

Introduction to Emerging Technologies

Chapter Three

Artificial Intelligence (AI)

Outline

- **Definitions**
- History
- Levels of AI
- Types of AI
- Influencers of Artificial Intelligence
- Applications of AI
- AI Tools and Platforms
- Sample Applications

Introduction

- In the previous chapter we have **looked over** data science, data acquisition, analysis and storage. Basic concepts of **big data** were also reviewed.
- In this chapter; **history, types, and applications** of AI will be examined. **Tools and platforms**, as well as **sample AI applications**, shall be discussed

Learning outcomes

- After completing this chapter you should be able to:
 - Explain what artificial intelligence (AI) is.
 - Describe the ages of AI.
 - Explain the types and approaches of AI.
 - Describe applications of AI in health, agriculture, business and education.
 - List factors that influenced the advancement of AI in recent years.
 - Understand the relationship between human's way of thinking and AI systems
 - Identify AI research focus areas.
 - Identify real-world AI applications, platforms, and tools

AI Defined

- **Artificial Intelligence (AI)** as the branch of **computer science** by which we can create **intelligent machines** which can **behave like humans**, think like humans, and are able to **make decisions**. (adopted by MOSHE)
- **AI** is an umbrella term for “smart” technologies that are **aware** of and **can learn** from their **environments**. **AI** enables machines to **sense** their **environments**, **think**, **learn** and **respond** on their own, becoming increasingly **autonomous**. **Governance**

Definitions

Continued...

- **Machine learning (AI)** allows computer systems to **learn from data** and **recognize patterns, predict** outcomes, assist humans with understanding or suggest actions (becoming “smart”) **without being explicitly programmed**.
- *Among other things, machine learning (AI) can inform decision-making and make process automation more flexible.*

Definitions

Continued...

- **Artificial Intelligence** exists when machines can attain **human-based skills** such as **learning**, **reasoning**, and **taking actions** by their own.
- **Intelligence** is composed of:
 - Reasoning
 - Learning
 - Problem Solving
 - Perception
 - Linguistic Intelligence

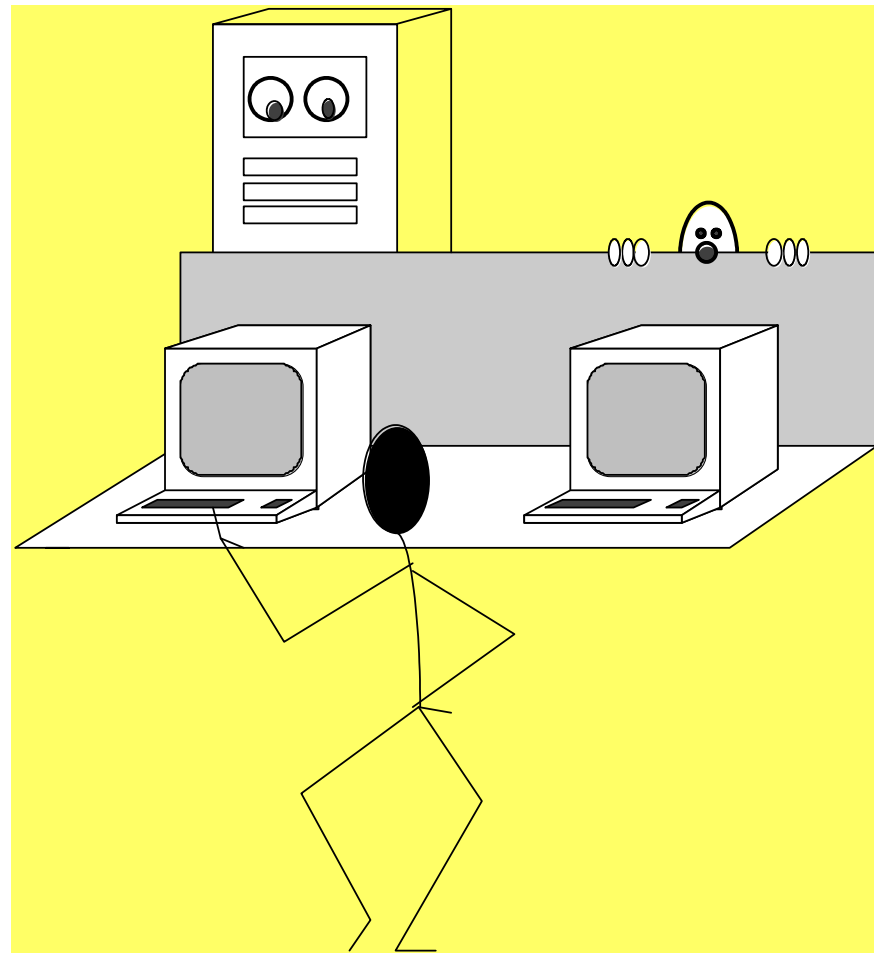
Systems that act like humans

Turing Test

- The Turing Test approach
 - a human questioner cannot tell if
 - there is a computer or a human answering his question, via teletype (remote communication)
 - The computer must behave intelligently
- Intelligent behavior
 - to achieve human-level performance in all cognitive tasks

What is Intelligence?

The Turing Test



A machine can be described as a thinking machine if it passes the Turing Test. i.e. If a human agent is engaged in two isolated dialogues (connected by teletype say); one with a computer, and the other with another human and the human agent cannot reliably identify which dialogue is with the computer.

The total Turing Test

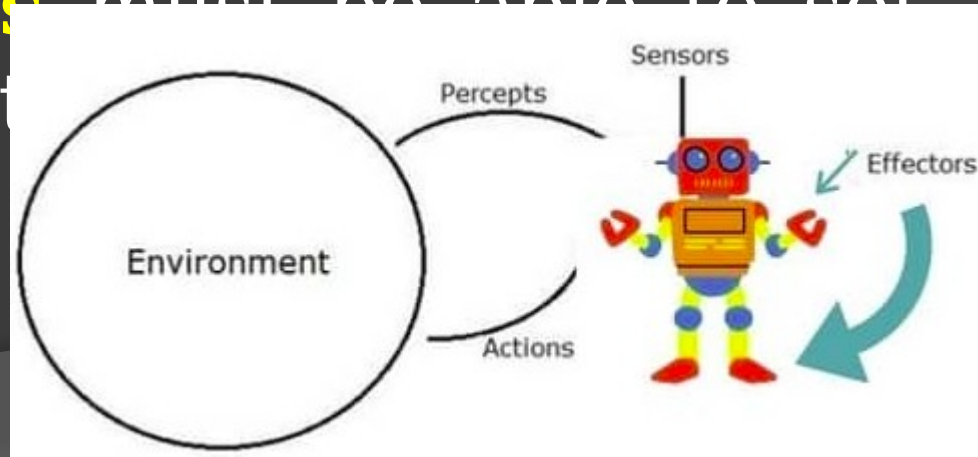
- Includes two more issues:
 - *Computer vision*
 - to perceive objects (seeing)
 - *Robotics*
 - to move objects (acting)

Objections to the TT

- **The Theological Objection**
 - "Thinking is a function of man's immortal soul. God has given an immortal soul to every man and woman, but not to any other animal or to machine. Hence no animal or machine can think."
- **The "Head in the Sand" Objection**
 - "The consequences of machines thinking are to dreadful to think about."

AI Systems

- An **AI system** can be visualized as **composed** of an **agent** and its **environment**. An **agent** (e.g., human or robot) is anything that can **perceive** its **environment** through **sensors** and **acts upon** that environment through **effectors**.
- **Intelligent agents** must be able to set **goals** and achieve them.



AI Systems

Continued...

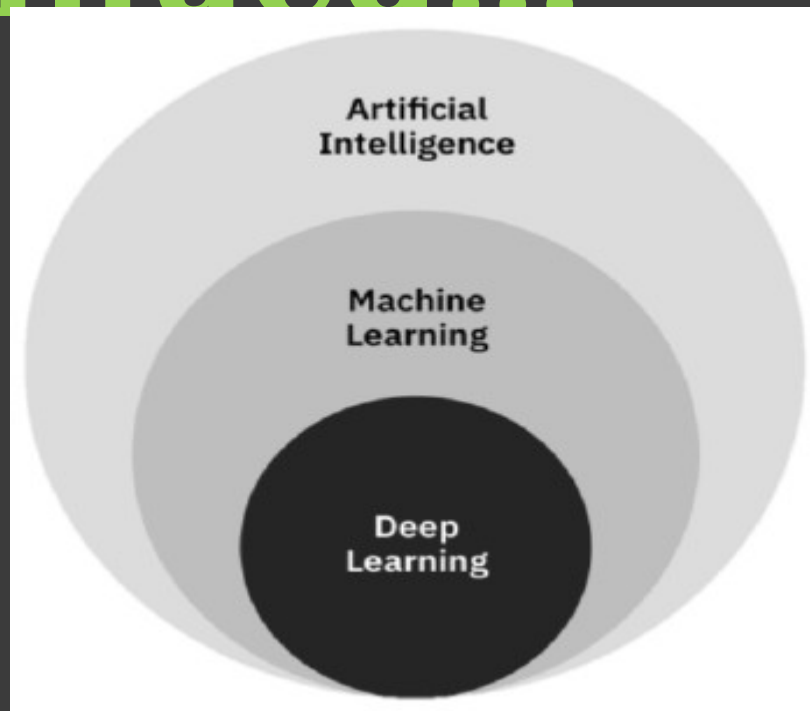
- High-profile **examples** of AI include **autonomous vehicles** (such as drones and self-driving cars), **medical diagnosis**, **creating art** (such as poetry), **proving mathematical theorems**, **playing games** (such as Chess or Go), **search engines** (such as Google search), **online assistants** (such as Siri), **etc.**

AI Systems

Continued...

- AI deals with the area of developing computing systems that are capable of performing tasks that humans are very good at, for example recognizing objects, speech recognition, and decision making in a constrained environment.
- Machine Learning (ML) is an advanced form of AI where the machine can learn as it goes rather than having every action programmed by humans.

AI Systems Continued...



Relationships of AI, ML, and
DL

- **Deep learning (DL)** is a field of **neural networks** with several hidden layers.

Need for Artificial Intelligence

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

Goals of Artificial Intelligence

- Replicate human intelligence
- Solve Knowledge-intensive tasks
- An intelligent connection of perception and action
- Building a machine which can perform tasks that requires human intelligence such as:
 - Proving a theorem
 - Playing chess (or other skill games)
 - Plan and execute some surgical operation
 - Driving a car in traffic

What Comprises of AI?

- **Intelligence** is an intangible **part of our brain** which is a combination of **Reasoning, learning, problem-solving, perception, language understanding**, etc.
- To **impart these qualities into machines**, Artificial Intelligence requires the following disciplines
 - **Mathematics**
 - **Biology**
 - **Psychology**
 - **Sociology**
 - **Computer Science**
 - **Neurons Study**
 - **Statistics**

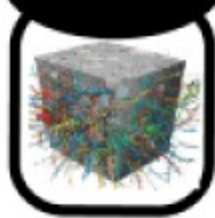
- **Reading Assignment:
Advantages and Disadvantages of
AI**

History of AI

- **Artificial Intelligence** is not a new discipline and not a new technology for researchers.
- **Milestones** in the **history of AI** are shown in the following slide.

History of AI in pictures...

1943



Evolution of
Artificial
neurons

1950



Turing
Machine

1956



Birth of AI:
Dartmouth
Conference

1966



First Chatboat :
ELIZA

1972



First
Intelligence
Robot :
WABOT -1

1974-1980



First AI
Winter

1980



Expert
Sstsem

1987-1993



Second AI
Winter

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

History of AI...

- Now **AI has developed** to a relatively remarkable level. The concept of **Deep learning, big data**, and **data science** are now **trending**.
- Companies like Google, Facebook, IBM, and Amazon are working with AI and creating amazing devices. The future of Artificial Intelligence is inspiring and **much more is to come**.

Levels of AI

- As we have mentioned frequently, **AI** technology machines were **anticipated** to **learn** from the **perceived environment's data** and to use past **experience** to make **proactive** decisions.
- **AI** never **emerged out of the blue** or overnight but it has **passed** & is **anticipated** to pass **through** various stages

Levels of AI

- **Level 1: Rule-Based Systems**
 - The **most common** uses of **AI today** fit in this category, covering everything from business software (**Robotic Process Automation**) and domestic appliances to aircraft autopilots.

Levels of AI ...

- **Level 2: Context Awareness and Retention**
 - Algorithms that develop information about specific domain of applications. These systems are trained on the knowledge and experience of the best people and the knowledgebase can be updated/upgraded as new situations and queries arise. Well, known applications of this level are

Levels of AI ...

- **Level 3: Domain-Specific Expertise**
 - Going beyond the capability of humans, these systems **build expertise** in a **specific context** using **massive volumes** of **information** for decision making. Successful **use cases** have been seen in **cancer diagnosis** and the well-known Google Deepmind's

Levels of AI ...

- **Level 4: Reasoning Machines**
 - These algorithms (**models**) have some ability to **attribute mental states** to themselves and others – they have **senses of beliefs, intentions, knowledge, and know how their own logic works**. This means they could **reason** or **negotiate** with **humans** and other **machines**.

Levels of AI ...

- **Level 5: Self Aware Systems / Artificial General Intelligence (AGI)**
 - These systems have **human-like intelligence** – the most commonly portrayed AI in media – however, **no such use** is in evidence **today**.

Levels of AI ...

- **Level 6: Artificial Super Intelligence (ASI)**
 - **AI algorithms** can outsmart even the most intelligent humans in every domain. Logically it is difficult for humans to **articulate** what the **capabilities** might be, yet we would hope examples would include **solving** problems we have failed to so far, such as **world hunger** and dangerous **environmental & climate changes**.

Levels of AI ...

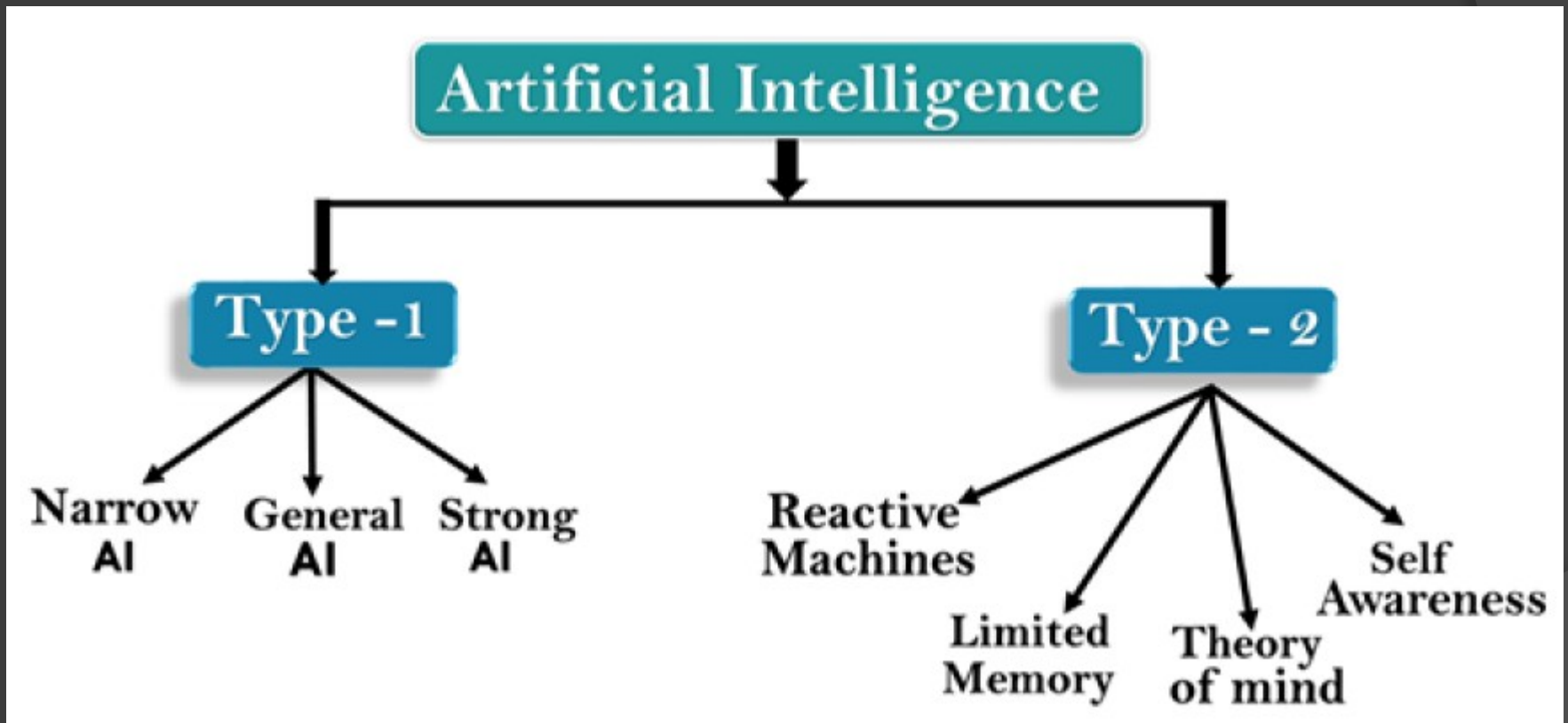
- **Level 7: Singularity and Transcendence**
 - This is the idea that development provided by ASI (Level 6) leads to a massive expansion in human capability. Human augmentation could connect our brains to each other and to a future successor of the current internet, creating a “hive mind” that shares ideas, solves problems collectively, and even gives others access to our dreams

- **Reading Assignment:**
 - **Read about Kurzweil's Predictions.**

Types of AI

- **AI** can be divided into various types, mainly into two types of **categorization** which are based on **capabilities** and **functional qualities** of Artificial Intelligence, as is shown in the following slide.

Types of AI



Type 1: Based on Capabilities

- **Weak or Narrow AI:** is a type of AI which is designed to perform a dedicated task with intelligence. The most common and currently available AI is Narrow AI. It cannot perform beyond its field or limits, as it is only trained for a specific task.

Type 1: Based on Capabilities

- **General AI:** This is a type of **intelligence** that could perform any intellectual task with efficiency, like a human. The idea behind general AI is to make a system that could be **smart** and **think** like a human on its own.

Type 1: Based on Capabilities

- **Super (Strong) AI:** This is a level of Intelligence at which machines could surpass human intelligence, and can perform tasks better than humans with **cognitive** properties. This refers to aspects like general wisdom, problem solving and creativity.

Type 2:

Based on Functional Qualities

- **Reactive Machines:** These are the most basic types of **AI** currently developed.
 - Do not store memories of past experiences for future use.
 - Only focuses on current scenarios and **react** with their best possible options.
 - IBM's Deep Blue system & Google's AlphaGo are example of reactive

Type 2: Based on Functional Qualities

- **Limited Memory:** These machines can store past experiences or some data for a short period of time.
 - Self-driving cars are one of the best examples of such systems.

Type 2: Based on Functional Qualities

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

Type 2: Based on Functional Qualities

- **Self-Awareness:** This type of AI is the future of Artificial Intelligence. These machines will be super intelligent and will have their own consciousness, sentiments, and self-awareness.

Activity

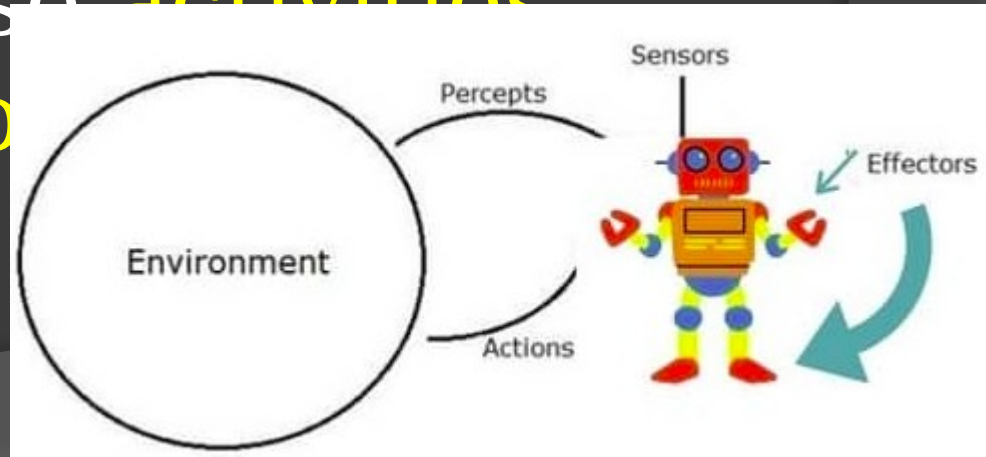
- *From our discussions, General AI could perform intellectual tasks with comparable efficiency to humans.
So, to achieve this intelligence level, do you think that future AI must mimic the way humans think? Why and why not?*

Mapping Human's Thinking to AI Components

- **So AI was defined as:**
 - **AI** is the study of ideas that enable computers to be as intelligent as humans.
 - **AI** is the part of computer science concerned with **design of computer systems** that exhibit **human intelligence**. (Concise Oxford Dictionary)

Mapping Human's Thinking to AI Components

- From the previous two definitions, we can see that AI has two major roles
 - Study the intelligent part concerned with humans.
 - Represent those activities (parts) using components



How Do Humans think?

- Intelligence or the cognitive process is composed of three main stages:
 - Observe and enter input information or data to the brain (**sensing**).
 - Interpret and process the perceived input, and evaluate the outcome.
 - Take actions or make decisions based on your cognition of the whole process.

Influencers of AI

- Big data
- Advancements in computer processing speed and new chip architectures
- Cloud computing and APIs
- Emergence of data science

Influencers of AI

- All the significant companies in the AI services market deliver their services and tools on the internet through **APIs over cloud platforms**:
 - IBM delivers Watson AI services over IBM Cloud.
 - Amazon AI services are delivered over Amazon Web Services (AWS).
 - Microsoft AI tools are available over the MS Azure cloud.
 - Google AI services are available in the Google Cloud Platform.

Influencers of AI

- Big data
- Advancements in computer processing speed and new chip architectures
- Cloud computing and APIs
- **Emergence of data science**

- **Reading Assignment:**
 - **Applications of AI (Section 3.6)** This part is left as a reading assignment for you.