- **CISC:**
  The main idea is that a single instruction will do all loading, evaluating, and storing operations just like a multiplication command will do stuff like loading data, evaluating, and storing it, hence it's complex.

  Characteristic of CISC –

  1. Complex instruction, hence complex instruction decoding.
  2. Instructions are larger than one-word size.
  3. Instruction may take more than a single clock cycle to get executed.
  4. Less number of general-purpose registers as operations get performed in memory itself.
  5. Complex Addressing Modes.
  6. More Data types.
- **RISC:**
  The main idea behind this is to make hardware simpler by using an instruction set composed of a few basic steps for loading, evaluating, and storing operations just like a load command will load data, a store command will store the data.

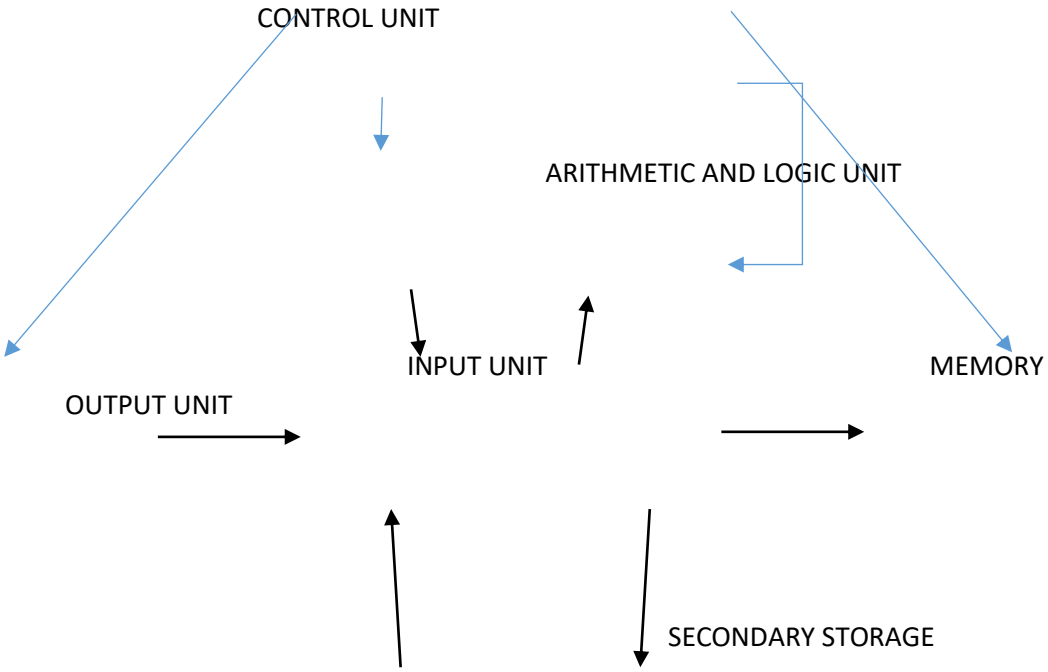
  Characteristic of RISC –

  1. Simpler instruction, hence simple instruction decoding.
  2. Instruction comes undersize of one word.
  3. Instruction takes a single clock cycle to get executed.
  4. More general-purpose registers.
  5. Simple Addressing Modes.
  6. Fewer Data types.
  7. A pipeline can be achieved.

Difference –

RISC	CISC
Focus on software	Focus on hardware
Uses only Hardwired control unit	Uses both hardwired and microprogrammed control unit
Transistors are used for more registers	Transistors are used for storing complex Instructions
Fixed sized instructions	Variable sized instructions
Can perform only Register to Register Arithmetic operations	Can perform REG to REG or REG to MEM or MEM to MEM
Requires more number of registers	Requires less number of registers
Code size is large	Code size is small
An instruction executed in a single clock cycle	Instruction takes more than one clock cycle
An instruction fit in one word.	Instructions are larger than the size of one word
Simple and limited addressing modes.	Complex and more addressing modes.
RISC is Reduced Instruction Cycle.	CISC is Complex Instruction Cycle.

RISC	CISC
The number of instructions are less as compared to CISC.	The number of instructions are more as compared to RISC.
It consumes the low power.	It consumes more/high power.
RISC is highly pipelined.	CISC is less pipelined.
RISC required more RAM.	CISC required less RAM.
Here, Addressing modes are less.	Here, Addressing modes are more.



BLOCK DIAGRAM OF COMPUTER

- **Basic units of Computer:**

1. Input unit: It creates links between user and computer. With the help of input unit, we enter the data into computer. The data is then to be processed by the computer are accepted by the input unit.

   Example: Keyboard, mouse, scanner, etc.

2. Output unit:
   This unit contains the devices with the help of which, we get information from the computer. The data those are processed by the CPU, according to the given instruction are displayed through the output unit.
   Example: Monitor, printer, etc.
3. CPU (Central processing unit):
   CPU is the brain of the computer. This unit controls the overall operations of the computer. This unit stores the data, instructions, and intermediate results. This unit is divided into sub units.
   i. Arithmetic Logical Unit (ALU):
      a. Arithmetic Unit: Its function is to perform arithmetic operations like addition, subtraction, multiplication and division. The complex operations can be performed by using repetitive action of the above processes.
      b. Logical unit: This section performs logical operations like logical AND, logical OR, logical NOT, selecting, comparing, etc.
   ii. Control unit: This unit controls the overall operations of the computer. None of the units will until control signal from the control unit is received. Control unit performs the following tasks:
      a. It integrates and controls overall operations.
      b. It selects and retrieves the instructions from the main memory.

c. Then it retrieves the data to be processed according to the instruction from memory unit.
d. It allows the CPU to perform the task according to the instructions.
e. It stores the result, in output area of the memory.
f. It fetches the next instruction and complete the whole cycle again and again; until results are obtained.

iii. Memory unit:
This unit stores the data, program and intermediate result. This unit gives the information to other unit when needed. This unit is also called as 'Internal memory' OR 'Random access memory (RAM)'. This unit is divided into 4 regions which have no physical boundaries. Those regions are-
a. Input storage area
b. Working storage area
c. Output storage area
d. Program storage area

4. <u>Secondary storage unit:</u>
This unit includes the devices that are not always (directly) accessible to computer. These devices are used to store large amount of data. This type of storage is also called 'secondary memory' or 'Auxiliary memory'.
Example: Hard drive, SSD, Pen drive, SD card, Floppy disk, DVDs, etc.

- **Programming languages:**
Programming languages acts as a mediator between user and computer, passing on the information and instructions.

Programming languages are a communication medium through which user can interact with the computer system using

statements. Statements are such type of sentences which can produce one value at a time – True or False. Statements are also known as “Proposition”.

The rules to write correct statements is called “Syntax”. That means, the grammar of programming languages to write appropriate statement is called Syntax.

- **Machine language:**
  Machine language is the 1st generation language which is written in pure binary form. Machine language is also called Low level language.

  The lowest level component of computer system is hardware, the programming language which has capability to handle lowest level component is called Low level programming language. Machine language has the capacity to directly handle the lowest level component of computer system, so it is called low-level programming language.

  Properties of Machine language:
  - Must be written in pure binary form.
  - Execution speed is maximum because any type of conversion is not needed.
  - It is very difficult to write and debug.
  - Understanding is very difficult.
  - It is not portable, which means, a single program cannot be executed in different computer systems.
  - Execution speed of machine language program is maximum, so some devices are replaced by machine level program, which is called firmware.
- **Assembly language:**

Assembly language is also called as 2nd generation programming language. This programming language uses alpha-numeric symbols to write the instruction of a program. Meaningful and easy to remember symbols are used in the instruction, for example- “ADD” for addition, “SUB” for subtraction, etc.

These symbols are called “Mnemonics”. A program written is mnemonics is called assembly language. It also machine depend language.

Properties of Assembly language:

- Writing and debugging is easier than machine language.
- Introduction of alphanumeric codes.
- Execution speed is comparatively slow due to need of compilation process.
- It is also non-portable that means, even assembly language programs cannot run on multiple machines without modification.

- **High level language:**

  High level languages were introduces after 2nd generation languages and they are categorized as 3rd, 4th or 5th generation languages. These programming languages uses English related words to write and understand the codes more easily. Due to use of English words, learning new programming languages is also easy.

  There are multiple high level languages which needs to compiled or interpreted before execution. Programs written in high level languages are portable and can run different machines without any changes.

  Properties of High level language:

- Writing and debugging is easier than ever due to use of English words and different programming paradigms.
- Execution is slow as compared to machine language or assembly language due to the need to be compiled or interpreted.
- Programs written in these programming languages can be run of different machines without any changes as these are portable.

- **Compilers:**

  A Compiler is a software that typically takes a high level language (Like C++ and Java) code as input and converts the input to a lower level language at once. It lists all the errors if the input code does not follow the rules of its language. This process is much faster than interpreter but it becomes difficult to debug all the errors together in a program.

  A compiler is a translating program that translates the instructions of high level language to machine level language. A program which is input to the compiler is called a Source program. This program is now converted to a machine level language by a compiler is known as the Object code.

  <u>Properties of Compiler:</u>

  - It is a piece of software which converts programs written in high level languages to machine language.
  - It can convert whole program at once and if there is any error in the syntax, it lists them all at once.
  - Debugging is bit tough as it gives all error at once as compared to interpreter.
  - It is fast as compared to interpreters.

- **Interpreters:**

All high level languages need to be converted to machine code so that the computer can understand the program after taking the required inputs. The software by which the conversion of the high level instructions is performed line-by-line to machine level language, other than compiler and assembler, is known as INTERPRETER.

If an error is found on any line, the execution stops till it is corrected. This process of correcting errors is easier as it gives line-by-line error but the program takes more time to execute successfully. It translates source code into some efficient intermediate representation and immediately execute this. Source programs are compiled ahead of time and stored as machine-independent code, which is then linked at run-time and executed by an interpreter.

It helps the programmer to find out the errors and to correct them before the control moves to the next statement. Interpreter system performs the actions described by the high-level program. For interpreted programs, the source code is needed to run the program every time. Interpreted programs run slower than compiled programs.

Properties of Interpreters:

- It is a piece of software which converts programs written in high level languages to machine language.
- It cannot convert whole program at once. It checks each line one-by-one and then converts it to machine language.
- Debugging is easier than compiled programming languages as user gets and error message for the same line.
- It is slow as compared to compilers.

- **Assemblers:**

The Assembler is used to translate the program written in Assembly language into machine code. The source program is an input of an assembler that contains assembly language instructions. The output generated by the assembler is the object code or machine code understandable by the computer.

Assembler is basically the 1st interface that is able to communicate humans with the machine. We need an Assembler to fill the gap between human and machine so that they can communicate with each other. Code written in assembly language is some sort of mnemonics (instructions) like ADD, MUL, MUX, SUB, DIV, MOV and so on. And the assembler is basically able to convert these mnemonics in Binary code.

Properties of Assemblers:

- It is a piece of software which converts programs written in assembly languages to machine language.
- It is an interface between user and machine.

- **Information system:**

Information systems are a set of interconnected elements working together to collect, process, store, and distribute information to help coordination, visualization in an organization, analysis, and decision-making.

The Information system can be defined as a collection of software, hardware, and telecommunications network that people develop and use to gather, create, and distribute useful data, mainly in organizational settings.

In other words, an information system means a collection of interrelated components which work together to gather, process, store, and break down the information to help decision making.

- **Centralized processing:**
  Centralized systems are systems that use client/server architecture where one or more client nodes are directly connected to a central server. This is the most commonly used type of system in many organizations where a client sends a request to a company server and receives the response.

  Characteristics of Centralized System –

  - Presence of a global clock:
    As the entire system consists of a central node (a server/ a master) and many client nodes (a computer/ a slave), all client nodes sync up with the global clock (the clock of the central node).
  - One single central unit:
    One single central unit which serves/coordinates all the other nodes in the system.
  - Dependent failure of components:
    Central node failure causes the entire system to fail. This makes sense because when the server is down, no other entity is there to send/receive responses/requests.
- **Decentralized processing:**
  In decentralized systems, every node makes its own decision. The final behaviour of the system is the aggregate of the decisions of the individual nodes. Note that there is no single entity that receives and responds to the request.

  Characteristics of Decentralized System –

  - Lack of a global clock:

Every node is independent of each other and hence, has different clocks that they run and follow.
    - Multiple central units (Computers/Nodes/Servers):
      More than one central unit which can listen for connections from other nodes.
    - Dependent failure of components:
      One central node failure causes a part of the system to fail; not the whole system.
- **Distributed process:**
  Distributed processing is a computing process where operations are partitioned across several computers connected via a network. The goal of distributed processing is to provide faster and more reliable service than can be achieved by a single machine.

  Very often, datasets are too big to fit on one machine. Distributed data processing breaks down these large datasets and stores them across multiple machines or servers, improving data management. It rests on Hadoop Distributed File System (HDFS). A distributed data processing system has a high fault tolerance. If one server in the network fails, you can reallocate data processing tasks to other available servers, which is not a very time-consuming job.
- **Management processing modes:**
  The method of data processing used will determine the response time to a query and how reliable the output is. For instance, in a situation where availability is crucial, such as a stock exchange portal, transaction processing should be the preferred method.

  It is important to note the difference between data processing and a data processing system. Data processing refers to the rules by which data converts into useful information. A data processing system is an application optimized for a specific type of data

processing. For instance, a timesharing system is designed to run timesharing processing optimally. You can use it to run batch processing, too.

- **Uniprocessor:**
  A uniprocessor system is defined as a computer system that has a single central processing unit that is used to execute computer tasks. As more and more modern software is able to make use of multiprocessing architectures, such as SMP and MPP, the term uniprocessor is therefore used to distinguish the class of computers where all processing tasks share a single CPU. Most desktop computers are shipped with multiprocessing architectures since the 2010s. As such, this kind of system uses a type of architecture that is based on a single computing unit. All operations (additions, multiplications, etc.) are thus done sequentially on the unit.
- **Multiprocessor:**
  A multiprocessor is a computer system with two or more central processing units (CPUs), with each one sharing the common main memory as well as the peripherals. This helps in simultaneous processing of programs.

  The key objective of using a multiprocessor is to boost the system's execution speed, with other objectives being fault tolerance and application matching.

  A good illustration of a multiprocessor is a single central tower attached to two computer systems. A multiprocessor is regarded as a means to improve computing speeds, performance and cost-effectiveness, as well as to provide enhanced availability and reliability.

  <u>Benefits of using a multiprocessor include:</u>

- Enhanced performance
- Multiple applications
- Multiple users
- Multi-tasking inside an application
- High throughput and/or responsiveness
- Hardware sharing among CPUs

- **Batch processing:**
  As the name suggests, batch processing is when chunks of data, stored over a period of time, are analysed together or in batches. Batch processing is required when business owners and data scientists require a large volume of data to analyse for detailed insights. For example, sales figures will typically undergo batch processing, allowing businesses to use data visualization features like charts, graphs, and reports to derive value from data. Since a large volume of data is involved, the system will take time to process it. Processing the data in batches saves on computational resources.

  You might prefer batch processing over real-time processing when accuracy is more important than speed. Additionally, you can measure the efficiency of batch processing in terms of throughput. Throughput is the amount of data processed per unit of time.

- **Real time processing:**
  Real-time processing is the process of computing data as soon as it is generated or received. It's a form of distributed processing that allows you to capture and analyse incoming data streams in real-time, allowing you to act quickly on the insights given by the analysis.

Real-time processing is that you use it in situations where you expect output in real-time. Real-time processing computes incoming data as quickly as possible. If it encounters an error in incoming data, it ignores the error and moves to the next chunk of data input coming in. GPS-tracking applications are the most common example of real-time data processing.

- **Time sharing processing:**
  Time-sharing, in data processing, method of operation in which multiple users with different programs interact nearly simultaneously with the central processing unit (CPU) of a large-scale digital computer. Because the CPU operates substantially faster than most peripheral equipment (e.g., video display terminals and printers), it has sufficient time to solve several discrete problems during the input/output process. Even though the CPU addresses the problem of each user in sequence, access to and retrieval from the time-sharing system seems instantaneous from the standpoint of remote terminals since the solutions are available to them the moment the problem is completely entered.

  Commonly used time-sharing techniques include multiprocessing, parallel operation, and multiprogramming. Also, many computer networks organized for the purpose of exchanging data and resources are centred on time-sharing systems.

- **Electronic mail:**
  Email (electronic mail) is the exchange of computer-stored messages from one user to one or more recipients via the internet. Emails are a fast, inexpensive and accessible way to communicate for business or personal use. Users can send emails

from anywhere as long as they have an internet connection, which is typically provided by an internet service provider.

Email is exchanged across computer networks, primarily the internet, but it can also be exchanged between both public and private networks, such as a local area network. Email can be distributed to lists of people as well as to individuals.

- **Tele-text conferencing:**
  Teletext or broadcast teletext is a standard for displaying text and rudimentary graphics on suitably equipped television sets. Teletext is a system that links a computer with a television by which text and graphic information can be transmitted on a one way basis to home viewers. Indian television join the advance nations in 1985, it started the teletext known as index service to telecast the latest news and information on the stock exchange air lines, railway timings, weather information etc. In the system a fix number of pages are broadcast sequentially but continuously, each page consist of television screen, display of text and graphic shapes.

- **<u>Disk Operating System:</u>**
  Disk operating system is an open-source operating system, provided by Microsoft.
  Some of the main features of DOS are as follows:
  a) It is a single user OS.
  b) It is a single tasking OS.
  c) It can manage memory of machine.
  d) It manages peripheral devices.
  e) It can control input and output unit of the system.
  f) It works on textual format that means, there is no use of mouse in DOS.

g) DOS support:

- Internal command
- External command
- Batch files (.bat)

- **Internal commands:**
  The DOS commands which are inbuilt inside the DOS system files are called internal commands.

1. **cls (Clear the screen):**
   This command is used to clear the screen.
   C:\> cls
   NOTE: The C:\> is known as DOS prompt, C prompt or generally as prompt.
2. **date (Date command):**
   It can show and modify the current system date.
   C:\> date MM/DD/YY
3. **time (Time command):**
   This command can be used to show or modify current system time.
   C:\> time
4. **copy con (File creating command):**
   To create a new file in current directory.
   C:\> copy con abc.txt
   Press ctrl+z to save file.
5. **type (File opening command):**
   To show content of a file.
   C:\> type abc.txt
6. **copy (Copy command):**
   To copy files from one directory to other directory.
   C:\> copy abc.txt folder
   To merge files into one file.
   C:\> copy a1.txt+a2.txt a3.txt
7. **ren (Rename command):**

Used to rename file or directory.

C:\> ren abc.txt bcd.txt

C:\> ren s1 s2

8. md (Make a directory):

Used to make a new directory in current or desired directory.

C:\> md new1

9. cd (Change directory):

Used to change the current directory.

C:\> cd new1

10. cd.. (Change directory to parent directory):

Used to change directory to immediate parent directory.

C:\new1> cd..

11. cd \ (Root directory):

Used to change directory to root directory.

C:\new1> cd \

12. rd (Remove a directory):

Used to remove a blank directory.

C:/> rd new1

13. dir (Directory command):

Used to show all components of desired directory.

C:\> dir

Switches:

a. /p: Shows components pagewise.

C:\> dir/p

b. /w: Shows components in multiple columns.

C:\> dir/w

c. /AD: Shows only directories.

d. /A-D: Shows only files.

e. /AH: Shows only files with ‘hidden’ attribute.

f. /AR: Shows only files with ‘Read-only’ attribute.

g. /AS: Shows only files with ‘system’ attribute.

h. /AA: Shows only files with ‘archive’ attribute.

i. /ON: Ordered by Name (Asc).
j. /O-N: Ordered by Name (Desc).
k. /OE: Ordered by extension (Asc).
l. /O-E: Ordered by extension (Desc).
m. /OS: Ordered by size (Asc).
n. /O-S: Ordered by size (Desc).
o. /OD: Ordered by date (Asc).
p. /O-E: Ordered by date (Desc).
q. /S: Show sub-directories.

14. ver (Version command):

Show current system version.

C:\> ver

15. vol (Volume command):

Show label, serial number of the current volume.

C:\> vol

16. color (Color command):

Used to change foreground and background color.

C:\> color/?

- **External commands:**

The commands which are present in additional files other than system files, are called external commands.

1. attrib (Attribute command):

Attribute command is used to add/ remove attributes to the given file.

Switches:

a. +H: Add hidden
b. –H: Remove hidden
c. +A: Add archive
d. –A: Remove archive

e. +S: Add system
f. –S: Remove system
g. +R: Add read only
h. –R: Remove read only

2. **xcopy:**
   Better version of copy command.
   /s: Copies directories and sub-directories with all files.
   C:\> xcopy abc bcd /s
3. **CHKDSK:**
   To check disk error and partition error.
   C:\> CHKDSK E:
4. **diskcopy:**
   To copy an entire disk to another disk or partition.
   C:\> diskcopy A: D:
5. **more:**
   To show results pagewise.
   C:\> type abc.txt |more
6. **print:**
   To print textual file from default printer.
   C:\> print R.txt

7. **edit:**
   This command provides a better editing experience for a file. In edit window, we can edit any line or any column.
   C:\> edit r.txt
8. **label:**
   This command is used to change, modify, add or remove the label of any desired drive or partition.
   C:\> label D:
9. **format:**
   It is used to format a drive or a partition.
   Switches:

a. /q: to quick format
b. /s: to copy system files to formatted drive

C:\> format E: /q

10. fc:

It is used to compare files, if two files have different information.

C:\> fc abc.txt bcd.txt

11. mem:

To inspect memory usage.

C:\> mem

12. find:

To search content inside a given file. It can search required text and its details.

Switches:

a. /n: to check line number
b. /I: to ignore case sensitivity
c. /c: to count number of output
d. /v: to show results except given string.

C:\> find "a" abc.txt /I

13. doskey:

To show history.

C:\> doskey/history

- **Batch files:**

  A batch file or batch job is a collection, or list, of commands that are processed in sequence often without requiring user input or intervention. With a computer running a Microsoft operating system such as Windows, a batch file is stored as a file with a .bat file extension.

Batch files are often used to help load programs, run multiple processes at a time, and perform common or repetitive tasks.

For example, a batch job could be used to back up files, process log files, run several calculations or diagnostics, or any other job that require multiple commands to run. A batch job can accomplish multiple tasks without interaction from the user, freeing up the user's time for other tasks.

- **Types of files in DOS:**

  1. Configuration files:

  CONFIG.SYS is a configuration file on DOS systems.
  It is a text file that contains the settings and commands to load drives in a DOS system.

  The CONFIG.SYS file is read every time a DOS system is booted. The system then reads that file and executes the command following it. Users can easily make changes as per their requirements by simply saving changes in the CONFIG.SYS file. Since it is a text file, it can be edited it in any editing program. This file is located in the root directory of the drive; this is the same location from where system is booted.

  2. COM files:

  A COM file is an executable program capable of being run by MS-DOS and Windows. It is saved in a binary format and is similar to an .EXE file, but differs in that it has a maximum size of roughly 64KB and it has no header or metadata. COM files are commonly used for executing a set of instructions whereas EXE files are used for fully developed programs.

- **SASD (Sequential Access Storage Device):**
  The SASD is a computer storage device whose content is accessed sequentially, as opposed to directly. These devices do not allow the user to access any record directly. For example, if a user needs to read and record the number 50, they have to first bypass record 49, only after that they would be able to read the desired record. It works like a cassette of a tape recorder.
  For example: Tape drive.

- **DASD (Direct Access Storage Device):**
  A DASD is another name of secondary storage devices that store data in discrete locations with a unique address. Direct-access storage devices allow the host computer to access data directly from wherever it is stored within the storage device because each data chunk is saved in a discrete and separate location from other chunk, complete with a unique address. This allows the computer to directly point to that location to get the data. Access methods include indexed, sequential and direct.
  Example: Hard disk, Optical drive, Magnetic devices, etc.

- **Punch Card:**
  Punch cards are paper cards where holes may be punched by hand or machine to represent computer data and instructions. They were a widely-used means of inputting data into early computers. The cards were fed into a card reader connected to a computer, which converted the sequence of holes to digital information.
  For example, an early computer programmer would write a program by hand, then convert the program to several punched cards using a punch card machine. The programmer would then take the stack of cards to a computer and feed the cards into a card reader to input the program.

- **Magnetic Tapes:**
  In magnetic tape only one side of the ribbon is used for storing data. It is sequential memory which contains thin plastic ribbon to store data and coated by magnetic oxide. Data read/write speed is slower because of sequential access. It is highly reliable which requires magnetic tape drive writing and reading data.

  Advantages of Magnetic Tapes:
  - These are inexpensive, i.e., low cost memories.
  - It provides backup or archival storage.
  - It can be used for large files.
  - It can be used for copying from disk files.
  - It is a reusable memory.
  - It is compact and easy to store on racks.

  Disadvantages of Magnetic Tapes:
  - Sequential access is the disadvantage, means it does not allow access randomly or directly.
  - It requires caring to store, i.e., vulnerable humidity, dust free, and suitable environment.
  - It stored data cannot be easily updated or modified, i.e., difficult to make updates on data.
- **Hard disk:**
  Hard disks are used as secondary memory for mass storage of information permanently. A hard is made up of aluminium base with thin magnetic material coating over it. Digital information is stored on the magnetic film by applying current pulses of suitable polarity to the magnetizing coil of the R/W head. The logic 1 or 0 depends upon the direction of magnetisation of very small area of the magnetic film which comes under the R/W head.
  Tracks: Concentric parts of the magnetic disk in hard disk is called tracks.

Sector: Small parts of tracks are known as sectors. Tracks and sectors do not have physical existence on the surface of a disk.

Seek time: The time required to move the R/W head from current position to the specified position.

Latency Time: The time required to rotate the specified sector under the head.

Access Time: The sum of latency time and seek time is called Access time.

Some features of Hard disks:

a) Storage capacity of hard disks vary from few GBs to 2000 GBs.
b) Storage capacity per platter varies from a few GBs to 500 GBs.
c) Speed is about 3500 rpm to 15000 rpm.
d) Data transfer rate is 25 to 100 MB/s.
e) Access time is 5 ms to 20 ms.

- **Floppy disk:**

  A floppy disk is a thin circular plastic disk coated with magnetic material on the surface. It is a removable disk and it is used as backup memory to store programs, data and other information. The standard size of a floppy disk is 3.5 inch diameter.

  It has tracks and sectors as hard disk and have low rotating speed of about 360 rpm. Its storage capacity is 1.44 MB.

- **Formulas for numerical:**

  a) Capacity of disk pack
     = Total number of surfaces x Number of tracks per surface x Number of sectors per track x Number of bytes per sector.
  b) Total number of sectors
     = Total number of surfaces x Number of tracks per surface x Number of sectors per track
  c) Formatting overhead
     = Total number of sectors x overhead per sector

d) Amount of memory lost due to formatting
   = Formatting overhead
   = Total number of sectors x Overhead per sector
e) Recording density of innermost track
   = Capacity of a track / Circumference of innermost track
f) Data transfer rate
   = Number of heads x Capacity of one track x Number of rotations in one second
g) Average rotational delay
   = 1/2 x Time taken for one full rotation
h) Average access time
   = Average seek time + Average rotational delay + Transfer time + Controller overhead + queuing delay

- **What is computer?**
  Computer is an electronic device that accepts the data as an input, process the data, according to the given instructions and gives desired output.
  As per the definition, computer performs following tasks:
  a. It accepts the data as an input.
  b. It processes the given data according to the given instruction.
  c. It gives a desired output, or stores the result in provided file/data files.
- **Characteristics of Computer:**
  1. <u>Speed</u>:
     Computers can perform logical and mathematical calculations at much higher speed than human. It can perform millions of calculations in a mere second. Now a days, the speed of a computer is of the order of microsecond (10^{-6} second) to nanosecond (10^{-9} second).
  2. <u>Accuracy</u>:

Computer performs mathematical calculation with 100% accuracy. There may be some error due to inconsistency or inaccuracy of data.

3. Automation:

   Computer can perform mathematical calculation automatically, without any human interference.

4. Storage capacity:
   Computer can store large amount of data. It can store the data in any form.
5. Diligence (No tiredness):
   Computer performs a number of tasks without any fatigue or lack of concentration.

6. Versatility:
   Computer can perform different kinds of work with same accuracy and efficiency.
7. Multitasking:

   Computer can perform multiple tasks at the same time resulting in efficiency and time saving.

8. No feelings:

   Computer have no feelings and emotions. It can work continuously according to the instructions provided.

9. No IQ:
   Computer doesn't have their own IQ, it is a dumb machine without a user. It works only according to the instructions provided by the user.

   It cannot correct or modify the given data itself, even if some inconsistent or inaccurate data is provided.

- **Comparison between Human brain and Computer:**

  Human brain is like a powerful computer that controls all the actions of the human body.

  Like a computer, brain inputs, and processes and gives an output. It can also store information.

  Following are the comparisons between 'A human Brain' and 'A Computer':

Field of comparison	**Human Brain**	**Computer**
Construction	Neurons and synapsis	IC, Transistor, Diodes, Capacitors, etc.
Memory growth	Increases each time by connecting synaptic link.	By adding more storage devices.
Information transmission	Use chemicals to transmit the info.	Uses electricity to transmit the info.
Information processing speed	Low	High
Information processing power	Low	High
Storage capacity	High	Low
Reliability	Self-managed, self-organised and reliable.	Performs monotonous tasks, cannot correct itself.
Driving power	Uses oxygen and Carbs.	Uses electrical power.

- **Computer applications:**

  Now a days, computers are an essential part of lives. It is used in perhaps every sector to increase efficiency, reduce error and improve security.

  Some of the main uses of computers are:

1. Home: Computers are widely used in homes to connect with friends and family, paying utility bills, watching shows and movies, improve security, home tutoring. It enables students to access information from internet.
2. Medical field: Computers are used in Medical field to manage patient details, to perform diagnosis, perform various scans and checks.
3. Entertainment: A big part of use of computer is for entertainment purposes. They can be used to watch movies or shows, playing games, social media, and many other stuffs.
4. Education: Computers have become a big part of education industry to provide better learning to students from any part of the world. Computers have enables the access of internet through which, any information can be retrieved from any part of the world.
5. Banking: Computers helps banks to manage their data and also provide better security in terms of any data errors. It has also helped banks to make data centralised to reduce data redundancy and improve customer services. Due to this, users can access their bank account from anywhere without any worries.

- **Early History of Computer**

  Since the evolution of humans, devices have been used for calculations for thousands of years. One of the earliest and most well-known devices was an abacus. Then in 1822, the father of computers, **Charles Babbage** began developing what would be the first mechanical computer. And then in 1833 he actually designed an Analytical Engine which was a general-purpose computer. It contained an ALU, some basic flow chart principles and the concept of integrated memory.

Then more than a century later in the history of computers, we got our first electronic computer for general purpose. It was the ENIAC, which stands for Electronic Numerical Integrator and Computer. The inventors of this computer were John W. Mauchly and J.Presper Eckert.

And with times the technology developed and the computers got smaller and the processing got faster. We got our first laptop in 1981 and it was introduced by Adam Osborne and EPSON.

- **Generations of Computer:**

  The division of generations of computer are primarily based on changes in hardware technologies and software.

  The latest computer generations inherited all the good features of previous generations. A short description of various generations of computer are as follows:

1. First generation (1946 – 1954):
   - Vacuum tubes were used as main electronic component.
   - Processing speed was in milliseconds.
   - They used machine dependent language for programming.
   - Large amount of heat was generated; thus, they required Air conditioners.
   - Slow mercury based memory.
   - Power consumptions were very high.
   - Very costly and less reliable.
   - Very large in size, thus not portable.

     Examples: ENIAC (Electronic Numerical Integrator and Computer), EDVAC (Electronic discrete variable computer), UNIVAC (Universal automatic computer).

2. Second generation (1955-1964):
   - Second generation computers used transistor which was faster, energy efficient and made the computer small in size.
   - Transistor were used in CPU, input/output processor and other electronic component.
   - Processing speed was increased to microsecond.
   - Magnetic ferrite core was used as main memory.
   - Magnetic disk and magnetic tape was used as a secondary memory.
   - Machine independent high level programming language like FORTRAN was used.
   - Hardware for floating point arithmetic was developed.
   - Input/output processor was developed to supervise and control input/output operation.
   - Index register was developed which increased the flexibility in programming.
   - Use of transistor made the computer smaller, faster and reliable.

   Example: IBM-1620, IBM-7090, IBM-7094, Digital Equipment Corporation's PDP-1, PDP-5, PDP-8 (Program data processor).

3. Third generation Computer (1965-1974):

   In this generation ICs (Integrated circuits) were used in CPU, I/O processor and other electronic components. The use IC made the computer even smaller, faster and more energy efficient. The important features of 3rd generation computer were:
   - ICs were used in CPU, I/O processor and other electronic components.
   - The processing speed was increased to nanoseconds.
   - Semiconductor was used as main memory.

- Machine independent high level languages were used.
- Parallel processing and multiprogramming were developed.
- Computers were smaller, faster, reliable and more energy efficient.

Example: Control Data Corporation's CDC-7600, PDP-11, CDC's CYBER-175, etc.

4. Fourth generation Computer (1975-1990):

In this generation, microprocessor was used as a CPU, the CPU built on single IC is called micro-processor. Memory, I/O processor and other supporting chips also uses ICs, LSI (Large Scale Integration) and VLSI (Very LSI).

In earlier generation, computer cache memory, memory management unit (MMU) and floating point unit (FPU) used separate ICs. But with VLSI technology, it became possible to integrate all these component on single IC along with CPU.

Some important features of these generation computer were:

- Microprocessor were used as CPU.
- Processing speed is increased to Pico second.
- CRT screen was developed.
- Laser printer, inkjet printer and scanner were developed.
- Multi-feature and multi-functional peripheral chips.
- Computer were more user friendly which uses many high level language for programming.
- High speed of computer network such as- LAN and WAN were developed.

Example: Honeywell 6080 series;
Motorola's 68000, 68020, 68030;
Intel's 8086, 80286, CRAY-1, CRAY-2, CRAY-XMD.

5. Fifth generation Computer (1991-Till now):
   This generation computers uses ULSI (Ultra large scale integration). An ULSI chip contains millions of component in single IC. 5^{th} gen computers accept spoken commands besides that in earlier generation computers.
   It also supports AI. Some fields where AI is used are-
   I. Robotics
   II. Neural network
   III. Game play
   IV. Natural language processing
   V. Development of expert system to decide real time solution.

   Important features of 5^{th} gen computers:

   - Uses ULSI technology.
   - Development of AI.
   - Advance in parallel processing.
   - Computers are more user friendly and supports all types of high level languages like- C, C++, Java, Kotlin, Swift, etc.
   - Development of huge amount of storage.
   - Reduced in size, faster, energy efficient and reliable.

   Example: Desktop, laptop, smartphone, etc.

- **Number system**:
  For any number, which contains *(n+1)* integral digits and *k* fraction digits, then it is represented by:
  $d_n d_{n-1} d_{n-2} d_{n-3} \ldots . d_2 d_1 d_0 . d_{-1} d_{-2} d_{-3} \ldots . d_{-k}$

For any number with base *'b',* its decimal equivalent is:
$(d_n \times b_n) + (d_{n-1} \times b_{n-1}) + .. + (d_0 \times b_0) + (d_{-1} \times b_{-1}) + \ldots + (d_{-k} \times b_{-k})$

There are different number system, divided as per the uses required by a computer to process, transmit and store data in a better way.

There are 4 types of number system:

1. Binary system (0, 1)
2. Octal System (0, 1, 2, 3, 4, 5, 6, 7)
3. Decimal System (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
4. Hexadecimal System (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)

- **Binary number system:**
  - Base or Radix = 2
    (Base: The number of symbols used in a number system is called its base or its radix)
  - Symbols are '0' and '1'.
  - Binary digits are also known as 'Bits' in short.
  - This number is used for **processing data** in computers.
  - Any binary number with 'n' integral digits and 'k' fractional digits can be written as-
    $b_n\ b_{n-1}\ b_{n-2} \ldots b_2\ b_1\ b_0\ .\ b_{-1}\ b_{-2} \ldots b_{-k}$
    Where b_n = Most significant bit;
    b_{-k} = Least significant bit.
    Examples = $(10)_{10} = (1010)_2$, $(5)_{10} = (101)_2$, $(1)_{10} = (1)_2$, etc.
- **Octal number system:**
  - Base or radix = 8
  - Symbols are 1, 2, 3, 4, 5, 6, and 7.
  - These numbers are used for **transmitting data** in computers.
  - Any octal number with 'n' integral and 'k' fractional digits can be written as-

$o_n\ o_{n-1}\ o_{n-2} \ldots o_2\ o_1\ o_0 . o_{-1}\ o_{-2} \ldots o_{-k}$

Examples = $(10)_{10} = (12)_8$, $(5)_{10} = (5)_8$, $(17)_{10} = (21)_8$, etc.

- **Hexadecimal number system:**
  - Base or radix = 16
  - Symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.
  - These numbers are used for **storing data** in computers.

  Example: $(10)_{10} = (10)_{16}$, $(15)_{10} = (F)_{16}$, $(17)_{10} = (11)_{16}$, etc.

- **Decimal number system:**
  - Base or radix = 10
  - Symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.
  - These numbers are used for **showing results to user** in computers.
  - Numbers are written as-
    0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, etc.

- **<u>Conversion of number systems:</u>**

1. Binary to decimal:

Binary number- $b_{n-1}\ b_{n-2} \ldots b_2\ b_1\ b_0 . b_{-1}\ b_{-2} \ldots b_{-k}$

Decimal number- $(b_{n-1} \times 2^{n-1}) + (b_{n-2} \times 2^{n-2}) + \ldots + (b_0 \times 2^0) + (b_{-1} \times 2^{-1}) + (b_{-2} \times 2^{-2}) + \ldots + (b_{-k} \times 2^{-k})$.

Example: $(11011)_2 = (27)_{10}$

2. Binary to octal:

a. Make triads (collection of 3) from last integral digit and first decimal digit, and complete the last triad by putting zeros.
b. Convert each triad to their respective decimal equivalent value.
c. The result is the octal form of the given number.

Example: $(1011111010100000)_2 = (137240)_8$

- **Binary to hexadecimal:**
  a. Make groups of 4 bits from left of binary point, and complete last group by putting zeroes.
  b. Convert each group into decimal value and then corresponding hexadecimal values of the decimal value.
  c. The resultant number is a hexadecimal form of given number.

  Example: $(1100\ 0011\ 0000\ 1100)_2$

  12 3 0 12

  C 3 0 C

  $= (C30C)_{16}$

- **Octal to binary:**
  a. Convert every digit of octal into binary numbers of 3 bits each.
  b. Arrange them into original order.
  c. The resultant number is binary form of given octal number.

  Example = $(256)_8$

  010 101 110

  = $(010101110)_2$

- **Octal to hexadecimal:**
  Octal number -> Binary number -> Hexadecimal number

- **Hexadecimal to binary:**
  a. Convert each digit of hexadecimal number to binary number of 4 bits.
  b. Combining them we will get the required number.

- **Hexadecimal to octal:**
  Hexadecimal number -> Binary number -> Octal number.

- **Addition of numbers:**
- **Addition of decimals:**
    a. Arrange both numbers in ordered way.
    b. Starting from the last, add each digit and write the result.
    c. If carry, then add it to next digit's sum and repeat the process.
    d. Resulting number is the answer.
- **Addition of binary:**
    a. Use these results to add:
        0 + 0 = 0
        1 + 0 = 1
        0 + 1 = 1
        1 + 1 = 0 (With carry 1)
        1 + 1 + 1 = 1 (With carry 1)
    b. Add carry to next digit's sum.
- **Addition of octal or hexadecimal:**
    a. Arrange the numbers and add each digit from last.
    b. If carry, add it to next digit's sum and repeat the process.

- **r's complement of a number:**

r's complement of a number can be given as:

$$\textbf{r's complement} = r^n - N$$

where r = base/radix of number system,
n = number of digit
N = number

- **(r-1)'s complement of a number:**

(r-1)'s complement of a number be given a:

$$\textbf{(r-1)'s complement} = r^n - N - 1$$

Now, we can also write:

r's = (r-1)'s + 1

SHORT TRICK TO FIND r's AND r-1's:

- Find (r-1)'s by subtracting each digit from highest symbol of given number system.
- Add 1 to get r's compliment.

SHORT TRICK TO FIND 2's AND 1's complement of Binary:

- Find 1's by flipping each bit.
- Add 1 to get 2's compliment.

- **<u>Rules for subtraction:</u>**
- **Using r's complement (A-B):**
  a. Adjust digits of A and B.
  b. Find r's complement of B.
  c. Add A and B'.
  d. If carry is present then ignore it;
     Otherwise Recompliment the sum and put a –ve sign to the produced result.
- **Using (r-1)'s complement:**
  a. Adjust A and B digits.
  b. Find (r-1)'s complement of B.
  c. Add A and B'.
  d. If carry is present then add the carry with the sum and produce the result;
     Otherwise recompliment the sum and put a –ve sign to produce result,

- **General method:**
  a. Adjust A and B digits.
  b. Subtract each digits of A from B from last one-by-one.
  c. The final number is the required result.

NOTE: Computer uses the r's complement method ONLY, and other methods are just theoretical methods.

- **ASCII (American Standard code for Information Interchange):**

  It is a seven bit code and there are 2^7 (=128) different combinations of 0's and 1's to encode lowercase, uppercase and special characters besides 10 decimal symbols.
  It is extensively used for printer and terminals that interface the small computer system.
  Such as- A = 65, B = 66, etc.

- **EBCDIC (Extended Binary Coded Decimal Interchange Code):**

  It is 8 bit code in which there are 2^8 different combinations of 0's and 1's that are used to encode all the characters of ASCII and also some other characters.

- **Program:**
  Computer program, detailed plan or procedure for solving a problem with a computer; more specifically, an unambiguous, ordered sequence of computational instructions necessary to achieve such a solution. The distinction between computer programs and equipment is often made by referring to the former as software and the latter as hardware.

  Programs stored in the memory of a computer enable the computer to perform a variety of tasks in sequence or even intermittently.
- **Characteristics of good program:**
  A computer program is a sequence or set of instructions in a programming language for a computer to execute. While making great projects, we need to follow the specific rules of the programming language to make an

effective program. These are some best practises we should always have in mind.

  - Meaningful identifiers
  - Consistent indentation
  - Limit line length
  - File and folder structure
  - Comments

- **Programming steps:**
  All programming involves creating something that solves a problem. The problems can range from something of great scientific or national importance, through to something as trivial as relieving personal boredom!

  This section describes one approach to solving such problems - think of it as a rough guide to the things you should do when entering the land of programming.

  In broad terms, those things are:

  1. Identify the Problem
  2. Design a Solution
  3. Write the Program
  4. Check the Solution

- **Algorithms:**
  The word Algorithm means ” A set of finite rules or instructions to be followed in calculations or other problem-solving operations ” Or ” A procedure for solving a mathematical problem in a finite number of steps that frequently involves recursive operations”.

  The Algorithm designed are language-independent, i.e. they are just plain instructions that can be implemented in any language, and yet the output will be the same, as expected.

  Properties of Algorithm:
  - It should terminate after a finite time.

- It should produce at least one output.
- It should take zero or more input.
- It should be deterministic means giving the same output for the same input case.
- Every step in the algorithm must be effective i.e. every step should do some work.

Example:

Algorithm to add 3 numbers and print their sum:

1. START
2. Declare 3 integer variables num1, num2 and num3.
3. Take the three numbers, to be added, as inputs in variables num1, num2, and num3 respectively.
4. Declare an integer variable sum to store the resultant sum of the 3 numbers.
5. Add the 3 numbers and store the result in the variable sum.
6. Print the value of the variable sum
7. END

- **Flow chart:**
  Flowchart is a graphical representation of an algorithm. Programmers often use it as a program-planning tool to solve a problem. It makes use of symbols which are connected among them to indicate the flow of information and processing.
  The process of drawing a flowchart for an algorithm is known as "flowcharting".

  Basic Symbols used in Flowchart Designs:

1. Terminal:
   The oval symbol indicates Start, Stop and Halt in a program's logic flow. A pause/halt is generally used in a program logic under some error conditions. Terminal is the first and last symbols in the flowchart.
2. Input/Output:
   A parallelogram denotes any function of input/output type. Program instructions that take input from input devices and display output on output devices are indicated with parallelogram in a flowchart.
3. Processing:

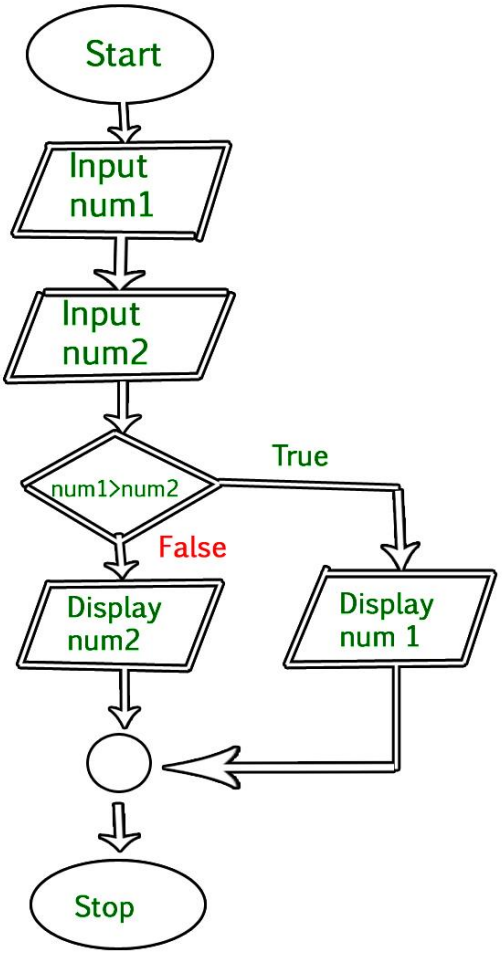
A box represents arithmetic instructions. All arithmetic processes such as adding, subtracting, multiplication and division are indicated by action or process symbol.

4. Decision:
   Diamond symbol represents a decision point. Decision based operations such as yes/no question or true/false are indicated by diamond in flowchart.
5. Connectors:
   Whenever flowchart becomes complex or it spreads over more than one page, it is useful to use connectors to avoid any confusions. It is represented by a circle.
6. Flow lines:
   Flow lines indicate the exact sequence in which instructions are executed. Arrows represent the direction of flow of control and relationship among different symbols of flowchart.

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 is associated with the arrow line.

Example:
Draw a flowchart to input two numbers from the user and display the larger of two numbers.



- **QBASIC:**

The name QBasic is an acronym for Quick Beginners All Purpose Symbolic Instruction Code. It was developed and launched by Microsoft in the year 1991 and is considered to be one of the most ideal languages for absolute beginners. It was intended as a replacement for GW-BASIC. QBasic was based on earlier QuickBasic 4.5 compiler. It does not produce .exe files but instead generates files with extension .bas which can only be executed immediately by the built in QBasic interpreter. It is based on DOS operating systems but is also executable on windows.

Applications of Qbasic:

- QBasic is the most suitable language for the beginners to start with. It introduces people to programming without any need to worry about the internal working of the computer.

- QBasic is very easy and simple to apply and create business applications, for creating games and even simple databases. It offers commands like SET, CIRCLE, LINE, etc. which allow the programmer to draw using Qbasic. Hence, graphics can also be created using QBasic.
- QBasic also supports creating sounds of some desired frequency through the speakers of your PC. Though only one sound can be played at once.

Advantages of QBasic:

- The key feature of the language is its close resemblance to English.
- Syntax of your code is checked automatically.
- Qbasic has a dynamic program debugging feature.
- Lengthy programs can be broken into smaller modules

Disadvantages of QBasic:

- The language is not structured.
- Qbasic is DOS based and has now become obsolete and is limited only in the field of education and programming.

- **Types of computer:**
  1. Analog Computer:

     This type of computers are used to process analog data. Analog data are continuous type of data that have not any discrete value. For example: Temperature, Rotation of earth, Energy from the sun, Pressure, etc.

     Analog computers are used for scientific and industrial applications. They are widely used even after advent of digital computers. They became obsolete in 1950s.

Example: Operational Amplifier.

2. Digital Computer:
   Digital computers are used to process discrete types of data. Now a days, digital computers are used in all fields of life.
   Example: Desktop, laptop, etc.
3. Hybrid Computer:
   These computers have features of both- Analog and digital computers.
   Digital component are used for logical and arithmetical operations while analog component are used to solve differential equation and complex mathematical problems.
   Example: HYCOMP 250, HYDAC 2400.

- **Difference between Analog and Digital Computer:**

Basis	Analog Computer	Digital Computer
Type of data	Continuous data is processed.	Discrete type of data is processed
Accuracy	Less accurate	High accurate
Processing speed	Slower	Faster
Power consumption	High	Low
Reliability	Not/Less reliable	More reliable
Architecture	Complex	Simple
Memory	Low memory	High memory
Components	Network of capacitors, inductors, etc.	Large number of logic gates, microprocessor, etc.

Application	It is used for scientific and industrial application.	In every field of life.

- **General purpose computer:**
  A general-purpose computer is one that, given the application and required time, should be able to perform the most common computing tasks. Desktops, notebooks, smartphones and tablets, are all examples of general-purpose computers.
  A general-purpose computer is made up of a central processing unit, memory, input/output devices and a bus connecting these components.

  The term is used to differentiate general-purpose computers from other types, in particular the specialized embedded computers used in intelligent systems.

- **Turn-Key system:**
  A computer system that has been customized for a particular application. The term derives from the idea that the end user can just turn a key and the system is ready to go. Turnkey systems include all the hardware and software necessary for the particular application. They are usually developed by OEMs (original equipment manufacturers) who buy a computer from another company and then add software and devices themselves.

- **Microcomputer (Personal Computer):**
  Microcomputer, an electronic device with a microprocessor as its central processing unit (CPU). Microcomputer was formerly a commonly used term for personal computers, particularly any of a

class of small digital computers whose CPU is contained on a single integrated semiconductor chip. Thus, a microcomputer uses a single microprocessor for its CPU, which performs all logic and arithmetic operations. The system also contains a number of associated semiconductor chips that serve as the main memory for storing program instructions and data and as interfaces for exchanging data of this sort with peripheral devices (e.g., keyboard, video display, and printer) and auxiliary storage units. The earliest microcomputers marketed in the mid-1970s contained a single chip on which all CPU, memory, and interface circuits were integrated.

As large-scale integration and then very-large-scale integration progressively increased the number of transistors that could be placed on one semiconductor chip, so the processing capacity of microcomputers using such single chips grew commensurately. During the 1980s microcomputers came to be used widely in other applications besides electronic game systems and other relatively simple computer-based recreations. Increasingly powerful microcomputers began to be used in personal computer systems and workstations, for instance. High-performance microcomputer systems began to be used widely in business, in engineering, in “smart” or intelligent machines employed in the factory and office, and in military electronics systems.

- **Mini Computer:**
  Minicomputer is a medium size multiprocessing computer. In this type of computer, there are two or more processors, and it supports 4 to 200 users at one time. Minicomputers are used in places like institutes or departments for different work like billing, accounting, inventory management etc. It is smaller than a

mainframe computer but larger in comparison to the microcomputer.

Characteristics of minicomputer:

- Its weight is low.
- Because of its low weight, it is easy to carry anywhere.
- Less expensive than a mainframe computer.
- It is fast.

- **Mainframe computer:**
  Mainframe computers are designed in such a way that it can support hundreds or thousands of users at the same time. It also supports multiple programs simultaneously. So, they can execute different processes simultaneously. All these features make the mainframe computer ideal for big organizations like banking, telecom sectors, etc., which process a high volume of data in general.

  Characteristics of mainframe computers:

  - It is also an expensive or costly computer.
  - It has high storage capacity and great performance.
  - It can process a huge amount of data (like data involved in the banking sector) very quickly.
  - It runs smoothly for a long time and has a long life.

- **Super Computer:**
  When we talk about speed, then the first name that comes to mind when thinking of computers is supercomputers. They are the biggest and fastest computers (in terms of speed of processing data). Supercomputers are designed such that they can process a huge amount of data, like processing trillions of instructions or

data just in a second. This is because of the thousands of interconnected processors in supercomputers. It is basically used in scientific and engineering applications such as weather forecasting, scientific simulations, and nuclear energy research. It was first developed by Roger Cray in 1976.

Characteristics of supercomputers:

- Supercomputers are the computers which are the fastest and they are also very expensive.
- It can calculate up to ten trillion individual calculations per second, this is also the reason which makes it even faster.
- It is used in the stock market or big organizations for managing the online currency world such as bitcoin etc.
- It is used in scientific research areas for analyzing data obtained from exploring the solar system, satellites, etc.

- **Hard copy output:**
  Hard copy refers to the digital document file which is printed on paper or other material like transparency. In hard copy the output is printed on the paper and sometimes it is referred as permanent copy. We can touch the hard copy. We can say it is a physical copy.
  For example- News Paper, Book, Notebook, printed document files, etc.

  Advantages of hard copy include:

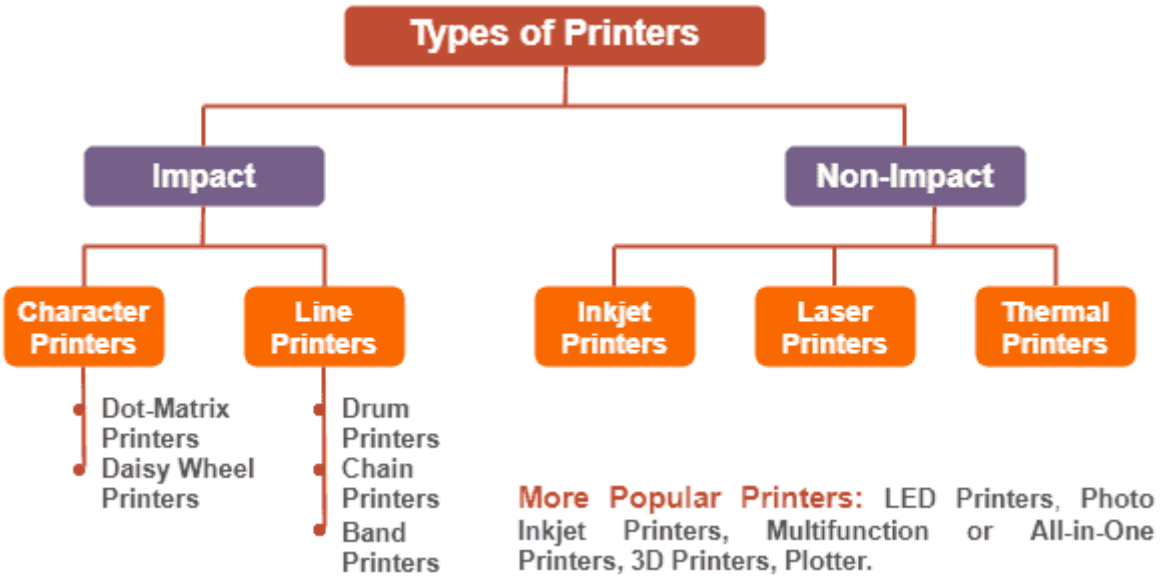
  - Durability: Hard copy documents are resistant to damage from electronic failures or power outages, and can be stored for long periods of time.

- Accessibility: Hard copy documents can be read by anyone with access to the document, without requiring a computer or other electronic device.

- **Plotters:**
  A plotter is a printer that interprets commands from a computer to make line drawings on paper with one or more automated pens. Unlike a regular printer, a plotter can draw continuous point-to-point lines directly from vector graphic files or commands.

  Types of plotters include the following:

  - **Drum plotters**, which draw on paper wrapped around a drum that turns to produce one direction of the plot while the pens move to provide the other direction.
  - **Flatbed plotters**, which draw on paper placed on a flat surface.
  - **Electrostatic plotters**, which draw on negatively charged paper with positively charged toner.
  - **Inkjet plotters**, which use inkjet printer technology and coloured inkjet pens to deliver beads of ink in an assortment of colours to the drawing surface using vector graphic technology to move the pen plotters.



- **Impact printers:**

  Impact printers are printers that typically use a specific type of hammer with which the print heads are attached. When the print command is given, the hammer pushes the print heads onto the ink ribbon. Print heads have different characters, and therefore, they help the ink ribbon to draw the corresponding character on the paper that is placed near the ink ribbon.

  They are slow and mostly cannot print images hence they have become obsolete. However they cost less and therefore considered for bulk printing.

  Two types of impact printers are:

  1. Character printers: Character printers are defined as impact printers that typically print only one character at a time. That means, these printers use a single stroke of a hammer or print head at a time. That's why they are slow and cannot print the entire line at once.

     They are further divided into 2 types:

     a. Dot matrix Printers:

        Dot matrix printers, also known as pin printers, are the most popular type of impact printer. These printers have a matrix of pins on their print heads to create character or graphics.

The more pins in a dot matrix printer, the faster the performance and better the print quality.

Dot-matrix printers are cheap and usually print 100-600 characters per second.

b. Daisy Wheel printers:

Daisy wheel printers are impact printer used primarily to achieve quality found with typewriters. Because these printers have a mechanism that looks like a daisy (a flower), they are named daisy wheel printers. More specifically, these printers have a disk that includes print heads and the ends of these print heads have a moulded metal character.

When the print command is given, the printer rotates the disk with all its associated characters. As soon as the desired character arrives at the correct print location, the hammer hits the disc and the corresponding character hits the ink to produce a character on a paper.

2. <u>Line printers:</u>

Line printers, also called bar printers, are defined as impact printers that usually print an entire line at a time. This means that these printers use multiple strokes of a hammer with different with different print head at once.
They are faster than character printers and can print up to 6000 lines per minutes.
Line printers are further categorized into following types:

a. Drum printers:
It consists of a rotating cylindrical drum with a circular band of characters on its surface. In particular, the surface is

divided into tracks equal to the size of the supported printing paper. It has separate hammer for each set of characters.

When the print command is given, the drum rotates and when the desired character reaches under the hammer, the hammer quickly strikes the ink ribbon against the paper to print the corresponding character.

b. Chain printers:
The chain printers consists of a revolving chain with characters on its surface. These printers typically have a character set of 48, 64 or 96 characters. The chain is connected using gears in such a way that it can rotate horizontally.
When the print command is given, the chain rotates with its respective characters. As soon as the desired character reaches the correct print position, the hammer strikes the ink ribbon against the paper and the corresponding character on the chain.

- **Non-impact printers:**
Non-impact printers have no hammer to hit the print heads on the ink ribbon. These types of printers do not even ink ribbon to produce prints. Instead they use various technologies.

Unlike impact printers, internal machinery components of non-impact printers typically do not make any direct contact with the paper.

Some categories of non-impact printers:

1. Inkjet printers:
They are non-impact printers that are widely used by home users and small businesses. These printers make prints by

spraying a pattern of ink droplets on the paper with help of a nozzle or jet.

2. Laser printers:
   Laser printers are non-impact printers, typically using laser or non-impact photocopier technology to produce dots needed to print text or images on paper. When the print command is given, the laser beam produces a text or image structure on a drum by controlling the electric charges.
3. Thermal printers:
   They use a specific heat-sensitive paper and they produce prints by pushing electrically heated pins onto the paper. The paper used in these printers has a special heat-sensitive coating.