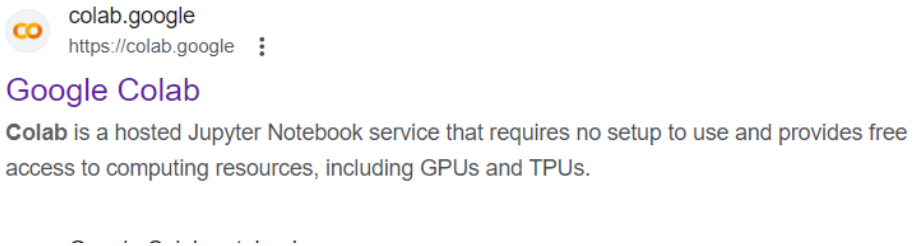
What We Expect

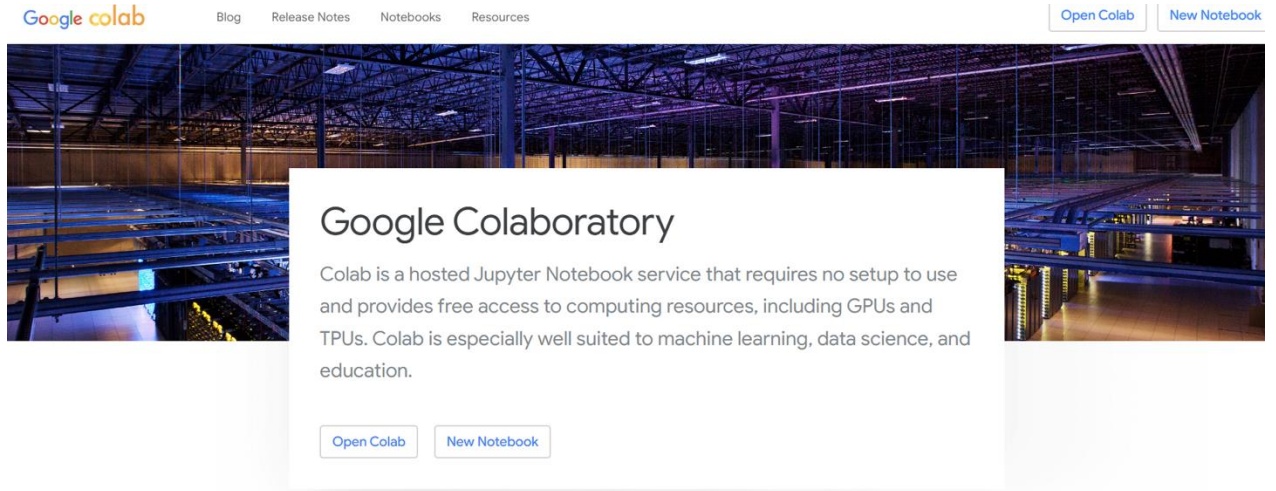
- To train neural networks at a variety of tasks;
- To select appropriate neural network architectures for a variety of tasks;
- To discuss the contents and contributions of important papers/projects in the field
- To have a basic theoretical and empirical understanding of the tools of deep learning

Introduction to Google Colab

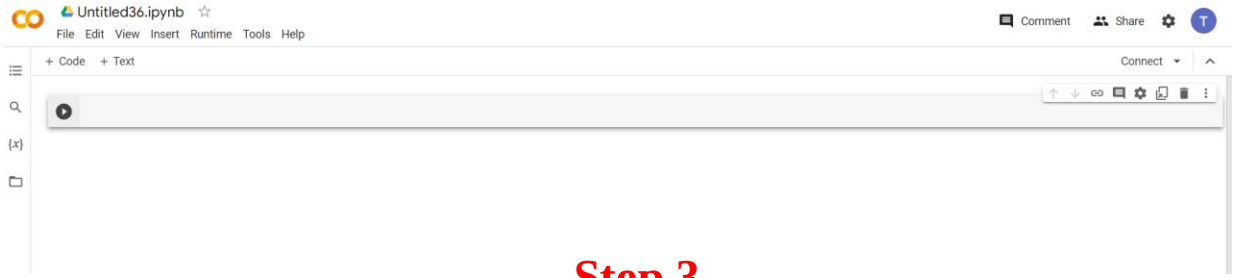
- Google Colab is a document that allows you to write, run, and share Python code within your browser. It is a version of the popular Jupyter Notebook within the Google suite of tools. Jupyter Notebooks (and therefore Google Colab) allow you to create a document containing executable code along with text, images, HTML, LaTeX, etc. which is then stored in your google drive and shareable to peers and colleagues for editing, commenting, and viewing.



Step 1



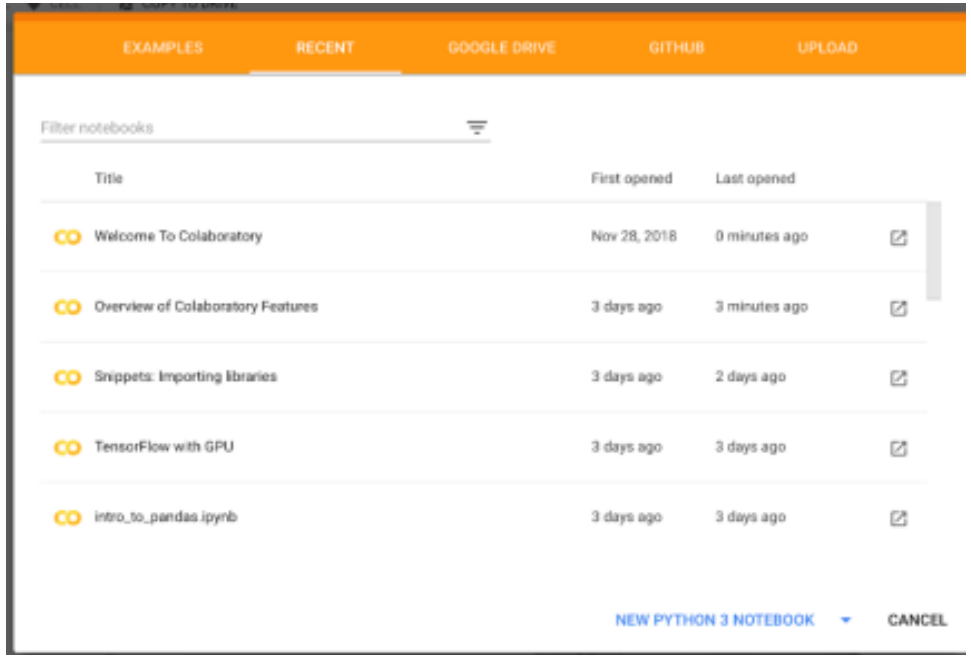
Step 2



Step 3

Google Colab

- *Starting a document:*
  - In order to create a new document, access Google Colab at colab.research.google.com. Once here, you can begin a new document, or "notebook" in one of two ways. Upon visiting the site, a box with your recently visited Colab documents will appear.
  - Select "New Notebook" to begin a new document. Alternatively, to create a new document from any screen, select "File" in the top left corner, then select "New Notebook" from the dropdown box.



- *Basic Functions*

After you have created a new notebook, you will see an empty code cell. Python code can be entered into these code cells and executed at any time by either clicking the Play button to the left of the code cell or by pressing:

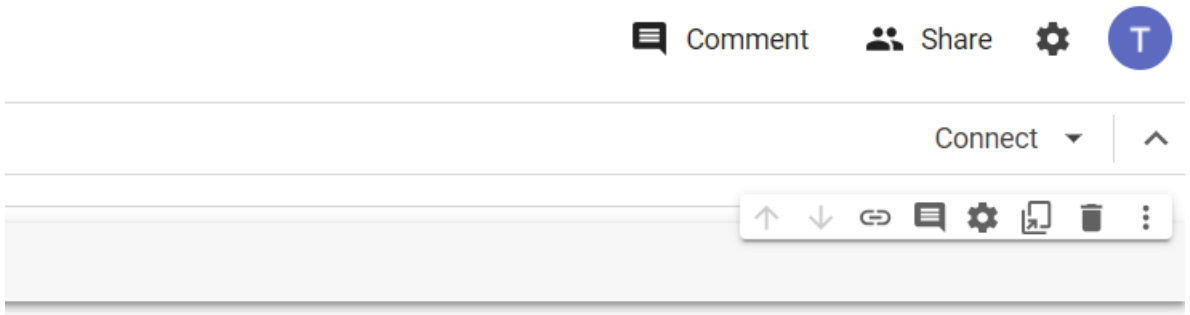
Ctrl+Enter On your keyboard.

At the top of your notebook, you will find two buttons: **+Code** and **+Text** Add a new code cell by clicking the "**+ Code**" button in the top left corner of the document.

Add a text cell by clicking the "**+ Text**" button in the top left corner of the document

- *Sharing a Colab notebook*

As with other Google Apps, Colab Notebooks can be shared. Look for the "share" button in the top right-hand corner of the window. Google Colab documents can also be shared in Google Drive, just you do with other types of documents.



[Please refer to the guide on Canvas for more details.]

Summary of Machine Learning!

Overview of Machine Learning: Learning Definition

- *Definition of Learning:*
  - Learning is any process by which a system improves performance from experience.

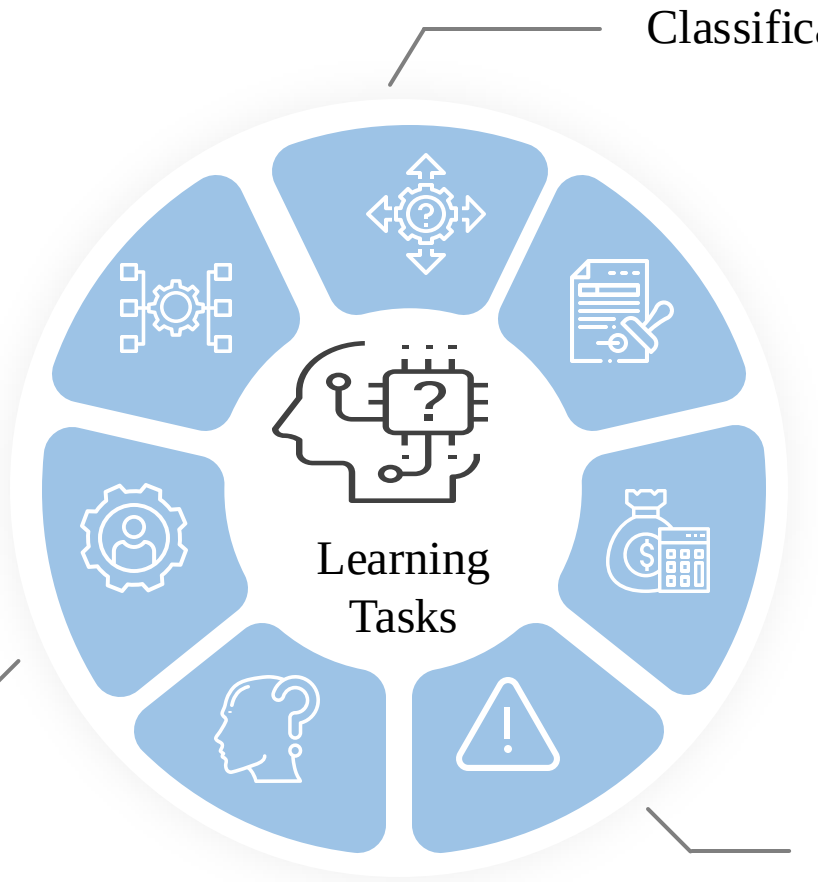
- *Importance of Learning:*

  - Learning is essential for unknown environments,
    i.e., when designer lacks omniscience.

  - Learning is useful as a system construction method,
    i.e., expose the agent to reality rather than trying to write it down.

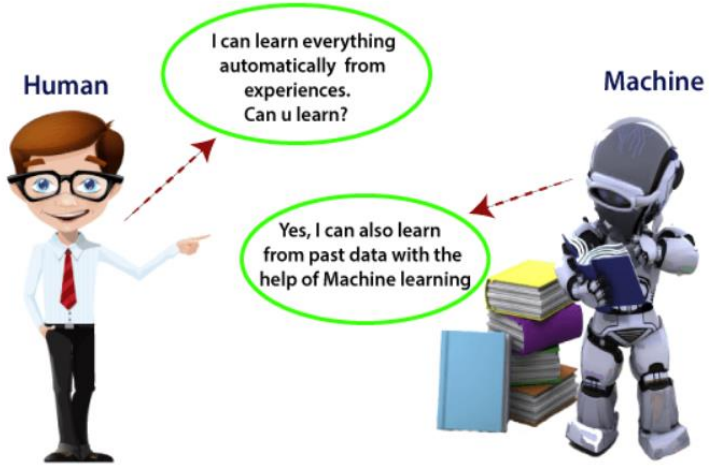
  - Learning modifies the agent's decision mechanisms to
    improve performance.

- *Learning Tasks:*



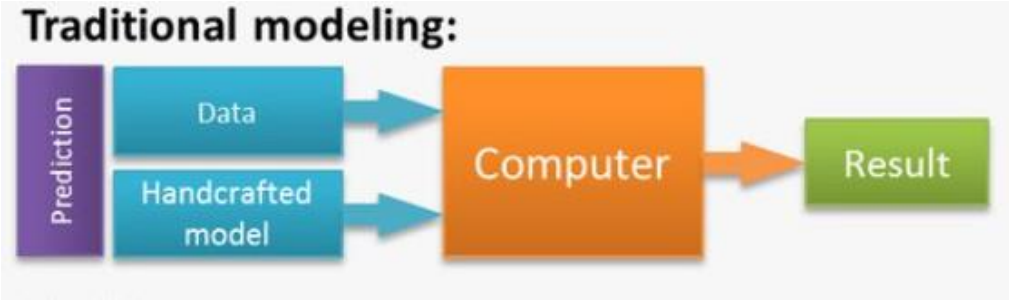
Overview of Machine Learning: Definition

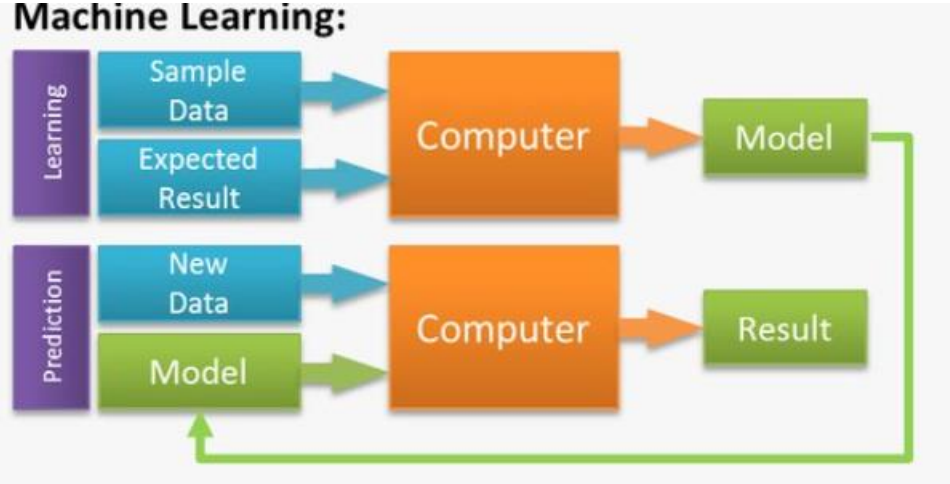
- *Definition :*
  - Changes in system that enable to do the same task or tasks drawn from the same population more efficiently and more effectively the next time.



- *Difference between Traditional Modeling vs Machine Learning*
- *Methods for a system to use Machine Learning:*

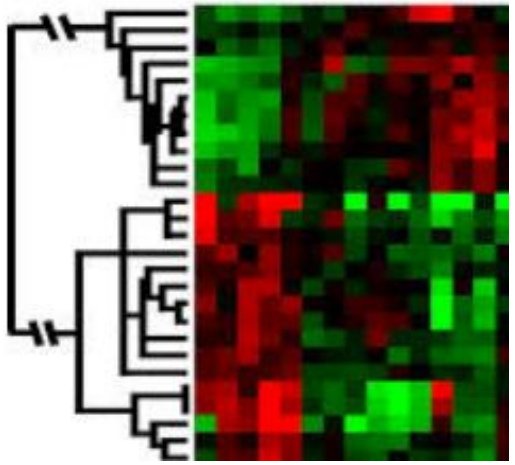
1. By acquiring new knowledge:
   - Acquiring new facts
   - Acquiring new skills
2. By adapting its behavior:
   - Solving problems more accurately
   - Solving problems more efficiently



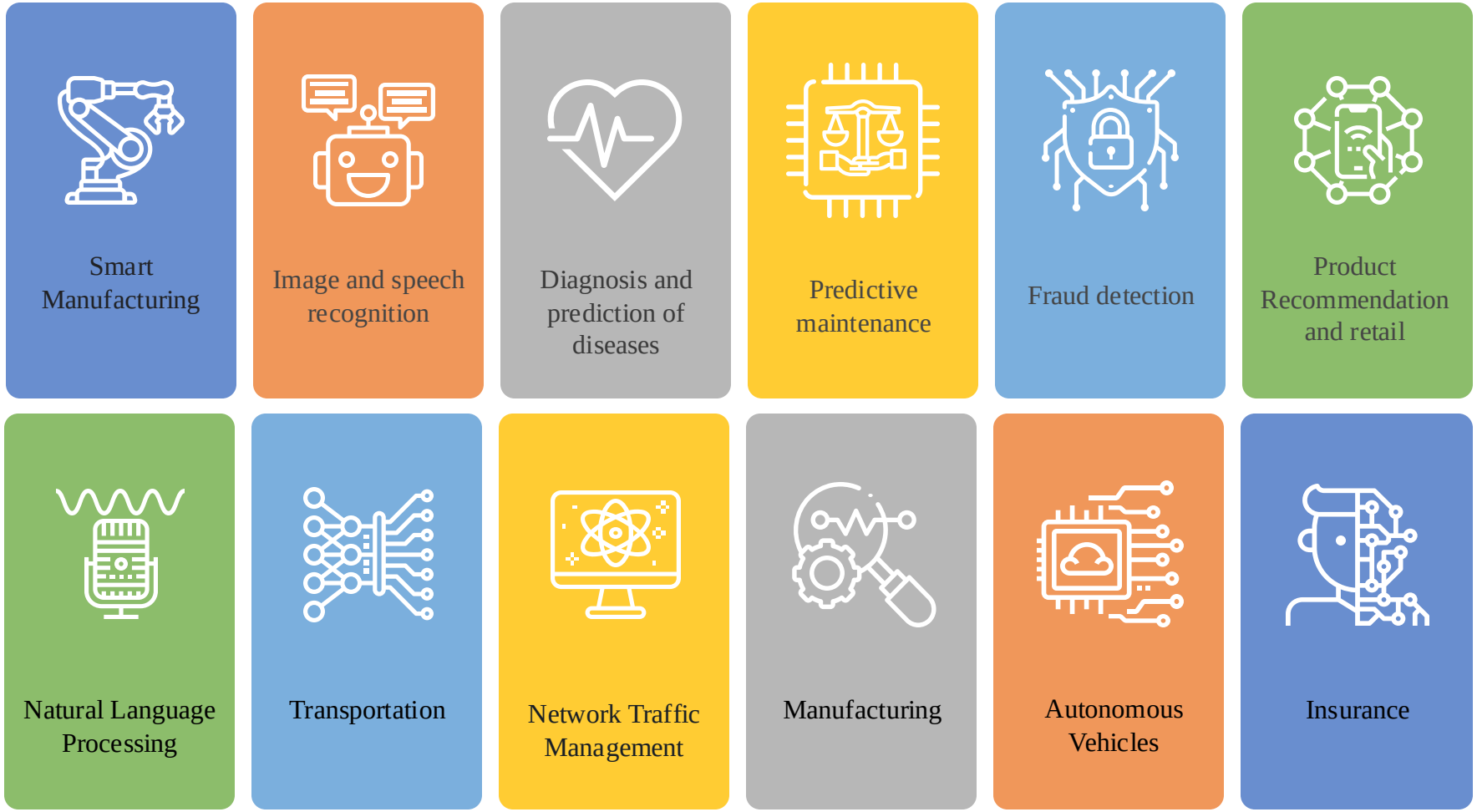


Overview of Machine Learning: Usage

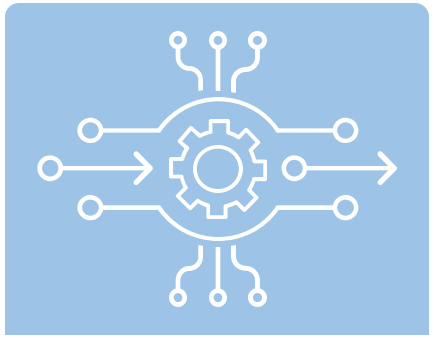
- Human expertise does not exist:
  - Navigating on Mars
- Humans can’t explain their expertise:
  - Speech recognition
- Models must be customized:
  - Personalized medicine
- Models are based on huge amounts of data:
  - Genomics



Overview of Machine Learning: Applications

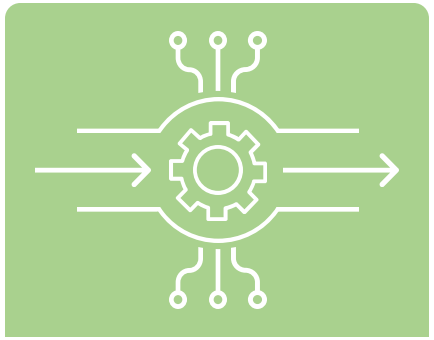


Overview of Machine Learning: Types



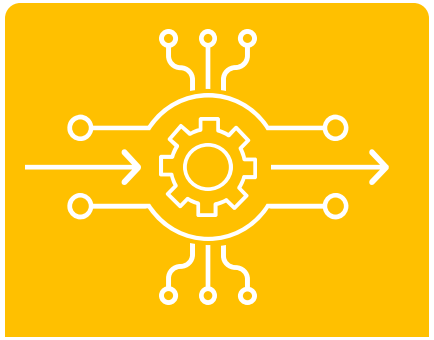
Supervised Machine Learning

- Deals with labeled datasets
- Two processes
  - **Classification**
  - **Regression**



Unsupervised Machine Learning

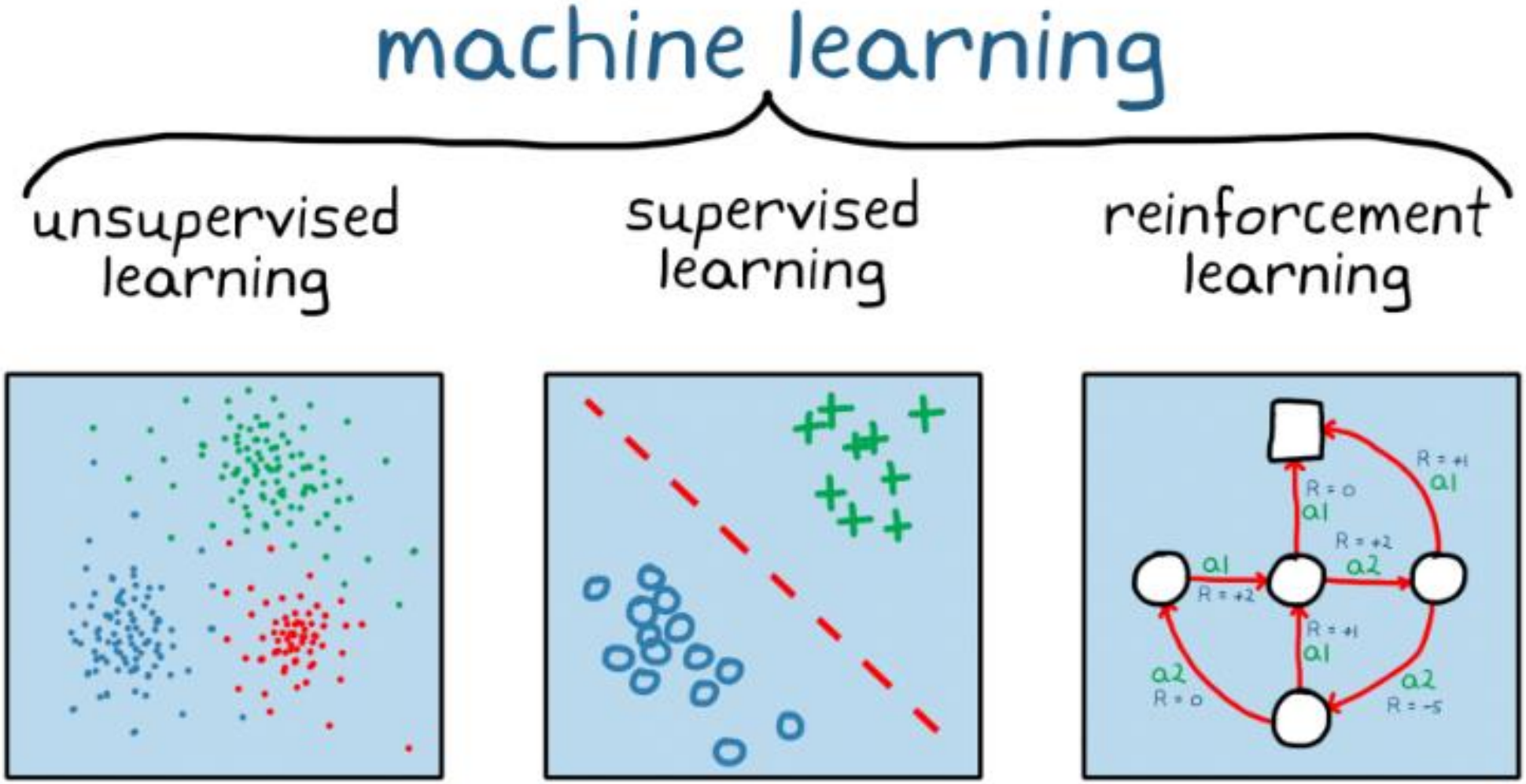
- It uses unlabeled data
- No idea which types of results are expected
- Two types
  - **Clustering**
  - **Association**



Reinforcement Machine Learning

- There are no training datasets
- An example of reinforcement learning problem is playing game

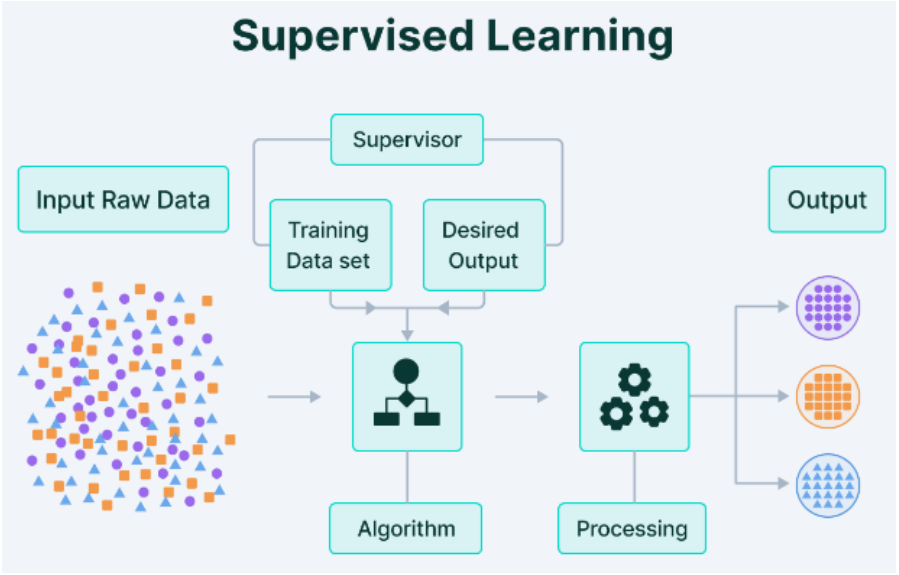
Overview of Machine Learning: Types

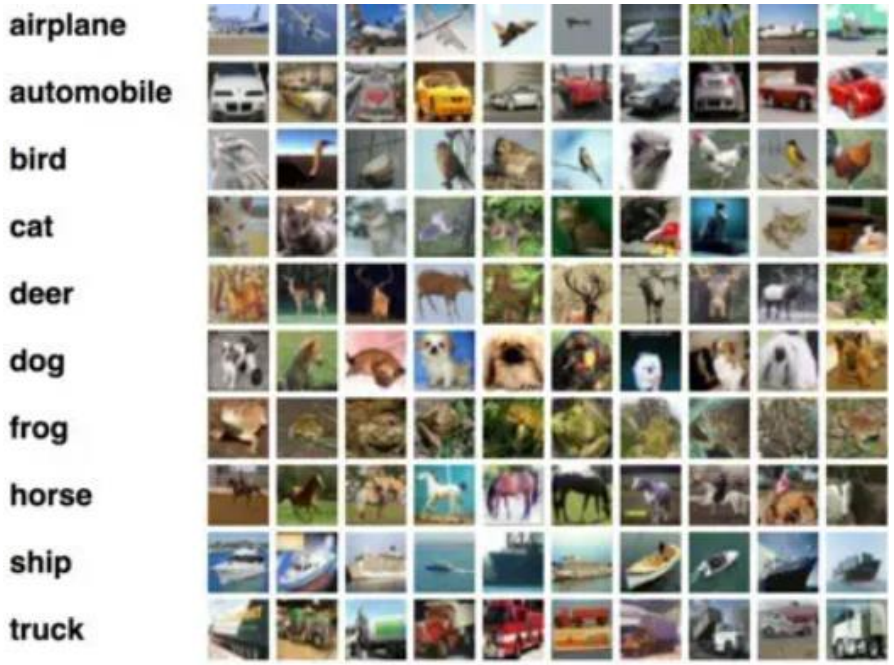


Supervised Learning: General Overview

- Supervised machine learning algorithms use labelled training datasets to predict an output.
- The algorithms are trained on a subset of the data and the predictions are compared against the actual test data for the evaluation of the models.

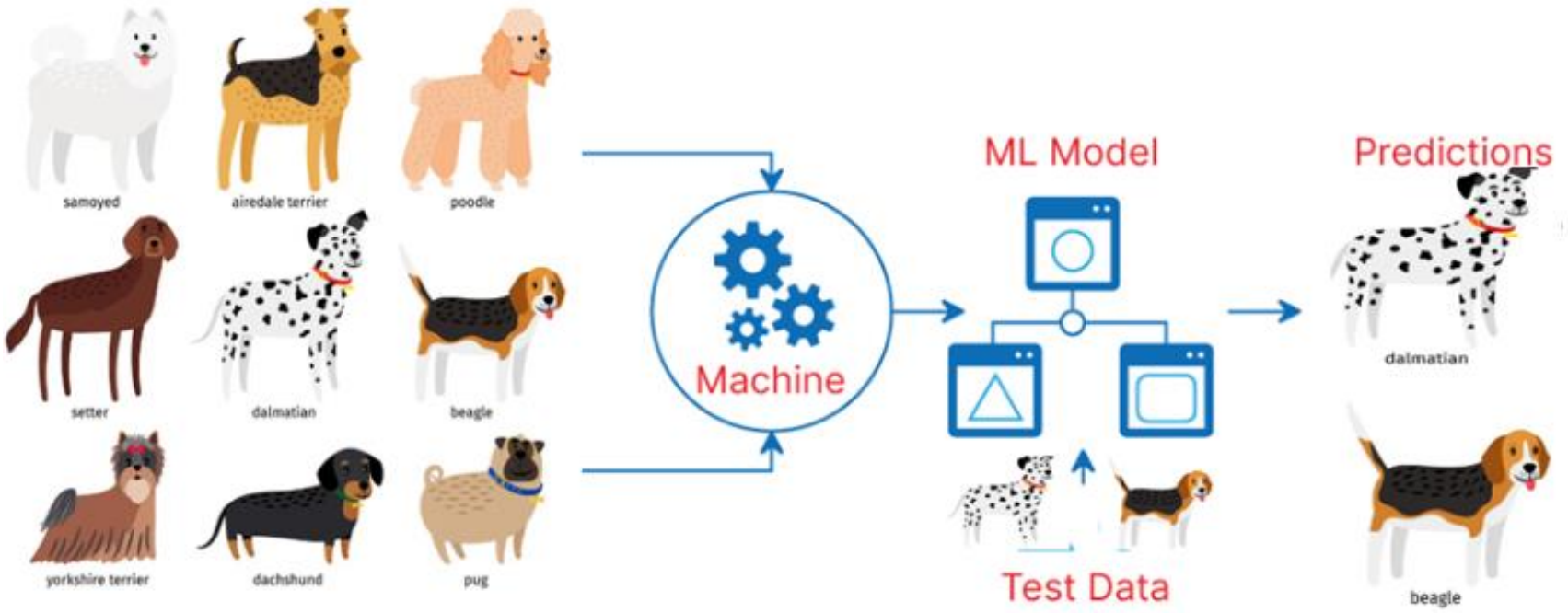
1. Use existing labelled dataset or add labels to existing data.
2. Split into training and test set.
3. Train the machine learning model on the training set.
4. Generate predictions from the training data.
5. Compare the prediction with the actual results from the test set.



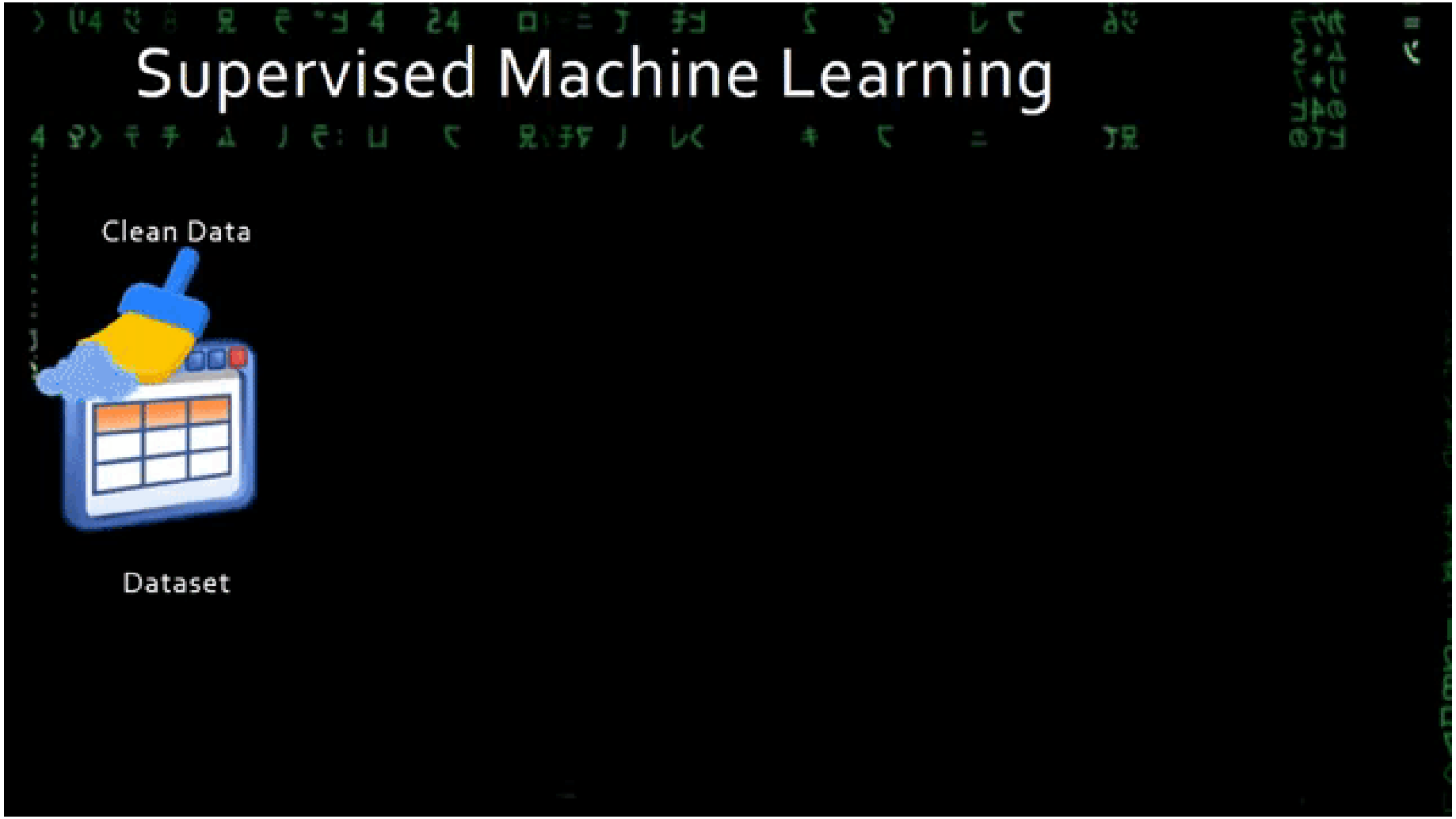


Supervised Learning: Example

- We are using a machine learning model to learn about different breeds of dogs. We have a list of dogs with their breed names, and we use this information to teach the model. The model tries to figure out which characteristics are typically associated with each breed of dog. After the model has learned enough, it can guess which breed a dog belongs to, even if it has never seen that specific dog before.



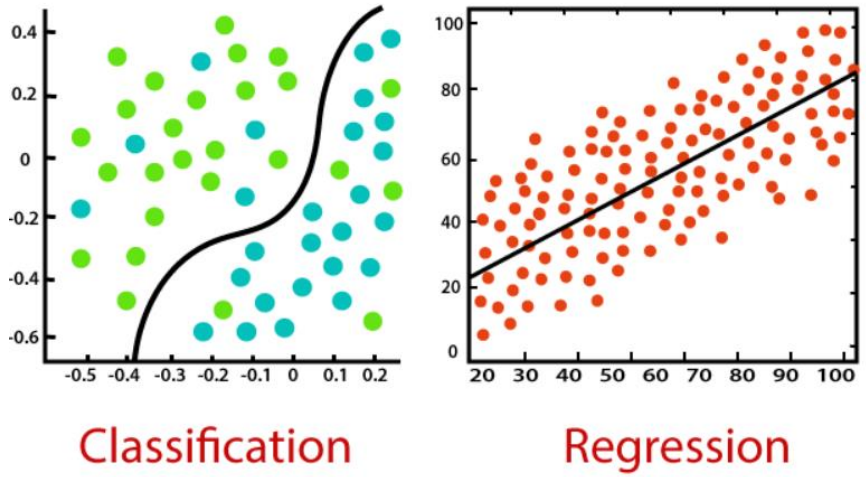
Supervised Learning: Process



Supervised Learning: Types

- *Classification*
  - Dividing the dataset into classes based on various parameters,
  - Helping classify discrete variables, such as email and spam classification,
  - Predicting the willingness of bank customers to pay their loans, and
  - Identifying cancer tumor cells.
  - Algorithms: Logistic Regression, K-Nearest Neighbors, Support Vector Machine, Kernel SVM, Naïve Bayes , Decision Tree Classification, Random Forest Classification.

- *Regression*
  - Finding correlations between dependent and independent variables,
  - Helping predict continuous variables such as house prices, market trends, weather patterns, oil and gas prices (a critical task these days),
  - Algorithms: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Support Vector Regression, Decision Tree Regression, Random Forest Regression.



- The main difference between Regression and Classification algorithms that Regression algorithms are used to **predict the continuous** values such as price, salary, age, etc. and Classification algorithms are used to **predict/Classify the discrete values** such as Male or Female, True or False, Spam or Not Spam.

Supervised Learning: Scenarios

Regression

What will be the temperature tomorrow?

Fahrenheit

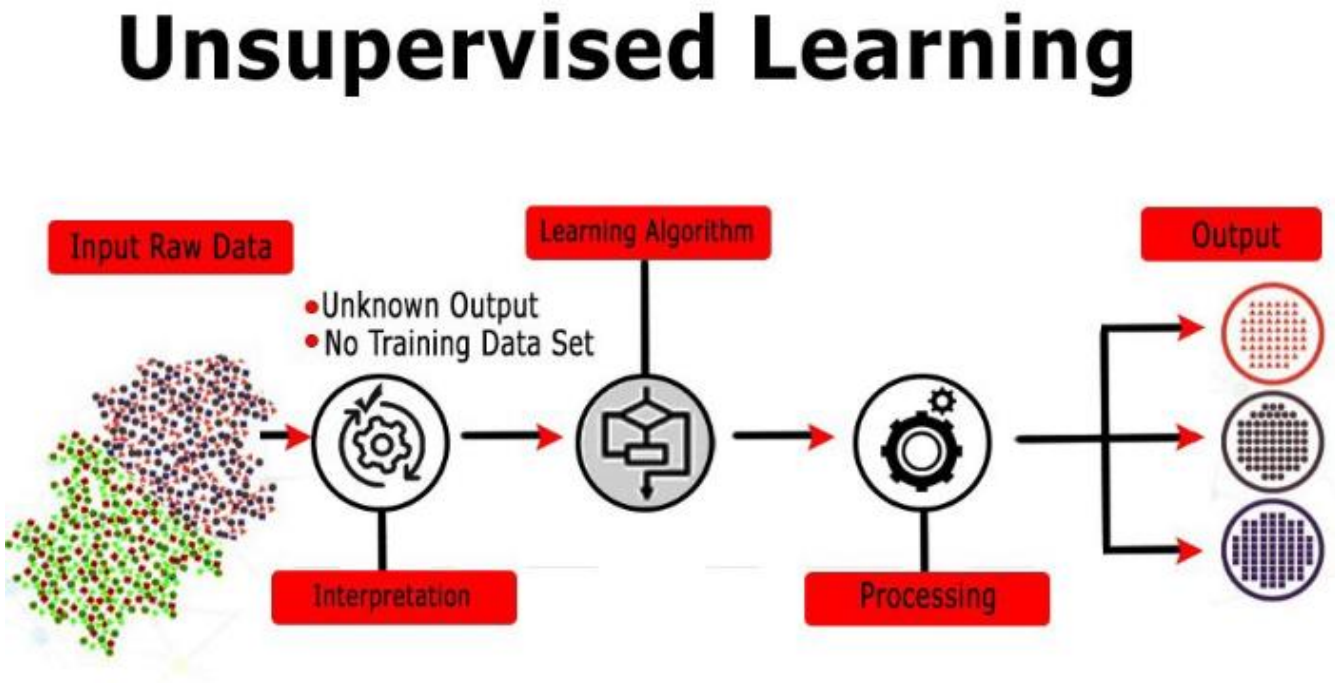
Classification

Will it be hot or cold tomorrow?

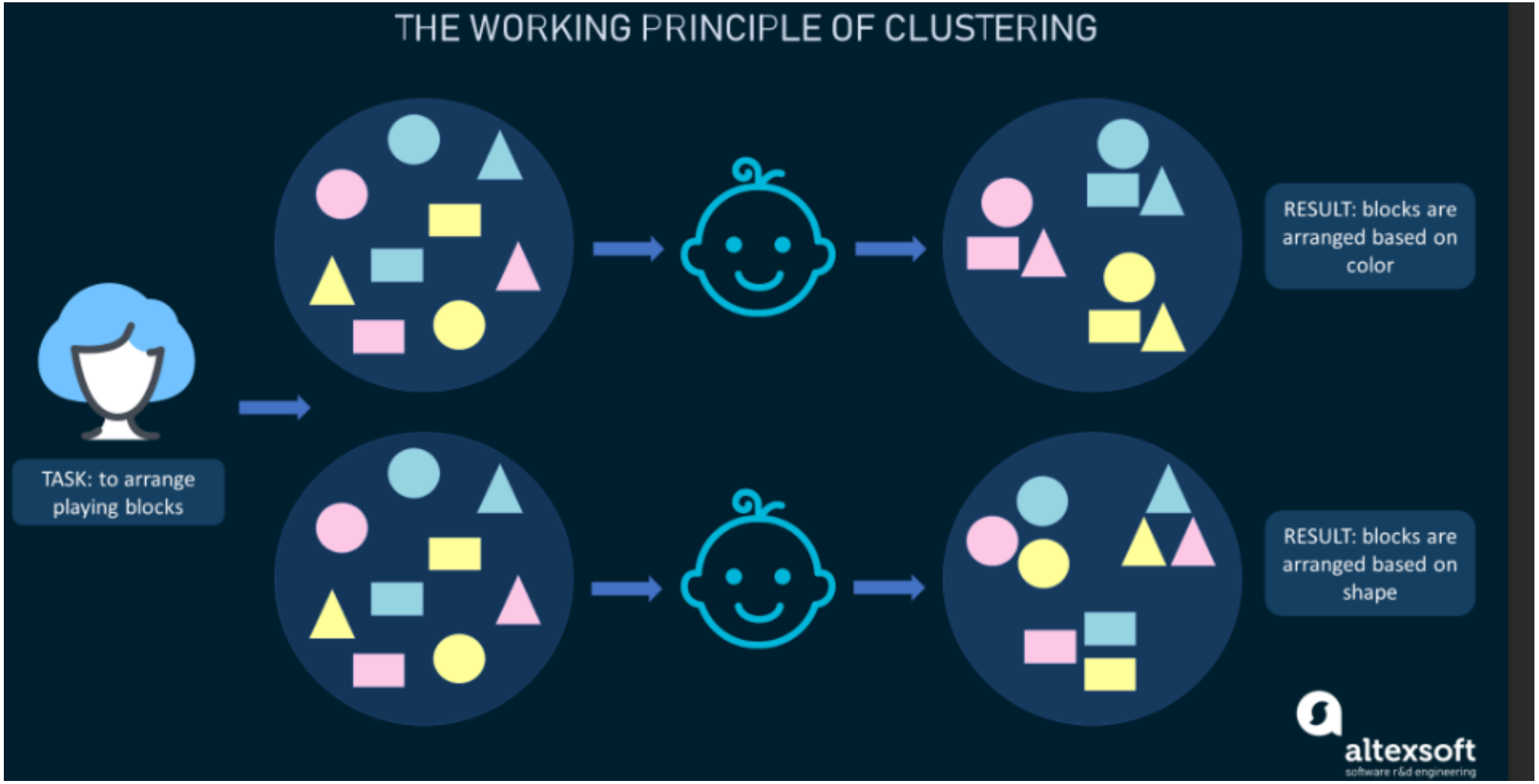
Fahrenheit

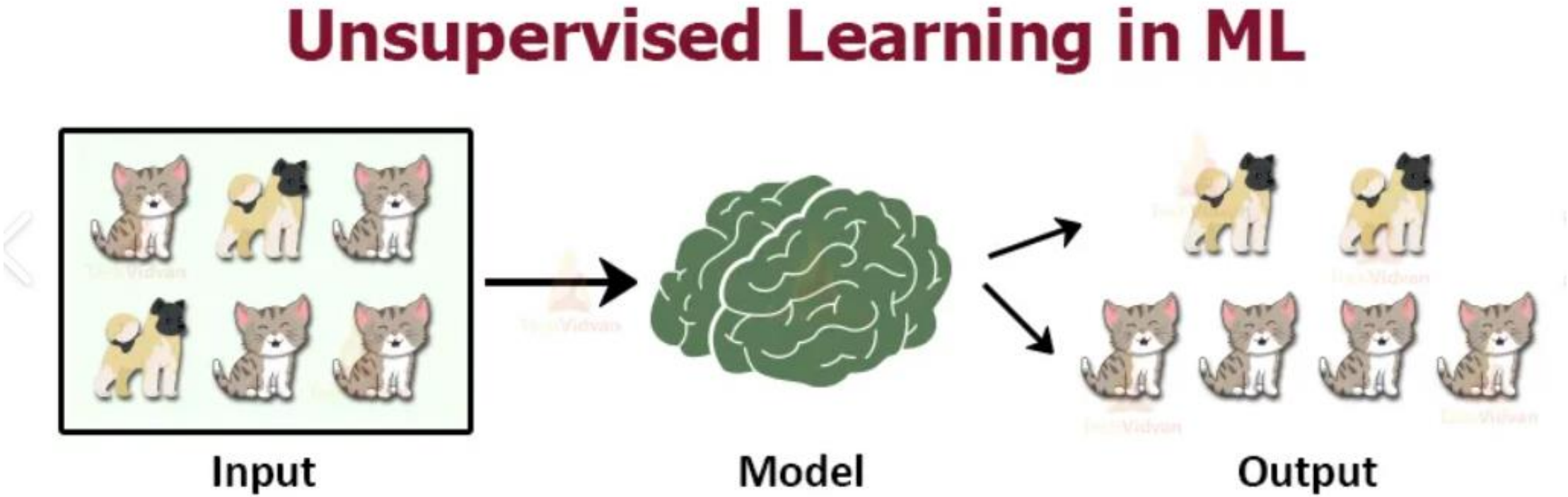
Unsupervised Learning: General Overview

- Unsupervised learning, also known as unsupervised machine learning, uses machine learning algorithms to analyze and cluster unlabeled datasets. These algorithms discover hidden patterns or data groupings without the need for human intervention.
- Its ability to discover similarities and differences in information make it the ideal solution for exploratory data analysis, cross-selling strategies, customer segmentation, and image recognition.



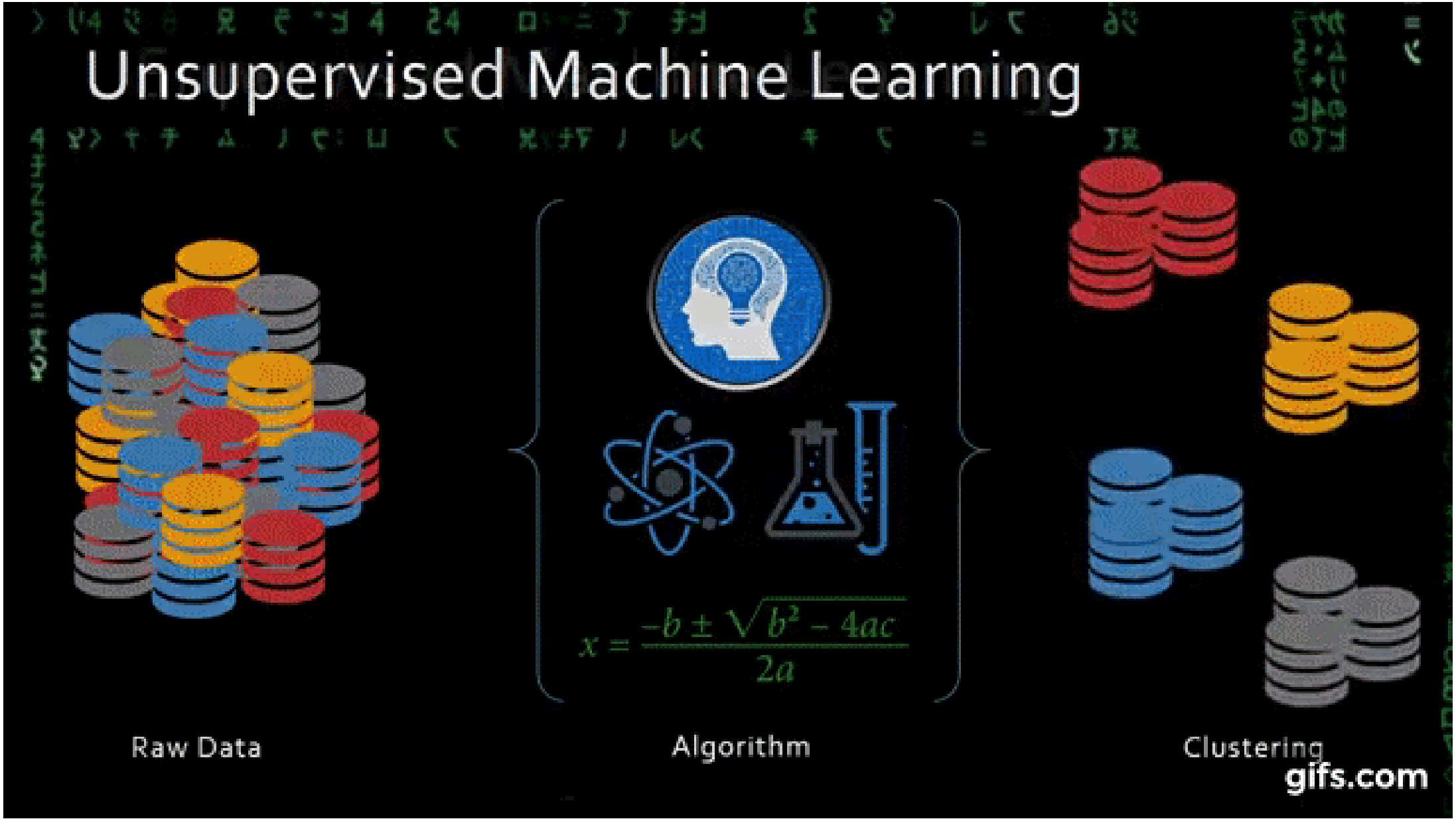
Unsupervised Learning: Example



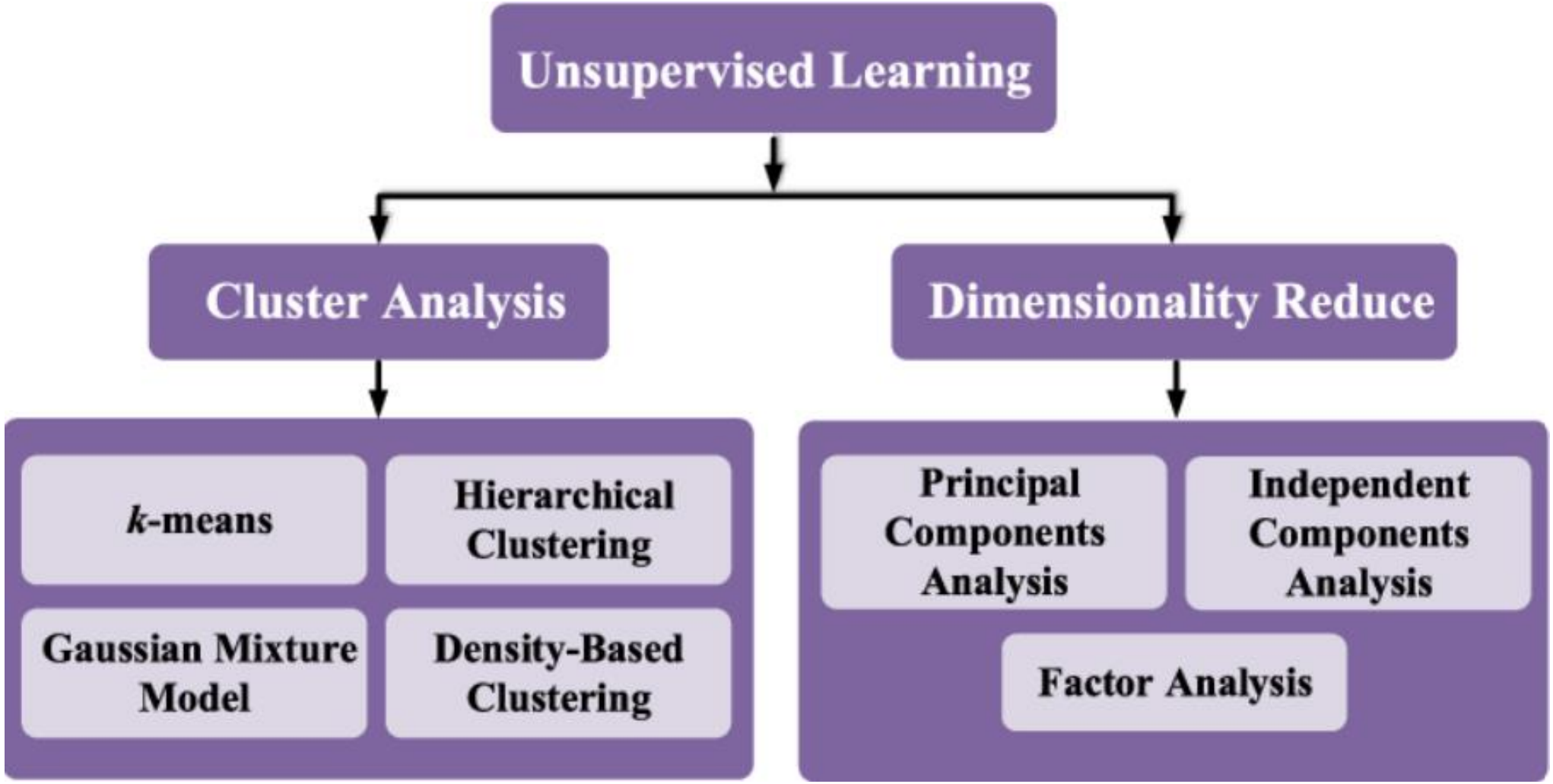


Unsupervised Learning: Example

Unsupervised Learning: Process

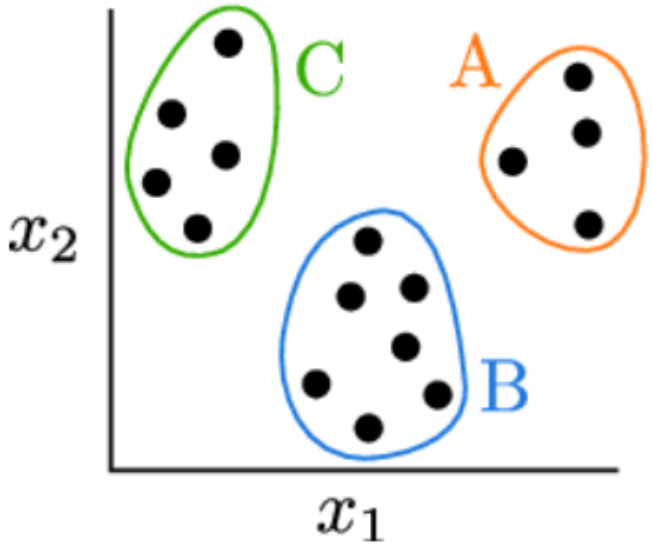


Unsupervised Learning: Types

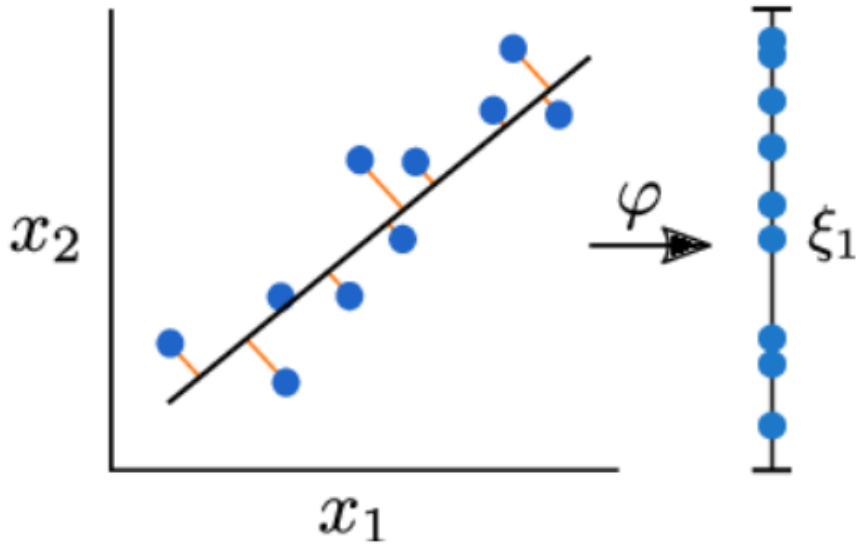


Schematic Overview of Unsupervised Algorithms

Clustering

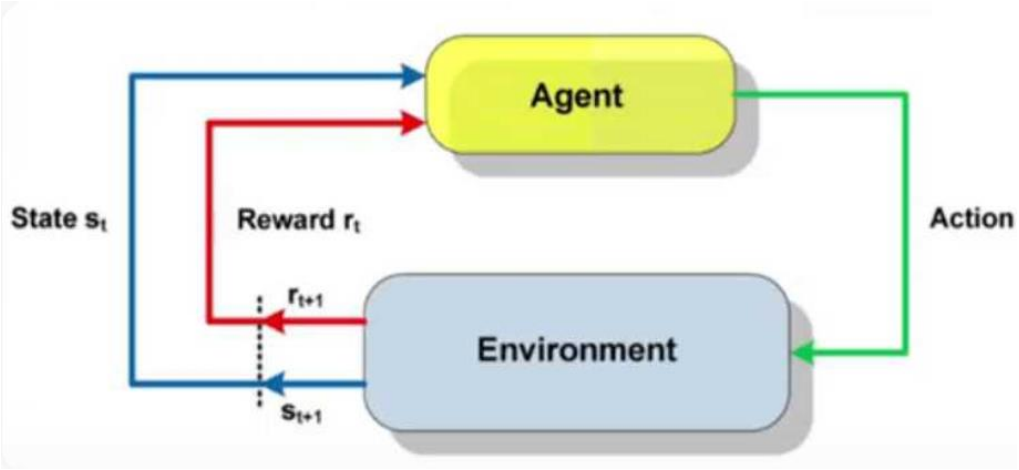


Dimensionality Reduction



Reinforcement Learning: General Overview

- Reinforcement learning is an area of Machine Learning. It is about taking suitable action to maximize reward in a particular situation.
- Reinforcement learning differs from supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning, there is no answer, but the reinforcement agent decides what to do to perform the given task.
- In the absence of a training dataset, it is bound to learn from its experience.



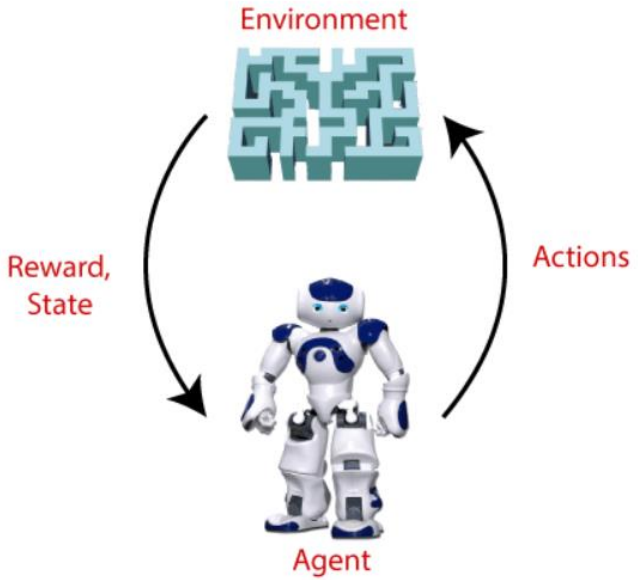
Process:

•The agent interacts with the environment and explores it by itself. The primary goal of an agent in reinforcement learning is to improve the performance by getting the maximum positive rewards.

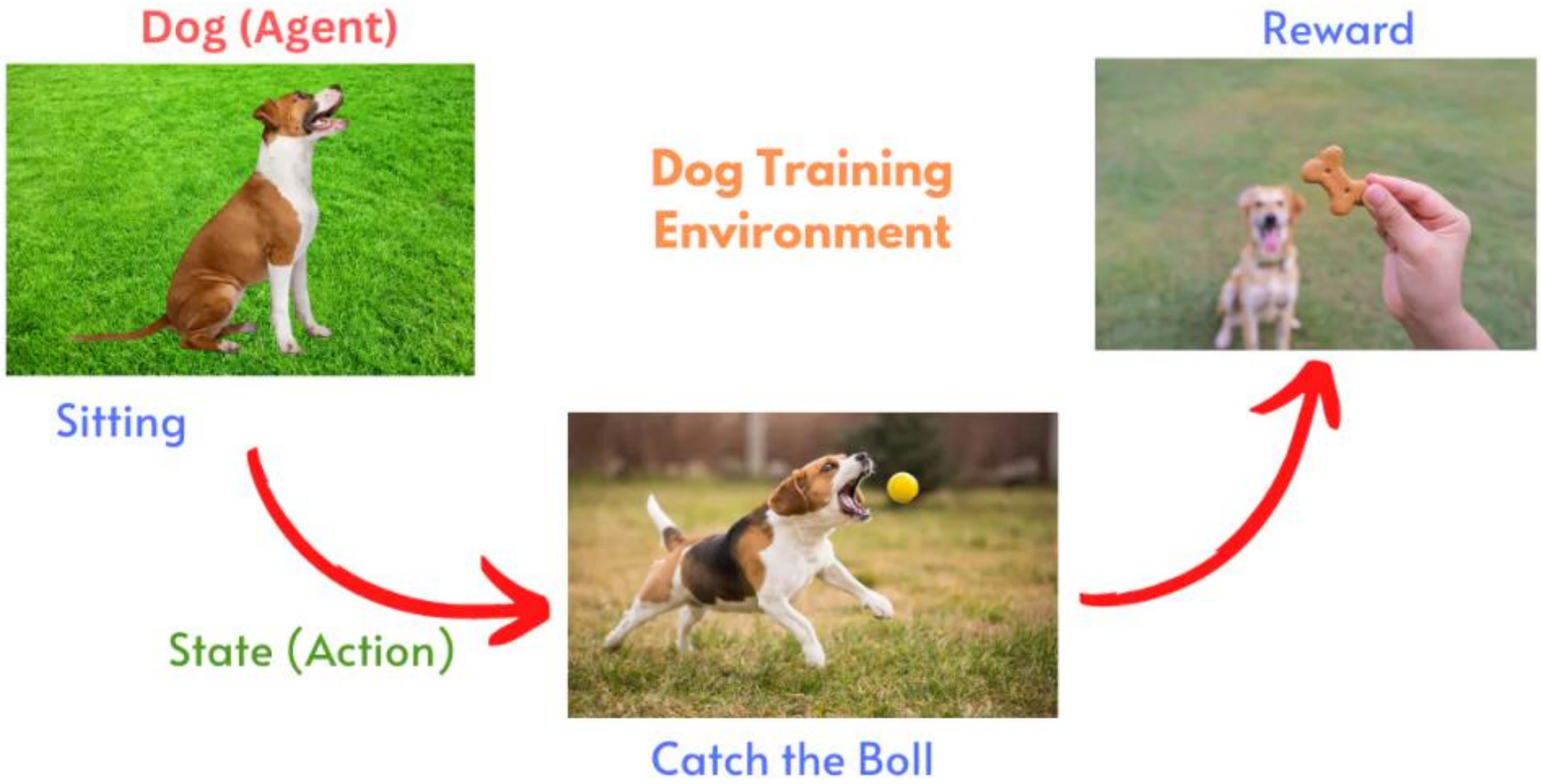
•The agent learns with the process of hit and trial, and based on the experience, it learns to perform the task in a better way. Hence, we can say that "Reinforcement learning is a type of machine learning method where an intelligent agent (computer program) interacts with the environment and learns to act within that.

Terms used in Reinforcement Learning:

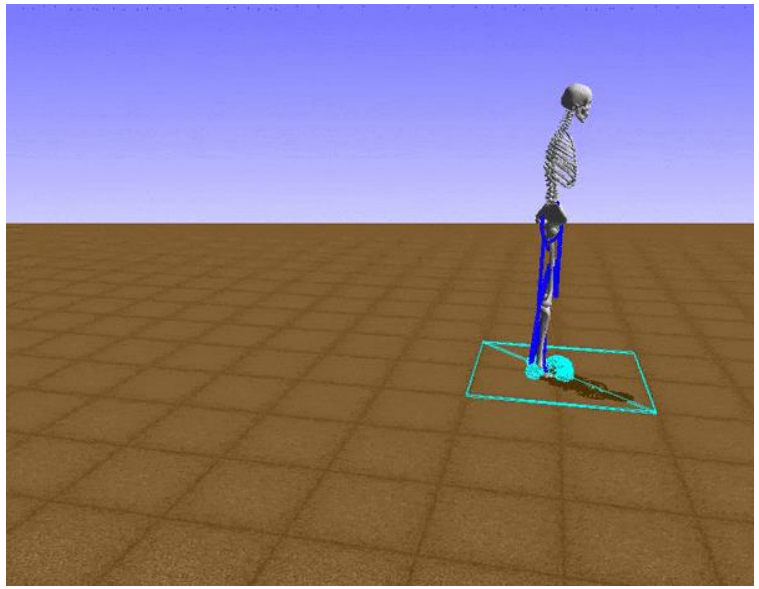
•**Agent():** An entity that can perceive/explore the environment and act upon it.
•**Environment():** A situation in which an agent is present or surrounded by. In RL, we assume the stochastic environment, which means it is random in nature.
•**Action():** Actions are the moves taken by an agent within the environment.
•**State():** State is a situation returned by the environment after each action taken by the agent.
•**Reward():** A feedback returned to the agent from the environment to evaluate the action of the agent.
•**Policy():** Policy is a strategy applied by the agent for the next action based on the current state.
•**Value():** It is expected long-term retuned with the discount factor and opposite to the short-term reward.
•**Q-value():** It is mostly similar to the value, but it takes one additional parameter as a current action (a).

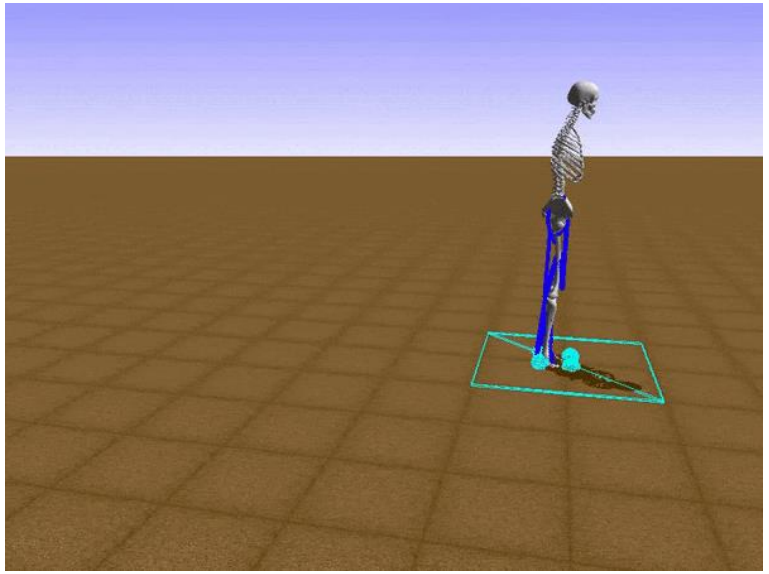


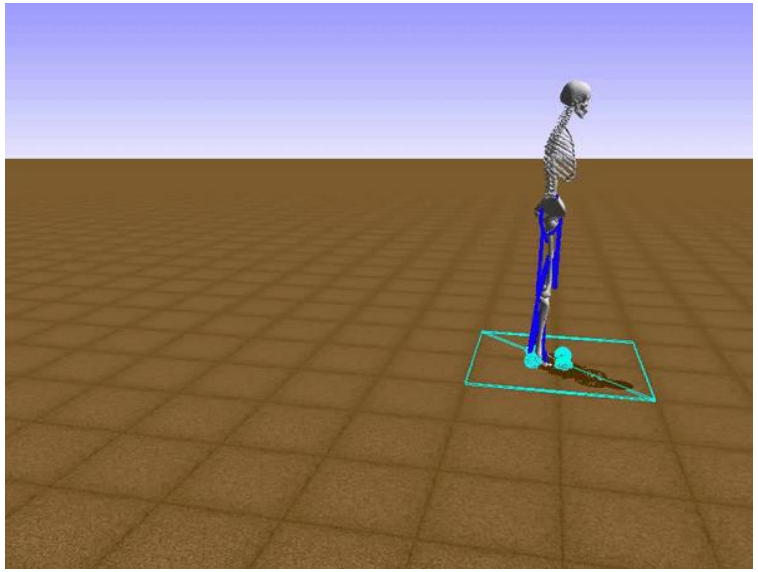
Reinforcement Learning: Example

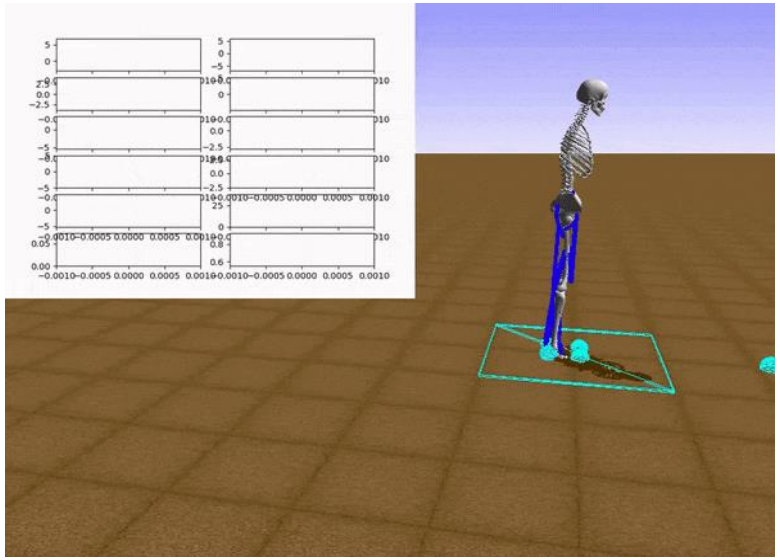


Reinforcement Learning: Example

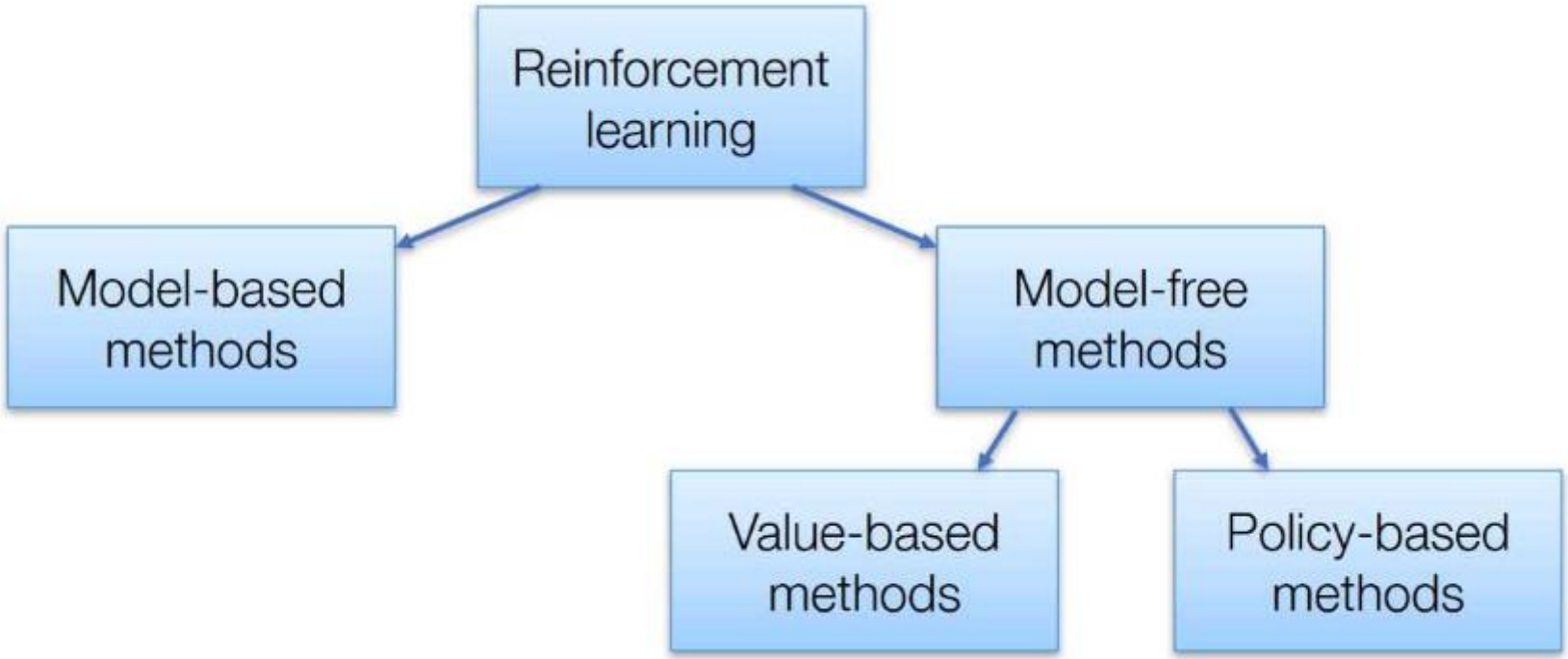








Reinforcement Learning: Types



Comparison: Supervised, Unsupervised, and Reinforcement

Learning Types	Type of Data	Training	Used for		Algorithms
Supervised Learning	Labeled data	Trained using labeled data (extra supervision)	Regression for nowcasting and forecasting	Classification in binary and multiple classes	Linear regression, logistic regression, RF, SVM, KNN, RNN, DNN, etc.
Unsupervised Learning	Unlabeled data	Trained using unlabeled data without any guidance (no supervision)	Clustering		K—Means, C—Means, Agglomerative Hierarchical Clustering, DBSCAN, Gaussian Mixture Models, OPTICS, etc.
Reinforcement Learning	Without predefined data	Works based on the interaction between agent and environment (no supervision)	Decision making		Q—Learning, SARSA, DQN, double DQN, dueling DQN, etc.

Summary

- Introducing course expectations and getting to know each other
- A discussion of Google Colab,
- Brief overview of Python
- Summary of Machine Learning.