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**UNIT- V**

**NEW IT INITIATIVES**

**5.5 Advancements in AI, IoT**

### 5.5.1 Advancements in Artificial Intelligence:

Artificial intelligence (AI) makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Most AI examples that you hear about today – from chess-playing computers to self-driving cars – rely heavily on deep learning and natural language processing.

**Artificial intelligence** (**AI**) is the intelligence of machines or software, as opposed to the intelligence of humans or other animals. It is a field of study in computer science that develops and studies intelligent machines. Such machines may be called AIs.

Artificial intelligence can be viewed from a variety of perspectives.

 From the perspective of intelligence artificial intelligence is making machines "intelligent" -- acting as we would expect people to act.

- The inability to distinguish computer responses from human responses is called the Turing test. o Intelligence requires knowledge
- Expert problem solving - restricting domain to allow including significant relevant knowledge

 From a business perspective AI is a set of very powerful tools, and methodologies for using those tools to solve business problems.

 From a programming perspective, AI includes the study of symbolic programming, problem solving, and search.

o Typically AI programs focus on symbols rather than numeric processing.

o Problem solving - achieve goals.

o Search - seldom access a solution directly. Search may include a variety of techniques.

o AI programming languages include: – LISP, developed in the 1950s, is the early programming language strongly associated with AI. LISP is a functional programming language with procedural extensions. LISP (LISt Processor) was specifically designed for processing heterogeneous lists -- typically a list of symbols. Features of LISP are run-time type checking, higher order functions (functions that have other functions as parameters), automatic memory management (garbage collection) and an interactive environment.

**5.5.1.1 What is Intelligence?**

The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations.

***Types of Intelligence:***

As described by Howard Gardner, an American developmental psychologist, the Intelligence comes in multifold:

i. Linguistic intelligence
ii. Musical intelligence
iii. Logical, mathematical intelligence
iv. Spatial intelligence
v. Bodily-Kinesthetic intelligence
vi. Intra-personal intelligence
vii. Interpersonal intelligence

You can say a machine or a system is artificially intelligent when it is equipped with at least one and at most all intelligences in it.

The intelligence is intangible. It is composed of:

1. Reasoning
2. Learning
3. Problem Solving
4. Perception
5. Linguistic Intelligence

Let us go through all the components briefly:

1. **Reasoning:** It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types:

   ***Inductive Reasoning :*** It conducts specific observations to makes broad general statements. Even if all of the premises are true in a statement, inductive reasoning allows for the conclusion to be false. Example: “Nita is a teacher. All teachers are studious. Therefore, Nita is studious.”

   ***Deductive Reasoning:*** It starts with a general statement and examines the possibilities to reach a specific, logical conclusion. If something is true of a class of things in general, it is also true for all members of that class. Example: "All women of age above 60 years are grandmothers. Shalini is 65 years. Therefore, Shalini is a grandmother.

2. **Learning**: It is the activity of gaining knowledge or skill by studying, practising, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study. The ability of learning is possessed by humans, some animals, and AI-enabled systems. Learning is categorized as:
   i. **Auditory Learning**: It is learning by listening and hearing. For example, students listening to recorded audio lectures.
   ii. **Episodic Learning**: To learn by remembering sequences of events that one has witnessed or experienced. This is linear and orderly.
   iii. **Motor Learning**: It is learning by precise movement of muscles. For example, picking objects, Writing, etc.

iv. **Observational Learning**: To learn by watching and imitating others. For example, child tries to learn by mimicking her parent.
v. **Perceptual Learning**: It is learning to recognize stimuli that one has seen before. For example, identifying and classifying objects and situations.
vi. **Relational Learning**: It involves learning to differentiate among various stimuli on the basis of relational properties, rather than absolute properties. For Example, Adding 'little less' salt at the time of cooking potatoes that came up salty last time, when cooked with adding say a tablespoon of salt.
vii. **Spatial learning**: It is learning through visual stimuli such as images, colors, maps, etc. For Example, A person can create roadmap in mind before actually following the road.
viii. **Stimulus-Response Learning**: It is learning to perform a particular behavior when a certain stimulus is present. For example, a dog raises its ear on hearing doorbell.

3. **Problem solving**: It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles. Problem solving also includes decision making, which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.
4. **Perception**: It is the process of acquiring, interpreting, selecting, and organizing sensory information. Perception presumes sensing. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.
5. **Linguistic Intelligence**: It is one's ability to use, comprehend, speak, and write the verbal and written language. It is important in interpersonal communication.

### 5.5.1.2 Difference between Human and Machine Intelligence:

1. Humans perceive by patterns whereas the machines perceive by set of rules and data.

2. Humans store and recall information by patterns, machines do it by searching algorithms. For example, the number 40404040 is easy to remember, store and recall as its pattern is simple.
3. Humans can figure out the complete object even if some part of it is missing or distorted; whereas the machines cannot correctly.

**5.5.1.3 Features of Artificial Intelligence**:

Modernization is the art of growing through the wheels of time. What started as the way to find the survival of the fittest is now the race of modernization. Ages ago when electricity was discovered by Benjamin Franklin it was regarded as the biggest revolution of history and was supposed to change our lives, which it did. The same is the case with AI because it is also believed to change our lives for the better.

There are several characteristics which makes Artificial Intelligence one of the most loved skills and important technology because it gives machines the ability to make human-like decisions. Machines are faster than humans, smarter and more accurate too, but they can't think for themselves and that's where humans are rated above machines. AI is supposed to change this fact and give machines a brain of themselves. It gives them the ability to think.

But if you think it's just that which makes AI one of the most talked about skills in the history of technology, you are wrong. Then what other things are there that make AI as important as it is? Well, to understand this properly, let's have a look at all the features AI has, understand its characteristics and then we can decide for ourselves.

There are various features associated with AI, some are listed below: –

***1. Facial Recognition***

It is not something people had thought of in the earlier days but technology has somehow made it possible. Artificial intelligence has even made it possible to recognise faces. Using biometric mapping to figure out the faces of individuals is a huge achievement in

itself. It compares whatever is being shown to a database where it finds the match and declares a successful match.

Example: The face look feature in smartphones is an example of facial recognition. It matches the features of the face from that present in your phone and opens the lock if it's a successful match.

***2. Deep Learning***

This is a subpart of machine learning which is a part of artificial intelligence. It enables the machines to think exactly like humans and therefore provides an opportunity to increase the technological presence. A lot of work is being done in this area because it is by far the most revolutionary idea in this field.

Example: - A very simple and common example of deep learning includes self-driving features embedded in cars like Tesla. Deep learning plays a very important role in developing such features, it helps in distinguishing between a lamppost and a human being.

***3. Futuristic***

This new technology is based on adaptive learning i.e. it observes and adapts to the surrounding environment and learns accordingly, therefore making it a very advanced approach. As stated earlier, self-driving cars are an example of artificial intelligence. Unlike the cars of today, they'll be better connected to technology and would be a step forward in the future.

***4. Ingestion of Data***

With the way technology is growing, the amount of data produced everyday just grows exponentially. This is where the need for AI steps in. AI not only helps in organizing the data, it saves the time and manual labor required in doing so. Data ingestion is the process of transporting knowledge from various data sources to a particular database. A feature called neural network helps with the organization of data.

### *5. Chatbots*

Chatbots are amongst one of the most important things you'll find on a website. They provide a way for the customers to get their queries solved either through text or audio. It is one of the most important developments of artificial intelligence because it gives a wide array of understanding as the chatbots are programmed to understand language and not just commands.

Example: Watson AI is a chatbot developed by IBM which is made in such a way that it requires no human intervention and is made in such a way that it can handle websites, applications and messengers too.

### *6. Cloud Computing*

With the kind of data that is being produced everyday, it would be extremely difficult to store all such data manually and in physical form. It is much more efficient, convenient and therefore came with the development of cloud computing. This is one of the most important developments in the field of artificial intelligence insight driven.

Example: Microsoft Azure is one of the most commonly used cloud computing technologies.

### *7. Elimination of Mundane Tasks*

At some time in our lives, we've all completed a chore just because we had to, rather than because we wanted to. That work was uninteresting or dull to us. However, with a machine, you will never get bored in the same way. No matter how many times a job is given to an artificially intelligent system, it will do it and continue to do so. Furthermore, such technologies only make users' lives simpler by making monotonous, large-scale operations easier.

Take, for example, Dialog Flow, a Google subsidiary firm that claims credit for developing the Google Assistant. In a single day, we offer this assistance so many orders! The

assistant can handle everything from asking Ok Google to call mum to asking Ok Google to get sandwiches.

***8. Automation***

AI has the ability to perform the same task over and over without breaking a sweat. Take Siri, Apple Inc.'s voice-activated assistant, for example, to better grasp this capability. It's capable of handling a large number of orders in a single day! The assistant can do it all, from taking notes for a brief to rescheduling an appointment on the calendar to navigating us through the streets via navigation.

Previously, all of these tasks had to be completed manually, which took a lot of time and effort. Automation would not only boost efficiency, but it would also cut overhead expenses and, in some situations, create a safer working environment.

***9. Quantum Computing***

With the aid of quantum neural networks, AI is assisting in the solution of challenging quantum physics issues with the precision of supercomputers. This might pave the way for game-changing breakthroughs in the near future. It's an interdisciplinary field that focuses on developing quantum algorithms for better AI tasks, including sub-fields like machine learning. The entire notion of quantum-enhanced AI algorithms is still in the research phase.

Google AI Quantum, for example, is a pioneer in this field, with the goal of developing superconducting qubit computers and quantum-assisted optimization for a variety of applications.

***10. Imitates Human Cognition***

Because it essentially imitates or duplicates the way the human mind works and solves issues, we call it an artificially intelligent system. This is what distinguishes AI. An AI can effectively comprehend the world and respond appropriately in the same way as people study their surroundings, form inferences, and then interact with it properly. This makes

us even more excited for the day when an AI system will be able to fully replicate the human mind and act in human-like ways.

To be honest, I'm looking forward to the day when just my own AI system interacts with people in my place, and a social me binge watches web series in the privacy of my own house.

For example, Baidu, a Chinese computer behemoth, is a Chinese-language search engine aimed largely at Chinese residents.

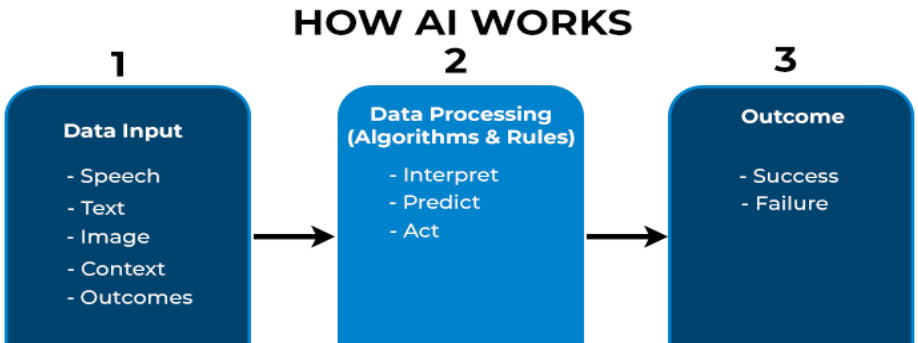
***11. Prevention from Natural Disasters***

When given data from thousands of prior disasters, artificially intelligent systems may reliably anticipate the future of disasters that may occur. Today, scientists are investigating more than a lac of previously occurring earthquakes and comparable calamities such as tremors and volcanic eruptions using artificial intelligence elements such as these.

Seismic information, which is information on changes in the tectonic plates beneath the earth's surface, is also being studied by AI systems. Scientists are also looking at ash particles produced by lava during a volcanic eruption, as well as other geological data, to anticipate abrupt eruptions.

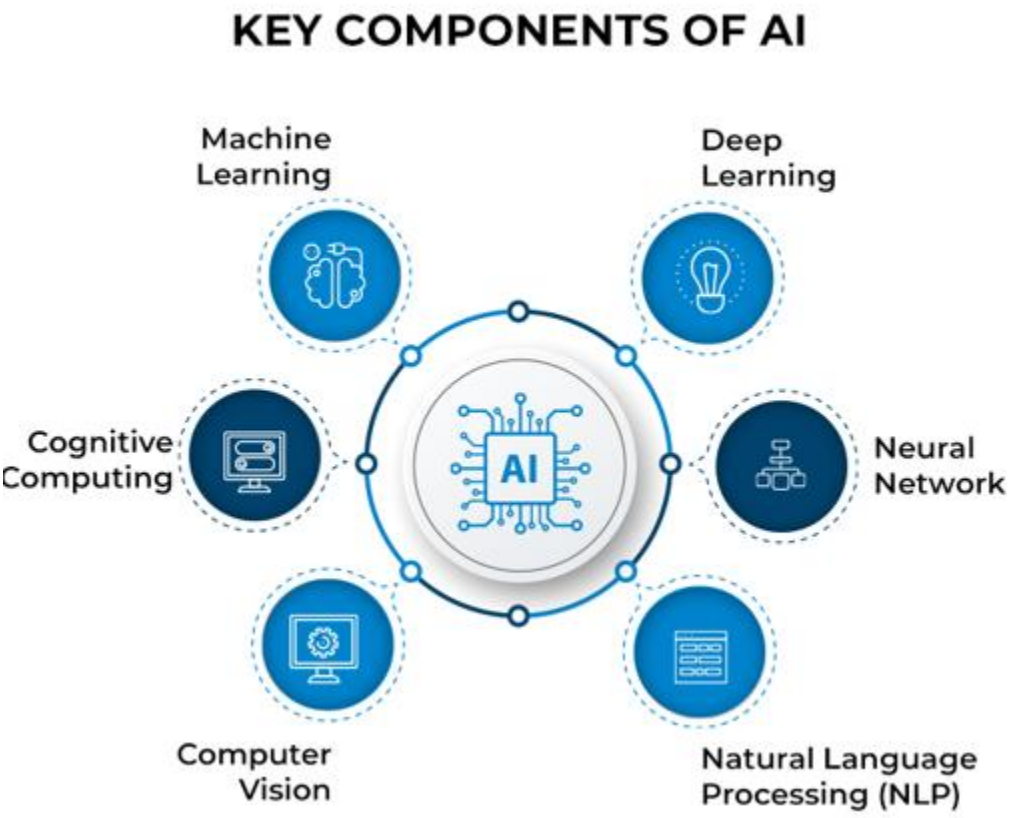
For example: In May 2019, Cyclone Fani struck Bangladesh and Odisha, India's south-eastern state. The Indian Meteorological Department forecasted and tracked the storm ahead of time, allowing nearly 1.2 million Odisha people to be evacuated on time and relocated to cyclone shelters established at higher elevations.

**5.5.1.4 How AI Works**:



To begin with, an AI system accepts data input in the form of speech, text, image, etc. The system then processes data by applying various rules and algorithms, interpreting, predicting, and acting on the input data. Upon processing, the system provides an outcome, i.e., success or failure, on data input. The result is then assessed through analysis, discovery, and feedback. Lastly, the system uses its assessments to adjust input data, rules and algorithms, and target outcomes. This loop continues until the desired result is achieved.

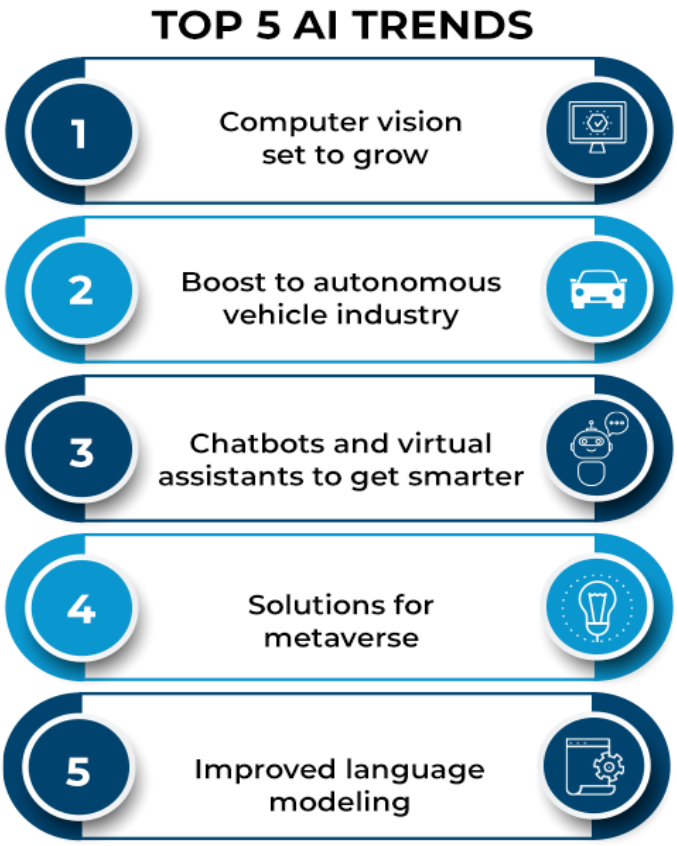
### 5.5.1.5 Key components of AI:




1. **Machine learning:** Machine learning is an AI application that automatically learns and improves from previous sets of experiences without the requirement for explicit programming.
2. **Deep learning:** Deep learning is a subset of ML that learns by processing data with the help of artificial neural networks.
3. **Neural network**: Neural networks are computer systems that are loosely modelled on neural connections in the human brain and enable deep learning.
4. **Cognitive computing**: Cognitive computing aims to recreate the human thought process in a computer model. It seeks to imitate and improve the interaction between humans and machines by understanding human language and the meaning of images.

5. **Natural language processing** (NLP): NLP is a tool that allows computers to comprehend, recognize, interpret, and produce human language and speech.
6. **Computer vision:** Computer vision employs deep learning and pattern identification to interpret image content (graphs, tables, PDF pictures, and videos).

### 5.5.1.6 Top 5 AI Trends in 2022:




1. **Computer vision set to grow**

In the race for AI supremacy, organizations and businesses are set to embrace computer vision technology at an unprecedented scale in 2022. According to a September 2021

survey by Gartner, organizations investing in AI are expected to make the highest planned investments in computer vision projects in 2022.

Computer vision refers to AI that uses ML algorithms to replicate human-like vision. The models are trained to identify a pattern in images and classify the objects based on recognition. For example, computer vision can scan inventory in warehouses in the retail sector. Similarly, the technology finds application in several other industries such as healthcare, agriculture & farming, manufacturing, autonomous vehicles, and more.

2. **Boost to the autonomous vehicle industry**

As more and more car manufacturers continue to invest in autonomous vehicles, the market penetration of driverless cars is expected to rise considerably. According to Statista's Dec 2021 projections, the global autonomous vehicle market is estimated to be valued at around $146.4 billion in 2022, a substantial rise from $105.7 billion in 2021.

Self-driving cars enabled with computer vision are already being tested by companies like Tesla, Uber, Google, Ford, GM, Aurora, and Cruise. This trend is only expected to scale in the next 12 months. In August 2021, Tesla unveiled the 'Dojo' chip specifically designed to process large volumes of images collected by computer vision systems embedded in its self-driving cars. Around the same time, Waymo, Google's subsidiary, expanded its self-driving taxi services outside Arizona.

3**. Chatbots and virtual assistants to get smarter**

Another AI trend that is most talked about in 2022 is smarter chatbots and virtual assistants. This comes from the pandemic, as global industries are now comfortable giving their employees digital workplace experiences. Most chatbots and virtual assistants use deep learning and NLP technologies on the verge of automating routine tasks. Moreover, researchers and developers continue to add features and enhance these bots.

For example, Amelia, a global leader in conversational AI, performs complex conversation tasks with supplemental training provided by developers. Amelia claims to achieve 90%

accuracy in identifying customer intent and a customer satisfaction rate of 91%, which is at par with human assistants. Tech companies such as Nuance, IBM, and Amazon Lex are making significant efforts to improve their virtual assistance through smarter bots.

### 4**. Solutions for metaverse**

AI agents and virtual assistants will play a key role as the tech world plunges into the concept of the metaverse. Metaverse defines a virtual environment that allows users to interact with digital tools and gives them an immersive experience. In October 2021, Mark Zukerberg rebranded Facebook as 'Meta' and announced plans to build a metaverse.

Virtual agents are expected to use AI to enable people to connect to the virtual environment. The famous humanoid AI robot Sophia is tokenized for metaverse appearance. Developers claim that tokenized Sophia, being AI, will interact with users from anywhere, at any time, and across devices and media platforms.

Although metaverse may not reveal itself in a full-fledged version in 2022, the blend of virtual and augmented technologies and AI will continue to stay as a backbone of the metaverse. Metaverse is therefore expected to be one of the major AI research trends in the next 12 months.

### **5. Improved language modelling**

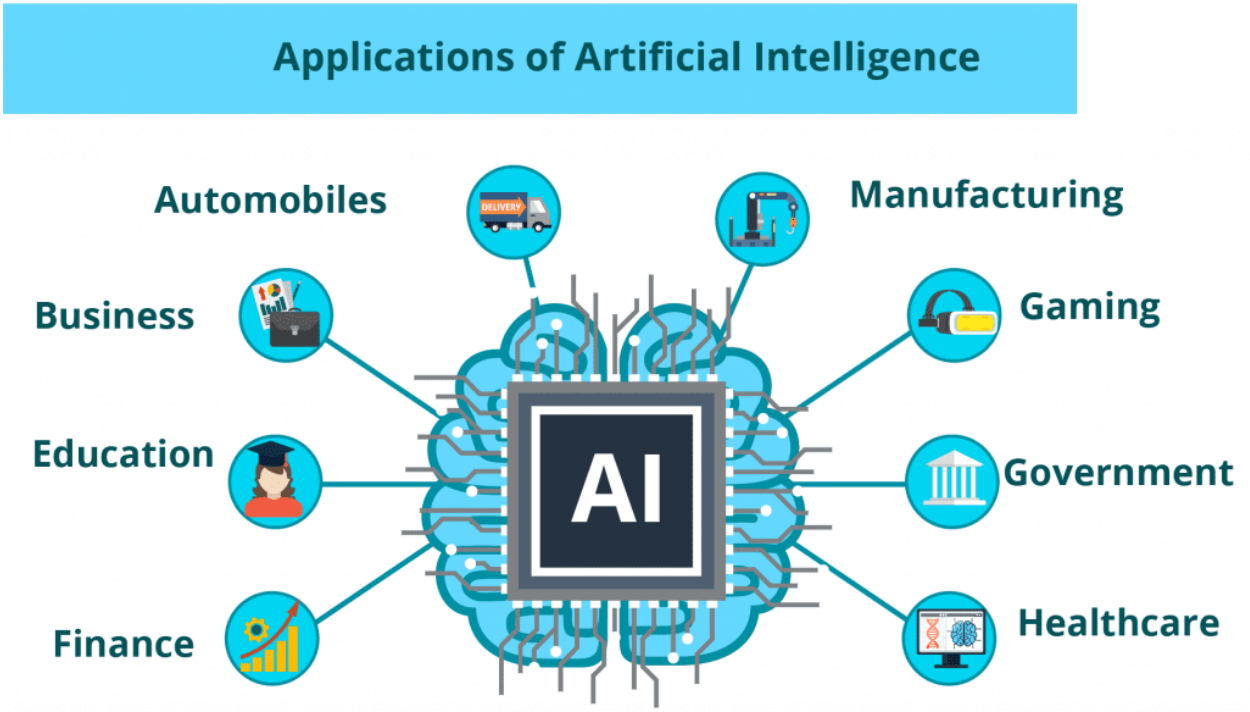
Another AI trend that will continue to feature in 2022 is improved language modeling. Language modeling is a technology that allows computers to understand language semantics, complete sentences via word prediction, and convert text into computer codes.

Generative Pre-trained Transformer 3 (GPT-3), by Open AI, is a comprehensive language modeling tool available today. It uses 175 billion parameters to process and generate human-like language. Also, Open AI, in August 2021, released a better version of its tool, Codex, which parses natural language and generates programming code in response. The company is also working on the next version of GPT-3 (i.e., GPT-4), and it is expected

that GPT-4 will be 500 times the size of GPT-3 in terms of the parameters that it may use to parse a language.

Apart from the trends listed above, other popular AI trends that could grab attention in 2022 include hyper automation in modern businesses, the rise of artificial intelligence as a service (AIaaS), AI in cybersecurity, and increased sophistication in AIoT (merger of AI and the internet of things (IoT).

**5.5.1.7 Applications of Artificial Intelligence**:




**Business:**

Businesses are utilising AI for facilitating a better relationship with their customers as well as to tackle tasks that would be carried out by humans but can be done faster using robotic process automation. Further, websites are utilising machine learning algorithms to explore the best ways to serve the customers. Amongst the diverse applications of Artificial Intelligence in the business sector, chatbots are included in websites to ensure immediate services to the customers. AI possesses the potential of boosting sales, carrying out predictive analysis, better connecting with the consumers by enhancing their overall experience as well as formulating efficient and effective work processes.

**Education:**

When it comes to the education sector, AI has brought key changes in revolutionising the traditional methods of teaching. **Digital** technologies can be effectively incorporated for grading assignments as well as to provide smart content through **online study** materials, e-conferencing, etc. Further, AI is also being proficiently utilised by admission portals like **Leverage Edu** to help students find best-fit courses and universities as per their preferences and career goals. There are innumerable other applications of Artificial Intelligence in education such as online courses and learning platforms and digital applications, intelligent AI tutors, **online career counselling**, virtual facilitators, amongst others.

**Healthcare:**

Artificial Intelligence has proved to be a significant and effective technology for the healthcare sector as it has revolutionized **medical** equipment, diagnosis, research, amongst others. Other than using **computing** technologies for better and faster diagnoses of diseases, there are various significant applications of Artificial Intelligence as complex algorithms can be utilised to emulate human cognition for analysis and interpretation of complicated **medical** and **healthcare** data. AI systems can handle larger chunks of data and analyze them to suggest the best ways for treatment. Many **healthcare** companies have also designed digital applications such as Lybrate,

WebMD, etc. where patients can report their patients and seek medical assistance from healthcare professionals.

**Banking:**

Applications of artificial intelligence in the banking sector are also exponentially growing. There are a number of banks in the world that are already taking advantage of artificial intelligence for detecting frauds related to the activities of credit cards as well as facilitating online banking. Almost every bank is providing its users with online apps where they can track their account transactions, carry out **online payments** as well as to detect anti-money laundering patterns as well as payment frauds. Famous companies like MasterCard and RBS WorldPay equally rely on AI and Deep Learning.

**Finance:**

In the **financial** sector, Artificial intelligence is playing a major role in determining the future patterns of the market. The main aim & objective of AI-based technologies in the finance sector is to thoroughly analyze the dynamism of stock trading. Using different applications of Artificial Intelligence, the finance industry is incorporating adaptive intelligence, algorithm trading and machine learning into financial processes. Based on the prediction of market prices, they help individuals in taking the right decisions.

**Agriculture:**

There are many issues related to environmental change which are miserably affecting the lives of farmers and crop production. In order to do away with the agricultural crises, a number of AI-based machines are at the forefront, be it robots and algorithms, helping farmers in sustainable **agricultural** production. They help farmers discover more effective means of protecting crops from weeds. Effectively using applications of Artificial Intelligence in **Agriculture**, the ‘Blue River Technology’ has set a great example as it has created see and spray machines that can detect weedicide on cotton plants. These

automated machines spray plants with the help of computer vision technologies which helps them protect against herbicide.

**Gaming:**

Applications of Artificial Intelligence in the arena of gaming also deserves prominent mention. AI has achieved phenomenal growth in the gaming industry itself. Using machine learning and algorithms, a surreal **gaming** environment can be brought forwards for gamers. Implementation of augmented reality and virtual reality gaming to bring a real environment for players, AI possesses the potential of transforming even the simplest of video games into dynamic, engaging and interactive ones! DeepMind's AI-based AlphaGo software is considered one of the prolific and phenomenal achievements in the field of AI. It has defeated Lee Sedol, the world champion in the GO game. There are many examples of applications of artificial intelligence in the gaming industry which includes the *First Encounter Assault Recon*, popularly known as F.E.A.R.

**Autonomous Vehicles:**

Smart cars are the best examples of autonomous vehicles. It is one of the popular applications of artificial intelligence in the **automobile** sector. There are prolific companies like Waymo, which has conducted a series of test drives to make their product successful. They included a vehicle ranging system, **cloud services**, GPS as well as cameras in order to produce and control signals for vehicular movement. Tesla's self-driving cars are purely based on Artificial intelligence is another best example of autonomous vehicles.

**Other Applications**

Following are some of the other applications of artificial intelligence:

- Astronomy
- Travel & Tourism
- E-Commerce

- Social Media
- Data Security
- Lifestyle
- Navigation
- **Human Resource**
- Chatbots

### 5.5.2 Internet of Things (IoT) :

IoT stands for Internet of Things. It refers to the interconnectedness of physical devices, such as appliances and vehicles, that are embedded with software, sensors, and connectivity which enables these objects to connect and exchange data. This technology allows for the collection and sharing of data from a vast network of devices, creating opportunities for more efficient and automated systems.

**Internet of Things (IoT)** is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment. In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a few of the categorical examples where IoT is strongly established.

IOT is a system of interrelated things, computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers. And the ability to transfer the data over a network requiring human-to-human or human-to-computer interaction.

#### 5.5.2.1 Four Key Components of IOT

- Device or sensor
- Connectivity

- Data processing
- Interface

  Over 9 billion 'Things' (physical objects) are currently connected to the Internet, as of now. In the near future, this number is expected to rise to a whopping 20 billion.

**5.5.2.2 Main Components Used in IoT**

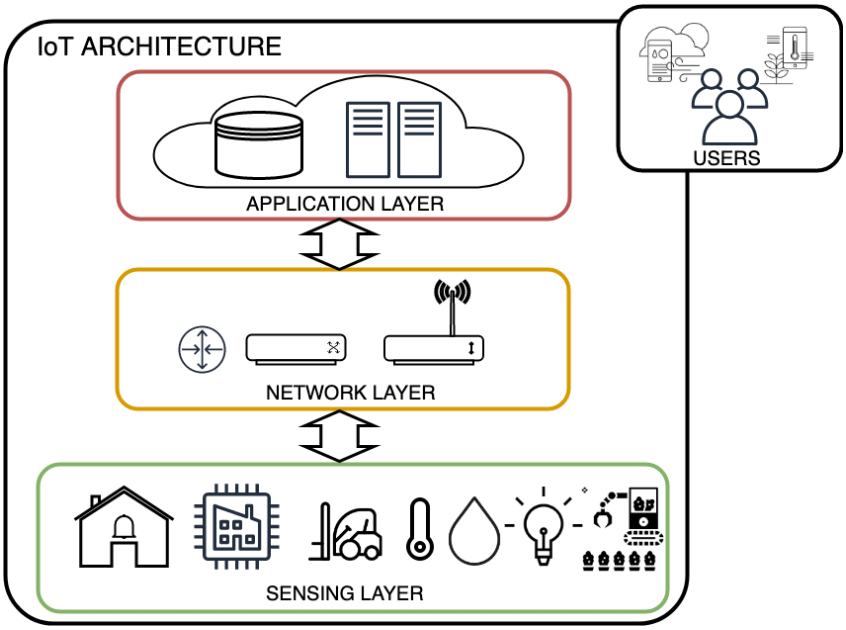
- **Low-power embedded systems:** Less battery consumption, high performance are the inverse factors that play a significant role during the design of electronic systems.
- **Sensors:** Sensors are the major part of any IoT application. It is a physical device that measures and detects certain physical quantities and converts it into signal which can be provided as an input to processing or control unit for analysis purpose
- Different types of Sensors:
    - Temperature Sensors
    - Image Sensors
    - Gyro Sensors
    - Obstacle Sensors
    - RF Sensor
    - IR Sensor
    - MQ-02/05 Gas Sensor
    - LDR Sensor
    - Ultrasonic Distance Sensor
- **Control Units:** It is a unit of small computer on a single integrated circuit containing microprocessor or processing core, memory and programmable input/output devices/peripherals. It is responsible for major processing work of IoT devices and all logical operations are carried out here.
- **Cloud computing:** Data collected through IoT devices is massive, and this data has to be stored on a reliable storage server. This is where cloud computing comes into

play. The data is processed and learned, giving more room for us to discover where things like electrical faults/errors are within the system.

- **Availability of big data:** We know that IoT relies heavily on sensors, especially in real-time. As these electronic devices spread throughout every field, their usage is going to trigger a massive flux of big data.
- **Networking connection:** In order to communicate, internet connectivity is a must, where each physical object is represented by an IP address. However, there are only a limited number of addresses available according to the IP naming. Due to the growing number of devices, this naming system will not be feasible anymore. Therefore, researchers are looking for another alternative naming system to represent each physical object.

### 5.5.2.3 Working with IoT Devices

- **Collect and Transmit Data :** For this purpose sensors are widely used they are used as per requirements in different application areas.
- **Actuate device based on triggers produced by sensors or processing devices:** If certain conditions are satisfied or according to user's requirements if certain trigger is activated then which action to perform that is shown by Actuator devices.
- **Receive Information:** From network devices, users or devices can take certain information also for their analysis and processing purposes.
- **Communication Assistance:** Communication assistance is the phenomenon of communication between 2 networks or communication between 2 or more IoT devices of same or different networks. This can be achieved by different communication protocols like: MQTT, Constrained Application Protocol, ZigBee, FTP, HTTP etc.




Three-layer Internet of Things (IoT) architecture. The data is collected through the sensing layer and transferred over the network layer to servers and databases in the application layer. Users connect to the system over the cloud.

### 5.5.2.5 Characteristics of IoT :

- Massively scalable and efficient
- IP-based addressing will no longer be suitable in the upcoming future.
- An abundance of physical objects is present that do not use IP, so IoT is made possible.
- Devices typically consume less power. When not in use, they should be automatically programmed to sleep.
- A device that is connected to another device right now may not be connected in another instant of time.
- Intermittent connectivity – IoT devices aren't always connected. In order to save bandwidth and battery consumption, devices will be powered off periodically when not in use. Otherwise, connections might turn unreliable and thus prove to be inefficient.
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## 5.5.2.6 Desired Quality of any IoT Application

**Interconnectivity**

It is the basic first requirement in any IoT infrastructure. Connectivity should be guaranteed from any devices on any network then only devices in a network can communicate with each other.

**Heterogeneity**

There can be diversity in IoT enabled devices like different hardware and software configuration or different network topologies or connections, but they should connect and interact with each other despite so much heterogeneity.

**Dynamic in Nature**

IoT devices should dynamically adapt themselves to the changing surroundings like different situations and different prefaces.

**Self-adapting and self configuring technology**

For example, surveillance camera. It should be flexible to work in different weather conditions and different light situations (morning, afternoon, or night).

**Intelligence**

Just data collection is not enough in IoT, extraction of knowledge from the generated data is very important. For example, sensors generate data, but that data will only be useful if it is interpreted properly. So intelligence is one of the key characteristics in IoT. Because data interpretation is the major part in any IoT application because without data processing we can’t make any insights from data. Hence, big data is also one of the most enabling technologies in IoT field.

**Scalability**

The number of elements (devices) connected to IoT zones is increasing day by day. Therefore, an IoT setup should be capable of handling the expansion. It can be either expand capability in terms of processing power, storage, etc. as vertical scaling or horizontal scaling by multiplying with easy cloning.

**Identity**

Each IoT device has a unique identity (e.g., an IP address). This identity is helpful in communication, tracking and to know status of the things. If there is no identification then it will directly affect security and safety of any system because without discrimination we can't identify with whom one network is connected or with whom we have to communicate. So there should be clear and appropriate discrimination technology available between IoT networks and devices.

**Safety**

Sensitive personal details of a user might be compromised when the devices are connected to the Internet. So data security is a major challenge. This could cause a loss to the user. Equipment in the huge IoT network may also be at risk. Therefore, equipment safety is also critical.

**Architecture**

It should be hybrid, supporting different manufacturer's products to function in the IoT network.

As a quick note, IoT incorporates trillions of sensors, billions of smart systems, and millions of applications.

## 5.5.2.6 Applications of IoT:

1**. Smart Home and Office:**

Smart home applications with the use of smart sensors are becoming popular now. Any smart device can be configured and connected to the internet and controlled using a simple mobile application.

A. **Smart Door access control system**

Smart locks and door access systems are one of the most popular and cost-effective solutions of the Internet of Things. Smart locks are easy to implement and control using a web interface or Smartphone application.

B. **Smart lighting for home and office**

Smart lighting is one of the attractive smart home applications using the Internet of Things. In addition to energy saving, it also enables us to manage effectively. Light ambiance can be changed using smart hub devices or smartphone apps.

C. **Automated Gate and garage**

Using smart sensor technology and the Internet of Things, gates and garages can be controlled (operated) conveniently. Once you are about to enter the house or after leaving the premises, you may open or close the gate using mobile devices.

D. **Smart thermostats and humidity controllers**

Smart thermostats are cost-effective and convenient smart-home solutions that can be controlled using an internet connection and smart hub device (or using a Smartphone app).

E. **Traffic Management**

Analyzing traffic over a period of time gives an insight into possible trends and patterns that could occur during peak hours. It will help to inform commuters to take alternative routes to avoid congestion and delay.

F. **Smart lighting on streets**

Smart lighting is an effective solution to save energy in the cities. Smart sensors can detect the presence of people or vehicles in proximity and increase light intensity when someone passes by.

G. **Pollution monitoring and reporting**

Increasing air pollution is one of the challenges we face in growing cities. To solve this issue, smart sensors are deployed across the cities to monitor any changes continuously.

H. **Smart Parking Solutions**

Smart sensors installed in the parking area collect information about the availability of parking slots and update it to the database in real-time. Once the spot is occupied, it will be updated without any delay.

IoT and smart sensor technology enable us to manage this issue efficiently. With a smart waste management system, authorities can predict the amount of waste produced in a particular location, how to process it properly, trigger waste clearance, analyze data for future planning, etc…

Example: smart sensors implemented on trash bins can send alerts to the waste management system once the bin is full (or reached the threshold limit). If the waste quantity in the bin is low, it will not be emptied.

2. **Wearable Devices**

Wearable smart devices were introduced as smart watches around a decade ago, and many more functions have been added since then. Now our smartwatches and wearables are capable of reading text messages, showing notifications of other apps,

tracking location, monitoring workout status, reminding schedules, and continuously monitoring health conditions.

With the Internet of Things, wearable technology can be used beyond these functions. Major smart wearable manufacturers are developing special operating systems and applications dedicated to smart wearable devices.

Many people have shared their stories of how a smartwatch saved their life during an accident and medical emergencies. Life-saving applications make smart wearables one of the most favorite devices among other IoT devices.

Parents can track their child's location; caretakers will get a notification if the patient's vitals are low or blood sugar levels are changing. Using wearable technology, doctors and medical professionals can continuously monitor their patient's body conditions in real time.

Future smart devices like smartwatches and fitness bands will be optimized to perform more functions and connect with other smart IoT devices in the smart home and other applications. Pairing with Smartphone applications will enable these smart wearables to initiate more tasks and get notified promptly.

a) **Future of Wearable Technology**

Future wearable technology will be capable of detecting diseases early and triggering treatment during early stages. Sensitive nano-sensors can detect components in our body fluids (sweat, tears, and saliva) and notify certain physical conditions that could trigger more severe diseases in the future.

Surgical implanted nano-sensors will indicate possible medical conditions (like cancer) that could develop in our body before it become severe. Finding a medical condition in the early stages has more effectiveness in treatment.

## 3. Healthcare

The healthcare industry has been utilizing the possibilities of the Internet of Things for life-saving applications. Starting from collecting vital data from bedside devices, real-time diagnosing process, and accessing medical records and patient information across multiple departments, the entire patient care system can be improved with IoT implementation.

IoT will offer convenience for medical practitioners, improve accuracy in the information (helps to reduce error in the data), increase overall efficiency, and saves time for each procedure.

Doctors can monitor patients' status remotely and suggest necessary procedures when required.

Data loss and mistakes will be reduced to a lower level with IoT devices. Most modern medical devices can be connected to the network, and data can be accessed securely (In the future, all devices will be able to connect to the network).

Round-the-clock patient monitoring is possible with smart IoT devices. Immediate changes in a patient's vitals will automatically notify responsible medical practitioners in real-time.

Doctors can prescribe medicine after assessing patients remotely with the help of smart IoT devices. In many cases, hospital visits may not be required.

Example: Many hospitals are offering telemedicine facilities. Patients can follow up on treatment via video conferencing.

Besides the healthcare systems' efficiency and cost-effectiveness, IoT also offers better patient satisfaction. Overall, the hospital experience will be improved with the implementation of IoT in healthcare.

**4. Autonomous Driving**

Autonomous driving has been evolving with artificial intelligence and smart sensor technology in the Internet of Things. An earlier generation of autonomous vehicles (partial automation) will assist drivers in driving safely, avoiding collisions, and warning about road and vehicle conditions. Examples: cruise control assistance, parking assistance, line changing assistance and efficient fuel /energy management, etc.

As we collect huge amounts of data from thousands of vehicles (using millions of sensors and camera units), AI can predict certain scenarios on the road and help to implement them in the future generation of vehicles for better safety and efficiency.

Self-driving cars and connected car concepts will offer a much safer road experience in the future with the use of the Internet of Things and artificial intelligence (AI). One of the significant components of IoT in automobiles is smart sensors, which continually collect information about the vehicle, road condition, other vehicles, objects on the road, and road conditions.

5. **Agriculture and Smart farming**

There are a lot of challenges in the agriculture and farming industry to produce more crops and vegetables to feed the increasing human population. The Internet of Things can assist farmers and researchers in this area in finding more optimized and cost-effective ways to increase production.

In developed countries, the young generation is not attracted to conventional farming and agriculture. A lack of support staff could lead to productivity; authorities have to find alternative ways to overcome this issue.

- Smart irrigation
- Smart Greenhouse using sensors
- Smart Farming

For example, movement (cow, sheep) from a particular location, age and weight of the individual, and vaccination details can be stored in the database and easily accessed by just scanning the smart tag.

**6. Industrial IoT for manufacturing:**

The manufacturing industry is one of the early adopters of the Internet of Things which entirely changed several stages of a product development cycle. Industrial IoT will help optimize various stages of product manufacturing, such as:

- Monitoring of supply chain and inventory management
- Optimization in product development
- Automate mass production processes
- Quality testing and product improvement
- Improves packaging and management
- Process optimization using data collected from a huge number of sensor networks
- Cost-effective solution for the overall management of factories

**7. Disaster management**

The Internet of Things, with a wide range of smart sensors, allows engineers to build a more effective emergency response system for factories, schools, hospitals, airports, and any other public gathering places. Any emergency situations like a fire outbreak or

flooding will be automatically detected using sensors, and this information is shared with responsible work groups in real time.

A disaster management team can respond effectively within seconds to start recovery operations. With a better preparation plan, a disaster management team can work safely and assist each individual in evacuating safely during an emergency situation.

During an emergency, the fire department, emergency response volunteers, police force, ambulance units, and nearby hospitals will receive an alert about the scenario. An automated warning system improves preparedness and allows authorities to plan and handle any situation immediately.

Some of the common sensors: are smoke detectors, temperature sensors, humidity sensors, CO2 monitoring sensors, and precipitation detectors.

**8. Logistic and fleet management**

Smart logistics is complex since the goods must be handled with greater care and efficiency. Apart from moving from one location to another, service providers have to ensure the perfect condition is maintained during transportation.

Smart sensors capable of connecting to IoT networks continuously monitor the GPS location, temperature, humidity, shock, and tilt angle of the container used for transpiration. Data collected from these sensors are processed and analyzed in a central cloud system.

The logistics team can access this information from anywhere using an internet connection. The movement of the fleet can be monitored in real-time and updated to customers about the progress of delivery.

**9. Smart Grids and energy management**

The smart grid concept is an enhancement of existing power grids with sensors deployed on the transmission lines and individual customer outlets. These sensors help to notify of any failure or abnormality in the line and understand the nature of usage and behavior patterns over time.

These data can be used to find areas of improvement, lossy nodes during transmission, and peak time usage statistics using smart meters and sensors. Energy companies can use this information to improve existing grids and implement new changes during upgrades and thus reduce carbon emissions.

## 10. Big Data Analytics

One of the basic components of big data analytics is the data itself; many organizations consider data as the most valuable asset to grow their business strategies. The source of data could be from anywhere, like machines, the environment, plants, people or even animals.

The Internet of Things uses hundreds of types of sensors designed to collect data from wide range of applications. Huge amounts of data from millions of smart sensors will help big data analytics to improve its decision-making algorithm using artificial intelligence and machine learning.

For example, autonomous driving technology needs a lot of data from many sensors embedded in the vehicles. These smart sensors collect the behavior of the engine, field data, maps, and camera feeds to improve self-driving algorithms to handle any situation that could occur while driving.

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