

chapter 5

Machine Learning ✓

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→ It is similar to data mining. In both cases, the system search through data to look for patterns. However, instead of extracting data for human comprehension, machine learning uses the data to detect patterns and to adjust program actions accordingly.

→ Example : Facebook newsfeed uses machine learning to personalized each members feed. If a member frequently stops in order to read or like a particular friend post the newsfeed will start to show more of that friend activity in the feed.



→ It is a type of AI that provides computer with the ability to learn without being explicitly programmed.

→ It focuses on the development of computer programs that can teach themselves to grow & change when exposed to new data.

Application of Machine learning: ↗

→ Data mining & knowledge discovery.

→ Speech / Image / Video recognition

→ Autonomous vehicles / Robots.

⇒ Decision support system.

⇒ A computer program is said to learn from experience ' E ' with respect to some class of task ' T ' and performance measure ' p ', then a learning system is characterized by task ' T ', experience ' E ' performance measure ' p '.

Learning

⇒ Learning is the process of acquiring new or modifying existing knowledge, behaviours, skills, values, or preferences.

⇒ It is the improvement of performance with experience overtime.

⇒ Learning element is the portion of a learning AI system that decides how to modify the performance element and implement thoughts modifications.

Q. Define rational agent. Explain learning agent with block diagram.

Machine Learning Framework:

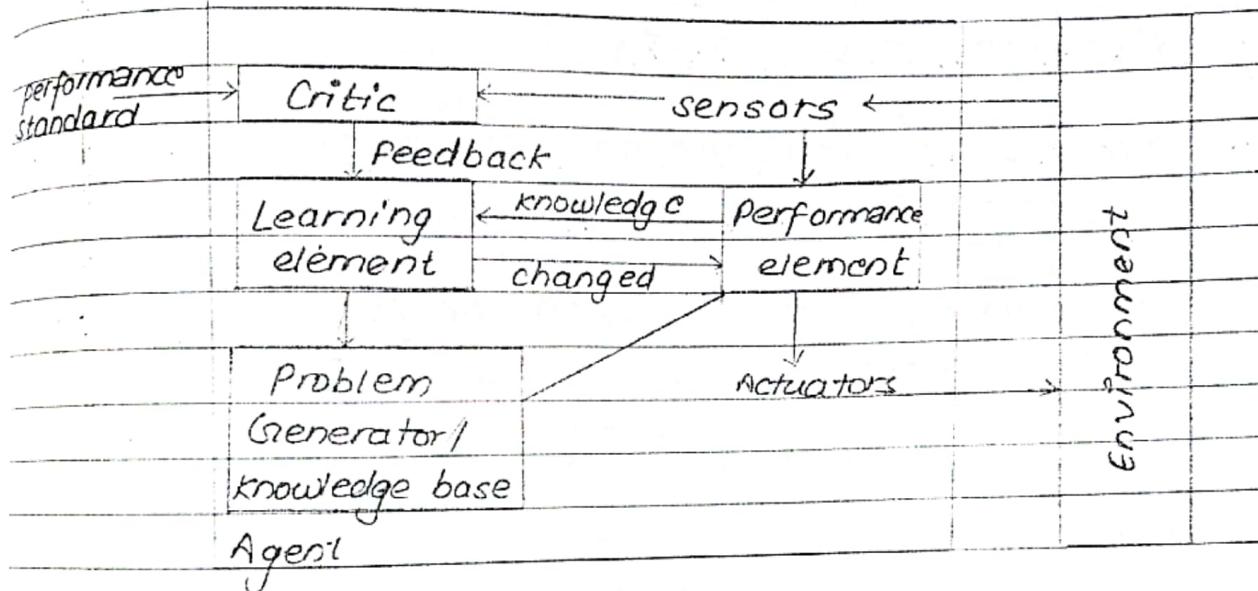


Fig: Machine Learning Framework

1) Environment:

- It refers to the nature and the quality of information given to the learning element.
- It is the place where learning agent acts.

2) Learning element:

- Acquire new knowledge through learning element.

- Learning may be of different types.

3) Problem generator / knowledge base:

- Stores the informations about the problems & its solution.

⇒ knowledge base information should be expressive, modifiable & extendable.

4) Performance Element:-

⇒ This part analyzes how complex the learning is being performed.

⇒ Complexity depends upon the type of task to be performed.

⇒ It must send feedback to the learning element.

5) Sensors & Actuator:-

⇒ Sensors collects information from environment.

⇒ Actuator implements the suggested action to the environment.

Types of Learning:

1. Rote learning ✓
2. Direct Instruction (by being told)
3. Learning by analogy
4. Inductive learning.
5. Learning by deduction

complexity

1. Rote learning (Rartne).

- ⇒ It is a technique which focuses on memorization.
- ⇒ It avoids understanding the inner complexity & inferences of surface that is being learned and instead focuses on memorizing the material.
- ⇒ Ex:- multiplication table.

2. Direct Instruction. (A Bujhera Rartne).

- ⇒ It is a type of learning which require more inferences than Rote learning since, the knowledge must be transformed into an operational form before learning.
- ⇒ Example: When a teacher presents no. of facts directly toward in a well organized manner
- ⇒ It is more complex than Rote learning.

3. Learning by analogy (Similar concepts by example)

- ⇒ Analogical learning is a process of learning a new concept or solution through the use of similar known concepts or solution.
- ⇒ We use this type of learning when solving question in an exam where previously learned example serve as a guide.

4. Inductive learning. (Experiencing the sensation) Parerai Janeto

- ⇒ Based on classification of problem prior to solving.
- ⇒ It's a powerful form of learning like analogical learning which also require more inferences than the first two method.
- ⇒ This learning requires the use of inductive

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inference, a form of invalid inference but useful inference.

- ⇒ Based on induction of result.
- ⇒ For example: We learn the concept of color or sweet taste after experiencing the sensation associated with several examples of coloured object or sweet food.

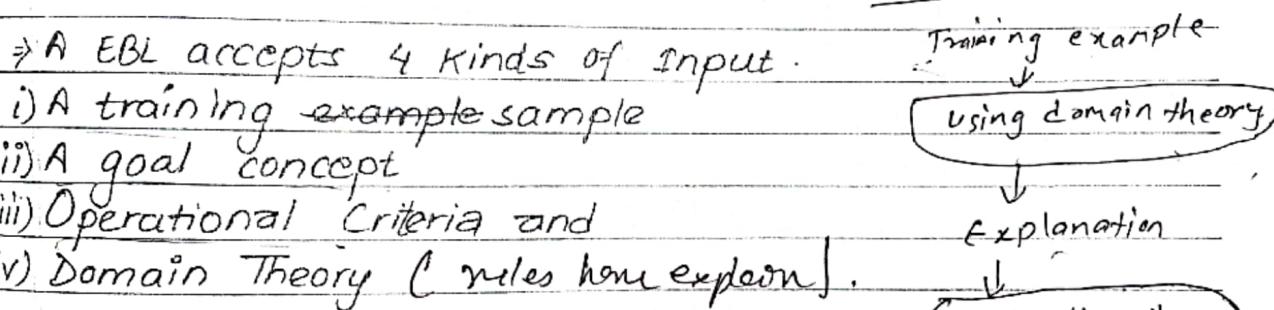
5. Learning by deduction (facts kei aadhar mantra (facts nibalney)).

- ⇒ Deductive learning is completed through a sequence of deductive inference steps known as facts.
- ⇒ From the known facts new facts or relationships are logically derived.
- ⇒ It usually requires more inference than other methods.

S.N. # Explanation based Learning (EBL)

- ⇒ EBL is a form of machine learning that exploits a very strong or even perfect domain theory to make generalization or form concepts from training examples.
- ⇒ In other words, A EBL system accepts an example that is a training example and explains what it learns from the example.
- ⇒ The EBL system takes only the relevant cases of the training.

- This explanation is translated into particular form that a problem solving program can understand.
- The explanation is generalized so that it can be used in many other problems.
- An example of EBL using a perfect domain theory is a program that learns to play chess by being shown examples.



Classification of Learning:

Learning may be classified into 3 categories:

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

1. Supervised learning

→ The network is presented with inputs together with the target (teacher signal) output.

→ A neural network tries to produce an output as close as possible to the target signal by adjusting the values of internal weights.

⇒ The most common supervised learning model is the error correction method.

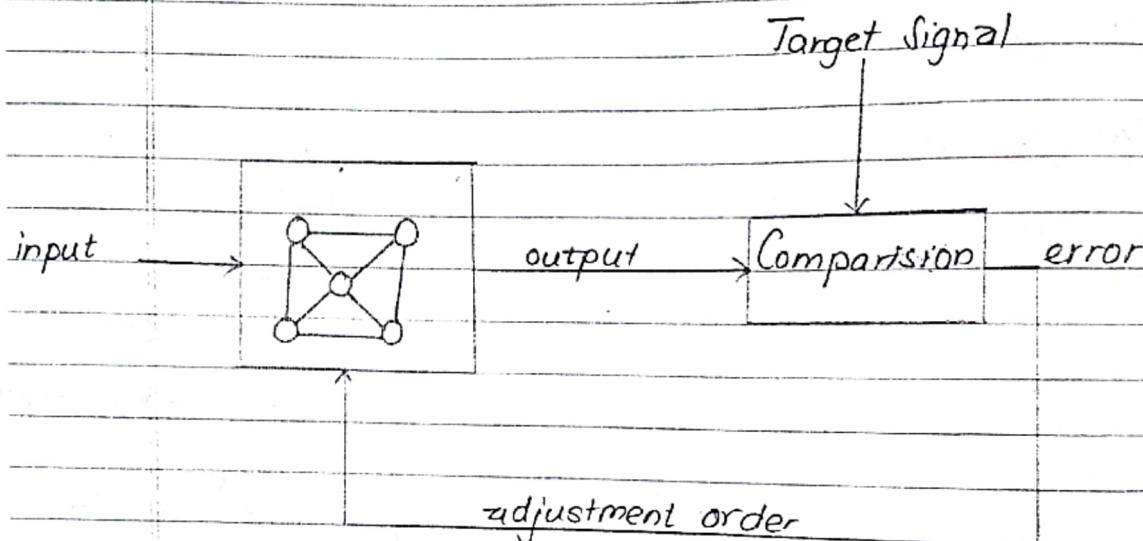


Fig: Error Correction method

⇒ Error Correction method is used for network with their neurons having discrete output functions.

Neural

⇒ Neural network are trained with this method to reduce the error to zero.

⇒ Ex:

Suppose you are given a basket filled with different kinds of fruit. Now, the first step is to train the machine with all different fruit one by one as:

- if shape of an object is rounded and depression at top having colour red than it will be labelled as apple.

सुगम स्टेसनरी सप्लायर्स एण्ड कॉटोकपी सर्विस
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After training the data, you have been given new separate fruit say orange from basket and asked to identify it.

Since, machine has already learned things from previous data, it will first classify the fruit with its shape & color & identify it as orange.

Supervised learning can be classified into two categories of algorithm:

1) Classification

A classification problem is when the op variable is a category such as red, blue or disease and no disease.

Naive Bayes Classifier

In machine learning Naive Bayes Classifier are a family of simple probabilistic classifier based on applying bayes theorem with strong (Naive) Independent assumption between the features.

Naive Bayes classifier are highly scalable requiring a no. of parameter linear in a no. of variables (Features/predictors) in a learning problem.

2. Regression

A regression problem is when the op variable is a real value such as money (dollar, rupee) weight, height, etc.

Logistic Regression

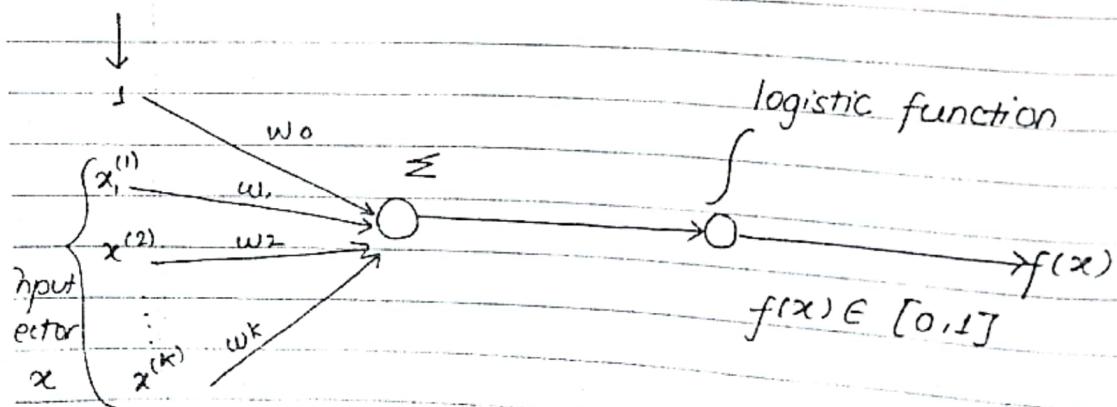
- It is used whenever you need to assign an input to one of several classes.
- It applies a logistic prob func to a linear combination of feature resulting a probability for an ip to be in one of the classes.
- The op is usually binary and can be applied to multiclass classification problem.

A function model with smooth switching

$$f(x) = g(w_0 + w_1 x^{(1)} + \dots + w_k x^{(k)})$$

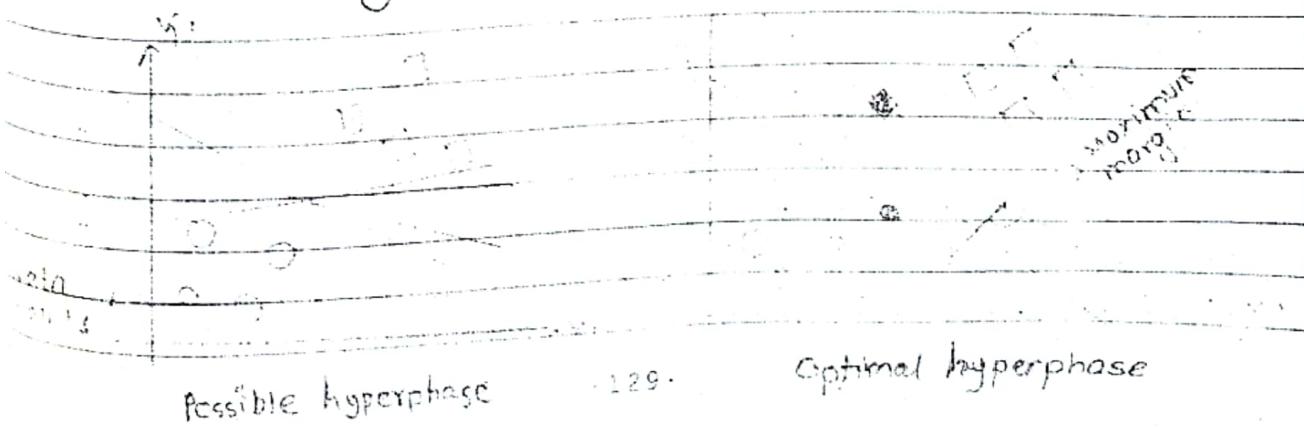
where, w are parameters of the models .
 $g(z)$ is a logistic function $g(z) = \frac{1}{1+e^{-z}}$

Bias term



Support Vector Machine (SVM)

- ⇒ In machine learning, SVM or support vector network model are supervised learning model with associated learning model that analyse data used for classification & regression analysis.
- ⇒ They analyse large amount of data to identify pattern from them.
- ⇒ It uses a technique or kernel trick to transform or data and based on those transformation it finds an optimal boundary between the possible OP.
- ⇒ Given a set of training examples each marked as belonging to one or other of the two categories and SVM training algorithm builds a model that assigns new example to one category or the other.
- ⇒ A SVM model is a representation of the example as points in space. The objective of the support vector machine algorithm is to find a hyper plane in an N -dimensional space ($N \rightarrow$ number of features) that distinctly classifies the data.



⇒ To separate the two classes of data point there are many possible hyperplanes that could be chosen.

⇒ Our objective is to find a plane that has the maximum length i.e. maximum distance betn data points of both classes.

⇒ SVM algorithm can be of two cases:

1) Separable case:

⇒ Infinite boundaries are possible to separate the data into two classes.

2) Non-separable case:

⇒ Two classes are separated but overlapped with each other at some point (measuring classification error)

Application of SVM

⇒ SVM are helpful in text & hyper text categorization.

⇒ Hand written characters can be recognized by using SVM.

⇒ Classification of images can be performed using SVMs.

⇒ It is widely used in biology and other sciences like protein classification, etc.

Q. Explain SVM in brief along with its application in real life scenario.

Q. Write short notes on:

1) Supervised Learning

2) Naïve Bayes Classifier

3) Classification versus regression in supervised learning.

4) Support Vector Networks or Support Vector Machine.

2) Unsupervised Learning

→ It is the training of machine using information i.e. neither classified nor labelled and allowing the algorithm to act on that information without guidance.

→ In unsupervised learning, there is no teacher (target signal) from outside and the network adjust its weight in response to only the input pattern.

→ The goal for unsupervised learning is to model the underlined structure or distribution in the data in order to learn more about the data.

→ Ex: For instance suppose it is given an image having both dogs and cats which have not been seen yet. Thus, machine have no idea about the feature of dogs and cats so we cannot categorize it into dogs and cat. But it can categorise them according to similarity pattern and differences i.e. we can categorize the above picture into two parts.

continue ↳ 1st may contain all pictures having dogs in it.
and 2nd may contain all the pictures having cats in it.

↳ Here, you did not learn anything before meaning no training data or examples.

Unsupervised learning can be categorized into two categories:

- 1) Clustering
- 2) Association

1) Clustering

↳ A clustering problem is where you want to discover the inherent grouping in the data such as grouping customers by purchasing behaviour.

↳ Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar to each other than to those in other groups.

↳ It is a main task of exploratory data mining and a common technique for data analysis used in many field including machine learning, pattern recognition, image analysis, bioinformatics and data compression.

↳ Cluster analysis itself is not a one specific algorithm but the general task to be solved.

↳ It can be achieved by various algorithm that differ significantly in their notion of what

constitute a cluster and to efficiently find them.

⇒ Clustering can therefore be formulated as multi-objective optimization problem.

• Dimensionality Reduction

⇒ In machine learning, Dimensionality Reduction or Dimension Reduction is the process of reducing a no. of random various variable under consideration via obtaining a set of uncorrelated principle variables.

⇒ It can be divided into feature selection & feature extraction.

⇒ For high dimensional data sets i.e. with no. of dimension more than 10, dimension reduction is usually performed before to applying k-nearest neighbours algorithm (k-NN) in order to avoid the effect of curse of dimensionality.

2) Association

⇒ An association rule learning problem is where you want to discover rules that describe large portion of data such as: people that buy X also tend to buy Y.

Supervised learning vs Unsupervised Learning

Parameter	SL	USL
Input data	Uses known and labelled data as i/p.	Uses unknown data as i/p.
Computational Complexity	Very Complex	Less Complex
Real time	Uses offline analysis.	Uses real time analysis of data.
No. of classes	No. of classes are known.	No. of classes are unknown.
Accuracy result	Accurate & reliable result for trained data.	Moderate accurate and reliable data result.
	→ Predictive in Nature classification, Regression	→ Descriptive in nature clustering, Association Algo

Q. Compare & Contrast between SL & USL.

Q. Write Short notes on:

- a) Dimensionality reduction
- b) Clustering
- c) Types of USL.

3) Reinforcement Learning :

→ It is similar to supervised learning in that some feedback is given, However instead of providing a target o/p a reward is given based on how well the system performs.

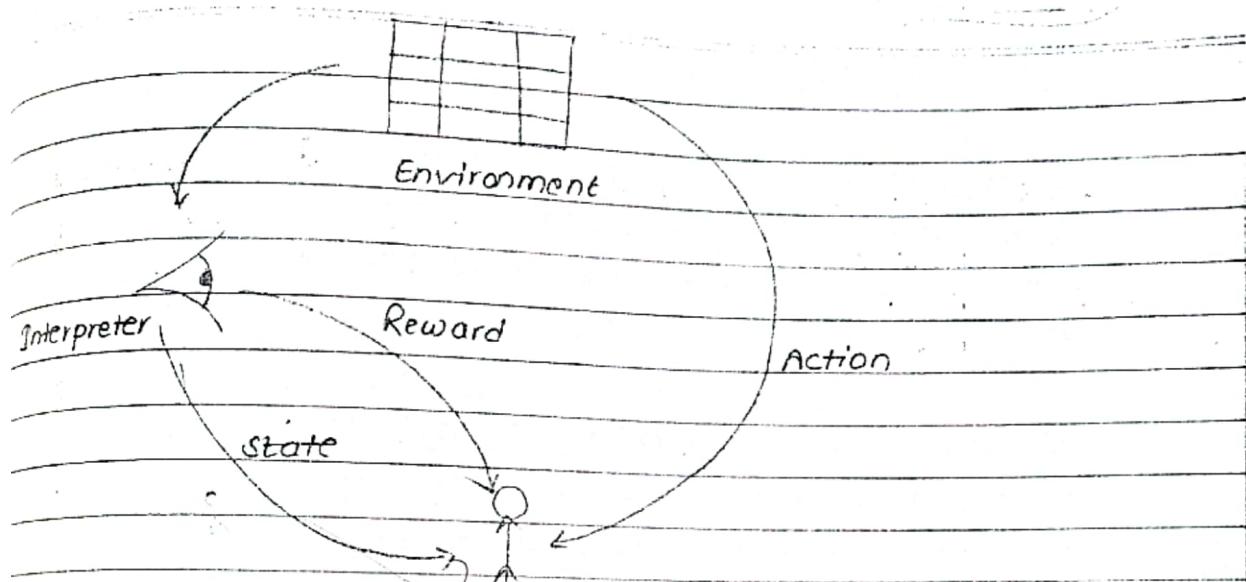


Fig:- Reinforcement Learning.

- The aim of Reinforcement Learning is to maximize the reward the system receives through trial and error.
- This paradigm relates strongly how learning works in nature.
- For ex:- An animal might remember the actions it took previously in order to find the reward.
- Q What is Reinforcement learning? Explain with eg.

K-means Clustering

- ⇒ k-means clustering is a type of unsupervised learning which is used when you have unlabeled data i.e. (data without defined categories or group).
- ⇒ We are given a data set of items with certain features & values for this feature (like a vector), the task is to categorize those items into groups.
- ⇒ To achieve this, we will use the k-means algorithm.
- ⇒ A cluster refers to a collection of datapoints aggregated together because of certain similarities.
- ⇒ The algorithm works as:
 - i) First we initialize 'k' points called means randomly.
 - ii) We categorize each items to its closest means & we update the means coordinate which are the averages of the items categorized in that mean so far.
 - iii) We repeat the process for a given no. of iteration & at end, we have our cluster.

→ For example: in computer graphics, color quantization is the task of reducing the color palette of an image to a fixed number of colors 'k'.

The k-means algorithm can easily be used for this task & produces competitive result.

Applications:

→ It is used in market segmentation, computer vision, geo-statistics, astronomy & agriculture.

Q. What is k-means clustering? Explain its algorithm along with example.

Fuzzy learning:

→ The term "fuzzy" refers to things which are not clear or are vague.

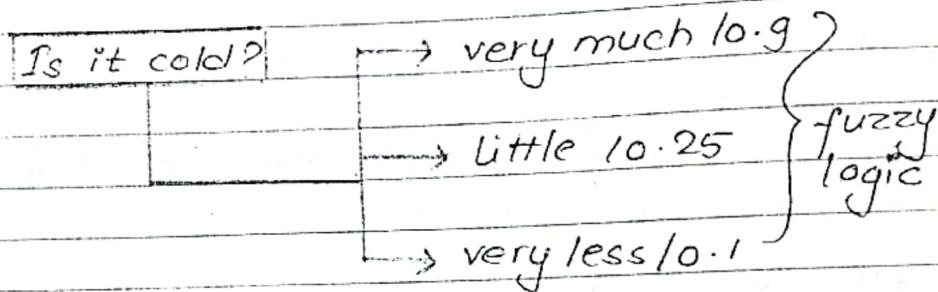
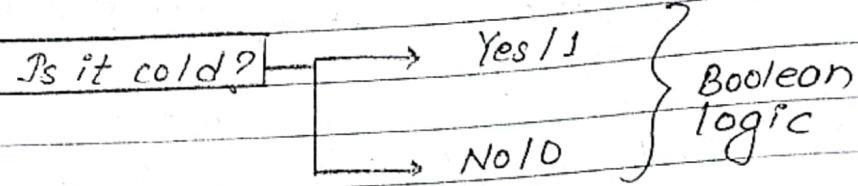
→ In the real world scenario, we encounter a situation, when we cannot determine whether the state is true or false.

→ In this case, fuzzy logic provide a very valuable flexibility for reasoning.

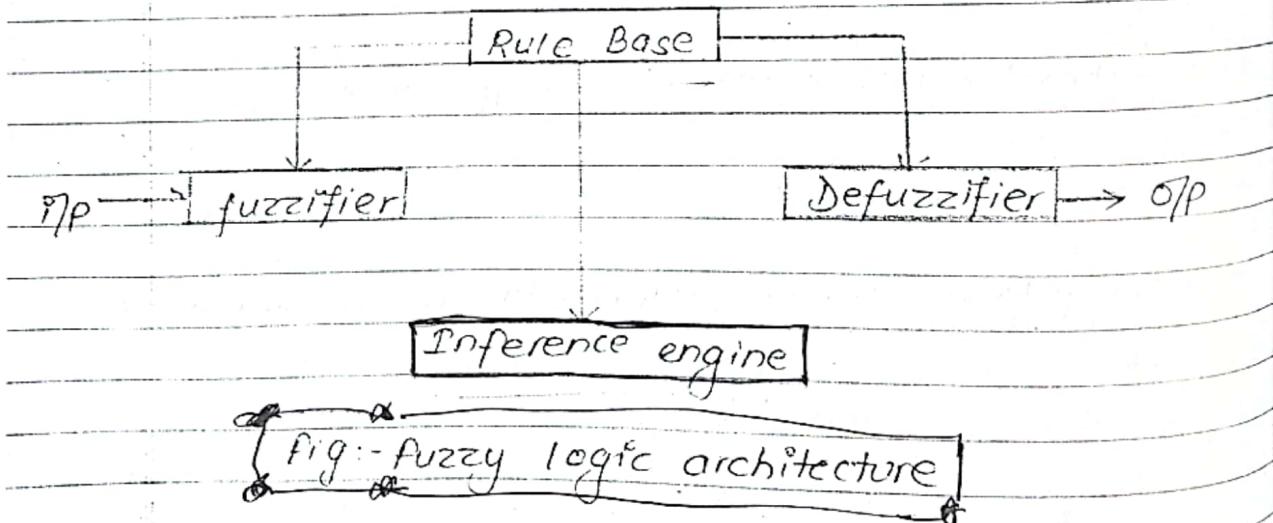
→ In boolean system, truth value '1.0' represents absolute truth value & 0.0 represents absolute false value.

→ In the fuzzy system there is no logic for absolute truth & absolute false value

rather there is an intermediate value which is partially true & partially false.



Architecture of fuzzy logic:



→ It consists of four parts:

i) Rule base:-

→ It contains the set of rules & if NAND condition provided by the inputs to govern the decision making system on the

basis of linguistic information.

(ii) Fuzzifier:

- It is used to convert input into fuzzy sets.
- Crisp inputs are basically the exact inputs major by census & passed into the control system for processing such as temperature, pressure.

(iii) Interference Engine:

- It determines the matching degree of the current fuzzy input w.r.t. to each rule & decides which rule are to be fired according to input field.

(iv) Defuzzier:

- It is used to convert the fuzzy set obtained by inference engine into a crisp value.
- There are several defuzzification no. from which the best suited one is chosen by experts.

Advantages:

- i) It is widely used for commercial & practical purposes.
- ii) It is easy and understandable.
- iii) It can work with any types of input whether it is imprecise or distorted & noisy input information.
- iv) The algorithm can be described with little data so little memory is required.
- v) It provide a very efficient solution to complex problems.
- vi) You can easily modify to fit. Improve or alter system performance.

problem along with human reasoning & decision making.

→ If feedback sensor stop working, you can program it into any situation

Disadvantages

1) Many researchers propose different way to solve a given problem through which leads to ambiguity.

→ There is no systematic approach to solve a given problem through fuzzy logic.

= → is not always accurate.

2) It is difficult to breakdown problem into mathematical shapes.

= → It cannot recognize machine learning as well as neural network type pattern.

Application:-

1) It is used in aerospace field for altitude control of spacecraft & satellite.

→ It controls the speed & traffic in the automotive system

2) It is used for decision making support system & personal evaluation in the large business company.

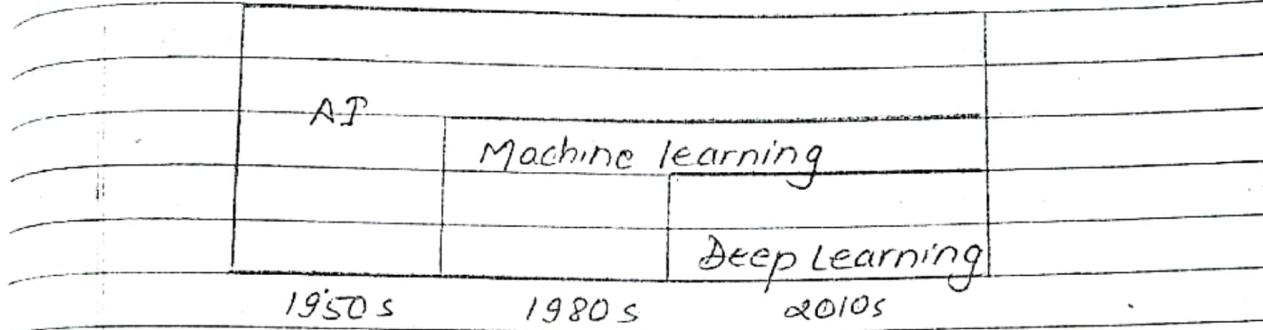
→ It also controls PH, drying, process in chemical industry

3) It is used in natural language processing & various intensive application in AI like expert system & neural network.

Q. Explain the architecture of fuzzy logic along with its disadvantages.

Q. Explain how fuzzy logic is different from boolean logic along with its architecture.

Deep Learnings:-



→ It is a part of broader family of machine learning method based on learning data representation. Learning can be supervised and unsupervised. It is class of machine learning algorithm that:-

i) Use a cascade of multiple layers of non-linear processing unit for feature extraction & transformation.

Each successive layer uses the output from the previous layer as input.

ii) Learn in supervise (Ex:- classification) or unsupervised (Pattern analysis manner)

iii) Learn multiple levels of representation that correspond to different level of abstraction.

→ Deep learning architecture such as deep neural network, deep belief network & recurrent neural network have been applied

in this field.

→ These models are based on artificial neural network.

Applications:-

i) Automatic image/speech recognition.

ii) Natural Language processing.

iii) Financial fraud detection.

iv) Image restoration & Military field.

Q. Write short note on:-

a) Deep Learning.

Q Explain the types of stochastic neurons in Boltzmann machine.

Boltzmann machine

- These are stochastic learning process have recurrent structure & are the basis of the early optimization technique used in ANN (Artificial Neural Network)
- They consist of stochastic neuron which have one of the following state either 1 or 0.
- If we apply simulated annealing on discrete Hopfield Network then it would become Boltzmann machine.

Objective:

- The main propose of boltzmann machine is to optimize the solution of a problem.
- It is the work of boltzmann machine to optimize the ^{weight} & quantity related to that particular problem.

A boltzmann machine is a network of units with an energy define for the overall network.

The global energy 'E' in a boltzmann machine is identical in form of that of Hopfield Network. And is given by:

$$E = - \left(\sum_{i,j} w_{ij} s_i s_j + \sum_i \theta_i s_i \right)$$

where,

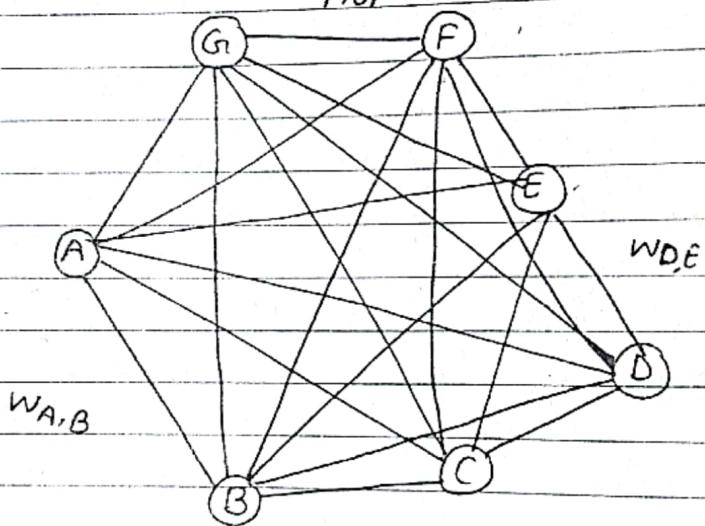
w_{ij} = the connection strength betⁿ unit j & unit i .

s_i^t = the state, $s_i^t \in \{0, 1\}$ of unit i .

θ_i^t = the bias of unit i in the global energy function

($-\theta_i^t$ is the bias of unit activation threshold for the unit)

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→ Boltzmann machine are used to solve two diff. computational problem.

1) For a search problem the way on the connection are fixed & are used to represent a cost function.

The function with the low cost value are chosen.

2) For a learning problem the Boltzmann machine must learn to generate weight as per the need to solve different problem.

Q. Define clustering and k-means clustering. Discuss briefly about fuzzy learning & its importance.

Q. Define fuzzy learning. Explain reinforcement learning with suitable example.

Q. What is learning? Explain rote learning and inductive learning. Why is the process of knowledge acquisition so tedious?

Q. Discuss briefly about deep learning and machine learning.

Q. Compare & contrast Supervised learning and unsupervised learning.

Q. Define fuzzy. Briefly explain the architecture of fuzzy logic along with its pros & cons.