# CREATIVE DATA MINING

Introduction to Knowledge Discovery Process

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# Data Mining Example from the Chair of Information Architecture

Source:
www.esum.arch.ethz.ch

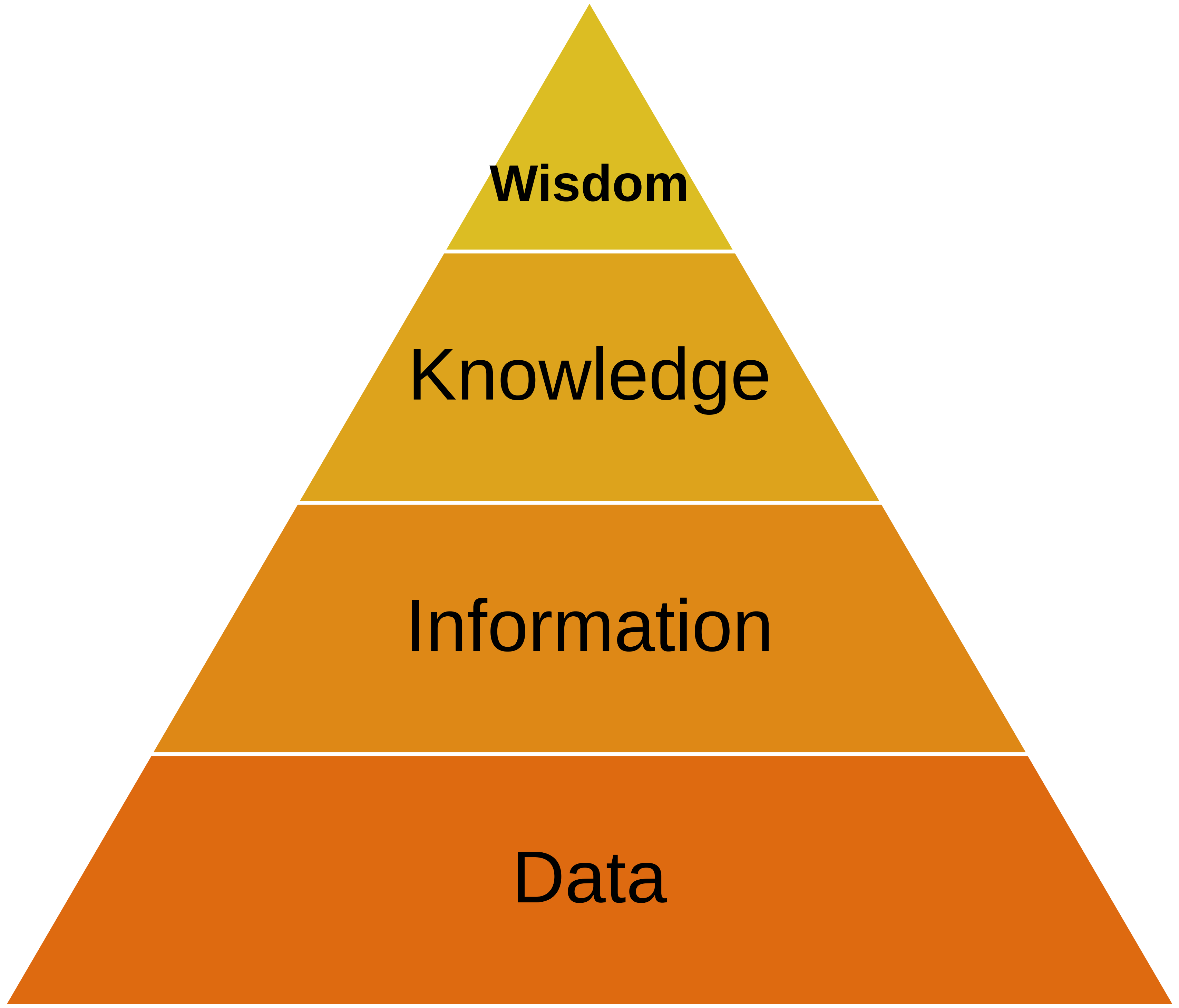
# CREATIVE DATA MINING

Introduction to Knowledge Discovery Process

## Course Structure

| | |
|---|---|
| 25.09.2017 (Today) | Introduction to the Course |
| 02.10.2017 | Concept of Python Programming Language |
| 09.10.2017 | Fundamentals of Supervised Learning |
| 16.10.2017 | Advanced Supervised Learning Algorithms |
| 30.10.2016 | Supervised Learning Problem Solving |
| 06.11.2016 | Fundamentals of Unsupervised Learning |
| 13.11.2017 | Advanced Unsupervised Learning Algorithms |
| 20.11.2017 | Unsupervised Learning Problem Solving |
| 27.11.2017 | Introduction of Machine Learning tools |
| 04.12.2017 | Exploration of Real-World Problems |
| 11.12.2017 | Discussion and Summary |
| 18.12.2017 | Final Critique |

# Why Data Mining?




| | |
|---|---|
| Applied | • I should stop the car |
| Context | • Traffic light in the direction of driving has turned red |
| Meaning | • Traffic light has turned red |
| Raw | • (47.41, 8.51), Red, 10 kmph, (46.23, 8.11) , 10 m |

Source: http://www.allthingy.com/data-information-knowledge-wisdom/

# What to do in Data Mining?

Importance of data processing and knowledge discovery

Identifying applications

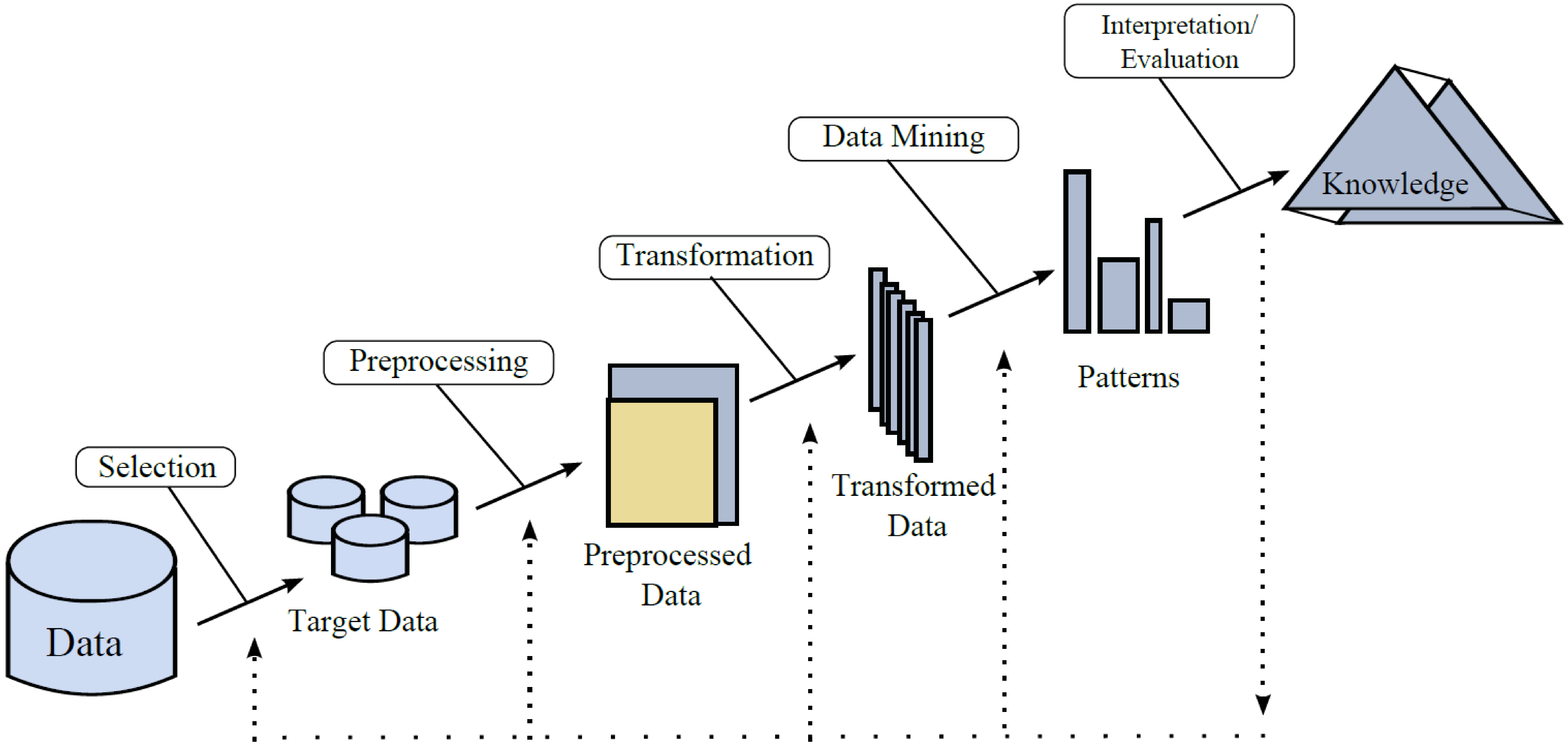
Generating good quality data (data quality assurance)

Cleaning and preprocessing data

Identifying computational methods

Discovering meaning (interpreting discovered knowledge)

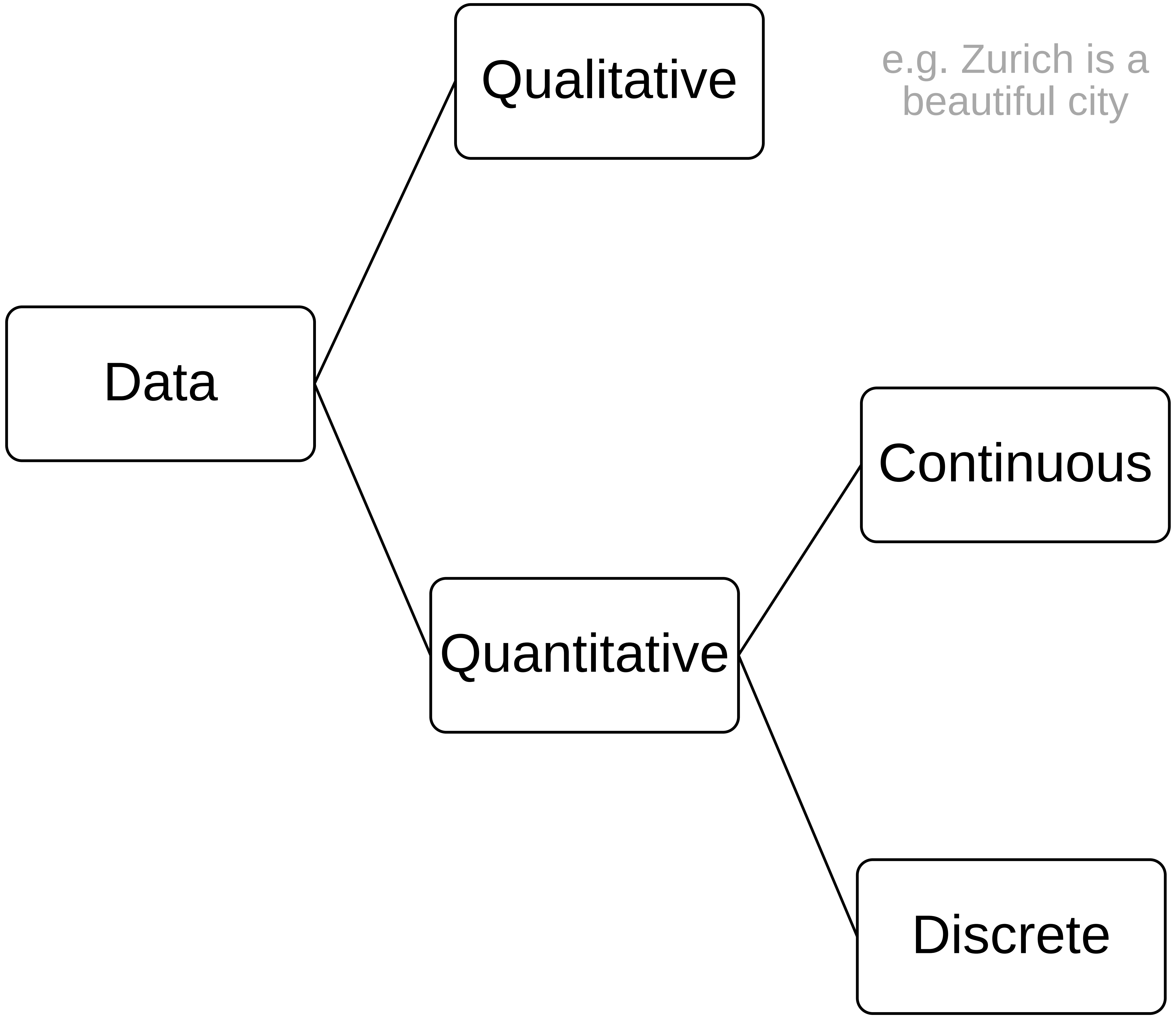
# How to Perform Data Mining?




Source: Usama Fayyad, Gregory Piatetsky-Shapiro, and Padhraic Smyth, From Data Mining to Knowledge Discovery in Databases, AI Magazine Volume 17 Number 3 (1996)

# Data

Defining Variables




e.g. Zurich is a beautiful city

Continuous

- Always numeric
- Can be any number, positive or negative

*Something we can measure, e.g., height*

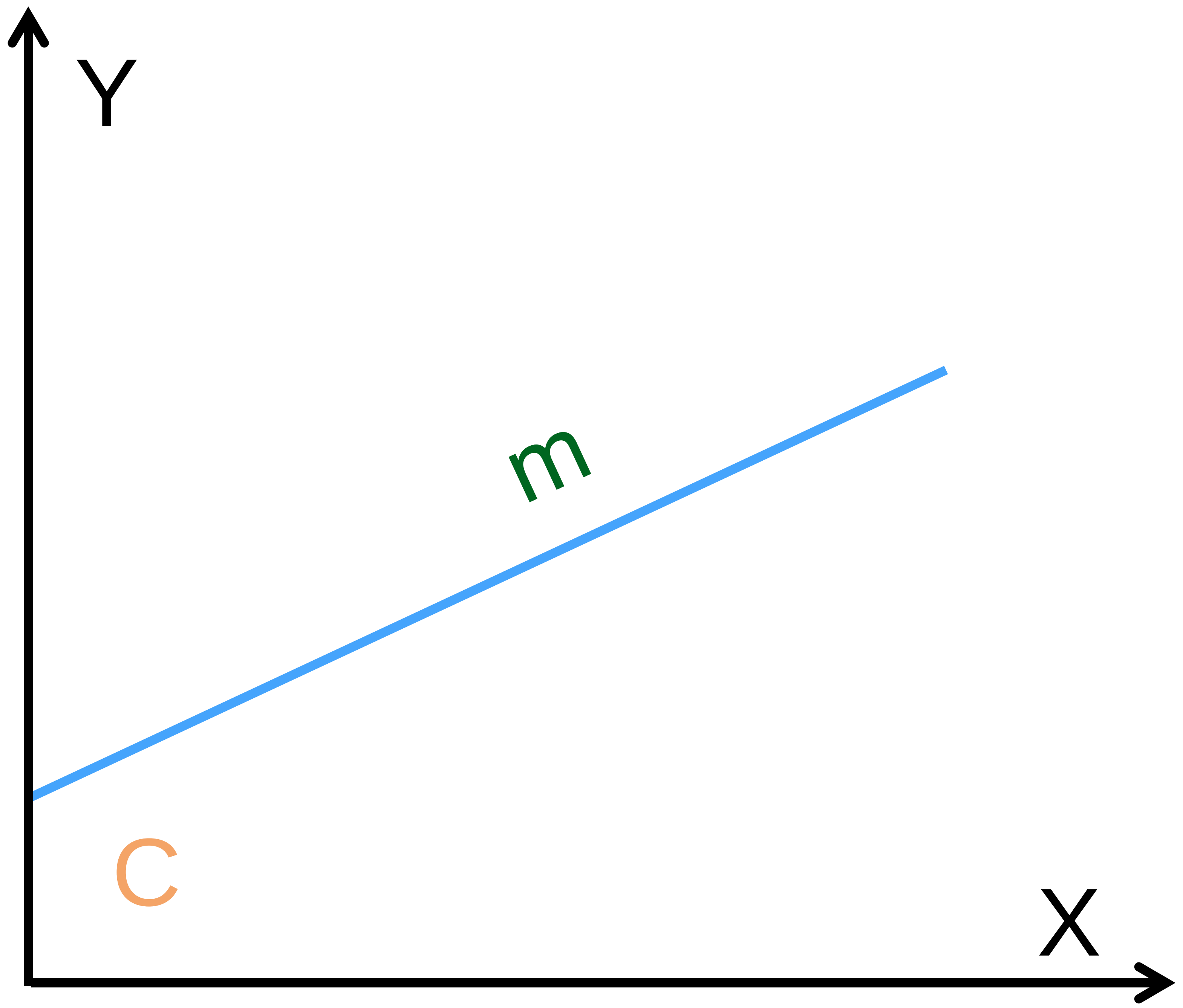
Categorical/Discrete

- Ordinal variable – e.g. rating (excellent, good, fair, poor) or Score (0 – 5)
- Nominal variable – e.g. : gender (male, female)
- Binary variables – Yes or No (0 /1)

*Something we can count, e.g., number of students*

# Data

Defining Variable Types



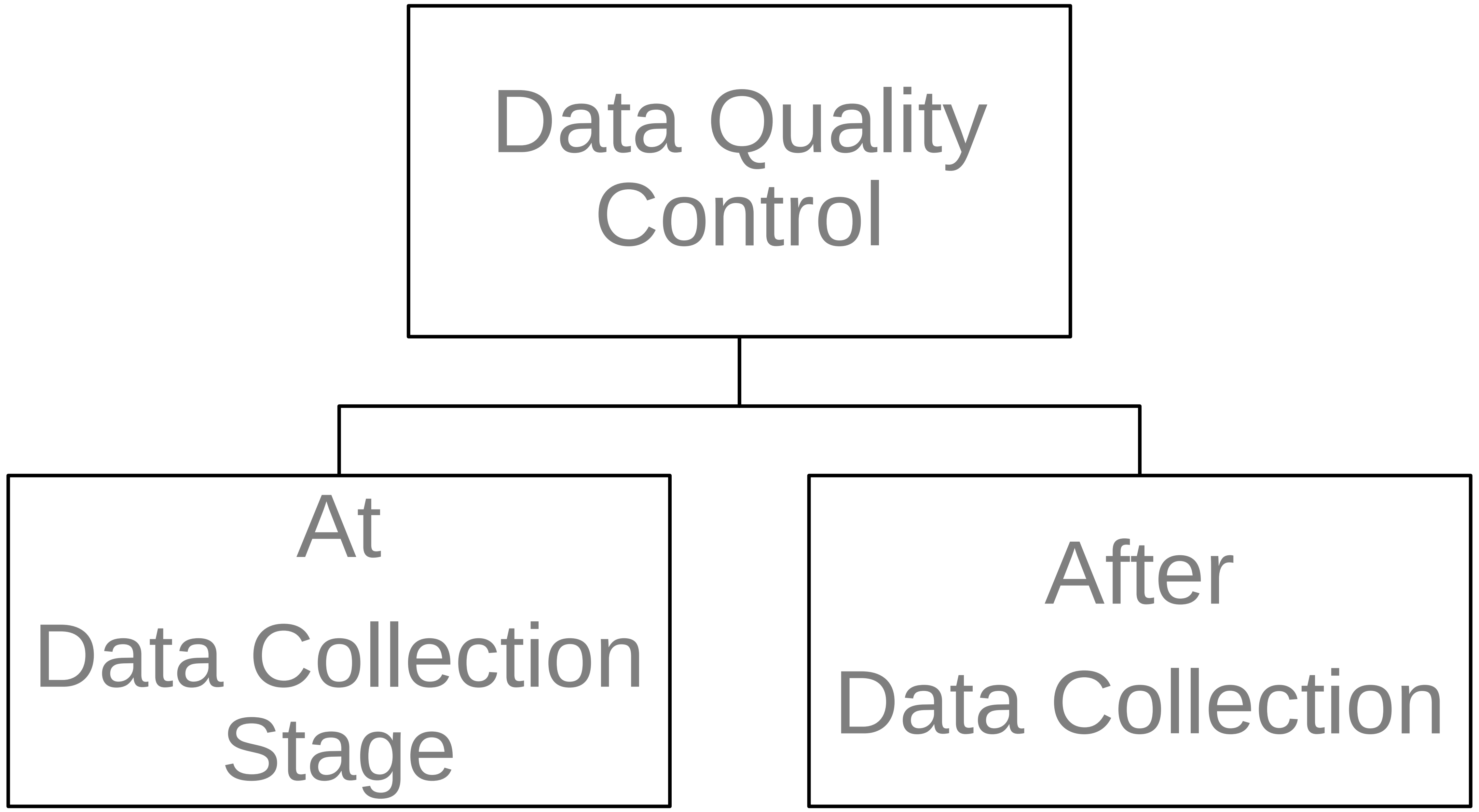

Independent / Dependent

e.g., Y = mX + C

Value of  Y depended on m, X, and C

# Data Preprocessing

Improving Data Quality



# Data Preprocessing

Improving Data Quality


Reference: Mónica Bobrowski, Martina Marré, Daniel Yankelevich, Measuring Data Quality, Report no.: 99-002, Pabellón 1 - Planta Baja - Ciudad Universitaria

# Data Preprocessing

Improving Data Quality

**Data cleaning**

Fill in missing values, smooth noisy data, identify or remove outliers, and resolve inconsistencies

**Data integration**

Integration of multiple databases, data cubes, or files

**Data transformation**

Normalization and aggregation

**Data reduction**

Obtains reduced representation in volume but produces the same or similar analytical results

**Data discretization**

Part of data reduction but with particular importance, especially for numerical data

Reference: http://www.mimuw.edu.pl/~son/datamining/DM/4-preprocess.pdf

# Data Preprocessing

## Data Cleaning

| | Features (Variables) | | | | |
|---|---|---|---|---|---|
| | Input features (Independent Variables) | | | | Output feature (dependent variable) |
| Samples | Input V1 | Input V2 | Input V3 | Input V4 | Output V1 |
| Sample 1 | 2.3 | 0.25 | Good | 1.5 | $y_1$ |
| Sample 2 | 4.5 | 43598.21 | Good | 1.8 | $y_2$ |
| Sample 3 | 4.7 | 0.33 | Excellent | 1.9 | $y_3$ |
| Sample 4 | ? | 0.22 | Good | 3.9 | $y_4$ |
| Sample 5 | ? | 0.19 | Average | 1.2 | $y_5$ |
| : | 6.7 | 0.88 | Good | 1.8 | : |
| Sample N | 5.5 | 0.36 | Bad | 1.6 | $y_N$ |

Missing Value

Outlier

Noise (required smoothing)

$y_i$ Output variable can be continuous/discrete

# Data Preprocessing

## Data Transformation

| | Features (Variables) | | |
|---|---|---|---|
| | Input features (Independent Variables) | | Output feature (dependent variable) |
| Samples | Input V1 | Input V2 | Output V1 |
| Sample 1 | 2.3 | 0.25 | $y_1$ |
| Sample 2 | 4.5 | 0.39 | $y_2$ |
| Sample 3 | 4.7 | 0.33 | $y_3$ |
| Sample 4 | 2.99 | 0.22 | $y_4$ |
| Sample 5 | 3.18 | 0.19 | $y_5$ |
| : | 6.7 | 0.36 | : |
| Sample N | 5.5 | 0.88 | $y_N$ |

| | Features (Variables) | | |
|---|---|---|---|
| | Input features (Independent Variables) | | Output feature (dependent variable) |
| Samples | Input V1 | Input V2 | Output V1 |
| Sample 1 | 0.00 | 0.09 | $y_1$ |
| Sample 2 | 0.50 | 0.29 | $y_2$ |
| Sample 3 | 0.55 | 0.20 | $y_3$ |
| Sample 4 | 0.16 | 0.04 | $y_4$ |
| Sample 5 | 0.20 | 0.00 | $y_5$ |
| : | 1.00 | 0.25 | : |
| Sample N | 0.73 | 1.00 | $y_N$ |

Max value

Min value

Transformed Variable

# Data Preprocessing

## Data Reduction

| | Features (Variables) | | | |
|---|---|---|---|---|
| | Input features | | | Output feature |
| Samples | Input V1 | Input V2 | Input V4 | Output V1 |
| Sample 1 | 2.3 | 0.25 | 1.5 | $y_1$ |
| Sample 2 | 4.5 | 0.39 | 1.8 | $y_2$ |
| Sample 3 | 4.7 | 0.33 | 1.9 | $y_3$ |
| Sample 4 | 2.99 | 0.22 | 1.6 | $y_4$ |
| Sample 5 | 3.18 | 0.19 | 1.2 | $y_5$ |
| : | 6.7 | 0.88 | 1.8 | : |
| Sample N | 5.5 | 0.36 | 1.6 | $y_N$ |

Feature Extraction

| | Features (Variables) | | | |
|---|---|---|---|---|
| | Input features | | | Output feature |
| Samples | PCA 1 | PCA 2 | | Output V1 |
| Sample 1 | -1.97 | 0.06 | | $y_1$ |
| Sample 2 | 0.25 | 0.15 | | $y_2$ |
| Sample 3 | 0.45 | 0.22 | | $y_3$ |
| Sample 4 | -1.28 | 0.09 | | $y_4$ |
| Sample 5 | -1.14 | -0.33 | | $y_5$ |
| : | 2.48 | -0.04 | | : |
| Sample N | 1.21 | -0.15 | | $y_N$ |

Feature Selection

| | Features (Variables) | | | |
|---|---|---|---|---|
| | Input features | | | Output feature |
| Samples | Input V1 | | Input V4 | Output V1 |
| Sample 1 | 2.3 | | 1.5 | $y_1$ |
| Sample 2 | 4.5 | | 1.8 | $y_2$ |
| Sample 3 | 4.7 | | 1.9 | $y_3$ |
| Sample 4 | 2.99 | | 1.6 | $y_4$ |
| Sample 5 | 3.18 | | 1.2 | $y_5$ |
| : | 6.7 | | 1.8 | : |
| Sample N | 5.5 | | 1.6 | $y_N$ |

Extracted Features

# What's Next

## A: Installing Python

**Python IDE**

https://www.jetbrains.com/pycharm/

## B: Tutorial on Python

Programming practice in Python

## C: Machine Learning Algorithms

Supervised and Unsupervised

# Thank you!

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