Data Mining

Lecture 2

IN THE PREVIOUS EPISODE...

In the previous lecture…

- **What is Data Mining?**
  - Information extraction
  - Data excavation
  - Data intellectual analysis
  - Search for regularities
  - Knowledge extraction
  - Pattern analysis
  - Knowledge Discovery in Databases, KDD
  - Statistics and ML
- **Data**
  - Facts
  - Sources
  - Metadata
- **Methods and stages of Data Mining**
  - Discovery
  - Forecasting
  - Exception analysis

Lecture outline

- Data Mining problems:
  - Information and knowledge.
  - Classification and clustering.
  - Forecasting and visualization

INFORMATION AND KNOWLEDGE

Information and knowledge

Data

Information

Knowledge

Information and knowledge

- Data mining tasks:
  - Classification
  - Clusterization
  - Association
  - Forecasting
  - Visualization

Information and knowledge

- **Classification**
  - Detecting features characterizing group of items in the given dataset – classes. Thus new object can be attributed to a predefined class.
  - Methods:
    - Nearest Neighbor
    - K-Nearest Neighbors
    - Bayesian Networks
    - Decision Tree classifier
    - Neural networks

Information and knowledge

- **Clusterization**
  - Dividing objects into groups undefined beforehand according to the newly discovered common charachteristics.
  - Methods:
    - K-means
    - Agglomerative Clusterization
    - Mean shift
    - Affinity propagation
    - Kochonnen cards

Information and knowledge

- **Association**
  - Uncovering associative rules of the linked objects or events.
  - Methods:
    - Apriori algorithm

Information and knowledge

- **Forecasting**
  - On the basis of analysis of historical data missing or future values are predicted.
  - Methods:
    - Mathematical statistics (regression analysis)
    - Neural networks

Information and knowledge

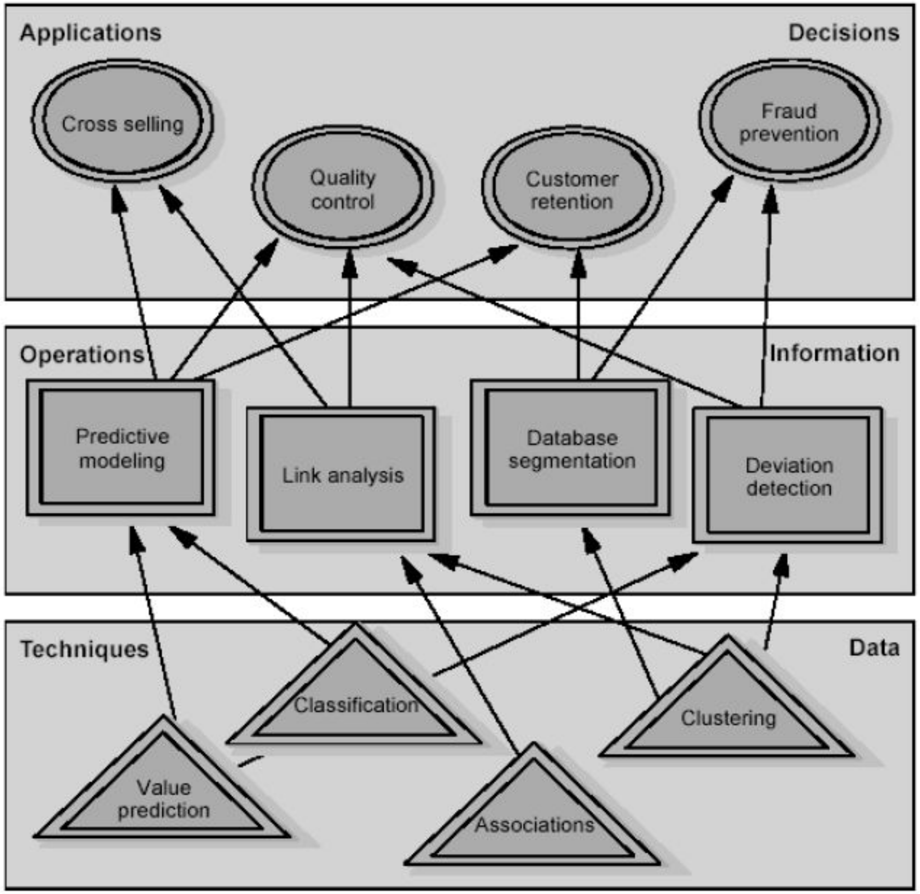
- **Visualization**
  - Creating graphical representation of the analyzed data.
  - Methods:
    - 2-D and 3-D visualizations
    - Graph representations
    - Dendrogramme

Information and knowledge

- **Data Mining tasks classification**
  - **By strategy**
    - Supervised learning
      - Classification
      - Forecasting
    - Unsupervised learning
      - Clusterization
  - By model type
    - Descriptive
      - Informative, summarizing, differentiating data charachteristics
      - Characteristics and comparison
    - Predictive
      - Trend analysis

Information and knowledge

- **From task to application**



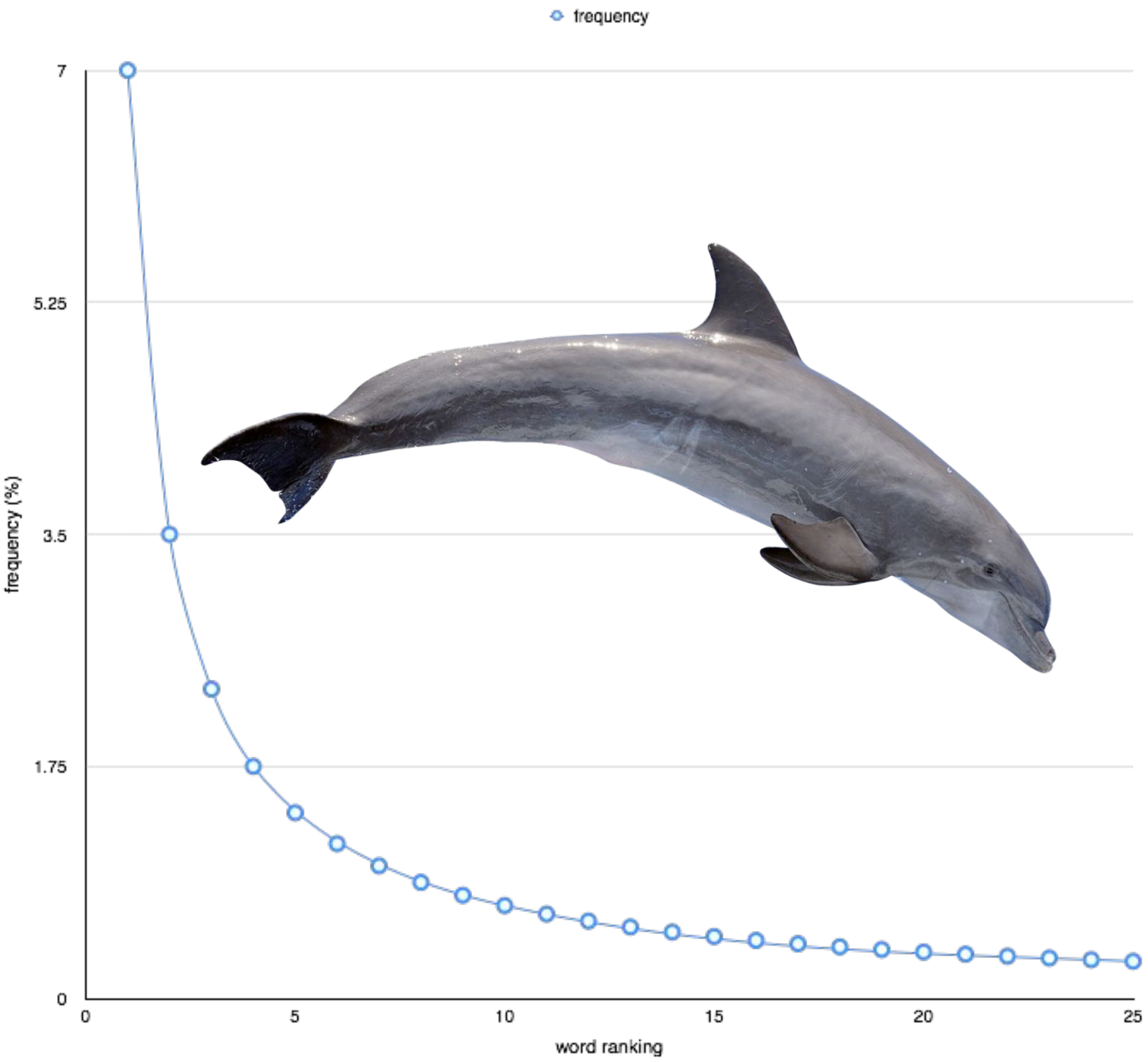
Information and knowledge

- **Information**
  - Any message about anything
  - Intelligence as the object of storage, processing and transfer
  - Quantitative measure of entropy detraction, system organization. Information theory.

https://getpocket.com/explore/item/listening-for-extraterrestrial-blah-blah

Can we tell if aliens are speaking to us?

- SETI project
- Zipf law



Information and knowledge

- **Information properties**
  - Completeness for decision making
  - Trustworthiness
  - Value
  - Adequacy
  - Actuality
  - Clarity
  - Accessibility
  - Subjectivity

Information and knowledge

- **Knowledge**
  - Complex of facts, regularities and heuristic rules helping to solve problems
  - Knowledge evolves on the interconnection of information of different origin
  - Denham Gray “ is the absolute usage of information and data, together with the practical experience potential, abilities, ideas, intuition and beliefs of people.

Information and knowledge

- **Knowledge properties**
  - Structure
  - Easiness of access and digestion
  - Laconicism
  - Non-controversy
  - Processing procedures

CLASSIFICATION AND CLUSTERING

Classification and clustering

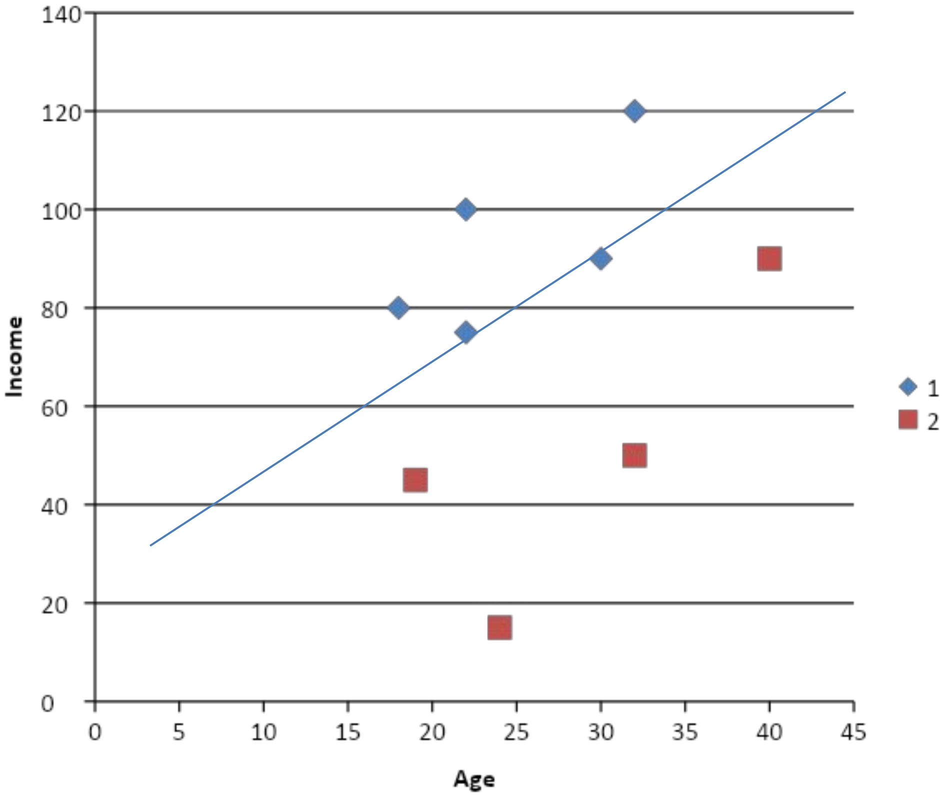
Classification - is a division or category in a system which divides things into groups or types.

- Supervised learning
- Predicting class based on feature vector consisting of continuous and categorical value

Classification and clustering

Classification example

ID	Age	Income	Class
1	18	80	1
2	22	100	1
3	30	90	1
4	32	120	1
5	24	15	2
6	25	22	2
7	32	50	2
8	19	45	2
9	22	75	1
10	40	90	2



Classification and clustering

Classification process

Data

- Preprocess (clean, feat eng)

Train/test split

Training

- Classification models

Testing

- Metrics:
  - Accuracy
  - Precision
  - Recall
  - F1

Application

Classification and clustering

Classification applications

- Face recognition (image)
- OCR (text)
- Text genre detection (text)
- Speaker recognition (sound)

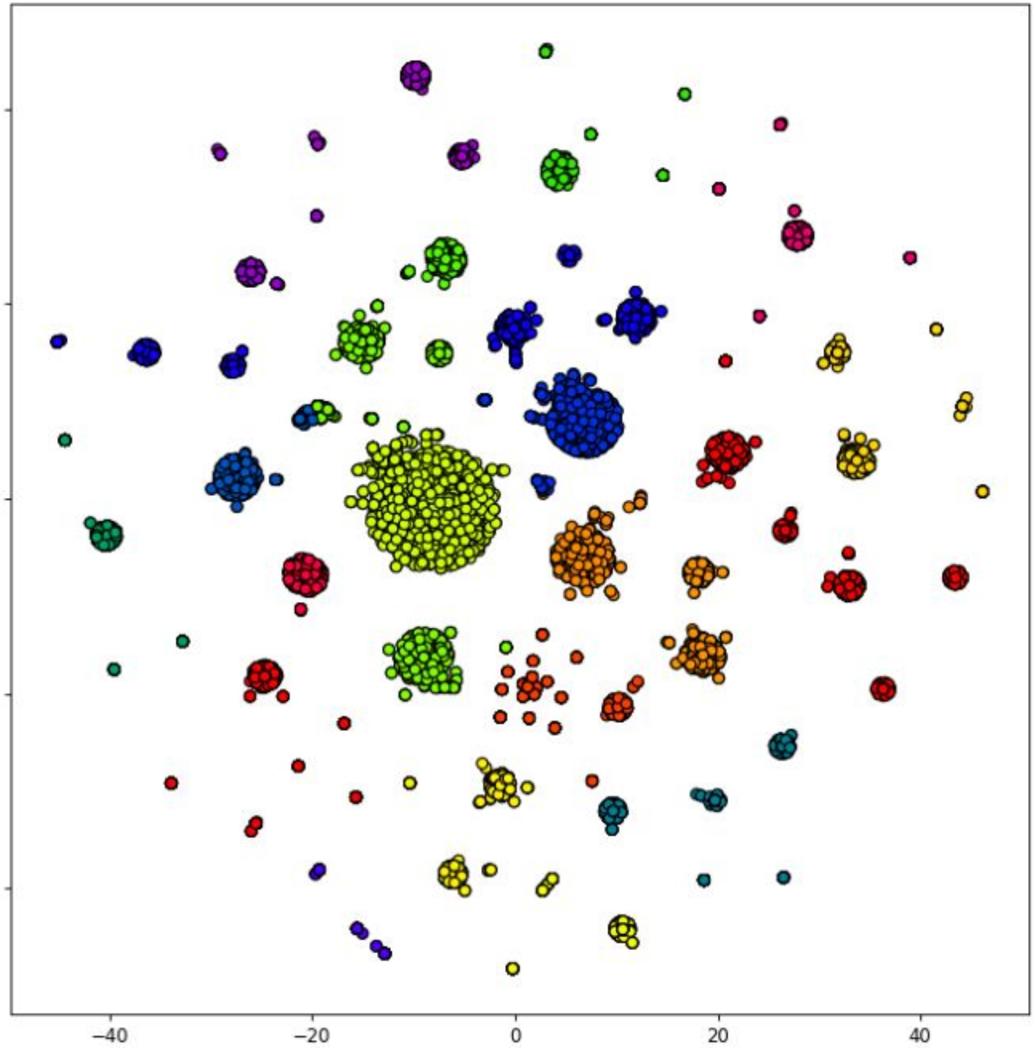
Classification and clustering

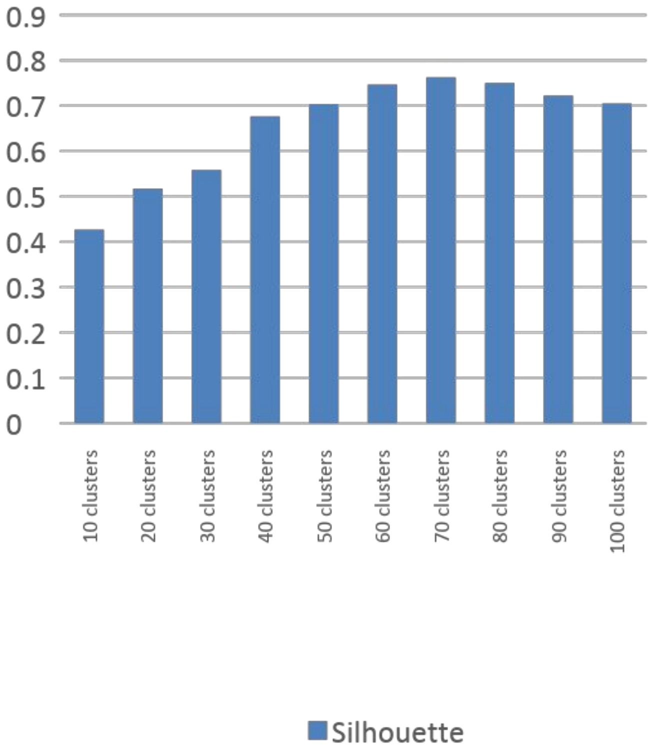
Clustering - is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters).

- Unsupervised learning
- Attributing a data point to a cluster based on its similarity to other data points with respect to a set of characteristics

Classification and clustering

Clustering example





Classification and clustering

Clustering process

Data

- Preprocess (clean, feat eng)

Train/test split

Training

- Clustering models

Testing

- Metrics:
  - Silhouette
  - Jackard measure

Application

Classification and clustering

Clustering applications

- Topic modeling (texts)
- Text to speech (sounds)
- Client base clustering (business)

FORECASTING AND VISUALIZATION

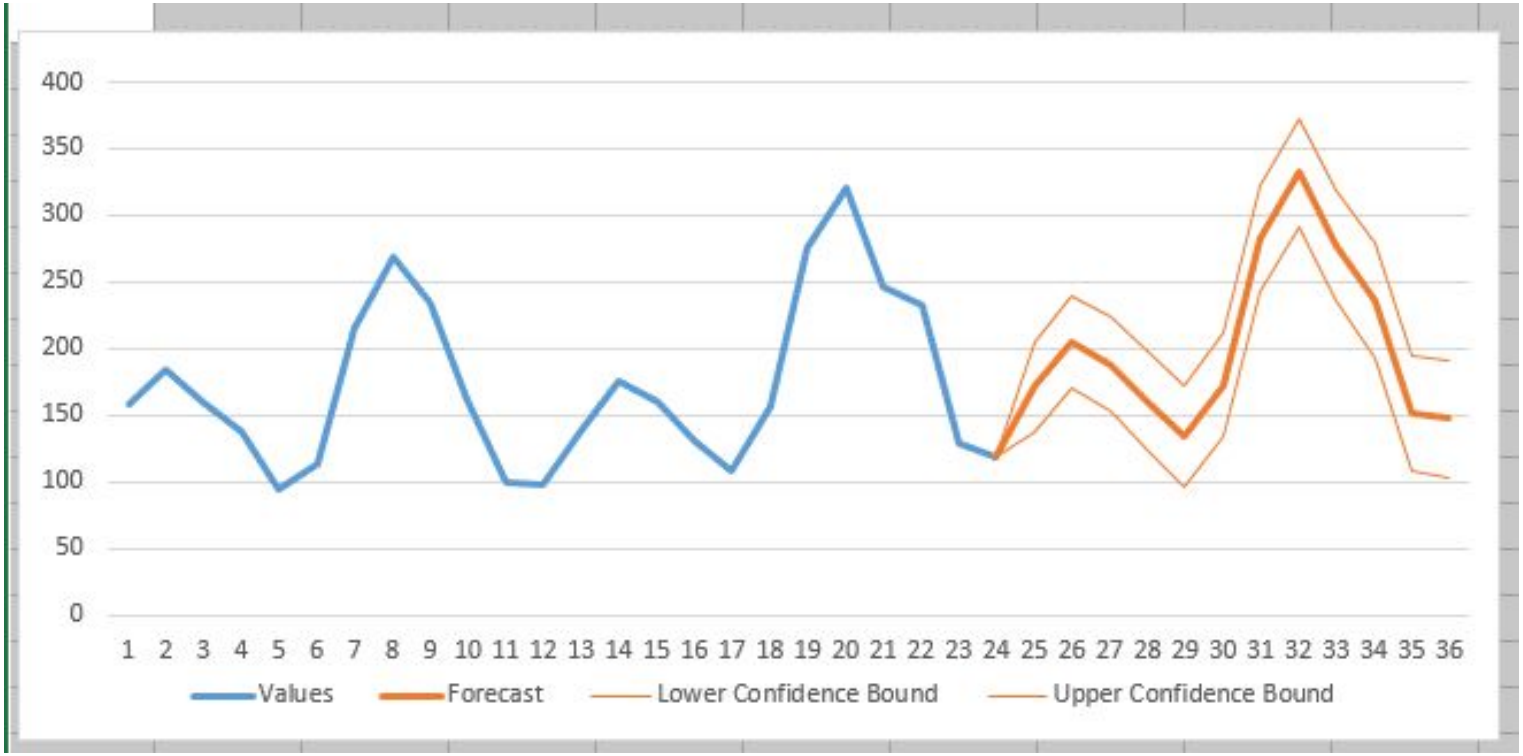
Forecasting and visualization

Forecasting - is the process of making predictions of the future based on past and present data and most commonly by analysis of trends. A commonplace example might be estimation of some variable of interest at some specified future date. Prediction is a similar, but more general term.

- Supervised learning

Forecasting and visualization

Forecasting example



Forecasting and visualization

Forecasting process

Data

- Preprocess (clean, feat eng)

Train/test split

Training

- Forecasting models
  - Regression
  - ARIMA

Testing

- Metrics:
  - R2
  - MAE
  - MSE

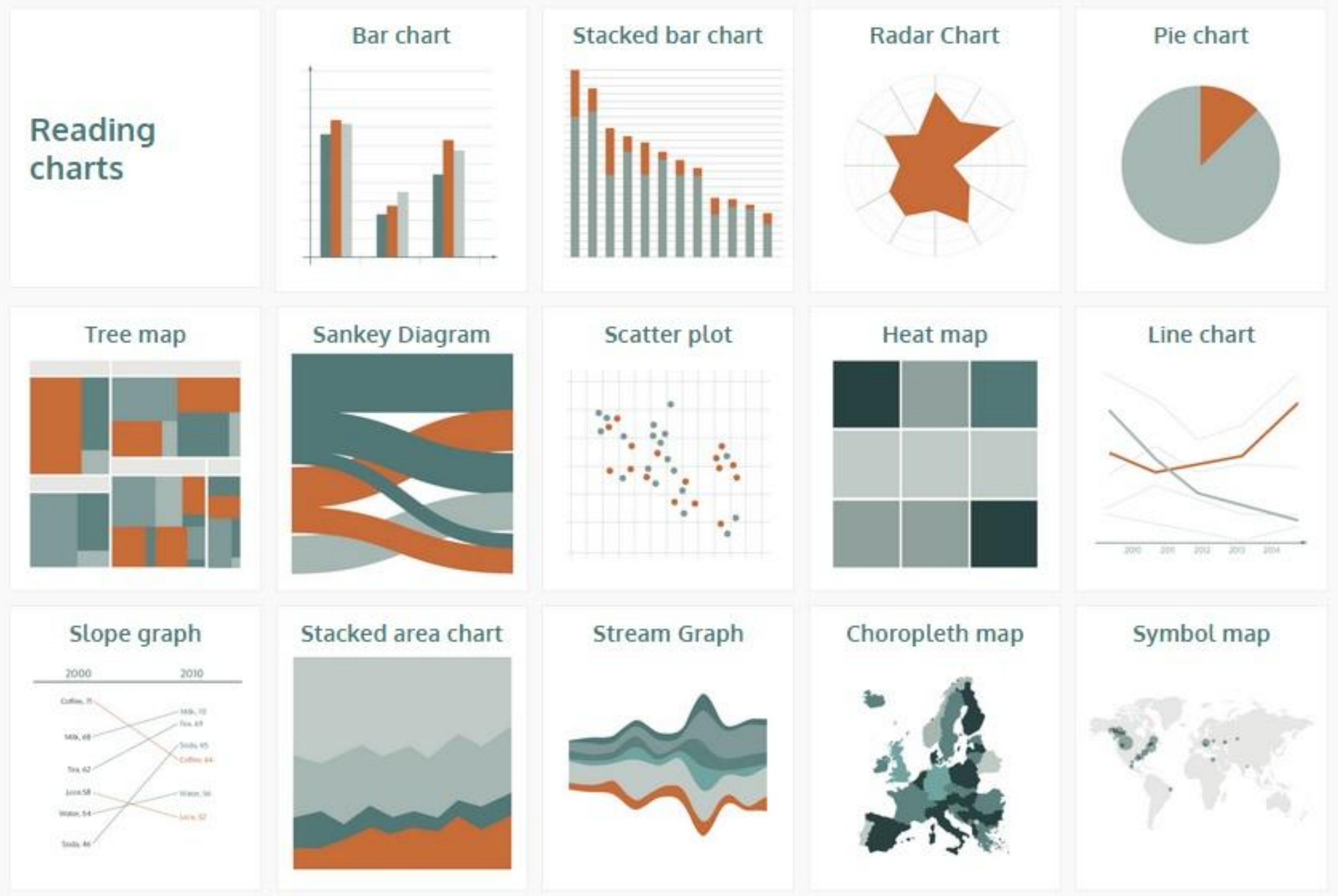
Application

Forecasting and visualization

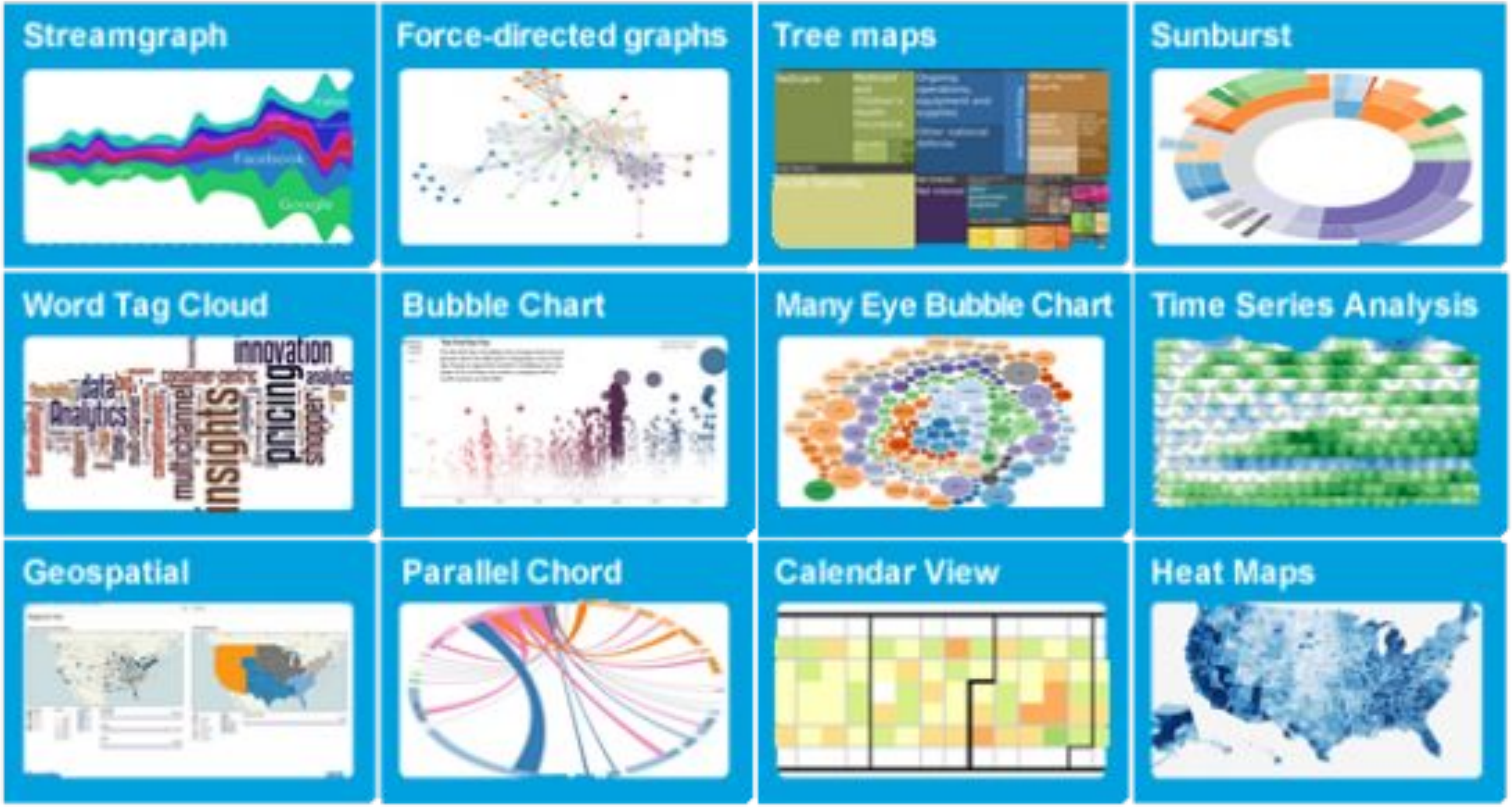
Forecasting application

- Pricing (cars, real estate)
- Price movements (time series)
- Missing values and interpolation
- Revenue predicts (business)

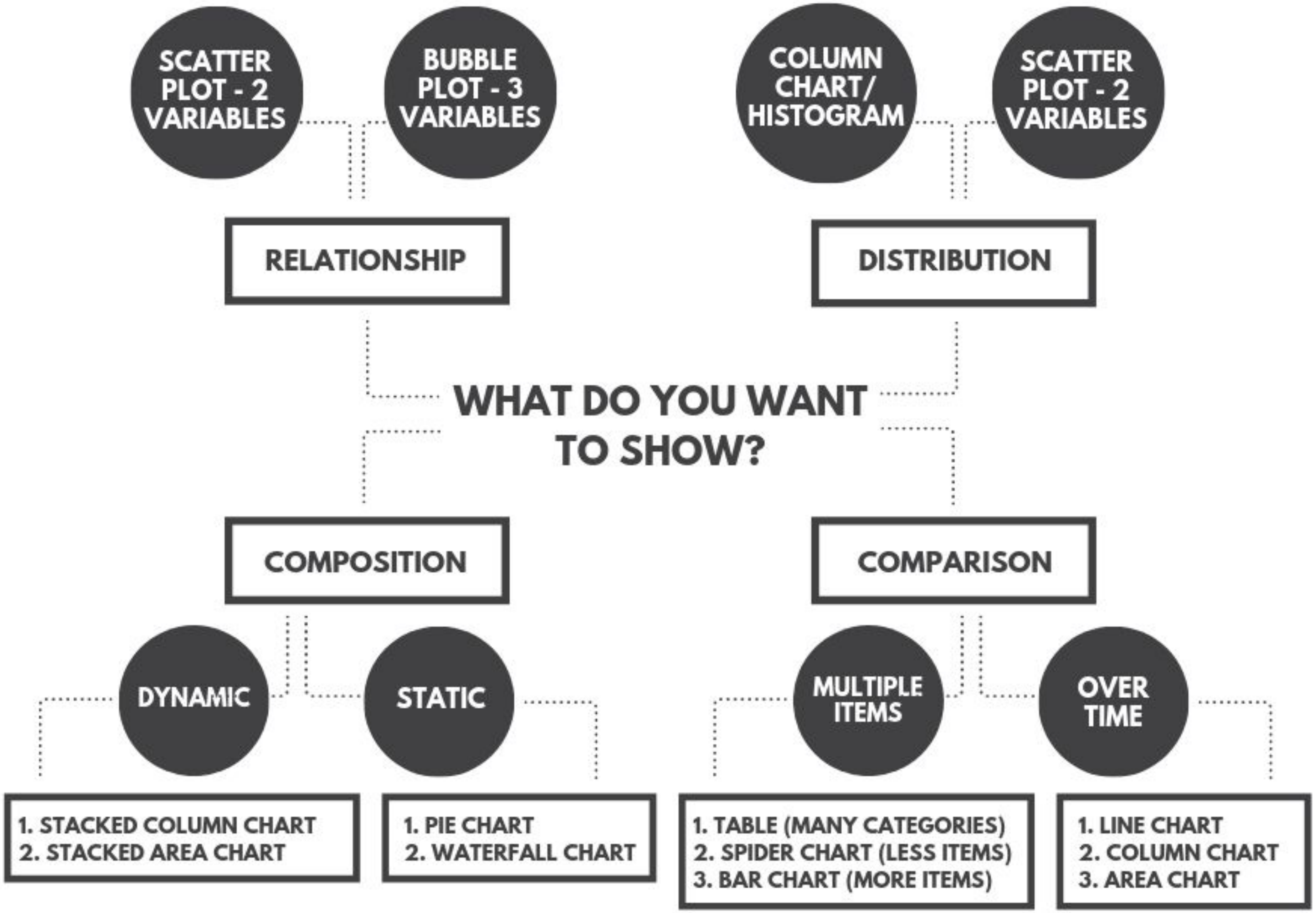
Forecasting and visualization



Forecasting and visualization



Forecasting and visualization



WHAT DO YOU WANT TO SHOW?

RELATIONSHIP

SCATTER PLOT - 2 VARIABLES

BUBBLE PLOT - 3 VARIABLES

DISTRIBUTION

COLUMN CHART/ HISTOGRAM

SCATTER PLOT - 2 VARIABLES

COMPOSITION

DYNAMIC

1. STACKED COLUMN CHART
2. STACKED AREA CHART

STATIC

1. PIE CHART
2. WATERFALL CHART

COMPARISON

MULTIPLE ITEMS

1. TABLE (MANY CATEGORIES)
2. SPIDER CHART (LESS ITEMS)
3. BAR CHART (MORE ITEMS)

OVER TIME

1. LINE CHART
2. COLUMN CHART
3. AREA CHART

Summary

- Data Mining problems:
  - Information and knowledge.
    - Data-Information-Knowledge
    - Support decision making process
  - Classification and clustering.
  - Forecasting and visualization