WeST People and Knowledge Networks | Institute for Web Science & Technologies

UNIVERSITÄT KOBLENZ · LANDAU

Machine Learning and Data Mining WS21/22

"1 Introduction"

Dr. Zeyd Boukhers

@ZBoukhers

Institute for Web Science and Technologies

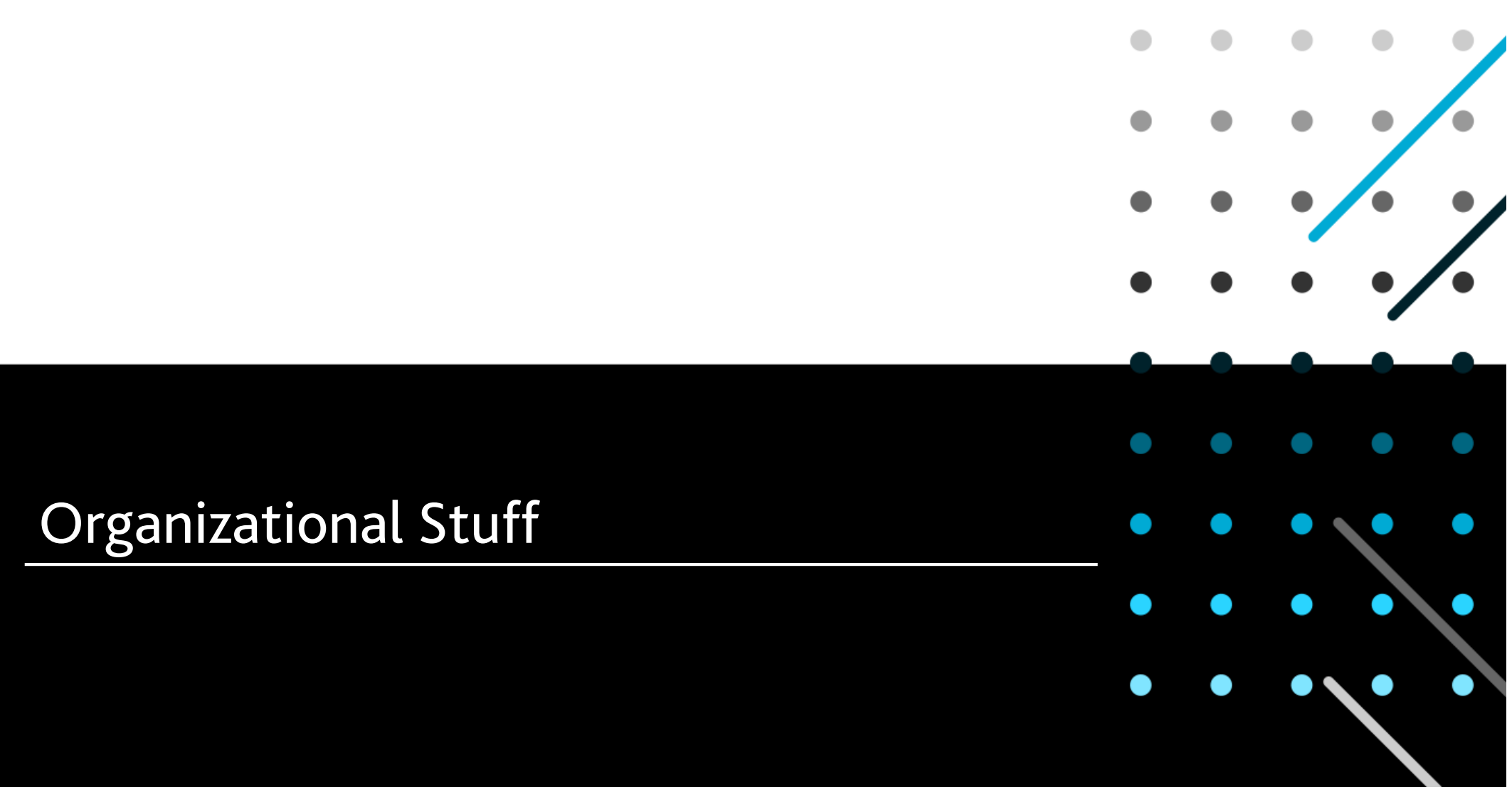
University of Koblenz-Landau

October 27, 2021

Agenda

- Organizational Stuff.
- What is MLDM?
- Predictive & Descriptive learning.
- Supervised & Unsupervised learning.
- Other learning approaches.

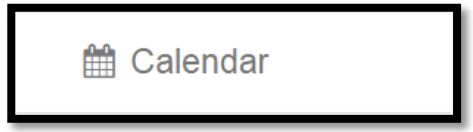
Organizational Stuff

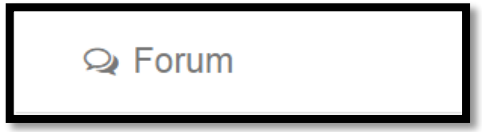


About the MLDM course

- Course ID:
  - 04IN2028.
- Aim:
  - understanding the fundamentals and basics of machine learning, data mining and related topics such as optimization.
- Who is this course for?
  - Master students in: 1) Web Science (Web & Data Science) , 2) Computer Science, 3) Computer Visualistic, 4) Mathematical Modelling, 5) etc.
  - Bachelor students
- **Credit points:**
  - 6 ECTS

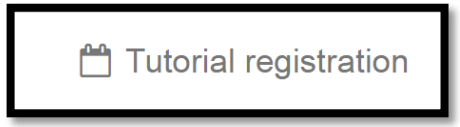
About the MLDM course

- **Where:**
  - Hybrid: Virtual and in-person.
- **When:**
  - **Lectures**: Exclusively video recordings that are released on Wednesdays at 12:00 pm (Noon)
  - **Tutorials**: In-person and live streaming on Thursdays at 02:00 pm (may be also at 04:00 pm)
    - They will be recorded.
  - See the full schedule on the calendar in Olat 

- **Consultation:**
  - Forum in Olat 

- **Material and further information:**
  - Olat: https://olat.vcrp.de/url/RepositoryEntry/3382739338
- **Klips Link:**
  - https://klips.uni-koblenz-landau.de/v/139109

In-person tutorial

- Regulation:
  - The distancing rules are not applied anymore.
  - It is mandatory to wear a mask during the entire session.
  - It is mandatory to possess a negative test result or proof of vaccination or recovery
  - The tutorial will be cancelled if the tutor shows Covid-19 symptoms.
- How it works:
  - For every tutorial, apply to attend at 

in Olat at 11:00 am on the tutorial day at the latest.
  - Every student who cannot attend in-person, must not apply or cancel his/her registration.
  - If the total number of registered students is 60 or less, only the tutorial at 14:00 will be held and the other one will be cancelled.
  - In all cases, only the tutorial at 14:00 will be live-streamed and recorded.

MLDM Team

Lecturer & Tutor

Zeyd Boukhers

Assistants

Akshaya Raja

Sowjanya Chennamaneni

Azeddine Bouabdallah

Assignments

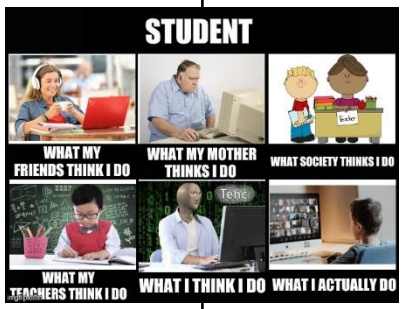
- An assignment is released every Wednesday at 02:00 pm.
- It is an online test on Olat.
- It contains three sections: *Knowledge Questions*, *Practice* and *Programming*.
  - An additional section "*Recall*" will be included in the first assignments
- Each section might contain several tasks.
- You have one week to work on it ***individually***.
- It must be submitted by the following Wednesday at 10:59 pm at the latest.
- Each assignment has 100 points.
- The corresponding tutorial will be the next following Thursday at 02:00 pm.

Structure

× 12

Lecture
Wed. at 12:00 pm

Assignment release
Wed. at 14:00 pm



One week

Assignment submission
Wed. at 22:59 pm

Next day

Tutorial
Thu. at 14:00 pm

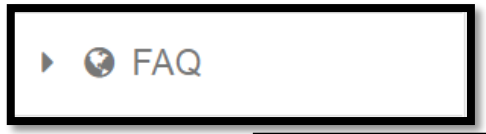
Exams

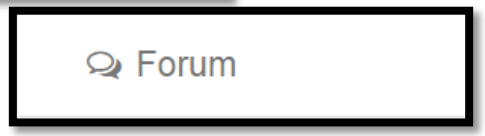
- Demo exam
  - **How?**: Online in Olat
  - **When?**: December 22 at 12:00 pm (Noon).
  - It covers the first eight lectures/assignments.
  - No eligibility is applied and no registration is required (Any one can take it).
- First exam (Official):
  - **How?**: not yet decided.
  - **When?**: February 23 at 10:00 am.
  - You must be eligible and register for the exam (see the calendar).
- Second exam (Official):
  - **How?**: similar to the first exam.
  - **When?**: March 23 at 10:00 am.
  - You must be eligible and register for the exam (see the calendar).

Exam eligibility

- To be eligible to write the exam, you need to:
  - Collect at least 720 points in 12 assignments.
  - Collect at least 40 points in each assignment.
    - This means that you need to submit all assignments in time.
  - If you were eligible in the WS 20/21, you may also write the exam without fulfilling the two previous conditions.

What else?

- Most of your questions are answered in ***FAQ*** in Olat. 

- If you do not find an answer, open a new topic in the Forum. 

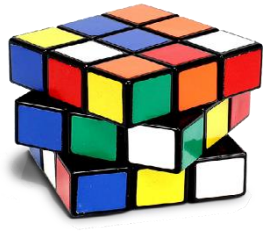
  - We will answer all the questions before every Tuesday and Friday at noon (This means that your question will be answered within 3 days at most.
  - Avoid sending emails.
- It is recommended to:
  - Add the schedule to your calendar.
  - Enable the notification on your calendar. 

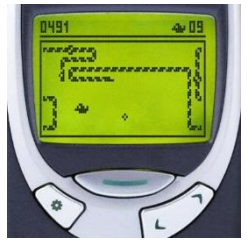
What do I need?

- The fundamental concepts of algebra
- The fundamental concepts of calculus
- The fundamental concepts of probability theory
- The fundamental concepts of statistics
- Programming skills (i.e. Python)

How to successfully pass the course?

- Watch the video lectures.
- Attend/watch the tutorials.
- Take notes.
- Solve the tasks of the assignments yourself.
- Do not forget to submit the assignment in time.
- Practice programming.
- Refresh and enhance your knowledge in Algebra and Probability theories.
- Prepare for the exam.
- Ask questions.
- Never plagiarize.





What is plagiarism?

- Turning in someone else's work as your own.
- Copying words or ideas from someone else without giving credit.
- Failing to put a quotation in quotation marks.
- Giving incorrect information about the source of a quotation.
- Changing words but copying the sentence structure of a source without giving credit.
- Copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules).

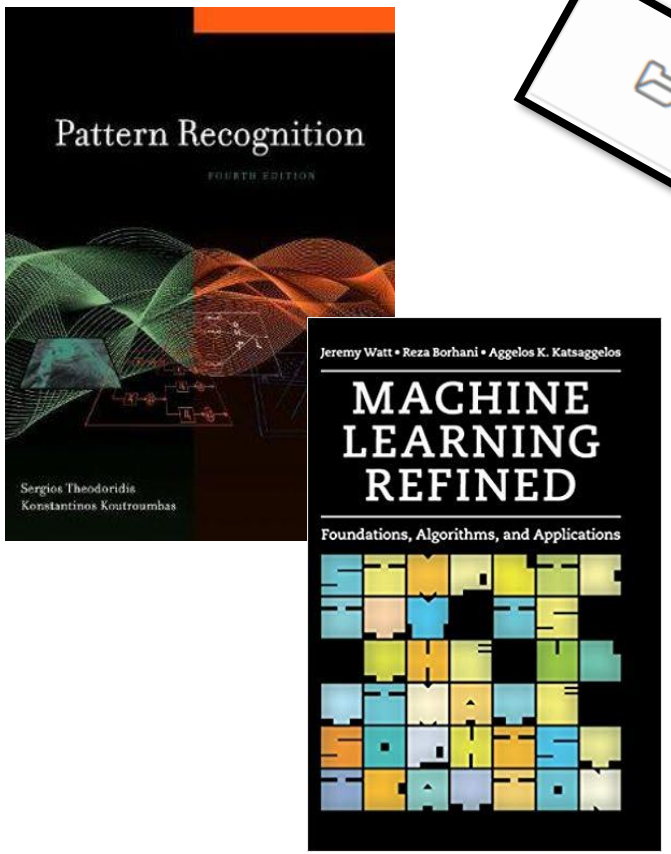
➢ Acknowledging that material has been borrowed and providing your audience with the information necessary to find that source is **usually** enough to prevent plagiarism.

Important to know

« **Any** sharing, copying or plagiarism of **any** exercise or assignment will lead to repeat the class next year for both students. »

We take this very seriously!

Books



In Olat

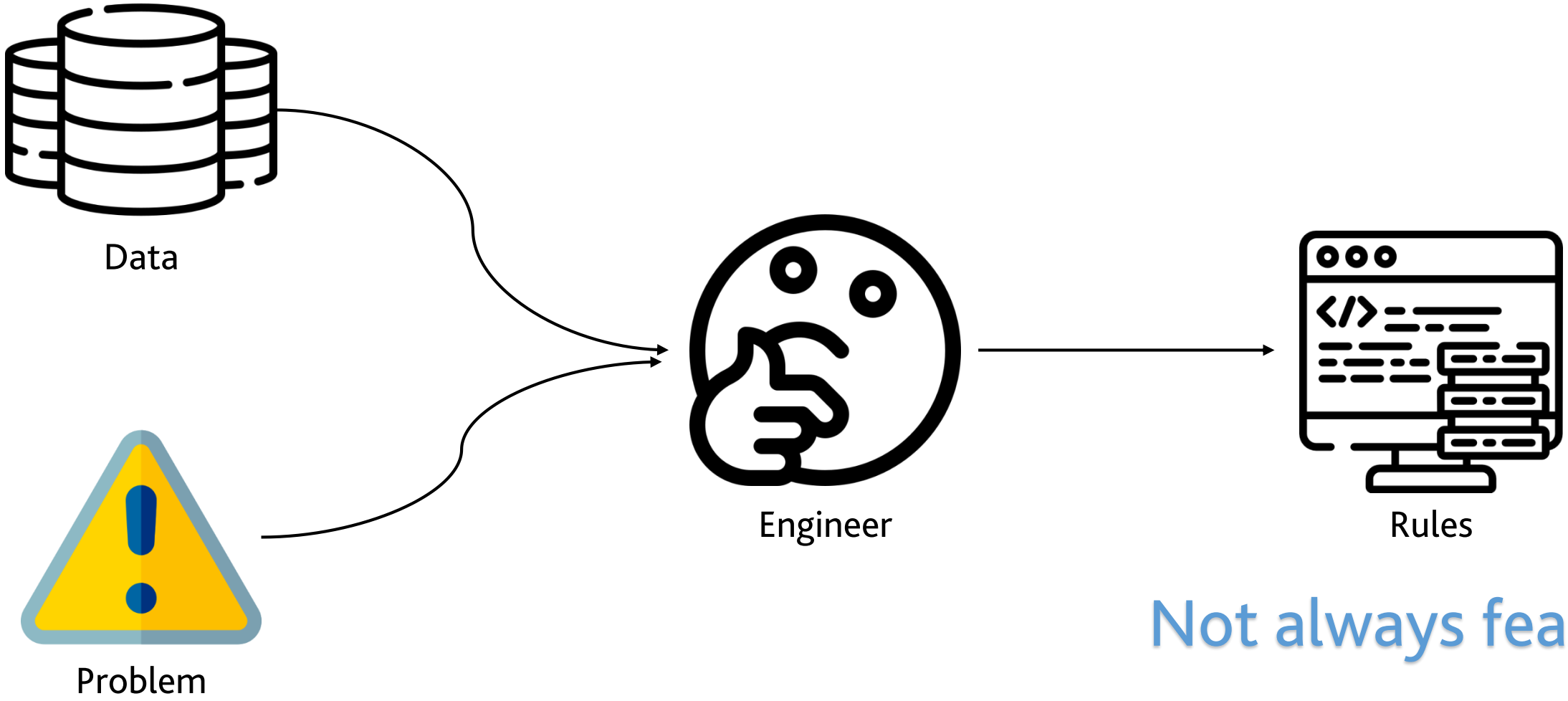
External materials

How to?

Screen Sharing

Let‘s get started!

Why Machine Learning & Data Mining?



Not always feasible

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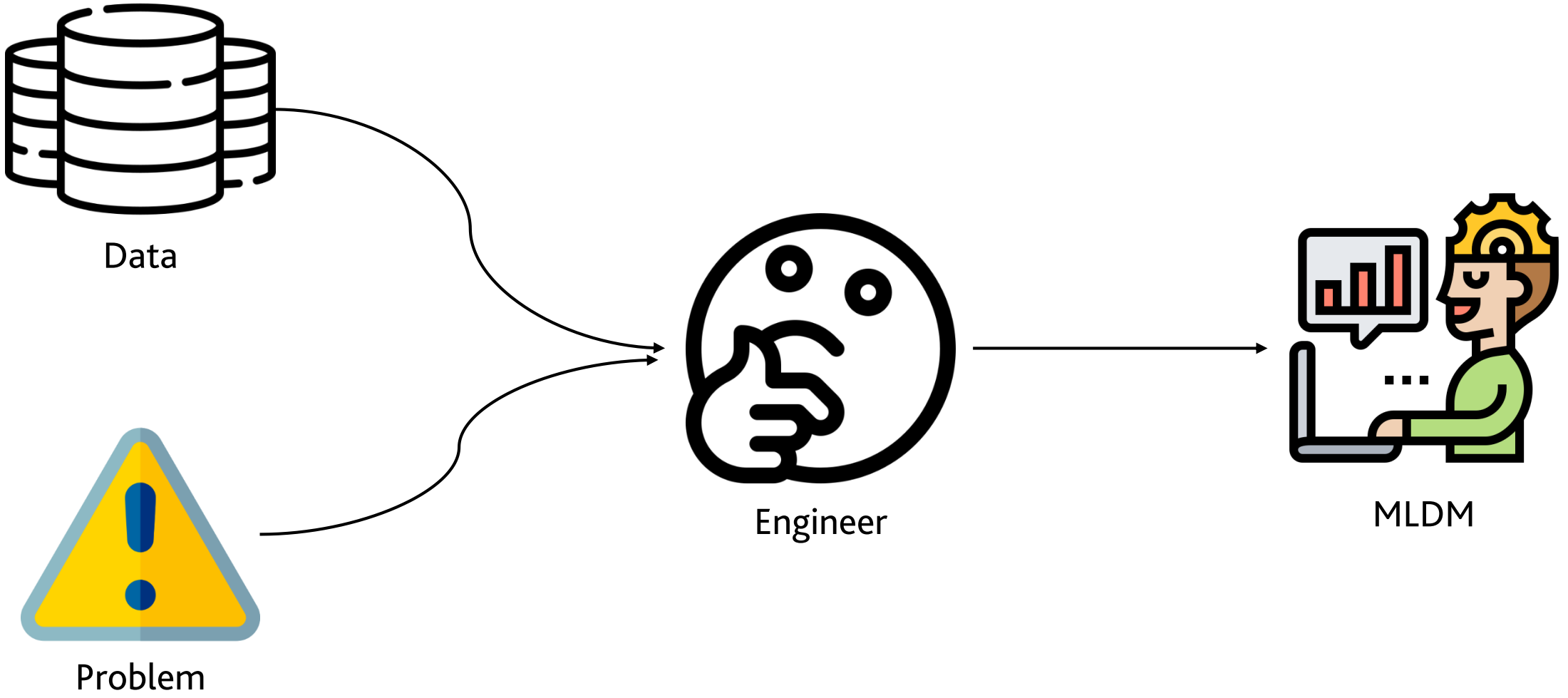
Why Machine Learning & Data Mining?



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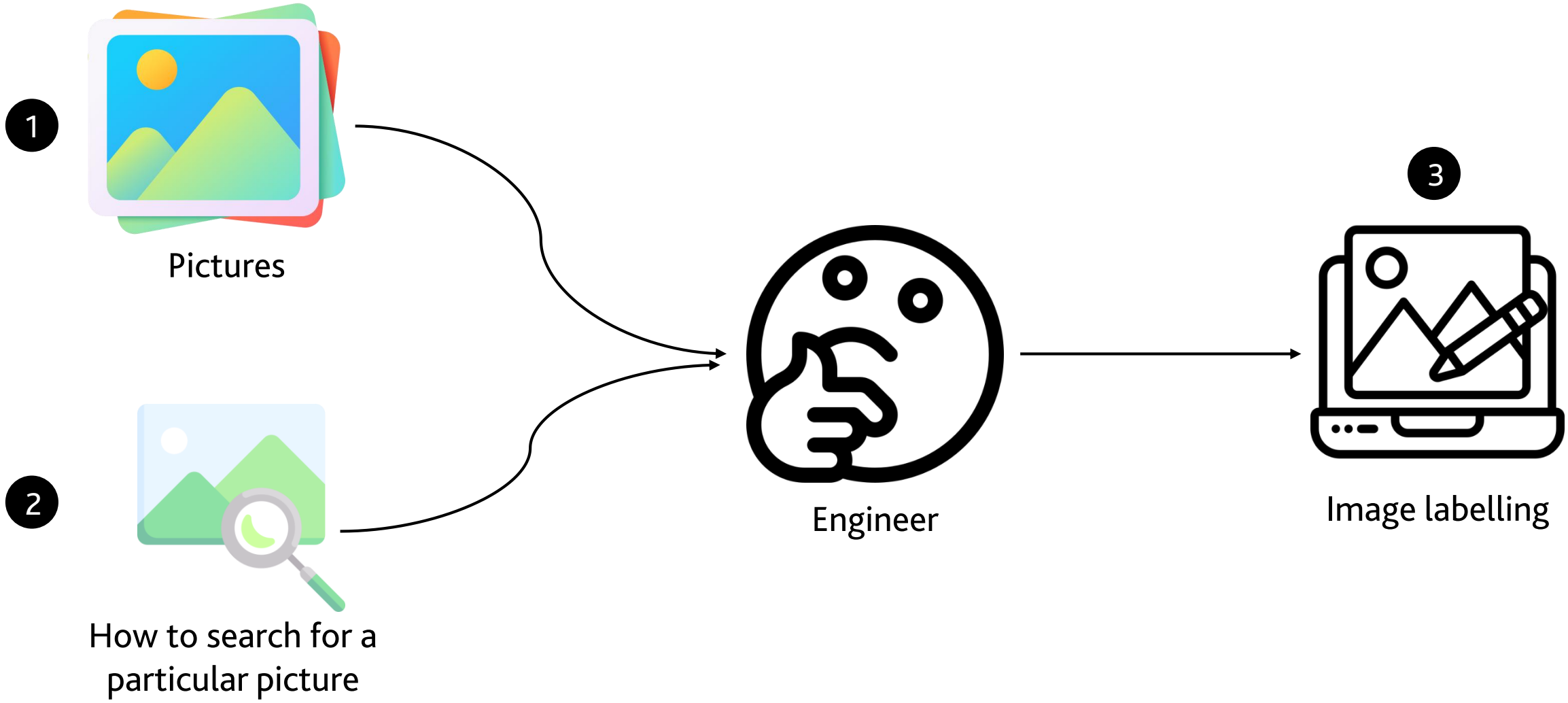

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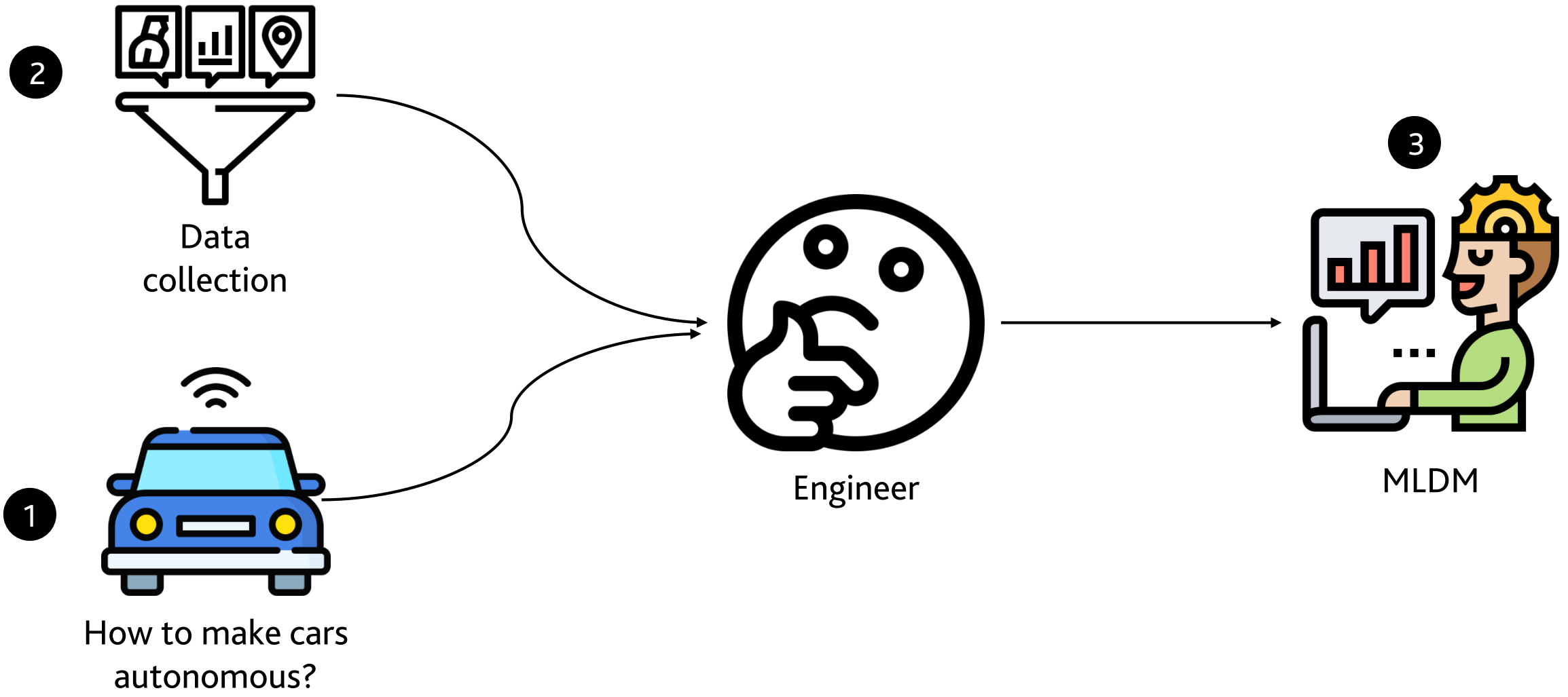
Why Machine Learning & Data Mining?



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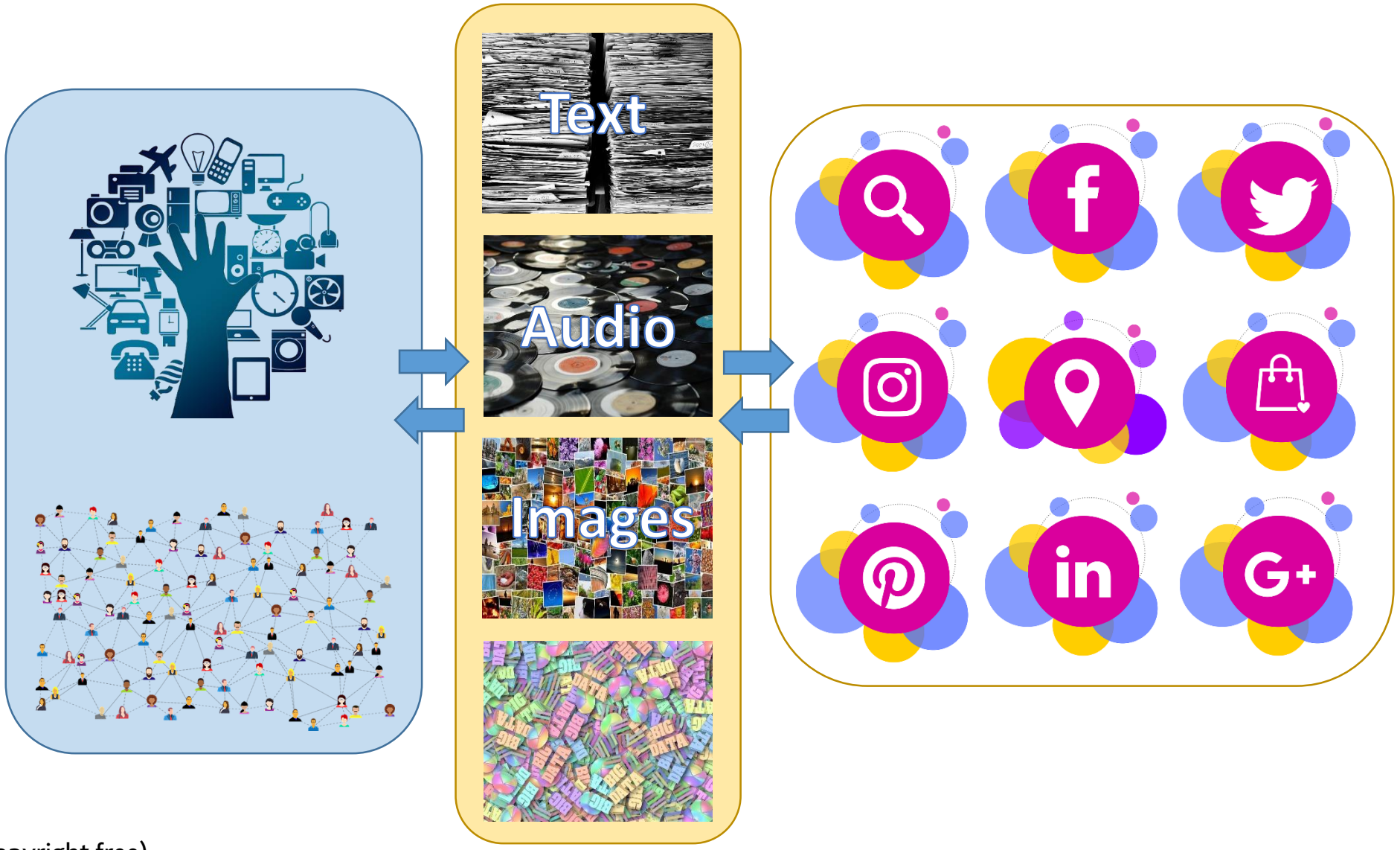

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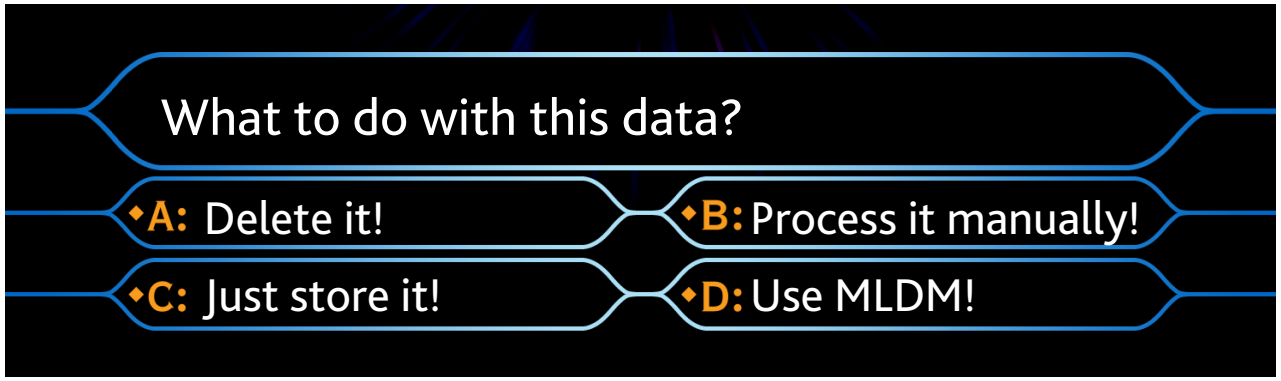
Why Machine Learning & Data Mining?

- We and our devices massively store and collect data in and from different platforms, e.g. Google, Facebook, amazon, etc.
  - 40,000 search queries are submitted every second on Google. [*]
  - 300 new hours of video show up on YouTube every minute. [*]
  - 100 terabytes of data are shared every day on Facebook. [*]
  - 5 quintillion bytes of data are produced every day by our smart devices. [*]

- Is that all?
  - **No**, There is also non-shared data (for example students' grades) and instantaneous/non-collected data (like videos in autonomous driving).

[*] https://hostingtribunal.com/blog/big-data-stats/

Why Machine Learning & Data Mining?



- Data Mining:
  - Helps human decision making by automatically extracting useful knowledge from a large amount of data.

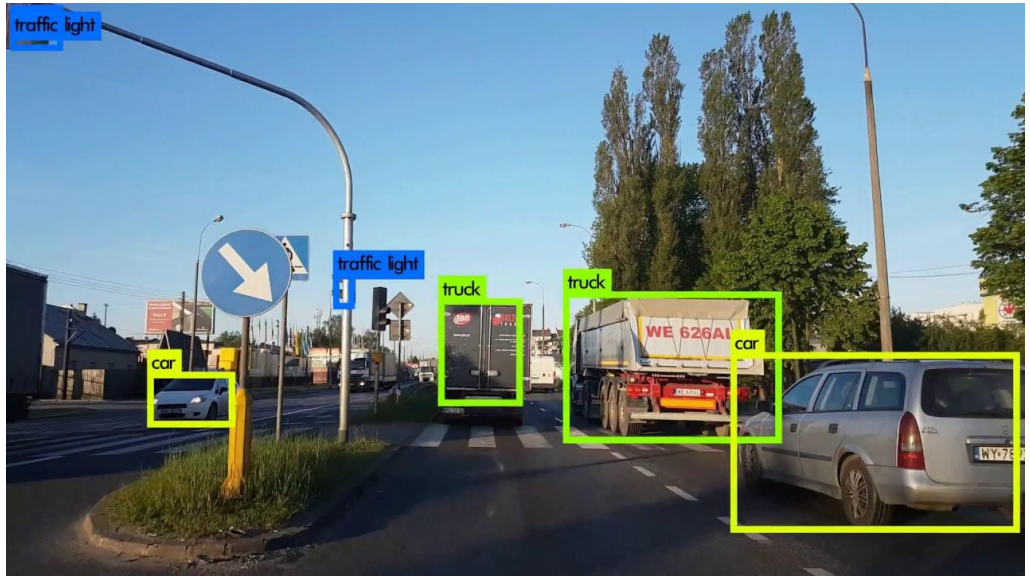
- Machine Learning:
  - Uses data to discover patterns and learn from them to make decisions that a human is capable for (e.g. autonomous driving) or that human cannot do (e.g. image generation, time series prediction).

Definition

Arthur Samuel (1959): *"Machine Learning is a field of study that gives computers the ability to learn without being explicitly programmed."*

Some of the applications of MLDM

Image Processing: Object Detection, Recognition & Localisation



- Used in:
  - Autonomous driving
  - Image tagging and classification
  - Face recognition
  - Image annotation
  - Etc.

Natural Language Processing

- Used in:
  - Spam filtering.
  - Information extraction.
  - Text classification
  - Plagiarism detection.
  - And so many other applications

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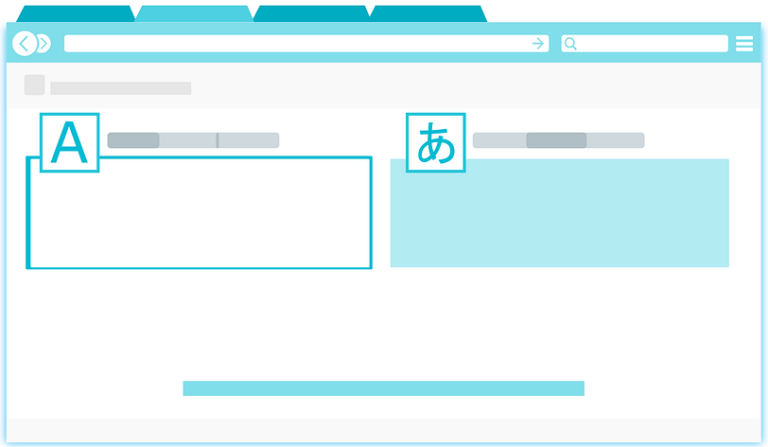
Machine Translation



- Used because:
  - Real time.
  - Cheaper.
  - Easily accessible.

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Speech Recognition

- Used in:
  - Easy and fast interaction with devices.
  - Important alternative for people with visual impairments.
  - Voice biometrics for identity recognition.
  - Effective communication with a big number of clients.
  - Etc.

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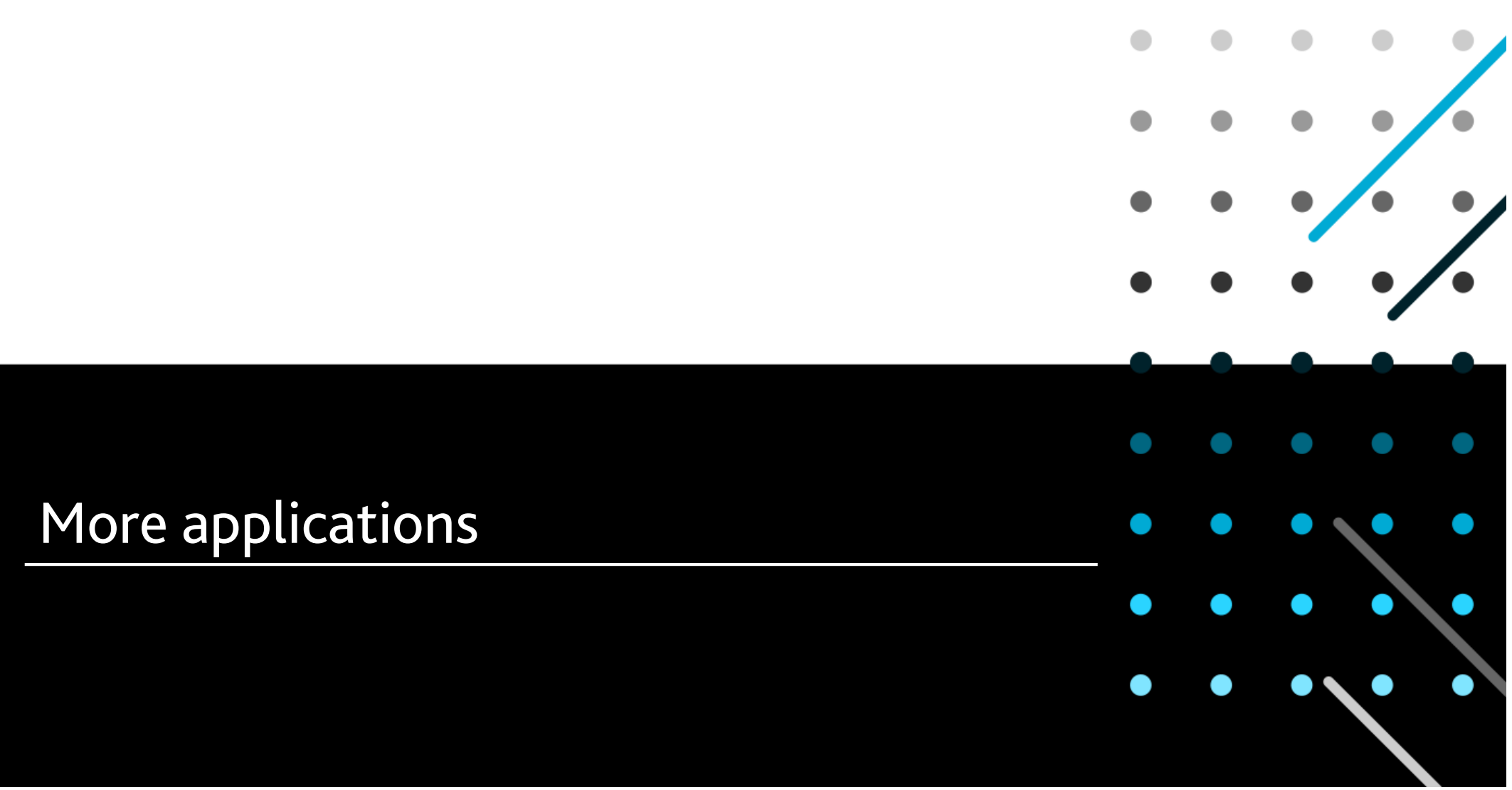
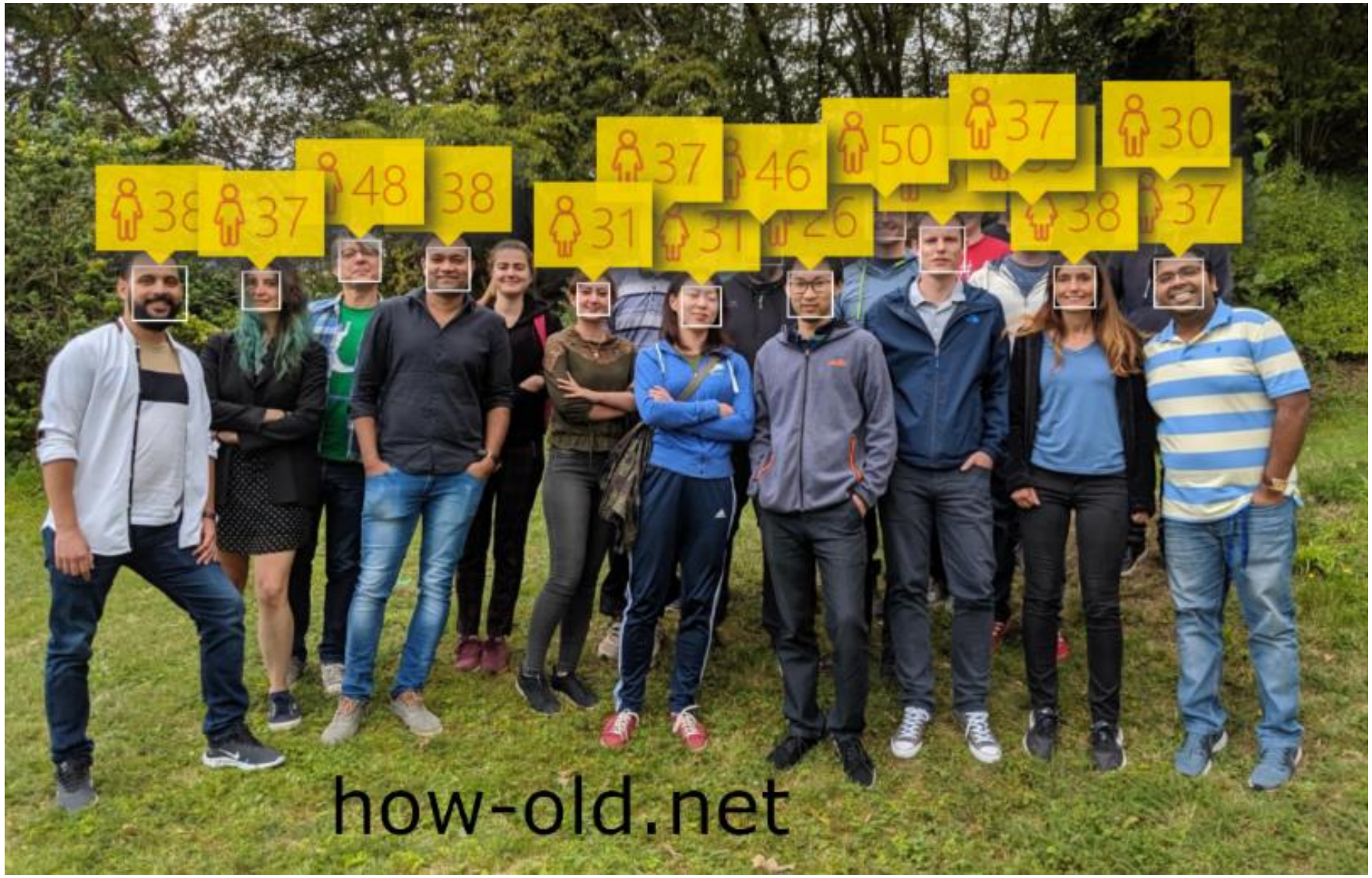
More applications

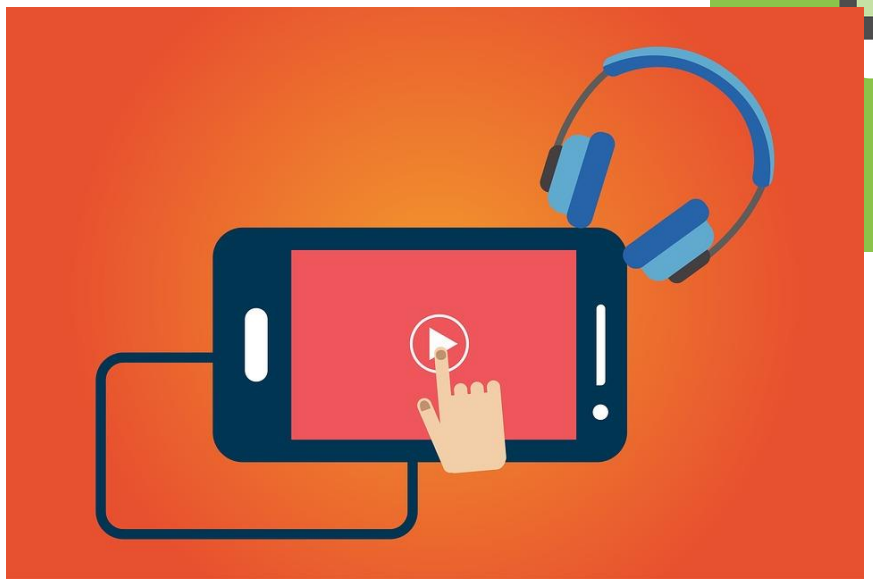


Age and gender detection



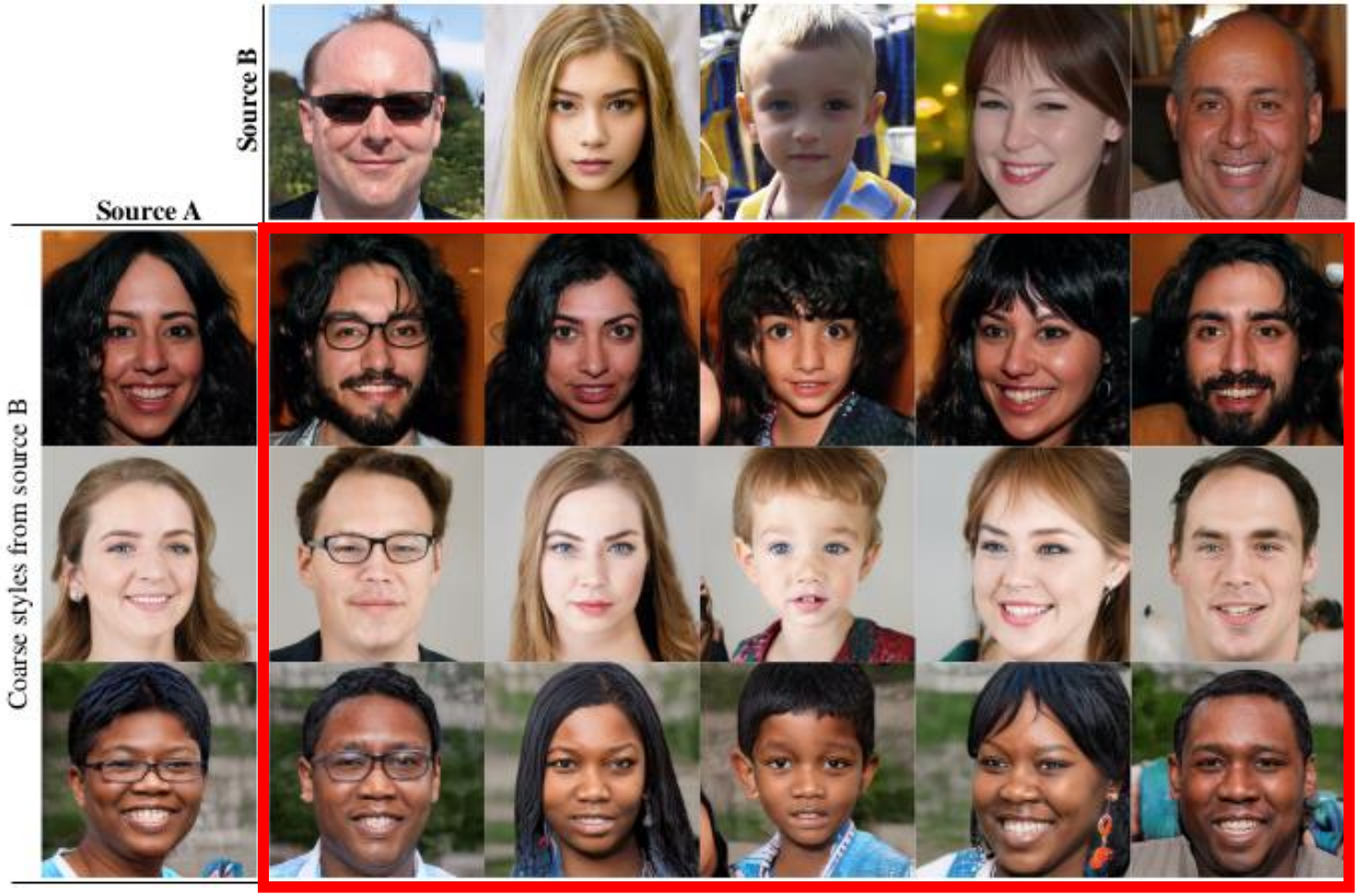
Recommendation system

- Ads
- Videos
- Products
- Etc.



Google Ads

Data Generation



FAKE!!

Karras, T., Laine, S., & Aila, T. "A style-based generator architecture for generative adversarial networks." In *CVPR, 2019.*

And there are even more in all domains . . .

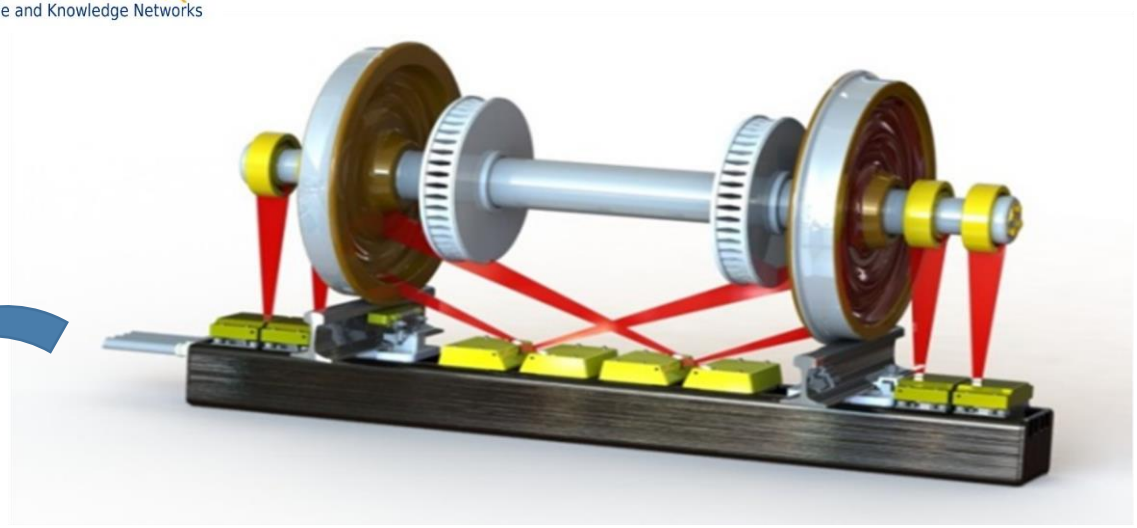
- Finance & Banking
- Security & Surveillance
- Transport & Traffic
- Healthcare & Well-being
- Media
- Commerce
- Sport
- Game & Entertainment
- Etc.

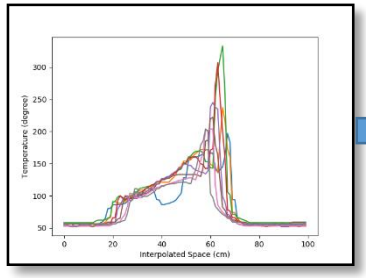
MLDM @ WeST

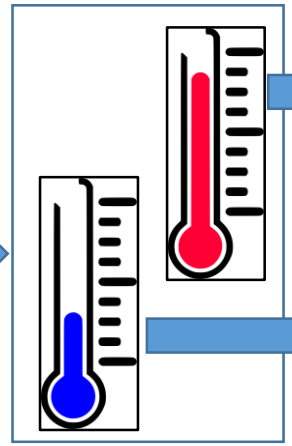
Example from past projects

Railway Monitoring System

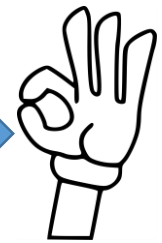
WeST
People and Knowledge Networks

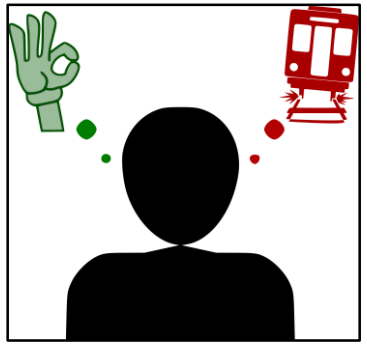




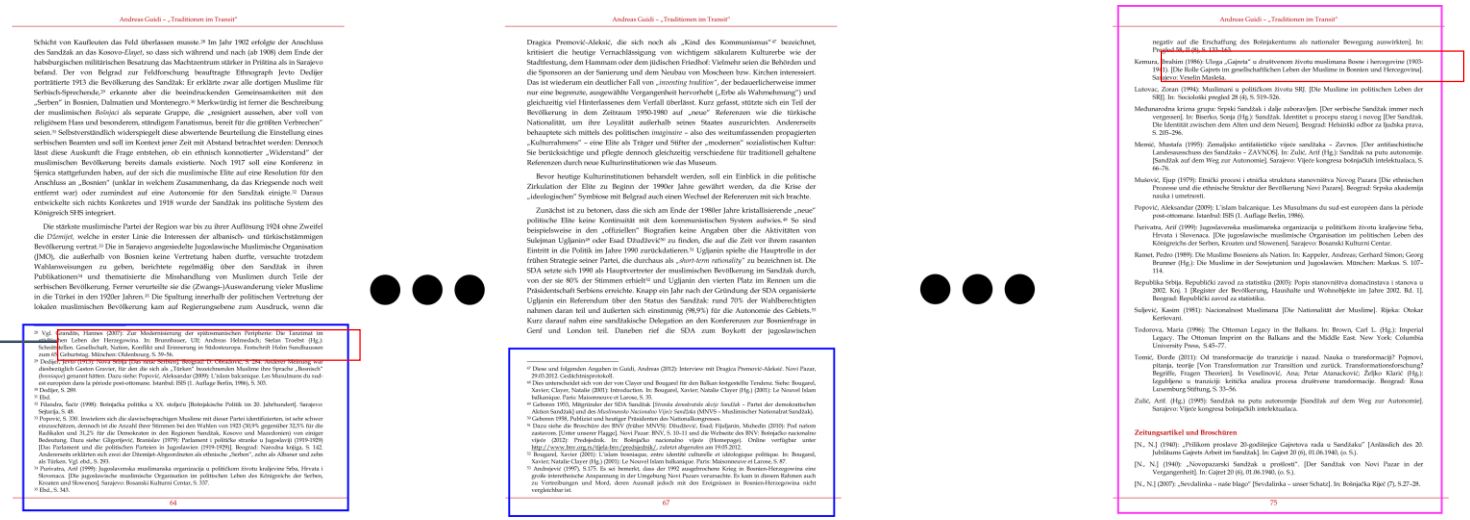


MLDM





Extracting and Parsing References



28 Vgl. Grandits, Hannes (2007): Zur Modernisierung der spätosmanischen Peripherie: Die Tanzimat im städtischen Leben der Herzegowina. In: Brunnbauer, Ulf; Andreas Helmedach; Stefan Troebst (Hg.): Schnittstellen. Gesellschaft, Nation, Konflikt und Erinnerung in Südosteuropa. Festschrift Holm Sundhaussen zum 65. Geburtstag. München: Oldenbourg. S. 39–56.

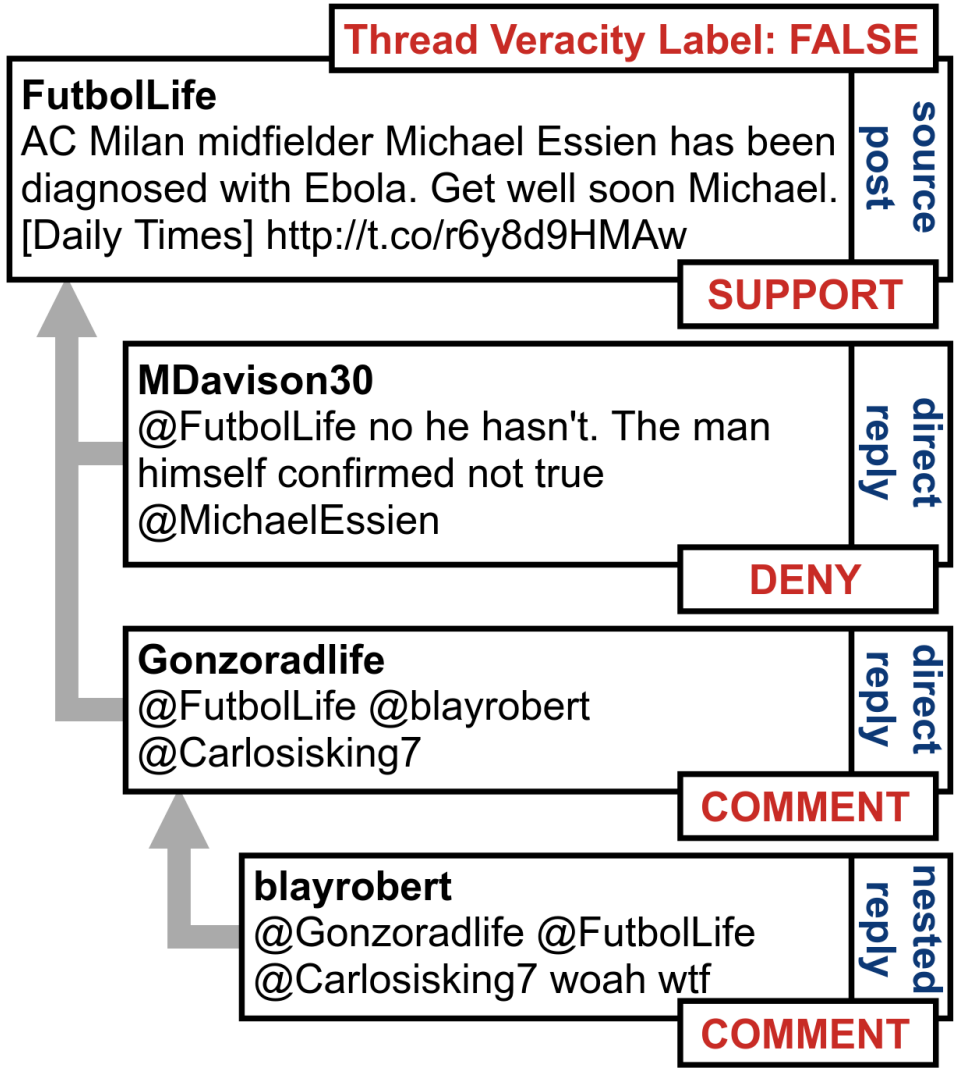
Author* Author** Title

19. Viola, P., Jones, M.: Rapid object detection using a boosted cascade of simple features. In: CVPR01. (2001) I:511–518

Title Source Year Page range

Boukhers, Z., Ambhore, S., & Staab, S. (2019). An end-to-end approach for extracting and segmenting high-variance references from PDF documents. In *JCDL*

Rumour detection and stance classification



Baris, I., Schmelzeisen, L., & Staab, S. (2019). CLEARumor at SemEval-2019 Task 7: ConvoLving ELMo Against Rumors. *arXiv preprint arXiv:1904.03084*.

Predictive learning problems

Predictive learning problems

- "*They constitute the majority of tasks machine learning can be used to solve today.*"

Machine Learning

v.s.

Human Learning

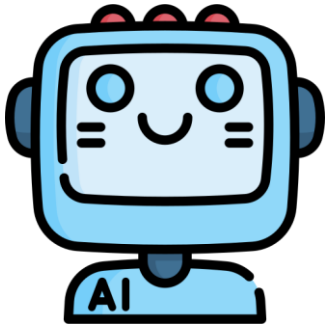
Classification

- **Human learning**

Teach a child how to distinguish between a “pear” and “apple”.

- **Machine learning**

Teach a computer to distinguish between a “pear image” and “apple image”.



Defining Task

Collecting Data

Designing Features

Training Model

Testing Model

Evaluating Model

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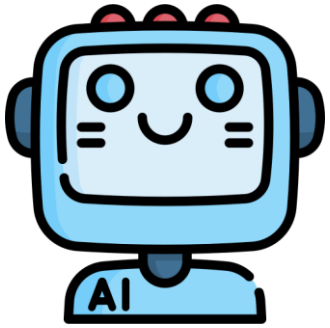
Classification

- **Human learning**
  - Give the child scientific definition « Genus: Malus, etc. »
  - the child is presented with one, few or many examples of what they are told are either “apples” or “pears” until he/she fully grasp the two concepts.

- **Machine learning**
  - Similarly, examples of “apples” and “pears” must be collected, labelled with their class names and presented to a computer.
  - The larger and more diverse the data set the better a computer can perform (applied also in human learning).



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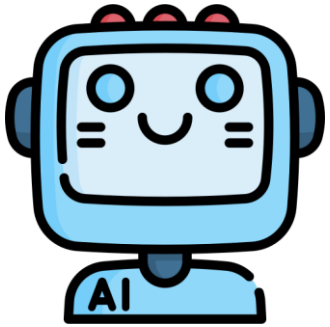

Defining Task

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Classification

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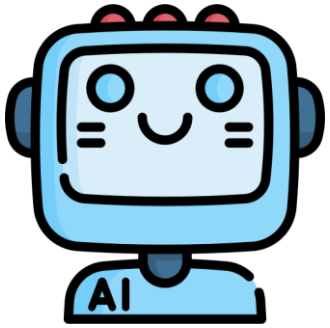
Classification

- **Human learning**
  - How do we **visually** distinguish between an “apple” and “pear”?
  - Colour, shape, size, taste, etc.
  - Features must be discriminative.

- **Machine learning**
  - **Similarly**



Defining Task

Collecting Data

Designing Features

Training Model

Testing Model

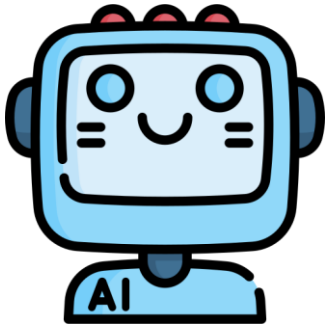
Evaluating Model

Icon vectors designed by Freepik

Classification

- **Human learning**
  - Show all examples to the child and explain to him the difference between the two classes.

- **Machine learning**
  - Find a line that separates between the two classes (Linear Classification). We will see it in details in the upcoming lectures.



- **Defining Task**
- **Collecting Data**
- **Designing Features**
- **Training Model**
- Testing Model
- Evaluating Model

Icon vectors designed by Freepik

Classification

For a better visualisation, we consider only two features.

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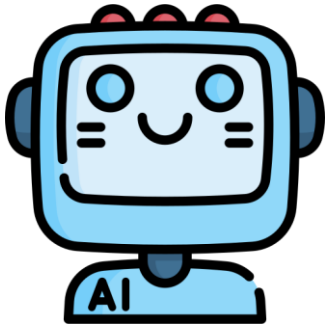
Classification

- **Human learning**
  - Did the child understand the concept?
  - Show him/her **other** examples to confirm.
  - Don't give him/her the label of course!

- **Machine learning**
  - Let the trained model predict the classes of completely new example (not used in the training phase).



- Defining Task
- Collecting Data
- Designing Features
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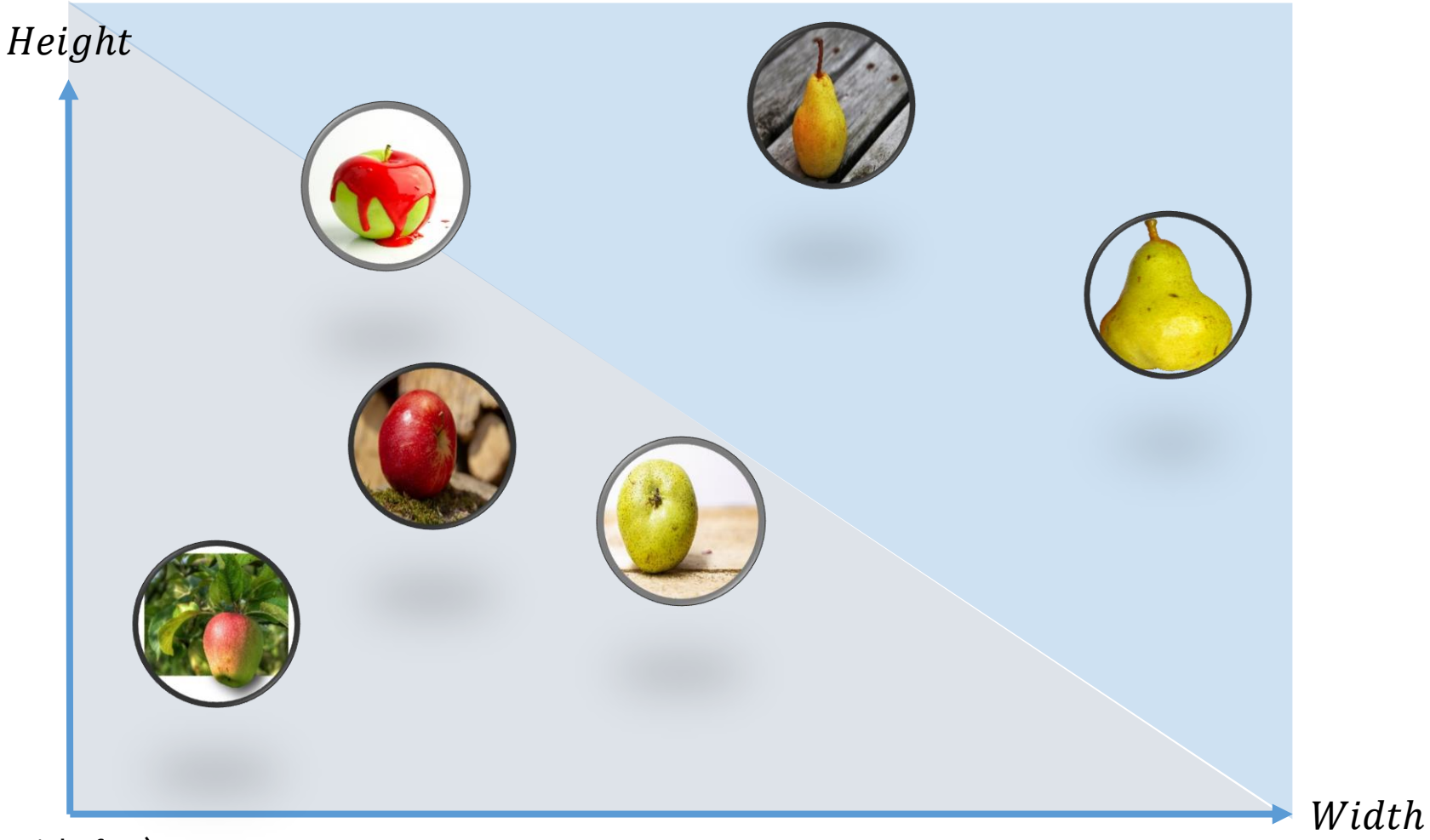
Icon vectors designed by Freepik

Classification

For a better visualisation, we consider only two features.



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Classification

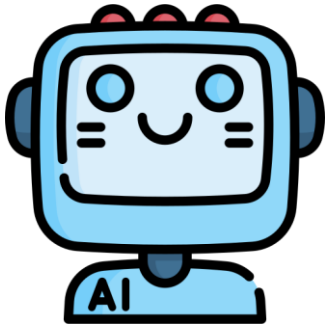
- **Human learning**

Bravo!

- **Machine learning**
  - How good is the model?

Confusion Matrix, Precision, Recall, Accuracy, F-Score, etc.

(we will see them in the upcoming lectures)



Defining Task

Collecting Data

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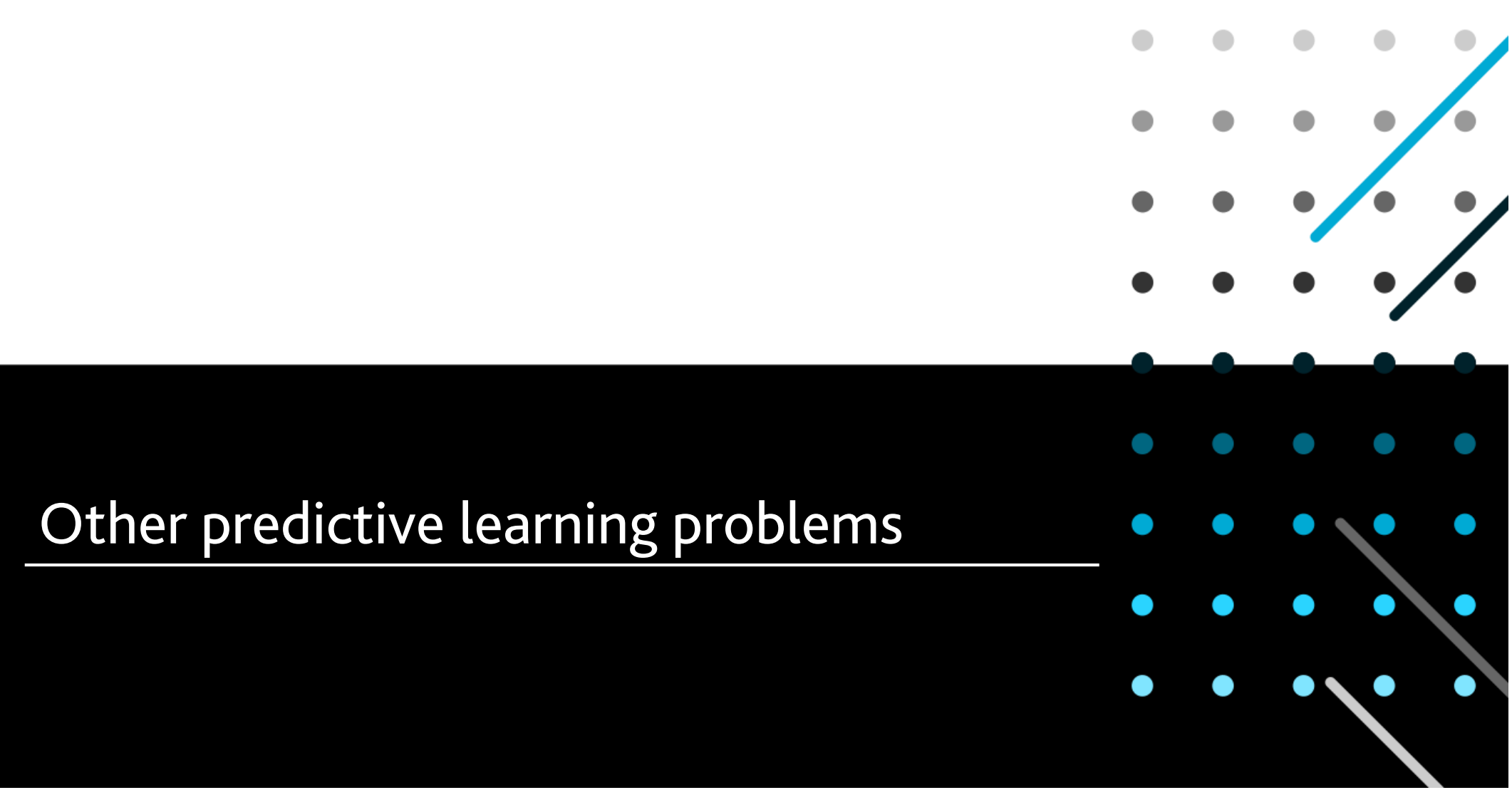
Icon vectors designed by Freepik

More examples of classification

- Is the skin mole a malignant melanoma?
  - False / True
    - Binary classification.
    - Two-class classification problem.
    - Categorical (discrete) classification.

- What is the topic of a given document?
  - Sport / Politics / Events / Society
    - Multi-class classification problem.
    - Categorical

Other predictive learning problems



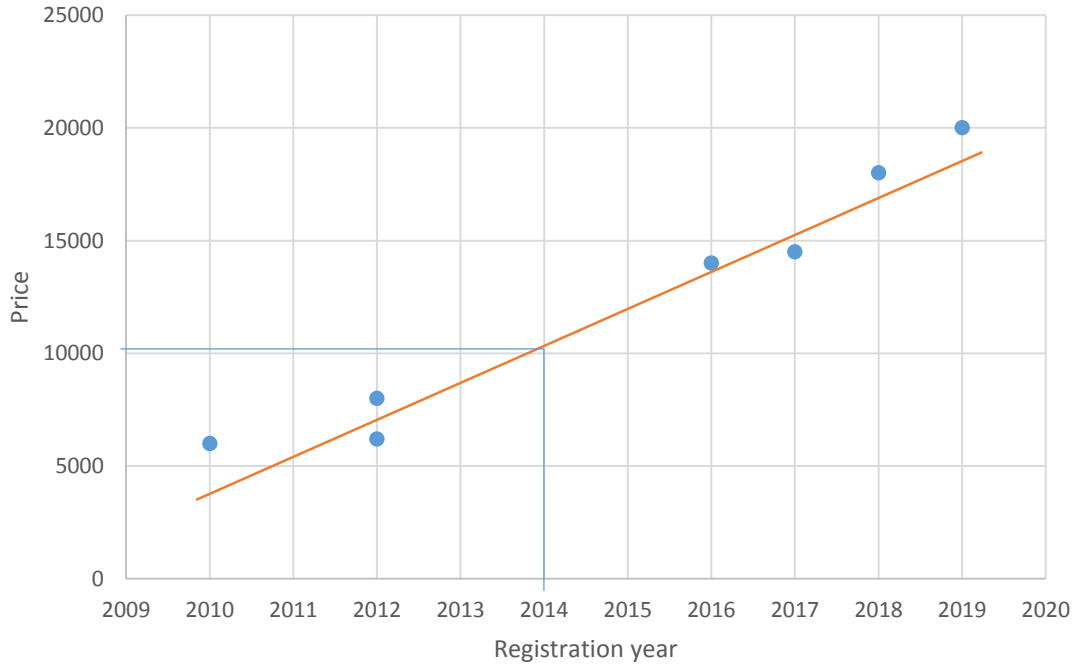
Regression

- We want to predict the price of our car based on the registration year, say 2014.
  - Obviously, all other properties (e.g. model, colour, etc.) are known.
  - We could obtain some examples of the same car from e-commerce websites:

How much is our car worth?

Registration Year	Price in €
2010	6,000
2012	7,200
2012	8,000
2016	14,000
2017	14,500
2018	18,000
2019	20,000

Regression

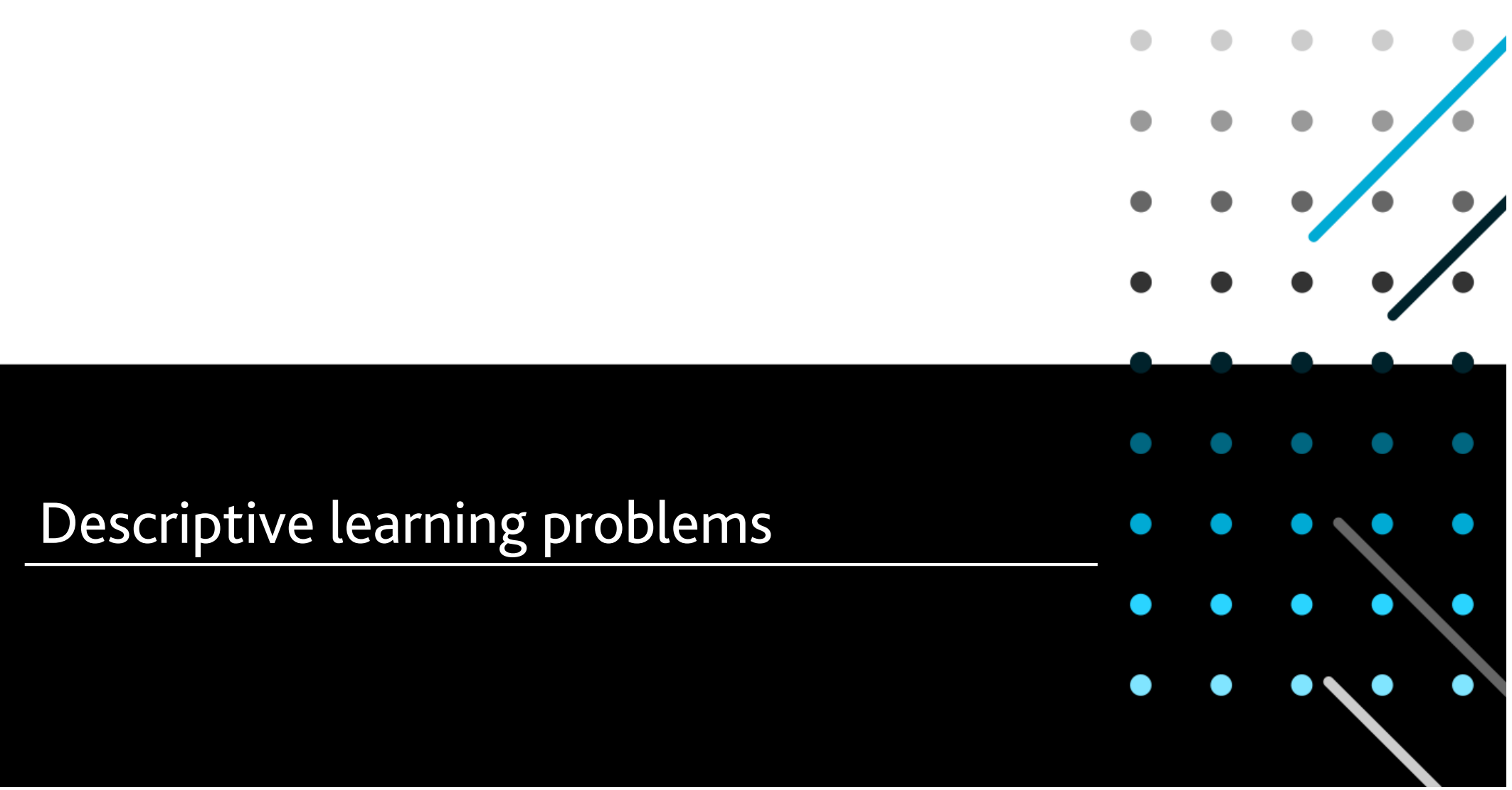


- Based on this data, our car should cost around 10,500 €.

More examples of regression

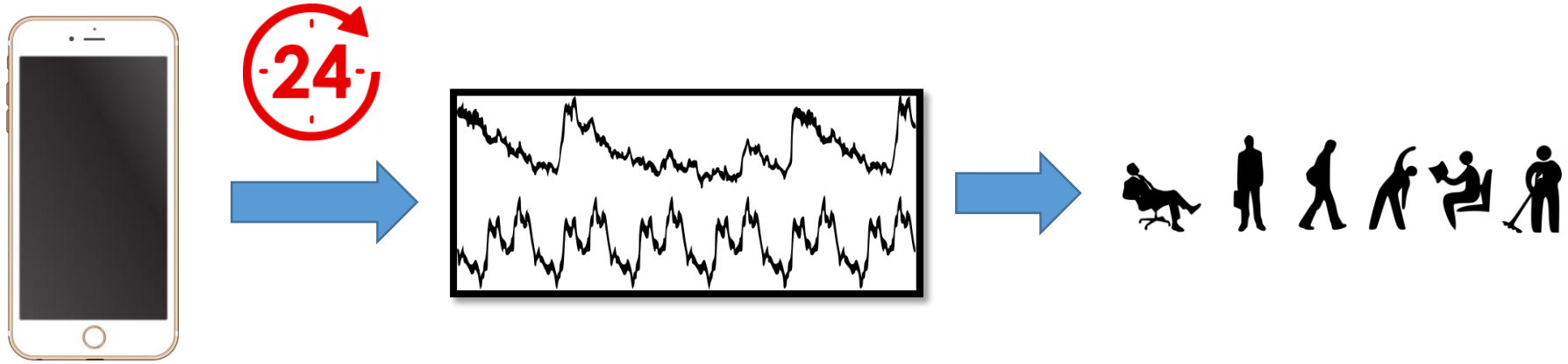
- What is the height given the age?
  - [45, 210] cm
    - Continuous prediction.
    - Called regression.

Descriptive learning problems



Clustering

- Considering the following problem:
  - Extracting the different pattern activities that a person X performs in 24 hours using sensory data acquired from his/her smartphone per 15min.
  - Note that we don't have the labels of the activities.
  - We might as we might not know the number of activities.



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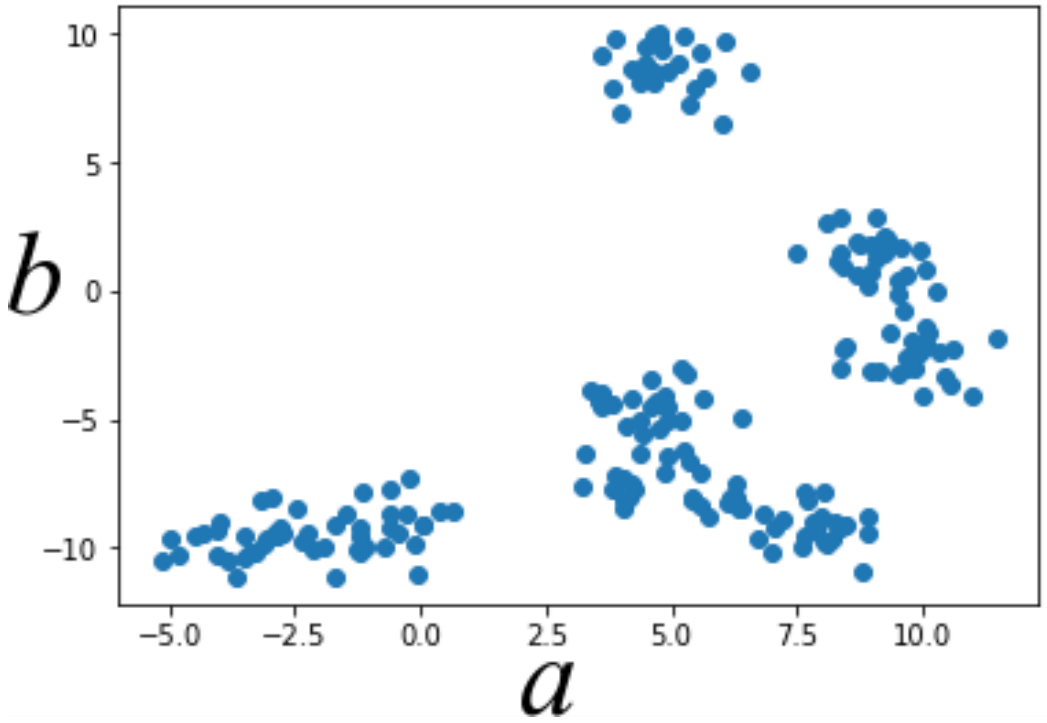
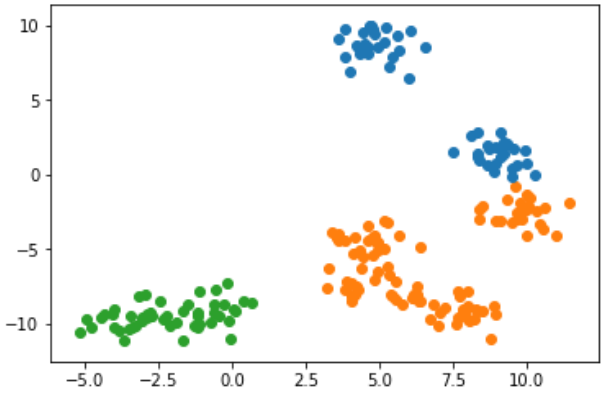
Clustering

- **For the sake of visualization**, the data (measurements) are represented by two features (a and b).

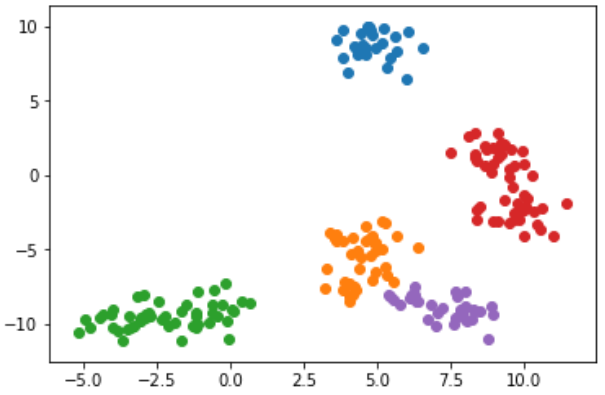


Clustering

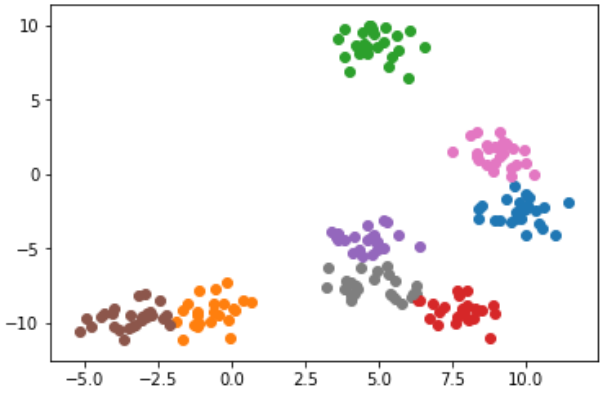
N. Clusters = 3



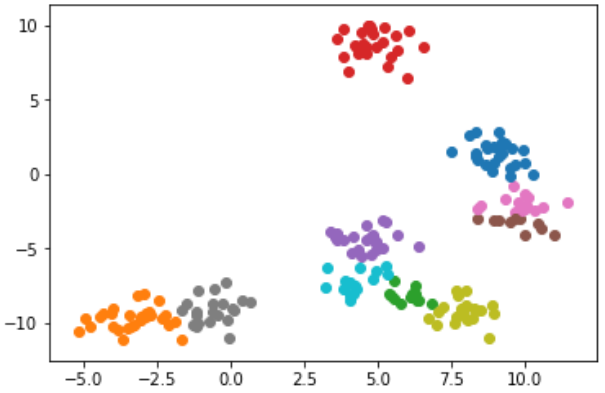
N. Clusters = 5



N. Clusters = 8



N. Clusters = 10



Some notions

Predictive vs. Descriptive learning

- **Predictive learning** is the task of learning from existing data to predict something about new data, such as:
  - Classifying it based on its classes.
  - Estimating the value of a propriety (regression).
  - Forecasting upcoming states.
  - Etc.
- **Descriptive learning** is the task of learning something about the data at hand, such as:
  - Discovering latent patterns (clustering).
  - Detecting anomalies.
  - Ranking.

Supervised vs. Unsupervised learning

- Supervised learning:
  - Labelled training data
  - Predict the label of new data
- Unsupervised learning:
  - Non-labelled data.
  - Capture the hidden structure in data.

- Although most of predictive tasks are supervised and most of the descriptive tasks are unsupervised,
  - Predictive learning ≠ Supervised learning
  - Descriptive learning ≠ Unsupervised learning

(Un-) Supervised vs. Predictive/Descriptive

	Predictive	Descriptive
Supervised	• The model uses past data to predict events or outcome in future data. • The model is trained with labelled data.	• The model extracts knowledge from the data at hand. • The model is trained with labelled data.
Unsupervised	• The model uses past data to predict events or outcome in future data. • The model is fed with unlabelled data only.	• The model extracts knowledge from the data at hand. • The model is fed with unlabelled data only.

Examples

	Predictive	Descriptive
Supervised	• Object classification • Object detection • Object extraction • Etc.	• I couldn't think of any example!
Unsupervised	• Anomaly detection (e.g. Bank transactions, Human activities, etc.)	• Image segmentation • Topic modelling • Clustering • Etc.

Other learning approaches

Semi-supervised learning

- It combines a small labelled data with a large unlabelled data.
- Commonly, adopted when collecting large labelled data is difficult and/or costly. For example:
  - Human activities
  - Speech analysis
  - Web pages classification
  - Biological sequence classification
  - Note that difficulty and cost are subjective.
- Example methods:
  - Positive Unlabelled (PU) learning
    - e.g. Suspicious activity detection.
  - Combining clustering & classification
    - Cluster → Label → Train/Classify
    - Label → Cluster → Train/Classify

Reinforcement learning

- It is goal-oriented that learns how to achieve a complex goal.
  - For every state, it takes an action.
  - The series of actions is supposed to reach the goal.
  - The data is unlabelled.
  - It learns by exploration and exploitation.
    - Exploration: try different sequence of actions.
    - Exploitation: take advantage of the actions/states that led good result.
- Examples of usage:
  - Games
  - Robotics
  - Trading
  - Etc.

Active Learning

- The model is trained with a small labelled data
- Then, It queries a user/expert or any information source to label some samples.
- It is mainly applied when:
  - The unlabelled data is abundant
  - But, the labelling is costly.
- Examples:
  - URL classification
  - Image classification.
  - Etc.

Summary

Summary

- Organization:
  - It is important to stick to the deadlines mentioned in the calendar.
  - Being registered in Olat & Microsoft teams and Panopto is all what you need for this course.

- MLDM:
  - MLDM is very important.
  - A lot of disciplines are benefiting from MLDM.
  - There are several tasks in MLDM: Supervised, Unsupervised, …
  - There are several techniques in MDLM: Predictive, descriptive, …

Thank you!

Zeyd Boukhers

E-mail: Boukhers@uni-koblenz.de
Phone: +49 (0) 261 287-2765
Web: Zeyd.Boukhers.com

University of Koblenz-Landau
Universitätsstr. 1
56070 Koblenz