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Introduction to Emerging Technologies

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Chapter 1: Introduction to Emerging Technologies

Introduction

In this chapter evolution of technology, the role of data for emerging technology, enabling devices and networks for technologies (programmable devices), Human to Machine Interaction (HCI) and future trends of technologies are discussed.

After completing this chapter, the students will be able to:

- Develop knowledge about the era of industrial evolutions
- Identify the technological advances that made the industrial revolution possible
- Analyze the changing conditions created by the industrial revolution in both Europe and the united states
- Understand the causes of the Industrial Revolution in Great Britain, continental Europe, and the United States.
- Describe the technological innovations that spurred industrialization
- Identifies and understand the programmable device
- Understand concepts relating to the design of human-computer interfaces in ways making computer-based systems comprehensive, friendly and usable.
- Develop general knowledge about emerging technologies

1.1 Evolution of Technologies

Activity 1.1

Define emerging technologies?

- *Define Technology and Evolution in the context of your prior knowledge and compare it with the discussion given below?*

Emerging technology is a term generally used to describe a new technology, but it may also refer to the continuing development of existing technology; it can have slightly different meanings when used in different areas, such as media, business, science, or education. The term commonly refers to technologies that are currently developing, or that are expected to be available within the next five to ten years, and is usually reserved for technologies that are creating or are expected to create significant social or economic effects. Technological evolution is a theory of radical transformation of society through technological development.

What is the root word of technology and evolution?

- **Technology**: 1610s, "discourse or treatise on an art or the arts," from Greek tekhnologia "systematic treatment of an art, craft, or technique," originally referring to grammar, from tekhno- (see techno-) + -logy. The meaning "science of the mechanical and industrial arts" is first recorded in 1859.
- **Evolution**: evolution means the process of developing by gradual changes. This noun is from Latin evolutio, "an unrolling or opening," combined from the **prefix** e-, "out," plus volvere, "to roll."

Activity 1.2

- *List out at list top five currently available emerged technologies?*

List of some currently available emerged technologies

- Artificial Intelligence

- Blockchain
- Augmented Reality and Virtual Reality
- Cloud Computing
- Angular and React
- DevOps
- Internet of Things (IoT)
- Intelligent Apps (I-Apps)
- Big Data
- Robotic Processor Automation (RPA)

1.1.1 Introduction to the Industrial Revolution (IR)

The Industrial Revolution was a period of major industrialization and innovation that took place during the late 1700s and early 1800s. An Industrial Revolution at its core occurs when a society shifts from using tools to make products to use new sources of energy, such as coal, to power machines in factories. The revolution started in England, with a series of innovations to make labor more efficient and productive. The Industrial Revolution was a time when the manufacturing of goods moved from small shops and homes to large factories. This shift brought about changes in culture as people moved from rural areas to big cities in order to work.

The American Industrial Revolution commonly referred to as the Second Industrial Revolution, started sometime between 1820 and 1870. The impact of changing the way items was manufactured had a wide reach. Industries such as textile manufacturing, mining, glass making, and agriculture all had undergone changes. For example, prior to the Industrial Revolution, textiles were primarily made of wool and were handspun. From the first industrial revolution (mechanization through water and steam power) to the mass production and assembly lines using electricity in the second, the fourth industrial revolution will take what was started in the third with the adoption of computers and automation and enhance it with smart and autonomous systems fueled by data and machine learning.

Generally, the following industrial revolutions fundamentally changed and transfer the world around us into modern society.

- The steam engine,
- The age of science and mass production, and
- The rise of digital technology
- Smart and autonomous systems fueled by data and machine learning.

Activity 1.3

- *What are the most important inventions of industrial revolutions?*

1.1.2 The Most Important Inventions of the Industrial Revolution

- Transportation: The Steam Engine, The Railroad, The Diesel Engine, The Airplane.
- Communication.: The Telegraph. The Transatlantic Cable. The Phonograph. The Telephone.
- Industry: The Cotton Gin. The Sewing Machine. Electric Lights.

1.1.3 Historical Background (IR 1.0, IR 2.0, IR 3.0)

The industrial revolution began in Great Britain in the late 1770s before spreading to the rest of Europe. The first European countries to be industrialized after England were Belgium, France, and the German states. The final cause of the Industrial Revolution was the effects created by the Agricultural Revolution. As previously stated, the Industrial Revolution began in Britain in the 18th century due in part to an increase in food production, which was the key outcome of the Agricultural Revolution.

The four types of industries are:

- **The primary industry** involves getting raw materials e.g. mining, farming, and fishing.
- **The secondary industry** involves manufacturing e.g. making cars and steel.
- **Tertiary industries** provide a service e.g. teaching and nursing.

- **The quaternary industry** involves research and development industries e.g. IT.

Activity 1.4

- *Describe the social, economic, and environmental impact of the Industrial Revolution and make connections between the impact of the Industrial Revolution and the ideological and political responses?*
- *Discussed the relationship between the industrialized and no industrialized parts of the world by demonstrating the cases of China, Egypt, and India?*
- *To write about the **First**, **Second**, **Third** and **Fourth** Industrial Revolution. After you are completed writing then read the discussion below and then compares your notes with it. To write your note, use the space provided below?*

1.1.3.1 Industrial Revolution (IR 1.0)

The Industrial Revolution (IR) is described as a transition to new manufacturing processes. IR was first coined in the 1760s, during the time where this revolution began. The transitions in the first IR included going from hand production methods to machines, the increasing use of steam power (see Figure 1.1), the development of machine tools and the rise of the factory system.

Figure 1.1 steam engine

1.1.3.2 Industrial Revolution (IR 2.0)

The Second IR, also known as the Technological Revolution, began somewhere in the 1870s. The advancements in IR 2.0 included the development of methods for manufacturing interchangeable parts and widespread adoption of pre-existing technological systems such as telegraph and railroad networks. This adoption allowed the vast movement of people and ideas, enhancing communication. Moreover, new technological systems were introduced, such as electrical power (see Figure 1.2) and telephones.

Figure 1.2 Electricity transmission line

1.1.3.3 Industrial Revolution (IR 3.0)

Then came the Third Industrial Revolution (IR 3.0). IR 3.0 introduced the transition from mechanical and analog electronic technology to digital electronics (see Figure 1.3) which began from the late 1950s. Due to the shift towards digitalization, IR 3.0 was given the nickname, “Digital

Revolution". The core factor of this revolution is the mass production and widespread use of digital logic circuits and its derived technologies such as the computer, handphones and the Internet. These technological innovations have arguably transformed traditional production and business techniques enabling people to communicate with another without the need of being physically present. Certain practices that were enabled during IR 3.0 is still being practiced until this current day, for example – the proliferation of digital computers and digital record.

Figure 1.3 High Tech Electronics

Activity 1.4
○ *What do you think that IR 4.0 differs from the previous IR (i.e. 1-3)?*

1.1.3.4 Fourth Industrial Revolution (IR 4.0)

Now, with advancements in various technologies such as robotics, Internet of Things (IoT see Figure 1.4), additive manufacturing and autonomous vehicles, the term "Fourth Industrial Revolution" or IR 4.0 was coined by Klaus Schwab, the founder and executive chairman of World Economic Forum, in the year 2016. The technologies mentioned above are what you call – cyberphysical systems. A cyber-physical system is a mechanism that is controlled or monitored by computer-based algorithms, tightly integrated with the Internet and its users.

One example that is being widely practiced in industries today is the usage of Computer Numerical Control (CNC) machines. These machines are operated by giving it instructions using a computer. Another major breakthrough that is associated with IR 4.0 is the adoption of Artificial Intelligence (AI), where we can see it being implemented into our smartphones. AI is also one of the main elements that give life to Autonomous Vehicles and Automated Robots.

Figure 1. 4 Anybody Connected device (ABCD)

Activity 1.5
○ *Discus about Agricultural Revolutions, Information Revolutions and level of the industrial revolution in Ethiopia and also compare with UK, USA, and China?*

1.2 Role of Data for Emerging Technologies

Data is regarded as the new oil and strategic asset since we are living in the age of big data, and drives or even determines the future of science, technology, the economy, and possibly everything in our world today and tomorrow. Data have not only triggered tremendous hype and buzz but more importantly, presents enormous challenges that in turn bring incredible innovation and economic opportunities. This reshaping and paradigm-shifting are driven not just by data itself but all other aspects that could be created, transformed, and/or adjusted by understanding, exploring, and utilizing data.

The preceding trend and its potential have triggered new debate about data-intensive scientific discovery as an emerging technology, the so-called “fourth industrial revolution,” There is no doubt, nevertheless, that the potential of data science and analytics to enable data-driven theory, economy, and professional development is increasingly being recognized. This involves not only core disciplines such as computing, informatics, and statistics, but also the broad-based fields of business, social science, and health/medical science.

Activity 1.6

- *Did barfly discuss Data, Information and Big Data?*
- *List out some programmable devices and explain their property?*

1.3 Enabling devices and network (Programmable devices)

In the world of digital electronic systems, there are four basic kinds of devices: memory, microprocessors, logic, and networks. Memory devices store random information such as the contents of a spreadsheet or database. Microprocessors execute software instructions to perform a wide variety of tasks such as running a word processing program or video game. Logic devices provide specific functions, including device-to-device interfacing, data communication, signal processing, data display, timing and control operations, and almost every other function a system must perform. The network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices connected to one another to allow the sharing of data. An excellent example of a network is the Internet, which connects millions of people all over the world Programmable devices (see Figure 1.5) usually refer to chips that incorporate field programmable logic devices (FPGAs), complex programmable logic devices (CPLD) and programmable logic devices (PLD). There are also devices that are the analog equivalent of these called field programmable analog arrays.

Figure 1.5 programmable device Why is a computer referred to as a programmable device?

Because what makes a computer a computer is that it follows a set of instructions. Many electronic devices are computers that perform only one operation, but they are still following instructions that reside permanently in the unit.

1.3.1 List of some Programmable devices

- Achronix Speedster SPD60
- Actel**'s**
- Altera Stratix IV GT and Arria II GX
- Atmel's AT91CAP7L
- Cypress Semiconductor's programmable system-on-chip (PSoC) family
- Lattice Semiconductor's ECP3
- Lime Microsystems' LMS6002
- Silicon Blue Technologies
- Xilinx Virtex 6 and Spartan 6
- Xmos Semiconductor L series

Activity 1.7

- *Under subtopic of enabling devices and network, we have seen some list of programmable devices now barfly discussed futures of some programmable devices?*

A full range of network-related equipment referred to as Service Enabling Devices (SEDs), which can include:

- Traditional channel service unit (CSU) and data service unit (DSU)

- Modems
- Routers
- Switches
- Conferencing equipment
- Network appliances (NIDs and SIDs)
- Hosting equipment and servers

1.4 Human to Machine Interaction

Human-machine interaction (HMI) refers to the communication and interaction between a human and a machine via a user interface. Nowadays, natural user interfaces such as gestures have gained increasing attention as they allow humans to control machines through natural and intuitive behaviors

What is interaction in human-computer interaction?

HCI (human-computer interaction) is the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings. As its name implies, HCI consists of three parts: the user, the computer itself, and the ways they work together.

How do users interact with computers?

The user interacts directly with hardware for the human input and output such as displays, e.g. through a graphical user interface. The user interacts with the computer over this software interface using the given input and output (I/O) hardware.

How important is human-computer interaction?

The goal of HCI is to improve the interaction between users and computers by making computers more user-friendly and receptive to the user's needs. The main advantages of HCI are simplicity, ease of deployment & operations and cost savings for smaller set-ups. They also reduce solution design time and integration complexity.

1.4.1 Disciplines Contributing to Human-Computer Interaction (HCI)

- Cognitive psychology: Limitations, information processing, performance prediction, cooperative working, and capabilities.

- Computer science: Including graphics, technology, prototyping tools, user interface management systems.
- Linguistics.
- Engineering and design.
- Artificial intelligence.
- Human factors.

1.5 Future Trends in Emerging Technologies

1.5.1 Emerging technology trends in 2019

- 5G Networks
- Artificial Intelligence (AI)
- Autonomous Devices
- Blockchain
- Augmented Analytics
- Digital Twins
- Enhanced Edge Computing and
- Immersive Experiences in Smart Spaces

Activity 1.8
○ *Which emerging technologies will have more effect on our day to day life & How?*

1.5.2 Some emerging technologies that will shape the future of you and your business

The future is now or so they say. So-called emerging technologies are taking over our minds more and more each day. These are very high-level emerging technologies though. They sound like tools that will only affect the top tier of technology companies who employ the world's top 1% of geniuses. This is totally wrong. Chatbots, virtual/augmented reality, blockchain, Ephemeral Apps and Artificial Intelligence are already shaping your life whether you like it or not. At the end of the day, you can either adapt or die.

Activity 1.9

- *Barfly discussed these emerging technologies how it could be shaping the future of you and your business*
  - *Chatbots*
  - *Virtual, Augmented & Mixed Reality*
  - *Blockchain. The blockchain frenzy is real*
  - *Ephemeral Apps and*
  - *Artificial Intelligence.*

Activity 1.10

- *Divide your class into small groups of 3-5 students. Using an informal debate format, assign each group an innovation or invention from the Industrial Revolution to discuss the importance of, stating why it was the most important advancement of the time. Each student will speak for 1-2 minutes on the following subjects:*

  - *Describing what their innovation or invention was.*
  - *Why their assigned innovation or invention was the most important?*
  - *The impact on society of their innovation. (note, this may not be completely apparent at first but will require some critical thinking. These can be both positive and negative)*

- *The student's job is to convince the class that their invention was the most important invention of the industrial revolution. You can even vote after the presentations to see which group the class believes had the most important invention.*

  Possible innovations and inventions are:

  - *Steam Engine*
  - *Railroad*
  - *Interchangeable Parts*
  - *Steamboat*
  - *Spinning Jenny*
  - *High-quality iron*

Chapter One Review Questions

1. Where did the Industrial Revolution start and why did it begin there?
2. What does “emerging” mean, emerging technologies and how are they found?
3. What makes “emerging technologies” happen and what impact will they have on Individuals, Society, and Environment?
4. Discussed the economic and ideological causes of the American, the French, and the Chinese Revolutions, and to see the larger historical contexts in which these events took place?
5. Discuss and compare the course of the American, the French, and the Chinese revolutions and analyze the reasons for and significance of the different outcomes of these three revolutions?
6. Discuss the successes and the shortcomings of the conservative reaction to the French Revolution as seen in the actions of the Congress of Vienna and the Holy Alliance?
7. How do recent approaches to “embodied interaction” differ from earlier accounts of the role of cognition in human-computer interaction?
8. What is the reason for taking care of design a good computer-human interface?
9. Discuss the pros and cons of human-computer interaction technology?

Chapter 2: Data Science

Introduction

In the previous chapter, the concept of the role of data for emerging technologies was discussed. In this chapter, you are going to learn more about data science, data vs. information, data types and representation, data value chain, and basic concepts of big data.

After completing this chapter, the students will be able to:

- Describe what data science is and the role of data scientists.
- Differentiate data and information.
- Describe data processing life cycle
- Understand different data types from diverse perspectives
- Describe data value chain in emerging era of big data.
- Understand the basics of Big Data.
- Describe the purpose of the Hadoop ecosystem components.

2.1. An Overview of Data Science

Activity 2.1

- What is data science? Can you describe the role of data in emerging technology?
- What are data and information?
- What is big data?

Data science is a multi-disciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured, semi-structured and unstructured data. Data science is much more than simply analyzing data. It offers a range of roles and requires a range of skills.

Let's consider this idea by thinking about some of the data involved in buying a box of cereal from the store or supermarket:

- Whatever your cereal preferences—teff, wheat, or burly—you prepare for the purchase by writing "cereal" in your notebook. This planned purchase is a piece of data though it is written by pencil that you can read.
- When you get to the store, you use your data as a reminder to grab the item and put it in your cart. At the checkout line, the cashier scans the barcode on your container, and the cash register logs the price. Back in the warehouse, a computer tells the stock manager that it is time to request another order from the distributor because your purchase was one of the last boxes in the store.
- You also have a coupon for your big box, and the cashier scans that, giving you a predetermined discount. At the end of the week, a report of all the scanned manufacturer coupons gets uploaded to the cereal company so they can issue a reimbursement to the grocery store for all of the coupon discounts they have handed out to customers. Finally, at the end of the month, a store manager looks at a colorful collection of pie charts showing all the different kinds of cereal that were sold and, on the basis of strong sales of cereals, decides to offer more varieties of these on the store's limited shelf space next month.
- So, the small piece of information that began as a scribble on your notebook ended up in many different places, most notably on the desk of a manager as an aid to decision making. On the trip from your pencil to the manager's desk, the data went through many transformations. In addition to the computers where the data might have stopped by or stayed on for the long term, lots of other pieces of hardware—such as the barcode scanner—were involved in collecting, manipulating, transmitting, and storing the data. In addition, many different pieces of software were used to organize, aggregate, visualize, and present the data. Finally, many different human systems were involved in working with the data. People decided which systems to buy and install, who should get access to what kinds of data, and what would happen to the data after its immediate purpose was fulfilled.

As an academic discipline and profession, data science continues to evolve as one of the most promising and in-demand career paths for skilled professionals. Today, successful data professionals understand that they must advance past the traditional skills of analyzing large amounts of data, data mining, and programming skills. In order to uncover useful intelligence for their organizations, data scientists must master the full spectrum of the data science life cycle and possess a level of flexibility and understanding to maximize returns at each phase of the process. Data scientists need to be curious and result-oriented, with exceptional industry-specific knowledge and communication skills that allow them to explain highly technical results to their non-technical counterparts. They possess a strong quantitative background in statistics and linear algebra as well as programming knowledge with focuses on data warehousing, mining, and modeling to build and analyze algorithms. In this chapter, we will talk about basic definitions of data and information, data types and representation, data value change and basic concepts of big data.

Activity 2.2

- *Describe in some detail the main disciplines that contribute to data science.*
- *Let the teacher explain the role of data scientists and students may write a small report on the same.*

2.1.1. What are data and information?

Data can be defined as a representation of facts, concepts, or instructions in a formalized manner, which should be suitable for communication, interpretation, or processing, by human or electronic machines. It can be described as unprocessed facts and figures. It is represented with the help of characters such as alphabets (A-Z, a-z), digits (0-9) or special characters (+, -, /, *, <,>, =, etc.). Whereas ***information*** is the processed data on which decisions and actions are based. It is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in the current or the prospective action or decision of recipient. Furtherer more, information is interpreted data; created from organized, structured, and processed data in a particular context.

2.1.2. Data Processing Cycle

Data processing is the re-structuring or re-ordering of data by people or machines to increase their usefulness and add values for a particular purpose. Data processing consists of the following basic steps - input, processing, and output. These three steps constitute the data processing cycle.

Figure 2.1 Data Processing Cycle

- **Input** – in this step, the input data is prepared in some convenient form for processing. The form will depend on the processing machine. For example, when electronic computers are used, the input data can be recorded on any one of the several types of storage medium, such as hard disk, CD, flash disk and so on.

- **Processing** – in this step, the input data is changed to produce data in a more useful form. For example, interest can be calculated on deposit to a bank, or a summary of sales for the month can be calculated from the sales orders.

- **Output** – at this stage, the result of the proceeding processing step is collected. The particular form of the output data depends on the use of the data. For example, output data may be payroll for employees.

Activity 2.3

- *Discuss the main differences between data and information with examples.*
- *Can we process data manually using a pencil and paper? Discuss the differences with data processing using the computer.*

2.3 Data types and their representation

Data types can be described from diverse perspectives. In computer science and computer programming, for instance, a data type is simply an attribute of data that tells the compiler or interpreter how the programmer intends to use the data.

2.3.1. Data types from Computer programming perspective

Almost all programming languages explicitly include the notion of data type, though different languages may use different terminology. Common data types include:

- Integers(int)- is used to store whole numbers, mathematically known as integers
- Booleans(bool)- is used to represent restricted to one of two values: true or false
- Characters(char)- is used to store a single character
- Floating-point numbers(float)- is used to store real numbers
- Alphanumeric strings(string)- used to store a combination of characters and numbers

A data type makes the values that expression, such as a variable or a function, might take. This data type defines the operations that can be done on the data, the meaning of the data, and the way values of that type can be stored.

2.3.2. Data types from Data Analytics perspective

From a data analytics point of view, it is important to understand that there are three common types of data types or structures: Structured, Semi-structured, and Unstructured data types. Fig. 2.2 below describes the three types of data and metadata.

Figure 2.2 Data types from a data analytics perspective

Structured Data

Structured data is data that adheres to a pre-defined data model and is therefore straightforward to analyze. Structured data conforms to a tabular format with a relationship between the different rows and columns. Common examples of structured data are Excel files or SQL databases. Each of these has structured rows and columns that can be sorted.

Semi-structured Data

Semi-structured data is a form of structured data that does not conform with the formal structure of data models associated with relational databases or other forms of data tables, but nonetheless, contains tags or other markers to separate semantic elements and enforce hierarchies of records and fields within the data. Therefore, it is also known as a self-describing structure. Examples of semi-structured data include JSON and XML are forms of semi-structured data.

Unstructured Data

Unstructured data is information that either does not have a predefined data model or is not organized in a pre-defined manner. Unstructured information is typically text-heavy but may contain data such as dates, numbers, and facts as well. This results in irregularities and ambiguities that make it difficult to understand using traditional programs as compared to data stored in structured databases. Common examples of unstructured data include audio, video files or NoSQL databases.

Metadata – Data about Data

The last category of data type is metadata. From a technical point of view, this is not a separate data structure, but it is one of the most important elements for Big Data analysis and big data solutions. Metadata is data about data. It provides additional information about a specific set of data.

In a set of photographs, for example, metadata could describe when and where the photos were taken. The metadata then provides fields for dates and locations which, by themselves, can be considered structured data. Because of this reason, metadata is frequently used by Big Data solutions for initial analysis.

Activity 2.4

- *Discuss data types from programing and analytics perspectives.*
- *Compare metadata with structured, unstructured and semi-structured data*
- *Given at least one example of structured, unstructured and semi-structured data types*

2.4. Data value Chain

The Data Value Chain is introduced to describe the information flow within a big data system as a series of steps needed to generate value and useful insights from data. The Big Data Value Chain identifies the following key high-level activities:

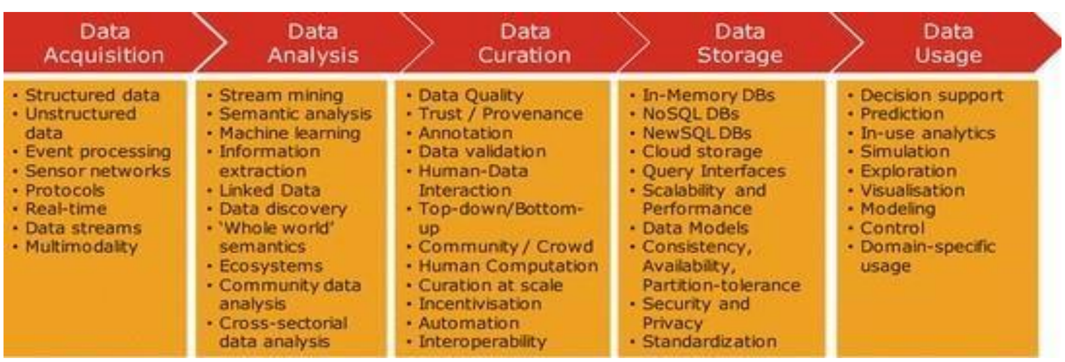

Figure 2.3 Data Value Chain

2.4.1. Data Acquisition

It is the process of gathering, filtering, and cleaning data before it is put in a data warehouse or any other storage solution on which data analysis can be carried out. Data acquisition is one of the major big data challenges in terms of infrastructure requirements. The infrastructure required to support the acquisition of big data must deliver low, predictable latency in both capturing data and in executing queries; be able to handle very high transaction volumes, often in a distributed environment; and support flexible and dynamic data structures.

2.4.2. Data Analysis

It is concerned with making the raw data acquired amenable to use in decision-making as well as domain-specific usage. Data analysis involves exploring, transforming, and modeling data with the goal of highlighting relevant data, synthesizing and extracting useful hidden information with high potential from a business point of view. Related areas include data mining, business intelligence, and machine learning.

2.4.3. Data Curation

It is the active management of data over its life cycle to ensure it meets the necessary data quality requirements for its effective usage. Data curation processes can be categorized into different activities such as content creation, selection, classification, transformation, validation, and preservation. Data curation is performed by expert curators that are responsible for improving the accessibility and quality of data. Data curators (also known as scientific curators or data annotators) hold the responsibility of ensuring that data are trustworthy, discoverable, accessible, reusable and fit their purpose. A key trend for the duration of big data utilizes community and crowdsourcing approaches.

2.4.4. Data Storage

It is the persistence and management of data in a scalable way that satisfies the needs of applications that require fast access to the data. Relational Database Management Systems (RDBMS) have been the main, and almost unique, a solution to the storage paradigm for nearly 40 years. However, the ACID (Atomicity, Consistency, Isolation, and Durability) properties that guarantee database transactions lack flexibility with regard to schema changes and the performance and fault tolerance when data volumes and complexity grow, making them unsuitable for big data scenarios. NoSQL technologies have been designed with the scalability goal in mind and present a wide range of solutions based on alternative data models.

2.4.5. Data Usage

It covers the data-driven business activities that need access to data, its analysis, and the tools needed to integrate the data analysis within the business activity. Data usage in business decisionmaking can enhance competitiveness through the reduction of costs, increased added value, or any other parameter that can be measured against existing performance criteria.

Activity 2.5

- *Which information flow step in the data value chain you think is labor-intensive? Why?*
- *What are the different data types and their value chain*?

2.5. Basic concepts of big data

Big data is a blanket term for the non-traditional strategies and technologies needed to gather, organize, process, and gather insights from large datasets. While the problem of working with data that exceeds the computing power or storage of a single computer is not new, the pervasiveness, scale, and value of this type of computing have greatly expanded in recent years.

In this section, we will talk about big data on a fundamental level and define common concepts you might come across. We will also take a high-level look at some of the processes and technologies currently being used in this space.

2.5.1. What Is Big Data?

Big data is the term for a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications.

In this context, a "large dataset" means a dataset too large to reasonably process or store with traditional tooling or on a single computer. This means that the common scale of big datasets is constantly shifting and may vary significantly from organization to organization. Big data is characterized by 3V and more:

- **Volume**: large amounts of data Zeta bytes/Massive datasets
- **Velocity**: Data is live streaming or in motion
- **Variety**: data comes in many different forms from diverse sources • **Veracity**: can we trust the data? How accurate is it? etc.

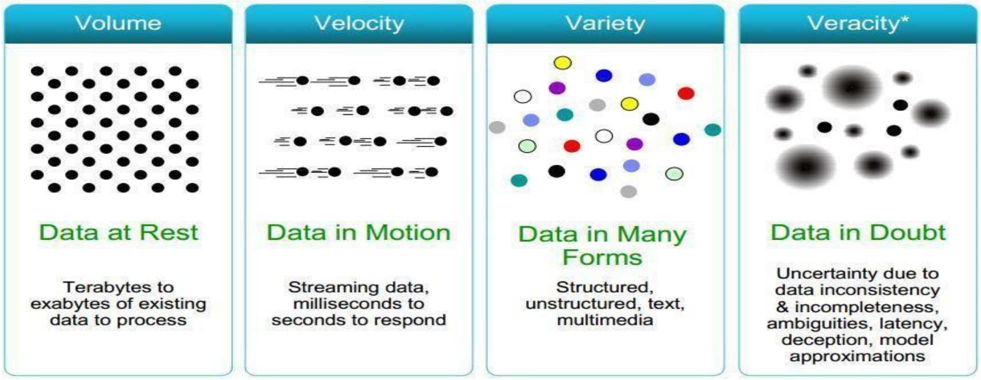

Figure 2.4 Characteristics of big data

2.5.2. Clustered Computing and Hadoop Ecosystem

2.5.2.1.Clustered Computing

Because of the qualities of big data, individual computers are often inadequate for handling the data at most stages. To better address the high storage and computational needs of big data, computer clusters are a better fit.

Big data clustering software combines the resources of many smaller machines, seeking to provide a number of benefits:

- **Resource Pooling**: Combining the available storage space to hold data is a clear benefit, but CPU and memory pooling are also extremely important. Processing large datasets requires large amounts of all three of these resources.
- **High Availability**: Clusters can provide varying levels of fault tolerance and availability guarantees to prevent hardware or software failures from affecting access to data and processing. This becomes increasingly important as we continue to emphasize the importance of real-time analytics.
- **Easy Scalability**: Clusters make it easy to scale horizontally by adding additional machines to the group. This means the system can react to changes in resource requirements without expanding the physical resources on a machine.

Using clusters requires a solution for managing cluster membership, coordinating resource sharing, and scheduling actual work on individual nodes. Cluster membership and resource allocation can be handled by software like **Hadoop's YARN** (which stands for Yet Another Resource Negotiator).

The assembled computing cluster often acts as a foundation that other software interfaces with to process the data. The machines involved in the computing cluster are also typically involved with the management of a distributed storage system, which we will talk about when we discuss data persistence.

Activity 2.6

- *List and discuss the characteristics of big data*
- *Describe the big data life cycle. Which step you think most useful and why?*
- *List and describe each technology or tool used in the big data life cycle.*
- *Discuss the three methods of computing over a large dataset.*

2.5.2.2.Hadoop and its Ecosystem

Hadoop is an open-source framework intended to make interaction with big data easier. It is a framework that allows for the distributed processing of large datasets across clusters of computers using simple programming models. It is inspired by a technical document published by Google. The four key characteristics of Hadoop are:

- **Economical:** Its systems are highly economical as ordinary computers can be used for data processing.
- **Reliable:** It is reliable as it stores copies of the data on different machines and is resistant to hardware failure.
- **Scalable:** It is easily scalable both, horizontally and vertically. A few extra nodes help in scaling up the framework.
- **Flexible:** It is flexible and you can store as much structured and unstructured data as you need to and decide to use them later.

Hadoop has an ecosystem that has evolved from its four core components: data management, access, processing, and storage. It is continuously growing to meet the needs of Big Data. It comprises the following components and many others:

- **HDFS:** Hadoop Distributed File System
- **YARN:** Yet Another Resource Negotiator
- **MapReduce:** Programming based Data Processing
- **Spark:** In-Memory data processing
- **PIG, HIVE:** Query-based processing of data services
- **HBase:** NoSQL Database
- **Mahout, Spark MLLib:** Machine Learning algorithm libraries
- **Solar, Lucene:** Searching and Indexing
- **Zookeeper:** Managing cluster
- **Oozie:** Job Scheduling

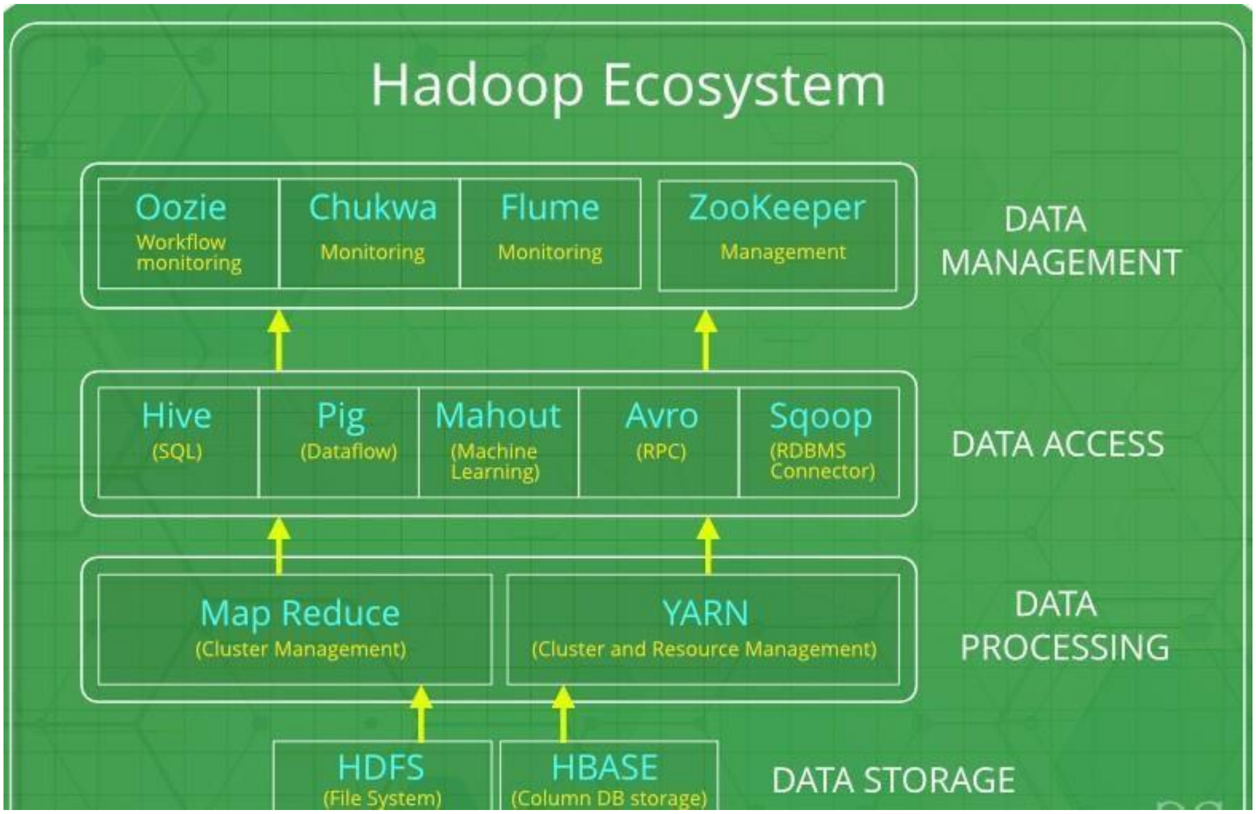

Figure 2.5 Hadoop Ecosystem

Activity 2.7

- *Students in a group shall discuss the purpose of each Hadoop Ecosystem components?*

2.5.3. Big Data Life Cycle with Hadoop

2.5.3.1. Ingesting data into the system

The first stage of Big Data processing is Ingest. The data is ingested or transferred to Hadoop from various sources such as relational databases, systems, or local files. Sqoop transfers data from RDBMS to HDFS, whereas Flume transfers event data.

2.5.3.2. Processing the data in storage

The second stage is Processing. In this stage, the data is stored and processed. The data is stored in the distributed file system, HDFS, and the NoSQL distributed data, HBase. Spark and MapReduce perform data processing.

2.5.3.3. Computing and analyzing data

The third stage is to Analyze. Here, the data is analyzed by processing frameworks such as Pig, Hive, and Impala. Pig converts the data using a map and reduce and then analyzes it. Hive is also based on the map and reduce programming and is most suitable for structured data.

2.5.3.4. Visualizing the results

The fourth stage is Access, which is performed by tools such as Hue and Cloudera Search. In this stage, the analyzed data can be accessed by users.

Chapter Two Review Questions

1. Define data science; what are the roles of a data scientist?
2. Discuss data and its types from computer programming and data analytics perspectives?
3. Discuss a series of steps needed to generate value and useful insights from data?
4. What is the principal goal of data science?
5. List out and discuss the characteristics of Big Data?
6. How we ingest streaming data into Hadoop Cluster?

Chapter 3: Artificial Intelligence (AI)

Introduction

In the previous chapter you have been studied about data science, how data acquisition, analyzed and stored. Basic concepts of big data were also studied. In this chapter, artificial intelligence, history, types, and applications in different sectors are studied. Finally, some tools and platforms, as well as a real sample of AI applications, are discussed.

After completing this chapter, the students will be able to:

- Explain what artificial intelligence (AI) is.
- Describe the eras of AI.
- Explain the types and approaches of AI.
- Describe the applications of AI in health, agriculture, business and education
- List the factors that influenced the advancement of AI in recent years.
- Understand the relationship between the human's way of thinking and AI systems
- Identify AI research focus areas.
- Identify real-world AI applications, some platforms, and tools.

3.1. What is Artificial Intelligence (AI)

Artificial Intelligence is composed of two words Artificial and Intelligence.

Activity 3.1
How do you define the word Artificial? And the word Intelligence?

Artificial defines "man-made," and intelligence defines "thinking power", or "the ability to learn and solve problems" hence Artificial Intelligence means "a man-made thinking power."

So, we can define Artificial Intelligence (AI) as the 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.

Intelligence, as we know, is the ability to acquire and apply knowledge. Knowledge is the information acquired through experience. Experience is the knowledge gained through exposure (training). Summing the terms up, we get artificial intelligence as the "copy of something natural (i.e., human beings) 'WHO' is capable of acquiring and applying the information it has gained through exposure."

Activity 3.2
- *What do you think to make the machine think and make a decision like human beings do?*

Artificial Intelligence exists when a machine can have human-based skills such as learning, reasoning, and solving problems with Artificial Intelligence you do not need to preprogram a machine to do some work, despite that you can create a machine with programmed algorithms which can work with own intelligence.

Intelligence is composed of:

- Reasoning
- Learning
- Problem Solving
- Perception
- Linguistic Intelligence

An AI system is composed of an agent and its environment. An agent (e.g., human or robot) is anything that can perceive its environment through sensors and acts upon that environment through effectors. Intelligent agents must be able to set goals and achieve them. In classical planning problems, the agent can assume that it is the only system acting in the world, allowing the agent to be certain of the consequences of its actions. However, if the agent is not the only actor, then it requires that the agent can reason under uncertainty. This calls for an agent that cannot only assess its environment and make predictions but also evaluate its predictions and adapt based on its assessment. Machine perception is the ability to use input from sensors (such as cameras, microphones, sensors, etc.) to deduce aspects of the world. e.g., Computer Vision.

High-profile examples of AI include autonomous vehicles (such as drones and self-driving cars), medical diagnosis, creating art (such as poetry), proving mathematical theorems, playing games (such as Chess or Go), search engines (such as Google search), online assistants (such as Siri), image recognition in photographs, spam filtering, prediction of judicial decisions and targeting online advertisements

AI deals with the area of developing computing systems that are capable of performing tasks that humans are very good at, for example recognizing objects, recognizing and making sense of speech, and decision making in a constrained environment.

The advent of Big Data, driven by the arrival of the internet, smart mobile and social media has enabled AI algorithms, in particular from Machine Learning and Deep Learning, to leverage Big Data and perform their tasks more optimally. This combined with cheaper and more powerful hardware such as Graphical Processing Units (GPUs) has enabled AI to evolve into more complex architectures. Machine Learning is an advanced form of AI where the machine can learn as it goes rather than having every action programmed by humans.

Many times, students get confused between Machine Learning and Artificial Intelligence (see figure 3.1), but Machine learning, a fundamental concept of AI research since the field's inception, is the study of computer algorithms that improve automatically through experience. The term machine learning was introduced by Arthur Samuel in 1959. Neural networks are biologically inspired networks that extract features from the data in a hierarchical fashion. The field of neural networks with several hidden layers is called deep learning.

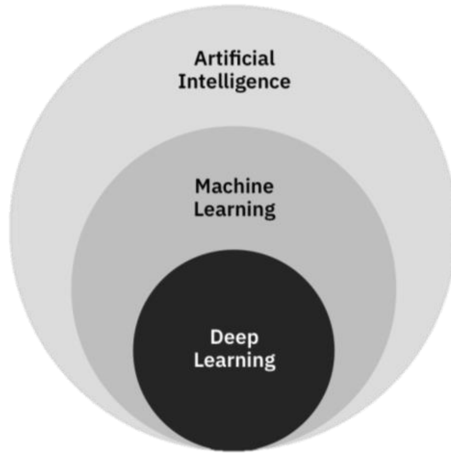

Figure 3.1 Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL)

3.1.1. Need for Artificial Intelligence

Activity 3.3 ○ *Why we need AI at this time?*

1. To create expert systems that exhibit intelligent behavior with the capability to learn, demonstrate, explain and advice its users.
2. Helping machines find solutions to complex problems like humans do and applying them as algorithms in a computer-friendly manner.

3.1.2. Goals of Artificial Intelligence

Activity 3.4
○ *You have been learned about AI and the need for it. What do you think the main goal of the advancement in AI?*

Following are the main goals of Artificial Intelligence:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:

Proving a theorem

Playing chess

Plan some surgical operation

Driving a car in traffic

5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

3.1.3. What Comprises to Artificial Intelligence?

Activity 3.5

- *To make a machine learn and make a decision like humans do, AI requires the knowledge of some disciplines. Write down some disciplines which AI requires?*

Artificial Intelligence is not just a part of computer science even it's so vast and requires lots of other factors that can contribute to it. To create the AI-first we should know that how intelligence is composed, so Intelligence is an intangible part of our brain which is a combination of Reasoning, learning, problem-solving, perception, language understanding, etc.

To achieve the above factors for a machine or software Artificial Intelligence requires the following disciplines (see Figure 3.2):

Mathematics

Biology

Psychology

Sociology

Computer Science

Neurons Study

Statistics

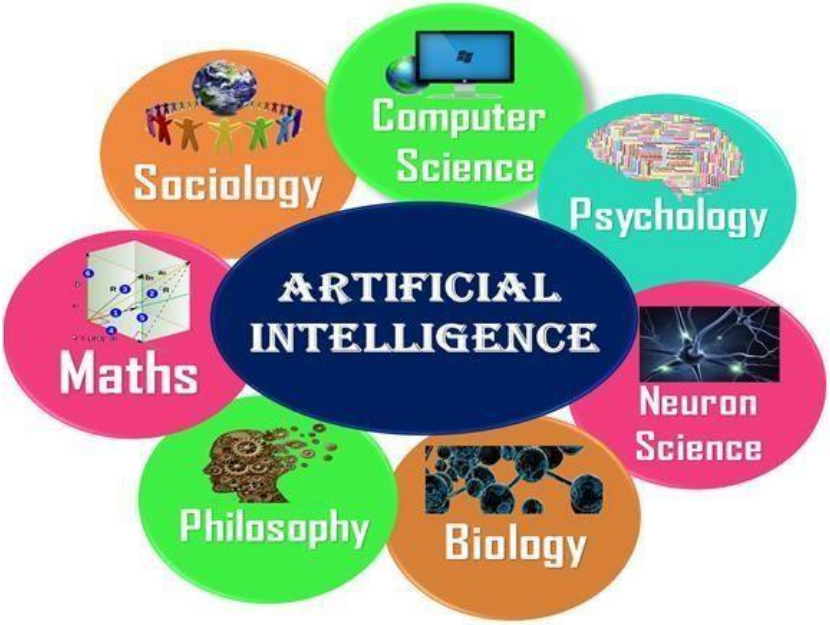

Figure 3.2 Artificial Intelligence is multidisciplinary

3.1.4. Advantages of Artificial Intelligence

Activity 3.6

- *What do we get from using AI technology instead of previous reactive technology?*

Following are some main advantages of Artificial Intelligence:

- **High Accuracy with fewer errors**: AI machines or systems are prone to fewer errors and high accuracy as it takes decisions as per pre-experience or information.
- **High-Speed**: AI systems can be of very high-speed and fast-decision making, because of that AI systems can beat a chess champion in the Chess game.
- **High reliability**: AI machines are highly reliable and can perform the same action multiple times with high accuracy.
- **Useful for risky areas**: AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.

- **Digital Assistant**: AI can be very useful to provide digital assistant to users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirements.
- **Useful as a public utility**: AI can be very useful for public utilities such as a selfdriving car which can make our journey safer and hassle-free, facial recognition for security purposes, Natural language processing (for search engines, for spelling checker, for assistant like Siri, for translation like google translate), etc.

3.1.5. Disadvantages of Artificial Intelligence

Activity 3.7

- *As we all know, engineering is a tradeoff; improving or enhancing in one aspect will lead you to worsen or deteriorating in another aspect. In the previous chapter, we have learned the advantages of AI; write down some disadvantages of AI?*

One of the key features that distinguishes us, humans, from everything else in the world is intelligence. This ability to understand, apply knowledge and improve skills has played a significant role in our evolution and establishing human civilization. But many people (including Elon Musk the founder of ….) believe that the advancement in technology can create a superintelligence that can threaten human existence.

Every technology has some disadvantages, and the same goes for Artificial intelligence. Being so advantageous technology still, it has some disadvantages which we need to keep in our mind while creating an AI system. Following are the disadvantages of AI:

- **High Cost**: The hardware and software requirement of AI is very costly as it requires lots of maintenance to meet current world requirements.
- **Can't think out of the box**: Even we are making smarter machines with AI, but still they cannot work out of the box, as the robot will only do that work for which they are trained, or programmed.

- **No feelings and emotions**: AI machines can be an outstanding performer, but still it does not have the feeling so it cannot make any kind of emotional attachment with humans, and may sometime be harmful for users if the proper care is not taken.
- **Increase dependence on machines**: With the increment of technology, people are getting more dependent on devices and hence they are losing their mental capabilities.
- **No Original Creativity**: As humans are so creative and can imagine some new ideas but still AI machines cannot beat this power of human intelligence and cannot be creative and imaginative.

3.2. History of AI

Activity 3.8

- Do you think AI is old technology? If your answer is yes, why? Can you name the person who coined the term AI? And when?

Artificial Intelligence is not a new word and not a new technology for researchers. This technology is much older than you would imagine. Even there are the myths of Mechanical men in Ancient Greek and Egyptian Myths. The following are some milestones in the history of AI which define the journey from the AI generation to till date development (see Figure 3.3).

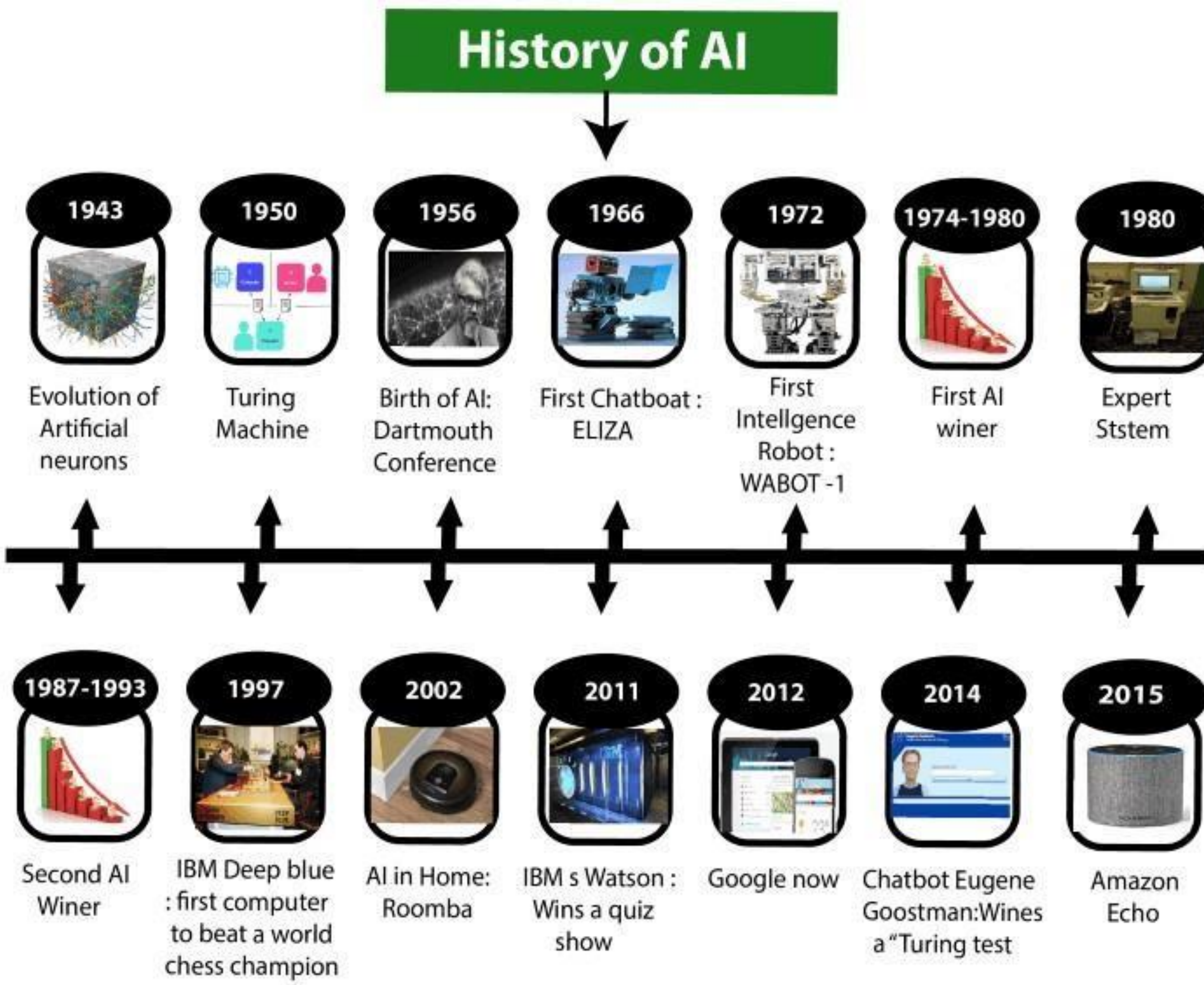

Figure 3.3 History of Artificial Intelligence (AI)

A. Maturation of Artificial Intelligence (1943-1952)

- **The year 1943**: The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of artificial neurons.
- **The year 1949**: Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called Hebbian learning.

- **The year 1950**: The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes "Computing Machinery and Intelligence" in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a Turing test.

B. The birth of Artificial Intelligence (1952-1956)

- **The year 1955**: An Allen Newell and Herbert A. Simon created the "first artificial intelligence program" Which was named "Logic Theorist". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **The year 1956**: The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field. At that time high-level computer languages such as FORTRAN, LISP, or COBOL were invented. And the enthusiasm for AI was very high at that time.

C. The golden years-Early enthusiasm (1956-1974)

- **The year 1966**: The researchers emphasized developing algorithms that can solve mathematical problems. Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA.
- **The year 1972**: The first intelligent humanoid robot was built in Japan which was named WABOT-1.

D. The first AI winter (1974-1980)

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

E. A boom of AI (1980-1987)

- **The year 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.
- In the Year 1980, the first national conference of the American Association of Artificial Intelligence was held at Stanford University.

F. 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 due to high cost but not efficient results. The expert system such as XCON was very cost-effective.

G. The emergence of intelligent agents (1993-2011)

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

H. Deep learning, big data and artificial general intelligence (2011-present)

- **The year 2011**: In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- **The year 2012**: Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- **The year 2014**: In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."
- **The year 2018**: The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "Duplex" which was a virtual assistant and which had taken hairdresser appointment on call, and the lady on the other side didn't notice that she was talking with the machine.

Now AI has developed to a remarkable level. The concept of Deep learning, big data, and data science are now trending like a boom. Nowadays companies like Google, Facebook, IBM, and

Amazon are working with AI and creating amazing devices. The future of Artificial Intelligence is inspiring and will come with high intelligence.

3.3. Levels of AI

Activity 3.9

- *As we discussed previously, AI technology learns from the environment as well as through experience to make decisions that make them proactive. This technology never emerged out of the blue or overnight but it has passed different stages. What do you think the stages AI passed to get at the current stage of its development?*

Stage 1 – Rule-Based Systems

The most common uses of AI today fit in this bracket, covering everything from business software (Robotic Process Automation) and domestic appliances to aircraft autopilots.

Stage 3 – Context Awareness and Retention

- Algorithms that develop information about the specific domain they are being applied in. They are trained on the knowledge and experience of the best humans, and their knowledge base can be updated as new situations and queries arise. Well, known applications of this level are chatbots and “roboadvisors”.

Stage 3 – Domain-Specific Expertise

- Going beyond the capability of humans, these systems build up expertise in a specific context taking in massive volumes of information which they can use for decision making. Successful use cases have been seen in cancer diagnosis and the well-known Google Deepmind’s AlphaGo. Currently, this type is limited to one domain only would forget all it knows about that domain if you started to teach it something else.

Stage 4 – Reasoning Machines

- These algorithms have some ability to attribute mental states to themselves and others – they have a sense of beliefs, intentions, knowledge, and how their own logic works. This means they could reason or negotiate with humans and other machines. At the moment these algorithms are still in development, however, commercial applications are expected within the next few years.

Stage 5 – Self Aware Systems / Artificial General Intelligence (AGI)

- These systems have human-like intelligence – the most commonly portrayed AI in media – however, no such use is in evidence today. It is the goal of many working in AI and some believe it could be realized already from 2024.

Stage 6 – Artificial Superintelligence (ASI)

- AI algorithms can outsmart even the most intelligent humans in every domain. Logically it is difficult for humans to articulate what the capabilities might be, yet we would hope examples would include solving problems we have failed to so far, such as world hunger and dangerous environmental change. Views vary as to when and whether such a capability could even be possible, yet there a few experts who claim it can be realized by 2029. Fiction has tackled this idea for a long time, for example in the film Ex Machina or Terminator.

Stage 7 – Singularity and Transcendence

- This is the idea that development provided by ASI (Stage 6) leads to a massive expansion in human capability. Human augmentation could connect our brains to each other and to a future successor of the current internet, creating a "hive mind" that shares ideas, solves problems collectively, and even gives others access to our dreams as observers or participants. Pushing this idea further, we might go beyond the limits of the human body and connect to other forms of intelligence on the planet – animals, plants, weather systems, and the natural environment. Some proponents of singularity such as Ray Kurzweil, Google's Director of Engineering, suggest we could see it happen by 2045 as a result of exponential rates of progress across a range of science and technology disciplines. The other side of the fence argues that singularity is impossible and human consciousness could never be digitized.

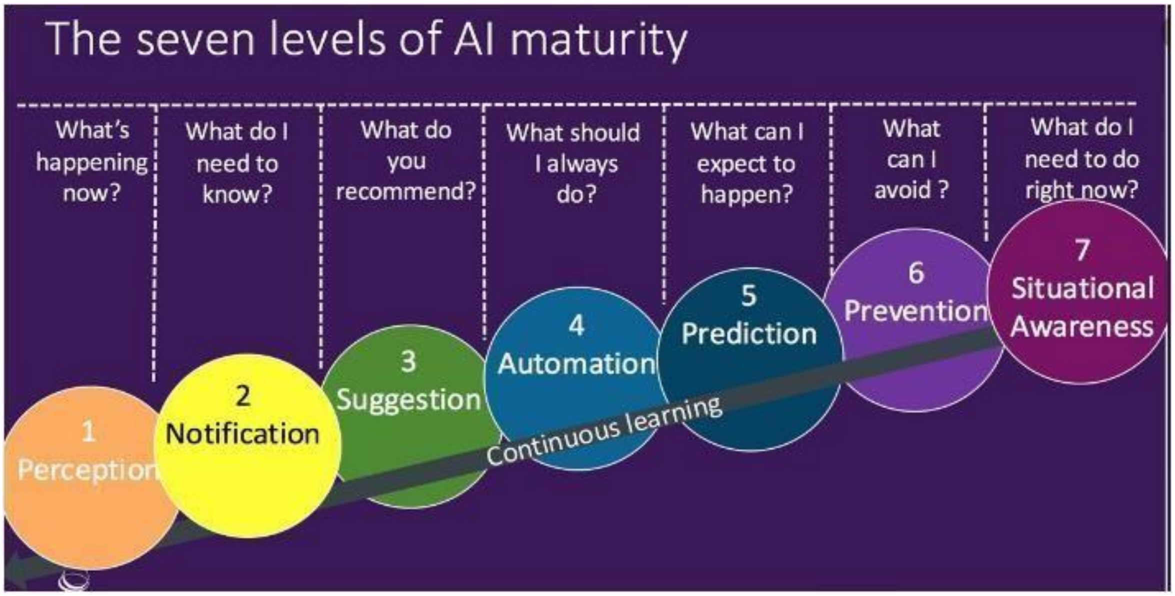

Figure 3.4 The seven layers of AI maturity

3.4. Types of AI

Activity 3.10
Since AI is making a machine intelligent, based on the strength of intelligence and functionality, list down some types or classification of AI?

Artificial Intelligence can be divided into various types, there are mainly two types of the main categorization which are based on capabilities and based on functionally of AI, as shown in figure 3.5.
Following is the flow diagram which explains the types of AI.

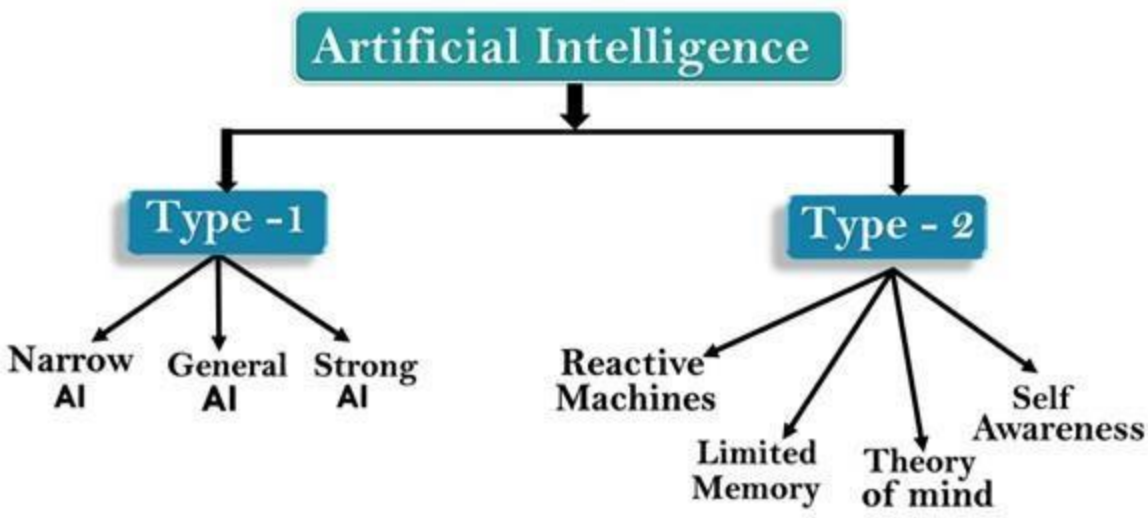

Figure 3.5 types of Artificial Intelligence (AI)

A. Based on Capabilities

1. Weak AI or Narrow AI:

- Narrow AI is a type of AI which is able to perform a dedicated task with intelligence. The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
- Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI. Narrow AI can fail in unpredictable ways if it goes beyond its limits.
- Apple Siri is a good example of Narrow AI, but it operates with a limited predefined range of functions.
- IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.

- Some Examples of Narrow AI are Google translate, playing chess, purchasing suggestions on e-commerce sites, self-driving cars, speech recognition, and image recognition.

2. General AI:
   - General AI is a type of intelligence that could perform any intellectual task with efficiency like a human.
   - The idea behind the general AI to make such a system that could be smarter and think like a human on its own.
   - Currently, there is no such system exists which could come under general AI and can perform any task as perfect as a human. It may arrive within the next 20 or so years but it has challenges relating to hardware, the energy consumption required in today’s powerful machines, and the need to solve for catastrophic memory loss that affects even the most advanced deep learning algorithms of today
   - The worldwide researchers are now focused on developing machines with General AI.
   - As systems with general AI are still under research, and it will take lots of effort and time to develop such systems.
3. Super AI:
   - Super AI is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than a human with cognitive properties. This refers to aspects like general wisdom, problem solving and creativity. It is an outcome of general AI.
   - Some key characteristics of strong AI include capability include the ability to think, to reason solve the puzzle, make judgments, plan, learn, and communicate on its own.
   - Super AI is still a hypothetical concept of Artificial Intelligence. The development of such systems in real is still a world-changing task.

B. Based on the functionality

1. Reactive Machines
   - Purely reactive machines are the most basic types of Artificial Intelligence.
   - Such AI systems do not store memories or past experiences for future actions.

- These machines only focus on current scenarios and react on it as per possible best action.
- IBM's Deep Blue system is an example of reactive machines.
- Google's AlphaGo is also an example of reactive machines.

2. Limited Memory
    - Limited memory machines can store past experiences or some data for a short period of time.
    - These machines can use stored data for a limited time period only.
    - Self-driving cars are one of the best examples of Limited Memory systems. These cars can store the recent speed of nearby cars, the distance of other cars, speed limits, and other information to navigate the road.
3. Theory of Mind
    - Theory of Mind AI should understand human emotions, people, beliefs, and be able to interact socially like humans.
    - This type of AI machines is still not developed, but researchers 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 selfawareness.
    - These machines will be smarter than the human mind.
    - Self-Awareness AI does not exist in reality still and it is a hypothetical concept.

3.4.1. How humans think

Activity 3.11

- *From the previous discussion, General AI is intelligence that could perform any intellectual task with efficiency like a human. So, to achieve this intelligence* *level, do you think that future intelligence must mimic the way humans think? If your answer is yes, why?*

The goal of many researchers is to create strong and general AI that learns like a human and can solve general problems as the human brain does. Achieving this goal might require many more years.

How does a human being think? Intelligence or the cognitive process is composed of three main stages:

- Observe and input the information or data in the brain.
- Interpret and evaluate the input that is received from the surrounding environment.
- Make decisions as a reaction towards what you received as input and interpreted and evaluated.

AI researchers are simulating the same stages in building AI systems or models. This process represents the main three layers or components of AI systems.

3.4.2. Mapping human thinking to artificial intelligence components

Activity 3.12

- Is it possible to map the way of human thinking to artificial intelligence components? If your answer is yes, why?

Because AI is the science of simulating human thinking, it is possible to map the human thinking stages to the layers or components of AI systems.

In the first stage, humans acquire information from their surrounding environments through human senses, such as sight, hearing, smell, taste, and touch, through human organs, such as eyes, ears, and other sensing organs, for example, the hands.

In AI models, this stage is represented by the sensing layer, which perceives information from the surrounding environment. This information is specific to the AI application. For example, there are sensing agents such as voice recognition for sensing voice and visual imaging recognition for sensing images. Thus, these agents or sensors take the role of the hearing and sight senses in humans.

The second stage is related to interpreting and evaluating the input data. In AI, this stage is represented by the interpretation layer, that is, reasoning and thinking about the gathered input that is acquired by the sensing layer.

The third stage is related to taking action or making decisions. After evaluating the input data, the interacting layer performs the necessary tasks. Robotic movement control and speech generation are examples of functions that are implemented in the interacting layer.

3.5. Influencers of artificial intelligence

Activity 3.13

- List down some influential factors that accelerate the rise of AI?

This section explores some of the reasons why AI is taking off now. The following influencers of AI are described in this section:

- Big data: Structured data versus unstructured data
- Advancements in computer processing speed and new chip architectures
- Cloud computing and APIs
- The emergence of data science

3.5.1. Big Data

Activity 3.14

- From chapter two, what is big data? Where do you get big data?

Big data refers to huge amounts of data. Big data requires innovative forms of information processing to draw insights, automate processes, and help decision making. Big data can be structured data that corresponds to a formal pattern, such as traditional data sets and databases.

Also, big data includes semi-structured and unstructured formats, such as word-processing documents, videos, images, audio, presentations, social media interactions, streams, web pages, and many other kinds of content. Figure 3.6 depicts the rapid change of the data landscape.

Figure 3.6 Current changes in the data landscape

3.5.1.1. Structured data versus unstructured data

Activity 3.15

- What is structured and unstructured data mean? Where do you get structured and unstructured data? Which one of them is better to analyze? Which of the two is the influencer of AI? Is AI important to analyze structured or unstructured data? Why?

Traditionally, computers primarily process structured data, that is, information with an organized structure, such as a relational database that is searchable by simple and straightforward search engine algorithms or SQL statements. But, real-world data such as the type that humans deal with constantly does not have a high degree of organization. For example, text that is written or spoken in natural language (the language that humans speak) does not constitute structured data.

Unstructured data is not contained in a regular database and is growing exponentially, making up most of the data in the world. The exponential growth of unstructured data that is shown in Figure

3.7 below drives the need for a new kind of computer system.

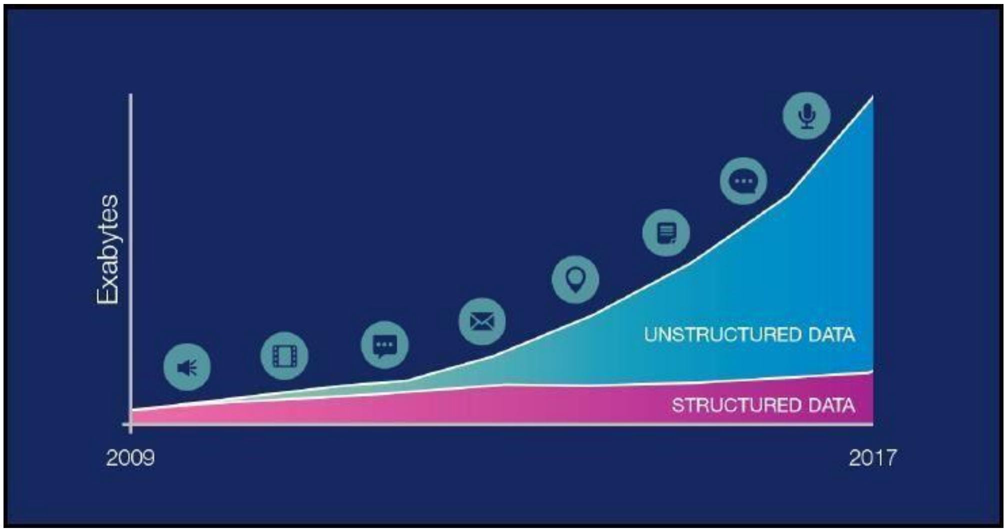

Figure 3.7 The comparison between the growth of structured and unstructured data

In the last few years, the availability of larger volumes and sources of data is enabling capabilities in AI that could not be used in the past due to lack of data availability, limited sample sizes, and an inability to analyze massive amounts of data in milliseconds.

3.5.1.2. Advancements in computer processing speed, new chip architectures, and big data file systems.

Activity 3.16

- *Why is that the advancement in computer processing speed and architecture influence AI?*

Significant advancements in computer processing and memory speeds enable us to make sense of the information that is generated by big data more quickly. In the past, statisticians and early data scientists were limited to working with sample data sets. In recent years, big data and the ability to process a large amount of data at high speeds have enabled researchers and developers to access and work with massive sets of data. Processing speeds and new computer chip architectures contribute to the rapid evolution of AI applications.

The meaning of big data expanded beyond the volume of data after the release of a paper by Google on MapReduce and the Google File System (GFS), which evolved into the Apache Hadoop opensource project. The Hadoop file system is a distributed file system that may run on a cluster of commodity machines, where the storage of data is distributed among the cluster and the processing is distributed too. This approach determines the speed with which data is processed. This approach includes an element of complexity with the introduction of new, structured, unstructured, and multi-structured data types. Large manufacturers of computer chips such as IBM and Intel are prototyping “brain-like” chips whose architecture is configured to mimic the biological brain’s network of neurons and the connections between them called synapses.

3.5.2. Cloud computing and application programming interfaces

Activity 3.17

- *What is the cloud? What do you know about cloud computing?*

Cloud computing is a general term that describes the delivery of on-demand services, usually through the internet, on a pay-per-use basis. Companies worldwide offer their services to customers over cloud platforms. These services might be data analysis, social media, video storage, e-commerce, and AI capabilities that are available through the internet and supported by cloud computing.

In general, application programming interfaces (APIs) expose capabilities and services. APIs enable software components to communicate with each other easily. The use of APIs as a method for integration injects a level of flexibility into the application lifecycle by making the task easier to connect and interface with other applications or services. APIs abstract the underlying workings of a service, application, or tool, and expose only what a developer needs, so programming becomes easier and faster. AI APIs are usually delivered on an open cloud-based platform on which developers can infuse AI capabilities into digital applications, products, and operations by using one or more of the available APIs.

All the significant companies in the AI services market deliver their services and tools on the internet through APIs over cloud platforms, for example:

- IBM delivers Watson AI services over IBM Cloud.
- Amazon AI services are delivered over Amazon Web Services (AWS).
- Microsoft AI tools are available over the MS Azure cloud.
- Google AI services are available in the Google Cloud Platform.

These services benefit from cloud platform capabilities, such as availability, scalability, accessibility, rapid deployment, flexible billing options, simpler operations, and management.

3.5.3. The emergence of data science

Data science has emerged in the last few years as a new profession that combines several disciplines, such as statistics, data analysis, machine learning, and others. The goal of data science is to extract knowledge or insights from data in various forms, either structured or unstructured, which is like data mining. After you collect a large enough volume of data, patterns emerge. Then, data scientists use learning algorithms on these patterns. Data science uses machine learning and AI to process big data.

3.6. Applications of AI

Artificial Intelligence has various applications in today's society. It is becoming essential for today's time because it can solve complex problems in an efficient way in multiple industries, such as Healthcare, entertainment, finance, education, etc. AI is making our daily life more comfortable and faster.

Activity 3.18

- *Having said that, AI is making our daily life more comfortable and faster in different sectors. Write down some applications of AI in health, agriculture, education, and business?*

Following are some sectors which have the application of Artificial Intelligence:

1. AI in agriculture
    - Agriculture is an area that requires various resources, labor, money, and time for the 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, predictive analysis. AI in agriculture can be very helpful for farmers.
2. AI in Healthcare
    - In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry.
    - Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach the patient before hospitalization.
3. 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 time and any place.
4. AI in Finance and E-commerce
    - AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.
    - AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand.
5. AI in Gaming

- AI can be used for gaming purposes. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

6. 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. Some examples such as AEG bot, AI2 Platform, are used to determine software bugs and cyber-attacks in a better way.
7. AI in Social Media
    - Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyze lots of data to identify the latest trends, hashtags, and requirements of different users.
8. AI in Travel &Transport
    - AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangements to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AIpowered chatbots which can make human-like interaction with customers for a better and fast response.
9. AI in the Automotive Industry
    - Some Automotive industries are using AI to provide virtual assistants to their use for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant.
    - Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure.
10. AI in Robotics:

- Artificial Intelligence has a remarkable role in Robotics. Usually, general 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.
- Humanoid Robots are the best examples for AI in robotics, recently the intelligent Humanoid robot named Erica and Sophia has been developed which can talk and behave like humans.

11. AI in Entertainment
    - We are currently using some AI-based applications in our daily life with some entertainment services such as Netflix or Amazon. With the help of ML/AI algorithms, these services show the recommendations for programs or shows.

3.7. AI tools and platforms

Activity 3.19

- *What do you know about a platform? Why we need platforms? List down some platforms you used or familiarized previously for any purpose?*
- *As we discussed previously, AI has vast applications in different sectors? Do you think that AI platforms are important to get some advantages of AI? List down some AI platforms you know or previously used?*

The business has workflows that are repetitive, tedious and difficult which tend to slow down production and also increases the cost of operation. To bring down the costs of operation, businesses have no option rather than automate some of the functions to cut down the cost of production. By digitizing repetitive tasks, an enterprise can cut costs on paperwork and labor which further eliminates human error thus boosting efficiency leading to better results. For a business to gain from the above benefits, they must choose the right automation tools otherwise it will all be in vain. Automating processes involving employing artificial intelligence platforms that can support the digitalization process and deliver the same or better results than human beings would have achieved.

AI platforms are defined as some sort of hardware architecture or software framework (including application frameworks), that allows the software to run. It involves the use of machines to perform the tasks that are performed by human beings. The platform simulates the cognitive function that human minds perform such as problem-solving, learning, reasoning, social intelligence as well as general intelligence.

Artificial intelligence (AI) platforms provide users a tool kit to build intelligent applications. These platforms combine intelligent, decision-making algorithms with data, which enables developers to create a business solution. Some platforms offer pre-built algorithms and simplistic workflows with such features as drag-and-drop modeling and visual interfaces that easily connect necessary data to the end solution, while others require a greater knowledge of development and coding. These algorithms can include functionality for image recognition (It gives the machine the ability to identify an image which is helpful in police stations to recognize a criminal), natural language processing (It gives machines the ability to read and understand human language. Some straightforward applications of natural language processing include information retrieval, text mining, question answering, and machine translation.), voice recognition (It gives the machine the ability to differentiate the voice of a person), recommendation systems, and predictive analytics (It gives the machine to predict the question and prepare the answer, in online marketing platforms this will predict the items you may buy), in addition to other machine learning capabilities.

AI platforms are frequently used by developers to create both the learning algorithm and intelligent application. However, users without intensive development skills will benefit from the platforms' pre-built algorithms and other features that curb the learning curve. AI platforms are very similar to Platforms as a Service (PaaS), which allows for basic application development, but these products differ by offering machine learning options. As intelligent applications become the norm, it may become commonplace for all PaaS products to begin to provide the same machine learning options as AI Platforms.

Activity 3.20

- *What is the tool? Do you think AI requires some tools? If your answer is yes, why?*
- *List down some AI tools?*

Many tools are used in AI, including versions of search and mathematical optimization, logic, methods based on probability and economics.

AI has developed a large number of tools to solve the most difficult problems in computer science, like:

Search and optimization

Logic

Probabilistic methods for uncertain reasoning

Classifiers and statistical learning methods

Neural networks

Control theory

Languages

The most common artificial intelligence platforms include Microsoft AZURE Machine Learning, Google Cloud Prediction API, IBM Watson, TensorFlow, Infosys Nia, Wipro HOLMES, API.AI, Premonition, Rainbird, Ayasdi, MindMeld, and Meya.

3.8. Semple AI application

I. Commuting

- Google's AI-Powered Predictions
- Ridesharing Apps Like Uber and Lyft
- Commercial Flights Use an AI Autopilot

II. Email

- Spam Filters
- Smart Email Categorization

III. Social Networking

- Facebook - When you upload photos to Facebook, the service automatically highlights faces and suggests friends tag.

- Pinterest - Pinterest uses computer vision, an application of AI where computers are taught to “see,” in order to automatically identify objects in images (or “pins”) and then recommend visually similar pins. Other applications of machine learning at Pinterest includes spam prevention, search, and discovery, ad performance and monetization, and email marketing.
- Instagram - Instagram, which Facebook acquired in 2012, uses machine learning to identify the contextual meaning of emoji, which have been steadily replacing slang (for instance, a laughing emoji could replace “lol”)
- Snapchat - Snapchat introduced facial filters, called Lenses, in 2015. These filters track facial movements, allowing users to add animated effects or digital masks that adjust when their faces moved.

IV. Online Shopping

- Search - Your Amazon searches (“ironing board”, “pizza stone”, “Android charger”, etc.) quickly return a list of the most relevant products related to your search

- Recommendations - You see recommendations for products you’re interested in as “customers who viewed this item also viewed” and “customers who bought this item also bought”, as well as via personalized recommendations on the home page, bottom of item pages, and through email. Amazon uses artificial neural networks to generate these product recommendations.

V. Mobile Use

- Voice-to-Text - A standard feature on smartphones today is voice-to-text. By pressing a button or saying a particular phrase (“Ok Google”, for example), you can start speaking and your phone converts the audio into text
- Smart Personal Assistants - Now that voice-to-text technology is accurate enough to rely on for basic conversation, it has become the control interface for a new generation of smart personal assistants.
    - Siri and Google Now (now succeeded by the more sophisticated Google Assistant), which could perform internet searches, set reminders, and integrate with your calendar.
    - Amazon expanded upon this model with the announcement of complementary hardware and software components:
    - Alexa, an AI-powered personal assistant that accepts voice commands to create to-do lists, order items online, set reminders, and answer questions (via internet searches) ○ Echo (and later, Dot) smart speakers that allow you to integrate Alexa into your living room and use voice commands to ask natural language questions, play music, order pizza, hail an Uber, and integrate with smart home devices.
- Microsoft has followed suit with Cortana, its own AI assistant that comes preloaded on Windows computers and Microsoft smartphones.

Chapter Three Review Questions

1. Briefly explain intelligence? What it is composed of?
2. Define artificial intelligence?
3. Why we need artificial intelligence?
4. Write down the driving factors which accelerated the rise of AI?
5. List down disciplines which artificial intelligence requires?
6. Write the pros and cons of AI?
7. Who coined the term AI for the first time?
8. Who is Alan Turing? What is his contribution to AI?
9. What are the seven stages of AI? Briefly explain each of them?
10. Based on the level of strength we can classify AI into three, briefly explain each of them?
11. Based on the functionality we can classify AI into four, briefly explain each of them?
12. Briefly explain the mapping of human thinking to artificial intelligence components?
13. Why big data influence the rise of AI?
14. Write down some applications of AI in agriculture, health, education, and business?
15. List down some well-known AI tools and platforms?
16. List down some concrete examples of AI in social media, online shopping, and mobile phone usage?

Chapter 4: Internet of Things (IoT)

Introduction

In the previous, you learned about the basics of Artificial Intelligence. In this chapter, you will learn about the overview of the Internet of Things (IoT), how it works, IoT tools and platforms, and sample applications of IoT.

After accomplishing this chapter, Students will be able to:

- Describe IoT
- Explain the history of IoT
- Describe the pros and cons of IoT
- Explain how IoT works
- Explain the architecture of IoT
- Describe IoT tools and platforms
- Describe some of the application areas of IoT

4.1. Overview of IoT

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below −

- **AI** − IoT essentially makes virtually anything “smart”, meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.

- **Connectivity** − New enabling technologies for networking and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

- **Sensors** − IoT loses its distinction without sensors. They act as defining instruments that transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** − Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

Small Devices − Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

Activity 4.1

- *Explain the key features of the Internet of Things (IoT)?*
- *What is the Internet of Things (IoT)?*
- *What does IoT play in the day-to-day lives of people and in organizations?*

4.1.1. What is IoT?

The description of the Internet of Things is related to different definitions used by several groups for promoting the particular concept in the whole world.

- According to the Internet Architecture Board’s (IAB) definition, IoT is the networking of smart objects, meaning a huge number of devices intelligently communicating in the presence of internet protocol that cannot be directly operated by human beings but exist as components in buildings, vehicles or the environment.
- According to the Internet Engineering Task Force (IETF) organization’s definition, IoT is the networking of smart objects in which smart objects have some constraints such as limited bandwidth, power, and processing accessibility for achieving interoperability among smart objects.

- According to the IEEE Communications category magazine's definition, IoT is a framework of all things that have a representation in the presence of the internet in such a way that new applications and services enable the interaction in the physical and virtual world in the form of Machine-to-Machine (M2M) communication in the cloud.

- According to the Oxford dictionary's definition, IoT is the interaction of everyday object's computing devices through the Internet that enables the sending and receiving of useful data.

- The term Internet of Things (IoT) according to the 2020 conceptual framework is expressed through a simple formula such as:

$$IoT = Services + Data + Networks + Sensors$$

Generally, The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT is a network of devices that can sense, accumulate and transfer data over the internet without any human intervention.

Simply stated, the Internet of Things consists of any device with an on/off switch connected to the Internet. This includes almost anything you can think of, ranging from cellphones to building maintenance to the jet engine of an airplane. Medical devices, such as a heart monitor implant or a biochip transponder in a farm animal, can transfer data over a network and are members of the IoT. If it has an off/on the switch, then it can, theoretically, be part of the system. The IoT consists of a gigantic network of internet-connected "things" and devices. Ring, a doorbell that links to your smartphone, provides an excellent example of a recent addition to the Internet of Things. Ring signals you when the doorbell is pressed and lets you see who it is and to speak with them.

The internet of things (IoT) has found its application in several areas such as connected industry, smart-city, smart-home, smart-energy, connected car, smart agriculture, connected building and campus, health care, logistics, among other domains (see Figure 4.1). IoT systems allow users to achieve deeper automation, analysis, and integration within a system. They improve the reach of these areas and their accuracy.

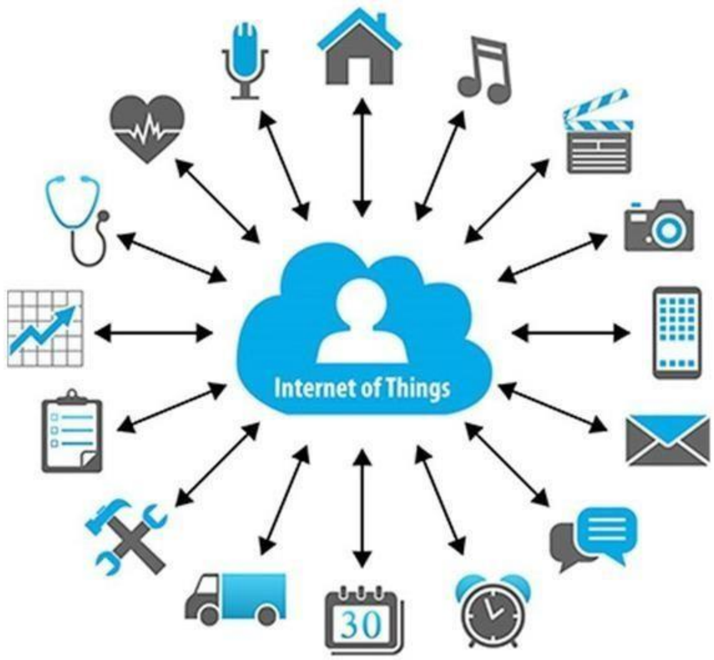

Figure 4.1 IoT in Different Domains

IoT utilizes existing and emerging technology for sensing, networking, and robotics. IoT exploits recent advances in software, falling hardware prices, and modern attitudes towards technology. Its new and advanced elements bring major changes in the delivery of products, goods, and services; and the social, economic, and political impact of those changes.   4.1.2. History of IoT

The Internet of Things has not been around for very long. However, there have been visions of machines communicating with one another since the early 1800s. Machines have been providing direct communications since the telegraph (the first landline) was developed in the 1830s and

1840s. Described as "wireless telegraphy," the first radio voice transmission took place on June 3, 1900, providing another necessary component for developing the Internet of Things. The development of computers began in the 1950s.

The Internet, itself a significant component of the IoT, started out as part of DARPA (Defense Advanced Research Projects Agency) in 1962 and evolved into ARPANET in 1969. In the 1980s, commercial service providers began supporting public use of ARPANET, allowing it to evolve into our modern Internet. Global Positioning Satellites (GPS) became a reality in early 1993, with the Department of Defense providing a stable, highly functional system of 24 satellites. This was quickly followed by privately owned, commercial satellites being placed in orbit. Satellites and landlines provide basic communications for much of the IoT. One additional and important component in developing a functional IoT was IPV6's remarkably intelligent decision to increase address space.

The Internet of Things, as a concept, wasn't officially named until 1999. One of the first examples of an Internet of Things is from the early 1980s and was a Coca Cola machine, located at the Carnegie Melon University. Local programmers would connect by the Internet to the refrigerated appliance, and check to see if there was a drink available and if it was cold, before making the trip.

By the year 2013, the Internet of Things had evolved into a system using multiple technologies, ranging from the Internet to wireless communication and from micro-electromechanical systems (MEMS) to embedded systems. The traditional fields of automation (including the automation of buildings and homes), wireless sensor networks, GPS, control systems, and others, all support the IoT.

Kevin Ashton, the Executive Director of Auto-ID Labs at MIT, was the first to describe the Internet of Things, during his 1999 speech. Kevin Ashton stated that Radio Frequency Identification (RFID) was a prerequisite for the Internet of Things. He concluded if all devices were "tagged," computers could manage, track, and inventory them. To some extent, the tagging of things has been achieved through technologies such as digital watermarking, barcodes, and QR codes.

Inventory control is one of the more obvious advantages of the Internet of Things.

Activity 4.2

- *State the history of the Internet of Things (IoT)?*
- *What was the role of Kevin Ashton in the history of IoT?*

4.1.3. IoT − Advantages

The advantages of IoT span across every area of lifestyle and business. Here is a list of some of the advantages that IoT has to offer:

- **Improved Customer Engagement** − Current analytics suffer from blind-spots and significant flaws inaccuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.
- **Technology Optimization** − The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.
- **Reduced Waste** − IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to the more effective management of resources.
- **Enhanced Data Collection** − Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces and places it exactly where humans really want to go to analyze our world. It allows an accurate picture of everything.

Activity 4.3

- *The use of the Internet of Things (IoT) provides a number of advantages. What are they?*

4.1.4. IoT – Disadvantages

Here is a list of some of the disadvantages of IoT. these are:

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.
- If there's a bug in the system, it's likely that every connected device will 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.
- Enterprises 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.

Activity 4.4

- Briefly discussed the cons of IoT related to security and compatibility?
- Briefly discussed security requirements at a different layer of IoT?

4.1.5. Challenges of IoT

Though IoT delivers an impressive set of advantages, it also presents a significant set of challenges. Here is a list of some its major issues:

- **Security** − IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.

- **Privacy** − The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.
- **Complexity** − Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.
- **Flexibility** − Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locking systems.
- **Compliance** − IoT, like any other technology in the realm of business, must comply with regulations. Its complexity makes the issue of compliance seem incredibly challenging when many consider standard software compliance a battle.

Activity 4.5

- *What are the most frequently raised challenges that of IoT has been facing?*

4.2. How does it work?

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or another edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices. For instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

4.2.1. Architecture of IoT

In general, an IoT device can be explained as a network of things that consists of hardware, software, network connectivity, and sensors. Hence, the architecture of IoT devices comprises four major components: sensing, network, data processing, and application layers (as depicted in Figure 4.2). A detailed description of these layers is given below.

1. ***Sensing Layer*** - The main purpose of the sensing layer is to identify any phenomena in the devices' peripheral and obtain data from the real world. This layer consists of several sensors. Using multiple sensors for applications is one of the primary features of IoT devices. Sensors in IoT devices are usually integrated through sensor hubs. A sensor hub is a common connection point for multiple sensors that accumulate and forward sensor data to the processing unit of a device. *Actuators* can also intervene to change the physical conditions that generate

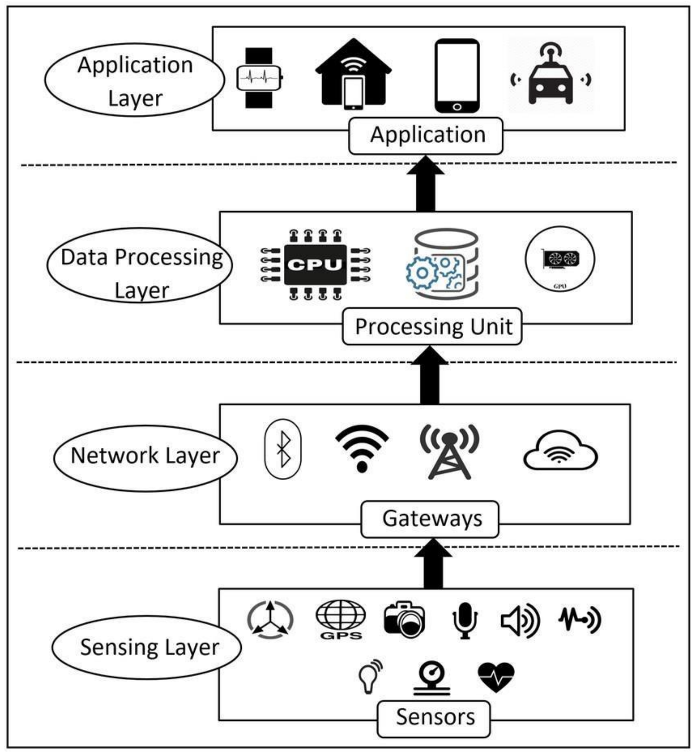

Figure 4.2 Architecture of IoT

the data. An actuator might, for example, shut off a power supply, adjust an airflow valve, or move a robotic gripper in an assembly process. Sensors in IoT devices can be classified into three broad categories as described below:

   A. ***Motion Sensors:*** Motion sensors measure the change in motion as well as the orientation of the devices. There are two types of motions one can observe in a device: *linear* and *angular* motions. The linear motion refers to the linear displacement of an IoT device while the angular motion refers to the rotational displacement of the device.

B. ***Environmental Sensors:*** Sensors such as Light sensors, Pressure sensors, etc. are embedded in IoT devices to sense the change in environmental parameters in the device's peripheral. The primary purpose of using environmental sensors in IoT devices is to help the devices to take autonomous decisions according to the changes of a device's peripheral. For instance, environment sensors are used in many applications to improve user experience (e.g., home automation systems, smart locks, smart lights, etc.).

   C. ***Position sensors:*** Position sensors of IoT devices deal with the physical position and location of the device. The most common position sensors used in IoT devices are magnetic sensors and Global Positioning System (GPS) sensors. Magnetic sensors are usually used as digital compass and help to fix the orientation of the device display. On the other hand, GPS is used for navigation purposes in IoT devices.

2. **Network Layer** - The network layer acts as a communication channel to transfer data, collected in the sensing layer, to other connected devices. In IoT devices, the network layer is implemented by using diverse communication technologies (e.g., Wi-Fi, Bluetooth, Zigbee, ZWave, LoRa, cellular network, etc.) to allow data flow between other devices within the same network.
3. **Data Processing Layer** - The data processing layer consists of the main data processing unit of IoT devices. The data processing layer takes data collected in the sensing layer and analyses the data to make decisions based on the result. In some IoT devices (e.g., smartwatch, smart home hub, etc.), the data processing layer also saves the result of the previous analysis to improve the user experience. This layer may share the result of data processing with other connected devices via the network layer.
4. **Application Layer** - The application layer implements and presents the results of the data processing layer to accomplish disparate applications of IoT devices. The application layer is a user-centric layer that executes various tasks for the users. There exist diverse IoT applications, which include smart transportation, smart home, personal care, healthcare, etc.

Activity 4.6

- *There are four components in the IoT architecture. What are they?*
- *Explain the functions of each layer of IoT.*
- *What is the difference between the sensors used in IoT devices?*

4.2.2. Devices and Networks

Connected devices are part of a scenario in which every device talks to other related devices in an environment to automate home and industrial tasks, and to communicate usable sensor data to users, businesses and other interested parties. IoT devices are meant to work in concert for people at home, in industry or in the enterprise. As such, the devices can be categorized into three main groups: consumer, enterprise and industrial.

Consumer connected devices include smart TVs, smart speakers, toys, wearables, and smart appliances. smart meters, commercial security systems and smart city technologies such as those used to monitor traffic and weather conditions are examples of industrial and enterprise IoT devices. Other technologies, including smart air conditioning, smart thermostats, smart lighting, and smart security, span home, enterprise, and industrial uses. In the enterprise, smart sensors located in a conference room can help an employee locate and schedule an available room for a meeting, ensuring the proper room type, size and features are available. When meeting attendees enter the room, the temperature will adjust according to the occupancy, and the lights will dim as the appropriate PowerPoint loads on the screen and the speaker begins his presentation.

IoT network typically includes a number of devices with constrained resources (power, processing, memory, among others) and some of those devices may be massively deployed over large areas like smart cities, industrial plants, whereas others may be deployed in hard-to-reach areas like pipelines hazardous zones, or even in hostile environments like war zones. Therefore, the efficient management of IoT networks requires considering both the constraints of low power IoT devices and the deployment complexity of the underlying communication infrastructure. IoT landscape is depicted by an increasing number of connected devices characterized by their heterogeneity and the presence of resources constrained networks. To ensure the correct functioning of those connected devices, they must be remotely accessed to configure, monitoring their status, and so forth. Traditional management solutions cannot be used for low power devices networks given their resources limitation and scalability issues. Therefore, efficient and autonomic management of IoT networks is needed. Developing an IoT network management solution is not an easy task because of the intrinsic constraints of IoT networks (architecture, technologies, physical layer).

Indeed, it is necessary to take into account several elements such as scalability, interoperability, energy efficiency, topology control, Quality of Service (QoS), fault tolerance, and security. The security, context-aware, and the standard model of messages still in an early stage and should be resolved in a new management platform. Therefore, this work proposes a platform for IoT networks and devices management, called M4DN.IoT (Management for Device and Network in the Internet of Things). This solution integrates and controls the individual functionalities of the devices in an IoT network as well as the status and characteristics of this network. M4DN. IoT defines a management structure in two scopes: local management, where the platform runs in the same environment as the devices, and remote management, where the platform controls the devices in different networks.

The structure of the platform is expandable, allowing the addition of new types of network devices or applications. In addition, the platform provides standard web services, such as device discovery, data storage, and user authorities, which are basic requirements for creating IoT applications.

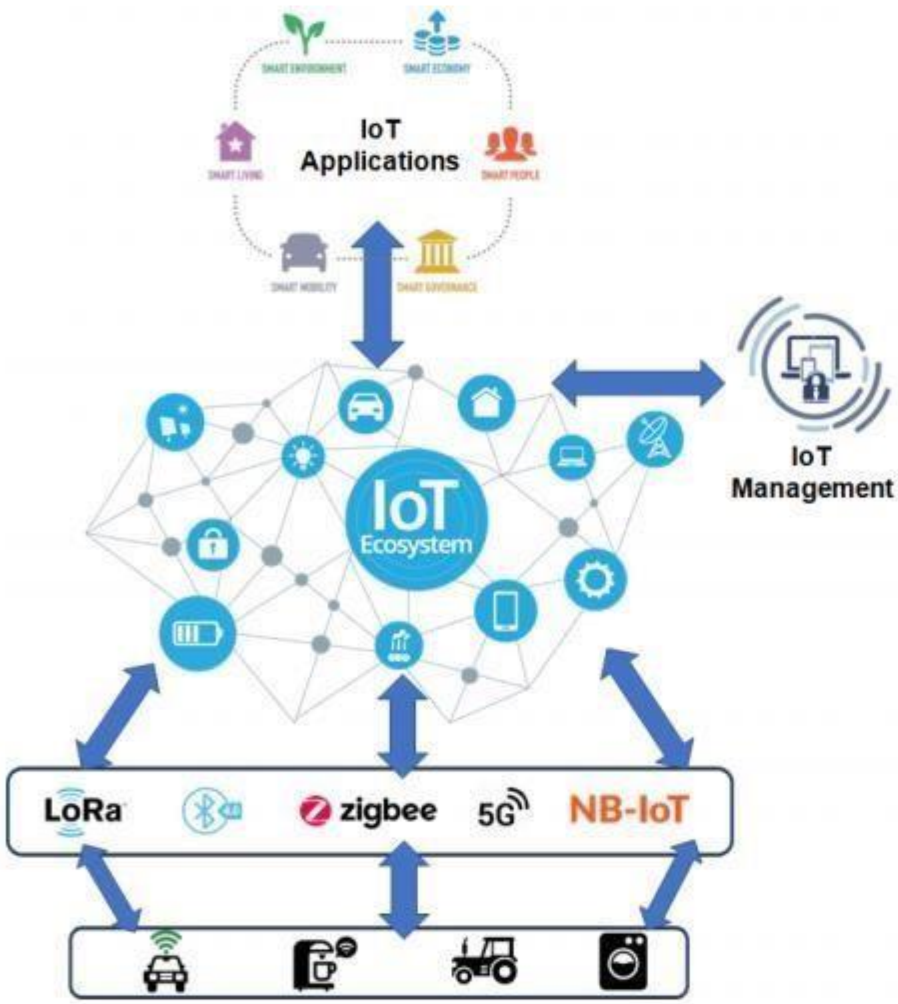

Figure 4.3 Networked IoT Devices

Activity 4.7

- *List and discussed at least three examples of IoT devices and their application?*
- *Dear leaner please make a note about Management for Device and Network in the Internet of Things (M4DN.IoT) later discussed in the group?*

4.3. IoT Tools and Platforms

There are many vendors in the industrial ***IoT platform*** marketplace, offering remarkably similar capabilities and methods of deployment. These IoT Platform Solutions are based on the Internet of Things and cloud technology. They can be used in areas of smart home, city, enterprise, home automation, healthcare or automotive, just to name a few.

IoT Platform	**Key features**
KAA	• Manage an unlimited number of connected devices • Set up cross-device interoperability • Perform real-time device monitoring • Perform remote device provisioning and configuration • Collect and analyze sensor data • Analyze user behavior and deliver targeted notifications • Create cloud services for smart products
SiteWhere	• Run any number of IoT applications on a single SiteWhere instance • Spring delivers the core configuration framework • Add devices through self-registration • Integrates with third-party integration frameworks such as Mule any point • Default database storage is MongoDB • Eclipse Californium for CoAP messaging • InfluxDB for event data storage • Grafana to visualize SiteWhere data
ThingSpeak	• Collect data in private channels • Share data with public channels • MATLAB analytics and visualizations • Alerts • Event scheduling • App integrations • Worldwide community

DeviceHive	• Directly integrate with Alexa • Visualization dashboard of your choice • It supports Big data solutions such as ElasticSearch, Apache Spark, Cassandra and Kafka for real-time and batch processing. • Connect any device • It comes with Apache Spark and Spark Streaming support. • Supports libraries written in various programming languages, including Android and iOS libraries • It allows running batch analytics and machine learning on top of your device data
Zetta	• Supports a wide range of hacker boards • Zetta allows you to assemble smartphone apps, device apps, and cloud apps
ThingsBoard	• Real-time data visualization and remote device control • Customizable rules, plugins, widgets and transport implementations
	• Allows monitoring client-side and provision server-side device attributes. • Support multi-tenant installations out-of-the-box. • Supports transport encryption for both MQTT and HTTP(s) protocols.

Activity 4.8

- Briefly discussed some of the IoT development tools that are listed below?

  - Tessel 2 • Raspbian
  - Eclipse IoT • OpenSCADA
  - Arduino • Node-RED
  - PlatforIO • Kimono Create
  - IBM Watson • Device Hive

4.4. Applications of IoT

The versatile nature of IoT makes it an attractive option for so many businesses, organizations, and government branches, that it doesn't make sense to ignore it. Here's a sample of various industries, and how IoT can be best applied.

- ***Agriculture*** - For indoor planting, IoT makes monitoring and management of microclimate conditions a reality, which in turn increases production. For outside planting, devices using IoT technology can sense soil moisture and nutrients, in conjunction with weather data, better control smart irrigation and fertilizer systems. If the sprinkler systems dispense water only when needed, for example, this prevents wasting a precious resource.
- ***Consumer Use*** - For private citizens, IoT devices in the form of wearables and smart homes make life easier. Wearables cover accessories such as Fitbit, smartphones, Apple watches, health monitors, to name a few. These devices improve entertainment, network connectivity, health, and fitness. Smart homes take care of things like activating environmental controls so that your house is at peak comfort when you come home. Dinner that requires either an oven or a crockpot can be started remotely, so the food is ready when you arrive. Security is made more accessible as well, with the consumer having the ability to control appliances and lights remotely, as well as activating a smart lock to allow the appropriate people to enter the house even if they don't have a key.
- *H**ealthcare*** **-** First and foremost, wearable IoT devices let hospitals monitor their patients' health at home, thereby reducing hospital stays while still providing up to the minute realtime information that could save lives. In hospitals, smart beds keep the staff informed as to the availability, thereby cutting wait time for free space. Putting IoT sensors on critical equipment means fewer breakdowns and increased reliability, which can mean the difference between life and death. Elderly care becomes significantly more comfortable with IoT. In addition to the above-mentioned real-time home monitoring, sensors can also determine if a patient has fallen or is suffering a heart attack.
- ***Insurance*** - Even the insurance industry can benefit from the IoT revolution. Insurance companies can offer their policyholders discounts for IoT wearables such as Fitbit. By employing fitness tracking, the insurer can offer customized policies and encourage healthier habits, which in the long run benefits everyone, insurer, and customer alike.

- ***Manufacturing*** - The world of manufacturing and industrial automation is another big winner in the IoT sweepstakes. RFID and GPS technology can help a manufacturer track a product from its start on the factory floor to its placement in the destination store, the whole supply chain from start to finish. These sensors can gather information on travel time, product condition, and environmental conditions that the product was subjected to. Sensors attached to factory equipment can help identify bottlenecks in the production line, thereby reducing lost time and waste. Other sensors mounted on those same machines can also track the performance of the machine, predicting when the unit will require maintenance, thereby preventing costly breakdowns.
- ***Retail* -** IoT technology has a lot to offer the world of retail. Online and in-store shopping sales figures can control warehouse automation and robotics, information gleaned from IoT sensors. Much of this relies on RFIDs, which are already in heavy use worldwide. Mall locations are iffy things; business tends to fluctuate, and the advent of online shopping has driven down the demand for brick and mortar establishments. However, IoT can help analyze mall traffic so that stores located in malls can make the necessary adjustments that enhance the customer’s shopping experience while reducing overhead. Speaking of customer engagement, IoT helps retailers target customers based on past purchases. Equipped with the information provided through IoT, a retailer could craft a personalized promotion for their loyal customers, thereby eliminating the need for costly massmarketing promotions that don’t stand as much of a chance of success. Much of these promotions can be conducted through the customers’ smartphones, especially if they have an app for the appropriate store.
- ***Transportation*** - By this time, most people have heard about the progress being made with self-driving cars. But that’s just one bit of the vast potential in the field of transportation. The GPS, which if you think of it is another example of IoT, is being utilized to help transportation companies plot faster and more efficient routes for trucks hauling freight,

thereby speeding up delivery times. There's already significant progress made in navigation, once again alluding to a phone or car's GPS. But city planners can also use that data to help determine traffic patterns, parking space demand, and road construction and maintenance.

- ***Utilities*** - IoT sensors can be employed to monitor environmental conditions such as humidity, temperature, and lighting. The information provided by IoT sensors can aid in the creation of algorithms that regulate energy usage and make the appropriate adjustments, eliminating the human equation (and let's face it, who of us hasn't forgotten to switch off lights in a room or turn down the thermostat?). With IoT-driven environmental control, businesses and private residences can experience significant energy savings, which in the long run, benefits everyone, including the environment! On a larger scale, data gathered by the Internet of Things can be used to help run municipal power grids more efficiently, analyzing factors such as usage. In addition, the sensors can help pinpoint outages faster, thereby increasing the response time of repair crews and decreasing blackout times.

4.3.1. IoT Based Smart Home

Smart Home initiative allows subscribers to remotely manage and monitor different home devices from anywhere via smartphones or over the web with no physical distance limitations. With the ongoing development of mass-deployed broadband internet connectivity and wireless technology, the concept of a Smart Home has become a reality where all devices are integrated and interconnected via the wireless network. These "smart" devices have the potential to share information with each other given the permanent availability to access the broadband internet connection.

- **Remote Control Appliances**: Switching on and off remotely appliances to avoid accidents and save energy.
- **Weather**: Displays outdoor weather conditions such as humidity, temperature, pressure, wind speed and rain levels with the ability to transmit data over long distances.
- **Smart Home Appliances**: Refrigerators with LCD screen telling what's inside, food that's about to expire, ingredients you need to buy and with all the information available on a

smartphone app. Washing machines allowing you to monitor the laundry remotely, and. The kitchen ranges with the interface to a Smartphone app allowing remotely adjustable temperature control and monitoring the oven's self-cleaning feature.

- **Safety Monitoring**: cameras, and home alarm systems making people feel safe in their daily life at home.
- **Intrusion Detection Systems**: Detection of window and door openings and violations to prevent intruders.
- **Energy and Water Use**: Energy and water supply consumption monitoring to obtain advice on how to save cost and resources, & many more.

4.3.2. IoT Based Smart City

In cities, the development of smart grids, data analytics, and autonomous vehicles will provide an intelligent platform to deliver innovations in energy management, traffic management, and security, sharing the benefits of this technology throughout society.

- **Structural Health**: Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
- **Lightning**: intelligent and weather adaptive lighting in street lights.
- **Safety**: Digital video monitoring, fire control management, public announcement systems.
- **Transportation**: Smart Roads and Intelligent High-ways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.
- **Smart Parking**: Real-time monitoring of parking spaces available in the city making residents able to identify and reserve the closest available spaces,
- **Waste Management**: Detection of rubbish levels in containers to optimize the trash collection routes. Garbage cans and recycle bins with RFID tags allow the sanitation staff to see when garbage has been put out.

4.3.3. IoT Based Smart Farming

- **Green Houses**: Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.

- **Compost**: Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.
- **Animal Farming/Tracking**: Location and identification of animals grazing in open pastures or location in big stables, Study of ventilation and air quality in farms and detection of harmful gases from excrements.
- **Offspring Care**: Control of growing conditions of the offspring in animal farms to ensure its survival and health.
- **Field Monitoring**: Reducing spoilage and crop waste with better monitoring, accurate ongoing data obtaining, and management of the agriculture fields, including better control of fertilizing, electricity and watering.

Activity 4.9 o

What is the application of IoT in agriculture?

- *What is the application of IoT for the use of consumers?*
- *What is the application of IoT in healthcare?*
- *What is the application of IoT in insurance companies?*
- *What is the application of IoT in manufacturing industries?*
- *What is the application of IoT in retail industries?*
- *What is the application of IoT in transportation?*
- *What is the application of IoT in utilities?*

Chapter Four Review Questions

1. What are the main parts of the IoT system?
2. What are the security concerns related to IoT?

3. Explain IoT Protocol stack?
4. What is meant by a smart city regarding the IoT?
5. Give examples of the impact of IoT on our lives?
6. What influence will the IoT have on monetary growth?
7. Why will be the IoT successful in the coming years?
8. What impact will the IoT have on the health care sector?
9. What are the main social and cultural impacts of IoT?
10. What the main challenges of an IoT?
11. What role does the network play in the IoT of everything?
12. How wireless communication might affect the development and implementations of IoT?

Chapter 5: Augmented Reality (AR)

Introduction

In the previous chapter, you learned about the basics of the Internet of things (IoT). In this chapter, we will take a closer look at the overview of augmented reality, the difference between virtual reality (VR), augmented reality (AR) and mixed reality (MR), architecture of AR systems, and its application of AR systems such as in education, medicine, entertainment, etc. are discussed.

After accomplishing this chapter, Students will be able to:

- Explain augmented reality
- Explain the features of augmented reality
- Explain the difference between AR, VR, and MR
- Explain the architecture of augmented reality systems
- Describe the application areas of augmented reality

5.1. Overview of augmented reality

Activity 5.1.

- *What do you think about augmented reality?*
- *What are the common features of augmented reality?*

The fundamental idea of AR is to combine, or mix, the view of the real environment with additional, virtual content that is presented through computer graphics. Its convincing effect is achieved by ensuring that the virtual content is aligned and registered with the real objects. As a person moves in an environment and their perspective view of real objects changes, the virtual content should also be presented from the same perspective

Augmented reality (AR) is a form of emerging technology that allows users to overlay computergenerated content in the real world. AR refers to a live view of a physical real-world environment whose elements are merged with augmented computer-generated images creating a mixed reality. The augmentation is typically done in real-time and in semantic context with environmental elements. By using the latest AR techniques and technologies, the information about the surrounding real world becomes interactive and digitally usable. Through this augmented vision, a user can digitally interact with and adjust information about their surrounding environment.

Augmented Reality (AR) as a real-time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computer-generated information to it.

Augmented reality is the integration of digital information with the user's environment in realtime. Unlike virtual reality, which creates a totally artificial environment, augmented reality uses the existing environment and overlays new information on top of it. A live direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data.

5.2. Virtual reality (VR), Augmented Reality (AR) vs Mixed reality (MR)

With constant development in computer vision and the exponential advancement of computer processing power, virtual reality (VR), augmented reality (AR), and mixed reality (MR) technology is becoming more and more prominent. With some overlap in the applications and functions of these emerging technologies, sometimes these terms get confused or are used incorrectly. The main differences between them are explained below (see Figure 5.1).

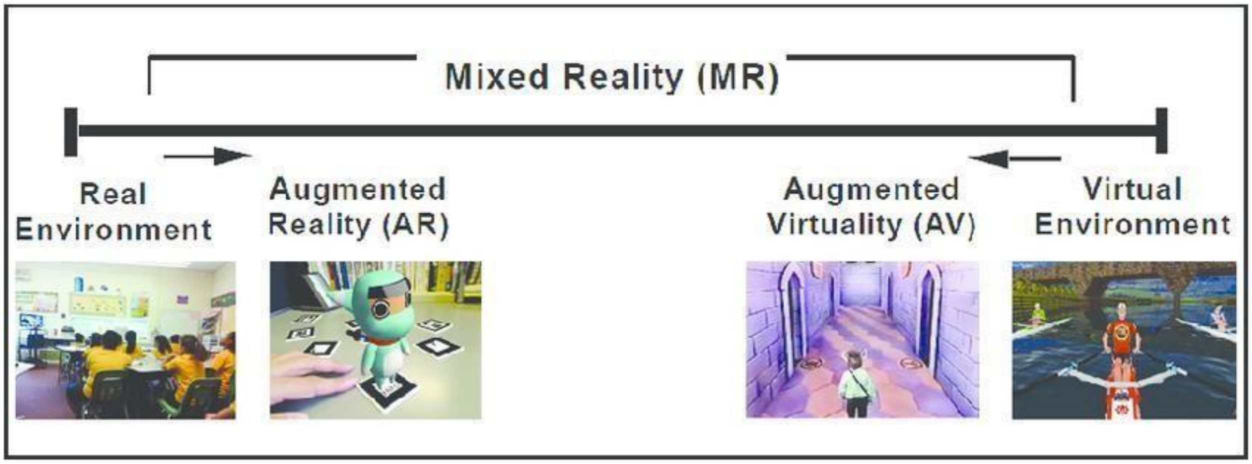

Figure 5.1 Paul Milgram's Reality-Virtuality (RV) Continuum

5.2.1. Virtual Reality (VR)

VR is fully immersive, which tricks your senses into thinking you're in a different environment or world apart from the real world. Using a head-mounted display (HMD) or headset, you'll experience a computer-generated world of imagery and sounds in which you can manipulate objects and move around using haptic controllers while tethered to a console or PC. It is also called a computer-simulated reality. It refers to computer technologies using reality headsets to generate realistic sounds, images and other sensations that replicate a real environment or create an imaginary world. Advanced VR environment will engage all five senses (taste, sight, smell, touch, sound), but it is important to say that this is not always possible (See Figure 5.2).

Using VR devices such as HTC Vive, Oculus Rift or Google Cardboard, users can be transported into a number of real-world and imagined environments.

The most advanced VR experiences even provide freedom of movement – users can move in a digital environment and hear sounds. Moreover, special hand controllers can be used to enhance VR experiences.

Figure 5.2 Example of Immersive Technology

Most VR headsets are connected to a computer (Oculus Rift) or a gaming console (PlayStation VR) but there are standalone devices (Google Cardboard is among the most popular) as well. Most standalone VR headsets work in combination with smartphones – you insert a smartphone, wear a headset, and immerse in the virtual reality (see Figure 5.3).

Figure 5.3 VR Case that Inserts a Smartphone

5.2.2. Augmented Reality (AR)

In augmented reality, users see and interact with the real world while digital content is added to it. If you own a modern smartphone, you can easily download an AR app and try this technology.

There's a different way to experience augmented reality, though – with special AR headsets, such as Google Glass, where digital content is displayed on a tiny screen in front of a user's eye.

AR adds digital elements to a live view often by using the camera on a smartphone. Examples of augmented reality experiences include Snapchat lenses and the game Pokemon Go. Augmented

Reality (AR) is a live, direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data (see Figure 5.4).

Figure 5.4 Direct and Indirect Augmentation of Objects

5.2.3. Mixed Reality (MR)

Mixed Reality (MR), sometimes referred to as hybrid reality, is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real-time. It means placing new imagery within a real space in such a way that the new imagery is able to interact, to an extent, with what is real in the physical world we know (see Figure 5.5 and Figure 5.6).

For example, with MR, you can play a virtual video game, grab your real-world water bottle, and smack an imaginary character from the game with the bottle. Imagination and reality have never been so intermingled.

The key characteristic of MR is that the synthetic content and the real-world content are able to react to each other in real-time.

Figure 5.5 Mixed Reality in Engineering and Medicine

In mixed reality, you interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. MR allows you to see and immerse yourself in the world around you even as you interact with a virtual environment using your own hands—all without ever removing your headset.

Figure 5.6 Mixed Reality in Entertainment

It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary, offering an experience that can change the way you game and work today.

One of the most obvious differences among augmented reality, virtual reality, and mixed reality is the hardware requirements and also VR is content which is 100% digital and can be enjoyed in a fully immersive environment, AR overlays digital content on top of the real-world. and MR is a digital overlay that allows interactive virtual elements to integrate and interact with the real-world environment. Numerous augmented reality apps and games can run on almost every smartphone on the market.

On the other hand, virtual reality programs require specialized VR headsets, noise-canceling headphones, cameras to track room space and boundaries, and sometimes even motion capture technology. Some of the biggest names in VR tech today are the Oculus Rift, HTC Vive, and PlayStation VR. For the enjoyment of simple VR videos, there are affordable makeshift VR headsets like the Google Cardboard, which work by running a video in 360 modes on your smartphone and inserting the phone into the headset.

Mixed reality hardware is still emerging and hasn't quite broken into the mainstream consumer market, most likely due to the price. The consumer releases of the Microsoft HoloLens and Magic Leap One retail for over $2000 USD, which is 3 to 4 times the cost of the PlayStation VR and HTC Vive VR headsets. However, mixed reality applications sometimes require exponentially more processing power and thus require more powerful hardware.

For example, the Microsoft HoloLens includes a built-in microphone array, binaural sound capabilities, a built-in camera for recording, a depth sensor, head-tracking cameras, and an inertial measurement unit which helps track your head movement. On top of the traditional CPU and GPU, Microsoft also created a Holographic Processing Unit to help track where the user is looking and understand command gestures.

Activity 5.2.

- *Describe AR, VR and MR*
- *Compare and contrast AR, VR and MR.*

5.3. The architecture of AR Systems

The first Augmented Reality Systems (ARS) were usually designed with a basis on three main blocks, as is illustrated in Figure 5.7: (1) Infrastructure Tracker Unit, (2) Processing Unit, and (3) Visual Unit. The Infrastructure Tracker Unit was responsible for collecting data from the real world, sending them to the Processing Unit, which mixed the virtual content with the real content and sent the result to the Video Out module of the Visual Unit. Some designs used a Video In, to acquire required data for the Infrastructure Tracker Unit.

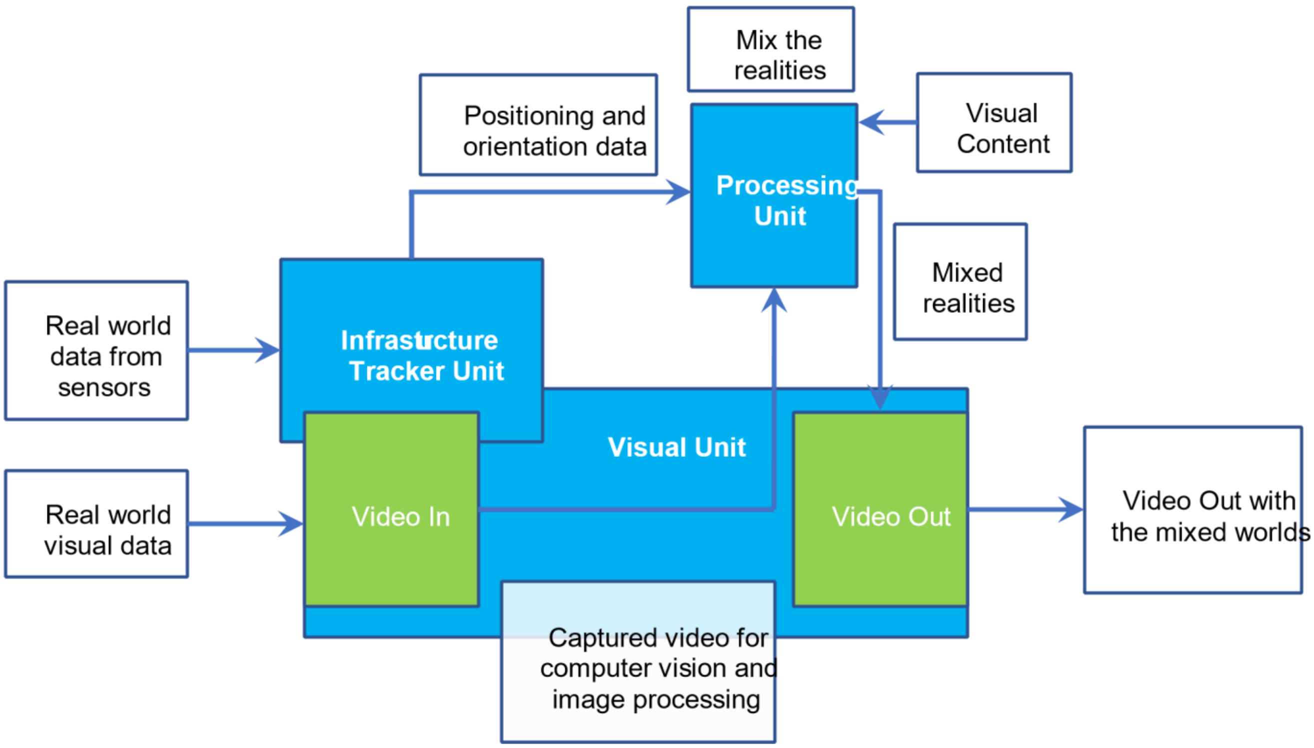

Figure 5.7 Augmented Reality Systems (ARS) standard architecture

The Visual Unit can be classified into two types of system, depending on the followed visualization technology:

1. Video see-through: It uses a Head-Mounted Display (HMD) that employs a video-mixing and displays the merged images on a closed-view HMD.
2. Optical see-through: It uses an HMD that employs optical combiners to merge the images within an open-view HMD.

HMDs are currently the dominant display technology in the AR field. However, they lack in several aspects, such as ergonomics, high prices and relatively low mobility due to their sizes and connectivity features. An additional problem involving HMD is the interaction with the real environment, which places virtual interactive zones to the user, making the collision with these zones hard due to the difficulty to interact with multiple points in different depths. Alternative approaches to developing ARS involve the use of monitors and tablets. Monitors are used as an option for indirect view since the user does not look directly into the mixed world. Tablets are used in direct view since the user points the camera to the scene and looks directly into the mixed world. Both approaches still have difficulties in getting a collision.

Activity 5.3

- *What are the three blocks/components of the AR system architecture?*
- *Describe the functions of the Infrastructure Tracking Unit, the Processing Unit, and the Visual Unit?*
- *What is the difference between Video-see through and Optical-see through visualization technologies?*

5.4. Applications of AR Systems

Technology is ever-changing and ever-growing. One of the newest developing technologies is augmented reality (AR), which can be applied to many different disciplines such as education, medicine, entertainment, military, etc. Let us see some of its applications.

5.4.1. AR In education

Augmented reality allows flexibility in use that is attractive to education. AR technology can be utilized through a variety of mediums including desktops, mobile devices, and smartphones. The technology is portable and adaptable to a variety of scenarios. AR can be used to enhance content and instruction within the traditional classroom, supplement instruction in the special education classroom, extend content into the world outside the classroom, and be combined with other technologies to enrich their individual applications. More importantly, the following reasons for using augmented reality in education:

- *Affordable learning materials* - posters, digital illustrations, physical models, prototypes are very expensive and it's impossible for schools to find enough money to purchase all the supplementary materials they would like to. Using AR technology allows for avoiding investments in physical materials. Besides, students can get access to learning materials and interact with them anytime.

- *Interactive lessons* - when AR technology is used in classrooms, students can view models on their own smartphones and get a better idea of the concepts they are studying. That increases engagements and reinforces the learning.
- *Higher engagement* - when teachers integrate augmented reality into their lectures, they attract the attention of their students and make lessons more effective. When students are interested, it is much easier to make them work more productively.

- *Higher retention* - using the AR app, students can get access to augmented models that represent any real objects from a famous monument or work of art to a molecule. Besides, students can get access to a website with specific information. When learning with AR technology, students use different senses and retain more knowledge for a long time.

- *Boost intellectual curiosity* - augmented reality makes students more excited about learning certain subjects. Modern students were born in a digital era so they will always be excited with innovative technologies that can help them learn new ideas and develop their critical thinking skills.

When using AR technology in the classroom, teachers can create an authentic learning environment for students with different learning styles.

5.4.2. AR In Medicine

Augmented reality is one of the current technologies changing all industries, including healthcare and medical education.

The purpose of any invention and technology is to simplify our life. Augmented reality has the potential to play a big role in improving the healthcare industry. Only a few years since the first implementations of augmented reality in medicine, it has already filled an important place in doctors' and nurses' routine, as well as patients' lives.

This new technology is enhancing medicine and healthcare towards more safety and efficiency.

For now, augmented reality has already made significant changes in the following medical areas:

- surgery (minimally invasive surgery);
- education of future doctors;
- diagnostics;
- AR tools may also aid to detect the signs of depression and other mental illnesses by reading from facial expressions, voice tones, and physical gestures.

In medicine, AR has the following applications:

1) ***Describing symptoms*** - Have you ever been in a situation when it was hard to describe to the doctor what was bothering you? It is a common problem for all us, the roots of which extend to overreacting and lack of knowledge. And what is most important, it impacts on finding out the accurate diagnosis. The first steps to find the solutions are already made.

To increase patients' education, medical app AyeDecide is using augmented reality to show the simulation of the vision, harmed by the different diseases. It helps patients to understand their conditions and describe correctly their symptoms.

2) ***Nursing care*** - About 40% of the first intravenous injections fail, and this ratio is even higher in the case of children and elderly patients. The AccuVein uses augmented reality to cope with this negative statistic. A handheld scanner projects on the skin and shows the patients' veins. It increases the successful finding of the vein from the first try in 3,5 times. That is why this invention got the greatest recognition among the general public and medical staff.
3) ***Surgery*** - In no sphere augmented reality does not have such practical application as in the medicine, especially in surgery, where it literally helps to save lives. Threedimensional reconstructions of organs or tumors will help surgeons become more efficient at surgery operations. For example, spinal surgery, as usually, is a long and difficult process. But with the use of AR, it can reduce the time, cut the

risks and improve the results. The Israeli startup Augmedics had created an augmented reality headset for spine surgeons. This technology overlays a 3D model of the CT-scan on the spine, so, the surgeon gets some kind of “X-ray” vision.

4) ***Ultrasounds*** - Some time ago ultrasound made a small revolution in medicine. Today, it has another one chance to make the same with using augmented reality. Already a few AR software companies developed handy ultrasound scanner, which with the help of smart glasses works as a traditional one. It is hard to overestimate the usefulness of this technology. Especially when we talk about using it in the developing countries, in military medicine (on the battlefields) and even in the ambulance.
5) ***Diabetes management*** - In 2017, the number of people struggle with diabetes reached up to 425 million adults worldwide. And the amount of diagnosed people is increasing every year. In 2014, Google revealed the plans for creating a smart contact lens (Google

Contact Lens), in which the main function will be to measure the glucose levels in the tears. It will help people with this disease to live the life they used to, without permanent worries about sugar level in the blood.

6) ***Navigation*** - The using AR in navigation apps has already become a “traditional” way. By pointing your phone to the city landscape, you get the information about nearby objects of your interest (museums, hotels, shops, metro stations, etc.). The same way AR can be useful to provide information about the nearest hospitals. For example, the EHBO app helps to find the nearest to you AEDs (automated external defibrillators).

Generally, AR provides the following benefits to patients and healthcare workers:

- Reduce the risks associated with minimally invasive surgery.
- Better informed decisions about the right treatment and illness prevention.
- Make procedures more tolerable.
- Better aftercare

- Medical training and education.
- Assistance in medical procedures and routine tasks.

Activity 5.4
○ *Briefly discussed applications of an AR system in assistance?*

5.4.3. AR In Entertainment

Augmented reality can be used in various “entertainment” industries as entertainment covers quite a number of different industries – music, movies, live shows, games – and all of them can benefit from using augmented reality.

- ***AR in games*** - the AR games were praised for increasing physical activity in people – you actually have to move around to find your target, for example, Pokémon. At the same time, there are complaints that players could cause various incidents and accidents being too engrossed in the game. In any case, Pokémon GO has rightfully earned its popularity and opened the world of AR games to us.

- ***AR in music*** - music is not only about listening to favorite tracks and putting together playlists. When we like a piece, we often want to find out more about its background: the performers’ bios, the lyrics of the song, the making of the recording or the music video. Augmented reality can do all that and much more providing complete information on the track or its performer. Augmented reality can enhance live performances by illustrating the story told by a track or displaying the way it was created by the band.
- ***AR on TV*** - this may seem a bit far-fetched, as television already shows a virtual world, thus adding augmented reality will raise it to the second power. However, some experiments of fusing augmented reality on TV are already being made with the promise of future enhancements. One way of integrating augmented reality in television is adding

supplementary information to what is going on the TV screen – such as match scores, betting options, and the like.

- ***AR in eSports*** - recently, the industry of eSports has been gaining popularity in all parts of the globe. Competitive online gaming has become as fascinating as real sports, and the technology is following it closely with new solutions and unusual implementations. Augmented reality turns eSports shows into interactive experiences allowing the watchers to become participants.
- ***AR in the theater*** - in this sector, augmented reality can serve not only for entertainment purposes but also for the purposes of accessibility. The possibility to overlay virtual objects over the real environment can be used, for example, for subtitling in various theater shows. Now, many theaters use LED displays either to provide subtitles for translation or to assist hearing-impaired visitors. However, LED equipment is not available in each theater and even when it is, it can distract the viewers from the show.

Activity 5.5

Describe the applications of AR in education?

- *What are the reasons to apply AR in education?*
- *List some of the applications of AR in medicine?*
- *Describe the benefits of AR to patients and healthcare workers.*
- *How AR can be used in Entertainment?*

Chapter Five Review Questions

1. what is augmented, virtual and mixed reality and its application?
2. what are good examples of augmented, virtual and mixed reality?
3. what is the difference between augmented, virtual and mixed reality?
4. How is augmented, virtual and mixed reality achieved?
5. What is the benefit of augmented, virtual and mixed reality?
6. How Can AR, VR, and MR improve engineering instructions?
7. Can VR be a substitute for Real Life Experience?
8. What is the impact of VR on Educational Learning rather than games?
9. What is the most technical challenge for MR?

Chapter 6: ETHICS AND PROFESSIONALISM OF EMERGING TECHNOLOGIES

Introduction

In the previous chapters, emerging technologies like big data, artificial intelligence, internet of things and augmented reality were discussed. After having a discussion on all of the above emerging technologies, it is time to study their connection with our ethical values as well as social values. In this chapter, the connection of emerging technologies with professional ethics, privacy, accountability, trust was discussed. Finally, the threats and challenges of emerging technologies will be explained.

After accomplishing this chapter, Students will be able to:

- Distinguish the link between ethics and technology.
- Understand general, professional and leadership ethical questions.
- Explain what digital privacy is, its components and why it is important.
- know the importance of accountability and trust in emerging technologies.
- Identify the threats and challenges we face in developing and utilizing emerging technologies.

6.1. Technology and ethics

Activity 6.1

- From your civic and ethical education course, what do you understand about the word ethics?

The Internet boom has provided many benefits for society, allowing the creation of new tools and new ways for people to interact. As with many technological advances, however, the Internet has not been without negative aspects. For example, it has created new concerns about privacy, and it has been hampered by spam and viruses. Moreover, even as it serves as a medium for communication across the globe, it threatens to cut off people who lack access to it.

Technology can serve to promote or restrict human rights. The Information Society should foster the use of emerging technologies in such a way as to maximize the benefits that they provide while minimizing the harms. In many cases, this promotion may be less a matter of technological control than of oversight: establishing the proper legal or regulatory system to ensure that technology capable of abuse is not in fact abused and that the benefits of technology are shared among all.

Ethics is particularly important for the accountancy profession, with a code for professional ethics based on five basic principles – integrity, objectivity, competence and due care, confidentiality, and professional behavior. However, the emergence of new technologies raises some new challenges for the profession to address.

6.2. New ethical questions

Activity 6.2

- *What do you think the need for ethics in data science? Is it really important to include ethical rules when dealing with big data? If your answer is yes, why?*

The increasing use of big data, algorithmic decision-making, and artificial intelligence can enable more consistent, evidence-based and accurate judgments or decisions, often more quickly and efficiently. However, these strengths can potentially have a darker side too, throwing up questions around the ethical use of these fairly new technologies.

For example, outputs can be based on biased data, which could lead to discriminatory outcomes. Indeed, where systems learn from real-world data, there is a significant risk that those systems simply recreate the past and subsequently build in errors or systemic biases. Closely linked to discrimination is personalization, and the impact of tailoring decisions very specifically to individuals, based on preferences, activities and other features. While this can be beneficial for many, others can lose out, and outcomes can again seem unfair or unethical.

Activity 6.3

- *As we discussed in chapter three, AI is all about making a machine learn and decide as humans do. Do you think that it is necessary to rely on machines and give all the opportunity to decide? Why?*

Additionally, questions are being asked regarding the interaction between computers and humans. How much reliance can we place on data and models, and what is the role of human judgment, as well as how do we ensure that we understand the decision-making process? Whatever the power of the machine, humans will still need to be involved, so that people can be held accountable, or explain the reasons behind a decision.

Activity 6.4

- *Do you think that integrating ethical rules with emerging technologies is important? If your answer is yes, why? What are the challenges of integrating ethical rules with the new technologies?*

A central problem of the ethics of technology is that it tends to arrive too late. In many cases, ethical issues are only recognized when the technology is already on the market and problems arise during its widespread use. Ethics can then become a tool to clean up a mess that might have been avoidable. It is probably not contentious to say it would be desirable to have ethical input at the earlier stages of technology design and development. Indeed, there are ethical theories and approaches that explicitly aim at an early integration of ethics into the technology life cycle. One central problem of this type of approach is that the future is unknown. By definition, we do not know with certainty what will happen in the future and ethics that relies on future development needs to be able to answer the question of how it decides which technological developments to pursue. Ethics has traditionally not been well equipped to deal with issues of uncertainty and, in particular, future uncertainty.

6.2.1. General ethical principles

Activity 6.5

- *List down common ethical rules that must be applied in all technologies?*

1. Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing. 2. Avoid harm.

3. Be honest and trustworthy.

4. Be fair and take action not to discriminate
5. Respect the work required to produce new ideas, inventions, creative works, and computing artifacts.
6. Respect privacy.
7. Honor confidentiality

6.2.2. Professional responsibilities.

Activity 6.6
List down ethical principles related to professional responsibility?

1. Strive to achieve high quality in both the processes and products of professional work.
2. Maintain high standards of professional competence, conduct, and ethical practice.
3. Know and respect existing rules pertaining to professional work.
4. Accept and provide appropriate professional review.
5. Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks.
6. Perform work only in areas of competence.
7. Foster public awareness and understanding of computing, related technologies, and their consequences.
8. Access computing and communication resources only when authorized or when compelled by the public good.
9. Design and implement systems that are robustly and usably secure.

6.2.3. Professional leadership principles.

Activity 6.7

- *List down ethical principles related to professional leadership?*

1. Ensure that the public good is the central concern during all professional computing work.
2. Articulate, encourage acceptance of and evaluate fulfillment of social responsibilities by members of the organization or group.
3. Manage personnel and resources to enhance the quality of working life.
4. Articulate, apply, and support policies and processes that reflect the principles of the Code.
5. Create opportunities for members of the organization or group to grow as professionals.
6. Use care when modifying or retiring systems. Interface changes, the removal of features, and even software updates have an impact on the productivity of users and the quality of their work.
7. Recognize and take special care of systems that become integrated into the infrastructure of society.

Activity 6.8

- *Discuss some specific professional ethical principles related to big data, AI and IoT?*

6.3. Digital privacy

Activity 6.9

- What do you think about privacy in general? Is it really important?
- In this digital world, what do you mean by digital privacy? Give concrete examples?

Digital Privacy is the protection of personally identifiable or business identifiable information that is collected from respondents through information collection activities or from other sources.

It is a collective definition that encompasses three sub-related categories; information privacy, communication privacy, and individual privacy It is often used in contexts that promote advocacy on behalf of individual and consumer privacy rights in digital spheres, and is typically used in opposition to the business practices of many e-marketers/businesses/companies to collect and use such information and data.

6.3.1. Information Privacy

Activity 6.10
○ What do you think that private information like passwords, PIN numbers, will be guarded or shared with the public? Why?

In the context of digital privacy, information privacy is the notion that individuals should have the freedom, or right, to determine how their digital information, mainly that pertaining to personally identifiable information, is collected and used. Every country has various laws that dictate how information may be collected and used by companies. Some of those laws are written to give agency to the preferences of individuals/consumers in how their data is used. In other places, like in the United States, privacy law is argued by some to be less developed in this regard, For example, some legislation, or lack of, allows companies to self-regulate their collection and dissemination practices of consumer information.

6.3.2. Communication Privacy

Activity 6.11
○ *Do you think communication privacy is the only one who is accessing the message will be the sender's intended receiver? If your answer is yes, why?*

In the context of digital privacy, communication privacy is the notion that individuals should have the freedom, or right, to communicate information digitally with the expectation that their communications are secure; meaning that messages and communications will only be accessible to the sender's original intended recipient. However, communications can be intercepted or delivered to other recipients without the sender's knowledge, in a multitude of ways.

Communications can be intercepted directly through various hacking methods; this is expanded upon further below. Communications can also be delivered to recipients unbeknownst to the sender due to false assumptions made regarding the platform or medium which was used to send information. An example of this is a failure to read a company's privacy policy regarding communications on their platform could lead one to assume their communication is protected when it is in fact not. Additionally, companies frequently have been known to lack transparency in how they use information, this can be both intentional and unintentional. Discussion of communication privacy necessarily requires consideration of technological methods of protecting information/communication in digital mediums, the effectiveness, and ineffectiveness of such methods/systems, and the development/advancement of new and current technologies.

6.3.3. Individual Privacy

Activity 6.12
- Do you think that it is good to make yourself exposed to every information on the internet? Why?

In the context of digital privacy, individual privacy is the notion that individuals have a right to exist freely on the internet, in that they can choose what types of information they are exposed to, and more importantly that unwanted information should not interrupt them An example of a digital breach of individual privacy would be an internet user receiving unwanted ads and emails/spam, or a computer virus that forces the user to take actions they otherwise wouldn't. In such cases the individual, during that moment, doesn't exist digitally without interruption from unwanted information; thus, their individual privacy has been infringed upon.

6.3.4. Some digital privacy principles

Activity 6.13
- *Give some examples you have to consider to make your data as well as communication private?*

- Data Minimization: collect the minimal amount of information necessary from individuals and businesses consistent with the Department’s mission and legal requirements.

- Transparency: Notice covering the purpose of the collection and use of identifiable information will be provided in a clear manner. Information collected will not be used for any other purpose unless authorized or mandated by law.
- Accuracy: Information collected will be maintained in a sufficiently accurate, timely, and complete manner to ensure that the interests of the individuals and businesses are protected.
- Security: Adequate physical and IT security measures will be implemented to ensure that the collection, use, and maintenance of identifiable information are properly safeguarded and the information is promptly destroyed in accordance with approved records control schedules.

6.4. Accountability and trust

Activity 6.14
- *Why are accountability and trust so important in using emerging technologies?*

When emerging technology creates far-reaching and rapid change, it can also bring new risks. Understanding and mitigating them will help to build confidence. Often legal and regulatory frameworks haven't kept pace with digital transformation, and organizations are seeking guidance.

This challenge is exacerbated by the speed at which technological change is occurring and the breadth of its adoption – which is introducing new risks that demand new responses.

Emerging technologies can provide improved accuracy, better quality and cost efficiencies for businesses in every sector. They can enhance trust in the organization's operations and financial processes, which is crucial for sustainable success. But this can produce a paradox: the very solutions that can be used to better manage risk, increase transparency and build confidence are often themselves the source of new risks, which may go unnoticed.

There's a danger that the use of technology will degrade people's willingness to judge and intervene because they feel that they are less personally connected to consumers and consumer outcomes – the logic of the machine has taken over from individual responsibility.

The obligation of an individual or organization to account for its activities, accept responsibility for them, and to disclose the results in a transparent manner. It also includes the responsibility for money or other entrusted property.

6.5. Treats and challenges

6.5.1. Ethical and regulatory challenges

Activity 6.15

- *What are the challenges of using technologies like AI, IoT, and big data?*

With Technology moving at a fast pace it is always been a challenge for Security. As security professionals, we need to keep pace with ever-changing technology and be aware of the AI, IoT, Big Data, Machine Learning, etc. It is no more Guards, guns & gates it is more than that & we need to play a major role for a security professional to support business or rather we should be able to understand the language of business and talk to the leaders in their language. With Growing needs Cyber & Data Security is getting prominence that requires security practitioners to focus on the business need for securing data, understanding security and risk from a business perspective by extensively interacting with the business community in understanding their requirements or what they want.

Activity 6.16

- *What role can technologies such as AI, IoT, Machine Learning and Big Data play in enhancing the security of an organization?*

Emerging technologies are already impacting how we live and work. They're also changing how we approach, plan, and integrate security operations. Certainly, we are living in an era where innovation, agility, and imagination are all essential in order to keep pace with the exponential technological transformation taking place. For security, both physical and cyber, the equation is the same catalyzing many new potential applications for emerging technologies. Emerging technologies are making an impact include:

1. Counter-terrorism and law enforcement informatics via predictive analytics and artificial intelligence.
2. Real-time horizon scanning and data mining for threats and information sharing
3. Automated cybersecurity and information assurance
4. Enhanced Surveillance (chemical and bio-detection sensors, cameras, drones, facial recognition, license plate readers)
5. Simulation and augmented reality technologies for training and modeling
6. Safety and security equipment (including bullet and bomb proof) made with lighter and stronger materials
7. Advanced forensics enabled by enhanced computing capabilities (including future quantum computing)
8. Situational awareness capabilities via GPS for disaster response and crisis response scenarios
9. Biometrics: assured identity security screening solutions by bio-signature: (every aspect of your physiology can be used as a bio-signature. Measure unique heart/pulse rates, electrocardiogram sensor, blood oximetry, skin temperature)
10. Robotic Policing (already happening in Dubai!)

6.5.1.1. Challenges in using Artificial Intelligence

Activity 6.17

- *AI has a wide application in health and manufacturing industries. What are the challenges the world face when implementing the applications of AI in the previously mentioned industries?*

AI is only as good as the data it is exposed to, which is where certain challenges may present themselves. How a business teaches and develops its AI will be the major factor in its usefulness. Humans could be the weak link here, as people are unlikely to want to input masses of data into a system.

Another dilemma that comes along with AI is its potential to replace human workers. As machines become more "intelligent" they could begin to replace experts in higher-level jobs. Alternatively, AI also has the potential to take the burden of laborious and time-consuming tasks from these people, freeing up their time and brainpower for other things e.g. doctors using diagnostic AI to help them diagnose patients will analyze the data presented by the AI and make the ultimate decision. Managing the challenges posed by AI will require careful planning to ensure that the full benefits are realized and risks are mitigated.

6.5.1.2. Challenges in using Robotics in manufacturing

Activity 6.18

- *Write down the challenges of using robots in the manufacturing industry? Debate on the pros and cons of giving jobs to humans or to robots in the manufacturing industry?*

With automation and robotics moving from production lines out into other areas of work and business, the potential for humans losing jobs is great here too. As automation technologies become more advanced, there will be a greater capability for automation to take over more and more complex jobs. As robots learn to teach each other and themselves, there is the potential for much greater productivity but this also raises ethical and cybersecurity concerns.

6.5.1.3. Challenges in using the Internet of Things

Activity 6.19
○ *As we discussed in chapter 4, IoT has a vast application in different sectors. Write down some challenges of using IoT in our daily activities?*

As more and more connected devices (such as smartwatches and fitness trackers) join the Internet of Things (IoT) the amount of data being generated is increasing. Companies will have to plan carefully how this will affect the customer-facing application and how to best utilize the masses of data being produced. There are also severe security implications of mass connectivity that need to be addressed.

6.5.1.4. Challenges in Big Data

Almost all the technologies mentioned above have some relation to Big Data. The huge amount of data being generated on a daily basis has the potential to provide businesses with better insight into their customers as well as their own business operations.

Although data can be incredibly useful for spotting trends and analyzing impacts, surfacing all this data to humans in a way that they can understand can be challenging. AI will play a role here.

6.5.2. Treats

Activity 6.20
○ *Write down some risks in emerging technologies like driverless cars, drones, and IoT?*

New and emerging technologies pose significant opportunities for businesses if they utilize them well and understand their true value early on. They also pose risks and questions not only to business but to society as a whole. Planning for how to deal with these emerging technologies and where value can be derived while assessing potential risks before they become a fully-fledged reality is essential for businesses that want to thrive in the world of AI, Big Data and IoT.

Some risks of emerging technology are:

- Driverless car: while a compelling option for future fleer cars, companies could crash and burn from claims related to bodily injury and property damage.
- Wearables: Google glass, Fitbit and other wearables can expose companies to the invasion of privacy claims that may not be covered by general liability or personal injury claims that weren't foreseen.
- Drones: Turbulence is in the offing for manufacturers and organizations that fail to protect themselves for property damage and bodily injury, as well as errors and omissions.
- Internet of things: The proliferation of sensors and cross-platform integration creates potential exposure from privacy invasion, bodily injury and property damage that may connect an organization to huge liabilities.

Chapter Six Review Questions

1. What is the importance of ethics in emerging technologies?
2. List down some general ethical rules?
3. List down some professional responsibility related to ethical rules
4. What is digital privacy? What is its importance?
5. Briefly explain digital privacy principles
6. Why we need accountability in using emerging technologies?
7. Is the trust necessary to use an emerging technology platform? Why?
8. Briefly explain the challenges in using:
    a. AI?
    b. Robots?
    c. IoT?
9. Briefly explain the risks we face in augmented reality, IoT and AI?
10. Do you think that dealing with big data demands high ethical regulations, accountability, and responsibility of the person as well as the company? Why?

Chapter 7: Other emerging technologies

Introduction

Dear students, in the previous chapter, you had studied some emerging technologies like data science, artificial intelligence, the internet of things and augmented reality and their ethical issues. In this chapter, you are going to discuss other emerging technologies like nanotechnology, biotechnology, block-chain technology, cloud and quantum computing, autonomic computing, computer vision, embedded systems, cybersecurity, and 3D printing.

After accomplishing this chapter, Students will be able to:

- Explain nanotechnology and its application in different sectors.
- Explain biotechnology and its application in different sectors.
- Explain block-chain technology and its application.

- Has gain insights about the cloud, quantum and autonomic computing, their differences, and applications.
- Explain how computer vision works and its application.
- Identify and explain embedded systems and their pros and cons.
- Describe cybersecurity, types of cybersecurity treat and its benefits.
- Distinguish the difference between additive manufacturing and 3D printing.

7.1.Nanotechnology

Activity 7.1
- Explain Nanoscale? Compare it with meters? Give examples in Nanoscale?

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

7.1.1. How it started

Activity 7.2
- *What do you think the need to study materials in Nanoscale?*

The ideas and concepts behind nanoscience and nanotechnology started with a talk entitled "There's plenty of room at the bottom" by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology (CalTech) on December 29, 1959, long before the term nanotechnology was used. In his talk, Feynman (see Figure 7.1) described a process in which scientists would be able to manipulate and control individual atoms and molecules. Over a decade later, in his explorations of ultraprecision machining, Professor Norio Taniguchi coined the term nanotechnology. It wasn't until 1981, with the development of the scanning tunneling microscope that could "see" individual atoms, that modern nanotechnology began.

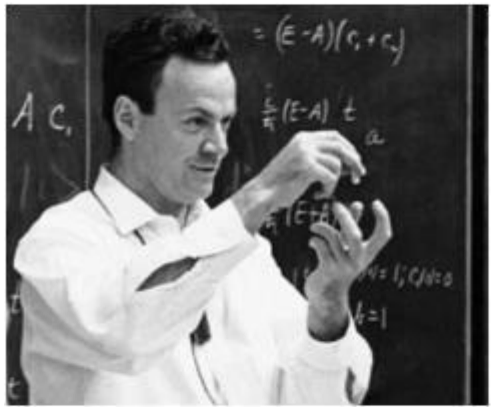

Figure 7.1 Physicist Richard Feynman, the father of nanotechnology

7.1.2. Fundamental concepts in nanoscience and nanotechnology

It’s hard to imagine just how small nanotechnology is. One nanometer is a billionth of a meter or 10^{-9} of meters. Here are a few illustrative examples:

- There are 25,400,000 nanometers in an inch
- A sheet of newspaper is about 100,000 nanometers thick
- On a comparative scale, if a marble were a nanometer, then one meter would be the size of the Earth

Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms—the food we eat, the clothes we wear, the buildings and houses we live in, and our own bodies.

But something as small as an atom is impossible to see with the naked eye. In fact, it’s impossible to see with the microscopes typically used in high school science classes. The microscopes needed to see things at the nanoscale were invented relatively recently about 30 years ago.

As small as a nanometer is, it's still large compared to the atomic scale. An atom has a diameter of about 0.1 nm. An atom's nucleus is much smaller about 0.00001 nm. Atoms are the building blocks for all matter in our universe. You and everything around you are made of atoms. Nature has perfected the science of manufacturing matter molecularly. For instance, our bodies are assembled in a specific manner from millions of living cells. Cells are nature's nanomachines. At the atomic scale, elements are at their most basic level. On the nanoscale, we can potentially put these atoms together to make almost anything.

In a lecture called "Small Wonders: The World of Nanoscience," Nobel Prize winner Dr. Horst Störmer said that the nanoscale is more interesting than the atomic scale because the nanoscale is the first point where we can assemble something -- it's not until we start putting atoms together that we can make anything useful.

People are interested in the nanoscale – because it is at this scale that the properties of materials can be very different from those at a larger scale. We define nanoscience as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale; and nanotechnologies as the design, characterization, production, and application of structures, devices, and systems by controlling shape and size at the nanometer scale.

The properties of materials can be different at the nanoscale for two main reasons:

- First, nanomaterials have a relatively larger surface area when compared to the same mass of material produced in a larger form. This can make materials more chemically reactive (in some cases materials that are inert in their larger form are reactive when produced in their nanoscale form), and affect their strength or electrical properties.
- Second, quantum effects can begin to dominate the behavior of matter at the nanoscale particularly at the lower end – affecting the optical, electrical and magnetic behavior of materials. Materials can be produced that are nanoscale in one dimension (for example, nanowires, nanorods, and nanotubes), in two dimensions (plate-like shapes like nanocoating, nanolayers, and graphene) or in all three dimensions (for example, nanoparticles)

Today's scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

Activity 7.3

- *As you discussed before, understanding the behavior of the material at Nanoscale advantageous. What do you think about the advantages of nanotechnology in medicine and agriculture?*

7.1.3. Applications of nanotechnology:

- **Medicine**: customized nanoparticles the size of molecules that can deliver drugs directly to diseased cells in your body. When it's perfected, this method should greatly reduce the damage treatment such as chemotherapy does to a patient's healthy cells.
- **Electronics**: it has some answers for how we might increase the capabilities of electronics devices while we reduce their weight and power consumption.
- **Food**: it has an impact on several aspects of food science, from how food is grown to how it is packaged. Companies are developing nanomaterials that will make a difference not only in the taste of food but also in food safety and the health benefits that food delivery.
- **Agriculture**: nanotechnology can possibly change the whole agriculture part and nourishment industry anchor from generation to preservation, handling, bundling, transportation, and even waste treatment.
- **Vehicle manufacturers**: Much like aviation, lighter and stronger materials will be valuable for making vehicles that are both quicker and more secure. Burning motors will likewise profit from parts that are all the more hardwearing and higher temperature safe.

7.2.Biotechnology

Activity 7.4

- *What do you think biotechnology is all about? Just begin by defining the two words bio and technology?*
- *Do you think biotechnology is an old science? If your answer is yes, why? Give some concrete examples of ancient biotechnology products?*

It is the broad area of biology involving living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".

At its simplest, biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. We have used the biological processes of microorganisms for more than 6,000 years to make useful food products, such as bread and cheese, and to preserve dairy products.

Brewing and baking bread are examples of processes that fall within the concept of biotechnology (use of yeast (= living organism) to produce the desired product). Such traditional processes usually utilize the living organisms in their natural form (or further developed by breeding), while the more modern form of biotechnology will generally involve a more advanced modification of the biological system or organism.

One example of modern biotechnology is genetic engineering. Genetic engineering is the process of transferring individual genes between organisms or modifying the genes in an organism to remove or add a desired trait or characteristic.

Today, biotechnology covers many different disciplines (e.g. genetics, biochemistry, molecular biology, etc.). New technologies and products are developed every year within the areas of e.g. Medicine (development of new medicines and therapies), agriculture (development of genetically modified plants, biofuels, biological treatment) or industrial biotechnology (production of chemicals, paper, textiles, and food).

7.2.1. History

When Edward Jenner invented vaccines and when Alexander Fleming discovered antibiotics, they were harnessing the power of biotechnology. And, of course, modern civilization would hardly be imaginable without the fermentation processes that gave us beer, wine, and cheese.

When he coined the term in 1919, the agriculturalist Karl Ereky described ‘biotechnology’ as “all lines of work by which products are produced from raw materials with the aid of living things.” In modern biotechnology, researchers modify DNA and proteins to shape the capabilities of living cells, plants, and animals into something useful for humans. Biotechnologists do this by sequencing or reading, the DNA found in nature, and then manipulating it in a test tube – or, more recently, inside of living cells.

Activity 7.5
- *Write down some biotechnology applications in agriculture, medicine environment?*

7.2.2. Application of biotechnology

- **Agriculture (Green Biotechnology):** Biotechnology had contributed a lot to modify the genes of the organism known as **Genetically Modified Organisms** such as Crops, Animals, Plants, Fungi, Bacteria, etc. Genetically modified crops are formed by the manipulation of **DNA** to introduce a new trait into the crops. These manipulations are done to introduce traits such as pest resistance, insect resistance, weed resistance, etc.
- **Medicine (Medicinal Biotechnology):** This helps in the formation of genetically modified insulin known as humulin. This helps in the treatment of a large number of diabetes patients. It has also given rise to a technique known as gene therapy. Gene therapy is a technique to remove the genetic defect in an embryo or child. This technique involves the transfer of a normal gene that works over the non-functional gene.
- **Aquaculture Fisheries:** It helps in improving the quality and quantity of fishes. Through biotechnology, fishes are induced to breed via gonadotropin-releasing hormone.

- **Environment (Environmental biotechnology):** is used in waste treatment and pollution prevention. Environmental biotechnology can more efficiently clean up many wastes than conventional methods and greatly reduce our dependence on methods for land-based disposal. Every organism ingests nutrients to live and produces by-products as a result. Different organisms need different types of nutrients. Some bacteria thrive on the chemical components of waste products. Environmental engineers use bioremediation, the broadest application of environmental biotechnology, in two basic ways. They introduce nutrients to stimulate the activity of bacteria already present in the soil at a waste site or add new bacteria to the soil. The bacteria digest the waste at the site and turn it into harmless byproducts. After the bacteria consume the waste materials, they die off or return to their normal population levels in the environment.

7.3.Blockchain technology

Activity 7.6
○ *What do you think blockchain is all about? Just begin by defining the two words block and chain?* ○ *Do you know anything about bitcoin? If your answer is yes, is it related to blockchain?* ○ *Do you think blockchain is an old science? Can you guess who coined the term blockchain?*

Originally blockchain is a growing list of records, called *blocks*, that are linked using cryptography. Each block contains a cryptography hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree).

A blockchain is, in the simplest of terms, a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity. Each of these blocks of data (i.e. block) is secured and bound to each other using cryptographic principles (i.e. chain).

“Blocks” on the blockchain are made up of digital pieces of information. Specifically, they have three parts:

1. Blocks store information about transactions like the date, time, and dollar amount of your most recent purchase from Amazon. (NOTE: This Amazon example is for illustrative purchases; Amazon retail does not work on a blockchain principle)
2. Blocks store information about who is participating in transactions. A block for your splurge purchase from Amazon would record your name along with Amazon.com, Inc. Instead of using your actual name, your purchase is recorded without any identifying information using a unique “digital signature,” sort of like a username.
3. Blocks store information that distinguishes them from other blocks. Much like you and I have names to distinguish us from one another, each block stores a unique code called a “hash” that allows us to tell it apart from every other block. Let’s say you made your splurge purchase on Amazon, but while it’s in transit, you decide you just can’t resist and need a

second one. Even though the details of your new transaction would look nearly identical to your earlier purchase, we can still tell the blocks apart because of their unique codes.

When a block stores new data it is added to the blockchain. Blockchain, as its name suggests, consists of multiple blocks strung together. In order for a block to be added to the blockchain, however, four things must happen:

1. A transaction must occur. Let's continue with the example of your impulsive Amazon purchase discussed in the introduction part of blockchain technology. After hastily clicking through multiple checkout prompt, you go against your better judgment and make a purchase.

2. That transaction must be verified. After making that purchase, your transaction must be verified. With other public records of information, like the Securities Exchange

   Commission, Wikipedia, or your local library, there's someone in charge of vetting new data entries. With blockchain, however, that job is left up to a network of computers. These networks often consist of thousands (or in the case of Bitcoin, about five million) computers spread across the globe. When you make your purchase from Amazon, that network of computers rushes to check that your transaction happened in the way you said it did. That is, they confirm the details of the purchase, including the transaction's time, dollar amount, and participants. (More on how this happens in a second.)

3. That transaction must be stored in a block. After your transaction has been verified as accurate, it gets the green light. The transaction's dollar amount, your digital signature, and Amazon's digital signature are all stored in a block. There, the transaction will likely join hundreds, or thousands, of others like it.

4. That block must be given a hash. Not unlike an angel earning its wings, once all of a block's transactions have been verified, it must be given a unique, identifying code called a hash. The block is also given the hash of the most recent block added to the blockchain. Once hashed, the block can be added to the blockchain.

By design, a blockchain is resistant to modification of the data. It is "an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way".

For use as a distributed ledger, a blockchain is typically managed by a peer-to-peer network collectively adhering to a protocol for inter-node communication and validating new blocks. Once recorded, the data in any given block cannot be altered retroactively without the alteration of all subsequent blocks, which requires the consensus of the network majority. Although blockchain records are not unalterable, blockchains may be considered secure by design and exemplify a distributed computing system.

The blockchain network has no central authority; it is the very definition of a democratized system. Since it is a shared and immutable ledger, the information in it is open for anyone and everyone to see. Hence, anything that is built on the blockchain is by its very nature transparent and everyone involved is accountable for their actions.

7.3.1. History

The first work on a cryptographically secured chain of blocks was described in 1991 by Stuart Haber and W. Scott Stornetta. They wanted to implement a system where document timestamps could not be tampered with. In 1992, Bayer, Haber, and Stornetta incorporated Merkle trees to the design, which improved its efficiency by allowing several document certificates to be collected into one block.

The first blockchain was conceptualized by a person (or group of people) known as Satoshi Nakamoto in 2008. Nakamoto improved the design in an important way using the Hash cash like the method to add blocks to the chain without requiring them to be signed by a trusted party. The design was implemented the following year by Nakamoto as a core component of the cryptocurrency bitcoin, where it serves as the public ledger for all transactions on the network.

In August 2014, the bitcoin blockchain file size, containing records of all transactions that have occurred on the network, reached 20 GB (Gigabyte). In January 2015, the size had grown to almost 30 GB, and from January 2016 to January 2017, the bitcoin blockchain grew from 50 GB to 100 GB in size.

The words *block* and *chain* were used separately in Satoshi Nakamoto's original paper but were eventually popularized as a single word, *blockchain,* by 2016.

7.3.2. Blockchain Explained

Activity 7.7
- *From your previous discussion, what is a transaction in blockchain? Does transaction have a cost in blockchain? Why?* - *Can you give a concrete example of blockchain?*

A blockchain carries no transaction cost. (An infrastructure cost yes, but no transaction cost.) The blockchain is a simple yet ingenious way of passing information from A to B in a fully automated and safe manner. One party to a transaction initiates the process by creating a block. This block is verified by thousands, perhaps millions of computers distributed around the net. The verified block is added to a chain, which is stored across the net, creating not just a unique record, but a unique record with a unique history. Falsifying a single record would mean falsifying the entire chain in millions of instances. That is virtually impossible. Bitcoin uses this model for monetary transactions, but it can be deployed in many other ways.

Think of a railway company. We buy tickets on an app or the web. The credit card company takes a cut for processing the transaction. With blockchain, not only can the railway operator save on credit card processing fees, it can move the entire ticketing process to the blockchain. The two parties in the transaction are the railway company and the passenger. The ticket is a block, which will be added to a ticket blockchain. Just as a monetary transaction on the blockchain is a unique, independently verifiable and unfalsifiable record (like Bitcoin), so can your ticket be. Incidentally, the final ticket blockchain is also a record of all transactions for, say, a certain train route, or even the entire train network, comprising every ticket ever sold, every journey ever taken.

But the key here is this: it’s free. Not only can the blockchain transfer and store money, but it can also replace all processes and business models that rely on charging a small fee for a transaction or any other transaction between two parties.

Blockchain may make selling recorded music profitable again for artists by cutting out music companies and distributors like Apple or Spotify. The music you buy could even be encoded in the blockchain itself, making it a cloud archive for any song purchased. Because the amounts charged can be so small, subscription and streaming services will become irrelevant.

7.3.3. The Three Pillars of Blockchain Technology

Activity 7.8

- *What are the most important principles in blockchains? Is it possible for the blockchain to be centralized? If your answer is no, Why?*

The three main properties of Blockchain Technology are:

1. Decentralization

- In a decentralized system (see Figure 7.2), the information is not stored by one single entity. In fact, everyone in the network owns the information.
- In a decentralized network (see Figure 7.2), if you wanted to interact with your friend then you can do so directly without going through a third party. That was the main ideology behind Bitcoins. You and only you alone are in charge of your money. You can send your money to anyone you want without having to go through a bank.

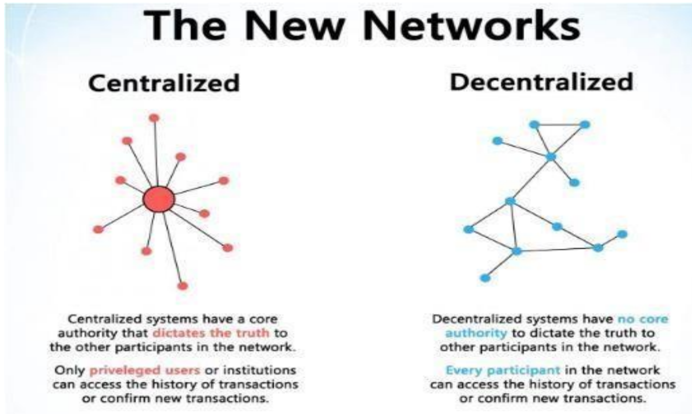

Figure 7.2 comparisons of a centralized and decentralized network

Activity 7.9

- *Can you give a concrete example of centralized and decentralized systems?*
- *Do you know about BitTorrent? What is it? For what purpose you use it?*
- *Is BitTorrent centralized or decentralized? Why?*

2. **Transparency**

Activity 7.10

- *What do you think about transparency in blockchain? Is transparency in governance related to transparency in blockchain?*

- One of the most interesting and misunderstood concepts in blockchain technology is "transparency." Some people say that blockchain gives you privacy while some say that it is transparent. Why do you think that happens?
- A person's identity is hidden via complex cryptography and represented only by their public address. So, if you were to look up a person's transaction history, you will not see "Bob sent 1 BTC" instead you will see "1MF1bhsFLkBzzz9vpFYEmvwT2TbyCt7NZJ sent 1 BTC".
- So, while the person's real identity is secure, you will still see all the transactions that were done by their public address. This level of transparency has never existed before within a financial system. It adds that extra, and much needed, level of accountability which is required by some of these biggest institutions.

3. Immutability

- Immutability, in the context of the blockchain, means that once something has been entered into the blockchain, it cannot be tampered with.

Activity 7.11
○ *Do you think immutability is valuable for financial institutions? If your answer is yes, Why?*

- The reason why the blockchain gets this property is that of the cryptographic hash function.
- In simple terms, hashing means taking an input string of any length and giving out an output of a fixed length. In the context of cryptocurrencies like bitcoin, the transactions are taken as input and run through a hashing algorithm (Bitcoin uses SHA-256) which gives an output of a fixed length.
- Let's see how the hashing process works. We are going to put in certain inputs. For this exercise, we are going to use the SHA-256 (Secure Hashing Algorithm 256).

INPUT	HASH
Hi	3639EFCD08ABB273B1619E82E78C29A7DF02C1051B1820E99FC395DCAA3326B8
Welcome to blockgeeks. Glad to have you here.	53A53FC9E2A03F9B6E66D84BA701574CD9CF5F01FB498C41731881BCDC68A7C8

- As you can see, in the case of SHA-256, no matter how big or small your input is, the output will always have a fixed 256-bits length. This becomes critical when you are dealing with a huge amount of data and transactions. So basically, instead of remembering the input data which could be huge, you can just remember the hash and keep track.

7.3.4. How Blockchain Works

Picture a spreadsheet that is duplicated thousands of times across a network of computers. Then imagine that this network is designed to regularly update this spreadsheet and you have a basic understanding of the blockchain.

Information held on a blockchain exists as a shared and continually reconciled database. This is a way of using the network that has obvious benefits. The blockchain database isn't stored in any single location, meaning the records it keeps are truly public and easily verifiable. No centralized version of this information exists for a hacker to corrupt. Hosted by millions of computers simultaneously, its data is accessible to anyone on the internet.

To go in deeper with the Google spreadsheet analogy, read the following scenario:

"The traditional way of sharing documents with collaboration is to send a Microsoft Word document to another recipient and ask them to make revisions to it. The problem with that scenario is that you need to wait until receiving a return copy before you can see or make other changes because you are locked out of editing it until the other person is done with it. That's how databases work today. Two owners can't be messing with the same record at once. That's how banks maintain money balances and transfers; they briefly lock access (or decrease the balance) while they make a transfer, then update the other side, then re-open access (or update again). With Google Docs (or Google Sheets), both parties have access to the same document at the same time, and the single version of that document is always visible to both of them. It is like a shared ledger, but it is a shared document. The distributed part comes into play when sharing involves a number of people. Imagine the number of legal documents that should be used that way. Instead of passing them to each other, losing track of versions, and not being in sync with the other version, why can't all business documents become shared instead of transferred back and forth? So many types of legal contracts would be ideal for that kind of workflow. You don't need a blockchain to share documents, but the shared documents analogy is a powerful one."

Activity 7.12

- *From the previous scenario, can you differentiate Microsoft word sharing, google docs sharing and blockchain sharing? Which one is more related to BitTorrent sharing?*

The reason why the blockchain has gained so much admiration is that:

- It is not owned by a single entity, hence it is decentralized
- The data is cryptographically stored inside

- The blockchain is immutable, so no one can tamper with the data that is inside the blockchain
- The blockchain is transparent so one can track the data if they want to

7.3.5. Why do people use the peer-to-peer network?

Activity 7.13
What is peer to peer means? Does it have a relationship with BitTorrent?

One of the main uses of the peer-to-peer network is file sharing, also called torrenting. If you are to use a client-server model for downloading, then it is usually extremely slow and entirely dependent on the health of the server. Plus, as we said, it is prone to censorship.

However, in a peer-to-peer system, there is no central authority, and hence if even one of the peers in the network goes out of the race, you still have more peers to download from. Plus, it is not subject to the idealistic standards of a central system.

Comparison between Traditional Centralized Downloading and Decentralized Peer-to-Peer Downloading (see Figure 7.3)

A. The sharing economy

- With companies like Uber and Airbnb flourishing, the sharing economy is already a proven success. Currently, however, users who want to hail a ride-sharing service have to rely on an intermediary like Uber. By enabling peer-to-peer payments, the blockchain opens the door to direct interaction between parties a truly decentralized sharing economy results.

B. Crowdfunding

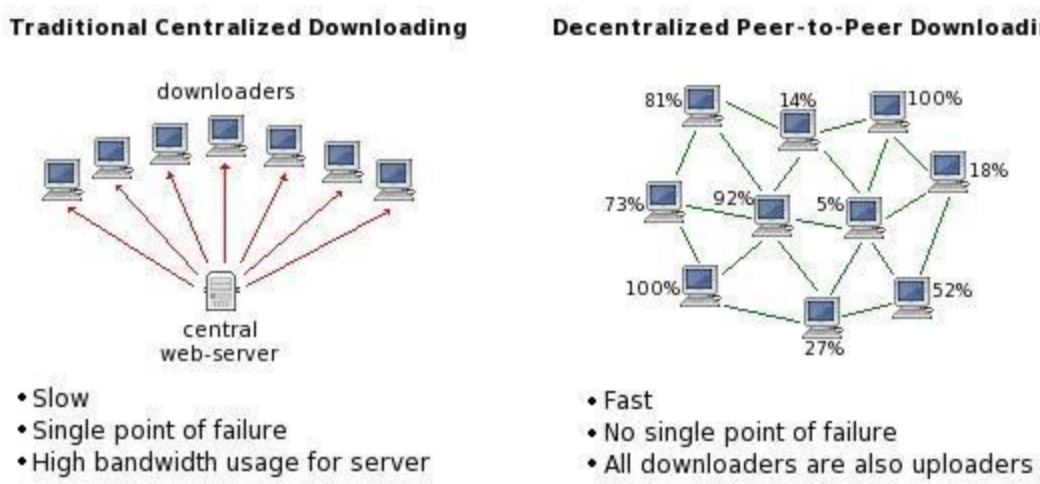

Figure 7.3 central and peer-to-peer downloading

7.3.6. Application of blockchain

Activity 7.14
○ List some applications of blockchain in business, file storage, in supply chain auditing?

- Crowdfunding initiatives like Kickstarter and GoFundMe are doing the advance work for the emerging peer-to-peer economy. The popularity of these sites suggests people want to have a direct say in product development. Blockchains take this interest to the next level, potentially creating crowd-sourced venture capital funds.

- In 2016, one such experiment, the Ethereum-based DAO (Decentralized Autonomous Organization), raised an astonishing $200 million USD in just over two months.

  Participants purchased “DAO tokens” allowing them to vote on smart contract venture capital investments (voting power was proportionate to the number of DAO they were holding).

C. Governance

- By making the results fully transparent and publicly accessible, distributed database technology could bring full transparency to elections or any other kind of poll taking.

Ethereum-based smart contracts help to automate the process.

- The app, Boardroom, enables organizational decision-making to happen on the blockchain. In practice, this means company governance becomes fully transparent and verifiable when managing digital assets, equity or information.

D. Supply chain auditing

- Consumers increasingly want to know that the ethical claims companies make about their products are real. Distributed ledgers provide an easy way to certify that the backstories of the things we buy are genuine. Transparency comes with blockchain-based timestamping of a date and location — on ethical diamonds, for instance — that corresponds to a product number.
- The UK-based Provenance offers supply chain auditing for a range of consumer goods. Making use of the Ethereum blockchain, a Provenance pilot project ensures that fish sold in Sushi restaurants in Japan have been sustainably harvested by its suppliers in Indonesia.

E. File storage

- Decentralizing file storage on the internet brings clear benefits. Distributing data throughout the network protects files from getting hacked or lost.
- Interplanetary File System (IPFS) makes it easy to conceptualize how a distributed web might operate. Similar to the way a BitTorrent moves data around the internet, IPFS gets rid of the need for centralized client-server relationships (i.e., the current web). An internet made up of completely decentralized websites has the potential to speed up file transfer and streaming times. Such an improvement is not only convenient. It's a necessary upgrade to the web's currently overloaded content-delivery systems.

7.4.Cloud and quantum computing

7.4.1. Cloud computing

Activity 7.15
What do you think cloud computing is? Is it related to the term cloud?

Cloud computing is a means of networking remote servers that are hosted on the Internet. Rather than storing and processing data on a local server, or a PC's hard drive, one of the following three types of cloud infrastructure is used.

The first type is a public cloud. Here a third-party provider manages the servers, applications, and storage much like a public utility. Anyone can subscribe to the provider's cloud service, which is usually operated through their own data center.

A business or organization would typically use a private cloud. This might be hosted on their onsite data center, although some companies host through a third-party provider instead. Either way, the computing infrastructure exists as a private network accessible over the Internet.

The third option is a hybrid cloud. Here private clouds are connected to public clouds, allowing data and applications to be shared between them. Private clouds existing alone can be very limiting, and a hybrid offers a business more flexibility. Often a hybrid cloud includes multiple service providers. Hybrids can offer more computing capacity for a business application when the need for its spikes. This sudden expansion into the public cloud is known as cloud bursting. Hybrids also enable applications to keep sensitive client data in a private cloud but connect to end-user software in a public cloud.

Cloud computing services can focus on infrastructure, web development or a cloud-based app. These are often regarded as a stack; all are on-demand, pay-as-you-go. Infrastructure as a Service (IaaS) gives you management of the whole deal: servers, web development tools, applications.

Platform as a Service (PaaS) offers a complete web development environment, without the worry of the hardware that runs it. Finally, Software as a Service (SaaS) allows access to cloud-based apps, usually through a web browser interface. SaaS is the top of the stack. Cloud computing has been around since 2000.

Yet it's only in the last 10 years that major players like IBM, Amazon, and Google have offered commercially viable, high-capacity networks.

7.4.2. Advantages of cloud computing

Activity 7.16
○ *List some applications of cloud computing in business, file storage?*

Well, much like with any utility -a business benefits from economy of scale, which means cheap computing power. Because a cloud provider’s hardware and software are shared, there’s no need for the initial costly capital investment. And it goes much further than that. Businesses save on the electricity required 24/7 to power and cool that computing infrastructure. In effect, energy costs are shared.

It gets better. Cloud providers have vast resources of computing power at their fingertips. They can allocate these whenever required with just a few mouse clicks. Cloud providers source on a global scale, so they can deliver the precise bandwidth, storage and power business needs when it needs it.

The cloud allows you and multiple users to access your data from any location. Smartphone, laptop, desktop, wherever you are, you can access the data you need at any time.

With cloud computing a business processes its data more efficiently, increasing productivity. Maintenance is much cheaper, often free, so reliability is rarely a worry. Cloud computing allows CEOs to focus on running their business.

7.4.3. Quantum computing

Quantum computers truly do represent the next generation of computing. Unlike classic computers, they derive their computing power by harnessing the power of quantum physics. Because of the rather nebulous science behind it, a practical, working quantum computer still remains a flight of fancy.

Give clients access to a quantum computer over the internet, and you have quantum cloud computing. Currently, the only organization which provides a quantum computer in the cloud is IBM. They allow free access to anyone who wishes to use their 5-qubit machine. Earlier this year they installed a 17-qubit machine. So far over 40,000 users have taken advantage of their online service to run experiments.

Not to be outdone, Google provided the fastest quantum computer with 53qubits and speed of 200 seconds computation while the supercomputer took 10000 years.

So, what is qubit and how many do you need?

Qubit is short for a sequence of quantum bits. With a classic computer, data is stored in tiny transistors that hold a single bit of information, either the binary value of 1 or 0. With a quantum computer, the data is stored in qubits. Thanks to the mechanics of quantum physics, where subatomic particles obey their own laws, a qubit can exist in two states at the same time. This phenomenon is called superposition.

So, a qubit can have a value of 1, 0, or some value between. Two qubits can hold even more values. Before long, you are building yourself an exponentially more powerful computer the more qubits you add.

Quantum computer theory was first rooted in the 1980s and only now are the first rudimentary machines being constructed. Quantum computers are big machines, reminiscent of the old mainframe computers of the 1960s. One serious logistical problem is the need for deep-freezing of the superconducting circuits. Only at sub-zero temperatures can the qubits maintain a constant, predictable superposition. Heating up qubits can result in calculation errors.

7.4.4. Advantages of quantum computing

Getting a quantum computer to function usefully is an exciting prospect for scientists. Their gargantuan computing power would allow them to crunch very long numbers. They would be able to make complex calculations that would only overwhelm classic computers.

Accessing a cloud-based quantum computer combines the benefits of both technologies exponentially. Quantum computing could help in the discovery of new drugs, by unlocking the complex structure of chemical molecules. Other uses include financial trading, risk management, and supply chain optimization. With its ability to handle more complex numbers, data could be transferred over the internet with much safer encryption.

7.5. Autonomic computing (AC)

Activity 7.17
○ *What is autonomous? What is computing? What do you think about autonomous computing?*

Autonomic computing (AC) is an approach to address the complexity and evolution problems in software systems. It is a self-managing computing model named after, and patterned on, the human body's autonomic nervous system. An autonomic computing system would control the functioning of computer applications and systems without input from the user, in the same way, that the autonomic nervous system regulates body systems without conscious input from the individual. The goal of autonomic computing is to create systems that run themselves, capable of high-level functioning while keeping the system's complexity invisible to the user.

It refers to the self-managing characteristics of distributed resources, adapting to unpredictable changes while hiding intrinsic complexity to operators and users. Initiated by IBM in 2001, this initiative ultimately aimed to develop computer systems capable of self-management, to overcome the rapidly growing complexity of computing system management, and to reduce the barrier that complexity poses to further growth.

7.5.1. Characteristics of Autonomic Systems

An autonomic system can self-configure at runtime to meet changing operating environments, selftune to optimize its performance, self-heal when it encounters unexpected obstacles during its operation, and of particular current interest. Protect itself from malicious attacks. An autonomic system can self-manage anything including a single property or multiple properties (see picture below).

Figure 7.4 Autonomic Characteristics

Autonomic systems/applications exhibit eight defining characteristics:

- **Self-Awareness**: An autonomic application/system "knows itself" and is aware of its state and its behaviors.
- **Self-Configuring**: An autonomic application/system should be able to configure and reconfigure itself under varying and unpredictable conditions.
- **Self-Optimizing**: An autonomic application/system should be able to detect suboptimal behaviors and optimize itself to improve its execution.
- **Self-Healing**: An autonomic application/system should be able to detect and recover from potential problems and continue to function smoothly.
- **Self-Protecting**: An autonomic application/system should be capable of detecting and protecting its resources from both internal and external attacks and maintaining overall system security and integrity.

- **Context-Aware**: An autonomic application/system should be aware of its execution environment and be able to react to changes in the environment.

- **Open**: An autonomic application/system must function in a heterogeneous world and should be portable across multiple hardware and software architectures. Consequently, it must be built on standard and open protocols and interfaces.
- **Anticipatory**: An autonomic application/system should be able to anticipate to the extent possible, its needs and behaviors and those of its context, and be able to manage itself proactively

7.6.Computer vision

Activity 7.18
- *What do you think about computer vision? Does it mean computers can see and interpret as humans do? If your answer is yes, how can computers can see?*

7.6.1. History

The origins of computer vision go back to an MIT undergraduate summer project in 1966. It was believed at the time that computer vision could be solved in one summer, but we now have a 50year old scientific field that is still far from being solved.

Early experiments in computer vision took place in the 1950s, using some of the first neural networks to detect the edges of an object and to sort simple objects into categories like circles and squares. In the 1970s, the first commercial use of computer vision interpreted typed or handwritten text using optical character recognition. This advancement was used to interpret written text for the blind. As the internet matured in the 1990s, making large sets of images available online for analysis, facial recognition programs flourished. These growing data sets helped make it possible for machines to identify specific people in photos and videos.

7.6.2. Definition

It is an interdisciplinary scientific field that deals with how computers can be made to gain a highlevel understanding of digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions. Understanding in this context means the transformation of visual images (the input of the retina) into descriptions of the world that can interface with other thought processes and elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory.

Another way to define computer vision is through its applications. Computer vision is building algorithms that can understand the content of images and use it for other applications.

7.6.3. How computer vision works

1. **Acquiring an image**: Images, even large sets, can be acquired in real-time through video, photos or 3D technology for analysis.
2. **Processing the image**: Deep learning models automate much of this process, but the models are often trained by first being fed thousands of labeled or pre-identified images.
3. **Understanding the image**: The final step is the interpretative step, where an object is identified or classified.

There are many types of computer vision that are used in different ways:

- Image segmentation partitions an image into multiple regions or pieces to be examined separately.
- Object detection identifies a specific object in an image. Advanced object detection recognizes many objects in a single image: a football field, an offensive player, a defensive player, a ball and so on. These models use an X, Y coordinate to create a bounding box and identify everything inside the box.
- Facial recognition is an advanced type of object detection that not only recognizes a human face in an image but identifies a specific individual.
- Edge detection is a technique used to identify the outside edge of an object or landscape to better identify what is in the image.

- Pattern detection is a process of recognizing repeated shapes, colors and other visual indicators in images.
- Image classification groups images into different categories.
- Feature matching is a type of pattern detection that matches similarities in images to help classify them.

Simple applications of computer vision may only use one of these techniques, but more advanced users, like computer vision for self-driving cars, rely on multiple techniques to accomplish their goal.

7.6.4. Applications of computer vision

Activity 7.19

- *Do you think that the way computer vision works is similar to humans' vision?*
- *Write down some specific applications of computer vision?*

Computer vision is being used today in a wide variety of real-world applications, which include:

- Optical character recognition (OCR): reading handwritten postal codes on letters (Figure 7.5a) and automatic number plate recognition (ANPR);
- Machine inspection: rapid parts inspection for quality assurance using stereo vision with specialized illumination to measure tolerances on aircraft wings or auto body parts (Figure 7.5b) or looking for defects in steel castings using X-ray vision;
- Retail: object recognition for automated checkout lanes (Figure 7.5c);
- Medical imaging: registering pre-operative and intra-operative imagery (Figure 7.5d) or performing long-term studies of people’s brain morphology as they age;
- Automotive safety: detecting unexpected obstacles such as pedestrians on the street, under conditions where active vision techniques such as radar or lidar do not work well (Figure 7.5e).
- Surveillance: monitoring for intruders, analyzing highway traffic (Figure 7.5f), and monitoring pools for drowning victims;

- Fingerprint recognition and biometrics: for automatic access authentication as well as forensic applications

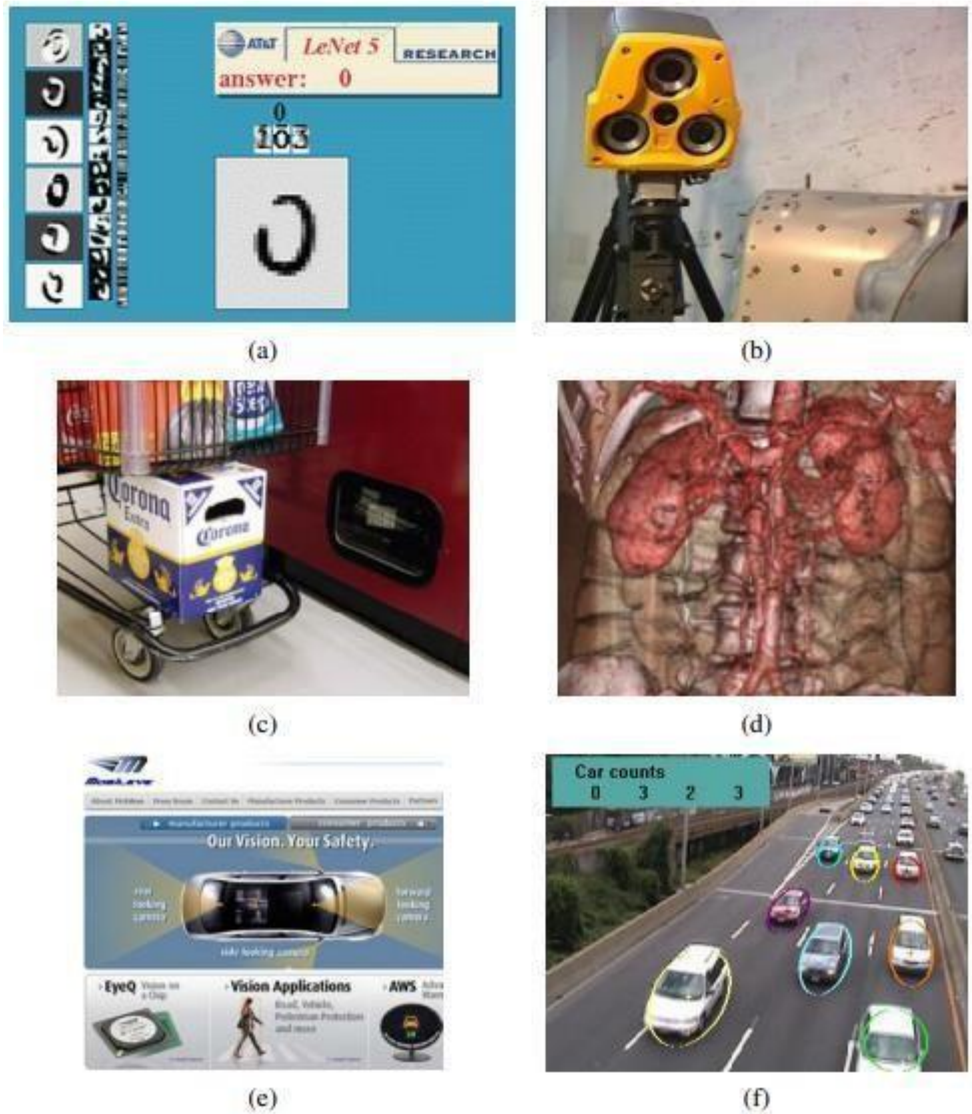

Figure 7.5 Some industrial applications of computer vision: (a) optical character recognition (OCR) (b) mechanical inspection (c) retail (d) medical imaging (e) automotive safety (f) surveillance and traffic monitoring

7.7.Embedded systems

Activity 7.20

- *What is the word embed mean? How can you define embedded systems?*

It is a controller with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is *embedded* as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Ninety-eight percent of all microprocessors manufactured are used in embedded systems.

Modern embedded systems are often based on microcontrollers (i.e. microprocessors with integrated memory and peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more complex systems. In either case, the processor(s) used may be types ranging from general-purpose to those specialized in a certain class of computations, or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).

7.7.1. Advantages and disadvantages of embedded system Advantages of Embedded

- Easily Customizable
- Low power consumption
- Low cost
- Enhanced performance

Disadvantages of Embedded systems

- High development effort
- Larger time to market

7.7.2. Basic Structure of an Embedded System Figure 7.6 shows the basic structure of an embedded system.

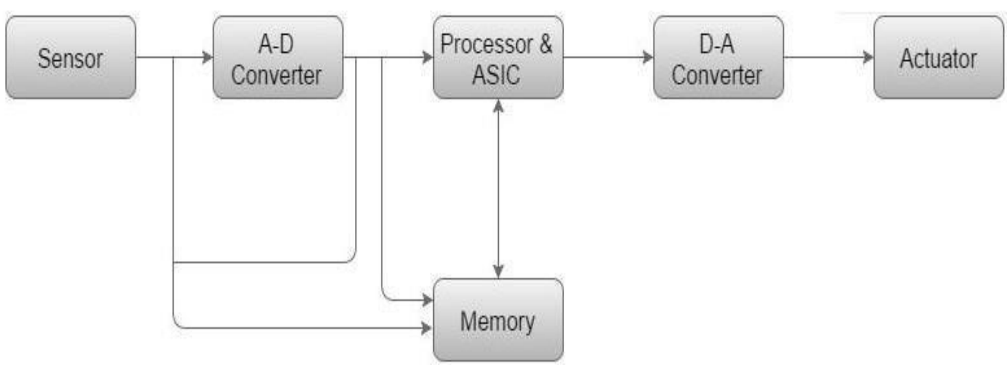

Figure 7.6 Basic structure of an embedded system

- **Sensor** − It measures the physical quantity and converts it to an electrical signal which can be read by an observer or by any electronic instrument like an A2D converter. A sensor stores the measured quantity to the memory.
- **A-D Converter** − An analog-to-digital converter converts the analog signal sent by the sensor into a digital signal.
- **Processor & ASICs** − Processors process the data to measure the output and store it to the memory.
- **D-A Converter** − A digital-to-analog converter converts the digital data fed by the processor to analog data.
- **Actuator** − An actuator compares the output given by the D-A Converter to the actual (expected) output stored in it and stores the approved output.

7.8.Cybersecurity

Activity 7.21

- *Can you describe cybersecurity? Begin by defining the two words cyber and security?*

Do you think cybersecurity is important? Why?

7.8.1. Definition

It is the protection of computer systems from the theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide.

The field is becoming more important due to increased reliance on computer systems, the Internet and wireless network standards such as Bluetooth and Wi-Fi, and due to the growth of smart devices, including smartphones, televisions, and the various devices that constitute the Internet of Things. Due to its complexity, both in terms of politics and technology, cybersecurity is also one of the major challenges in the contemporary world.

Cybersecurity is often confused with information security but it focuses on protecting computer systems from unauthorized access or being otherwise damaged or made inaccessible. Information security is a broader category that looks to protect all information assets, whether in hard copy or in digital form.

The term cybercrime is used to describe an unlawful activity in which computer or computing devices such as smartphones, tablets, Personal Digital Assistants (PDAs), etc. which are standalone or a part of a network are used as a tool or/and target of criminal activity. It is often committed by the people of destructive and criminal mindset either for revenge, greed or adventure. Combating this is a multi-disciplinary affair that spans hardware and software through to policy and people all of it aimed at both preventing cybercrimes occurring in the first place, and minimizing its impact when it does.

7.8.2. Cybersecurity measures

Activity 7.22

- *How can someone secure himself/herself from hackers or digital criminals? Do you think securing yourself is important at this time?*

The following are some security measures to be taken to prevent cybercrimes:

- **Staff awareness training: -** Human error is the leading cause of data breaches, so you need to equip staff with the knowledge to deal with the threats they face. Training courses will show staff how security threats affect them and help them apply best-practice advice to real-world situations.
- **Application security: -** Web application vulnerabilities are a common point of intrusion for cybercriminals. As applications play an increasingly critical role in business, it is vital to focus on web application security.
- **Network security: -** Network security is the process of protecting the usability and integrity of your network and data. This is achieved by conducting a network penetration test, which scans your network for vulnerabilities and security issues.
- **Leadership commitment: -** Leadership commitment is the key to cyber resilience. Without it, it is very difficult to establish or enforce effective processes. Top management

must be prepared to invest in appropriate cybersecurity resources, such as awareness training.

- **Password management: -** Almost half of the UK population uses 'password', '123456' or 'qwerty' as their password. You should implement a password management policy that provides guidance to ensure staff create strong passwords and keep them secure.

7.8.3. Types of cybersecurity threats

- **Ransomware: -** It is a type of malicious software. It is designed to extort money by blocking access to files or the computer system until the ransom is paid. Paying the ransom does not guarantee that the files will be recovered or the system restored.
- **Malware:-** itis a type of software designed to gain unauthorized access or to cause damage to a computer[64].
- **Social engineering: -** it is a tactic that adversaries use to trick you into revealing sensitive information. They can solicit a monetary payment or gain access to your confidential data. Social engineering can be combined with any of the threats listed above to make you more likely to click on links, download malware, or trust a malicious source.
- **Phishing: -** it is the practice of sending fraudulent emails that resemble emails from reputable sources. The aim is to steal sensitive data like credit card numbers and login information. It's the most common type of cyber-attack. You can help protect yourself through education or a technology solution that filters malicious emails.

7.8.4. Benefits of cybersecurity

Benefits of utilizing cybersecurity include:

- Business protection against malware, ransomware, phishing, and social engineering.
- Protection for data and networks.
- Prevention of unauthorized users.
- Improves recovery time after a breach.
- Protection for end-users.
- Improved confidence in the product for both developers and customers.

7.8.5. Cybersecurity vendors

Vendors in cybersecurity fields will typically use endpoint, network and advanced threat protection security as well as data loss prevention. Three commonly known cybersecurity vendors include Cisco, McAfee, and Trend Micro.

Activity 7.23

- *Can you mention some cybersecurity threats you face?*
- *Write down some benefits of cybersecurity measures?*
- *List down some anti-virus vendors?*

7.9.Additive manufacturing (3D Printing)

Activity 7.24

- Define additive manufacturing? Just begin by defining the two words additive and manufacturing?
- What is the 3D printer?

Are "3D printing" and "additive manufacturing" (AM) the same thing? In general, we know that terms stretch over time to include more than just their default meanings. Whatever the name, new ways of fabricating directly from bytes to stuff are radically changing the what, where, how, and when of making objects. What roles, then, do the two terms "additive manufacturing" and "3D printing" play in describing new ways of making?

Let's start by considering what the experts have to say:

- The American Society for Testing and Materials (ASTM) equates the two terms in their definition: "Additive manufacturing, also known as 3D printing, uses computer-aided design to build objects layer by layer."

- Wikipedia says, “Today, the precision, repeatability, and material range has increased to the point that 3D printing is considered as industrial production technology, with the name of additive manufacturing.”
- Author Deve Turbide puts it simply, suggesting that additive manufacturing is “the industrial version of 3D printing”.

7.9.1. 3D Printing: It's All About the Printer

When MIT invented binder jet printing in the 1980s, they wrote: “three-dimensional printing is a process under development at MIT for the rapid and flexible production of prototype parts, enduse parts, and tools directly from a CAD model.”

Today our concept of “3D printing” is much broader, but the term is often associated with filamentbased plastic printers, which are the pride and joy of many a hobbyist and selfdescribed maker. But there are also binder jet printers, laser metal 3D printers, as well as glass and clay 3D printers[66].

7.9.2. Additive Manufacturing: A Bytes-to-Parts Supply Chain

“Additive manufacturing” (AM) is a big-picture term more at home in the boardroom than the factory floor or garage. Naturally, AM separates itself from older, subtractive technologies like milling. Otherwise, the term is less about the 3D printer itself, and more about the manufacturing process transformed by 3D printing.

What is that transformation? AM changes the way we think about inventory and supply chain, taking parts from the point of manufacture to the point of use?

AM is flexible in the time it takes to load a file, from anywhere in the world. It enables customized parts, in volume, and involves stocking raw materials like filament and printing spare parts on demand.

Additive manufacturing (AM) describes types of advanced manufacturing that are used to create three-dimensional structures out of plastics, metals, polymers and other materials that can be sprayed through a nozzle or aggregated in a vat. These constructs are added layer by layer in realtime based on digital design. The simplicity and low cost of AM machines, combined with the scope of their potential creations, could profoundly alter global and local economies and affect international security.

Chapter Seven Review Questions

1. What is nanotechnology? Write down some applications of nanotechnology?
2. Briefly explain biotechnology and its importance in agriculture, medicine, and the environment?
3. What is Blockchain technology? Briefly explain how it works?
4. Briefly explain cloud and quantum computing?
5. What is autonomic computing? Write down some of its characteristics?
6. What is Computer vision? List down some real-world applications?
7. Briefly explain embed systems and its components?
8. What is cybersecurity? List some cybersecurity treats? Write down the advantages of cybersecurity?
9. Briefly explain additive manufacturing?

Bibliography

E. S. Ruiz and F. M. U. R. Perez, “German carro fernandez, sergio martin gutierrez, elio sancristobal ruiz, francisco mur perez, and manuel castro gil ©,” no. June, pp. 51–58, 2012.

F. Griffiths and M. Ooi, “The fourth industrial revolution - Industry 4.0 and IoT [Trends in Future I&M],” *IEEE Instrum. Meas. Mag.*, vol. 21, pp. 29–43.

M. Maier, S. Member, and M. Lévesque, “Dependable Fiber-Wireless (FiWi) Access Networks and Their Role in a Sustainable Third Industrial Revolution Economy,” vol. 63, no. 2, pp. 386–400, 2014.

S. Product, “Revolution Impact : Technology,” no. April, pp. 51–56, 2017.

J. Y. Park, J. Song, E. Seol, M. Seok, and K. Song, “MON-PO326: Constructing Standardized Nursing Practice on Korean Nutrition Support Nurses,” *Clin. Nutr.*, vol. 38, no. 2019, pp. S178–S179.

J. Hoerni, “Semiconductors and the second industrial revolution,” pp. 38–39, 1982.

C. Production, “YEAR 6 : THE INDUSTRIAL REVOLUTION (6 lessons) Lesson 1. Introduction to the Industrial Revolution.”

J. Wan *et al.*, “Software-Defined Industrial Internet of Things in the Context of Industry 4. 0,” vol. 16, no. 20, pp. 7373–7380, 2016.

H. Xu, W. Yu, D. Griffith, and N. Golmie, “A Survey on Industrial Internet of Things : A CyberPhysical Systems Perspective,” *IEEE Access*, vol. PP, no. c, p. 1, 2018.

Data Science: A Comprehensive Overview LONGBING CAO, University of Technology Sydney, Australia 2017

Smith, F.J., Data science as an academic discipline. Data Science Journal, 5, 2006. pp.163–164.

Mike Loukides, “What is Data Science?”, O’Reilly Media, Inc.”2011. pp10-22.

Thomas L. Floyd, “Digital Fundamentals with PLD Programming”, Pearson Prentice Hall, 2006, Prakash G. Gupta, “Data Communications and Computer Networking”, Prentice-Hall, 2006 Martin L. Shoemaker, “Human-Machine Interface”, Independently Published, 2019

“An Introduction to Big Data Concepts and Terminology” [Online]. Available : https://www.digitalocean.com/community/tutorials/an-introduction-to-big-data-conceptsandterminology [Accessed: September 7, 2019]

“Data Types: Structured vs. Unstructured Data” [Online]. Available: https://www.bigdataframework.org/data-types-structured-vs-unstructured-data/ Accessed September 7, 2019.

“What is Data Science? “https://datascience.berkeley.edu/about/what-is-data-science/ [Online]. Available : [Accessed: September 7, 2019]

“The Data Value Chain”https://opendatawatch.com/reference/the-data-value-chainexecutivesummary/ [Online]. Available : [Accessed: September 7, 2019]

“Big Data Analytics – Data Scientist” https://www.tutorialspoint.com/big_data_analytics/data_scientist.htm [Online]. Available : [Accessed: September 7, 2019]

“Introduction of Artificial Intelligence - Javatpoint,” www.javatpoint.com. [Online]. Available: https://www.javatpoint.com/introduction-to-artificial-intelligence. [Accessed: 07-Nov-2019].

“Artificial Intelligence | An Introduction,” GeeksforGeeks, 08-Sep-2017.

“An introduction to Artificial Intelligence.” [Online]. Available: https://hackernoon.com/understanding-understanding-an-intro-to-artificialintelligencebe76c5ec4d2e. [Accessed: 07-Nov-2019].

“AI Overview,” Snips. [Online]. Available: https://snips.ai/content/intro-to-ai/#device-metrics. [Accessed: 07-Nov-2019].

“History of Artificial Intelligence - Javatpoint,” www.javatpoint.com. [Online]. Available: https://www.javatpoint.com/history-of-artificial-intelligence. [Accessed: 08-Nov-2019].

"Top 15 Artificial Intelligence Platforms - Compare Reviews, Features, Pricing in 2019," PAT RESEARCH: B2B Reviews, Buying Guides & Best Practices, 15-Jul-2019. [Online]. Available: https://www.predictiveanalyticstoday.com/artificial-intelligence-platforms/. [Accessed: 08Nov2019].

"Best AI Platforms Software in 2019 | G2." [Online]. Available: https://www.g2.com/categories/ai-platforms. [Accessed: 08-Nov-2019].

Brewster, C., Roussaki, I., Kalatzis, N., Doolin, K., & Ellis, K. (2017). IoT in agriculture: Designing a Europe-wide large-scale pilot. *IEEE communications magazine*, *55*(9), 26-33.

Ramakrishna, G.Kiran Kumar, A.Mallikarjuna Reddy, Pallam Ravi (2018). A Survey on various IoT Attacks and its Countermeasures. International Journal of Engineering Research in Computer Science and Engineering (IJERCSE), 5(4), 2394-2320.

Elijah, O., Rahman, T. A., Orikumhi, I., Leow, C. Y., & Hindia, M. N. (2018). An overview of the Internet of Things (IoT) and data analytics in agriculture: Benefits and challenges. *IEEE Internet of Things Journal*, *5*(5), 3758-3773.

Elijah, O., Rahman, T. A., Orikumhi, I., Leow, C. Y., & Hindia, M. N. (2018). An overview of the Internet of Things (IoT) and data analytics in agriculture: Benefits and challenges. *IEEE Internet of Things Journal*, *5*(5), 3758-3773.

Foote, K. D. (2016). A brief history of the internet of things. *Data Education for Business and IT Professionals. Available online: http://www. dataversity. net/brief-history-internet-things/ (accessed on 12 November 2018)*.

Gupta, B. B., & Quamara, M. (2018). An overview of the Internet of Things (IoT): Architectural aspects, challenges, and protocols. *Concurrency and Computation: Practice and Experience*, e4946.

John Terra (2019). Everything You Need to Know About IoT Applications. https://www.simplilearn.com/iot-applications-article

Mohamed, K. S. (2019). The Era of Internet of Things: Towards a Smart World. In the Era of Internet of Things (pp. 1-19). Springer, Cham.

Vyas, D. A., Bhatt, D., & Jha, D. (2015). IoT: trends, challenges, and future scope. *IJCSC*, *7*(1), 186-197.

Antonioli, M., Blake, C., & Sparks, K. (2014). Augmented reality applications in education. *The Journal of Technology Studies*, 96-107.

Chavan, S. R. (2016). Augmented Reality Vs Virtual Reality: Differences and Similarities. *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)*, *5*(6).

Håkansson, L. (2018). Virtual and Augmented Reality in Marketing.

Kipper, G., & Rampolla, J. (2012). *Augmented Reality: an emerging technologies guide to AR*. Elsevier.

Kirner, C., Cerqueira, C., & Kirner, T. (2012). Using augmented reality artifacts in education and cognitive rehabilitation. *Virtual Reality in Psychological, Medical and Pedagogical Applications 2 Will-be-set-by-IN-TECH*, 247-270.

Margetis, G., Papagiannakis, G., & Stephanidis, C. (2019). Realistic Natural Interaction with Virtual Statues in X-Reality Environments. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *42*(2/W11).

Thimbleby, H. (2013). Technology and the future of healthcare. *Journal of public health research*, *2*(3).

Thomas, B. H. (2012). A survey of visual, mixed, and augmented reality gaming. *Computers in Entertainment (CIE)*, *10*(1), 3.

“Ethics and new technologies.” [Online]. Available: https://www.icaew.com/technical/ethics/ethics-and-new-technologies. [Accessed: 25-Aug-2019].

J. Weckert and R. Lucas, Professionalism in the Information and Communication Technology Industry. Canberra: ANU Press, 2013.

"Code of Ethics," PROFESSIONAL CERTIFICATIONS FOR EMERGING TECH. [Online]. Available: http://iccp.org/code-of-ethics.html. [Accessed: 25-Aug-2019].

"IT Privacy Policy, Office of Privacy and Open Government, U.S. Department of Commerce." [Online]. Available: http://www.osec.doc.gov/opog/privacy/digital_policy.html. [Accessed: 25Aug-2019].

"As technology advances, will accountability be a casualty?" [Online]. Available: https://www.ey.com/en_gl/banking-capital-markets/as-technology-advances-willaccountabilitybe-a-casualty. [Accessed: 02-Sep-2019].

"How can you build trust when emerging technologies bring new risks?" [Online]. Available: https://www.ey.com/en_gl/digital/how-can-you-build-trust-when-emerging-technologiesbringnew-risks. [Accessed: 02-Sep-2019].

"What comes after those ellipses?," BusinessDictionary.com. [Online]. Available: http://www.businessdictionary.com/definition/accountability.html. [Accessed: 08-Sep-2019].

"'Emerging Technologies are Already Impacting Security Strategies,'" IFSEC India, 11-Jan2019. [Online]. Available: https://www.ifsec.events/india/visit/news-andupdates/emergingtechnologies-are-already-impacting-security-strategies. [Accessed: 02-Sep2019].

C. Lovatt, "5 Big Technology Challenges For Enterprises In The Future." [Online]. Available: https://blog.cutover.com/technology-challenges-enterprises-future. [Accessed: 08-Sep-2019]. "What are the ethical implications of emerging tech?," World Economic Forum. [Online]. Available: https://www.weforum.org/agenda/2015/03/what-are-the-ethical-implicationsofemerging-tech/. [Accessed: 25-Aug-2019].

B. Dainow, "Ethics in Emerging Technology," ITNOW, vol. 56, pp. 16–18, Aug. 2014.

"7 Emerging Technology Risks," Risk & Insurance, 04-Aug-2014. [Online]. Available: https://riskandinsurance.com/7-emerging-tech-risks/. [Accessed: 08-Sep-2019].

"12 Examples of Artificial Intelligence: AI Powers Business." [Online]. Available:

https://www.datamation.com/artificial-intelligence/examples-of-artificial-intelligence.html. [Accessed: 09-Nov-2019].

"What is Nanotechnology? | Nano." [Online]. Available: https://www.nano.gov/nanotech101/what/definition. [Accessed: 08-Sep-2019].

"How Nanotechnology Works," HowStuffWorks, 25-Oct-2007. [Online]. Available: https://science.howstuffworks.com/nanotechnology.htm. [Accessed: 08-Sep-2019]. "Nanotechnology - Definition and Introduction. What is nanotechnology?" Nanowerk. [Online].

Available: https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php. [Accessed: 08-Sep-2019].

"Nanotechnology Applications | Nanotechnology Uses." [Online]. Available: https://www.understandingnano.com/nanotech-applications.html. [Accessed: 08-Sep-2019].

R. M. Divya TN, "Applications of Nanotechnology," J. Nanomedicine Biotherapeutic Discov., vol. 05, no. 01, 2015.

"What is Biotechnology?" BIO. [Online]. Available: https://www.bio.org/what-biotechnology. [Accessed: 08-Sep-2019].

C. Fossen, "What is Biotechnology? - Department of Biotechnology and Food Science." [Online]. Available: https://www.ntnu.edu/ibt/about-us/what-is-biotechnology. [Accessed: 08-Sep-2019].

"Benefits & Risks of Biotechnology," Future of Life Institute. [Online]. Available: https://futureoflife.org/background/benefits-risks-biotechnology/. [Accessed: 08-Sep-2019].

"Biotechnology and its Applications - Study Material for NEET (AIPMT) & Medical Exams | askIITians." [Online]. Available: /biology/biotechnology-and-its-applications/. [Accessed: 08Sep2019].

"What is Blockchain Technology? A Step-by-Step Guide for Beginners," Blockgeeks, 18Sep2016. [Online]. Available: https://blockgeeks.com/guides/what-is-blockchain-technology/. [Accessed: 23-Nov-2019].

"5 applications for blockchain in your business." [Online]. Available: https://execed.economist.com/blog/industry-trends/5-applications-blockchain-yourbusiness. [Accessed: 08-Sep-2019].

L. Fortney, "Blockchain Explained," Investopedia. [Online]. Available: https://www.investopedia.com/terms/b/blockchain.asp. [Accessed: 08-Sep-2019].

"What is Quantum Cloud Computing?" [Online]. Available: http://quantumly.com/quantumcloudcomputer-computing.html. [Accessed: 08-Sep-2019].

H. A. Müller, L. O'Brien, M. Klein, and B. Wood, "Autonomic Computing," p. 61.

"What is autonomic computing? - Definition from WhatIs.com," WhatIs.com. [Online]. Available: https://whatis.techtarget.com/definition/autonomic-computing. [Accessed: 02-Sep-2019].

M. Parashar and S. Hariri, "Autonomic Computing: An Overview," in Unconventional Programming Paradigms, vol. 3566, J.-P. Banâtre, P. Fradet, J.-L. Giavitto, and O. Michel, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2005, pp. 257–269.

C. R. Krishna, "Computer Vision: Foundations and Applications," p. 213.

"Computer Vision: What it is and why it matters." [Online]. Available: https://www.sas.com/en_us/insights/analytics/computer-vision.html. [Accessed: 02-Sep-2019].

R. Szeliski, "Computer Vision: Algorithms and Applications," p. 979.

"Embedded Systems - Overview - Tutorialspoint." [Online]. Available: https://www.tutorialspoint.com/embedded_systems/es_overview.htm. [Accessed: 02-Sep-2019].

"What is Cyber Security? | IT Governance UK." [Online]. Available: https://www.itgovernance.co.uk/what-is-cybersecurity. [Accessed: 02-Sep-2019].

D. J. Pande, “Introduction to Cyber Security,” p. 152.

“Cybersecurity: Threats, Challenges, Opportunities,” p. 72.

“What Is Cybersecurity?” Cisco. [Online]. Available: https://www.cisco.com/c/en/us/products/security/what-is-cybersecurity.html. [Accessed: 02Sep2019].

“What is Cybersecurity? - Definition from WhatIs.com,” SearchSecurity. [Online]. Available: https://searchsecurity.techtarget.com/definition/cybersecurity. [Accessed: 02-Sep-2019].

“3D Printing and Additive Manufacturing – What’s the Difference?” All3DP, 24-Jan-2019. [Online]. Available: https://all3dp.com/2/3d-printing-and-additive-manufacturing-what-sthedifference/. [Accessed: 02-Sep-2019].

T. Johnston, T. Smith, and J. Irwin, Additive Manufacturing in 2040: Powerful Enabler, Disruptive Threat. RAND Corporation, 2018.

B.-H. Lu, H.-B. Lan, H.-Z. Liu, 1State Key Laboratory for Manufacturing System Engineering, Xi’an Jiao Tong University, Xi’an 710049, China, 2Qingdao Engineering Research Center for 3D Printing, Qingdao University of Technology, Qingdao 266033, China, and 3Nanomanufacturing and Nano-Optoelectronics Lab, Qingdao University of Technology, Qingdao 266033, China,

“Additive manufacturing frontier: 3D printing electronics,” Opto-Electron. Adv., vol. 1, no. 1, pp. 17000401–17000410, 2018.