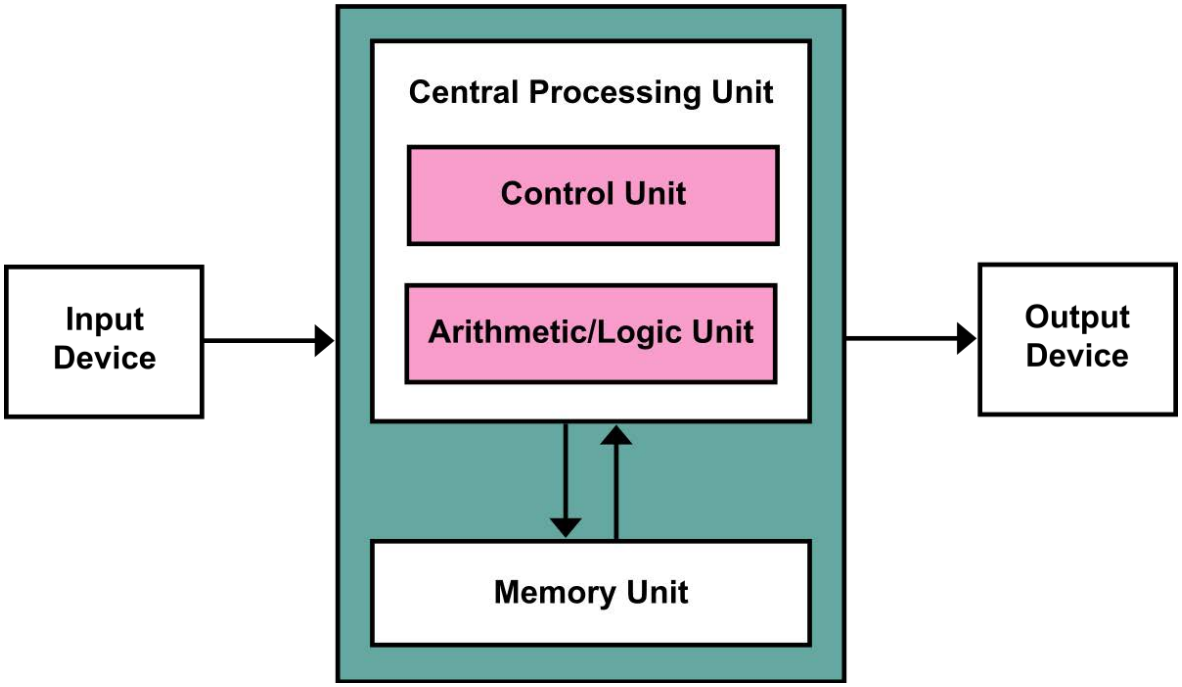
Von Neumann Architecture



Introduction

- In 1945, just after the World War, Jon Von Neumann proposed to build a more flexible computer.
- Von Neumann had been working on the Manhattan Project to build the first atomic bomb which needed a vast amount of manual calculations
- Up to that time, the computers were 'programmed' by rebuilding the entire machine to carry out a different task.
- For example, the early computer called ENIAC took three weeks to re-wire in order to do a different calculation.

Introduction

- The new idea was that not only the data should be stored in memory, but the program processing that data should also be stored in the same memory.
- A computer built with this architecture would be much easier to re-program.

What is Von Neumann Architecture?

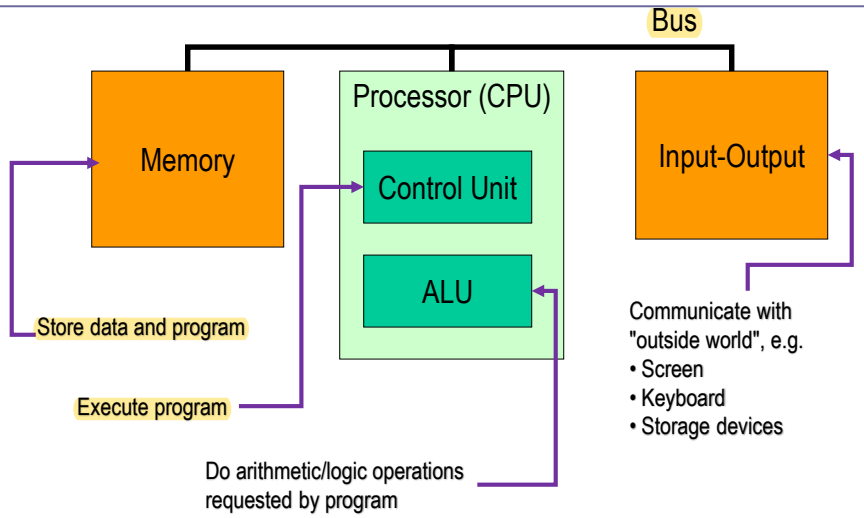
- The Von Neumann architecture is a design model for a stored-program digital computer.
- This model (architecture) describes a general framework, or structure, that a computer's hardware, programming, and data should follow.

- All computers more or less based on the same basic design, the von Neumann Architecture! what ever it be a multi-million dollar.

Von Neumann Architecture Characteristics

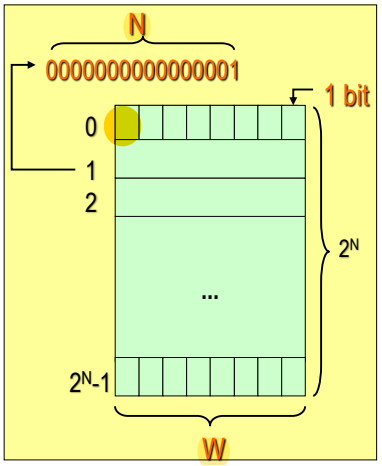
- This Model is based on the following three characteristics:
  1) The computer consists of four main sub-systems:
     - Memory
     - ALU (Arithmetic/Logic Unit)
     - Control Unit
     - Input / Output System (I/O)
     - While only 4 sub-components are called out, there is a 5th, key player in this operation: a bus, or wire, that connects the components together and over which data flows from one sub-component to another
  2) Program is stored in memory during execution.
  3) Program instructions are executed sequentially.

Von Neumann Components



Von Neumann Components

- **Memory**
- The Most Important feature is the Memory that can holds both Data and the program processing that data, this memory is called RAM (Random Access Memory).
- Memory width (W):
  - How many bits is each memory cell, typically one byte (=8 bits)
- Address width (N):
  - How many bits used to represent each address, determines the maximum memory size = address space
  - If address width is N-bits, then address space is 2^N (0,1,...,2^N-1)



How does processing unit get data to/from memory?

- **MAR:** Memory Address Register
- •Holds address of memory location being referenced
- **MDR:** Memory Data Register
- On a read (or **load**), holds value from memory
- On a write (or **store**), holds value being written to memory
- **Fetch (Address):**
  - 1. Load the address (A) into the MAR.
  - 2. Copy the content of memory cell with specified address into MDR.
- • **Store (Address, Value):**
  - 1. Load the address into MAR; load the value into MDR
  - 2. copy content of MDR into memory cell with specified address.

Von Neumann Components

- **Input – Output:**

This architecture allows the users to interact with the Computer.

- **Arithmetic Logic Unit (ALU):**

This unit performs:

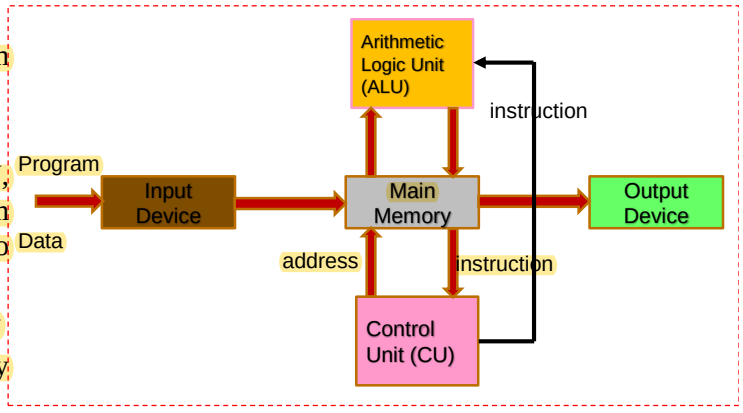
- mathematical operations (+, -, x, /, …)
- logic operations (=, <, >, and, or, not, ...)

- **Control Unit (CU):**

- The CU manages the process of moving data and program into and out of memory and also deal with execution of program instructions - one at a time.
- The 'one-at-a-time' phrase means that the von Neumann Architecture is a sequential processing machine.

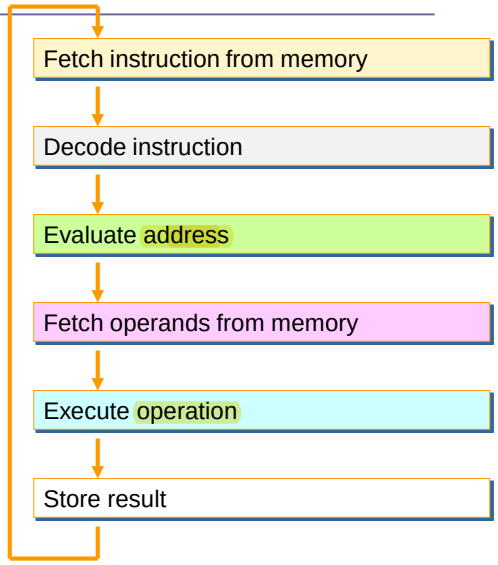
How von Neumann computer works?

- Step 1. send data and program 1+1 to main memory through input device
- Step 2. CU read + instruction from memory according to Address
- Step 3. CU send instruction to ALU, and then read data 1 and 1 from memory to ALU according to Address.
- Step 4. ALU store results to memory
- Step 5. Output results from memory to output device.



Instruction Processing

- The instruction is the fundamental unit of work.
- Specifies two things:
  - **Opcode:** operation to be performed
  - **Operands:** data/locations to be used for operation



Introduction to Main Digital Component