

FUNDAMENTAL OF COMPUTERS & EMERGING TECHNOLOGIES

KCA-101

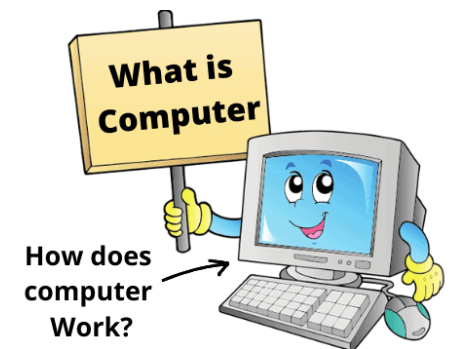
Contents of Unit-1

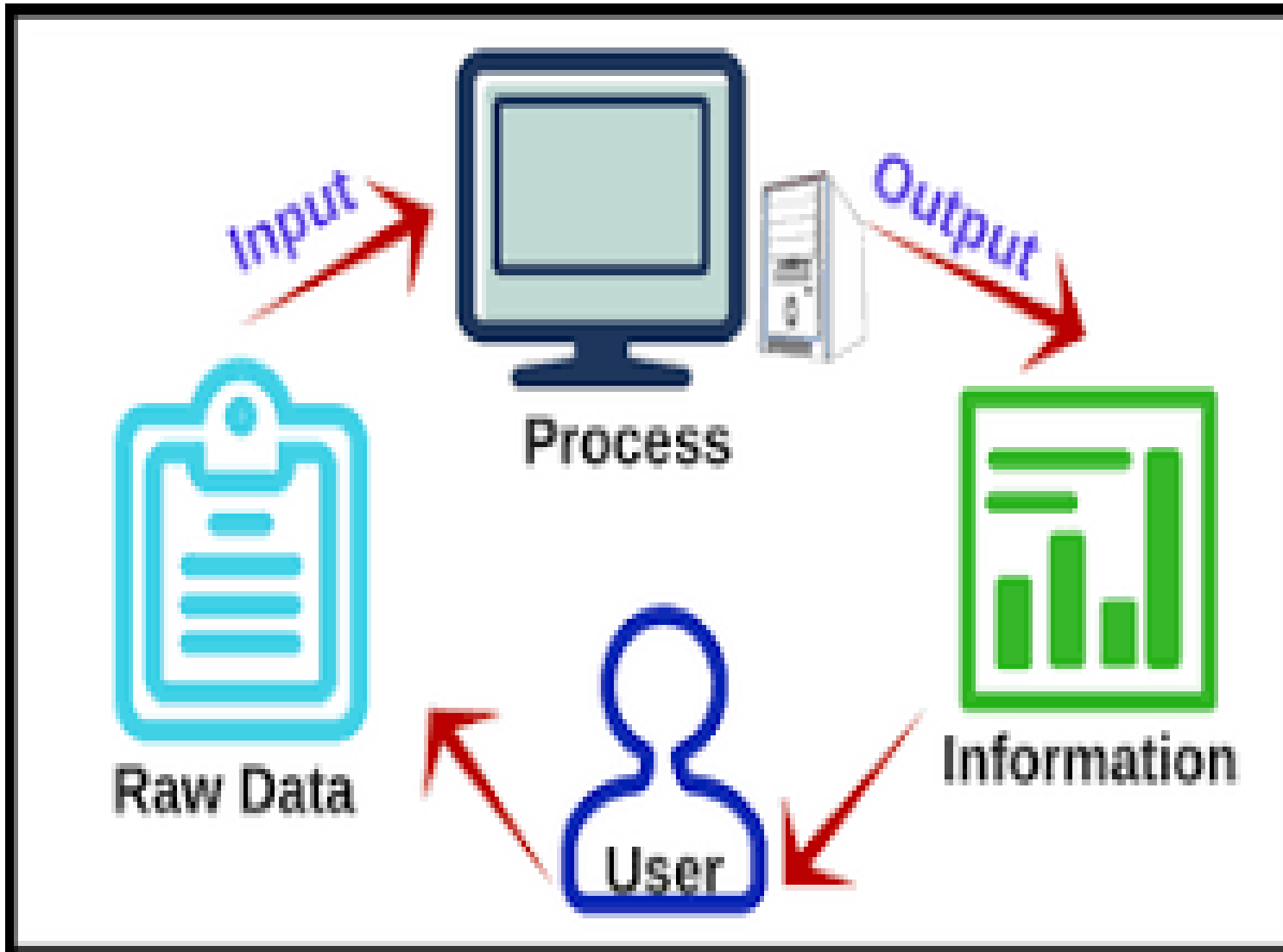
- Introduction to Computer: Definition, Computer Hardware & Computer Software
- Components: Hardware – Introduction, Input devices, Output devices
- Components: Central Processing Unit
- Memory – Primary and Secondary.
- Software – Introduction, Types of Software – System and Application
- Computer Languages: Introduction
- Concept of Compiler, Interpreter & Assembler
- Problem solving concept: Algorithms – Introduction, Definition, Characteristics
- Limitations, Conditions in pseudo-code, Loops in pseudo code

What is Computer?

A computer is a machine that can be programmed to accept data (input), process it into useful information (output), and store it away (in a secondary storage device) for safekeeping or later reuse. The processing of input to output is directed by the software but performed by the hardware.

Technically, a computer is a programmable machine. This means it can execute a programmed list of instructions and respond to new instructions that it is given.





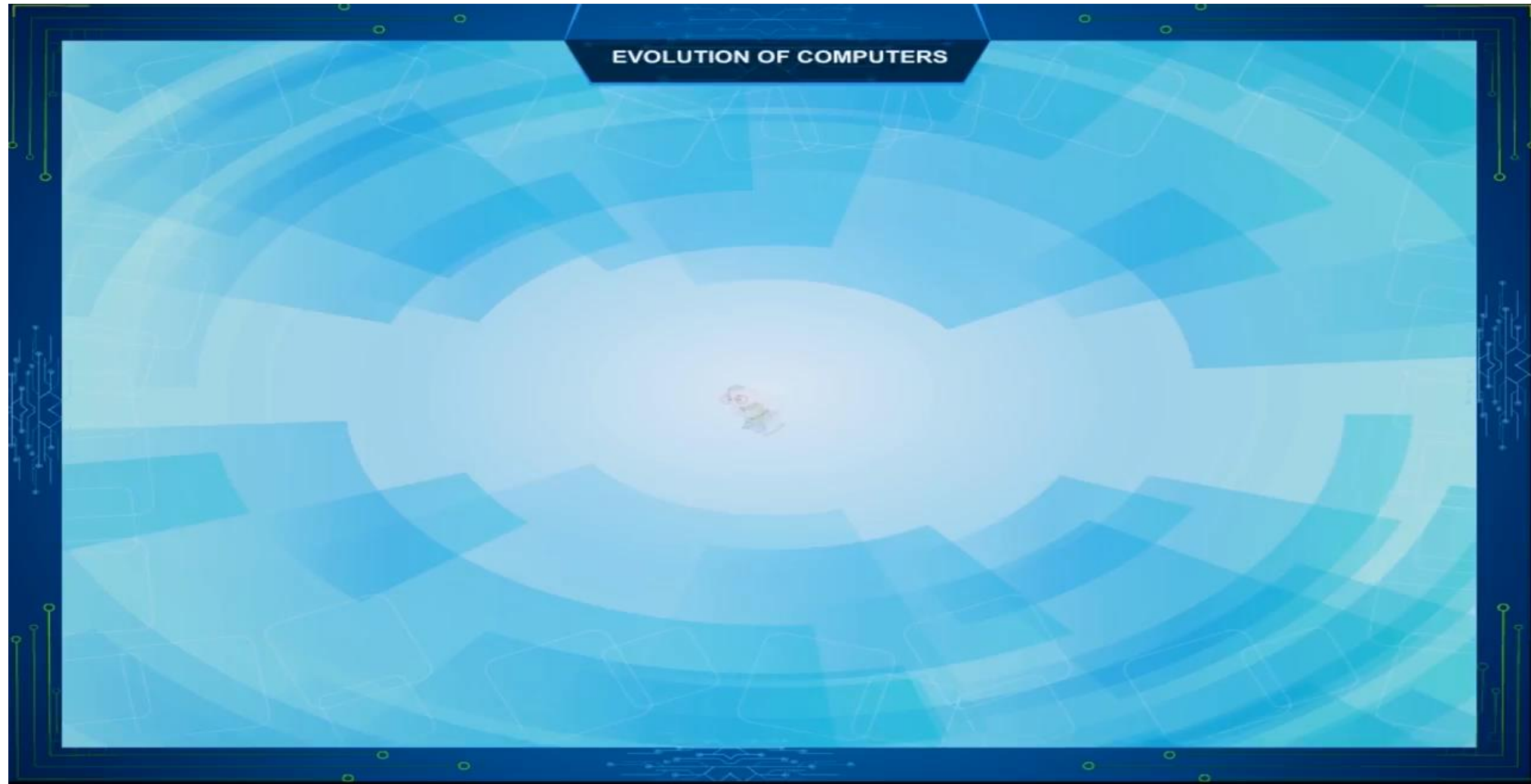
Computer: Information Processing System

DATA is a collection of independent and unorganized facts.

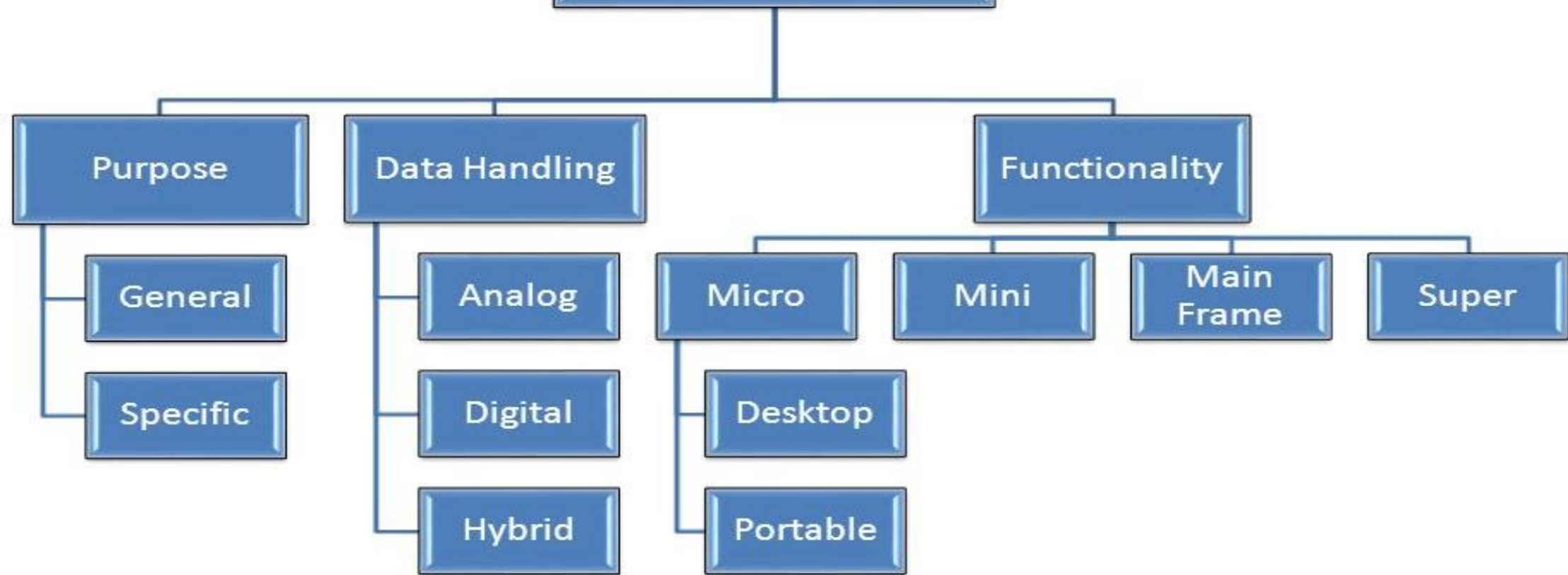
INFORMATION is the processed and organized data presented in a meaningful form.

DATA PROCESSING is the course of doing things in a sequence of steps.

Evolution of Computer



Classification of Computers



General purpose computer: This is the computer designed to solve a wide variety of problems from different fields. The hardware and software of such systems are adaptable for different environments.

Examples:

- Most of the computers used in our normal day to day work are general purpose computers.

Special purpose computer: This is the computer designed for a particular type of application only. It is defined as a stored program digital computer, whose architecture is oriented towards one or more applications.

Examples:

- Computer meant for process control in an industry.
- Computer meant for air traffic control.
- Computer used in robots.
- Computer used for desktop publishing, etc.

S. No.	General-purpose	Special-purpose
1	It is designed to perform variety or task.	It is designed for a specific application
2	It is more versatile.	It is less versatile.
3	It is less efficient.	It is more efficient.
4	Programs are temporarily stored in memory.	Instruction permanently programmed into the memory.
5	It is comparatively slower than special purpose computer.	It is comparatively faster than general purpose computer.
6	Example: microcomputer.	Example: to control traffic lights.

What is Analog Computer?

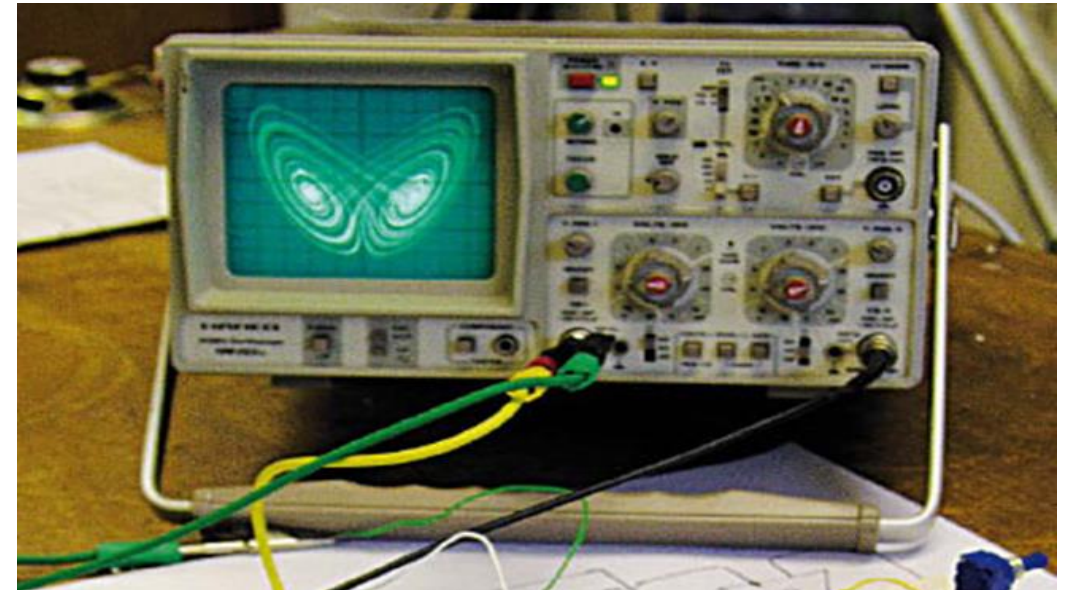
- An Analog computer is a special type of computer which works continuously to form and measure physical quantities such as length, height, and temperature, etc.
- It can store analog data in continuous physical quantities like mechanical motion and electrical potential.
- Example: Analog Computers in Petrol Pump that controls flow of petrol into quality and price.

Characteristics of analog computer

- It depends on continuous data.
- Computers calculate natural and physical data.
- No storage facility.
- Accuracy is very low but faster than digital computers.

Application areas of Analog computer

- Hybrid controller
- Simulation of a spaceship,
- Simulation of a Car-Suspension System
- Telephone lines
- Television
- Analog sound processor
- Resistance of capacitor, etc.



Advantages of Analog Computer

- Real-time operations allow several signal values to be manipulated at the same time.
- Programmers can diagnose and correct problems in real-time.
- Bandwidth use is reduced.
- It produces results at a faster rate.

Disadvantages of Analog Computer

- The dynamic range of computation operations is limited.
- The size of the produced results can consume an excessive amount of setup time.
- More energy is used.
- The rate of signal conversion is higher, as seen within.

What is Digital Computer?

- A digital computer is this type of computer which works on a discrete set of time, number, and figure. Four major parts in Digital Computer are Input, Processing, Output & Memory Devices.
- Digital takes input and gives output within a fraction of a second. It performs logic, arithmetic operations, and processes in digital form (0101)binary digit(number).
- Example: Desktop PC

Characteristics of digital computers

- It works on discrete data.
- Used for general purpose.
- Those computers are reliable, and the accuracy is 100%.
- Large storage capacity.
- Digital Computers are programmable.
- Slower than an analog computer.

Application areas of Digital Computer

- Banking and Financial company
- Education
- Industries
- Entertainments
- Hospital
- Data processing
- Science and Engineering
- Offices

Advantages of Digital Computer

- Many technological, industrial, and economic developments that would not have been feasible without the use of Computer.
- Cost-effective
- more reliable, Flexibility and compatibility
- Digital computer systems can make data storage easier than analog computer systems.
- A digital interface can also be expanded with new functionality more quickly.

Disadvantages of Digital Computer

- To accomplish the same tasks, digital circuits use more energy, resulting in more heat.
- Since a single piece of digital data may be lost or misinterpreted, the value of large blocks of similar data can be completely changed.
- A binary code is used to modify discrete elements of information in a digital computer.
- During analog signal sampling, there may be quantization error.
- The speed of digital computers is lower than analog computers.

What is Hybrid Computer?

- A hybrid computer is a computing system used in a large organization to solve technical, logical, complex differential equations. That has the combined features of both analog and digital computers.
- A hybrid computer is a mix of digital and analog computers that incorporates the best aspects of both. i.e., Analog computers handle complex mathematical computations (problems), and Digital computers handle logical and numerical operations.
- A processor, for example, is located in a petrol pump that transforms fuel flow calculation into quantity and price.
- Similarly, In hospitals, a hybrid computer is used to track a patient's pulse, to measure the heartbeat of patients, etc.

Characteristics of hybrid computer

- Hybrid computers have combined quality of analog and digital computer.
- These computers can process both continuous and digital data.
- These computers have the capacity to convert analog to digital data & vice-versa.
- Hybrid computers are the cost-effective method of performing complex solutions.
- The cost of Hybrid computers is generally high.

Application areas of hybrid computer

- Ultrasound Machine
- Airlines System
- Petrol Pump
- Weather System calculations
- Monitoring Machine



Advantages of Hybrid computer

- A hybrid computer is a combined feature of both analog and digital computers.
- It takes the speed of digital computers and the accuracy of analog computers.
- It helps to solve complex real-time equations.
- It is a cost-effective method of performing complex solutions.
- These computers can convert analog to digital data & vice-versa.
- Process quick and precise.
- On-line data processing.

Disadvantages of Hybrid computer

- It is very costly/expensive.
- Before designing it, proper planning for using software, hardware, and other configurations.

Microcomputers

These are the smallest computers. Their size ranges from a calculator to a desktop. Any computer that has a microprocessor chip as its CPU is called a Microcomputer. It is a single-user computer. Examples: Desktop, Laptop, Smartphone, Tablet, Hybrid, Netbook.

The first microcomputer was the Micral based on intel 8008 chip



Desktop computer



Laptop



Netbook



Hybrid



Tablet



Smartphone

Minicomputers

These are more powerful, faster, have more memory space and larger than microcomputers. These are multi-user computers, which can support up to two hundred users at the same time. It is a smaller computer designed for business applications and services, and can-do time-sharing, batch processing, online processing, etc. These are used in places like banks.

The first Minicomputer was 'Digital Equipment Corporation' with PDP (Programmed Data Processor)and it was priced around USD 120,000.

Example : AS/400 computers, Motorola 68040, MV 1500etc.



S.No.	Micro Computer	Minicomputer
1.	Microcomputer was launched in 1970.	Minicomputer was launched in 1960
2.	It consists of a single microprocessor that performs all the operations.	It consists of multiple processors.
3.	Microcomputers are generally used for learning and fun.	Minicomputers are generally used by companies to accomplish their tasks.
4.	It is affordable and more user-friendly.	It is expensive and less user-friendly.
5.	The speed and performance are slower than minicomputers.	As it consists of a multiprocessor, the speed and performance are faster than a microcomputer.
7.	The storage space is in Gigabyte (GB)	The storage space is in Terabyte (TB).
8.	Minicomputers are mainly used for administrative tasks, word processing, process control, etc.	Microcomputers are mainly used for managing databases, graphics, word processing etc.
9.	Microcomputers are less powerful.	Minicomputers are more powerful.

Mainframe Computers

These are large computers. They are faster and have greater memory space than minicomputers. These are also multi-user computers, capable of supporting hundreds or even thousands of users at the same time. These are used by large companies or government agencies to store large amounts of data in a centralized location. Banks, educational institutions and insurance companies use them to store data about their customers, students and insurance policy holders. They can also act as a server in a network environment



Super Computers

These are the fastest and the most powerful type of computer. These are very expensive, big in size as compared to Mainframe computers. Supercomputers are used for special purposes like weather forecasting, weapons research and development, earthquake studies etc.

In 1960, UNIVAC built the Livermore Atomic Research Computer (LARC), today considered among the first supercomputers, for the US Navy Research and Development Center

Example: Cray-3, Cyber 205, Param



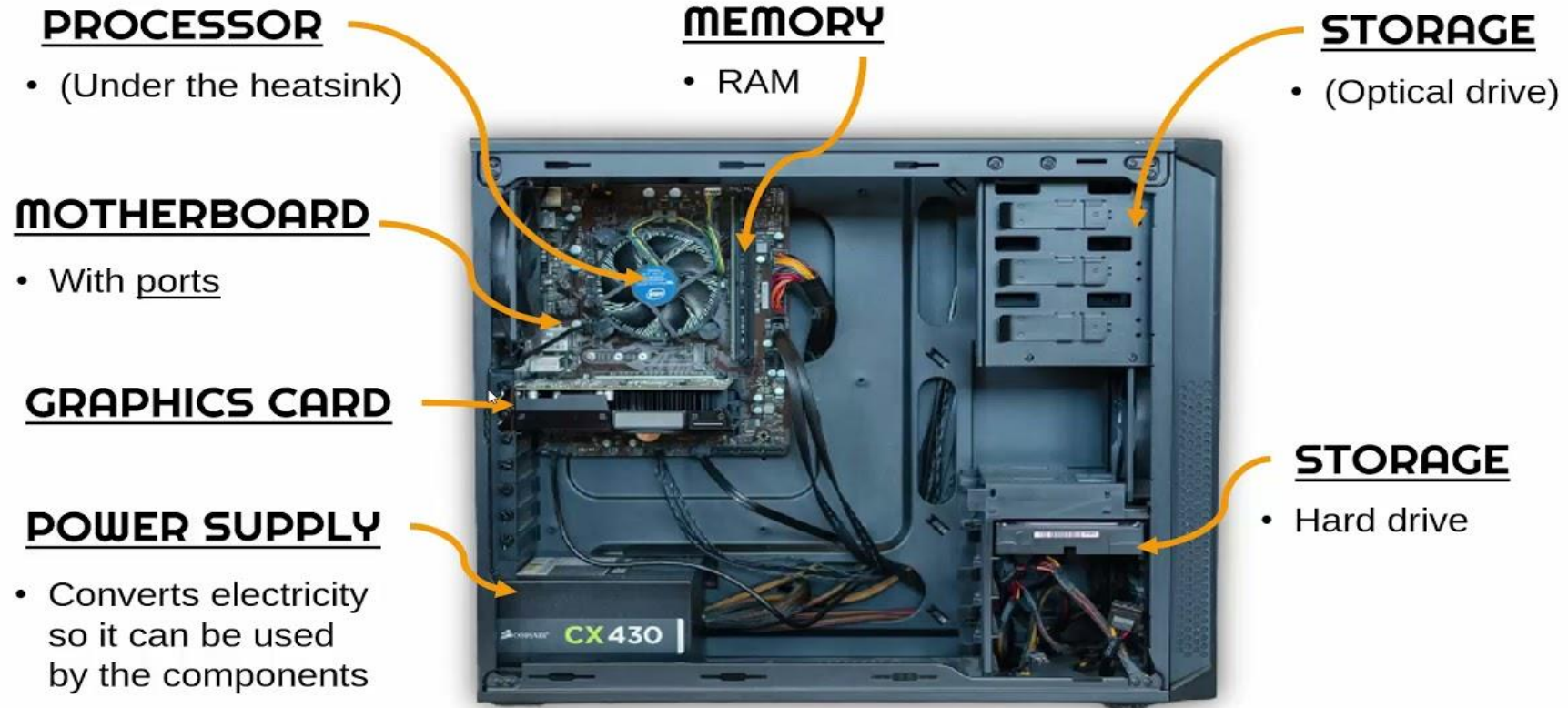
Computer Hardware

Hardware refers to the physical devices or components that are physically connected to the computer. Hardware devices are tangible and help to set up a computer system. Some hardware devices can be touched and seen directly, while others are assembled inside the computer case (like CPU)

Hardware devices or components are usually classified into internal or external hardware, depending on whether we can directly or indirectly see and touch such devices.

Example: RAM is internal hardware while keyboard is external hardware

Computer Hardware Components



Can a computer run without hardware?

Internal Hardware where components are contained within the case

- Motherboard
- Central processing unit (CPU)
- RAM & ROM (computer memory)
- Internal hard drives like HDDs and SSDs
- Disk drives – CD, DVD, Blu-ray, and the long-extinct floppy drive

External Hardware where components are found outside the computer case

- Monitor
- Keyboard
- Mouse
- Speakers
- Printer
- Scanner
- Joysticks, gamepads, and other gaming controllers
- Microphone
- USB flash drive

Components of Internal Hardware



Motherboard

The motherboard is at the center of what makes a PC work. It houses the CPU and is a hub that all other hardware runs through. The motherboard acts as a brain; allocating power where it's needed, communicating with and coordinating across all other components – making it one of the most important pieces of hardware in a computer.

When choosing a motherboard, it's important to check what hardware ports the motherboard supplies. It's vital to check how many USB ports, and what grade (USB 2.0, 3.0, 3.1) they are, as well as what display ports are used (HDMI, DVI, RGB) and how many of each there are. The ports on the motherboard will also help you define what other hardware will be compatible with your computer, such as what type of RAM and graphics card you can use.

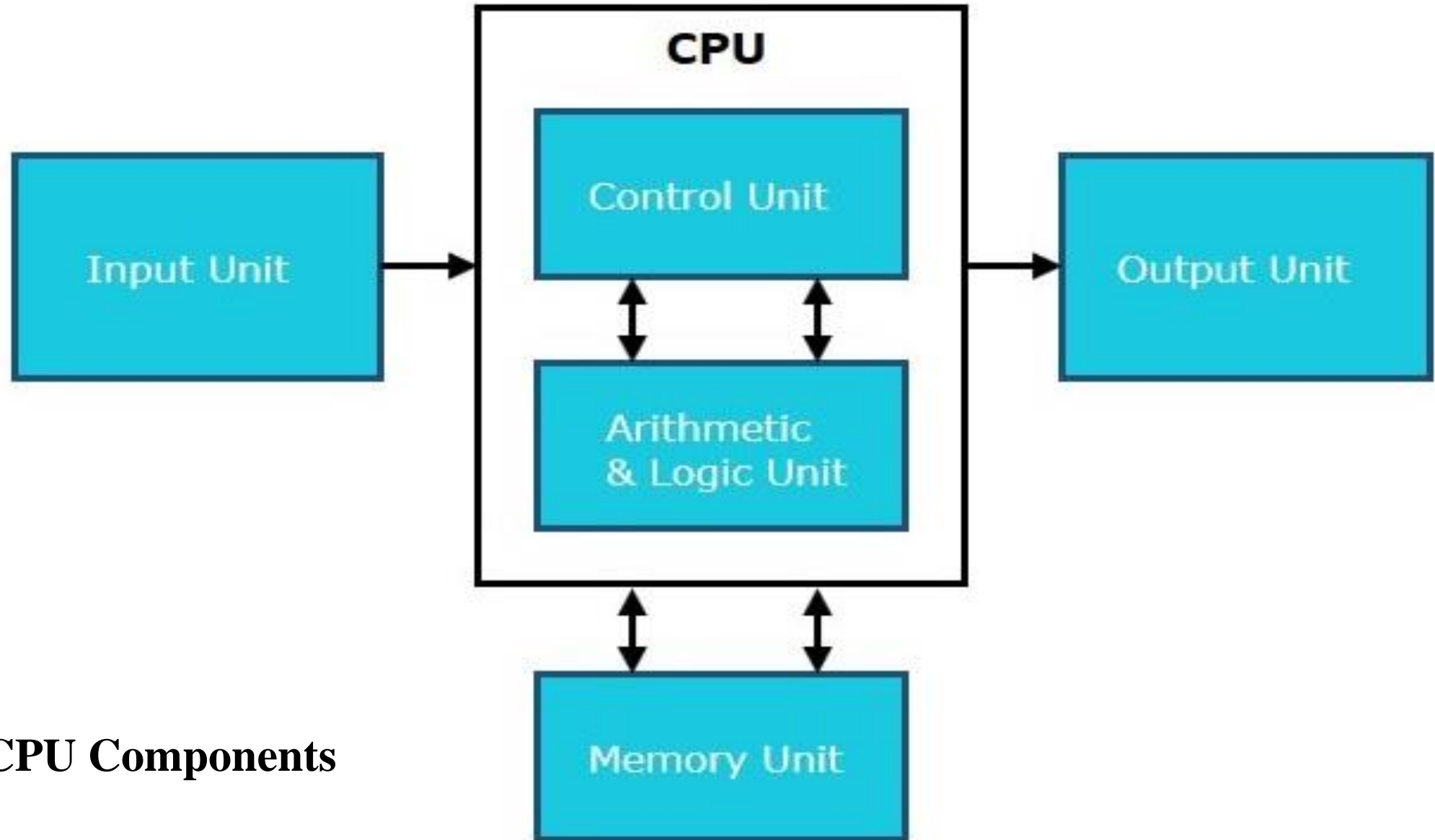
CPU (Central Processing/Processor Unit)

CPU is the brain of the computer. All types of data processing operations and all the important functions of a computer are performed by the CPU. It helps input and output devices to communicate with each other and perform their respective operations. It also stores data which is input, intermediate results in between processing, and instructions.

Now, the CPU consists of 3 major units, which are:

- Memory or Storage Unit
- Control Unit
- ALU(Arithmetic Logic Unit)





CPU Components

Memory Unit

Memory unit can store instructions, data, and intermediate results. The memory unit is responsible for transferring information to other units of the computer when needed. It is also known as an internal storage unit or the main memory or the primary storage or Random Access Memory (RAM) as all these are storage devices. Its size affects speed, power, and performance. There are two types of memory in the computer, which are primary memory and secondary memory. Some main functions of memory units are listed below:

- Data and instructions are stored in memory units which are required for processing.
- It also stores the intermediate results of any calculation or task when they are in process.
- The final results of processing are stored in the memory units before these results are released to an output device for giving the output to the user.
- All sorts of inputs and outputs are transmitted through the memory unit.

A Control Unit (CU) controls the operations of all parts of the computer, but it does not carry out any data processing operations. For executing already stored instructions, It instructs the computer by using the electrical signals to instruct the computer system. It takes instructions from the memory unit and then decodes the instructions after that it executes those instructions. So, it controls the functioning of the computer. It's main task is to maintain the flow of information across the processor. Some main functions of the control unit are listed below:

- Controlling of data and transfer of data and instructions is done by the control unit among other parts of the computer.
- The control unit is responsible for managing all the units of the computer.
- The main task of the control unit is to obtain the instructions or data which is input from the memory unit, interprets them, and then directs the operation of the computer according to that.
- The control unit is responsible for communication with Input and output devices for the transfer of data or results from memory.
- The control unit is not responsible for the processing of data or storing data.

ALU (Arithmetic Logic Unit)

ALU (Arithmetic Logic Unit) is responsible for performing arithmetic and logical functions or operations. It consists of two subsections, which are:

- Arithmetic Section
- Logic Section

Arithmetic Section: By arithmetic operations, we mean operations like addition, subtraction, multiplication, and division, and all these operation and functions are performed by ALU. Also, all the complex operations are done by making repetitive use of the mentioned operations by ALU.

Logic Section: By Logical operations, we mean operations or functions like selecting, comparing, matching, and merging the data, and all these are performed by ALU.

Note: CPU may contain more than one ALU and ALUs can be used for maintaining timers that help run the computer system.

Random Access Memory (RAM)

RAM (Random Access Memory) is the internal memory of the CPU for storing data, program, and program result. It is a read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased. RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure. Hence, a backup Uninterruptible Power System (UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.



RAM is of two types –

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

Static RAM (SRAM)

The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not be refreshed on a regular basis.

There is extra space in the matrix, hence SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher. SRAM is thus used as cache memory and has very fast access.

Characteristic of Static RAM

- Long life
- No need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

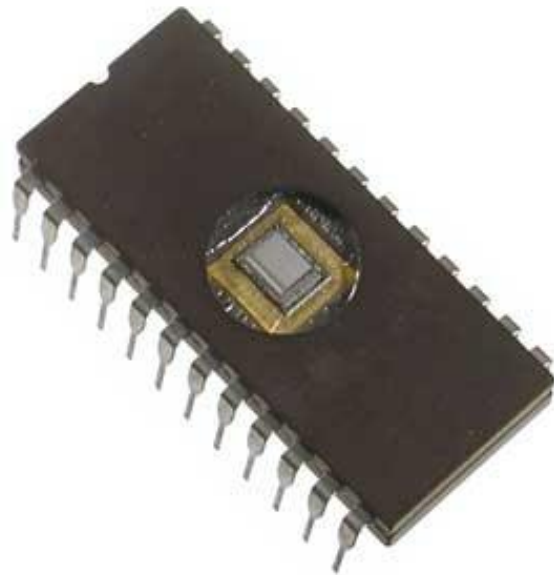
Dynamic RAM (DRAM)

DRAM, unlike SRAM, must be continually **refreshed** in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory as it is cheap and small. All DRAMs are made up of memory cells, which are composed of one capacitor and one transistor.

Characteristics of Dynamic RAM

- Short data lifetime
- Needs to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM
- Smaller in size
- Less expensive
- Less power consumption

ROM stands for **Read Only Memory**. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM stores such instructions that are required to start a computer. This operation is referred to as **bootstrap**. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.



Advantages of ROM

- Non-volatile in nature
- Cannot be accidentally changed
- Cheaper than RAMs
- Easy to test
- More reliable than RAMs
- Static and do not require refreshing
- Contents are always known and can be verified

Types of Read-Only Memory (ROM)

- **PROM (Programmable read-only memory)** – PROM is a computer memory chip that can be programmed once it has been created. The data that is stored in PROM becomes permanent.
- **EPROM (Erasable Programmable read-only memory)** – It can be reprogrammed. The memory chip can be written and erased by exposing it to UV light
- **EEPROM (Electrically erasable programmable read-only memory)** – memory chip that can be reprogrammed and erased by using electricity. An example of EEPROM is flash memory.

Hard Drive

The hard drive is a storage device responsible for storing permanent and temporary data. This data comes in many different forms but is essentially anything saved or installed to a computer: for example, computer programs, family photos, operating system, word-processing documents, and so on.

There are two different types of storage devices: the traditional hard disk drive (HDD) and the newer solid-state drives (SSD). Hard disk drives work by writing binary data onto spinning magnetic disks called platters that rotate at high speeds, while a solid-state drive stores data by using static flash memory chips.



Topic	SSD	HDD
Speed	35 to 100 microsecond access speed, nearly 100 times faster than HDD.	Takes about 5000 to 10, 000 microseconds to access data.
Reliability	SSD has no moving parts, so it can keep your data safe when your laptop bag drops or your system gets shaken while it's operating.	The HDD has moving parts and magnetic platters, so they are prone to get wear and tear with more usage.
Noise	Since SSD comes with no moving parts, it won't make much noise when working.	With spinning platters and moving heads, the HDD will produce noises when functioning.
Heat	No moving parts and using the flash memory, the SSD generates less heat, helping increase the lifespan and durability.	With inside moving parts, more heat will be added and damage the electronics gradually. Higher heat will cause more potential damage.
Power	SSD uses less power, so you can enjoy lower engery bill over time and an increased battery life of an laptop.	HDD costs more power than an SSD, because all the HDD parts are required to spin the platters.
Size	Available in 2.5", 1.8", and 1.0", helping save lots of precious space in computers, especially desktops.	Usually, HDD has only 3.5"and 2.5" size for desktops and laptops respectively, no smaller ones.

A **disk drive** is a physical drive in a computer capable of holding and retrieving information. Below is a list of all the different types of computer disk drives.

CD: A Compact Disc is an optical storage medium that can hold about 670MB. “Optical” means that light is used to read the data from the disk (it is not a magnetic medium).

Types of CD:

- CD-R (Compact Disc - Recordable)
- CD-RW (Compact Disk – ReWritable)

DVD: DVD stands for "Digital Versatile Disk" or "Digital Video Disc". It is a digital optical disc storage format, which is used to store any kind of digital data and is especially used to store photographs, music, and videos. Some DVDs are mainly used to store the videos that can be watched using DVD players, while others may have software programs or computer files.



Blu-Ray: Blu-ray is a digital disc storage format like CD and DVD, which is designed to record and play a huge amount of data with high-definition quality. It can store several hours of videos with high-quality. It is named "Blu-ray" because blue laser is used to read the disc, which enables to store the information at greater density compared to red-laser used in DVD. It is because the blue-violet has a shorter wavelength compared to the red laser, which allows the user to store more information within a smaller area.



Floppy Disk: A floppy disk is a type of storage media that reads data storage information, also known as a floppy diskette, floppy, or floppy disk that is used to store electronic data, like a computer file. It was extremely expensive as it was one of the first types of hardware storage created in 1967 by IBM, which could read/write a portable device.



Components of External Hardware

Monitor

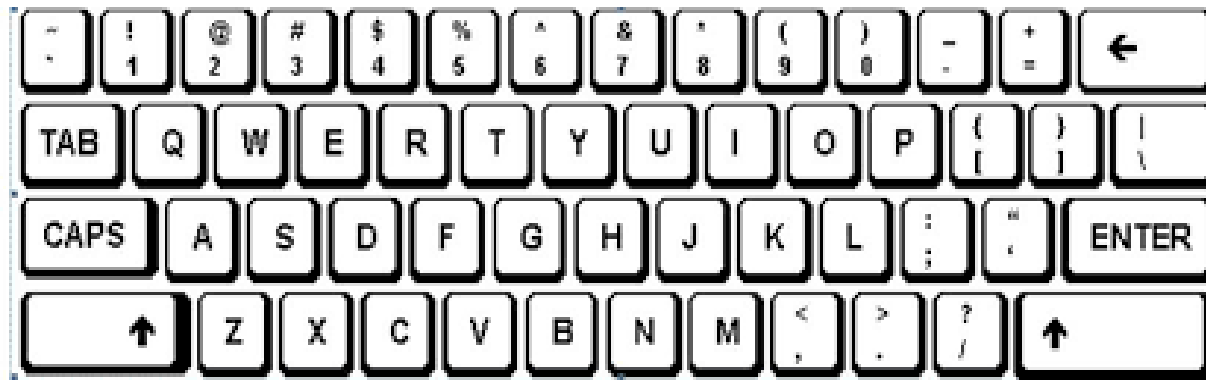
A monitor is an electronic output device that is also known as a **video display terminal** (VDT) or a **video display unit** (VDU). It is used to display images, text, video, and graphics information generated by a connected computer via a computer's video card. Although it is almost like a TV, its resolution is much higher than a TV. The first computer monitor was introduced on **1 March 1973**, which was part of the Xerox Alto computer system.

Types of Monitors

- Cathode Ray Tube (CRT) Monitors
- Flat Panel Monitors
- Touch Screen Monitors
- LED Monitors
- OLED Monitors
- DLP Monitors
- TFT Monitors
- Plasma Screen Monitors

Keyboard

Keyboard is the most common and very popular input device which helps to input data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.



Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

S. No.	Keys & Description
1	Typing Keys: These keys include the letter keys (A-Z) and digit keys (09) which generally give the same layout as that of typewriters.
2	Numeric Keypad: It is used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
3	Function Keys: The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose.
4	Control keys: These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
5	Special Purpose Keys: Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

Mouse

Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

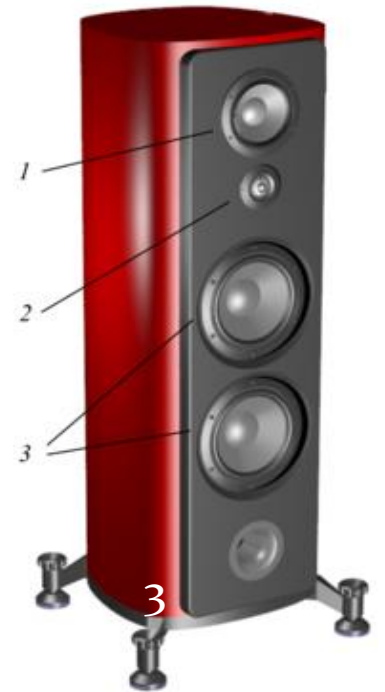


Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.

A **computer speaker** is an output hardware device that connects to a computer to generate sound. The signal used to produce the sound that comes from a computer speaker is created by the computer's sound card.

Types of speakers:

- Subwoofers
- Computer Speakers
- Loudspeakers
- Studio Monitors
- Floor Standing Speakers
- Bookshelf Speakers
- In-Wall/Ceiling Speakers
- Satellite Speakers
- Bluetooth Speakers
- Outdoor Speakers



Printer

A printer is a hardware output device that is used to generate hard copy and print any document. A document can be of any type such as a text file, image, or the combination of both. It accepts input command by users on a computer or on other devices to print the documents. For example, if you have to submit a project report at your college, you need to create a soft copy of your report and print it with the help of the printer.

Types of Printer

- Inkjet Printers
- Laser Printers
- 3D Printers
- LED Printers
- Solid Ink Printers
- Dot Matrix Printers
- Thermal printer
- Plotter



Scanner

A scanner is an electrical device that reads and converts documents such as photos and pages of text into a digital signal. This changes the documents in a form that can be viewed and or modified on a computer system by using software applications. There are numerous kinds of scanners available in the market that have different resolutions.

Types of Scanner:

- Flatbed Scanners
- Sheetfed Scanners
- Handheld Scanner
- Drum Scanner
- Photo Scanner
- Film Scanner
- Portable Scanners



Joystick

A joystick is an input device that is commonly used to control gaming applications and, sometimes, used in graphics applications. It was first invented by C. B. Mirick at the U.S. Naval Research Laboratory and patented in 1926. Generally, the use of a joystick is to manage a machine or character in a computer program. It includes a base and a stick that can be move to the left or right direction, also, it can be rotated in different amounts to handle the movement of the cursor in a computer device. With the help of maneuvering a lever on the joystick, the movement of a pointer or cursor is controlled. They consist of extra buttons for additional functionality and look similar to the control device found on an arcade game. The below image is an instance of a joystick.



Microphone

A microphone is an input device that was developed by **Emile Berliner in 1877**. It is used to **convert sound waves into electric waves** or **input the audio into computers**. It captures audio by converting sound waves into an electrical signal, which may be a digital or analog signal. This process can be implemented by a computer or other digital audio devices. The first electronic microphone was based on a liquid mechanism, which used a diaphragm that was connected to a current- charged needle in a diluted sulfuric acid solution. It was not able to reproduce the intelligible speech.

Types of Microphone:

- Omnidirectional microphone
- Unidirectional microphone
- Close-talk microphone
- Bidirectional microphone
- Clip-on microphone



Universal Serial Bus (USB) flash drive

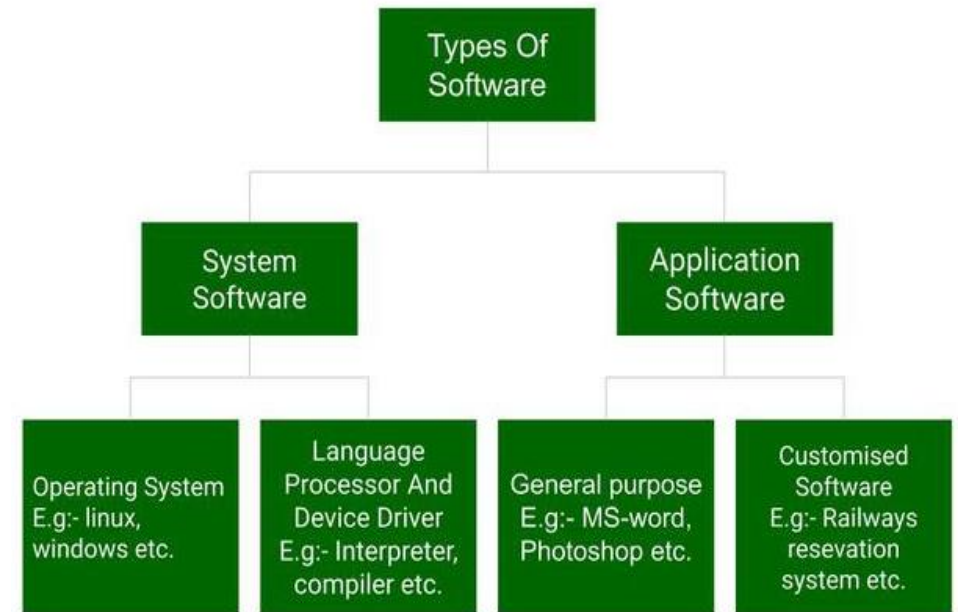
A compact plug-and-play storage system that uses flash storage and is compact enough to connect to a keychain is a USB flash drive, also known as a USB stick, USB thumb drive or pen drive. Instead of a compact disc, a USB flash drive may be used. The machine's operating system identifies the device as a removable drive and assigns a drive letter when a user plugs the flash memory card into the **USB** port.



Computer Software

A set of instructions that drives computer to do stipulated tasks is called a program. Software instructions are programmed in a computer language, translated into machine language, and executed by computer. Software can be categorized into two types –

- System software
- Application software



Can a computer run without the software?

System Software

System software is software that directly operates the computer hardware and provides the basic functionality to the users as well as to the other software to operate smoothly.

System software basically controls a computer's internal functioning and also controls hardware devices such as monitors, printers, and storage devices, etc. It is like an interface between hardware and user applications, it helps them to communicate with each other because hardware understands machine language(i.e., 1 or 0) whereas user applications are work in human-readable languages like English, Hindi, German, etc. so system software converts the human-readable language into machine language and vice versa.

Features of system Software:

1. System Software is closer to the computer system.
2. System Software is written in a low-level language in general.
3. System software is difficult to design and understand.
4. System software is fast in speed(working speed).
5. System software is less interactive for the users in comparison to application software.

Types of System Software

- Operating System
- Device Driver
- Assembler
- Compiler
- Loader

- 1. Operating System:** It is the main program of a computer system. When the computer system ON it is the first software that loads into the computer's memory. Basically, it manages all the resources such as memory, CPU, printer, hard disk, etc., and provides an interface to the user, which helps the user to interact with the computer system. It also provides various services to other computer software. Examples of operating systems are Linux, Apple macOS, Microsoft Windows, etc.
- 2. Language Processor:** It converts programs written in high-level programming languages like Java, C, C++, Python, etc. (known as source code), into sets of instructions that are easily readable by machines (known as object code or machine code).
- 3. Device Driver:** A device driver is a program or software that controls a device and helps that device to perform its functions. Every device like a printer, mouse, modem, etc. needs a driver to connect with the computer system eternally.

Application Software

Software that performs special functions or provides functions that are much more than the basic operation of the computer is known as application software.

Application software is designed to perform a specific task for end-users. It is a product or a program that is designed only to fulfill end-users' requirements. It includes word processors, spreadsheets, database management, inventory, payroll programs, etc.

Features of application software:

1. An important feature of application software is it performs more specialized tasks like word processing, spreadsheets, email, etc.
2. Mostly, the size of the software is big, so it requires more storage space.
3. Application software is more interactive for the users, so it is easy to use and design.
4. The application software is easy to design and understand.
5. Application software is written in a high-level language in general.

Types of application software

- General purpose Software
- Customized Software
- Utility Software

1. **General Purpose Software:** This type of application software is used for a variety of tasks, and it is not limited to performing a specific task only. For example, MS-Word, MS-Excel, PowerPoint, etc.
2. **Customized Software:** This type of application software is used or designed to perform specific tasks or functions or designed for specific organizations. For example, railway reservation system, airline reservation system, invoice management system, etc.
3. **Utility Software:** This type of application software is used to support the computer infrastructure. It is designed to analyze, configure, optimize and maintains the system, and take care of its requirements as well. For example, antivirus, disk fragmenter, memory tester, disk repair, disk cleaners, registry cleaners, disk space analyzer, etc.

System Software	Application Software
It is designed to manage the resources of the computer system, like memory and process management, etc.	It is designed to fulfill the requirements of the user for performing specific tasks.
Written in a low-level language	Written in a high-level language
Less interactive for the users	More interactive for the users
System software plays vital role for the effective functioning of a system.	Application software is not so important for the functioning of the system, as it is task specific.
It is independent of the application software to run.	It needs system software to run.

Basis	Computer Hardware	Computer Software
Type	It is the physical part of the device that takes care of data processing.	It is internal to the computer that uses a set of instructions to command the device for different tasks.
Development	It is made by manufacturing.	It is made by developers and engineers.
Language	Uses binary codes to function.	Relies on high-level programming languages to function.
Function	Monitors machine-level tasks.	Monitors the hardware functioning.
Dependency	It depends on the software to execute the task.	It depends on hardware to process the information.

Basis	Computer Hardware	Computer Software
Use	Works for most of the computers in general as they have uniform architecture.	Is designed according to the computer system and updates according to user preference.
Categories	It mainly consists of input devices, output devices, storage, and internal components.	System software and Application software are two of its major types.
Components	Integrated Circuits, diodes, registers, crystals, insulators, etc.	Numbers, alphabets, symbols, keywords, etc.
Protection	The viruses cannot attack the hardware system.	The viruses can attack the software system.
Faults	They are very random and hard to find.	Usually have something to do with the system and troubleshoots automatically.

Basis	Computer Hardware	Computer Software
Transfer	Their electric transmission is possible from one place to another electrically using a network.	They can easily transfer from different locations using the network.
Durability	Depreciates over time.	Keeps updating with time.
Replacement	In case of damage, a new device replaces the hardware.	In case of damage, it undergoes reinstallation.
Examples	Keyboard, Monitor, Printer, CPU, Hard disk, ROM, etc.	Ms Word, Operating system, Photoshop, MySQL, etc.

What is Language?

Language is a mode of communication that is used to **share ideas, opinions with each other**. For example, if we want to teach someone, we need a language that is understandable by both communicators.

What is a Programming Language?

A programming language is a computer language that is used by programmers (developers) to communicate with computers. It is a set of instructions written in any specific language (C, C++, Java, Python) to perform a specific task. A programming language is mainly used to develop desktop applications, websites, and mobile applications.

Characteristics of a programming Language

- A programming language must be simple, easy to learn and use, have good readability, and be human recognizable.
- Abstraction is a must-have Characteristics for a programming language in which the ability to define the complex structure and then its degree of usability comes.
- A portable programming language is always preferred.
- Programming language's efficiency must be high so that it can be easily converted into a machine code and executed consumes little space in memory.
- A programming language should be well structured and documented so that it is suitable for application development.
- Necessary tools for the development, debugging, testing, maintenance of a program must be provided by a programming language.
- A programming language should provide a single environment known as Integrated Development Environment(IDE).
- A programming language must be consistent in terms of syntax and semantics.

Computer Languages

```
graph TD; A[Computer Languages] --> B[Low Level Language  
( Machine Language )]; A --> C[Middle Level Language  
( Assembly Language )]; A --> D[High Level Language]; B --> B1[Use 1's & 0's to  
create instructions]; B --> B2[Ex: Binary Language]; C --> C1[Use mnemonics to  
create instructions]; C --> C2[Assembly Language]; D --> D1[Similar to  
human language]; D --> D2[COBOL, FORTRAN, BASIC  
C, C++, JAVA];
```

Low Level Language (Machine Language)

Use 1' s & 0' s to
create instructions

Ex: Binary Language

Middle Level Language (Assembly Language)

Use mnemonics to
create instructions

Assembly Language

High Level Language

Similar to
human language

COBOL, FORTRAN, BASIC
C, C++, JAVA

Low Level Language

Low level languages are the machine codes in which the instructions are given in machine language in the form of 0 and 1 to a Computer system. It is mainly designed to operate and handle all the hardware and instructions set architecture of a Computer. The main function of the Low-level language is to operate, manage and manipulate the hardware and system components. There are various programs and applications written in low level languages that are directly executable without any interpretation or translation.

Low level language is also divided into two parts:

- Machine language
- Assembly language

Machine Language

Machine Language is one of the low-level programming languages which is the first-generation language developed for communicating with a Computer. It is written in machine code which represents 0 and 1 binary digits inside the Computer string which makes it easy to understand and perform the operations. As we know a Computer system can recognize electric signals so here 0 stands for turning off electric pulse and 1 stands for turning on electric pulse. It is very easy to understand by the Computer and increases the processing speed.

Machine Instruction	Machine Operation
00000000	Stop Program
00000001	Turn bulb fully on
00000010	Turn bulb fully off
00000100	Dim bulb by 10%
00001000	Brighten bulb by 10%
00010000	If bulb is fully on, skip over next instruction
00100000	If bulb is fully off, skip over next instruction
01000000	Go to start of program (address 0)

Advantages of Machine Language

- Machine language makes fast and efficient use of the computer.
- It requires no translator to translate the code. It is directly understood by the computer.

Disadvantages of Machine Language

- All operation codes must be remembered
- All memory addresses must be remembered.
- It is hard to amend or find errors in a program written in the machine language.

Assembly Language is the second-generation programming language that has almost similar structure and set of commands as Machine language. Instead of using numbers like in Machine languages here we use words or names in English forms and symbols. The programs that have been written using words, names and symbols in assembly language are converted to machine language using an Assembler. Because a Computer only understands machine code languages that's why we need an Assembler that can convert the Assembly level language to Machine language, so the Computer gets the instruction and responds quickly.

Is Assembly Language portable?

Example: Translate the following C statement to assembly language and machine code. $x=y*(y+z)$;

Assume x,y and z are stored in memory locations 0,1 and 2 and there are general purpose registers called A,B,C...etc

Assembly Language	Machine Code
MOV A,[1]	3e 00 01 ; A=y
MOV B,[2]	3f 00 02 ; B=z
ADD A,B	8c ; A=A+B;
MULT A,B	9f ; A=A*B
MOV [0],A	4e 00 00 ; x=A

Types of Assemblers

Assembly language must be translated into machine language using an assembler. There are two primary types of assemblers.

- A **single-pass assembler** scans a program one time and makes an equivalent binary program. This type of assembler validates assembly language code by looking the code up in a mnemonic code table. A single-pass assembler is often faster than a multi-pass assembler, and there is usually no need to construct any intermediate code.
- A **multi-pass assembler** means the assembler uses more than one pass. Multi-pass assemblers create a table with every symbol and each of their values in the first pass, then use the table in future passes to generate new code. Each separate pass usually handles a different specific task. Though usually slower, multi-pass assemblers with modular structures can often be reused for different machines.

What steps are used to convert a source program in assembly language to a target program in machine language?

Advantages of Assembly Language

- Execution may be simpler compared to other languages
- Execution is usually faster compared to other languages
- Allows for direct control over hardware
- Code may remain smaller compared to other languages

Disadvantages of Assembly Language

- Programming may be more challenging to pick up compared to high-level languages
- Syntax of assembly languages is difficult
- Not portable between machines

Machine Language	Assembly Language
Machine language is a low-level programming language	Assembly language is a human-only language that is not understood by computers.
Machine language includes binary digits (0s and 1s), hexadecimal and octal decimal	Mnemonics such as Mov, Add, Sub, End, and others make up the assembly language,
Machine languages are platform-dependent	The syntaxes of Assembly languages are like the English language
In machine language, all data is present in binary format that makes it fast in execution.	Comparatively, the execution speed of assembly language is slow.
The first-generation programming languages are Machine languages, which do not need a translator.	The second generation of programming languages is assembly languages, which use assembler as a translator
Machine language is hardware-dependent and does not allow for modification.	Assembly language is not portable, and it is machine-dependent and can be modified easily.

High Level Language

A high-level language (HLL) is a programming language that enables a programmer to write programs that are independent of a particular type of computer. Such languages are considered high-level because they are closer to human languages and further from machine languages. This programming language requires a compiler or interpreter to translate the program into machine language (execute the program).

A high-level language is further divided into three parts:

1. Procedural Oriented programming language
2. Object-Oriented Programming language
3. Natural language

Advantage of High-Level Language

- The high-level language is easy to read, write, and maintain as it is written in English like words
- The high-level languages are designed to overcome the limitation of low-level language, i.e., portability. The high-level language is portable
- Machine Independent
- Debugging is Easy
- Easy to Maintain Program

Disadvantages of High-Level Language

- Poor Control on Hardware
- Slow Execution

High Level Language	Low Level Language
Programmer friendly	Machine friendly
Less memory efficient	Highly memory efficient
Easy to understand for programmers	Tough to understand for programmers
Simple to debug	Complex to debug comparatively
Simple to maintain	Complex to maintain comparatively
Portable	Non-portable
Can run on any platform	Machine-dependent
Needs compiler or interpreter for translation	Needs assembler for translation
Widely used for programming	Not commonly used in programming

Middle-level programming language

Middle-level programming language **lies between the low-level programming language and high-level programming language**. It is also known as the intermediate programming language and pseudo-language.

A middle-level programming language's advantages are that it supports the features of high-level programming, it is a user-friendly language, and closely related to machine language and human language. **Example:** C, C++, language

Concept of Compiler & Interpreter

Compiler

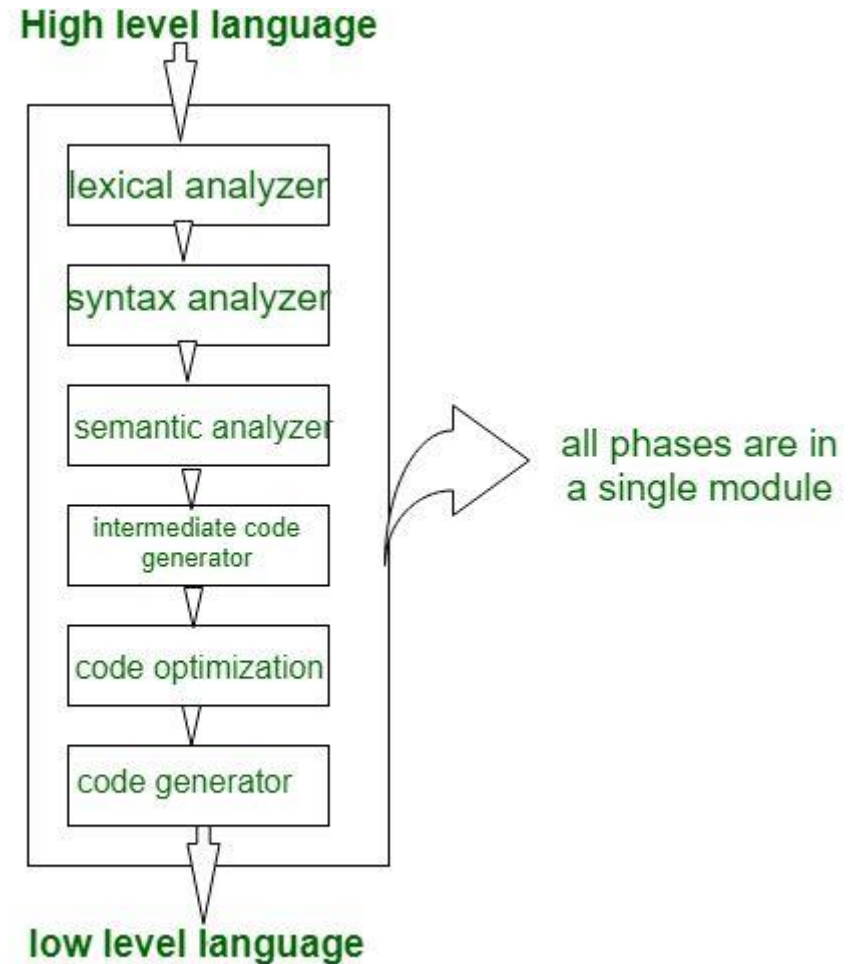
A compiler is a computer program that reads a program written in a high-level language and translate it into the same program in a low-level language including machine language. The compiler also finds out the various errors encountered during the compilation of a program.

The compiler converts high-level language into low-level language using various phases. Compiler pass are two types: **Single Pass Compiler**, and Two Pass Compiler or **Multi Pass Compiler**.

Single Pass Compiler:

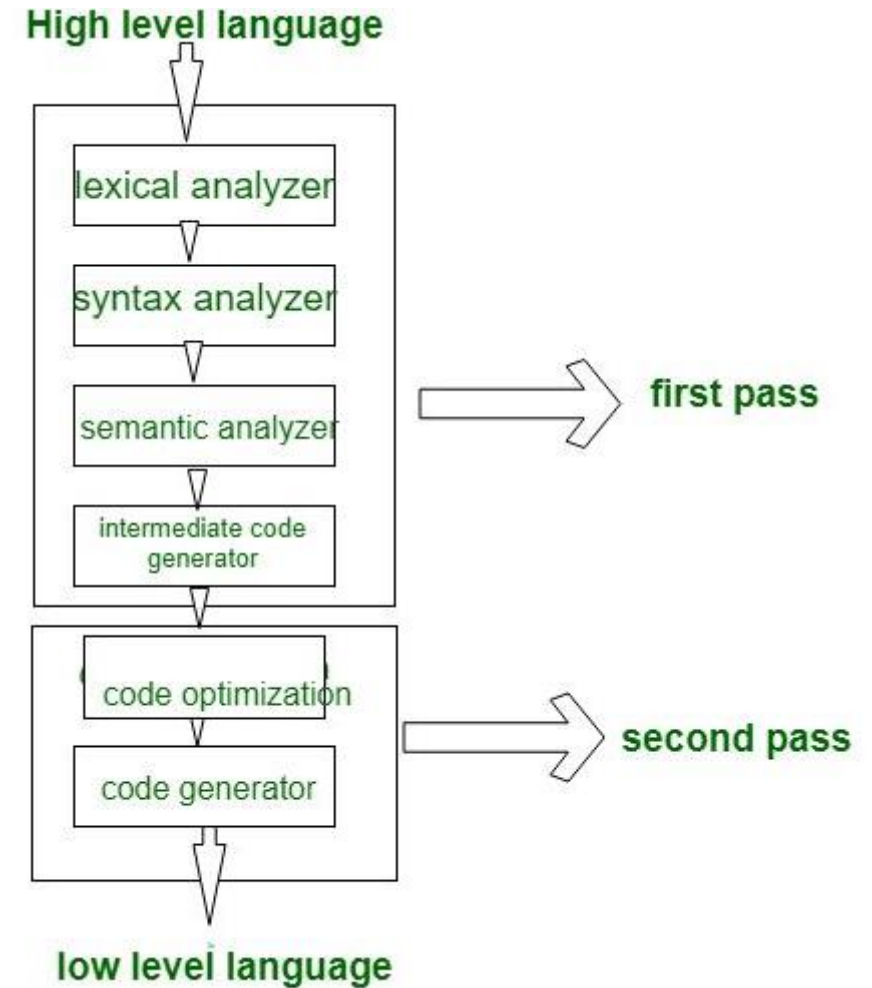
If we combine or group all the phases of compiler design in a **single** module known as single pass compiler. A one pass/single pass compiler is that type of compiler that passes through the part of each compilation unit exactly once.

Note: Single pass compiler almost never done, early Pascal compiler did this as an introduction.



Two Pass compiler or Multi Pass compiler:

A Two pass/multi-pass Compiler is a type of compiler that processes the source code or abstract syntax tree of a program multiple times. In multi-pass Compiler we divide phases in two pass as:



One-Pass Compiler	Multi-Pass Compiler
It reads the code only once and translates it at a similar time.	It reads the code multiple times, each time changing it into numerous forms.
They are faster.	They are "slower." As more number of passes means more execution time.
Less efficient code optimization and code generation.	Better code optimization and code generation.
It is also called a "Narrow compiler." It has limited scope.	It is also called a "wide compiler." As they can scan every portion of the program.
The compiler requires large memory.	The memory occupied by one pass can be reused by a subsequent pass; therefore, small memory is needed by the compiler.
Example – Pascal & C languages use one-pass compilation.	Example – Modula-2 languages use multi-pass compilation.

Advantages of Compiler

There are various advantages of the compiler which are as follows –

- A compiler translates a program in a single run.
- It consumes less time.
- CPU utilization is more.
- Both syntactic and semantic errors can be checked concurrently.
- It is easily supported by many high-level languages like C, C++, JAVA, etc

Interpreter

An interpreter is a program that executes the programming code directly instead of just translating it into another format. It translates and executes programming language statements one by one. An interpreter takes less time to interpret a source program as distinguished by a compiler.

Advantages of Interpreter

- An interpreter translates the program line by line.
- The interpreter is smaller in size.
- It is flexible.
- Error localization is easier.
- The interpreter facilitates the implementation of computer programming language constructs.

Interpreter	Compiler
Translates program one statement at a time.	Scans the entire program and translates it as a whole into machine code.
Interpreters usually take less amount of time to analyze the source code. However, the overall execution time is comparatively slower than compilers.	Compilers usually take a large amount of time to analyze the source code. However, the overall execution time is comparatively faster than interpreters.
No Object Code is generated, hence are memory efficient.	Generates Object Code which further requires linking, hence requires more memory.
Programming languages like JavaScript, Python, Ruby use interpreters.	Programming languages like C, C++, Java use compilers.

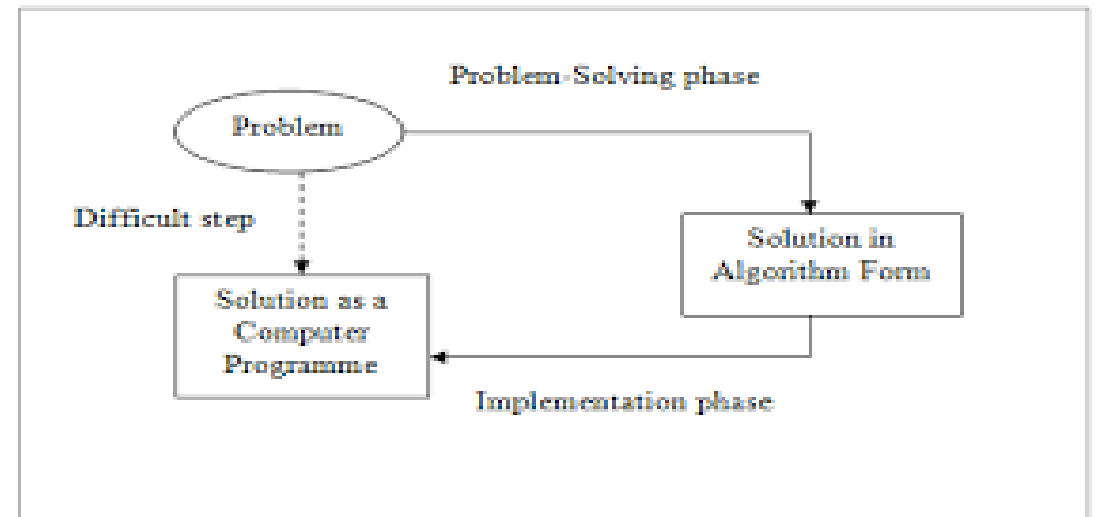
Problem solving concept

A computer is a tool to solve a problem.

Problem solving is the process of transforming the description of a problem into a solution by using our knowledge of the problem domain and by relying on our ability to select and use appropriate problem-solving strategies, techniques and tools.

Programming is a problem-solving activity. When we write a program, we are writing an instruction for the computer to solve something for us. Using a computer as a problem-solving tool following steps are involved:

1. Problem Analysis
2. Algorithm Development
3. Flowcharting
4. Coding
5. Compilation & Execution
6. Debugging & Testing
7. Documentation

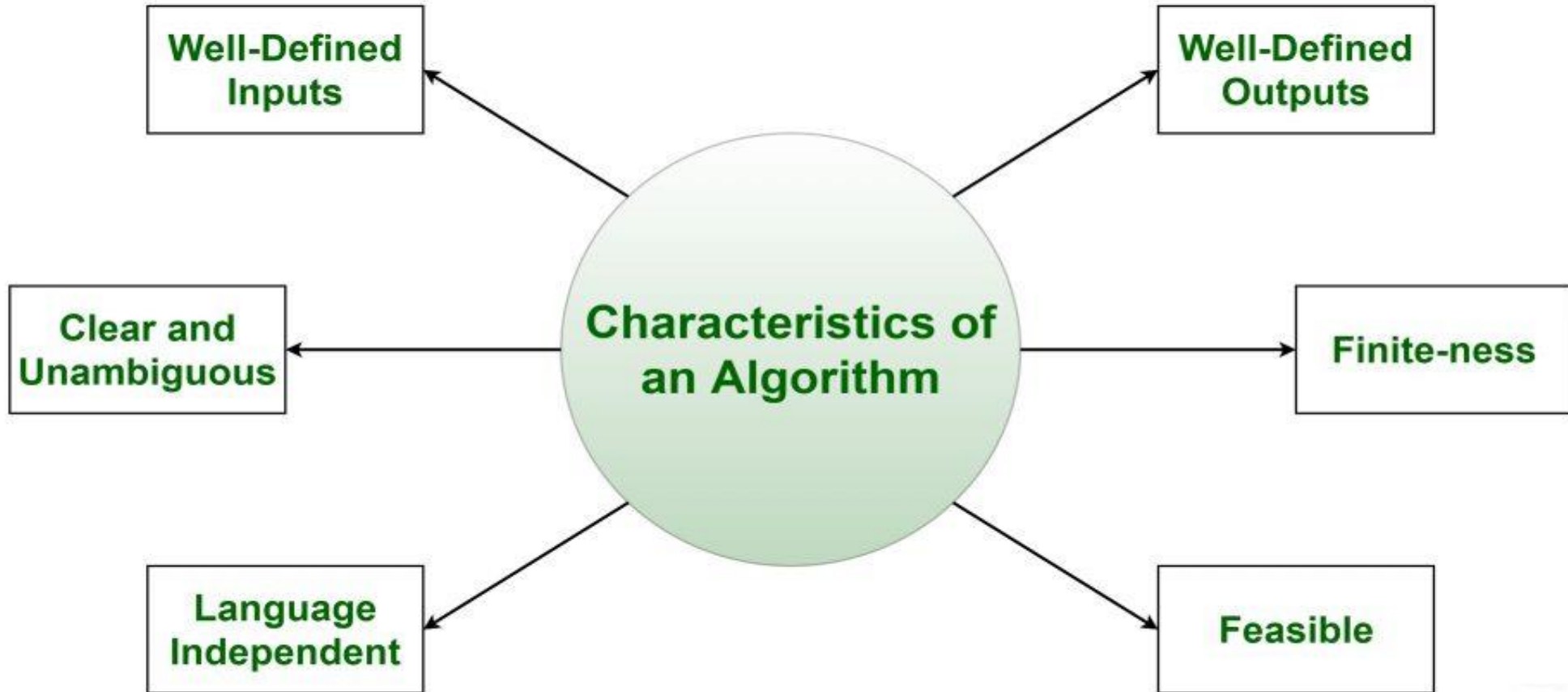


What is an Algorithm?

In computer programming terms, “A set of finite rules or instructions to be followed in calculations or other problem-solving operations”

The selection of an algorithm depends upon the nature of the given problem. Thus, the problem is first analyzed, and then the best algorithm is used to solve it. An algorithm follows a systematic and a logical approach, where the procedure is defined step-wise.

Characteristics of an Algorithm



What are the Characteristics of an Algorithm?

- **Clear and Unambiguous:** The algorithm should be clear and unambiguous. Each of its steps should be clear in all aspects and must lead to only one meaning.
- **Well-Defined Inputs:** If an algorithm says to take inputs, it should be well-defined inputs. It may or may not take input.
- **Well-Defined Outputs:** The algorithm must clearly define what output will be yielded and it should be well-defined as well. It should produce at least 1 output.
- **Finite-ness:** The algorithm must be finite, i.e., it should terminate after a finite time.
- **Feasible:** The algorithm must be simple, generic, and practical, such that it can be executed with the available resources. It must not contain some future technology or anything.
- **Language Independent:** The Algorithm designed must be language-independent, i.e., it must be just plain instructions that can be implemented in any language, and yet the output will be the same, as expected.

Types of Algorithms

1. Brute Force Algorithm: It is the simplest approach for a problem. A brute force algorithm is the first approach that comes to finding when we see a problem. It goes through all possible choices until a solution is found
2. Recursive Algorithm: A recursive algorithm is based on recursion. In this case, a problem is broken into several sub-parts and called the same function again and again.
3. Backtracking Algorithm: The backtracking algorithm basically builds the solution by searching among all possible solutions. Whenever a solution fails, we trace back to the failure point and build on the next solution and continue this process till we find the solution, or all possible solutions are looked after.
4. Searching Algorithm: Searching algorithms are the ones that are used for searching elements or groups of elements from a particular data structure. They can be of different types based on their approach or the data structure in which the element should be found.

Advantages of Algorithms

1. It is a step-wise representation of a solution to a given problem, which makes it easy to understand.
2. An algorithm uses a definite procedure.
3. It is not dependent on any programming language, so it is easy to understand for anyone even without programming knowledge.
4. Every step in an algorithm has its own logical sequence so it is easy to debug.
5. By using algorithm, the problem is broken down into smaller pieces or steps hence, it is easier for programmer to convert it into an actual program.

Disadvantages of Algorithms

1. Algorithms is Time consuming.
2. Difficult to show Branching and Looping in Algorithms.
3. Big tasks are difficult to put in Algorithms.

Example of an Algorithm

Problem: Create an algorithm that multiplies two numbers and displays the output.

Step 1 – Start
Step 2 – declare three integers x, y & z
Step 3 – define values of x & y
Step 4 – multiply values of x & y
Step 5 – store result of step 4 to z
Step 6 – print z
Step 7 – Stop

OR

Step 1 – Start mul
Step 2 – get values of x & y
Step 3 – $z \leftarrow x * y$
Step 4 – display z
Step 5 – Stop

Flow Charts









A flowchart is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem.

Rules For Creating Flowchart

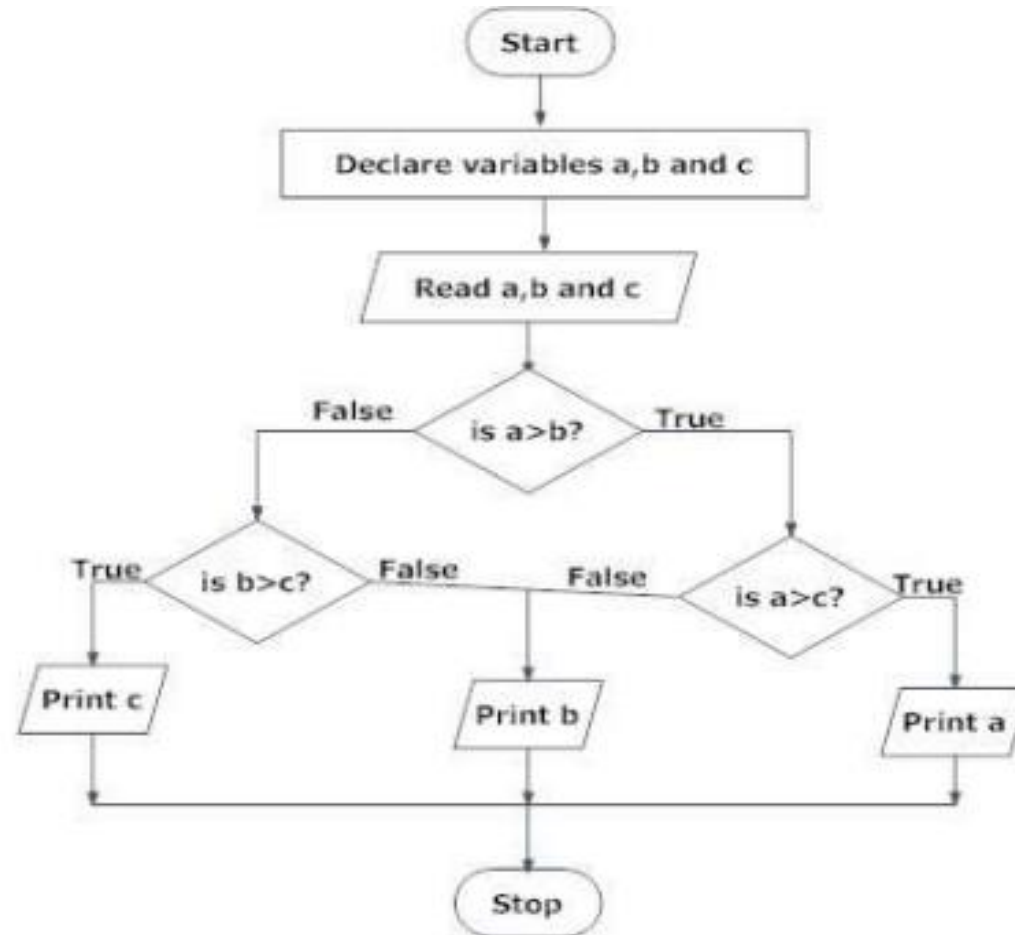
A flowchart is a graphical representation of an algorithm.it should follow some rules while creating a flowchart

- Rule 1: Flowchart opening statement must be ‘start’ keyword.
- Rule 2: Flowchart ending statement must be ‘end’ keyword.
- Rule 3: All symbols in the flowchart must be connected with an arrow line.
- Rule 4: The decision symbol in the flowchart cannot be associated with the arrow line.

Symbols Used In Flowchart

Symbol	Purpose	Description
	Flow line	Used to indicate the flow of logic by connecting symbols.
	Terminal(Stop/Start)	Used to represent start and end of flowchart.
	Input/Output	Used for input and output operation.
	Processing	Used for airthmetic operations and data-manipulations.
	Desicion	Used to represent the operation in which there are two alternatives, true and false.
	On-page Connector	Used to join different flowline
	Off-page Connector	Used to connect flowchart portion on different page.
	Predefined Process/Function	Used to represent a group of statements performing one processing task.

Draw flowchart to find the largest among three different numbers entered by user.



1. Draw a flowchart to find all the roots of a quadratic equation $ax^2+bx+c=0$
2. Draw a flowchart to find the Fibonacci series till $\text{term} \leq 1000$.
3. Develop an algorithm to find the average of three numbers
4. Write an algorithm to find the square of a number
5. Write an algorithm to find the largest of three numbers X, Y,Z
6. Write an algorithm to check whether the given number is prime or not
7. Draw a flowchart to solve the problem of a non-functioning light bulb
8. Write an algorithm to display the sum of two numbers entered by user, using both pseudocode and flowchart.
9. Write an algorithm to calculate area and perimeter of a rectangle, using both pseudocode and flowchart. Pseudocode for calculating area and perimeter of a rectangle.
10. write a pseudocode and draw a flowchart where multiple conditions are checked to categorise a person as either child (<13), teenager (≥ 13 but <20) or adult (≥ 20), based on age specified:
 - Input: Age
 - Process: Check Age as per the given criteria
 - Output: Print either “Child”, “Teenager”, “Adult”

Assignment

Advantages of Flowchart

- Flowcharts are a better way of communicating the logic of the system.
- Flowcharts act as a guide for blueprint during program designed.
- Flowcharts help in debugging process.
- With the help of flowcharts programs can be easily analyzed.
- It provides better documentation.
- Flowcharts serve as a good proper documentation.
- Easy to trace errors in the software.
- Easy to understand.
- The flowchart can be reused for inconvenience in the future.
- It helps to provide correct logic.

Disadvantages of Flowchart

- It is difficult to draw flowcharts for large and complex programs.
- There is no standard to determine the amount of detail.
- Difficult to reproduce the flowcharts.
- It is very difficult to modify the Flowchart.
- Making a flowchart is costly.
- Some developer thinks that it is waste of time.
- It makes software processes low.
- If changes are done in software, then the flowchart must be redrawn

What is a Pseudocode?

Pseudo code: It's simply an implementation of an algorithm in the form of annotations and informative text written in plain English. It has no syntax like any of the programming language and thus can't be compiled or interpreted by the computer.

Pseudo code, as the name suggests, is a false code or a representation of code which can be understood by even a layman with some school level programming knowledge.

Why Is Pseudocode Used, and Why Should I Write It?

- Pseudocode describes how an algorithm should be structured to work.
- Given an algorithm to implement, pseudocode can act as an intermediate step when converting the initial algorithm into executable code, making it easier to understand how the algorithm can be accurately converted into executable code.

Suggestions to Write Pseudocode

1. Begin with writing down what's the purpose of the process.
2. Start with BEGIN, end with END, and always capitalize the initial word.
3. Have only one statement per line.
4. Organize and indent sections of pseudocode properly (for clarity of decision control and execution mechanism and readability). Indent to show hierarchy, improve readability, and show nested constructs.
5. Always end multi-line sections using any of the END keywords like ENDIF, ENDWHILE, etc.

Main Constructs Of Pseudocode

1. **Sequence** represents linear tasks sequentially performed one after the other.
2. **While** a loop with a condition at its beginning.
3. **Repeat-until** a loop with a condition at the bottom.
4. **For** another way of looping.
5. **If-then-else** a conditional statement changing the flow of the algorithm.
6. **CASE** the generalization form of IF-THEN-ELSE.

PSEUDOCODE CONSTRUCTS

SEQUENCE

Input: READ, OBTAIN, GET
Output: PRINT, DISPLAY, SHOW
Compute: COMPUTE,
CALCULATE, DETERMINE
Initialize: SET, INIT
Add: INCREMENT, BUMP
Sub: DECREMENT

FOR

FOR iteration bounds
sequence
ENDFOR

WHILE

WHILE condition
sequence
ENDWHILE

CASE

CASE expression OF
condition 1: sequence 1
condition 2: sequence 2
...
condition n: sequence n
OTHERS:
default sequence
ENDCASE

REPEAT-UNTIL

REPEAT
sequence
UNTIL condition

IF-THEN-ELSE

IF condition THEN
sequence 1
ELSE
sequence 2
ENDIF

Example: FizzBuzz Problem Statement

Write code to print numbers from 1 to 100. The catch is:

- For multiples of 3, you need to print “Fizz”
- For multiples of 5, you need to print “Buzz”
- For the multiples of both 3 and 5, you need to print “FizzBuzz”

FizzBuzz Pseudocode

```
Read J
FOR j ← 1 TO 100 DO
  IF j is divisible by 3 AND j is divisible by 5 THEN
    OUTPUT "FizzBuzz"
  ELSE IF j is divisible by 5 THEN
    OUTPUT "Buzz"
  ELSE IF j is divisible by 3 THEN
    OUTPUT "Fizz"
  ELSE
    OUTPUT j
```


Advantages of Pseudocode	Disadvantages of Pseudocode
It improves the readability of any approach. It's one of the best approaches to start the implementation of a complex/long algorithm.	It does not provide a visual representation of the logic of programming.
It acts as a bridge between the program and the algorithm or flowchart and works as rough documentation.	There is no proper format for writing the pseudocode.
Its main goal is to explain what each line of a program should do, hence making the code construction phase easier for the programmer.	Despite Pseudocode, there is often still an extra need to maintain documentation.

BASIS OF COMPARISON	ALGORITHM	PSEUDOCODE
Description	Algorithm is a well-defined sequence of steps that provides a solution for a given problem.	A Pseudocode is one of the methods that can be used to represent an algorithm.
Nature	It is a systematic and a logical approach, where the procedure is defined step-wise.	It is a simpler version of coding in a programming language.
Construction Rules	There are no rules to follow while constructing it.	Certain rules are followed while constructing it. Control structures such as ‘while’, ‘if-then-else’, ‘repeat-until’, and so on can be used.
Programming	Algorithms can be used in any complex programming language as it uses simple logical code snippets.	Pseudocodes are not used in any complex programming languages.
Outlook	Algorithms can be considered as pseudocodes.	Pseudocodes cannot be considered as algorithms.



LEARNING