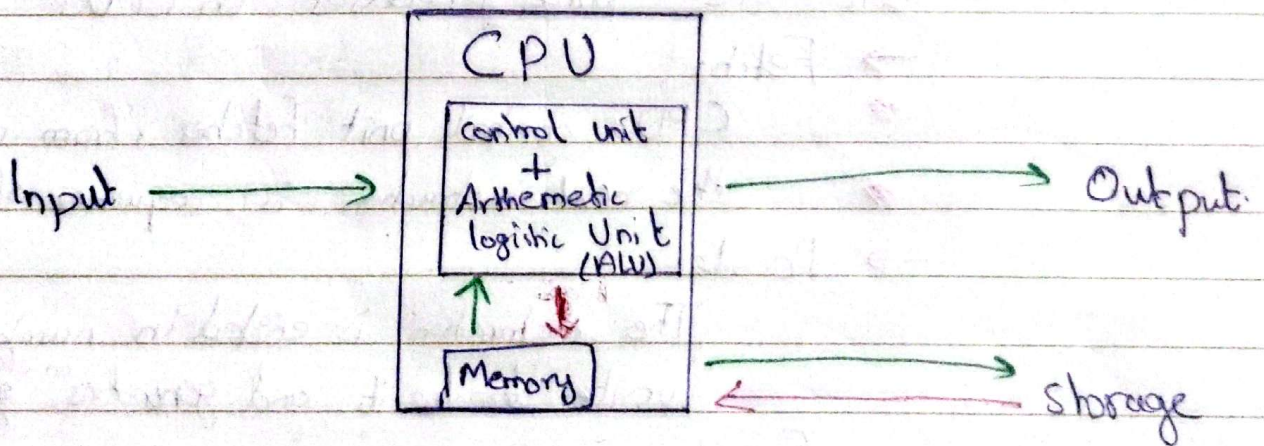# Computer Systems

Hardware   ~~Hardware~~

- Currently for many years we are following the ~~~~ von Neumann architecture.

- Hardware refers to the physical components of which a computer is made:
  1) CPU
  2) Main memory
  3) Secondary Storage Devices
  4) Input devices
  5) Output devices

CPU:

The central process unit or CPU, is part of computer that actually runs the program. Its job is to fetch instructions, follow them and produce some result.

- It consists of two ~~units~~ parts:
    → The control unit
    → The arithmetic and logical unit (ALU)

Control Unit:

It coordinates all of the computer's operations by using control signals.

ALU:

It is designed to perform mathematical operations.

- There are three processes in CPU:

→ Fetch:
CPU's control unit fetches, from main memory the next instruction is sequence of program.

→ Decode:
The instruction is encoded in numbers; The control units decodes it and generates an electrical a signal

→ Execute:
The signal is routed to the appropriate component of computer. This signal causes the component to perform an operation.

— This fetch/Decode/Execute is called a machine cycle, and it will run again and again as long as there are instructions to perform.

Main memory:
It can be said as the computer's work area. It is commonly known as RAM (Random access memory).

- It is usually a volatile type of memory, which means that it only a temporary storage while program is running. when computer is turned off, contents of RAM are erased.

Memory Hierarchy:
There are different types of ~~memories~~ storage memories in computers, and they have two characteristics:
1- speed
2- storage

- Registers are the fastest ~~to~~ because they lie on the CPU.

speed increases → Registers → Cache → RAM → Storage   storage increases
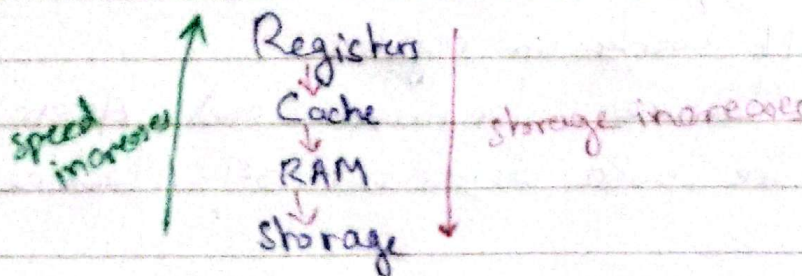
– Cache stores frequently used instruction.

Software:
Software is something which has the system under control.

Generally there are 2 categories of Software:
1) System software
2) Application software.

Programming languages:

1) Machine language.
   - It is a low level language

   - It is directly understood by the computer and no translator is needed.
   - It is very hard to understand by us humans.
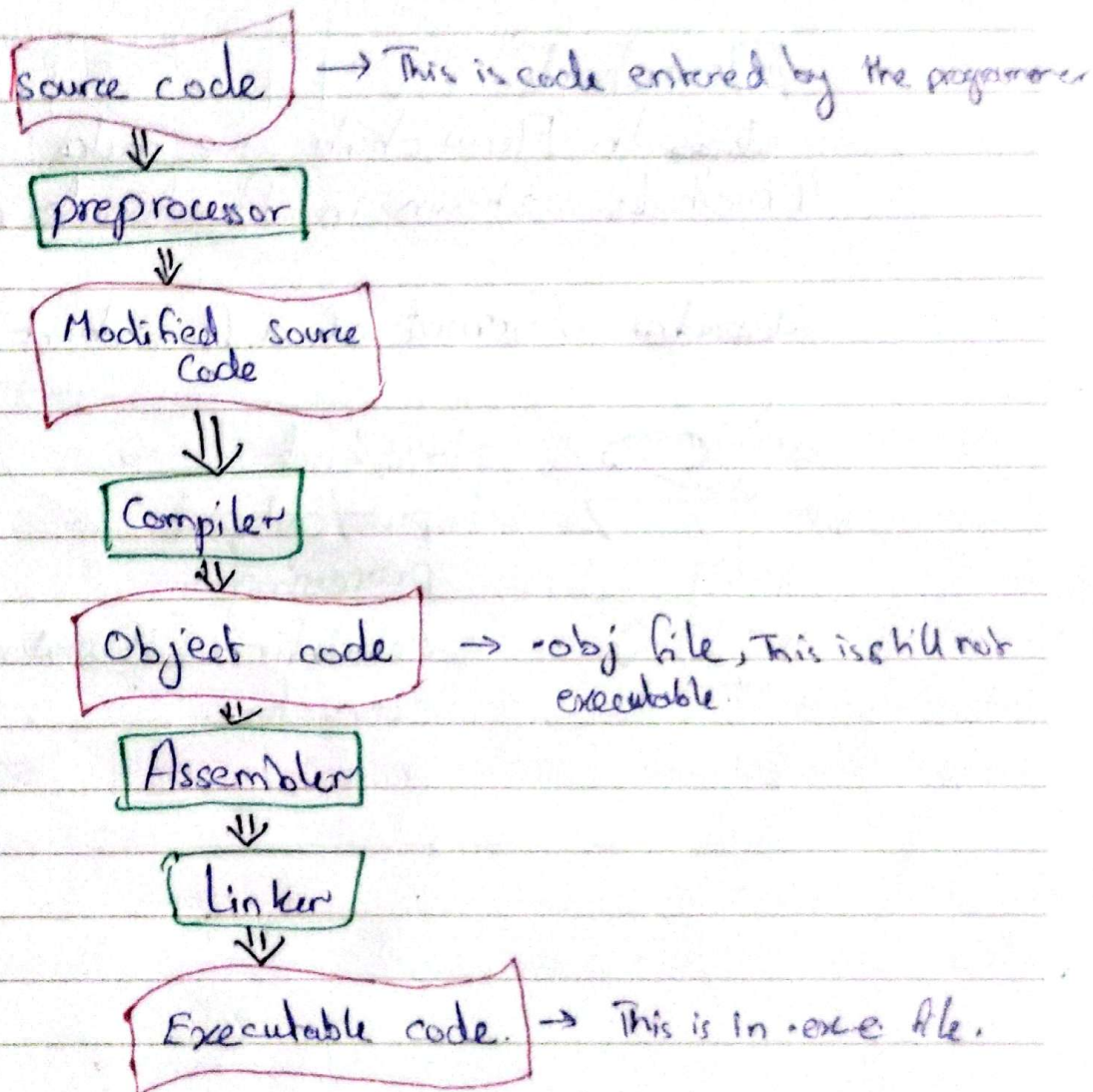   - Very hard to debug.

2) Middle level language:
   - Assembly language
   - It requires a translator i.e assembler
   - It works on registers.
   - Machine language and Assembly language are both dependent on Machine.

3) High level language (HLL)

- These are easily understood by humans but hard for machines.
- These are fast and easier to code.
- It does require a translator to convert it to machine code.
- It is machine independent.

- Any code in HLL is a called a source code, and it needs to be converted into an executable code (.exe)

$$\boxed{\text{source code}} \rightarrow \text{This is code entered by the programmer}$$

$$\downarrow$$

$$\boxed{\text{preprocessor}}$$

$$\downarrow$$

$$\boxed{\text{Modified source Code}}$$

$$\Downarrow$$

$$\boxed{\text{Compiler}}$$

$$\downarrow$$

$$\boxed{\text{Object code}} \rightarrow \text{.obj file, This is still not executable.}$$

$$\downarrow$$

$$\boxed{\text{Assembler}}$$

$$\downarrow$$

$$\boxed{\text{Linker}}$$

$$\downarrow$$

$$\boxed{\text{Executable code.}} \rightarrow \text{This is in .exe file.}$$

Yousaf