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Notes of “Artificial Intelligence for Engineering/Engineers(KMC-101)”

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Notes Part-2
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Artificial Intelligence for Engineering

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UNIT 1: An Overview of AI

1.1 What is AI?

AI is composed of two words *Artificial* and *Intelligence*, where Artificial defines "*man-made*," and intelligence defines "*thinking power*".

Hence AI means "**a man-made thinking power**".

Artificial Intelligence exists when a machine can have human-based skills such as learning, reasoning, and problem solving.

With AI you do not need to pre-program a machine to do some work, despite that you can create a machine with programmed algorithms which can work with own intelligence.

Definition: It is a 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.

1.2 Goals of AI

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. Like playing Chess, Driving a car.

Creating some system which can learn new things by itself, demonstrate, explain, and can advise to its user.

1.3 Advantages of AI

Reduction in Human Error
Useful for risky areas
High Reliability
Fast
Digital Assistant
Faster Decisions
Available 24x7

1.4 Disadvantages of AI

- × High Cost
- × Can't Replace Humans
- × Doesn't Improve with Experience
- × Lack of Creativity
- × Risk Of Unemployment.
- × No Feelings and Emotions

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1.5 Evolution of AI

i) Maturation of AI (1943-1952)

- ✧ **1943:** The first work toward AI was done by Warren McCulloch and Walter Pitts in 1943. They proposed a model of **artificial neurons**.
- ✧ **1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.
- ✧ **1950:** The Alan Turing proposed a test which can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.

ii) The birth of AI (1952-1956)

- ✧ **1955:** Allen Newell and Herbert A. Simon created the "first artificial intelligence program" which was named as "**Logic Theorist**". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- ✧ **1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference.

iii) The golden years-Early enthusiasm (1956-1974)

- ✧ **1966:** Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA.
- ✧ **Year 1972:** The first intelligent humanoid robot was built in Japan which was named as WABOT-1.

iv) The first AI winter (1974-1980)

- ✧ AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches. 1974 to 1980 was the first AI winter duration.
- ✧ During AI winters, an interest of publicity on artificial intelligence was decreased.

v) A boom of AI (1980-1987)

- ✧ **1980:** After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert.

vi) The second AI winter (1987-1993)

- ✧ The duration between the years 1987 to 1993 was the second AI Winter duration.

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- ✧ Again, Investors and government stopped in funding for AI research.

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vii) The emergence of intelligent agents (1993-2011)

- ✧ **1997:** In the year 1997, IBM Deep Blue beats world chess champion, Garry Kasparov, and became the first computer to beat a world chess champion.
- ✧ **2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- ✧ **2006:** Companies like Facebook, Twitter, and Netflix also started using AI.

viii) Deep learning, Big data and Artificial general intelligence (2011-Present)

- ✧ **2011:** IBM's Watson won a quiz show, where it had to solve the complex & tricky questions as well as riddles. Watson had proved that it could understand natural language.
- ✧ **2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- ✧ **2014:** In 2014, a Chatbot won a competition in "Turing test."
- ✧ **2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.

- ✧ **2018:** Google has demonstrated an AI virtual assistant "Duplex", which mimicked human voice, allowed users to do things like booking tables at restaurants.

1.6 Various approaches to AI / Types of AI

A) **Based on Capabilities:** Based on capabilities of a machine, there are three types of Artificial Intelligence approaches:

1. Artificial Narrow Intelligence (ANI) / Weak AI / Narrow AI

It has a narrow range of capabilities.

Weak AI focuses on performing a specific task, such as answering questions based on user input or playing chess. It can perform one type of task, but not both.

More Examples - Virtual assistants (Siri, Alexa, Cortana), Image/facial recognition software, Email spam filters, Self-driving cars.

2. Artificial General Intelligence (AGI) / Strong AI / Deep AI / General AI

It is on par with human capabilities.

Strong AI can perform a variety of functions, eventually teaching itself to solve for new problems.

It is the concept of a machine with

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general intelligence that mimics human intelligence and/or behaviour, with the ability to learn and apply its intelligence to solve any problem.

AGI can think, understand, and act in a way that is indistinguishable from that of a human in any given situation.

In theory, then, anything a human can do, a strong AI can do too.

AI researchers and scientists have not yet achieved strong AI.

3. Artificial Superintelligence (ASI)

It is more capable than a human.

ASI is the hypothetical AI that doesn't just mimic or understand human intelligence and behaviour; ASI is where machines become self-aware and surpass the capacity of human intelligence and ability.

Super AI is purely speculative at this point.

B) Based on Functionalities: Based on the ways the machines behave and functionalities, there are four types of Artificial Intelligence approaches:

1. Reactive Machines

These machines are the most basic form of AI applications.

Such AI system do not store memories or past experiences for future actions.

These machines focus only on current scenario and react on it as per possible best action.

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Example: Games like Deep Blue & IBM's chess- playing supercomputer.

Self-awareness AI does not exist till now and it is a hypothetical concept.

2. Limited Memory

Limited Memory machines can retain data for a short period of time. While they can use this data for specific time period, they cannot add it to a library of their experiences. Many self-driving cars use Limited Memory technology: they store data such as the recent speed of nearby cars, the distance of such cars, the speed limit, & other information that can help them navigate roads.

3. Theory of Mind

Theory of mind is AI should understand the human emotions, beliefs and be able to interact socially like humans. Resources are making lots of efforts and improvement for developing such AI machines

4. Self-Awareness

Self-awareness AI is the future of artificial intelligence. These machines will be super intelligent and will have their own consciousness, sentiments and self-awareness. These machines will be smarter than human mind.

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1.7 Skills Required to Become an AI Engineer

1. **Programming Skills:** The first skill required to become an AI engineer is programming. For this, it's crucial to learn programming languages, such as Python, R, Java, and C++ to build and implement models.

2. **Linear Algebra, Probability, and Statistics:** To understand and implement different AI models, you must have detailed knowledge of linear algebra, probability, and statistics.

3. **Spark and Big Data Technologies:** AI engineers work with large volumes of data, which could be streaming or real-time production level data in terabytes or petabytes. For such data, these engineers need to know about Spark and other big data technologies to make sense of it.

4. **Algorithms and Frameworks:** Understanding how machine learning algorithms like linear regression, KNN, Naive Bayes, Support Vector Machine, and others work will help you implement machine learning models with ease. Additionally, to build AI models with unstructured data, you should understand deep learning algorithms and implement them using a framework.

5. **Communication and Problem-solving Skills:** AI engineers need to communicate correctly to pitch their products and ideas to stakeholders. They should also have excellent problem-solving skills to resolve obstacles for decision making and drawing helpful business insights.

6. **Necessary Business Skills:** The following are some of the business skills required to be a successful AI engineer:

→ *Creative thinking*

→ *Effective communication*

→ *Analytic problem-solving skills*

→ *Industry Knowledge*

1.8 Other Emerging Technologies

1. The Internet of Things (IoT):

Refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention.

The Internet of things describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

It enables devices to interact, collaborate

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and, learn from each other's experiences just like humans do.

IoT Examples:

- ✓ Smart Home security systems
- ✓ Smart Wearables health monitors
- ✓ IoT in agriculture
- ✓ Smart Speakers (Amazon Echo Dot: Alexa)
- ✓ Smart Cities
- ✓ Smart Door Locks

2. Cloud Computing:

Cloud computing is the on-demand availability of computer system resources, especially data storage (cloud storage) and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet.

Types of Cloud Computing

1. **Public Cloud** – Whole computing infrastructure is located on the premises (sites) of a cloud computing company that offers the **cloud service**.
2. **Private Cloud** – Hosting all your computing infrastructure yourself and is not shared. The security and control level are highest while using a private network.
3. **Hybrid Cloud** – using both private and public clouds, depending on their purpose. You host your most

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important applications on your own servers to keep them more secure and secondary applications elsewhere.

4. **Community Cloud** – A community cloud is shared between organizations with a common goal or that fit into a specific community (professional community, geographic community, etc.).

3. Blockchain:

A blockchain is a peer-to-peer distributed ledger technology. Which is an immutable, decentralized, encrypted, distributed ledger technology.

The name comes from its structure, in which individual records, called blocks, are linked together in single list, called a chain. Blockchains are used for recording transactions made with cryptocurrencies, such as Bitcoin, and have many other applications.

Each transaction added to a blockchain is validated by multiple computers on the Internet (Miners). These systems form a peer-to-peer network.

Applications of Blockchain:
Cryptocurrency, Smart Contract, Online Voting, etc.

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4. 3D Printing:

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.

The creation of a 3D printed object is achieved using additive process in which an object is created by laying down successive layers of material until the object is created.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.

3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

5. Augmented reality (AR):

AR is an interactive experience of a real-world environment where AR combines the physical world with computer-generated virtual elements overlay. These 2D or 3D virtual content are projected in reality within people's field of view (through smartphone camera or smart glasses).

Augmented reality is a technology that virtually places a 2D/3D visual into a "real-world" experience. This gives the user the appearance that the virtual object is co-existing with them in the physical world.

In a few words, AR is the real world with an added layer of virtual content (2D/3D).

6. Virtual Reality (VR):

Virtual reality (VR) refers to a computer-generated simulation in which a person can interact within an artificial 3D environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors. In this simulated artificial environment, the user is able to have a realistic-feeling experience.

It uses software to produce images, sounds, and other sensations to create a different place so that a user feels like he or she is really part of this other place.

7. 5G technology:

5G is the latest upgrade in the long-term evolution (LTE) mobile broadband networks. 5G mainly works in 3 bands.

1. **Low band spectrum:** It has shown great promise in terms of coverage and speed of internet and data exchange, the maximum speed is limited to 100 Mbps.
2. **Mid band spectrum:** It offers higher speeds compared to the low band, but has limitations in terms of coverage area. This spectrum doesn't

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penetrate

buildings very well, but it does deliver speeds around 1 Gbps.

3. **High band spectrum:** It offers the highest speed of all the three bands, but has extremely limited coverage and signal penetration strength. Internet speeds in the high-band spectrum of 5G has been tested to be as high as 20 Gbps.

8. Brain Computer Interface (BCI):

BCIs acquire brain signals, analyze them, and translate them into commands that are relayed to output devices that carry out desired actions.

BCIs measure brain activity, extract features from that activity, and convert those features into outputs that replace, restore, enhance, supplement, or improve human functions.

1.9 AI and Ethical Concerns

1. **Unemployment:** As AI become more and more advance, it will obviously take over jobs that were once performed by humans. People will move from physical and repetitive jobs to jobs that actually requires creative and strategic thinking.

2. **AI is Imperfect:** AIs are not

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immune to making mistakes and machine learning takes time to become useful. If trained well, using good data, then AIs can perform well. However, if we feed AIs bad data or make errors with internal programming, the AIs can be harmful.

3. **Biasness:** Human beings are sometimes biased against other religion, gender and nationalities. This bias may unconsciously also enter into AI system that are developed by humans. There are many companies that are working towards creating unbiased AI system.

4. **Artificial Stupidity:** Intelligence comes from learning, systems usually have a training phase in which they learn to detect the right patterns and act according to their input. Obviously, the training phase cannot cover all the possible examples that a system may deal with in the real world. So, these systems can be fooled in ways that humans wouldn't be.

5. **Loss of skills:** We lose more and more human skills due to the use of computers and smartphones.

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6. **Security:** The more powerful a technology becomes, the more can it be used for unfair reasons as well as good. AI system can cause damage if used maliciously. In terms of Cyber security, in future we will deal with AI system that is faster and more capable than us by order of magnitude.

7. **Technological singularity:** Technological singularity is a point when artificial intelligence may become more intelligent than human. It would make AI the dominant species on earth and lead to huge changes in human existence or human extinction.

8. **Humanity:** AI Bots becoming better and better at modelling human conversation and relationships. Tech addiction is the new frontier of human dependency. In future, we will interact frequently with machines as if they are human; whether in customer services or sales.

9. **Everything becomes unreliable:** For Examples, fake news and fake videos & audios of an individual. Smart systems are becoming increasingly capable of creating content – they can

create faces, compose texts, produce tweets, manipulate images, clone voices and engage in smart advertising.

1.10 AI Applications

1. **Chatbots:** AI Powered Chatbots can simulate a conversation (or a chat) with a user in natural language through messaging applications, websites, mobile apps or through the telephone.

2. **AI in Healthcare:** There are lot of AI applications in the healthcare sector. AI is used to detect diseases and uses the combination of historical data & medical intelligence for the discovery of new drugs.

3. **Handwriting Recognition:** The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

4. **Speech Recognition:** Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

5. **Natural Language Processing:** It

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is possible to interact with the computer that understands natural language spoken by humans.

6. **AI in Gaming:** AI can be used for gaming purpose. The AI machines can play strategic games like chess, poker, tic-tac-toe, where the machine needs to think of a large number of possibilities.

7. **AI in Robots:** Generally, robots are programmed such that they can perform some repetitive tasks, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.

8. **AI in Finance:** The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

9. **AI in Agriculture:** Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring.

10. **AI in Education:** AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant. AI in the future can be work as a personal virtual tutor for students, which will be accessible easily

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at any time and any place.

11. **AI in Data Security:** The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure.

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