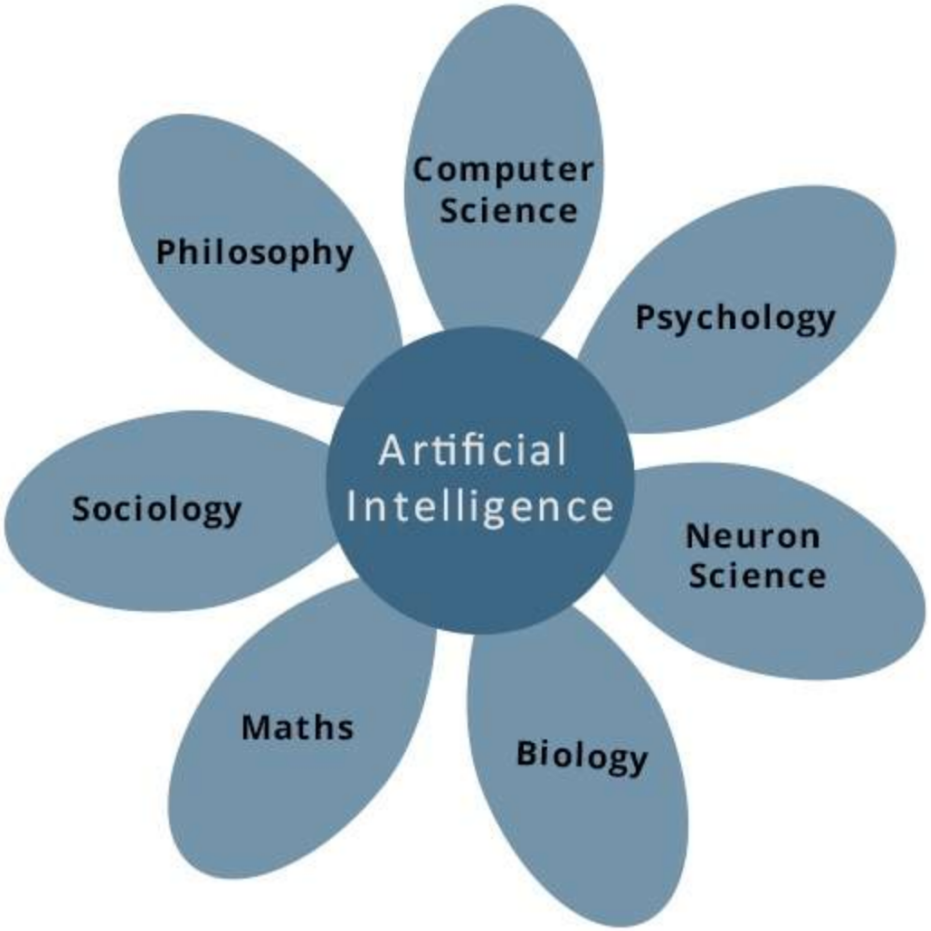
Artificial intelligence - Introduction

According to the father of Artificial Intelligence, John McCarthy, it is *"The science and engineering of making intelligent machines, especially intelligent computer programs"*



Artificial Intelligence is an approach to make a computer, a robot, or a product to think how smart human think. AI is a study of how human brain think, learn, decide and work, when it tries to solve problems. And finally this study outputs intelligent software systems.The aim of AI is to improve computer functions which are related to human knowledge, for example, reasoning, learning, and problem-solving.

The intelligence is intangible. It is composed of

- Reasoning
- Learning
- Problem Solving
- Perception
- Linguistic Intelligence

The objectives of AI research are reasoning, knowledge representation, planning, learning, natural language processing, realization, and ability to move and manipulate objects. There are long-term goals in the general intelligence sector.

Applications of AI

· Gaming − AI plays important role for machine to think of large number of possible positions based on deep knowledge in strategic games. for example, chess,river crossing, N-queens problems and etc.

· Natural Language Processing − Interact with the computer that understands natural language spoken by humans.

· Expert Systems − Machine or software provide explanation and advice to the users.

· Vision Systems − Systems understand, explain, and describe visual input on the computer.

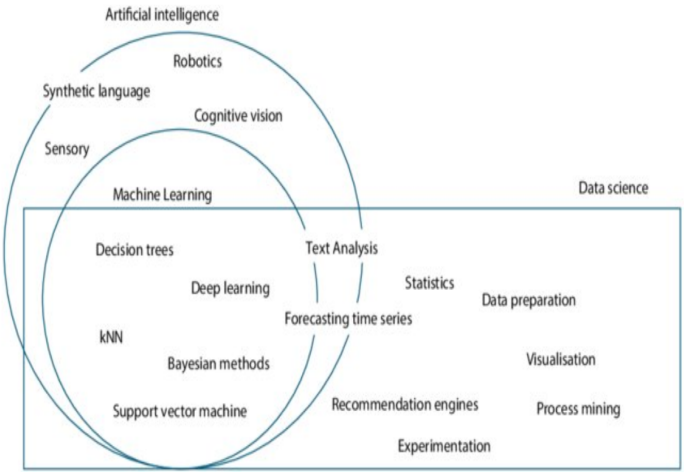
· Speech Recognition − There are some AI based speech recognition systems that have ability to hear and express sentences and understand their meanings while a person talks to it. For example Siri and Google assistant.

· Handwriting Recognition − The handwriting recognition software reads the text written on paper and recognizes the shapes of the letters and converts it into editable text.

· Intelligent Robots − Robots are able to perform the instructions given by a human.

Major Goals

- Knowledge reasoning
- Planning
- Machine Learning
- Natural Language Processing
- Computer Vision



Figure

Caption

Figure 5. Artificial intelligence, machine learning and data science Retrieved from "Data Science: Concepts and Practice" by Kotu, V., Deshpande, B. (2019). (2 ed.): Morgan Kaufmann. p. 3.

- Robotics

What is Knowledge Representation?

Knowledge Representation in AI describes the representation of knowledge. Basically, it is a study of how the **beliefs, intentions**, and **judgments** of an **intelligent agent** can be expressed suitably for automated reasoning. One of the primary purposes of Knowledge Representation includes modeling intelligent behavior for an agent.

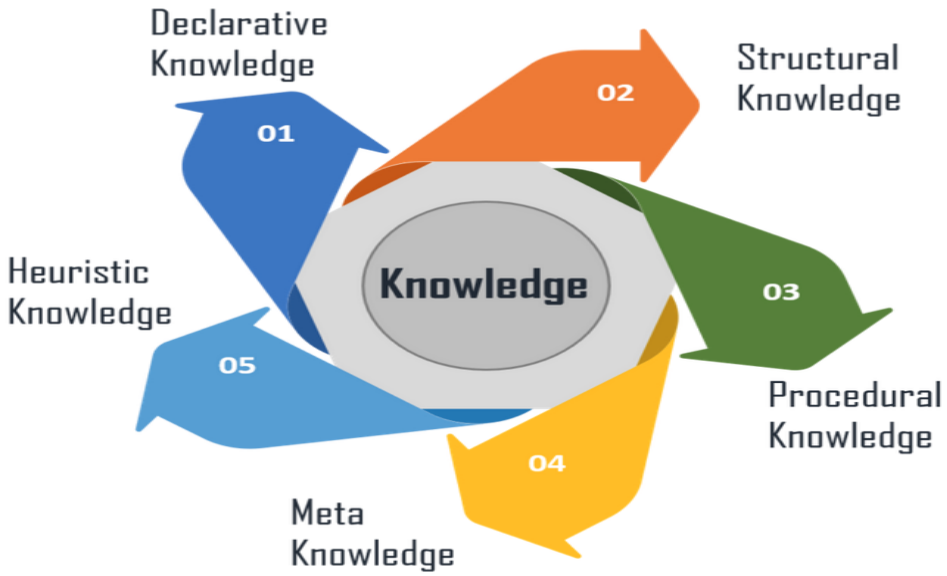
Knowledge Representation and Reasoning (**KR, KRR**) represents information from the real world for a computer to understand and then utilize this knowledge to solve **complex real-life problems** like communicating with human beings in natural language. Knowledge representation in AI is not just about storing data in a database, it allows a machine to learn from that knowledge and behave intelligently like a human being.

The different kinds of knowledge that need to be represented in AI include:

- **Objects**
- **Events**
- **Performance**
- **Facts**
- **Meta-Knowledge**
- **Knowledge-base**

Different Types of Knowledge

There are 5 types of Knowledge such as:



- **Declarative Knowledge – It includes concepts, facts, and objects and expressed in a declarative sentence.**

- **Structural Knowledge – It is a basic problem-solving knowledge that describes the relationship between concepts and objects.**

- **Procedural Knowledge – This is responsible for knowing how to do something and includes rules, strategies, procedures, etc.**

- **Meta Knowledge – Meta Knowledge defines knowledge about other types of Knowledge.**

- **Heuristic Knowledge – This represents some expert knowledge in the field or subject.**
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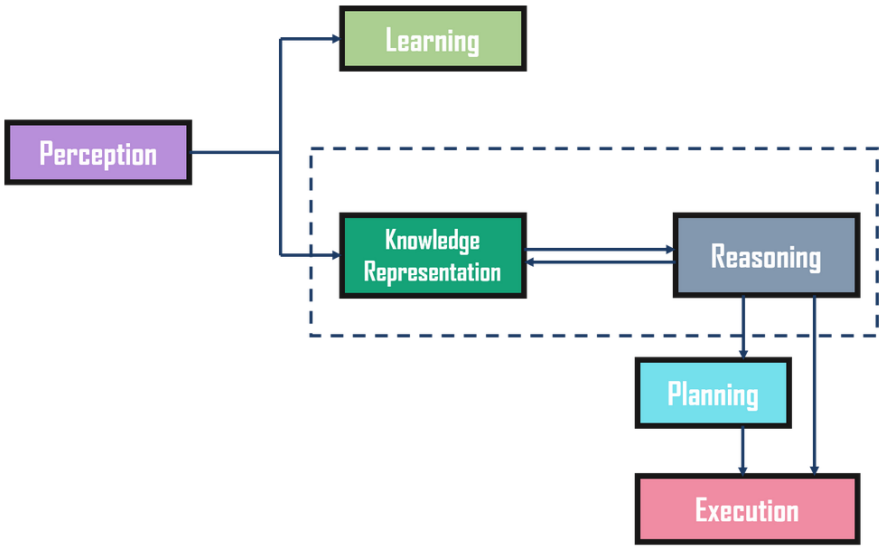
Cycle of Knowledge Representation in AI

Artificial Intelligent Systems usually consist of various components to display their intelligent behavior. Some of these components include:

- **Perception**
- **Learning**
- **Knowledge Representation & Reasoning**
- **Planning**
- **Execution**



The above diagram shows the interaction of an AI system with the **real world** and the **components** involved in showing intelligence.

- The **Perception component** retrieves data or information from the environment. with the help of this component, you can retrieve data from the environment, find out the

source of noises and check if the AI was damaged by anything. Also, it defines how to respond when any sense has been detected.

- Then, there is the **Learning Component** that learns from the captured data by the perception component. The goal is to build computers that can be taught instead of programming them. Learning focuses on the process of self-improvement. In order to learn new things, the system requires knowledge acquisition, inference, acquisition of heuristics, faster searches, etc.
- The main component in the cycle is **Knowledge Representation and Reasoning** which shows the human-like intelligence in the machines. Knowledge representation is all about understanding intelligence. Instead of trying to understand or build brains from the bottom up, its goal is to understand and build intelligent behavior from the top-down and focus on what an agent needs to know in order to behave intelligently. Also, it defines how automated reasoning procedures can make this knowledge available as needed.
- The **Planning and Execution** components depend on the analysis of knowledge representation and reasoning. Here, planning includes giving an initial state, finding their preconditions and effects, and a sequence of actions to achieve a state in which a particular goal holds. Now once the planning is completed, the final stage is the execution of the entire process.

Learning Techniques

Supervised , unsupervised and reinforcement

Supervised Learning input is provided as a **labelled dataset,** a model can learn from it to provide the result of the problem easily.

Types of Problems

Supervised Learning deals with two types of problem- **classification problems** and **regression problems**.

Classification problems

This algorithm helps to predict a discrete value. It can be thought, the input data as a member of a particular class or group. For instance, taking up the photos of the fruit dataset, each photo has been labeled as a mango, an apple, etc. Here, the algorithm has to **classify** the new images into any of these categories. Examples:

- Naive Bayes Classifier
- Support Vector Machines
- Logistic Regression

Regression problems

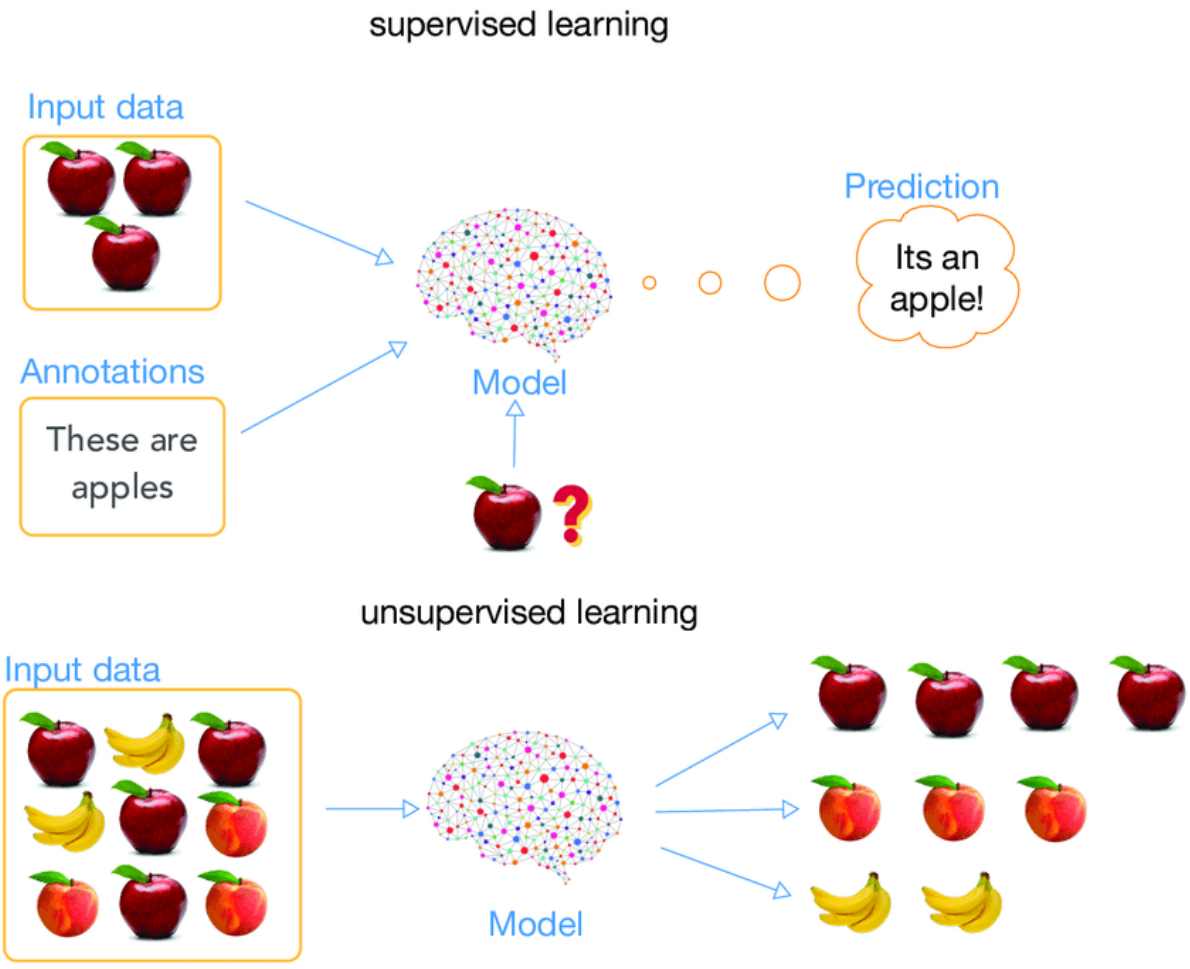
These problems are used for continuous data. For example, predicting the price of a piece of land in a city, given the area, location, number of rooms, etc. And then the input is sent to the machine for calculating the price of the land according to previous examples. Examples-

- Linear Regression
- Nonlinear Regression
- Bayesian Linear Regression

Unsupervised Learning

This learning algorithm is completely opposite to Supervised Learning. In short, there is **no complete and clean labelled dataset in unsupervised learning**. Unsupervised learning is self-organized learning. Its main aim is to explore the underlying patterns and predicts the output. Here we basically provide the machine with data and ask to look for hidden features and cluster the data in a way that makes sense. Example

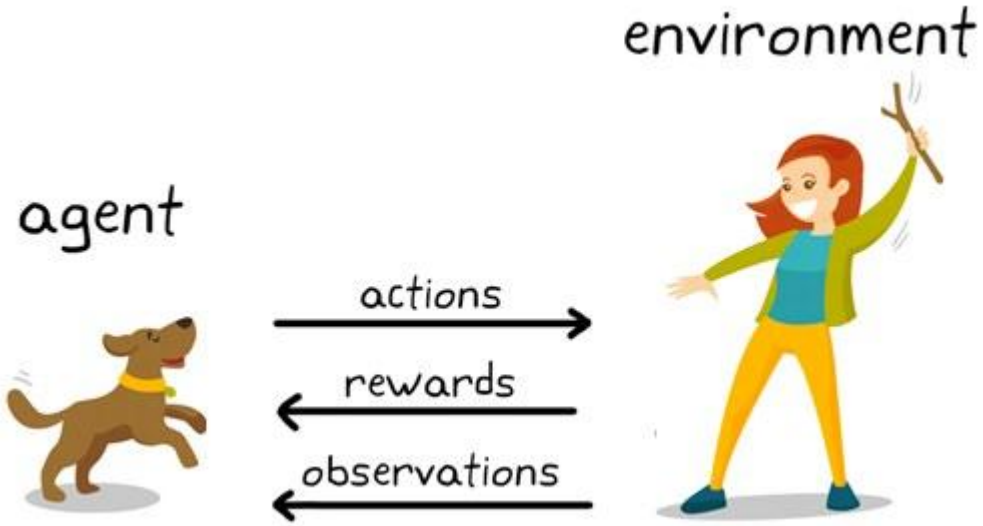
- K – Means clustering
- Neural Networks
- Principal Component Analysis

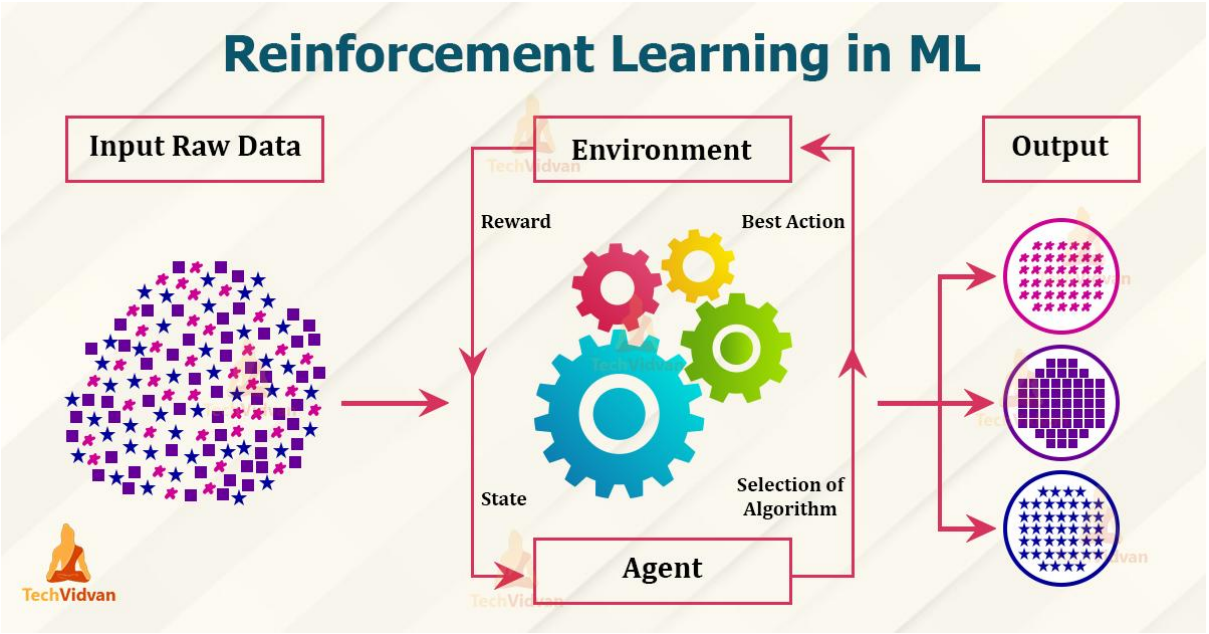


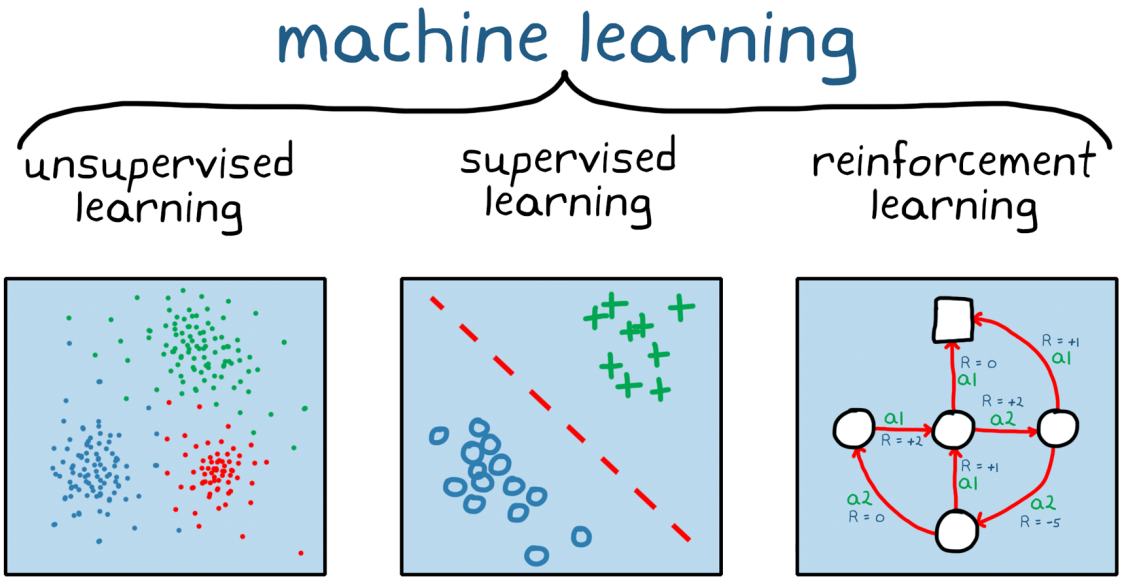
Reinforcement Learning

It is neither based on supervised learning nor unsupervised learning. Moreover, here the algorithms learn to react to an environment on their own. It is rapidly growing and moreover producing a variety of learning algorithms. These algorithms are useful in the field of Robotics, Gaming etc.

For a learning agent, there is always a start state and an end state. However, to reach the end state, there might be a different path. In Reinforcement **Learning Problem** an **agent** tries to manipulate the **environment**. The agent travels from one **state** to another. The agent gets the **reward**(appreciation) on success but will **not receive any reward** or appreciation on failure. In this way, the agent learns from the environment.







Comparison Table

Criteria	Supervised ML	Unsupervised ML	Reinforcement ML
Definition	Learns by using labelled data	Trained using unlabelled data without any guidance.	Works on interacting with the environment
Type of data	Labelled data	Unlabelled data	No – predefined data
Type of problems	Regression and classification	Association and Clustering	Exploitation or Exploration
Supervision	Extra supervision	No supervision	No supervision
Algorithms	Linear Regression, Logistic Regression, SVM, KNN etc.	K – Means, C – Means, Apriori	Q – Learning, SARSA
Aim	Calculate outcomes	Discover underlying patterns	Learn a series of action
Application	Risk Evaluation, Forecast Sales	Recommendation System, Anomaly Detection	Self Driving Cars, Gaming, Healthcare