

Chapter 1: Introduction to Emerging Technologies

1.1 Evolution of Technologies

Emerging technology describe

- A new technology
- The continuing development of existing technology
- Technologies that are currently developing
- That are expected to be available within the next five to ten years
- 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.

Technology: science of the mechanical and industrial arts

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 Process Automation (RPA)

1.1.1 Introduction to the Industrial Revolution (IR)

The Industrial Revolution

- was a period of major industrialization and innovation
- took place during the late 1700s and early 1800s.
- core occurs when a society shifts from using tools to make products to using new sources of energy, such as coal, to power machines in factories.
- started in England, with a series of innovations to make labor more efficient and productive.

- 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.

first industrial revolution mechanization through water and steam power

Second industrial revolution mass production and assembly lines using electricity

The fourth industrial revolution will take what was started in the **third industrial revolution** 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
- The rise of digital technology
- Smart and autonomous systems fueled by data and machine learning.

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.

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 and began in the 1760s
- Going from hand production methods to machines
- The increasing use of steam power
- The development of machine tools and the rise of the factory system

1.1.3.2 Industrial Revolution (IR 2.0)

- The Second IR, also known as the **Technological Revolution**,
- Began somewhere in the 1870s.
- Advancements 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.
- New technological systems were introduced, such as electrical power and telephones.

1.1.3.3 Industrial Revolution (IR 3.0)

introduced the transition from mechanical and analog electronic technology to digital electronics 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.

1.1.3.4 Fourth Industrial Revolution (IR 4.0)

Now, with advancements in various technologies such as robotics, Internet of Things , additive manufacturing and autonomous vehicles, the term “Fourth Industrial Revolution” or IR 4.0 was coined. 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.

Example Computer Numerical Control (CNC) machines.

Another major breakthrough that is associated with IR 4.0 is the adoption of Artificial Intelligence (AI),

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.

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
- 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.

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

Logic devices can be classified into two broad categories - fixed and programmable.

Fixed Logic Devices:

As the name suggests, the circuits in a fixed logic device are permanent, they perform one function or set of functions - once manufactured, they cannot be changed.

With fixed logic devices, the time required to go from design, to prototypes, to a final manufacturing run can take from several months to more than a year, depending on the complexity of the device.

And, if the device does not work properly, or if the requirements change, a new design must be developed.

Programmable Logic Devices

A programmable logic device(PLD) is an electronic component used to build reconfigurable digital circuits. Unlike a logic gate, which has a fixed function, a PLD has an undefined function at the time of manufacture.

Programmable logic refers to a general class of devices which can be configured to perform a variety of logic functions.

Before the PLD can be used in a circuit it must be programmed, that is, reconfigured by using a specialized program.

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

- Silicon Blue Technologies
- Xmos Semiconductor L series
- 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
- Xilinx Virtex 6 and Spartan 6

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

- 1 Traditional channel service unit (CSU) and data service unit (DSU)
- 2 Modems
- 3 Routers
- 4 Switches
- 5 Conferencing equipment
- 6 Network appliances (NIDs and SIDs)
- 7 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

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

Chapter 2: Data Science

Data science is a multidisciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured, semi-structured and unstructured data.

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.).

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

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.

- **Input** – in this step, the input data is prepared in some convenient form for processing. The form will depend on the processing machine.
- **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.

2.3.1. Data types from Computer programming perspective

- 1 • **Integers(int)**- is used to store whole numbers, mathematically known as integers

- 2 • Booleans(bool)**- is used to represent restricted to one of two values: true or false
- 3 • Characters(char)**- is used to store a single character
- 4 • Floating-point numbers(float)**- is used to store real numbers
- 5 • Alphanumeric strings(string)**- used to store a combination of characters and numbers

This data type defines

- 1 the operations that can be done on the data,
- 2 the meaning of the data, and
- 3 the way values of that type can be stored.

2.3.2. Data types from Data Analytics perspective

there are three common types of data types or structures:

- Structured
- Semi-structured
- Unstructured data types

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.

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 makes 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

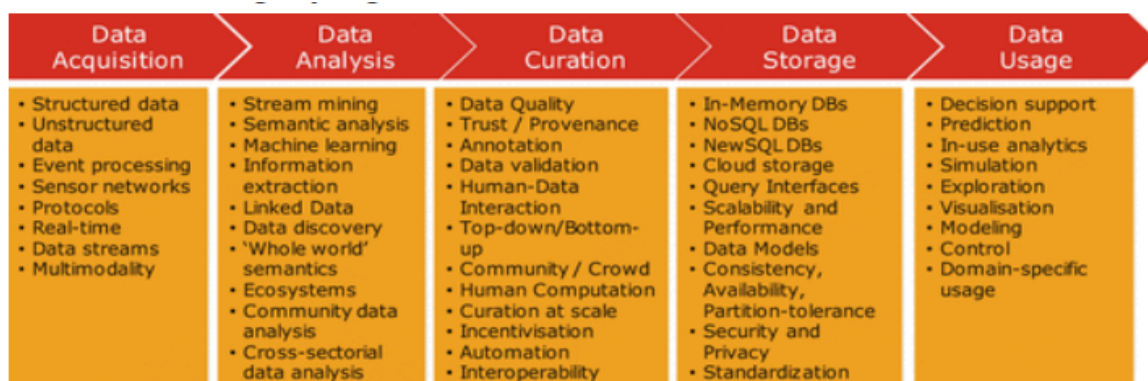
From a technical point of view, this is not a separate data structure, but it is one of the most important elements for Big Data analysis and big data solutions.

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.

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:



2.4.1. Data Acquisition

It is the process of

- gathering
- filtering
- 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 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

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.

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.

value

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.
- **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.

Cluster membership and resource allocation can be handled by software like **Hadoop's YARN** (which stands for Yet Another Resource Negotiator).

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:

- 1 data management
- 2 access
- 3 processing
- 4 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

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 reduces 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 3: Artificial Intelligence (AI)

3.1. What is Artificial Intelligence (AI)

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."

Artificial Intelligence (AI) is the branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and be able to make decisions.

Intelligence 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.”

Intelligence is composed of:

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

An AI system is composed of an agent and its environment

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),

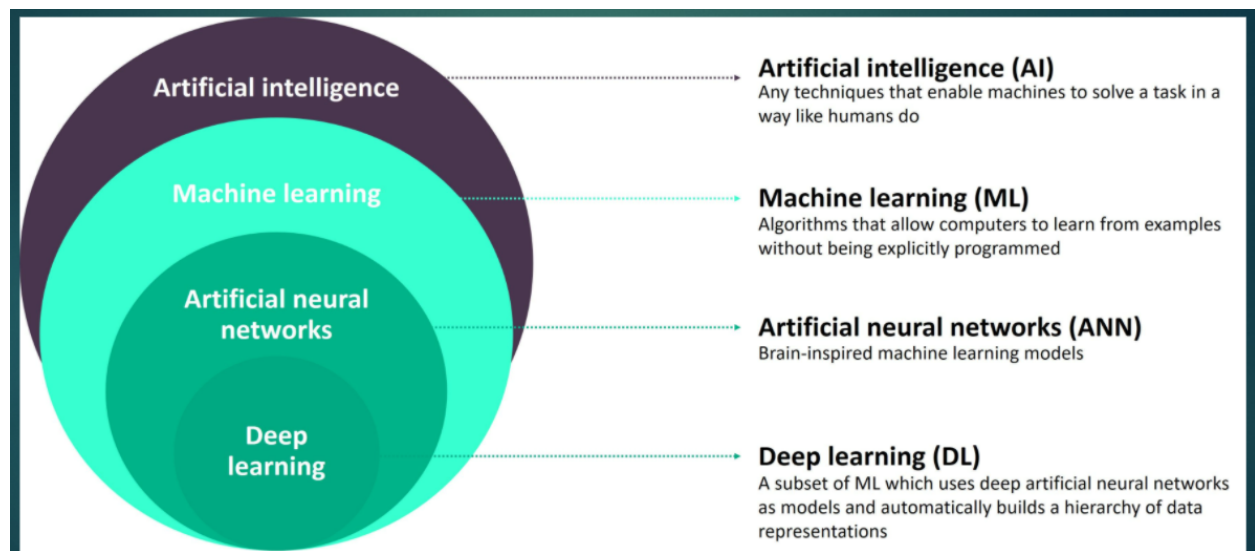
- online assistants (such as Siri),
- image recognition in photographs,
- spam filtering,
- prediction of judicial decisions and targeting online advertisements

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.

Machine Learning is an advanced form of AI where the machine can learn as it goes rather than having every action programmed by humans.

The field of neural networks with several hidden layers is called deep learning



3.1.1. Need for Artificial Intelligence

1. To create expert systems that exhibit intelligent behavior with the capability to learn, demonstrate, explain and advise 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

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?

Intelligence for humans 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

- ✓ Mathematics
- ✓ Biology
- ✓ Psychology
- ✓ Sociology
- ✓ Computer Science
- ✓ Neurons Study
- ✓ Statistic

3.1.4. Advantages of Artificial Intelligence

Following are some main advantages of Artificial Intelligence:

1 High Accuracy with fewer errors:

2 High-Speed:

3 High reliability: AI machines are highly reliable and can perform the same action multiple times with high accuracy.

4 Useful for risky areas:

5 Digital Assistant:

6 Useful as a public utility:

3.1.5. Disadvantages of Artificial Intelligence

➤ **High Cost:**

➤ **Can't think out of the box:**

- **No feelings and emotions:**
- **Increase dependence on machines:**
- **No Original Creativity:**

Components of AI system

Applications: Image recognition, Speech recognition, Chatbots, Natural language generation, and Sentiment analysis.

Types of Models: Deep learning, Machine learning, and Neural Networks.

Software/Hardware for training and running models: Graphic Processing Units (GPUs), Parallel processing tools (like Spark), Cloud data storage and computer platforms.

Programming languages for building models: Python, TensorFlow, Java, and C/C++, etc.

3.2. History of AI

AI winter refers to the time period where computer scientists dealt with a severe shortage of funding from the government for AI researches.

3.3. Levels of AI

Stage 1 – Rule-Based Systems

Stage 2 – Context Awareness and Retention

Stage 3 – Domain-Specific Expertise

Stage 4 – Reasoning Machines

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

Stage 6 – Artificial Superintelligence (ASI)

Stage 7 – Singularity and Transcendence

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 2 – 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

- 1 cancer diagnosis and the well-known
- 2 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

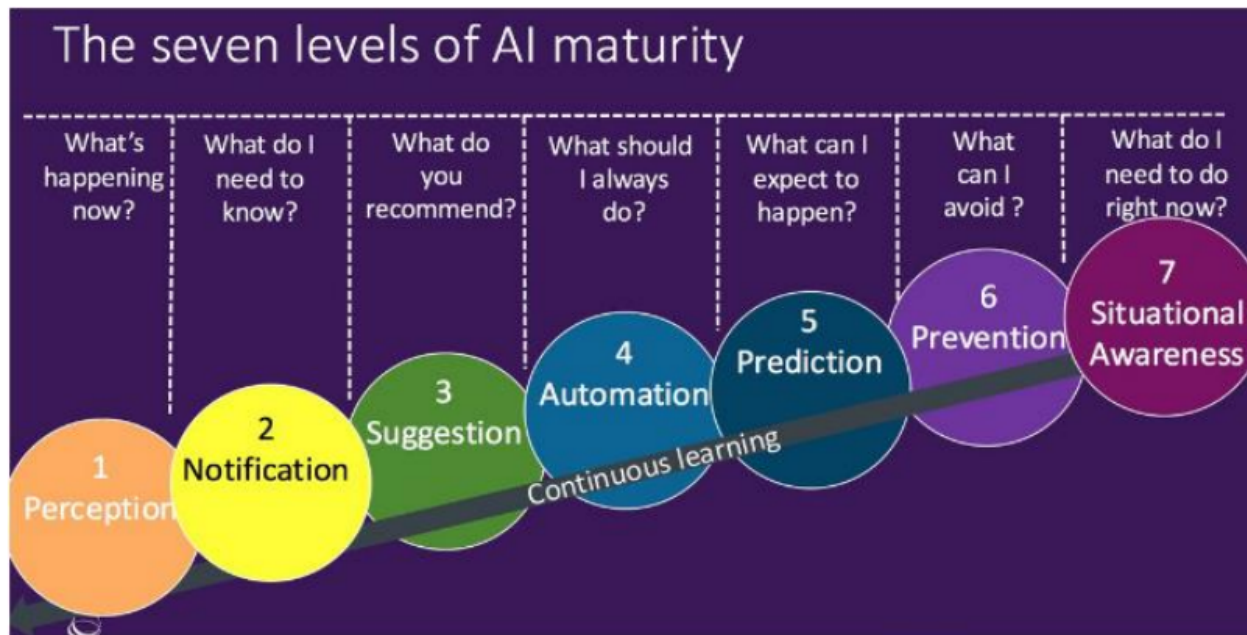
Stage 6 – Artificial Superintelligence (ASI)

➤ AI algorithms can outsmart even the most intelligent humans in every domain.

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.



3.4. Types 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 functionality 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.
- 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.
- Some Examples of Narrow AI are
 - Google translate
 - playing chess,
 - purchasing suggestions on e-commerce sites,
 - self-driving cars,
 - speech, and image recognition.
 - Apple Siri
 - IBM's Watson supercomputer

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.
- its development 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

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.

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.

example

- IBM's Deep Blue system
- Google's AlphaGo

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.

Example

- Self-driving cars

3. Theory of Mind

- Theory of Mind AI should understand human emotions, people, beliefs, and be able to interact socially like humans.

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.

3.4.1. How humans 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.

This process represents the main three layers or components of AI systems.

3.4.2. Mapping human thinking to artificial intelligence components

First stage is represented by the **sensing layer**, which perceives information from the surrounding environment.

example, there are sensing agents such as
voice recognition for sensing voice and
visual imaging recognition for sensing images.

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(to its development)

- 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

Applications of AI

AI in agriculture

AI in Healthcare

AI in education

AI in Finance and E-commerce

AI in Gaming

AI in Social Media

AI in Data Security

AI in Travel &Transport

AI in Robotics

AI in Entertainment

AI in the Automotive Industry

AI tools and platforms

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

- Search and optimization
- Logic
- Neural networks
- Control theory
- Languages
- Probabilistic methods for uncertain reasoning
- Classifiers and statistical learning methods

Sample AI application

- Email (Spam filtering)
- Social Networking
- Online Shopping
- Mobile Use

➤ **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 include spam prevention, search, and discovery, ad performance and monetization, and email marketing.