



## Module 2: Types of Learning

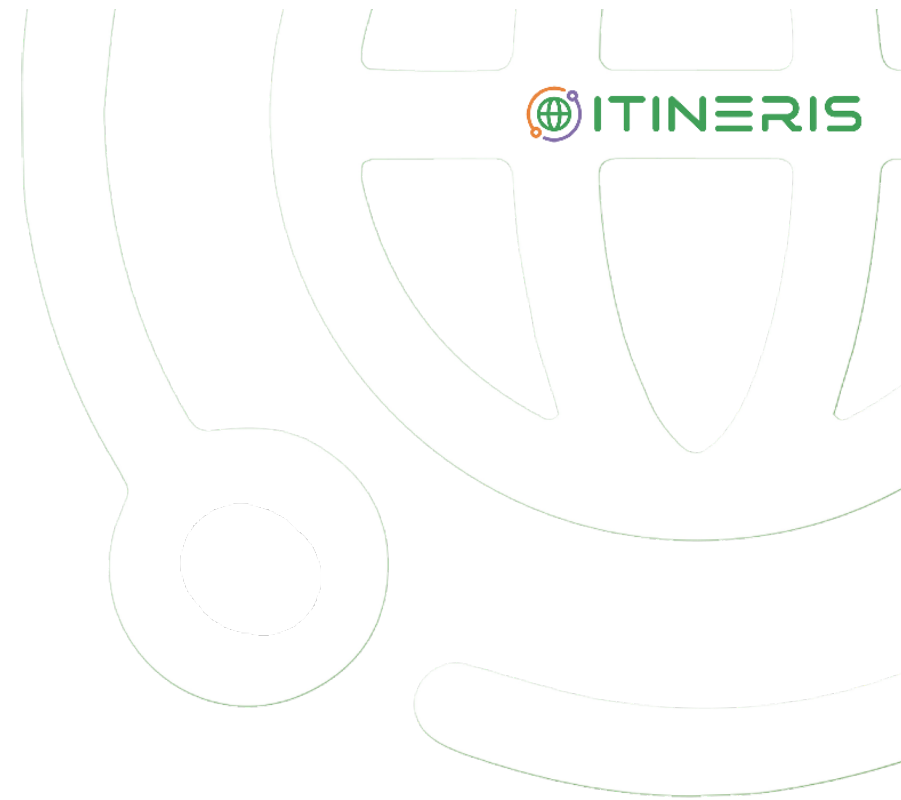
- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning
- Use cases for each learning type
- 📌 Demo: Teachable Machine (e.g., image classification)
- 📌 Discussion: Which learning type fits which kind of problem?

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Mission 4 “Education and Research” - Component 2: “From research to business” - Investment  
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



## Why Learning Types Matter

- 🌐 They define how models learn from data
- 🌐 Help select the right approach for a task
- 🌐 Real-world relevance and use cases



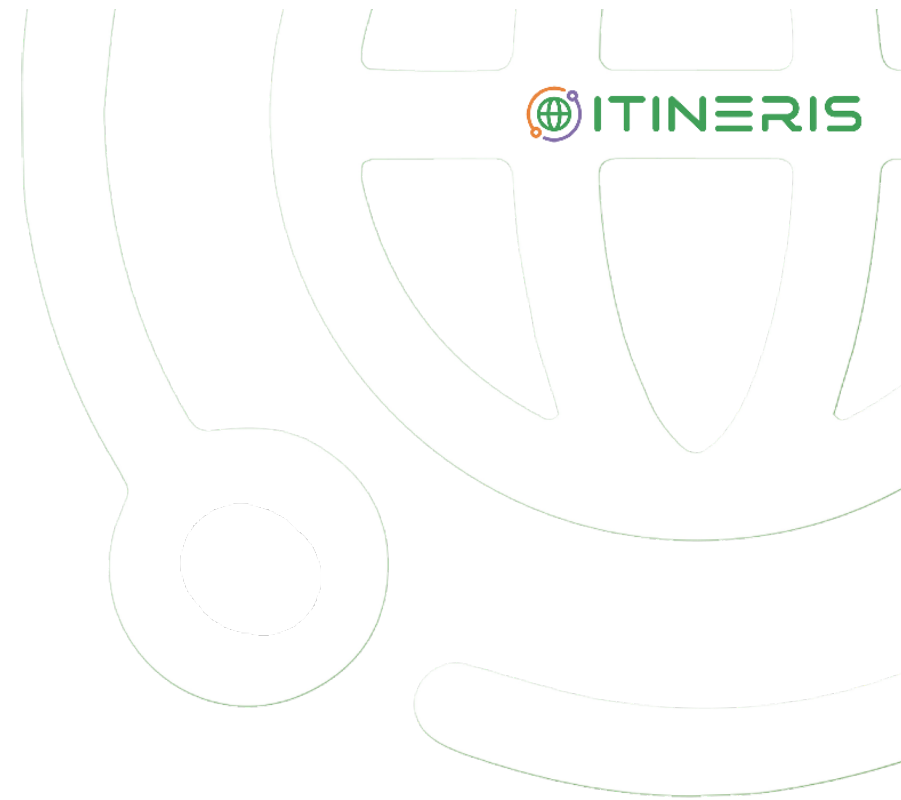
## What Is Supervised Learning?

- 🌐 Learns from labelled data
- 🌐 Predicts outcomes based on input-output pairs
- 🌐 Examples: classification, regression







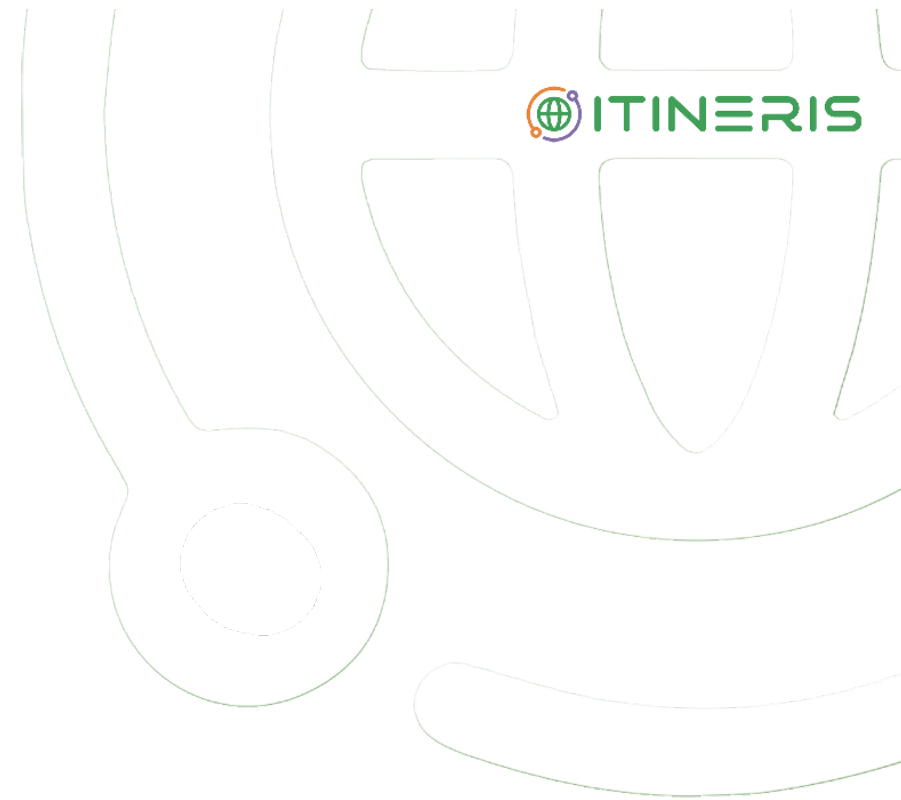
## How Supervised Learning Works

- 🌐 Training with input-output examples
- 🌐 Objective: minimize prediction error
- 🌐 Requires a labelled dataset



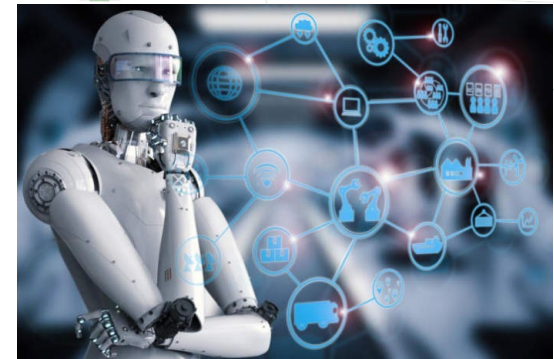
## Use Cases of Supervised Learning

-  Email spam detection
-  Fraud detection in finance
-  Medical image classification
-  Sales forecasting



# Supervised learning

- Data are labelled
- Labels are the targets (or output, or class): what we want to learn
- So, for each observation we have:
  - Input values
  - Label



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The machine learning algorithm learns such associations over time



## Supervised learning - example

- 🌐 We want to teach a small kid how to distinguish a bike from a car
- 🌐 He has not ever seen those before



*Input = a set of labelled images*

## Supervised learning - example

Let's proceed as follows:

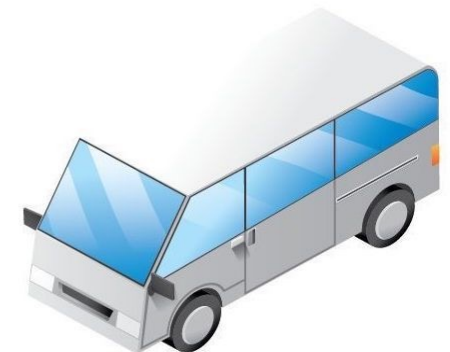
- Let's show the images of the bikes
- We tell him those are "bikes"
- We do not teach him about any specific characteristic



So we let the kid analyse those images to understand what makes those objects a "bike"

## Supervised learning - example

🌐 We do the same with the cars

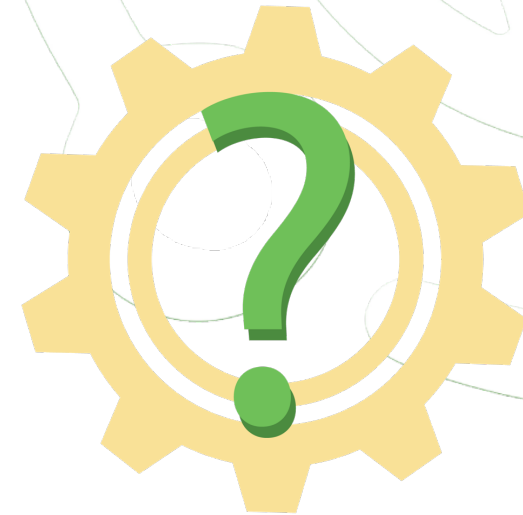


We let him “think and learn”



## Supervised learning - example

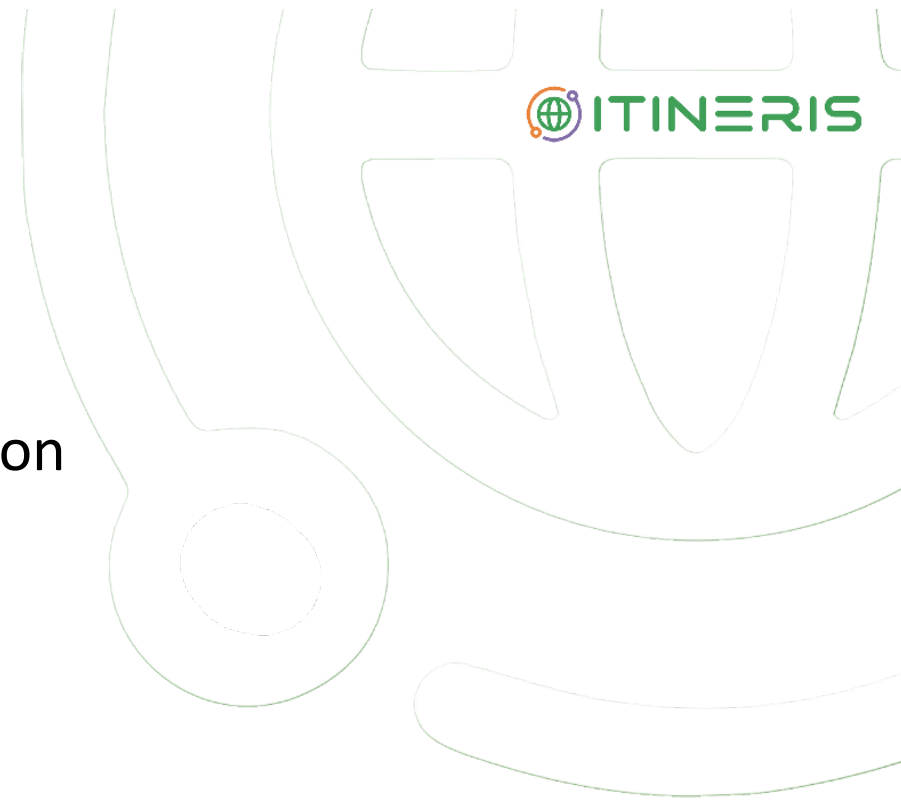
🌐 Eventually, we show him a picture and ask him to identify it



Notice: It's a new picture, he has not seen it before

## What Is Unsupervised Learning?

- 🌐 Learns patterns from unlabelled data
- 🌐 No predefined output
- 🌐 Examples: clustering, dimensionality reduction



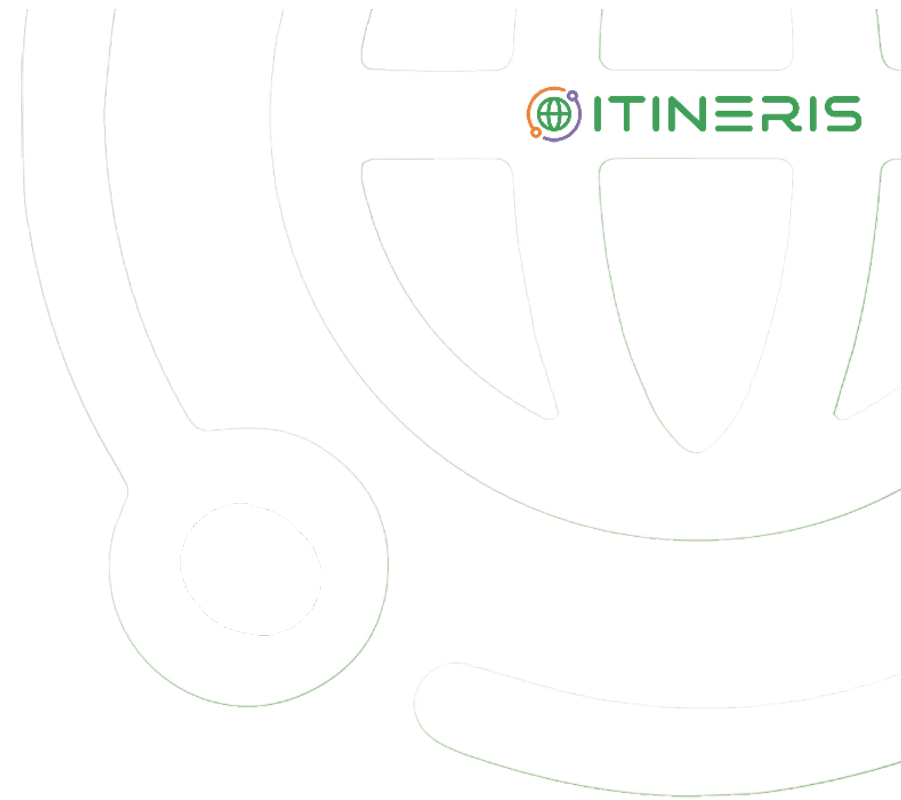
## How Unsupervised Learning Works

- 🌐 Finds structure in data
- 🌐 Groups similar items or reduces data complexity
- 🌐 Often used for exploration



## Use Cases of Unsupervised Learning

- 🌐 Customer segmentation
- 🌐 Anomaly detection
- 🌐 Market basket analysis
- 🌐 Topic modelling in documents



## Unsupervised learning

- 🌐 Here the algorithm learns without any label
- 🌐 The input to the algorithm is just a set of observations



In general, this is a more challenging class of problems

## Unsupervised learning - Example

- 🌐 Let's repeat the previous example with no supervision
- 🌐 This time we show the kid the images at once, bikes and cars together
- 🌐 **We don't tell him anything about the two type of objects!**

## Unsupervised learning

- 🌐 The kid has to learn by himself the two categories and what makes those different from each other



**He will use a different logical path to cluster the input images**

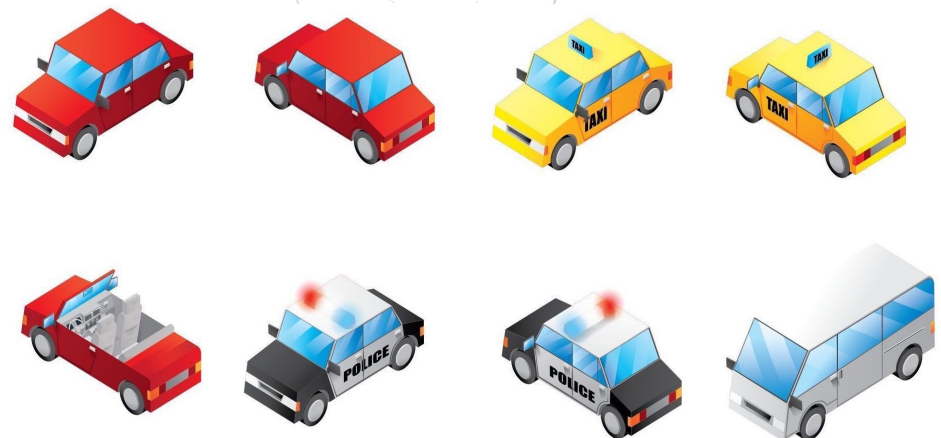
## Unsupervised learning - Example

🌐 Then, like before, we show him a new unseen image



# Unsupervised learning - Considerations

- 🌐 The kid in his learning may use more than two categories or a very different set of categories of what we expect
- 🌐 For instance, he may decide to put together objects based on color, size, or number of wheels (that he sees!)

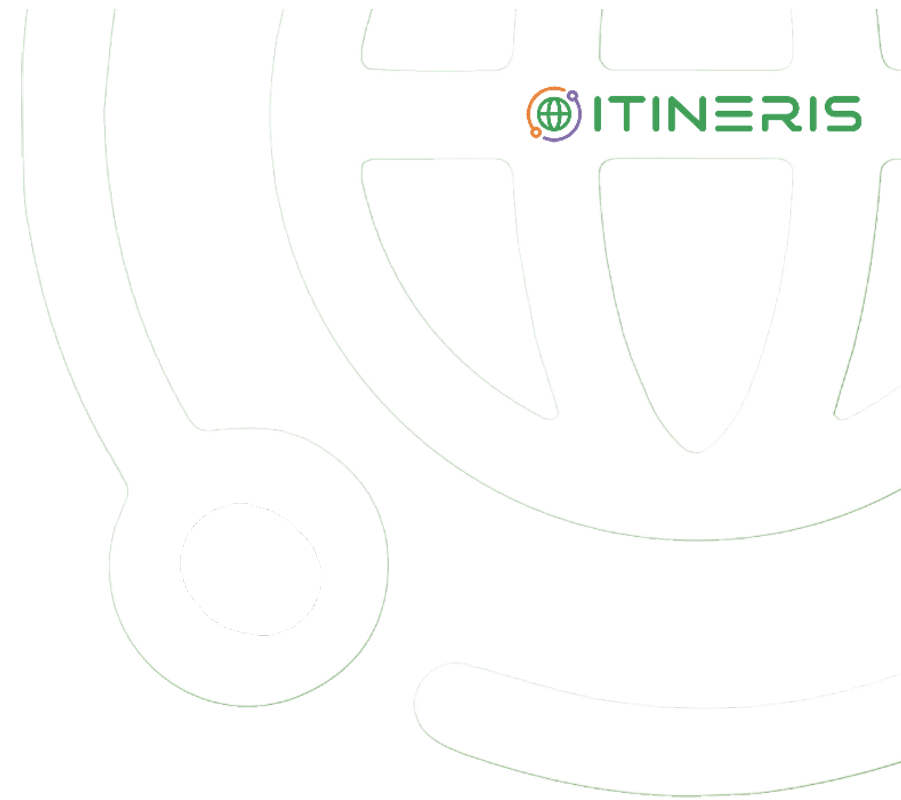


## Unsupervised learning - Considerations

- 🌐 The results is greatly dependent upon the quality of the input images
- 🌐 As usual, the more data in input the more accurate the learning, at least, until a certain point

## What Is Reinforcement Learning?

- 🌐 Learns by interacting with an environment
- 🌐 Receives rewards or penalties
- 🌐 Examples: game AI, robotics



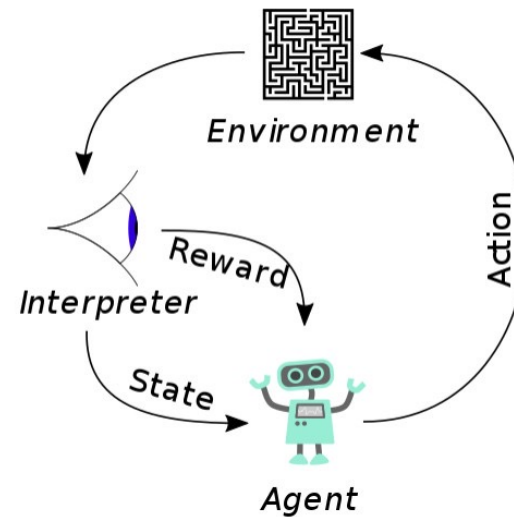
## How Reinforcement Learning Works

- 🌐 Agent takes actions to maximize cumulative reward
- 🌐 Trial-and-error learning
- 🌐 Uses policy, value functions



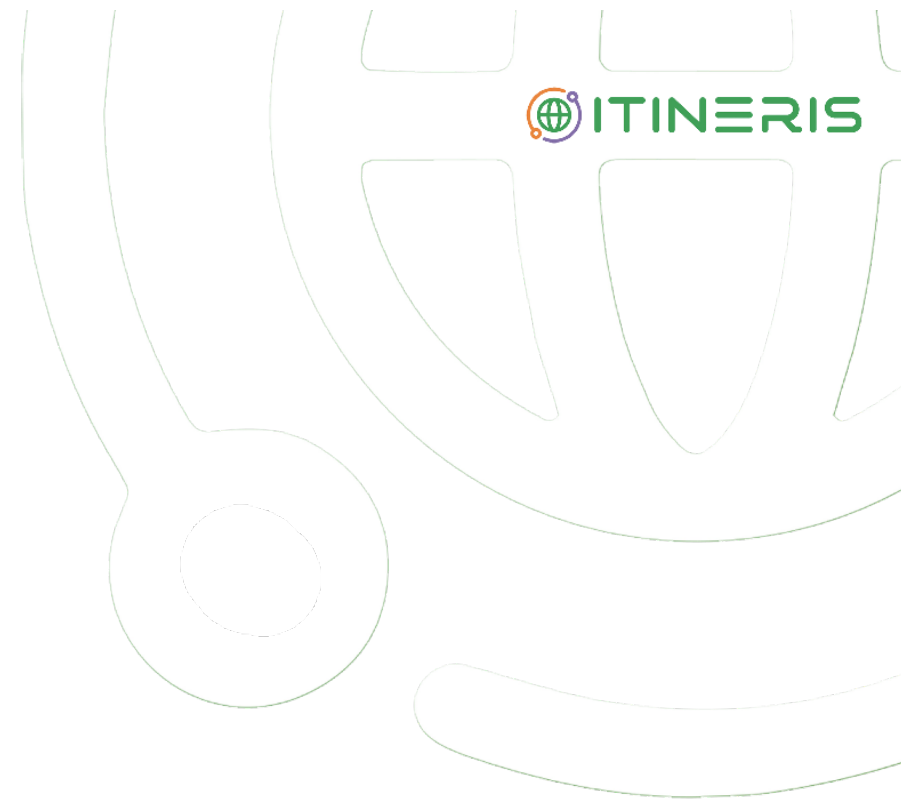
## Reinforcement learning - The basic principle

- 🌐 Learning is based on a gain function
- 🌐 Each time the machine reaches a positive state it gains something
- 🌐 The objective is to maximize gain



## Use Cases of Reinforcement Learning

- 🌐 Used by DeepMind to develop AlphaGo
- 🌐 Game playing (e.g., AlphaGo)
- 🌐 Autonomous vehicles
- 🌐 Dynamic pricing
- 🌐 Industrial automation



# Supervised Learning

- 🌐 Task to be learnt: to extract a description / labelling or pattern from the data, based on the training
- 🌐 Training examples labelled by a (human) supervisor
- 🌐 Use it to predict the output for further examples
- 🌐 Performance measured as how accurate the output is
- 🌐 Example applications
  - Credit approval
  - Medical diagnosis Fraud detection
  - Text and image labelling or classification

## Unsupervised Learning

- 🌐 Task to be learnt: finding interesting patterns/ groups/ categories in the data based on evidence
- 🌐 No pre-labeled data → detection of facts from raw data
- 🌐 Performance measured as how good / meaningful the groups / patterns are
- 🌐 Example applications
  - Customer segmentation
  - User behavior categorization
  - Grouping of items by similarity

# Reinforcement Learning

- 🌐 The machine learns through trial-and-error interactions
- 🌐 The goal is to maximize the amount of reward received from the environment
- 🌐 Iterative process
  - Trained through interactions with the environment
  - Rewards assigned upon success
  - Performance measured as amount of rewards collected
- 🌐 Example applications
  - Robot learning
  - Games

## Summary and Comparison

- 🌐 **Supervised:** labelled data, known outputs
- 🌐 **Unsupervised:** no labels, finds hidden patterns
- 🌐 **Reinforcement:** learns via rewards and penalties

