Notes of "Artificial Intelligence for Engineering/Engineers (KMC-101)" **Notes-Part-1**
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MS. SHWETA TIWARI
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"Artificial Intelligence for Engineering/Engineers (KMC-201)"_

UNIT-1: An Overview To AI

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November, 2021

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UNIT-1

“Artificial Intelligence for Engineering/Engineers (KMC-201)”

By SHWETA TIWARI
Artificial Intelligence for Engineering/Engineers (KMC-201)”

UNIT-1: An Overview To AI

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An overview to AI

"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."

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

With Artificial Intelligence you do not 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, and that is the awesomeness of AI.

Goals of Artificial Intelligence

Following are the main goals of Artificial Intelligence:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
    - Proving a theorem
    - Playing chess
    - Plan some surgical operation
    - Driving a car in traffic
5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

History of AI

Here is the history of AI during 20th century Year Milestone / Innovation

1923 Karel Čapek play named “Rossum's Universal Robots” (RUR) opens in London, first use of the word "robot" in English.

1943 Foundations for neural networks laid.

1945 Isaac Asimov, a Columbia University alumni, coined the term Robotics.

1950 Alan Turing introduced Turing Test for evaluation of intelligence and published Computing Machinery and Intelligence. Claude Shannon published Detailed Analysis of Chess Playing as a search.

1956 John McCarthy coined the term Artificial Intelligence. Demonstration of the first running AI program at Carnegie Mellon University.

1958 John McCarthy invents LISP programming language for AI.

1964 Danny Bobrow's dissertation at MIT showed that computers can understand natural language well enough to solve algebra word problems correctly.

1965 Joseph Weizenbaum at MIT built ELIZA, an interactive problem that carries on a dialogue in English.

1969 Scientists at Stanford Research Institute Developed Shakey, a robot, equipped with locomotion, perception, and problem solving.

1973 The Assembly Robotics group at Edinburgh University built Freddy, the Famous Scottish Robot, capable of using vision to locate and assemble models.

1979 The first computer-controlled autonomous vehicle, Stanford Cart, was built.

1985 Harold Cohen created and demonstrated the drawing program, Aaron.

1990 Major advances in all areas of AI −

- Significant demonstrations in machine learning
- Case-based reasoning
- Multi-agent planning
- Scheduling
- Data mining, Web Crawler

- natural language understanding and translation
- Vision, Virtual Reality
- Games

1997 The Deep Blue Chess Program beats the then world chess champion, Garry Kasparov.

2000 Interactive robot pets become commercially available. MIT displays Kismet, a robot with a face that expresses emotions. The robot Nomad explores remote regions of Antarctica and locates meteorites.

Applications of AI

AI has been dominant in various fields such as −

- **Gaming** − AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.
- **Natural Language Processing** − It is possible to interact with the computer that understands natural language spoken by humans.
- **Expert Systems** − There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.
- **Vision Systems** − These systems understand, interpret, and comprehend visual input on the computer. For example,
    - A spying aeroplane takes photographs, which are used to figure out spatial information or map of the areas.
    - Doctors use clinical expert system to diagnose the patient.
    - Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.
- **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.

- **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.
- **Intelligent Robots** − Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

1.1. The evolution of AI to the present

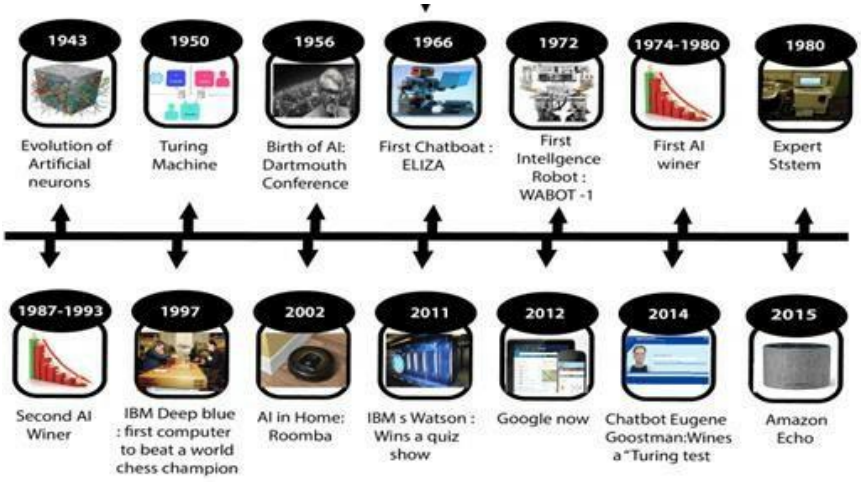

Figure 1.1: Evolution of

AI **Maturation of Artificial Intelligence (1943-1952)**

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of **artificial neurons**.
- **Year 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.
- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes **"Computing Machinery and Intelligence"** in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.

The birth of Artificial Intelligence (1952-1956)

- **Year 1955:** An 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.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field.

At that time high-level computer languages such as FORTRAN, LISP, or COBOL were invented. And the enthusiasm for AI was very high at that time.

The golden years-Early enthusiasm (1956-1974)

- **Year 1966:** The researchers emphasized developing algorithms which can solve mathematical problems. 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.

The first AI winter (1974-1980)

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

A boom of AI (1980-1987)

- **Year 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.
- In the Year 1980, the first national conference of the American Association of Artificial Intelligence **was held at Stanford University**.

The second AI winter (1987-1993)

- The duration between the years 1987 to 1993 was the second AI Winter duration.
- Again Investors and government stopped in funding for AI research as due to high cost but not efficient result. The expert system such as XCON was very cost effective.

The emergence of intelligent agents (1993-2011)

- **Year 1997:** In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.

- **Year 2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- **Year 2006:** AI came in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

Deep learning, big data and artificial general intelligence (2011-present)

- **Year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- **Year 2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- **Year 2014:** In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."
- **Year 2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "Duplex" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.

1.2. Various approaches to AI

Four approaches have been followed. As one might expect, a tension exists between approaches centred on humans and approaches centered around rationality. A Human

centred approach must be an empirical science, involving hypothesis and experimental confirmation. A rationalist approach involves a combination of mathematics and engineering. People in each group sometimes cast aspersions on work done in the other groups, but the truth is that each direction has yielded valuable insights. Let us look at each in more detail

Acting humanly: The Turing Test approach

The Turing Test, proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence. Turing defined intelligent behavior as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator. Roughly speaking, the test he proposed is that the computer should be interrogated by a human via a teletype, and passes the test if the interrogator cannot tell if there is a computer or a human at the

other end. Chapter 26 discusses the details of the test, and whether or not a computer is really intelligent if it passes. For now, programming a computer to pass the test provides plenty to work on. The computer would need to possess the following capabilities:

- natural language processing to enable it to communicate successfully in English (or some other human language);
- knowledge representation to store information provided before or during the interrogation;
- automated reasoning to use the stored information to answer questions and to draw new conclusions;
- machine learning to adapt to new circumstances and to detect and extrapolate patterns

Thinking humanly: If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get inside the actual workings of human minds.

Thinking rationally: The Greek philosopher Aristotle was one of the first to attempt to codify "right thinking," that is, irrefutable reasoning processes. His famous **syllogisms** provided patterns for argument structures that always gave correct conclusions given correct premises.

Acting rationally: Acting rationally means acting so as to achieve one's goals, given one's beliefs. An **agent** is just something that perceives and acts. (This may be an unusual use of the word, but you will get used to it.) In this approach, AI is viewed as the study and construction of rational agents.

1.3. What should all engineers know about AI?

An AI engineer builds AI models using machine learning algorithms and deep learning neural networks to draw business insights, which can be used to make business decisions that affect the entire organization. These engineers also create weak or strong AIs, depending on what goals they want to achieve.

AI engineers have a sound understanding of programming, software engineering, and data science. They use different tools and techniques so they can process data, as well as develop and maintain AI systems.

The next section of How to become an AI Engineer focuses on the responsibilities of an AI engineer.

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Responsibilities of an AI Engineer

As an AI engineer, you need to perform certain tasks, such as develop, test, and deploy AI models through programming algorithms like random forest, logistic regression, linear regression, and so on.

Responsibilities include:

- Convert the machine learning models into application program interfaces (APIs) so that other applications can use it
- Build AI models from scratch and help the different components of the organization (such as product managers and stakeholders) understand what results they gain from the model
- Build data ingestion and data transformation infrastructure
- Automate infrastructure that the data science team uses
- Perform statistical analysis and tune the results so that the organization can make better- informed decisions
- Set up and manage AI development and product infrastructure
- Be a good team player, as coordinating with others is a must

Skills Required to Become an AI Engineer

Professionals who are finding how to become an AI engineer should also know about the skills required in this field. Some of them include:

- **Programming Skills**

The first skill required to become an AI engineer is programming. To become well-versed in AI, it's crucial to learn programming languages, such as Python, R, Java, and C++ to build and implement models.

- **Linear Algebra, Probability, and Statistics**

To understand and implement different AI models—such as Hidden Markov models, Naive Bayes, Gaussian mixture models, and linear discriminant analysis—you must have detailed knowledge of linear algebra, probability, and statistics.

- **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. Along with Apache Spark, one can also use other big data technologies, such as Hadoop, Cassandra, and MongoDB.

- **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 (like a convolutional neural network, recurrent neural network, and generative adversarial network) and implement them using a framework. Some of the frameworks used in artificial intelligence are PyTorch, Theano, TensorFlow, and Caffe.

- **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.

Let us explore the career and roles in AI in the next section of the How to become an AI Engineer article.

- **AI Engineer Salary**

According to Glassdoor, the average annual salary of an AI engineer is $114,121 in the United States and ₹765,353 in India. The salary may differ in several organizations and with the knowledge and expertise, you bring to the table.

- **Career in AI**

Since several industries around the world use AI to some degree or the other, including healthcare and education, there has been exponential growth in the career opportunities within the field of AI. Some of these job roles are:

- **AI Developer**

An AI developer works closely with electrical engineers and develops software to create artificially intelligent robots.

- **AI Architect**

AI architects work closely with clients to provide constructive business and system integration services. They also create and maintain the entire architecture.

- **Machine Learning Engineer**

Machine learning engineers build predictive models using vast volumes of data. They have in-depth knowledge of machine learning algorithms, deep learning algorithms, and deep learning frameworks.

- **Data Scientists**

Data scientists collect, clean, analyze, and interpret large and complex datasets by leveraging both machine learning and predictive analytics.

- **Business Intelligence Developer**

They're responsible for designing, modeling, and analyzing complex data to identify the business and market trends.

1.4. Other emerging technologies

RPA (Robotic Process Automation) RPA Training Robotic process automation (or RPA) is a form of business process automation technology based on metaphorical software robots (bots) or on artificial intelligence (AI)/digital workers. It is sometimes referred to as software robotics.

- Automating repetitive tasks saves time and money. Robotic process automation bots expand the value of an automation platform by completing tasks faster, allowing employees to perform higher-value work.

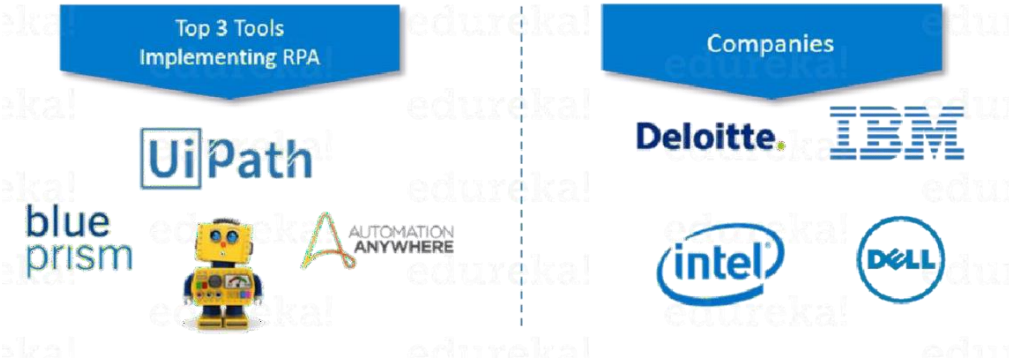

Figure 1.2: Robotic Process Automation

Big Data

Big Data is a collection of data that is huge in volume, yet growing exponentially with time. It is a data with so large size and complexity that none of traditional data management tools. Examples: Social Media

Hadoop and Spark are the two most famous frameworks for solving Big Data problems.

Types of Big Data

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Structured: Any data that can be stored, accessed and processed in the form of fixed format is termed as a 'structured' data.

Examples : An 'Employee' table in a database is an example of Structured Data

Employee_ID	Employee_Name	Gender	Department	Salary_In_lacs
2365	Rajesh Kulkarni	Male	Finance	650000
3398	Pratibha Joshi	Female	Admin	650000
7465	Shushil Roy	Male	Admin	500000
7500	Shubhojit Das	Male	Finance	500000
7699	Priya Sane	Female	Finance	550000

Table 1.1: Structured data

Unstructured : Any data with unknown form or the structure is classified as unstructured data. In addition to the size being huge, un-structured data poses multiple challenges in terms of its processing for deriving value out of it. A typical example of unstructured data is a heterogeneous data source containing a combination of simple text files, images, videos etc.

Example: Google search

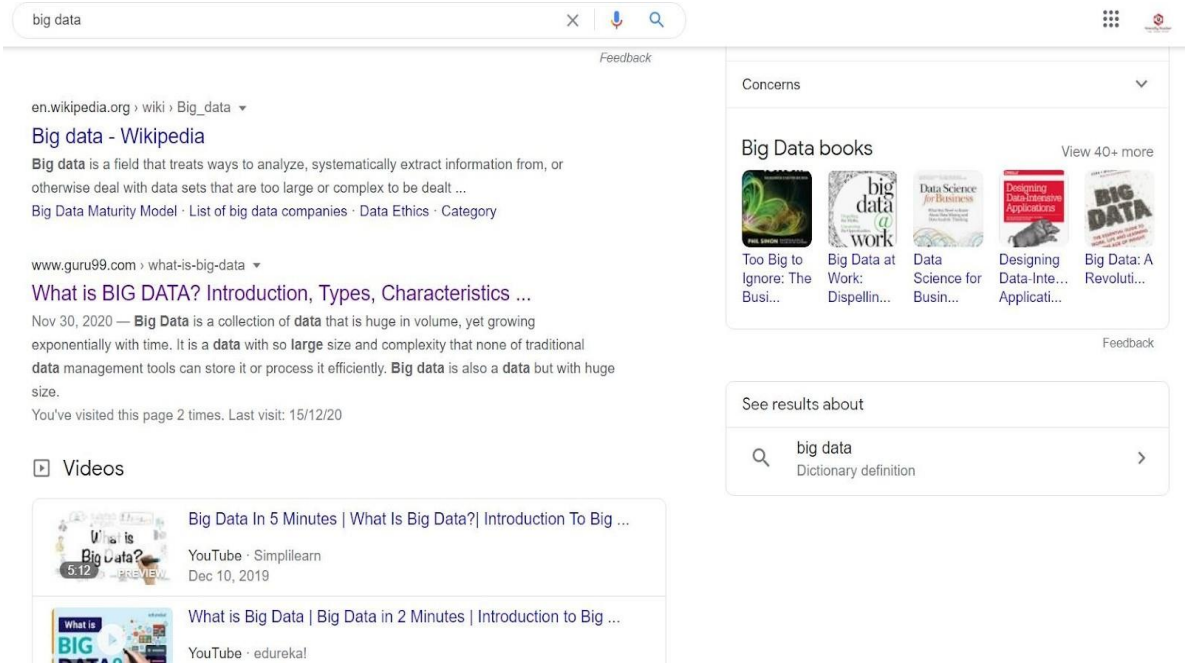

Figure 1.3: Unstructured data

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Semi-structured: Semi-structured data can contain both the forms of data. We can see semi-structured data as a structured in form but it is actually not defined with e.g. a table definition in relational DBMS. Example of semi-structured data is a data represented in an XML file.

Examples of semi-structured: CSV but XML and JSON documents are semi structured documents, NoSQL databases are considered as semi structured.

Characteristics Of Big Data

(i) Volume – The name Big Data itself is related to a size which is enormous. Size of data plays a very crucial role in determining value out of data.

(ii) Variety – Variety refers to heterogeneous sources and the nature of data, both structured and unstructured.

(iii) Velocity – The term **'velocity'** refers to the speed of generation of data.

- ***(iv) Variability –*** This refers to the inconsistency which can be shown by the dataat times, thus hampering the process of being able to handle and manage the data

effectively.

Intelligent Apps (I – Apps)

- I-Apps are pieces of software written for mobile devices based on artificial intelligence and machine learning technology, aimed at making everyday tasks easier.
- This involves tasks like organizing and prioritizing emails, scheduling meetings,

logging interactions, content, etc. Some familiar examples of I-Apps are Chatbots and virtual assistants.

As these applications become more popular, they will come with the promise of jobs and fat paychecks.

Figure 1.4: Intelligent apps

Internet of Things (IoT)

- The Internet of Things (IoT) 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.
- These devices range from ordinary household objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 10 billion by 2020 and 22 billion by 2025.

This includes everything from your:

- mobile phones,
- refrigerator,
- washing machines to almost everything that you can think of.

With IoT, we can have smart cities with optimized:

- traffic system,
- efficient waste management and
- energy use

So, start thinking of some new excuse for coming late to the office other than traffic.

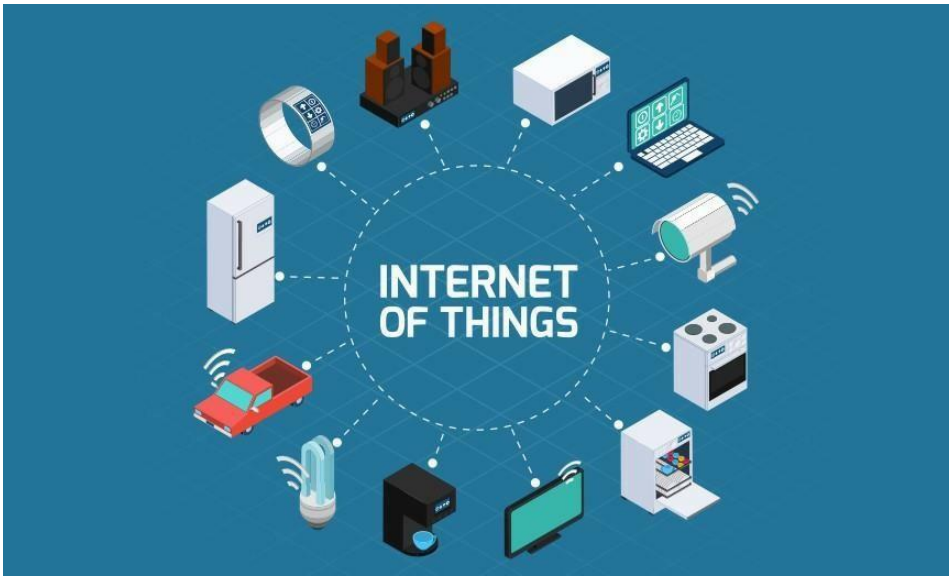

Figure 1.5: The Internet of Things

DevOps

DevOps Training This is the odd one out in the list. It is not a technology, but a methodology. DevOps is a methodology that ensures that both the development and operations go hand in hand. DevOps cycle is picturized as an infinite loop representing the integration of developers and operation teams by:

- automating infrastructure,
- workflows and
- continuously measuring application performance.

Figure 1.6: DevOps

It is basically the process of continual improvement, so why not start with yourself.

Angular and React

- Angular and React are JavaScript based Frameworks for creating modern web applications.
- Using React and Angular one can create a highly modular web app. So, you don't need to go through a lot of changes in your code base for adding a new feature.
- Angular and React also allows you to create a native mobile application with the

same JS, CSS & HTML knowledge.

- Best part – Open source library with highly active community support.

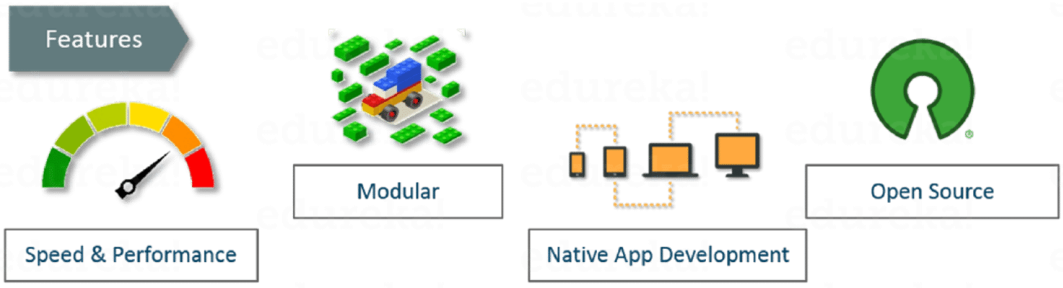

Figure 1.7: Angular and React

Cloud Computing

- cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale.
- You typically pay only for cloud services you use, helping lower your operating costs, run your infrastructure more efficiently and scale as your business needs change

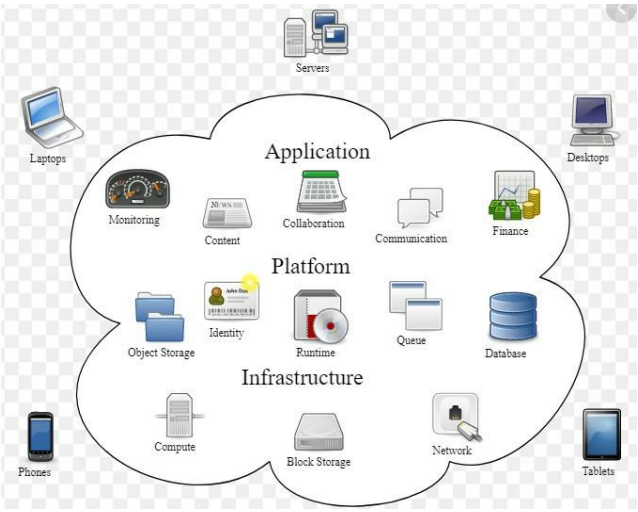

Figure 1.8: Cloud computing

Types of cloud computing

Public cloud: Public clouds are owned and operated by a third-party cloud service providers, which deliver their computing resources like servers and storage over the Internet. Microsoft Azure is an example of a public cloud. With a public cloud, all hardware, software and other supporting infrastructure is owned

and managed by the cloud provider.

Private cloud: A private cloud refers to cloud computing resources used exclusively by a single business or organisation. A private cloud can be physically located on the company's on-site datacenter. Some companies also pay third-party service providers to host their private cloud. Example: HP Data Centers, Microsoft, Elastra-private cloud, and Ubuntu.

Hybrid cloud: Hybrid clouds combine public and private clouds, bound together by technology that allows data and applications to be shared between them. By allowing data and applications to move between private and public clouds, a hybrid cloud gives your business greater flexibility, more deployment options and helps optimise your existing infrastructure, security and compliance. Example : Amazon Web Services (AWS) or Microsoft Azure.

Types of cloud services:

- **IaaS (Infrastructure as Service):** This is the most common service model of cloud computing as it offers the fundamental infrastructure of virtual servers, network, operating systems and data storage drives. It allows for the flexibility, reliability and scalability that many businesses seek with the cloud, and removes the need for hardware in the office.
- **PaaS (Platform-as-a-Service):** This is where cloud computing providers deploy the infrastructure and software framework, but businesses can develop and run their own applications. Web applications can be created quickly and easily via PaaS, and the service is flexible and robust enough to support them.
- **SaaS (Software as a Service):** This cloud computing solution involves the deployment of software over the internet to variousbusinesses who pay via subscription or a pay-per-use model. It is a valuable tool for CRM and for applications that need a lot of web or mobile access – such as mobile sales management software

Augmented Reality and Virtual Reality

- Virtual is real! VR and AR, the twin technologies that let you experience things in virtual, that are extremely close to real, are today being used by businesses of all sizes and shapes. But the underlying technology can be quite complex.
- Medical students use AR technology to practice surgery in a controlled environment.
- VR on the other hand, opens up newer avenues for gaming and interactive marketing.

Whatever your interest might be, AR and VR are must-have skills if you want to ride the

virtual wave!

Figure 1.9: Augmented Reality and Virtual Reality

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Blockchain:

Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system. A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain. Blockchain, sometimes referred to as Distributed Ledger Technology (DLT), makes the history of any digital asset unalterable and transparent through the use of decentralization and cryptographic hashing.

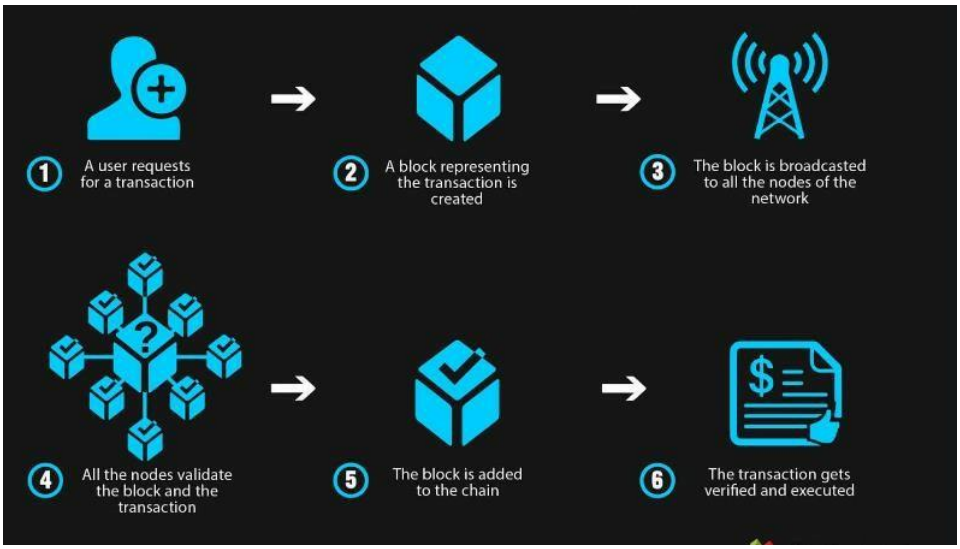

Figure 1.10: Working of blockchain

1.5. AI and ethical Concerns

Job Loss and Wealth Inequality

One of the primary concerns people have with AI is future loss of jobs. Should we strive to fully develop and integrate AI into society if it means many people will lose their jobs — and quite possibly their livelihood?

AI is Imperfect — What if it Makes a Mistake?

AIs are not 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 date or make errors with internal programming, the AIs can be harmful. Teka Microsoft's AI chatbot, Tay, which was released on Twitter in 2016. In less than one day, due to the information it was receiving and learning from other Twitter users, the robot learned to spew racist slurs and Nazi propaganda.

Microsoft shut the chatbot down immediately since allowing it to live would have obviously damaged the company's reputation.

Should AI Systems Be Allowed to Kill?

In this TEDx speech, Jay Tuck describes AIs as software that writes its own updates and renews itself. This means that, as programmed, the machine is not created to do what we want it to do — it does what it learns to do. Jay goes on to describe an incident with a robot called Tallon. Its computerized gun was jammed and open fired uncontrollably after an explosion killing 9 people and wounding 14 more.

Rogue AIs

If there is a chance that intelligent machines can make mistakes, then it is within the realm of possibility that an AI can go rogue, or create unintended consequences from its actions in pursuing seemingly harmless goals. One scenario of an AI going rogue is what we've already seen in movies like The Terminator and TV shows where a super-intelligent centralized AI computer becomes self- aware and decides it doesn't want human control anymore.

Singularity and Keeping Control Over AIs

Will AIs evolve to surpass human beings? What if they become smarter than humans and then try to control us? Will computers make humans obsolete? The point at which technology growth surpasses human intelligence is referred to as "technological singularity." Some believe this will signal the end of the human era and that it could occur as early as 2030 based on the pace of technological innovation. AIs leading to

human extinction — it's easy to understand why the advancement of AI is scary to many people.

How Should We Treat AIs?

Should robots be granted human rights or citizenship? If we evolve robots to the point that they are capable of "feeling," does that entitle them to rights similar to humans or animals? If robots are granted rights, then how do we rank their social status? This is one of the primary issues in "roboethics," a topic that was first raised by Isaac Asimov in 1942. In 2017, the Hanson Robotics humanoid robot, Sophia, was granted citizenship in Saudi Arabia. While some consider this to be more of a PR stunt than actual legal recognition, it does set an example of the type of rights AIs may be granted in the future.

AI Bias

AI has become increasingly inherent in facial and voice recognition systems, some of which have real business implications and directly impact people. These systems are vulnerable to biases and

errors introduced by its human makers. Also, the data used to train these AI systems itself can have biases. For instance, facial recognition algorithms made by Microsoft, IBM and Megvii all had biases when detecting people's gender.

Questions:

1. What is Intelligence?
2. Describe the four categories under which AI is classified with examples.
3. Define Artificial Intelligence.
4. List the fields that form the basis for AI.
5. What are various approaches to AI.
6. What is emerging technologies? Give some examples.
7. What is the importance of ethical issue in AI?
8. Write the history of AI.
9. What are applications of AI?
10. What should all engineers know about AI?