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5TH SEMESTER

AI/ML WEEK-2

What is machine learning?...

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

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

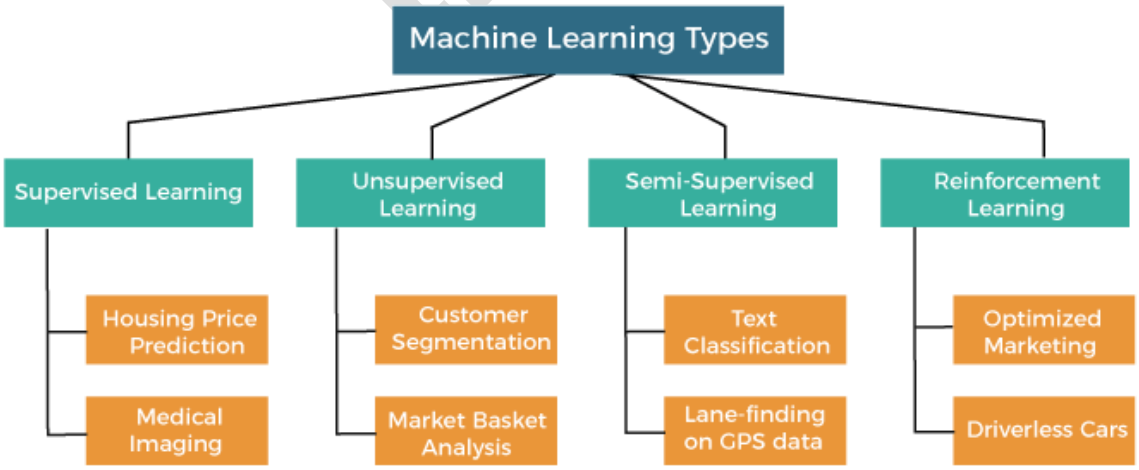
Machine Learning can be defined as the ability of a machine to learn something without having to be programmed for that specific thing. It is the field of study where computers use a massive set of data and apply algorithms for 'training' themselves and making predictions. Training in Machine Learning entails feeding a lot of data into the algorithm and allowing the machine itself to learn more about the processed information.

Types of Machine Learning

Machine learning is a subset of AI, which enables the machine to automatically learn from data, improve performance from past experiences, and make predictions. 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.

Based on the methods and way of learning, machine learning is divided into mainly four types, which are:

1. **Supervised Machine Learning**
2. **Unsupervised Machine Learning**
3. **Semi-Supervised Machine Learning**
4. **Reinforcement Learning**



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 preciously, 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.

Let's understand supervised learning with an example. 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.

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:

- **Classification**
- **Regression**

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:

- **Random Forest Algorithm**
- **Decision Tree Algorithm**
- **Logistic Regression Algorithm**
- **Support Vector Machine Algorithm**

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:

- **Simple Linear Regression Algorithm**
- **Multivariate Regression Algorithm**
- **Decision Tree Algorithm**

- **Lasso Regression**

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.

Applications of Supervised Learning

Some common applications of Supervised Learning are given below:

- **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.

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 un labelled 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.

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 preciously; 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**

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**

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.**

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 unlabelled dataset.
- Unsupervised algorithms are preferable for various tasks as getting the unlabelled 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.

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.

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.

Although Semi-supervised learning is the middle ground between supervised and unsupervised learning and operates on the data that consists of a few labels, it mostly consists of unlabeled data. As labels are costly, but for corporate purposes, they may have few labels. It is completely different from supervised and unsupervised learning as they are based on the presence & absence of labels.

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.

We can imagine these algorithms with an example. Supervised learning is where a student is under the supervision of an instructor at home and college. Further, if that student is self-analysing the same concept without any help from the instructor, it comes under unsupervised learning. Under semi-supervised learning, the student has to revise himself after analyzing the same concept under the guidance of an instructor at college.

- 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.
- We cannot apply these algorithms to network-level data.
- Accuracy is low.

4. 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.

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.

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. Some popular games that use RL algorithms are **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.

Advantages and Disadvantages of Reinforcement Learning

Advantages

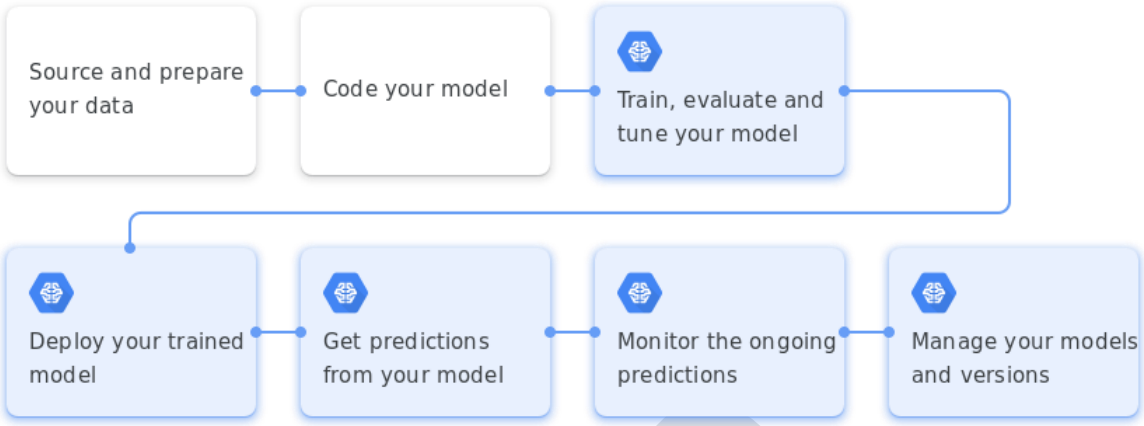
- It helps in solving complex real-world problems which are difficult to be solved by general techniques.
- The learning model of RL is similar to the learning of human beings; hence most accurate results can be found.
- Helps in achieving long term results.

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 ML workflow

The diagram below gives a high-level overview of the stages in an ML workflow. The blue-filled boxes indicate where AI Platform provides managed services and APIs:



ML workflow

To develop and manage a production-ready model, you must work through the following stages:

- Source and prepare your data.
- Develop your model.
- Train an ML model on your data:
  - Train model
  - Evaluate model accuracy
  - Tune hyperparameters
- Deploy your trained model.
- Send prediction requests to your model:
  - Online prediction
  - Batch prediction
- Monitor the predictions on an ongoing basis.
- Manage your models and model versions.

These stages are iterative. You may need to revaluate and go back to a previous step at any point in the process.

Machine learning workflows define the steps initiated during a particular machine learning implementation. Machine learning workflows vary by project, but four basic phases are typically included.

Gathering machine learning data

Gathering data is one of the most important stages of machine learning workflows. During data collection, you are defining the potential usefulness and accuracy of your project with the quality of the data you collect.

To collect data, you need to identify your sources and aggregate data from those sources into a single dataset. This could mean streaming data from Internet of Things sensors, downloading open source data sets, or constructing a data lake from assorted files, logs, or media.

Data pre-processing

Once your data is collected, you need to pre-process it. Pre-processing involves cleaning, verifying, and formatting data into a usable dataset. If you are collecting data from a single source, this may be a relatively straightforward process. However, if you are aggregating several sources you need to make sure that data formats match, that data is equally reliable, and remove any potential duplicates.

Building datasets

This phase involves breaking processed data into three datasets—training, validating, and testing:

- **Training set**—used to initially train the algorithm and teach it how to process information. This set defines model classifications through parameters.
- **Validation set**—used to estimate the accuracy of the model. This dataset is used to finetune model parameters.
- **Test set**—used to assess the accuracy and performance of the models. This set is meant to expose any issues or mis trainings in the model.

Training and refinement

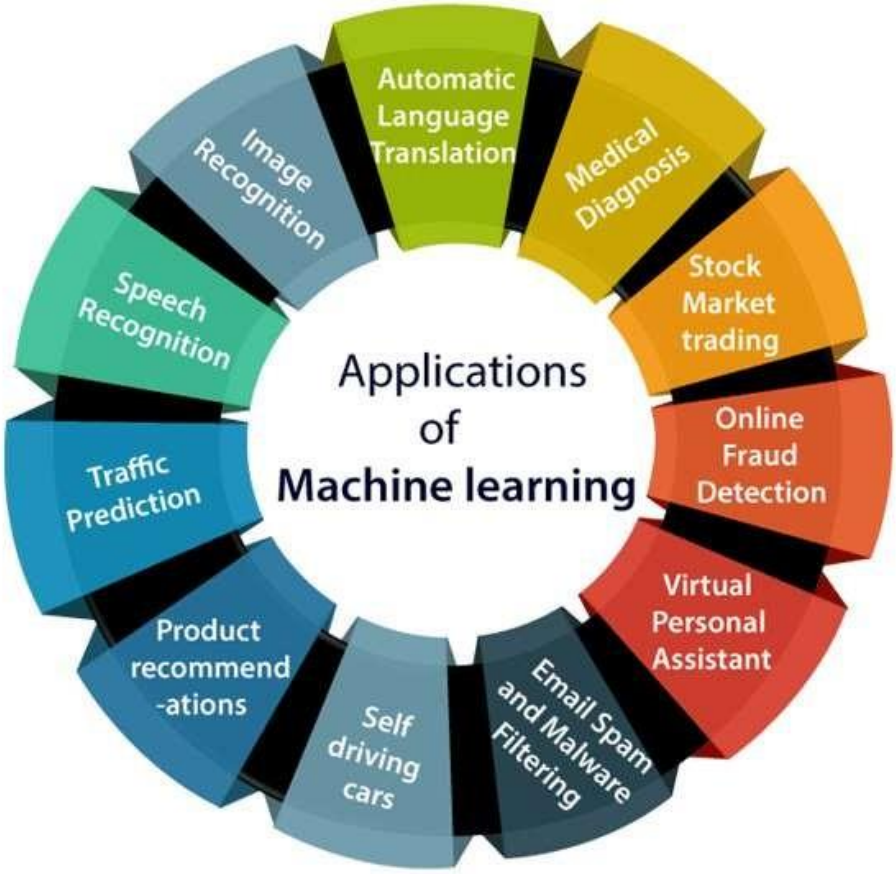
Once you have datasets, you are ready to train your model. This involves feeding your training set to your algorithm so that it can learn appropriate parameters and features used in classification.

Once training is complete, you can then refine the model using your validation dataset. This may involve modifying or discarding variables and includes a process of tweaking model-specific settings (hyperparameters) until an acceptable accuracy level is reached.

Machine learning evaluation

Finally, after an acceptable set of hyperparameters is found and your model accuracy is optimized you can test your model. Testing uses your test dataset and is meant to verify that your models are using accurate features. Based on the feedback you receive you may return to training the model to improve accuracy, adjust output settings, or deploy the model as needed.

Applications of Machine Learning:



1. Image Recognition:

Image recognition is one of the most common applications of machine learning. It is used to identify objects, persons, places, digital images, etc. The popular use case of image recognition and face detection is, **Automatic friend tagging suggestion**:

Facebook provides us a feature of auto friend tagging suggestion. Whenever we upload a photo with our Facebook friends, then we automatically get a tagging suggestion with name, and the technology behind this is machine learning's **face detection** and **recognition algorithm**.

It is based on the Facebook project named "**Deep Face**," which is responsible for face recognition and person identification in the picture.

2. Speech Recognition

While using Google, we get an option of "**Search by voice**," it comes under speech recognition, and it's a popular application of machine learning.

Speech recognition is a process of converting voice instructions into text, and it is also known as "**Speech to text**", or "**Computer speech recognition**." At present, machine learning algorithms are widely used by various applications of speech recognition. **Google assistant**, **Siri**, **Cortana**, and **Alexa** are using speech recognition technology to follow the voice instructions.

3. Traffic prediction:

If we want to visit a new place, we take help of Google Maps, which shows us the correct path with the shortest route and predicts the traffic conditions.

It predicts the traffic conditions such as whether traffic is cleared, slow-moving, or heavily congested with the help of two ways:

- **Real Time location** of the vehicle form Google Map app and sensors
- **Average time has taken** on past days at the same time.

Everyone who is using Google Map is helping this app to make it better. It takes information from the user and sends back to its database to improve the performance.

4. Product recommendations:

Machine learning is widely used by various e-commerce and entertainment companies such as **Amazon**, **Netflix**, etc., for product recommendation to the user. Whenever we search for some product on Amazon, then we started getting an advertisement for the same product while internet surfing on the same browser and this is because of machine learning.

Google understands the user interest using various machine learning algorithms and suggests the product as per customer interest.

As similar, when we use Netflix, we find some recommendations for entertainment series, movies, etc., and this is also done with the help of machine learning.

5. Self-driving cars:

One of the most exciting applications of machine learning is self-driving cars. Machine learning plays a significant role in self-driving cars. Tesla, the most popular car manufacturing company is working on self-driving car. It is using unsupervised learning method to train the car models to detect people and objects while driving.

6. Email Spam and Malware Filtering:

Whenever we receive a new email, it is filtered automatically as important, normal, and spam. We always receive an important mail in our inbox with the important symbol and spam emails in our spam box, and the technology behind this is Machine learning. Below are some spam filters used by Gmail:

- Content Filter
- Header filter
- General blacklists filter
- Rules-based filters
- Permission filters

Some machine learning algorithms such as **Multi-Layer Perceptron**, **Decision tree**, and **Naïve Bayes classifier** are used for email spam filtering and malware detection.

7. Virtual Personal Assistant:

We have various virtual personal assistants such as **Google assistant**, **Alexa**, **Cortana**, **Siri**. As the name suggests, they help us in finding the information using our voice instruction. These assistants can help us in various ways just by our voice instructions such as Play music, call someone, Open an email, Scheduling an appointment, etc.

8. Online Fraud Detection:

Machine learning is making our online transaction safe and secure by detecting fraud transaction. Whenever we perform some online transaction, there may be various ways that a fraudulent transaction can take place such as **fake accounts**, **fake ids**, and **steal money** in the middle of a transaction. So to detect this, **Feed Forward Neural network** helps us by checking whether it is a genuine transaction or a fraud transaction.

For each genuine transaction, the output is converted into some hash values, and these values become the input for the next round. For each genuine transaction, there is a specific pattern which gets change for the fraud transaction hence, it detects it and makes our online transactions more secure.

9. Stock Market trading:

Machine learning is widely used in stock market trading. In the stock market, there is always a risk of up and downs in shares, so for this machine learning's **long short term memory neural network** is used for the prediction of stock market trends.

10. Medical Diagnosis:

In medical science, machine learning is used for diseases diagnoses. With this, medical technology is growing very fast and able to build 3D models that can predict the exact position of lesions in the brain.

It helps in finding brain tumors and other brain-related diseases easily.

11. Automatic Language Translation:

Nowadays, if we visit a new place and we are not aware of the language then it is not a problem at all, as for this also machine learning helps us by converting the text into our known languages. Google's GNMT (Google Neural Machine Translation) provide this feature, which is a Neural Machine Learning that translates the text into our familiar language, and it called as automatic translation.

Challenges/Issues in Machine Learning:

Although machine learning is being used in every industry and helps organizations make more informed and data-driven choices that are more effective than classical methodologies, it still has so many problems that cannot be ignored. Here are some common issues in Machine Learning that professionals face to inculcate ML skills and create an application from scratch.

1. Inadequate Training Data

The major issue that comes while using machine learning algorithms is the lack of quality as well as quantity of data. Although data plays a vital role in the processing of machine learning algorithms, many data scientists claim that inadequate data, noisy data, and unclean data are extremely exhausting the machine learning algorithms. For example, a simple task requires thousands of sample data, and an advanced task such as speech or image recognition needs millions of sample data examples.

Further, data quality is also important for the algorithms to work ideally, but the absence of data quality is also found in Machine Learning applications. Data quality can be affected by some factors as follows:

- **Noisy Data-** It is responsible for an inaccurate prediction that affects the decision as well as accuracy in classification tasks.
- **Incorrect data-** It is also responsible for faulty programming and results obtained in machine learning models. Hence, incorrect data may affect the accuracy of the results also.
- **Generalizing of output data-** Sometimes, it is also found that generalizing output data becomes complex, which results in comparatively poor future actions.

2. Poor quality of data

As we have discussed above, data plays a significant role in machine learning, and it must be of good quality as well. Noisy data, incomplete data, inaccurate data, and unclean data lead to less accuracy in classification and low-quality results. Hence, data quality can also be considered as a major common problem while processing machine learning algorithms.

3. Non-representative training data

To make sure our training model is generalized well or not, we have to ensure that sample training data must be representative of new cases that we need to generalize. The training data must cover all cases that are already occurred as well as occurring.

Further, if we are using non-representative training data in the model, it results in less accurate predictions. A machine learning model is said to be ideal if it predicts well for generalized cases and provides accurate decisions. If there is less training data, then there will be a sampling noise in the model, called the non-representative training set. It won't be accurate in predictions. To overcome this, it will be biased against one class or a group.

Hence, we should use representative data in training to protect against being biased and make accurate predictions without any drift.

4. Overfitting and Underfitting

Overfitting:

Overfitting is one of the most common issues faced by Machine Learning engineers and data scientists. Whenever a machine learning model is trained with a huge amount of data, it starts capturing noise and inaccurate data into the training data set. It negatively affects the performance of the model. Let's understand with a simple example where we have a few training data sets such as 1000 mangoes, 1000 apples, 1000 bananas, and 5000 papayas. Then there is a considerable probability of identification of an apple as papaya because we have a massive amount of biased data in the training data set; hence prediction got negatively affected. The main reason behind overfitting is using non-linear methods used in machine learning algorithms as they build non-realistic data models. We can overcome overfitting by using linear and parametric algorithms in the machine learning models.

Methods to reduce overfitting:

- Increase training data in a dataset.
- Reduce model complexity by simplifying the model by selecting one with fewer parameters

- Ridge Regularization and Lasso Regularization
- Early stopping during the training phase
- Reduce the noise
- Reduce the number of attributes in training data.
- Constraining the model.

Underfitting:

Underfitting is just the opposite of overfitting. Whenever a machine learning model is trained with fewer amounts of data, and as a result, it provides incomplete and inaccurate data and destroys the accuracy of the machine learning model.

Underfitting occurs when our model is too simple to understand the base structure of the data, just like an undersized pant. This generally happens when we have limited data into the data set, and we try to build a linear model with non-linear data. In such scenarios, the complexity of the model destroys, and rules of the machine learning model become too easy to be applied on this data set, and the model starts doing wrong predictions as well.

Methods to reduce Underfitting:

- Increase model complexity
- Remove noise from the data
- Trained on increased and better features
- Reduce the constraints
- Increase the number of epochs to get better results.

5. Monitoring and maintenance

As we know that generalized output data is mandatory for any machine learning model; hence, regular monitoring and maintenance become compulsory for the same. Different results for different actions require data change; hence editing of codes as well as resources for monitoring them also become necessary.

6. Getting bad recommendations

A machine learning model operates under a specific context which results in bad recommendations and concept drift in the model. Let's understand with an example where at a specific time customer is looking for some gadgets, but now customer requirement changed over time but still machine learning model showing same recommendations to the customer while customer expectation has been changed. This incident is called a Data Drift. It generally occurs when new data is introduced or interpretation of data changes. However, we can overcome this by regularly updating and monitoring data according to the expectations.

7. Lack of skilled resources

Although Machine Learning and Artificial Intelligence are continuously growing in the market, still these industries are fresher in comparison to others. The absence of skilled resources in the form of manpower is also an issue. Hence, we need manpower having in-depth knowledge of mathematics, science, and technologies for developing and managing scientific substances for machine learning.

8. Customer Segmentation

Customer segmentation is also an important issue while developing a machine learning algorithm. To identify the customers who paid for the recommendations shown by the model and who don't even check them. Hence, an algorithm is necessary to recognize the customer behavior and trigger a relevant recommendation for the user based on past experience.

9. Process Complexity of Machine Learning

The machine learning process is very complex, which is also another major issue faced by machine learning engineers and data scientists. However, Machine Learning and Artificial Intelligence are very new technologies but are still in an experimental phase and continuously being changing over time. There is the majority of hits and trial experiments; hence the probability of error is higher than expected. Further, it also includes analyzing the data, removing data bias, training data, applying complex mathematical calculations, etc., making the procedure more complicated and quite tedious.

10. Data Bias

Data Biasing is also found a big challenge in Machine Learning. These errors exist when certain elements of the dataset are heavily weighted or need more importance than others. Biased data leads to inaccurate results, skewed outcomes, and other analytical errors. However, we can resolve this error by determining where data is actually biased in the dataset. Further, take necessary steps to reduce it.

Methods to remove Data Bias:

- Research more for customer segmentation.
- Be aware of your general use cases and potential outliers.
- Combine inputs from multiple sources to ensure data diversity.
- Include bias testing in the development process.
- Analyze data regularly and keep tracking errors to resolve them easily.
- Review the collected and annotated data.
- Use multi-pass annotation such as sentiment analysis, content moderation, and intent recognition.

11. Lack of Explainability

This basically means the outputs cannot be easily comprehended as it is programmed in specific ways to deliver for certain conditions. Hence, a lack of explainability is also found in machine learning algorithms which reduce the credibility of the algorithms.

12. Slow implementations and results

This issue is also very commonly seen in machine learning models. However, machine learning models are highly efficient in producing accurate results but are time-consuming. Slow programming, excessive requirements' and overloaded data take more time to provide accurate results than expected. This needs continuous maintenance and monitoring of the model for delivering accurate results.

13. Irrelevant features

Although machine learning models are intended to give the best possible outcome, if we feed garbage data as input, then the result will also be garbage. Hence, we should use relevant features in our training sample. A machine learning model is said to be good if training data has a good set of features or less to no irrelevant features.

Conclusion

An ML system doesn't perform well if the training set is too small or if the data is not generalized, noisy, and corrupted with irrelevant features. We went through some of the basic challenges faced by beginners while practicing machine learning. Machine learning is all set to bring a big bang transformation in technology. It is one of the most rapidly growing technologies used in medical diagnosis, speech recognition, robotic training, product recommendations, video surveillance, and this list goes on. This continuously evolving domain offers immense job satisfaction, excellent opportunities, global exposure, and exorbitant salary. It is high risk and a high return technology. Before starting your machine learning journey, ensure that you carefully examine the challenges mentioned above. **To learn this fantastic technology, you need to plan carefully, stay patient, and maximize your efforts. Once you win this battle, you can conquer the Future of work and land your dream.**

Steps involved in building a machine learning model:

Step 1: Collect Data

Given the problem you want to solve, you will have to investigate and obtain data that you will use to feed your machine. The quality and quantity of information you get are very important since it will directly impact how well or badly your model will work. You may have the information in an existing database or you must create it from scratch. If it is a small project you can create a spreadsheet that will later be easily exported as a CSV file. It is also common to use the web scraping technique to automatically collect information from various sources such as APIs.

Step 2: Prepare the data:

This is a good time to visualize your data and check if there are correlations between the different characteristics that we obtained. It will be necessary to make a selection of characteristics since the ones you choose will directly impact the execution times and the results. You can also reduce dimensions by applying PCA if necessary.

Additionally, you must balance the amount of data we have for each result -class- so that it is significant as the learning may be biased towards a type of response and when your model tries to generalize knowledge it will fail.

You must also separate the data into two groups: one for training and the other for model evaluation which can be divided approximately in a ratio of 80/20 but it can vary depending on the case and the volume of data we have.

At this stage, you can also pre-process your data by normalizing, eliminating duplicates, and making error corrections.

Step 3: Choose the model

There are several models that you can choose according to the objective that you might have: you will use algorithms of classification, prediction, linear regression, clustering, i.e. k-means or K-Nearest Neighbor, Deep Learning, i.e Neural Networks, Bayesian, etc.

There are various models to be used depending on the data you are going to process such as images, sound, text, and numerical values. In the following table, we will see some models and their applications that you can apply in your projects:

Model	Applications
Logistic Regression	Price prediction
Fully connected networks	Classification
Convolutional Neural Networks	Image processing
Recurrent Neural Networks	Voice recognition
Random Forest	Fraud Detection
Reinforcement Learning	Learning by trial and error
Generative Models	Image creation
K-means	Segmentation
k-Nearest Neighbors	Recommendation systems
Bayesian Classifiers	Spam and noise filtering

Step 4 Train your machine model

You will need to train the datasets to run smoothly and see an incremental improvement in the prediction rate. Remember to initialize the weights of your model randomly -the weights are the

values that multiply or affect the relationships between the inputs and outputs- which will be automatically adjusted by the selected algorithm the more you train them.

Step 5: Evaluation

You will have to check the machine created against your evaluation data set that contains inputs that the model does not know and verify the precision of your already trained model. If the accuracy is less than or equal to 50%, that model will not be useful since it would be like tossing a coin to make decisions. If you reach 90% or more, you can have good confidence in the results that the model gives you.

Step 6: Parameter Tuning

If during the evaluation you did not obtain good predictions and your precision is not the minimum desired, it is possible that you have overfitting -or underfitting problems and you must return to the training step before making a new configuration of parameters in your model. You can increase the number of times you iterate your training data- termed epochs. Another important parameter is the one known as the "learning rate", which is usually a value that multiplies the gradient to gradually bring it closer to the global -or local- minimum to minimize the cost of the function.

Increasing your values by 0.1 units from 0.001 is not the same as this can significantly affect the model execution time. You can also indicate the maximum error allowed for your model. You can go from taking a few minutes to hours, and even days, to train your machine. These parameters are often called Hyperparameters. This "tuning" is still more of an art than a science and will improve as you experiment. There are usually many parameters to adjust and when combined they can trigger all your options. Each algorithm has its own parameters to adjust. To name a few more, in Artificial Neural Networks (ANNs) you must define in its architecture the number of hidden layers it will have and gradually test with more or less and with how many neurons each layer. This will be a work of great effort and patience to give good results.

Step 7: Prediction or Inference

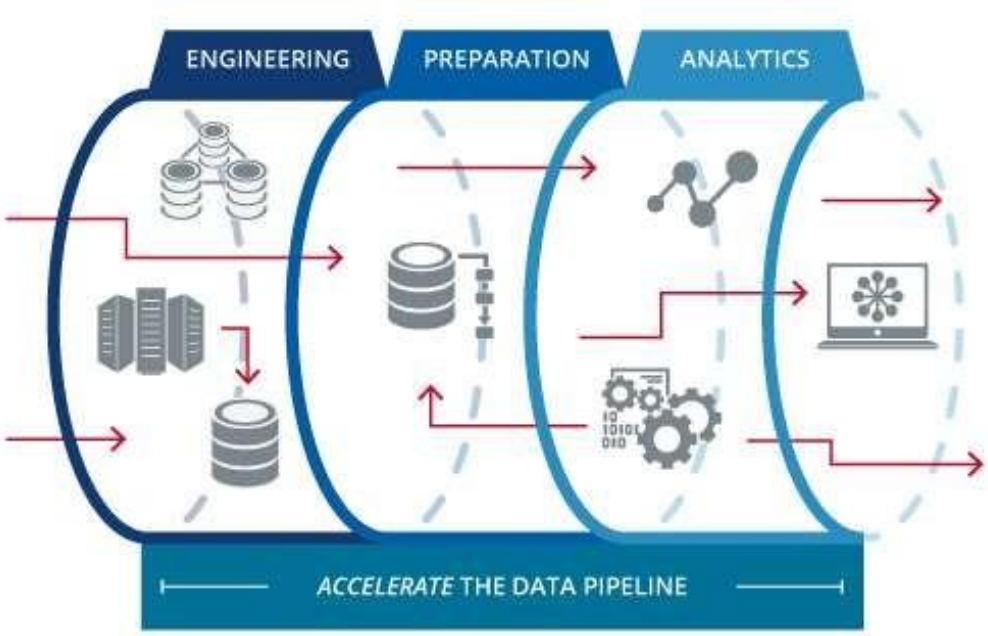
You are now ready to use your Machine Learning model inferring results in real-life scenarios.

Pipelines:

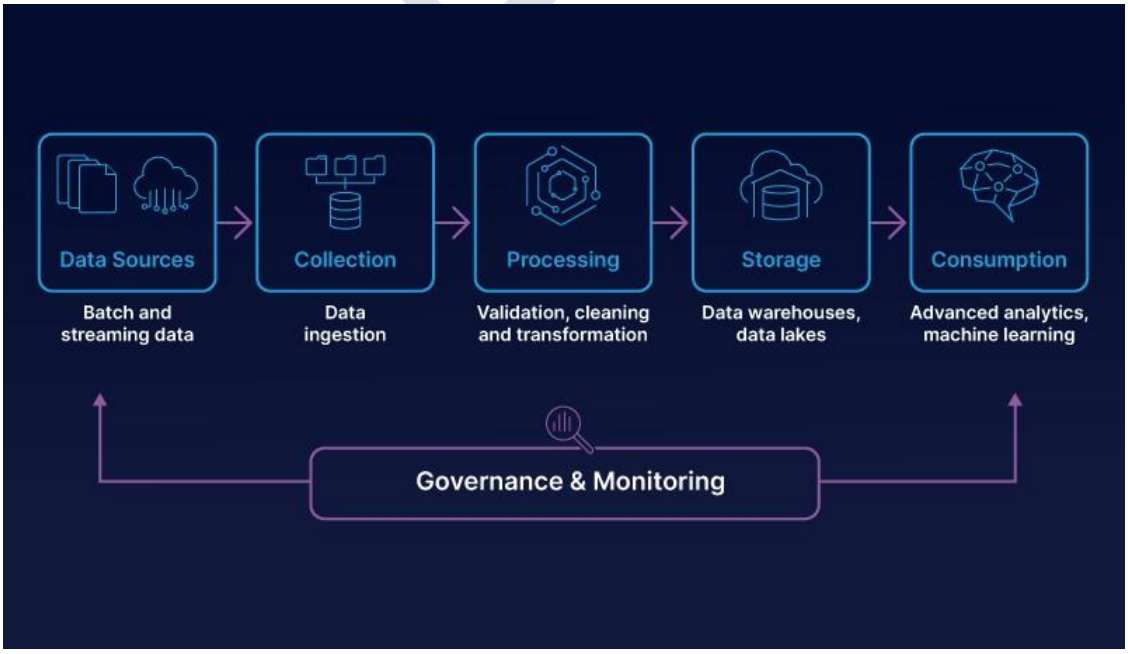
Data engineering pipelines:

What is a data engineering pipeline?

A data engineering pipeline is the design and structure of algorithms and models that copy, cleanse, or modify data as needed. It also directly sources data to a destination like a data lake or data warehouse. A data pipeline streamlines and automates the flow of data from one point to another, and automates all the data-related activities in the pipeline. **These include data extraction, data ingestion, data transformation, and data loading.**



Steps in designing a data pipeline:



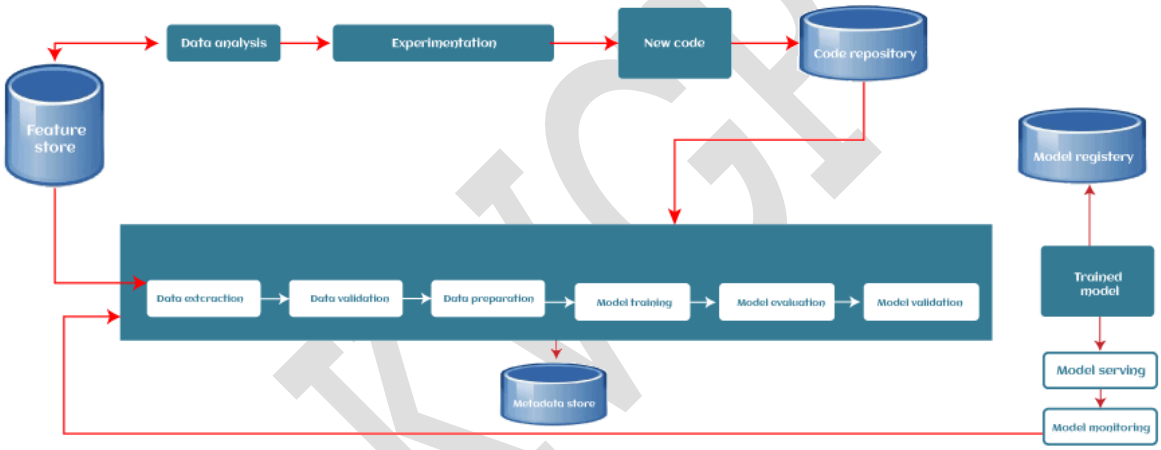
Machine Learning Pipeline:

What is Machine Learning Pipeline?

A Machine Learning pipeline is a process of automating the workflow of a complete machine learning task. It can be done by enabling a sequence of data to be transformed and correlated together in a model that can be analyzed to get the output. A typical pipeline includes raw data input, features, outputs, model parameters, ML models, and Predictions. Moreover, an ML Pipeline contains multiple sequential steps that perform everything ranging from data extraction and pre-processing to model training and deployment in Machine learning in a modular approach. It means that ***in the pipeline, each step is designed as an independent module, and all these modules are tied together to get the final result.***

Machine Learning Pipeline Steps

On the basis of the use cases of the ML model and the requirement of the organization, each machine learning pipeline may be different to some extent. However, each pipeline follows/works upon the general workflow of Machine learning, or there are some common stages that each ML pipeline includes. Each stage of the pipeline takes the output from its preceding stage, which acts as the input for that particular stage. A typical ML pipeline includes the following stages:



1. Data Ingestion

Each ML pipeline starts with the Data ingestion step. In this step, the data is processed into a well-organized format, which could be suitable to apply for further steps. This step does not perform any feature engineering; rather, this may perform the versioning of the input data.

2. Data Validation

The next step is data validation, which is required to perform before training a new model. Data validation focuses on statistics of the new data, e.g., range, number of categories, distribution of categories, etc. In this step, data scientists can detect if any anomaly present in the data. There are various data validation tools that enable us to compare different datasets to detect anomalies.

3. Data Pre-processing

Data pre-processing is one of the most crucial steps for each ML lifecycle as well as the pipeline. We cannot directly input the collected data to train the model without pr-processing it, as it may generate an abrupt result.

4. Model Training & Tuning

The model training step is the core of each ML pipeline. In this step, the model is trained to take the input (pre-processed dataset) and predicts an output with the highest possible accuracy.

However, there could be some difficulties with larger models or with large training data sets. So, for this, efficient distribution of the model training or model tuning is required.

This issue of the model training stage can be solved with pipelines as they are scalable, and a large number of models can be processed concurrently.

5. Model Analysis

After model training, we need to determine the optimal set of parameters by using the loss of accuracy metrics. Apart from this, an in-depth analysis of the model's performance is crucial for the final version of the model. The in-depth analysis includes calculating other metrics such as precision, recall, AUC, etc. This will also help us in determining the dependency of the model on features used in training and explore how the model's predictions would change if we altered the features of a single training example.

6. Model Versioning

The model versioning step keeps track of which model, set of hyperparameters, and datasets have been selected as the next version to be deployed. For various situations, there could occur a significant difference in model performance just by applying more/better training data and without changing any model parameter. Hence, it is important to document all inputs into a new model version and track them.

7. Model Deployment

After training and analyzing the model, it's time to deploy the model. An ML model can be deployed in three ways, which are:

- Using the Model server,
- In a Browser
- On Edge device

8. Feedback Loop

Each pipeline forms a closed-loop to provide feedback. With this close loop, data scientists can determine the effectiveness and performance of the deployed models. This step could be automated or manual depending on the requirement. Except for the two manual review steps (the model analysis and the feedback step), we can automate the entire pipeline.

Deployment Pipeline:

In software development, a deployment pipeline is a system of automated processes designed to quickly and accurately move new code additions and updates from version control to production. In past development environments, manual steps were necessary when writing, building, and deploying code. The introduction of automation in a deployment pipeline allowed development teams to focus more on innovating and improving the end product for the user. By reducing the need for any manual tasks, teams are able to deploy new code updates much quicker and with less risk of any human error.

Main Stages of a Deployment Pipeline

There are four main stages of a deployment pipeline:

1. Version Control
2. Acceptance Tests
3. Independent Deployment
4. Production Deployment

1. Version Control

It is the first stage of the pipeline. This occurs after a developer has completed writing a new code addition and committed it to a source control repository such as GitHub. Once the commit has been made, the deployment pipeline is triggered and the code is automatically compiled, unit tested, analyzed, and run through installer creation. If and when the new code passes this version control stage, binaries are created and stored in an artifact repository. The validated code then is ready for the next stage in the deployment pipeline.

2. Acceptance Tests:

In the **Acceptance Tests** stage of the deployment pipeline, the newly compiled code is put through a series of tests designed to verify the code against your team's predefined acceptance criteria. These tests will need to be custom-written based on your company goals and user expectations for the product. While these tests run automatically once integrated within the deployment pipeline, it's important to be sure to update and modify your tests as needed to consistently meet rising user and company expectations.

3. Independent Deployment:

Once code is verified after acceptance testing, it reaches the **Independent Deployment** stage where it is automatically deployed to a development environment. The development environment should be identical (or as close as possible) to the production environment in order to ensure an accurate representation for functionality tests. Testing in a development environment allows teams to squash any remaining bugs without affecting the live experience for the user.

4. Production Deployment:

The final stage of the deployment pipeline is **Production Deployment**. This stage is similar to what occurs in Independent Deployment, however, this is where code is made live for the user rather than a separate development environment. Any bugs or issues should have been resolved at this

point to avoid any negative impact on user experience. DevOps or operations typically handle this stage of the pipeline, with an ultimate goal of zero downtime. Using Blue/Green Drops or Canary Releases allows teams to quickly deploy new updates while allowing for quick version rollbacks in case an unexpected issue does occur.

Benefits of a Deployment Pipeline:

Building a deployment pipeline into your software engineering system offers several advantages for your internal team, stakeholders, and the end user. Some of the primary benefits of an integrated deployment pipeline include:

- Teams are able to release new product updates and features much faster.
- There is less chance of human error by eliminating manual steps.
- Automating the compilation, testing, and deployment of code allows developers and other DevOps team members to focus more on continuously improving and innovating a product.
- Troubleshooting is much faster, and updates can be easily rolled back to a previous working version.
- Production teams can better respond to user wants and needs with faster, more frequent updates by focusing on smaller releases as opposed to large, waterfall updates of past production systems.

What is Data Science?

Data science is a deep study of the massive amount of data, which involves extracting meaningful insights from raw, structured, and unstructured data that is processed using the scientific method, different technologies, and algorithms.

It is a multidisciplinary field that uses tools and techniques to manipulate the data so that you can find something new and meaningful.

Data science uses the most powerful hardware, programming systems, and most efficient algorithms to solve the data related problems. It is the future of artificial intelligence.

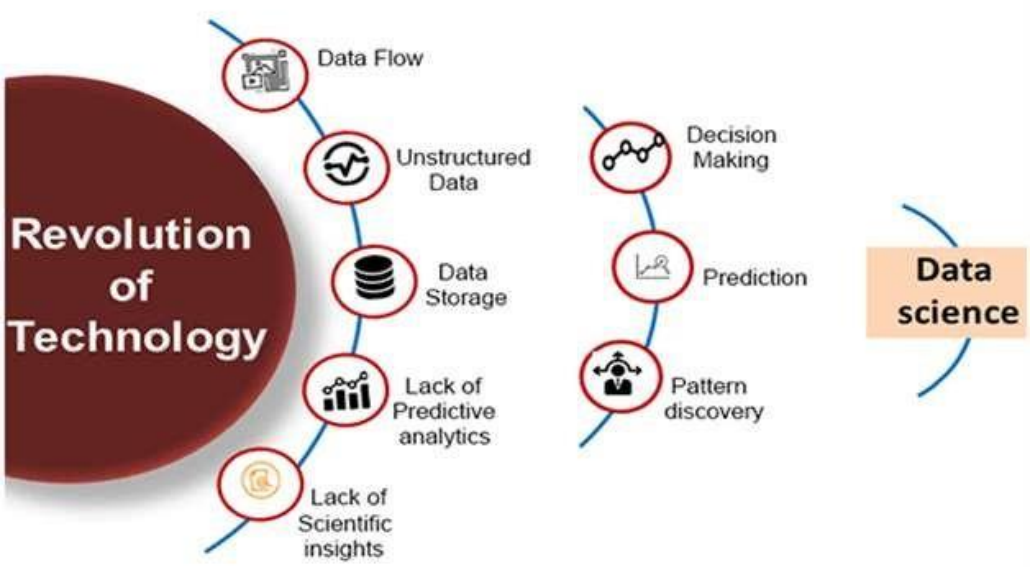
In short, we can say that data science is all about:

- Asking the correct questions and analyzing the raw data.
- Modelling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and finding the final result.

Example:

Let suppose we want to travel from station A to station B by car. Now, we need to take some decisions such as which route will be the best route to reach faster at the location, in which route there will be no traffic jam, and which will be cost-effective. All these decision factors will act as input data, and we will get an appropriate answer from these decisions, so this analysis of data is called the data analysis, which is a part of data science.

Need for Data Science:



Some years ago, data was less and mostly available in a structured form, which could be easily stored in excel sheets, and processed using BI tools.

But in today's world, data is becoming so vast, i.e., approximately **2.5 quintals bytes** of data is generating on every day, which led to data explosion. It is estimated as per researches, that by 2020, 1.7 MB of data will be created at every single second, by a single person on earth. Every Company requires data to work, grow, and improve their businesses.

Now, handling of such huge amount of data is a challenging task for every organization. So to handle, process, and analysis of this, we required some complex, powerful, and efficient algorithms and technology, and that technology came into existence as data Science.

Following are some main reasons for using data science technology:

- With the help of data science technology, we can convert the massive amount of raw and unstructured data into meaningful insights.
- Data science technology is opting by various companies, whether it is a big brand or a start-ups. Google, Amazon, Netflix, etc, which handle the huge amount of data, are using data science algorithms for better customer experience.
- Data science is working for automating transportation such as creating a self-driving car, which is the future of transportation.
- Data science can help in different predictions such as various survey, elections, flight ticket confirmation, etc.

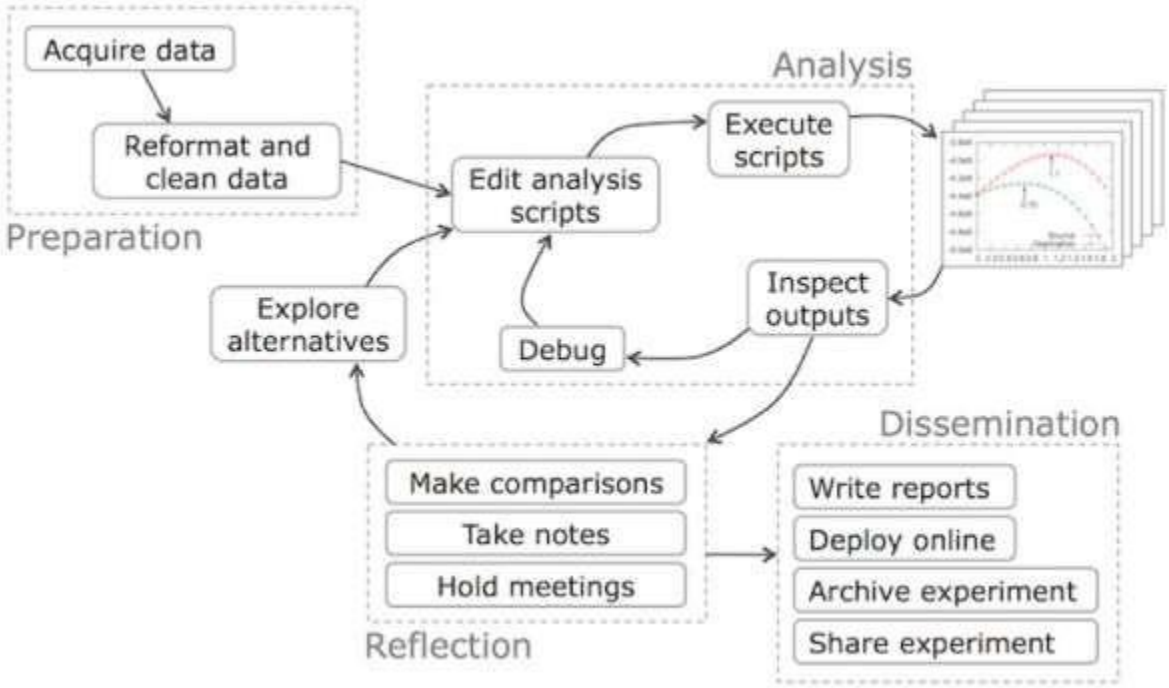
Data Science Workflow:

A *data science workflow* defines the phases (or steps) in a data science project. Using a well-defined data science workflow is useful in that it provides a simple way to remind all data science team members of the work to be done to do a data science project.

Data Science Workflow can be defined in many ways the respect to working principle and condition, For example, a workflow described by Aakash Tandel provides a high-level data science workflow, with a goal of serving as an example for new data scientists.

It includes the following five logical steps:

1. Understand the objective
2. Import the data
3. Explore and clean the data
4. Model the data
5. Communicate the results.



Applications / uses of Data Science:

1. In Search Engines

The most useful application of Data Science is Search Engines. As we know when we want to search for something on the internet, we mostly used Search engines like Google, Yahoo, Safari, Firefox, etc. So, Data Science is used to get Searches faster.

2. In Transport

Data Science also entered into the Transport field like Driverless Cars. With the help of Driverless Cars, it is easy to reduce the number of Accidents.

3. In Finance

Data Science plays a key role in Financial Industries. Financial Industries always have an issue of fraud and risk of losses. Thus, Financial Industries needs to automate risk of loss analysis in order to carry out strategic decisions for the company. Also, Financial Industries uses Data Science Analytics tools in order to predict the future. It allows the companies to predict customer lifetime value and their stock market moves.

4. In E-Commerce

E-Commerce Websites like Amazon, Flipkart, etc. uses data Science to make a better user experience with personalized recommendations.

5. In Health Care

In the Healthcare Industry data science act as a boon. Data Science is used for:

- **Detecting Tumor.**
- **Drug discoveries.**
- **Medical Image Analysis.**
- **Virtual Medical Bots.**
- **Genetics and Genomics.**
- **Predictive Modeling for Diagnosis etc.**

6. Image Recognition

Currently, Data Science is also used in Image Recognition. For Example, When we upload our image with our friend on Facebook, Facebook gives suggestions Tagging who is in the picture. This is done with the help of machine learning and Data Science. When an Image is Recognized, the data analysis is done on one's Facebook friends and after analysis, if the faces which are present in the picture matched with someone else profile then Facebook suggests us auto-tagging.

7. Targeting Recommendation

Targeting Recommendation is the most important application of Data Science. Whatever the user searches on the Internet, he/she will see numerous posts everywhere. This can be explained properly with an example: Suppose I want a mobile phone, so I just Google search it and after that, I changed my mind to buy offline. Data Science helps those companies who are paying for Advertisements for their mobile. So everywhere on the internet in the social media, in the websites, in

the apps everywhere I will see the recommendation of that mobile phone which I searched for. So this will force me to buy online.

8. Airline Routing Planning

With the help of Data Science, Airline Sector is also growing like with the help of it, it becomes easy to predict flight delays. It also helps to decide whether to directly land into the destination or take a halt in between like a flight can have a direct route from Delhi to the U.S.A or it can halt in between after that reach at the destination.

9. Data Science in Gaming

In most of the games where a user will play with an opponent i.e. a Computer Opponent, data science concepts are used with machine learning where with the help of past data the Computer will improve its performance. There are many games like Chess, EA Sports, etc. will use Data Science concepts.

10. Medicine and Drug Development

The process of creating medicine is very difficult and time-consuming and has to be done with full disciplined because it is a matter of Someone's life. Without Data Science, it takes lots of time, resources, and finance or developing new Medicine or drug but with the help of Data Science, it becomes easy because the prediction of success rate can be easily determined based on biological data or factors. The algorithms based on data science will forecast how this will react to the human body without lab experiments.

11. In Delivery Logistics

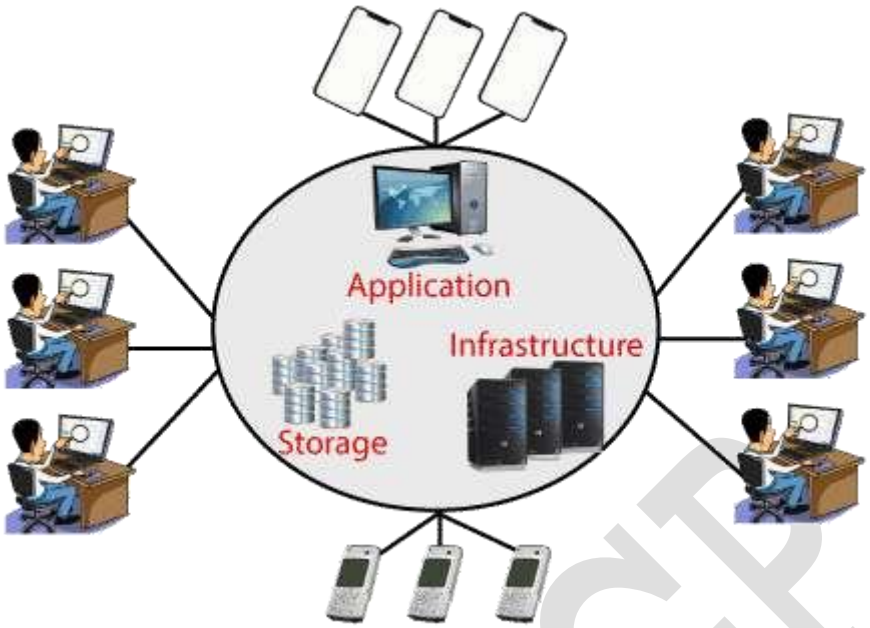
Various Logistics companies like DHL, FedEx, etc. make use of Data Science. Data Science helps these companies to find the best route for the Shipment of their Products, the best time suited for delivery, the best mode of transport to reach the destination, etc.

12. Autocomplete

AutoComplete feature is an important part of Data Science where the user will get the facility to just type a few letters or words, and he will get the feature of auto-completing the line. In Google Mail, when we are writing formal mail to someone so at that time data science concept of Autocomplete feature is used where he/she is an efficient choice to auto-complete the whole line. Also, in Search Engines in social media, in various apps, AutoComplete feature is widely used.

Introduction to Cloud Computing:

Cloud Computing is the delivery of computing services such as servers, storage, databases, networking, software, analytics, intelligence, and more, over the Cloud (Internet).



Cloud Computing provides an alternative to the on-premises datacentre. With an on-premises datacentre, we have to manage everything, such as purchasing and installing hardware, virtualization, installing the operating system, and any other required applications, setting up the network, configuring the firewall, and setting up storage for data. After doing all the set-up, we become responsible for maintaining it through its entire lifecycle.

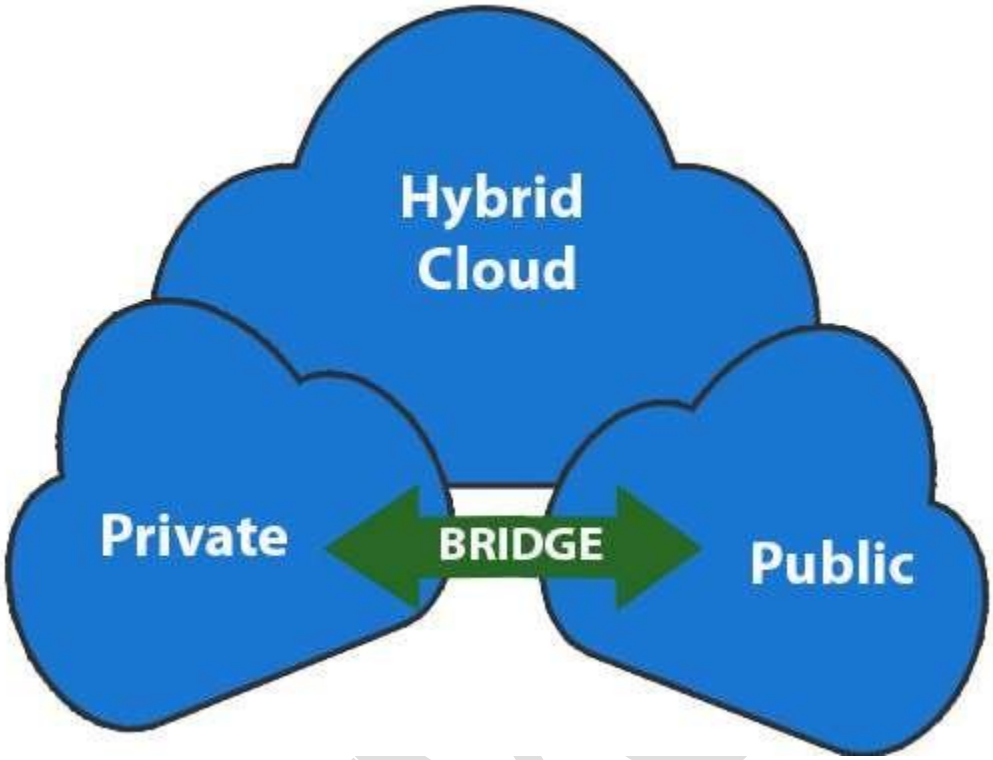
But if we choose Cloud Computing, a cloud vendor is responsible for the hardware purchase and maintenance. They also provide a wide variety of software and platform as a service. We can take any required services on rent. The cloud computing services will be charged based on usage.

Advantages of cloud computing

- **Cost:** It reduces the huge capital costs of buying hardware and software.
- **Speed:** Resources can be accessed in minutes, typically within a few clicks.
- **Scalability:** We can increase or decrease the requirement of resources according to the business requirements.
- **Productivity:** While using cloud computing, we put less operational effort. We do not need to apply patching, as well as no need to maintain hardware and software. So, in this way, the IT team can be more productive and focus on achieving business goals.
- **Reliability:** Backup and recovery of data are less expensive and very fast for business continuity.

- **Security:** Many cloud vendors offer a broad set of policies, technologies, and controls that strengthen our data security.

Types of Cloud Computing



- **Public Cloud:** The cloud resources that are owned and operated by a third-party cloud service provider are termed as public clouds. It delivers computing resources such as servers, software, and storage over the internet
- **Private Cloud:** The cloud computing resources that are exclusively used inside a single business or organization are termed as a private cloud. A private cloud may physically be located on the company's on-site datacentre or hosted by a third-party service provider.
- **Hybrid Cloud:** It is the combination of public and private clouds, which is bounded together by technology that allows data applications to be shared between them. Hybrid cloud provides flexibility and more deployment options to the business.

Components of Cloud Computing:

1. Client Infrastructure

The client infrastructure component is the part of the frontend which provides a graphic user interface for the user to interact with the cloud.

2. Application

An application is any platform like an app or software offered by a company by which the clients access the cloud.

3. Service

A cloud service manages the kind of service that a client needs to use according to his requirement. There are three types of services in cloud computing.

Software as a Service (SaaS): SaaS-based services are known as cloud application services. They run directly through a web browser eliminating the need for any download or installation of the applications—for example, slack Hubspot and Google apps.

Platform as a Service (PaaS): PaaS services are similar to SaaS. However, PaaS services provide a platform for users to build, edit, and launch the software. For example, Magneto commerce cloud and Windows Azure.

Infrastructure as a service (IaaS): IaaS manages application data runtime environments and middleware. It provides virtual services that eliminate the need for physical computing resources such as RAM, CPU, and data centres. In IaaS, the companies run virtual servers, networks, and storage on the cloud on a paid basis. For example, Google Compute Engine (GCE), Amazon Elastic Compute Cloud, and Amazon Web Services (AWS).

4. Runtime Cloud

The runtime cloud provides the execution and runtime environment to the virtual machines.

5. Storage

The storage component of cloud computing provides the storage capacity in the cloud for storing and managing data. In cloud storage, the data can be accessible to multiple clients simultaneously. Cloud storage is generally in the form of three basic configurations: public cloud, private cloud, and hybrid cloud.

6. Infrastructure

The infrastructure provides services on the host level, application level, and network level. It includes the software and hardware components such as the storage network devices server and any other storage resource required to support the cloud computing model**.**

7. Management

Management is used for managing the components such as storage services, applications, runtime cloud infrastructure, and security issues in the backend and for establishing coordination.

8. Security

Security is the backend component of cloud computing, which insurance the security of data in the cloud. The security system in the cloud includes a broad set of policies, technologies, applications, and controls that are used for protecting the IP's, data, applications, infrastructure, and the services offered in cloud computing.

9. Internet

Internet is the medium using which the frontend and backend components communicate and interact with each other.

Cloud Deployment Models:

The cloud deployment model identifies the specific type of cloud environment based on ownership, scale, and access, as well as the cloud's nature and purpose. The location of the servers you're utilizing and who controls them are defined by a cloud deployment model. It specifies how your cloud infrastructure will look, what you can change, and whether you will be given services or will have to create everything yourself. Relationships between the infrastructure and your users are also defined by cloud deployment types.

Different types of cloud computing deployment models are:

1. Public cloud
2. Private cloud
3. Hybrid cloud
4. Community cloud
5. Multi-cloud

1. Public Cloud

The public cloud makes it possible for anybody to access systems and services. The public cloud may be less secure as it is open for everyone. The public cloud is one in which cloud infrastructure services are provided over the internet to the general people or major industry groups. The infrastructure in this cloud model is owned by the entity that delivers the cloud services, not by the consumer. It is a type of cloud hosting that allows customers and users to easily access systems and services. **This form of cloud computing is an excellent example of cloud hosting, in which service providers supply services to a variety of customers. In this arrangement, storage backup and retrieval services are given for free, as a subscription, or on a per-use basis. Example: Google App Engine etc.**

Advantages of the public cloud model:

- **Minimal Investment:** Because it is a pay-per-use service, there is no substantial upfront fee, making it excellent for enterprises that require immediate access to resources.
- **No setup cost:** The entire infrastructure is fully subsidized by the cloud service providers, thus there is no need to set up any hardware.
- **Infrastructure Management is not required:** Using the public cloud does not necessitate infrastructure management.
- **No maintenance:** The maintenance work is done by the service provider (Not users).
- **Dynamic Scalability:** To fulfill your company's needs, on-demand resources are accessible.

2. Private Cloud

The private cloud deployment model is the exact opposite of the public cloud deployment model. It's a one-on-one environment for a single user (customer). There is no need to share your hardware with anyone else. The distinction between private and public cloud is in how you handle all of the hardware. It is also called the "internal cloud" & it refers to the ability to access systems and services within a given border or organization. The cloud platform is implemented in a cloud-based secure environment that is protected by powerful firewalls and under the supervision of an

organization's IT department.
The private cloud gives the greater flexibility of control over cloud resources.

Advantages of the private cloud model:

- **Better Control:** You are the sole owner of the property. You gain complete command over service integration, IT operations, policies, and user behavior.
- **Data Security and Privacy:** It's suitable for storing corporate information to which only authorized staff have access. By segmenting resources within the same infrastructure, improved access and security can be achieved.
- **Supports Legacy Systems:** This approach is designed to work with legacy systems that are unable to access the public cloud.
- **Customization:** Unlike a public cloud deployment, a private cloud allows a company to tailor its solution to meet its specific needs.

3. Hybrid cloud

By bridging the public and private worlds with a layer of proprietary software, hybrid cloud computing gives the best of both worlds. With a hybrid solution, you may host the app in a safe environment while taking advantage of the public cloud's cost savings. Organizations can move data and applications between different clouds using a combination of two or more cloud deployment methods, depending on their needs.

Advantages of the hybrid cloud model:

- **Flexibility and control:** Businesses with more flexibility can design personalized solutions that meet their particular needs.
- **Cost:** Because public clouds provide for scalability, you'll only be responsible for paying for the extra capacity if you require it.
- **Security:** Because data is properly separated, the chances of data theft by attackers are considerably reduced.

4. Community cloud

It allows systems and services to be accessible by a group of organizations. It is a distributed system that is created by integrating the services of different clouds to address the specific needs of a community, industry, or business. The infrastructure of the community could be shared between the organization which has shared concerns or tasks. It is generally managed by a third party or by the combination of one or more organizations in the community.

Advantages of the community cloud model:

- **Cost Effective:** It is cost-effective because the cloud is shared by multiple organizations or communities.
- **Security:** Community cloud provides better security.
- **Shared resources:** It allows you to share resources, infrastructure, etc. with multiple organizations.
- **Collaboration and data sharing:** It is suitable for both collaboration and data sharing.

5. Multi-cloud

We're talking about employing multiple cloud providers at the same time under this paradigm, as the name implies. It's similar to the hybrid cloud deployment approach, which combines public and private cloud resources. Instead of merging private and public clouds, multi-cloud uses many public clouds. Although public cloud providers provide numerous tools to improve the reliability of their services, mishaps still occur. It's quite rare that two distinct clouds would have an incident at the same moment. As a result, multi-cloud deployment improves the high availability of your services even more.

Advantages of a multi-cloud model:

- You can mix and match the best features of each cloud provider's services to suit the demands of your apps, workloads, and business by choosing different cloud providers.
- **Reduced Latency:** To reduce latency and improve user experience, you can choose cloud regions and zones that are close to your clients.
- **High availability of service:** It's quite rare that two distinct clouds would have an incident at the same moment. So, the multi-cloud deployment improves the high availability of your services.

Cloud Service Models

There are the following three types of cloud service models -

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)

1. Infrastructure as a Service (IaaS)

IaaS is also known as **Hardware as a Service (HaaS)**. It is a computing infrastructure managed over the internet. The main advantage of using IaaS is that it helps users to avoid the cost and complexity of purchasing and managing the physical servers.

Characteristics of IaaS

There are the following characteristics of IaaS -

- Resources are available as a service
- Services are highly scalable
- Dynamic and flexible
- GUI and API-based access
- Automated administrative tasks

Example: DigitalOcean, Linode, Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), Rackspace, and Cisco Metacloud.

2. Platform as a Service (PaaS)

PaaS cloud computing platform is created for the programmer to develop, test, run, and manage the applications.

Characteristics of PaaS

There are the following characteristics of PaaS -

- Accessible to various users via the same development application.
- Integrates with web services and databases.
- Builds on virtualization technology, so resources can easily be scaled up or down as per the organization's need.
- Support multiple languages and frameworks.
- Provides an ability to "**Auto-scale**".

Example: AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, Magento Commerce Cloud, and OpenShift.

3. Software as a Service (SaaS)

SaaS is also known as "**on-demand software**". It is a software in which the applications are hosted by a cloud service provider. Users can access these applications with the help of internet connection and web browser.

Characteristics of SaaS

There are the following characteristics of SaaS -

- Managed from a central location
- Hosted on a remote server
- Accessible over the internet
- Users are not responsible for hardware and software updates. Updates are applied automatically.
- The services are purchased on the pay-as-per-use basis

Example: BigCommerce, Google Apps, Salesforce, Dropbox, ZenDesk, Cisco WebEx, ZenDesk, Slack, and GoToMeeting.

Difference between IaaS, PaaS, and SaaS:

The below table shows the difference between IaaS, PaaS, and SaaS -

IaaS	Paas	SaaS
It provides a virtual data center to store information and create platforms for app development, testing, and deployment.	It provides virtual platforms and tools to create, test, and deploy apps.	It provides web software and apps to complete business tasks.
It provides access to resources such as virtual machines, virtual storage, etc.	It provides runtime environments and deployment tools for applications.	It provides software as a service to the end-users.
It is used by network architects.	It is used by developers.	It is used by end users.
IaaS provides only Infrastructure.	PaaS provides Infrastructure+Platform.	SaaS provides Infrastructure+Platform +Software.

Serverless Services:

Serverless is a cloud-native development model that allows developers to build and run applications without having to manage servers.

There are still servers in serverless, but they are abstracted away from app development. A cloud provider handles the routine work of provisioning, maintaining, and scaling the server infrastructure. Developers can simply package their code in containers for deployment.

Once deployed, serverless apps respond to demand and automatically scale up and down as needed. Serverless offerings from public cloud providers are usually metered on-demand through an event-driven execution model. As a result, when a serverless function is sitting idle, it doesn't cost anything.

Major cloud Services:

1. Amazon Web Services (AWS):

The clear leader in cloud computing, AWS offers both consumer and business-oriented artificial intelligence (AI) products and services. Many of its professional AI services build on the AI services available in consumer products.

Its Alexa - embedded into the Amazon Echo - introduces AI to the home with its intelligent voice server. For AWS, the company's primary AI services include: Lex, for building conversational interfaces into any application; Polly, which turns text to speech; and Recognition, an image recognition service.

Amazon Machine Learning provides visualisation tools that guide customers through the process of creating machine learning (ML) models without having to learn complex ML algorithms and technology.

2. Google Cloud

Leaders in AI and data analytics, Google has acquired a number of companies and startups to improve its AI capabilities for customers.

Google Cloud sells several AI and machine learning services to businesses, with an industry-leading software project in TensorFlow, as well as its own Tensor AI chip project. The Cloud Vision API can identify objects, logos, and landmarks within images, text within an image, can find similar images on the Web, or detect faces and read expressions.

The company also offers a Cloud ML service where developers can train high-quality machine learning models - such as customer service tech - using Google's existing APIs. For more experienced ML developers, Google offers ML Engine for bringing machine learning models to production, using TensorFlow models that need to be trained for various scenarios.

3. IBM Cloud

As a leader in AI for a number of years, it comes as no surprise that IBM has made this list.

With a number of cloud and AI acquisitions under its belt, IBM has a whole host of AI offerings available. In fact, under the Watson brand for AI services, IBM has no less than 16 services, and its Cloud AI services start with Watson Studio for building and training AI models, preparing data, and performing analysis on the data. IBM Watson Services for Core ML allows enterprises to build AI-powered apps that securely connect to their data and run either on-premises, offline or in the cloud.

4. Microsoft Azure

Microsoft Azure has a collection of AI solutions that can be split under three categories: AI Services, AI Tools and Frameworks, and AI Infrastructure.

AI Services is anything from pre-built capabilities - such as Azure Cognitive Services - to custom AI development with Azure Machine Learning (AML). With AI Tools and Frameworks, customers can utilise a number of Microsoft's AI services such as Azure Notebooks and Visual Studio Tools for AI. AI Infrastructure includes different services such as Azure Data Services and Azure Kubernetes Services.

5. Salesforce

With its AI platform, Einstein AI, Salesforce offers AI solutions that are fully integrated with other Salesforce cloud offerings. In doing so, the company enables its customers to build apps using ML and predictive analytics as well as utilising their Salesforce data. With this, customers can build apps such as chatbots and sales prediction.

By providing deep sights from its customers' data, Salesforce empowers customers to use these insights to strengthen relationships, prioritise leads, cases, and campaigns to drive the business forward.

Virtualization:

Virtualization allows to share a single physical instance of a resource or an application among multiple customers and organizations at one time. It does this by assigning a logical name to a physical storage and providing a pointer to that physical resource on demand. The term virtualization is often synonymous with hardware virtualization, which plays a fundamental role in efficiently delivering Infrastructure-as-a-Service (IaaS) solutions for cloud computing. Moreover, virtualization technologies provide a virtual environment for not only executing applications but also for storage, memory, and networking.

Benefits Of Virtualization:

1. More flexible and efficient allocation of resources.
2. Enhance development productivity.
3. It lowers the cost of IT infrastructure.
4. Remote access and rapid scalability.
5. High availability and disaster recovery.
6. Pay peruse of the IT infrastructure on demand.
7. Enables running multiple operating systems.

Types of Virtualizations:

1.Application Virtualization.

2.Network Virtualization.

3.Desktop Virtualization.

4.Storage Virtualization.

5.Server Virtualization.

6.Data virtualization.

What are Containers?

Containers are packages of software that contain all of the necessary elements to run in any environment. In this way, containers virtualize the operating system and run anywhere, from a private data center to the public cloud or even on a developer's personal laptop.

SDK:

Google Cloud SDK (Software Development Kit), in simple terms, is a set of tools that are used to manage applications and resources that are hosted on the Google Cloud Platform. It is composed of the gsutil, gcloud, and bqcommand line tools

Cloud SDK **provides language-specific Cloud Client Libraries supporting each language's natural conventions and styles**. This makes it easier for you to interact with Google Cloud APIs in your language of choice.

Cloud Billing:

Cloud billing is the combination of cloud computing and electronic billing. Many businesses are expanding their horizon by shifting to such a billing platform which is on premises. Cloud billing is revolutionizing the computer system which provides the flexibility for the billing and help to access the data easily. This is a great way to manage different products and services as well as subscription-based offers. Billing is the main interaction with any client customer relationship as with proper and well managed billing relationship is made strong.

Few of the benefits are as follows:

- Licensing costs are reduced; hence increase in revenues
- Service costs are reduced
- Security and data protection
- Increased scalability
- Modernized business collaboration tools
- Portability and mobility: you can work over it from anywhere you are sitting and can be accessed easily.
- Flexible pricing
- On-demand scalability
- Improved business insight & reporting
- Complete integration & enhanced operational processes
- Improves customer relationships

Cloud VPN:

Cloud VPN **securely connects your peer network to your Virtual Private Cloud (VPC) network through an IPsec VPN connection**. Traffic traveling between the two networks is encrypted by one VPN gateway and then decrypted by the other VPN gateway. This action protects your data as it travels over the internet.

SLA:

A cloud SLA (cloud service-level agreement) is an agreement between a cloud service provider and a customer that ensures a minimum level of service is maintained. It guarantees levels of reliability, availability and responsiveness to systems and applications; specifies who governs when there is a service interruption; and describes penalties if service levels are not met.

A cloud infrastructure can span geographies, networks and systems that are both physical and virtual. While the exact metrics of a cloud SLA can vary by service provider, the areas covered are uniform:

- volume and quality of work (including precision and accuracy);
- speed;
- responsiveness; and
- efficiency.

What is Big Data

Data which are very large in size is called Big Data. Normally we work on data of size MB(WordDoc ,Excel) or maximum GB(Movies, Codes) but data in Peta bytes i.e. 10^15 byte size is called Big Data. It is stated that almost 90% of today's data has been generated in the past 3 years.

Sources of Big Data

These data come from many sources like

- **Social networking sites:** Facebook, Google, LinkedIn all these sites generates huge amount of data on a day to day basis as they have billions of users worldwide.
- **E-commerce site:** Sites like Amazon, Flipkart, Alibaba generates huge amount of logs from which users buying trends can be traced.
- **Weather Station:** All the weather station and satellite gives very huge data which are stored and manipulated to forecast weather.
- **Telecom company:** Telecom giants like Airtel, Vodafone study the user trends and accordingly publish their plans and for this they store the data of its million users.
- **Share Market:** Stock exchange across the world generates huge amount of data through its daily transaction.

3V's of Big Data

1. **Velocity:** The data is increasing at a very fast rate. It is estimated that the volume of data will double in every 2 years.
2. **Variety:** Now a days data are not stored in rows and column. Data is structured as well as unstructured. Log file, CCTV footage is unstructured data. Data which can be saved in tables are structured data like the transaction data of the bank.
3. **Volume:** The amount of data which we deal with is of very large size of Peta bytes.
4. Veracity: This has been a more recent addition to the 3Vs and indicates the noise inherent in data, such as inconsistencies in recorded information that requires additional validation

Sources of Big Data:

- **Social networks**: Arguably, the primary source of all big data that we know of today is the social networks that have proliferated over the past 5-10 years. This is by and large unstructured data that is represented by millions of social media postings and other data that is generated on a second-by-second basis through user interactions on the web across the world. Increase in access to the internet across the world has been a self-fulfilling act for the growth of data in social networks.
- **Media**: Largely a result of the growth of social networks, media represents the millions, if not billions, of audio and visual uploads that take place on a daily basis. Videos uploaded on YouTube, music recordings on SoundCloud, and pictures posted on Instagram are prime examples of media, whose volume continues to grow in an unrestrained manner.
- **Data warehouses**: Companies have long invested in specialized data storage facilities commonly known as data warehouses. A DW is essentially collections of historical data that companies wish to maintain and catalog for easy retrieval, whether for internal use or regulatory purposes. As industries gradually shift toward the practice of storing data in platforms such as Hadoop and NoSQL, more and more companies are moving data from their pre-existing data warehouses to some of the newer technologies. Company emails, accounting records, databases, and internal documents are some examples of DW data that is now being offloaded onto Hadoop or Hadoop-like platforms that leverage multiple nodes to provide a highly-available and fault-tolerant platform.
- **Sensors**: A more recent phenomenon in the space of big data has been the collection of data from sensor devices. While sensors have always existed and industries such as oil and gas have been using drilling sensors for measurements at oil rigs for many decades, the advent of wearable devices, also known as the Internet Of Things such as Fitbit and Apple Watch, meant that now each individual could stream data at the same rate at which a few oil rigs used to do just 10 years back.

AI and Big Data:

Big data and artificial intelligence have a synergistic relationship. AI requires a massive scale of data to learn and improve decision-making processes and big data analytics leverages AI for better data analysis. With this convergence, you can more easily leverage advanced analytics capabilities like augmented or predictive analytics and more efficiently surface actionable insights from your vast stores of data. With big data AI powered analytics, you can empower your users with the intuitive tools and robust technologies they need to extract high-value insights from data, fostering data literacy across your organization while reaping the benefits of becoming a truly data-driven organization.

By bringing together big data and AI technology, companies can improve business performance and efficiency by:

- Anticipating and capitalizing on emerging industry and market trends.
- Analyzing consumer behavior and automating customer segmentation
- Personalizing and optimizing the performance of digital marketing campaigns
- Using intelligent decision support systems fueled by big data, AI, and predictive analytics