Ins..Dereje Almayhu

KOLLEEJJII AWAASH VAALII
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AWASH VALLEY COLLEGE

Introduction to Emerging Technologies

(EMTE1011/1012)

By:Dereje.A

CHAPTER ONE

INTRODUCTION

By:Dereje.A

1. Introduction to Emerging Technologies

Topics Covered

- Evolution of technologies
  - Introduction to Industrial revolution
  - Historical background (IR 1.0, IR 2.0, IR 3.0)
  - Fourth industrial revolution (IR 4.0)
- Role of data for Emerging technologies
- Enabling devices and networks for emerging technologies (programmable devices)
- Human to Machine Interaction
- Future trends in emerging technologies

Evolution of Technologies

- Refers to the continuing development of existing technology
- It may also refers technologies w/c are developing or expected to be developed in the next five to ten years and create some economic or social effect
- What is technology?
- What is evolution?

Evolution of Technologies

- **Technology:-** Greek word tekhnologia and meaning "systematic treatment of an art, craft, or technique"
- **Evolution**: means the process of developing by gradual changes and it was from Latin word evolutio "an unrolling or opening"

Introduction to the Industrial Revolution (IR)

- The Industrial Revolution was a period of major industrialization and innovation that took place during the late 1700s and early 1800s
- The Industrial Revolution was a time when the manufacturing of goods moved from small shops and homes to large factories (first industrial revolution) started in **England**
- This shift brought about changes in culture as people moved from rural areas to big cities in order to work
- American Industrial Revolution Second Industrial Revolution, started sometime between 1820 and 1870.

- The impact of changing the way items was manufactured had a wide reach. Industries such as textile manufacturing, mining, glass making, and agriculture all had undergone changes
- 1st IR (mechanization through water and steam power) to mass production and assembly lines using electricity in the second IR
- 4th IR will take what was started in the third with the adoption of computers and automation and enhance it with smart and autonomous systems fueled by data and machine learning

IR

- Generally industrial revolutions fundamentally changed and transfer the world around us into modern society
- Steam engine -> Age of science and mass production -> Rise of digital technology-> Smart and autonomous systems (automation and machine learning)

❖ Important Inventions of the IR

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

Historical Background (IR 1,2,3)

- IR began in Great Britain in the late 1770s before spreading to the rest of Europe
- Then it spread across Belgium, France and Germany
- The final cause of IR is the effect created by agricultural revolution
- Because IR was started due to increase food production which is the key outcome of Agricultural revolution

Four types of industries

- Primary industry:- focus on gaining raw materials
- Secondary industry:- focus on manufacturing
- Tertiary industry:- focus on service providing
- Quaternary industry:- focus on Research and devt of IT

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
- Reshaping and paradigm-shifting are driven not just by data itself but all other aspects that could be created, transformed and/or adjusted by understanding, exploring and utilizing data
- The potential of data science and analytics to enable data-driven theory, economy and professional development is increasingly being recognized

Enabling devices and network (Programmable devices)

- Digital electronic systems have four basic kinds of devices:
- Memory:- store random information (page contents)
- Microprocessors:- for instruction execution
- Logic:- used to 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
- Networks:- used for connecting device to one another to allow the sharing of data

- Best example network is the internet which connects millions of people over the world/across the world
- Programmable devices usually refer to chips that incorporate
- Field programmable logic devices (FPGAs)
- Complex programmable logic devices (CPLD)
- Programmable logic devices (PLD)
- Generally, network related equipments are referred to as Service Enabling Devices (SEDs), which can include:

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

Modems

Routers, Switches, Conferencing equipment,

HMI/HCI

- HMI:- 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 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
- HCI consists of three parts: the user, the computer itself, and the ways they work together

How do users interact with computers?

- The users interact with computer through the I/O h/ware
- 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

❑ Disciplines contributing to HCI:

- Cognitive psychology
- Computer science
- Linguistics
- Engineering and design
- Artificial intelligence.
- Human factors.

Emerging technology trends in 2019

- 5G Networks:- fifth generation wireless technology for digital cellular networks that began wide deployment in 2019
- Artificial Intelligence:- human intelligence demonstrated by machine or computer (mainly robots)
- Autonomous Devices:- robotic applications that can perform by their own including some physical exercises
- Block chain:- it is a distributed or decentralized business logic used for buying or selling from anywhere at anytime.
- Augmented Analytics:- this is working on data to get right decision by implementing the ML and NLP
- Digital Twins :- is the software representation of some physical assets used for simulation purpose
- Enhanced Edge Computing:- it is an infrastructure used for transforming the data handling way into wireless data handling
- Immersive Experiences in Smart Spaces :- smart space is the place where humans and technology are living in the same physical env't

Topics of future trends in networking technology

1. 5G technology:
2. Rise of decentralization
3. 2. Network developments in edge computing
4. Changing perspectives on ML and AI
5. More attention to network security
6. Going wireless
7. Cloud repatriation

Topics in human-computer interaction include the following

- Augmented reality
- Knowledge-driven human–computer interaction
- Emotions and human-computer interaction
- Social computing
- User customization
- Embedded computation
- Brain–computer interfaces

Chapter 2

Data Science

By:Dereje.A

- What is data science?

It 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.

It is not only about data analyzing

What are data and information

- Data can be defined as a representation of facts, concepts, or instructions in a formalized manner, which should be suitable for communication, interpretation, or processing, by human or electronic machines
- Information is the processed data on which decisions and actions are based. It is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in the current or the prospective action or decision of recipient.

What is Information?

- Information is organized or classified data, which has some meaningful values for the receiver. Information is the processed data on which decisions and actions are based.
- Information is a data that has been processed into a form that is meaningful to recipient and is of real or perceived value in the current or the prospective action or decision of recipient.
- For the decision to be meaningful, the processed data must qualify for the following characteristics −
  - Timely − Information should be available when required.
  - Accuracy − Information should be accurate.
  - Completeness − Information should be complete.

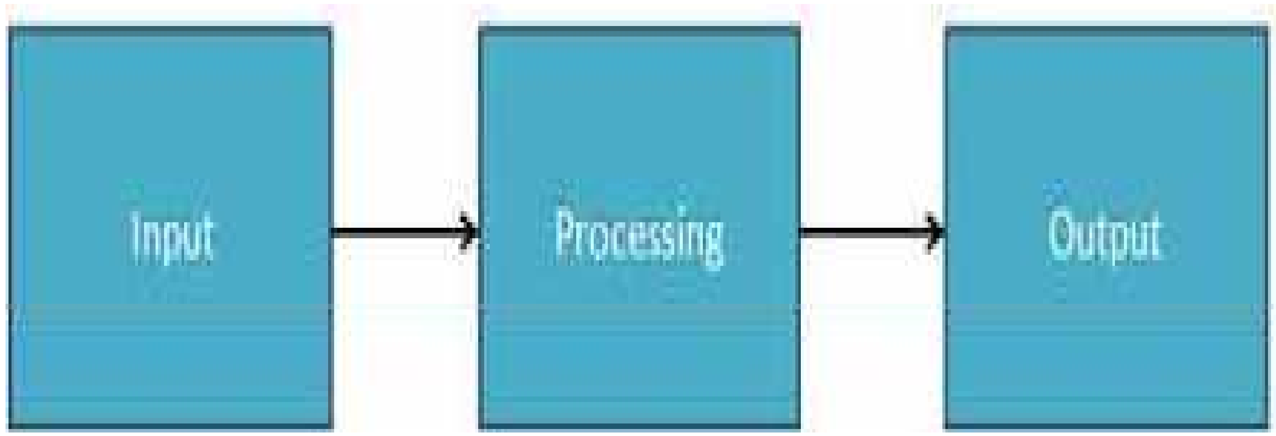
	Data	Information
Meaning	Data is raw, unorganized facts that need to be processed. Data can be something simple and seemingly random and useless until it is organized.	When data is processed, organized, structured or presented in a given context so as to make it useful, it is called information.
Example	Each student's test score is one piece of data.	The average score of a class or of the entire school is information that can be derived from the given data.

Summery: Data Vs. Information	
Data	Information
Described as unprocessed or raw facts and figures	Described as processed data
Cannot help in decision making	Can help in decision making
Raw material that can be organized, structured, and interpreted to create useful information systems.	Interpreted data; created from organized, structured, and processed data in a particular context.
‘groups of non-random’ symbols in the form of text, images, and voice representing quantities, action and objects'.	Processed data in the form of text, images, and voice representing quantities, action and objects'.

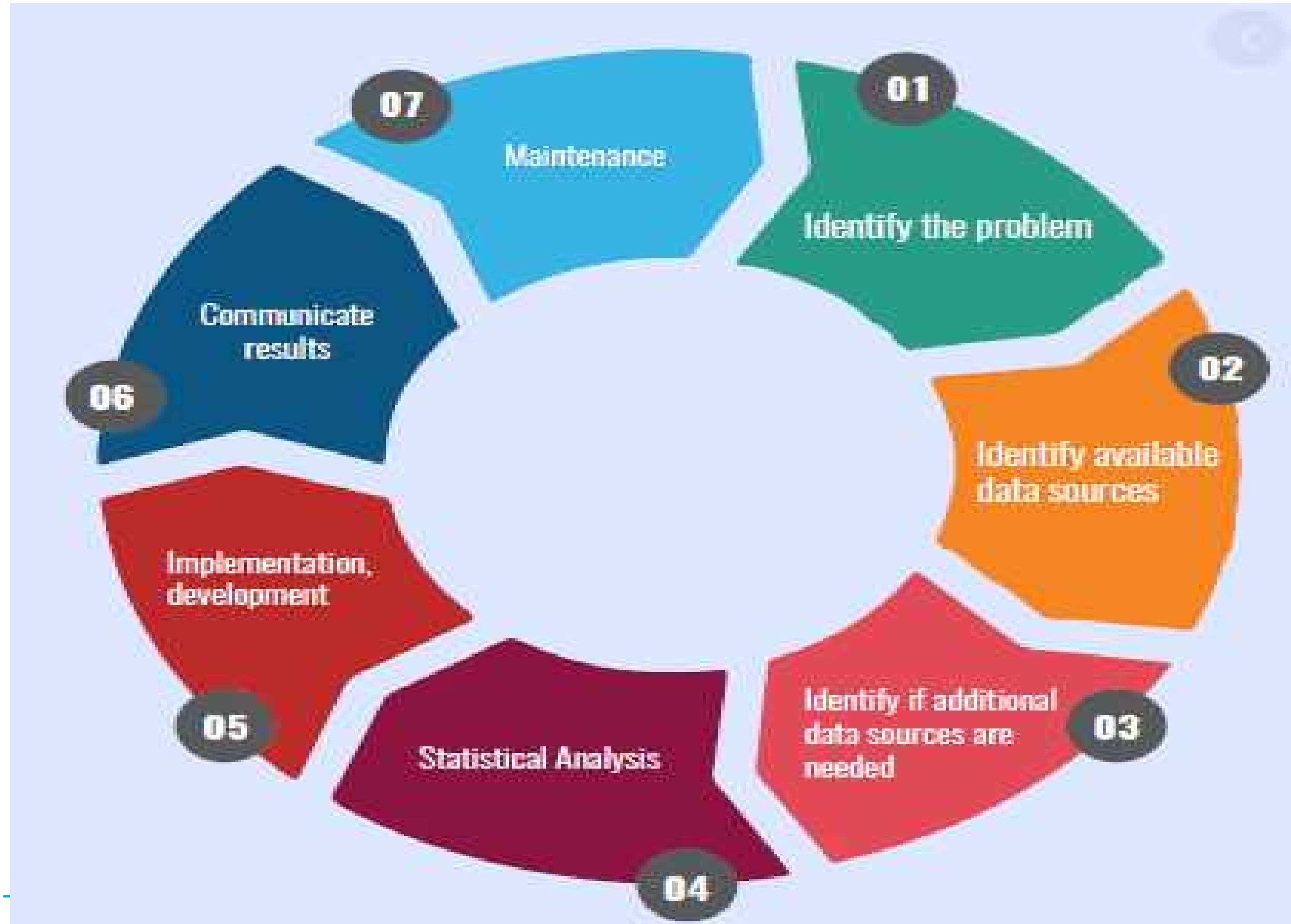
Data Processing Cycle

- Data processing is the re-structuring or re-ordering of data by people or machine to increase their usefulness and add values for a particular purpose.
- Data processing consists of the following basic steps - input, processing, and output. These three steps constitute the data processing cycle.
- **Input step** – the input data is prepared in some convenient form for processing.
- The form depends on the processing machine.
- For example - when electronic computers are used – input medium options include magnetic disks, tapes, and so on.
- **Processing step** – the input data is changed to produce data in a more useful form.
- For example - pay-checks can be calculated from the time cards, or a summary of sales for the month can be calculated from the sales orders.
- **Output step** – the result of the proceeding processing step is collected.
- The particular form of the output data depends on the use of the data.
- For example - output data may be pay-checks for employees.

Data Processing Cycle



Data Science Life cycle



Data Types and Their Representation

- In the area of computing, a data type is simply an attribute of data that tells the compiler or interpreter how the programmer intends to use the data
- Common data types include:-
- Integers(int)
- Booleans(bool)
- Characters(char)
- Floating-point numbers(float)
- Alphanumeric strings(string)
- This data type defines the operations that can be done on the data, the meaning of the data, and the way values of that type can be stored

Data types from Data Analytics perspective

- There are three common types of data types or structures:

Structured:- conforms to a tabular format like Excel files

- Structured data is considered the most ‘traditional’ form of data storage

Semi-structured:- known as a self-describing XML

- 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

Unstructured data:- does not have a predefined data model or is not organized in a pre-defined manner

- It can be typically text-heavy but may contain data such as dates, numbers, and facts
- It results in irregularities and ambiguities
- The ability to analyze unstructured data is especially relevant in the context of Big Data.
- The ability to extract value from unstructured data is one of main drivers behind the quick growth of Big Data.

Structured Data

- Well-defined content
- Examples
  - Customer data
  - Sales data
  - Sensor data
- Easily understood
- Stored in an RDBMS

Unstructured Data

- Structure not obvious
- Examples:
  - Images
  - Video
  - Natural language text
- Process data to understand
- RDBMS not a good fit

Semi-Structured Data

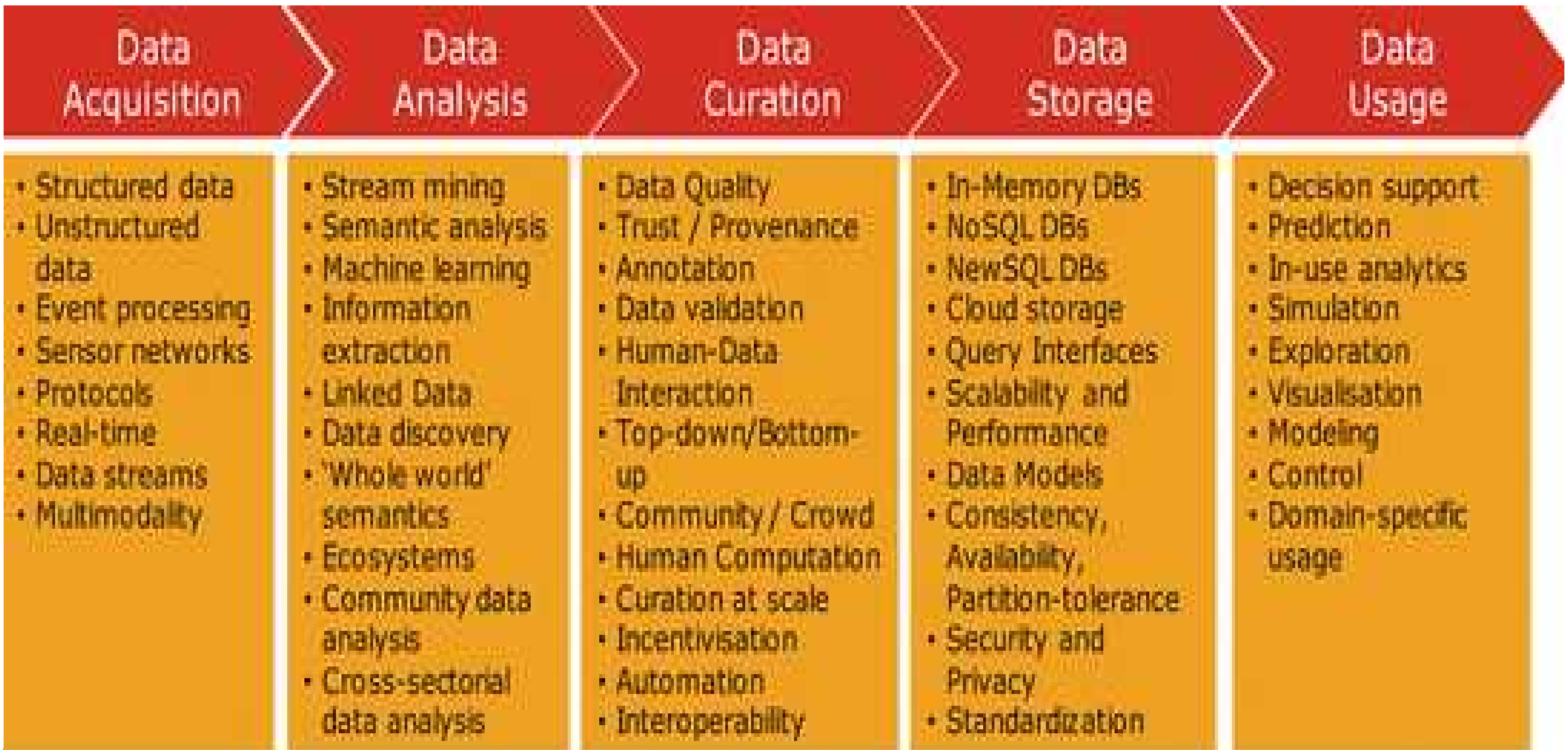
Combination of both, e.g. email, social media feeds

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
- It provides additional information about a specific set of data so it is data about data
- Eg. In photograph metadata could describe when and where the photos were taken and etc. A last category of data type is metadata. From a technical point of view, this is not a separate data structure, but it is one of the most important elements for Big Data analysis and big data solutions.
- Metadata is data about data.
- It provides additional information about a specific set of data.
- In a set of photographs, for example, metadata could describe when and where the photos were taken. The metadata then provides fields for dates and locations which, by themselves, can be considered structured data.
- Because of this reason, metadata is frequently used by Big Data solutions for initial analysis.

Data value Chain

- To describe the information flow within a big data system as a series of steps needed to generate value and useful insights from data. high-level activities



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
- 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.

Data Analysis

- 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

Data Curation

- 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 (data annotators) that are responsible for improving the accessibility and quality of data.

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
- 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

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 a blanket term for the non-traditional strategies and technologies needed to gather, organize, process, and gather insights from large datasets

- While the problem of working with data that exceeds the computing power or storage of a single computer is not new, the pervasiveness, scale, and value of this type of computing have greatly expanded in recent years

Basic concepts of big data

- Big data is a blanket term for the non-traditional strategies and technologies needed to gather, organize, process, and gather insights from large datasets.
- While the problem of working with data that exceeds the computing power or storage of a single computer is not new, the pervasiveness, scale, and value of this type of computing has greatly expanded in recent years.
- In this section, we will talk about big data on a fundamental level and define common concepts you might come across.
- We will also take a high-level look at some of the processes and technologies currently being used in this space.

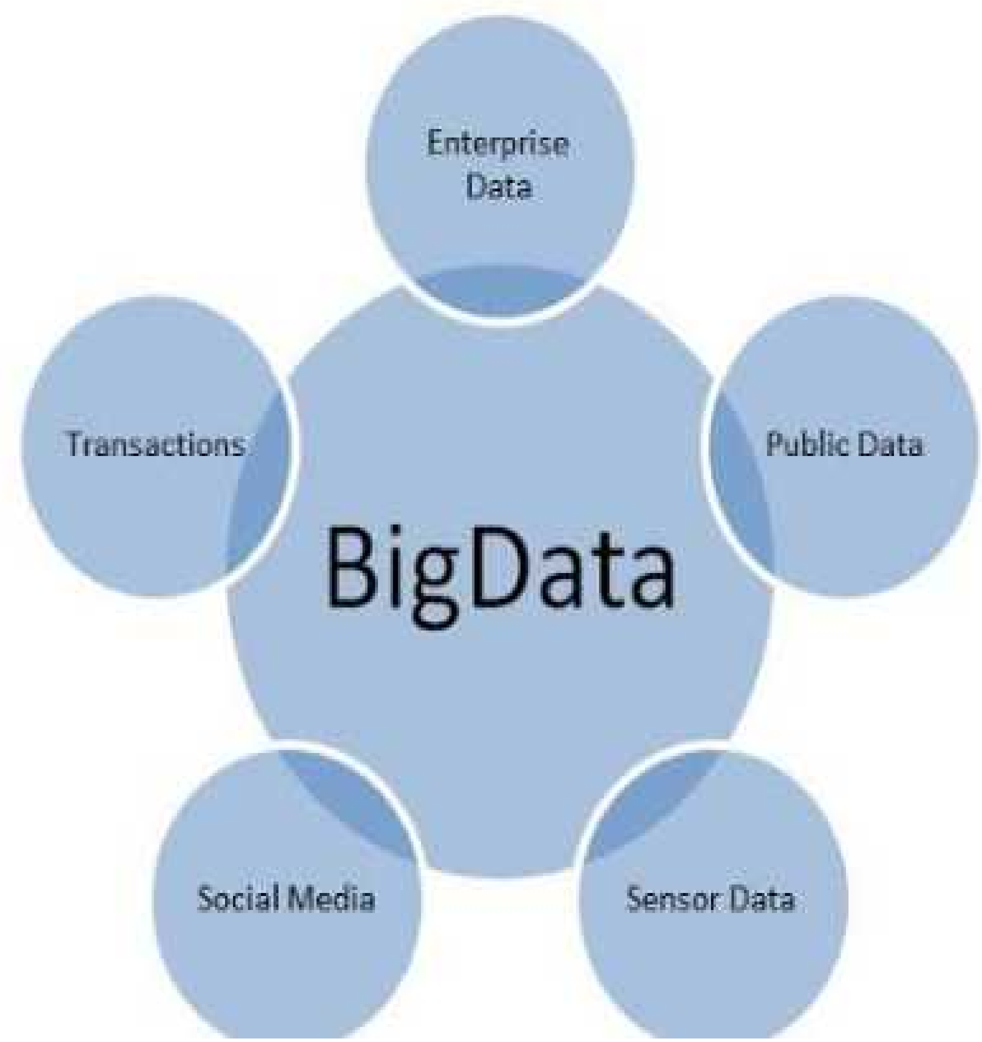
What Is Big Data?

- An exact definition of "big data" is difficult to nail down because projects, vendors, practitioners, and business professionals use it quite differently. With that in mind, generally speaking, big data is:
  1. large datasets
  2. the category of computing strategies and technologies that are used to handle large datasets
- In this context, "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.

Where does big data come from?

In a narrow definition, big data is a term for collection of datasets, it is so large and complex where existing tools and program are no longer appropriate / suitable to be used. Some examples include:

- **Activity data** – How we interact with Facebook, Instagram. How we use our browsers. Credit card companies also track your spending patterns.
- **Conversation data** – Think of the amount of emails we send, short text message. The rise of Whatsapp exponentially increased the amount of messages we send everyday.
- **Photo and Image** – Social media and digital photo sharing has enabled users to take photos.
- **Sensor data** – Weather sensor, air pollution sensor are gathering the change in environment. Waze is another classic example where everyone becomes its sensor to track traffic.


Enterprise Data
Transactions
Public Data
BigData
Social Media
Sensor Data

Why Are Big Data Systems Different?

- The basic requirements for working with big data are the same as the requirements for working with datasets of any size.
- However, the massive scale, the speed of ingesting and processing, and the characteristics of the data that must be dealt with at each stage of the process present significant new challenges when designing solutions.
- The goal of most big data systems is to surface insights and connections from large volumes of heterogeneous data that would not be possible using conventional methods.
- In 2001, Gartner's Doug Laney first presented what became known as the "three Vs of big data" to describe some of the characteristics that make big data different from other data processing:

Characteristics of Big Data – 3V's

Volume

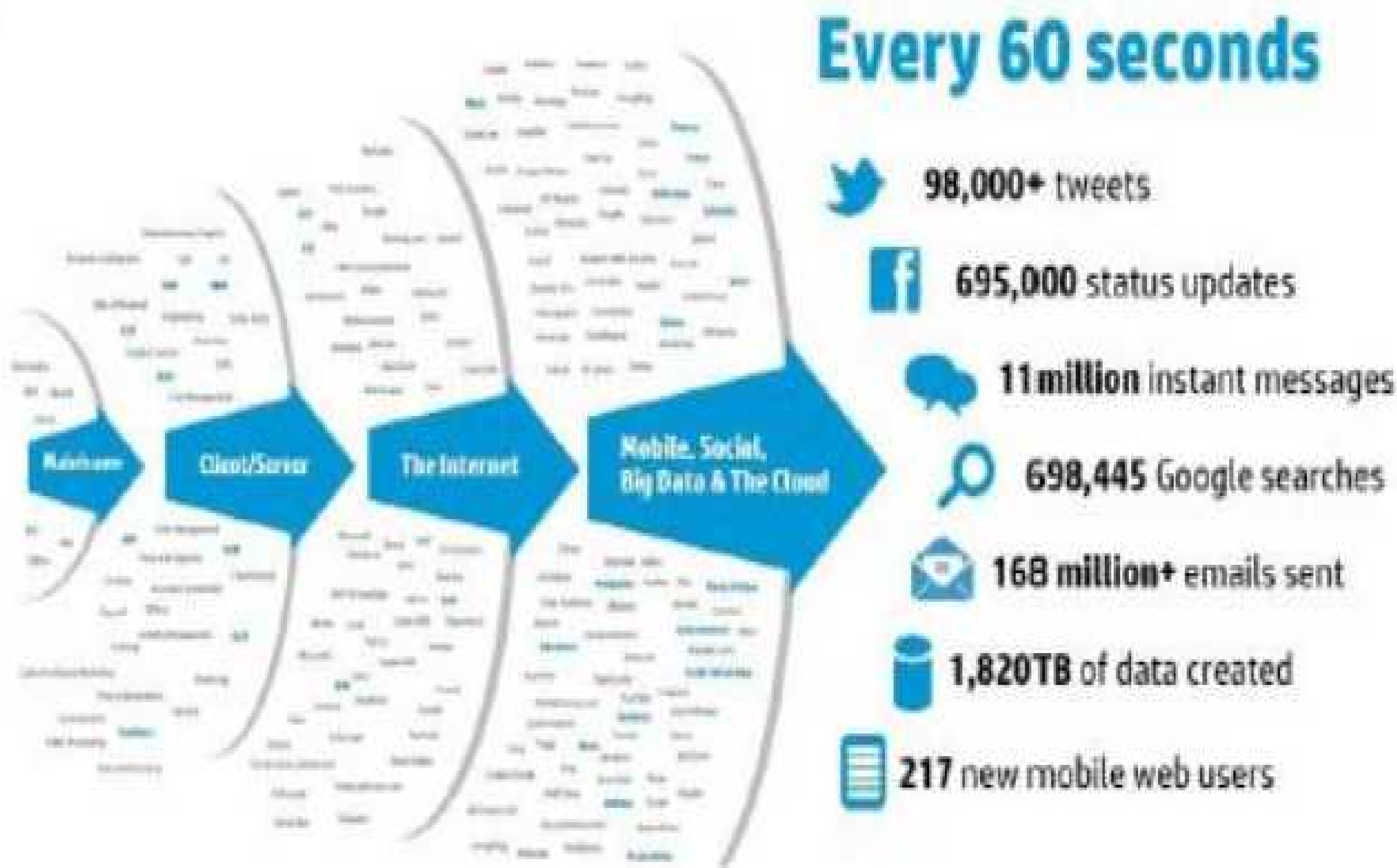
- The sheer scale of the information processed helps define big data systems.
- These datasets can be orders of magnitude larger than traditional datasets, which demands more thought at each stage of the processing and storage life cycle.
- Often, because the work requirements exceed the capabilities of a single computer, this becomes a challenge of pooling, allocating, and coordinating resources from groups of computers.
- Cluster management and algorithms capable of breaking tasks into smaller pieces become increasingly important.

Velocity

- Another way in which big data differs significantly from other data systems is the speed that information moves through the system.
- Data is frequently flowing into the system from multiple sources and is often expected to be processed in real time to gain insights and update the current understanding of the system.
- This focus on near instant feedback has driven many big data practitioners away from a batch-oriented approach and closer to a real-time streaming system.
- Data is constantly being added, massaged, processed, and analyzed in order to keep up with the influx of new information and to surface valuable information early when it is most relevant.
- These ideas require robust systems with highly available components to guard against failures along the data pipeline.

Variety

- Big data problems are often unique because of the wide range of both the sources being processed and their relative quality.
- Data can be ingested from internal systems like application and server logs, from social media feeds and other external APIs, from physical device sensors, and from other providers.
- Big data seeks to handle potentially useful data regardless of where it's coming from by consolidating all information into a single system.
- The formats and types of media can vary significantly as well. Rich media like images, video files, and audio recordings are ingested alongside text files, structured logs, etc.
- While more traditional data processing systems might expect data to enter the pipeline already labeled, formatted, and organized, big data systems usually accept and store data closer to its raw state.
- Ideally, any transformations or changes to the raw data will happen in memory at the time of processing.



Examples of big data velocity

Big Data Characteristics

Volume	Variety	Velocity
• Records • Pictures • Videos • Terabyte	• Structured • Semi-structured • Unstructured	• Batch • Stream • Realtime Processing

6V's

- Various individuals and organizations have suggested expanding the original 3Vs, which tended to describe challenges rather than qualities of big data. The additions include:
- **Veracity**: The variety of sources and the complexity of the processing can lead to challenges in evaluating the quality of the data (and consequently, the quality of the resulting analysis)
- **Variability**: Variation in the data leads to wide variation in quality. Additional resources may be needed to identify, process, or filter low quality data to make it more useful.
- **Value**: The ultimate challenge of big data is delivering value. Sometimes, the systems and processes in place are complex enough that using the data and extracting actual value can become difficult.

persisting, commuting & analyzing, and visualizing

- So how is data actually processed with a big data system?
- While approaches to implementation differ, there are some commonalities in the strategies and software that we can talk about generally.
- Therefore, the widely adopted steps are presented below (note it might not be true in all cases).
- The general categories of activities involved with big data processing are:
  - *Ingesting data into the system*
  - *Persisting the data in storage*
  - *Computing and Analyzing data*
  - *Visualizing the results*
- Before discussing these steps, understanding of clustered computing - an important strategy employed by most big data solutions is important.

Clustered Computing

- Setting up a computing cluster is often the foundation for technology used in each of the life cycle stages.
- Because of the quantities of big data, individual computers are often inadequate for handling the data at most stages.
- Therefore, to 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, 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 is also extremely important. Processing large datasets requires large amounts these three resources.
- **High Availability**: Clusters can provide varying levels of fault tolerance and availability guarantees to prevent hardware or software failures from affecting access to data and processing. This becomes increasingly important as we continue to emphasize the importance of real-time analytics.
- **Easy Scalability**: Clusters make it easy to scale horizontally by adding additional machines to the group. This means the system can react to changes in resource requirements without expanding the physical resources on a machine.
- Using clusters requires a solution for managing cluster membership, coordinating resource sharing, and scheduling actual work on individual nodes. Solution for cluster membership and resource allocation include:
  - software like Hadoop's YARN (which stands for Yet Another Resource Negotiator) or Apache Mesos.
- The assembled computing cluster often acts as a foundation which other software interfaces with to process the data. The machines involved in the computing cluster are also typically involved with the management of a distributed storage system (*discuss in data persistence)*.

Step 1: Ingesting Data into the System

- Data ingestion is the process of taking raw data and adding it to the system.
- Complexity of this operation depends - heavily on the format and quality of the data sources and how far the data is from the desired state prior to processing.
- Dedicated ingestion tools that can add data to a big data system are.
  - **Apache Sqoop** – technologies that can take existing data from relational databases and add it to a big data system.
  - Similarly, **Apache Flume and Apache Chukwa** are projects designed to aggregate and import application and server logs.
  - Queuing systems like **Apache Kafka** can also be used as an interface between various data generators and a big data system.
  - Ingestion frameworks like **Gobblin** can help to aggregate and normalize the output of these tools at the end of the ingestion pipeline.
- In the ingestion process - some level of analysis, sorting, and labelling usually takes place.
  - This process is sometimes called ETL (stands for extract, transform, and load).
- While this term conventionally refers to legacy data warehousing processes, some of the same concepts apply to data entering the big data system.
- Typical operations might include modifying the incoming data to format it, categorizing and labelling data, filtering out unneeded or bad data, or potentially validating that it adheres to certain requirements.
- With those capabilities in mind, ideally, the captured data should be kept as raw as possible for greater flexibility further on down the pipeline.

Step 2: Persisting the Data in Storage

- The ingestion processes typically hand the data off to the components that manage storage, so that it can be reliably persisted to disk.
- Although looks simple operation, the volume of incoming data, the requirements for availability, and the distributed computing layer make more complex storage systems necessary.
- This usually means leveraging a distributed file system for raw data storage.
- Solutions like Apache Hadoop's HDFS filesystem allow large quantities of data to be written across multiple nodes in the cluster.
- This ensures that the data can be accessed by compute resources, can be loaded into the cluster's RAM for in-memory operations, and can gracefully handle component failures.
- Other distributed filesystems can be used in place of HDFS including Ceph and GlusterFS.
- Data can also be imported into other distributed systems for more structured access.
- Distributed databases, especially NoSQL databases, are well-suited for this role because they are often designed with the same fault tolerant considerations and can handle heterogeneous data.
- Many different types of distributed databases available to choose from depending on how you want to organize and present the data.

Data

- Once the data is available, the system can begin processing the data to surface actual information.
- The computation layer is perhaps the most diverse part of the system.
  - the requirements and best approach can vary significantly depending on what type of insights desired.
- Data is often processed repeatedly - either iteratively by a single tool or by using a number of tools to surface different types of insights.
- **Two main method of processing: Batch and Real-time**
- **Batch processing** is one method of computing over a large dataset.
- The process involves: breaking work up into smaller pieces, scheduling each piece on an individual machine, reshuffling the data based on the intermediate results, and then calculating and assembling the final result.
- These steps are often referred: splitting, mapping, shuffling, reducing, and assembling, or collectively as a distributed map reduce algorithm. This is the strategy used by Apache Hadoop's MapReduce.
- Batch processing is most useful when dealing with very large datasets that require quite a bit of computation.

- **Real-time processing** - While batch processing is a good fit for certain types of data and computation, other workloads require more real-time processing.
- Real-time processing demands that information be processed and made ready immediately and requires the system to react as new information becomes available.
  - One way of achieving this is stream processing, which operates on a continuous stream of data composed of individual items.
- Another common characteristic of real-time processors is in-memory computing, which works with representations of the data in the cluster's memory to avoid having to write back to disk.
- Apache Storm, Apache Flink, and Apache Spark provide different ways of achieving real-time or near real-time processing.
- There are trade-offs with each of these technologies, which can affect which approach is best for any individual problem.
- In general, real-time processing is best suited for analyzing smaller chunks of data that are changing or being added to the system rapidly.
- The above examples represent computational frameworks. However, there are many other ways of computing over or analyzing data within a big data system. These tools frequently plug into the above frameworks and provide additional interfaces for interacting with the underlying layers.(see more on the module).

Step 4: Visualizing the Results

- Due to the type of information being processed in big data systems, recognizing trends or changes in data over time is often more important than the values themselves.
- Visualizing data is one of the most useful ways to spot trends and make sense of a large number of data points.
- Real-time processing is frequently used to visualize application and server metrics. The data changes frequently and large deltas in the metrics typically indicate significant impacts on the health of the systems or organization.
- Projects like Prometheus can be useful for processing the data streams as a time-series database and visualizing that information.
- Elastic Stack – is one popular way of visualizing data, formerly known as the ELK stack.
- Composed of Logstash for data collection, Elasticsearch for indexing data, and Kibana for visualization, the Elastic stack can be used with big data systems to visually interface with the results of calculations or raw metrics.
- A similar stack can be achieved using Apache Solr for indexing and a Kibana fork called Banana for visualization. The stack created by these is called Silk.
- Another visualization technology typically used for interactive data science work is a data "notebook".
- These projects allow for interactive exploration and visualization of the data in a format conducive to sharing, presenting, or collaborating. Popular examples of this type of visualization interface are Jupyter Notebook and Apache Zeppelin.

CHAPTER-3

ARTIFICIAL INTELIGENCE

By:Dereje.A

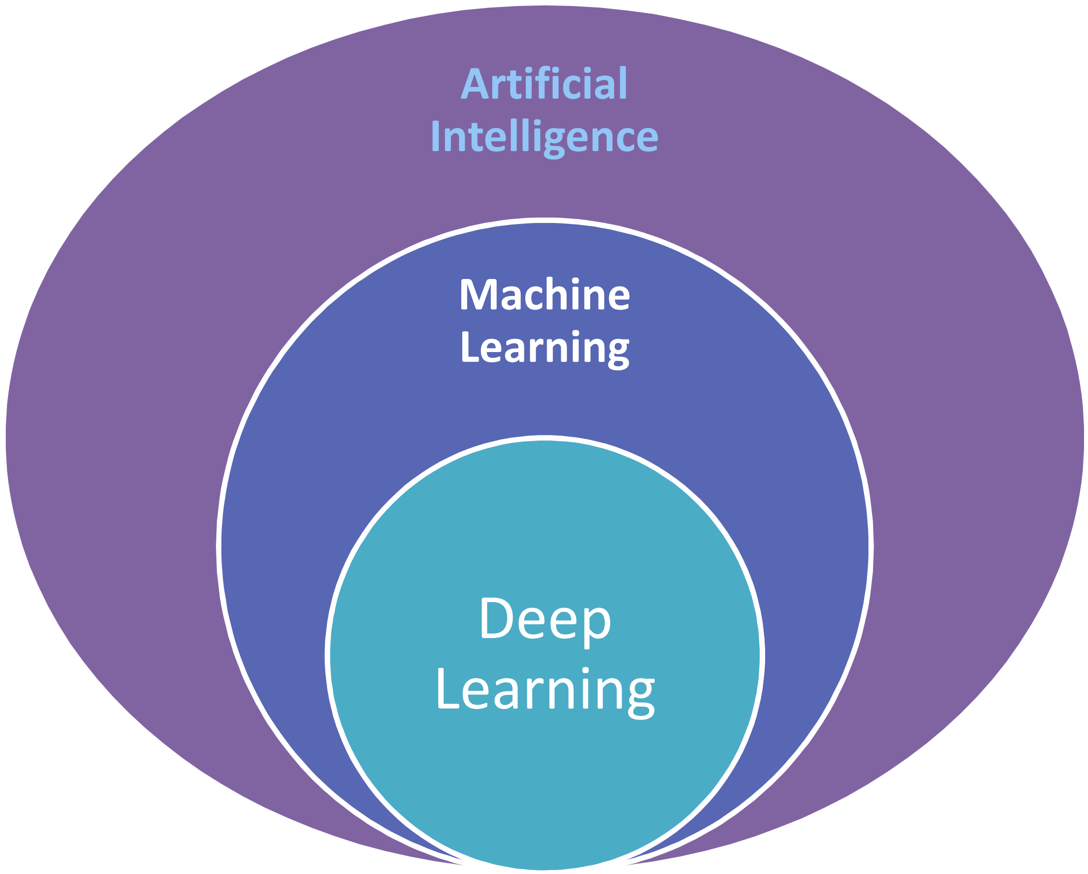
What is AI?

- Artificial = man-made
- Intelligence =thinking power or the ability to learn and solve problems
- AI is a man-made thinking power.
- AI is branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.
- Intelligence is composed of:
  - Reasoning
  - Learning
  - Problem Solving
  - Perception
  - Linguistic Intelligence

technologies that uses AI

- **Examples** of technologies that uses AI
  1) Machine Learning
  2) Robotics
  3) Machine Automation
  4) Virtual Reality
  5) Cloud Computing
  6) Augmented Reality
  7) Neural Networks
  8) Big Data
  9) Internet of Things
  10) Computer Vision

Types of Models AI



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

Need for Artificial Intelligence

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

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

What Comprises to Artificial Intelligence?

- To achieve the objective of AI the following things should be comprised:

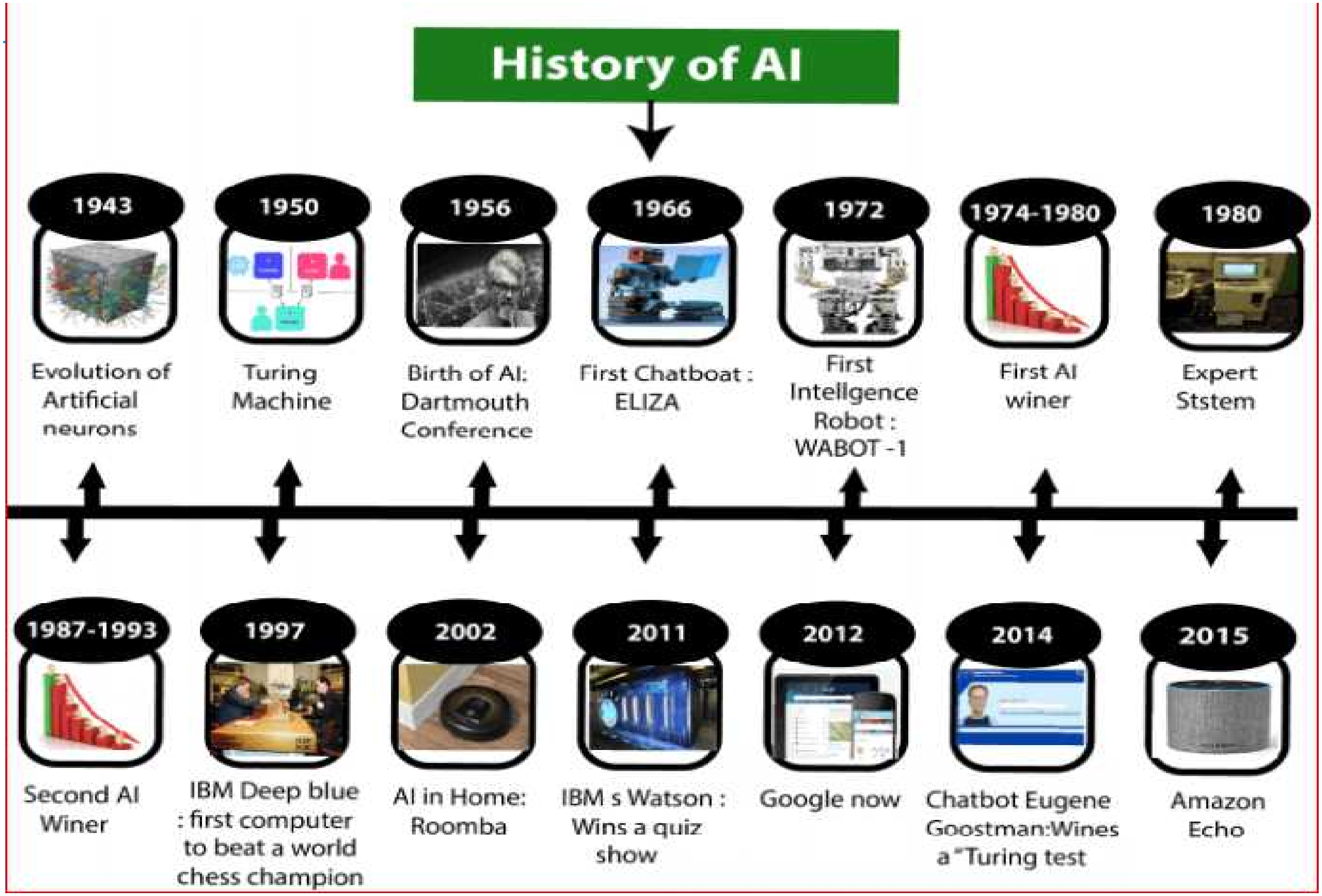
Advantages and Disadvantages of Artificial Intelligence

Advantages	Disadvantages
• High Accuracy with fewer errors	• High Cos
• High-Speed	• Can't think out of the box
• High reliability	• No feelings and emotions
• Useful for risky areas	• Increase dependence on machines
• Digital Assistant	• No Original Creativity
• Useful as a public utility	

History of AI

- Artificial Intelligence is not a new word and not a new technology for researchers.
- The following listed chronological eras are some milestones in the history of AI which define the journey from the AI generation to till date development.
  - **Maturation of Artificial Intelligence (1943-1952)**
  - **The birth of Artificial Intelligence (1952-1956)**
  - **The golden years-Early enthusiasm (1956-1974)**
  - **The first AI winter (1974-1980)**
  - **The second AI winter (1987-1993)**
  - **The emergence of intelligent agents (1993-2011)**
  - **Deep learning, big data and artificial general intelligence (2011-present)**

...cont.

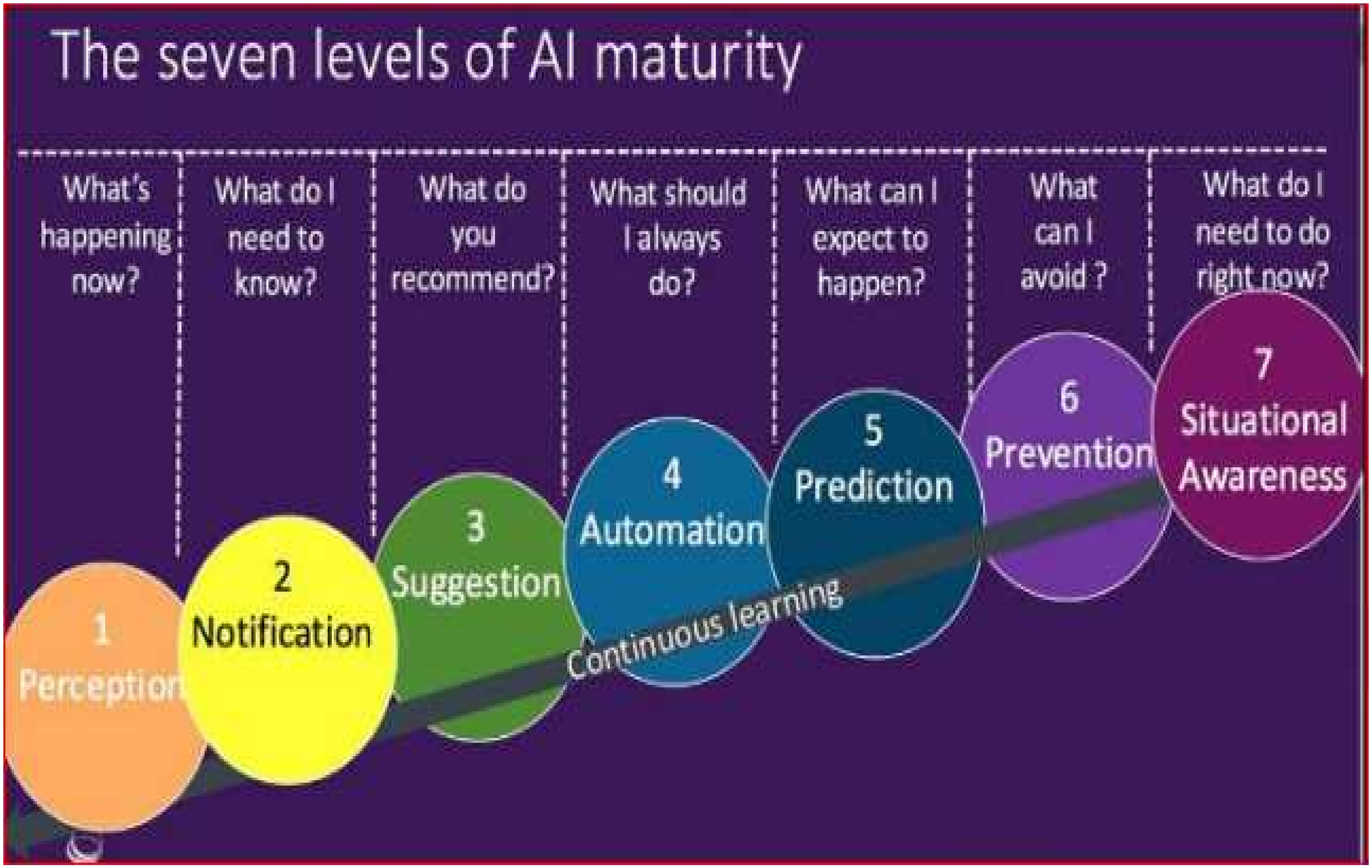

History of AI
1943
Evolution of Artificial neurons
1950
Turing Machine
1956
Birth of AI: Dartmouth Conference
1966
First Chatboat : ELIZA
1972
First Intellgence Robot : WABOT -1
1974-1980
First AI winer
1980
Expert Ststem
1987-1993
Second AI Winer
1997
IBM Deep blue : first computer to beat a world chess champion
2002
AI in Home: Roomba
2011
IBM s Watson : Wins a quiz show
2012
Google now
2014
Chatbot Eugene Goostman:Wines a "Turing test
2015
Amazon Echo

Levels of AI

There are seven level of Artificial Intelligence:

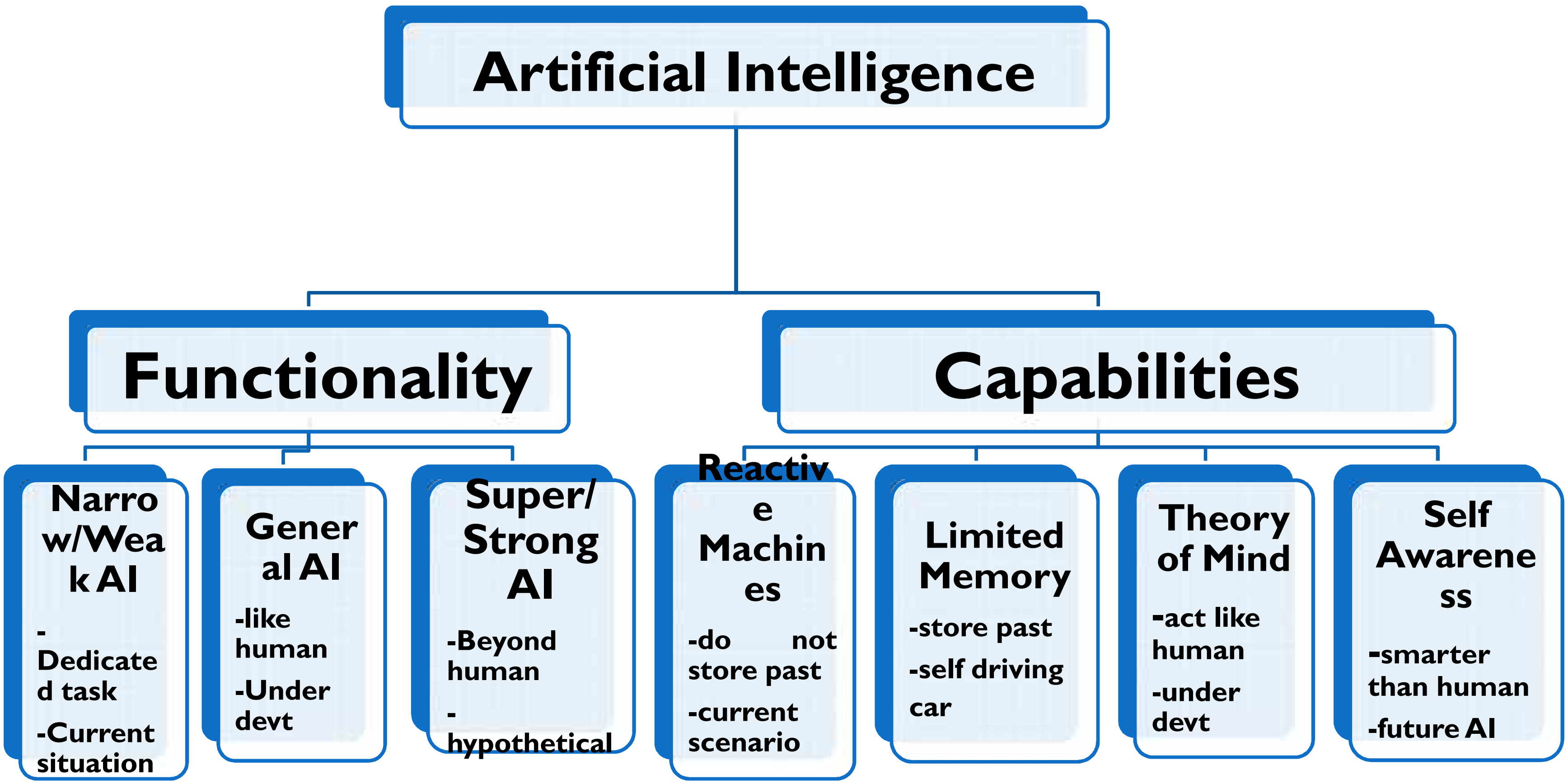
- **Stage 1 – Rule-Based Systems:** Robotic Process Automation
- **Stage 2 – Context Awareness and Retention:** chatbots and "roboadvisors"
- **Stage 3 – Domain-Specific Expertise:** Going beyond the capability of humans
- **Stage 4 – Reasoning Machines**
- **Stage 5 – Self Aware Systems / Artificial General Intelligence (AGI)**
- **Stage 6 – Artificial Superintelligence (ASI)**
- **Stage 7 – Singularity and Transcendence: -** beyond the limits of the human body

...cont.



The seven levels of AI maturity
What's happening now?
What do I need to know?
What do you recommend?
What should I always do?
What can I expect to happen?
What can I avoid ?
What do I need to do right now?
1 Perception
2 Notification
3 Suggestion
4 Automation
5 Prediction
6 Prevention
7 Situational Awareness
Continuous learning

Types of AI


Artificial Intelligence
Functionality
Capabilities
Narrow/Weak AI
-Dedicated task
-Current situation
General AI
-like human
-Under devt
Super/Strong AI
-Beyond human
-hypothetical
Reactive Machines
-do not store past
-current scenario
Limited Memory
-store past
-self driving car
Theory of Mind
-act like human
-under devt
Self Awareness
-smarter than human
-future AI

Types of Artificial Intelligence(AI)

Based on the level of intelligence embedded into a machine AI is divided into three.

1. **Artificial Narrow Intelligence (Weak AI or Narrow AI**
2. **Artificial General Intelligence (General AI or Strong AI)**
3. **Artificial Super Intelligence (Super AI)**

Cont’d

1. Artificial Narrow Intelligence (Weak AI or Narrow AI)

- a type of AI which is able to perform a dedicated task with intelligence.
- The most common and currently available.
- It is only trained for one specific task, cannot perform beyond its field or limitations

Example of narrow AI

- Playing chess,
- Purchasing suggestions on e-commerce site,
- Self-driving cars,
- Speech recognition, and
- Image recognition.

2. Artificial General Intelligence (General AI or Strong AI)

- a type of intelligence which could perform any intellectual task with efficiency like a human.
- The idea is to make a system which could be smarter and think like a human by its own.
- General AI systems are still under research.

3. Artificial Super Intelligence (Super AI)

- a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties.
- an outcome of general AI.
- Characteristics of strong AI include **the ability to think**, **to reason**, **solve the puzzle**, **make judgments**, **plan**, **learn**, and **communicate** by its own.
- Development of such systems in real is still world changing task.

Based on capabilities

1. **Reactive Machines**: Purely reactive machines are the most basic types of Artificial Intelligence. Such AI systems do not store memories or past experiences for future actions. These machines only focus on current scenarios and react on it as per possible best action.

- IBM's Deep Blue system and Google's AlphaGo is an example of reactive machines.

2. **Limited Memory**: Limited memory machines can store past experiences or some data for a short period of time. These machines can use stored data for a limited time period only.

- Self-driving cars are one of the best examples of Limited Memory systems. These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

3. Theory of Mind: Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans. This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.

- *Sophia* – the humanoid robot is one example of such effort where a number of young Ethiopians have contributed on the development.[

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 human mind.

- Self-Awareness AI does not exist in reality still and it is a hypothetical concept.

How humans think?

- **First** observe and input the information or data in the brain.
- **Second** interpret and evaluate the input that is received from the surrounding environment.
- **Third** make decisions as a reaction towards what you received as input and interpreted and evaluated.
- AI researchers are simulating the same stages in building AI systems or models.
- This process represents the main **three** layers or components of AI systems.

Mapping Human Thinking to Artificial Intelligence Components

Human	AI
Acquire data by sensing organs like eye, hand, nose…	**Sensing Layer** Acquire data by sensors like voice, speech, image recognition …
Reasoning and thinking about the gathered input by mind	**Interpretation Layer** Reasoning and thinking about the gathered input by machine
Taking action or making decisions	**Interacting Layer** Taking action or making decisions

Influencers of Artificial Intelligence

- 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

- It is becoming essential for today's time because it can solve complex problems in an efficient way in multiple industries, such as:-

Agriculture Healthcare,
Entertainment,
Finance,
Education,
Social Media

Travel &Transport,
Automotive Industry,
Robotics, Game,
Data Security,
Commuting,

Email, Social Networking, Online Shopping, Mobile Use, etc. AI is making our daily life more comfortable and faster.

AI Tools and Platforms

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

AI Tools

- Search and optimization,
- Logic,
- Classifiers and statistical learning methods,
- Neural networks,
- Control theory,
- Languages and others

AI Platforms

- Microsoft AZURE Machine Learning,
- Google Cloud Prediction API,
- IBM Watson,
- TensorFlow, Infosys Nia,
- Wipro HOLMES,
- API.AI,
- Premonition, and others

Cont'd

Examples of AI applications in the Business sector.

- **Improve Customer Services**
- **Automate Workloads**
- **Optimize Logistics**
- **Increase Manufacturing Output and Efficiency**
- **Prevent Outages**
- **Predict Performance**
- **Predict Behavior**
- **Manage and Analyze Data**
- **Improve Marketing and Advertising**

Chapter 4

Internet of Things (IoT)

By:Dereje.A

Introduction

Overview of IoT

- The most important features of IoT include:
  - Artificial intelligence,
  - Connectivity,
  - Sensors,
  - Active engagement, and
  - Small device use.

What is IoT?

- IoT is the networking of smart objects(IAB)
- IoT is a framework of all things that have a representation in the presence of the internet(IEEE)
- IoT is the interaction of everyday object's computing devices through the Internet(Oxford)
- IoT is a network of devices that can sense, accumulate and transfer data over the internet without any human intervention.
- IoT= Services+ Data+ Networks + Sensors

History of IoT

- The IoT has not been around for very long.
- However, there have been visions of machines communicating with one another since the early 1800s
  - Telegraph (the first landline) -1830s and 1840s
  - first radio voice transmission-1900s
  - computers -950s
  - Defense Advanced Research Projects Agency-1962
- One of the first examples of an Internet of Things is from the early 1980s and was a Coca Cola machine.

IoT – Advantages

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

IoT – Disadvantages

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.
- If there's a bug in the system, it's likely that every connected device will become corrupted.
- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.
- Enterprises may eventually have to deal with massive numbers maybe even millions of IoT devices and collecting and managing the data from all those devices will be challenging.

Challenges of IoT

- Security
- Privacy
- Complexity
- Flexibility
- Compliance

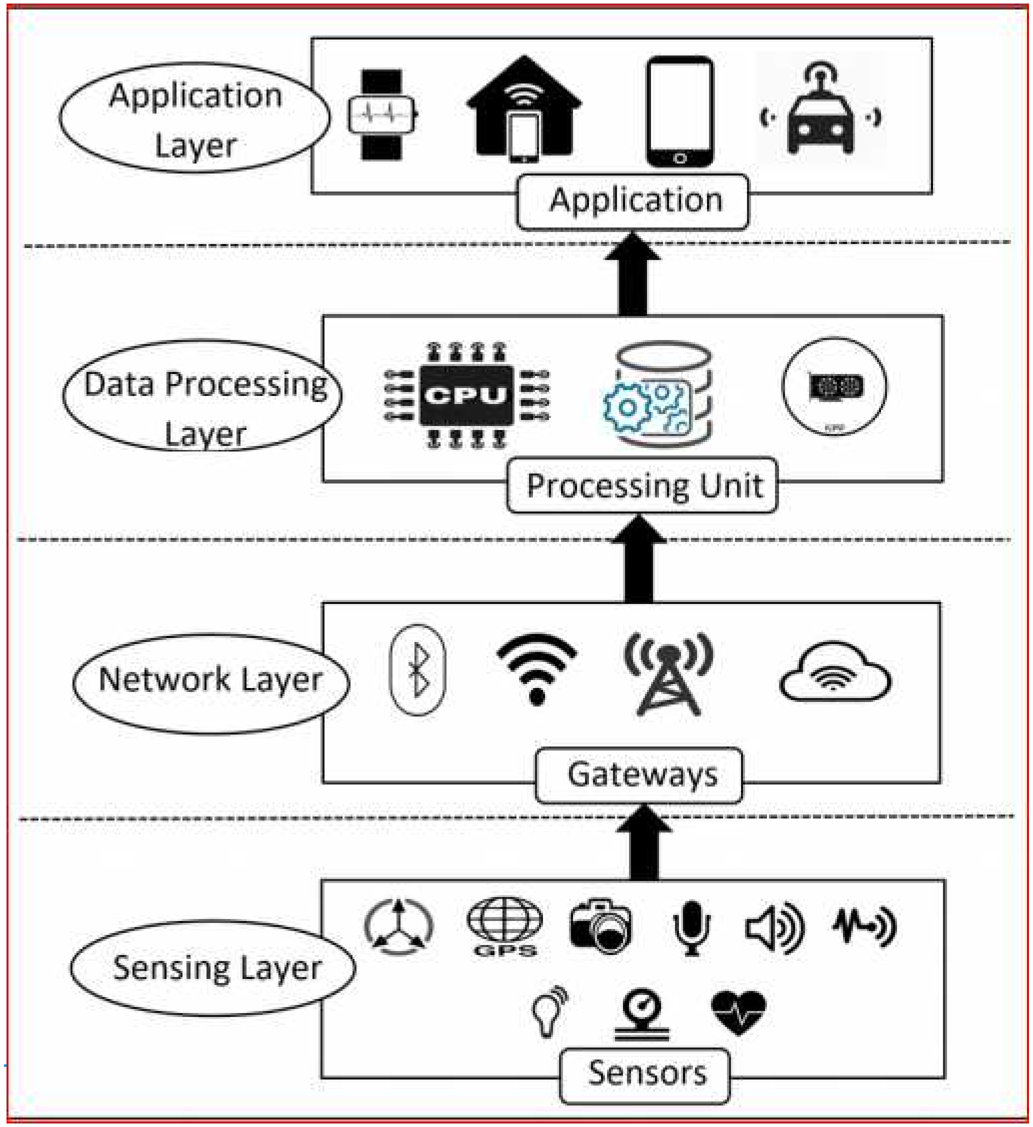
How does it work?

- An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments.
  - Intake data(sensors)=>share data (gateway)=>store(analyze)
- The devices do most of the work without human intervention

Architecture of IoT

The architecture of IoT devices comprises four major components:

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



Devices and Networks

- The devices can be categorized into three main groups:
  - **Consumer:** smart TVs, smart speakers, wearables
  - **Enterprise**: smart air conditioning, smart lighting..
  - **Industrial**: smart thermostats, commercial security systems
- IoT network typically includes a number of devices with constrained resources (power, processing, memory, among others) and some of those devices may be massively deployed over large areas like smart cities, industrial plants, whereas others may be deployed in hard-to-reach areas like pipelines hazardous zones, or even in hostile environments like war zones.

M4DN.IoT

- Thus, it needs serious management which is called M4DN.IoT (Management for Device and Network in the Internet of Things).
- There are 2 types of M4DN:
  1. **Local management**, where the platform runs in the same environment as the devices, and
  2. **Remote management,** where the platform controls the devices in different networks.

IoT Tools and Platforms

- There are many vendors in the industrial IoT platform marketplace
- Some examples of IoT platforms are:
  - KAA
  - SiteWhere
  - ThingSpeak
  - DeviceHive
  - Zetta
  - ThingsBoard

Applications of IoT

- Here's a sample of various industries, and how IoT can be best applied.
  - Agriculture -Consumer Use
  - Healthcare -Insurance
  - Manufacturing -Retail
  - Transportation -Utilities

IoT Based Smart Home

- Allows subscribers to remotely manage and monitor different home devices from anywhere via smartphones or over the web.

- Remote Control Appliances
- Weather
- Smart Home Appliances

- Intrusion Detection Systems
- Energy and Water Use
- Safety Monitoring

IoT Based Smart City

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

IoT Based Smart Farming

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

Thank You!!!