Assignment - 1

1. Define: Machine Learning with examples.

-> 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 focuses on the development of computer programs that can access data and use it to learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

2. Differentiate Human Learning Process and Machine Learning Process.

-> Humans acquire knowledge through experience either directly or shared by others. Machines acquire knowledge through experience shared in the form of past data. We have the terms, Knowledge, Skill, and Memory being used to define intelligence. Just

because you have good memory, that does not mean you are intelligent. And just because you are intelligent, it does not mean you should have a good memory. However, there are exceptions to these rules. Humans begin learning by memorizing. After few years, he realizes that mere capability to memorize is not intelligence. Then he practices on transforming the data stored in memory to knowledge and applies them to develop skills to solve problems faced in real life. A person with good memory and more knowledge without the required skills cannot be considered intelligent. Search engines replaces human memory and these days the focus is on acquiring intelligence by making use of data available on the web. In humans, learning speed depends on individuals and in machines, learning speed depends on the algorithm selected and the volume of examples exposed to it.

3. What are the types of machine learning? Explain each with example.

-> 1. Supervised Machine Learning

Imagine a teacher supervising a class. The teacher already knows the correct answers but the learning process doesnt stop until the students learn the

answers as well. This is the essence of Supervised Machine Learning Algorithms. Here, the algorithm learns from a training dataset and makes predictions that are compared with the actual output values. If the predictions are not correct, then the algorithm is modified until it is satisfactory. This learning process continues until the algorithm achieves the required level of performance. Then it can provide the desired output values for any new inputs.

2. Unsupervised Machine Learning

In this case, there is no teacher for the class and the students are left to learn for themselves! So for Unsupervised Machine Learning Algorithms, there is no specific answer to be learned and there is no teacher. In this way, the algorithm doesn't figure out any output for input but it explores the data. The algorithm is left unsupervised to find the underlying structure in the data in order to learn more and more about the data itself.

3. Semi-Supervised Machine Learning

The students learn both from their teacher and by themselves in Semi-Supervised Machine Learning.

And you can guess that from the name itself! This is a combination of Supervised and Unsupervised Machine Learning that uses a little amount of labeled data like Supervised Machine Learning and a larger amount of unlabeled data like Unsupervised Machine Learning to train the algorithms.

4. Reinforcement Machine Learning

Well, here are the hypothetical students who learn from their own mistakes over time (thats like life! So the Reinforcement Machine Learning Algorithms learn optimal actions through trial and error. This means that the algorithm decides the next action by learning behaviors that are based on its current state and that will maximize the reward in the future. This is done using reward feedback that allows the Reinforcement Algorithm to learn which are the best behaviors that lead to maximum reward. This reward feedback is known as a reinforcement signal.

4. Differentiate Discrete Distribution and Continuous Distribution.

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Discrete Distribution

A discrete distribution describes the probability of occurrence of each value of a discrete random variable. A discrete random variable is a random variable that has countable values, such as a list of non-negative integers.

With a discrete probability distribution, each possible value of the discrete random variable can be associated with a non-zero probability. Thus, a discrete probability distribution is often presented in tabular form.

5. What is Central Limit Theorem?

The sample mean will approximately be normally distributed for large sample sizes regardless of the distribution from which we are sampling.

Suppose we are sampling from a population with a finite mean and a finite standard-deviation(sigma). Then Mean and standard deviation of the sampling distribution of the sample mean can be given as:

\qquad \qquad \mu_{\bar{X}}=\mu \qquad \sigma_{\bar{X}}=\frac{\sigma}{\sqrt{n}}

Where \bar{X} represents the sampling distribution of the sample mean of size n each. \mu and \sigma are the mean and standard deviation of the population respectively.

The distribution of the sample tends towards the normal distribution as the sample size increases.

All this is saying is that as you take more samples, especially large ones, your graph of the sample means will look more like a normal distribution.

Heres what the Central Limit Theorem is saying, graphically. The picture below shows one of the simplest types of test: rolling a fair die. The more times you roll the die, the more likely the shape of the distribution of the means tends to look like a normal distribution graph.

6. Explain Hypothesis and Hypothesis Testing.

-> Hypothesis are statement about the given problem. Hypothesis testing is a statistical method that is used in making a statistical decision using experimental data.

Hypothesis testing is basically an assumption that we make about a population parameter. It evaluates two mutually exclusive statements about a population to determine which statement is best supported by the sample data.

Example:

You say an average student in the class is 30 or a boy is taller than girls. All those are an example in which we assume or need some statistic way to prove those. We need some mathematical conclusion whatever we are assuming is true.

Parameters of hypothesis testing

Null hypothesis(H0): In statistics, the null hypothesis is a general given statement or default position that there is no relationship between two measured cases or no relationship among groups.

In other words, it is a basic assumption or made based on the problem knowledge.

Example: A company production is = 50 unit/per day etc.

Alternative hypothesis(H1): The alternative hypothesis is the hypothesis used in hypothesis testing that is contrary to the null hypothesis.

Example : A company production is not equal to 50 unit/per day etc.

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Level of significance
It refers to the degree of significance in which we accept or reject the null-hypothesis. 100% accuracy is not possible for accepting a hypothesis, so we, therefore, select a level of significance that is usually 5%. This is normally denoted with \alpha and generally, it is 0.05 or 5%, which means your output should be 95% confident to give similar kind of result in each sample.

P-value
The P value, or calculated probability, is the probability of finding the observed/extreme results when the null hypothesis(H0) of a study given problem is true. If your P-value is less than the chosen significance level then you reject the null hypothesis i.e. accept that your sample claims to support the alternative hypothesis.

7. Explain Monte Carlo Approximation in brief.

→ Monte Carlo Integration is a process of solving integrals having numerous values to integrate upon. The Monte Carlo process uses the theory of large numbers and random sampling to approximate values that are very close to the actual solution of the integral. It works on the average of a function denoted by $\langle f(x) \rangle$. Then we can expand $\langle f(x) \rangle$ as the summation of the values divided by the number of points in the integration and solve the Left-hand side of the equation to approximate the value of the integration at the right-hand side. The derivation is as follows.

→ Simulation: Drawing one pseudo-random uniform variable from the interval $[0,1]$ can be used to simulate the tossing of a coin: If the value is less than or equal to 0.50 designate the outcome as heads, but if the value is greater than 0.50 designate the outcome as tails. This is a simulation, but not a Monte Carlo simulation.

→ Monte Carlo method: Pouring out a box of coins on a table, and then computing the ratio of coins that land heads versus tails is a Monte Carlo method of determining the behavior of repeated coin tosses, but it is not a simulation.