

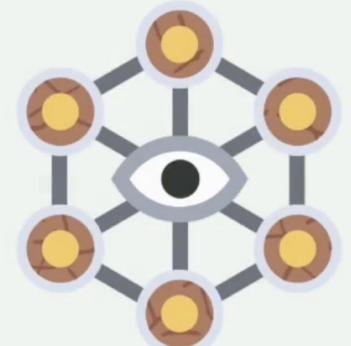
Introduction to AI and Machine Learning

Generative AI and Prompt Engineering

Ram N Sangwan

What is Artificial Intelligence?

Ability of machines to mimic the cognitive abilities and problem-solving capabilities of human intelligence.



Human Intelligence

Learn new skills through observation

Thinks abstractly and reasons

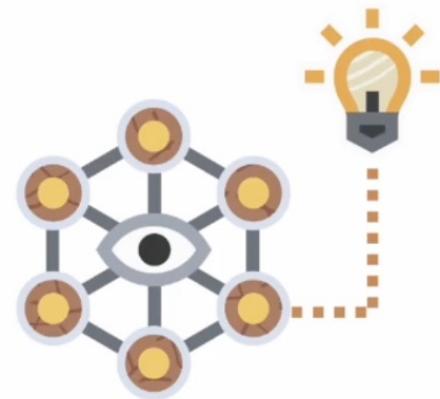
Communicates using a language and non-verbal cues

Handles complex situations in real time

Plans short and long term

Creates art, music and inventions

If you can replicate any of these capabilities in machines, that is **Artificial General Intelligence (AGI)**



When we apply AGI to solve problems with specific, narrow objectives, we call it **Artificial Intelligence (AI)**

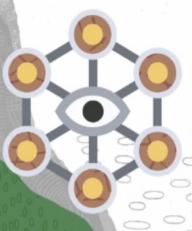
AI Use Cases

Automation and Decision Making

- Approve a credit card or loan.
- Process insurance claims.
- Recommend products to customers.
- Detect fraudulent transactions.
- Classify documents and images.

Creative Support

- Create content.
- Write stories and poems.
- Provide designs.
- Share code.
- Generate ideas.



Language-Related AI Tasks

Text-Related AI Tasks

Detect Language.

Extract entities from a text.

Extract key phrases.

Understand sentiment of a text.

Classify text based on content

Translate text.



Generative AI Tasks

Create story, poem, etc.

Summarize text.

Answer questions.

Generate image captions.

Complete text

Convert text to speech.

Data Representation – as Vectors

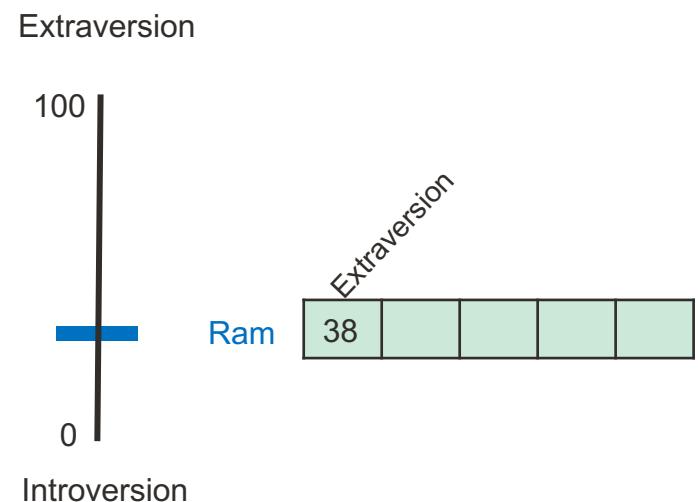
Why ...?

Vectors

- On a scale of 0 to 100, how introverted/extraverted are you?
- Have you ever taken a personality test like Big Five Personality Traits ?

These tests ask you a list of questions, then score you on a number of axes, introversion/extraversion being one of them.

Openness to experience	79 out of 100
Agreeableness	75 out of 100
Conscientiousness	42 out of 100
Negative emotionality	50 out of 100
Extraversion	58 out of 100

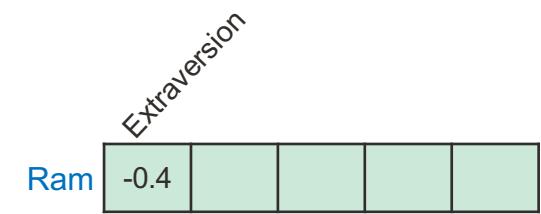
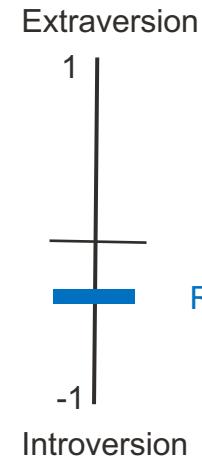


Vectors

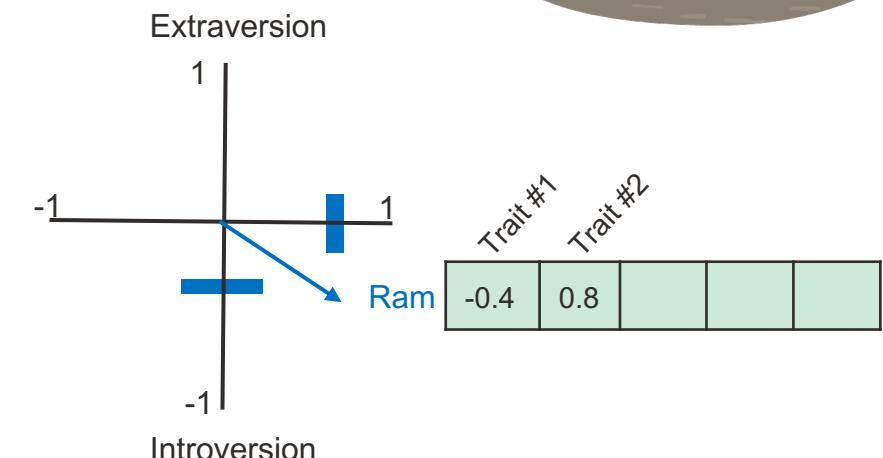
Let's switch the range to be from -1 to 1

- How well do you feel you know a person knowing only this one piece of information?
- Not much.

- We can represent the two dimensions as a vector from the origin to that point.
- I've hidden which traits we're plotting so that you get used to not knowing what each dimension represents
 - but still getting a lot of value from the vector representation of a person's personality.



Let's add another dimension – the score of another trait.



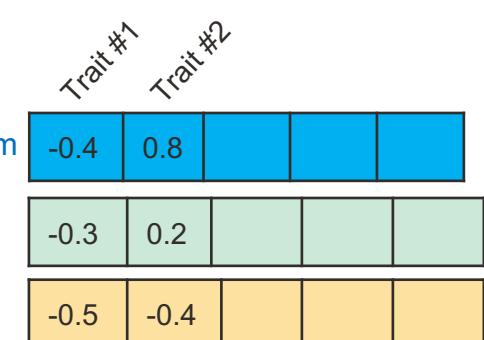
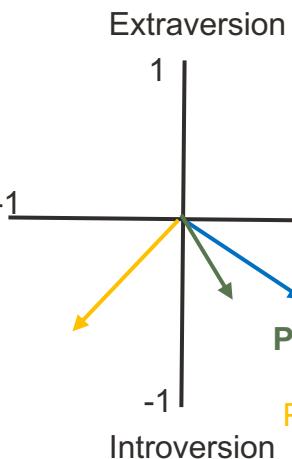
Vectors

- The usefulness of such representation comes when you want to compare me with others.

A common way to calculate a similarity score for vectors is cosine similarity

$$\text{cosine_similarity}(\begin{matrix} \text{Ram} \\ -0.4 \quad 0.8 \end{matrix}, \begin{matrix} \text{Person \#1} \\ -0.3 \quad 0.2 \end{matrix}) = 0.87 \checkmark$$

$$\text{cosine_similarity}(\begin{matrix} \text{Ram} \\ -0.4 \quad 0.8 \end{matrix}, \begin{matrix} \text{Person \#2} \\ -0.5 \quad -0.4 \end{matrix}) = -0.20$$



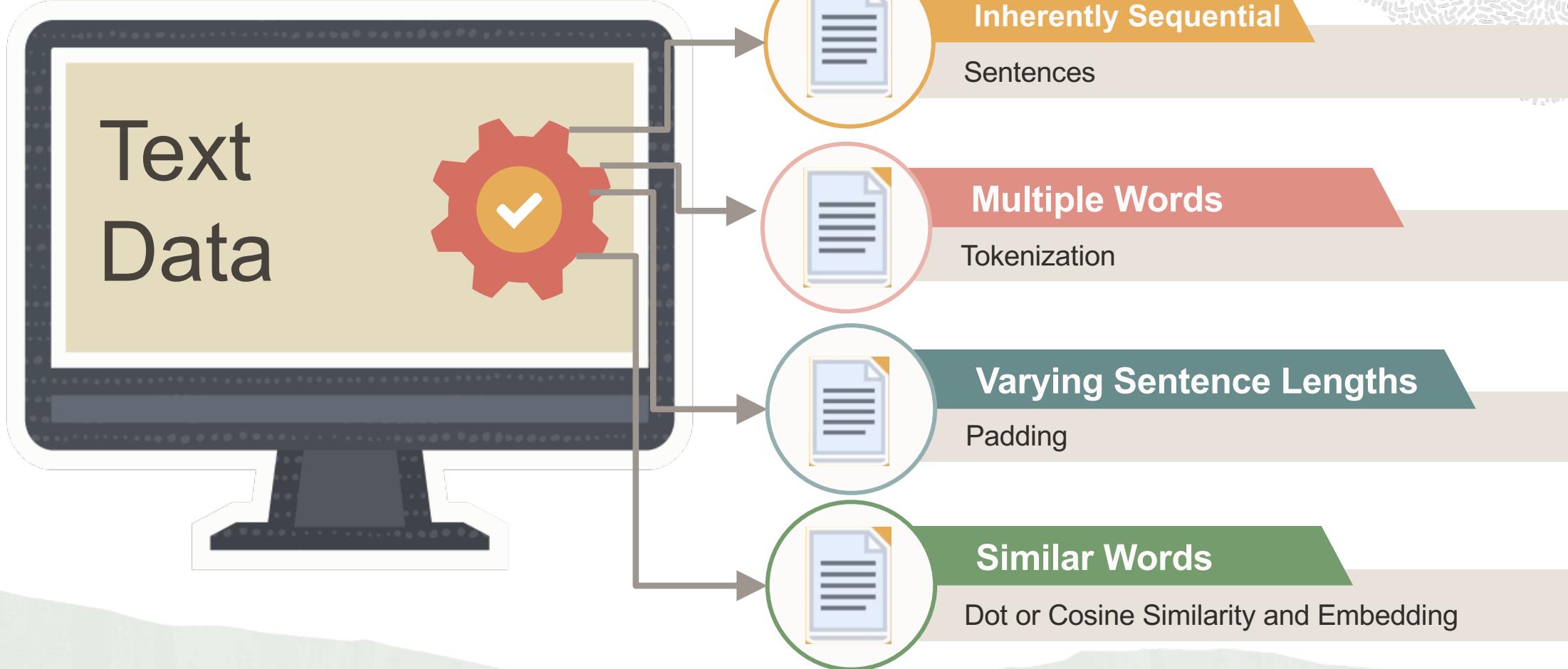
- Person #1 is more like me.
- Vectors pointing at the same direction (length plays a role as well) have a higher cosine similarity score.

Now we have two central ideas:

- We can represent people (and things) as vectors of numbers (which is great for machines!).
- We can easily calculate how similar vectors are to each other.

Say I am looking for someone with a similar personality.
Which of the two people is more like me?

Text as Data



Given two n -dimensional vectors of attributes, A and B , the cosine similarity, $\cos(\theta)$, is represented using a **dot product** and **magnitude** as

$$\text{cosine similarity} = S_C(A, B) := \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \cdot \sqrt{\sum_{i=1}^n B_i^2}},$$

Speech-Related AI Tasks

Speech-Related AI Tasks

Turn speech into text.

Recognize speaker.

Perform voice conversion.

Recognize speech emotions

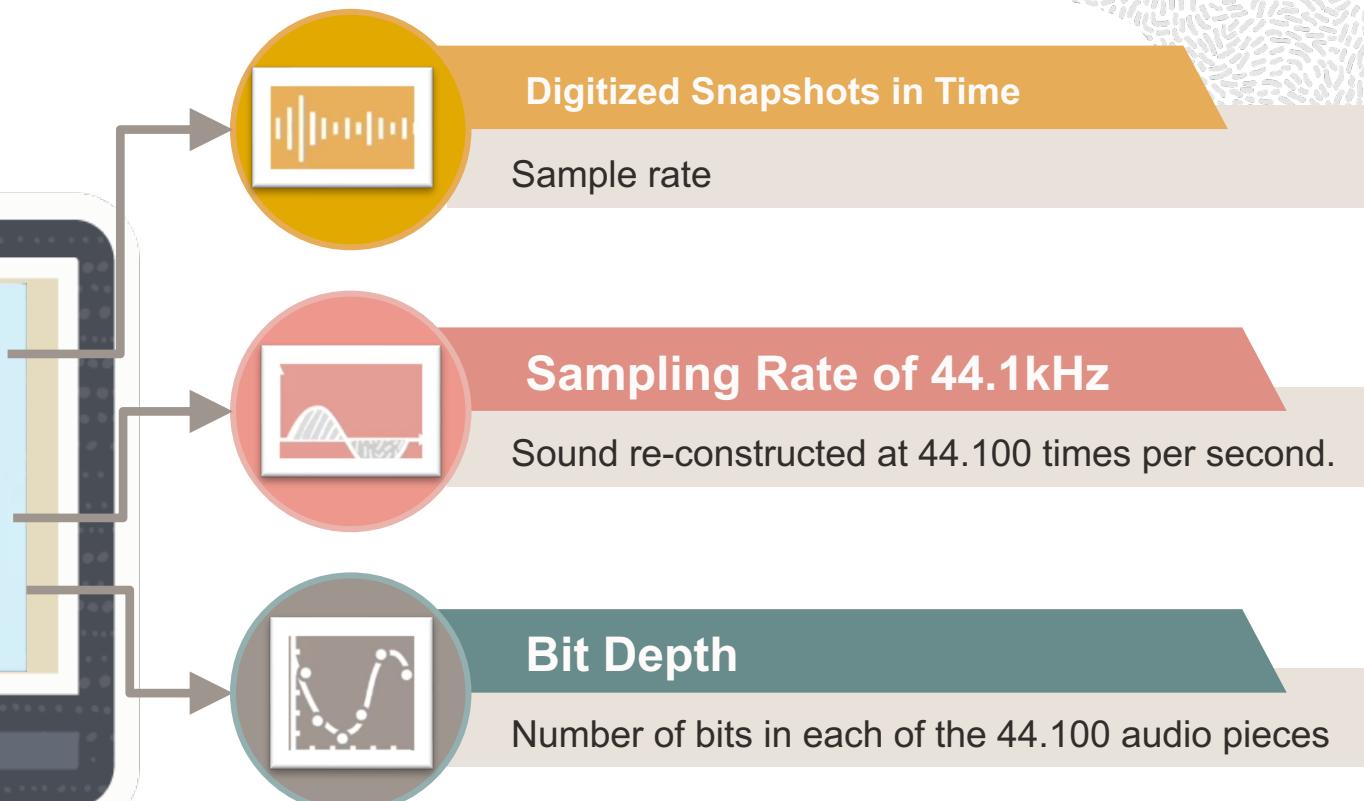


Generative AI Tasks

Music Composition

Speech synthesis

Audio Speech as Data



Not much can be inferred by looking at one audio sample. For example, listening a song for a fraction of second.

Vision Related AI Tasks

Image-Related AI Tasks

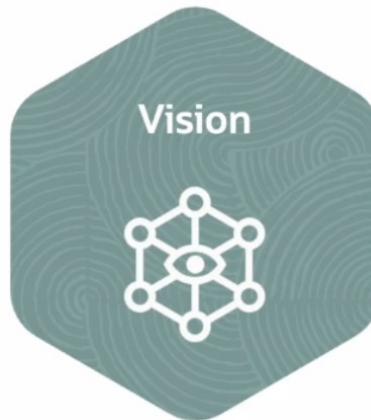
Classify images.

Identify objects in an image

Identify boundaries in an image

Extract text from an image

Count objects in an image



Generative AI Tasks

Create image from text.

Generate images of specific style.

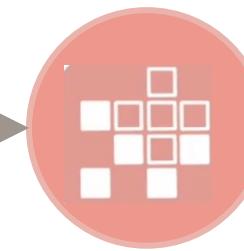
Generate high-resolution images.

Repair damaged images.

Perform image to image translation.

Get 3D views from 2D sketches.

Images as Data



Images consists of pixels.



Pixels are grey scale or color

We can not make out what an image is by looking at pixel

Other AI Tasks

Anomaly Detection

- Detects anomalies in time series data
- Example: Fraud detection

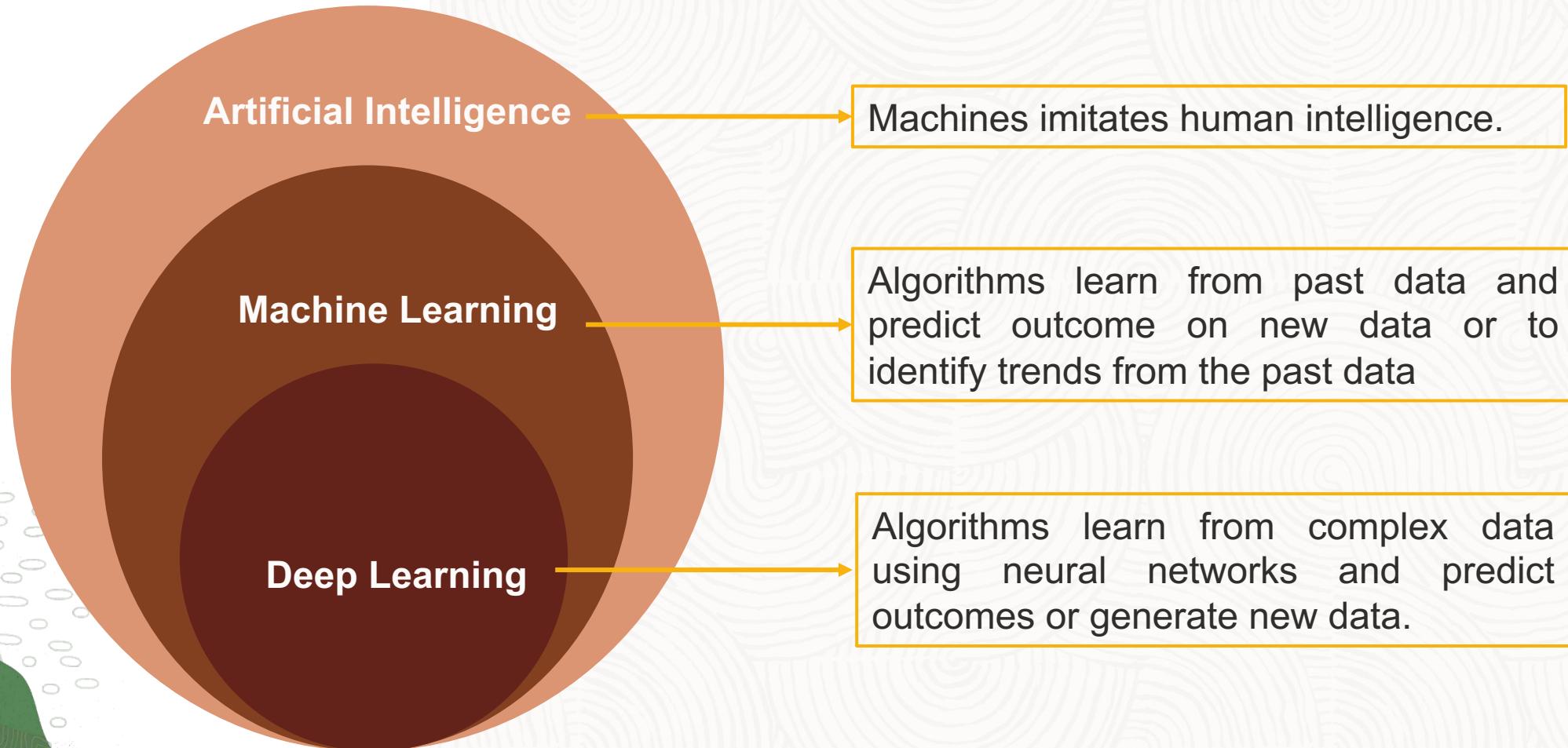
Recommendations

- Recommends products using data of similar products or users
- Example: Ecommerce websites

Forecasting

- Forecasts a future event or value using past data
- Examples: Weather forecast, stock prices

Relationship Between AI, ML and DL



What is Machine Learning?

- A subset of artificial intelligence that focuses on creating computer system that can learn and improve from experience.
- Powered by algorithms that incorporate intelligence into machines.



Machine Learning is All around Us



Online shopping



Netflix movie suggestions



ML provides statistical tools to analyze, visualize, and make predictions from data.

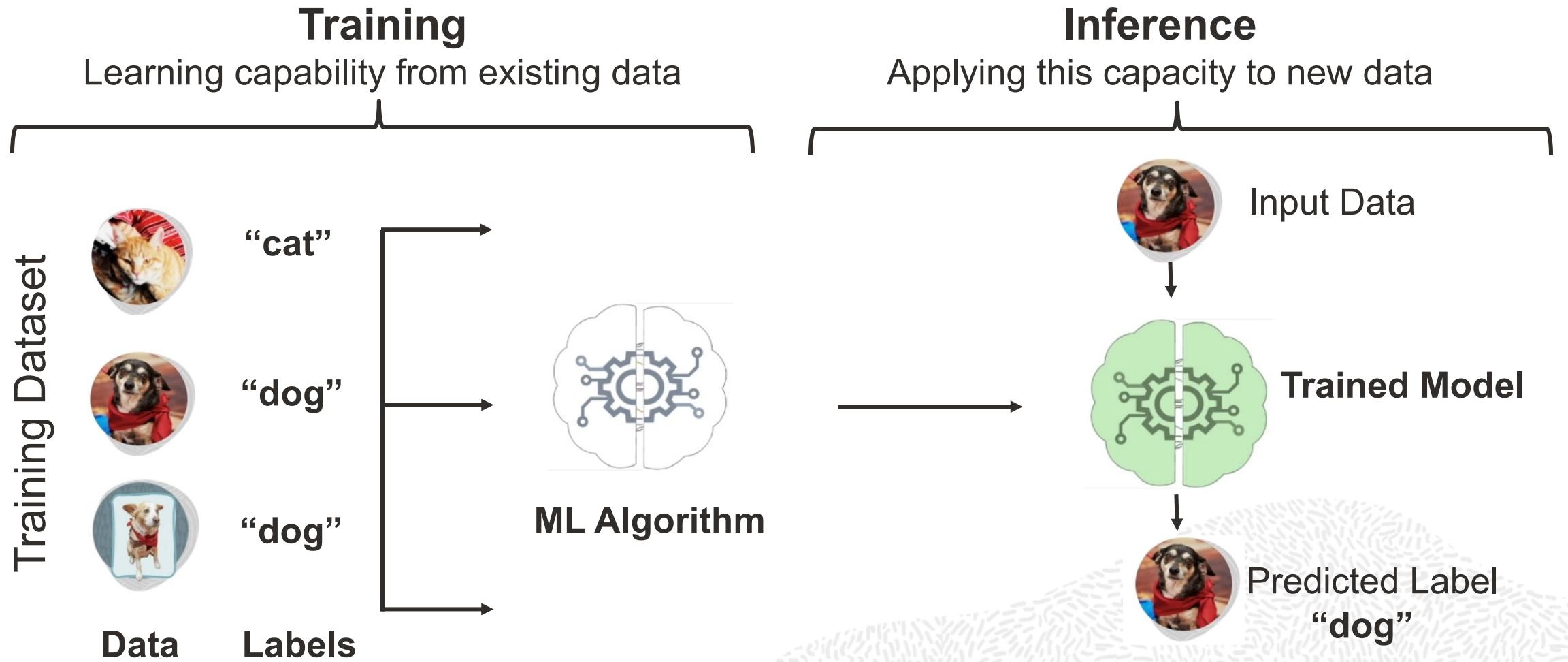


Spam mail warning



Self-driving cars





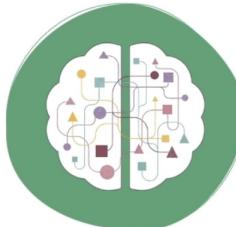
Machine Learning and its Use Cases



Supervised

Classify data or make predictions

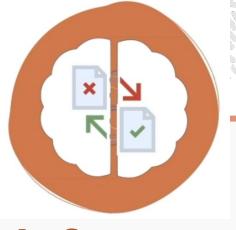
- Disease detection
- Weather forecasting
- Stock price prediction
- Spam detection
- Credit scoring



Unsupervised

Understand relationships with datasets

- Fraudulent transactions detection
- Customer segmentation
- Outlier detection
- Targeted marketing campaigns



Reinforcement

Make decisions or choices

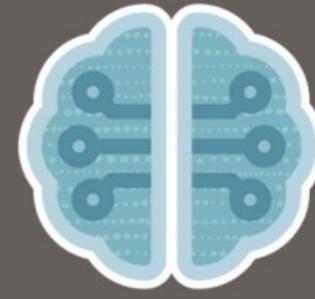
- Automated robots
- Autonomous cars
- Video games
- Healthcare

Supervised Learning

House
price
prediction



Machine learning
model that learns
from labeled data



Sentiment
analysis



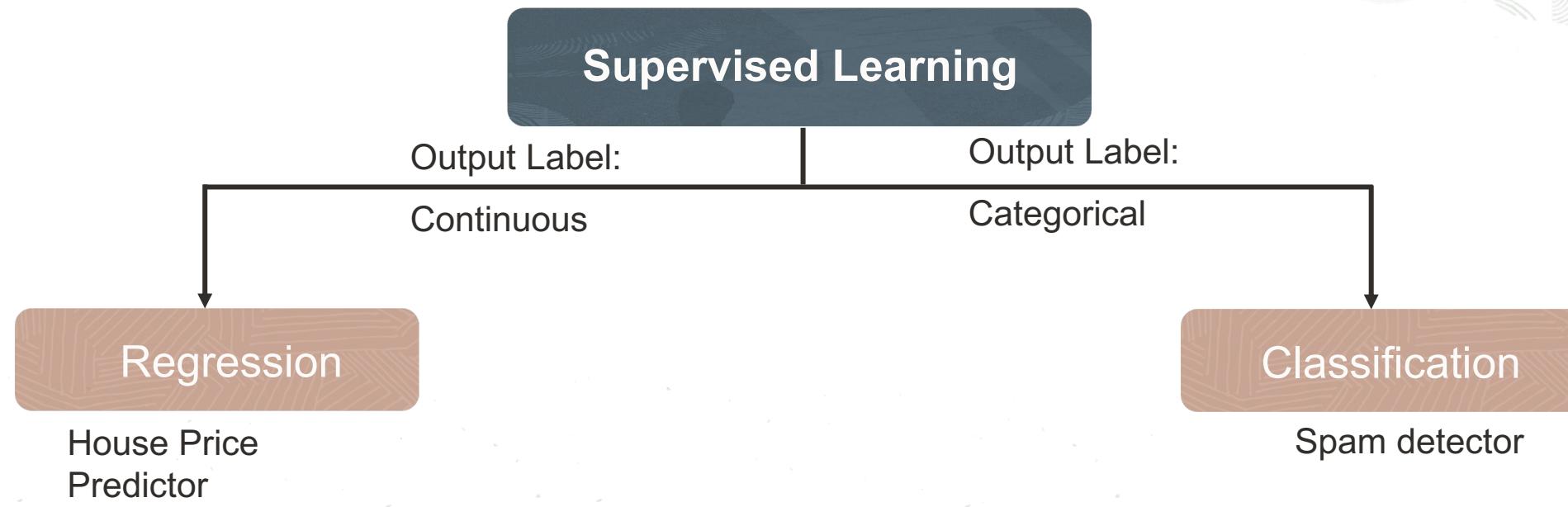
Disease
detection



Stock price
prediction

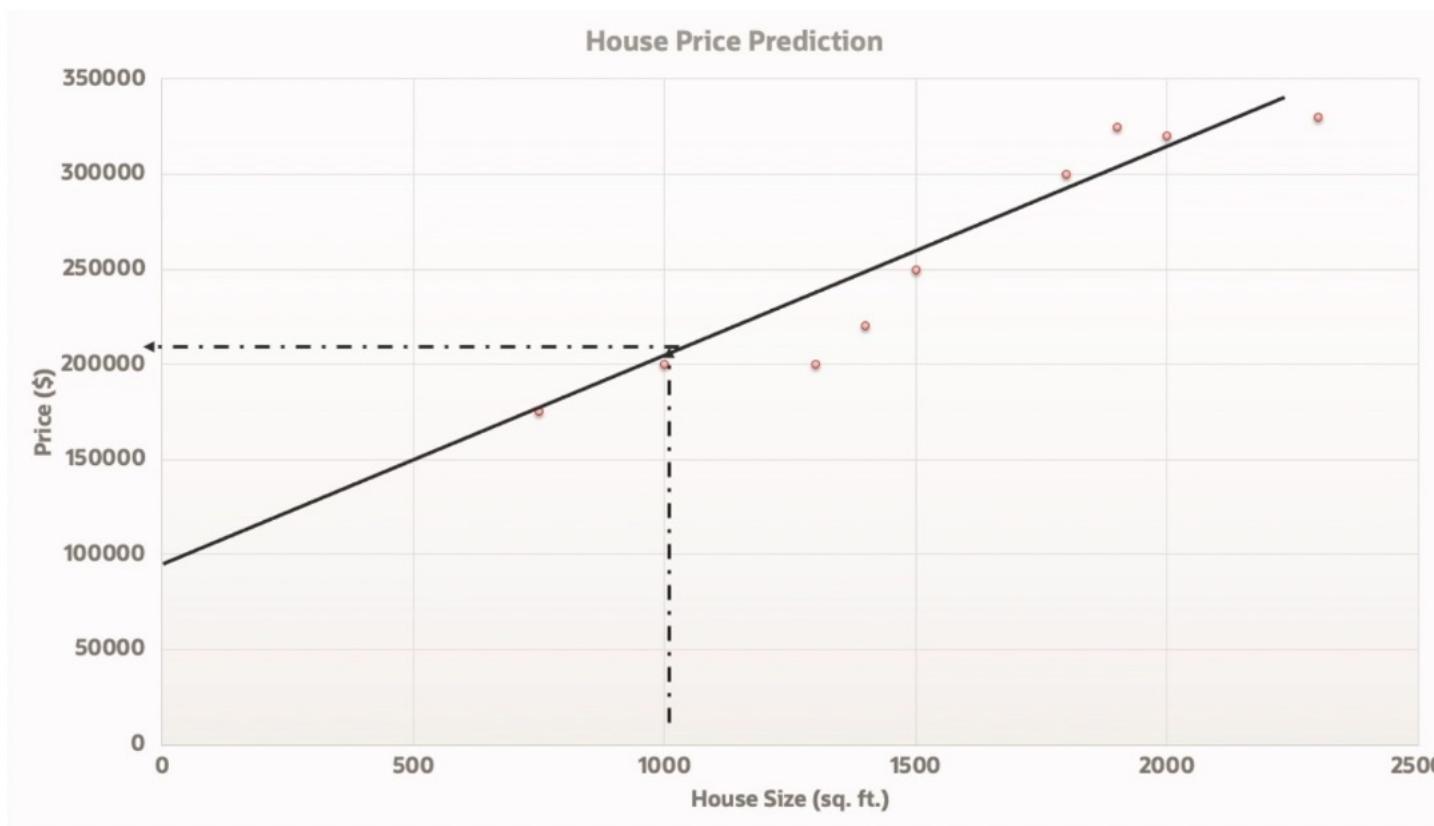


Types of Supervised Learning



Predicting House Price Based on House Size

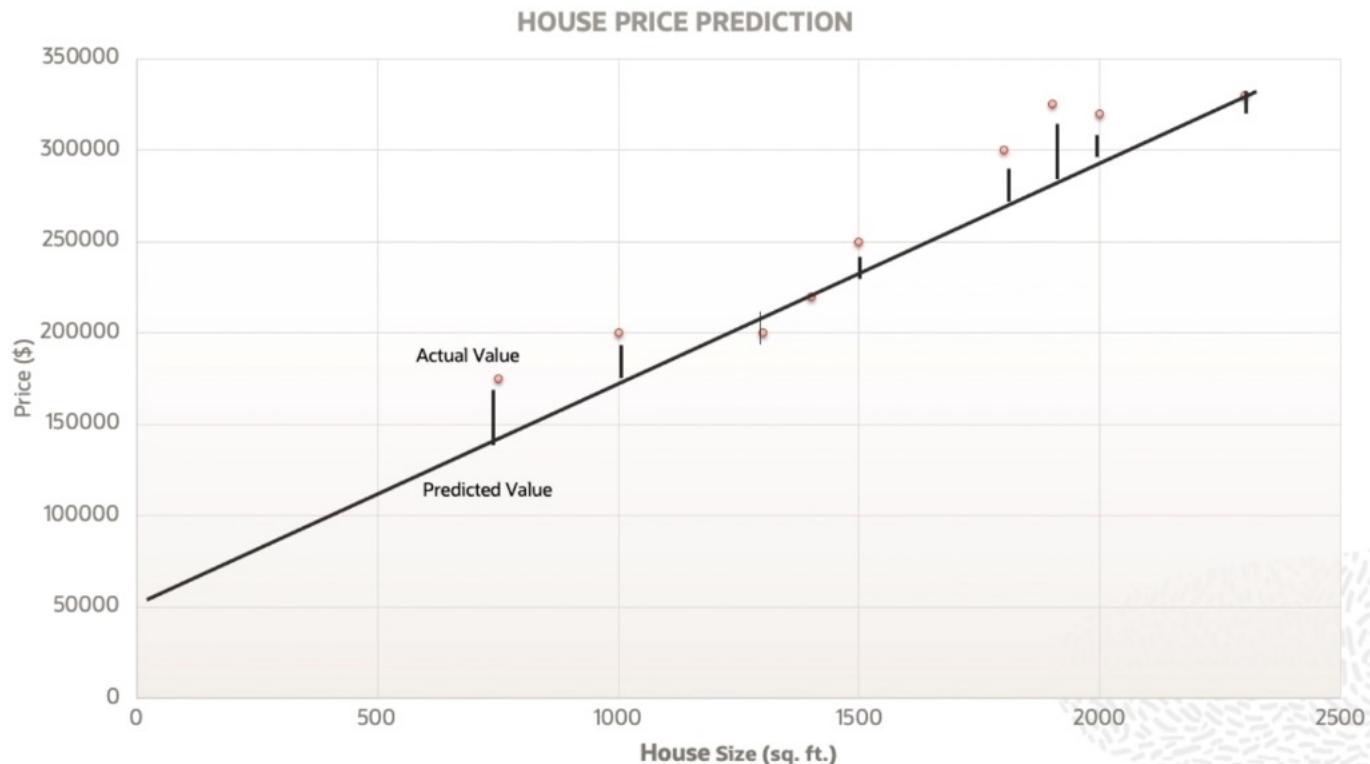
Scatter plots aid in visualizing the relationship between inputs and outputs.



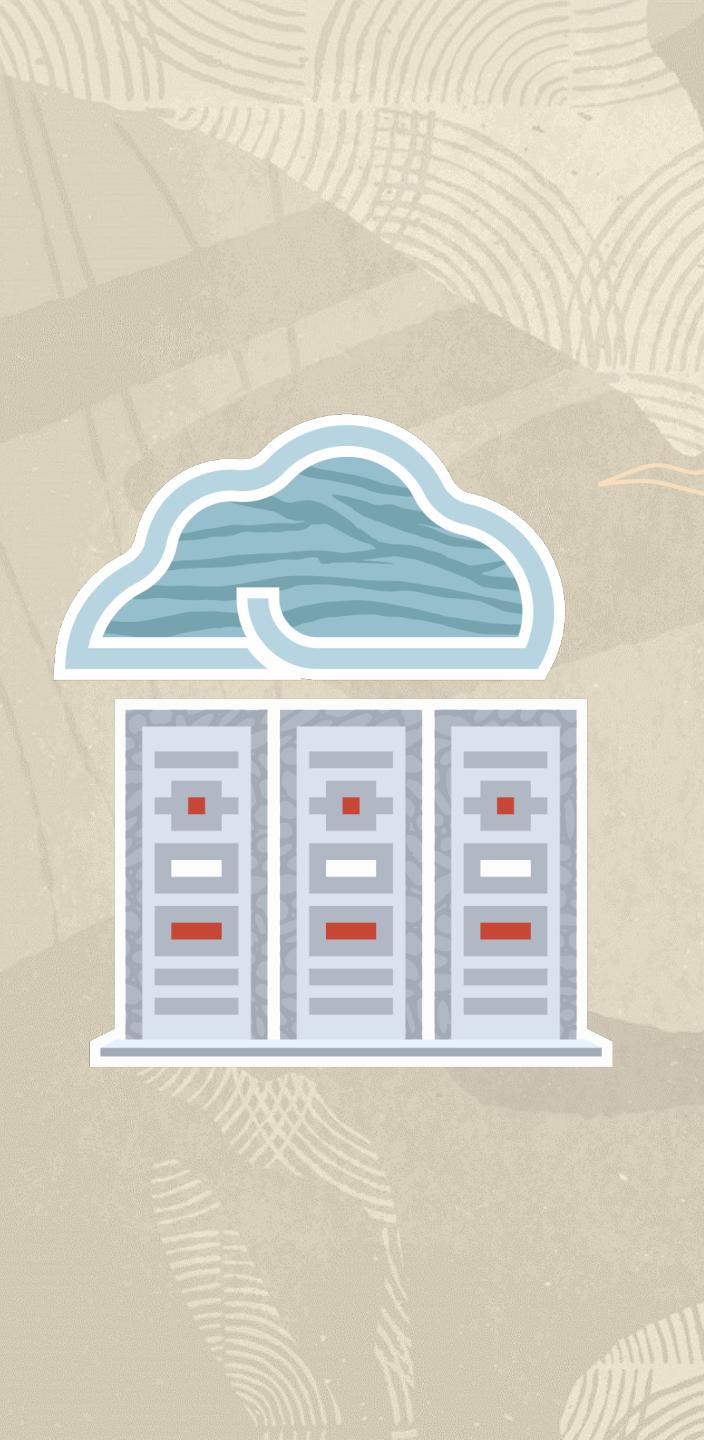
House Size (sq. ft.)	Price (\$)
1,400	220,000
1,800	300,000
2,000	320,000
1,300	200,000
1,900	325,000
2,300	330,000
1,500	250,000

Minimizing the Loss

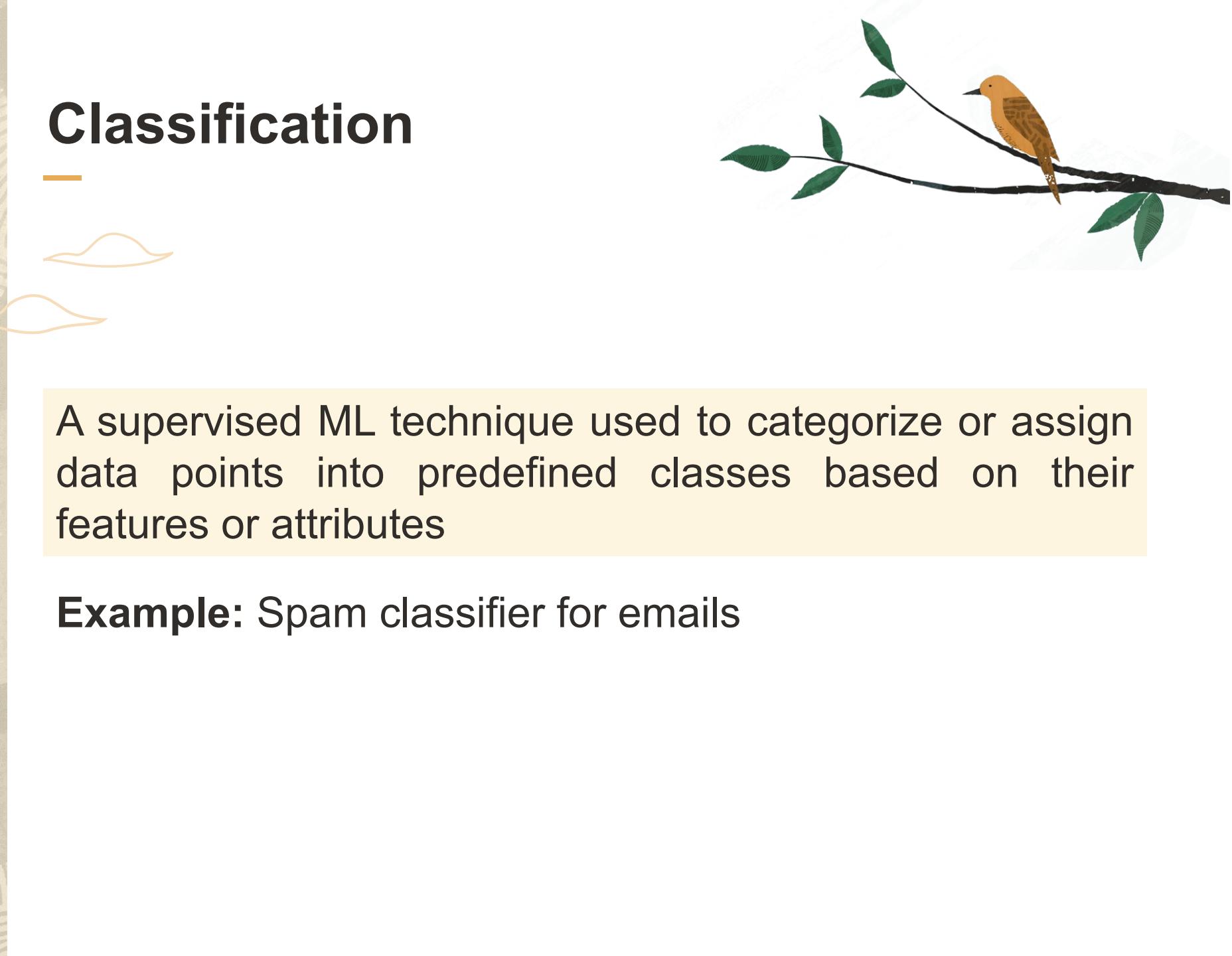
Loss is a number indicating how far the predicted value is from the actual value.



Squared error is the squared difference between the predicted point and the actual data point, which needs to be minimized during training.



Classification

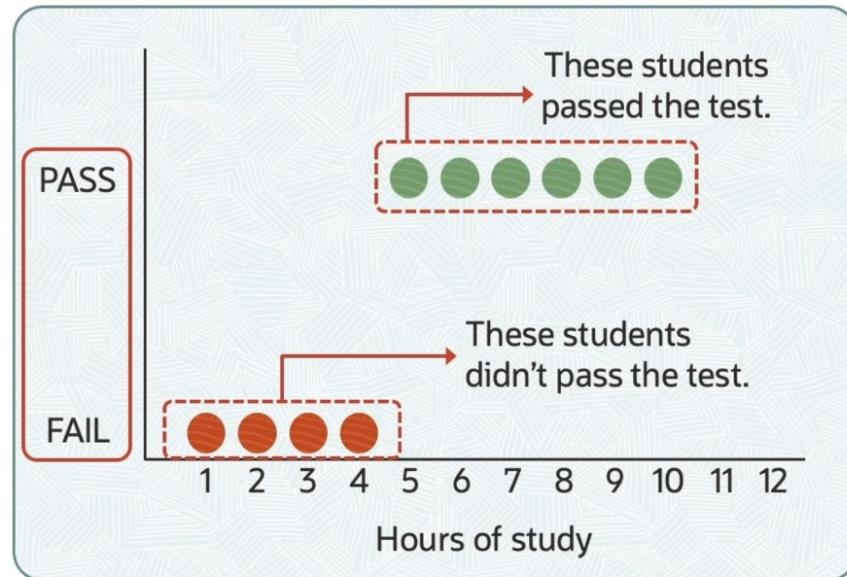


A supervised ML technique used to categorize or assign data points into predefined classes based on their features or attributes

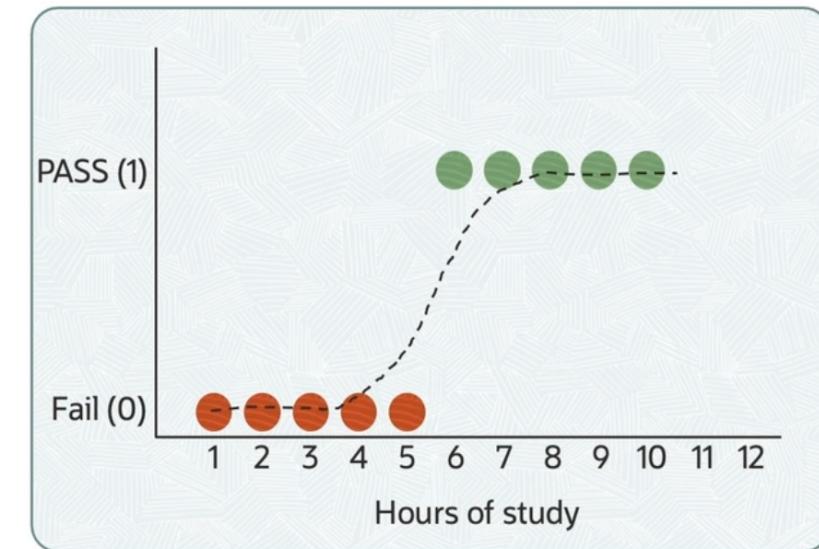
Example: Spam classifier for emails

Logistic Regression

Logistic Regression helps in predicting something is **True** or **False** instead of predicting something continuous such as the house prices

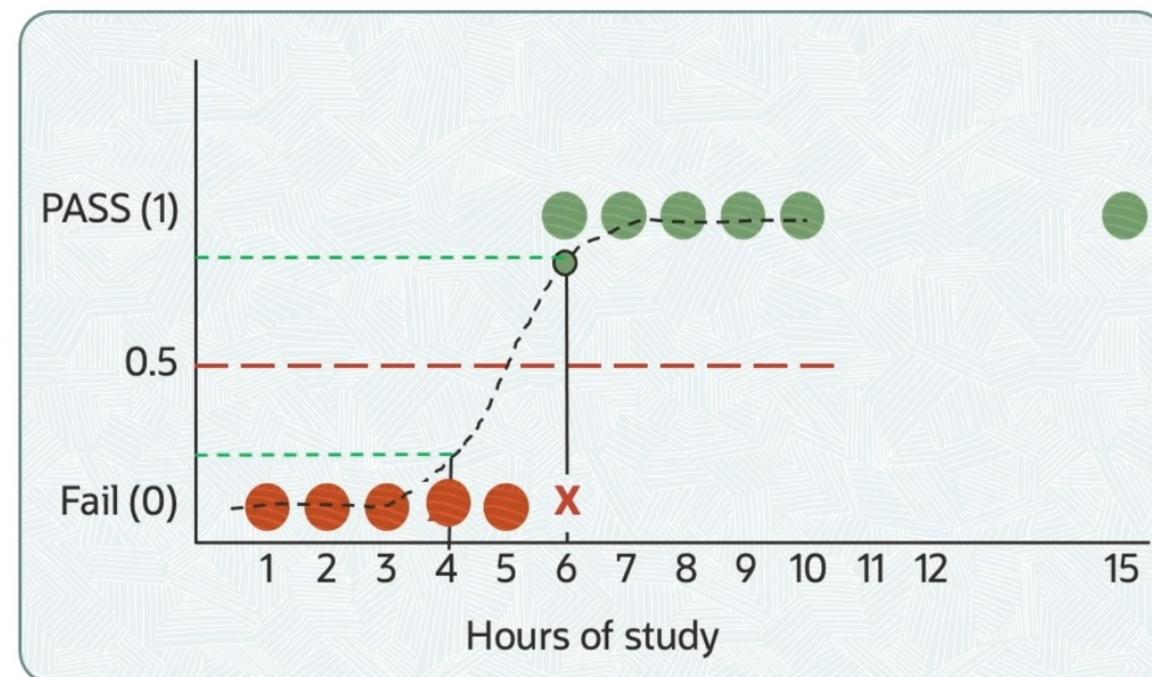


Instead of fitting a straight line to the data, Logistic Regression fits an S-shaped curve to the data



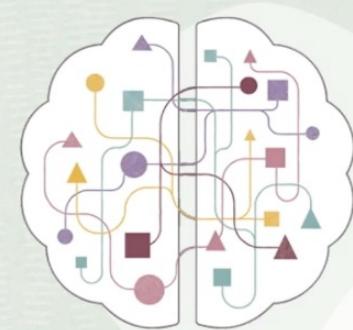
Logistic Regression

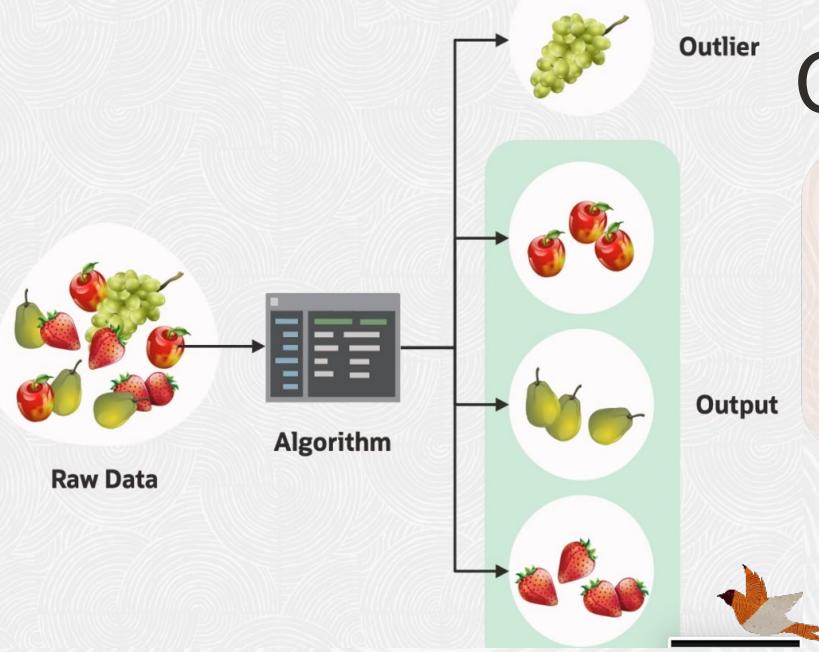
- A model build using Logistic Regression can be used for classification.



Unsupervised Learning

- A type of Machine Learning where there are no labeled outputs
- Algorithms learns the patterns in the data and group similar data items





Clustering

- Clustering is the grouping of similar data items
- Data items are more similar within a cluster than the items outside it.

Similarity



- Similarity is how close two data points are to each other and is a value between 0 and 1

Use Cases

Market Segmentation

Action:

- Input purchasing details
- Identify similar customers based on purchasing behavior.

Output:

- Target advertisements

Outlier Analysis

Action:

- Inputs credit card purchase details
- Identify fraudulent transactions.

Output:

- Anomaly detection

Recommendation Systems

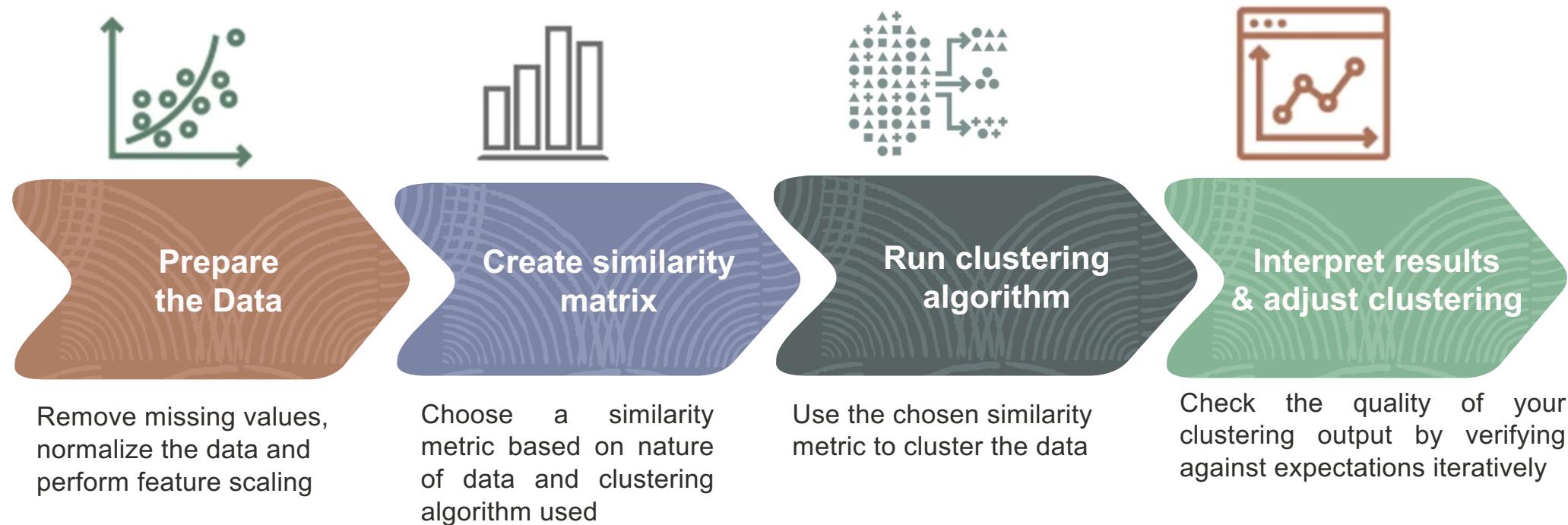
Action:

- Inputs are user's movie viewing history
- Identify Users based on genre of movies watched

Output:

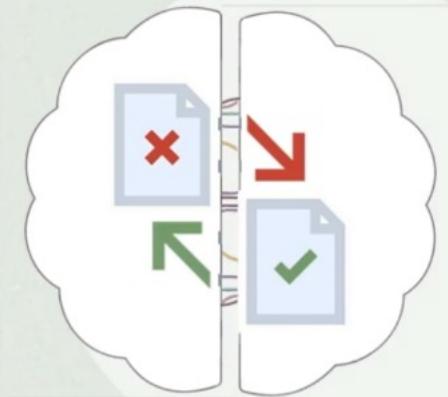
- Personalized movie recommendations

Unsupervised Workflow



Reinforcement Learning

- A Type of Machine Learning that enables an agent to learn from its interactions with the environment.
- Receives feedback in the form of rewards or penalties, without any labeled dataset.



Reinforcement Learning Examples

Autonomous
vehicles



Smart
devices



Industrial
automation



Gaming and
entertainment



Terminology in RL

Agent

Interacts with environment, takes actions, learns from feedback

Environment

External system with which the agent interacts

State

Representation of the current situation of the environment at a particular time

Action

Possible moves or decisions that the agent can take in each state

Policy

Mapping that the agent uses to decide which action to take in a given state

Train a Robotic Arm Using RL

Step 1



Environmental Setup

Set the robotic arm, warehouse layout, goods, and target locations.

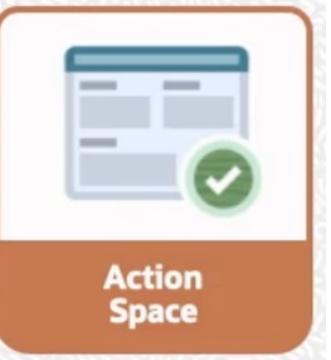
Step 2



State Representation

State includes position and orientation of arm, items to be picked, and target locations.

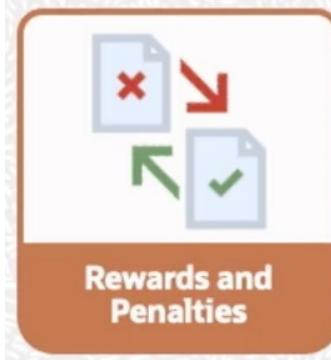
Step 3



Action Space

Define the possible actions the robotic arm can take in each state

Step 4



Rewards and Penalties

It learns by rewards and punishments.

Step 5



Training and Iterative Improvement

It starts in a random state and takes actions in the environment.

Through multiple training iterations, the robotic arm learns better strategies for picking up and placing items in the warehouse



A stylized illustration of a rocky cliff face. On the right side, three small figures (two adults and one child) are standing on a ledge. One figure is holding a purple flagpole with a small purple flag at the top. The cliff face is textured with various patterns, including a large green area with a complex, geometric line pattern.

Thank You