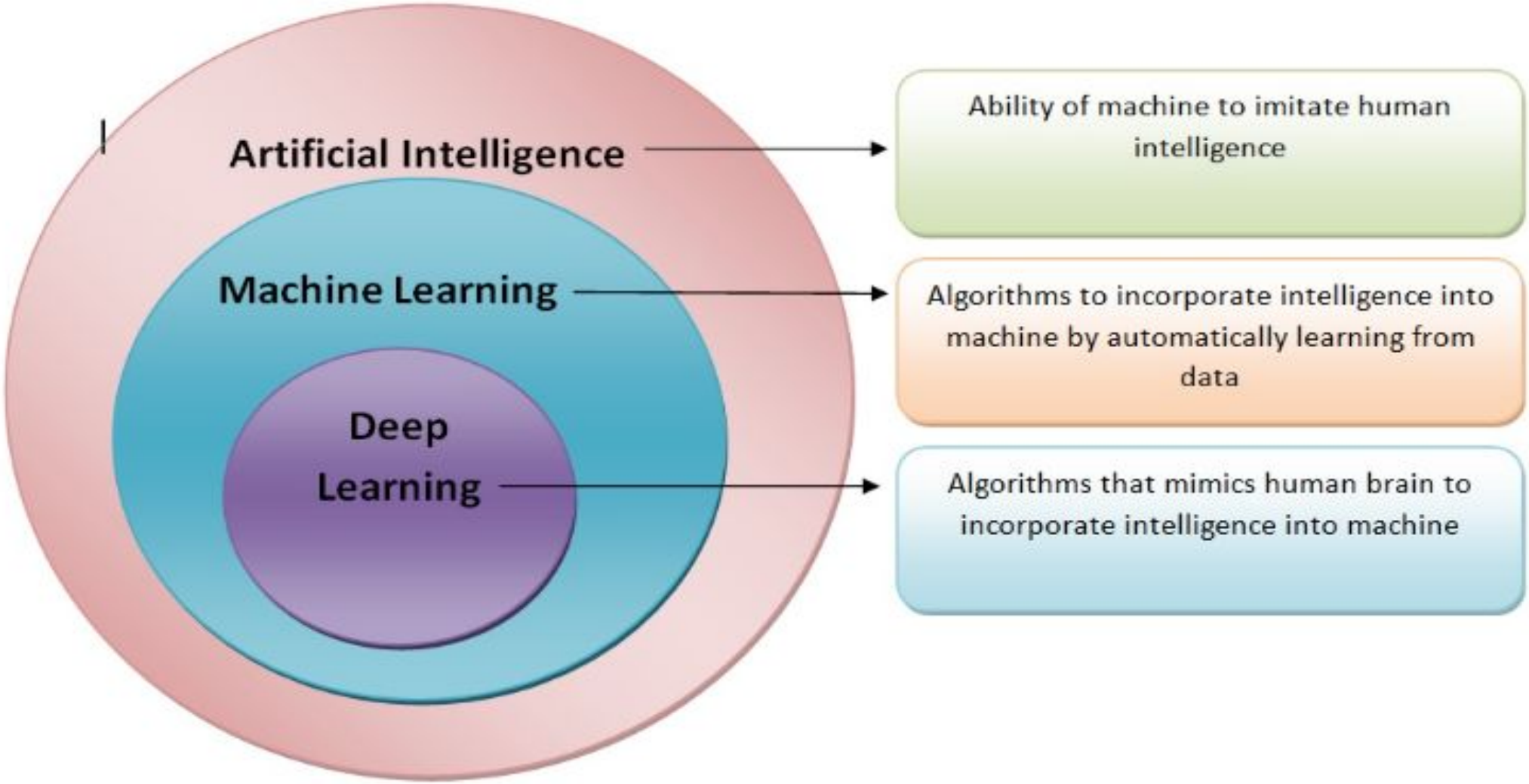
Machine Learning

Introduction

What is machine Learning ?

Machine learning (ML) is a branch of artificial intelligence (AI) and computer science that focuses on the using data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy.

AI vs ML vs DL


Artificial Intelligence
Machine Learning
Deep Learning
Ability of machine to imitate human intelligence
Algorithms to incorporate intelligence into machine by automatically learning from data
Algorithms that mimics human brain to incorporate intelligence into machine

AI vs ML vs DL (Cont.)

- What is Artificial Intelligence ?

- AI is a broader term that describes the capability of the machine to learn and solve problems just like humans. In other words, AI refers to the replication of humans, how it thinks, works and functions.
- On the lower ground, AI can be seen as a program that instructs the machine to function in a certain way according to the situation. So, we can call a bunch of if-else statements, AI. For instance, self-driving car moving on the road. A small algorithmic rule for such a car can be:

AI vs ML vs DL (Cont.)

```
if distance_from_in_front <100m:
    stop();
else:
    keep_moving();
```

- There are two ways of incorporating intelligence in artificial things i.e., to achieve artificial intelligence. One is through machine learning and another is through deep learning. That means DL and ML are ways of achieving AI.

AI vs ML vs DL (Cont.)

- What is Machine Learning ?

- ML comprises algorithms for accomplishing different types of tasks such as classification, regression, or clustering. The accuracy of algorithms increases with an increase in data.

- “Technique to learn from data through training and then apply learning to make an informed decision”

- Analyzing and learning from data comes under the training part of the machine learning model. During the training of the model, the objective is to minimize the loss between actual and predicted value.

AI vs ML vs DL (Cont.)

- What is Deep Learning ?

- Deep learning is an emerging field that has been in steady use since its inception in the field in 2010. It is based on an artificial neural network which is nothing but a mimic of the working of the human brain.

- Just like the ML model, the DL model requires a large amount of data to learn and make an informed decision and is therefore also considered a subset of ML. This is one of the reasons for the misconception that ML and DL are the same. However, the DL model is based on artificial neural networks which have the capability of solving tasks which ML is unable to solve.

Examples

- **Image Recognition:** Identifying objects, people, or patterns within images. Used in facial recognition, object detection, and self-driving cars.
- **Speech Recognition:** Converting spoken language into text. Used in virtual assistants, voice-controlled systems, and transcription services.
- **Stock Market Prediction:** Forecasting stock prices and market trends based on historical data.
- **Chatbots:** Creating conversational agents that can interact with users and answer queries.
- **Email Filtering:** AI algorithms categorize emails as spam or important based on content and user behavior.

What is machine learning ...?

- Learning is any process by which a system improves performance from experience.

- A branch of **artificial intelligence**, concerned with the design and development of algorithms that allows the computers to evolve behaviors based of empirical data.

In Simple term ,

Machine learning is learning from data.

Machine learning is programming computers to optimize a performance criterion using example data or past experience.

We have a model defined up to some parameters, and learning is the execution of a computer program to optimize the parameters of the model using the training data or past experience.

The model may be predictive to make predictions in the future, or descriptive to gain knowledge from data, or both.

what is machine learning ...?

- **Definition by Tom Mitchell (1998):**
- Machine Learning is the study of algorithm that
  - Improve their performance P
  - at some task T
  - with experience E.

★ A well-defined Machine Learning task is given by <P,T,E>.

Learning Problems

- ***Definition:*** A computer program is said to learn from experience ***E*** with respect to some class of tasks ***T*** and performance measure ***P***, if its performance at tasks in ***T***, as measured by ***P***, improves with experience ***E***.

- In general, to have a well-defined learning problem, we must identity these three features:
  1. the class of tasks,
  2. the measure of performance to be improved, and
  3. the source of experience.

Learning Problems

Definition

A computer program which learns from experience is called a machine learning program or simply a learning program.

Such a program is sometimes also referred to as a learner.

Learning Problems (Cont.)

- **A handwriting recognition learning problem:**

1. **Task T:** recognizing and classifying handwritten words within images.
2. **Performance measure P:** percent of words correctly classified.
3. **Training experience E:** a database of handwritten words with given classifications.

Learning Problems (Cont.)

- **A robot driving learning problem:**
  1. **Task T:** driving on public four-lane highways using vision sensors.
  2. **Performance measure P:** average distance traveled before an error (as judged by human overseer).
  3. **Training experience E:** a sequence of images and steering commands recorded while observing a human driver.

Learning Problems (Cont.)

- **Text Categorization Problem.**
  1. **Task T:** Assign a document to its content category.
  2. **Performance measure P:** Precision and Recall.
  3. **Training experience E:** Example pre-classified documents.

Learning Problems (Cont.)

- **In Spam E-Mail detection:**
  1. **Task T:** To classify mails into Spam or Not Spam.
  2. **Performance measure P:** Total percent of mails being correctly classified as being “Spam” or “Not Spam”.
  3. **Experience E:** Set of Mails with label “Spam”

Components of Learning

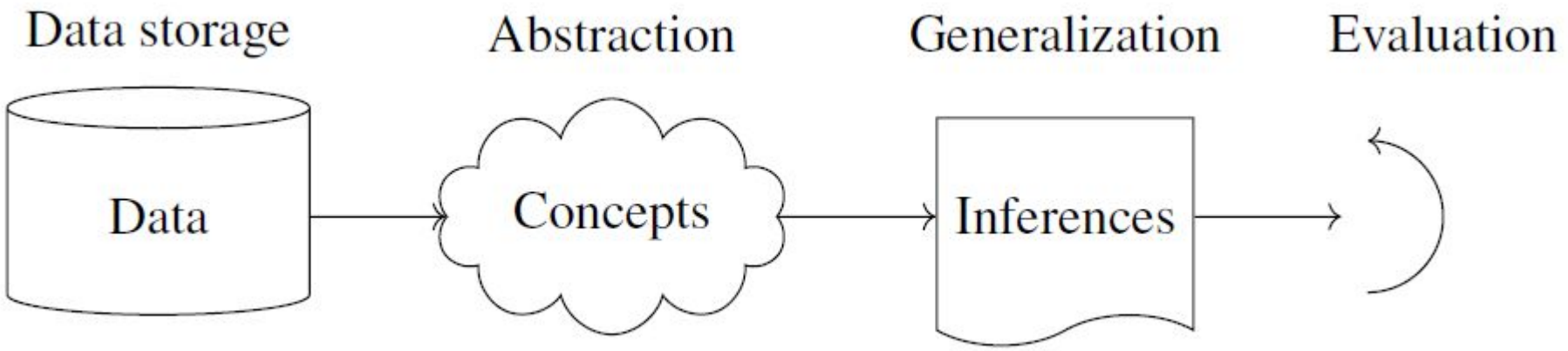
Learning is any process by which a system improves performance from experience.

Basic components of learning process

The learning process, whether by a human or a machine, can be divided into four components,namely, data storage, abstraction, generalization and evaluation.

Components of Learning

The various components and the steps involved in the learning process.



Components of Learning

1. Data storage

Facilities for storing and retrieving huge amounts of data are an important component of the learning process. Humans and computers alike utilize data storage as a foundation for advanced reasoning.

- In a human being, the data is stored in the brain, and data is retrieved using electrochemical signals.
- Computers use hard disk drives, flash memory, random access memory, and similar devices to store data and use cables and other technology to retrieve data.

Components of Learning

2. Abstraction

The second component of the learning process is known as abstraction.

Abstraction is the process of extracting knowledge about stored data. This involves creating general concepts about the data as a whole. The creation of knowledge involves the application of known models and the creation of new models.

The process of fitting a model to a dataset is known as training. When the model has been trained, the data is transformed into an abstract form that summarizes the original information.

Components of Learning

3. Generalization

The third component of the learning process is known as generalization. The term generalization describes the process of turning the knowledge about stored data into a form that can be utilized for future action. These actions are to be carried out on tasks that are similar, but not identical, to those that have been seen before. In generalization, the goal is to discover those properties of the data that will be most relevant to future tasks.

Components of Learning

4. Evaluation

Evaluation is the last component of the learning process. It is the process of giving feedback to the user to measure the utility of the learned knowledge. This feedback is then utilized to effect improvements in the whole learning process.

Why Machine Learning is so Popular..?

- We have seen Machine Learning as a buzzword for the past few years,
  - the reason for this might be the **high amount of data production** by applications,
  - the **increase of computation power** in the past few years, and
  - the **development of better algorithms.**
- You may already be using a device or application that utilizes it.
- For example, GMAIL, WhatsApp, E-Commerce Websites, Video Sharing Platforms, wearable fitness trackers like Fitbit, or intelligent home assistants like Google Home.

Applications of machine learning

The application of machine learning methods to large databases is called data mining. In data mining, a large volume of data is processed to construct a simple model with valuable use, for example, having high predictive accuracy.

The following is a list of some of the typical applications of machine learning.

In the retail business, machine learning is used to study consumer behavior.

In finance, banks analyze their past data to build models to use in credit applications, fraud detection, and the stock market.

In manufacturing, learning models are used for optimization, control, and troubleshooting.

Applications of machine learning

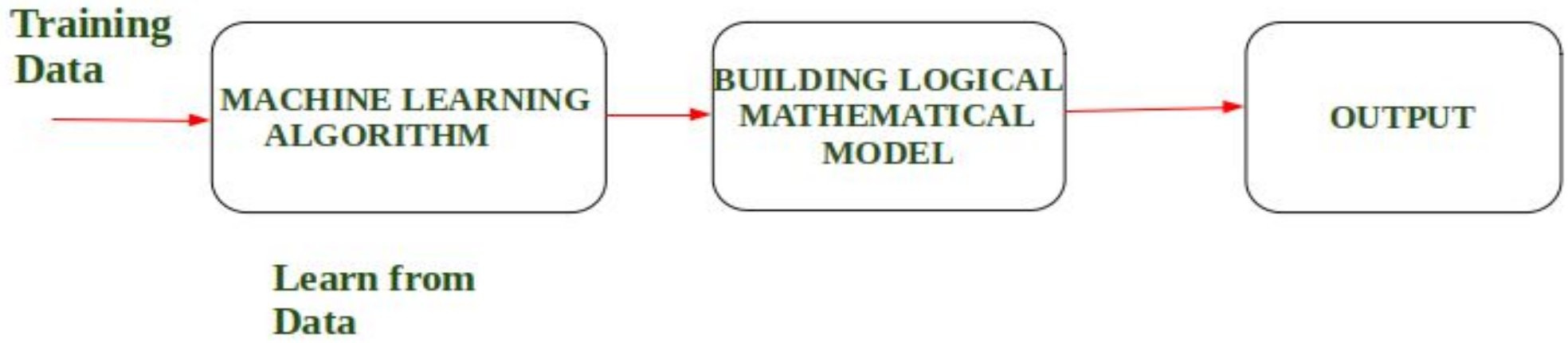
- **Recognizing patterns:**
  - Facial identities or facial expressions
  - Handwriting or spoken words
  - Medical Images
- **Generating patterns:**
  - generating images or motion sequences
- **Recognizing anomalies:**
  - unusual sequences of credit card transactions
  - unusual patterns of sensor reading in a nuclear power plant or unusual sound in your car engine
- **Prediction :**
  - future stock prices or currency exchange rates

Applications of machine learning

1. In medicine, learning programs are used for medical diagnosis.
2. In telecommunications, call patterns are analyzed for network optimization and maximizing the quality of service.
3. In science, large amounts of data in physics, astronomy, and biology can only be analyzed fast enough by computers. The World Wide Web is huge; it is constantly growing and searching for relevant information cannot be done manually.
4. In artificial intelligence, it is used to teach a system to learn and adapt to changes so that the system designer need not foresee and provide solutions for all possible situations.
5. It is used to find solutions to many problems in vision, speech recognition, and robotics.
6. Machine learning methods are applied in the design of computer-controlled vehicles to steer correctly when driving on a variety of roads.
7. Machine learning methods have been used to develop programs for playing games such as chess, backgammon, and Go.

Designing a Learning System

When we fed the Training Data to Machine Learning Algorithm, this algorithm will produce a mathematical model and with the help of the mathematical model, the machine will make a prediction and take a decision without being explicitly programmed. Also, during training data, the more machine will work with it the more it will get experience and the more efficient result is produced.



Designing a Learning System (Cont.)

- **Example :**

In Driverless Car, the training data is fed to Algorithm like how to Drive Car in Highway, Busy and Narrow Street with factors like speed limit, parking, stop at signal etc. After that, a Logical and Mathematical model is created on the basis of that and after that, the car will work according to the logical model. Also, the more data the data is fed the more efficient output is produced.

Designing a Learning System (Cont.)

Steps for Designing Learning System are:

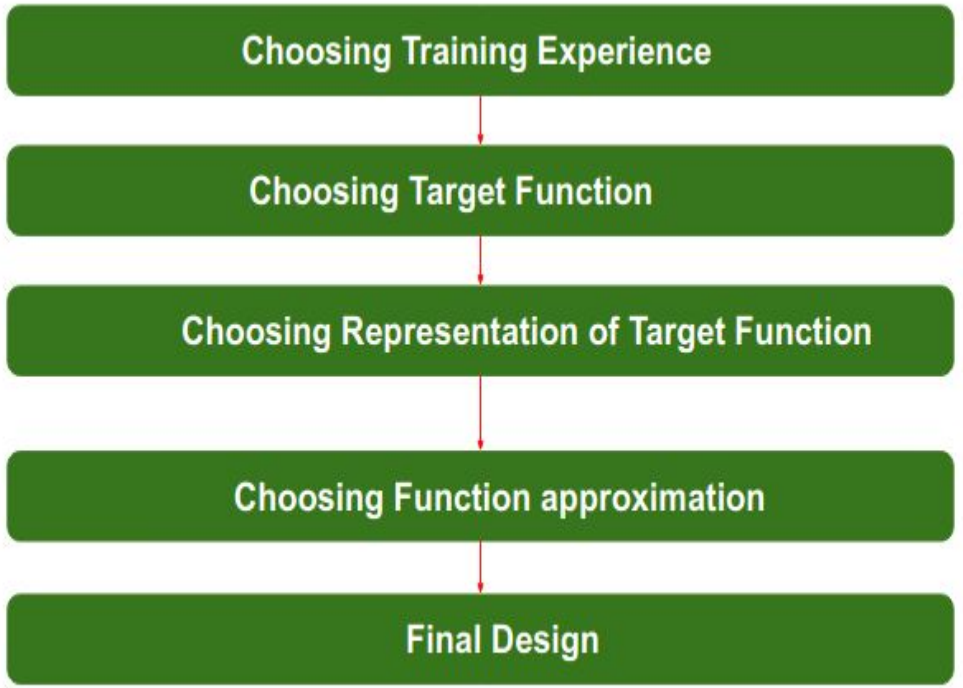
Step 1: Choosing the Training Experience

Step 2: Choosing target function

Step 3: Choosing Representation for Target function

Step 4: Choosing Function Approximation Algorithm

Step 5: Final Design



Designing a Learning System (Cont.)

Step 1- Choosing the Training Experience:

The very important and first task is to choose the training data or training experience which will be fed to the Machine Learning Algorithm. It is important to note that the data or experience that we fed to the algorithm must have a significant impact on the Success or Failure of the Model. So Training data or experience should be chosen wisely.

Designing a Learning System (Cont.)

Below are the attributes which will impact on Success and Failure of Data:

- The training experience will be able to provide direct or indirect feedback regarding choices.

Second important attribute is the degree to which the learner will control the sequences of training examples.

- Third important attribute is how it will represent the distribution of examples over which performance will be measured.

Designing a Learning System (Cont.)

Step 2- Choosing target function:

- The next important step is choosing the target function.

It means according to the knowledge fed to the algorithm the machine learning will choose Next Move function which will describe what type of legal moves should be taken.

- For example : While playing chess with the opponent, when opponent will play then the machine learning algorithm will decide what be the number of possible legal moves taken in order to get success.

Designing a Learning System (Cont.)

Step 3- Choosing Representation for Target function:

- When the machine algorithm will know all the possible legal moves the next step is to choose the optimized move using any representation i.e. using linear Equations, Hierarchical Graph Representation, Tabular form etc.

- The NextMove function will move the Target move like out of these move which will provide more success rate.

- For Example : while playing chess machine have 4 possible moves, so the machine will choose that optimized move which will provide success to it.

Designing a Learning System (Cont.)

Step 4- Choosing Function Approximation Algorithm:

- An optimized move cannot be chosen just with the training data.
- The training data had to go through with set of example and through these examples the training data will approximates which steps are chosen and after that machine will provide feedback on it.
- For Example : When a training data of Playing chess is fed to algorithm so at that time it is not machine algorithm will fail or get success and again from that failure or success it will measure while next move what step should be chosen and what is its success rate.

Designing a Learning System (Cont.)

Step 5- Final Design:

The final design is created at last when system goes from number of examples, failures and success, correct and incorrect decision and what will be the next step etc.

Example: DeepBlue is an intelligent computer which is ML-based won chess game against the chess expert Garry Kasparov, and it became the first computer which had beaten a human chess expert.

Learning Models

Machine learning is concerned with using the right features to build the right models that achieve the right tasks.

The basic idea of Learning models has divided into three categories.

For a given problem, the collection of all possible outcomes represents the sample space or instance space.

- **Using a Logical expression. (Logical models)**
- **Using the Geometry of the instance space. (Geometric models)**
- **Using Probability to classify the instance space. (Probabilistic models)**

An **instance space** is the space of all possible instances for some learning task.

Instance: In machine learning, an instance is a single observation of data.

A **learning task** is a decisioning task that requires improved task performance.

Learning Models

Logical models use a logical expression to divide the instance space into segments and hence construct grouping models.

A logical expression is an expression that returns a Boolean value, i.e., a True or False outcome. Once the data is grouped using a logical expression, the data is divided into homogeneous groupings for the problem we are trying to solve.

For example, for a classification problem, all the instances in the group belong to one class.

Learning Models

- **There are mainly two kinds of logical models:**
  - Tree models and Rule models.

Rule models consist of a collection of implications or IF-THEN rules.

For tree-based models, the 'if-part' defines a segment and the 'then-part' defines the behaviour of the model for this segment. Rule models follow the same reasoning.

Learning Models

Logical models and Concept learning

- To understand logical models further, we need to understand the idea of Concept Learning.
- Concept Learning **involves learning logical expressions or concepts from examples.** The idea of Concept Learning fits in well with the idea of Machine learning, i.e., inferring a general function from specific training examples.
- **Concept learning forms the basis of both tree-based and rule-based models.**
- **A Formal Definition for Concept Learning is "The inferring of a Boolean-valued function from training examples of its input and output."**

Learning Models

The following example explains this idea in more detail.

A Concept Learning Task – Enjoy Sport
Training Examples

Example	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
1	Sunny	Warm	Normal	Strong	Warm	Same	YES
2	Sunny	Warm	High	Strong	Warm	Same	YES
3	Rainy	Cold	High	Strong	Warm	Change	NO
4	Sunny	Warm	High	Strong	Warm	Change	YES

ATTRIBUTES

CONCEPT

Learning Models

Geometric models

In the previous section, we have seen that with logical models, such as decision trees, **a logical expression is used to partition the instance space. Two instances are similar when they end up in the same logical segment.**

In this section, we consider models that define similarity by considering the geometry of the instance space. **In Geometric models, features could be described as points in two dimensions (x- and y-axis) or a three-dimensional space (x, y, and z).**

Even when features are not intrinsically geometric, they could be modelled in a geometric manner (for example, temperature as a function of time can be modelled in two axes). In geometric models, there are two ways we could impose similarity.

Learning Models

We could use geometric concepts like lines or planes to segment (classify) the instance space.These are called Linear models.

Alternatively, **we can use the geometric notion of distance to represent similarity. In this case, if two points are close together, they have similar values for features and thus can be classed as similar. We call such models as Distance-based models.**

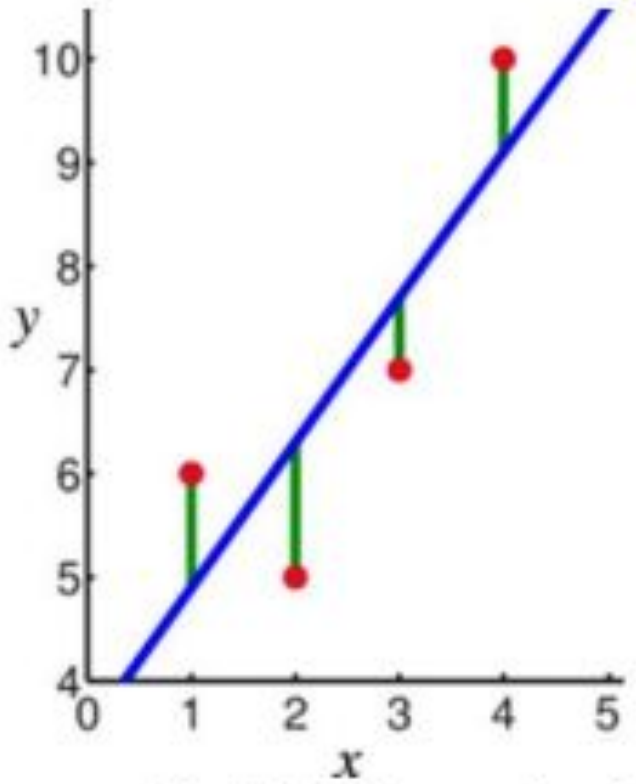
Learning Models

Linear models

Linear models are relatively simple. In this case, the function is represented as a linear combination of its inputs. Thus, if x1 and x2 are two scalars or vectors of the same dimension and a and b are arbitrary scalars, then ax1 + bx2 represents a linear combination of x1 and x2.

In the simplest case where f(x) represents a straight line, we have an equation of the form f (x) = mx + c where c represents the intercept and m represents the slope.

Learning Models



Learning Models

Linear models are parametric, which means that they have a fixed form with a small number of numeric parameters that need to be learned from data.

L**inear models are stable,** i.e., small variations in the training data have only a limited impact on the learned model.

Learning Models

Distance-based models

Distance-based models are the second class of Geometric models. Like Linear models, **distance- based models are based on the geometry of data.** As the name implies**, distance-based models work on the concept of distance.**

In the context of Machine learning, the concept of distance is n**ot based on merely the physical distance between two points. Instead, we could think of the distance between two points considering the mode of transport between two points.**

Travelling between two cities by plane covers less distance physically than by train because a plane is unrestricted.

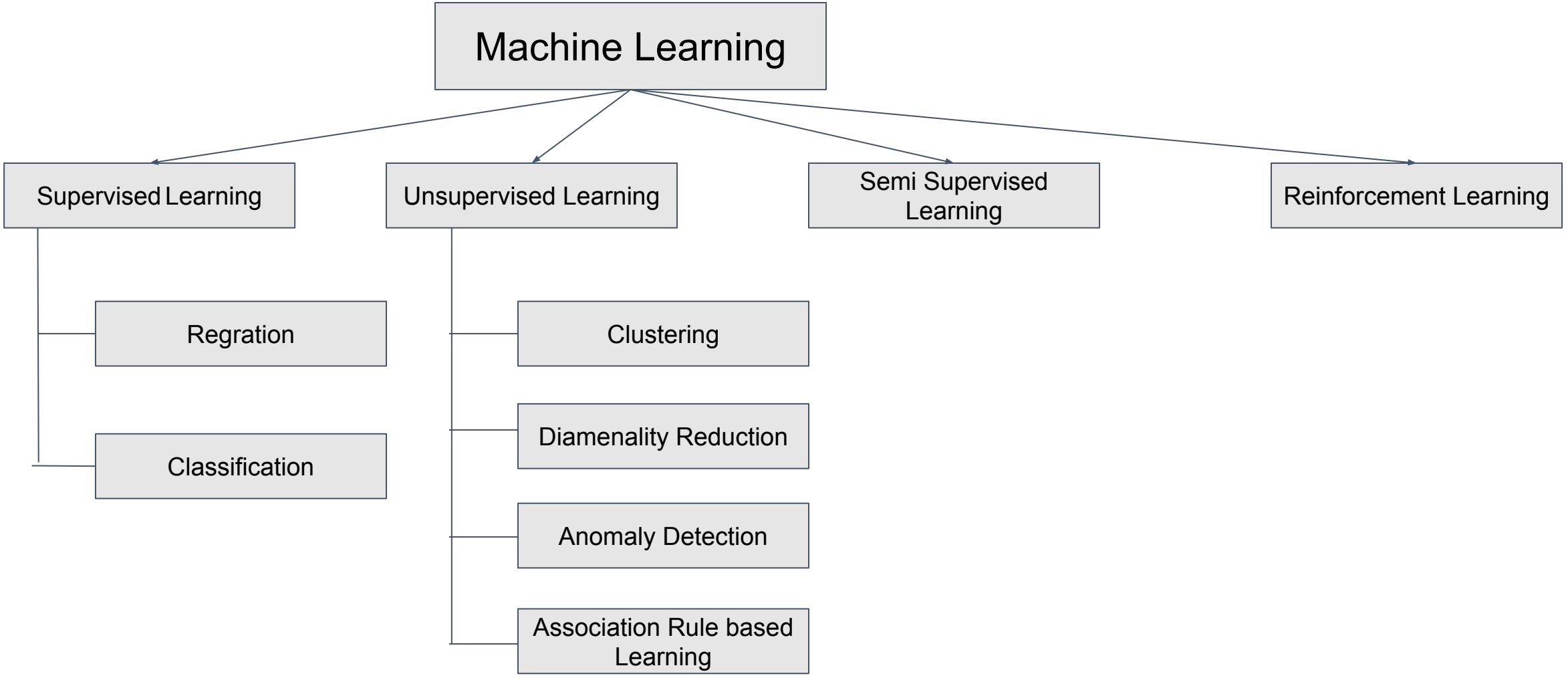
Types of Machine Learning

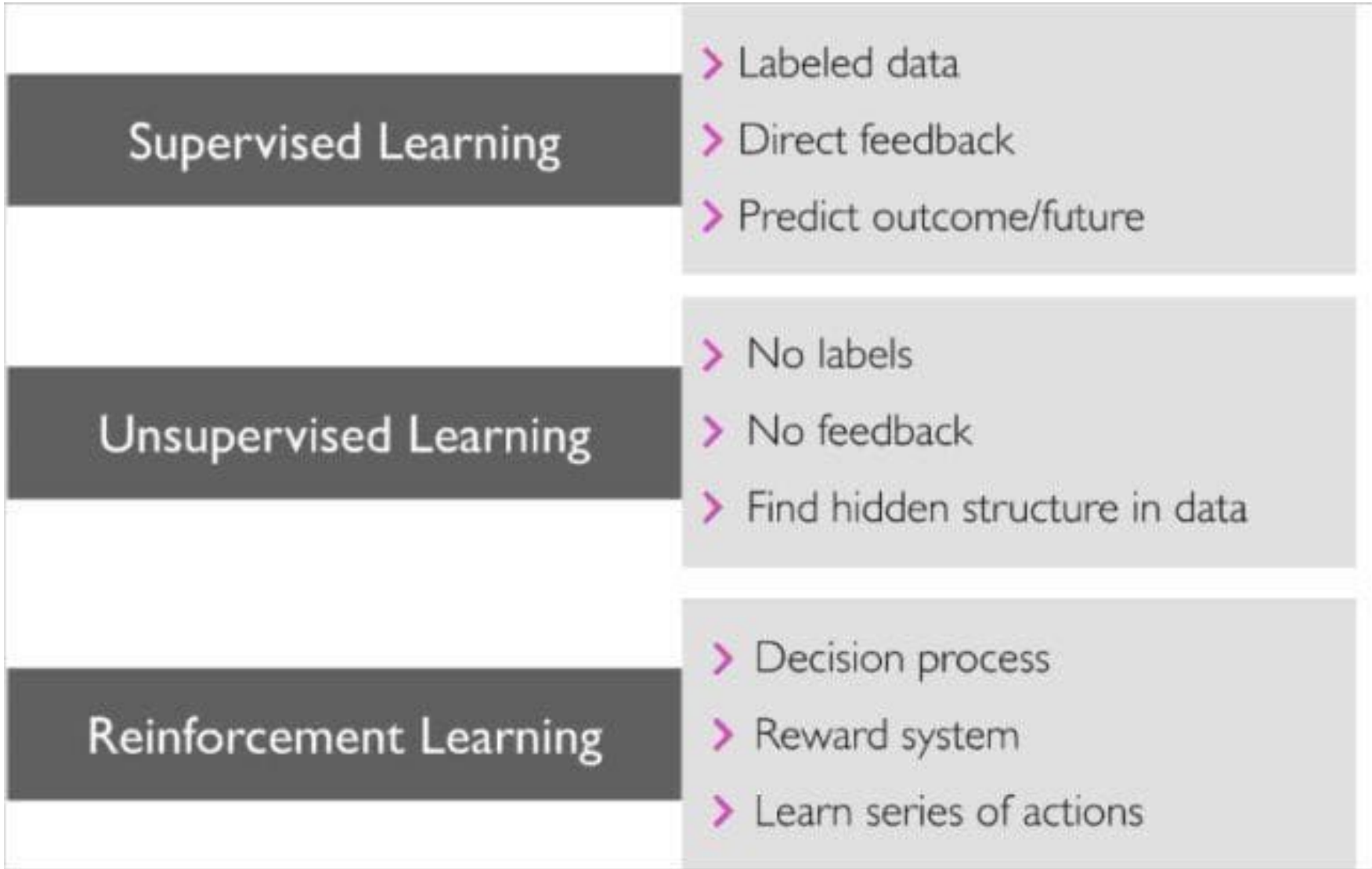
- Machine learning contains a set of algorithms that work on a huge amount of data. Data is fed to these algorithms to train them, and on the basis of training, they build the model & perform a specific task.

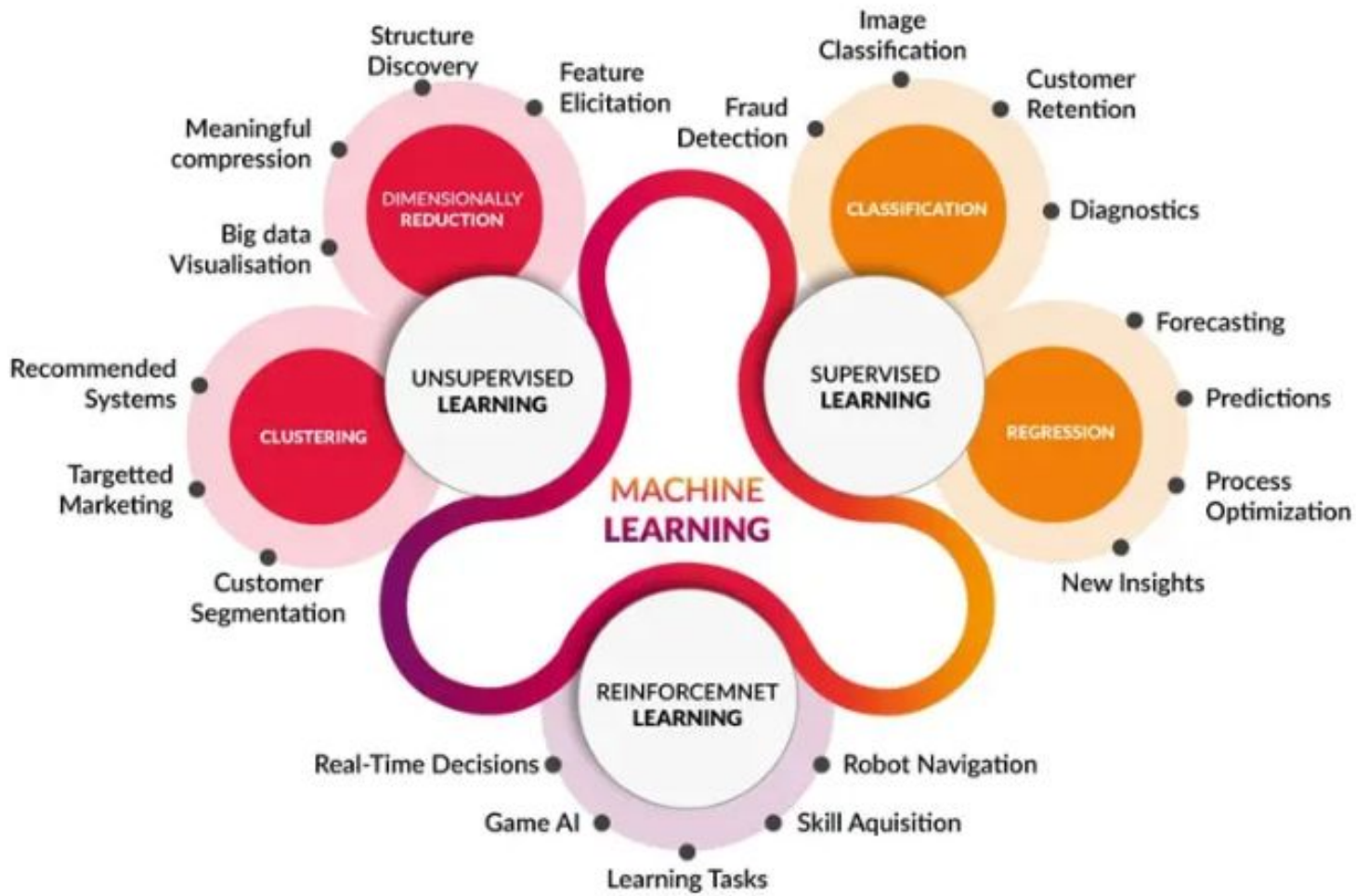
- These ML algorithms help to solve different business problems like Regression, Classification, Forecasting, Clustering, and Associations, etc.

- Based on the methods and way of learning, machine learning is divided into mainly three types, which are:
  1. Supervised Machine Learning
  2. Unsupervised Machine Learning
  3. Semi-Supervised Machine Learning
  4. Reinforcement Learning

Types of Machine Learning



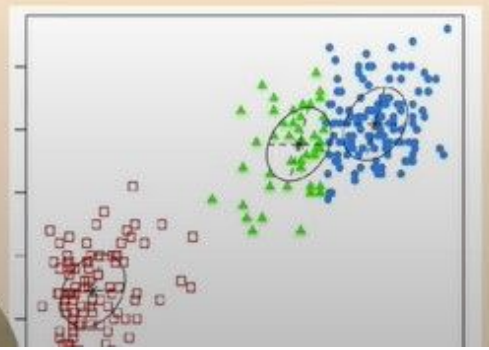

Supervised Learning
Labeled data
Direct feedback
Predict outcome/future
Unsupervised Learning
No labels
No feedback
Find hidden structure in data
Reinforcement Learning
Decision process
Reward system
Learn series of actions


MACHINE LEARNING
UNSUPERVISED LEARNING
SUPERVISED LEARNING
REINFORCEMNET LEARNING
DIMENSIONALLY REDUCTION
CLUSTERING
CLASSIFICATION
REGRESSION
Structure Discovery
Feature Elicitation
Meaningful compression
Big data Visualisation
Recommended Systems
Targetted Marketing
Customer Segmentation
Image Classification
Customer Retention
Fraud Detection
Diagnostics
Forecasting
Predictions
Process Optimization
New Insights
Real-Time Decisions
Robot Navigation
Game AI
Skill Aquisition
Learning Tasks

Unsupervised Learning

- ➔ Unlabeled data X
- ➔ Learn X
- ➔ Generate fakes, insights

"This product does what it is supposed to. I always keep three of these in my kitchen just in case ever I need a replacement cord."



Supervised Learning

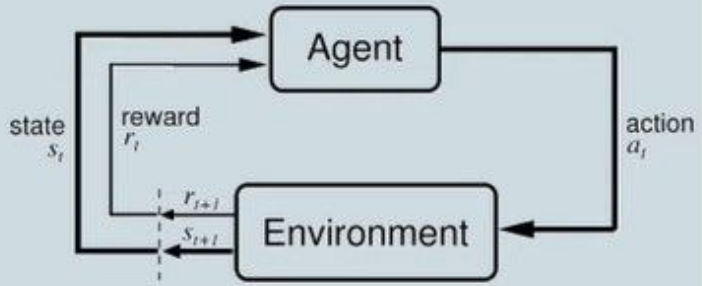
- ➔ Labeled data X and Y
- ➔ Learn X -> Y
- ➔ Make Predictions

→ *cat*

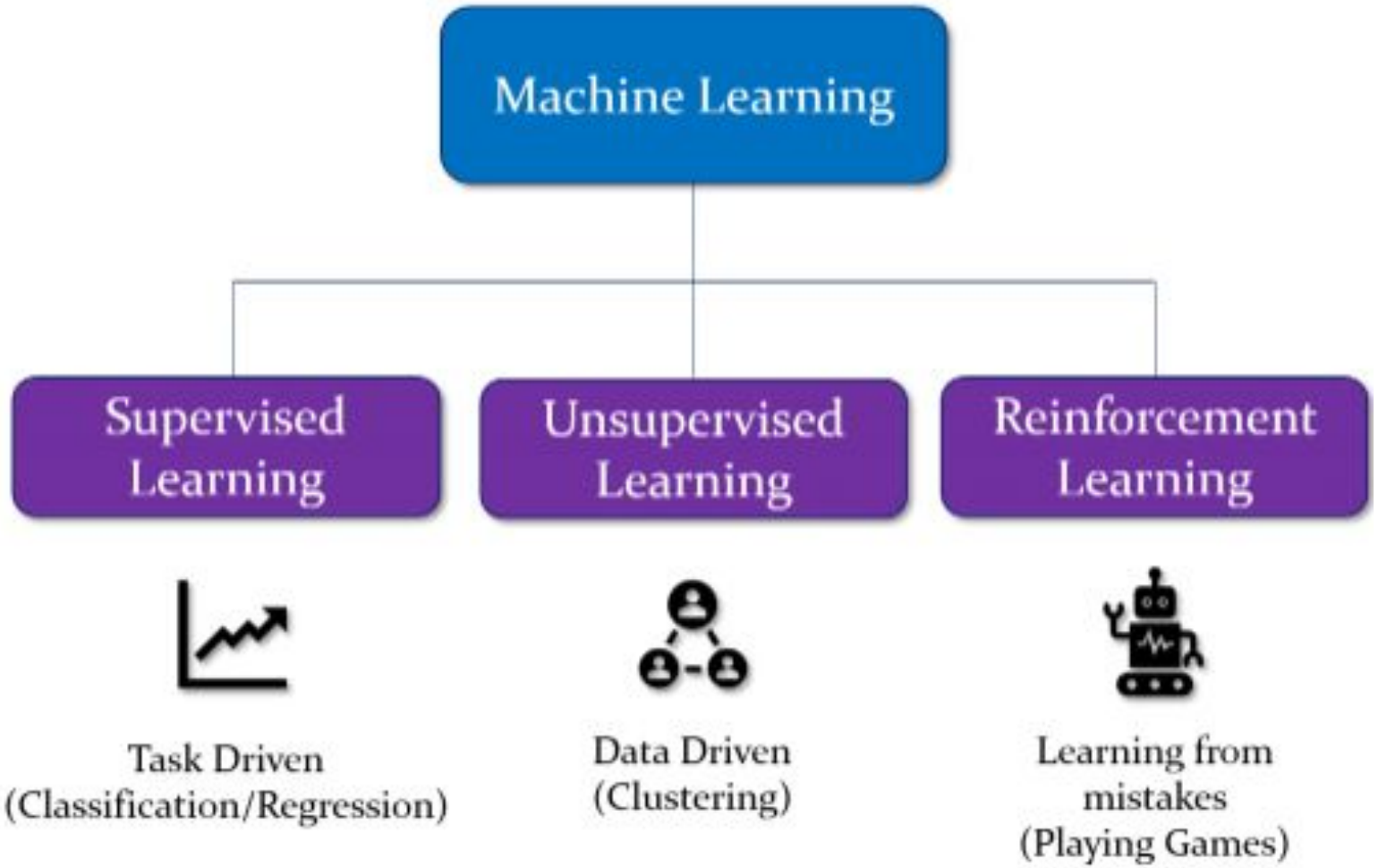
→ *"Hey Siri"*

Reinforcement Learning

- ➔ Learn how to take Actions in an Environment



classify based on task



Types of Machine Learning (cont.)

1. Supervised Machine Learning:

As its name suggests, Supervised machine learning is based on supervision.

It means in the supervised learning technique, we train the machines using the "labelled" dataset, and based on the training, the machine predicts the output.

Here, the labelled data specifies that some of the inputs are already mapped to the output.

More precisely, we can say; first, we train the machine with the input and corresponding output, and then we ask the machine to predict the output using the test dataset.

Types of Machine Learning (cont.)

- Suppose we have an input dataset of cats and dog images.
- So, first, we will provide the training to the machine to understand the images, such as the shape & size of the tail of cat and dog, Shape of eyes, colour, height (dogs are taller, cats are smaller), etc.
- After completion of training, we input the picture of a cat and ask the machine to identify the object and predict the output.
- Now, the machine is well trained, so it will check all the features of the object, such as height, shape, colour, eyes, ears, tail, etc., and find that it's a cat.
- So, it will put it in the Cat category. This is the process of how the machine identifies the objects in Supervised Learning.

Types of Machine Learning (cont.)

- The main goal of the supervised learning technique is to map the input variable(x) with the output variable(y). Some real-world applications of supervised learning are Risk Assessment, Fraud Detection, Spam filtering, etc.

Categories of Supervised Machine Learning

- Supervised machine learning can be classified into two types of problems, which are given below:
  - **i.** Classification
  - **ii.** Regression

Types of Machine Learning (cont.)

a) Classification

- Classification algorithms are used to solve the classification problems in which the output variable is categorical, such as "Yes" or No, Male or Female, Red or Blue, etc.
- The classification algorithms predict the categories present in the dataset. Some real-world examples of classification algorithms are Spam Detection, Email filtering, etc.
- Some popular classification algorithms are given below:
  - **i.** Random Forest Algorithm
  - **ii.** Decision Tree Algorithm
  - **iii.** Logistic Regression Algorithm
  - **iv.** Support Vector Machine Algorithm

Types of Machine Learning (cont.)

b) Regression

- Regression algorithms are used to solve regression problems in which there is a linear relationship between input and output variables. These are used to predict continuous output variables, such as market trends, weather prediction, etc.

Some popular Regression algorithms are given below:

i. Simple Linear Regression Algorithm
ii. Multivariate Regression Algorithm
iii. Decision Tree Algorithm
iv. Lasso Regression

Types of Machine Learning (cont.)

Advantages and Disadvantages of Supervised Learning

Advantages:

- Since supervised learning work with the labelled dataset so we can have an exact idea about the classes of objects.
- These algorithms are helpful in predicting the output on the basis of prior experience.

Disadvantages:

- These algorithms are not able to solve complex tasks.
- It may predict the wrong output if the test data is different from the training data.
- It requires lots of computational time to train the algorithm.

Types of Machine Learning (cont.)

Applications of Supervised Learning

Image Segmentation:

Supervised Learning algorithms are used in image segmentation. In this process, image classification is performed on different image data with pre-defined labels.

Medical Diagnosis:

Supervised algorithms are also used in the medical field for diagnosis purposes. It is done by using medical images and past labelled data with labels for disease conditions. With such a process, the machine can identify a disease for the new patients.

Fraud Detection:

Supervised Learning classification algorithms are used for identifying fraud transactions, fraud customers, etc. It is done by using historic data to identify the patterns that can lead to possible fraud.

Spam detection:

In spam detection & filtering, classification algorithms are used. These algorithms classify an email as spam or not spam. The spam emails are sent to the spam folder.

Speech Recognition:

Supervised learning algorithms are also used in speech recognition. The algorithm is trained with voice data, and various identifications can be done using the same, such as voice-activated passwords, voice commands, etc.

Types of Machine Learning (cont.)

2. Unsupervised Machine Learning:

Unsupervised learning is different from the Supervised learning technique; as its name suggests, there is no need for supervision. It means, in unsupervised machine learning, the machine is trained using the unlabeled dataset, and the machine predicts the output without any supervision.

In unsupervised learning, the models are trained with the data that is neither classified nor labelled, and the model acts on that data without any supervision.

Types of Machine Learning (cont.)

The main aim of the unsupervised learning algorithm is to group or categories the unsorted dataset according to the similarities, patterns, and differences.

Machines are instructed to find the hidden patterns from the input dataset.

Let's take an example to understand it more precisely; suppose there is a basket of fruit images, and we input it into the machine learning model. The images are totally unknown to the model, and the task of the machine is to find the patterns and categories of the objects.

So, now the machine will discover its patterns and differences, such as colour difference, shape difference, and predict the output when it is tested with the test dataset.

Categories of Unsupervised Machine Learning

Unsupervised Learning can be further classified into two types, which are given below:

- **Clustering**
- **Association**

Types of Machine Learning (cont.)

1) Clustering

The clustering technique is used when we want to find the inherent groups from the data. It is a way to group the objects into a cluster such that the objects with the most similarities remain in one group and have fewer or no similarities with the objects of other groups. An example of the clustering algorithm is grouping the customers by their purchasing behaviour.

Some of the popular clustering algorithms are given below:

- **K-Means Clustering algorithm**
- **Mean-shift algorithm**
- **DBSCAN Algorithm**
- **Principal Component Analysis**
- **Independent Component Analysis**

Types of Machine Learning (cont.)

2) Association

Association rule learning is an unsupervised learning technique, which finds interesting relations among variables within a large dataset.

The main aim of this learning algorithm is to find the dependency of one data item on another data item and map those variables accordingly so that it can generate maximum profit. This algorithm is mainly applied in **Market Basket analysis, Web usage mining, continuous production**, etc.

Some popular algorithms of Association rule learning are **Apriori Algorithm, Eclat, FP-growth algorithm.**

Types of Machine Learning (cont.)

Advantages and Disadvantages of Unsupervised Learning Algorithm

Advantages:

- These algorithms can be used for complicated tasks compared to the supervised ones because these algorithms work on the unlabeled dataset.
- Unsupervised algorithms are preferable for various tasks as getting the unlabeled dataset is easier as compared to the labelled dataset.

Disadvantages:

- The output of an unsupervised algorithm can be less accurate as the dataset is not labelled, and algorithms are not trained with the exact output in prior.
- Working with Unsupervised learning is more difficult as it works with the unlabelled dataset that does not map with the output.

Types of Machine Learning (cont.)

Applications of Unsupervised Learning

- **Network Analysis:** Unsupervised learning is used for identifying plagiarism and copyright in document network analysis of text data for scholarly articles.
- **Recommendation Systems:** Recommendation systems widely use unsupervised learning techniques for building recommendation applications for different web applications and e-commerce websites.
- **Anomaly Detection:** Anomaly detection is a popular application of unsupervised learning, which can identify unusual data points within the dataset. It is used to discover fraudulent transactions.
- **Singular Value Decomposition:** Singular Value Decomposition or SVD is used to extract particular information from the database. For example, extracting information of each user located at a particular location.

Types of Machine Learning (cont.)

3) Reinforcement Learning

Reinforcement learning works on a feedback-based process, in which an AI agent (A software component) automatically explore its surrounding by hitting & trail, taking action, learning from experiences, and improving its performance. Agent gets rewarded for each good action and get punished for each bad action; hence the goal of reinforcement learning agent is to maximize the rewards.

In reinforcement learning, there is no labelled data like supervised learning, and agents learn from their experiences only.

The reinforcement learning process is similar to a human being; for example, a child learns various things by experiences in his day-to-day life. An example of reinforcement learning is to play a game, where the Game is the environment, moves of an agent at each step define states, and the goal of the agent is to get a high score. Agent receives feedback in terms of punishment and rewards.

Types of Machine Learning (cont.)

Due to its way of working, reinforcement learning is employed in different fields such as **Game theory, Operation Research, Information theory, multi-agent systems.**

A reinforcement learning problem can be formalized using **Markov Decision Process(MDP).** In MDP, the agent constantly interacts with the environment and performs actions; at each action, the environment responds and generates a new state.

Categories of Reinforcement Learning

Reinforcement learning is categorized mainly into two types of methods/algorithms:

- **Positive Reinforcement Learning:** Positive reinforcement learning specifies increasing the tendency that the required behaviour would occur again by adding something. It enhances the strength of the behaviour of the agent and positively impacts it.
- **Negative Reinforcement Learning:** Negative reinforcement learning works exactly opposite to the positive RL. It increases the tendency that the specific behaviour would occur again by avoiding the negative condition.

Types of Machine Learning (cont.)

Real-world Use cases of Reinforcement Learning

- **Video Games:**
  RL algorithms are much popular in gaming applications. It is used to gain super-human performance. Example : **AlphaGO** and **AlphaGO Zero**.
- **Resource Management:**
  The "Resource Management with Deep Reinforcement Learning" paper showed that how to use RL in computer to automatically learn and schedule resources to wait for different jobs in order to minimize average job slowdown.
- **Robotics:**
  RL is widely being used in Robotics applications. Robots are used in the industrial and manufacturing area, and these robots are made more powerful with reinforcement learning. There are different industries that have their vision of building intelligent robots using AI and Machine learning technology.
- **Text Mining**
  Text-mining, one of the great applications of NLP, is now being implemented with the help of Reinforcement Learning by Salesforce company.

Types of Machine Learning (cont.)

Advantages and Disadvantages of Reinforcement Learning

Advantages

- It helps in solving complex real-world problems which are difficult to be solved by general techniques.
- The learning model of RL is similar to the learning of human beings; hence most accurate results can be found.
- Helps in achieving long term results.

Disadvantage

- RL algorithms are not preferred for simple problems.
- RL algorithms require huge data and computations.
- Too much reinforcement learning can lead to an overload of states which can weaken the results.

The curse of dimensionality limits reinforcement learning for real physical systems.

Types of Machine Learning (cont.)

3. Semi-Supervised Learning

Semi-Supervised learning is a type of Machine Learning algorithm that lies between Supervised and Unsupervised machine learning. It represents the intermediate ground between Supervised (With Labelled training data) and Unsupervised learning (with no labelled training data) algorithms and uses the combination of labelled and unlabeled datasets during the training period.

To overcome the drawbacks of supervised learning and unsupervised learning algorithms, the concept of Semi-supervised learning is introduced. The main aim of semi-supervised learning is to effectively use all the available data, rather than only labelled data like in supervised learning. Initially, similar data is clustered along with an unsupervised learning algorithm, and further, it helps to label the unlabeled data into labelled data. It is because labelled data is a comparatively more expensive acquisition than unlabeled data.

Types of Machine Learning (cont.)

Advantages and disadvantages of Semi-supervised Learning

Advantages:

- It is simple and easy to understand the algorithm.
- It is highly efficient.
- It is used to solve drawbacks of Supervised and Unsupervised Learning algorithms.

Disadvantages:

- Iterations results may not be stable.
- Accuracy is low.