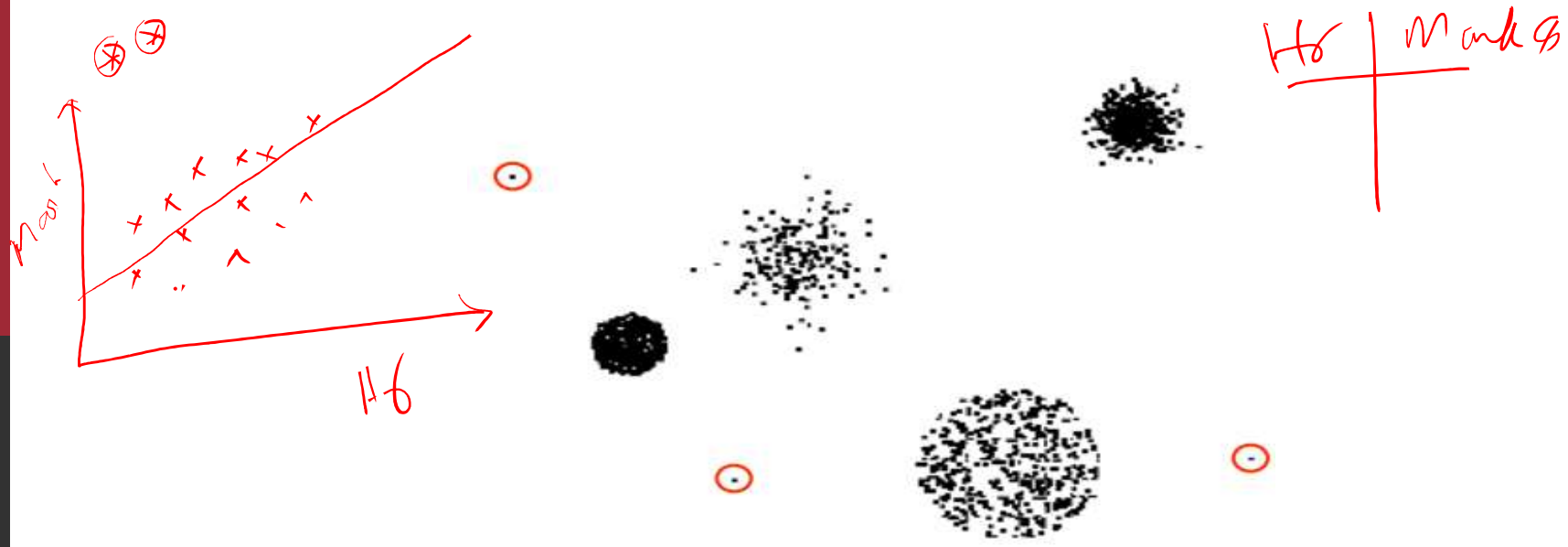
Data Quality: Missing Values

- Reasons for missing values
  - Information is not collected
    (e.g., people decline to give their age and weight)
  - Attributes may not be applicable to all cases
    (e.g., annual income is not applicable to children)

- Handling missing values
  - Eliminate Data Objects
  - Estimate Missing Values
  - Ignore the Missing Value During Analysis
  - Replace with all possible values (weighted by their probabilities)

Data Quality: Outliers

- Outliers are data objects with characteristics that are considerably different than most of the other data objects in the data set

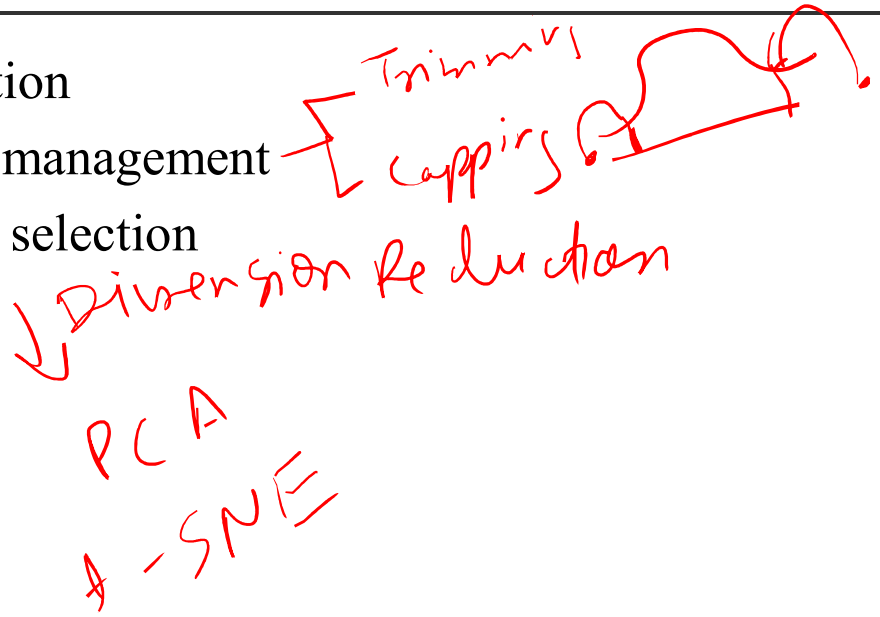


Data Quality: Duplicate Data

- Data set may include data objects that are duplicates, or almost duplicates of one another
  - Major issue when merging data from heterogenous sources
- Examples:
  - Same person with multiple email addresses
- Data cleaning
  - Process of dealing with duplicate data issues

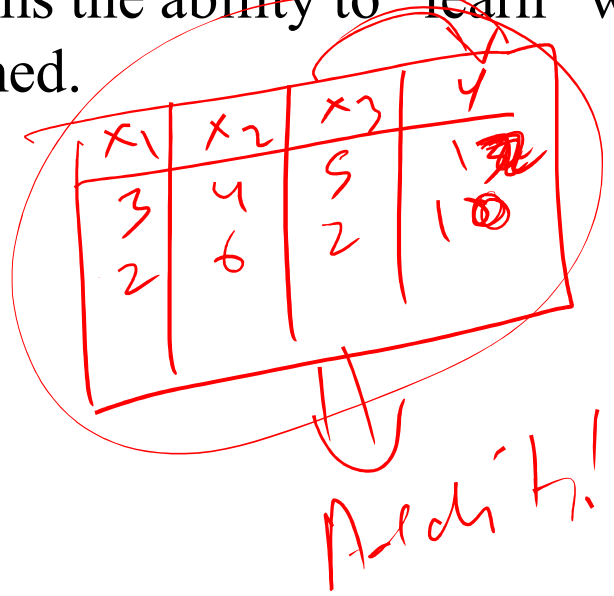
Data Preprocessing

- Imputation
- Outlier management
- Feature selection



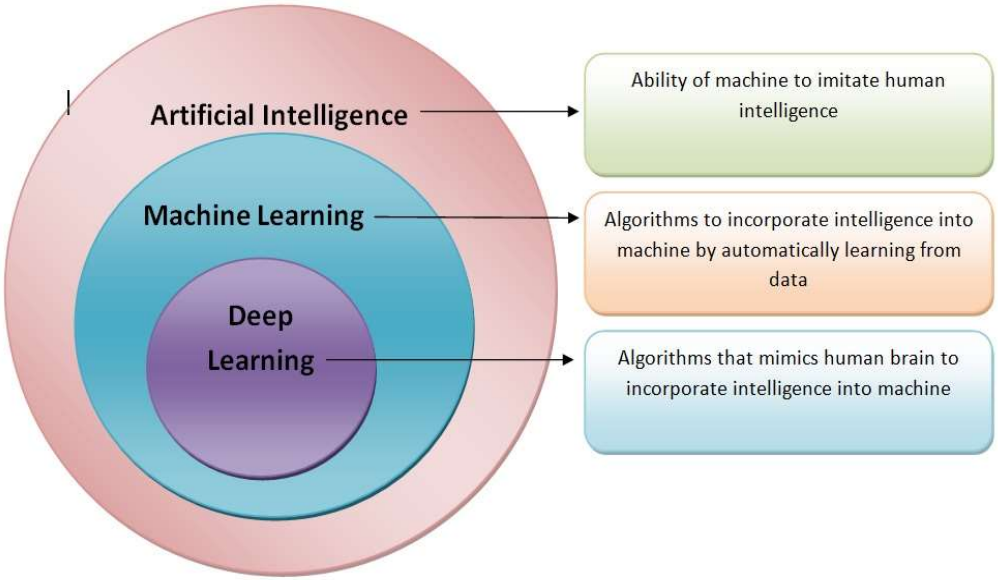
What is machine Learning?

Machine learning is a field of computer science that uses statistical techniques to give computer systems the ability to "learn" with data without being explicitly programmed.



- Applications:
  - E-mail spam filter
  - Image Classification
  - Hidden Data pattern

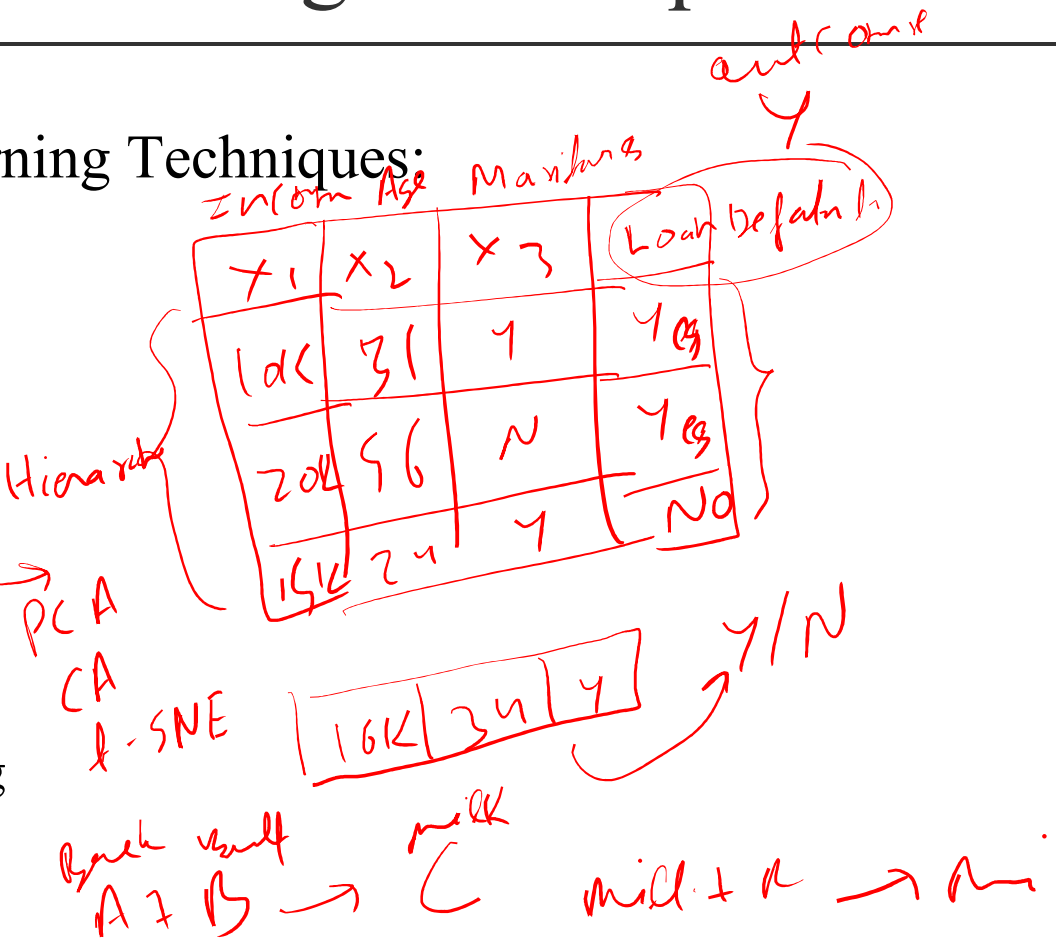
AI Vs ML Vs DL

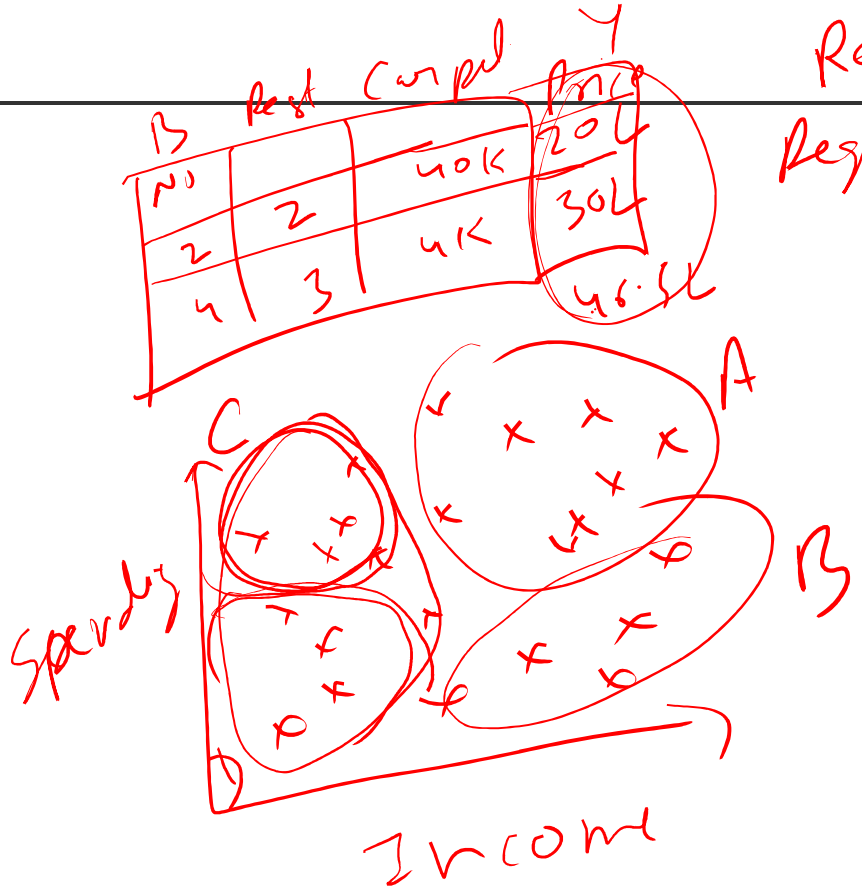


- AI is currently focused on pattern recognition and lacks capabilities like creativity and emotional intelligence.
- Expert systems were left behind due to their limited applicability in fuzzy logic problems.
- Machine learning is a better approach than symbolic AI because it learns patterns from data instead of relying on predefined rules
- Deep learning is a class of algorithms inspired by biological neurons.
- Deep learning is popular because it can automatically detect features without manual specification.
- Deep learning automatically extracts features and improves efficiency with more layers
- Deep Learning and Machine Learning are both important for building AI.

Type of Machine Learning Techniques

- Two Major types of Learning Techniques:
  - Supervised Learning
    - Regression
    - Classification
  - Unsupervised Learning
    - Clustering → K-Mean, Hierarchical
    - Dimensionality Reduction → PCA, CA, t-SNE
    - Anomaly Detection
    - Association Rule Mining
  - Semi-supervised Learning
  - Reinforcement Leaning





Regression

Regressis

What is Supervised Learning?

- In Supervised learning, you train the machine using data which is well “labeled.”
- It means some data is already tagged with the correct answer
- It can be compared to learning which takes place in the presence of a supervisor or a teacher.

What is Unsupervised Machine Learning?

- Unsupervised learning is a technique, where you do not need to supervise the model.
- Instead, you need to allow the model to work on its own to discover information.
- It mainly deals with the unlabelled data.

How Unsupervised Machine Works?

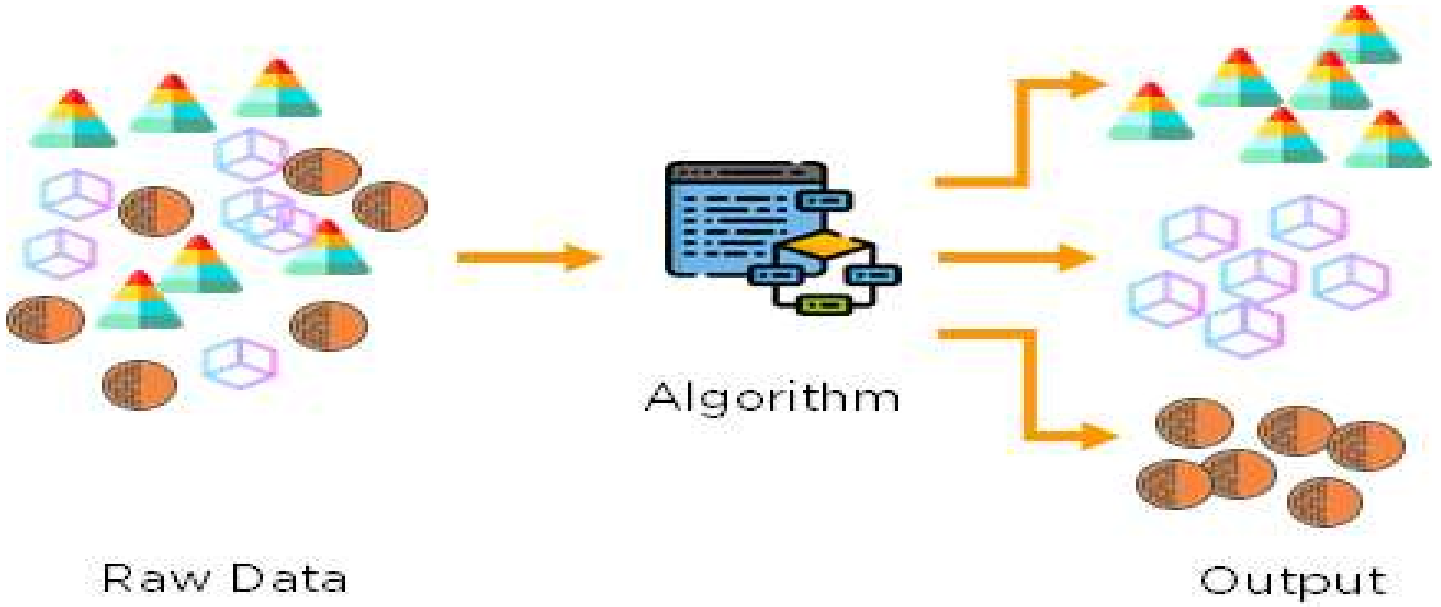


Image Source: https://medium.com/

Semi-supervised Learning

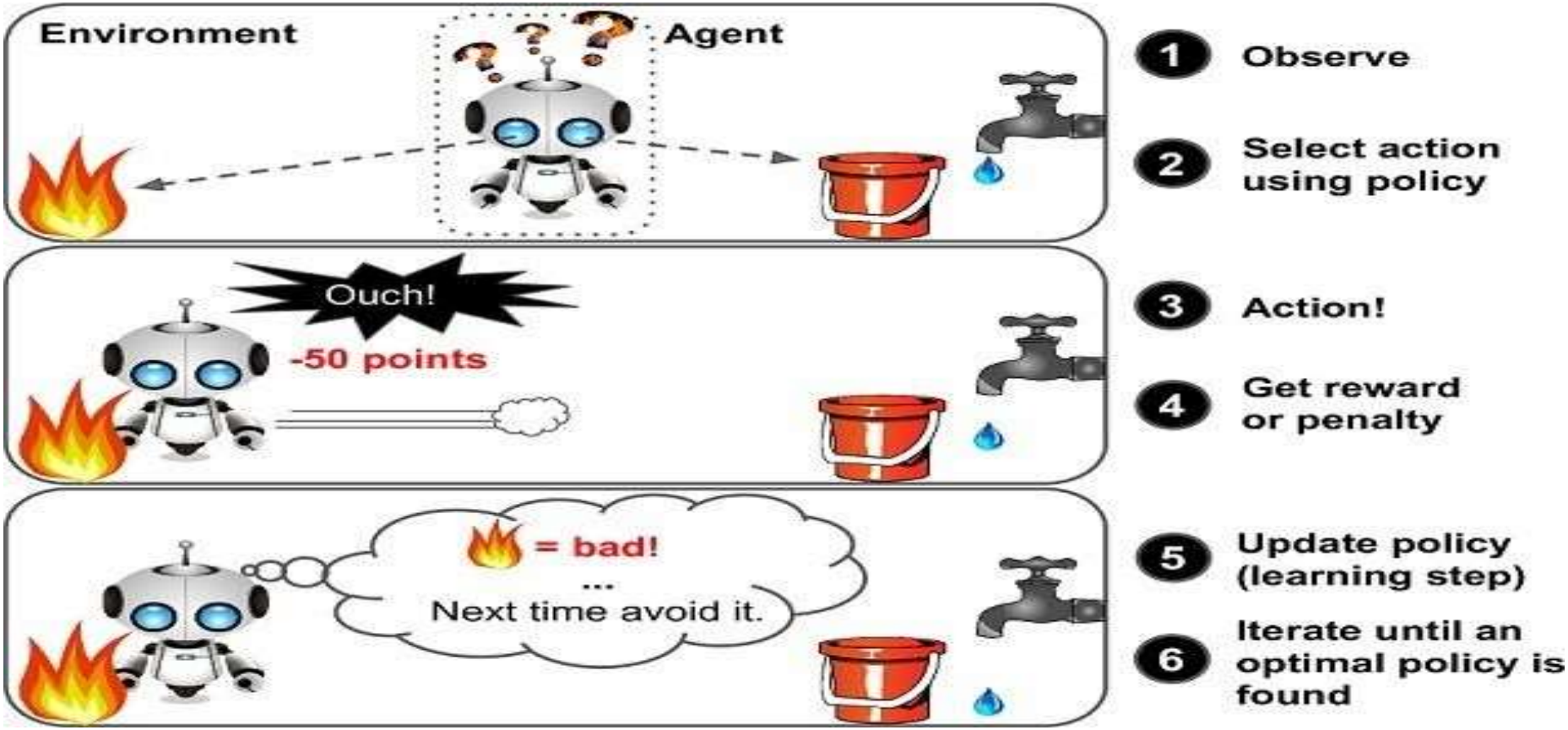
Semi-supervised learning is a type of machine learning that combines a small amount of labeled data with a large amount of unlabeled data during training. It falls between supervised learning (where all data is labeled) and unsupervised learning (where no labeled data is used).

Example:
Image classification

Reinforcement learning

- Reinforcement learning (RL) is a type of machine learning where an agent learns to make decisions by performing actions in an environment to maximize cumulative reward. The agent receives feedback in the form of rewards or penalties and adjusts its actions to achieve the best long-term outcomes.

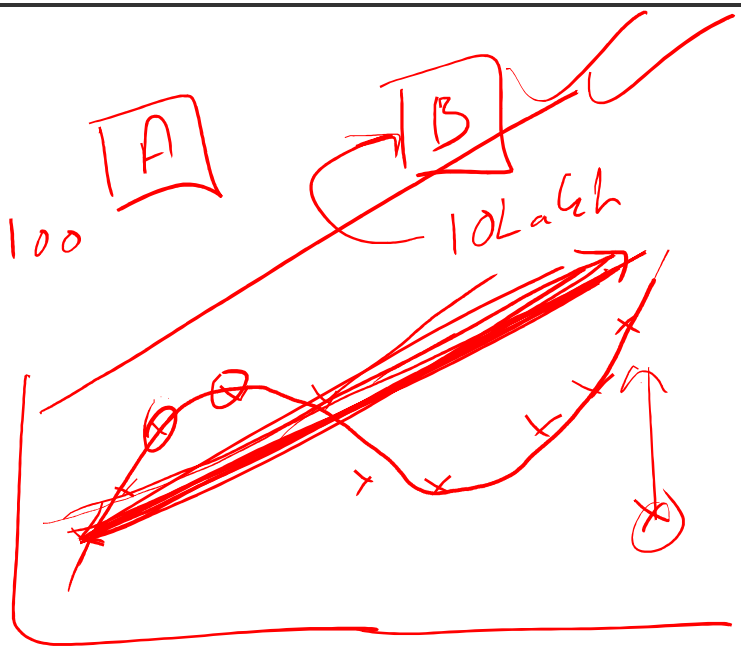
Reinforcement learning



Example: Go Game

Challenges in Business Analytics

- Data Collection
  - API or Web Scrapping
- Insufficient data/ Labelled Data
  - Unreasonable effectiveness of data
- No Representative Data
- Poor Quality Data
- Irrelevant Features
- Overfitting
- Underfitting
- Software Integration
- Company Culture
- Cost Involved

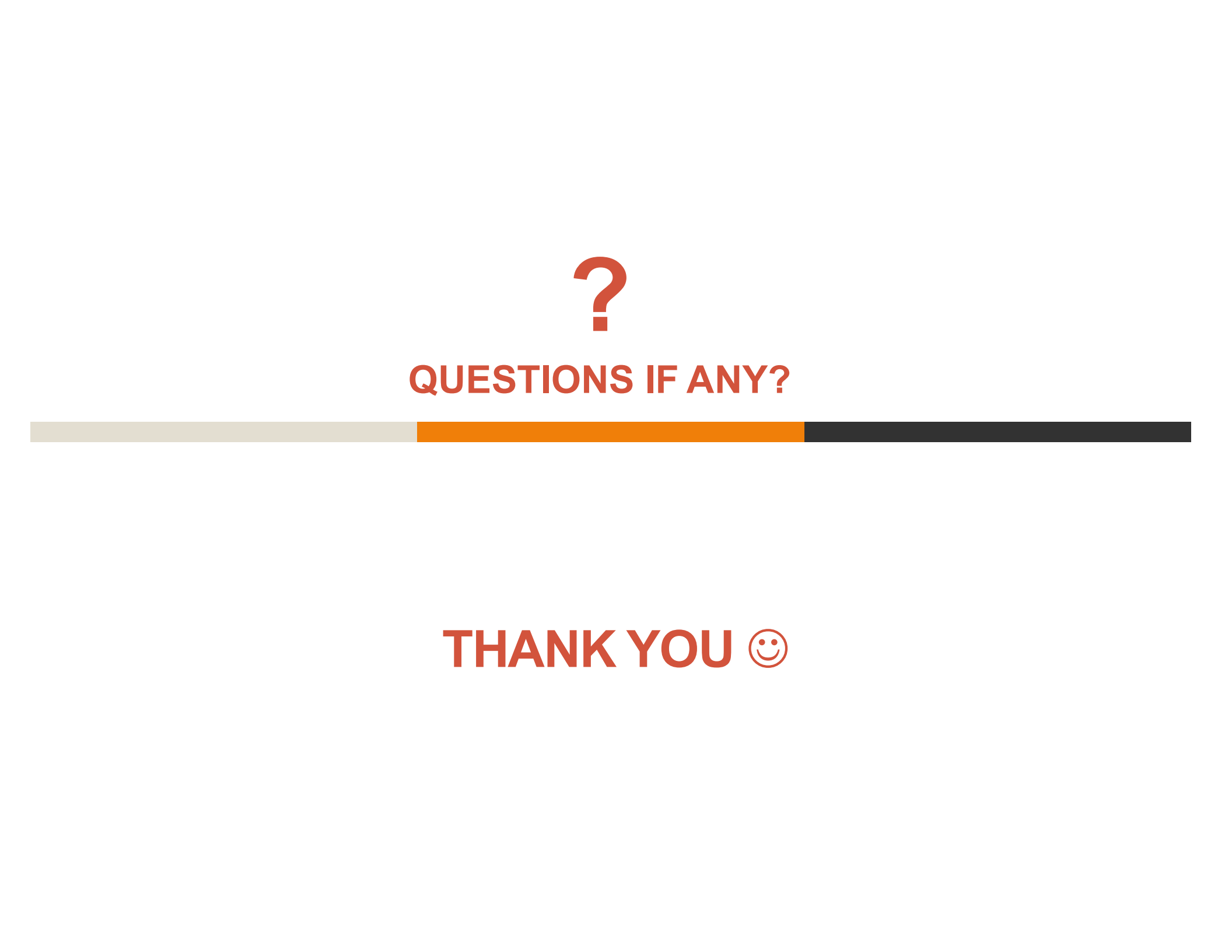


MLOPS


Cost Saving
Time Saving
More Productivity
ADVANTAGES
Increased customer satisfaction
Competitive advantage
Expanded sales/profits

When are Analytics not practical?

- When there's no time
- When there's no precedent
- When history is misleading?
- When the decision maker has considerable experience
- When the variable can't be measured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THANK YOU ☺