

Addis Ababa Science and Technology University

College of Mechanical and Electrical Engineering

Introduction to Emerging Technologies

Introduction to Emerging Technologies

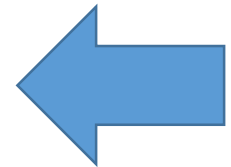
Contents

- Chapter objective
- Emerging technologies
- Evolution of technology
- Currently available emerging technologies
- Industrial revolution
- Roles of data for emerging technologies
- Enabling devices and networks
- Human to machine interaction (HMI/HCI)
- Future emerging technologies

The objective of the chapter

After the successfully completing this chapter, the students can

- Explain and identify emerging technologies
- Identify technological advancements that made I.R possible
- Analyze the changes created by I.R
- Explain the role of big data for emerging technologies
- Explain the 4 basic kinds of digital electronic system with examples
- Analyze the concepts of HMI

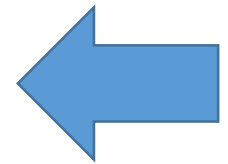


Brainstorming

Can you define or give an example for emerging technology?

Emerging Technology

- New technology;
- The continuing development of existing technology;
- Technologies that are currently developing;
- Technologies that are expected to be available within the next five to ten years;
- Technologies that are creating or are expected to create significant social or economic effects.



Evolution of Technology

TECHNOLOGY:

- The application of scientific knowledge for practical purposes (e.g. industry)
- Machinery or equipment developed from the application of scientific knowledge.
- Branch of knowledge dealing with engineering or applied sciences.
- Tools and machines that may be used to solve real-world problems.
- Science of Mechanical and Industrial Arts

...Evolution of Technology

EVOLUTION:

- The process of developing by gradual processes.
- Example: Cellular Communication Evolution

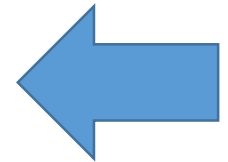


Currently available emerged technologies

- Artificial Intelligence
- Robotics
- IoT
- 5-G
- Biometrics
- 3D printing
- Cloud Computing
- Big Data



Source: internet



Industrial Revolution (I.R)

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

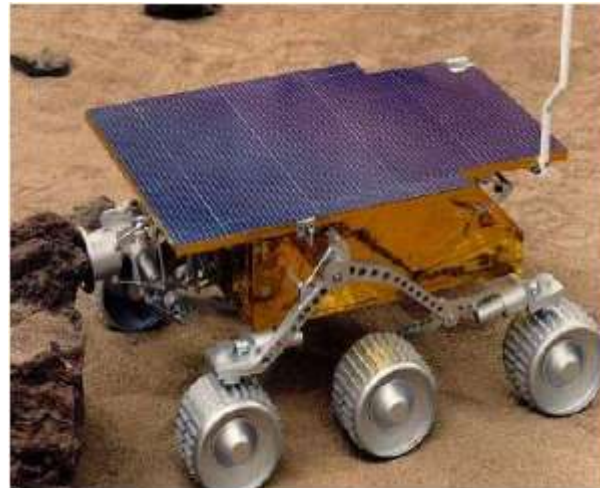
...Industrial Revolution (I.R)

- **First industrial revolution**: mechanization through water and steam power
 - Began in the 1760s
 - Transition from manual to machines
- **Second industrial revolution**: mass production and assembly lines using electricity
 - Known as *Technological Revolution*
 - Began in the 1870s



...Industrial Revolution (I.R)

- **Third industrial revolution**: adoption of computers and automation
 - Nicknamed “Digital Revolution” because transition of mechanical and analog → digital systems
 - Began in the 1950s
- **Fourth industrial revolution**: Smart and autonomous systems fueled by availability of data and machine learning.
 - Robotics
 - AI
 - IoT
 - CNC



...Industrial Revolution (I.R)

Generally, All the 4 I.Rs changed and transformed the world into modern society for the past 4 centuries.

Think about the global socio-economic impact of the industrial revolutions? Does it change our way of life?

...Industrial Revolution (I.R)

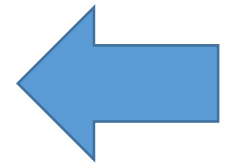
The Most Important Inventions of the Industrial Revolution

- **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.

...Industrial Revolution (I.R)

The four types of industries are:

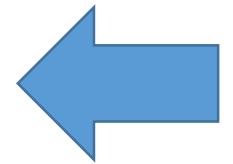
- **The primary industry** involves getting raw materials e.g. mining, farming, and fishing.
- **The secondary industry** involves manufacturing e.g. making cars and steel.
- **Tertiary industries** provide a service e.g. teaching and nursing.
- **The quaternary industry** involves research and development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



Role of Data for Emerging Technologies

Data:

- The new oil and strategic asset since we are living in the age of big data,
- Drives or even determines the future of science, technology, the economy, and possibly everything in our world today and tomorrow.
- Presents enormous challenges that in turn bring incredible innovation and economic opportunities.
- Involves not only core disciplines such as computing, informatics, and statistics, but also the broad-based fields of business, social science, and health/medical science.



Enabling devices and networks (Programmable devices)

Four basic kinds of digital electronic systems:

1. Memory devices: store some information (e.g. spreadsheet, database)
2. Microprocessors: execute instructions (programs) to process data
E.g. word processing, video game
3. Logic devices: provide specific functions like device-to-device interfacing, data communication, signal processing, data display, timing and control operations.
4. Network: is collection of computers, servers, mainframes, network devices, peripherals connected together to allow sharing of data or other resources.

➤ The Internet is the biggest network we have.

... Enabling devices and networks (Programmable devices)

Programmable devices are chips that incorporate:

- Field Programmable logic devices (FPGAs),
- Complex programmable logic devices (CPLD), and
- Programmable logic devices (PLD).

There are also devices that are the analog equivalent of these called field programmable analog arrays.



... Enabling devices and networks (Programmable devices)

Computer:

- Is the most common programmable device: it can be programmed to follow a set of instructions and produce some results.
- Has different types depending on their purposes
 - Small computers (many electronic devices we use such as calculators, phones, ...) perform only one or small number of operations, but still they are programmed to follow a certain set of instructions to achieve that.

List of some Programmable devices

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

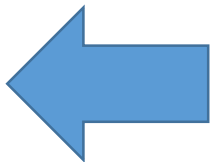


Network-related equipment's (Service Enabling Devices) (SEDs)

- Traditional channel service unit (CSU) and data service unit (DSU)
- Modems
- Routers
- Switches
- Conferencing equipment
- Network appliances (NIDs and SIDs)
- Hosting equipment and servers



Source: internet



Human to Machine Interaction

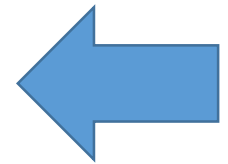
- Refers to the communication and interaction between a human and a machine via a user interface.
- Natural interfaces becoming so common: devices are capable of understanding some of human gestures.
- HCI – is the study of how people interact with computers and to what extent could computers interact with human beings successfully.
- Human to Machine Interaction (HMI) is also sometimes called Human to Computer Interaction (HCI)
- HCI improves the interaction between users and computers by making computers more user-friendly and receptive to the user's needs.

...Human to Machine Interaction

- Three components in HCI:
 - The user
 - The computer
 - The interaction (how they interact with each other).
- Users interact with computers using input/output devices
 - Displays – displaying graphical user interfaces which the user could use to send commands to the computer or receive results from the computer
 - Input devices (KB, mouse) allowing inputs to computer

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.



Future emerging technologies

Emerging technologies that will shape the future of us and our business are:

- Chatbots,
- Virtual/augmented reality,
- Blockchain,
- Ephemeral Apps and
- Artificial Intelligence

END!!

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Introduction to Emerging
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Data science

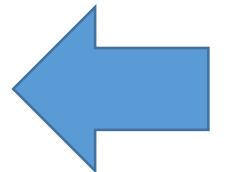
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Learning outcomes

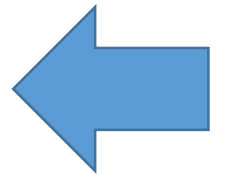
After the successfully completing this chapter, the students can

- Differentiate data and information
- Explain data processing life cycle
- Differentiate different data types from diverse perspectives
- Explain the data value chain
- Explain the basics of big data
- Analyze Hadoop ecosystem components and their use in big data



An Overview of Data Science

- 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 Vs Information

Data:

- Representation of facts, concepts, or instructions in a formalized manner, which should be suitable for communication, interpretation, or processing, by human or electronic machines.
- Described as unprocessed facts and figures.
- Represented with the help of characters such as alphabets (A-Z, a-z), digits (0-9) or special characters (+, -, /, *, <, >, =, etc.).

...Data Vs Information

Information:

- Processed data on which decisions and actions are based.
- 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.
- Interpreted data; created from organized, structured, and processed data in a particular context.

...Data Vs Information

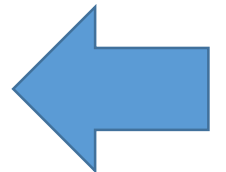
- ♦ Data – a collection of facts made up of text, numbers and dates:

Murray 35000 7/18/86

- ♦ Information - the meaning given to data in the way it is interpreted:

Mr. Murray is a sales person whose annual salary is \$35,000 and whose hire date is July 18, 1986.

Source: internet



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. It has three steps.

Input:

- Data preparation in convenient form for processing. The form will depend on the processing machine.
- For example, when electronic computers are used for data processing, the input data can be recorded on hard disk, CD, flash disk and so on.



Source: Introduction to emerging technology module page 23

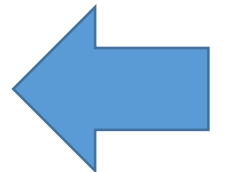
Data Processing Cycle

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 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.

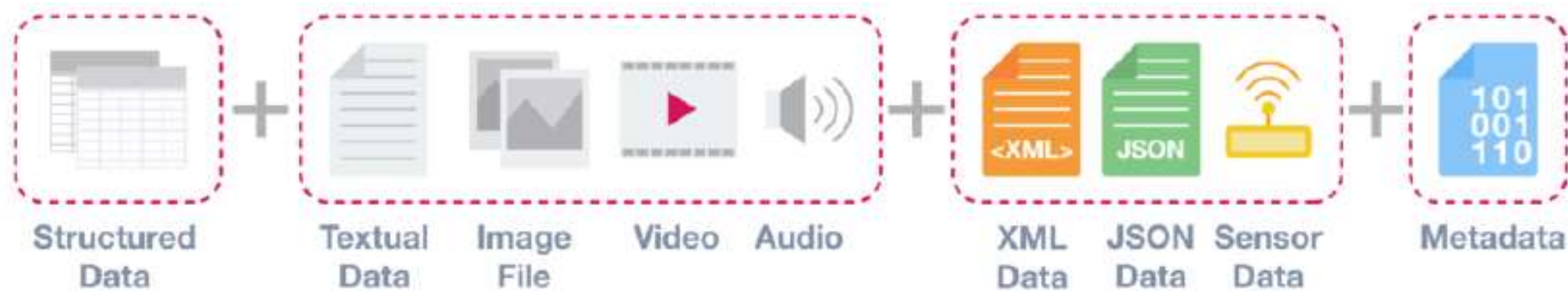


Data types and their representation

1. **Data types from Computer programming perspective:** 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.

E.G int, bool, char, float, double, string

2. **Data types from Data Analytics perspective:** there are three common types of data types or structures: Structured, Semi-structured, and Unstructured data types.



Source: Introduction to emerging technology module page 25

Structured Data

- It conforms to a tabular format with a relationship between the different rows and columns.
- Examples of structured data are Excel files or SQL databases. Each of these has structured rows and columns that can be sorted.

ID	Name	Age	Degree
1	John	18	B.Sc.
2	David	31	Ph.D.
3	Robert	51	Ph.D.
4	Rick	26	M.Sc.
5	Michael	19	B.Sc.

Source: internet

Semi-structured data

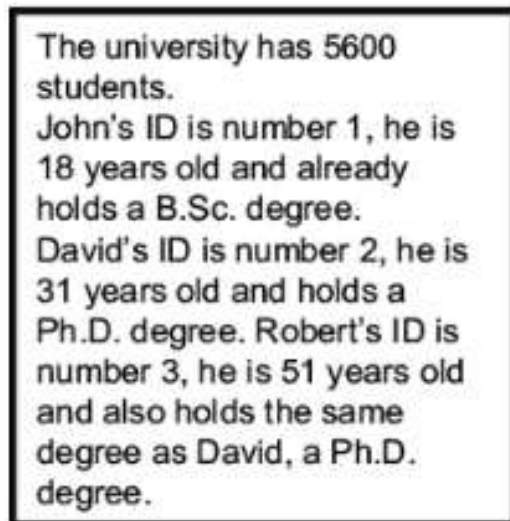
- It is a form of structured data that does not conform with the formal structure of data models associated with relational databases or other forms of data tables, but nonetheless, contains tags or other markers to separate semantic elements and enforce hierarchies of records and fields within the data.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

```
<University>
  <Student ID="1">
    <Name>John</Name>
    <Age>18</Age>
    <Degree>B.Sc.</Degree>
  </Student>
  <Student ID="2">
    <Name>David</Name>
    <Age>31</Age>
    <Degree>Ph.D. </Degree>
  </Student>
  ....
</University>
```

Source: internet

Unstructured Data

- It 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 which results in irregularities and ambiguities that make it difficult to understand using traditional programs as compared to data stored in structured databases.
- Examples of unstructured data include audio, video files or No-SQL databases.

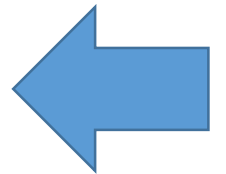


The university has 5600 students.
John's ID is number 1, he is 18 years old and already holds a B.Sc. degree.
David's ID is number 2, he is 31 years old and holds a Ph.D. degree. Robert's ID is number 3, he is 51 years old and also holds the same degree as David, a Ph.D. degree.

Source: internet

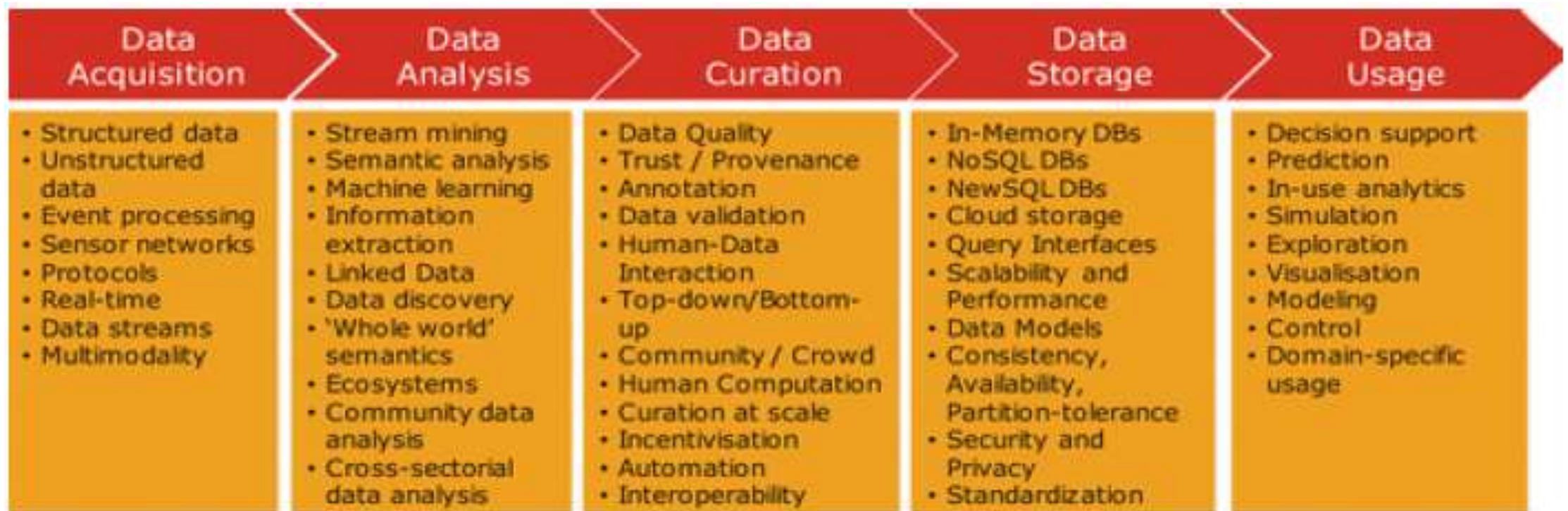
Metadata – Data about Data

- It 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.
- Example, In a set of photographs, metadata could describe when and where the photos were taken.



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.



Source: Introduction to emerging technology module page 26

...Data value Chain

Data Acquisition:

- 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.
- One of the major big data challenges in terms of infrastructure requirements because the infrastructure 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.

...Data value Chain

Data Analysis:

- Concerned with making the raw data acquired amenable to use in decision-making as well as domain-specific usage.
- 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.

...Data value Chain

Data Curation:

- The active management of data over its life cycle to ensure it meets the necessary data quality requirements for its effective usage.
- Its 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 hold the responsibility of ensuring that data are trustworthy, discoverable, accessible, reusable and fit their purpose.

...Data value Chain

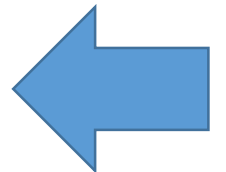
Data Storage:

- 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. However, the ACID (Atomicity, Consistency, Isolation, and Durability) properties that guarantee database transactions lack flexibility with regard to schema changes
- NoSQL technologies have been designed with the scalability goal in mind and present a wide range of solutions based on alternative data models.

...Data value Chain

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.



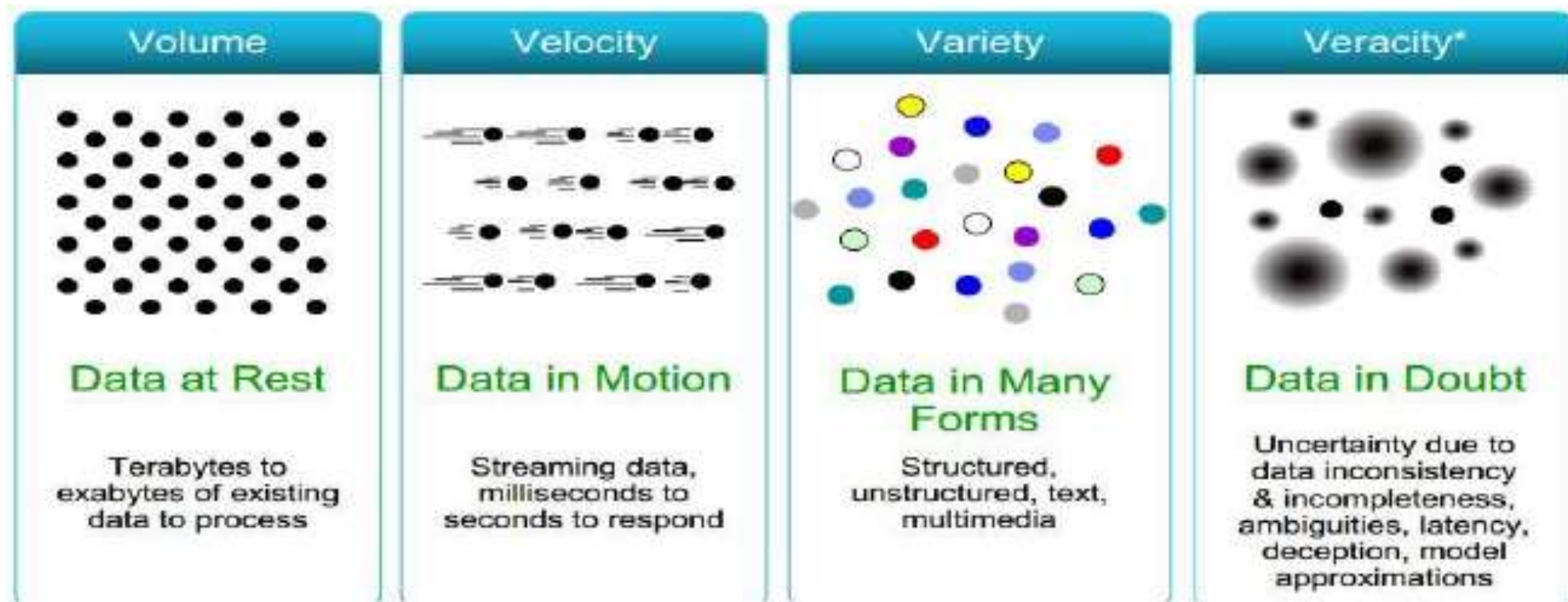
Basic concepts of big data

- **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.
- E.g.



Basic concepts of big data

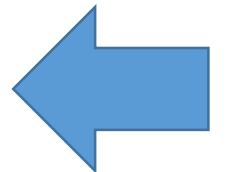
Big data is characterized by 3V and more:



Source: Introduction to emerging technology module page 29

Clustered Computing

- Individual computers are often inadequate for handling the big data at most stages.
- To address the high storage and computational needs of big data, computer clusters are needed.
- Big data clustering software combines the resources of many smaller machines, seeking to provide a number of benefits:
 - **Resource Pooling** → combine available storage space, CPU, ...
 - **High Availability** → fault tolerance and availability
 - **Easy Scalability** → expansion in resource requirement without expanding the physical resources on the machine
- The good example of clustering software is **Hadoop's YARN**



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.
- Gives the massive data storage facility, enormous computational power and the ability to handle different virtually limitless jobs or tasks.
- The four key characteristics of Hadoop are:
 - Economical → ordinary computers can be used for data processing
 - Reliable → stores copies of data on different machines (resistant to HW failure)
 - Scalable → expand horizontally or vertically by adding few extra nodes
 - Flexible → store as much structured and unstructured data as you need

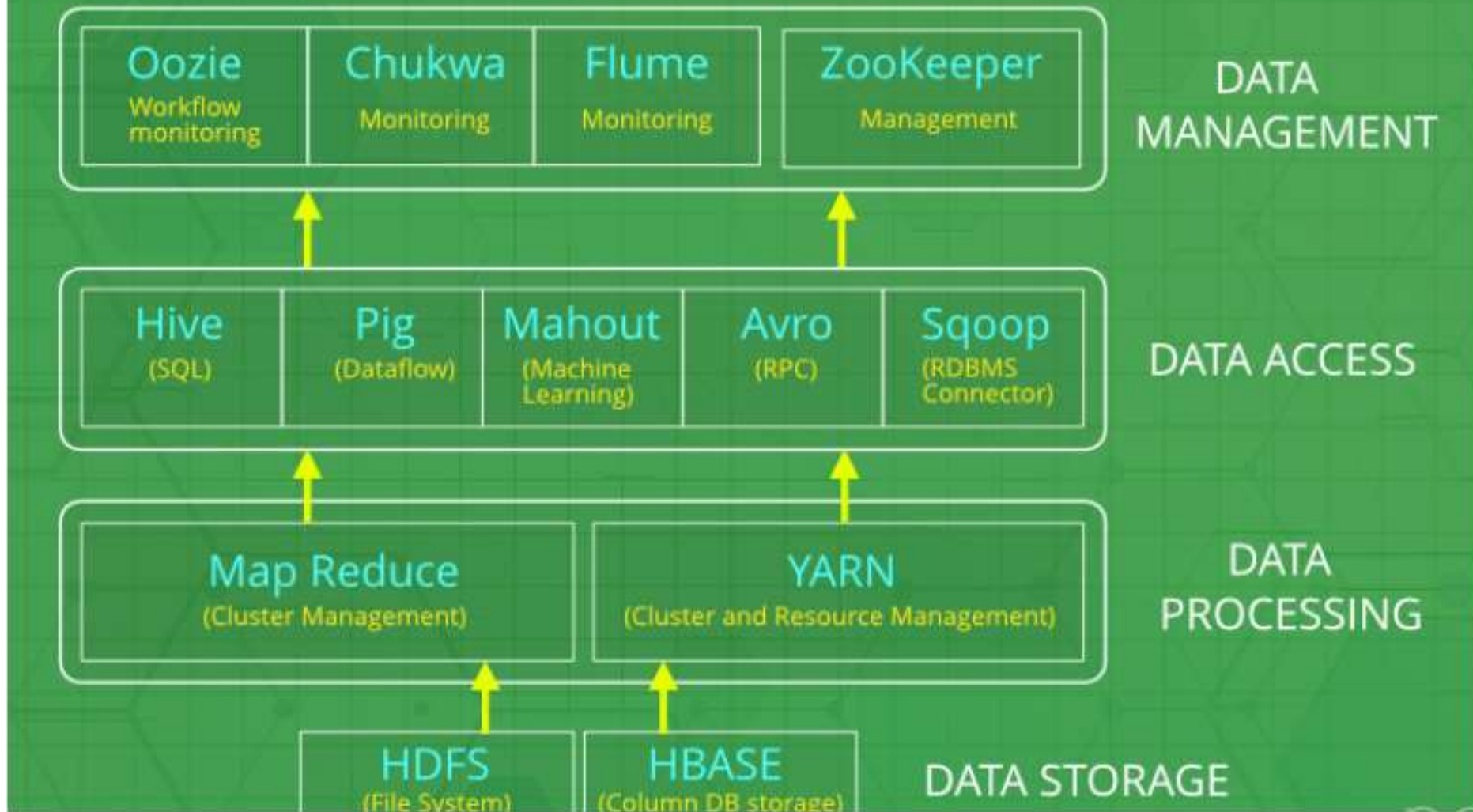
...Hadoop and its Ecosystem

Hadoop Ecosystem has evolved from its four core components:

1. Data management,
2. Data access,
3. Data processing, and
4. Data storage.

It is continuously growing to meet the needs of Big Data.

Hadoop Ecosystem

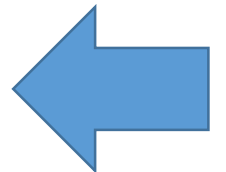


Source: Introduction to emerging technology module page 31

Big Data Life Cycle with Hadoop

Has 4 stages:

1. **Ingesting:** transferring data into to Hadoop from various sources such as relational databases, systems, or local files. Sqoop transfers data from RDBMS to HDFS
2. **Processing:** 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.
3. **Computing and analyzing:** data analyzation using processing frameworks such as Pig, Hive, and Impala. Pig converts the data using a map and reduce and then analyzes it.
4. **Visualizing:** accessing the result, performed by tools such as Hue and Cloudera Search.



Review Questions

- Briefly explain data Vs information?
- Discuss data and its types from computer programming and data analytics perspectives?
- Briefly explain each steps of data value chain?
- List out and discuss the characteristics of Big Data?
- What is Hadoop system? What is it used for?

END!!

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Artificial Intelligence

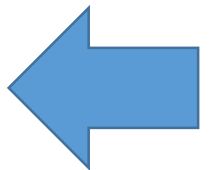
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Learning Outcomes

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

- Explain AI with examples
- Differentiate AI, ML and deep learning
- Elaborate the need, goal, advantages and disadvantages of AI
- Explain the types and approaches of AI
- Analyze the humans thinking with AI
- Elaborate the applications of AI in health, agriculture, business and education
- Identify AI tools and platforms

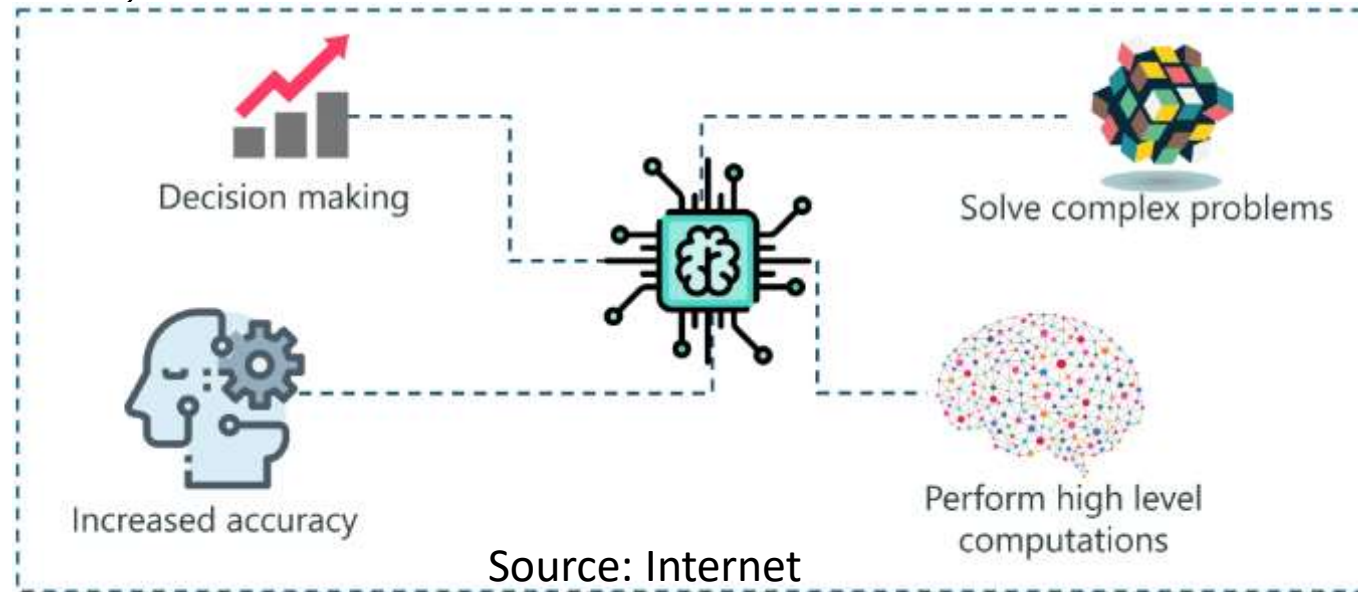


Brainstorming

What do you think about Artificial Intelligence? Can you give an example?

What is Artificial Intelligence (AI) ?

- In 1956, the term artificial intelligence was defined by John McCarthy. He defined AI as: ‘The science and engineering of making intelligent machines.’
- The development of computer systems that are capable of performing tasks that require human intelligence, such as decision making, object detection, solving complex problems, and so on.



What is Artificial Intelligence (AI) ?

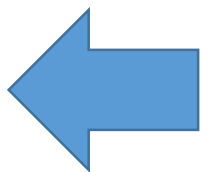
- Artificial defines "man-made," and intelligence defines "thinking power", or “the ability to learn and solve problems” hence Artificial Intelligence means "a man-made thinking power."
- The branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.
- The “copy of something natural (i.e., human beings) ‘WHO’ is capable of acquiring and applying the information it has gained through exposure.”
- Artificial Intelligence exists when a machine can have human-based skills such as learning, reasoning, and solving problems.

...What is Artificial Intelligence (AI) ?

- With AI no 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.

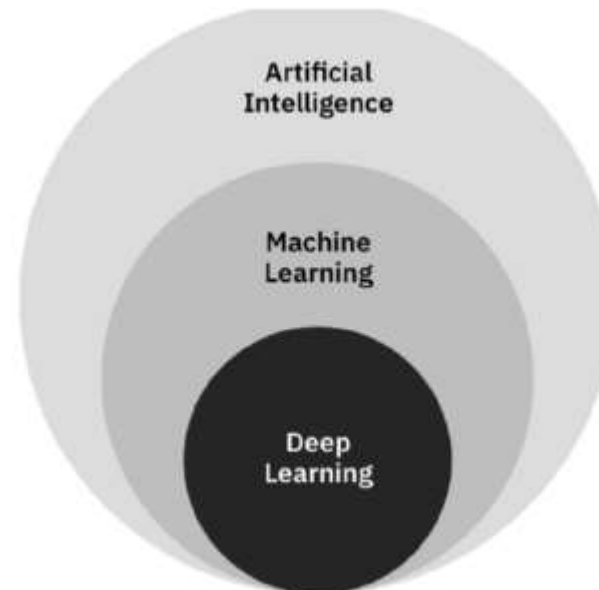
Intelligence is composed of:

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

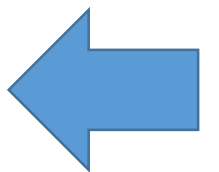


AI and Machine Learning (ML)

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



Source: Introduction to emerging technology module page 36



Need for Artificial Intelligence

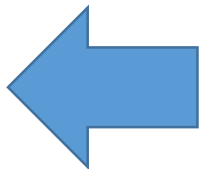
1. To create expert systems with the capability to learn, demonstrate, explain and advice its users.
2. Helping machines find solutions to complex problems like humans do and applying them as algorithms.



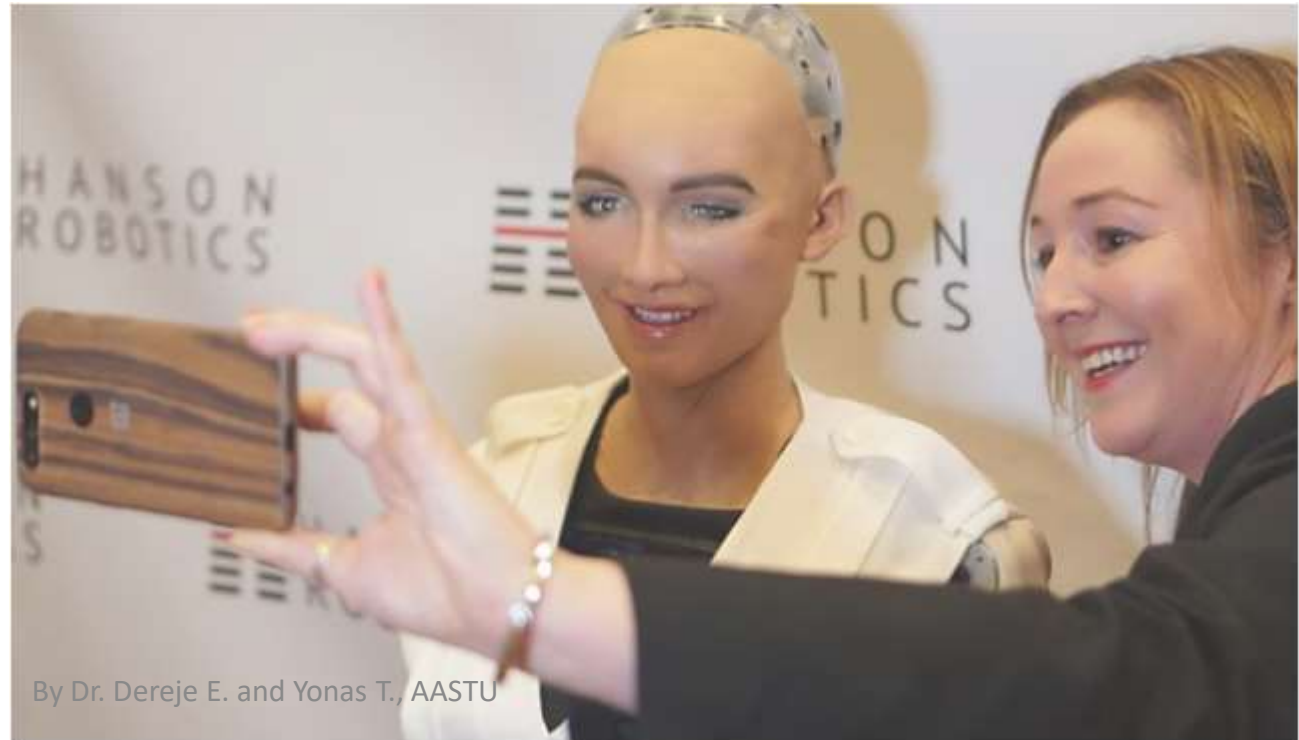
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Goals of Artificial Intelligence

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

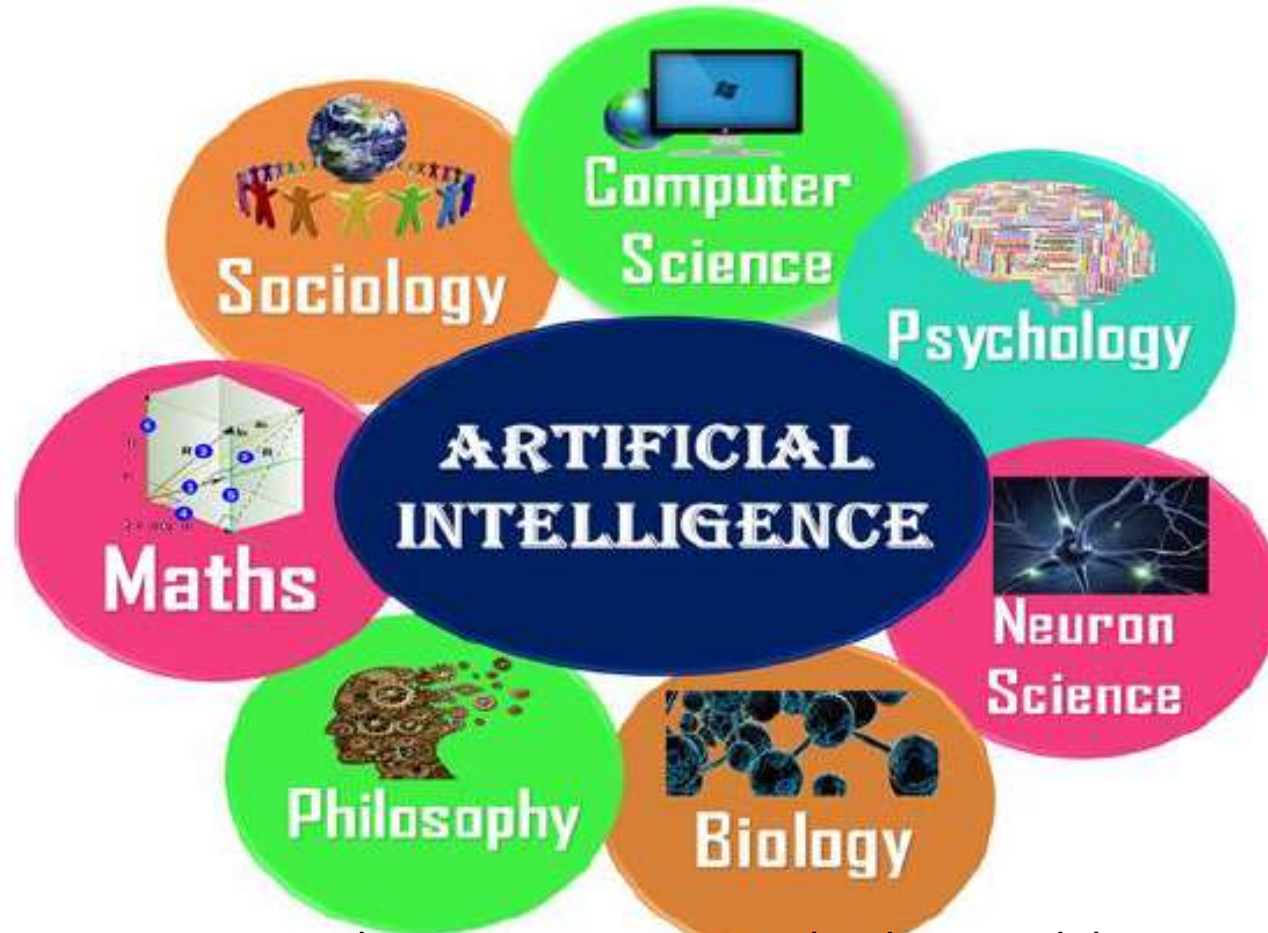


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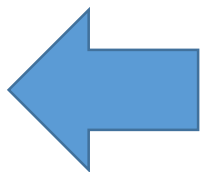


By Dr. Dereje E. and Yonas T., AASTU

What Comprises to Artificial Intelligence?

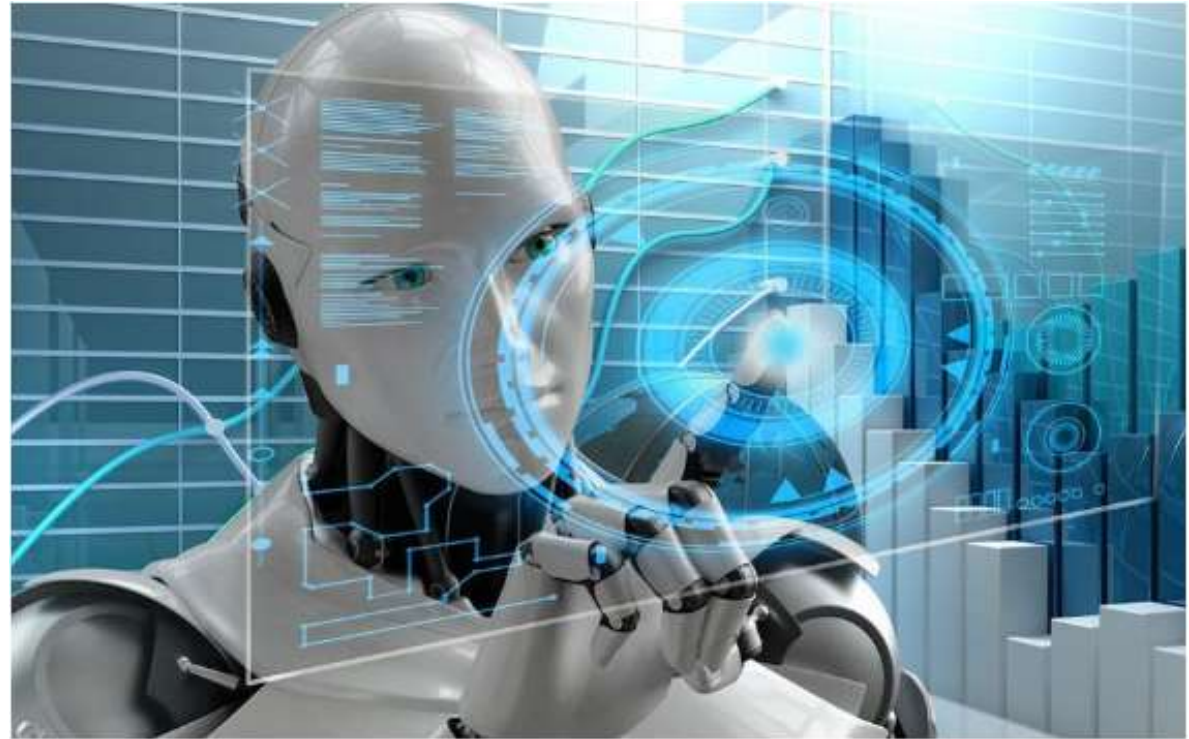


Source: Introduction to emerging technology module page 38



Advantages of AI

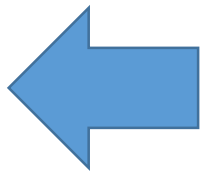
- High Accuracy with fewer errors
- High-Speed
- High reliability
- Useful for risky areas
- Digital Assistant
- Useful as a public utility



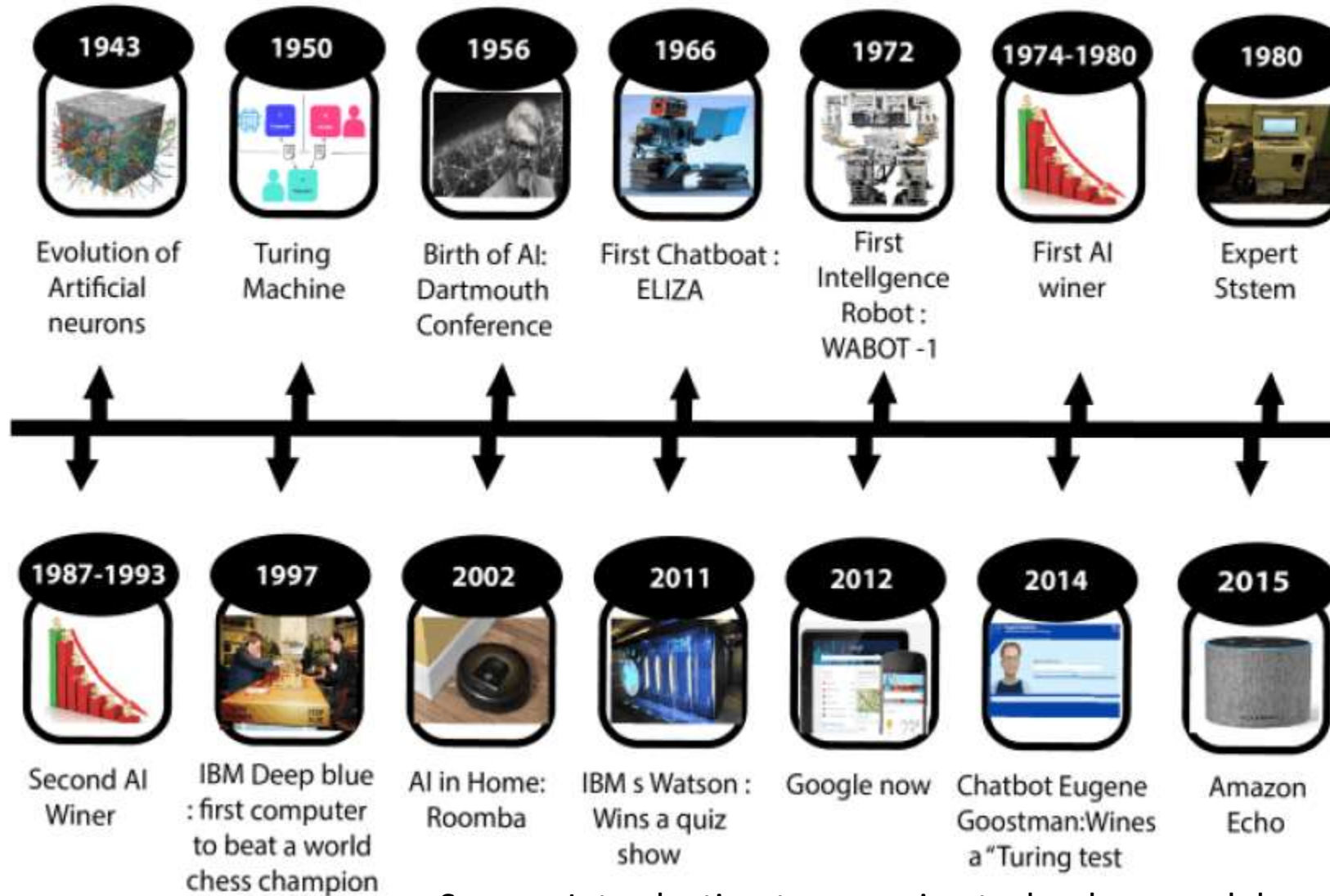
Source: Internet

Disadvantages of AI

- High Cost
- Can't think out of the box
- No feelings and emotions
- Increase dependence on machines
- No Original Creativity

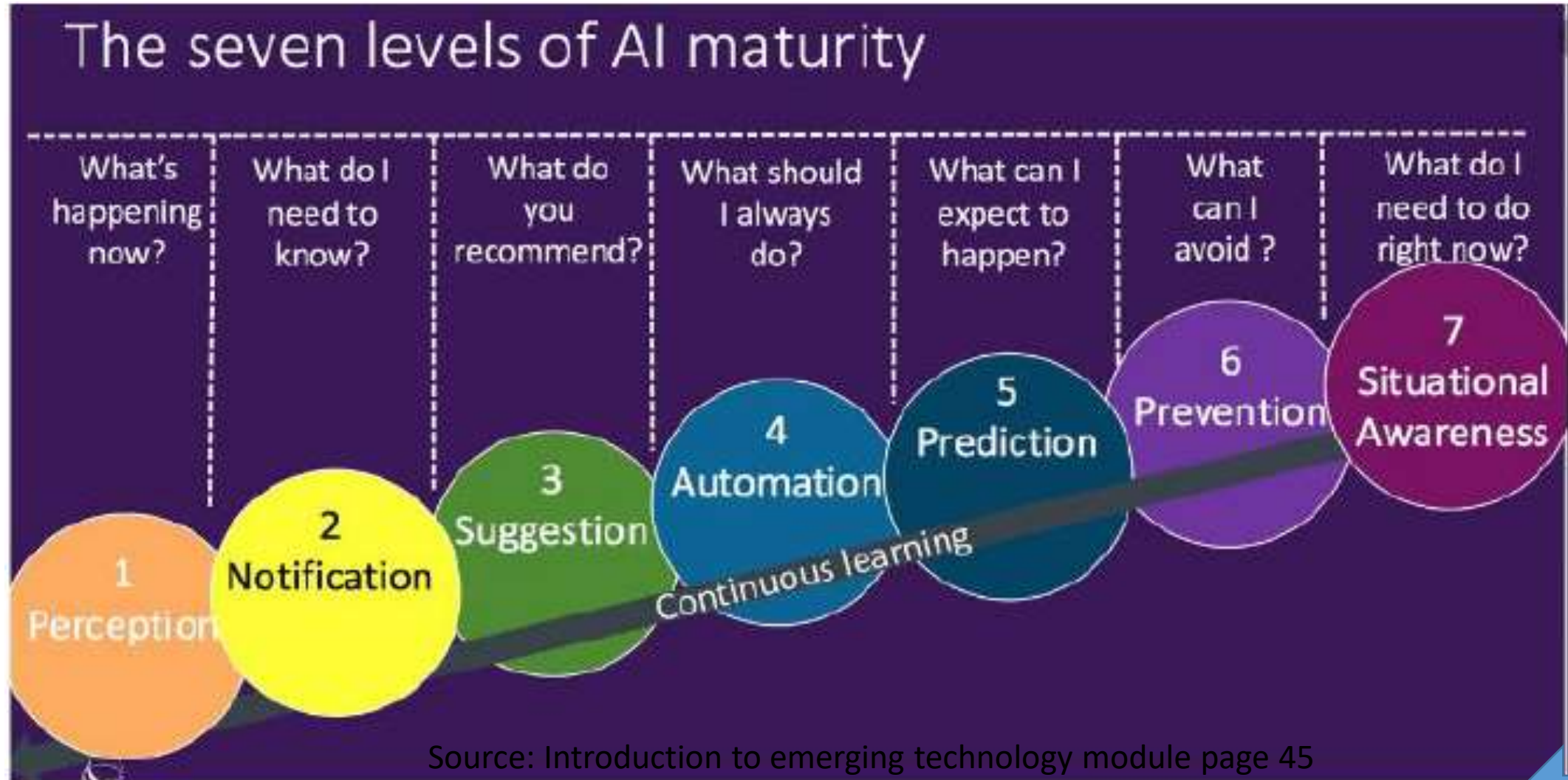


History of AI

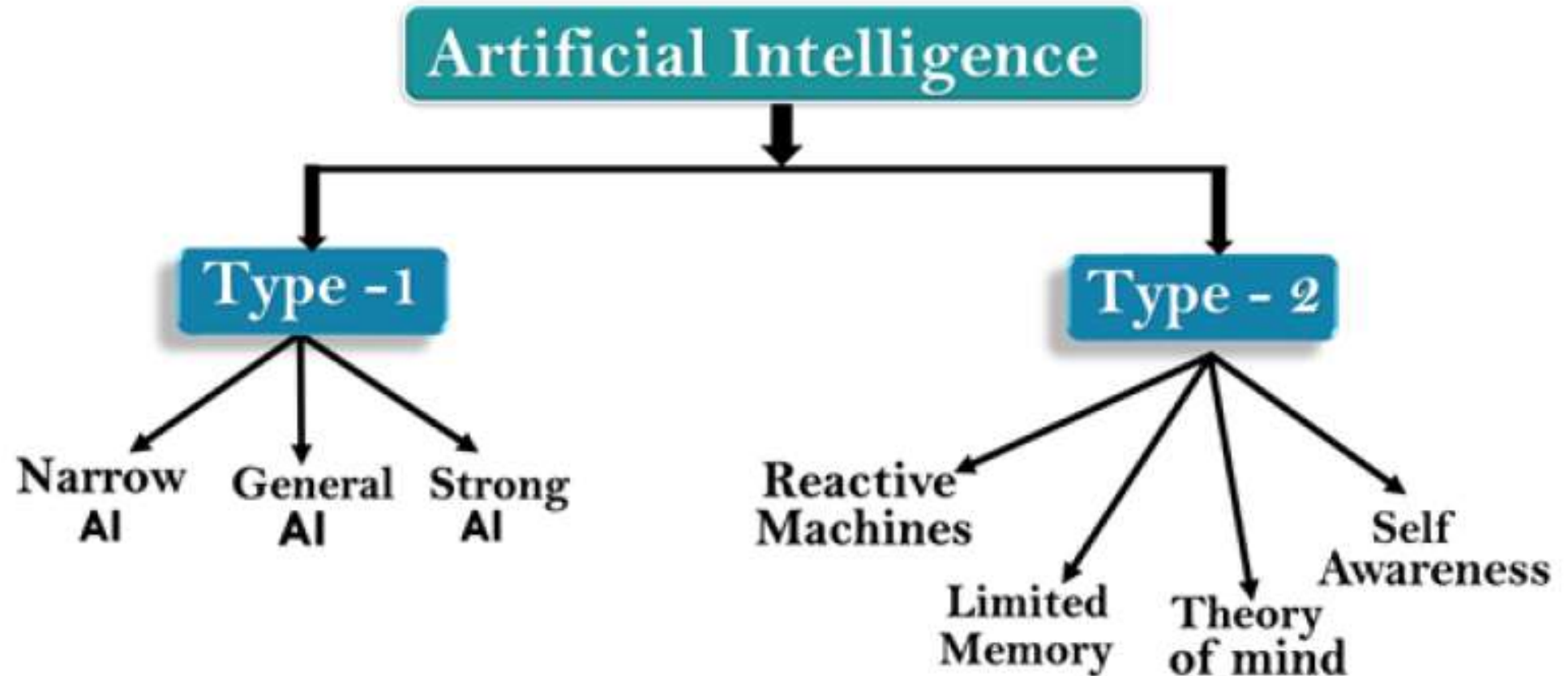


Source: Introduction to emerging technology module page 41

Levels of AI



Types of AI



Source: Introduction to emerging technology module page 46

...Types of AI

Weak AI (Narrow AI):

- Perform a dedicated task with intelligence.
- The most common and currently available AI in the world
- Cannot perform beyond its field or limitations, as it is only trained for one specific task.
- Can fail in unpredictable ways if it goes beyond its limits.

E.g. Apple Siri, but it operates with a limited pre-defined range of functions; Google translate, purchasing suggestions on e-commerce sites

...Types of AI

General AI:

- Perform any intellectual task with efficiency like a human.
- 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
- Challenges in developing GAI are:
 - 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

...Types of AI

Super AI:

- 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.
- 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.
- Hypothetical concept of Artificial Intelligence. The development of such systems in real is still a world-changing task.

...Types of AI

Reactive Machines AI:

- The most basic types of Artificial Intelligence.
- Do not store memories or past experiences for future actions.
- Only focus on current scenarios and react on it as per possible best action.

E.g. IBM's Deep Blue, Google's AlphaGo

...Types of AI

Limited Memory AI:

- Store past experiences or some data for a short period of time.
- Use stored data for a limited time period only.

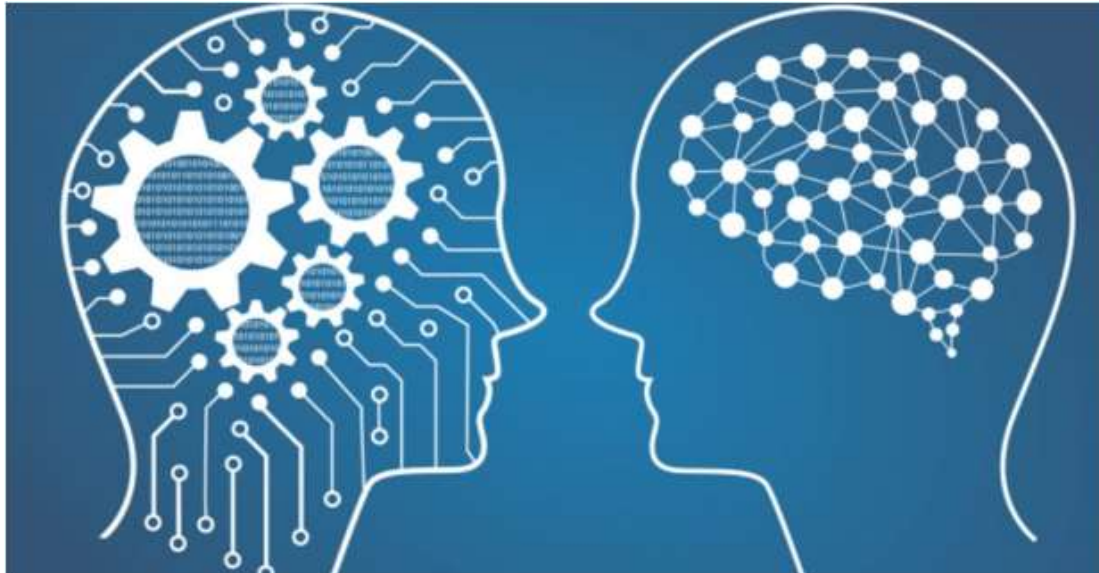
E.g. Self-driving cars. These cars can store the recent speed of nearby cars, the distance of other cars, speed limits, and other information to navigate the road.



...Types of AI

Theory of Mind AI:

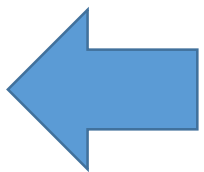
- Understand human emotions, people, beliefs, and be able to interact socially like humans.
- Still not developed, but researchers are making lots of efforts and improvements for developing such AI machines.



...Types of AI

Self-Awareness AI:

- The future of Artificial Intelligence. These machines will be super intelligent and will have their own consciousness, sentiments, and self-awareness.
- Smarter than the human mind.
- Does not exist in reality still and it is a hypothetical concept.



How humans think ?

Human Intelligence or the cognitive process is composed of three main stages:

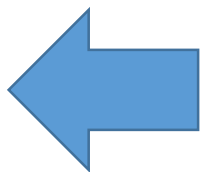
- Observe and input the information or data in the brain.
- Interpret and evaluate the input that is received from the surrounding environment.
- Make decisions as a reaction towards what you received as input and interpreted and evaluated.

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.



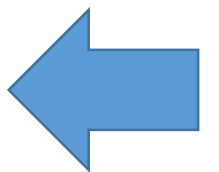
Mapping human thinking to AI components

Stages	Humans	AI
First stage (Sensing layer)	humans acquire information from their surrounding environments through human senses organs like eyes, ears,...	perceives information from the surrounding environment using sensing agents specific to the AI application like voice and imaging recognitions, ...
Second stage (Interpretation layer)	interpreting and evaluating the input data using brain	reasoning and thinking about the gathered input that is acquired by the sensing layer
Third stage (interacting layer)	taking action or making decisions	After evaluating the input data, the interacting layer performs the necessary tasks using actuators.



Influencers of AI

1. Big data: Structured data versus unstructured data
2. Advancements in computer processing speed and new chip architectures
3. Cloud computing and APIs (on-demand services, usually through the internet, on a pay-per-use basis.) E.g. IBM, Amazon, Microsoft, Google ...
4. The emergence of data science



Applications of AI

AI in agriculture

- agriculture robotics, soil and crop monitoring, predictive analysis.

AI in Healthcare

- help doctors with diagnoses and can inform when patients are worsening so that medical help can reach the patient before hospitalization.

AI in education

- automate grading, AI chatbot can communicate with students as a teaching assistant.

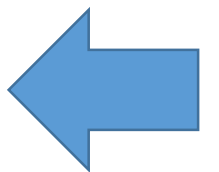
Applications of AI

AI in Social Media

- 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.

AI in Travel &Transport

- 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.



AI tools and platforms

- AI platforms are some sort of hardware architecture or software framework (including application frameworks), that allows the software to run. It involves the use of machines to perform the tasks that are performed by human beings.
- AI platforms provide users a tool kit to build intelligent applications like decision-making algorithms with data, which enables developers to create a business solution.
- Some platforms offer pre-built algorithms and simplistic workflows with such features as drag-and-drop modeling and visual interfaces that easily connect necessary data to the end solution, while others require a greater knowledge of development and coding.

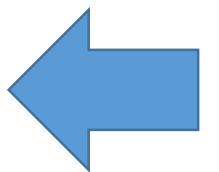
...AI tools and platforms

- AI platforms are frequently used by developers to create both the learning algorithm and intelligent application. However, users without intensive development skills will benefit from the platforms' pre-built algorithms and other features that curb the learning curve.
- The most common AI platforms include
 - Microsoft AZURE Machine Learning,
 - Google Cloud Prediction API,
 - IBM Watson,
 - TensorFlow,
 - Infosys Nia,
 - Wipro HOLMES,
 - API.AI, Premonition,

...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
- Probabilistic methods for uncertain reasoning
- Classifiers and statistical learning methods
- Neural networks
- Control theory
- Languages



Examples of AI application

Email

- Spam Filters
- Smart Email Categorization

Social Networking

- Facebook - When you upload photos to Facebook, the service automatically highlights faces and suggests friends tag.
- Instagram – uses ML to identify the contextual meaning of emoji, which have been steadily replacing slang (for instance, a laughing emoji could replace “lol”)
- Snapchat - Snapchat introduced facial filters to track facial movements, allowing users to add animated effects or digital masks that adjust when their faces moved.

...Examples of AI application

Mobile Use

- Voice-to-Text
- Smart Personal Assistants (Siri, Alexa, Cortana ...)

Online Shopping

- Search - Your Amazon searches quickly return a list of the most relevant products related to your search
- Recommendations - You see recommendations for products you're interested in as “customers who viewed this item also viewed” and “customers who bought this item also bought”,
- Amazon uses artificial neural networks to generate these product recommendations.

Review questions

- Define AI?
- Write down some advantages and disadvantages of AI?
- Briefly explain the type of AI based on capabilities and functionalities?
- Write down some applications of AI in agriculture, business, education?

END!!

Addis Ababa Science and Technology University

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Introduction to Emerging Technologies

Internet of Things

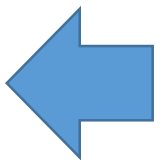
Contents

- [Learning outcomes](#)
- [What is IoT?](#)
- [Important features of IoT](#)
- [History of IoT](#)
- [Advantages and disadvantages of IoT](#)
- [Challenges of IoT](#)
- [How IoT works?](#)
- [Architecture of IoT](#)
- [Device and networks](#)
- [Tools and platforms of IoT](#)
- [Applications of IoT in homes, cities and farming](#)
- [Review Questions](#)

Learning Outcomes

After successful completion of this chapter, the students be able to:

- Explain IoT
- Elaborate the advantages and disadvantages of IoT
- Explain how IoT works?
- Explain the architecture of IoT
- Describe IoT tools and platforms
- Describe IoT application in different sector



Brainstorming

What do you think about IoT?
Can you give an example?

What is IoT?

Several definitions used by different groups:

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

...What is IoT?

Several definitions used by different groups:

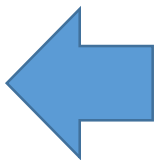
- **Oxford dictionary's:** IoT is the interaction of everyday object's computing devices through the Internet that enables the sending and receiving of useful data.
- **IEEE Communications category magazine:** IoT is a framework of all things that have a representation in the presence of the internet in such a way that new applications and services enable the interaction in the physical and virtual world in the form of Machine-to Machine (M2M) communication in the cloud.

...What is IoT?

- IoT according to 2020 conceptual framework is expressed through a simple formula such as:

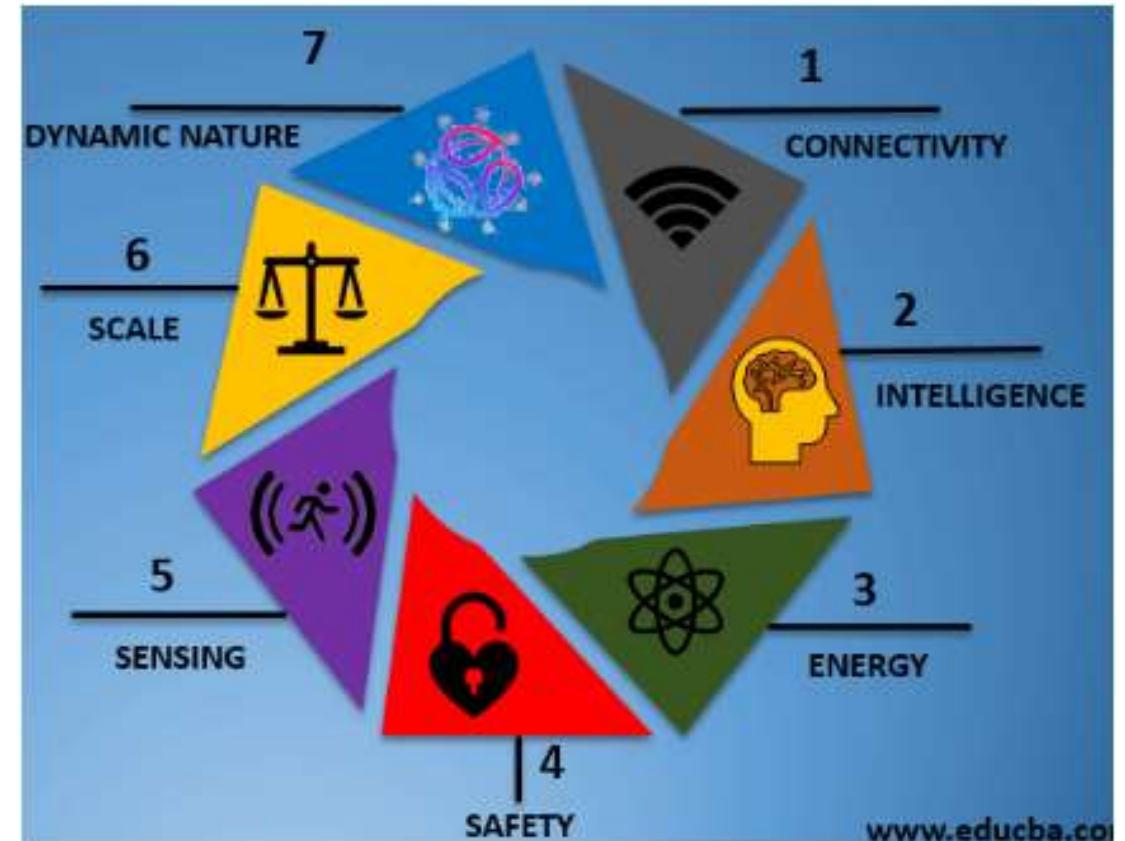
$$\text{IoT} = \text{Services} + \text{Data} + \text{Networks} + \text{Sensors}$$

- 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.

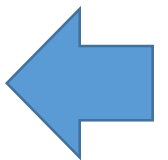


Most important features of IoT

- AI → makes virtually anything “smart”,
- Connectivity → creates these small networks between its system devices.
- Sensors → transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- Active engagement → introduces a new paradigm for active content, product, or service engagement.

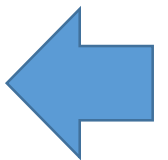


Source: internet



History of IoT?

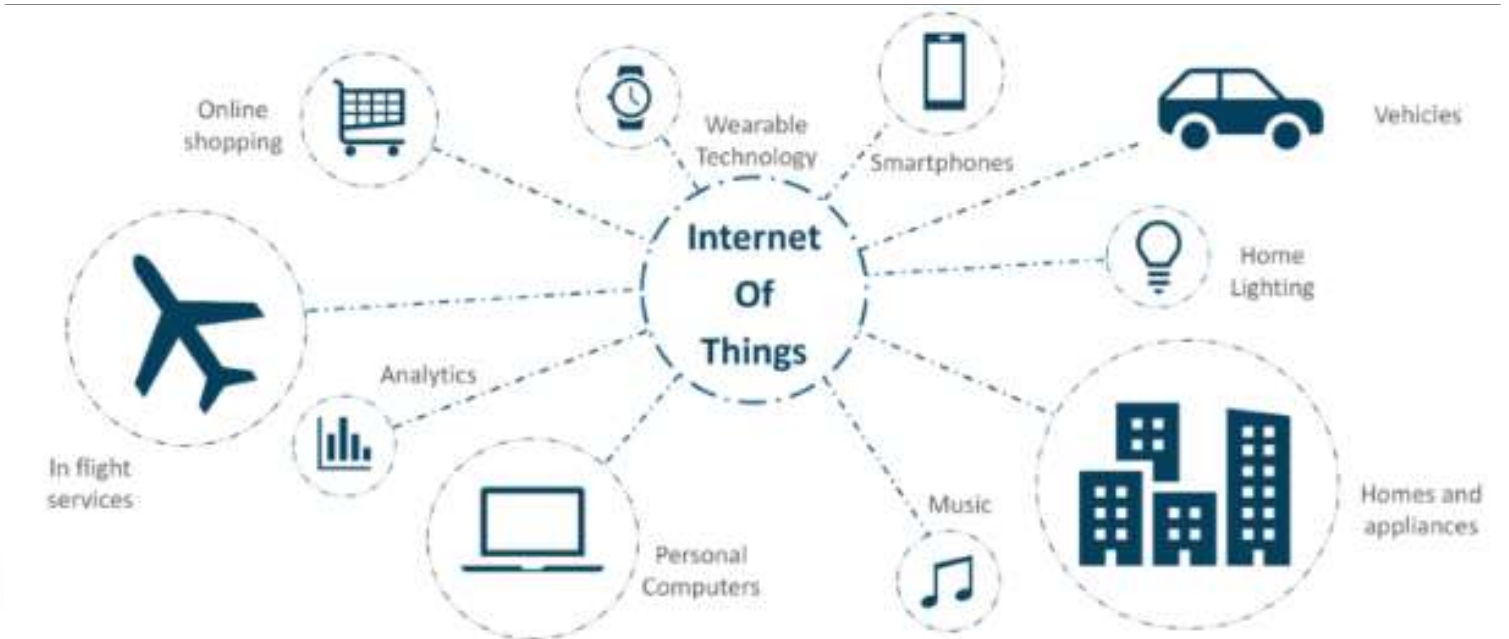
- Telegraph (the first landline) - 1830s
- “wireless telegraphy,” the first radio voice transmission - June 3, 1900
- Computers development - 1950s.
- The Internet, by DARPA (Defense Advanced Research Projects Agency) in 1962 and evolved into ARPANET in 1969 – commercialized in 1980s.
- Global Positioning Satellites (GPS) - 1993, by the Department of Defense
- The first examples of an Internet of Things is in the early 1980s and was a Coca Cola machine, located at the Carnegie Mellon University .
- Kevin Ashton, the Executive Director of Auto-ID Labs at MIT, was the first to describe the Internet of Things, during his 1999 speech.
- 2013, the Internet of Things had evolved into a system using multiple technologies



Advantages and disadvantages of IoT

Advantages:

- Improved Customer Engagement
- Technology Optimization
- Reduced Waste
- Enhanced Data Collection



Source: internet

Advantages and disadvantages of IoT

Disadvantages

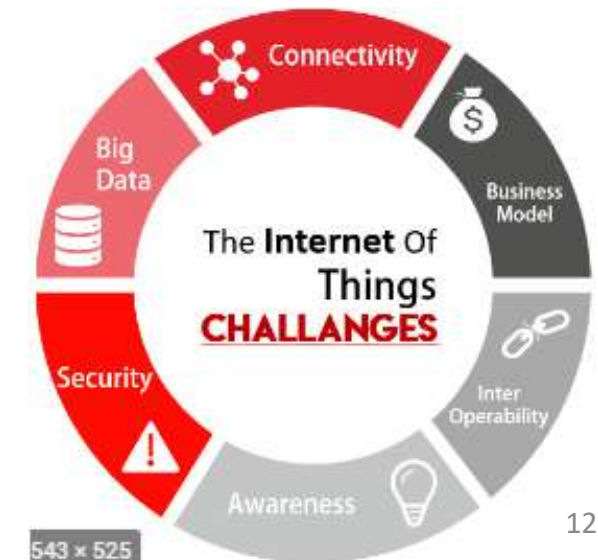
- Potential that a hacker could steal confidential information
- A bug in the system, potentially corrupt every connected device
- Difficulty for devices from different manufacturers to communicate with each other.



Source: internet

Challenges of IoT?

- Security → users can be exposed to various attackers or hackers
- Privacy → make substantial personal data in extreme detail without the user's active participation
- Complexity → complication in terms of design, deployment, and maintenance given their use of multiple technologies
- Flexibility → difficulty to integrate easily with another system.
- Compliance → challenging issue of compliance

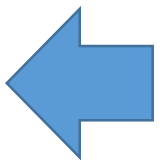


How does IoT works?

An IoT ecosystem consist:

- A. Web-enabled smart devices that use embedded processors and connected to sensors, actuators and internet,
- B. Sensors to collect data from the environment and send it back to the end smart deice for analyzation
- C. Communication protocols used by the smart device to send data to the cloud to be analyze and provide remote access

The devices do most of the work without human intervention, although people can interact with the devices.



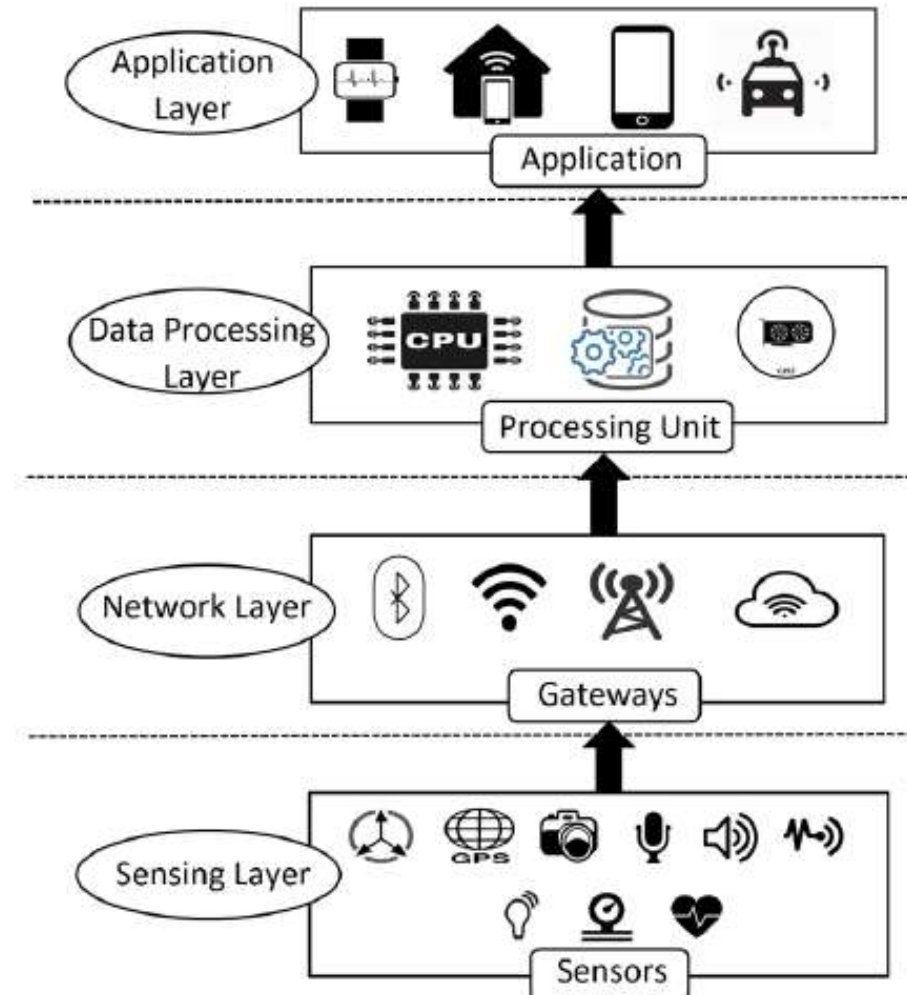
Architecture of IoT

An IoT device consists:

- Hardware,
- Software,
- Network connectivity, and
- Sensors.

Hence, the architecture of IoT comprises:

- Sensing layer,
- Network layer,
- Data processing layer, and
- Application layers



Source: Introduction to merging technologies module page 69

Devices and Networks

IoT 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...
- Enterprise and Industrial devices include smart city technologies such as those used to monitor traffic and weather conditions, smart sensors in conference room, smart air conditioning, smart thermostats, smart lighting, smart security...

...Devices and Networks

IoT network devices are massively deployed over range of areas like smart cities, industries.. And in hard-to-reach areas like hazardous zones;

IoT network challenges

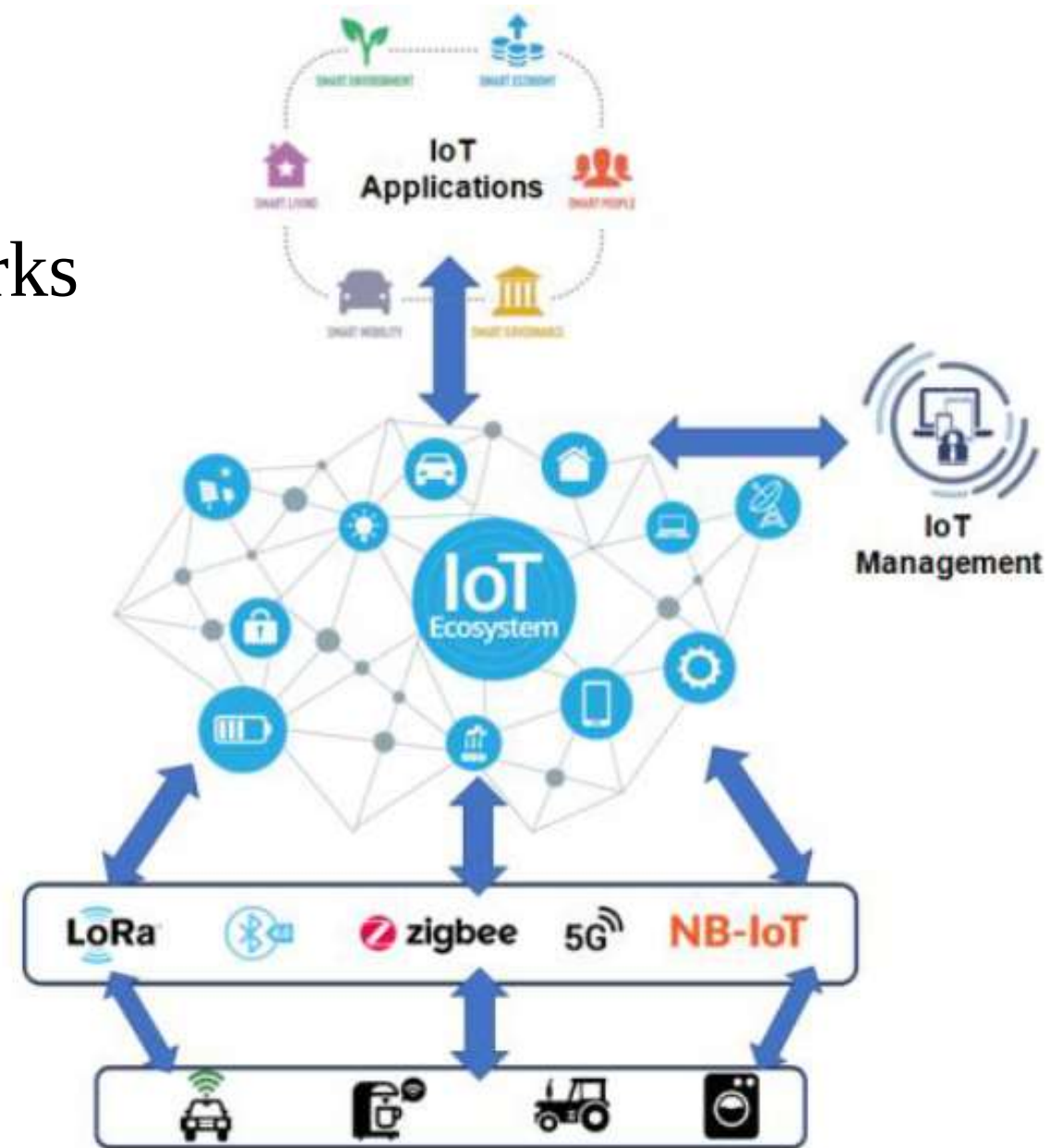
- scalability,
- interoperability,
- energy efficiency,
- topology control,
- Quality of Service (QoS),
- fault tolerance, and
- security.

Therefore, efficient and autonomic management of IoT networks is needed.

...Devices and Networks ...

- Management for Device and Network in the Internet of Things (M4DNIoT): integrates and controls the individual functionalities of the devices in an IoT network as well as the status and characteristics of this network.
- IoT network management structure scopes:
 - local management, where the platform runs in the same environment as the devices,
 - remote management, where the platform controls the devices in different networks.
- IoT minimum network requirements
 - Expandable
 - Provide standard web service (device discovery, data storage, and user authorities)

Examples of IoT Device and networks



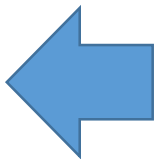
Source: Introduction to merging technologies module page 73



IoT tools and platforms

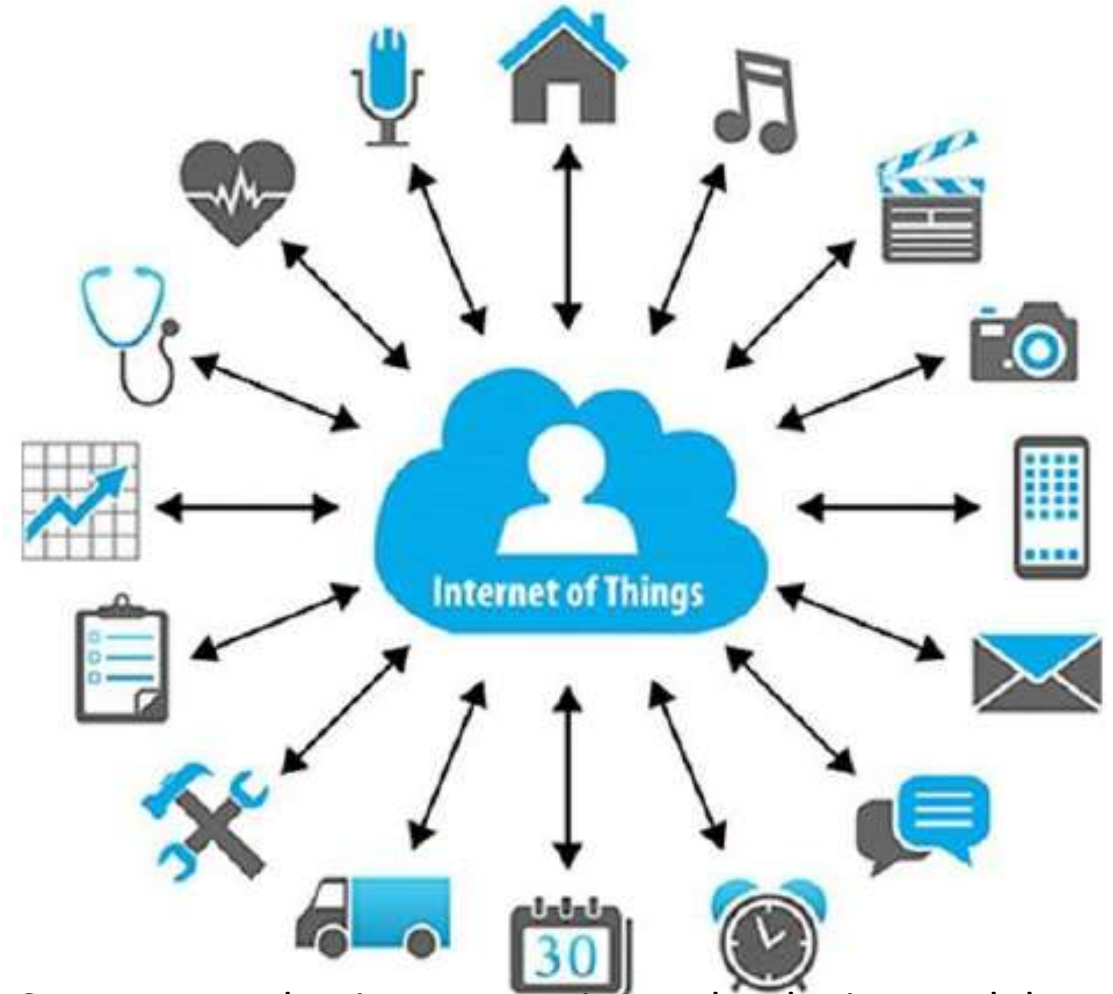
- IoT Platforms are based on the Internet of Things and cloud technology.
- The following are some IoT platform vendors
 - KAA
 - SiteWhere
 - ThingSpeak
 - DeviceHive
 - Zetta

Discuss some of the key features provided by the above vendors?



Applications of IoT

- Agriculture
- Consumer Use
- Healthcare
- Insurance
- Manufacturing
- Retail
- Transportation
- Utilities

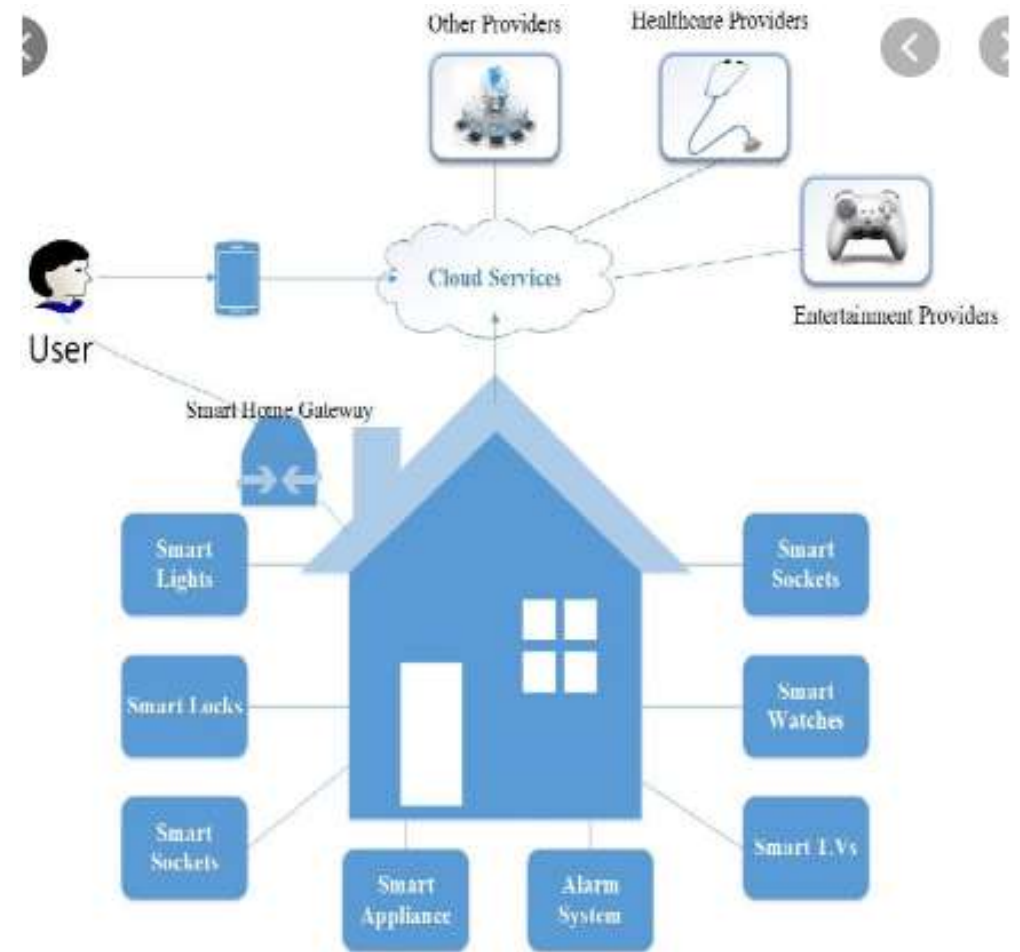


Source: Introduction to merging technologies module page 65

IoT Based Smart Home

It includes:

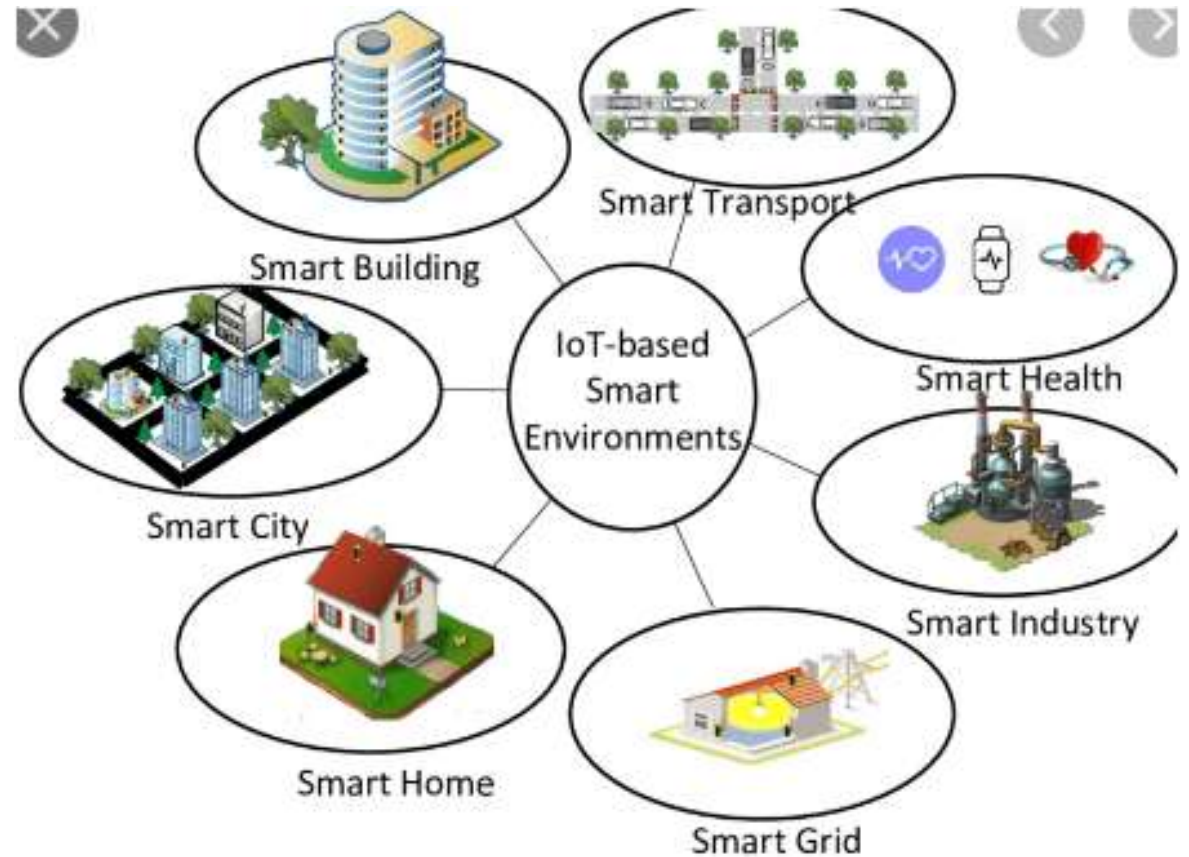
- Remote Control Appliances
- Weather
- Smart Home Appliances
- Safety Monitoring
- Intrusion Detection Systems
- Energy and Water Use



IoT Based Smart City

It includes:

- Structural Health
- Lightning
- Safety
- Transportation
- Smart Parking
- Waste Management



IoT Based Smart Farming

It includes:

- Green Houses
- Compost
- Animal Farming/Tracking
- Offspring Care
- Field Monitoring



Review Questions

- Briefly explain IoT
- Briefly explain the architecture of IoT and how IoT works?
- Write down application of IoT in smart city, home and farming?
- Write down some IoT devices?
- What are the challenges of IoT?
- List down some IoT tools and platforms?

END!!

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Introduction to Emerging
Technologies

Augmented Reality

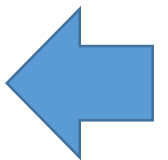
Contents

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- [VR](#)
- [AR](#)
- [MR](#)
- [Differences between AR, VR and, MR](#)
- [Architecture of AR](#)
- [Challenges of AR](#)
- [Application of AR](#)
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Learning Outcomes

After successful completion of this chapter, the students be able to:

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



Brainstorming

What do you think about Augmented Reality?
Can you give an example of AR?

What is AR?

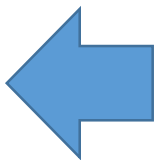
- **Augmented reality (AR)** is a form of emerging technology that allows users to overlay computer-generated content in the real world. AR refers to a live view of a physical real-world environment whose elements are merged with augmented computer-generated images creating a mixed reality. The augmentation is typically done in real-time and in semantic context with environmental elements.
- **Augmented Reality (AR)** is a live direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data.

...What is AR?

- **Augmented reality** is the integration of digital information with the user's environment in real-time. Unlike virtual reality, which creates a totally artificial environment, augmented reality uses the existing environment and overlays new information on top of it.



Source: internet



Virtual Reality (VR)

- VR is fully immersive, which tricks your senses into thinking you're in a different environment or world apart from the real world. Using a head-mounted display (HMD) or headset, you'll experience a computer-generated world of imagery and sounds in which you can manipulate objects and move around using haptic controllers. It is also called a computer-simulated reality.



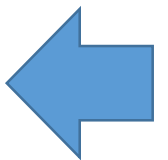
Source: Introduction to emerging technologies page 83

...Virtual Reality (VR)

- VR refers to computer technologies using reality headsets to generate realistic sounds, images and other sensations that replicate a real environment or create an imaginary world. Advanced VR environment will engage all five senses (taste, sight, smell, touch, sound).
- Most VR headsets are connected to a computer (Oculus Rift) or a gaming console (PlayStation VR) but there are standalone devices (Google Cardboard is among the most popular). Most standalone VR headsets work in combination with smartphones – you insert a smartphone, wear a headset, and immerse in the virtual reality



Source: Introduction to emerging technologies page 83



Augmented Reality (AR)

- In augmented reality, users see and interact with the real world while digital content is added to it by using the camera.
- Examples of AR include Snapchat lenses and the game Pokemon Go.
- Augmented Reality (AR) is a live, direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data



Source: Introduction to emerging technologies page 84

Mixed Reality (MR)

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



Source: Introduction to emerging technologies page 85

...Mixed Reality (MR)

Examples of MR: playing a virtual video game, grab your real-world water bottle, and smack an imaginary character from the game with the bottle.

The key characteristic of MR is that

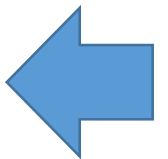
- The synthetic content and the real-world content are able to react to each other in real-time.
- Imagination and reality have never been so intermingled.

...Mixed Reality (MR)

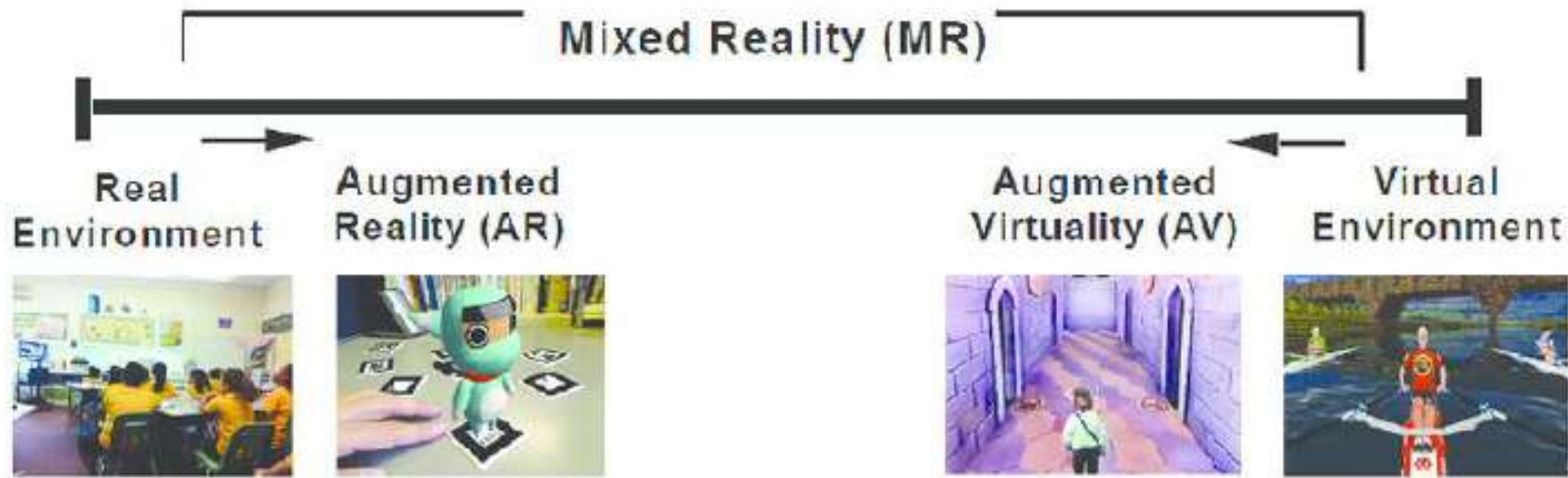
- MR allows you to see and immerse yourself in the world around you even as you interact with a virtual environment using your own hands—all without ever removing your headset.
- It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary, offering an experience that can change the way you game and work today.



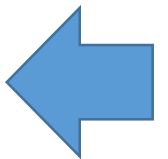
Source: Introduction to emerging technologies page 85

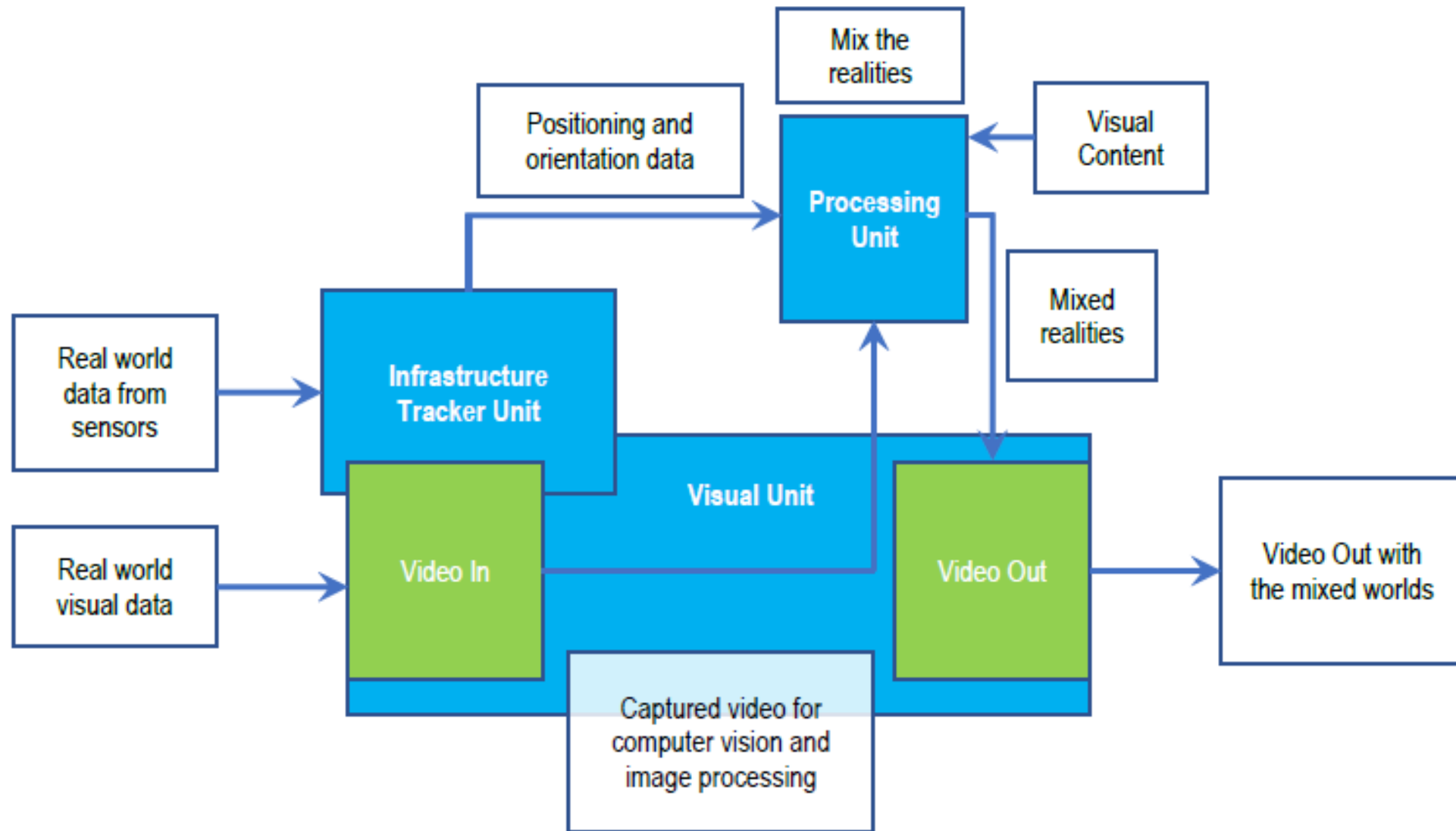


AR, VR and MR differences



Source: Introduction to emerging technologies page 82



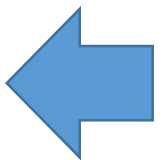


Source: Introduction to emerging technologies page 87



Challenges of ARS

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



Applications of AR Systems

In education:

- Affordable learning materials
- Interactive lessons
- Higher engagement
- Higher retention
- Boost intellectual curiosity



Source: internet

Applications of AR Systems

In Medicine:

- Describing symptoms
- Nursing care
- Surgery
- Ultrasounds
- Diabetes management



Source: internet

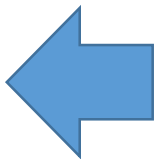
...Applications of AR Systems

In Entertainment

- games
- music
- TV
- eSports
- heater



Source: internet



Review Questions

- Briefly explain AR, VR, and MR?
- What is the difference between augmented, virtual and mixed reality?
- Briefly explain the architecture of AR?
- Write down the challenges of AR?
- Write down some applications of AR system in education, entertainment and medicine?

END!!

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Introduction to Emerging Technologies

ETHICS AND PROFESSIONALISM

Technology and ethics

- Ethics is – integrity, objectivity, competence and due care, confidentiality, and professional behavior.
- Technology can serve to promote or restrict human rights. The Information Society should foster the use of emerging technologies in such a way as to maximize the benefits that they provide while minimizing the harms.
- Establishing the proper legal or regulatory system is important to reduce the effect of abusing technology rather than sharing technological benefits

Ethical questions related emerging technology

Ethics in Big data:

- The increasing use of big data, algorithmic decision-making, and artificial intelligence can enable more consistent, evidence-based and accurate judgments or decisions, often more quickly and efficiently. However, these strengths can potentially have a darker side too, throwing up questions around the ethical use of these fairly new technologies.
- For example, systems learn from real-world data, there is a significant risk that those systems simply recreate the past and subsequently build in errors or systemic biases.

Technology and ethics

Ethics in AI:

- Whatever the power of the machine, humans will still need to be involved, so that people can be held accountable, or explain the reasons behind a decision.
- Ethical issues are only recognized when the technology is already on the market and problems arise during its widespread use. Ethics can then become a tool to clean up a mess that might have been avoidable.

General ethical principles

1. Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing.
2. Avoid harm.
3. Be honest and trustworthy.
4. Be fair and take action not to discriminate
5. Respect the work required to produce new ideas, inventions, creative works, and computing artifacts.
6. Respect privacy.
7. Honor confidentiality

Professional responsibilities

1. Strive to achieve high quality in both the processes and products of professional work.
2. Maintain high standards of professional competence,
3. Know and respect existing rules pertaining to professional work.
4. Accept and provide appropriate professional review.
5. Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks.
6. Perform work only in areas of competence.
7. Foster public awareness and understanding of computing, and their consequences.

Professional leadership principles

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

Digital privacy

- It is the protection of personally identifiable or business identifiable information that is collected from respondents through information collection activities or from other sources.
- It encompasses three sub-related categories;
 1. Information privacy,
 2. Communication privacy, and
 3. Individual privacy
- It promotes advocacy on behalf of individual and consumer privacy rights in digital spheres, and is typically used in opposition to the business practices of many e-marketers/businesses/companies to collect and use such information and data.

Information Privacy

- It is the notion that individuals should have the freedom, or right, to determine how their digital information, mainly that pertaining to personally identifiable information, is collected and used.
- Every country has various laws that dictate how information may be collected and used by companies. Some of those laws are written to give agency to the preferences of individuals/consumers in how their data is used.

Communication Privacy

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

Individual Privacy

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

Digital privacy principles

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

Accountability and trust

- When emerging technology creates far-reaching and rapid change, it can also bring new risks. Understanding and mitigating them will help to build confidence. Often legal and regulatory frameworks haven't kept pace with digital transformation, and organizations are seeking guidance.
- Emerging technologies can provide improved accuracy, better quality and cost efficiencies for businesses in every sector. They can enhance trust in the organization's operations and financial processes, which is crucial for sustainable success. But this can produce a paradox: the very solutions that can be used to better manage risk, increase transparency and build confidence are often themselves the source of new risks, which may go unnoticed.

...Accountability and trust

- There's a danger that the use of technology will degrade people's willingness to judge and intervene because they feel that they are less personally connected to consumers and consumer outcomes – the logic of the machine has taken over from individual responsibility.
- The obligation of an individual or organization to account for its activities, accept responsibility for them, and to disclose the results in a transparent manner. It also includes the responsibility for money or other entrusted property.

Ethical and regulatory challenges

Emerging technologies are already impacting how we live and work. They're also changing how we approach, plan, and integrate security operations which include:

1. Counter-terrorism and law enforcement informatics via predictive analytics and artificial intelligence.
2. Real-time horizon scanning and data mining for threats and information sharing
3. Automated cybersecurity and information assurance
4. Enhanced Surveillance (chemical and bio-detection sensors, cameras, drones, facial recognition, license plate readers)
5. Simulation and augmented reality technologies for training and modeling

...Ethical and regulatory challenges

6. Safety and security equipment (including bullet and bomb proof) made with lighter and stronger materials
7. Advanced forensics enabled by enhanced computing capabilities (including future quantum computing)
8. Situational awareness capabilities via GPS for disaster response and crisis response scenarios
9. Biometrics: assured identity security screening solutions by bio-signature: (every aspect of your physiology can be used as a bio-signature. Measure unique heart/pulse rates, electrocardiogram sensor, blood oximetry, skin temperature)

Challenges in using Artificial Intelligence

- AI is only as good as the data it is exposed to, which is where certain challenges may present themselves. How a business teaches and develops its AI will be the major factor in its usefulness. Humans could be the weak link here, as people are unlikely to want to input masses of data into a system.
- AI has a potential to replace human workers. As machines become more “intelligent” they could begin to replace experts in higher-level jobs.
- Alternatively, AI also has the potential to take the burden of laborious and time-consuming tasks from people, freeing up their time and brainpower for other things

Challenges in using Robotics in manufacturing

- With automation and robotics moving from production lines out into other areas of work and business, the potential for humans losing jobs is greater.
- As robots learn to teach each other and themselves, there is the potential for much greater productivity but this also raises ethical and cybersecurity concerns.

Challenges in using the Internet of Things

- As more and more connected devices (such as smartwatches and fitness trackers) join the Internet of Things (IoT) the amount of data being generated is increasing. Companies will have to plan carefully how this will affect the customer-facing application and how to best utilize the masses of data being produced without compromising the individual privacy.

Challenges in Big Data

- The huge amount of data being generated on a daily basis has the potential to provide businesses with better insight into their customers as well as their own business operations.
- Although data can be incredibly useful for spotting trends and analyzing impacts, surfacing all this data to humans in a way that they can understand can be challenging.

Treats

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

...Treats

Some risks of emerging technology are:

- Driverless car: cars could crash and burn from errors resulted to bodily injury and property damage.
- Wearables: Google glass, Fitbit and other wearables can expose companies to the invasion of privacy claims that may not be covered by general liability or personal injury claims that weren't foreseen.

...Treats

Some risks of emerging technology are:

- Drones: Turbulence is in the offing for manufacturers and organizations that fail to protect themselves for property damage and bodily injury, as well as errors and omissions.
- Internet of things: The proliferation of sensors and cross-platform integration creates potential exposure from privacy invasion, bodily injury and property damage that may connect an organization to huge liabilities.

END!!

Addis Ababa Science and Technology University

College of Mechanical and Electrical Engineering

Introduction to Emerging Technologies

Other emerging technologies

Other emerging technologies

- Nanotechnology
- Biotechnology
- Block-chain technology
- Cloud and quantum computing
- Autonomic computing
- Computer vision
- Embedded systems
- Cybersecurity
- 3D printing

Nanoscale

- Nanotechnology is science, engineering and technology conducted at the nanoscale, which is about 1 to 100 nanometer.
- Study and application of extremely small things and can be used across all the other science fields. Such as chemistry, biology, physics, materials science, and engineering.

- IDEA – (Feynman) described a process in which scientists would be able to manipulate and control individual atoms and molecules.
- The ability to see and to control individual atoms and molecules.
- Scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum.

- Application of nanotechnology
 - **Medical** - deliver drugs directly to disease cells in your body.
 - **Electronics** - reduce their weight and power consumption
 - **Food** - from how food is grown to how it is packaged.
 - **Agriculture** - generation to preservation, handling, bundling, transportations, and even waste managements.
 - **Vehicle manufacturers** - like aviation, lighter and stronger materials

Biotechnology

- it is the broad area of biology involving systems and organisms to develop or make products, or "any technology application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".
- At its simplest, biotechnology is technology based on biology.
- - genetic engineering (ex. In medicine, agriculture, industrial biotechnology)

Blockchain technology

- Originally blockchain is a growing list of records, called blocks, that are linked using cryptography.
- A blockchain is, a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity.
- In order for a block to be added to blockchain,
 - A transaction must occur
 - That transaction must be verified
 - That transaction must be stored in a block
 - That block must be given a hash

- The Three Pillars of Blockchain Technology

1. Decentralization
2. Transparency
3. Immutability

Application of Blockchain

- The sharing economy
- Crowdfunding
- Governance
- Supply chain auditing
- File storage

Cloud and quantum computing

- Cloud computing
 - Cloud computing is a means of networking remote servers that are hosted on the internet. Rather than storing and processing data on a local server, or PC's hard drive.
- Service can focus on infrastructure, web development or a cloud-based app. These are often regarded as a stack.
 - Infrastructure as a Service(IaaS)
 - Platform as service(PaaS)
 - Software as a service(SaaS)

- Quantum computing

Unlike classic computers, they derive their power by harnessing the power of quantum physics.

1 and 0 $\rightarrow$ qubit (can hold even more values)

Advantage - power of computing

- Autonomic computing (AC)

Autonomic computing is an approach to address the complexity and evolution problems in software systems. It is a self-managing computing model named after, and patterned on, the human body's autonomic nervous system.

- Self-Awareness
- Self-Configuring
- Self-Optimizing
- Self-Healing
- Self-protecting
- Context-Aware
- Open
- Anticipatory

- Computer vision

It is an interdisciplinary scientific field that deals with how computers can be made to gain a high-level understanding of digital images or videos.

How computer vision works

1. Acquiring an image
2. Processing the image
3. Understanding the image

- image segmentation
- Object detection
- Facial recognition
- Pattern detection
- Image classification

- Applications
 - OCR (optical character recognition)
 - Machine inspection
 - Retail
 - Medical imaging
 - Automotive safety
 - Surveillance
 - Fingerprint recognition

- Embedded systems

It is a controller with a dedicated function within a large mechanical or electrical system.

Modern embedded systems are often based on microcontroller.

Advantages of Embedded

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

Disadvantages of Embedded systems

- High development effort
- Larger time to market

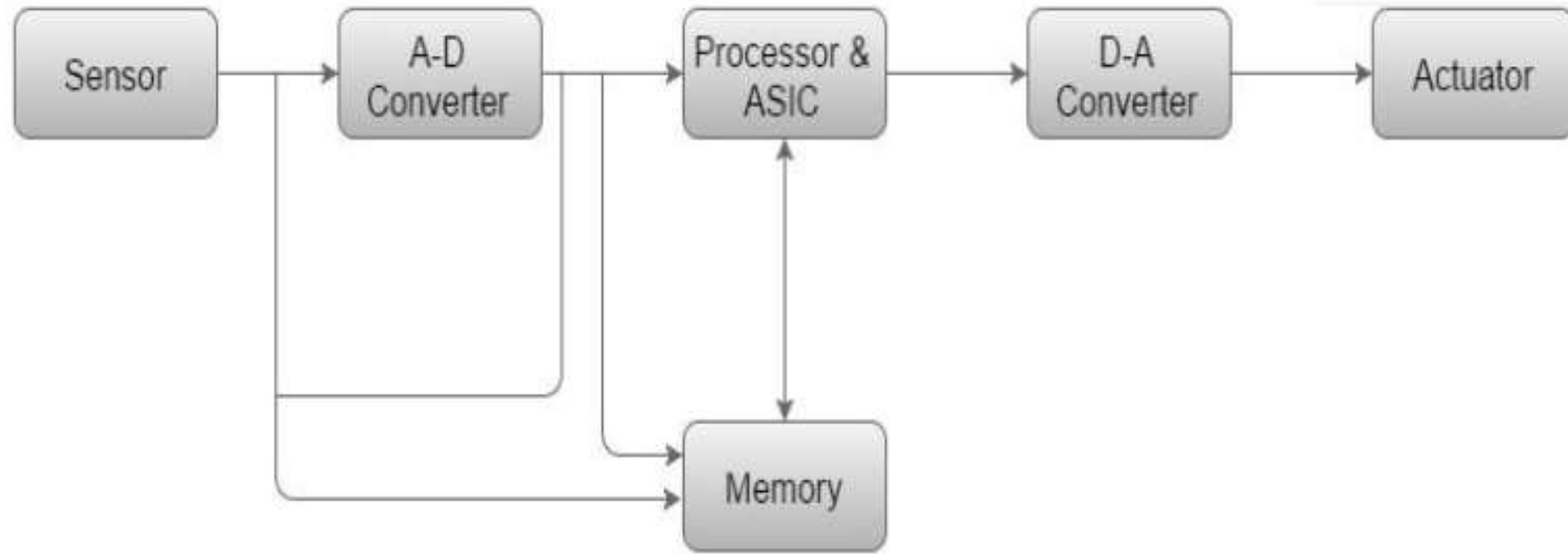


Figure 7.6 Basic structure of an embedded system

- Cybersecurity

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

- Cybersecurity measures

- The following are some security measures to be taken to prevent cybercrime

- Staff awareness training
 - Application security
 - Network security
 - Leadership commitment
 - Password management

- Types of cybersecurity threats

- Ransomware
 - Malware
 - Social engineering
 - Phishing

- Additive manufacturing(3D Printing)
 - The American Society for testing and Materials define: " Additive manufacturing, also known as 3D printing, uses computer-aided design to build objects layer by layer.
 - Additive manufacturing describes types of advanced manufacturing that are used to create three-dimensional-structures out of plastics, metals, polymers and other materials that can be sprayed through a nozzle or aggregated in a vat.