Q.1: Write about Evolution of AI,Ml and DL

Ans. The History of Artificial Intelligence, Machine Learning and Deep Learning

The Prehistory of Artificial Intelligence: 1700 - 1900

1623: Wilhelm Schickard creates the calculator

Wilhelm Schickard was a prominent German teacher, mathematician, theologian, and cartographer. Wilhelm invented several machines for various purposes, but his most notable contributions were the first mechanical calculator and a machine for learning Hebrew grammar. In 1623, Wilhelm Schickard invented a device that allowed him to perform arithmetic operations completely mechanically, he called it the calculating clock. Its operation was based on rods and gears that mechanized the functions that were previously performed manually.

1822: Charles Babbage built the mechanical calculator.

He is considered the father of modern printers and a pioneer of computing. In 1822, Babbage was able to develop and partially design a mechanical calculator capable of performing calculations in tables of numerical functions by the method of differences and designing the analytical machine to run tabulation or computation programs. Among his inventions, there is also the differential machine. Later, Babbage worked with Ada Lovelace to translate her writing into Italian on the analytical machine. Their relationship would help to cement the principles of what would become artificial intelligence.

1830: Ada Lovelace, the first programmer

British mathematician Ada Lovelace developed contributions that still greatly impact today, such as the development of the first algorithm together with Charles Babbage.Another important contribution of Lovelace was the concept of the universal machine. He created a device that, in theory, could be programmed and reprogrammed to perform a variety of tasks not limited to mathematical calculation, such as processing symbols, words and even music.

The Beginning of the Computational Era: 1900 - 1950

1924: Creation of IBM

Founded in 1911, it was initially a company that developed punch card counting machines. Due to its success and to reflect the organization's international growth, the company's name was changed to International Business Machines Corp. or IBM in 1924.

Their beginnings in the business would lead them to be leaders in software solutions, hardware, and services that have marked the technological advancement of this era. The company has managed to adapt to the technological changes in the market to create innovative solutions over the years.

1936: Turing Machine

The Turing Machine was created in 1936 by Alan Turing, known as the father of Artificial Intelligence. He created a computational model capable of storing and processing information virtually, marking the history of computing, and considered the origin of computers, cell phones, tablets, and other current technologies. This computational model can be adapted to simulate the logic of any algorithm. Its creation demonstrated that some of these Turing machines could perform any mathematical computation if it were representable by an algorithm.

1943: First functional digital computer ENIAC

The Electronic Numerical Integrator And Computer project, ENIAC, was created in 1943 by Americans John William Mauchly and John Presper Eckert. It was conceived for military purposes but was not completed until 1945 and was presented to the public in 1946 and used for scientific research. The machine weighed 27 tons, measured 167 square meters and consisted of 17,468 tubes. It was programmable to perform any numerical calculation, had no operating system or stored programs, and only kept the numbers used in its operations.

The Beginning of Artificial Intelligence 1950 - 2000

1950: Turing Test

Alan Turing developed the Turing test. This test aims to determine whether Artificial Intelligence can imitate human responses. It is a conversation between a human, a computer, and another person, but without knowing which of the two conversationalists is a machine. The person asks questions to the chatbot and another person, and in case of not distinguishing the human from the machine, the computer will have successfully passed the Turing test.

1956: First Dartmouth College Conference on Artificial Intelligence

In the summer of 1956, Marvin Minsky, John McCarthy, and Claude Shanon organized the first conference on Artificial Intelligence at Dartmouth College. This important event was the starting point of Artificial Intelligence. McCarthy coined the term Artificial Intelligence for the first time during this event. It was also determined that in the next 25 years computers would do all the work humans did at that time. In addition, theoretical logic was considered the first Artificial Intelligence program to solve heuristic search problems.

1970-1980: Expert systems

These systems were very popular in the 1970s. They used expert knowledge to create a program in which a user asks a question to the system to receive an answer and it is categorized as useful or not. The software uses a simple design and is reasonably easy to design, build and modify. These simple

programs became quite useful and helped companies save large amounts of money. Today, these systems are still available but their popularity has declined over the years.

1974-1980: First AI winter

The term "AI winter" relates to the decline in interest, research, and investment in this field. It started when AI researchers had two basic limitations: low memory and processing speed, which is minimal compared to the technology in this decade. This period began after the first attempts to create machine translation systems, which were used in the Cold War and ended with the introduction of expert systems that were adapted by hundreds of organizations around the world.

1980: Natural language processors

These technologies make it possible for computers and machines to understand human language. They began to be designed to translate Russian into English for Americans in the early 1960s. Still, they did not have the expected result until 1980, when different algorithms and computational technologies were applied to provide a better experience.

1987-1993: Second AI winter

Carnegie Mellon University developed the first commercial AI system called XCON. The LISP programming language was created and became the common denominator among AI developers. Hundreds of companies invested in this system as it promised millions in profits to those who implemented it. But in 1987, the market collapsed with the dawn of the PC era as this technology overshadowed the expensive LISP machines. Now Apple and IBM devices could perform more actions than their predecessors, making them the best choice in the industry.

1990: Intelligent Agents

Also known as bots or virtual digital assistants. The creation and research of these systems began in 1990. They are able to interpret and process the information they receive from their environment and act based on the data they collect and analyze, to be used in news services, website navigation, online shopping and more.

The Evolution of Artificial Intelligence: 2000 - 2023

2011: Virtual assistants

A virtual assistant is a kind of software agent that offers services that help automate and perform tasks. The most popular virtual assistant is undoubtedly Siri, created by Apple in 2011. Starting with the iPhone 4s, this technology was integrated into the devices. It understood what you said and responded with an action to help you, whether it was searching for something on the internet, setting an alarm, a reminder or even telling you the weather.

2016: Sophia

Sophia was created in 2016 by David Hanson. This android can hold simple conversations like virtual assistants, but unlike them, Sophia makes gestures like people and generates knowledge every time it interacts with a person, subsequently mimicking their actions.

2018: BERT by Google

BERT, designed by Google in 2018, is a Machine Learning technique applied to natural language processors, aiming to understand better the language we use every day. It analyzes all the words used in a search to understand the entire context and yield favorable user results. It is a system that uses transformers, a neural network architecture that analyzes all possible relationships between words within a sentence.

2020: Autonomous AI

The North American firm, Algotive, develops Autonomous Artificial Intelligence algorithms that enhance video surveillance systems in critical industries. Its algorithms rely on Machine Learning, the Internet of Things (IoT), and unique video analytics algorithms to perform specific actions depending on the situation and the organization's requirements. vehicleDRX, its solution for public safety, is an example of how the organization's algorithms make video surveillance cameras intelligent to respond to emergencies and help officers do their jobs better.

2022: GATO by Deep Mind

The new AI system created by Deep Mind has the ability to complete more than 600 different tasks simultaneously, from writing image descriptions to controlling a robotic arm. It acts as a vision and language model that has been trained to execute different tasks with different modalities and be performed successfully. It is expected that this system will have a larger number of actions to perform in the future and will pave the way for Artificial General Intelligence.

2022: vehicleDRX by Algotive

Algotive's novel software, vehicleDRX has the ability to identify and monitor vehicles of interest and suspicious behavior on motorcycles in real time, analyzing risky situations on the street and leveraging the video surveillance infrastructure of state governments and law enforcement agencies.

The History of Machine Learning

1952: Arthur Samuel creates the first program to play checkers.

Arthur Samuel is one of the pioneers of computer games and Artificial Intelligence. In 1952 he began writing the first computer program based on Machine Learning in which he was able to give an early demonstration of the fundamental concepts of Artificial Intelligence. The software was a program that played Chinese checkers and could improve its game with each game. It was able to compete with middle-level players. Samuel continued to refine the program until it was able to compete with high-level players.

1957: Frank Rosenblatt designed the Perceptron.

Perceptron is an instrument developed by psychologist Frank Rosenblatt to classify, explain and model pattern recognition skills in images. It was the first computer built specifically to create neural networks. The Perceptron was implemented in one of IBM's computers. Thanks to it, it was able to execute 40,000 instructions per second.

1963: Donald Michie built MENACE

MENACE was a mechanical computer made of 304 matchboxes designed and built by Michie since he did not have a computer. Michie built one of the first programs with the ability to learn to play Tic-Tac-Toe. He named it the Motor Educable Machine of Zeros and Crosses (MENACE). The machine learned to play more and more games where it eliminated a losing strategy by the human player at every move.

1967: Nearest Neighbor Algorithm

Also known as k-NN, it is one of the most basic and essential classification algorithms in Machine Learning. It is a supervised learning classifier that uses proximity to recognize patterns, data mining, and intrusion detection to an individual data point to classify the interest of the surrounding data. It solves various problems such as recommender systems, semantic search, and anomaly detection.

1970: Seppo Linnainmaa and automatic differentiation

Linnainmaa published the inverse model of automatic differentiation in 1970. This method later became known as backpropagation and is used to train artificial neural networks. Backpropagation is a set of techniques for evaluating the derivative of a function specified by a computer in which a sequence of elementary arithmetic operations (addition, subtraction, division, etc.) and elementary functions (exp, sin, log, cos, etc.) are executed to apply the chain rule by performing automatic calculations.

1979: Hans Motavec created the first autonomous vehicle

Motavec built the Standford Cart in 1979. It consisted of 2 wheels and a mobile television camera from side to side, without the need to move it. The Standford Cart was the first autonomous vehicle controlled by a computer and capable of avoiding obstacles in a controlled environment. In that year, the vehicle successfully crossed a room full of chairs without the need for human intervention in 5 hours.

1981: Gerald Dejong and the EBL concept

Dejong introduced the "Explanation based learning" (EBL) concept in 1981, a Machine Learning method that makes generalizations or forms concepts from training examples that allow it to discard less important data or data that does not affect the investigation. It is linked with coding to help with supervised learning.

1985: Terry Sejnowski invents NETtalk

NETtalk is an artificial neural network created by Terry Sejnowski in 1986. This software learns to pronounce words in the same way a child would. NETtalk's goal was to build simplified models of the complexity of learning cognitive tasks at the human level. This program learns to pronounce written English text by matching phonetic transcriptions for comparison.

1990: Kearns and Valiant proposed Boosting

It is a Machine Learning meta-algorithm that reduces bias and variance in supervised learning to convert a set of weak classifiers to a robust classifier. It combines many models obtained by a method with low predictive capability to boost it. The idea of Valiant and Kearns was not satisfactorily solved until Freund and Schapire in 1996, presented the AdaBoost algorithm, which was a success.

1997: Jürgen Schmidhuber and Sepp Hochreiter created Speech Recognition

It is part of Deep Learning with a technique called LSTM that uses neural network models where it can learn previously done tasks. It can collect data such as images, words, and sounds where algorithms interpret it and store this information to perform actions. It is a technique that, with its evolution, we have come to use daily in applications and devices such as Amazon's Alexa, Apple's Siri, Google Translate, and more.

2002: Launch of Torch

Torch was an open-source library that provided an environment for numerical development, Machine Learning, and Computer Vision with a particular emphasis on Deep Learning. It was one of the fastest and most flexible frameworks for Machine and Deep Learning, which was implemented by companies such as Facebook, Google, Twitter, NVIDIA, Intel and more. It was discontinued in 2017 but is still used for finished projects and even developments through PyTorch.

2006: Facial recognition

Facial recognition was evaluated through 3D facial analysis and high-resolution images. Several experiments were carried out to recognize individuals and identify their expressions and gender from relevance analysis, even identical twins could be recognized thanks to strategic analysis.

2006: The Netflix Award

Netflix created this award which consisted of participants having to create Machine Learning algorithms with the highest efficiency in recommending content and predicting user ratings for movies, series and documentaries. The winner would receive one million dollars if they could improve the organization's recommendation algorithm, called Cinematch, by 10%.

2009: Fei-Fei Li created ImageNet

Fei-Fei invented ImageNet, which enabled major advances in Deep Learning and image recognition, with a database of 140 million images. It now consists of a quintessential dataset for evaluating image classification, localization and recognition algorithms. ImageNet has now created its own competition, ILSVRC, designed to foster the development and benchmarking of state-of-the-art algorithms.

2010: Kaggle, the community for data scientists

Kaggle is a platform created by Anthony Goldbloom and Ben Hamner. It is a subsidiary of Google and brings together the world's largest Data Science and Machine Learning community. This platform has more than 540 thousand active members in 194 countries where users can find important resources and tools to carry out Data Science projects.

2011: IBM and its Watson system

Watson is a system based on Artificial Intelligence that answers questions formulated in natural language, developed by IBM. This tool has a database built from numerous sources such as encyclopedias, articles, dictionaries, literary works and more, and also consults external sources to increase its response capacity. This system beat champions Rutter and Jennings on the TV show Jeopardy!

2014: Facebook develops Deep Face

In 2014, Facebook developed a software algorithm that recognizes individuals in photos on the same level as humans do called Deep Face. This tool allowed Facebook to identify with 97.25% accuracy the people appearing in each image, almost matching the functionality of the human eye. The social network decided to activate face recognition as a way to speed up and facilitate the tagging of friends in the photos uploaded by its users.

The History of Deep Learning

1943: Pitts and McCulloch's neural network

University of Illinois neurophysiologist Warren McCulloch and cognitive psychologist Walter Pitts published "A Logical Calculus of the ideas Imminent in Nervous Activity" in 1943, describing the "McCulloch - Pitts" neuron, the first mathematical model of a neural network. Their work helped to describe the cerebellum's functions and demonstrate the computational power connected elements in a neural network could have. This laid the theoretical foundation for the artificial neural networks used today.

1960: Henry J. Kelley invents the Backward Propagation Model

In his paper "Gradient Theory of Optimal Flight Paths", Henry J. Kelley shows the first version of a continuous Backward Propagation Model. It is the essence of neural network training, with which Deep Learning models can be refined. This model can adjust the weights of a neural network based on the error rate obtained from previous attempts.

1979: Fukushimma designs first convolutional neural networks with Neocognitron

In 1979, Kunihiko Fukushima first designed convolutional neural networks with multiple layers, developing an artificial neural network called Neocognitron. This design allowed the computer to recognize visual patterns. It also allowed the computer to increase the weight of certain connections on the most important features. Many of his concepts are still in use today.

1982: The Hopefield Network is invented

John Hopefield creates the first recurrent neural network, which he calls Hopefield network. The main innovation of this network is its memory system that will help various RNR models in the modern era of Deep Learning. Hopefield sought to have his artificial neural network store and remember information like the human brain. From pattern recognition, it can detect errors in the information and even recognize when the information does not correspond to what it seeks to achieve.

1986: Parallel distributed processing is created

In 1986, Rumelhart, Hinton, and McClelland popularized this concept, thanks to the successful implementation of the backward propagation model in a neural network. This was a major step forward in Deep Learning as it allowed the training of more complex neural networks, which was one of the biggest obstacles in this area. The three fundamental principles of distributed parallel processing are the distribution of information representation, memory and knowledge are stored within the connections between neurons, and learning occurs as the strength of the relationship changes through experience.

1989: Yann LeCun demonstrates the backward propagation model in a practical way

One of the greatest exponents of Deep Learning, Yann LeCun used convolutional neural networks and backpropagation to teach a machine how to read handwritten digits.

1997: IBM's Deep Blue beats Garry Kasparov

Garry Kasparov, world chess champion, was defeated by the IBM-built supercomputer Deep Blue on May 11, 1997. Deep Blue won two games, drew three and lost one, making it the first virtual world chess champion.

1999: Nvidia creates the first GPU

Geforce 256 was the first GPU in history, created in 1999 by Nvidia. This technology would unlock possibilities that were previously only possible in theory. Thanks to this technological component, many advances in Deep Learning and Artificial Intelligence were realized.

2006: Deep belief networks are created

In their paper "A fast learning algorithm for deep belief nets" Geoffrey Hinton, Ruslan Salakhutdinov, Osindero, and Teh demonstrated the creation of a new neural network called the Deep Belief Network. This type of neural network made the training process with large amounts of data easier.

2008: GPU for Deep Learning

10 years after the first GPU was created by Nvidia, the group of. Andrew NG's group at Stanford began to promote the use of specialized GPUs for Deep Learning. This would allow them to train neuronal networks faster and more efficiently.

2012: Google's cat experiment

Google showed over 10 million random YouTube videos to a brain. After being shown over 20,000 different objects, it began recognizing cats' images using Deep Learning algorithms without being told the cat's properties or characteristics. This opened a new door in Machine Learning and Deep Learning since it proved that images did not need to be labeled for a model to recognize the information presented.

2014: Adversarial generative neural networks are created

Ian Goodfellow creates generative adversarial neural networks which opens a new door in technological advances within areas as different as the arts and sciences, thanks to their ability to synthesize real data. It works because two neural networks compete against each other in a game and through this technique, can learn to generate new data with the same statistics as the training set.

2016: AlphaGo beats the world Go champion

Deepmind's deep reinforcement learning model beats the human champion in the complex game of Go. The game is far more complex than chess, so these feat capture everyone's imagination and take the promise of deep learning to a new level.

2020: AlphaFold 2020

AlphaFold is an AI system developed by DeepMind that predicts the 3D structure of a protein from its amino acid sequence. It regularly achieves accuracy that rivals that of experiments. DeepMind and the EMBL European Bioinformatics Institute (EMBL-EBI) have partnered to create the AlphaFold database and make these predictions available to the scientific community.

2022: IMAGEN and Dall-E mini

This year, Google and Deepmind launch their two models that can create original images from lines of text fed by users. This is one of the most important steps within the AI industry, as it allows for the first time to demonstrate the creative capacity of these technologies and the frontiers we could reach when humans work collaboratively with machines.

Q.2: How DL works at neuron Level?

Ans: Deep learning is a fascinating field that has revolutionized artificial intelligence. Let's dive into the neuron level to understand how deep learning neural networks operate.

Neurons in Deep Learning:

Neurons are the fundamental building blocks of deep learning models. They play a crucial role in processing information and making predictions.

Imagine a neuron as a tiny computational unit within a neural network. These neurons are inspired by the structure and function of biological neurons in the human brain.

Artificial Neural Networks (ANNs): Geoffrey Hinton, often regarded as the founding father of deep learning, conceptualized artificial neural networks (ANNs) in the 1980s.

ANNs consist of layers of interconnected nodes (neurons). Each node behaves similarly to a neuron in the brain.

The layers in an ANN include:

- Input Layer: Receives raw data or features.
- Hidden Layers: Intermediate layers where computations occur.
- Output Layer: Produces the final prediction or output.

Nodes within the neural network perform calculations and pass signals to other nodes deeper in the network.

How Neurons Work:

A neuron receives one or more input signals. These signals can come from either the raw data or from neurons in the previous layer. The neuron processes these input signals using a mathematical function (often involving weights and biases).

The result of this computation is then passed to other neurons in subsequent layers. The connections between neurons are analogous to synapses in the brain. In summary, neurons receive, process, and transmit information, allowing the neural network to learn patterns and make predictions.

Deep Learning's Evolution:

Deep learning faced challenges due to limited resources (data and computing power) during its early days. Researchers lacked sufficient data and computational capabilities to build and train meaningful deep learning models.

Over time, advancements in computing power and the availability of large datasets led to deep learning's prominence today.

Mathematical Formulation:

Deep learning involves optimizing model parameters (weights and biases) to minimize a loss function.

For example, the loss function for binary classification is often expressed as: [L(a, y) = -(y \log(a) + (1-y) \log(1-a))] where:

(a) represents the predicted output (activation) of the neuron.

(y) is the true label (0 or 1).

The goal is to adjust the weights to minimize this loss.

In summary, deep learning models, with their interconnected neurons, learn from data to make accurate predictions. Understanding neurons at this level helps us appreciate the power of artificial neural networks in solving real-world problems.

Hard-Coding vs. Soft-Coding

There are two main ways that you can develop computer applications. Before digging in to how neural networks are trained, it's important to make sure that you have an understanding of the difference between hard-coding and soft-coding computer programs.

- Hard-coding means that you explicitly specify input variables and your desired output variables. Said differently, hard-coding leaves no room for the computer to interpret the problem that you're trying to solve.

- Soft-coding is the complete opposite. It leaves room for the program to understand what is happening in the data set. Soft-coding allows the computer to develop its own problem-solving approaches.

A specific example is helpful here. Here are two instances of how you might identify cats within a data set using soft-coding and hard-coding techniques.

Hard-coding: you use specific parameters to predict whether an animal is a cat. More specifically, you might say that if an animal's weight and length lie within certain

Soft-coding: you provide a data set that contains animals labelled with their species type and characteristics about those animals. Then you build a computer program to predict whether an animal is a cat or not based on the characteristics in the data set.

As you might imagine, training neural networks falls into the category of soft-coding. Keep this in mind as you proceed through this course. There are two main ways that you can develop computer applications. Before digging in to how neural networks are trained, it's important to make sure that you have an understanding of the difference between hard-coding and soft-coding computer programs.

Modifying A Neural Network

After an initial neural network is created and its cost function is imputed, changes are made to the neural network to see if they reduce the value of the cost function.

More specifically, the actual component of the neural network that is modified is the weights of each neuron at its synapse that communicate to the next layer of the network.

The mechanism through which the weights are modified to move the neural network to weights with less error is called gradient descent. For now, it's enough for you to understand that the process of training neural networks looks like this:

- Initial weights for the input values of each neuron are assigned
- Predictions are calculated using these initial values
- The predictions are fed into a cost function to measure the error of the neural network
- A gradient descent algorithm changes the weights for each neuron's input values
- This process is continued until the weights stop changing (or until the amount of their change at each iteration falls below a specified threshold)

Q.3: Write merits and Applications of DL

Ans: Merits of Deep Learning:

1. **Automatic Feature Learning:**

DL algorithms can automatically learn features from data, eliminating the need for manual feature engineering. This is particularly advantageous for tasks like image recognition, where defining features manually can be challenging.

2. **Handling Large and Complex Data:**

DL algorithms excel at processing large and intricate datasets that might overwhelm traditional machine learning methods. This makes DL a powerful tool for extracting insights from big data.

3. **Improved Performance:**

Deep learning models achieve state-of-the-art performance across various domains, including image and speech recognition, natural language processing, and computer vision.

4. **Handling Non-Linear Relationships:**

DL can uncover non-linear relationships in data that are difficult to detect using traditional methods. This flexibility allows it to capture intricate patterns and dependencies.

5. **Structured and Unstructured Data Handling:**

DL algorithms can process both structured (e.g., tabular data) and unstructured (e.g., images, text, audio) data.

6. **Predictive Modeling:**

DL can make predictions about future events or trends, aiding organizations in strategic decision-making.

Applications of Deep Learning:

1. **Computer Vision:**

DL plays a crucial role in image and video recognition, object detection, and semantic segmentation. Applications include self-driving cars, medical imaging, and surveillance systems.

2. **Natural Language Processing (NLP):**

DL models excel in tasks like sentiment analysis, machine translation, and chatbots. They understand context, semantics, and nuances in human language.

3. **Speech Recognition:**

DL powers voice assistants (e.g., Siri, Alexa) and transcription services. It converts spoken language into text and vice versa.

4. **Recommendation Systems:**

DL algorithms personalize recommendations for users based on their preferences and behavior. Think of Netflix suggesting movies or Amazon recommending products.

5. **Healthcare:**

DL aids in diagnosis, disease prediction, and drug discovery. It analyzes medical images (X-rays, MRIs) and genomic data.

6. **Finance and Trading:**

DL models predict stock prices, detect fraud, and optimize trading strategies. They handle vast financial datasets.

7. **Autonomous Vehicles:**

DL enables self-driving cars by interpreting sensor data and making real-time decisions.