UNIT 1: An Overview of AI

1.1 What is AI?

AI is composed of two words *Artificial and Intelligence*, where Artificial defines "*man-made,*" and intelligence defines "*thinking power*".
Hence AI means "**a man-made thinking power"**.

Artificial Intelligence exists when a machine can have human based skills such as learning, reasoning, and problem solving.

With AI you do not need to pre-program a machine to do some work, despite that you can create a machine with programmed algorithms which can work with own intelligence.

Definition: It is a branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.

1.2 Goals of AI

- ✓ Replicate human intelligence.
- ✓ Solve Knowledge-intensive tasks.
- ✓ An intelligent connection of perception and action.
- ✓ Building a machine which can perform tasks that requires human intelligence. Like playing Chess, Driving a car.
- ✓ Creating some system which can learn new things by itself, demonstrate, explain, and can advise to its user.

1.3 Advantages of AI

- ✓ Reduction in Human Error
- ✓ Useful for risky areas
- ✓ High Reliability
- ✓ Fast
- ✓ Digital Assistant
- ✓ Faster Decisions
- ✓ Available 24x7

1.4 Disadvantages of AI

- × High Cost
- × Can't Replace Humans
- × Doesn't Improve With Experience
- × Lack of Creativity
- × Risk Of Unemployment.
- × No Feelings And Emotions

1.5 Evolution of AI

i) Maturation of AI (1943-1952)

- ✧ **1943:** The first work toward AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of **artificial neurons**.
- ✧ **1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.
- ✧ **1950:** The Alan Turing proposed a test which can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.

ii) The birth of AI (1952-1956)

- ✧ **1955:** An Allen Newell and Herbert A. Simon created the "first artificial intelligence program" Which was named as **"Logic Theorist"**. This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- ✧ **1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference.

iii) The golden years-Early enthusiasm (1956-1974)

- ✧ **1966:** Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA.
- ✧ **Year 1972:** The first intelligent humanoid robot was built in Japan which was named as WABOT-1.

iv) The first AI winter (1974-1980)

- ✧ AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches. 1974 to 1980 was the first AI winter duration.
- ✧ During AI winters, an interest of publicity on artificial intelligence was decreased.

v) A boom of AI (1980-1987)

- ✧ **1980:** After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert.

vi)The second AI winter (1987-1993)

- ✧ The duration between the years 1987 to 1993 was the second AI Winter duration.
- ✧ Again Investors and government stopped in funding for AI research.

Made By Kulbir Thakur

vii) The emergence of intelligent agents (1993-2011)

- ✧ **1997:** In the year 1997, IBM Deep Blue beats world chess champion, Garry Kasparov, and became the first computer to beat a world chess champion.
- ✧ **2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- ✧ **2006:** Companies like Facebook, Twitter, and Netflix also started using AI.

viii) Deep learning, Big data and Artificial general intelligence (2011-Present)

- ✧ **2011:** IBM's Watson won a quiz show, where it had to solve the complex & tricky questions as well as riddles. Watson had proved that it could understand natural language.
- ✧ **2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- ✧ **2014:** In 2014, a Chatbot won a competition in "Turing test."
- ✧ **2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- ✧ **2018:** Google has demonstrated an AI virtual assistant "Duplex", which mimicked human voice, allowed users to do things like booking tables at restaurants.

1.6 Various approaches to AI / Types of AI

A) <u>Based on Capabilities:</u> Based on capabilities of a machine, there are three types of Artificial Intelligence approaches:

1. Artificial Narrow Intelligence (ANI) / Weak AI / Narrow AI

- ✓ It has a narrow range of capabilities.
- ✓ Weak AI focuses on performing a specific task, such as answering questions based on user input or playing chess. It can perform one type of task, but not both.
- ✓ More Examples - Virtual assistants (Siri, Alexa, Cortana), Image/facial recognition software, Email spam filters, Self-driving cars.

2. Artificial General Intelligence (AGI) / Strong AI / Deep AI / General AI

- ✓ It is on par with human capabilities.
- ✓ Strong AI can perform a variety of functions, eventually teaching itself to solve for new problems.
- ✓ It is the concept of a machine with general intelligence that mimics human intelligence and/or behaviour, with the ability to learn and apply its intelligence to solve any problem.
- ✓ AGI can think, understand, and act in a way that is indistinguishable from that of a human in any given situation.
- ✓ In theory, then, anything a human can do, a strong AI can do too.
- ✓ AI researchers and scientists have not yet achieved strong AI.

3. Artificial Superintelligence (ASI)

- ✓ It is more capable than a human.
- ✓ ASI is the hypothetical AI that doesn't just mimic or understand human intelligence and behaviour; ASI is where machines become self-aware and surpass the capacity of human intelligence and ability.
- ✓ Super AI is purely speculative at this point.

B) <u>Based on Functionalities:</u> Based on the ways the machines behave and functionalities, there are four types of Artificial Intelligence approaches:

1. Reactive Machines

- ✓ These machines are the most basic form of AI applications.
- ✓ Such AI system do not store memories or past experiences for future actions.
- ✓ These machines focus only on current scenario and react on it as per possible best action.
- ✓ Example: Games like Deep Blue & IBM's chess-playing supercomputer.

2. Limited Memory

- ✓ Limited Memory machines can retain data for a short period of time.
- ✓ While they can use this data for specific time period, they cannot add it to a library of their experiences.
- ✓ Many self-driving cars use Limited Memory technology: they store data such as the recent speed of nearby cars, the distance of such cars, the speed limit, & other information that can help them navigate roads.

3. Theory of Mind

- ✓ Theory of mind is AI should understand the human emotions, beliefs and be able to interact socially like humans.
- ✓ Resources are making lots of efforts and improvement for developing such AI machines

4. Self-Awareness

- ✓ Self awareness AI is the future of artificial intelligence. These machines will be super intelligent and will have their own consciousness, sentiments and self-awareness.
- ✓ These machines will be smarter than human mind.
- ✓ Self awareness AI does not exist till now and it is a hypothetical concept.

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

1.7 Skills Required to Become an AI Engineer

1. Programming Skills : The first skill required to become an AI engineer is programming. For this, it's crucial to learn programming languages, such as Python, R, Java, and C++ to build and implement models.

2. Linear Algebra, Probability, and Statistics: To understand and implement different AI models, you must have detailed knowledge of linear algebra, probability, and statistics.

3. Spark and Big Data Technologies: AI engineers work with large volumes of data, which could be streaming or real-time production level data in terabytes or petabytes. For such data, these engineers need to know about Spark and other big data technologies to make sense of it.

4. Algorithms and Frameworks: Understanding how machine learning algorithms like linear regression, KNN, Naive Bayes, Support Vector Machine, and others work will help you implement machine learning models with ease. Additionally, to build AI models with unstructured data, you should understand deep learning algorithms and implement them using a framework.

5. Communication and Problem-solving Skills: AI engineers need to communicate correctly to pitch their products and ideas to stakeholders. They should also have excellent problem-solving skills to resolve obstacles for decision making and drawing helpful business insights.

6. Necessary Business Skills: The following are some of the business skills required to be a successful AI engineer:

→ *Creative thinking*
→ *Effective communication*
→ *Analytic problem-solving skills*
→ *Industry Knowledge*

1.8 Other Emerging Technologies

1. <u>The Internet of Things (IoT):</u>

Refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention.

The Internet of things describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.
It enables devices to interact, collaborate and, learn from each other's experiences just like humans do.

IoT Examples:

- ✓ Smart Home security systems
- ✓ Smart Wearables health monitors
- ✓ IoT in agriculture
- ✓ Smart Speakers (Amazon Echo Dot: Alexa)
- ✓ Smart Cities
- ✓ Smart Door Locks

2. <u>Cloud Computing:</u>

Cloud computing is the on-demand availability of computer system resources, especially data storage (cloud storage) and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet.

Types of Cloud Computing

1. **Public Cloud** – Whole computing infrastructure is located on the premises (sites) of a cloud computing company that offers the **cloud service**.
2. **Private Cloud** – Hosting all your computing infrastructure yourself and is not shared. The security and control level is highest while using a private network.
3. **Hybrid Cloud** – using both private and public clouds, depending on their purpose. You host your most important applications on your own servers to keep them more secure and secondary applications elsewhere.
4. **Community Cloud** – A community cloud is shared between organizations with a common goal or that fit into a specific community (professional community, geographic community, etc.).

3. <u>Blockchain:</u>

A blockchain is a peer-to-peer distributed ledger technology. Which is an immutable, decentralized, encrypted, distributed ledger technology.

The name comes from its structure, in which individual records, called blocks, are linked together in single list, called a chain. Blockchains are used for recording transactions made with cryptocurrencies, such as Bitcoin, and have many other applications.

Each transaction added to a blockchain is validated by multiple computers on the Internet (Miners). These systems form a peer-to-peer network.

Applications of Blockchain: Cryptocurrency, Smart Contract, Online Voting, etc.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

4. 3D Printing:

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive process in which an object is created by laying down successive layers of material until the object is created.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.

3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

5. Augmented reality (AR):

AR is an interactive experience of a real-world environment where AR combines the physical world with computer-generated virtual elements overlay. These 2D or 3D virtual content are projected in reality within people's field of view (through smartphone camera or smartglasses.

Augmented reality is a technology that virtually places a 2D/3D visual into a "real-world" experience. This gives the user the appearance that the virtual object is co-existing with them in the physical world.

In a few words, AR is the real world with an added layer of virtual content (2D/3D).

6. Virtual Reality (VR):

Virtual reality (VR) refers to a computer-generated simulation in which a person can interact within an artificial 3D environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors. In this simulated artificial environment, the user is able to have a realistic-feeling experience.
It uses software to produce images, sounds, and other sensations to create a different place so that a user feels like he or she is really part of this other place.

7. 5G technology:

5G is the latest upgrade in the long-term evolution (LTE) mobile broadband networks. 5G mainly works in 3 bands.

1. **Low band spectrum**: It has shown great promise in terms of coverage and speed of internet and data exchange, the maximum speed is limited to 100 Mbps.

2. **Mid band spectrum**: It offers higher speeds compared to the low band, but has limitations in terms of coverage area. This spectrum doesn't penetrate buildings very well, but it does deliver speeds around 1 Gbps.

3. **High band spectrum**: It offers the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength. Internet speeds in the high-band spectrum of 5G has been tested to be as high as 20 Gbps.

8. Brain Computer Interface (BCI):

BCIs acquire brain signals, analyze them, and translate them into commands that are relayed to output devices that carry out desired actions.

BCIs measure brain activity, extract features from that activity, and convert those features into outputs that replace, restore, enhance, supplement, or improve human functions.

1.9 AI and Ethical Concerns

1. Unemployment: As AI become more and more advance, it will obviously take over jobs that were once performed by humans. People will move from physical and repetitive jobs to jobs that actually requires creative and strategic thinking.

2. AI is Imperfect: AIs are not immune to making mistakes and machine learning takes time to become useful. If trained well, using good data, then AIs can perform well. However, if we feed AIs bad date or make errors with internal programming, the AIs can be harmful.

3. Biasness: Human being are sometimes biased against other religion, gender and nationalities. This bias may unconsciously also enter into AI system that are developed by humans. There are many companies that are working towards creating unbiased AI system.

4. Artificial Stupidity: Intelligence come from learning, systems usually have a training phase in which they learn to detect the right patterns and act according to their input. Obviously, the training phase can not cover all the possible examples that a system may deal with in the real world. So this systems can be fooled in a ways that humans wouldn't be.

5. Loss of skills: We lose more and more human skills due to the use of computers and smartphones.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

6. Security: The more powerful a technology becomes, the more can it be used for unfair reasons as well as good. AI system can cause damage if used maliciously. In terms of Cyber security, in future we will deal with AI system that is faster and more capable than us by order of magnitude.

7. Technological singularity: Technological singularity is a point when artificial intelligence may become more intelligent than human. It would make AI the dominant species on earth and lead to huge changes in human existence or human extinction.

8. Humanity: AI Bots becoming better and better at modelling human conversation and relationships. Tech addiction is the new frontier of human dependency. In future, we will interact frequently with machines as if they are human; whether in customer services or sales.

9. Everything becomes unreliable: For Examples, fake news and fake videos & audios of an individual. Smart systems are becoming increasingly capable of creating content – they can create faces, compose texts, produce tweets, manipulate images, clone voices and engage in smart advertising.

1.10 AI Applications

1. Chatbots: AI Powered Chatbots can simulate a conversation (or a chat) with a user in natural language through messaging applications, websites, mobile apps or through the telephone.

2. AI in Healthcare: There are lot of AI applications in the healthcare sector. AI is used to detect diseases and uses the combination of historical data & medical intelligence for the discovery of new drugs.

3. Handwriting Recognition: The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

4. Speech Recognition: Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

5. Natural Language Processing: It is possible to interact with the computer that understands natural language spoken by humans.

6. AI in Gaming: AI can be used for gaming purpose. The AI machines can play strategic games like chess, poker, tic-tac-toe, where the machine needs to think of a large number of possibilities.

7. AI in Robots: Generally robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.

8. AI in Finance: The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

9. AI in Agriculture: Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring.

10. AI in Education: AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant. AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any tune and any place.

11. AI in Data Security: The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

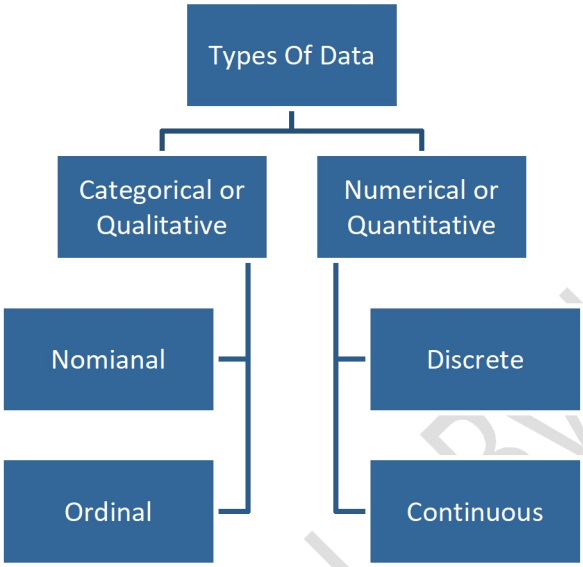
UNIT 2: Data & Algorithms

2.1 Data & it's Types

In Computers, Data is information processed (used) or stored by a computer. This information may be in the form of text documents, images, audio clips, software programs, or other types of data.

Data is a bunch of ones and zeros, known as binary data. So. it can be created, processed, saved, and stored digitally.

- **Structured data** is highly-organized and formatted in a way so it's easily searchable in relational databases.
- **Unstructured data** has no pre-defined format or organization, making it much more difficult to collect, process, and analyze.



A) Qualitative Data Type

This type of data can't be counted or measured easily using numbers.

1. Nominal: These are the set of values that don't possess a natural ordering.
Example- Colours, we can't compare one color with others. It is not possible to state that 'Red' is greater than 'Blue'.

2. Ordinal: These types of values have a natural ordering while maintaining their class of values.
Example- Size of Shirt, we can easily sort them according to their name tag in the order of small < medium < large.

B) Quantitative Data Type

This data type tries to quantify things and it does by considering numerical values that make it countable in nature.

1. Discrete: The numerical values which fall under are integers or whole numbers are placed under this category.

2. Continuous: The fractional numbers are considered as continuous values.

2.2 Algorithms

An algorithm is a set of instructions designed to perform a specific task or solving a problem.

Big data is a huge data that it does not fit in the main memory of a single machine, and the need to process big data by efficient algorithms.

2.3 History of Data

Data feeds the growth of exciting technology like artificial intelligence (AI). It helps personalise our online experiences, and it helps us move forward in the quest for more knowledge.

1600s: Early Interpretations

- In 1640s, The word 'data' first saw English use. **John Graunt** conducted one of the earliest recorded instances of data analysis.
- So, Graunt is generally considered to be the founder.

Late 1800s: Data Processing Problems

- In 1880 US census. The issue was that there was now more data of populance than collectors could analyse.
- **Hollerith**'s machine made it possible to process and analyse large amounts of data.

1900s: A Question of Storage

- In 1928, **Fritz Pfleumer** invented magnetic tape for recording purposes (to collect & store data). The hard disc drives, floppy discs and tapes that would follow toward the end of the century were all enabled by magnetic data storage.
- In 1960s, the conception (but not the creation) of cloud data storage by **Dr Joseph** is given. This idea forms the basis of cloud computing.
- In 1970s, E.F. Codd presented a framework for a relational model of database management.

Made By Kushagra

1990s: The Internet

- Naturally, the most noteworthy 1990s event in the history of data is the invention of the internet.
- **Sir Tim Berners Lee** created hyperlinks and hypertext, enabling data sharing worldwide.
- In mid 1990s, The first instance of all web-based storage was launched by AT&T.
- In 1997, The Google Search Engine was launched. This put data very much in the hands of anyone with computer access.

2.4 Data Storage & it's Types

Data storage means that files and documents are recorded digitally and saved in a storage system for future use.

Data storage can occur on physical hard drives, disk drives, USB drives or virtually in the cloud.

Types of Data Storage:

There are two types of data Storage.

1. **Direct Attached Storage (DAS)**
   It is a types of data storage that are physically connected to your computer.
   This storage is generally accessible to only a single machine.
   Example: Hard Drive, SSD, CD/DVD, Pendrives,etc.
2. **Network Attached Storage (NAS)**
   It allows multiple machines to share storage over a network. Data can be easily shared among connected machines.

Types of Data Storage Devices:

There are lot of Data Storage device availble in market, some of them are old and slow. Example -

1. Hard Drive Disks (HDD)
2. Floppy Disks
3. Tapes
4. Compact Discs (CDs)
5. DVD and Blu-ray Discs
6. USB Flash Drives
7. Secure Digital Cards (SD Cards)
8. Solid-State Drives (SSDs)
9. Cloud Storage, etc.

2.4 Importance of Data

Below are the various reasons, why the data is important.

1. Improve people's lives

Data will help people to improve quality of life: Improving quality is first and foremost among the reasons why organizations should be using data.

2. Make informed decisions

Data = Knowledge. Good data provides indisputable evidence, while casually collected data might lead to wasted resources due to taking action based on an incorrect conclusion.

3. Find solutions to problems

Data allows organizations to more effectively determine the cause of problems then find the appropriate solution based on the data.

4. Be strategic in your approaches

Data increases efficiency. Effective data collection and analysis will allow you to make a good strategy.

5. Get The Results You Want

Data allows organizations to measure the effectiveness of a given strategy. Collecting data will allow you to determine how well your solution is performing, and whether or not your approach needs to be tweaked or changed over the long-term.

6. Stop The Guessing Game

Data will help you explain (both good and bad) decisions to your stakeholders. You can be confident that you developed your approach based not upon guesses, but good solid data.

7. Know What You Are Doing Well

Data analysis will support you to identify high-performing programs, service areas, and people. Once you identify your high-performers, you can study them in order to develop strategies to assist programs, service areas and people that are low-performing.

8. Keep Track Of It All

Good data allows organizations to establish baselines, benchmarks, and goals to keep moving forward. Because data allows you to measure, you will be able to establish baselines, find benchmarks and set performance goals.

9. Stand out from the crowd

By knowing and comparing your business against others, you can find out what you offer that others don't, and use this to your advantage.

Made By Kushjhan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

2.5 Data Acquisition (DAQ/DAS)

Data acquisition is the process of digitizing data from the world around us. So that it can be displayed, analyzed and stored in a computer.
Example - The process of measuring temperature in a room as a digital value using a sensor.

Data Acquisition Systems: The systems, used for data acquisition are known as data acquisition systems.
These data acquisition systems will perform the tasks such as conversion of data, storage of data, transmission of data and processing of data.

Types of Data Acquisition Systems:
Data acquisition systems can be classified into the following two types.

1. **Analog Data Acquisition Systems :** It is a systems, which can be operated with analog signals are known as analog data acquisition systems. Following are the blocks of analog data acquisition systems.
   - **Transducer** − It converts physical quantities into electrical signals.
   - **Signal conditioner** − It performs the functions like amplification and selection of desired portion of the signal.
   - **Display device** − It displays the input signals for monitoring purpose.
   - **Graphic recording instruments** − These can be used to make the record of input data permanently.
   - **Magnetic tape instrumentation** − It is used for acquiring, storing & reproducing of input data.

2. **Digital Data Acquisition Systems :** It is a systems, which can be operated with digital signals are known as digital data acquisition systems. So, they use digital components for storing or displaying the information.
Following are the blocks of Digital data acquisition systems.
   - **Transducer** − It converts physical quantities into electrical signals.
   - **Signal conditioner** − It performs the functions like amplification and selection of desired portion of the signal.
   - **Multiplexer** − connects one of the multiple inputs to output. So, it acts as parallel to serial converter.
   - **Analog to Digital Converter** − It converts the analog input into its equivalent digital output.
   - **Display device** − It displays the data in digital format.
   - **Digital Recorder** − It is used to record the data in digital format.

2.6 Data Processing

It is a process of converting raw facts or data into a meaningful information. Below are the stages of Data processing.

1. **Collection**
   - Collection of data refers to gathering of data.
   - The data gathered should be defined and accurate.
2. **Preparation**
   Preparation is a process of constructing a dataset of data from different sources for future use.
3. **Input**
   - Input refers to supply of data for processing:
   - It can be fed into computer through any of input devices like keyboard, scanner, mouse, etc.
4. **Processing**
   - The process refers to concept of an actual execution of instructions.
   - In this stage, raw facts or data is converted to meaningful information.
5. **Output and Interpretation**
   In this process, output will be displayed to user in form of text, audio, video, etc. Interpretation of output provides meaningful information to user.
6. **Storage**
   In this process, we can store data, instruction and information in permanent memory for future reference.

2.7 Data Visualization

Data visualization is the graphical representation of information and data. By using visual elements like charts, graphs, and maps.

It enables decision makers to see analytics presented visually.

It helps users in analyzing a large amount of data in a simpler way because it converts large and small data sets into visuals, which is easy to understand and process for humans.

Why Use Data Visualization?
- ✓ To make easier in understand and remember.
- ✓ To discover unknown facts, outliers, and trends.
- ✓ To ask a better question and make better decisions.
- ✓ To competitive analyze.
- ✓ To improve insights.

Made By Kullonishan

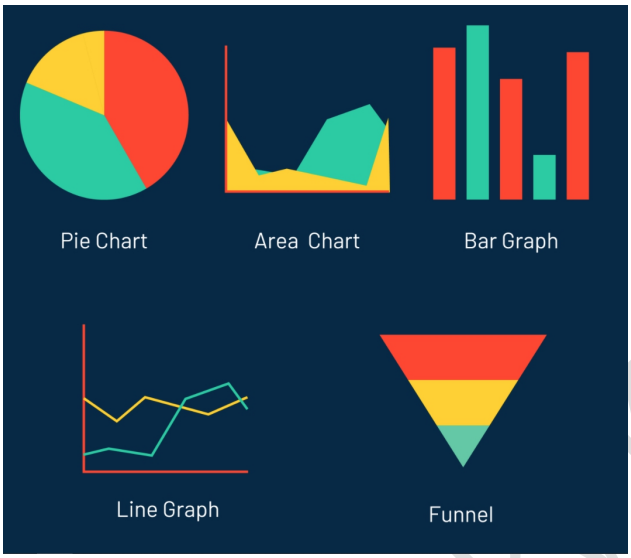
Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

Pros of Data Visualization

- ✓ It can be accessed quickly by a wider audience.
- ✓ It provides a lot of information in a small space.
- ✓ It makes your report more visually appealing.

General types of data visualization:

- Charts
- Tables
- Graphs
- Maps
- Histograms
- Heat maps
- Tree maps
- Pie Chart
- Venn Diagram



2.8 Regression

Regression is a process of finding the correlations between dependent and independent variables. It helps in predicting the continuous variables such as prediction of Market Trends, prediction of House prices, etc.

The task of the Regression algorithm is to find the mapping function to map the input variable(x) to the continuous output variable(y).

Example - For weather forecasting, we will use the Regression algorithm. The model is trained on the past data, and once the training is completed, it can easily predict the weather for future days.

Types of Regression Algorithm:

- Simple Linear Regression
- Multiple Linear Regression
- Polynomial Regression
- Support Vector Regression
- Decision Tree Regression
- Random Forest Regression

2.9 Classification

Classification is a process of finding a function which helps in dividing the dataset into classes based on different parameters.

In Classification, a computer program is trained on the training dataset and based on that training, it categorizes the data into different classes.

The task of the classification algorithm is to find the mapping function to map the input(x) to the discrete output(y).

Example - In Email Spam Detection, The model is trained on the basis of millions of emails on different parameters, and whenever it receives a new email, it identifies whether the email is spam or not. If the email is spam, then it is moved to the Spam folder.

Types of ML Classification Algorithms:

- Logistic Regression
- K-Nearest Neighbours
- Support Vector Machines
- Kernel SVM
- Naïve Bayes
- Decision Tree Classification
- Random Forest Classification

2.10 Regression V/s Classification

Regression Algorithm	Classification Algorithm
The output variable must be of continuous nature or real value.	The output variable must be a discrete value.
The task is to map the input value (x) with the continuous output variable(y).	The task is to map the input value(x) with the discrete output variable(y).
Used with continuous data.	Used with discrete data.
In Regression, we try to find the best fit line, to predict the output more accurately.	In Classification, we try to find the decision boundary, to divide the dataset into different classes.
Used to solve such as Weather Prediction, House price prediction, etc.	Used to solve such as Identification of spam emails, Identification of cancer cells, etc.
Divided into Linear and Non-linear Regression.	Divided into Binary Classifier and Multi-class Classifier.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

2.11 Prediction

Prediction refers to the output of an algorithm after it has been trained on a historical dataset and applied to new data when forecasting the likelihood of a particular outcome.

It is a type of guess. However, a prediction is an estimation made from observation

Example - You observe that everytime the wind blow, flower petals fall from the tree. So, you can predict that if the wind blows, petals will fall from the tree.

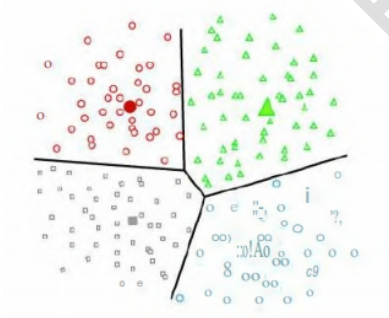
2.12 Clustering

Clustering methods are one of the most useful unsupervised machine learning methods. These methods are used to find similarity as well as the relationship patterns among data samples and then cluster those samples into groups having similarity based on features.

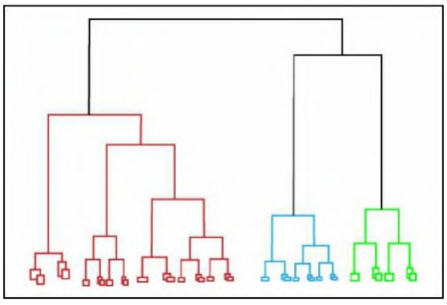
In Simple words, Cluster is a group of objects that belongs to the same class. Which means, similar objects are grouped in one cluster and dissimilar objects are grouped in another cluster.

The following are the most important and useful clustering algorithms:

1. K-means Clustering: This clustering algorithm computes the centroids and iterates until it finds optimal centroid. It assumes that the numbers of clusters are already known. It is also called flat clustering algorithm. The number of clusters identified from data by algorithm is represented by 'K' in K-means.



2. Hierarchical Clustering: It is another unsupervised learning algorithm that is used to group together the unlabeled data points having similar characteristics.



Applications of Clustering:

- **In Identification of Cancer Cells:** The clustering algorithms are widely used for the identification of cancerous cells. It divides the cancerous and non-cancerous data sets into different groups.
- **In Biology:** It is used in the biology stream to classify different species of plants and animals using the image recognition technique.
- **Customer Segmentation:** It is used in market research to segment the customers based on their choice and preferences.
- **Libraries:** Clustering books based on Topics & Information.

2.13 Recommender Systems

Recommender systems are the systems that are designed to recommend things to the user based on many different factors. These systems predict the most likely product that the users are most likely to purchase and are of interest to. Companies like Netflix, Amazon, etc. use recommender systems.

Benefits of Recommender systems

- Benefits users in finding items of their interest.
- Help item providers in delivering their items to the right user.
- Identity products that are most relevant to users.
- Personalized content.
- Help websites to improve user engagement.

Methods for Building Recommender systems

1. Content-Based Recommendation: The goal of this content based recommendation is to predict the scores for unrated items of the users. The basic idea behind content filtering is that each items have some feature x. For example, a movie has a high score for a feature x_1 but a low score for feature x_2

2. Collaborative filtering: The disadvantage of the content filtering is that it need the side information for each item. The collaborative filtering are done based on the user's behaviour. History of the user plays an important role. It is of two types.

I. **User-User collaborative filtering:** In this, user vector include all the item purchased by the user and the rating given for each particular product.

II. **Item-Item collaborative filtering:** In this, rather than considering similar users, similar items are considered.

By Kubrin Shah

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

UNIT 3: Natural Language Processing

3.1 What is NLP?

Natural Language Processing (NLP) refers to the technology that is used by machines to understand, analyze, manipulate, and interpret human's language such as English.

The input and output of an NLP system can be-

- ✓ Speech
- ✓ Written Text

Components of NLP

There are two components of NLP:

1. **Natural Language Understanding (NLU):** It helps the machine to understand and analyse human natural language.
2. **Natural Language Generation (NLG):** It is a translator that converts the computerized data into natural language representation.

3.2 Steps in NLP

1. **Lexical Analysis (Morphology)** – It involves identifying and analyzing the structure of words. It divides the whole chunk of text into paragraphs, sentences, and words.
2. **Syntactic Analysis (Parsing)** – It involves analysis of words in the sentence for grammar and arranging words in a manner that shows the relationship among the words. The sentence such as "The school goes to boy" is rejected by English syntactic analyzer.
3. **Semantic Analysis** – It draws the exact meaning or the dictionary meaning from the text. The text is checked for meaningfulness. The semantic analyzer disregards sentence such as "hot ice cream".
4. **Discourse Integration** – The meaning of any sentence depends upon the meaning of the sentence just before it. In addition, it also brings about the meaning of immediately succeeding sentence.
5. **Pragmatic Analysis** – During this, what was said is re-interpreted on what it actually meant. It involves deriving those aspects of language which require real world knowledge.

3.3 Applications of NLP

1. **Speech recognition:** This technology uses natural language processing to transform spoken language into a machine-readable format.
2. **Chatbot:** They are used for automatic question answering, designed to understand natural language and deliver an appropriate response through natural language generation.
3. **Virtual Assistants:** A voice assistant is a software that uses speech recognition, natural language understanding, and natural language processing to understand the verbal commands of a user and perform actions accordingly.
4. **Character Recognition:** Optical Character Recognition (OCR) is the process of converting images of handwritten, typed, or printed text into machine-encoded language. It is one of the commonly used approaches to digitize printed texts so it can be saved, edited, searched electronically.
5. **Text Extraction:** It automatically detects specific information in a text, such as names, companies, places, and more. This is also known as named entity recognition. You can also extract keywords within a text, as well as pre-defined features such as product serial numbers and models.
6. **Machine Translation:** It is an automatic translation from one language to another. The benefit of machine translation is that it is possible to translate large amount of text in a very short time. It is one of the first applications of NLP.
7. **Auto-Correct:** NLP plays a vital role in grammar checking software and auto-correct functions. Tools like Grammarly, for example, use NLP to help you improve your Writing, by detecting grammar, spelling, or sentence structure errors.
8. **Email Filtering:** The emails are filtered using text classification, which is a natural language processing technique. It classifies all the into the sections of primary, social, and promotions.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

3.4 Speech Recognition

Speech recognition is the process that enables a computer to recognize and respond to spoken words and then converting them in a format that the machine understands.

Example: Voice Typing in GBaord and other transcription programs use speech recognition to convert your spoken words into text while digital assistants like Siri and Alexa respond in text format or voice.

Speech recognition focuses on the translation of speech from a verbal format to a text one whereas **voice recognition** just seeks to identify an individual's voice.

Why do we need Speech Recognition?

- ✓ Most natural form of communication.
- ✓ Differently abled people can use it with ease.
- ✓ Helps people who can't read or write, Hence they can communicate with computers normally.
- ✓ Increase adaption of technology by making it easier to use.

Types of Speech Recognition

There are three types of speech recognition.

1. **Speaker Dependent:** software works by learning the unique characteristics of a single person's voice, in a way similar to voice recognition. New users must first "train" the software by speaking to it, so the computer can analyze how the person talks.
2. **Speaker Independent:** software is designed to recognize anyone's voice, so no training is involved. This means it is the only real option for applications such as interactive voice response systems. Hence it's mostly voice recognition along with speech recognition.
3. **Speaker Adaptive:** They usually begins as a speaker independent model and slowly adapts and adjusts to the individual using the systems. Virtual Assistants like, Google, Alexa, Siri etc. uses similar methods.

Applications of Speech Recognition:

1. **Voice to text:** Speech recognition enables hands free computing. Users don't need to type emails, reports, and other documents.
2. **Voice commands to smart home devices:** Smart home applications are mostly designed to take a certain action after the user gives voice commands.
3. **Security**: As technology integrates into our daily lives, security protocols are an increasing priority. Voice-based authentication adds a viable level of security.
4. **Voice Search:** This is the most common use of speech recognition. Users prefer to use voice searches Siri and Google voice search, over the traditional method of typing.
5. **Automotive**: In-car speech recognition systems, aim to remove the distraction of looking down at your mobile phone while you drive. Drivers can use simple voice commands to initiate phone calls, select radio stations or play music.

3.5 Natural Language Understanding

- Natural language understanding (NLU) is a sub-topic of natural language processing, which involves breaking down the human language into a machine-readable format.
- Interesting applications include text categorization, machine translation, and question answering.
- NLU uses grammatical rules and common syntax to understand the overall context and meaning of "natural language,".
- In shorts, Its goal is to understand written or spoken language the way a human would.

Examples of NLU:

1. **Machine Translation (MT):**
   - ✓ MT is an automatic translation from one language to another. The advantage of machine translation is that it is possible to translate large amount of text in a very short time.
   - ✓ You can type text or upload whole documents and receive translations in dozens of languages using machine translation tools.
2. **Automated Reasoning**
   - ✓ Automated reasoning is a sub-field of cognitive science which is used to automatically prove mathematical theorems about a medical diagnosis.
   - ✓ It gives machines a form of reasoning or logic, and allows them to infer new facts by deduction.
3. **Automatic Ticket Routing**
   - ✓ With text analysis solutions, machines can understand the content of customer support tickets and route them to the correct departments without employees having to open every single ticket.
   - ✓ This not only save customer support teams hundreds of hours, but it also helps them prioritize urgent tickets.
4. **Question Answering**
   - ✓ Question answering uses NLU to help computers automatically understand natural language questions.

Made By Kulbhushan

- ✓ For example, If we ask Google Assistant: "What is the weather like tomorrow?"
- ✓ NLP tools can split this question into topic (weather) and date (tomorrow), understand it and gather the most appropriate answer from unstructured collections of "natural language documents": online news reports, collected web pages etc.
- ✓ The goal of question answering is to give the user response in their natural language, rather than a list of text answer.

3.6 Natural Language Generation

Natural language generation (NLG) is a process of producing meaningful phrases and sentences in the form of natural language.

It automatically generates narratives that describe, summarize or explain input structured data in a human like manner at the speed of thousands of pages per second.

Applications of NLG

1. **Analytics Dashboards:** Analytics dashboards are among the earliest and the most obvious application areas for natural language generation. NLG-powered tools can generate information in an easily comprehensible format from the Analytics so that they can make quick and effective decisions.
2. **Chatbots:** The best chatbots are the ones that give users the impression that they are chatting with a real human. These chatbots can be used for multiple purposes, such as complaint and query resolution and virtual assistance for online processes (e.g., form filling).
3. **Content Creation:** AI research will truly achieve new heights when machines that are capable of creating content with the naturalness and quirkiness of human writers are developed. Such as part and product descriptions, internal communications, agreements and contracts, and other similar forms of textual communications.
4. **Grammaticalization:** Grammaticalization stage makes sure that the whole report follows the correct grammatical form, spelling, and punctuation.

3.7 Chatbots

A chatbot is artificial intelligence (AI) software that can simulate a conversation (or a chat) with a user in natural language through messaging applications, websites, mobile apps or through the telephone.

A chatbot is often described as one of the most advanced and promising expressions of interaction between humans and machines.

Working of a Chatbot

There are two different tasks at the core of a chatbot:

1. **User request analysis:** This is the first task that a chatbot performs. It analyzes the user's request to identify the user intent and to extract relevant entities.
   It is the first condition and the most relevant step at the core of a chatbot: If you are not able to correctly understand the user's request, you would not be able to provide the correct answer.
2. **Returning the response:** Once the user's intent has been identified, the chatbot must provide the most appropriate response for the user's request. The answer maybe:
   - ✓ A generic and predefined text.
   - ✓ A text retrieved from a knowledge base that contains different answers.
   - ✓ A contextualized piece of information based on data the user has provided.
   - ✓ The result of an action that the chatbot performed by interacting with one or more backend application.
   - ✓ A disambiguation question that helps the chatbot to correctly understand the user's request.

Importance of chatbots

- ✓ Chatbot applications streamline interactions between people and services, enhancing customer experience.
- ✓ Offer companies new opportunities to improve the customer's engagement process and operational efficiency by reducing the typical cost of customer service.
- ✓ AI chatbots can make attending to customers quick and effortless. There is no off day for them and can engage with customers at all time.
- ✓ Using AI chatbots, don't need to invest in 24x7 customer service teams.
- ✓ AI chatbots interact with customers, collect valuable data, and analyze this data. We can systematically collect and use this data to understand your audience and market to them.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

3.8 Machine Translation

- Machine translation (MT) is an automatic translation from one language to another.
- The benefit of machine translation is that it is possible to translate large swathes of text in a very short time.
- If you specially train the machine to your needs, machine translation provides the perfect combination of quick and cost-effective translations.
- With a specially trained machine, MT can capture the context of full sentences before translating them, which provides you with a high quality and human-sounding output.

Advantages of Machine Translation

✓ Fast and does not require vetting and managing of translators
✓ Cost-efficient for large volumes of translations
✓ Reduced time-to-market due to faster translation delivery
✓ Flexibility from a number of Machine Translation source engines
✓ Adaptable, programmable, and developer-friendly
✓ Ability to retrain MT into customized workflows and strings

Limitation of Machine Translation

× Inability to account for certain local phrases due to lack of context
× Possibility for diluted marketing and brand messages due to word-for-word translations
× Difficulty to accurately translate nuances, slang, and other culturally relevant phrases
× Possibility for brand damage due to lack of cultural awareness and cohesiveness
× Difficulty translating complicated or industry-specific terms
× Difficulty predicting and correcting specific grammatical and cultural errors

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

4.1 Artificial Neural Networks (ANNs)

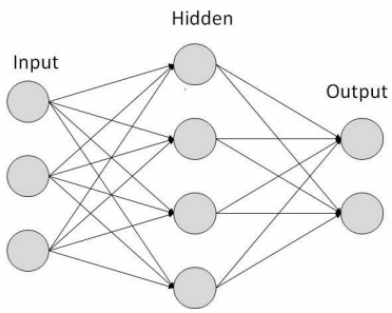
- ✓ An ANN is the piece of a computing system designed to simulate the way the human brain analyzes and processes information.
- ✓ It is the foundation of artificial intelligence (AI) and solves problems that would prove impossible or difficult by human or statistical standards.
- ✓ ANNs have self-learning capabilities that enable them to produce better results as more data becomes available.
- ✓ The term "Artificial Neural Network" is derived from Biological neural networks that develop the structure of a human brain.
- ✓ Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks. These neurons are known as nodes.

Biological Neural Network	Artificial Neural Network
Dendrites	Inputs
Cell nucleus	Nodes
Synapse	Weights
Axon	Output

Architecture of an ANN:

Artificial Neural Network primarily consists of three layers:

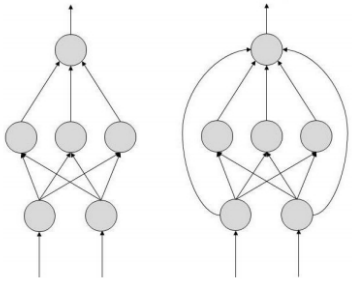
1. **Input Layer:** As the name suggests, it accepts inputs in several different formats provided by the programmer.
2. **Hidden Layer:** The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.
3. **Output Layer:** The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.



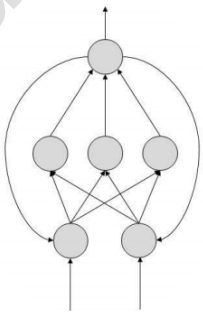
Types of Artificial Neural Network:

There are two Artificial Neural Network topologies.

1. Feedforward ANN: In this ANN, the information flow is unidirectional. A unit sends information to other unit from which it does not receive any information. There are no feedback loops. They are used in pattern generation/recognition/classification. They have fixed inputs and outputs.



2. Feedback ANN: Here, feedback loops are allowed. They are used in content addressable memories.



Advantages of Artificial Neural Network (ANN)

1. Parallel processing: Artificial neural networks have a numerical value that can perform more than one task simultaneously.

2. Storing data on the network: Data that is used in traditional programming is stored on the whole network, not on a database. The disappearance of a couple of pieces of data in one place doesn't prevent the network from working.

3. Incomplete knowledge: After ANN training, the information may produce output even with inadequate data. The loss of performance here relies upon the significance of missing data.

4. Fault tolerance: Extortion of one or more cells of ANN does not prohibit it from generating output, and this feature makes the network fault-tolerance.

Made By Kulbhushan

Disadvantages of Artificial Neural Network:

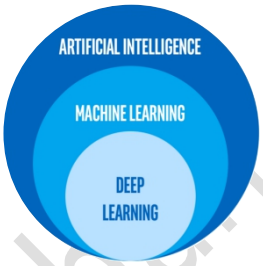
1. **Assurance of proper network structure:** There is no particular guideline for determining the structure of artificial neural networks. The appropriate network structure is accomplished through experience, trial, and error.
2. **Hardware dependence:** Artificial neural networks need processors with parallel processing power, as per their structure. Therefore, the realization of the equipment is dependent.
3. **Unrecognized behaviour of the network:** When ANN produces a testing solution, it does not provide insight concerning why and how. It decreases trust in the network.
4. **Difficulty of showing the issue to the network:** ANNS can work with numerical data. Problems must be converted into numerical values before being introduced to ANN. The presentation mechanism to be resolved here will directly impact the performance of the network. It relies on the user's abilities.
5. **The duration of the network is unknown:** The network is reduced to a specific value of the error, and this value does not give us optimum results.

Applications of Artificial Neural Networks

- ✓ **Aerospace**: Autopilot aircrafts, aircraft fault detection.
- ✓ **Automotive:** Automobile guidance systems.
- ✓ **Military:** Weapon orientation and steering, target tracking, object discrimination, facial recognition, signal/image identification.
- ✓ **Electronics:** Code sequence prediction, IC chip layout, chip failure analysis, machine vision, voice synthesis.
- ✓ **Financial:** Real estate appraisal, loan advisor, mortgage screening, corporate bond rating, portfolio trading program, value prediction, document readers, credit application evaluators. corporate financial analysis, currency
- ✓ **Medical:** Cancer cell analysis, EEG and ECG analysis. prosthetic design, transplant time optimizer.
- ✓ **Speech:** Speech recognition, speech classification, text to speech conversion.
- ✓ **Telecommunications:** Image and data compression, automated information services, real-time spoken language translation. Transportation - Truck Brake system diagnosis, vehicle scheduling, routing systems.
- ✓ **Software:** Pattern Recognition in facial recognition, optical character recognition, etc.

4.2 Deep Learning

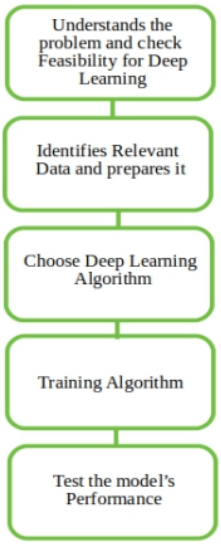
Deep Learning is a part of machine learning, which is a subset of Artificial Intelligence. Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks. It is useful in processing Big Data and can create important patterns that provide valuable insight into important decision making.



Deep learning is a branch of machine learning which is completely based on artificial neural networks, as neural network is going to mimic the human brain so deep learning is also a kind of mimic of human brain.

Working:

1. First, we need to identify the actual problem in order to get the right solution and it should be understood, the feasibility of the Deep Learning should also be checked (whether it should fit Deep Learning or not).
2. Second, we need to identify the relevant data which should correspond to the actual problem and should be prepared accordingly.
3. Third, Choose the Deep Learning Algorithm appropriately.
4. Fourth, Algorithm should be used while training the dataset.
5. Fifth, Final testing should be done on the dataset.



Made By Kulbhushan

Languages used:
R, Python, Matlab, CPP, Java, Julia, Lisp, Java Script, etc.

Advantages:
- ✓ Best in-class performance on problems.
- ✓ Reduces need for feature engineering.
- ✓ Eliminates unnecessary costs.
- ✓ Identifies defects easily that are difficult to detect.

Disadvantages:
- × Large amount of data required.
- × Computationally expensive to train.
- × No strong theoretical foundation.

Applications:
1. **Automatic Text Generation**: Corpus of text is learned and from this model new text is generated, word-by-word or character-by-character.
2. **Healthcare:** Helps in diagnosing various diseases and treating it.
3. **Automatic Machine Translation:** Certain words, sentences or phrases in one language is transformed into another language (Deep Learning is achieving top results in the areas of text, images).
4. **Image Recognition:** Recognizes and identifies peoples and objects in images as well as to understand content and context. This area is already being used in Gaming, Retail, Tourism, etc.
5. **Predicting Earthquakes**: Teaches a computer to perform viscoelastic computations which are used in predicting earthquakes.

4.3 Recurrent Neural Networks (RNNs)

Recurrent Neural Network(RNN) are a type of Neural Network where the output from previous step are fed as input to the current step. In traditional neural networks, all the inputs and outputs are independent of each other, but in cases like when it is required to predict the next word of a sentence, the previous words are required and hence there is a need to remember the previous words.

Why Recurrent Neural Networks?
Recurrent neural networks were created because there were a few issues in the feed-forward neural network:
- × Cannot handle sequential data
- × Considers only the current input
- × Cannot memorize previous inputs

The solution to these issues is the Recurrent Neural Network (RNN). An RNN can handle sequential data, accepting the current input data, and previously received inputs. RNNs can memorize previous inputs due to their internal memory.

Types of Recurrent Neural Networks
There are four types of Recurrent Neural Networks:
1. **One to One RNN:** This type of neural network is known as the Vanilla Neural Network. It's used for general machine learning problems, which has a single input and a single output.
2. **One to Many RNN:** This type of neural network has a single input and multiple outputs. An example of this is the image caption.
3. **Many to One RNN:** This RNN takes a sequence of inputs and generates a single output. Sentiment analysis is a good example of this kind of network where a given sentence can be classified as expressing positive or negative sentiments.
4. **Many to Many RNN:** This RNN takes a sequence of inputs and generates a sequence of outputs. Machine translation is one of the examples.

Applications of Recurrent Neural Networks
- ✓ **Image Captioning:** RNNs are used to caption an image by analysing the activities present.
- ✓ **Time Series Prediction:** Any time series problem, like predicting the prices of stocks in a particular month, can be solved using an RNN.
- ✓ **Next Word Prediction:** Taking a sequence of words as input, we try to predict the possibility of the next word.
- ✓ **Machine Translation:** Given an input in one language, RNNs can be used to translate the input into different languages as output.

4.4 Convolutional Neural Networks (CNNs)

- ✓ CNNs are class of Artificial Neural Networks which are used to process images. They can detect image features such as bright or dark or specific color spots edges in various orientations , patterns and others.
- ✓ So, if an image is input to a CNN, it should rightly recognize it . So, CNN needs to be trained with all such images using whose features it can rightly recognize the input image.
- ✓ Convolutional neural networks can operate directly on a raw image and do not need any pre-processing.
- ✓ Convolutional neural networks (CNN) are one of the most popular models used today.
- ✓ This neural network computational model uses a variation of multilayer perceptrons and contains one or more convolutional layers that can be either entirely connected or pooled.
- ✓ These convolutional layers create feature maps that record a region of image which is ultimately broken into rectangles and sent out for nonlinear processing.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

Comparison of Different Layers

There are three types of layers in a CNN. Each of these layers has different parameters that can be optimized and performs a different task on the input data.

1. **Convolutional layers:** are the layers where filters are applied to the original image, or to other feature maps in a deep CNN. This is where most of the user-specified parameters are in the network. The most important parameters are the number of kernels and the size of the kernels.
2. **Pooling Layers:** They are used to reduce the dimensions of the feature maps. This layer summarises the features present in a region of the feature map generated by a convolution layer.
3. **Fully connected layers:** They are placed before the classification output of a CNN and are used to flatten the results before classification.

What do CNN layers learn?

1. Each CNN layer learns filters of increasing complexity.
2. The first layers learn basic feature detection filters: edges, corners, etc
3. The middle layers learn filters that detect parts of objects. For faces, they might learn to respond to eyes, noses, etc
4. The last layers have higher representations: they learn to recognize full objects, in different shapes and positions.

Advantages

- ✓ Very High accuracy in image recognition problems.
- ✓ Automatically detects the important features without any human supervision.
- ✓ Weight sharing.

Disadvantages

- × CNN do not encode the position and orientation of object.
- × Lack of ability to be spatially invariant to the input data.
- × Lots of training data is required.

Applications of CNN

- ✓ Image and Video recognition
- ✓ Recommender systems
- ✓ Image classification
- ✓ Medical Image analysis
- ✓ Computer Vision
- ✓ Natural Language processing
- ✓ Financial time series
- ✓ Autonomous Cars

CNN	RNN
CNN stands for Convolutional Neural Network	RNN stands for Recurrent Neural Network
CNN considered to be more potent	RNN includes less feature compatibility
Ideal for images and video processing	Ideal for text and speech Analysis
Suitable for spatial data like images	RNN is used for temporal data
Takes fixed-size inputs and generates fixed size output	RNN can handle arbitrary input/ output lengths

4.5 Universal Approximation Theorem

- ✓ The Universal Approximation Theorem states that a neural network with 1 hidden layer can approximate any continuous function for inputs within a specific range.
- ✓ Mathematically speaking, any neural network architecture aims mathematical function y= f(x) that can map attributes(x) to output(y).
- ✓ The accuracy of this function i.e. mapping differs depending on the distribution of the dataset and the architecture of the network employed.
- ✓ The function f(x) can be arbitrarily complex. The Universal Approximation Theorem tells us that Neural Networks has a kind of universality i.e. no matter what f(x) is, there is a network that can approximately approach the result and do the job. This result holds for any number of inputs and outputs.
- ✓ In the mathematical theory of artificial neural networks, universal approximation theorems are results that establish the density of an algorithmically generated class of functions within a given function space of interest.
- ✓ Most universal approximation theorems can be parsed into two classes. The first quantifies the approximation capabilities of neural networks with an arbitrary number of artificial neurons ("arbitrary width" case) and the second focuses on the case with an arbitrary at finding any number of hidden layers, each containing a limited number of artificial neurons ("arbitrary depth" case).
- ✓ Universal approximation theorems imply that neural networks can represent a wide variety of interesting functions when given appropriate weights.
- ✓ On the other hand, they typically do not provide a construction for the weights, but merely state that such a construction is possible.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

4.6 Generative Adversarial Networks (GANs)

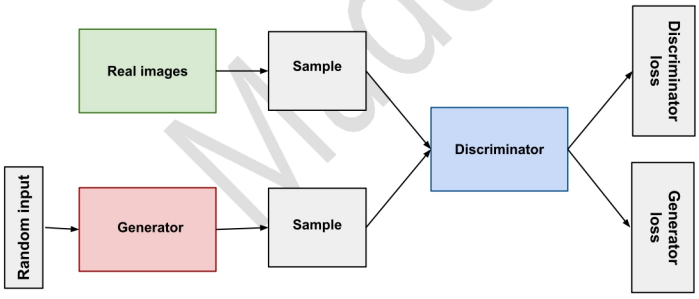
- Generative Adversarial Networks (GANs) were introduced in 2014 by Ian J. Goodfellow and co-authors.
- GANs perform unsupervised learning tasks in machine learning. It consists of 2 models that automatically discover and learn the patterns in input data.
- The two models are known as **Generator and Discriminator.**
- They compete with each other to scrutinize, capture, and replicate the variations within a dataset. GANs can be used to generate new examples that plausibly could have been drawn from the original dataset.

1. Generator

A Generator in GANs is a neural network that creates fake data to be trained on the discriminator. The main aim of the Generator is to make the discriminator classify its output as real.

2. Discriminator

- The Discriminator is a neural network that identifies real data from the fake data created by the Generator. The discriminator's training data comes from different two sources:
- The real data instances, such as real pictures of birds, humans, currency notes, etc., are used by the Discriminator as positive samples during training.
- The fake data instances created by the Generator are used as negative examples during the training process.



Steps for Training GAN

1. Define the problem
2. Choose the architecture of GAN
3. Train discriminator on real data
4. Generate fake inputs for the generator
5. Train discriminator on fake data
6. Train generator with the output of the discriminator

How does GANs work?

1. GANs consists of two neural networks. There is a Generator G(x) and a Discriminator D(x). Both of them play an adversarial game.
2. The generator's aim is to fool the discriminator by producing data that are similar to those in the training set.
3. The discriminator will try not to be fooled by identifying fake data from real data. Both of them work simultaneously to learn and train complex data like audio, video, or image files.
4. The Generator network takes a sample and generates a fake sample of data. The Generator is trained to increase the Discriminator network's probability of making mistakes.

Applications of GANs:

1. Photo to photo translation.
2. Deep Fake
3. Voice Cloning
4. Generate Cartoon Character
5. Face Aging
6. Super-resolution
7. 3D object generation
8. Clothing translation
9. Photograph editing
10. Image enhancement

Made By Kushagra

5.1 Image and Face Recognition

Image Recognition

- Image recognition refers to technology of AI that identify places, logos, people, objects, buildings, and several other variables in images.
- Image recognition is a part of computer vision and a process to identify and detect an object or attribute in a digital video or image.
- The best example of image recognition solutions is the face recognition – say, to unlock your smartphone you have to let it scan your face.

Modes and types of image recognition

We can break image recognition into two separate problems: single and multiclass recognition.

- In single class image recognition, models predict only one label per image.
- In cases where only two classes are involved (dog; no dog), we refer to these models as binary classifiers.
- Multiclass recognition models can assign several labels to an image.

Working of Image Recognition

1. We need a dataset containing images with their respective labels. For example, an image of a dog must be labelled as a dog or something that we can understand.
2. Next, these images are to be fed into a convolutional Neural Network and then trained on them. These networks consist of convolutional layers and pooling layers in addition to Multiperceptron layers (MLP).
3. We feed in the image that is not in the training set and get predictions.

Uses of Image Recognition

1. **Drones:** Drones equipped with image recognition capabilities can provide vision-based automatic monitoring, inspection, and control of the assets located in remote areas.
2. **Manufacturing:** Inspecting production lines, evaluating critical points on a regular basis within the premises. Monitoring the quality of the final products to reduce the defects.
3. **Forest Activities:** Drones can monitor the forest, predict changes that can result in forest fires, and prevent poaching.
4. **Autonomous vehicles:** Autonomous vehicles with image recognition can identify activities on the road and take necessary actions. Mini robots can help logistics industries to locate and transfer the objects from one place to another.
5. **Military Surveillance:** Detection of unusual activities in the border areas and automatic decision-making capabilities can help prevent infiltration and result in saving the lives of soldiers.
6. **Face Recognition:** Face recognition is a method of identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time.

Working of Face Recognition

The stepwise method is as follows:

1. **Face Detection:** To begin with, the camera will detect and recognize a face. The face can be best detected when the person is looking directly at the camera as it makes it easy for facial recognition.
2. **Face Analysis:** Then the photo of the face is captured and analysed. Most facial recognition relies on 2D images rather than 3D because it is more convenient to match to the database.
3. **Image to Data mathematical Conversion**: Now it is converted to a Formula and these facial features become numbers. This numerical code is known a face print. As every person has a unique fingerprint, in the same way, they have unique face print.
4. **Match Finding:** Then the code is compared against a database of other face prints. This database has photos with identification that be compared. The technology then identifies a match for your exact features in the provided can database

Face Recognition Softwares :

1. **Deep Vision AI:** Deep Vision AI is a front runner company excelling in facial recognition software. The company owns the proprietorship of advanced computer vision technology that can understand images and videos automatically. It then turns the visual content into real-time analytics and provides very valuable insights.
2. **SenseTime:** The technology offered by Sense Time is multifunctional. The aspects of this technology are expanding and include the Capabilities of Facial recognition, Image recognition, intelligent video analytics, autonomous driving, and medical image recognition.

Made By Kulbir Shah

3. **Amazon Rekognition:** This solution allows an easy method add image and video analysis to various applications. It uses a highly scalable and proven deep learning technology.
4. **FaceFirst:** FaceFirst is secure, accurate, private, fast, and scalable included for software. Plug-and-play solutions are also included for physical security, authentication of identity, access control, and visitor analytics.

Applications of Face Recognition:

1. **Genetic Disorder Identification:** There are healthcare apps such as Face2Gene and software like Deep Gestalt that uses facial recognition to detect a genetic disorder. This face is then analyzed and matched with the existing database of disorders.
2. **Airline Industry:** Some airlines use facial recognition to identify passengers. This face scanner would help saving time and to prevent the hassle of keeping track of a ticket.
3. **Hospital Security:** Facial recognition can be used in hospitals to keep a record of the patients that is far better than keeping records and finding their names, address.
4. **Detection of emotions and sentiments**: It can be used to detect emotions which patients exhibit during their stay in the hospital and analyze the data to determine how they are feeling.

Problems and Challenges

The face recognition technology is facing several challenges.

1. **Pose:** A Face Recognition System can tolerate cases with small rotation angles, but it becomes difficult to detect if the angle would be large.
2. **Expressions:** Because of the emotions, human mood varies and results in different expressions. With these facial expressions, the machine could make mistakes to find the correct person identity.
3. **Aging:** With time and age face changes it is unique and does not remain rigid due to which it may be difficult to identify a person who is now 60 years old.
4. **Identify similar faces:** Different persons may have a similar appearance that sometimes makes it impossible to distinguish.

Disadvantages of Face Recognition

1. Danger of automated blanket surveillance.
2. Lack of clear legal or regulatory framework.
3. Violation of the principles of necessity and proportionality.
4. Violation of the right to privacy.

5.2 Object Recognition

- Object recognition is the area of artificial intelligence (AI) concerned with the abilities of robots and other AI implementations to recognize various things and entities.
- Object recognition allows robots and AI programs to pick out and identify objects from inputs like video and still camera images.
- Object recognition is at the convergence points of robotics, machine vision, neural networks and AI. Google and Microsoft are among the companies working in the area - Google's driverless car and Microsoft's Kinect system both use object recognition.
- Object recognition consists of recognizing, identifying, and locating objects within a picture with a given degree of confidence.
- In this process, the four main tasks are:
    1. Classification & Tagging.
    2. Detection & Segmentation.

1. Classification and tagging

An important task in object recognition is to identify what is in the image and with what level of confidence. While classification recognizes only one class of objects, tagging can recognize multiple ones for a given image.

2. Detection and segmentation

Once identified what is in the image, we want to locate the objects. There are two ways to do so: detection and segmentation. Detection outputs a rectangle, also called bounding box, where the objects are. segmentation identifies the objects for each pixel in the image, resulting in a very precise map.

5.3 Speech Recognition

Speech recognition is the process that enables a computer to recognize and respond to spoken words and then converting them in a format that the machine understands.

Example: Voice Typing in GBaord and other transcription programs use speech recognition to convert your spoken words into text while digital assistants like Siri and Alexa respond in text format or voice.

Speech recognition focuses on the translation of speech from a verbal format to a text one whereas **voice recognition** just seeks to identify an individual's voice.

Made By Kushagra

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

Why do we need Speech Recognition?

- ✓ Most natural form of communication.
- ✓ Differently abled people can use it with ease.
- ✓ Helps people who can't read or write, Hence they can communicate with computers normally.
- ✓ Increase adaption of technology by making it easier to use.

Types of Speech Recognition

There are three types of speech recognition.

1. **Speaker Dependent:** software works by learning the unique characteristics of a single person's voice, in a way similar to voice recognition. New users must first "train" the software by speaking to it, so the computer can analyze how the person talks.
2. **Speaker Independent:** software is designed to recognize anyone's voice, so no training is involved. This means it is the only real option for applications such as interactive voice response systems. Hence it's mostly voice recognition along with speech recognition.
3. **Speaker Adaptive:** They usually begins as a speaker independent model and slowly adapts and adjusts to the individual using the systems. Virtual Assistants like, Google, Alexa, Siri etc. uses similar methods.

Applications of Speech Recognition:

1. **Voice to text:** Speech recognition enables hands free computing. Users don't need to type emails, reports, and other documents.
2. **Voice commands to smart home devices:** Smart home applications are mostly designed to take a certain action after the user gives voice commands.
3. **Security**: As technology integrates into our daily lives, security protocols are an increasing priority. Voice-based authentication adds a viable level of security.
4. **Voice Search:** This is the most common use of speech recognition. Users prefer to use voice searches Siri and Google voice search, over the traditional method of typing.
5. **Automotive**: In-car speech recognition systems, aim to remove the distraction of looking down at your mobile phone while you drive. Drivers can use simple voice commands to initiate phone calls, select radio stations or play music.

5.4 Computer Vision (CV)

Computer vision is the field of computer science that focuses on replicating parts of the complexity of the human vision system and enabling computers to identify and process objects in images and videos in the same way that humans do.

One of the driving factors behind the growth of computer vision is the amount of data we generate today that is then used to train and make computer vision better.

Hardware of Computer Vision System

1. Power supply
2. Image acquisition device such as camera
3. A processor
4. A software
5. A display device for monitoring the system
6. Accessories such as camera stands, cables, and connectors

Computer Vision tasks:

1. **Object Detection** is the ability to detect or identify objects in any given image correctly along with their spatial position in the given image, in the form of rectangular boxes (known as Bounding Boxes) which bound the object within it.
2. **Image Classification** basically means identifying what class the object belongs to. For example there are objects present belonging to various classes such as trees, huts, giraffe, etc. The machine or deep learning model would determine that the animal detected in the image belongs to class giraffe with the highest probability.
3. **Image Captioning** is looking at an image and describing what is happening in the image. The image contains annotations or labels which describe what is happening in the Image which should give you a good idea about what Image Captioning does.
4. **Image Reconstruction or Image Inpainting** is the ability to identify what is missing in an image in order to reconstruct it.
5. **Face recognition** is identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time.
6. **Semantic Segmentation** basically tries to identify similar objects in the object which belong to the same class at the pixel Level.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha

Applications of Computer Vision

1. **Self-Driving Cars:** Computer vision enables self-driving cars to make sense of their surroundings. Cameras capture video from different angles around the car and feed it to computer vision software to find the extremities of roads, read traffic signs, detect other cars, objects and pedestrians.
2. **CV In Facial Recognition:** Computer vision also plays an important role in facial recognition applications, the technology that enables computers to match images of people's faces to their identities. Computer vision algorithms detect facial features in images and compare them with databases of face profiles.
3. **CV In Augmented Reality & Mixed Reality** Computer vision also plays an important role in augmented and mixed reality, the technology that enables computing devices such as smartphones, tablets and smart glasses to overlay and embed virtual objects on real world imagery.
4. **CV In Healthcare** Computer vision has also been an important part of advances in health-tech. Computer vision algorithms can help automate tasks such as detecting cancerous moles in skin images or finding symptoms in x-ray and MRI scans.
5. More from the Applications of Object, Image and Face Recognition.

5.5 Robots & Robotics

Robots are artificial agents working in real world environment. Robots are aimed at manipulating the objects by perceiving, picking, moving, modifying the physical properties of object.

Components of a Robot

1. **Power Supply :** The robots are powered by batteries, solar power, hydraulic, or pneumatic power sources.
2. **Actuators :** They convert energy into movement.
3. **Electric motors (AC/DC):** They are required for rotational movement.
4. **Pneumatic Air Muscles :** They contract when air is sucked in them.
5. **Muscle Wires :** They contract by only 5% when electric current is passed through them.
6. **Piezo Motors and Ultrasonic Motors** : Best for industrial robots.
7. **Sensors :** They provide knowledge of real time information on the task environment. They are equipped with vision sensors to be to compute the depth in the environment.

Robot Locomotion

Locomotion is the mechanism that makes a robot capable of moving in its environment. There are various types of locomotions -

1. **Legged Locomotion:** This type of locomotion consumes more power while demonstrating walk, jump, trot, hop, climb up or down, etc
2. **Wheeled Locomotion:** It requires fewer number of motors to accomplish a movement. It is little easy to implement as there are less stability issues in case of more number of wheels. It is power efficient as compared to legged locomotion.
3. **Slip/Skid Locomotion:** In this type, the vehicles use tracks as in a tank. The robot is steered by moving the tracks with different speeds in the same or opposite direction. It offers stability because of large contact area of track and ground.

Robotics

Robotics is a domain in artificial intelligence that deals with the study of creating intelligent and efficient robots. Aspects of Robotics:

1. The robots have mechanical construction, form, or shape designed to accomplish a particular task.
2. They have electrical components which power and control the machinery.
3. They contain some level of computer program that determines what, when and how a robot does something.

Applications of Robotics

The robotics has been used in the various fields:

1. **Industries**: Robots are used for handling material, cutting, welding, drilling, polishing.
2. **Military:** Autonomous robots can reach inaccessible and hazardous zones during war.
3. **Medicine:** The robots are capable of carrying out hundreds of Clinical tests simultaneously, rehabilitating permanently disabled people, and performing complex Surgeries
4. **Entertainment:** Disney's engineers have created hundreds of robots for movie making.
5. **Space Exploration:** There are many things in space that are very dangerous for astronauts to do. Robots are a great choice because there are no chances for the loss of human life then.

Made By Kulbhushan

Downloaded from: www.KKWorld.in Made By: YouTube.com/KrazyKaksha