UNIT-1
Introduction to Components of a Computer System

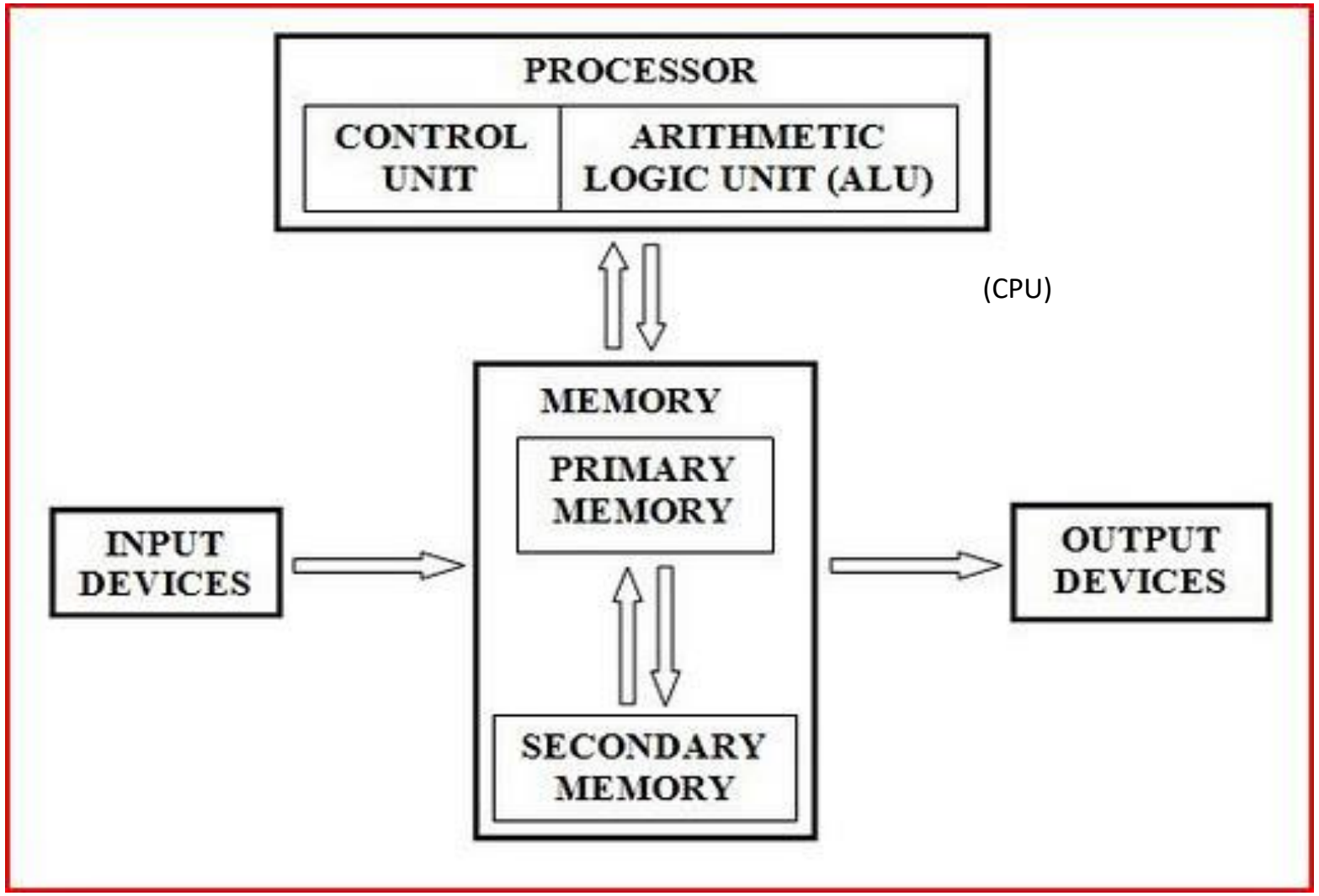
Computer:

The term computer is derived from the word compute. A computer is an electronic device that takes data and instructions as an input from the user, processes the data according to set of instructions (called program) and provides useful information known as output.

A collection of related program is referred to as the software. The physical circuitry and components are known as the hardware.

Hardware can be categorized in five blocks : (i) Input Unit (ii) Arithmetic Logic Unit (iii) Control Unit (iv) Memory (v) Output Unit

Components of Computer



Block diagram of Computer

Input Unit

This unit contains devices with the help of which we enter data and instruction into the computer. This unit makes link between user and computer. The data read from the computer device is stored in the computer's memory.

Most used input devices among other are;

a) Keyboards b) mouse c) scanner d)digital camera e) joy sticks

Computer peripherals are any computer components that expand system functionality and are not necessary for basic operation (not the part of CPU).

CPU (Central Processing Unit)

ALU(Arithmetic Logic Unit): The ALU performs arithmetic and logical operations. The arithmetic operations include addition, subtraction, multiplication and division. Numerical data in the form of integers are supported by all the computers. Some computers also support floating point numbers. Logical operations include the Boolean functions such as AND, OR and NOT. These operations used during conditional branching.

Control Unit (CU)

A computer control unit is a part of the computer processor. The control unit fetches internal instructions of programs from the main memory to the processor. The control unit coordinates the activities of the various components of the computer. The arithmetic logic unit and the control unit together comprise the Central Processing Unit (CPU)

Control unit controls flow of data:

a. From input device to memory
b. From memory to output device or secondary storage
c. From secondary storage to memory
d. From ALU to memory
e. From memory to ALU

Memory Unit

The information (instruction and data) required is stored in memory . The computer’s memory is constructed out of semi-conductor material and stores information in binary form. The memory is organized into equal sized units (usually collection of 8 bits, called a byte) these units are arranged in a sequence and are identified by numbers called addresses.

Output Unit

Just as input devices are used to supply the computer with data, there should be some means for the computer to communicate with the user. The information generated by the computer is displayed using an output device. Examples of output devices are Monitors, printer, card punch etc.

Classification of Computer Memory

- **Registers:** Registers are location within the CPU where data stored temporarily during processing. These internal high-speed registers are used in arithmetic and logic operations for holding data operands. Some registers are accessible by the user through instructions. Others are reserved for the use of the CPU to perform it’s activities.

- **Cache Memory:** Cache memory is a very high-speed memory which speeds up the CPU working. It acts as a buffer between CPU and a main memory. The regularly used data's and program files which are used by CPU are stored in the Cache memory. CPU can access the data whenever required. When the Operating system starts it transfers some important files and data from disk to cache memory from where CPU can access them easily.

Primary Memory (Main Memory)

There are two kinds of primary Memory

RAM –Random Access Memory (this is used for storing programs that are currently running and data that is being processed)

Main Memory Stores info about applications that are open.

VOLATILE –When you switch off the machine, all the data will disappears!!!

ROM –Read Only Memory (its contents are PERMANENTLY fixed into the memory chip at the manufacturing stage. It is used –for example –to load the bootstrap loader (the program that loads as soon as you start the machine)

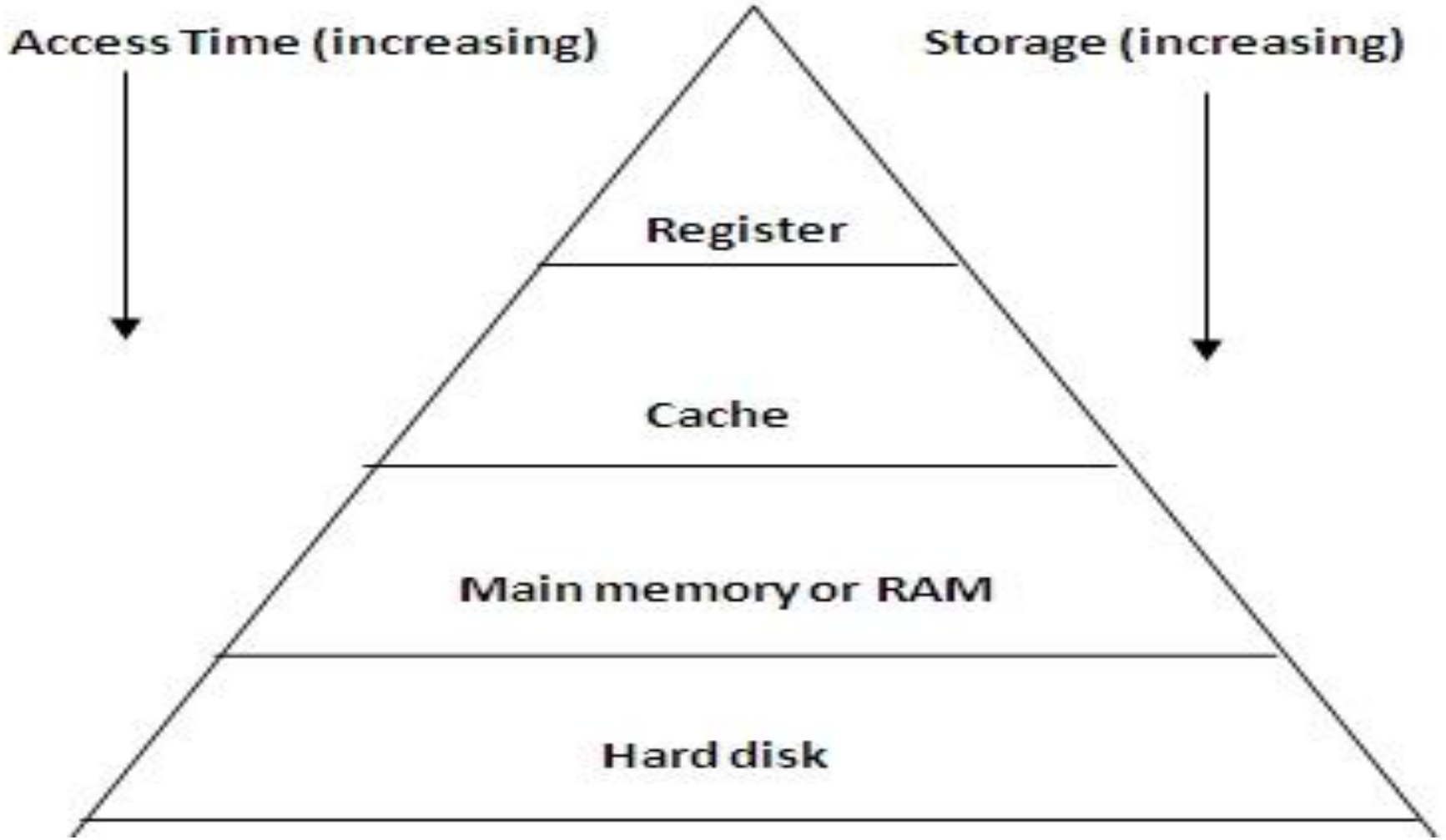
Non-Volatile (does not change)

Programs that are necessary for the computer to run Boot up program etc.

- **Secondary Memory**

This memory is also known as external memory. It is slower than main memory. These are used for storing data and Information permanently on it. CPU access the data of secondary memory by some input-output routines. Contents of secondary memories are first transferred to main memory, and then CPU can access it. Example of secondary memory: DVD , disk, CD-ROM etc.

MEMORY HIERARCHY DIAGRAM



In above figure various types of memory are shown in the order of increasing size, decreasing speed and decreasing cost

The capacity and size of memory of a computer is measured in terms of the number of bytes associated with it. Each one of the digits 0 and 1 of the binary system is called 1 bit.

The following units are used to measure storage capacity of the storage unit..

1 Bit	= Binary Digit (single 1 or 0)	
4 Bit	= Nibble	
8 Bits	= 1 Byte	B
1024 Bytes	= 1 Kilobyte	KB
1024 Kilobytes	= 1 Megabyte	MB
1024 Megabytes	= 1 Gigabyte	GB
1024 Gigabytes	= 1 Terabyte	TB
1024 Terabytes	= 1 Petabyte	PB
1024 Petabytes	= 1 Exabyte	EB
1024 Exabytes	= 1 Zettabyte	ZB
1024 Zettabytes	= 1 Yottabyte	YB
1024 Yottabytes	= 1 Brontobyte	BB
1024 Brontobytes	= 1 Geopbyte	

Classification based on operation

- Analog Computer
- Digital Computer and
- Hybrid computer

1. Analog Computer:

These are used to process analog data. Analog data is of continuous nature and which is not discrete or separate. Such type of data includes temperature, pressure, speed weight, voltage, depth etc. Analog computers are the first computers being developed and provided the basis for the development of the modern digital computers.

2. Digital Computer:

A Digital Computer, as its name implies, works with digits to represent numerals, letters or other special symbols. Digital Computers operate on inputs which are ON-OFF type and its output is also in the form of ON-OFF signal. A digital computer can be used to process numeric as well as non-numeric data. Analog computers lack memory whereas digital computers store information.

3. Hybrid computer:

A hybrid is a combination of digital and analog computers. It combines the best features of both types of computers, i.e. It has the speed of analog computer and the memory and accuracy of digital computer. Hybrid computers for example are used for scientific calculations, in defense and radar systems.

Classification of Digital Computer based on configuration:

- Microcomputer
- Minicomputers
- Mainframe Computers
- Supercomputers

1.Micro-computer:

A microcomputer is defined as a computer that has a microprocessor as its CPU. The microcomputer system can perform the following basic operations: Inputting, storage, Processing, Outputting & Controlling. Only one person can work on this computer at a time. Example Desktop(PC) , Laptop, tablet etc.

2. Mini-computer:

A minicomputer is a medium sized computer that is more powerful than a microcomputer. A important distinction between microcomputer and minicomputer is that unlike microcomputer minicomputer is designed to serve multiple users simultaneously. 100’s of workstations or terminals attached to central minicomputer. Example IBM-17,HP-9000, DEC etc.

3.Mainframe-Computer:

This computer helps in handling the information like banks, insurance companies, & railways. Mainframe computer are placed on a central location and are connected to several user terminals, which can act as access station & may be located in the same building. May have 1000's of terminals – geographically remote locations. 100's of disk drives & hardware units are used Location often kept secret! (terrorist attacks) eg IBM-370, UNIVAC-1110,VA_x

4. Super- Computer:

Super computer are the most powerful and expensive computer available at present they are also the fastest computer available. It is mainly used for complex scientific application. Cost Millions. Mostly used by scientific and nuclear, industrial research departments

- NASA –government agencies, Weather Centers, Stock Exchanges, Large Commercial Organizations

- **World’s Fastest Computer**

Fugaku (RIKEN Center for Computational Science, Japan)
Roadrunner (Los Alamos National Lab, New Mexico, US)
Jaguar (National Centre for Computational Sciences, Oakridge, US)

Indian Scenario

EKa (Computational Research Laboratories Ltd, Pune)
PARAM (CDAC, 1990-91 Pune) ANURAG
PARAM Yuva-II : speed 524 Tera Flops
PARAM SIDDHI AI(DST & CDAC, Pune)

Super Computers of China:

Sunway tedulite and Tiyanhe-2 have recently been declared as the fastest machines in the world.

Generation of computers

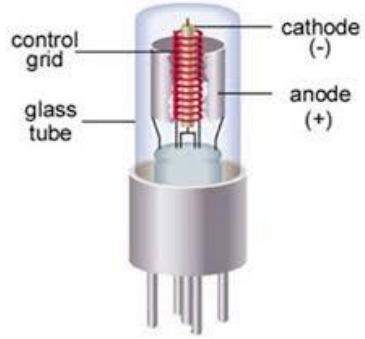
The different computing devices developed over the years can be categories into several generations. Each generation of computer is the result of a technological development , which changes the way to operate computers

- Computer can be categories into five generation
- First generation (1940 -1956)
- Second generation (1956- 1963)
- Third generation (1963- 1971)
- Fourth generation (1972 – 1989)
- Fifth generation (1989 – till date)

First Generation – Vacuum Tubes (1940 – 1956)

These ancient computers utilized vacuum tubes as circuitry and magnetic drums for recollection. As a result they were huge, actually taking up entire rooms and costing resources to run. These were ineffective materials which produce a huge amount of heat, sucked huge electricity and subsequently produced a plenty of heat which caused continuous breakdowns.

These first generation computers relied on ‘machine language’. These computers were limited to solving one problem at a time. Input was predicated on punched cards and paper tape. Output emerged on print-outs. The two eminent machines of this era were the UNIVAC and ENIAC machines – the UNIVAC is the first ever commercial computer which was purchased in 1951 by a business named as the US Census Bureau.



Second Generation – Transistors (1956 – 1963)

The supersession of vacuum tubes by transistors, visualized the beginning of the second generation of computing. They were a huge development over the vacuum tube, despite the fact still subjecting computers to destroying different levels of heat. However they were extremely superior to the vacuum tubes, making computers smaller, more expeditious, inexpensive and less burden some on electricity use. They still count on punched card for input/printouts.

The language emerged from strange binary language to symbolic (‘assembly’) languages. This meant programmers could discover instructions in words. Meanwhile during the same time high caliber programming languages were being developed (early versions of COBOL and FORTRAN). Transistor-driven machines were the first computers to store instructions. The anticipatory versions of these machines were created for the atomic energy industry. Honeywell 400, IBM-1401.

Third Generation – Integrated Circuits (1964 – 1971)

By this phase, transistors were now being reduced and put on silicon chips. This led to a huge improvement in speed and effectiveness of these machines. These were the first computers where users interacted utilizing keyboards and monitors which interfaced with an operating system, a consequential leap up from the punch cards and printouts. This facilitated these machines to run various applications at once utilizing a central program which functioned to monitor memory.

As a result of these advances which again made machines more reasonable and more tiny, a brand new group of users emerged during the ‘60s. The main computers for the generation were:

IBM-360, ICL-2903, NCR-365

Fourth Generation – Microprocessors (1972 – 1989)

- The innovation in this generation can be defined in one word: Intel. The chip-maker accomplished the Intel 4004 chip in 1971, which located all components of computer such as CPU, recollection, input/output controls onto a single chip. What overcrowded a room in the 1940s now gets fit in the palm of the hand. The Intel chip contained thousands of unified circuits. The year 1981 saw the first ever computer (IBM) categorically designed for home use and 1984 saw the Macintosh introduced by Apple. Microprocessors even transformed beyond the realm of computers and into an incrementing number of everyday products.
- The incremented power of these small computers denoted they could be linked, establishing networks. Which eventually led to the expansion, birth and rapid evolution of the Internet. Other primary advances during this period have been the Graphical user interface (GUI), the mouse and more of late the startling advances in laptop capability and hand-held contrivances.

Fifth Generation – Artificial Intelligence (1989 Onwards)

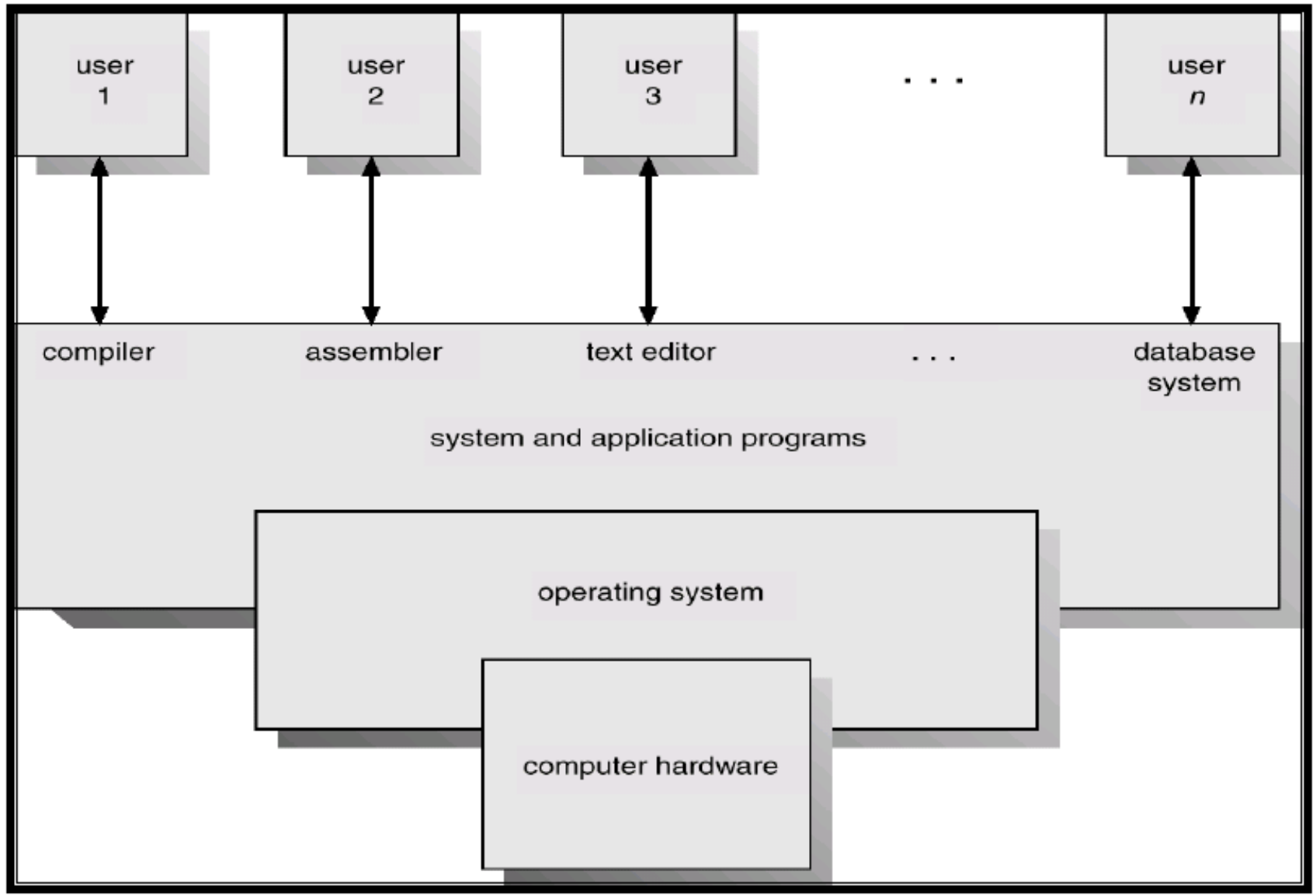
Computer devices with artificial potentiality are still in development, but some of these technologies are commencing to emerge and be used such as voice recognition. AI is an authenticity, made possible by adopting parallel processing and superconductors. Inclining to the future, computers will be thoroughly revolutionized again by quantum computation, molecular and nano technology. The essence of fifth generation will be utilizing these technologies to ultimately engender machines which can proceed and acknowledge natural language and have efficiency to determine and organise themselves. These computers have become much popular in different fields like communication technology, education, medical science, entertainment etc.

The main computers of this generation are:

Desktop, Laptop, Palm top, Super computer

Operating System (OS):

- The operating system may be considered as a collection of software program which allows a user to interact with the hardware. The operating system provides several routines which control the hardware and provide an environment for any user to execute their application program without knowing the details of the hardware.
- **“The operating system is system software which is loaded in the memory of computer at the time of booting process. It remains there all the time and provides a platform on top of which application program may run.”**


user 1
user 2
user 3
. . .
user n
compiler
assembler
text editor
. . .
database system
system and application programs
operating system
computer hardware

Management function of an OS –

The OS are in two modes, single user mode and multi user mode. In single user mode, it is assumed that only one user will have to access to all the resources of a computer system. In the multi user mode, The OS is designed to allow several users at a time.

Based on the resources, OS perform following four management function:

- **Memory Management**
- **Process Management**
- **Device Management**
- **File Management**

1.Memory Management:

The memory management function finds all the available free space in the memory and allocates it to the processes. The process is a program/ task under execution stage. The OS manages whole memory by dividing it into several blocks and partition. Every job under execution stage requires memory. If there exist two or more than two processes, then the OS allocates the memory segment as per the requirement of the job. When process is executed completely it finally free the allocated memory space.

2.Process Management:

The process management function of OS is related with allocation of process or job to the processor. The speed of processor or CPU is much faster than peripheral devices. So the scheduling is done in such a way that CPU remains idle for minimum amount of time. When a process waits for I/O to be completed, during that wait time, the CPU may be allocated to other process waiting for processor.

3.Device management:

The function of OS deals with allocation of devices to process. OS Schedules the I/O devices, I/O channel to process, whenever it requires in I/O scheduling, after finding the status of device, channels, and a schedule is prepared which states which device is allocated to the process.

4.File Management:

- The file management of OS is related with management of files stored in to secondary storage. The file is considered as collection of logically related data item which are organized in records. These files may contain a set of commands, executable code or reports. File managements of OS keeps track of all information on files. It finds and records the following for all files:
- Location, size, usage, status, etc. It also finds as to which process, which file is required, checks through the protection routine, opens the file if allowed, & allocates it to the process.

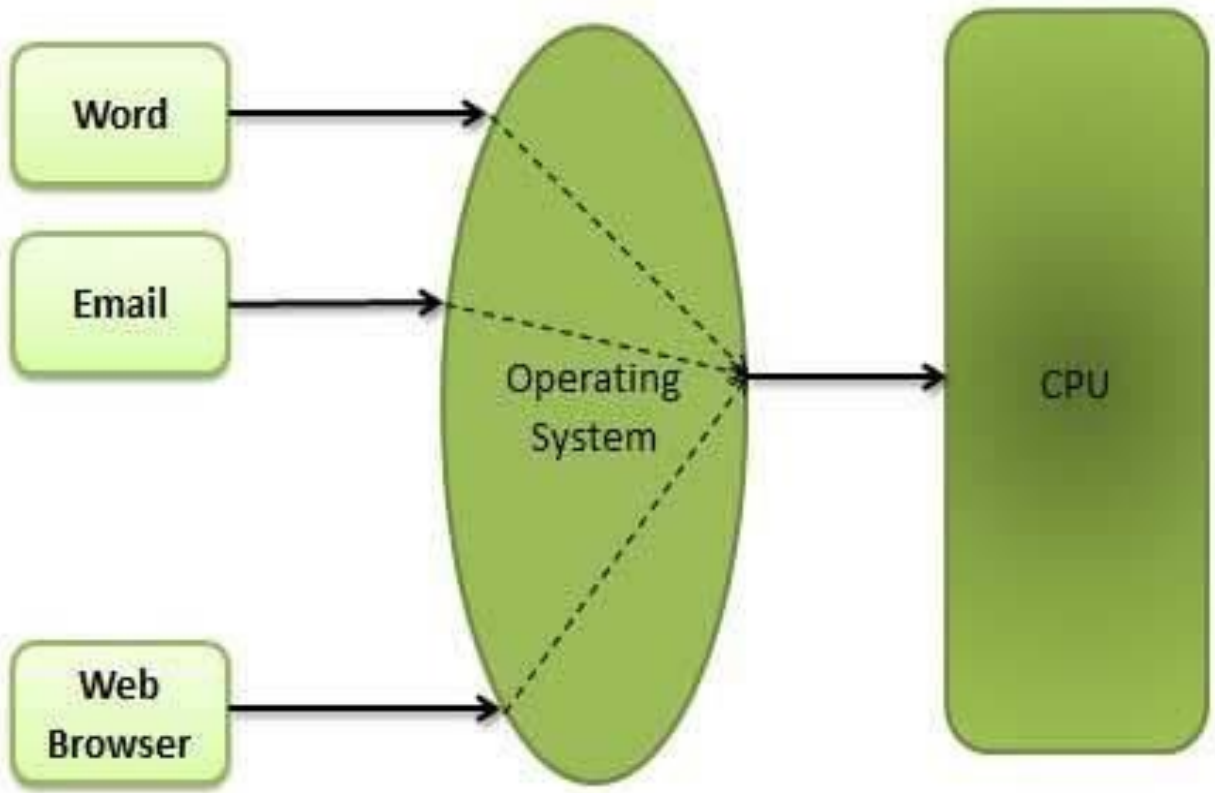
Following are a few common services provided by an operating system

- Program execution
- I/O operations
- File System manipulation
- Communication
- Error Detection
- Resource Allocation
- Protection

Operating System Properties

Multitasking

Multitasking is when multiple jobs are executed by the CPU simultaneously by switching between them. Switches occur so frequently that the users may interact with each program while it is running. Multitasking Operating Systems are also known as Time-sharing systems. A time-shared operating system uses the concept of CPU scheduling and multiprogramming to provide each user with a small portion of a time-shared CPU.


Word
Email
Web Browser
Operating System
CPU

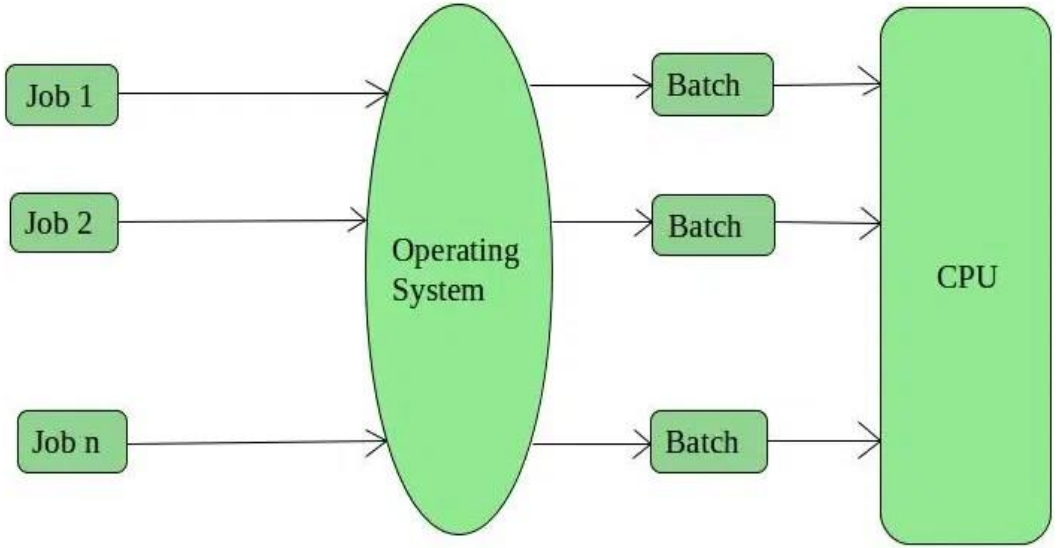
Multiprogramming

Sharing the processor, when two or more programs reside in memory at the same time, is referred as multiprogramming. Multiprogramming assumes a single shared processor. Multiprogramming increases CPU utilization by organizing jobs so that the CPU always has one to execute. Multiprogramming operating systems monitor the state of all active programs and system resources using memory management programs to ensures that the CPU is never idle, unless there are no jobs to process.

Types of operating system

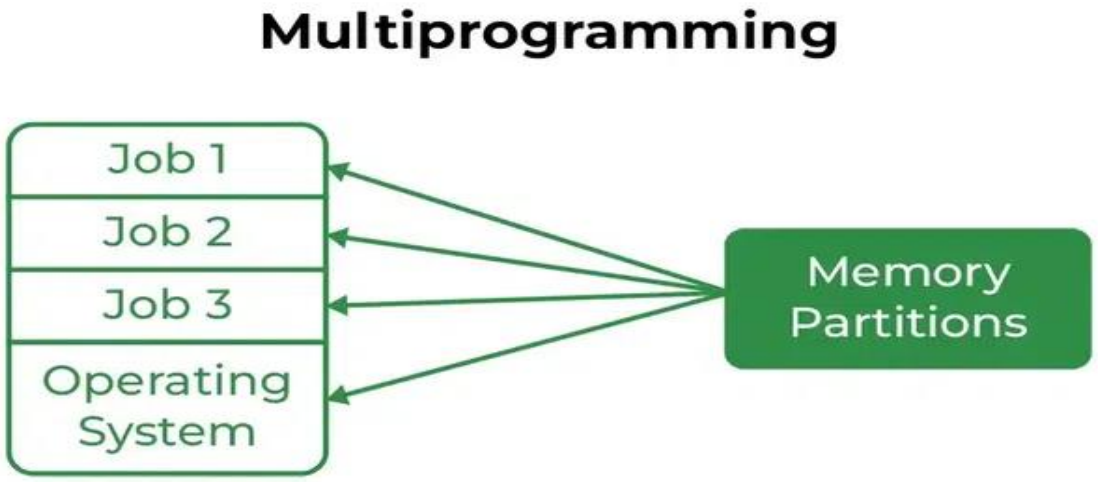
1. Batch Operating System

- This type of operating system does not interact with the computer directly. There is an operator which takes similar jobs having the same requirement and groups them into batches. It is the responsibility of the operator to sort jobs with similar needs.



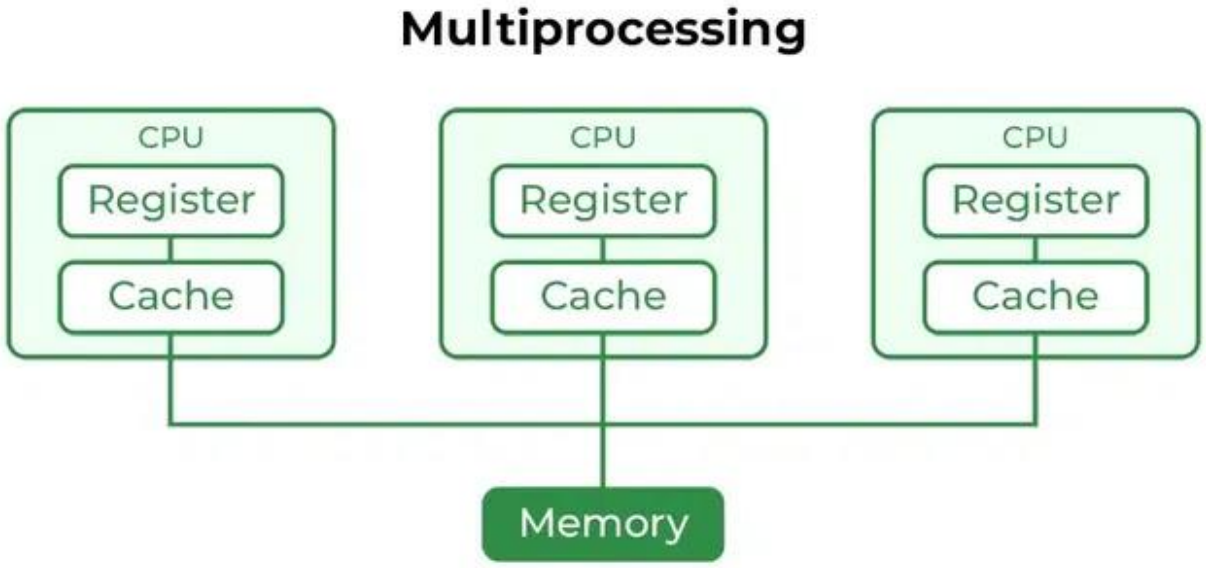
2. Multi-Programming Operating System

- Multiprogramming Operating Systems can be simply illustrated as more than one program is present in the main memory and any one of them can be kept in execution. This is basically used for better execution of resources.

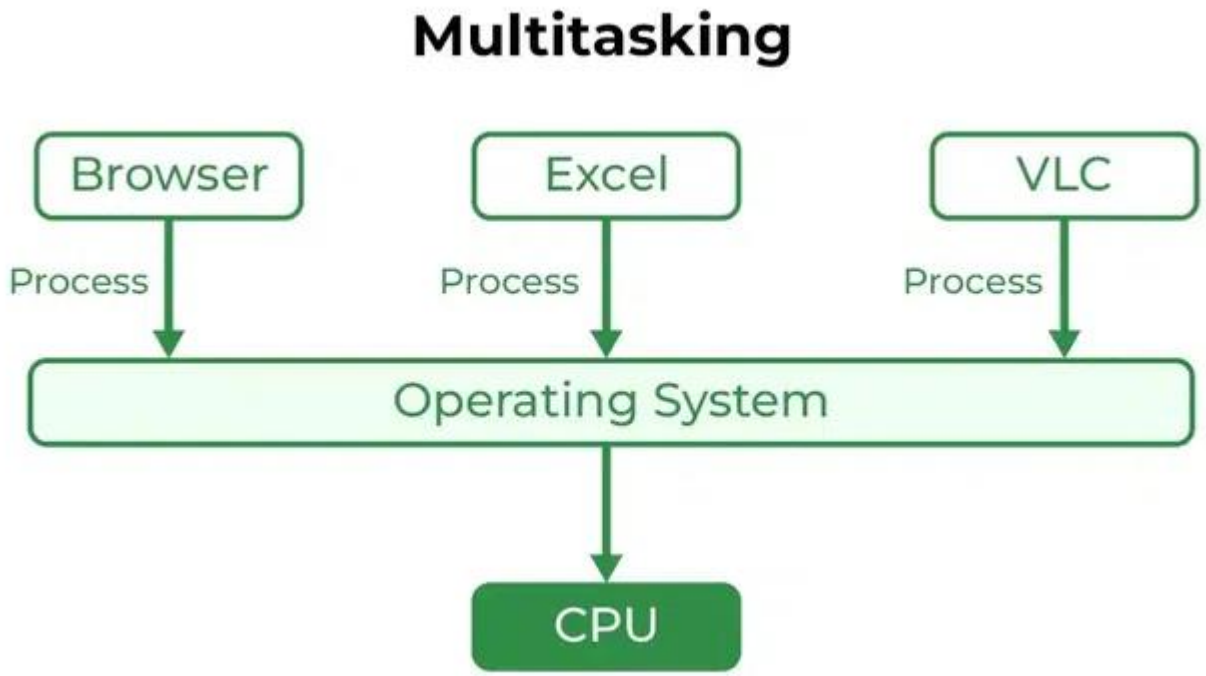


3. Multi-Processing Operating System

- Multi-Processing Operating System is a type of Operating System in which more than one CPU is used for the execution of resources. It betters the throughput of the System.

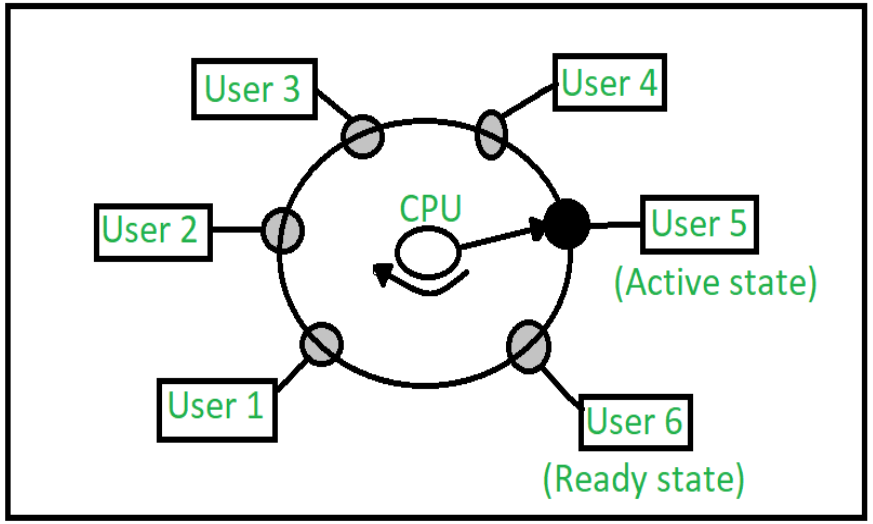


4. Multi-Tasking Operating System



5. Time-Sharing Operating Systems

- Each task is given some time to execute so that all the tasks work smoothly. Each user gets the time of the CPU as they use a single system. These systems are also known as Multitasking Systems. The task can be from a single user or different users also. The time that each task gets to execute is called quantum. After this time interval is over OS switches over to the next task.



6. Real-Time Operating System

- These types of OSs serve real-time systems. The time interval required to process and respond to inputs is very small. This time interval is called response time.
- Real-time systems are used when there are time requirements that are very strict like missile systems, air traffic control systems, robots, etc.

Examples of Operating Systems

MS-DOS (Character User Interface Operating System (CUI))

Tim Patterson originally developed MS-DOS in 1980. DOS is still 16-bit OS and does not support multiple users or multitasking. MS-DOS stands for Microsoft Disk operating System. This OS was originally written for the IBM pc by the Microsoft Corporation. The first release of the DOS came in 1981 which is a single user operating system, which allows the user to enter command using textual interface. It has three essential files and many command files. These essential files are: IO.SYS (Input Output System), MSDOS.SYS (Microsoft Disk Operating System), and COMMAND.COM. These files are called system files of MS-DOS.

Windows OS

- MS Window was introduced by Microsoft Corporation in the year 1985, generally referred to as Windows, is an operating system based on a **GUI** (Graphical User Interface). That means it uses **WIMP**(windows, icons, menus, and pointing devices) to make using the operating system easier.
- Windows is a **multi-tasking** operating system - a single user can run multiple programs at the same time. The programs share the Central Processing Unit (CPU) resources.
- As with all operating systems, the Windows Operating System (OS) controls all input, processing, and output.

Basic Features of Windows Operating System

1) **Windows Easy Transfer:** One of the first things you might want to do is to transfer your files and settings from your old computer to the new computer. You can do this using an Easy Transfer Cable, CDs or DVDs, a USB flash drive, a network folder, or an external hard disk.

2) Windows Anytime Upgrade: This feature of Windows Operating System allows you to upgrade to any higher windows version available for your system, so you can take full advantage of enhanced digital entertainment and other features.

3) Windows Basics: If you are new to Windows or want to refresh your knowledge about areas such as security or working with digital pictures, this features will help you to get started.

4) Searching and Organizing: Most folders in Windows have a search box in the upper- right corner. To find a file in a folder, type a part of the file name in the search box.

5) Parental Controls : Parental Controls give you the means to decide when your children use the computer, which website they visit, and which games they are allowed to play. You can also get reports of your children's computer activity as well.

LINUX Operating System

Linux is basically multi user, multitasking operating system. It provides character interface & graphical user interface. Both for interacting with computer. It was originally designed and developed by ‘Linux Benedict Torvalds in the year 1991.

- The objective behind developing Linux was to bring out an operating system, which was low in cost and had the power of UNIX operating system.
- Its Version is available free of cost to everyone.
- Many software developing companies have incorporated many functionalities into it and are marketing it. Red Hats Linux is one such operating system and many more also exist.

- Linux also has powerful networking features incorporated in to it and has built in internet facilities.
- Linux has gained popularity these days and is emerging as parallel competitor, window and UNIX operating system.
- Linux operating system provides both type of user interface. It supports CUI & GUI both. graphical interface provides windows look alike working environment, features like drag and drop, cut and paste, file sharing, multitasking etc. are also available in Linux. Character user interface of Linux is really powerful and provides thousands of commands for doing wide variety of tasks.

Android Operating System

- Android is a popular, Linux-based mobile phone operating system developed by Google primarily for touch screen mobile devices such as smart phones and tablet computers. The Android operating system (OS) powers phones, watches, and even car stereos.
- The android is a powerful operating system and it supports large number of applications in Smartphones. These applications are more comfortable and advanced for the users. The hardware that supports android software is based on ARM (Advanced RISC Machines) architecture platform. The android is an open source operating system means that it’s free and any one can use it. The android has got millions of apps available that can help you managing your life one or other way and it is available low cost in market at that reasons android is very popular.

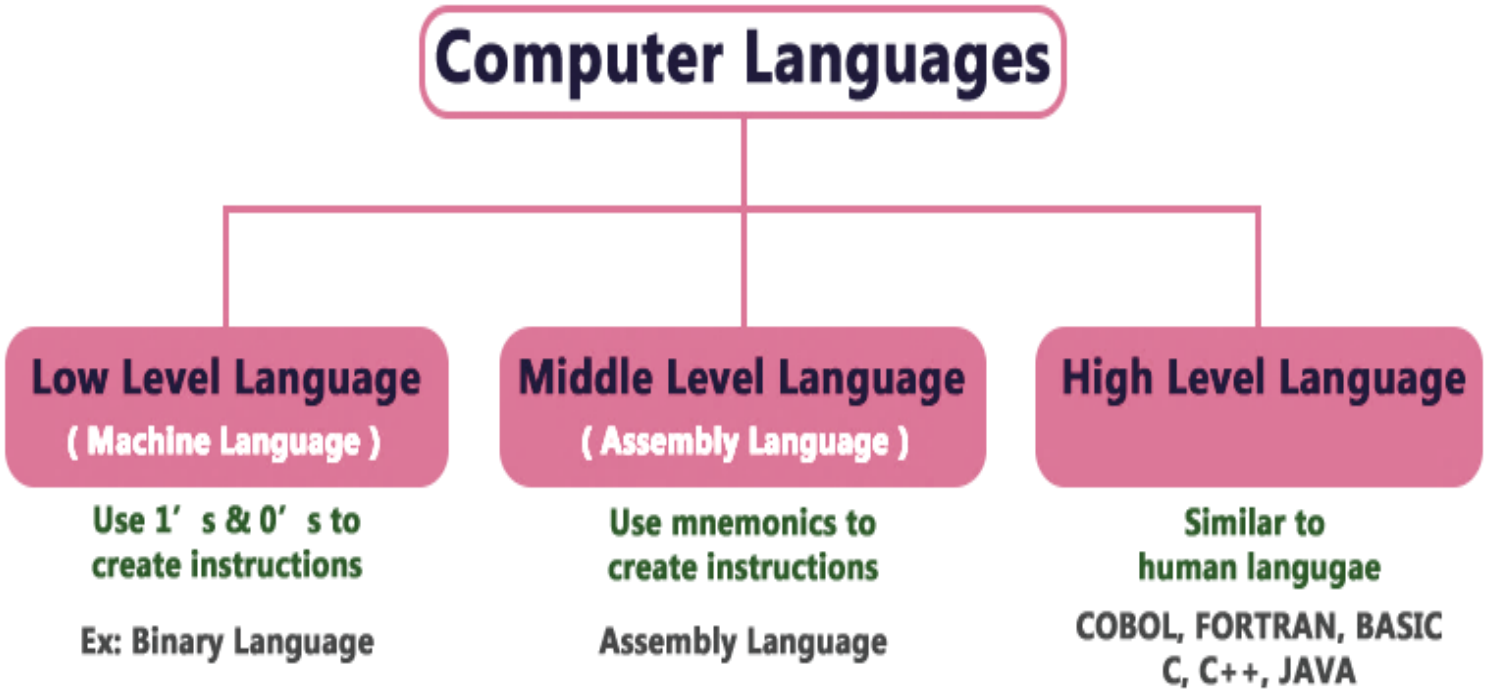
- **Advantages:**
- Android is Linux based open source operating system , it can be developed by any one
- Easy access to the android apps
- You can replace the battery and mass storage, disk drive and UDB option
- Its supports all Google services
- The operating system is able to inform you of a new SMS and Emails or latest updates.
- It supports Multitasking
- Android phone can also function as a router to share internet
- Its free to customize
- Can install a modified ROM
- Its supports 2D and 3D graphics

Computer Languages

- Generally, we use languages like English, Hindi, Telugu etc., to make communication between two persons. That means, when we want to make communication between two persons, we need a language through which persons can express their feelings. Similarly, when we want to make communication between user and computer or between two or more computers, we need a language through which user can give information to computer and vice versa. When user wants to give any instruction to the computer the user needs a specific language, and that language is known as computer language.
- User interacts with the computer using programs and that programs are created using computer programming languages like C, C++, Java etc.,
- Computer languages are the languages through which user can communicate with the computer by writing program instructions.
- Every computer programming language contains a set of predefined words and a set of rules (syntax) that are used to create instructions of a program.

Computer Languages Classification

Over the years, computer languages have been evolved from Low Level to High Level Languages. In the earliest days of computers, only Binary Language was used to write programs. The computer languages are classified as follows...



Low Level Language (Machine Language)

- Low Level language is the only language which can be understood by the computer. Binary Language is an example of low-level language. Low level language is also known as Machine Language. The binary language contains only two symbols 1 & 0. All the instructions of binary language are written in the form of binary numbers 1's & 0's. A computer can directly understand the binary language. Machine language is also known as Machine Code.

- As the CPU directly understands the binary language instructions, it does not require any translator. CPU directly starts executing the binary language instructions and takes very less time to execute the instructions as it does not require any translation. Low level language is considered as the First-Generation Language (1GL).

Advantages

- A computer can easily understand the low-level language.
- Low level language instructions are executed directly without any translation.
- Low level language instructions require very less time for their execution.

Disadvantages

- Low level language instructions are very difficult to use and understand.
- Low level language instructions are machine dependent, that means a program written for a particular machine does not executes on other machine.
- In low level language, there is more chance for errors and it is very difficult to find errors, debug and modify.

Middle Level Language (Assembly Language)

Middle level language is a computer language in which the instructions are created using symbols such as letters, digits and special characters. Assembly language is an example of middle level language. In assembly language, we use predefined words called mnemonics. Binary code instructions in low level language are replaced with mnemonics and operands in middle level language. But computer can not understand mnemonics, so we use a translator called Assembler to translate mnemonics into binary language. Assembler is a translator which takes assembly code as input and produces machine code as output.

- Following are some examples of typical assembly language statements:

```
INC COUNT      ; Increment the memory variable COUNT
MOV TOTAL, 48  ; Transfer the value 48 in the
               ; memory variable TOTAL
ADD AH, BH     ; Add the content of the
               ; BH register into the AH register
AND MASK1, 128 ; Perform AND operation on the
               ; variable MASK1 and 128
ADD MARKS, 10 ; Add 10 to the variable MARKS
MOV AL, 10     ; Transfer the value 10 to the AL register
```

Advantages

- Writing instructions in middle level language is easier than writing instructions in low level language.
- Middle level language is more readable compared to low level language.
- Easy to understand, find errors and modify.

Disadvantages

- Middle level language is specific to a particular machine architecture, that means it is machine dependent.
- Middle level language needs to be translated into low level language.
- Middle level language executes slower compared to low level language.

High Level Language

- High level language is a computer language which can be understood by the users. High level language is very similar to the human languages and have a set of grammar rules that are used to make instructions more easily. Every high-level language have a set of predefined words known as Keywords and a set of rules known as Syntax to create instructions. High level language is more easier to understand for the users but the computer can not understand it. High level language needs to be converted into low level language to make it understandable by the computer. We use Compiler or Interpreter to convert high level language to low level language.
- Languages like COBOL, FORTRAN, BASIC, C ,C++, JAVA,PYTHON etc., are the examples of high-level languages. All these programming languages use human understandable language like English to write program instructions. These instructions are converted to low level language by the compiler so that it can be understood by the computer.

Advantages

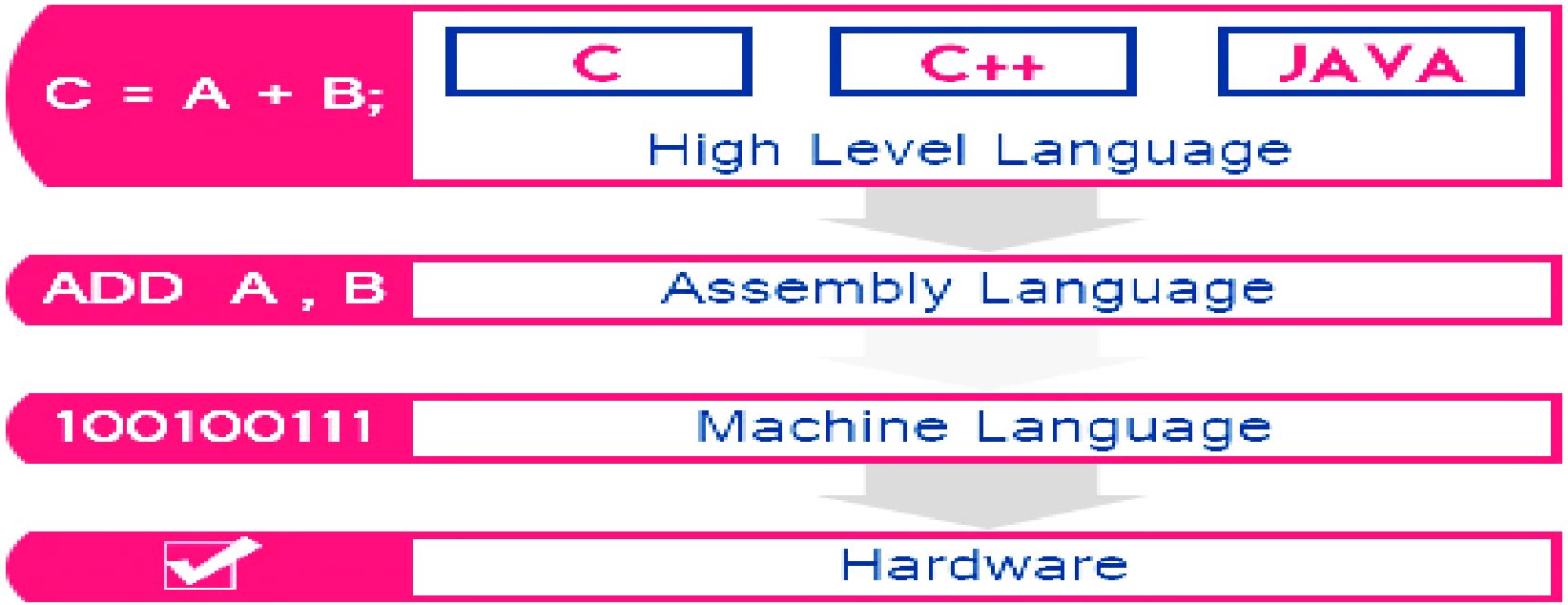
- Writing instructions in high level language is more easier.
- High level language is more readable and understandable.
- The programs created using high level language runs on different machines with little change or no change.
- Easy to understand, create programs, find errors and modify.

Disadvantages

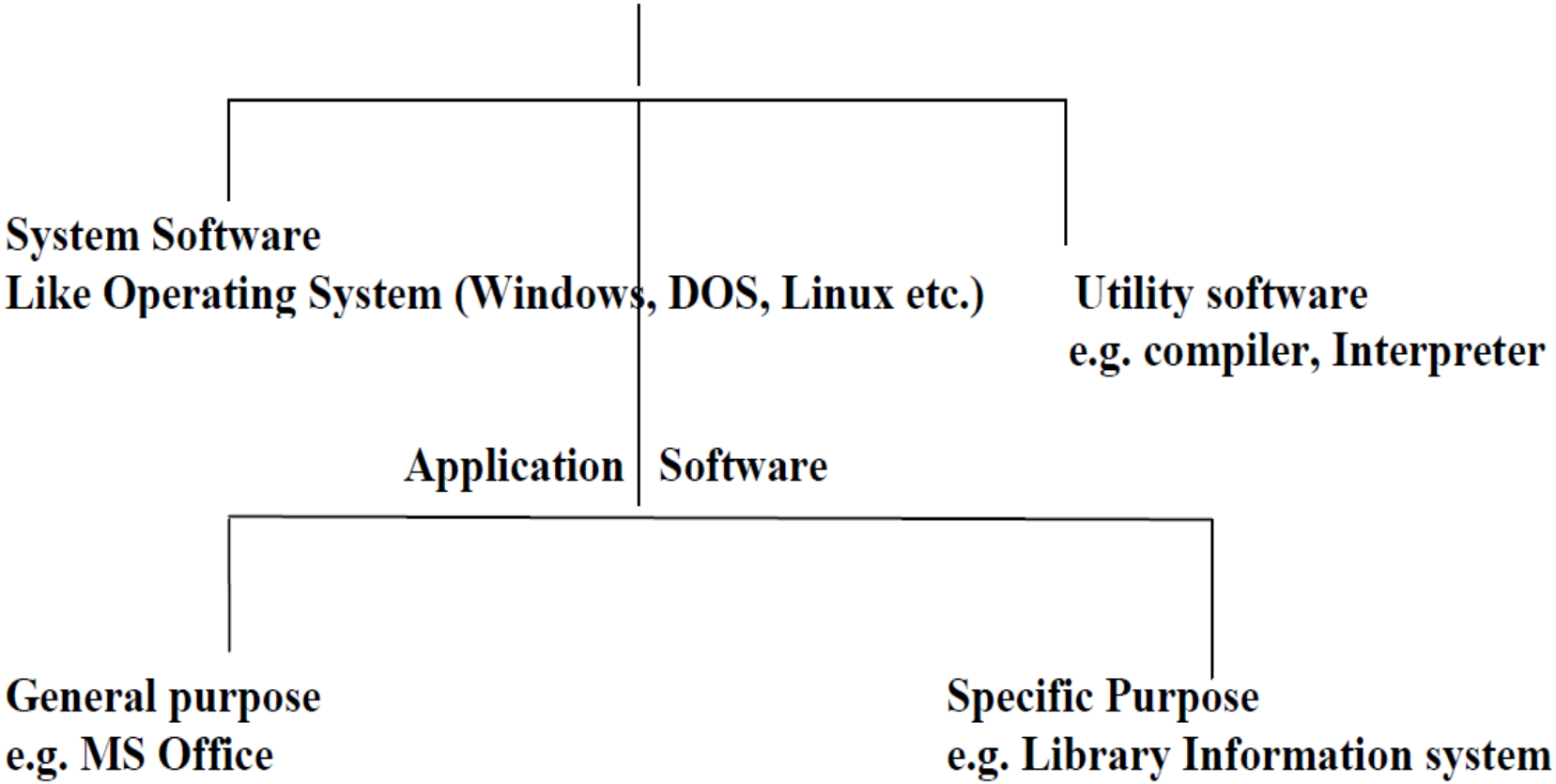
- High level language needs to be translated to low level language.
- High level language executes slower compared to middle and low level languages.

Understanding Computer Languages

- The following figure provides few key points related to the computer languages.



Classification of software



TRANSLATORS

- A computer will not understand any program written in a language, other than its machine language. The programs written in other languages must be translated into the machine language. Such translation is performed with the help of software called translator.

TRANSLATORS

Assembler:

- A program which translates an assembly language program into a machine language program is called an assembler. If an assembler which runs on a computer and produces the machine codes for the same computer then it is called **self assembler** or resident assembler. If an assembler that runs on a computer and produces the machine codes for other computer then it is called **Cross Assembler**.
- Assemblers are further divided into two types: One Pass Assembler and Two Pass Assembler. One pass assembler is the assembler which assigns the memory addresses to the variables and translates the source code into machine code in the first pass simultaneously. A Two Pass Assembler is the assembler which reads the source code twice. In the first pass, it reads all the variables and assigns them memory addresses. In the second pass, it reads the source code and translates the code into object code.

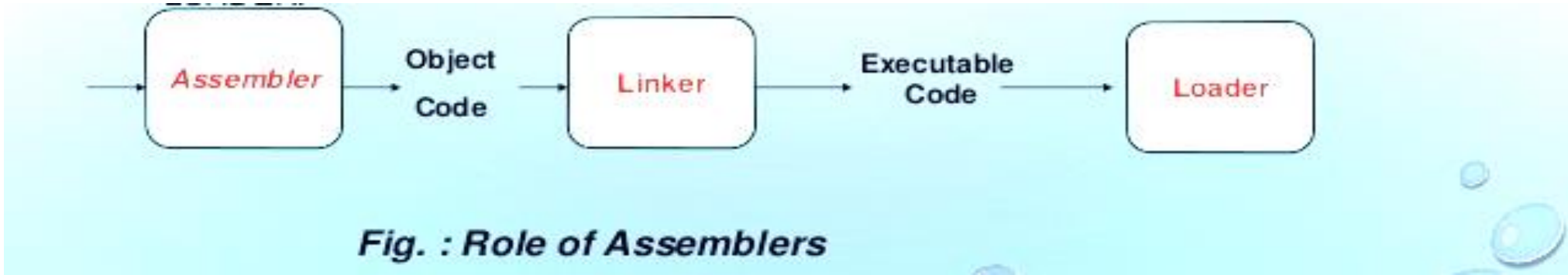
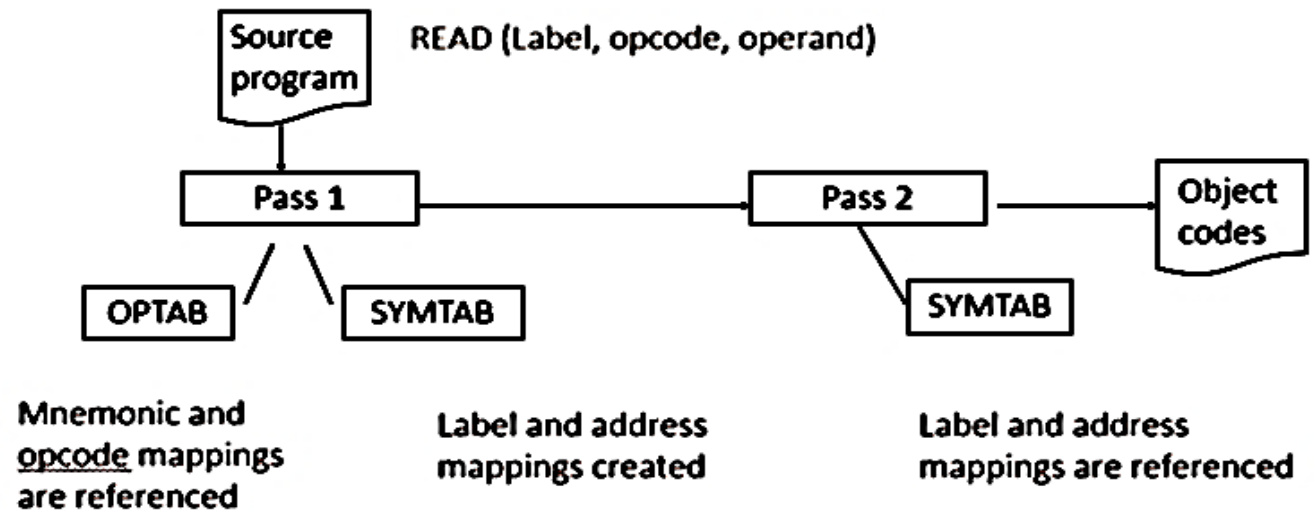


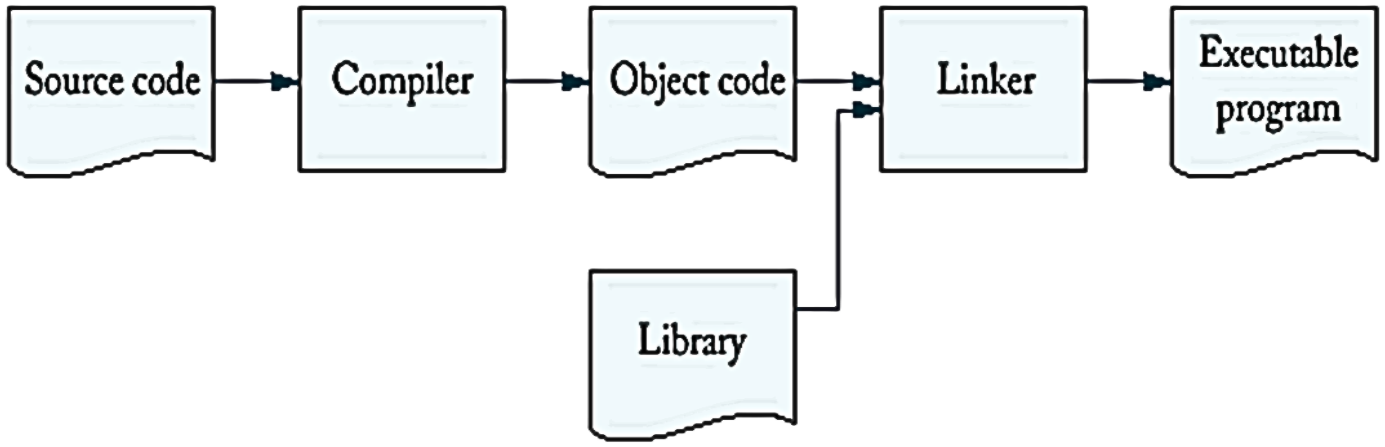
Fig. : Role of Assemblers

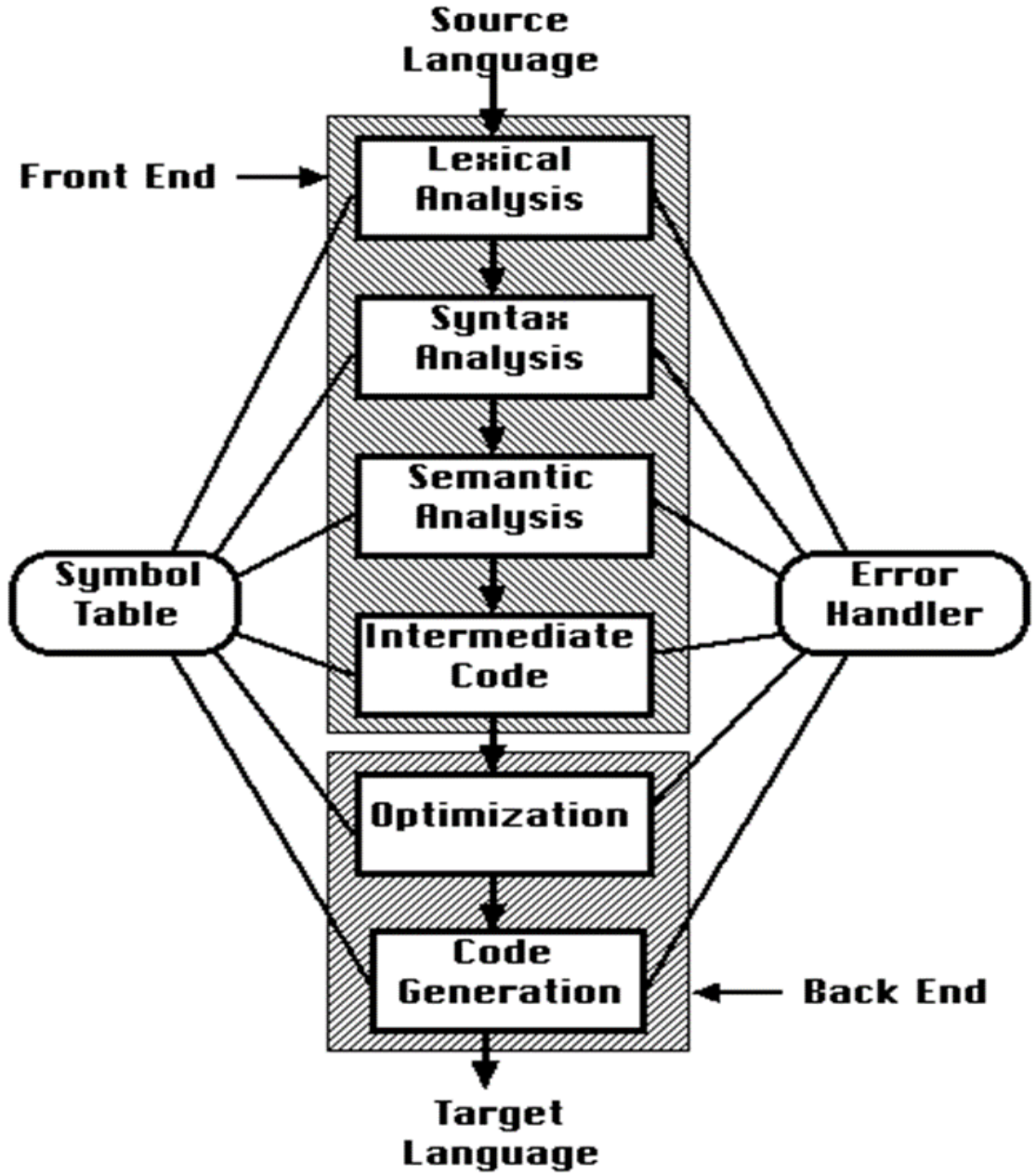
A Simple Two Pass Assembler Implementation



Compiler:

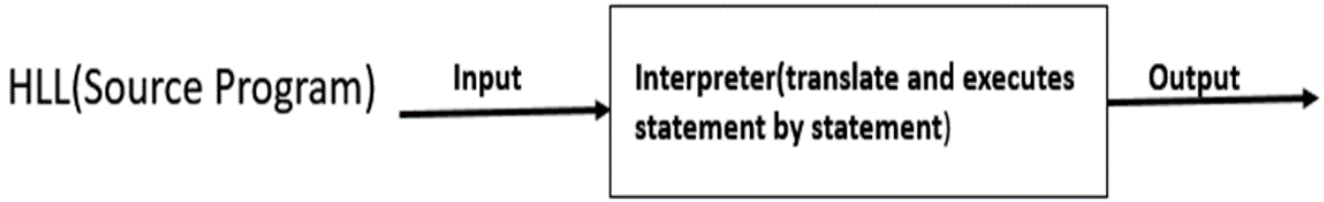
Compiler is a computer program(s) that transforms source code written in a programming language into machine language that is the target language which usually has a binary form known as object code. compiler goes through the entire program and then translates the entire program into machine codes and intelligently checks all kinds of limits, ranges, errors etc. and report if any.




Source Language
Front End
Lexical Analysis
Syntax Analysis
Semantic Analysis
Intermediate Code
Symbol Table
Error Handler
Optimization
Code Generation
Back End
Target Language

Interpreter:

- An interpreter is a program which translates statements of a program into machine code. It translates only one statement of the program at a time. It reads only one statement of program, translates it and executes it. Then it reads the next statement of the program again translates it and executes it. In this way it proceeds further till all the statements are translated and executed. On the other hand, a compiler goes through the entire program and then translates the entire program into machine codes. A compiler is 5 to 25 times faster than an interpreter.
- By the compiler, the machine codes are saved permanently for future reference. On the other hand, the machine codes produced by interpreter are not saved. An interpreter is a small program as compared to compiler. It occupies less memory space, so it can be used in a smaller system which has limited memory space.



Linker:

- In high level languages, some built in header files or libraries are stored. These libraries are predefined, and these contain basic functions which are essential for executing the program. These functions are linked to the libraries by a program called Linker. If linker does not find a library of a function, then it informs to compiler and then compiler generates an error. The compiler automatically invokes the linker as the last step in compiling a program.
- Not built in libraries, it also links the user defined functions to the user defined libraries. Usually a longer program is divided into smaller subprograms called modules. And these modules must be combined to execute the program. The process of combining the modules is done by the linker.

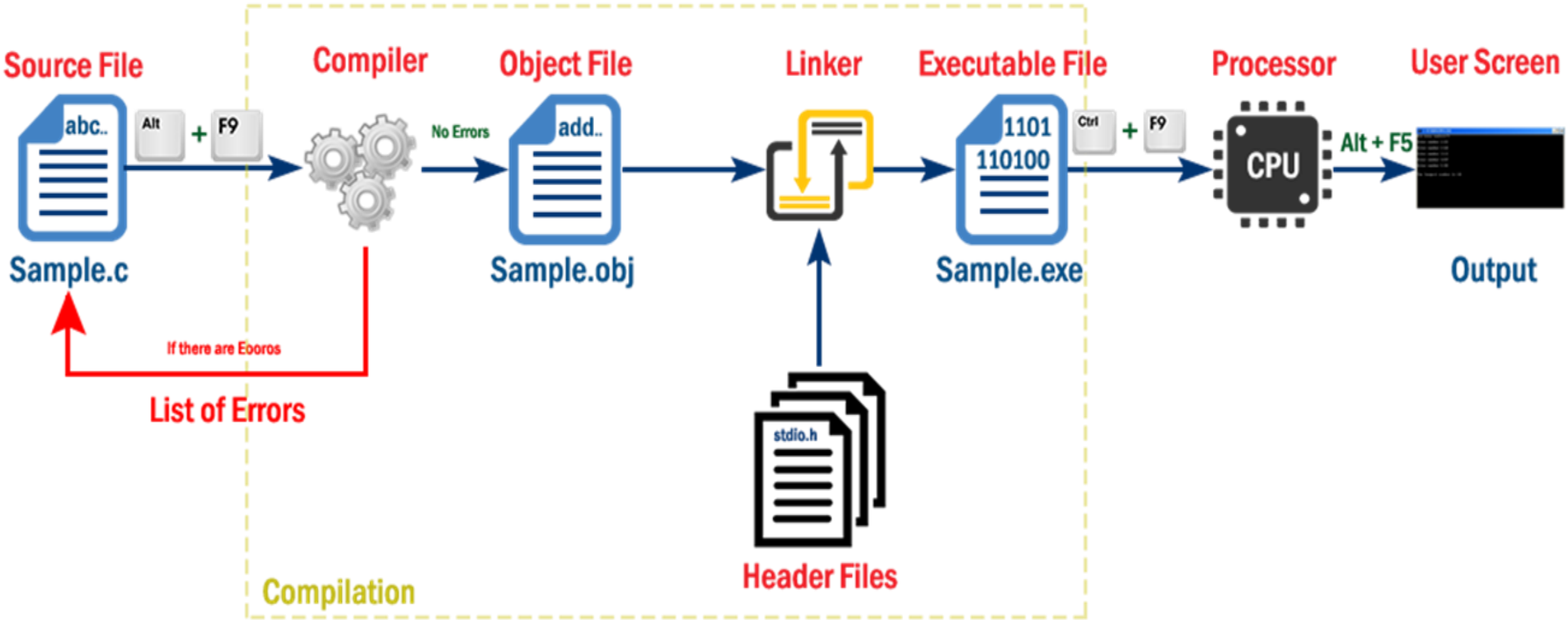
Loader:

Loader is a program that loads machine codes of a program into the system memory. In Computing, a loader is the part of an Operating System that is responsible for loading programs. It is one of the essential stages in the process of starting a program. Because it places programs into memory and prepares them for execution. Loading a program involves reading the contents of executable file into memory. Once loading is complete, the operating system starts the program by passing control to the loaded program code. All operating systems that support program loading have loaders. In many operating systems the loader is permanently resident in memory.

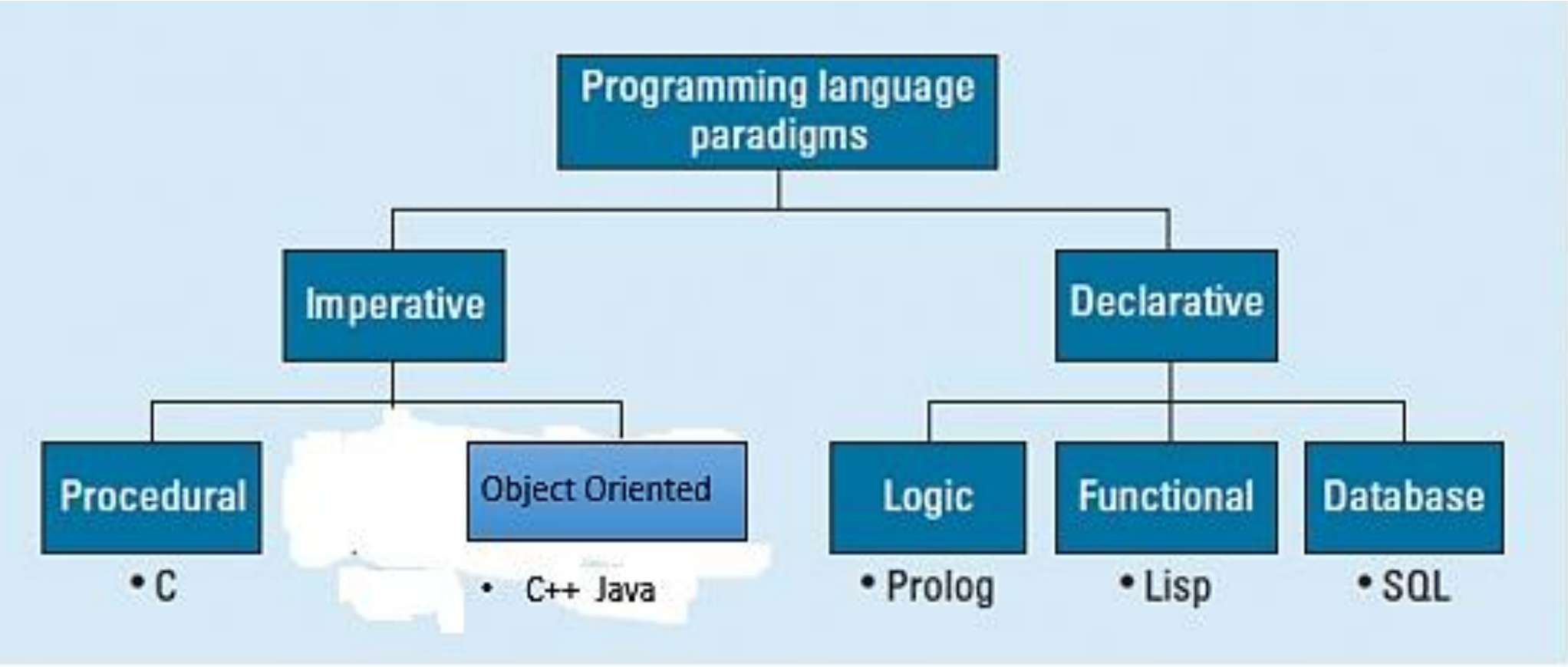
The difference between an interpreter and a compiler is given below:

Interpreter	Compiler
Translates program one statement at a time.	Scans the entire program and translates it as a whole into machine code.
It takes less amount of time to analyze the source code, but the overall execution time is slower.	It takes large amount of time to analyze the source code, but the overall execution time is comparatively faster.
No intermediate object code is generated, hence are memory efficient.	Generates intermediate object code which further requires linking, hence requires more memory.
Continues translating the program until the first error is met, in which case it stops. Hence debugging is easy.	It generates the error message only after scanning the whole program. Hence debugging is comparatively hard.
Programming language like Python, Ruby, Basic use interpreters.	Programming language like C, C++,Java use compilers.

Execution Process of a C Program



Classification of High level languages



Structured Programming

Structured programming frequently employs a top-down design model in which developers map out the overall program structure into separate subsections.

C is called a structured programming language because to solve a large problem, C programming language divides the problem into smaller modules called functions or procedures each of which handles a particular responsibility. The program which solves the entire problem is a collection of such functions. One major drawback of C language is that similar functions cannot be grouped inside a module or class. Also functions cannot be associated to a type or structure. Thus data and functions cannot be bound together. C++ language overcomes these problems by introducing object-oriented functionality in its programming capabilities.

Advantages

- C structured programming is simple and easy to understand and implement.
- It is well sited for small size implementation. However this is not restricted. A good design can extend it to large size implementation.
- Programmers do not require to know complex design concepts to start a new program.

Disadvantages

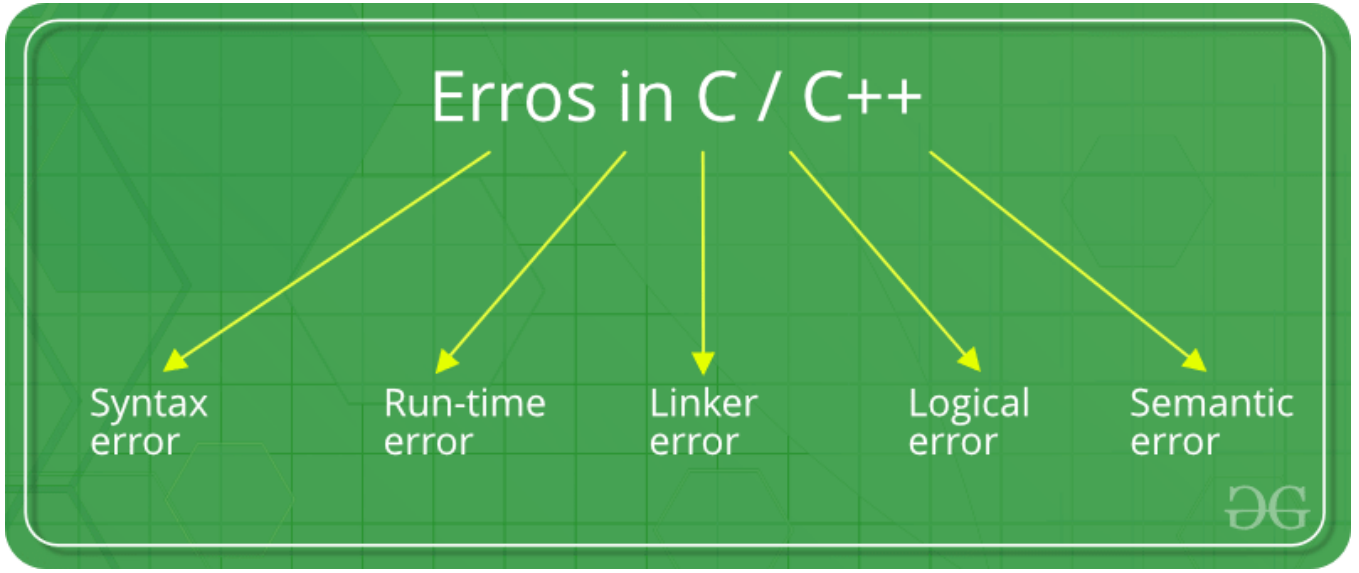
- Data and methods and not be bind together in a module. Polymorphism and inheritance are not available.
- Complex design and full object-oriented design cannot be implemented.

Object Oriented Programming?

In OOP, the focus is on thinking about the problem to be solved in terms of real-world elements and representing the problem in terms of objects and their behavior. Classes depict the abstract representations of real-world objects. Classes are like blueprints or templates, which gather similar items or things that can be grouped together. Classes have properties called attributes. Attributes are implemented as global and instance variables. Methods in the classes represent or define the behavior of these classes. Methods and attributes of classes are called the members of the class. An instance of a class is called an object. Therefore, an object is a data structure that closely resembles some real-world object. There are several important OOP concepts such as Data abstraction, Encapsulation, Polymorphism, and Inheritance.

Errors in C/C++

- Error is an illegal operation performed by the user which results in abnormal working of the program.
- Programming errors often remain undetected until the program is compiled or executed. Some of the errors prevent the program from getting compiled or executed. Thus errors should be removed before compiling and executing.
- The most common errors can be broadly classified as follows.



Syntax errors:

Errors that occur when you violate the rules of writing C/C++ syntax are known as syntax errors. This compiler error indicates something that must be fixed before the code can be compiled. All these errors are detected by compiler and thus are known as compile-time errors.

Most frequent syntax errors are:

Missing Parenthesis (})

Printing the value of variable without declaring it

Missing semicolon like this:

```
// C program to illustrate
// syntax error
#include<stdio.h>
void main()
{
    int x = 10;
    int y = 15;

    printf("%d", (x, y)) // semicolon missed
}
```

```
error: expected ';' before '}' token
```

Run-time Errors :

- Errors which occur during program execution(run-time) after successful compilation are called run-time errors. One of the most common run-time error is division by zero also known as Division error. These types of error are hard to find as the compiler doesn't point to the line at which the error occurs.
- For more understanding run the example given below.

```
#include<stdio.h>
void main()
{
   int n = 9, div = 0;
      // wrong logic
   // number is divided by 0,
   // so this program abnormally terminates
   div = n/0;

   printf("resut = %d", div);
}
```

Linker Errors:

These error occurs when after compilation we link the different object files with main's object using Ctrl+F9 key(RUN). These are errors generated when the executable of the program cannot be generated. This may be due to wrong function prototyping, incorrect header files. One of the most common linker error is writing Main() instead of main().

```
#include<stdio.h>
  void Main() // Here Main() should be main()
{
    int a = 10;
    printf("%d", a);
}
```

error: undefined reference to `main'

Logical Errors :

- On compilation and execution of a program, desired output is not obtained when certain input values are given. These types of errors which provide incorrect output but appears to be error free are called logical errors. These are one of the most common errors done by beginners of programming.
- These errors solely depend on the logical thinking of the programmer and are easy to detect if we follow the line of execution and determine why the program takes that path of execution.

```
int main()
{
   int i = 0;
    // logical error : a semicolon after loop
   for(i = 0; i < 3; i++);
   {
      printf("loop ");
      continue;
   }
   getchar();
   return 0;
}
```

No output

Semantic errors :

This error occurs when the statements written in the program are not meaningful to the compiler.

```
void main()
{
  int a, b, c;
  a + b = c; //semantic error
}
```

Error

error: value required as left operand of assignment
a + b = c; //semantic error