CHAPTER ONE

INTRODUCTION TO EMERGING TECHNOLOGIES

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Objective

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

Emerging Technology

Activity 1.1

1. Define emerging technologies?
2. Define Technology and Evolution in the context of your prior knowledge and compare it with the discussion given below?

- **Emerging technology** is 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**.
- It also refers to technologies that are **currently developing**, or that are expected to be available within the next five to ten years.
- It is usually reserved for technologies that are creating or are expected to create significant social or economic effects.

Cont'd…

- **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**: it 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."

❖ ***Technological evolution*** is a theory of radical transformation of society through technological development.

Activity 1.2

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

Cont'd…

❖ List of some currently available emerged technologies

- ✓ Artificial Intelligence
- ✓ Block chain
- ✓ 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)

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.
- 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.
- It 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.
- 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.

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Cont'd…

- 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.

Cont'd…

Activity 1.3

What are the most important inventions of industrial revolutions?

The Most Important Inventions of the Industrial Revolution are:

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

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.

1. Industrial Revolution (IR1.0)

- 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

2. Industrial Revolution (IR2.0)

- 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

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3. Industrial Revolution (IR3.0)

- 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

Cont'd…

Activity 1.4

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

4. Fourth Industrial Revolution (IR4.0)

- Now, with advancements in various technologies such as robotics, Internet of Things (IoT see Figure 1.4), additive manufacturing and autonomous vehicles.
- 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 – cyber- physical 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.

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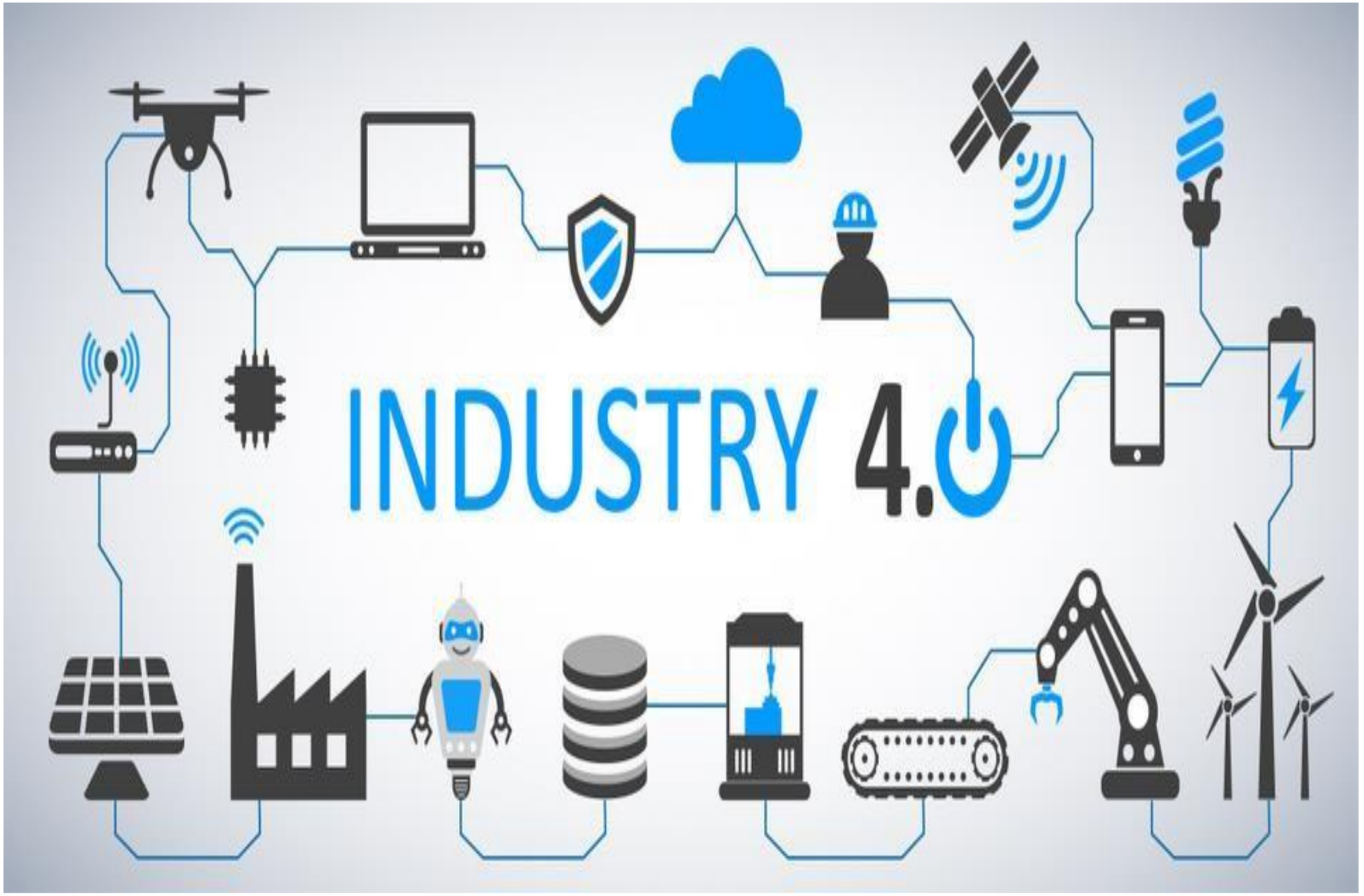

Figure 1. 4 Anybody Connected device (ABCD)

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?*

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 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.

Cont'd…

- 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.

Future Trends in Emerging Technologies

- 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

CHAPTER TWO

INTRODUCTION TO DATA SCIENCE

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Objective

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.

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.

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 orelectronic 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.).
- I***nformation*** 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.

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.*

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

Cont'd…

- **Input** − 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** − 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** − 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.

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.

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. 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

Cont'd…

Structured Data

- ✓ **Structured data** is data that adheres to a pre-defined data model and is therefore straightforward to analyze. ‘
- ✓ It 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 No- SQL 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*

Data value Chain

- 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:

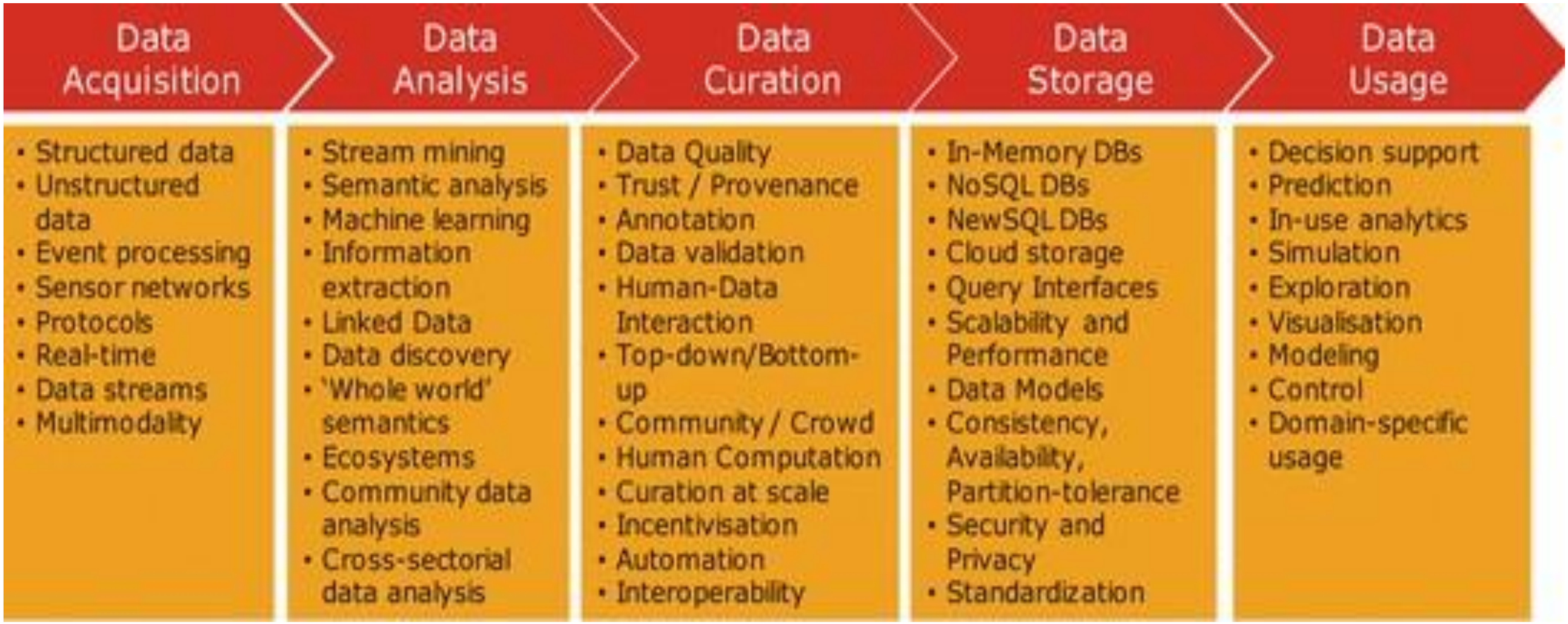

Figure 2.3 Data Value Chain

1. Data Acquisition

Cont'd…

- 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. 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.

Cont'd…

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.

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.

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 decision-making 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*?

Cont'd…

- 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.

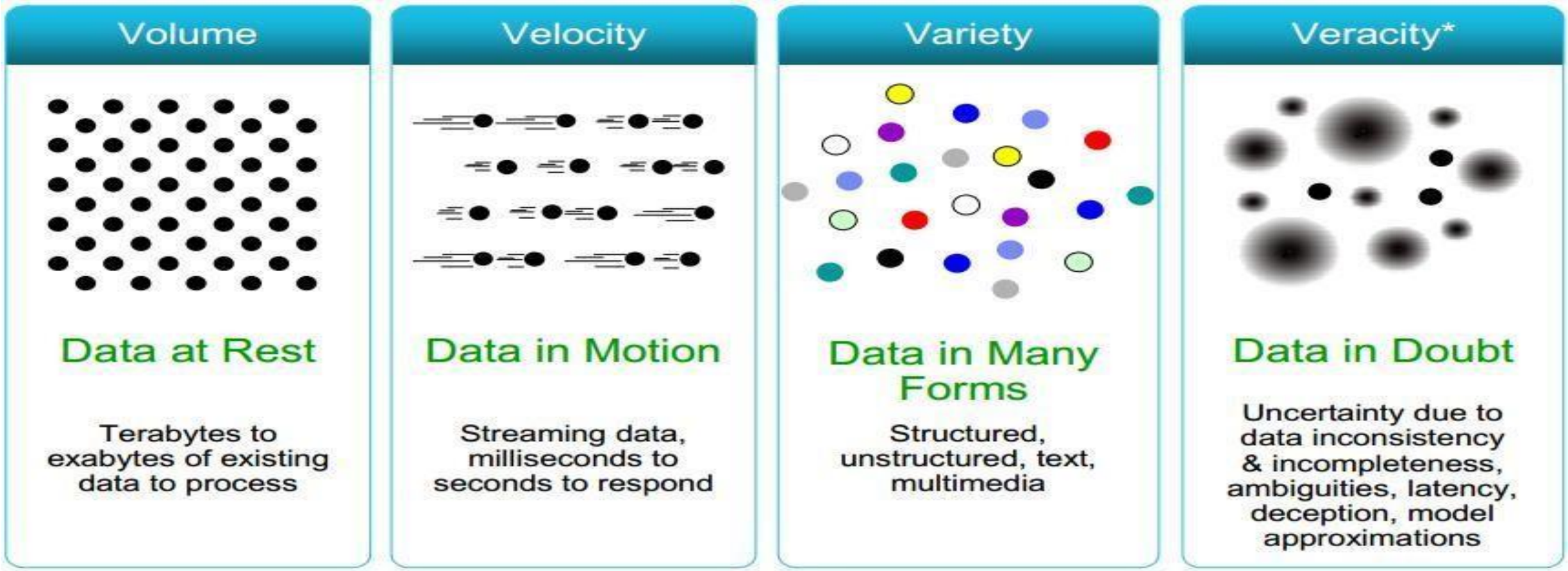

Figure 2.4 Characteristics of big data

CHAPTER THREE

ARTIFICIAL INTELLIGENCE (AI)

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Objective

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

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.

Cont'd…

- 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?*

Cont'd…

- 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.

Cont'd…

- 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**.

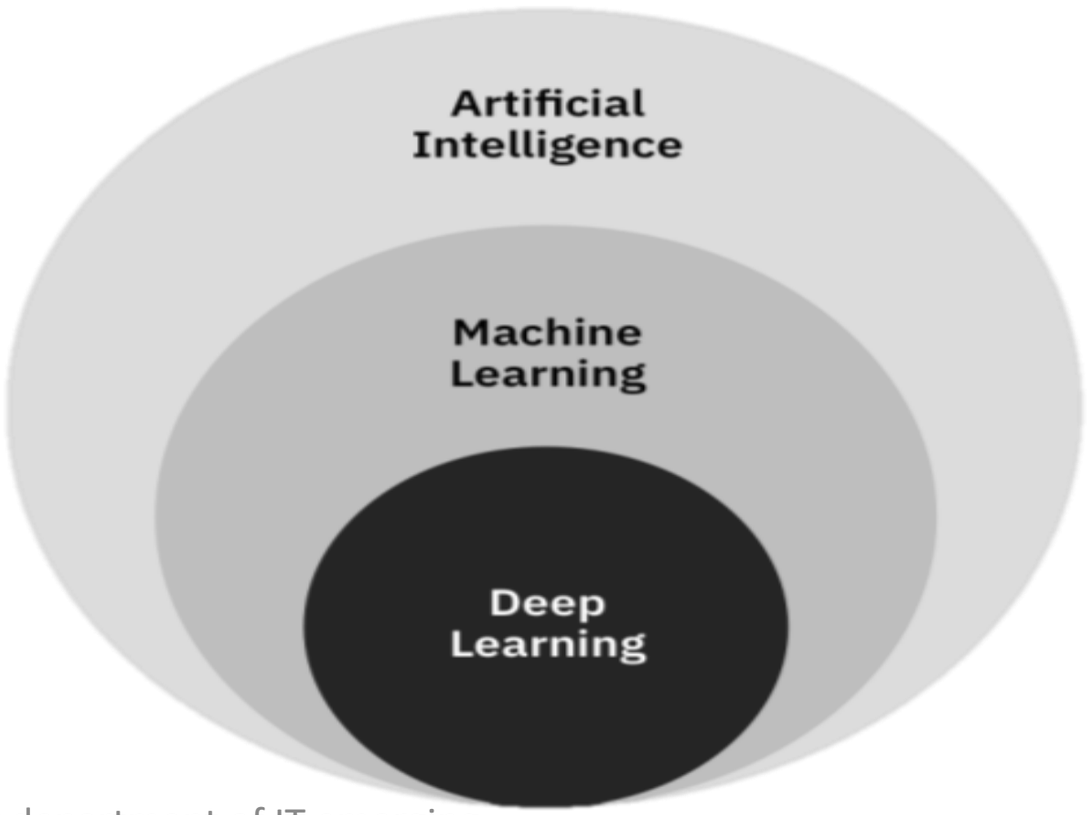

Figure 3.1 Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL)

Cont'd…

Activity 3.3

➢ *Why we need AI at this time?*

Need for Artificial Intelligence

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

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?*

Cont'd…

Goals of Artificial Intelligence

- Following are the main goals of Artificial Intelligence:
  - ✓ Replicate human intelligence
  - ✓ Solve Knowledge-intensive tasks
  - ✓ An intelligent connection of perception and action
  - ✓ Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation
    - Driving a car in traffic
  - ✓ Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

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 self-driving 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.

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?*

- 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.

Levels of AI *Cont'd…*

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.

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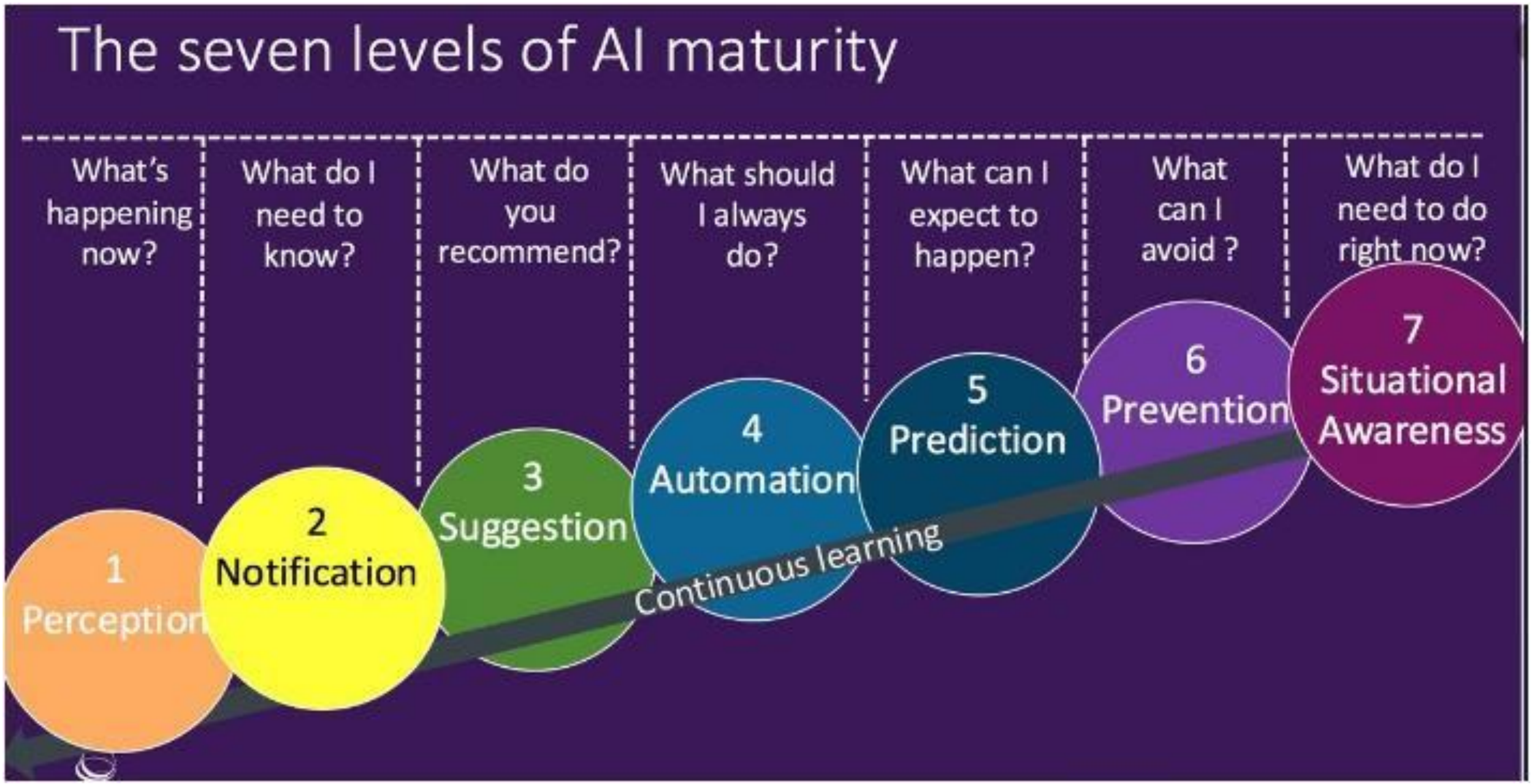

Figure 3.4 The seven layers of AI maturity

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.

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.

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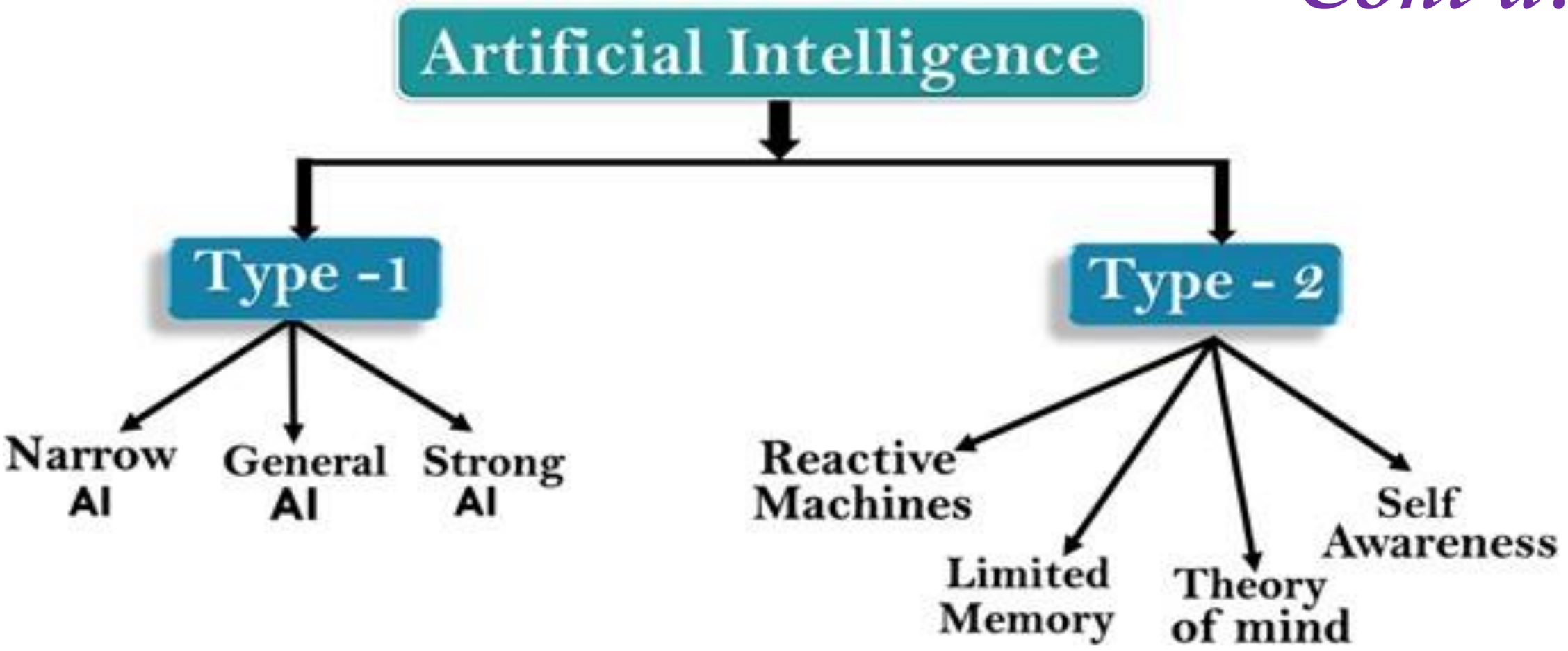

Figure 3.5 types of Artificial Intelligence (AI)

- 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 pre-defined 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

Cont'd…

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.

Cont'd…

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 self- awareness.
- These machines will be smarter than the human mind.
- Self-Awareness AI does not exist in reality still and it is a hypothetical concept.

How humans think *Cont'd...*

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.

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.

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- 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.

Influencers of artificial intelligence

Activity 3.13

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

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

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

Structured data versus unstructured data

Cont'd…

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

Cont'd...

- 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.

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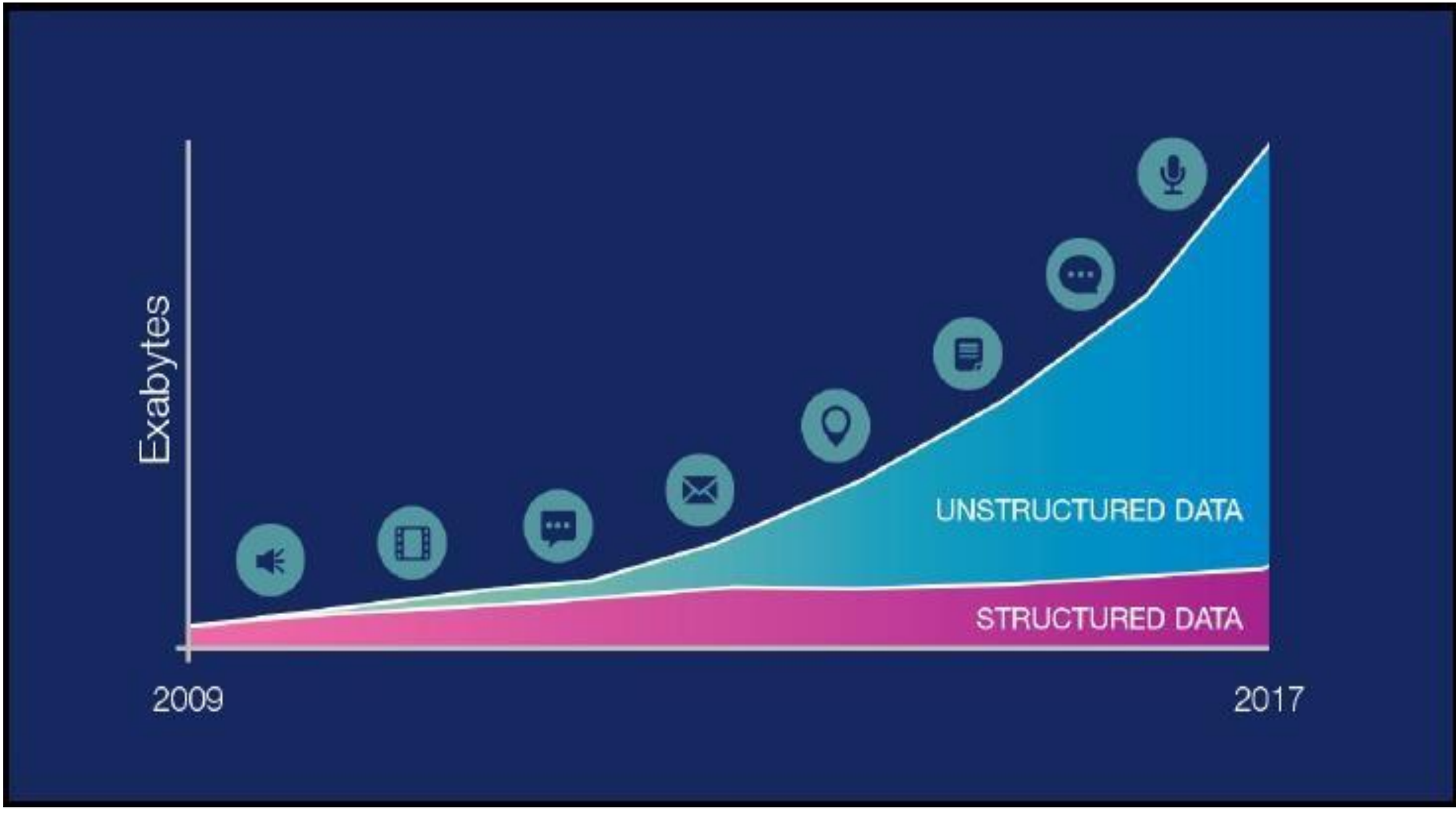

Figure 3.7 The comparison between the growth of structured and unstructured data

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, chat bot, 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.

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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 AI- powered 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.

CHAPTER FOUR

INTERNET OF THINGS (IOT)

Gage univeristy department of IT emerging technology

Objective

After completing this chapter, the 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

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.

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- **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.

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- he 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.

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- 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.

❖ IoT systems allow users to achieve deeper automation, analysis, and integration within a system. They improve the reach of these areas and their accuracy.

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- 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).

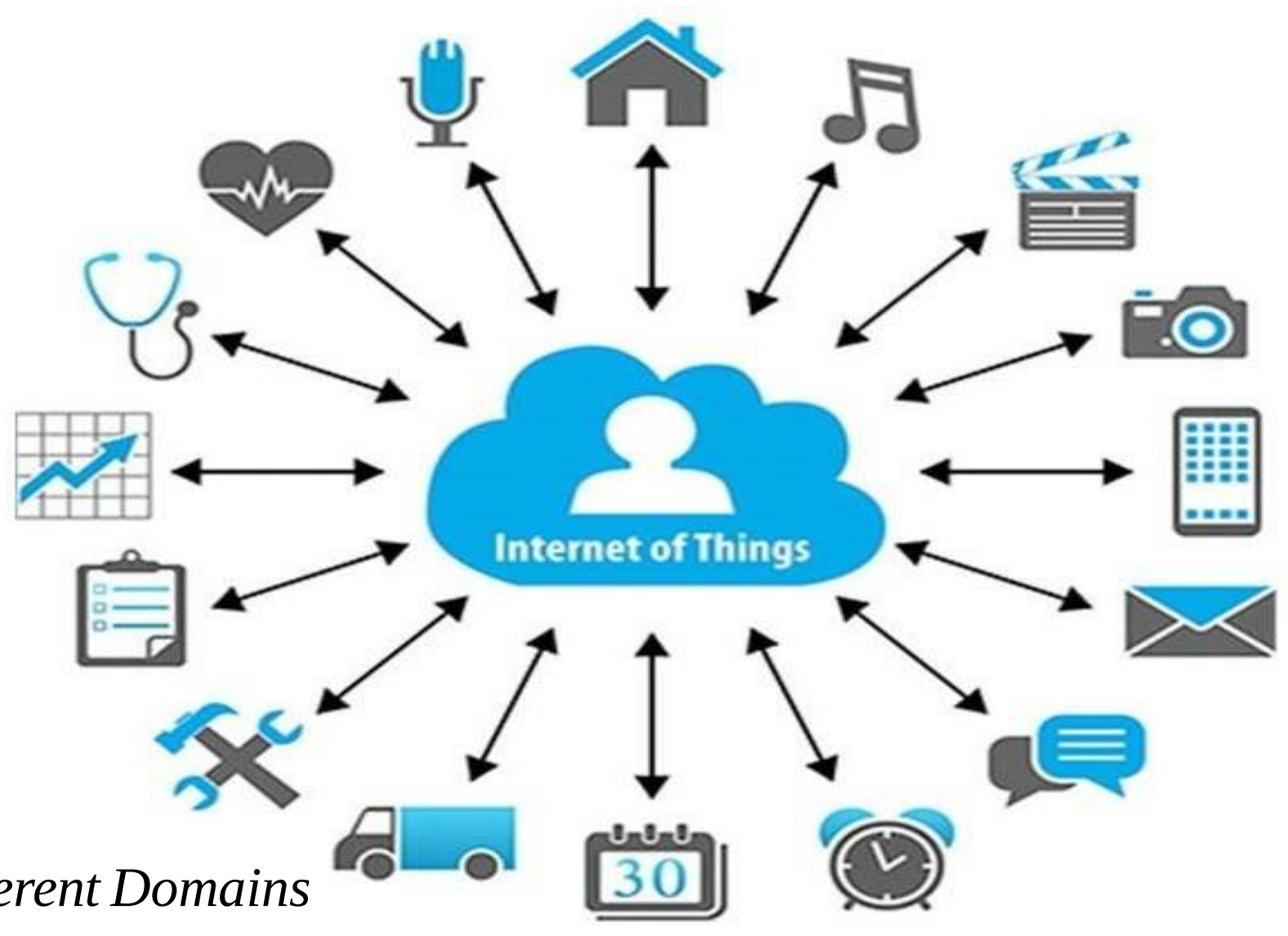

Figure 4.1 IoT in Different Domains

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- 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.

IoT – Advantages

Activity 4.3

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

❖ 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.

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- ✓ **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 4.4

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

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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.

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Challenges of IoT

Activity 4.5

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

❖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.

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- **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.

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 informationthey 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.

Architecture of IoT

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?

❖ 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).

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.

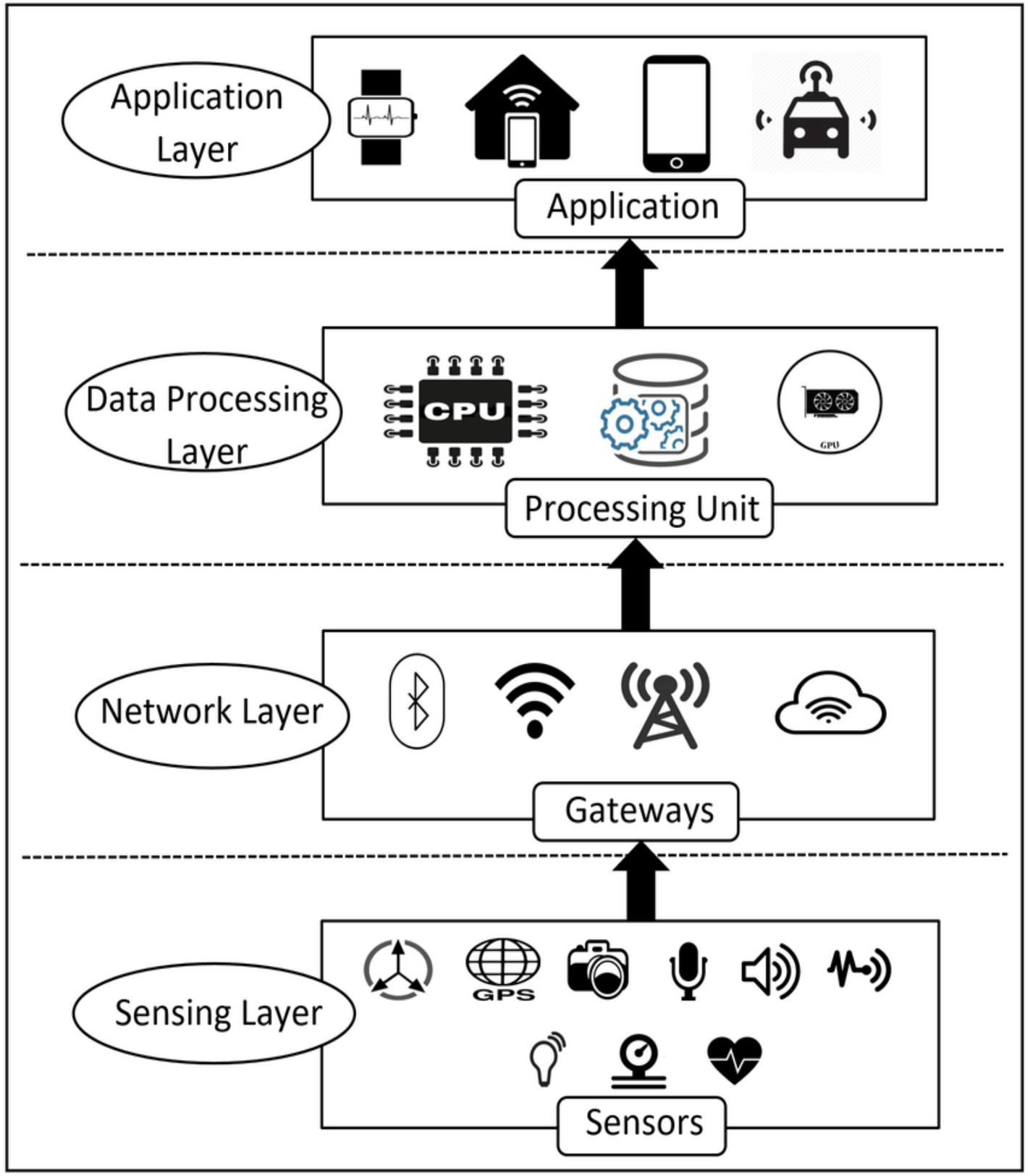

Figure 4.2 Architecture of IoT

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- 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 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.

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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, Z- Wave, LoRa, cellular network, etc.) to allow data flow between other devices within the same network.

3. Data Processing Layer

- It consists of the main data processing unit of IoT devices.
- It 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.

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.

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- 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.

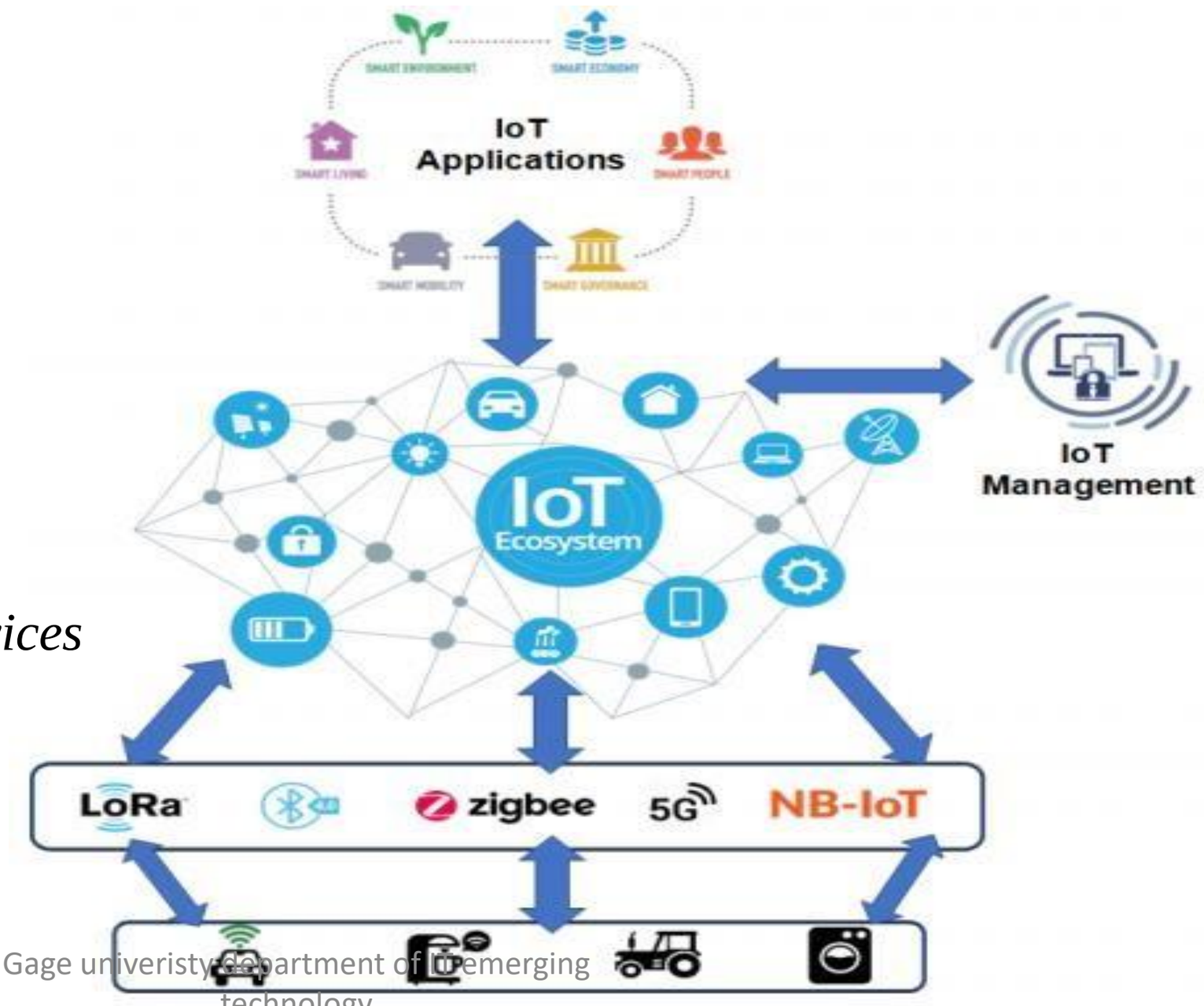

Figure 4.3 Networked IoT Devices

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 micro- climate 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.

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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.

- ***Healthcare*** **-** 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 real- time 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 mass- marketing 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.

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- ***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.

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.

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- **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.

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.

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.