

10

Emerging Trends

Outline

10.1 Introduction

The rapid growth of technology is not at all surprising but what surprises is the rate the technology is growing and evolving, impacting our lives in a way no one could have imagined some decades ago. Today, you can listen to news or play your favourite music without getting up from your place, by just giving spoken instructions. Based on your preferences or search history, your online shopping store recommends products for you and you are surprised with their thoughtful matching choices, no ? All this and much more, is possible because of modern age technologies.

In this chapter, we shall talk about some recent trends in computing and information technology. So, let us begin.

- 10.1 Introduction
- 10.2 Artificial Intelligence
- 10.3 Robotics
- 10.4 Big Data
- 10.5 Internet of Things (IoT)
- 10.6 Cloud Computing
- 10.7 Grid Computing
- 10.8 Blockchain Technology

10.2 Artificial Intelligence

Artificial Intelligence (AI) basically refers to the ability of a machine or a computer program to think and learn. In simple words, field of AI revolves around bringing out technologies that help build machines that can think, act, and learn like humans.

An AI based program and technology should bring out these things :

- ⇒ Firstly, it should be able to mimic human thought process and behavior *e.g.*, learning from mistakes, catching up with new ideas, learning new things from new exposure, past experiences (this ability is called **heuristics**.) etc.
- ⇒ Secondly, it should act in a human-like way — *intelligent, rational, and ethical, i.e.*, it should be able to take right decisions in ethical ways.

NOTE

Field of AI revolves around bringing out technologies that help build machines that can think, act, and learn like humans.

Thus, modern AI machines are designed and programmed to :

- ⇒ work with minimum human intervention.
- ⇒ create and update knowledge base, which keeps updating.
- ⇒ having heuristic abilities (*i.e.*, to learn from past mistakes, decisions and outcomes).

Most famous example of AI today is **social humanoid robot Sophia**, who has been awarded citizenship of *Saudi Arabia*.

Other common examples of AI today are :

- ⇒ *Siri* or *Alexa* — the personal assistants that have already become the new normal for thousands of people around the globe.
- ⇒ smart home devices like Google's *NEST*,
- ⇒ self-driving cars like those produced by *Tesla*,
- ⇒ online games like *Alien : Isolation*.

ARTIFICIAL INTELLIGENCE

“ Artificial Intelligence (AI) refers to the ability of a machine or a computer program to think, learn and evolve. ”

It is predicted that in coming 5 to 10 years AI will grow tremendously. AI based machines would outperform humans in tasks such as **translating languages, writing school essays, driving trucks** etc. However, more complicated tasks like *operating in place of a surgeon* or *coming out with heart-touching emotional books or bestsellers* etc. will take machines much more time to learn. AI is expected to master these skills in coming decades.

Let us now talk about various AI based technological trends.

10.2.1 Immersive Experience with Extended Reality (XR)

Extended Reality (XR) is an umbrella term that covers all of the various technologies that enhance our senses and gives us immersive experience. It includes technologies *Virtual Reality (VR), Augmented Reality (AR)* and *Mixed Reality (MR)* technologies. Let us learn about these technologies.

10.2.1A Virtual Reality (VR)

You must have seen 3D movies. Don't you feel that everything is happening in front of you, everything is real. For example, if in a 3D movie, a shot has train coming fast straight unto you, chances are that you may scream as it will feel real to you. Here things appear real but everything is pre-scripted and pre-shot, you cannot alter things interactively.

Virtual Reality is the next level of this. Here a user experiences a real world like environment in a virtual environment with the help of some digital equipment but one can change the look and feel of it interactively too. Please note that for virtual reality a 3D virtual environment is simulated which is generated and reproduced by the CPU of a specially designed VR device.

Virtual Reality makes it possible for users to interact with a virtual environment with multiple senses (as many senses as possible), including *sight, hearing, touch*, and sometimes even *smell and taste*. This is called **sensory synchronicity**.

A VR experience is made possible generally with devices like : *VR headset or helmet, instrumented and sensory VR glove(s) and instrumented and sensory VR bodysuit*.



Consider some examples of virtual reality :

- ❖ You are Ski player and want to participate in coming Ski Race. But you live in a place where there is not enough snow and matching terrain where you can practice. A company in your city helps you practice this with its VR setup and you get ample practice.
- ❖ Modern military training camps enable real fight and combat situations through VR environment.
- ❖ Pilots can learn and practice flying of the aeroplanes through VR environments.

and many more such applications.

10.2.1B Augmented Reality (AR)

Have you heard of the mobile game 'Pokémon Go' ? You simply walk around with the game app open on your phone, which will buzz when Pokémon are nearby, which you can catch using the *Pokémon Go* game app. But have you wondered – how come the Pokémon (virtual, scripted, animation characters) are nearby in your surroundings ?

VIRTUAL REALITY

“ **Virtual Reality (VR)** is a technology that allows people to experience and interact with own senses in a 3D virtual environment that appears and feels like a real environment with the use of an electronic equipment. ”

NOTE

Common VR devices popular today are Oculus Rift, HTC Vive, Gear VR, PlayStation VR etc.

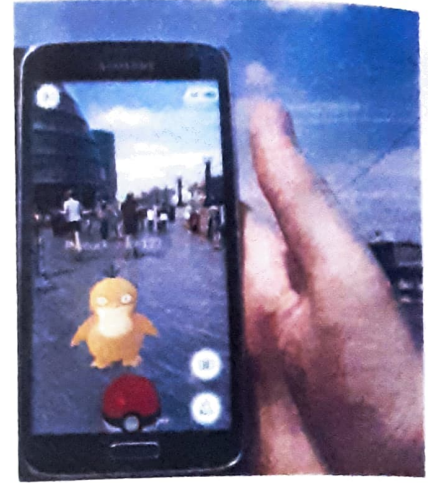
AUGMENTED REALITY

“ The **Augmented Reality (AR)** is a technology that transforms the view of physical real-world environment with superimposed computer-generated images, thus changing the perception of reality. ”

Well, the answer to this is augmented reality wherein the computer generated 3D imagery in the form of Pokémon, is superimposed on your real world.

Augmented reality is a new age technology that expands our physical real world by adding layers of digital information onto it *i.e.*, by adding digitally generated images information etc., on it and thus transforms our view of our surroundings.

Many modern devices already support Augmented reality – digital devices that can support sensors, cameras, accelerometer, gyroscope, digital compass, GPS, CPU, projected displays etc.



Augmented Reality vs. Virtual Reality

While both augmented reality and virtual reality alter our view, augmented reality superimposes the generated imagery and information on our existing physical world and what we view is a mix of real world and the digitally generated imagery/information. Virtual reality, on the other hand, replaces the physical world around us with a virtual world altogether.

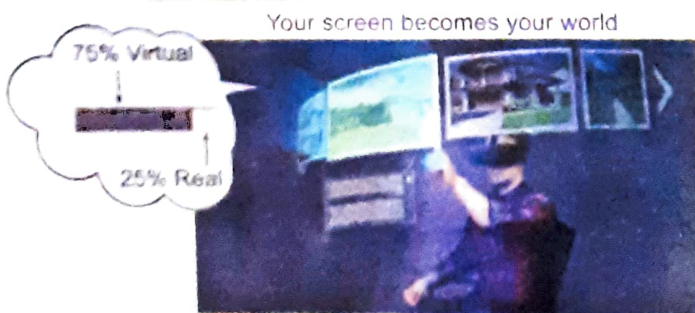
Table 10.1 Augmented Reality (AR) vs Virtual Reality (VR)

Augmented Reality (AR)	Virtual Reality (VR)
Augmented reality is a mix of the real world and the virtual world.	Virtual reality creates an entire virtual world.
It lets people interact with both worlds and distinguish clearly between both.	In this case, it is hard to differentiate between what is real and what is not real.
This is generally achieved by holding a smartphone in front of you.	This is generally achieved by wearing a helmet of goggles.

Following Fig. 10.1 describes the difference between AR and VR.

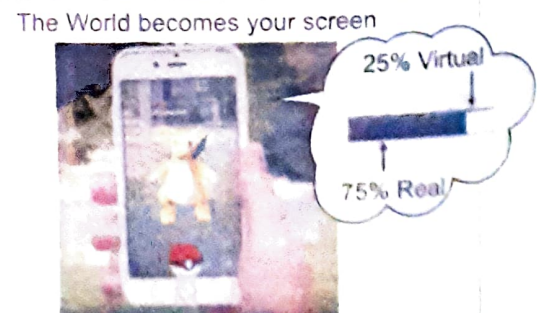
NOTE

In Virtual reality, your screen becomes your world while in Augmented reality, the world is your screen.



VR - Virtual reality is an artificially created world with the help of visual and virtual elements

Virtual reality completely blocks the existing reality - you see a fictional universe created with the help of specialized hardware



AR - Augmented reality refers to the enhanced form of real-world images

Augmented reality includes our existing reality-only with new elements, hints, graphics or characters

Figure 10.1

10.2.1C Mixed Reality (MR)

A combined technology that makes use of both Augmented Reality (AR) as well as Virtual Reality (VR) is called Mixed Reality (MR).

10.2.2 Machine Learning (ML)

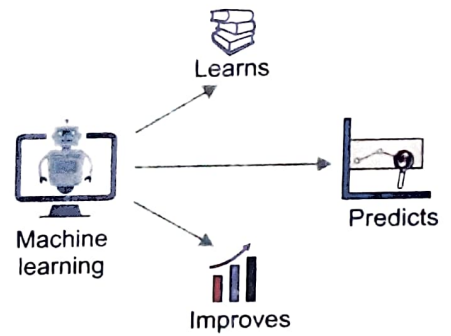
Machine Learning is a sub-area of artificial intelligence, which refers to the ability of computers to independently find solutions to problems by recognizing patterns in databases using statistical techniques. Machine Learning enables computers to recognize patterns on the basis of specific **algorithms** called **models** and data sets and to develop adequate solution concepts. Therefore, in Machine Learning, artificial knowledge is generated on the basis of experience.

MACHINE LEARNING

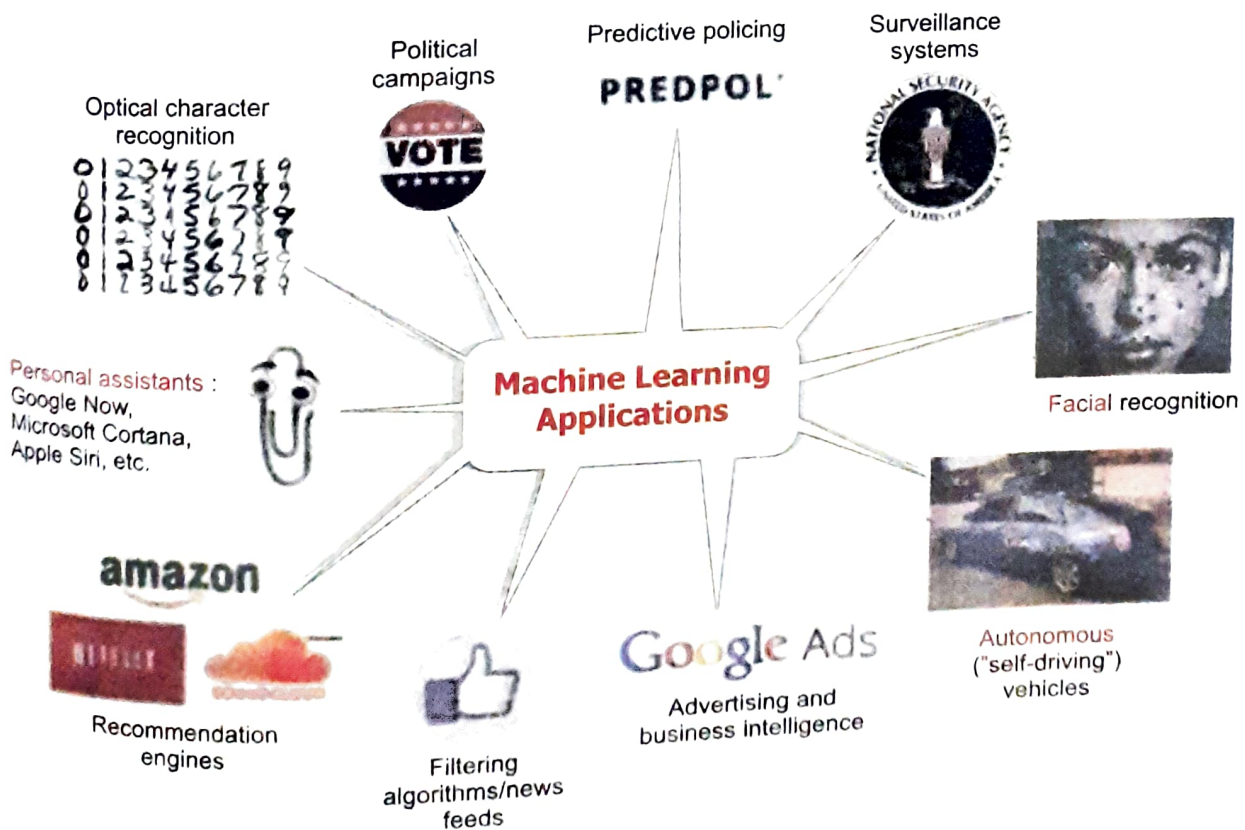
“ Machine Learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed, after initial trainings using test and training data and algorithms. ”

How ML works ?

In a way, Machine Learning works in a similar way to human learning. For example, if a child is shown images with specific objects on them, they can learn to identify and differentiate between them. Machine Learning works in the same way: Through specific data input (**training and testing data**), specific algorithms and certain commands (**models**), the computer is enabled to “learn” (i.e., **trained**) to identify certain patterns and to distinguish between them. With repeated such trainings and feedback, the systems evolve and learn to make predictions.



Following figure lists some common applications of Machine Learning :



ML applications learn from experience (well data) like humans without direct programming. When exposed to new data, these applications learn, grow, change, and develop by themselves. In other words, with Machine Learning, computers find insightful information without being told where to look. Instead, they do this by leveraging algorithms that learn from data in an iterative process.

Machine Learning has found applications in many areas of our lives such as *face recognition*, *online campaigns*, *virtual personal assistants* (like Siri, Alexa, Google Assistant, Cortana etc.), online *chatbots* (virtual chat assistants) and many more.

10.2.3 Natural Language Processing (NLP)

NLP (Natural Language Processing) is a field in machine learning that helps computers understand, interpret and manipulate human language and even potentially generate human language.

A few examples of NLP that you use every day directly or indirectly through computers, are :

- ✦ Spell check
- ✦ Autocomplete
- ✦ Voice text messaging (Speech-to-text)
- ✦ Audio output by computers/voice assistants (text-to speech)
- ✦ Spam Mail Filter
- ✦ Information Extraction (e.g., Gmail structures calendar events from emails)
- ✦ Information Retrieval (Related keywords on search engines)
- ✦ Machine Translation (e.g., Google Translate translates text from one language to another)
- ✦ Sentiment Analysis (e.g., Hater News give the sentiment of the user)
- ✦ Question/Answering (Siri, Alexa, Cortana or Google Assistant).

NLP

“ NLP (Natural Language Processing) is an artificially intelligent technology that helps computers understand, interpret and manipulate human language and even potentially generate human language. ”

In any case, the computer is able to identify the appropriate word, phrase, or response by using context clues, the same way that any human would. Conceptually, it's a fairly straightforward technology.

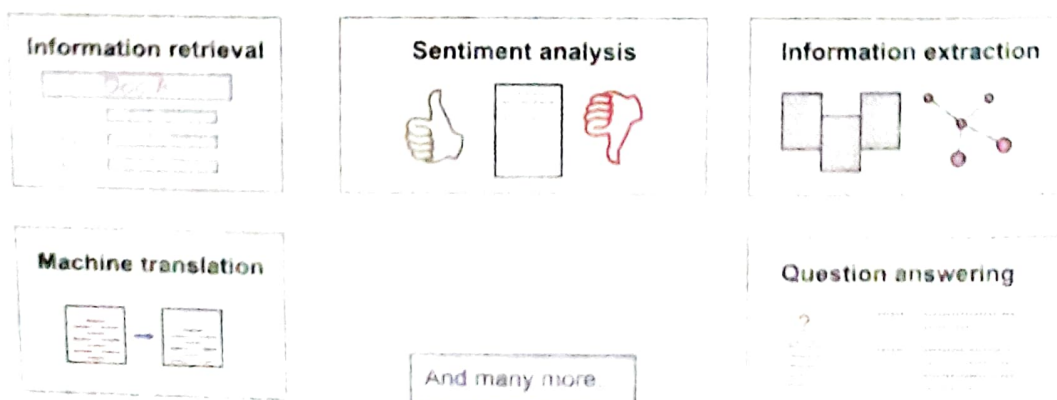


Figure 10.2 Natural Language Processing Applications.

10.3 Robotics

Robotics is a branch of technology that deals with physical robots. Robots are programmable machines that are usually able to carry out a series of actions autonomously, or semi-autonomously. Robots :

- ❖ interact with the physical world via *sensors* and *actuators*, the devices that actually move the robot joints.
- ❖ are programmable.
- ❖ are usually autonomous or semi-autonomous.

Most robots are mechanical and mainly carry out repetitive tasks. But there is a branch of robotics which helps create artificially intelligent robots, which can think and act like humans.

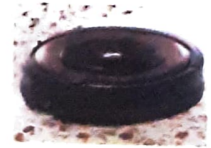
These days robots are being used in many different and diverse fields such as **aerospace** (e.g., **Mars Rover**, which is still collecting images and samples from Mars' surface and **Robonaut**); **household chores** (e.g., house cleaning robots) ; **disaster management** (e.g., Japan's **Packbot**, which inspected damage at the Fukushima Daiichi nuclear power station); unmanned aerial vehicles called **Drones**, which are used for a variety of purposes (filming, videography, journalism, delivery or shipping these days); **industry** (e.g., Amazon's warehouse robots); **Humanoids**, the AI based robots which look and act like humans (e.g., Honda's Asimo, Sophia, the robot etc.) ; to **counter physical disabilities** (e.g., exoskeleton) and many other fields such as education, entertainment and so forth.

NOTE

Robotics is a branch of technology that deals with physical robots.

ROBOTS

“ Robots are programmable machines that are usually able to carry out a series of actions autonomously, or semi-autonomously. ”



10.4 Big Data

What all can you do in a minute ? Write a paragraph; scribble a small email, count till a number and so on. So, the kind of work you can do and data you generate in a minute is easily countable. Now, asking the question again – how much work is done on the Internet and how much data is generated in one minute? As you agree that in one Internet minute, the online activity of billions of people globally takes place and hence billions and trillions of data bytes are generated. Can you imagine that in one *Internet minute*, about 188 millions of emails are sent and Google processes about 3.8 million search queries ? In short, in one *Internet minute*, quintillions of data bytes are generated and exchanged over the Internet.

When such humungous amounts of data are generated, it is termed as big-data.

Big data is a term used to describe extremely large data sets that traditional database applications cannot deal with. Big Data mainly was used as a term to refer to the size and complexity of data sets.

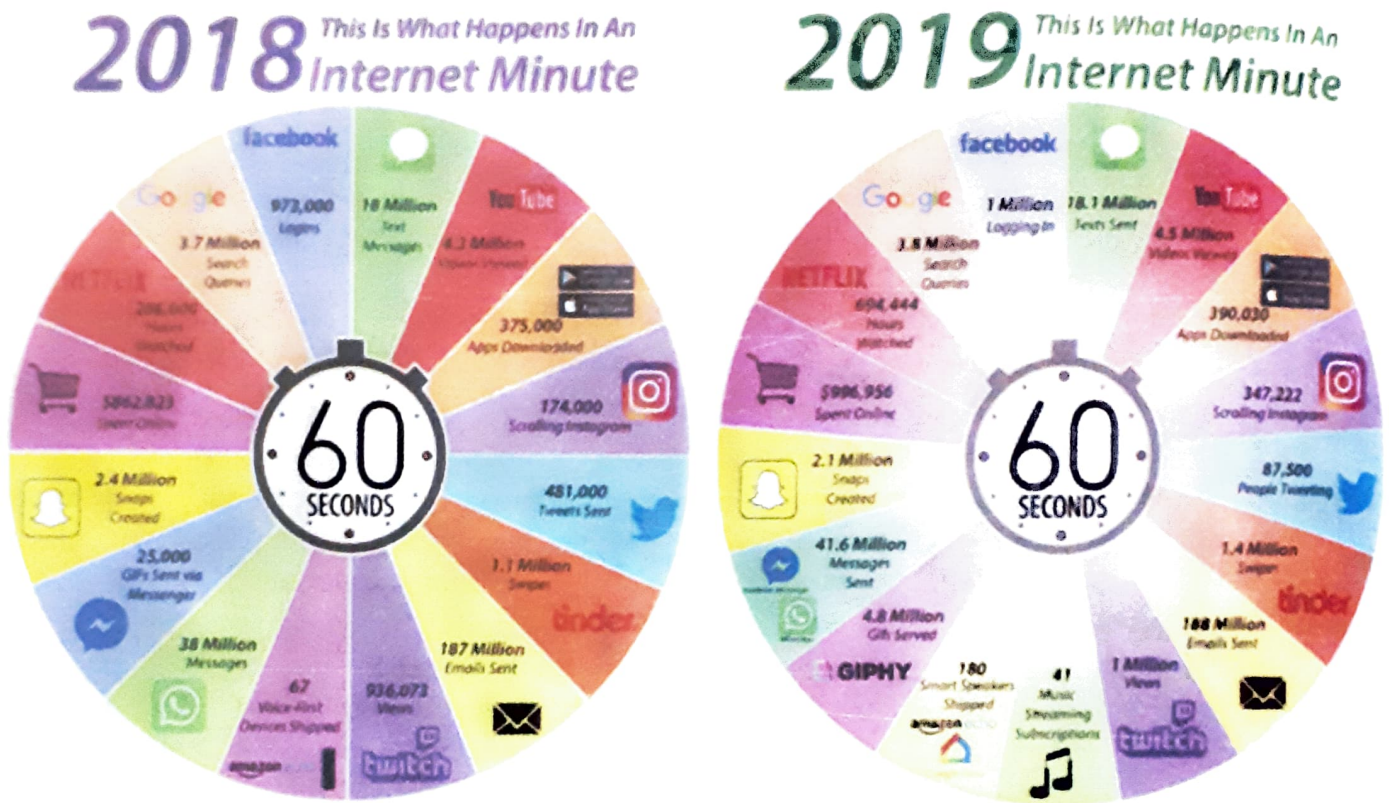
BIG DATA

“ Big data is a term used to describe extremely large data sets that traditional database applications cannot deal with. ”

NOTE

In one Internet minute, quintillions of data bytes are generated and exchanged over the internet.

Following infographic gives you idea about how much data was generated in one internet minute in years 2018 and 2019 respectively.



Source : @LoriLewis
@OfficiallyChadd

Figure 10.3 Data generated in one Internet minute in two different years.

Big data's unstructured nature makes it difficult to analyse the data. Conventional databases are not suited to storing big data because they require the data to conform to a row and column structure. Furthermore, conventional databases do not scale well across multiple servers. Examples of big data include *social media posts*, *communication over the Internet*, continuously monitored banking interactions, data from *surveillance systems* and many others.

10.4.1 Characteristics of Big Data

Characteristics of Big data sets are often defined in terms of :

- Volume.** It refers to the *enormous amount of data generated*. There is too much data for it all to fit in a conventional database & DBMS on a conventional hard drive or even a server. Data has to be stored over multiple servers, each of which is composed of many hard drives.
- Variety.** It refers to the *number of types of data generated*. With big data, along with the traditional structured data types (text, number, currency, Boolean), social media sites have to store a massive variety of unstructured data types (photographs, videos, likes, comments, messages, audio recordings etc.).
- Velocity.** Velocity is the measure of *how fast data is coming in*. It refers to the speed of data processing as the rate of generation of data can be extremely high. Modern social media sites must handle huge volumes of data every day. They must ingest it all, process it, file it, and be able to retrieve it. Data now arrives into servers continually and in real time, and results are only useful if the delay in processing this data is very short.

- (iv) **Veracity.** Data veracity is the *degree of accuracy or truthfulness of a data set*. In the context of big data, it's not just the quality of the data that is important, but how trustworthy the source, the type, and processing of the data are. **High veracity data** has many records that are valuable to analyze and that contribute in a meaningful way to the overall results. **Low veracity data**, on the other hand, contains a high percentage of meaningless data. The non-valuable in these data sets is referred to as *noise*. An example of a high veracity data set would be data from a medical experiment or trial.
- (v) **Value.** Since there is huge cost involved in the storage and processing of big data, it must become valuable for an organisation. Big data must be stored, processed and analysed in a way so that it gets converted into something valuable and *produces some real valuable Information*.

10.4.2 Data Analytics

Data analytics refers to discovering hidden patterns, trends and preferences, from the data set by employing specialised methods, programs, software and specialised systems. When data analytics methods are applied to big data, it is called big data analytics.

Data Analytics Applications provide a means of analysing these data sets and drawing conclusions to help organisations make informed business decisions, such as targeted marketing, better customer service or identifying new business opportunities. Python also makes available a library called Pandas using which you can apply various data analytics methods and techniques over data sets.

DATA ANALYTICS

“ Data analytics refers to discovering hidden patterns, trends and preferences, from the data set by employing specialised methods, programs, software and specialised systems. ”

10.5 Internet of Things (IoT)

You must have read stories like : “a person was able to monitor his home through his smartphone even while he himself was sitting in another country”; “scientists were able to monitor the progress of a whale who was operated upon and a chip was inserted in her body”; “a car sensor alerted the car owner about low air pressure in tires in time” and so on. All these are nothing but some examples of applications of **IoT**. But what is IoT? Have we discussed that already? No, in a moment, we are going to do this ☺.

The **IoT (Internet of Things)** is a new age technology that allows computing devices (*devices that can be programmed and can connect to Internet such as smart home appliances like smart refrigerators or smart air conditioners, a smart heart monitor chip etc.*), to transfer data over a network like Internet without requiring human-to-human or human-to-computer interaction.

INTERNET OF THINGS

“ The IoT (Internet of Things) is a new age technology that allows computing devices to transfer data over a network like Internet without requiring human-to-human or human-to-computer interaction. ”

Practical applications of IoT technology can be found in many fields/areas today, such as :

- **Health and Fitness.** IoT smart gadgets like *Fitbit, Jawbone, Nike and Misfit* etc. that monitor your heart rate, blood pressure etc. and take action accordingly such as sending emergency messages or updating daily fitness log or contacting appointed doctor etc.
- **Home Security.** There are many home safety and security devices for everyone that enable *video surveillance, motion, temperature and air quality control* to help you protect your family and your home when you're not around.

- ❖ **Transport.** Driverless cars can 'not only' drive on road without drivers but also can be in touch with servers all time.
- ❖ **Shopping.** There are smart refrigerators nowadays that can order for grocery items as soon their quantity in fridge goes below a set level.
- ❖ **Smart Cities.** The IoT technology is main enabler of making 'Smart city' a reality. *Smart surveillance, automated transportation, smarter energy management systems, water distribution, urban security and environmental monitoring etc., are examples of Internet of Things applications for smart cities.*

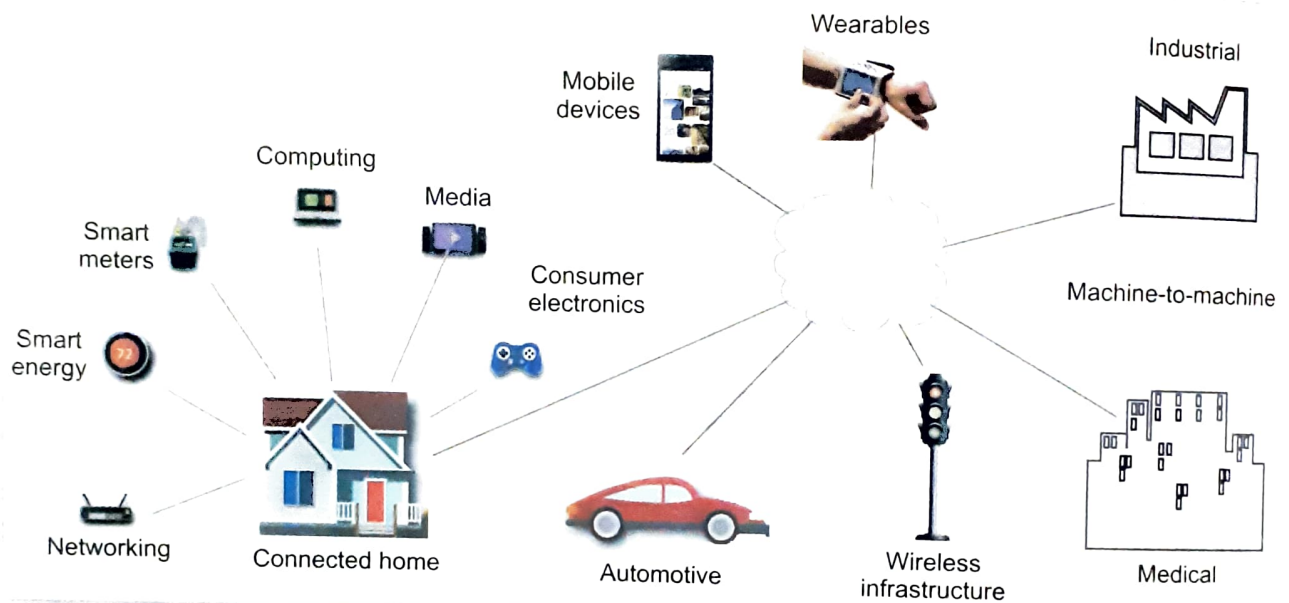


Figure 10.4 IoT (Internet of Things)

10.5.1 Web of Things (WoT)

The Web of Things (WoT) is framework with a vision where everyday's smart devices and objects, (*i.e.*, the objects that contain embedded devices, often called **microcontrollers**), are connected the Web **using existing Web technologies and standards**. That is, no new standards and technologies are developed for WoT. Examples of smart devices and objects are *Wireless Sensor Networks, Ambient devices, smartphones, smart household appliances like smart TVs, smart refrigerators, smart watches etc.*

The main feature of the Web of Things is that it re-uses the existing Web standards to connect the smart devices with the Web. That means, WoT uses the common standards and blueprints (such as URI, HTTP, etc.) of the web to access the functionality of the smart objects and expand their network. Unlike IoT, which requires special sensors or other technology to interconnect.

WEB OF THINGS

“ The **Web of Things (WoT)** is framework with a vision where everyday's smart devices and objects are connected the Web using existing Web technologies and standards. ”

10.5.2 Sensors

We all have access to sensors around us, directly or indirectly. In your school building, smoke sensors are mounted, which raise and alarm the moment some smoke is detected. Today's smartphones can sense the change in direction, your hands near the top, phone near another device and so forth. All these are sensors around us.

Sensors are the devices which measure some physical energy (like temperature or change in director etc.) and convert it into some type of signals. Sensors are used for measuring the physical properties or changes in them, such as Temperature, Resistance, Capacitance, Conduction, Heat Transfer etc.

Different types of sensors that are commonly used in various applications are :

Temperature Sensor (measure change in temperature), **Proximity Sensor** (measures the proximity/position of an object relative to the screen of a device), **Accelerometer** (measure position, motion, tilt, shock, vibration, and acceleration). **Pressure Sensor** (measure the pressure or change in pressure), **Light Sensor** (measure change in the light intensity), **Ultrasonic Sensor** (measure ultrasonic waves), **Smoke, Gas and Alcohol Sensor** (measure the leakage of smoke, gas or alcohol), **Touch Sensor** (sense the position and pressure on a specific position of device), **Colour Sensor** (senses the change in colour), **Humidity Sensor** (senses the humidity changes), **Gyroscope sensor** (senses position, motion, tilt, shock, vibration, and acceleration).

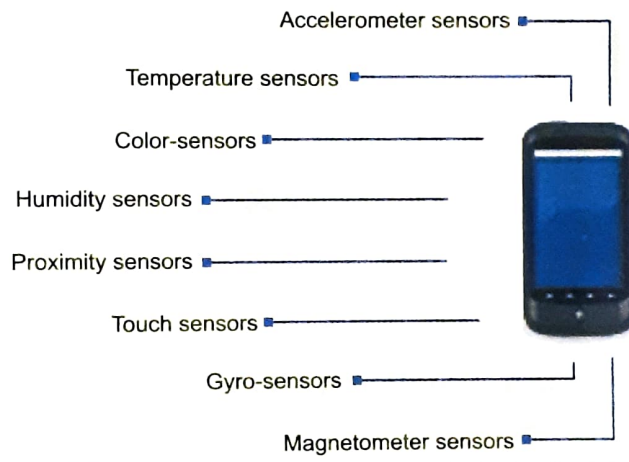


Figure 10.5 Smartphone Sensors

SMART SENSORS

“ **Smart sensors** are intelligent sensors that can convert the measured quantities into digital data, digitally process them, transmit them and can perform some form of decision making. ”

Sensors also play a very important role in Internet of Things (IoT). The sensors of IoT are mainly **smart sensors**. *Smart sensors* convert the real-world quantity that they're measuring into a digital data stream and are able to transmit them wirelessly over a network. The smart sensors have intelligent capabilities such as *wireless communication and being an on-board microcontroller. They are used for analog to digital conversion, digital processing, decision making and two-way communications.*

10.5.3 Smart Cities

A **smart city** is a city that uses technology to provide services and solve city problems. A smart city does things like : improved transportation and accessibility, improved social services, improved quality and sustainability. The main goals of a smart city are to improve policy efficiency, reduce waste and inconvenience, improve social and economic quality, and maximize social inclusion.

A smart city uses digital technology to connect, protect, and enhance the lives of its citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions.

SENSORS

“ **Sensors** are devices which measure some physical quantity (like temperature or change in director etc.) and convert it into some type of signals. ”

SMART CITY

“ A **smart city** is a city that uses ICT and digital technologies along with IoT, to provide services and solve city problems with improved quality and sustainability. ”



Figure 10.6 Smart City

A smart city is a framework, predominantly composed of Information and Communication Technologies (ICT), to develop, deploy, and promote sustainable development practices to address growing urbanization challenges :

- ❖ an intelligent network of connected objects and machines (IoT)
- ❖ data transmission using wireless technology and the cloud
- ❖ cloud-based IoT applications
- ❖ citizens engagement using smartphones and mobile devices, as well as connected cars and homes
- ❖ improved energy distribution
- ❖ streamlined trash collection
- ❖ decreased traffic congestion

10.6 Cloud Computing

Cloud computing is the Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. A basic definition of cloud computing is the use of the Internet for the tasks you perform on your computer for storage, retrieval and access. The "cloud" represents the Internet. Cloud computing is a new name for an old concept: the delivery of computing services from a remote location. Cloud computing services are delivered through a network, usually the Internet.

Figure 10.7 shows you the overview of cloud computing system.



Figure 10.7 Cloud Computing

Characteristics

Cloud computing has following *five* essential characteristics :

1. **On-demand self-service.** Users are able to provision, monitor and manage computing resources as needed without the help of human administrators.
2. **Broad network access.** Computing services are delivered over standard networks and heterogeneous devices.
3. **Rapid elasticity.** IT resources are able to scale out and in quickly and on as needed basis.
4. **Resource pooling.** IT resources are shared across multiple applications and tenants in a non-dedicated manner.
5. **Measured service.** IT resource utilization is tracked for each application and tenant, typically for public cloud billing or private cloud chargeback.

Common cloud examples are : *Google Drive, iCloud, Microsoft Azure, One Drive* etc.

The client consists of hardware and software that access cloud services. The client can be a **thick client** or a **thin client**. A **thick client** refers to a fully functional computer on each desk whereas a **thin client** machine provides just the functionality needed to accomplish the necessary tasks. Examples of *thin clients* include new age smartphones, tablets etc.

CLOUD COMPUTING

“ Cloud computing is the Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. The “cloud” represents the Internet. ”

NOTE

Some freely available public clouds are **Google Drive, Amazon Web Services (AWS)** – Which comes free for trial, free starter plan of **Red Hat Open Shift**.

10.6.1 Cloud Services

Using clouds, many types of services are offered, accessible through clients. There are broadly *three* types of cloud services offered that allow the clients to use an application or a platform or an infrastructure.

Common types of cloud services are being discussed below.

(i) Software as a Service (SaaS)

In this type of service, a complete application is offered to the customer, as a service on demand, the on-demand service. With SaaS, you don't have to worry about the installation, setup and running of the application. Service provider will do that for you. You just have to pay and use it through some client. For example, to use office applications online, to use email services online, sending bulk emails using a software, web conferencing, customer relationship management, project management, invoicing and many more. The Sipo app available with this book also uses some type of SaaS. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.

Examples of commonly available SaaS are : *Google Apps, Microsoft Office 365, Zoho One, Zoho CRM, Salesforce Customer 360* etc.

(ii) Platform as a Service (PaaS)

In this type of service, a development environment is offered as a service, upon which other higher levels of service can be built. PaaS provides the computing platforms which typically include *operating system, programming language execution environment, database, web server*

and so forth. For instance, PaaS can make you available a preconfigured Server and a front end to work on databases. The customer has the freedom to build his own applications, which run on the provider's platform. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySQL and PHP), restricted J2EE, Ruby etc.

Examples of commonly available PaaS are : *AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos.*

(iii) Infrastructure as a Service (IaaS)

IaaS provides basic storage and computing capabilities as standardized services over the network. **IaaS** provides the *computing infrastructure, physical or virtual machines like servers, and other resources like virtual-machine disk image library, block and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks* and so forth. The customer would typically deploy his own software on the infrastructure.

Examples of commonly available IaaS are : *Amazon EC2, Windows Azure, Rackspace, Google Compute Engine* and many more.

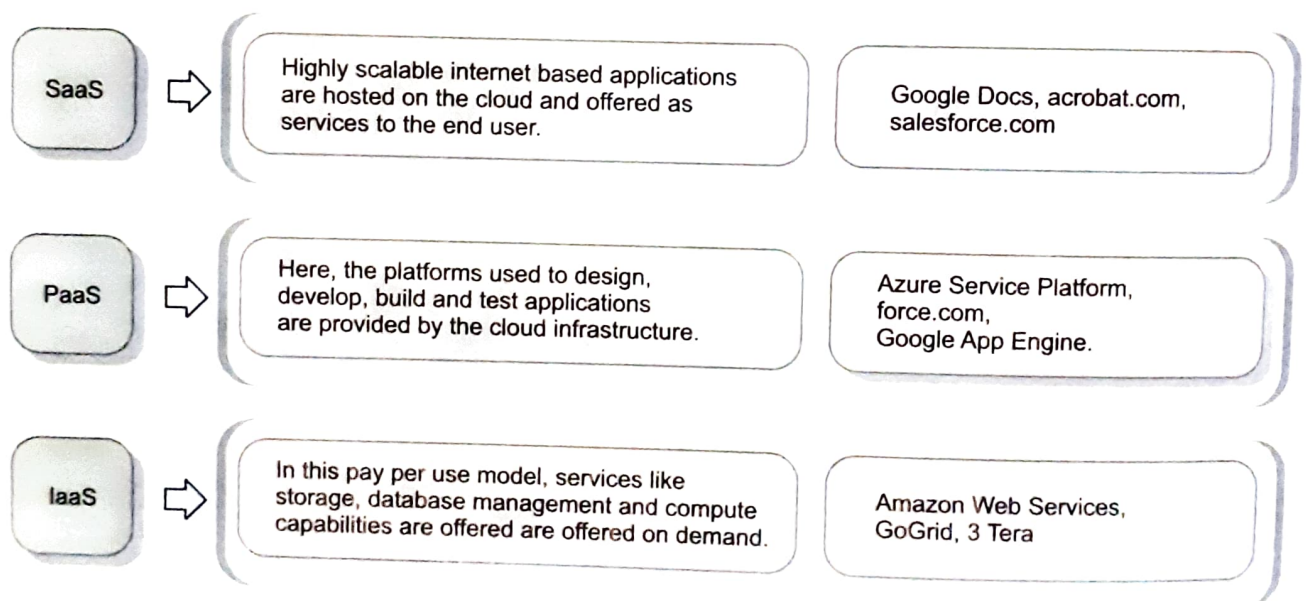


Figure 10.8 Types of Cloud computing services.

10.6.2 Types of Clouds

There are different types of clouds that you can subscribe to depending on your needs. As a home user or small business owner, you will most likely use public cloud services. Enterprises can choose to deploy applications on Public, Private or Hybrid clouds.

1. Private Clouds

A private cloud consists of computing resources used **exclusively owned by one business or organization**. In a private cloud, the services and infrastructure are always maintained on a private network and the hardware and software are dedicated solely to one organization.

Private clouds are often used by government agencies, financial institutions, any other mid- to large-size organizations with business-critical operations seeking enhanced control over their environment. A private cloud, also known as an internal or enterprise cloud, resides on company's intranet or hosted data center where all the data is protected behind a firewall.

2. Public Clouds

Public cloud refers to a **common cloud service** made available to multiple subscribers. The cloud resources (like servers and storage) are owned and operated by a third-party cloud service provider and delivered over the Internet. In a public cloud, you share the same hardware, storage, and network devices with other organizations that use the same cloud, called **cloud "tenants."**

Public cloud deployments are frequently used to provide web-based email, online office applications, storage, and testing and development environments.

Microsoft Azure, Google drive, Amazon Cloud Drive, iCloud etc. are examples of public cloud.

The combination of public and private clouds is called the *hybrid cloud* and the clouds used by a group of related organizations is called the *community cloud*.

10.7 Grid Computing

Grid computing is a distributed computing system formed by a network of independent heterogeneous computers in multiple locations. Grid computing links disparate, low-cost computers into one large infrastructure, harnessing their unused processing and other compute resources.

A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities. The grid links together computing resources (PCs, workstations, servers, storage elements) and provides a mechanism to access them.

Users (or client applications) gain access to computing resources (processors, storage, data, applications and so on) as needed with little or no knowledge of where these resources are located or what the underlying technologies, hardware, operating system and so on.

Grid computing is best suited for applications in which many parallel computations can happen independently, without the need to communicate between processors. In grid computing, each computing task is broken down into smaller pieces and distributed throughout the available computing resources for execution. These pieces are processed in parallel, and as a result, completion is achieved in a smaller amount of time.

In general, a grid computing system requires :

- ❖ At least one computer, usually a server, which handles all the administrative duties for the System.
- ❖ A network of computers running special grid computing network software.
- ❖ A collection of computer software called middleware.

The *two* common types of Grids are :

- (i) **Computational grid (Compute Grid).** Compute Grids allow you to take a computation, optionally split it into multiple parts, and execute them on different grid nodes in parallel. The obvious benefit here is that your computation will perform faster as it now can use resources from all grid nodes in parallel. Some Compute Grid vendors are : **GridGain** (a Professional Open Source), **JPPF** (Open Source).
- (ii) **Data Grid.** Data grids provide an infrastructure to support data storage, data discovery, data handling, data publication, and data manipulation of large volumes of data actually stored in various heterogeneous databases and file systems. Some Data Grid vendors are : **JBossCache** (Professional Open Source), **EhCache** (Open Source).

GRID COMPUTING

“ **Grid computing** is a form of distributed computing that involves the coordination and sharing of geographically distributed networked computational resources. ”

Grid computing is different from cloud services. Where clouds provide services, typically by a single vendor, grid computing focuses on the integration of resources located within different organizations to cater to a common application.

For example, IaaS cloud service, a vendor rents the required infrastructure to the users (specific service) but in grid computing, multiple computing nodes would be joined or integrated together to work upon some common computational problem (one application).

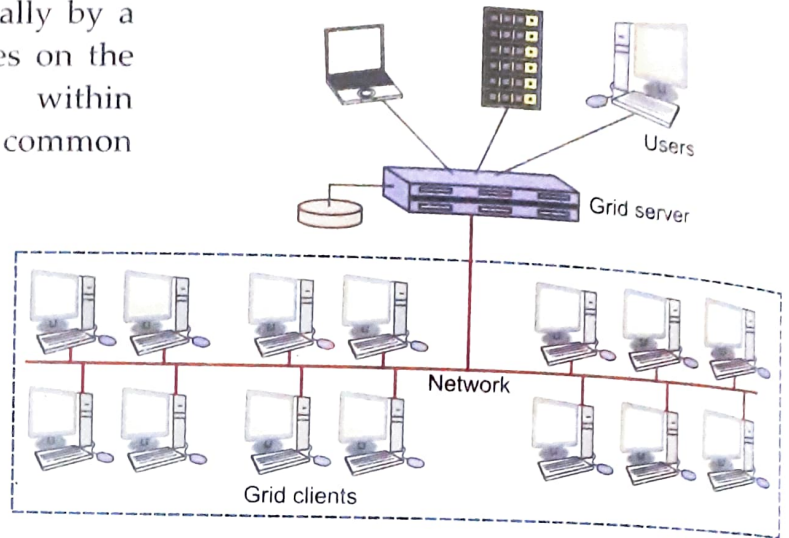


Figure 10.9 Grid Computing

When multiple nodes are joined to form a grid, a special type of grid software, called **middleware** is needed which implements the distributed processor architecture and uses the resources of individual node in optimum way. The middleware grid software takes care of *security, resource management, data management, communication, fault-detection*, and so forth. There are many such software available that help build grids from multiple nodes. One such open source software is the **Globus** toolkit (<http://toolkit.globus.org/toolkit>).

Table 10.2 Grid Computing vs. Cloud Computing

Criteria	Grid Computing	Cloud Computing
Means of utilization	Allocation of multiple servers onto a single application.	Virtualization of servers; one server to compute several tasks or services concurrently.
Typical usage pattern	Typically used for job execution, <i>i.e.</i> , the execution of a program for a limited time (Application Oriented).	More frequently used to support long-running services (Service Oriented).
Task	Single application	Multiple services
Computation service	Maximum computing for one application	On-demand services
Infrastructure	A decentralized system, which spans across geographically distributed sites and lack central control. It normally contains heterogeneous resources, such as hardware/software configurations, access interfaces and management policies	A central computer server with single access point and spans several computing centers, like Google and Amazon, in general contain homogeneous resources. Operated under central control.
Virtualization	Virtualization of data and computing resources	Virtualization of hardware, software and storage platforms.
Example	GridGain, JPPF, JBossCache, EhCache	GoogleDrive, OneDrive, Mobile Office Applications (e.g., Office 365, Google Docs), SharePoint, Microsoft Azure, iCloud, AWS (Amazon Web Services) etc

10.8 Blockchain Technology

A blockchain is a distributed ledger (storing all the transactions) across a peer-to-peer (P2P) network. *Confused ?*. Hmm. Well, don't be ; just read the following hypothetical situation in order to understand the above statement.

Hasan and Nitin were friends since their school days. During their adulthood, they were also doing business together. All their financial transactions took place through ABCXYZ Bank where both Hasan, Nitin and their clients made financial transactions. One day some common client of Hasan and Nitin hacked their financial data from the Bank and forged it. It led to heavy losses and the trust-violation of clients.

After sometime, Hasan and Nitin decided to continue the same business, but this time, they decided that every time a financial transaction would take place, each connected client would get a printed copy of it. So, all connected clients would get printed copies of each financial transaction taking place and thus would have their own copy of ledger containing details of all financial transactions.

Every time a new transaction takes place, all available financial data is compared with the existing ledger ; if they match, the transaction is considered valid. This happens at all clients' ends.

So, if someone tries to forge data, then its data will not match all copies of decentralized, distributed ledger available with all clients and thus will be rejected.

Hasan and Nitin are happy with this secure form of financial transactions and so are their clients.

Now, in the second style of the financial transactions, you can see that

- ❖ the financial transactions' ledger is not at a centralized location like a bank, but is distributed and is available to all connected clients.
- ❖ Every transaction's details (called a **block**) is sent to all the connected clients (peer-to-peer network).
- ❖ Each new block is chained with earlier existing blocks (forming a **blockchain**) to form a distributed ledger.

This style of financial transactions is called the **blockchain technology**. Now read the very first line of this section again. Now, I am sure the confusion is no more there.

Let us now understand the blockchain technology in technical terms.

10.8.1 Blockchain Technology Keyterms

Before we discuss the working of blockchain technology, it is important to know about the key elements involved.

The key elements involved in the blockchain technology are :

- ❖ **Blockchain Technology**. It is a decentralised, digitized, public ledger of each of the online transactions (mostly financial, but not always) occurring among a network of peers. (peer-to-peer network)
- ❖ **Block**. A block refers to a secured data chunk that stores encrypted details of a valid transaction that has occurred online. A block consists of two parts :
 - (i) a **header**, which is public to all and
 - (ii) **private details of transaction**, accessible only to the owner of the block.

- ❖ **Blockchain.** It is the group of linked blocks, which are related to each other and are in a proper, linear chronological order. It stores the complete trail of transactions.
- ❖ **Public ledger.** All confirmed transactions' linked blocks since the first transaction are available in the form of a blockchain called *public ledger*.
- ❖ **Mining.** It is the process of confirming a transaction after validation, and adding it to the *public ledger*.
- ❖ **P2P Network (Peer-to-Peer Network).** The traditional architecture of www is client-server type where the server stores all the information in a centralised database. The P2P network (Peer-to-Peer network) is the type of network used in blockchain technology. It is a distribution network where each participant computer within the network maintains, approves and updates the new entries. Each participant has equal power.

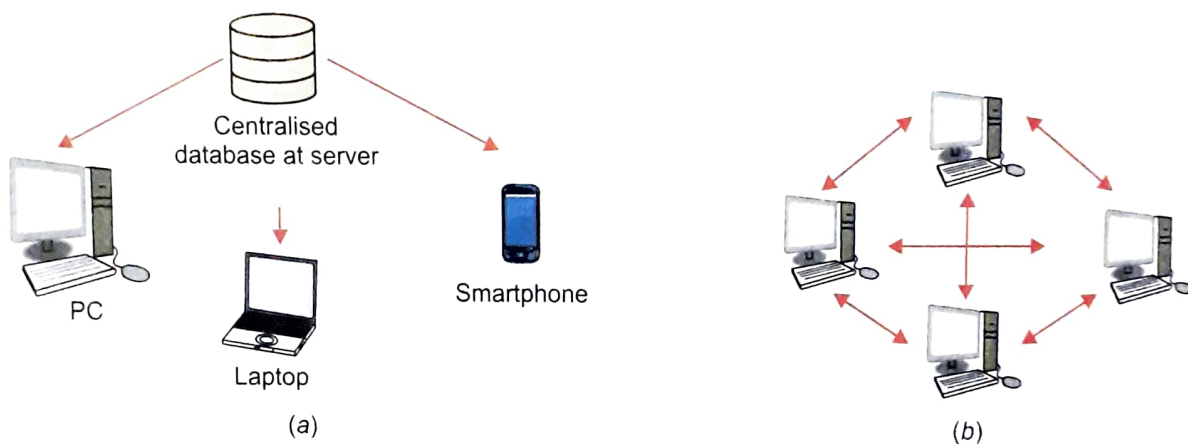


Figure 10.10 (a) Client-Server network architecture of www.
(b) P2P (Peer-to-Peer) network architecture of blockchain technology.

10.8.2 How Blockchain Technology Works

You know that a block is a secure data chunk storing encrypted details (using cryptography) of a valid transaction. A block is created when a user initiates a transaction. It stores the encrypted details of the transaction taking place.

A block gets connected with blockchain as a permanent database only **after validation**. A blockchain contains numerous linked blocks which are related to each other in a proper linear, chronological order.

To see
Blockchain
in action



Scan
QR Code

Each block contains a **hash** of the previous block. Hashing is a strong encrypting mechanism. Hashing not only encrypts, it makes forgery impossible because hashing cannot be reversed. Thus, a blockchain has complete information about different user addresses as well as their balances right from the origins set to the very recent completed block. Every node of the P2P network has access to the blockchain.

The blockchain technology ensures that all transactions are always available since its creation and no transaction can be deleted.

Blockchains have found their applications in *healthcare, voting mechanisms, banking sector, finances, Asset management, insurance claim processing, passports, property registrations* and many more.

Figure 10.11 explains how blockchain technology works.

NOTE

Many people assume that blockchain and cryptocurrency are the same. Blockchain is the underlying technology of cryptocurrency like Bitcoin.

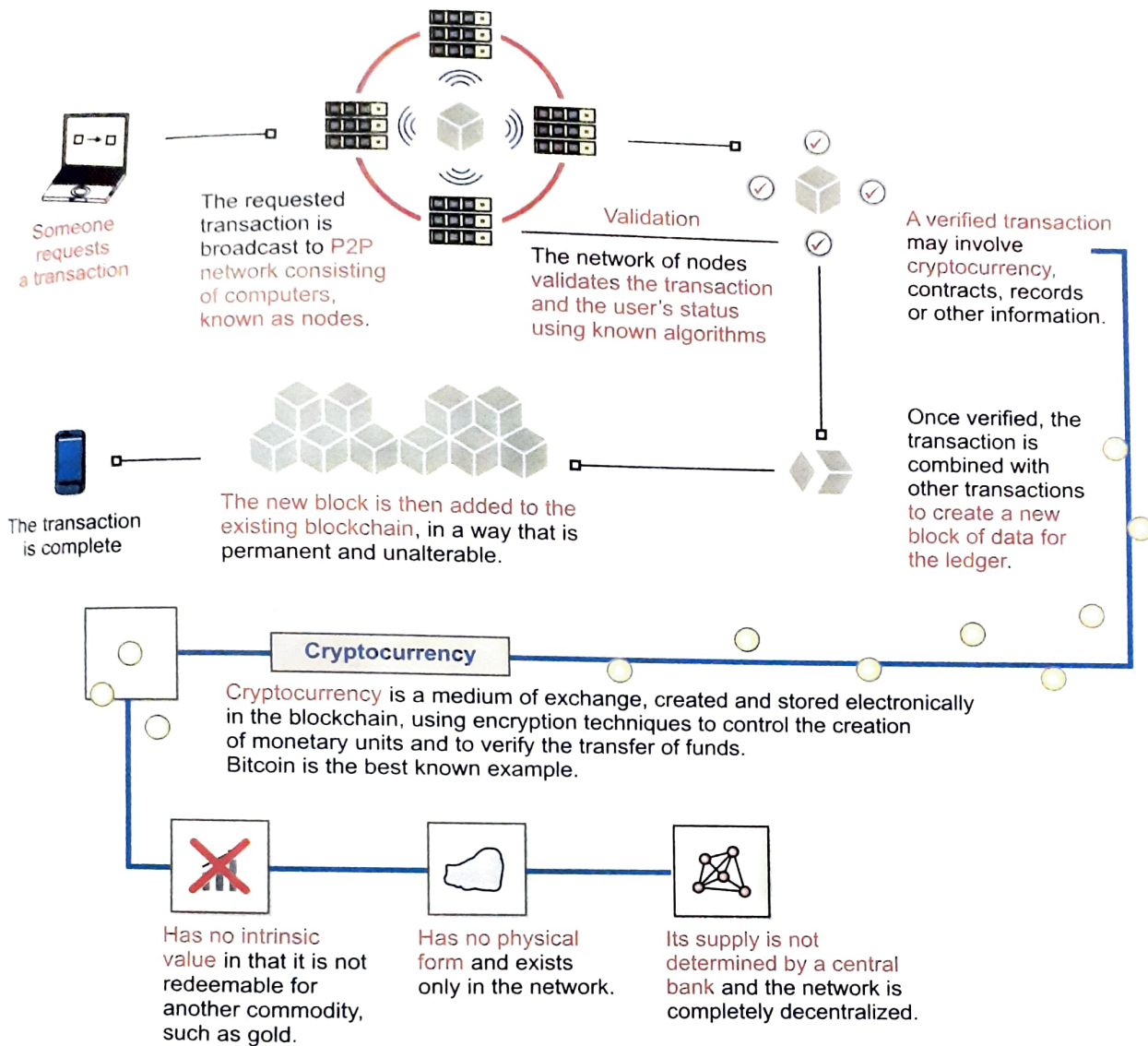


Figure 10.11 How blockchain technology works.

Check Point

10.1

1. Define the terms :
(i) AR (ii) VR (iii) MR (iv) ML (v) NLP
2. Give some examples of NLP applications.
3. What are Robots ?
4. Do all robots use AI ?
5. Name some mechanical robots.
6. Name some AI based robots.
7. What is big data ?
8. Expand the terms : (i) IoT (ii) WoT.
9. How much data is generated in one Internet minute ?
10. What is a cloud ?
11. What is a block ?
12. What is a blockchain ?

Benefits of Blockchain Technology

- ⇒ Increased time effectiveness due to the real-time transactions.
- ⇒ Direct Transactions eliminate the overheads and intermediary costs.
- ⇒ Reduced risks related to cybercrimes, frauds and tampering.
- ⇒ More transparent processes with a proper record creation and tracking.
- ⇒ Highly secure due to cryptographic and decentralized Blockchain protocols.

Blockchains can be of these types :

Consortium blockchains. In a consortium blockchain, the consensus process is controlled by a pre-selected group – a group of corporations, for example.

Semi-private blockchains Semi-private blockchains are run by a single company that grants access to any user who satisfies pre-established criteria.

Private blockchains Private blockchains are controlled by a single organisation that determines who can read it, submit transactions to it, and participate in the consensus process.

Public blockchains. Anyone can read a public blockchain, send transactions to it, or participate in the consensus process. They are considered to be “permissionless.” Every transaction is public, and users can remain anonymous. Bitcoin and Ethereum are prominent examples of public blockchains.

NOTE

Government of India has shown interest in the implementation of blockchain technology for many services like *land registration, tax data exchange, funds transfer, insurance claims settlement* and many more.

LET US REVISE

- ❖ Artificial intelligence (AI) refers to the ability of a machine or a computer program to think, learn and evolve.
- ❖ Virtual Reality (VR) is a technology that allows people to experience and interact in a 3D virtual environment that appears and feels like a real environment with the use of an electronic equipment.
- ❖ Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed, after initial trainings using test and training data and algorithms.
- ❖ NLP (Natural Language Processing) is an artificial intelligence technology helps computers understand, interpret and manipulate human language and even potentially generate human language.
- ❖ Robotics is a branch of technology that deals with physical robots.
- ❖ Robots are programmable machines that are usually able to carry out a series of actions autonomously, or semi-autonomously.
- ❖ Big data is a term used to describe extremely large data sets that traditional database applications cannot deal with.
- ❖ Characteristics of Big Data are **Volume, Variety, Velocity, Veracity and Value**.
- ❖ **Data analytics** refers to discovering hidden patterns, trends and preferences, from the data set by employing specialised methods, programs, software and specialised systems.
- ❖ The IoT (Internet of Things) is a new age technology that allows computing devices to transfer data over a network like Internet without requiring human-to-human or human-to-computer interaction.
- ❖ The Web of Things (WoT) is framework with a vision where everyday's smart devices and objects, are connected the Web using existing Web technologies and standards.
- ❖ Sensors are devices which measure some physical energy (like temperature or change in director etc.) and convert it into some type of signals.
- ❖ Smart sensors are intelligent sensors that can convert the measured quantities into a digital data, digitally process them, transmit them and can perform some form of decision making.
- ❖ Cloud computing is the Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. The “cloud” represents the Internet.
- ❖ Grid computing is a form of distributed computing that involves the coordination and sharing of geographically distributed networked computational resources.
- ❖ Blockchain is the group of linked blocks, which are related to each other and are in a proper, linear chronological order. It stores the complete trail of transactions.
- ❖ Blockchain Technology is a decentralised, digitized, public ledger of each of the online transactions (mostly financial, but not always) occurring among a network of peers. (peer-to-peer network)

Objective Type Questions

O T Q s

Multiple Choice Questions

1. _____ technology makes users feel as if they truly are in a virtual environment.
 - (a) NLP
 - (b) AR
 - (c) VR
 - (d) ML
2. _____ technology is able to take an existing environment and add a layer of virtual information on top of it.
 - (a) NLP
 - (b) AR
 - (c) VR
 - (d) ML
3. _____ is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience, after initial trainings.
 - (a) NLP
 - (b) AR
 - (c) VR
 - (d) ML
4. _____ is an artificially intelligent technology that helps computers understand, interpret and manipulate human language.
 - (a) NLP
 - (b) AR
 - (c) VR
 - (d) ML
5. _____ are programmable machines that are able to carry out actions autonomously.
 - (a) Grids
 - (b) Clouds
 - (c) Robots
 - (d) Robotics
6. Extremely large sets of data are _____.
 - (a) database
 - (b) big data
 - (c) cloud computers
 - (d) none of these
7. Intelligent sensors that can convert and process quantities digital are _____ sensors.
 - (a) Cloud
 - (b) AI
 - (c) Grid
 - (d) Smart
8. Distributed computing system formed by a network of independent computers is _____ computing.
 - (a) Cloud
 - (b) AI
 - (c) Grid
 - (d) Smart
9. What is cloud computing?
 - (a) A Network of computers and printers that is available within an organisation
 - (b) A type of Internet-based computing that provides shared computer processing resources and data to computers and other devices on demand
 - (c) A process of scheduling computer programs to work autonomously.
 - (d) Storage of Data on servers that is accessible by all members of an organisation.
10. Which of these is an advantage of cloud storage?
 - (a) The user has no control over their data
 - (b) Many programs can be run at the same time, regardless of the processing power of your device
 - (c) Accessible anywhere with an internet connection
 - (d) Portability
11. Which of these is an example of cloud storage?
 - (a) Google Drive
 - (b) Microsoft Azure
 - (c) iCloud
 - (d) All of these
12. Which of the following is not a cloud service?
 - (a) IaaS
 - (b) PaaS
 - (c) SaaS
 - (d) DaaS
13. The process of encrypting and decrypting information :
 - (a) Decentralized Application
 - (b) Cryptocurrency
 - (c) Block
 - (d) Cryptography
14. What is Blockchain?
 - (a) It is a decentralised ledger of all transactions across a peer to peer network.
 - (b) It is partially a distributed ledger of some transactions across a peer to peer network overviewed by a central authority.
 - (c) It is a distributed ledger of all transactions across a top down network.
 - (d) It is a technology that enabled the development of all kinds of apps which are overviewed by a centralised network.

15. When a transaction has been confirmed, it means it has been approved by the network and permanently appended to the blockchain in the form of a _____ .
 (a) Block (b) Confirmed
 (c) Circulating Supply (d) Address
16. Which are not the potential applications of blockchain ?
 (a) Voting (b) online gaming
 (c) health records (d) fund transfers
17. A blockchain is secured by _____ .
 (a) PIN code (b) 'hash' code
 (c) password (d) login
18. What does the block in the blockchain consist of ?
 (a) Transaction data (b) A Hash point
 (c) A Timestamp (d) all of these
19. Each block contains the hash of _____ .
 (a) The next block (b) The previous block
 (c) Of each block (d) Of each fork
20. The process of confirming a transaction after validating and adding it to the public ledger is called _____.
 (a) Block (b) hashing
 (c) mining (d) validation
- environment with superimposed computer-generated images, thus changing the perception of reality.
6. _____ is an AI based technology that helps computers understand, interpret and manipulate human language.
7. _____ is a branch of technology that deals with physical robots.
8. _____ means extremely large data sets.
9. _____ is a framework with a vision where everyday's smart devices and objects are connected the Web using existing Web technologies and standards.
10. _____ are the devices which measure some physical quantity and convert it into some type of signals.
11. _____ is a form of distributed computing that involves the coordination and sharing of geographically distributed networked computational resources.
12. _____ computing is Internet-Based computing.
13. IaaS, SaaS, PaaS are the types of _____ .
14. Clouds exclusively used by an organisation are _____ clouds.
15. The clouds used by multiple organisations on a shared basis are _____ clouds.
16. Decentralised, digitized, public ledger of each online transaction, occurring among a network of peers is called _____ .
17. A secured data chunk that stores encrypted details of a valid transaction, is called a _____ .
18. Group of linked blocks in a proper linear chronological order is called a _____ .
19. The process of confirming a transaction after validation, and adding it to the public ledger is called _____ .

Fill in the Blanks

- _____ refers to the ability of a machine or a computer program to think, learn and evolve.
 - The _____ is a new age technology that allows computing devices to transfer data over a network like Internet without requiring human-to-human or human-to-computer interaction.
 - The _____ technology is main enabler of making 'Smart city' a reality.
 - _____ is a technology that allows people to experience and interact in a 3D virtual environment that appears and feels like a real environment with the use of an electronic equipment.
 - The _____ is a technology that transforms the view of physical real-world
- ### True/False Questions
- Immersive reality is a form of VR.
 - Virtual Reality enhances the environment around us.

3. Augmented Reality enhances the environment around us.
4. AI based technology which makes computer learn and improve using test and training data is known as machine learning.
5. NLP is not AI based technology.
6. Robots may or may not be AI based.
7. 2-3 databases together are called big data.
8. When smart devices and objects connect to web using existing web technologies and standards, it is called IoT.
9. When smart devices and objects connect to web using existing web technologies and standards, it is called WoT.
10. Not all sensors are smart sensors.
11. A smart city is a city that uses technology to provide services and solve city problems.
12. Grid computing and cloud computing are the same.
13. Cloud based services consume disk space on your computer.
14. Mobility is one major advantage of the cloud services.
15. The cloud service which makes available a platform on the cloud, is called PaaS.
16. The cloud service which makes available a application/software on the cloud, is called PaaS.
17. The cloud service which makes available an infrastructure on the cloud, is called IaaS.
18. A blockchain technology uses centralised database.
19. A blockchain technology stores the complete trail of transactions as a public ledger.
20. Encrypted details of a single transaction is called a blockchain.
21. Encrypted details of a single transaction is called a block.
22. Whole of a block's data is publically available.
23. A block stores encrypted data and has code of its previous block.

NOTE : Answers for OTQs are given at the end of the book.

Solved Problems

1. What is Augmented Reality ?

Solution. Augmented reality (AR) is a live direct or composite view of a physical, real-world environment superimposed with virtual elements, which have augmented (enhanced) by computer-generated sensory input such as sound, video, graphics or GPS data.

Most popular recent example of augmented reality is *Pokemon Go* game app.

2. How is Augmented Reality different from Virtual Reality ?

Solution. The Augmented Reality enhances the real world view of our world with superimposed technology generate imagery and information. What we view is a mix of real physical world plus digitally generated superimposed imagery/information. We can interact with what we view.

The virtual reality replaces our real world with a different virtual world which is digitally generated that feels like real world and we can interactively participate in it.

3. What is IoT ?

Solution. IoT stands for *Internet of Things*. It is basically a network using which things can communicate with each other using Internet as means of communication between them. All the things should be IP protocol enabled in order to have this concept possible. Not one but multiple technologies are involved to make IoT a great success.

4. What is Artificial Intelligence (AI) ? What are some applications of AI ?

Solution. Artificial intelligence - or AI for short - is technology that enables a computer to think or act in a more 'human' way. It does this by taking in information from its surroundings, and deciding its response based on what it learns or senses. Some application areas of AI are *machine learning, Natural language processing, robotics, business analytics, driverless vehicles* and many more.

5. What is Machine Learning ? What are some applications of machine learning ?

Solution. Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. ML applications learn from experience like humans without direct programming. When exposed to new data, these applications learn, grow, change, and develop by themselves. In other words, with Machine Learning, computers find insightful information without being told where to look. Instead, they do this by leveraging algorithms that learn from data in an iterative process.

Machine Learning has found applications in many areas of our lives such as *face recognition, online campaigns, virtual personal assistants* (like Siri, Alexa, Google Assistant, Cortana etc.), *online chatbots* (virtual chat assistants) and many more.

6. What is NLP ?

Solution. Natural Language Processing (NLP) is the study and application of techniques and tools that enable computers to process, analyze, interpret, and reason about human language. It is used for practical purposes that help us with everyday activities, such as texting, e-mail, and communicating across languages.

7. What is Robotics ? How are Robots useful ?

Solution. Robotics is a branch of science and technology that deals with the conception, design, construction, manufacture, and operation of robots. A robot is a machine which has the ability to carry out complex actions and movements automatically.

Currently, the role of robots is to take over hard and dangerous jobs. Jobs that are repetitive and need great precision are the ones robots are good at. There's no room for human error in these jobs. Since robots are machines and computer-controlled, all the calculations of each movement are accurate.

8. Discuss some characteristics of Big data.

Solution. Some characteristics of big data are :

- (i) **Volume (size of data).** The data cannot be stored, processed, and interpreted by a single computing machine. Volume describes the amount of data generated by organizations or individuals. Big Data is usually associated with this characteristic, *e.g.,* Every day we create 2.5 quintillion bytes of data.
- (ii) **Velocity (Speed of data in and out, generated).** The system should be capable of accessing, storing, and processing this high-speed data. Velocity describes the frequency at which data is generated, captured and shared, *e.g.,* Every 60 seconds 400 hours of new YouTube video shares, 2430555 Instagram likes take place etc.
- (iii) **Variety (Types of data and sources).** The system should be capable of handling all kinds of data. Big data means much more than rows and columns. It means unstructured text, video, audio that can have important impacts on company decisions – if it's analyzed properly in time, *e.g.,* Image, audio, video, text, sensors etc.
- (iv) **Veracity (usefulness/accuracy of data).** The data can either be of questionable quality or lack authenticity. It is prone to noise or bias. It helps to decide "*Is the information is real or false*".
- (v) **Value.** Our ability and needs to turn data into value. So, value may be in the form of Profit, medical or social benefits, customer/employee or personal satisfaction.

9. What is the basic difference between IoT vs WoT ?

Solution. IoT (Internet of Things) is about creating a network of objects, things, people, systems and applications. WoT (Web of Things), tries to integrate the objects, things and people etc. to the Web using existing web standards. While IoT needs a single universal application protocol to integrate the things, WoT reuses and leverages readily available and widely popular Web protocols, standards and blueprints to make data and services offered by objects more accessible.

10. What is Grid Computing ?

Solution. Grid computing is a processor architecture that combines computer resources from various domains to work in tandem to achieve a common objective. In grid computing, the computers dispersed physically, work on a task together in parallel, and thus achieve computing powers of high power computers, sometimes super computer.

11. Write the full forms of these : (i) IaaS, (ii) PaaS, (iii) SaaS, (iv) P2P.

Solution. (i) Infrastructure as a Service (ii) Platform as a Service
(iii) Software as a Service (iv) Peer-to-Peer

12. What is cloud computing ?

Solution. Cloud computing describes the act of storing, managing and processing data online, as opposed to on a physical computer or network. In other words, cloud computing is the delivery of computing services such as servers, storage, databases, networking, software, analytics etc. over the Internet ("**the cloud**").

13. What is a cloud computing service provider ?

Solution. The cloud computing service provider is the company that provides and ensures 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.

14. What is a public cloud ?

Solution. 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. One can access these services and manage their account using a web browser.

15. What is a private cloud ?

Solution. 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 data center. Some companies also pay third-party service providers to host their private cloud. A private cloud is the one in which the services and infrastructure are maintained on a private network.

16. What is PaaS ?

Solution. The full form of PaaS is **Platform as a Service**. It refers to cloud computing services that supply an on-demand environment for developing, testing, delivering and managing software applications. PaaS is designed to make it easier for developers to quickly create web or mobile apps, without worrying about setting up or managing the underlying infrastructure of servers, storage, network and databases needed for development.

17. *What is SaaS ?*

Solution. Full form of SaaS is **Software as a Service**. It is a form of cloud computing used for delivering software applications over the Internet, on demand and typically on a subscription basis. With SaaS, cloud providers host and manage the software application and underlying infrastructure and handle any maintenance, like software upgrades and security patching. Users connect to the application over the Internet, usually with a web browser on their phone, tablet or PC.

18. *What is IaaS ?*

Solution. Full form of IaaS is **Infrastructure as a Service**. It is a form of cloud computing used for delivering a full compute stack — including servers, storage, networking and operating software — as an abstract, virtualized construct.

Like other service-based offerings (Software as a Service, Platform as a Service), IaaS allows users to consume only what they need while offloading complex and expensive management tasks to their provider.

19. *What does blockchain technology do ?*

Solution. Blockchain technology creates a viable, decentralised record of transactions – the distributed ledger – which allows the substitution of a single master database. It keeps an immutable record of all transactions, back to the originating point of a transaction.

20. *What is distributed ledger on blockchain technology ?*

Solution. A distributed ledger is a database of transactions that is shared and synchronised across multiple computers and locations – without centralised control. Each party owns an identical copy of the record, which is automatically updated as soon as any additions are made.

21. *How does blockchain work ?*

Solution. A blockchain records data across a peer-to-peer network. Every participant can see the data and verify or reject it using consensus algorithms. Approved data is entered into the ledger as a collection of “blocks” and stored in a chronological “chain” that cannot be altered.

22. *What is a block and what is its role in a blockchain ?*

Solution. Blocks hold batches of valid transactions that are hashed and encrypted. Each block includes the cryptographic hash of the prior block in the blockchain, linking the two. The linked blocks form a chain, called blockchain.

23. *List some advantages of blockchain technology ?*

Solution. Some advantages of blockchain technology are :

- ▀ Increased time effectiveness due to the real-time transactions.
- ▀ Direct Transactions eliminate the overheads and intermediary costs.
- ▀ Reduced risks related to cybercrimes, frauds and tampering.
- ▀ More transparent processes with a proper record creation and tracking.
- ▀ Highly secure due to cryptographic and decentralized Blockchain protocols.

24. *What is a thing with respect to IoT ?*

Solution. We distinguish two classes of things :

- ▀ Things that are computers including smart phones equipped with communication interfaces.
- ▀ Things that are not computers, but who are associated with computers equipped with communication interfaces.

25. List some examples of NLP in Real Life

Solution.

Information Retrieval (Google finds relevant and similar results).

Information Extraction (Gmail structures events from emails).

Machine Translation (Google Translate translates language from one language to another).

Text Simplification (Rewordify simplifies the meaning of sentences). Shashi Tharoor tweets could be used (pun intended).

Sentiment Analysis (Hater News gives us the sentiment of the user).

Text Summarization (Smmry tool or Reddit's auto TL; DR tool gives a summary of sentences).

Spam Filter (Gmail filters spam emails separately).

Auto-Predict (Google Search predicts user search results).

Auto-Correct (Google Keyboard and Grammarly correct words otherwise spelled wrong).

Speech Recognition (Google WebSpeech or Vocalware).

Question Answering (IBM Watson's answers to a query).

Natural Language Generation (Generation of text from image or video data.)

Guidelines to NCERT Questions [NCERT Chapter 2]

1. List some of the cloud-based services that you are using at present.

Ans. Google Drive, Office Applications like Google Docs, AWS (Amazon Web Services).

2. What do you understand by the Internet of Things ? List some of its potential applications.

Ans. Refer to Solved Problem 3.

Some Practical applications of IoT are : *Health and Fitness, Home Security, Transport, Shopping, Smart cities* etc.

3. Write a short note on the following : (a) Cloud computing (b) Big data and its characteristics

Ans. (a) Refer to section 10.6. (b) Refer to section 10.4.

4. Explain the following along with their applications : (a) Artificial Intelligence (b) Machine Learning.

Ans. (a) Refer to Solved Problem 4. (b) Refer to Solved Problem 5.

5. Differentiate between cloud computing and grid computing with suitable examples.

Ans. Refer to table 10.2.

6. Justify the following statement : 'Storage of data is cost effective and time saving in cloud computing'.

Ans. In cloud computing, the on-demand services are available instantly and one has to pay only for the service and not for the entire infrastructure. Thus, when one avails storage on a cloud, they just pay for the storage they used and not for other infrastructure, hence it is cost-effective. And since cloud services are readily available, these are **time-saving** too.

7. What is on-demand service? How it is provided in cloud computing ?

Ans. On-demand services allow users to use a service instantly as and when required. The cloud services are on-demand services which make available the cloud resources at run time, when and where needed. On-demand cloud services allow end users to use cloud computing, storage, software and other resources instantly and in many cases without limits.

8. Write examples of the following :

(a) Government provided cloud computing platform.

(b) Large scale private cloud service providers and the services they provide

Ans. (a) MeghRaj

(b) DropBox, Google Drive – these provide storage on demand.

9. A company interested in cloud computing is looking for a provider who offers a set of basic services, such as virtual server provisioning and on demand storage that can be combined into a platform for deploying and running customised applications. What type of cloud computing model fits these requirements ?

(a) Platform as a Service (b) Software as a Service (c) Infrastructure as a Service

Ans. (c) Infrastructure as a Service.

10. Which is not one of the features of IoT devices ?

(a) Remotely controllable

(b) Programmable

(c) Can turn themselves off if necessary

(d) All of the above

Ans. (b) Programmable

11. If Government plans to make a smart school by applying IoT concepts, how can each of the following be implemented in order to transform a school into IoT enabled smart school ?

(a) e-textbooks

(b) Smart boards

(c) Online tests

(d) Wifi sensors on classrooms doors

(e) Sensors in buses to monitor their location

(f) Wearables (watches or smart belts) for attendance monitoring

Ans.

(a) **e-textbooks** can be implemented using IoT ready tablets or smartphones.

(b) **Smartboards** can connect to the school's e-content repository and can update about the content usage.

(c) **Online Tests** can be carried out using IoT devices, which can make available the centralised tests and can record students' movements during the test.

(d) **WiFi sensors** on class doors can help create the class network, which can be used by the teachers and students.

(e) **Sensors in buses** enhance security and keep parents and school authorities well-informed

(f) **Wearables** for attendance monitoring will ensure correct and updated attendance records at all times.

12. Five friends plan to try a startup. However, they have a limited budget and limited computer infrastructure. How can they avail the benefits of cloud services to launch their startup ?

Ans. They can use some free services available on public clouds such as Google Drive, AWS (Amazon Web Services) etc.

13. Governments provide various scholarships to students of different classes. Prepare a report on how blockchain technology can be used to promote accountability, transparency and efficiency in distribution of scholarships ?

Ans. Using blockchain, a complete trail of all the scholarships allotted and the allottee's details will be available. Blockchain will ensure that it is available to all the clients and cannot be comprised or forged.

Thus, it will promote accountability, transparency and efficiency in the distribution of scholarships

14. How IoT and WoT are related ?

Ans. Refer to Solved Problem 9.

15. Match the following :

Column A	Column B
(a) You got a reminder to take medication	(i) Smart Parking
(b) You got a sms alert that you forgot to lock the door	(ii) Smart Wearable
(c) You got the sms alert that parking space is available near your block	(iii) Home Automation
(d) You turned off your LED TV from your wrist watch	(iv) Smart Health

Ans. (a) – (iv) ; (b) – (iii) ; (c) – (i) ; (d) – (ii)

GLOSSARY

Augmented Reality (AR)	Technologically generated a real view which is mix of real physical world along with superimposed digitally generated imagery and information.
Virtual Reality (VR)	Technologically generated view which is completely virtual but appears completely real.
IoT	Internet of Things
Internet of Things	Technology that allows computing devices to transfer data over a network like Internet without requiring human-to-human or human-to-computer interaction
Blockchain	It is the group of linked blocks, which are related to each other and are in a proper, linear chronological order. It stores the complete trail of transactions.
Blockchain Technology	It is a decentralised, digitized, public ledger of each of the online transactions (mostly financial, but not always) occurring among a network of peers. (peer-to-peer network)

Assignments

1. What is Artificial Intelligence ? How has it impacted our lives ?
2. Name some fields where AI has found applications.
3. What are new things that AI has made possible ?
4. What is Internet of Things ? What is its utility ?
5. What is Virtual Reality (VR) ?
6. List some uses of VR.
7. Enlist some VR devices.
8. What is Augmented Reality (AR) ?
9. How is Augmented Reality different from Virtual Reality ?
10. What is Mixed Reality ?
11. What is Machine Learning (ML) ?
12. Name some fields of ML applications.
13. Can you explain how ML be used in business ?
14. What is data analytics ? How is it useful ?
15. What is Natural Language Processing (NLP) ?
16. Name some NLP applications.

17. What is Robotics ? Is it related to AI ?
18. What are Robots ? Are all robots AI based ?
19. What is big data ? Can big data be stored in regular databases ?
20. Discuss some characteristics of Big data.
21. What do you understand by 'Low veracity data' ?
22. What is WoT ? Is it related to IoT ?
23. How is WoT different from IoT ?
24. What are sensors ? What are smart sensors ?
25. What is smart city ? Is it related to IoT ?
26. How is private cloud different from public cloud ?
27. What is cloud computing ?
28. List some benefits of cloud computing ?
29. What are different types of clouds available ?
30. Which type of cloud would you use if you do not want to share it with other organisations ?
31. What are different types of cloud services available ?
32. How is IaaS different from PaaS ?
33. What is SaaS ?
34. What is Grid computing ? How is it different from Cloud computing ?
35. What two common types of Grids ?
36. What is middleware ? What is its role in Grid computing ? Name a software used for Grid computing middleware setup.
37. What is blockchain technology ?
38. What is a block and how is it related to a blockchain ?
39. What is public ledger in a blockchain ?
40. What is mining in blockchain technology ?
41. How is the data in blockchain public, yet secured.
42. From the table given below, identity the field(s) of the term/application given, e.g., middleware is a term related to Grid computing.

Choose From : AI, ML, NLP, IoT, Cloud Computing, Grid Computing, Blockchain.

Term/Application	Field
Humanoid	
Drone	
Analysing business data from past records and improving Chatbots	
Virtual Assistants replying verbally	
Refridgerator automatically connecting to Internet	
Smart City	
Files saved on One Drive	
Automatic email sending service	
Utilizing different servers for common application	
Paying through cryptocurrency	