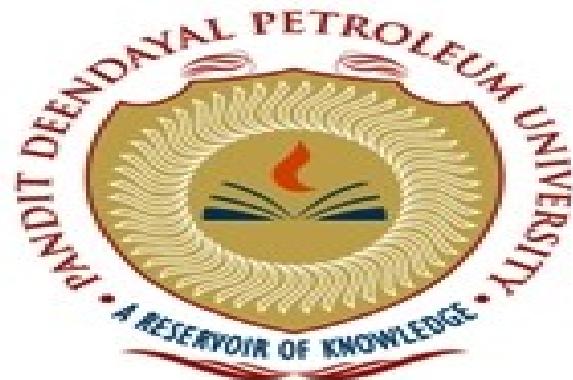


Artificial Intelligence(23CP307T)

AI Introduction



Course Coordinator: Dr. Sidheswar Routray

Course Faculty: Dr. Shilpa Pandey, Dr. Davinder Singh, Dr. Trishna Paul, Dr. Azriel Henry

**Department of Computer Science & Engineering
School of Technology**

Syllabus

Unit-I: INTRODUCTION TO AI AND SEARCHING

- ❖ AI Problems, Intelligent Agents, Problem Formulation, Basic Problem Solving Methods. Search strategies, Uniformed Search Strategies, State-Space Search, Bi-Directional Search, BFS, DFS, Heuristic Search Strategies, Local Search Algorithms, Hill Climbing, Greedy Best First Search, A* Search, Simulated Annealing, Measure of performance and analysis of search algorithms.

Unit –II: KNOWLEDGE REPRESENTATION AND INFERENCE

- ❖ Game playing, Knowledge representation using-Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic, Structured representation of knowledge, Production based system, Frame based system, First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution.

Unit – III: NEURAL NETWORKS

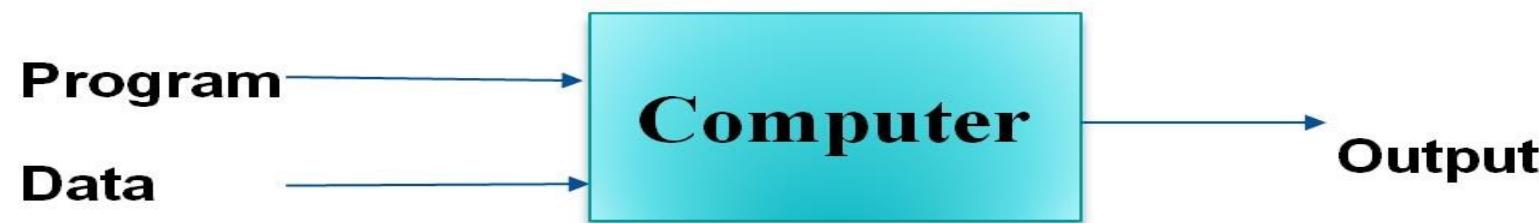
- ❖ Characteristics of Neural Networks, Historical Development of Neural Networks Principles. Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.

Unit –IV: Expert System

- ❖ Introduction to Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Example of expert systems - MYCIN, DART, XOOM, Expert systems shells, Introduction to Planning.

Traditional Programming

- Traditional programming is a manual process where programmer need to write a program that uses input data and runs on a computer to produce the output.



- Ex. C, C++, Java, Python etc.

Convert °C To °F

- The equation is as follows:

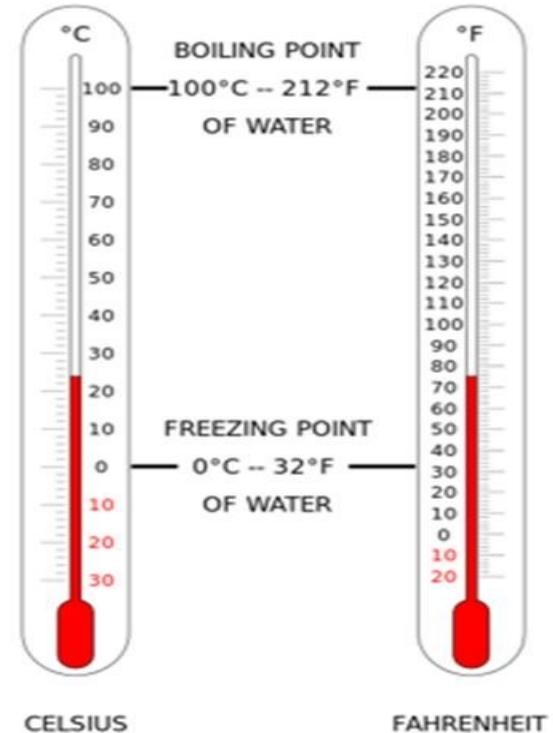
$$T(\text{°F}) = T(\text{°C}) \times 9/5 + 32$$

```
#include<stdio.h>

int main()
{
    float f, c;
    printf("Enter temperature in Celcius =");
    scanf("%f", &c);
    f = 9.0 / 5.0 * c + 32;
    printf("The temperature in Fahrenheit is = %.1f f", f);
    return 0;
}
```

- For Example, let's convert 5°C celsius temperature to F.

$$T(\text{°F}) = (5\text{°C} \times 9/5) + 32 = 41\text{°F}$$



- Based on Rule

Limitation: Not possible to write code for each real time problem.

Artificial Intelligence

- Artificial intelligence (AI) involves machines that can execute tasks that are similar to that of human intelligence; they were first invented in 1956 by John McCarthy.

- AI, the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

What is intelligence?

1) Learning

- The simplest is learning by **trial and error**. For example, a simple computer program for solving mate-in-one chess problems might try moves at random until mate is found. The program might then store the solution with the position so that the next time the computer encountered the same position it would recall the solution.
- This simple memorizing of individual items and procedures—known as **rote learning**—is relatively easy to implement on a computer.
- More challenging is the problem of implementing what is called **generalization**. Generalization involves applying past experience to related new situations.

2) Problem solving

- Problem solving, particularly in artificial intelligence, may be characterized as a **systematic search** through a range of possible actions in order to reach some predefined goal or solution.
- Problem-solving methods divide into **special purpose and general purpose**. A special-purpose method is tailor-made for a particular problem and often exploits very specific features of the situation in which the problem is embedded.
- In contrast, a general-purpose method is applicable to a wide variety of problems.

3) Reasoning

- To reason is to **draw inferences** appropriate to the situation. Inferences are classified as either **deductive or inductive**.
 - An example of the former is, “Sachin must be in either the museum or the café. He is not in the café; therefore he is in the museum,”
 - In inductive, “Previous accidents of this sort were caused by instrument failure; therefore this accident was caused by instrument failure.”
- The most significant difference between these forms of reasoning is that in the deductive case the truth of the premises **guarantees the truth of the conclusion**, whereas in the inductive case the truth of the premise lends support to the **conclusion without giving absolute assurance**.
- Inductive reasoning is common in **science**, where data are collected and tentative models are developed to describe and predict future behaviour—until the appearance of anomalous data forces the model to be revised.
- Deductive reasoning is common in **mathematics and logic**, where elaborate structures of irrefutable theorems are built up from a small set of basic rules.

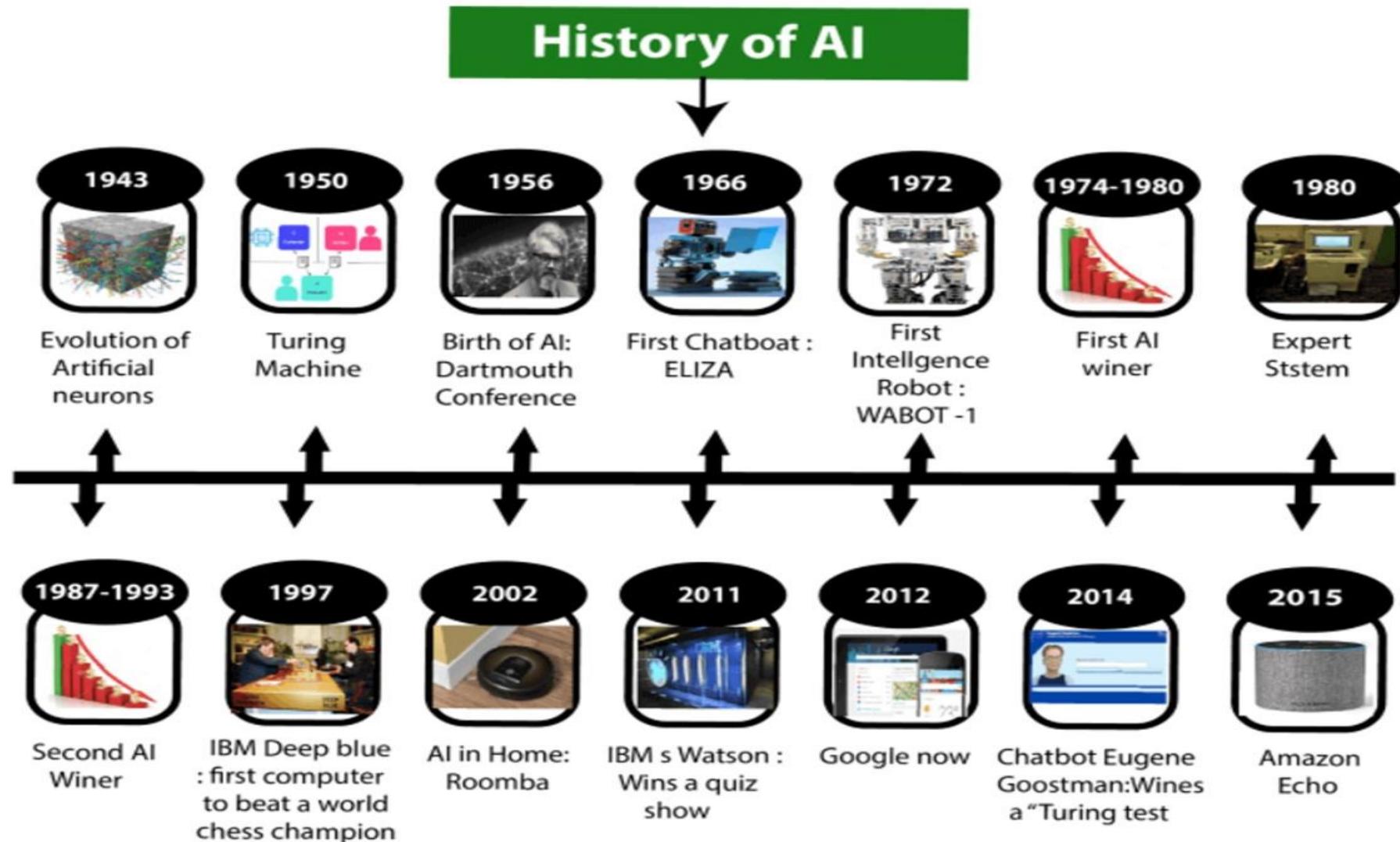
4) Perception

- In perception the environment is scanned by means of various sensory organs, real or artificial, and the scene is decomposed into separate objects in various spatial relationships.
- Analysis is complicated by the fact that an object may appear different depending on the angle from which it is viewed, the direction and intensity of illumination in the scene, and how much the object contrasts with the surrounding field.

5) Language

- A language is a system of **signs having meaning by convention**. In this sense, language need not be confined to the spoken word.
 - Traffic signs, for example, form a minilanguage, it being a matter of convention that Δ means “hazard ahead” in some countries.

History of Artificial Intelligence



❖Maturation of Artificial Intelligence (1943-1952)

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of **artificial neurons**.
- **Year 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.
- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes "**Computing Machinery and Intelligence**" in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.

❖ The birth of Artificial Intelligence (1952-1956)

- **Year 1955:** An Allen Newell and Herbert A. Simon created the "first artificial intelligence program" Which was named as "**Logic Theorist**". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field.

❖ The golden years-Early enthusiasm (1956-1974)

- **Year 1966:** The researchers emphasized developing algorithms which can solve mathematical problems. W. Joseph created the first chatbot in 1966, which was named as ELIZA.

❖ The first AI winter (1974-1980)

- The duration between years 1974 to 1980 was the first AI winter duration. AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches.
- During AI winters, an interest of publicity on artificial intelligence was decreased.

❖ A boom of AI (1980-1987)

- **Year 1980:** After AI winter duration, AI came back with "**Expert System**". Expert systems were programmed that emulate the decision-making ability of a human expert.
- In the Year 1980, the first national conference of the American Association of Artificial Intelligence **was held at Stanford University**.

❖ The second AI winter (1987-1993)

- The duration between the years 1987 to 1993 was the second AI Winter duration.
- Again Investors and government stopped in funding for AI research as due to high cost but not efficient result. The expert system such as XCON was very cost effective.

❖ The emergence of intelligent agents (1993-2011)

- **Year 1997:** In the year 1997, **IBM Deep Blue** beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- **Year 2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- **Year 2006:** AI came in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

❖ Deep learning, big data and artificial general intelligence (2011-present)

- **Year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- **Year 2012:** Google has launched an **Android app feature "Google now"**, which was able to provide information to the user as a prediction.
- **Year 2014:** In the year 2014, **Chatbot** won a competition in the infamous "Turing test."
- **Year 2018:** The "**Project Debater**" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "**Duplex**" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.

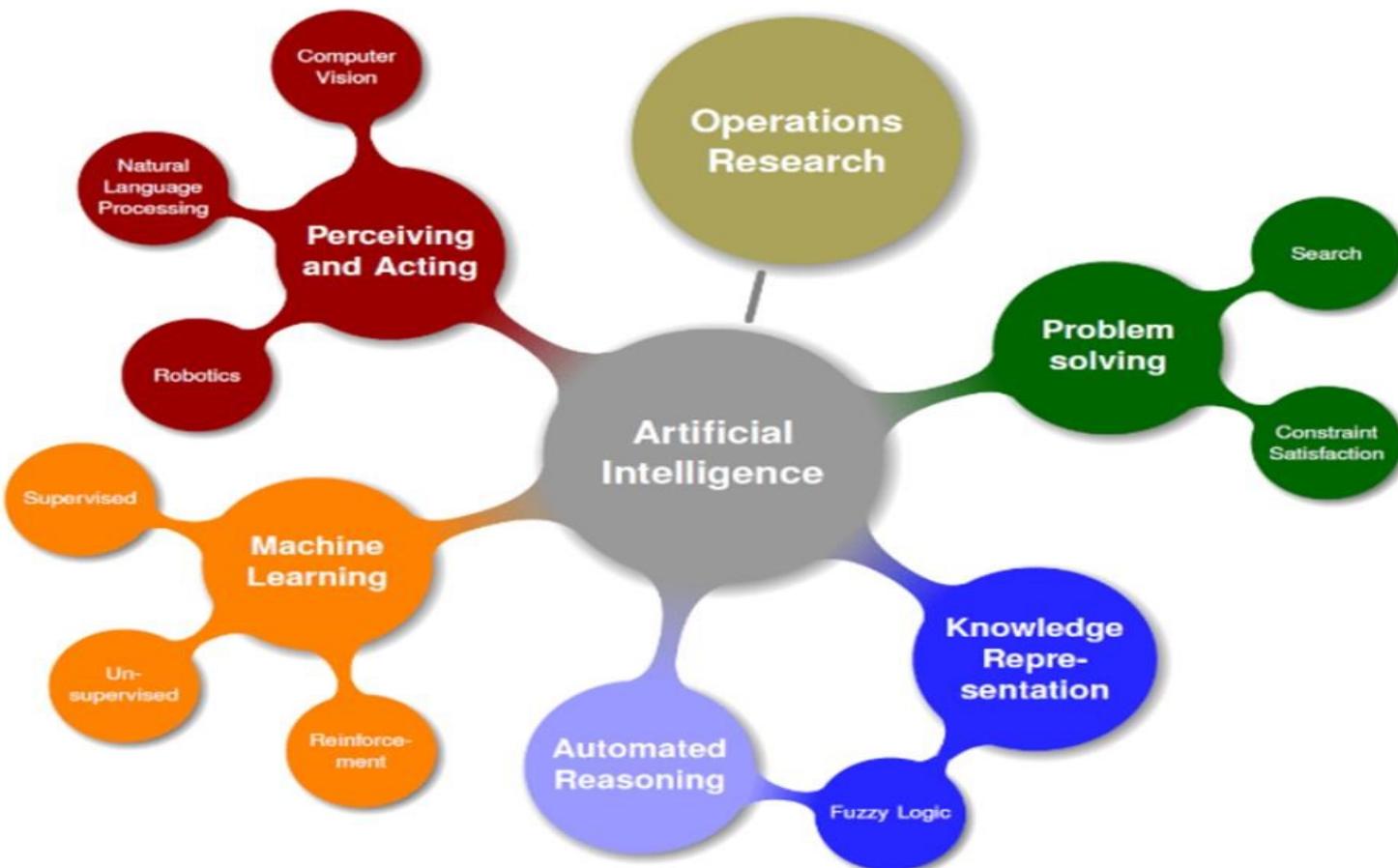
Artificial Intelligence

➤ AI has three different levels:

- **Narrow AI:** An artificial intelligence is said to be narrow **when the machine can perform a specific task better than a human.** The current research of AI is here now
- **General AI:** An artificial intelligence reaches the general state **when it can perform any intellectual task with the same accuracy** level as a human would
- **Active AI:** An AI is active when it can **beat humans** in many tasks



Different Areas Under Artificial Intelligence



Artificial Intelligence, Machine Learning and Deep Learning

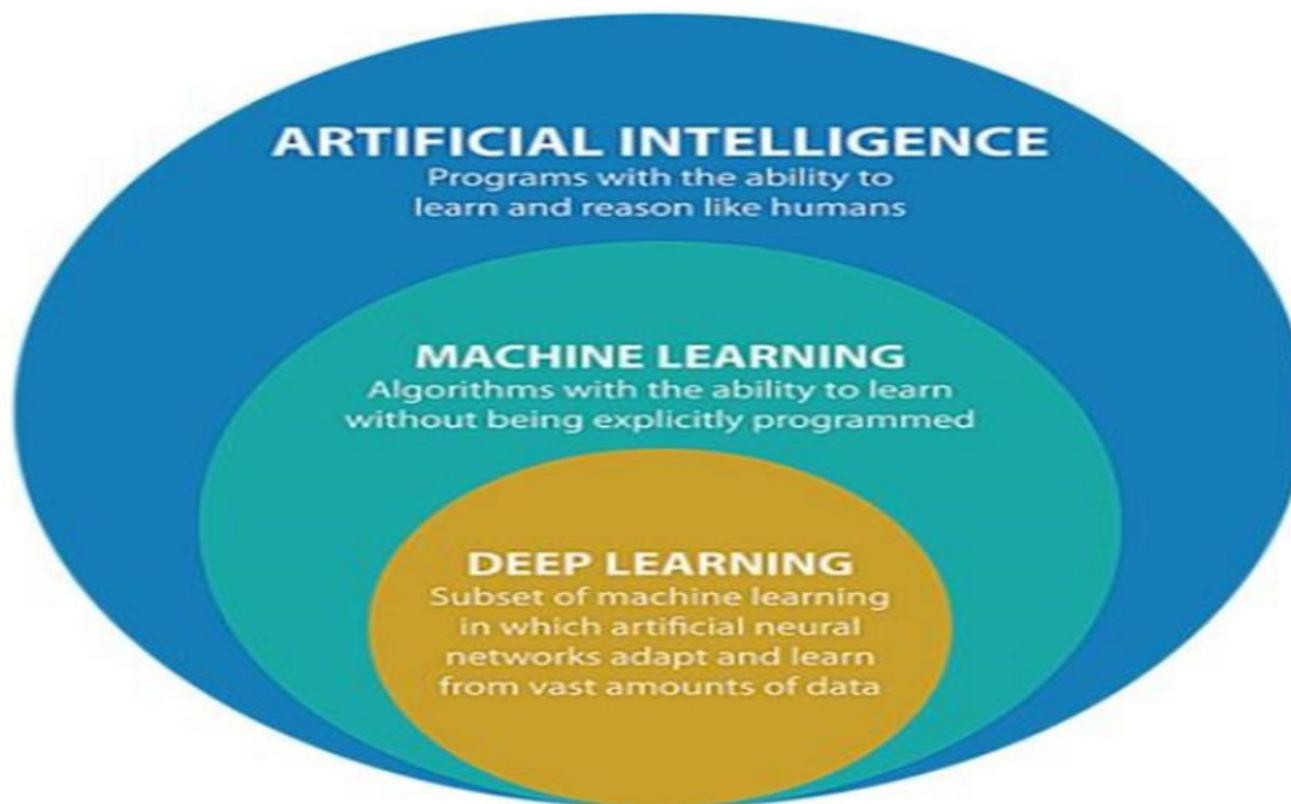


Image Source: <https://datacatchup.com/artificial-intelligence-machine-learning-and-deep-learning/>

Machine learning

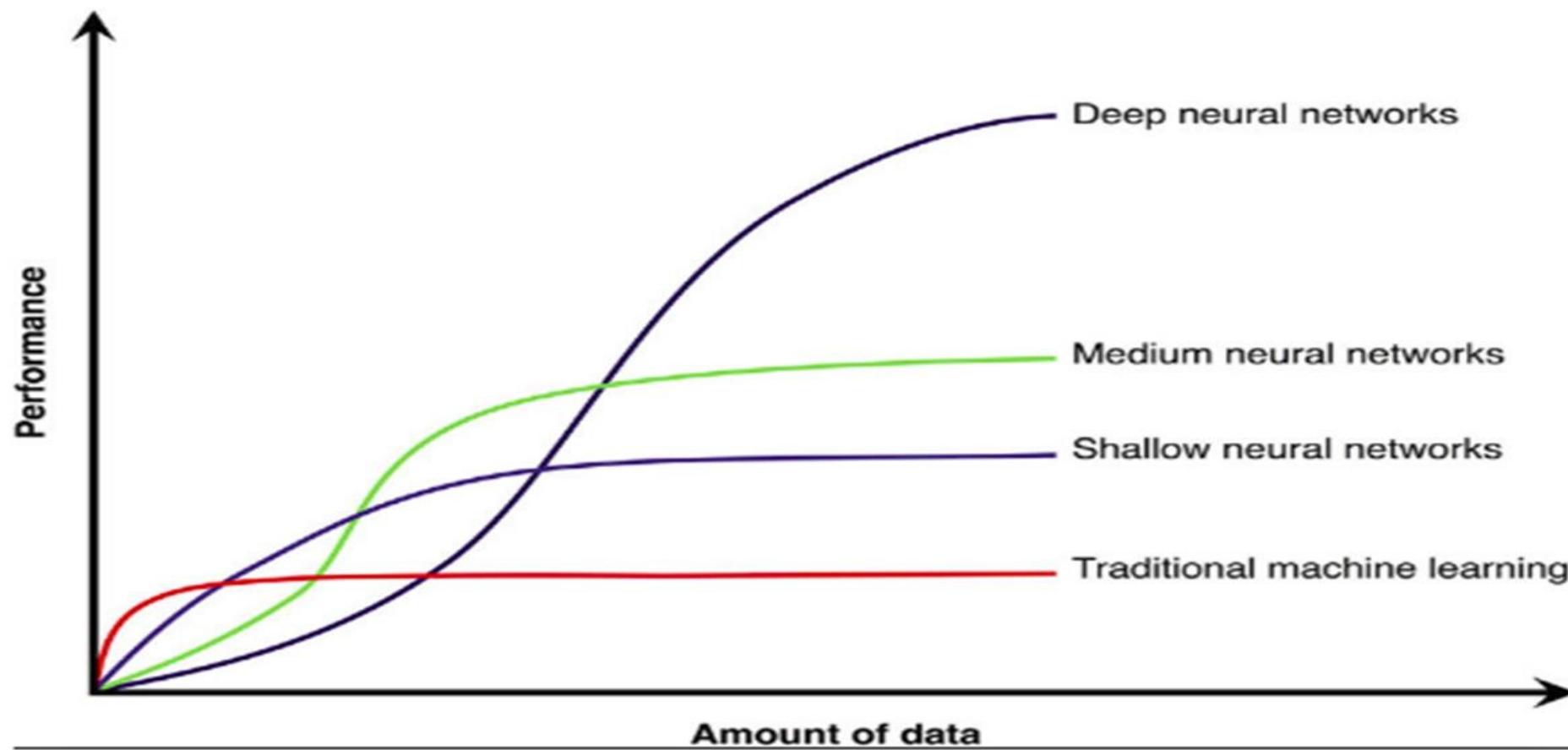
- Machine learning is a simple way of achieving AI. Arthur Samuel summoned the phrase not long after AI, in 1960, defining it as, “the capability to train without being overtly programmed”.

Deep learning

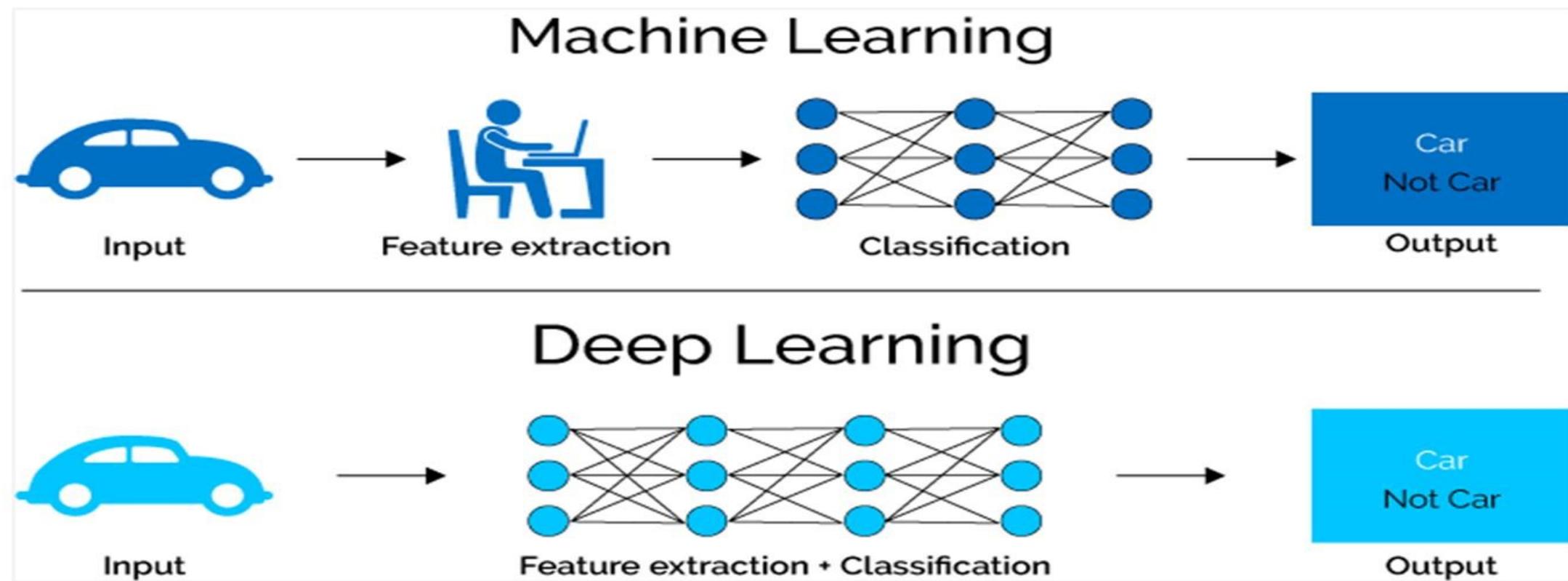
- It is a subset of machine learning and is called deep learning because it makes use of deep neural networks. Deep learning is a computer software that mimics the network of neurons in a brain.
- In deep learning, the learning phase is done through a neural network. A neural network is an architecture where the layers are stacked on top of each other

Machine Learning and Deep Learning

Performance w.r.t. Data



Machine Learning v/s Deep Learning



When to use ML or DL?

	Machine learning	Deep learning
Training dataset	Small	Large
Choose features	Yes	No
Number of algorithms	Many	Few
Training time	Short	Long

What are the Most Popular Languages for Machine Learning

- **Python**
- R
- MATLAB
- SAS (Statistical Analysis System)
- Scala
- JAVA
- C++
- Hadoop

Expert System

- In artificial intelligence, an expert system is a computer system that **emulates the decision-making ability** of a human expert.
- Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if–then rules rather than through conventional procedural code.
- The first expert systems were created in the 1950s and then production increases in the 1980s.
- Expert systems were among the first truly successful forms of artificial intelligence. For Example
 - MYCIN: To identify various bacteria that can cause severe infections and can also recommend drugs based on the person's weight.
 - CaDet: It is a clinical support system that could identify cancer in its early stages in patients.

How do humans make decisions?

Human decision making

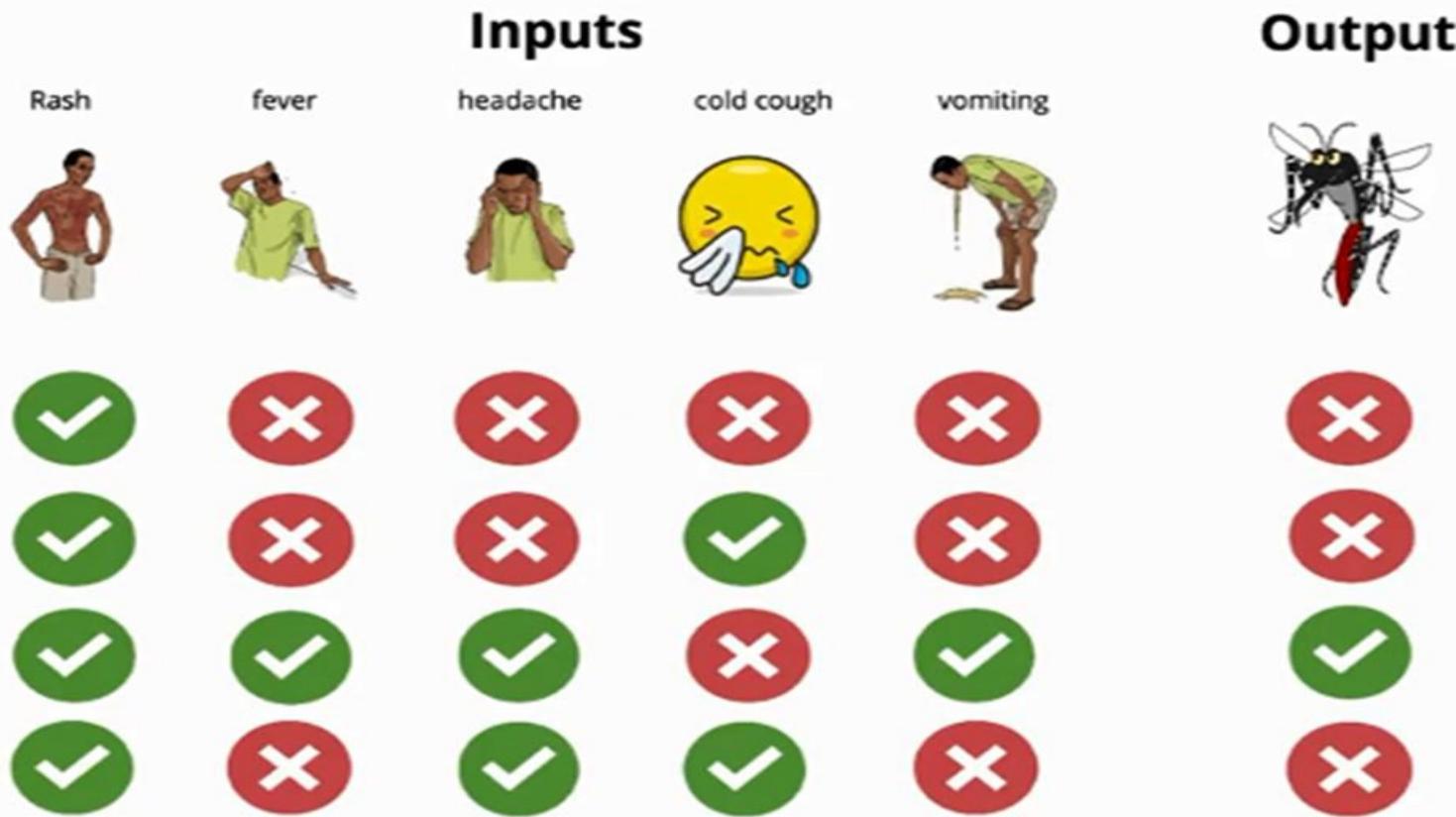
-  skin rash ✓
-  fever ✗
-  headache ✓
-  cold cough ✗
-  vomiting ✓



Dengue

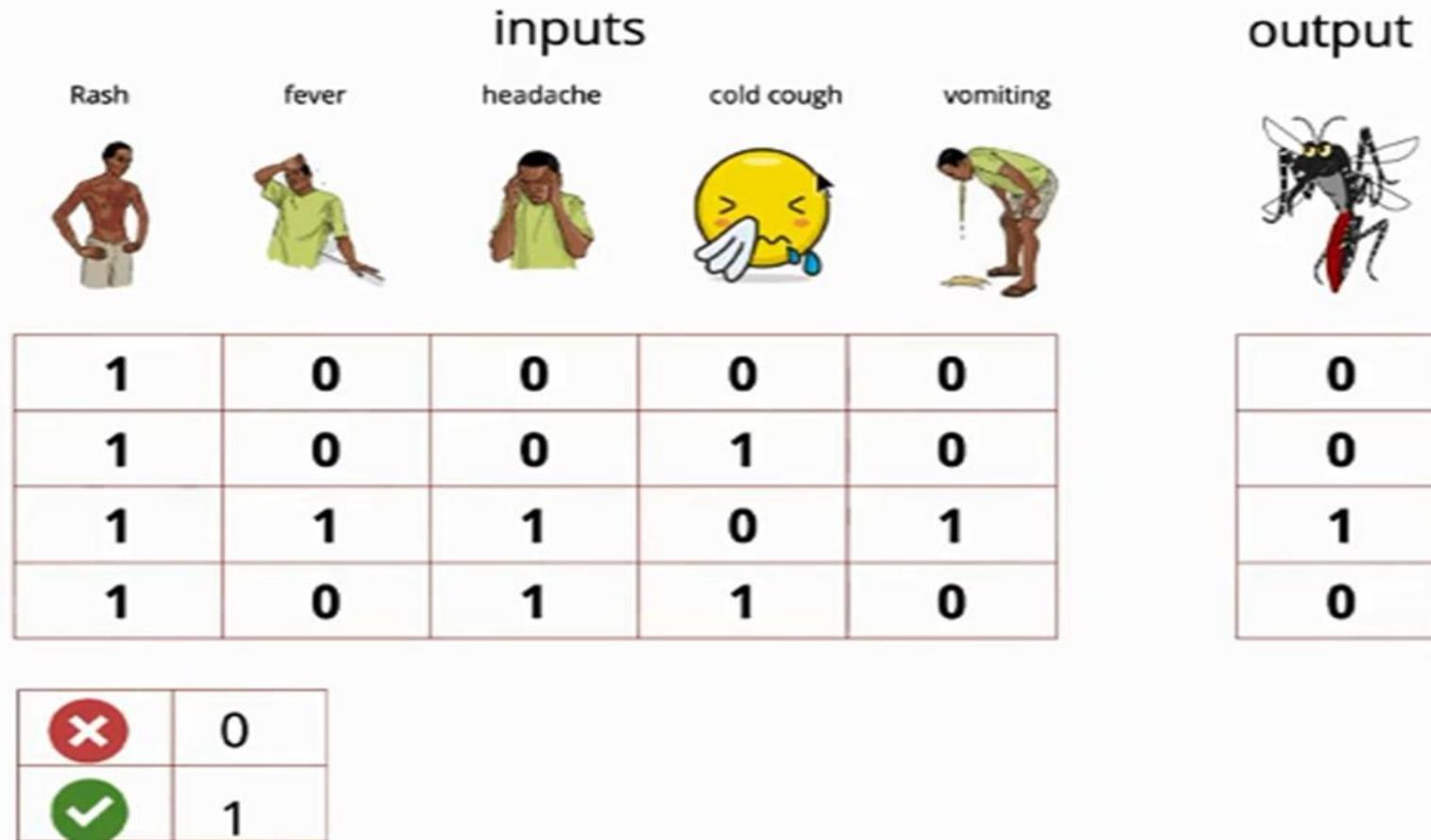
How do humans make decisions from past experiences?

Human decision making



How do humans make decisions from past experiences?

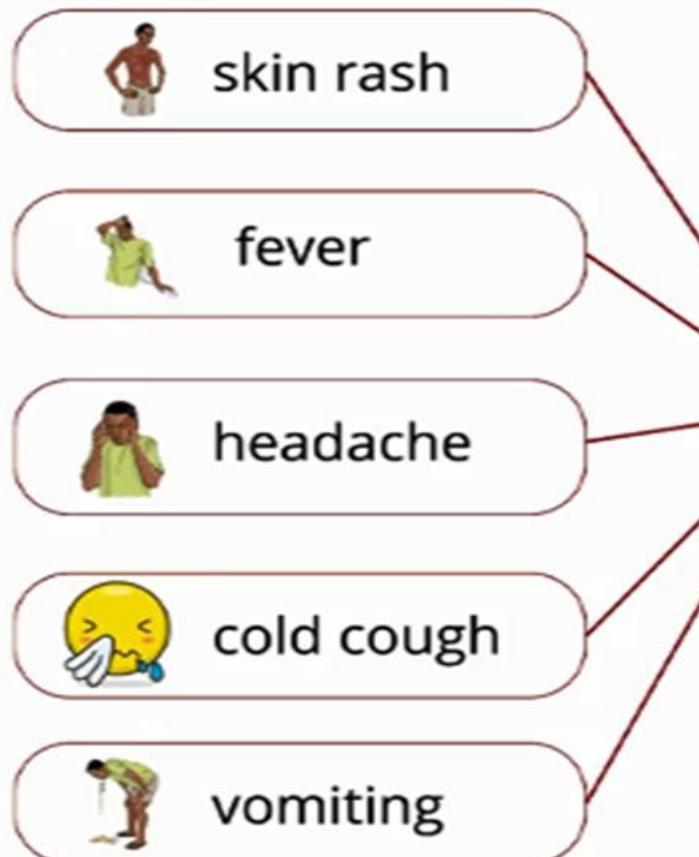
Human decision making



(c) One Fourth Labs

What is the semantics of decision making?

Features and Rules



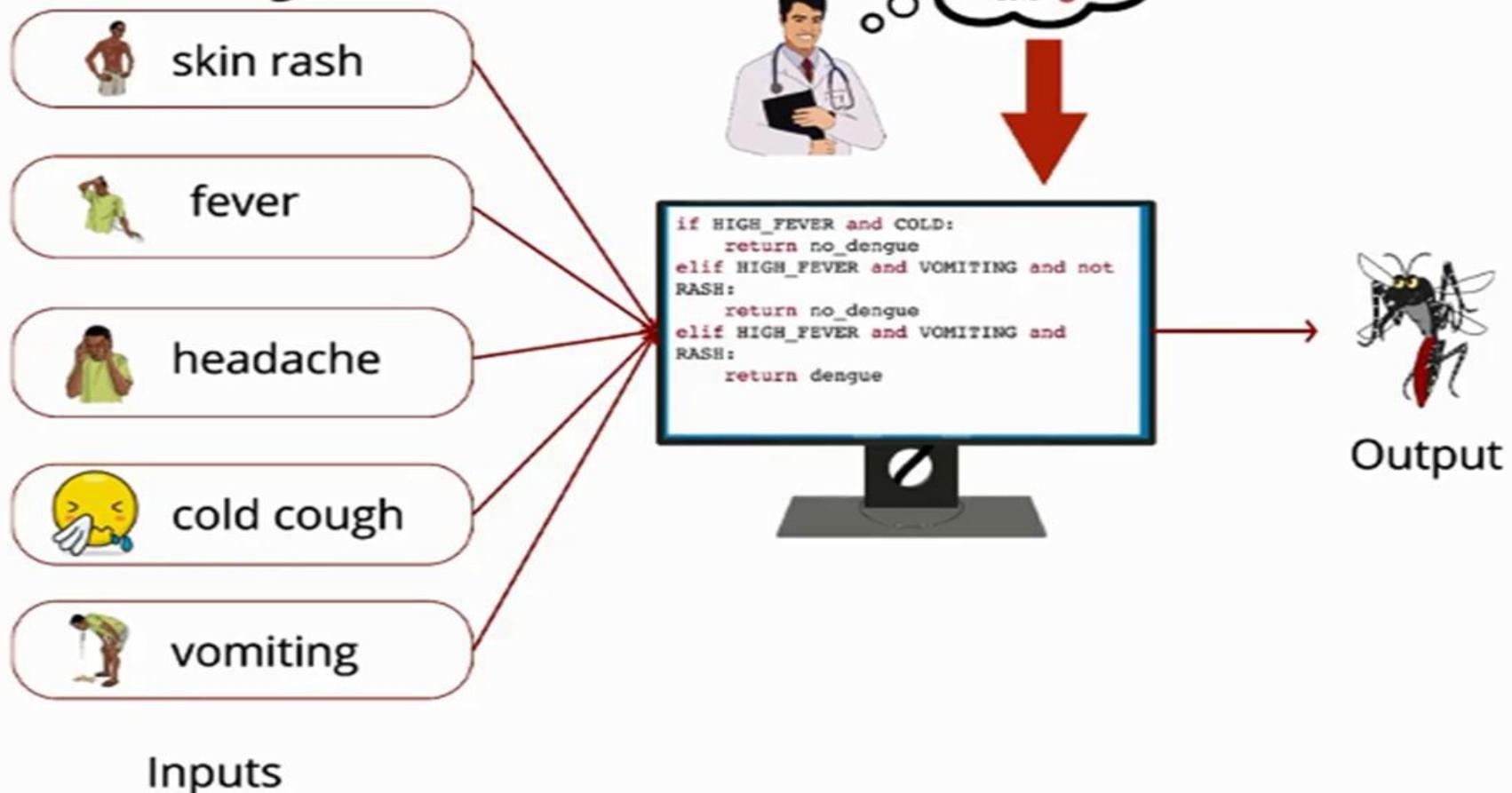
Output

Inputs

(c) One Fourth Labs

How do we outsource this to a machine?

Expert Systems



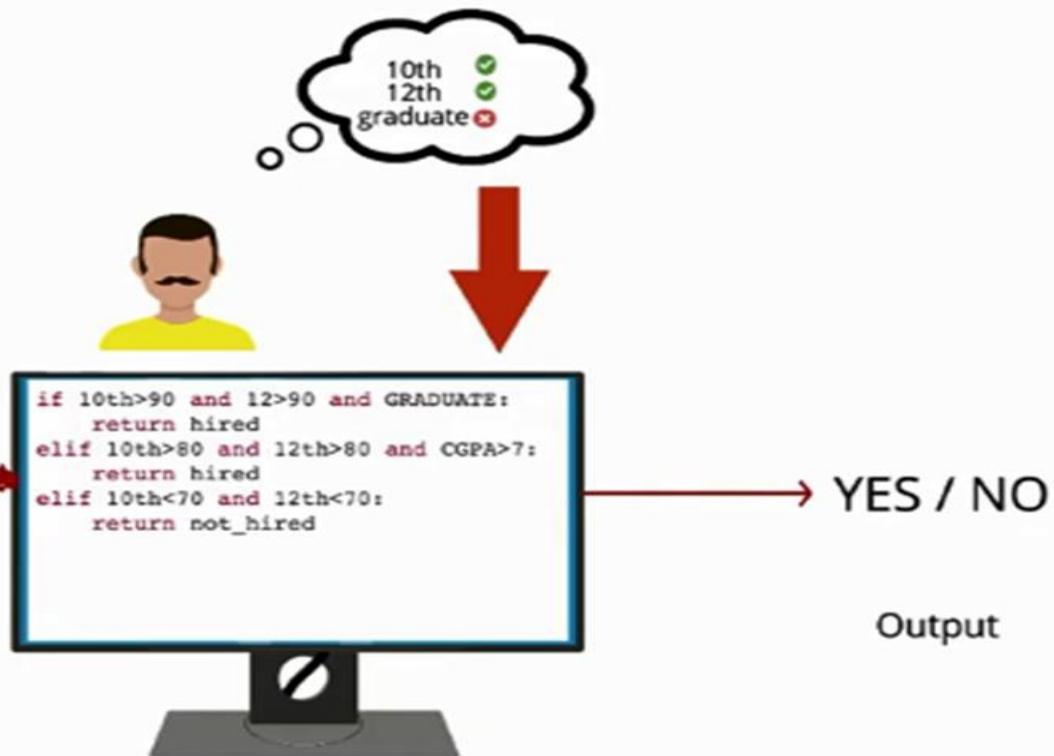
Do we need to look beyond expert systems?

Limitations

Task of hiring someone for a job

10th marks
12th marks
graduate
CGPA
projects

Inputs

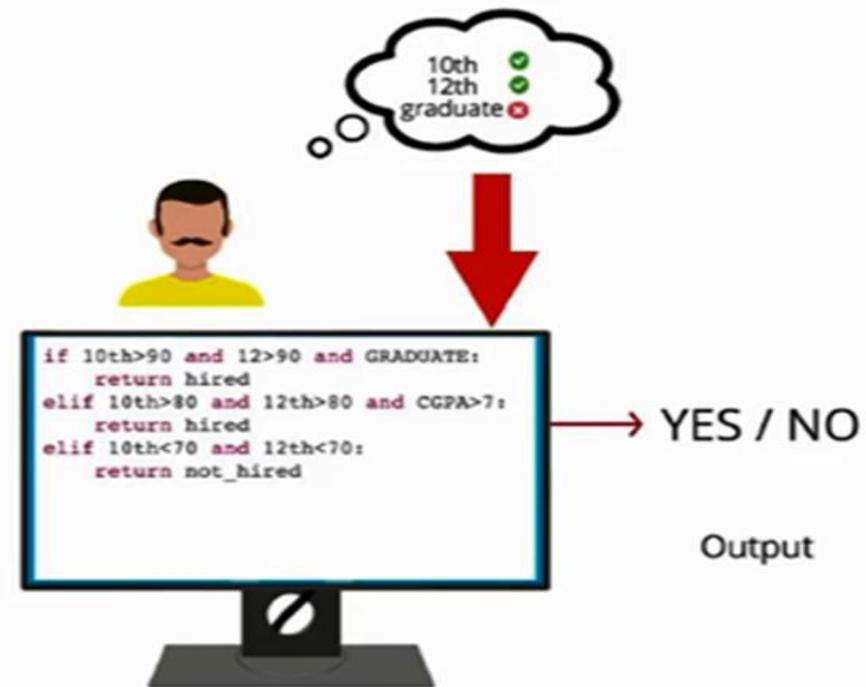


Do we need to look beyond expert systems?

Limitations

Lots of data to make sense from

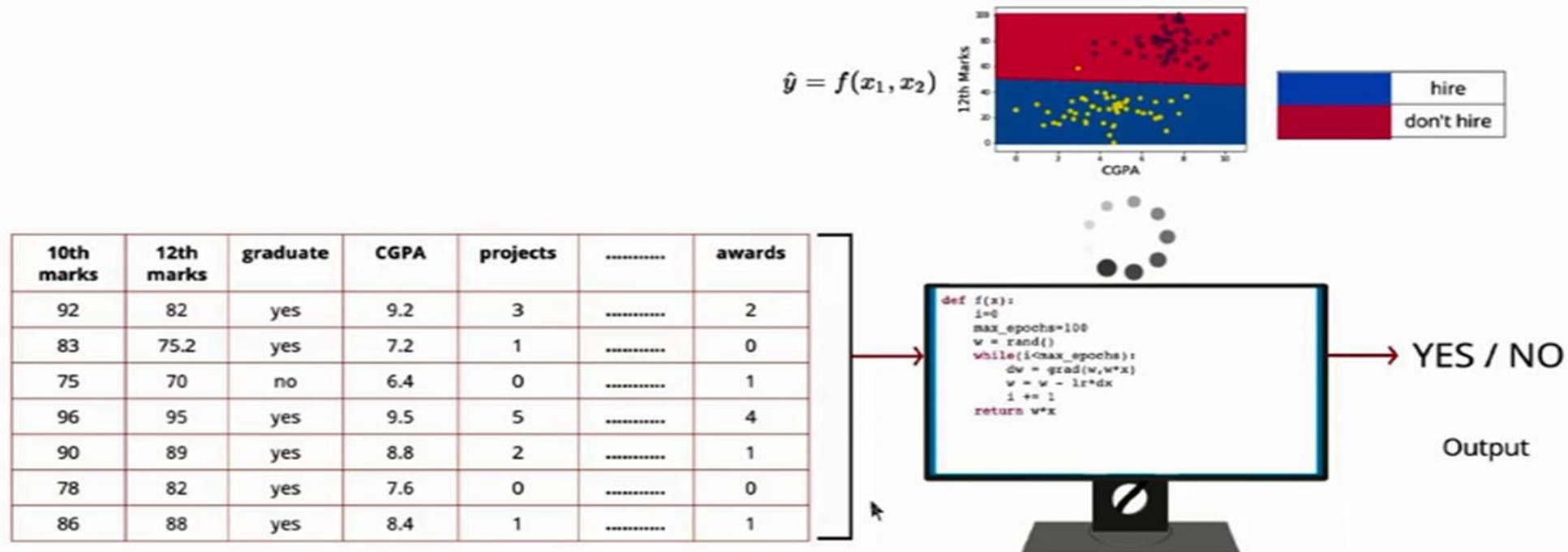
10th marks	12th marks	graduate	CGPA	projects	awards
92	82	yes	9.2	3	2
83	75.2	yes	7.2	1	0
75	70	no	6.4	0	1
96	95	yes	9.5	5	4
90	89	yes	8.8	2	1
78	82	yes	7.6	0	0
86	88	yes	8.4	1	1



- 1) Huge amount of data
- 2) Some time difficult to code express honesty, confidence, facial expression etc. that can be achieve by interaction
- 3) Some time rule can be unknown

How to move from writing rules to learning rules?

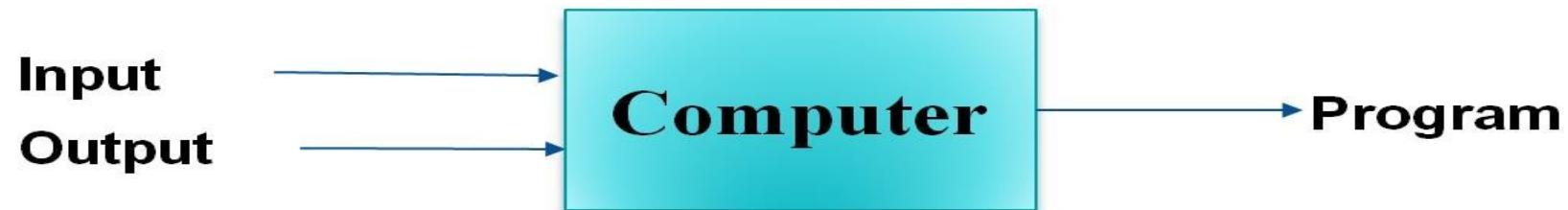
Say Hi to Machine Learning



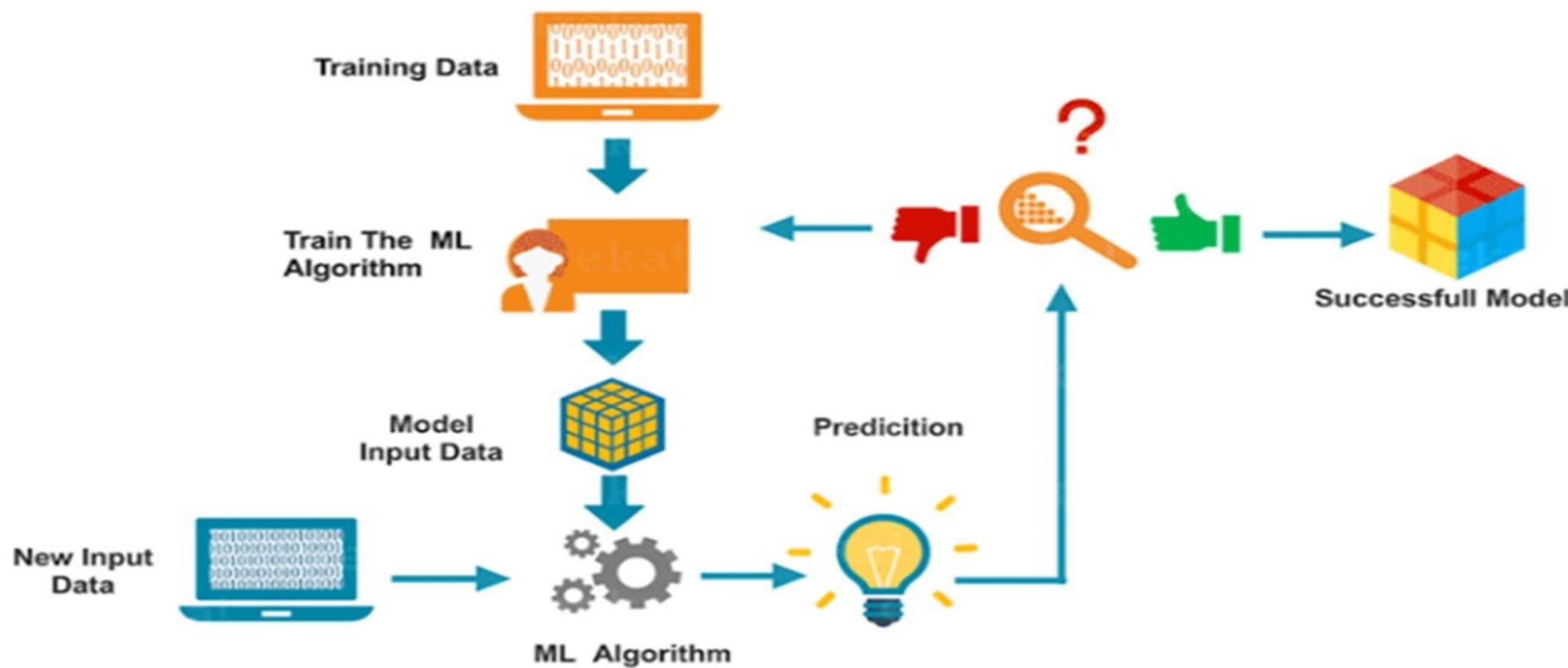
A shift from rule-based approach to a data-driven

Machine Learning

- Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.
- Machine Learning, the input data and output are fed to an algorithm to create a program.



How ML Algorithms Works?

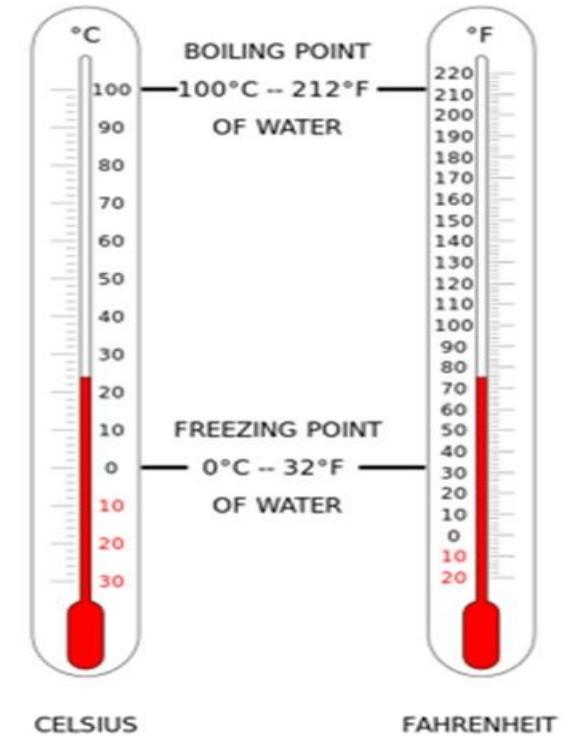


Source: <https://www.spaceotechnologies.com/machine-learning-app-development-complete-guide/>

Convert °C To °F

$$T(^{\circ}\text{F}) = T(^{\circ}\text{C}) \times 9/5 + 32$$

CELCIUS (°C)	FAHRENHEIT (°F)
95	203
100	212
105	221
110	230
115	239
120	248
125	257
130	266
135	275
140	284
145	293
150	302
155	311
160	320
165	329
170	338
175	347
180	356
185	365
190	374
195	383
200	392
205	401
210	410
215	419
220	428
225	437

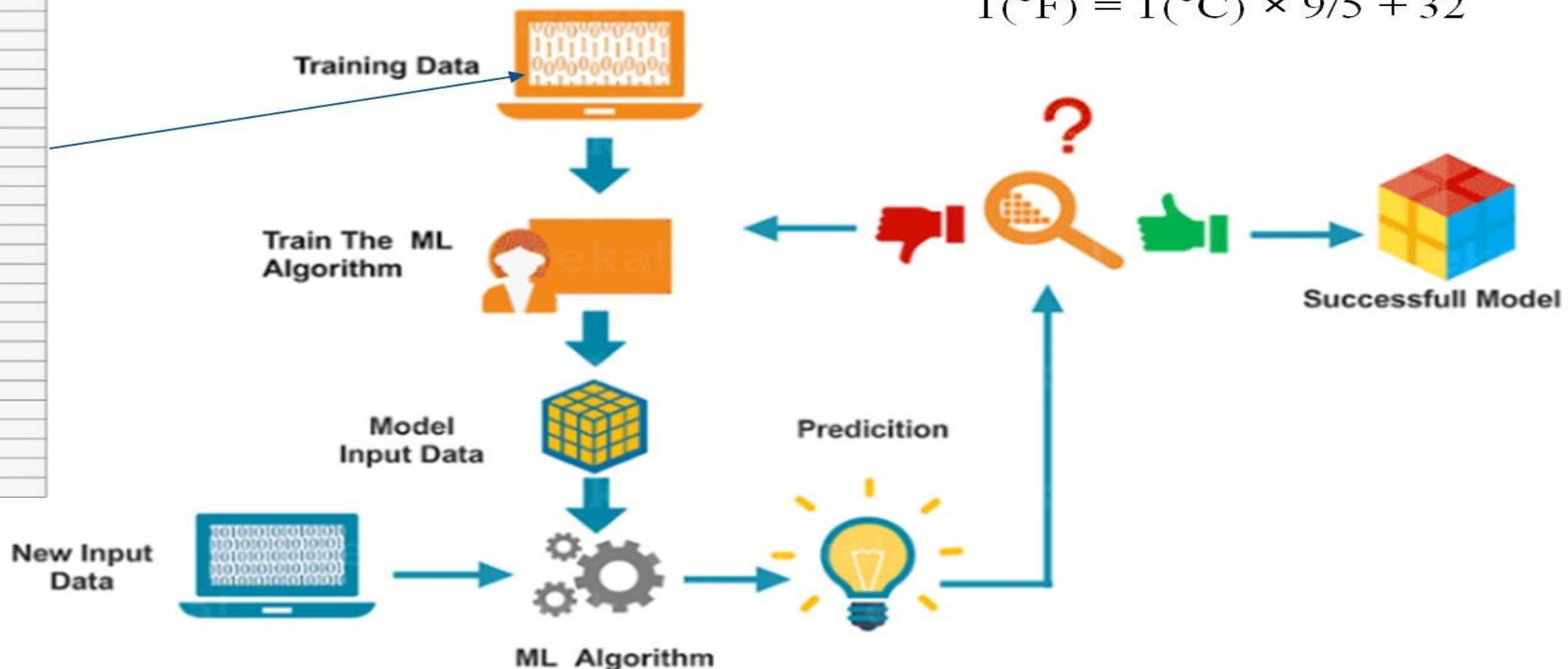


- For Example, let's convert 5°C celsius temperature to Fahrenheit:

$$T(^{\circ}\text{F}) = (5^{\circ}\text{C} \times 9/5) + 32 = 41^{\circ}\text{F}$$

How ML Algorithms Works?

CELCIUS (°C)	FAHRENHEIT (°F)
95	203
100	212
105	221
110	230
115	239
120	248
125	257
130	266
135	275
140	284
145	293
150	302
155	311
160	320
165	329
170	338
175	347
180	356
185	365
190	374
195	383
200	392
205	401
210	410
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220	428
225	437



$$T(^\circ F) = T(^\circ C) \times 9/5 + 32$$

Source: <https://www.spaceotechnologies.com/machine-learning-app-development-complete-guide/>

Pattern Recognition

- Pattern recognition is the process of recognizing patterns by using machine learning algorithm.
- Pattern recognition: Automated recognition of patterns and regularities in data .
- Pattern recognition is the study of how machine can
 - Observe the environment
 - Learn to classify pattern of interest
 - Make decision about the categories of pattern
- Two Phase : Learning and Detection.

Machine Learning v/s Pattern Recognition

- It is one of the integral elements of machine learning technology.
- Machine learning is basically the idea of training machines to recognize patterns and apply it to particle problems.

How Algorithm find Patterns?

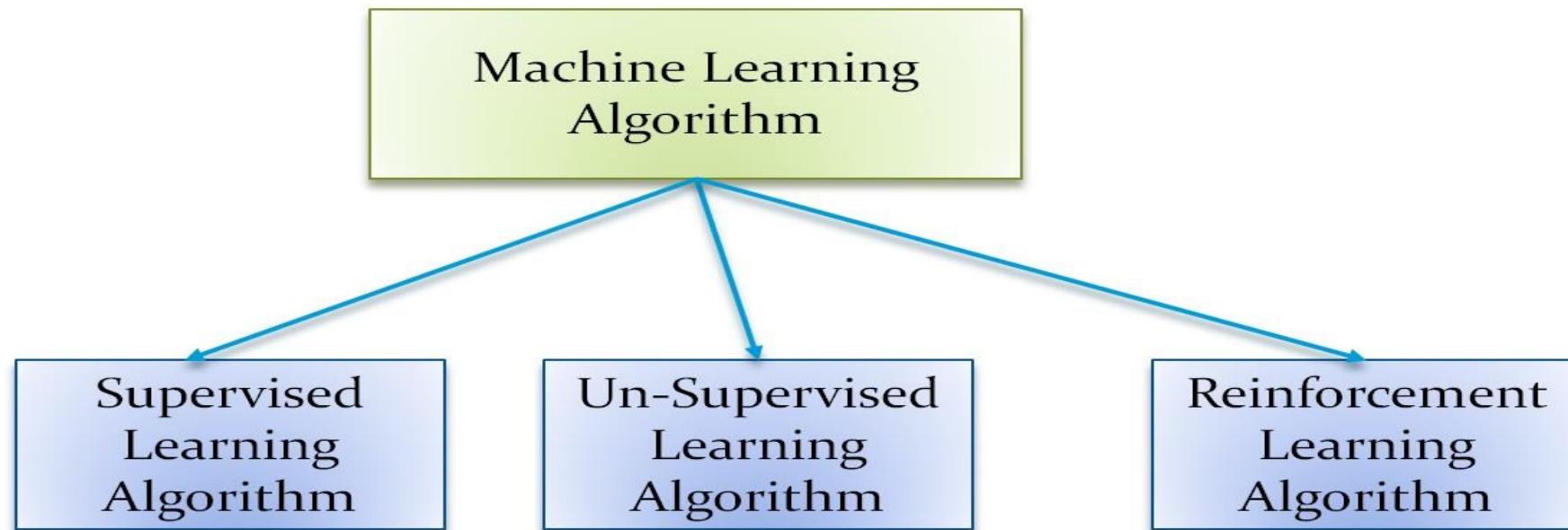
A B C D

Character	No. of Lines	No. of Curves
A	5	0
B	2	2
C	0	1
D	1	1



Learning Algorithm

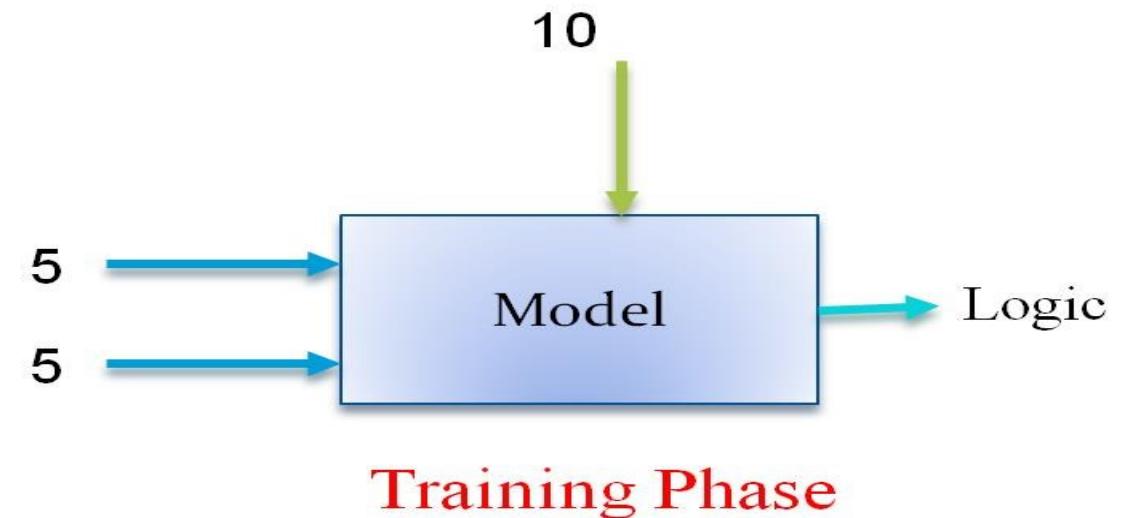
- Machine Learning is a concept which provides ability to the machine to automatically learn and improve from experience without being explicitly programmed.
- The process of learning begins with observations in order to find patterns in data and make better decisions in the future based on the examples that we provide.
- **The primary aim of learning algorithm is to allow the computers learn automatically without human intervention**

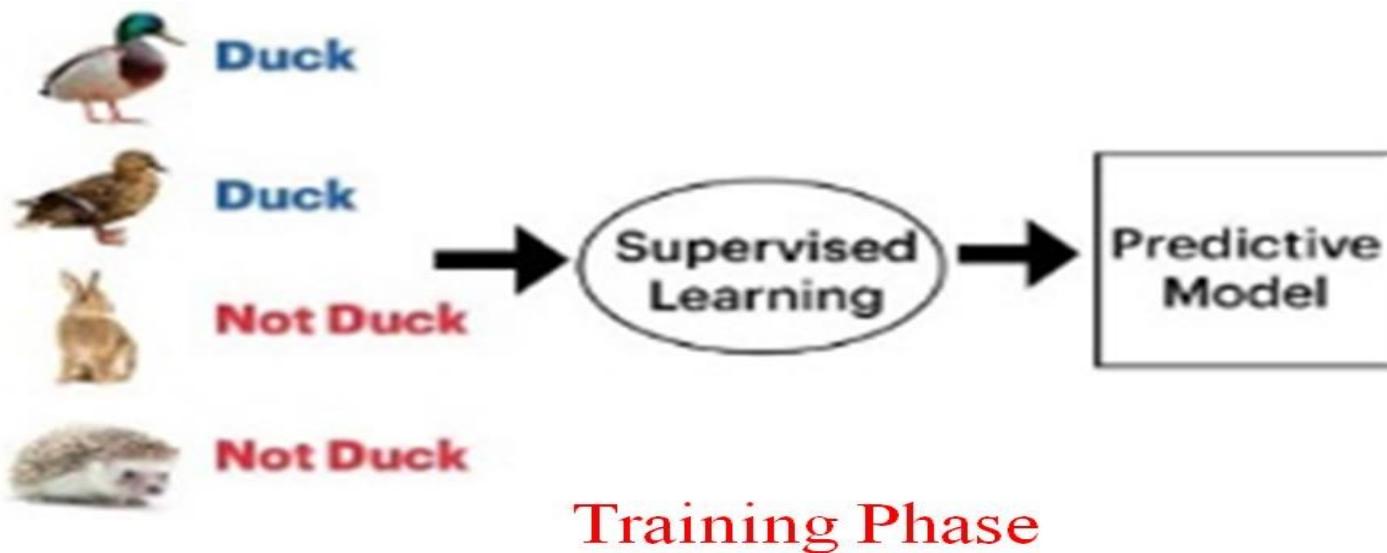


Supervised Learning

- Learning in the presence of **instructor**/supervisor/teacher
 - ❖ Ex. Classroom teaching
- Trained machine on a **labelled** dataset.
- Labelled dataset is one which have both **input** and **output parameters**.
- It is **task driven** because outcomes of a supervised learning algorithm are controlled by the task.

Num-1	Num-2	Sum
5	5	10
8	2	10
10	3	13
15	6	21
20	4	21
30	40	70





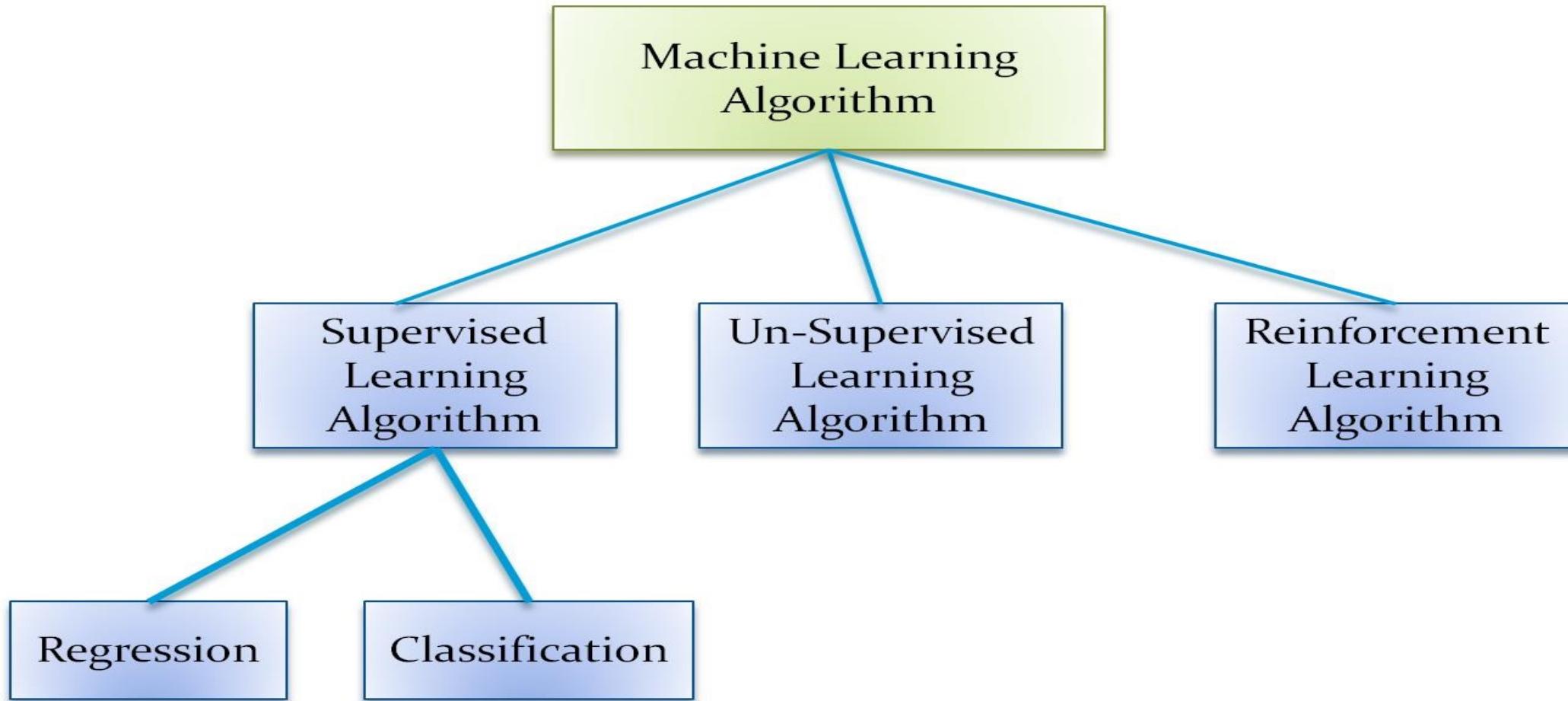
Training Phase



Testing Phase

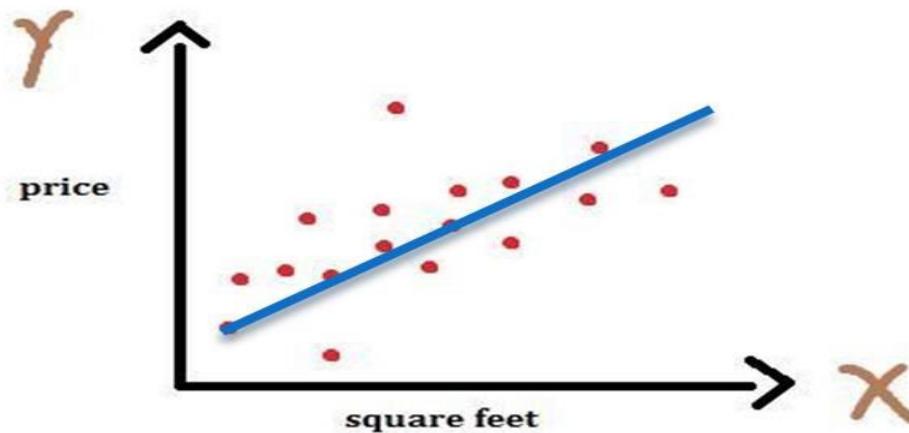
Source: <https://mc.ai/supervised-vs-unsupervised-learning/>

Types of Supervised Learning



Regression

- If the output of the model is a continuous value.
- It is used to predict a continuous value.

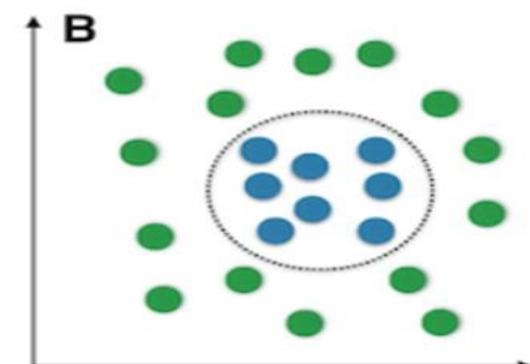
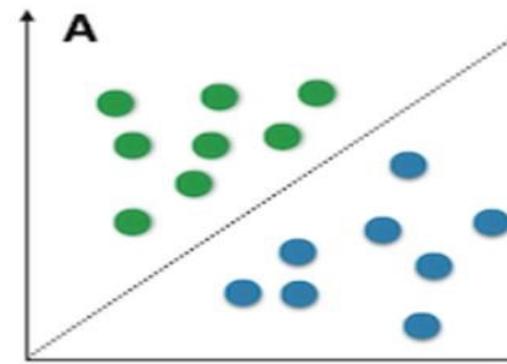


- Ex.
 - ❖ House price prediction
 - ❖ Stock market prediction
 - ❖ Predicting age of a person
 - ❖ number of copies a music album will be sold next month

Num-1	Num-2	Sum
5	5	10
8	2	10
10	3	13
15	6	21
20	4	21
30	40	70

Types of ML Classification Algorithms:

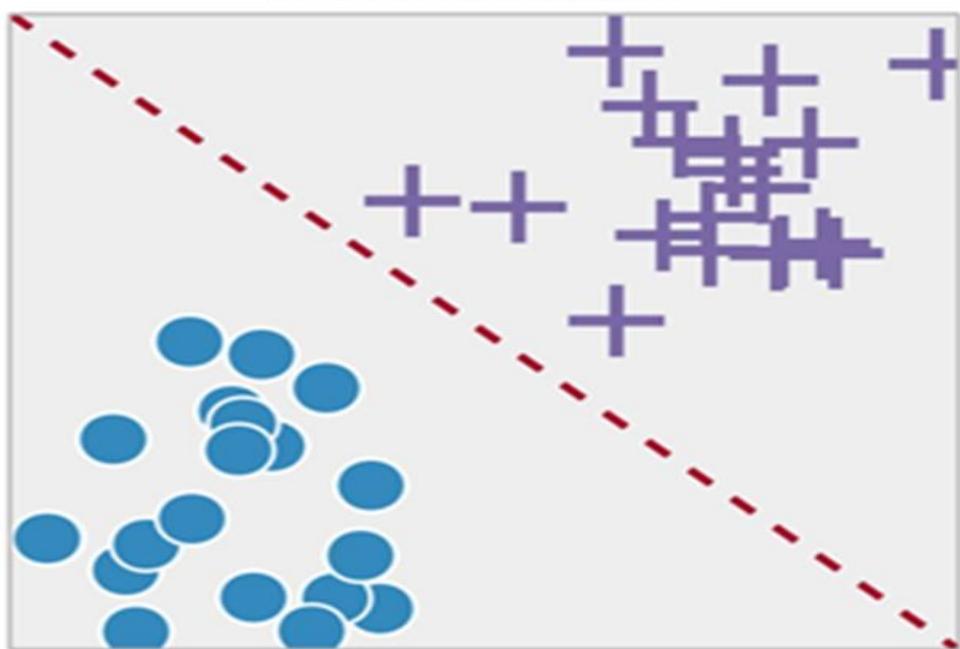
- **Linear Models**
 - Logistic Regression
 - Support Vector Machines
- **Non-linear Models**
 - K-Nearest Neighbours
 - Kernel SVM
 - Naïve Bayes
 - Decision Tree Classification
 - Random Forest Classification



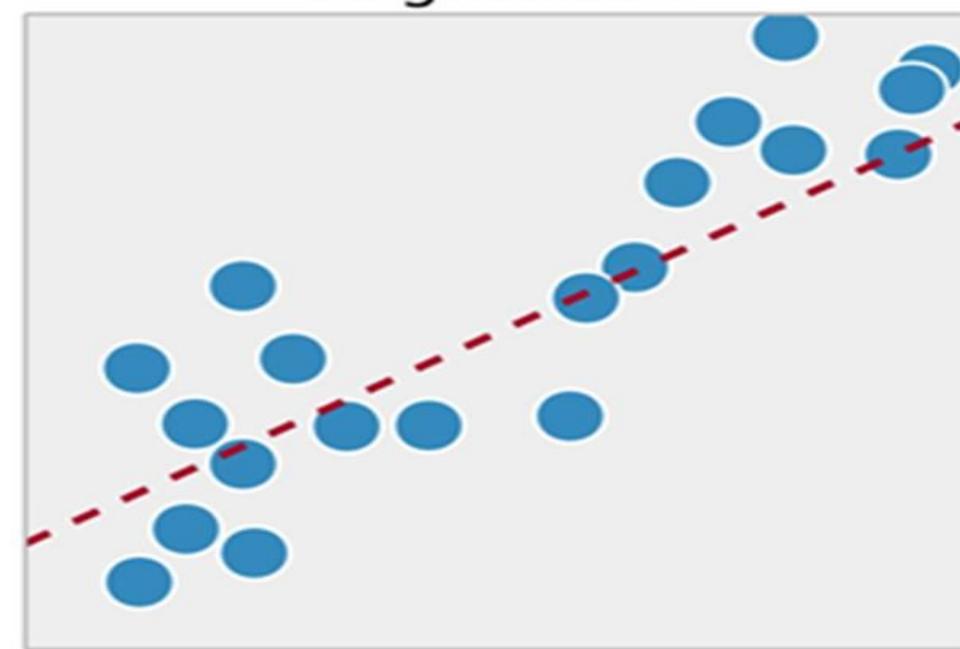
Source: <https://www.kdnuggets.com/2019/12/enabling-deep-learning-revolution.html>

Classification v/s Regression

Classification



Regression

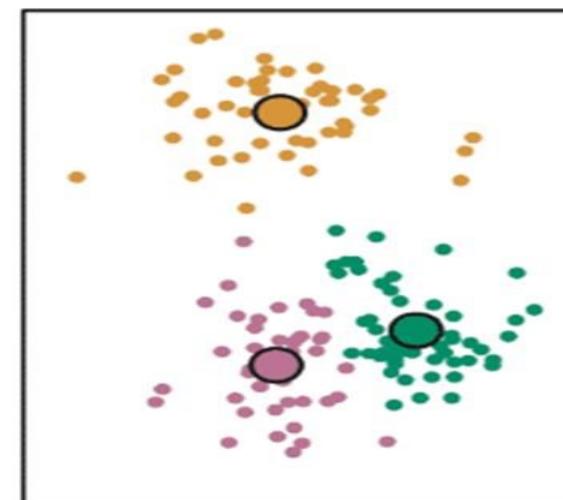
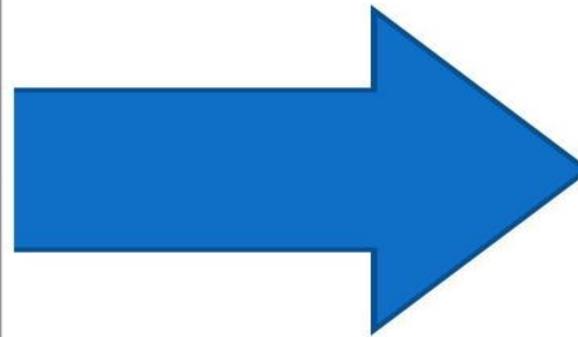
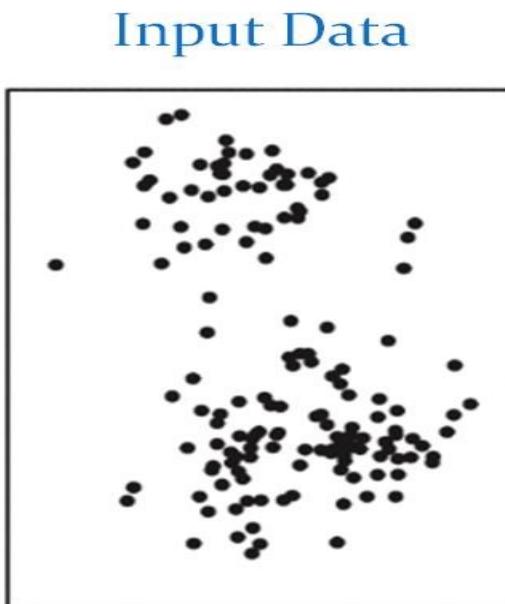


Source: <https://medium.com/deep-math-machine-learning-ai/different-types-of-machine-learning-and-their-types-34760b9128a2>

Unsupervised Learning

- Unsupervised learning is very much the opposite of supervised learning. It features are **not labeled**.
- In unsupervised learning approach, training data consists of a set of input vectors x without any corresponding target values.
- Instead, our algorithm would be fed a lot of data and given the tools to understand the properties/ hidden pattern of the data.
- The goal in such unsupervised learning problems may be to discover groups of similar group within the data

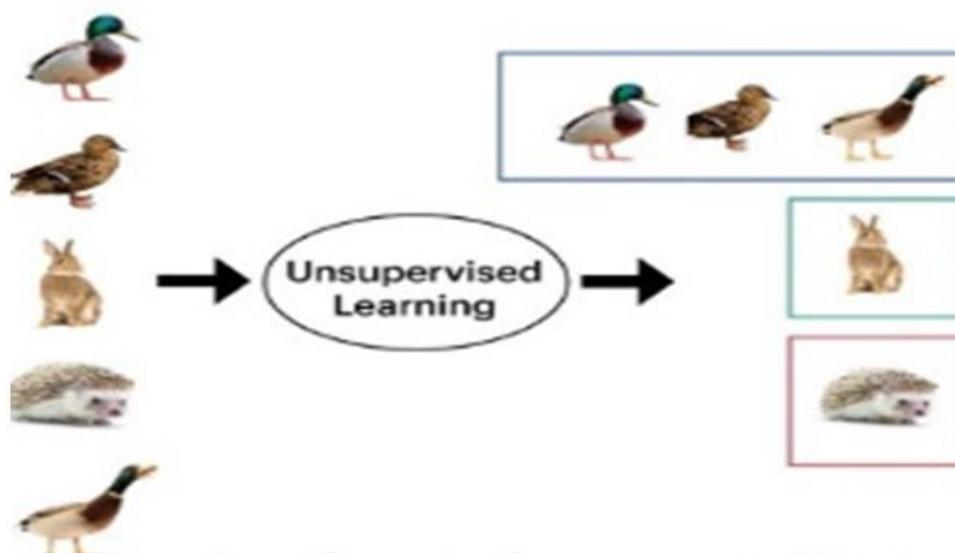
- Unsupervised learning is **data-driven** because outcomes of an unsupervised learning algorithm are controlled by the data.



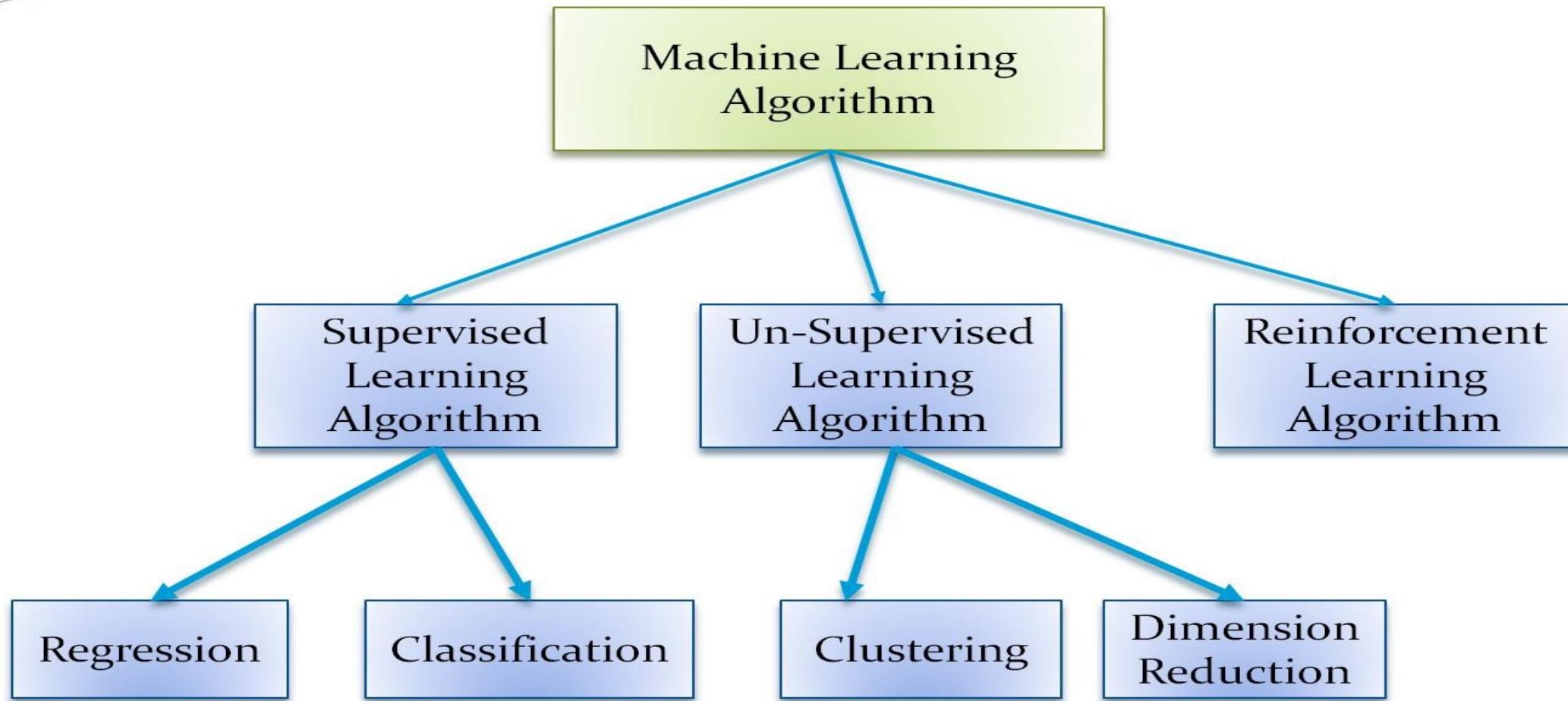
Num -1	Num- 2	Sum
5	5	10
8	2	10
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15	6	21
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30	40	70



Source: <https://towardsdatascience.com/what-are-the-types-of-machine-learning-e2b9e5d1756f>

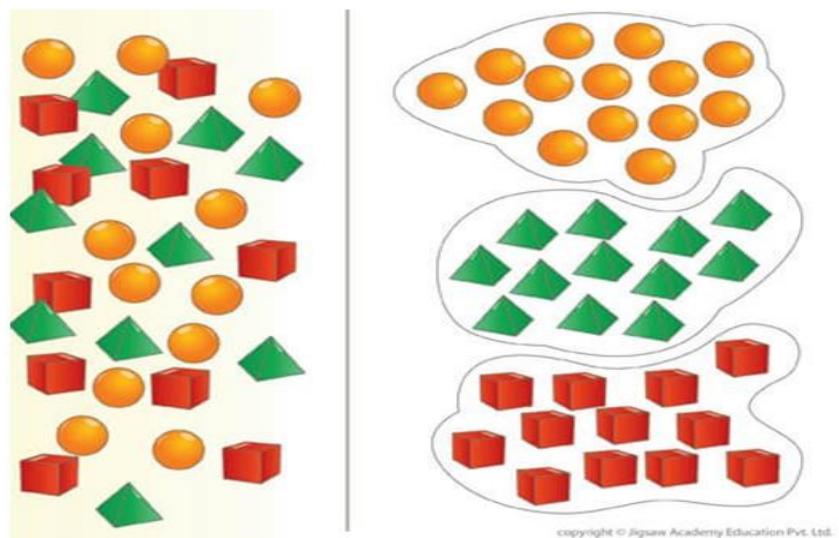


Source: <https://mc.ai/supervised-vs-unsupervised-learning/>

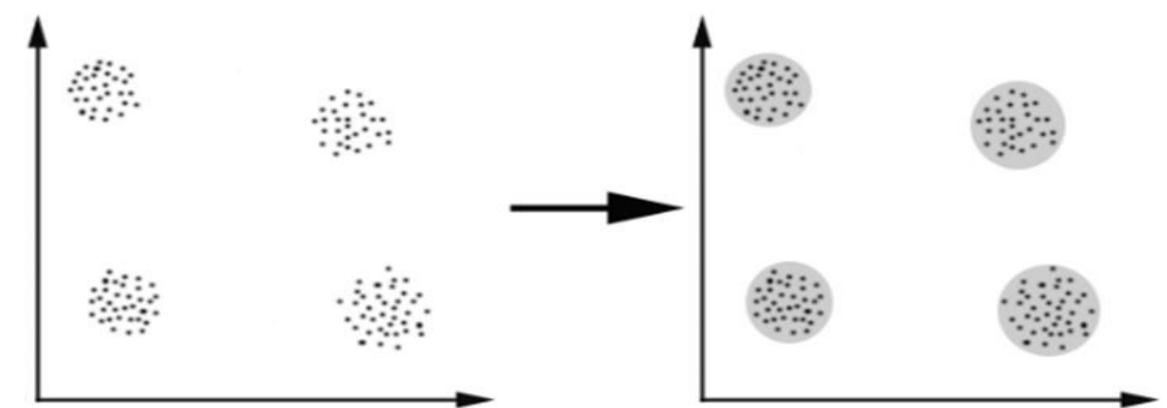


Clustering

- Clustering is “the process of organizing objects into groups whose members are similar in some way”.
- A *cluster* is therefore a collection of objects which are “similar” between them and are “dissimilar” to the objects belonging to other clusters.



Source: <http://bampe08.blogspot.com/2015/03/cluster-analysis-for-business.html>



Source: <https://towardsdatascience.com/unsupervised-learning-and-data-clustering-eeeccb78b422a>

Dimension Reduction

- **Dimensionality reduction** is simply, the process of reducing the dimension of your feature set.
 - ❖ Ex. Principal Component Analysis (PCA)
- **Advantages of Dimensionality Reduction**
 - ❖ It helps in data compression, and hence reduced storage space.
 - ❖ It reduces computation time.
 - ❖ It also helps remove redundant features, if any.
- **Disadvantages of Dimensionality Reduction**
 - ❖ It may lead to some amount of data loss.

Why Unsupervised Learning is needed?

- Annotating large datasets is very costly and hence we can label only a few examples manually.
 - ❖ Example: Speech Recognition
- There may be cases where we don't know how many/what classes is the data divided into.
 - ❖ Example: Data Mining

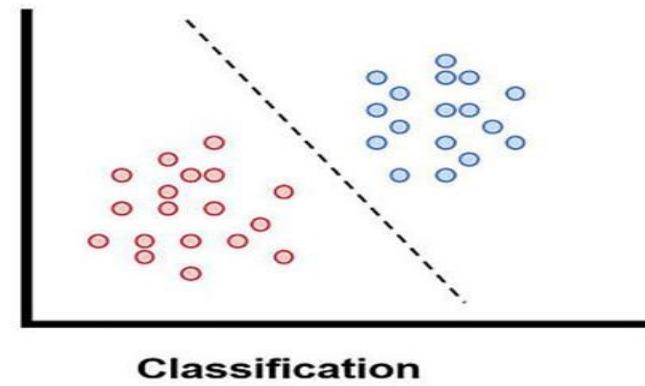
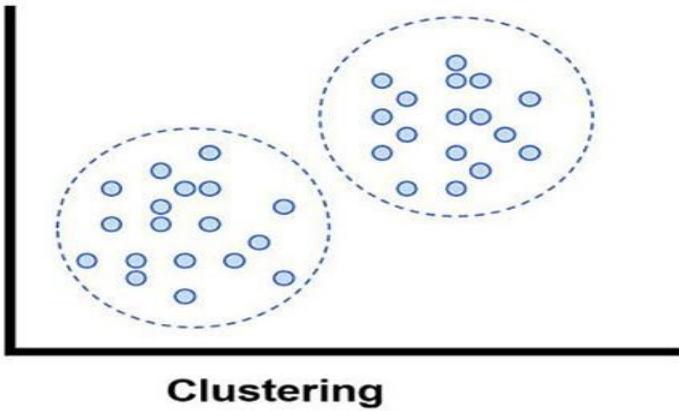
Examples of Unsupervised Learning

- **Recommender Systems:** Group customers into similar purchasing segments
 - ❖ YouTube or Netflix, you've video recommendation system.
- **Buying Habits:** Group customers into similar purchasing segments

Supervised vs. Unsupervised Learning

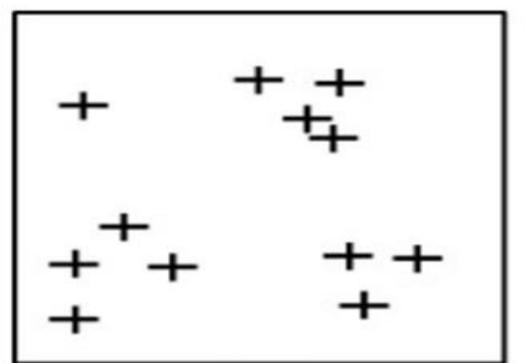
Parameter	Supervised Learning	Unsupervised Learning
Dataset	Labelled	Unlabelled
Method of Learning	Guided learning	The algorithm learns by itself using dataset
Complexity	Simpler method	Computationally complex
Accuracy	More Accurate	Less Accurate

Classification v/s Clustering

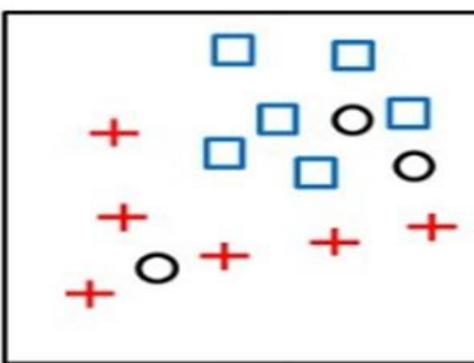


Source: https://deepcast.ai/article/2017/07/18/going_beyond_k_means_for_effective_clustering_of_production_curves

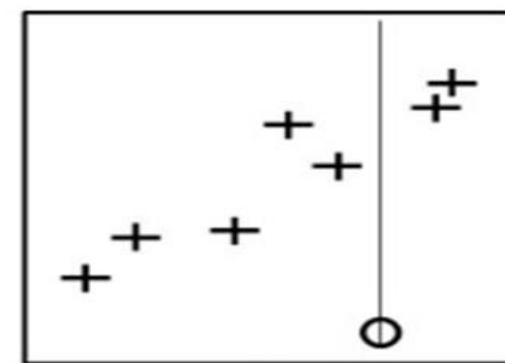
Classification v/s Clustering v/s Regression



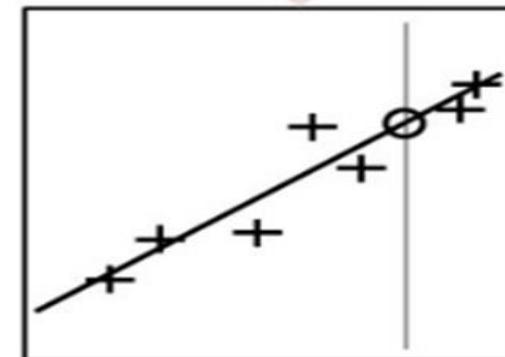
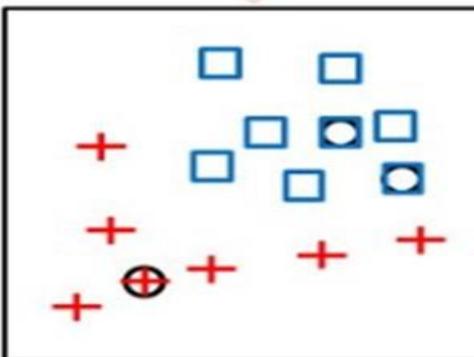
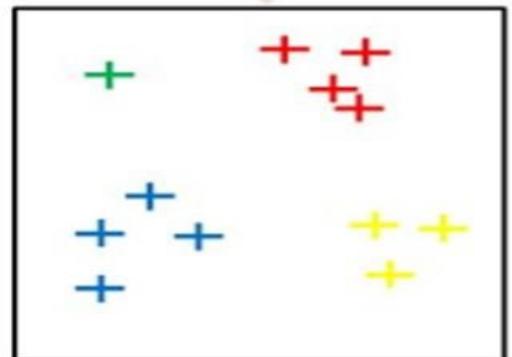
Clustering



Classification



Regression



Source: https://www.researchgate.net/publication/314626729_Parallel_Linear_Algebra/figures?lo=1

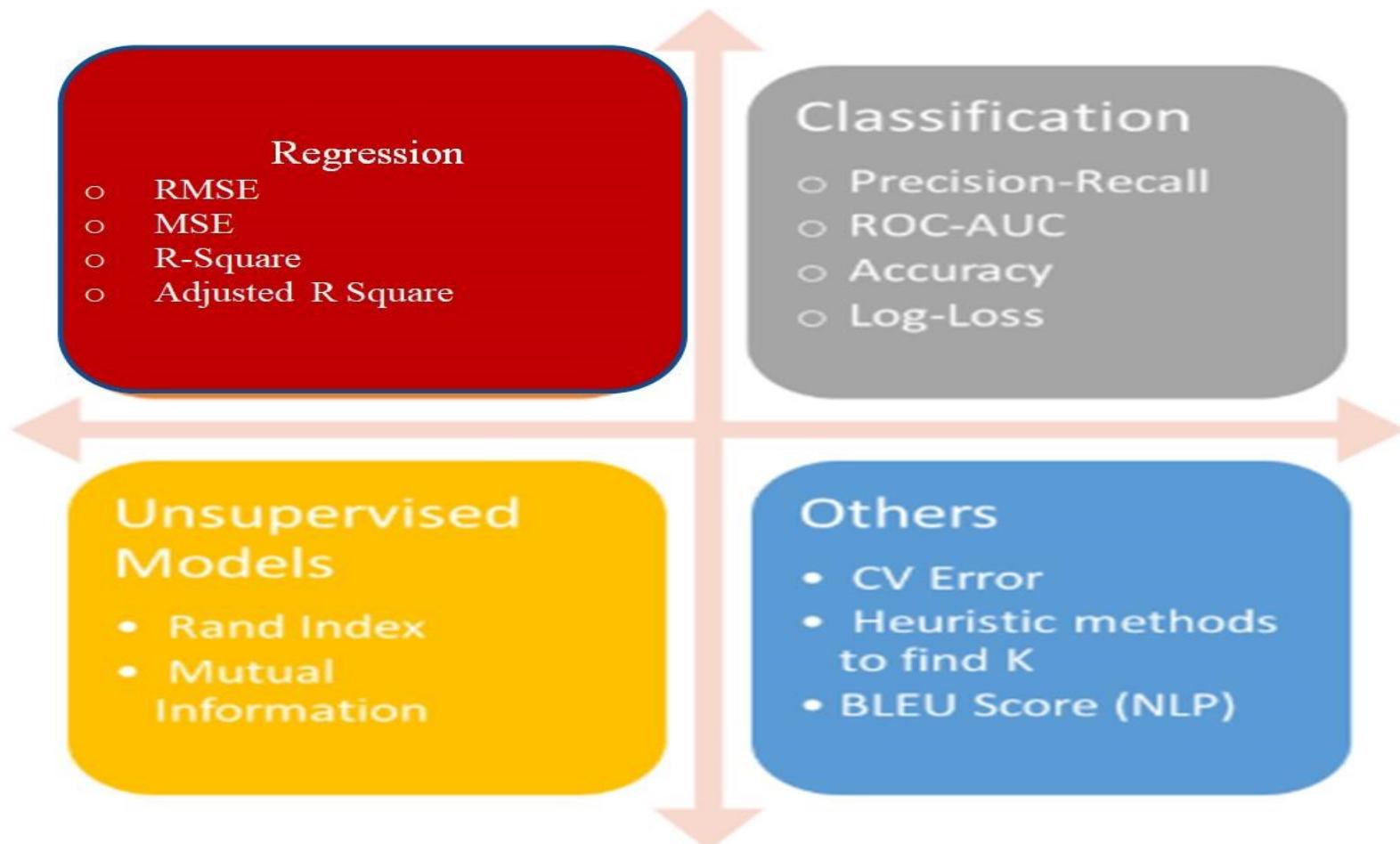
Reinforcement Learning

- It is about taking suitable action to maximize reward in a particular situation
- Reinforcement learning is the training of machine learning models to make a sequence of decisions.



Source: <https://www.geeksforgeeks.org/what-is-reinforcement-learning/>

Evaluation Metric



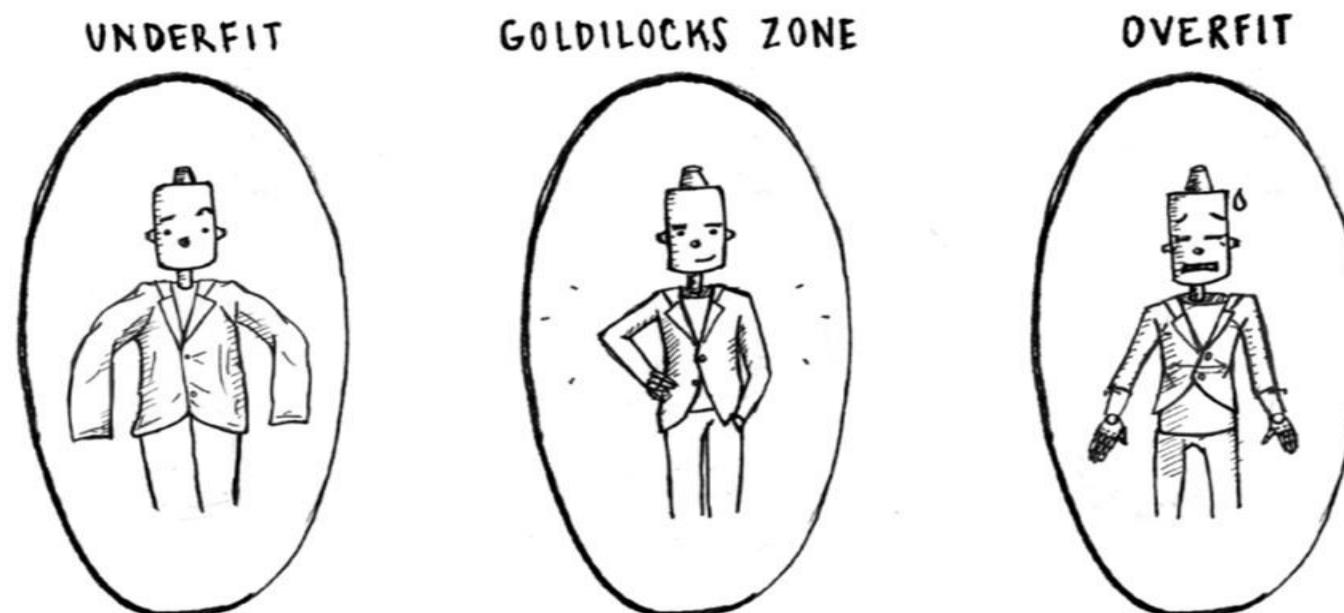
Deep learning

- It is a subset of machine learning.
- Deep learning is a computer software that mimics the network of neurons in a brain.
- In deep learning, the learning phase is done through a neural network. A neural network is an architecture where the layers are stacked on top of each other

Underfitting and Overfitting

Underfitting: **Low** training and test accuracy

Overfitting: **High training** accuracy and **low test** accuracy

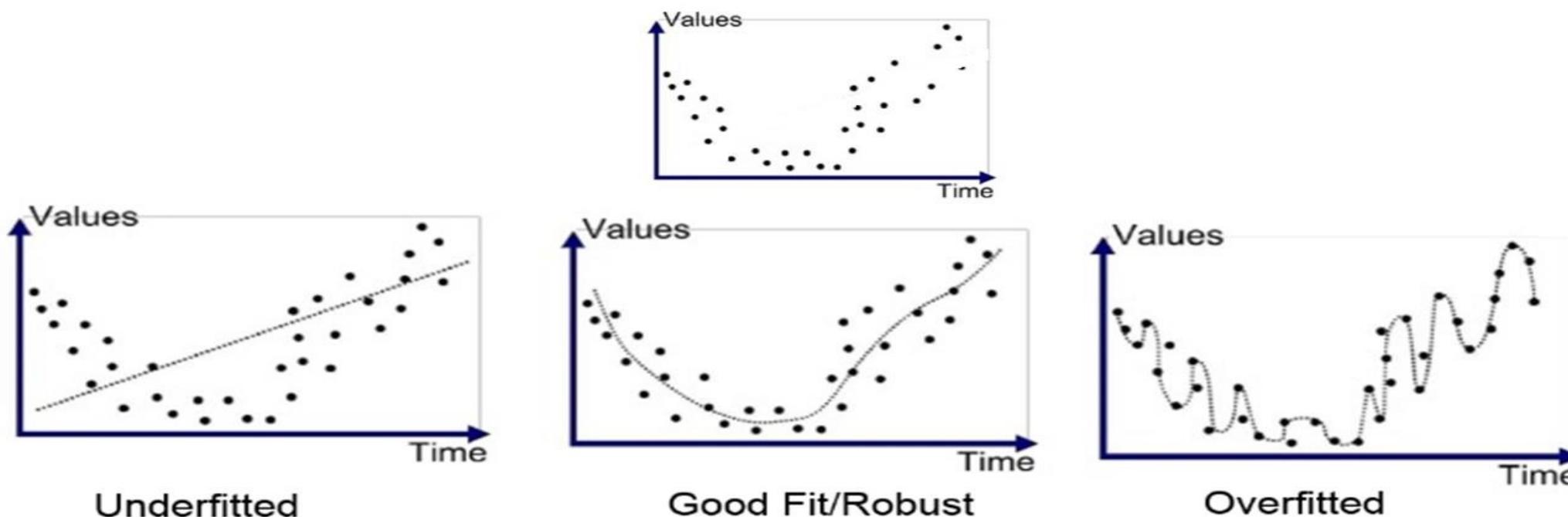


Source: <https://www.analyticsvidhya.com/blog/2020/02/underfitting-overfitting-best-fitting-machine-learning/>

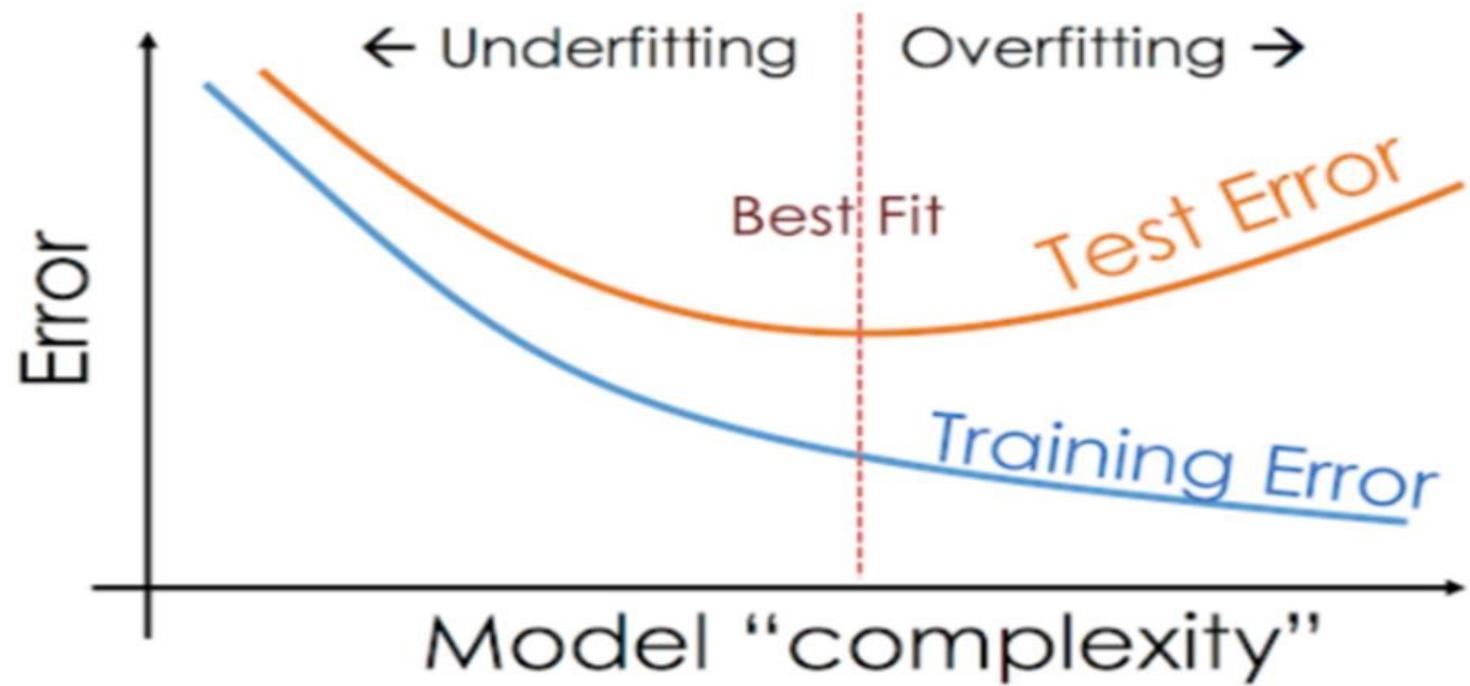
Underfitting and Overfitting

Underfitting: **Low** training and test accuracy

Overfitting: **High training** accuracy and **low test** accuracy



Source: <https://medium.com/greyatom/what-is-underfitting-and-overfitting-in-machine-learning-and-how-to-deal-with-it-6803a989c76/>



Source: <https://www.analyticsvidhya.com/blog/2020/02/underfitting-overfitting-best-fitting-machine-learning/>