

BIM

Semester: I

FOUNDATION OF INFORMATION TECHNOLOGY

Introduction to Contemporary Technologies



REFERENCE NOTE

Unit-10: Introduction to Contemporary Technologies

Data Warehouse

Data Warehouse is a relational database management system (RDBMS) construct to meet the requirement of transaction processing systems. It can be loosely described as any centralized data repository which can be queried for business benefits. It is a database that stores information oriented to satisfy decision-making requests. It is a group of decision support technologies, targets to enabling the knowledge worker (executive, manager, and analyst) to make superior and higher decisions. So, Data Warehousing support architectures and tool for business executives to systematically organize, understand and use their information to make strategic decisions.

Data Warehouse environment contains an extraction, transportation, and loading (ETL) solution, an online analytical processing (OLAP) engine, customer analysis tools, and other applications that handle the process of gathering information and delivering it to business users.



- It is a database designed for investigative tasks, using data from various applications.
- It supports a relatively small number of clients with relatively long interactions.
- It includes current and historical data to provide a historical perspective of information.
- Its usage is read-intensive.
- It contains a few large tables.

"Data Warehouse is a subject-oriented, integrated, and time-variant store of information in support of management's decisions."

Goals of Data Warehousing

- To help reporting as well as analysis
- Maintain the organization's historical information
- Be the foundation for decision making.

Need for Data Warehouse



Data Mining

The process of extracting information to identify patterns, trends, and useful data that would allow the business to take the data-driven decision from huge sets of data is called Data Mining.

In other words, we can say that Data Mining is the process of investigating hidden patterns of information to various perspectives for categorization into useful data, which is collected and assembled in particular areas such as data warehouses, efficient analysis, data mining algorithm, helping decision making and other data requirement to eventually cost-cutting and generating revenue.

Data mining is the act of automatically searching for large stores of information to find trends and patterns that go beyond simple analysis procedures. Data mining utilizes complex mathematical algorithms for data segments and evaluates the probability of future events. Data Mining is also called Knowledge Discovery of Data (KDD).

Data Mining is a process used by organizations to extract specific data from huge databases to solve business problems. It primarily turns raw data into useful information.



Advantages

- The Data Mining technique enables organizations to obtain knowledge-based data.
- Data mining enables organizations to make lucrative modifications in operation and production.
- Compared with other statistical data applications, data mining is a cost-efficient.
- Data Mining helps the decision-making process of an organization.

- It facilitates the automated discovery of hidden patterns as well as the prediction of trends and behaviors.
- It can be induced in the new system as well as the existing platforms.
- It is a quick process that makes it easy for new users to analyze enormous amounts of data in a short time.

Disadvantages of Data Mining

- There is a probability that the organizations may sell useful data of customers to other organizations for money. As per the report, American Express has sold credit card purchases of their customers to other organizations.
- Many data mining analytics software is difficult to operate and needs advance training to work on.
- Different data mining instruments operate in distinct ways due to the different algorithms used in their design. Therefore, the selection of the right data mining tools is a very challenging task.
- The data mining techniques are not precise, so that it may lead to severe consequences in certain conditions.

Data Mining Applications



Artificial Intelligence (AI)

AI stands for Artificial Intelligence. It is a concept of giving human-like intelligence to the machines. Though the computers do their work faster and better than the human beings, the intelligence of them is zero because they just follow the set of instructions given by



the user. In case of wrong instruction, they do wrong processing. It is because they do not have intelligence of their own. So, the scientists are in research of giving them artificial intelligence, so that they can understand the natural languages of the human beings and interact. They can express their feelings and many more.

Components of AI

Different disciplines contributed their ideas, viewpoint, and techniques to plan the foundation of AI that acts as components of AI. Some of the major contributions of various disciplines are given below

1. **Philosophy:** It introduces the concept of logic and methods of reasoning and studying the mind as a physical system. It creates the foundation for learning language, and rationality. It also expresses knowledge-based action to be embedded into the machine to act with AI
2. **Mathematics:** It introduces the concepts of the formal representation of facts and proof, algorithms, computation, and reasoning with uncertain information.
3. **Economics:** It introduces the concepts of the formal theory of rational decision.
4. **Neuroscience:** It introduces the concepts of mental activity which can be introduced into the machine.
5. **Psychology:** It introduces the concepts of the brain as an information processing device and phenomenon of perception and sensory-motor control.
6. **Linguistics:** It introduces the concepts of knowledge representation and grammar and how does language relates to thought.
7. **Control Theory and cybernetics:** It introduces the concepts of designing the system that maximizes an objective function over time. This is roughly similar to the concepts of AI that behave optimally. It describes how artifacts (objects) can operate under their own control. That is, it introduces the concept of a self-controlling machine.
8. **Computer science and engineering:** This component introduces the concept of hardware, software, and operating system. Apart from this, it also discusses the programming language and tools used in AI.

Uses/Applications of AI

The potential applications of Artificial Intelligence are abundant (plentiful). They stretch from the military for autonomous control and target identification, to the entertainment industry for computer games and robotic pets. Let's also not forget big establishments dealing with huge amounts of information such as hospitals, banks, industries, and insurances, which can use AI to predict customer behavior and detect trends.

1. Game playing:

General game playing (GGP) and General video game playing (GVGP) is the concept and designs for artificial intelligence programs to successfully play plenty of games. For video games, game rules have to be either learned over multiple repetitions by artificial players or are predefined manually in a domain-specific language and sent in advance to artificial players. For instance, the GGP of chess, computers are programmed to play these games using a specially designed algorithm. It was considered a necessary landmark on the way to Artificial General Intelligence. The first commercial practice of general game-playing technology was Zillions of Games in 1998.

2. Speech recognition:

In speech recognition, the input is given to the computer in the form of vibrations produced by the sound. This is done with the help of an analog to digital converter that converts the vibrations produced by the sound into digital format.

Then, a set of complex algorithms runs on that data to recognize the speech and return a text as a result. Depending upon the goal, the end result may vary to some extent. For example, Google Voice typing converts spoken words into suitable text format while personal assistants like Siri and Google Assistant take the sound as input and convert it into both voice and text format, giving output as per the user's requirement.

3. Understanding natural language:

Natural language understanding is a branch of artificial intelligence that uses computer software to take the input in the form of sentences using text or speech. It simply reduces the gap between humans and computers allowing them to interact easily with each other.

4. Computer vision:

Computer vision is a field of artificial intelligence (AI), which enables the computer and its systems to get input in the form of digital images and videos and take action based on the provided input.

5. Expert systems:

An expert system is a computer system that mimics or even surpasses the decision-making ability of a human expert. It is generally designed to solve complex problems by surfing through bodies of knowledge. It is further divided into two subsystems; the knowledge base (which represents facts and rules) and inference engine (which applies the rules to the known facts to deduce new facts).

6. Robotics:

Artificial intelligence (AI) in robotics is the ability of the computer or the robot to perform multiple tasks performed by humans, which require human intelligence and discernment. It gives robots a computer vision to navigate, sense, and calculate their reaction accordingly For example: Robotic packaging uses various forms of AI for quicker and

accurate packaging at a lower price. Likewise, Sophia which is also marked as a "social robot" is successfully able to mimic social behavior and induce feelings of love in humans.

7. Theorem proving:

Proving theorems requires high intelligence as many of the practical problems can be cast in terms of theorems. If knowledge is expressed by logic, proving theorem is reasoning. It uses various AI techniques such as heuristic search.

8. Symbolic mathematics:

Symbolic mathematics refers to the manipulation of formulas, rather than doing arithmetic on numeric values. It is often used in conjunction with ordinary scientific computation as a generator of programs, used to actually do the calculations.

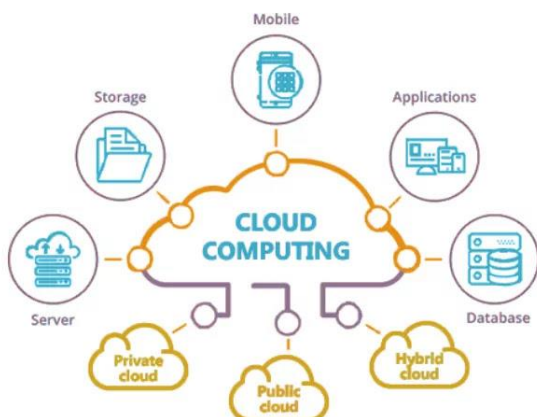
Robotics

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots. It is a discipline overlapping artificial intelligence and mechanical engineering. It is concerned with building robot programmable devices consisting of mechanical actuators and sensory organs that are linked to a computer. The mechanical structure might involve manipulators, as in industrial robotics, might concern the movement of the robot as a vehicle, as in mobile - robotics. Robotics research is used in artificial intelligence as a framework for exploring key problems and techniques through a well-defined application.

1. Robotics is the branch of technology that deals with the design, construction, operation, and application of robots.
2. It is a discipline overlapping artificial intelligence and mechanical engineering.
3. It is concerned with building robots programmable devices consisting of mechanical actuators and sensory organs that are linked to a computer.
4. Robots are being used in applications like: Industry, scientific research, Military applications, intelligent home applications, Health Services.

Cloud Computing

Cloud computing is the use of various services, such as software development platforms, servers, storage, and software, over the Internet, often referred to as the "cloud". It is defined as a type of computing that relies on sharing computing resources rather than having handle applications.



In cloud computing, the word cloud is used to represent "the Internet," so the phrase cloud computing means "a type of Internet-based computing," where different services - such as servers, storage, and applications are delivered to an organization's computers and devices through the Internet. Cloud computing allows application software to be operated using internet-enabled devices.

Types of Clouds

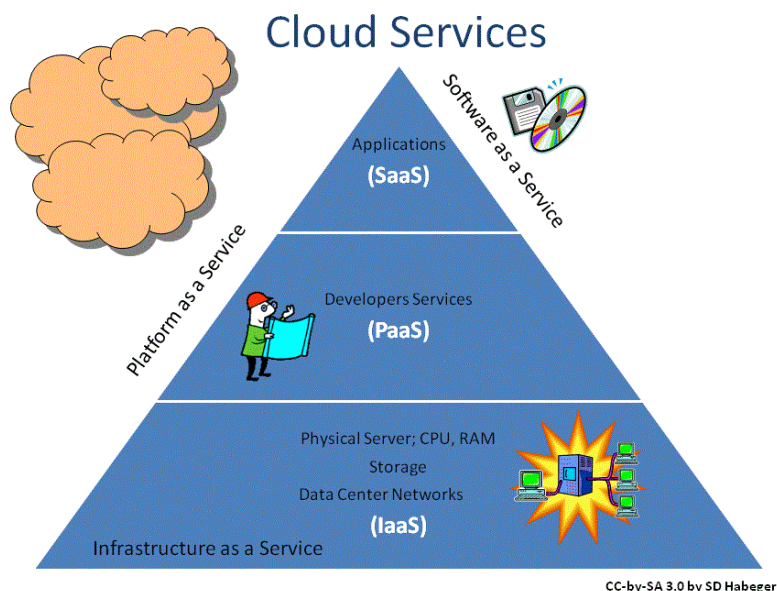
Clouds can be classified as **public, private, and hybrid**. **Public cloud** is made available to the general public or a large industry group. **Private cloud** computing environment resides within the boundaries of an organization and is used exclusively for the organizational benefits. **Hybrid cloud** is the combination of both public and private cloud. Sensitive With this cloud organizations might run non-core applications in a public cloud, while maintaining core applications and data in a private cloud.

Service Models of Cloud Computing

1. IaaS (Infrastructure as a Service): In this service, computing infrastructural components like server hardware, storage, bandwidth, and other fundamental computing resources are provided through the cloud.

2 SaaS (Software as a Service): This service includes complete software on the can access software hosted on the cloud without installing it on the user's own computer.

3. PaaS (Platform as a Service): It allows the user to rent virtualized servers and associated services used to run existing applications, or to design, develop, test, deploy and host applications. It provides clients with access to the basic operating software and optional services to develop and use software applications without the need to buy and manage the underlying computing infrastructure.



Advantages of Cloud Computing

Some of the advantages of this technology are:

- 1. Cost-efficient:** It is probably the most efficient method to use, maintain and upgrade.
- 2. Almost unlimited storage:** Storing information in the cloud gives us almost unlimited storage capacity.
- 3. Backup and recovery:** Since, all the data is stored in the cloud, backing it up and restoring the same is relatively much easier than storing the same on a physical device.

- 4. Automatic software integration:** In the cloud, software integration is usually something that occurs automatically. It also allows us to customize the options with great ease.
- 5. Easy access to information:** Once the user is registered in the cloud, the user can access the information from anywhere, where there is an Internet connection.
- 6. Quick deployment:** Once the method of functioning is selected, the entire system can be fully functional in a matter of few minutes.

Disadvantages of Cloud Computing

Despite its many benefits, as mentioned above, cloud computing also has its disadvantages.

- 1. Technical issues:** This technology is always prone to outages and other technical issues. Even the best cloud service providers run into this kind of trouble. Despite keeping up high standards of maintenance.
- 2. Security in the cloud:** Storing all the sensitive information to a third-party cloud service provider could potentially put the company at great risk.
- 3. Prone to Attack:** Storing information in the cloud could make the company vulnerable to external threats and attacks.

Big Data

Big Data refers to complex and large data sets that have to be processed and analyzed to uncover valuable information that can benefit businesses and organizations.

It has features like:

1. It refers to a massive amount of data that keeps on growing exponentially with time.
2. It is so voluminous that it cannot be processed or analyzed using conventional data processing techniques.
3. It includes data mining, data storage, data analysis, data sharing, and data visualization.
4. The term is an all-comprehensive one including data, data frameworks, along the tools and techniques used to process and analyze the data.

According to **Gartner**, the definition of Big Data- "Big data is high-volume, velocity, and information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making."

Types of Big Data

Big data can be classified as Structured, unstructured, and semi-structured.

- 1. Structured:** It means that data can be processed, stored, and retrieved in a fixed format. It refers to highly organized information that can be readily and seamlessly stored and accessed from a database by simple search engine algorithms.
- 2. Unstructured:** It refers to the data that lacks any specific form or structure whatsoever. This makes it very difficult and time-consuming to process and analyze unstructured data.
- 3. Semi-structured:** It relates to the data containing both the formats mentioned above, that is structured and unstructured data. To be precise, it refers to the data that although

has not been classified under a particular repository (database), yet contains vital information or tags that segregate individual elements within the data.

Characteristics of Big Data

The main characteristics of big data are:

- 1. Variety:** It refers to the variety of data gathered from multiple sources. The variety can be structured, unstructured, or semi-structured.
- 2. Velocity:** It refers to the speed at which data is being created in real-time. It also comprises the rate of change, linking of incoming data sets at varying speeds, and activity bursts.
- 3. Volume:** Big Data indicates huge 'volumes of data that are being generated daily from various sources like social media platforms, business processes, machines, networks, human interactions, etc.
- 4. Veracity:** It refers to the reliability or trustworthiness of the data. Due to the large volume of data, we have uncertainty about the validity, the accurateness of data.
- 5. Value:** It refers to the worth of business value of the collected data.
- 6. Variability:** It refers to the inconsistency of the big data and how the big data can be used and formatted.

Application Areas of Big Data

1. Healthcare or Medical sector.
2. Academia.
3. Banking.
4. Manufacturing.
5. Information Technology (IT).
6. Retail business.
7. Transportation.

Advantages of Big Data Processing

Some of the advantages of big data processing are:

1. Businesses can utilize outside intelligence while taking decisions.
2. Improved customer service.
3. Early identification of risk to the product/services,
4. Better operational efficiency.
5. Big data analysis derives innovative solutions. It helps in understanding and targeting customers. It helps in optimizing business processes.

Disadvantages of Big Data Processing

Despite its many benefits, big data processing has the following disadvantages.

1. Traditional storage can cost a lot of money to store big data.
2. Big data analysis is not useful in the short run. It needs to be analyzed for a longer duration to leverage its benefits.
3. Big data analysis results are sometimes misleading.



Virtual Reality

Virtual reality (VR) is a term that expresses computer-based simulated environments. Which can perceive as in the real world, as well as in unreal worlds.

The virtual reality environments are primarily concerned with the visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones.

Virtual reality creates such a realistic artificial environment that the s/he should feel as in the real world. Today the Virtual reality (VR) technology is applied to advance fields of medicine, engineering, education, design, training, and entertainment.

Some of the application areas of virtual reality are:

1. It can be used in medical studies to enable students to know the human body.
2. It can be used in scientific research laboratories so that scientists can easily research a structure.
3. It can be used in entertainment like games and movies to make the gaming experience more real and to allow individuals to experience adventures under extreme conditions.
4. It can be used in driving schools as it gives a real look at roads and traffic.
5. It can be used in military training for the soldiers to get familiar with different areas on the battlefield.

Advantages of Virtual Reality

Some of the advantages of virtual reality are:

1. Virtual reality creates a realistic world.
2. It enables users to explore places.
3. Through Virtual Reality, users can experiment with an artificial environment.
4. Virtual Reality makes education easier and more comfortable.

Disadvantages of Virtual Reality

Some of the disadvantages of virtual reality are:

1. The equipment's used in virtual reality are very expensive.
2. It consists of complex technology.
3. In virtual reality environment we can't move by our own like in the real world.

Internet of Things (IoT)

Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity, which enables these things to connect, collect and exchange data.



The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human to-computer interaction.

By combining these connected devices with automated systems, it is possible to "gather information, analyse it and create an action" to help someone with a particular task or learn from a process. A thing in the internet of things can be a person with a heart monitor implant, an animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low, or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and can transfer data over a network.

Advantages of IoT

- It automates tasks and helps to improve the quality of a business's services and reduces.
- It helps to operate the business operations more efficiently, better understand customers to deliver enhanced customer service.
- It supports to improve decision-making and increases the value of the business.
- It has the ability to access information from anywhere at any time on any device.
- It provides improved communication between connected electronic devices.
- Transferring data packets over a connected network saves time, effort, and money.

Disadvantages of IoT

- As the number of connected devices increases and more information is shared between devices, the chances of the system being attacked also increases.
- Organizations may eventually have to deal with massive numbers (maybe even millions) of IoT devices, and collecting and managing the data from all those devices will be challenging.
- If there's a bug in the system, every connected device will likely become corrupted.

- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

Application of IOT

1. Smart Health
2. Smart Education
3. Smart Transport
4. Smart City
5. Smart Farming
6. Smart Security
7. Smart Payment
8. Smart Manufacturing
9. Smart Home
10. Smart Application
11. Smart Car

Challenges to implement IOT

1. Connectivity
2. Power
3. Security and safety
4. Reliability and stability
5. Data storage
6. Complexity

Social Media

Social Media is a computer-based technology that is used for the creation and sharing of information, ideas, interests, and other forms of expression via virtual communities and networks. Facebook, Twitter, YouTube are popular social media tools.



Advantages of Social Media

- It provides easier and faster way to communicate.
- It provides worldwide real-time sharing of news and educational content.
- It is one of the effective marketing/advertising tools at present.
- It is the major source of entertainment at present.
- It helps to understand better the latest trends and events.

Disadvantages of Social Media

- It has increased cyber-crime.
- Productive times is lost due to time waster in social media.
- It is a common tool at present for spreading rumors and fake news/updates.
- It has a high risk of fraud.
- It has decreased privacy.