1. What is the concept of human learning? Please give two examples.

Human learning happens through various different ways and varies by the person. Mostly humans start learning by observation and experience. For instance, as a baby grows, it observes the surroundings and tries to grasp an understanding. They observe people around like their parents and try to mimic their behaviour, picking up skills like language, walking and other daily occurrences.

Other ways humans learn is by experimentation and study. This can be by learning from others experiences or having entirely different ones of their own. Human “intelligence” is usually defined by Knowledge, skill and Memory. Assessing human intelligence is often done by testing these three qualities. A good example of this is the education system humans have established, the whole purpose of which is to collect and pass down knowledge and experience to the new generation of humans to keep growing.

Skill for humans is the most important among the three as it allows a person to use their experience and intelligence to devise solutions for new domains. This is a key difference between human and machine learning as a machine requires previous data in a domain to detect patterns and solve problems

2. What different forms of human learning are there? Are there any machine learning equivalents?

There are several types of human learning as discussed below:

1. Classical Conditioning: This is learning through association. In this a neutral stimulus and is paired with a known stimulus that evokes a certain response which leads to the previously neutral stimulus leading to a similar response to the paired known stimulus.

Classification Algorithms are somewhat similar to this in the sense that they can associate the new data with the previous learnings and predict a suitable classification of the new input

1. Operant Conditioning: This is learning through consequences. Every action has a consequence, the desirability of which shapes the behaviour. The result of an action can be positive or negative which determines an increase or decrease in the behaviour.

The concept of Reinforcement learning in ML is utilizes a similar principle where the goal is to maximize the “reward” and minimize the “penalty”. Here, the model behaviour changes depending on positive and negative reinforcement that ultimately determines the outcome.

1. Observational Learning: As the name suggests, here the learning happens through observation. Previously available information is used to detect similarities and determine what the new observation is. This is probably the most common form of learning that can be observed in humans where we observe and imitate our surroundings

In machine learning, regression models are quite similar to this. They recognise patterns associated with certain outcomes and detect similar patterns in the new data to predict a possible outcome associated with that particular pattern.

3. What is machine learning, and how does it work? What are the key responsibilities of machine learning?

Machine learning is giving a Machine – A computing device – the capability to “learn” using algorithms that can visualize and detect patterns in data and provide predictions or decisions based on it without having to explicitly program the scenarios and outcomes.

ML works by using two techniques for learning, supervised – Where sample data is available with both input and output to derive observations from, and Unsupervised – where only input data is available and similarities have to be interpreted based solely on that.

ML models can be used for a variety of purposes from simple classification and regression problems, statistical analysis, complex tasks like image and voice recognition, medical diagnosis etc.

4. Define the terms "penalty" and "reward" in the context of reinforcement learning.

Reinforcement learning works on the principal of penalty and reward. Here reward and penalty denote good and bad actions respectively. A reward is a signal of a desired or “good” action and penalty is the signal for an undesired or “bad” action. The value function tries to estimate a course of actions for maximizing the reward and the algorithm learns based on this positive and negative feedback received.

5. Explain the term "learning as a search"?

In the context of applied machine learning, “Learning as a search” is the everlasting search for the perfect learning model for a given situation. In ML, the model created and the function that denotes the data fed to it is only an approximation of the “True” function. We never know the actual true outcome or the underlying function that perfectly denotes the data, we can only approximate it and make them better and closer to the True function. Various parameters from the selection of the data itself to the prediction models and the values used by these models are tuned to get the best possible approximation.

This search for the best decisions and parameters for the development of the learning model is said to be “Learning as a search”. We are always searching to make the learning process better.

6. What are the various goals of machine learning? What is the relationship between these and human learning?

The major goal of machine learning is to give a machine the ability to make decisions without having to explicitly program the expected outcomes and to adapt to the changing nature of input. This often means that the objective of an ML model is to predict outcome based on previous data for which the outcome is already known or derive similarities from completely unknown data.

ML is quite similar in some ways of human learning. We humans by observation and experience learn to derive patterns and similarities between things and use this previous data for our judgements. We create “models” in our brain just like ML to make decisions and adapt these models based on new experiences and observations.

7. Illustrate the various elements of machine learning using a real-life illustration.

Machine learning consists of several elements as discussed below:

1. Data: Data or Information is very essential for ML as this is the basis of how the model will be developed. This is like Fuel for a car which powers it. Just like fuel, the quality, quantity and type of data determines how well the ML model will be able to perform the intended task.
2. Task: The goal of our model is the task we it need to perform. This can be done by supervised or unsupervised learning based on the type of data we have. This is similar to setting a destination for a journey.
3. Model: Model is the function or algorithm that we use to define a relationship between the input data and the output, choosing the right model based on our use case and the type of data we have is essential as this basically determines how we approach our data. This can be equated to choosing the right vehicle for our journey based on the type of travel. It is essential to choose right as choosing the wrong vehicle can result in an altogether failure of the journey.
4. Loss Function: Loss Function is basically choosing the best approach for implementation of a model. We need to have the predicted values as close as possible to the real output. Hence, we need to minimize the loss function to determine which model is better for our purposes.

This is similar to choosing a best route for our journey where we need the shortest as well as the best quality way to reach our destination

1. The algorithm: The learning algorithm itself determines how good our model created will be, the various parameters like of an algorithm change its effectiveness. This will need to be tuned while learning as it requires a lot of experimentation and varies according to the input data.

Considering the example of a Journey, this is the actual travelling and driving that will be done where we make the take the route and make the small decisions and adjustments along the way. The speed we maintain, the stops we make, the food we eat etc.

1. Evaluation: The Final step here is to evaluate our model and test its effectiveness in the task. This determines how good our decisions were and if any changes are required in the process to improve it in any way possible.

A final step in our journey were we evaluate our decisions, calculate our expenditure and gain insights on how it could have been better and whether we reached where we set out for.

8. Provide an example of the abstraction method.

In python @abstractmethod is used to define an abstract method. This is used to provide a blueprint for implementation of the method rather than the actual implementation. This method can then be inherited into other subclasses and the actual implementation can be done with desired changes for the specific implementation.

Here is an example of abstraction:

From abc import ABC, abstractionmethod

Class Car(ABC):

def mileage(self):

pass

class Car1(Car):

def mileage(self):

print("The mileage is 30kmpl")

class Car2(Car):

def mileage(self):

print("The mileage is 25kmpl ")

Here, the mileage method is an abstract method with its implementation being unique to classes Car1 and Car2. As the mileage method is called via the object of Car1 it gives the output for its implementation in Car1 class

c1 = Car1()

c1.mileage()

This gives the output as “The mileage is 30kmpl”

C2 = Car2()

C2.mileage()

This gives the output as “The mileage is 25kmpl”

9. What is the concept of generalization? What function does it play in the machine learning process?

Generalization is the concept of writing code for general usage giving it the ability to handle similar but differing inputs of data and adapt to any discrepancies in the input. The programming is done in such a way that the code can handle variations in input and certain types of errors without having to completely stop the code in case of any slight deviation from the intention of the developer.

In machine learning, generalization is crucial for as vast amounts of data with varying quality are fed to a model and the code should be able to handle most of the commonly seen discrepancies in data without stopping dead in its tracks. This demonstrates the ability of the model to handle unforeseen data. This requires training the model with diverse data in terms of quality, proper tuning of hyperparameters, choosing the most suitable algorithm for the nature of data etc.

10. What is classification, exactly? What are the main distinctions between classification and regression?

Classification is separation of data into various classes. This could be supervised or unsupervised based on the type of input data. The output for classification is discrete as in if a datapoint belongs to a class or not.

Regression on the other hand is different in the sense that it is used for prediction of continuous values rather than rigid classes. For regression, small differences in output values matter unlike classification. Regression is used for prediction of values continuous in nature such as product prices, salaries, temperature, age etc whereas classification is used to divide data points in categories like male or female, true or false, age groups, target demographic etc.

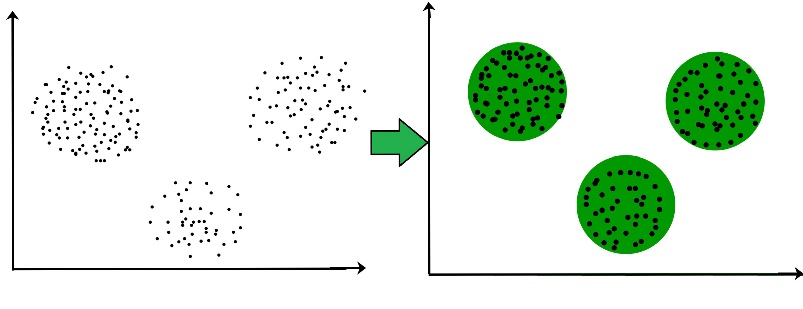
11. What is regression, and how does it work? Give an example of a real-world problem that was solved using regression.

Regression is used for prediction of continuous values of data. Regression works by finding a mapping function that best represents the input data and predict future values based on that function.

Regression is used in a variety of scenarios in the real world. A good example of this is the prediction of market trends that analyses the previous behaviour of a certain stock and provide a guess of how it would behave going forward, whether it would be suitable for investment and provide estimated returns.

12. Describe the clustering mechanism in detail.

Clustering is used to group similar datapoints into clusters. This is an unsupervised learning approach as it deals with unlabelled data.



As seen in the above graph, from the nature of datapoints we can clearly see that it can be divided into separate clusters of points having similar nature.

Different types of clustering methods are used based on the nature of data:

1. Density Based: Such methods consider the density of datapoints for formation of clusters. These methods have good accuracy and the ability to merge two clusters. DBSCAN and OPTICS used density-based approach for clustering
2. Hierarchical Methods: These methods from a tree like structure for formation of clusters. Previously formed clusters can be further divided to form new clusters. These methods follow the “Bottom up” or the “Top down” approach for clustering. CURE and BIRCH use this approach for the task
3. Partitioning Based: Here, the data is divided in partitions where each partition forms a cluster. The distance of data points from one another is essential in this from of clustering. Popular algorithms like K means use this approach
4. Grid Based: In this method, data is divided into cells and similar cells are grouped into one cluster. Clustering using this method is fast and independent of the number of data points

13. Make brief observations on two of the following topics:

a. Studying without supervision

In reference to machine learning, studying without supervision is not having any prior information on the provided data. Without prior knowledge of what to expect of the input data being fed, an unsupervised algorithm tries to detect hidden patterns and insights on the data provided. This is similar to one of the ways humans learn when encountered by previously unknown things. The algorithm tries to group similar data together and represents it in a compressed format.

This approach is useful in many conditions where input data with corresponding output is not always available to train with or there are no clear labelling or categorization of the data

b. Reinforcement learning is a form of learning based on positive reinforcement.

In reinforcement learning, the algorithm responds based on the feedback provided in response to an action. The feedback here can be positive or negative. This helps the algorithm decide whether to continue on the actions made or change its behaviour in case of negative feedback.

RL is said to be based on positive reinforcement as the value function tries to find a course of actions that can maximize the reward, that is, positive feedback. It tries to change the behaviour to find maximum reward and hence its basic nature becomes to get maximum reward