

Computer Organization and Operating  
System

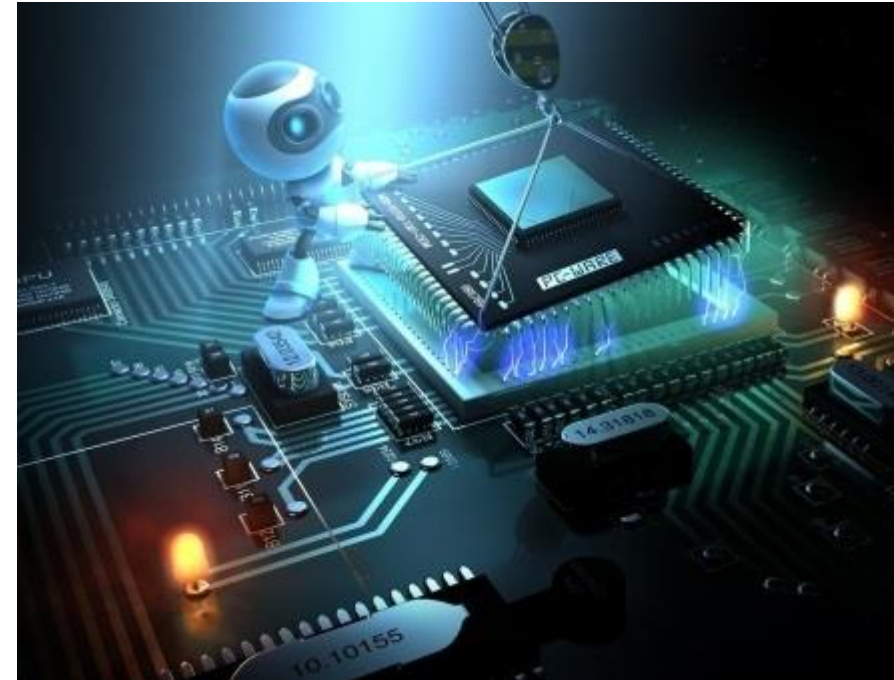
# Computer Organization Overview

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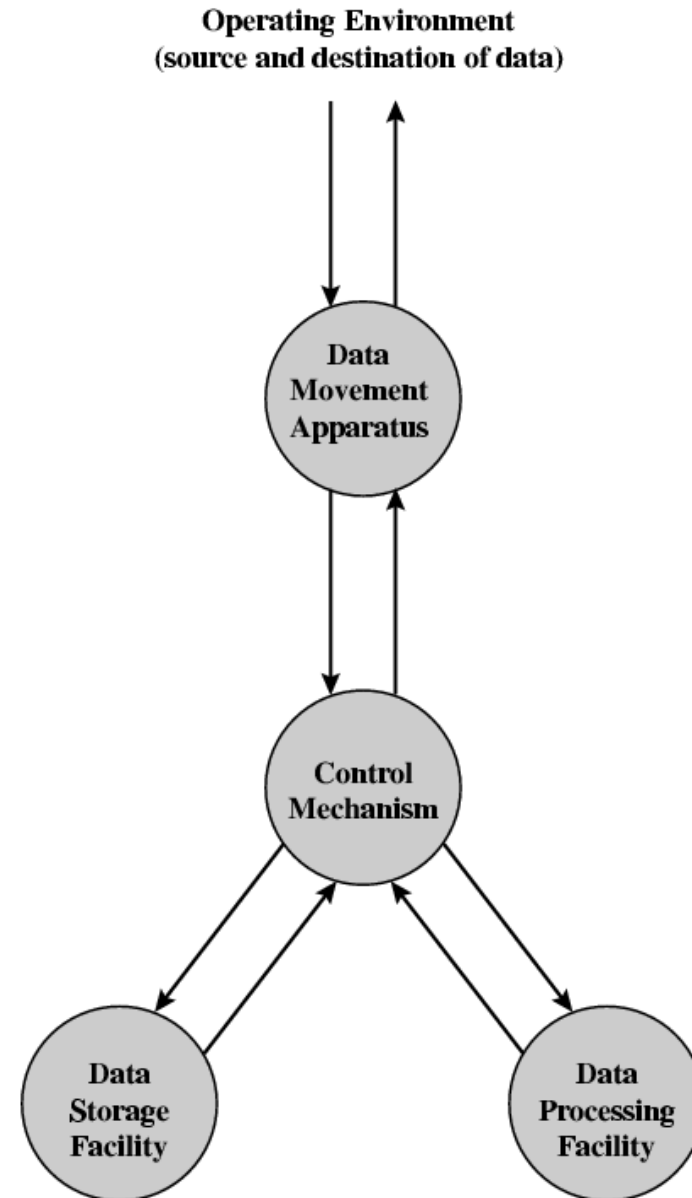
# Topic

- Computer Functions
- Computer Architecture
- CPU Architecture
- Computer Program Execution
- Conclusion



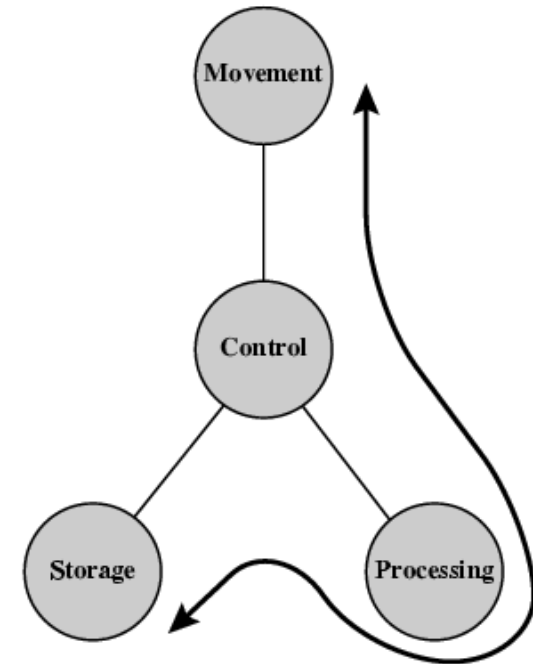
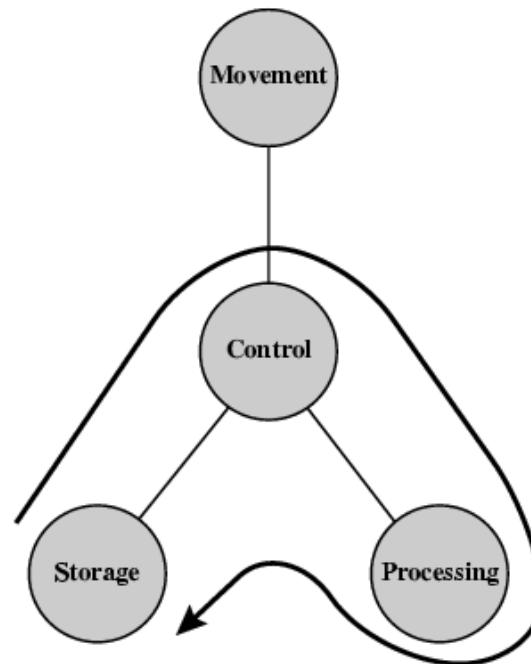
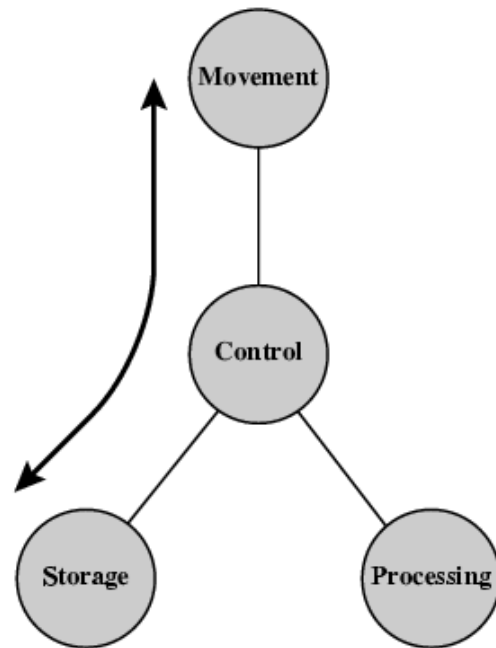
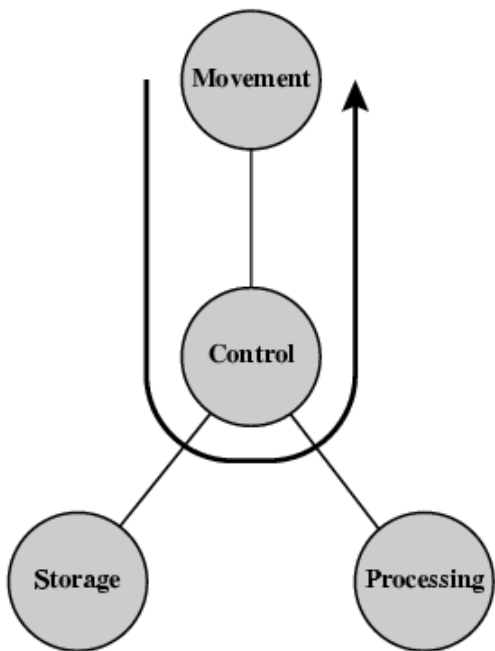
# Computer Functions

- All computer functions are:
  - Data processing
  - Data storage
  - Data movement
  - Control

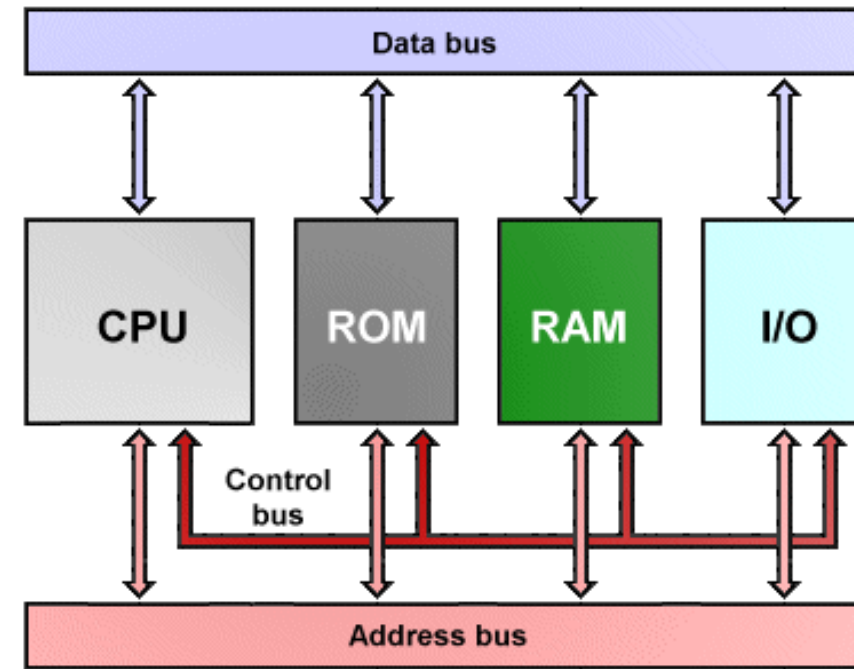


# Computer Functions

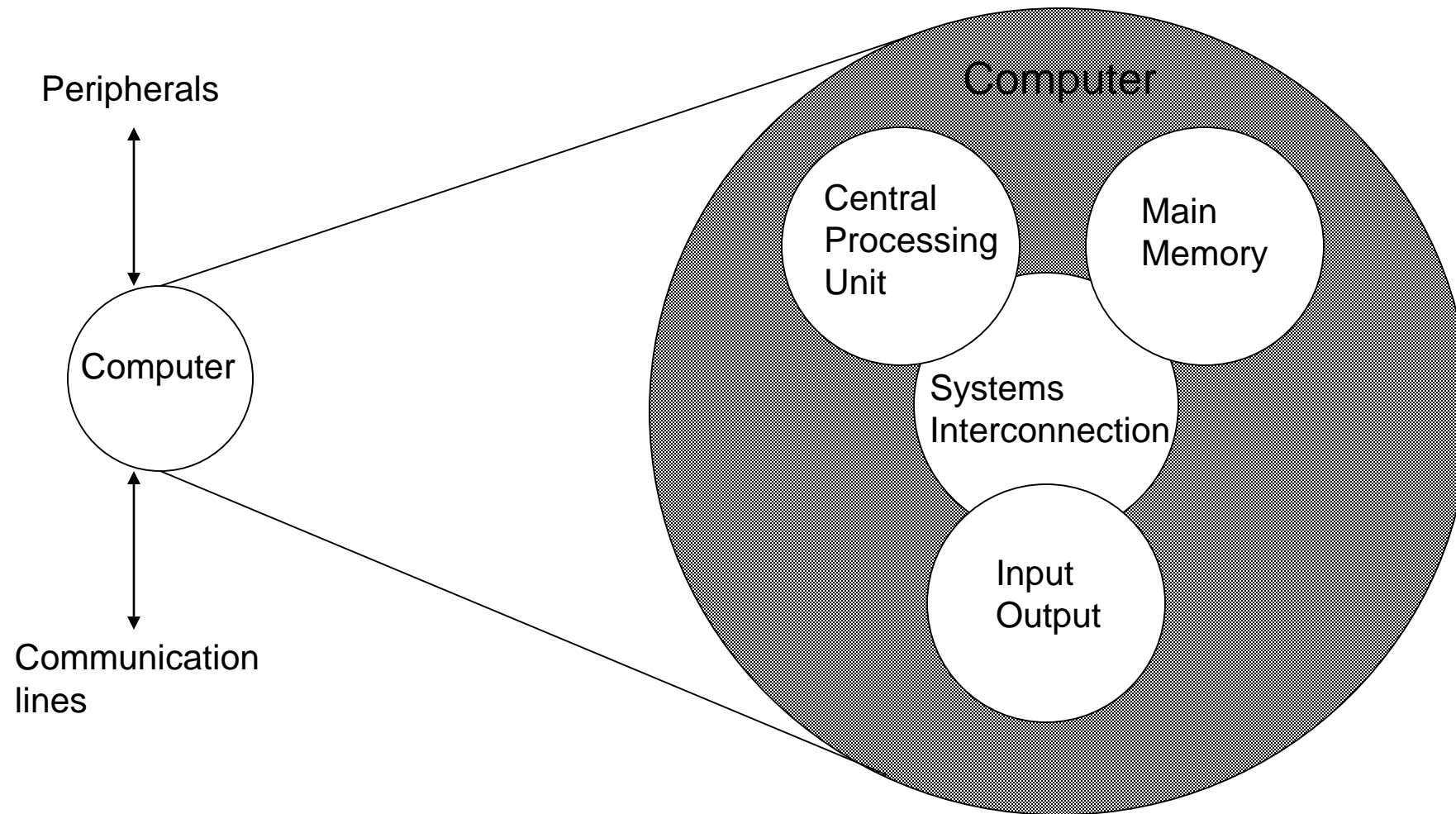
- Functional Views
  - (a) Data movement
  - (b) Storage
  - (c) Processing from/to storage
  - (d) Processing from storage to I/O



# Computer Architecture

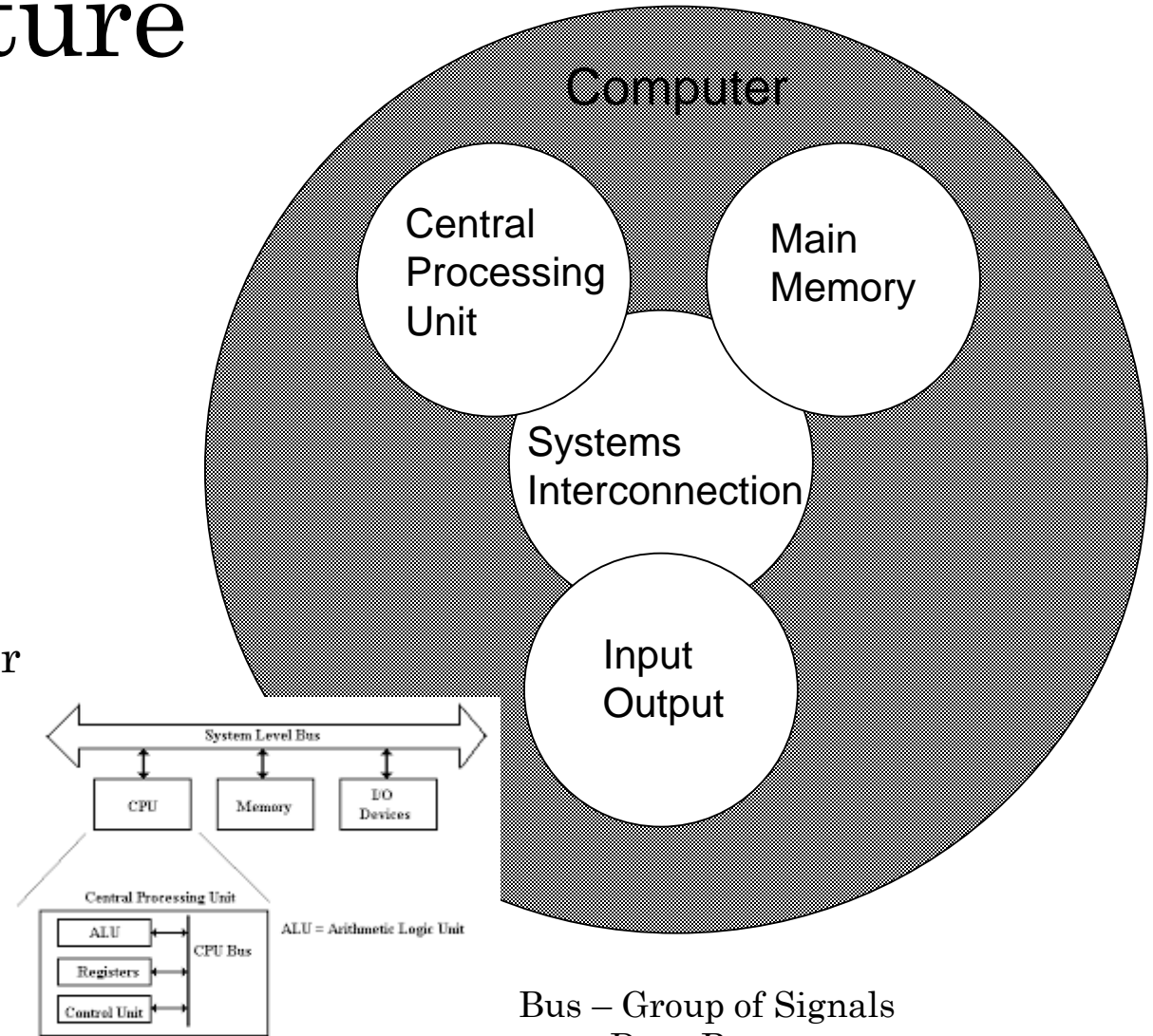


# Structure - Top Level



# Computer Architecture

- 3+1 Components
- Processor / CPU (Central Processing Unit)
  - Control and Process Data
- Main Memory - Store
  - Program – Sequence of Instructions
  - Data
  - State / Status
- Processor + Memory = Minimum Computer
  - But Useless
- Input and Output (IO)
  - Outside or World Communication
  - Human Use
- Interconnection
  - Bus – Only One Sender at a time, Simple
  - Switch – Multiple Senders at the same time, more performance

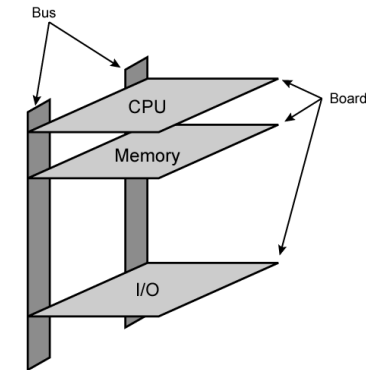
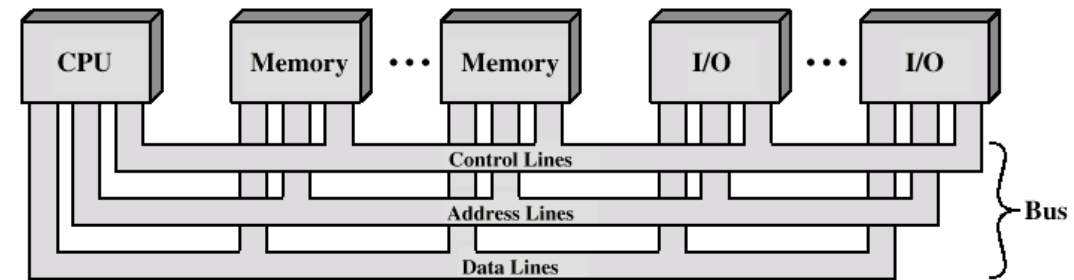


Bus – Group of Signals

- Data Bus
- Address Bus
- Control Bus

# What is a Bus?

- A communication pathway connecting two or more devices
  - Usually broadcast
  - Often grouped
    - A number of channels in one bus
    - e.g. 32 bit data bus is 32 separate single bit channels
  - Power lines may not be shown
- Data Bus
  - Carries data
    - Remember that there is no difference between “data” and “instruction” at this level
  - Width is a key determinant of performance
    - 8, 16, 32, 64 bit
- Address Bus
  - Identify the source or destination of data
  - e.g. CPU needs to read an instruction (data) from a given location in memory
  - Bus width determines maximum memory capacity of system
    - e.g. 8080 has 16 bit address bus giving 64k address space
- Control Bus
  - Control and timing information
    - Memory read/write signal
    - Interrupt request
    - Clock signals

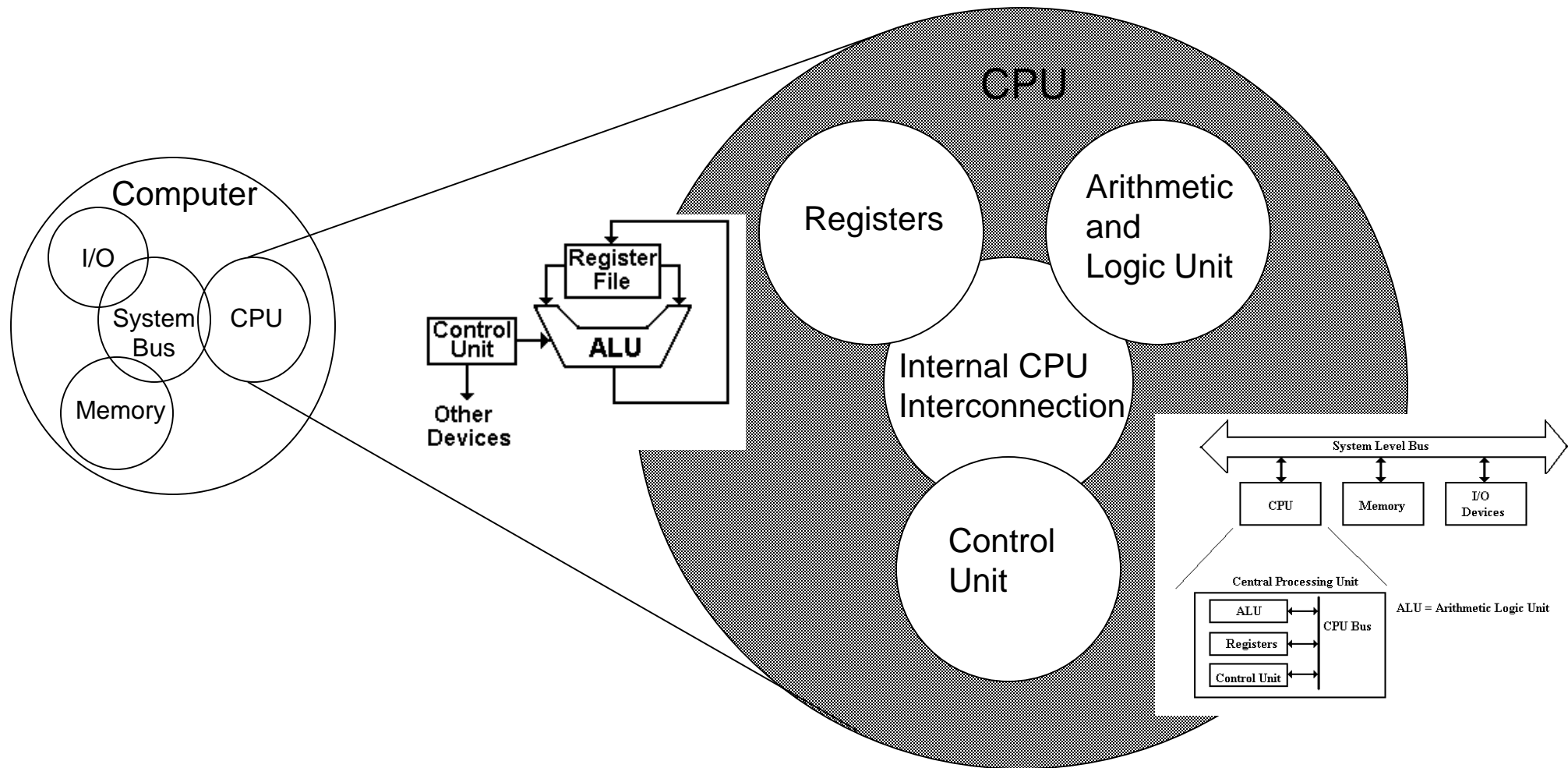


## What do buses look like?

- Parallel lines on circuit boards
- Ribbon cables
- Strip connectors on mother boards
  - e.g. PCI
- Sets of wires

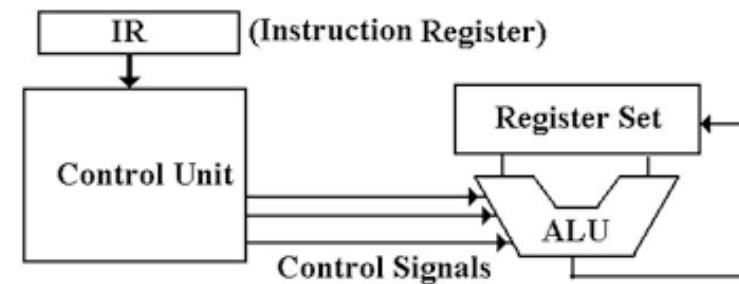
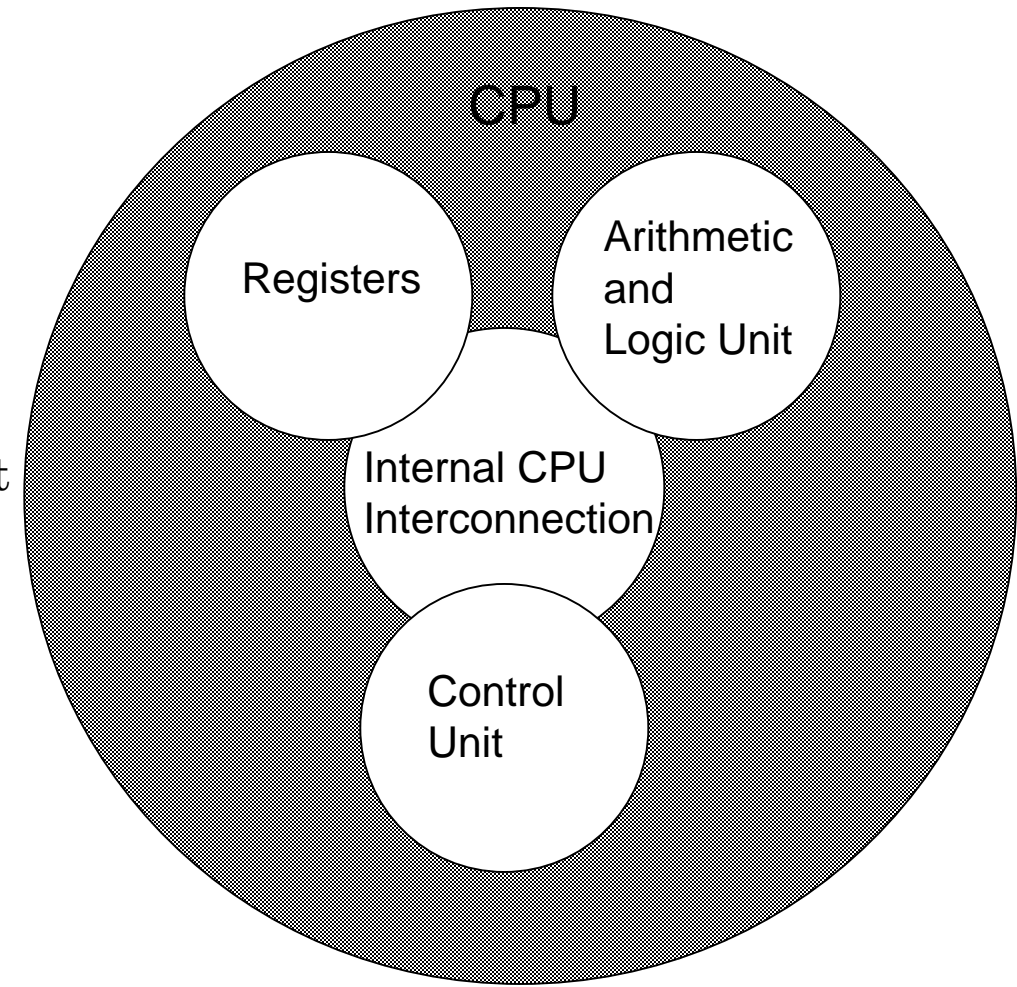


# Structure - The CPU

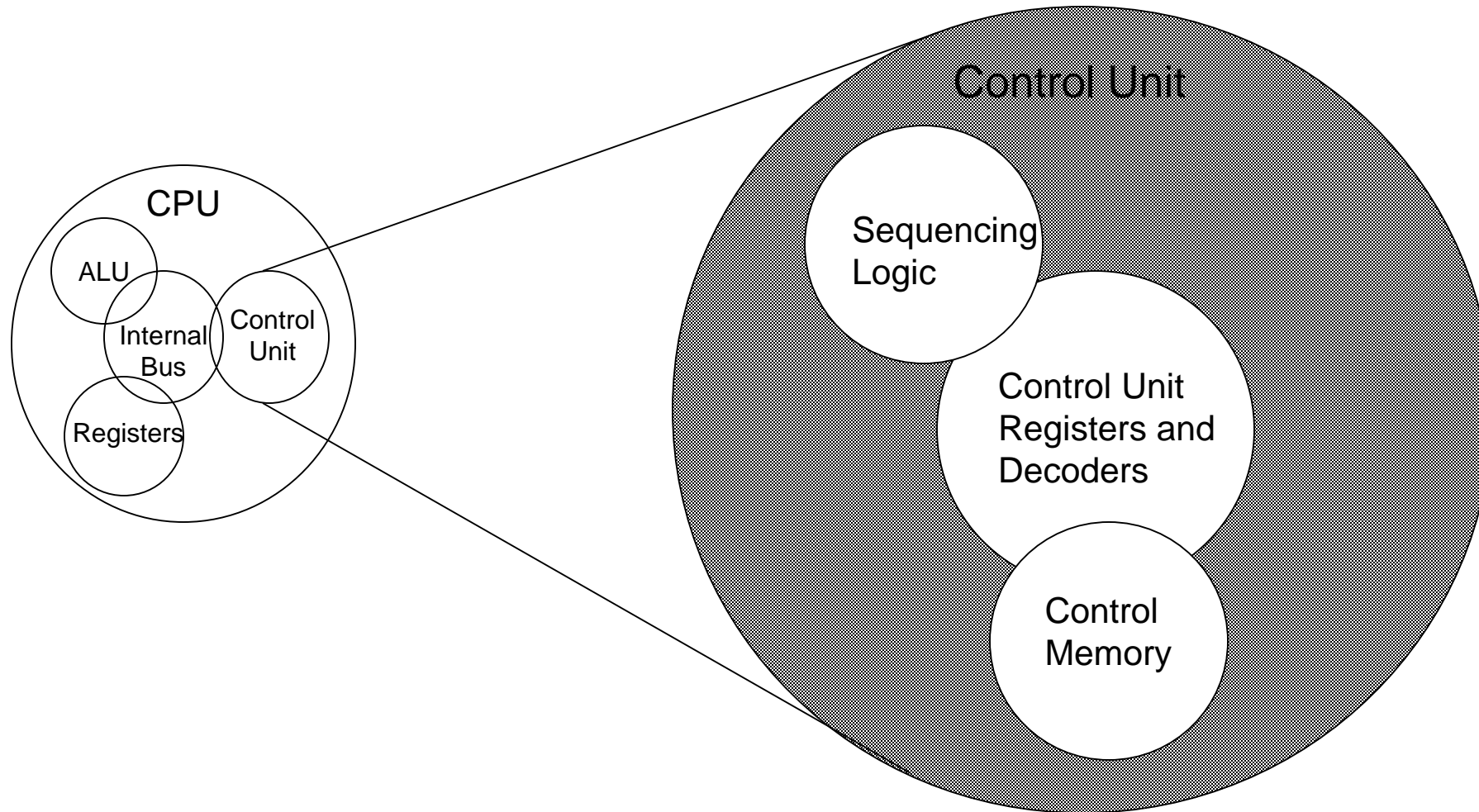


# CPU Architecture

- 3+1 Components
- Registers – Store (Temporary) everything
- ALU (Arithmetic and Logic Unit) – Operating Unit
  - Many Digital Logic Blocks/Modules
  - Number Operations
  - Associated with Instructions
  - E.g. Add, Subtract, Multiply, Divide, AND, OR, NOT, SHIFT, etc.
- Control Unit – Logic Control Signals
  - Control Signals to others
  - Inside and Outside CPU
- Internal CPU Interconnection
  - Bus
  - Switch

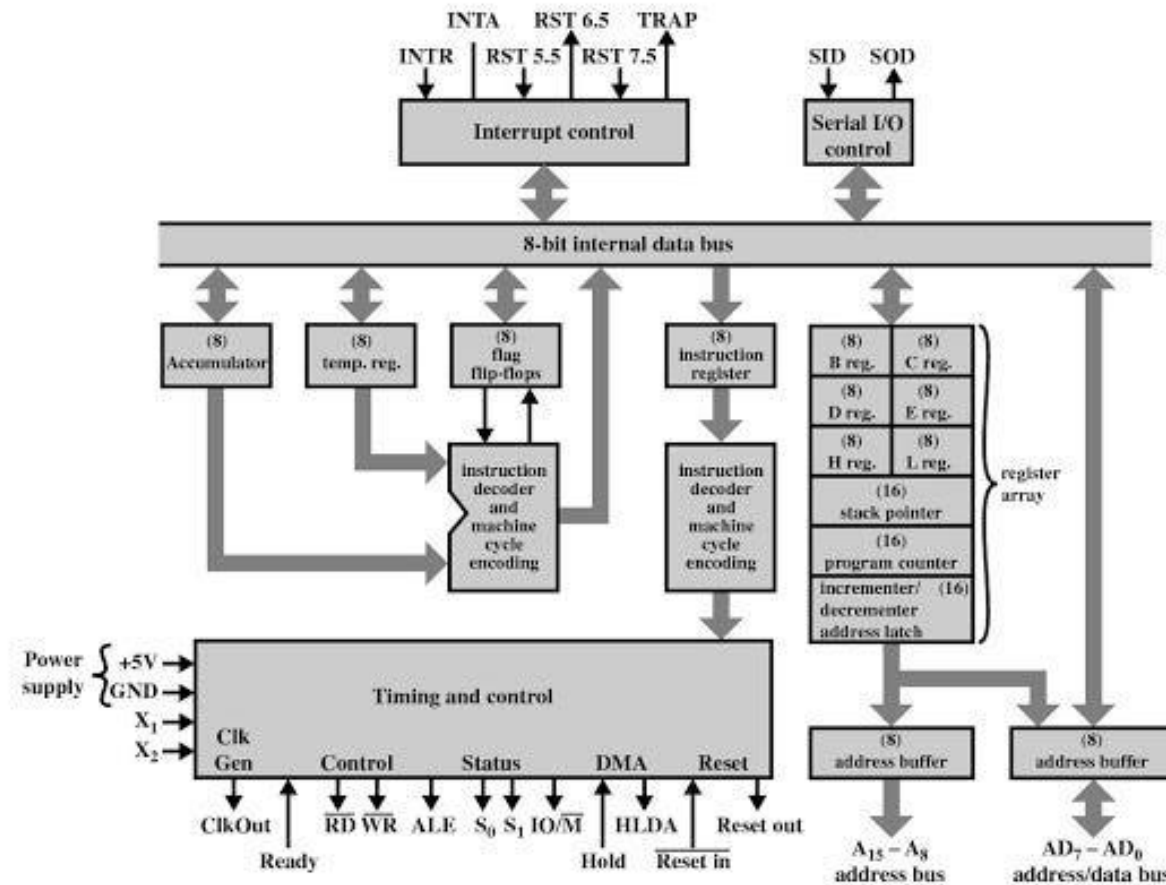


# Structure - The Control Unit

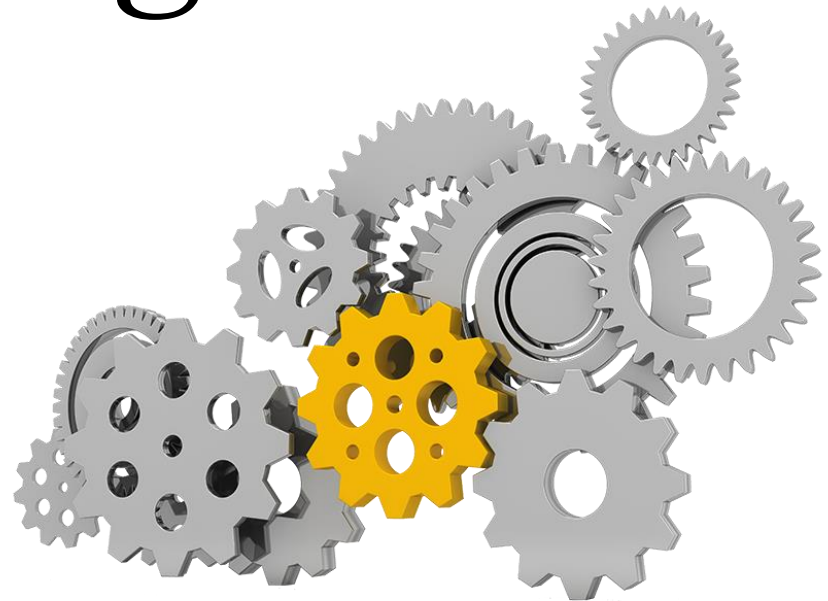


# Example:

## Microprocessor - 8085 Architecture

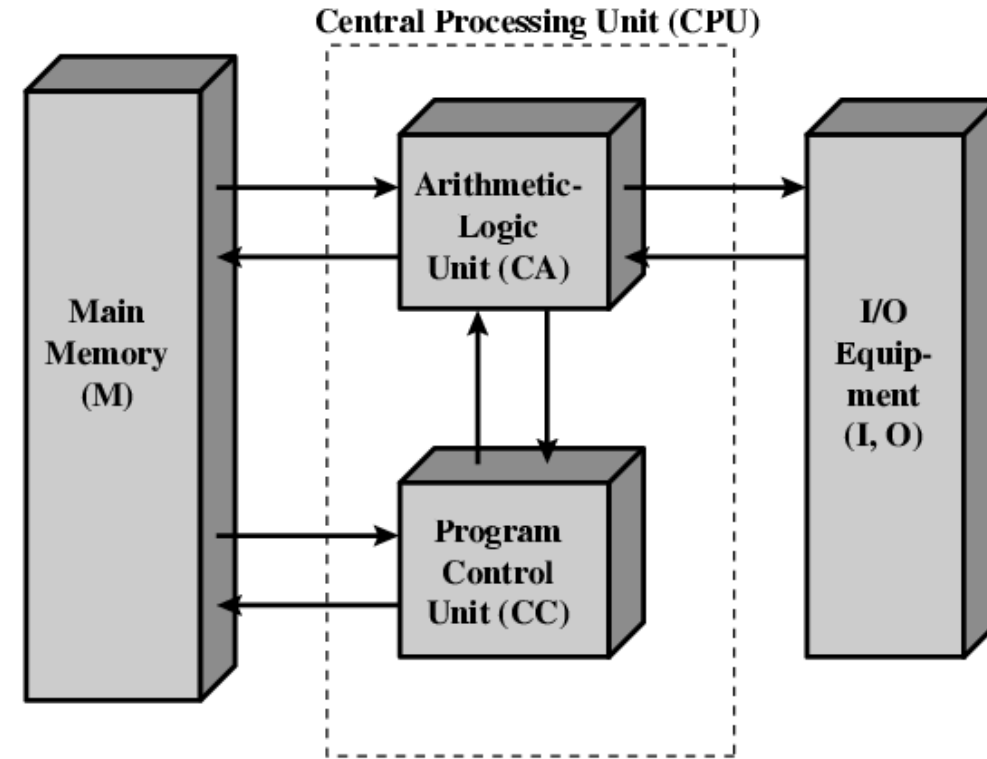


# Computer Program Execution



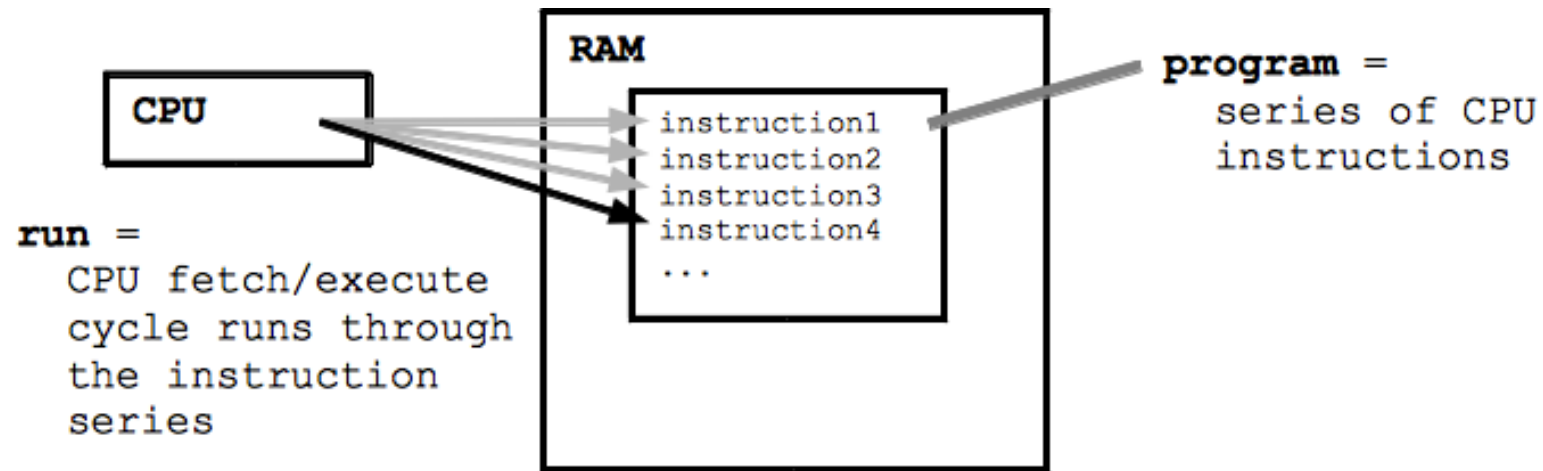
# von Neumann/Turing

- Stored Program concept
- Main memory storing programs and data
- ALU operating on binary data
- Control unit interpreting instructions from memory and executing
- Input and output equipment operated by control unit
- Princeton Institute for Advanced Studies
  - IAS
- Completed 1952

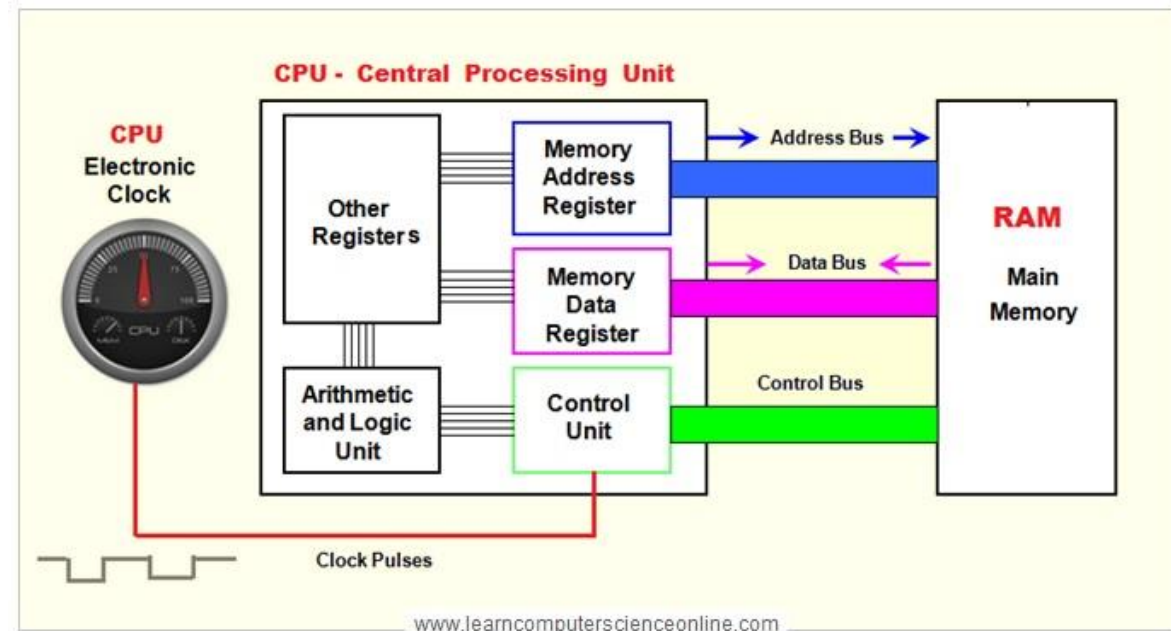
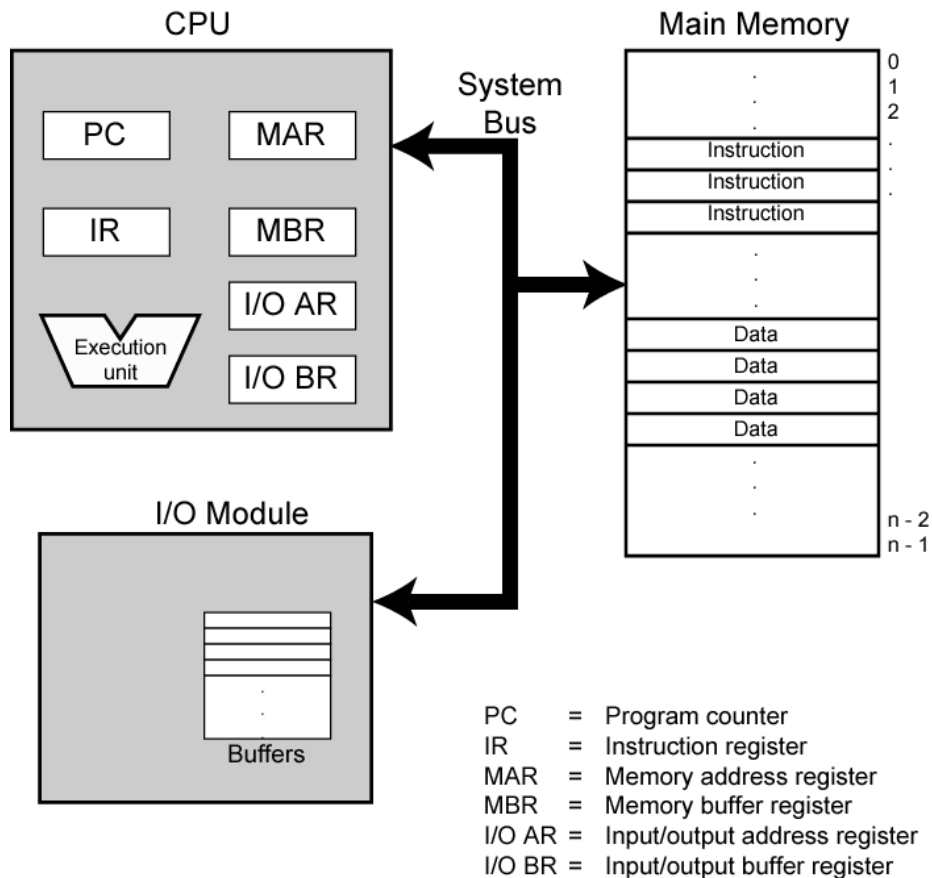


# What is a program?

- A sequence of steps / Instructions
- For each step, an arithmetic or logical operation is done
- For each operation, a different set of control signals is needed



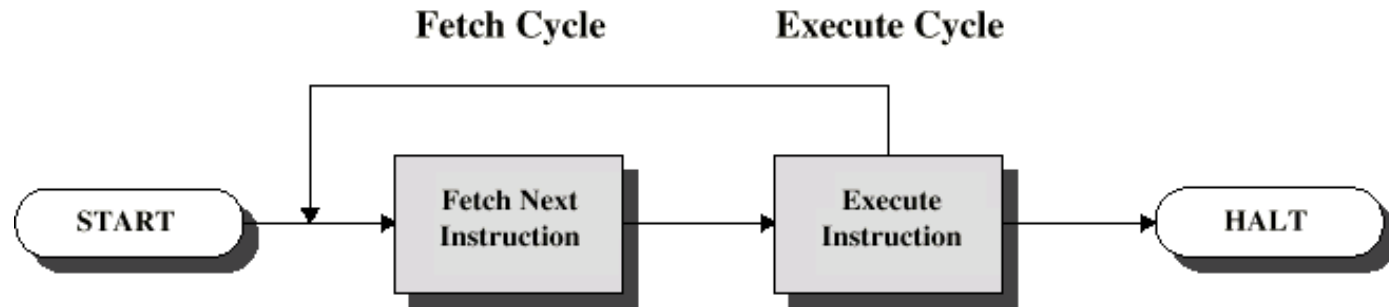
# Computer Execution Components: Top Level View





# Basic Instruction Cycle

- Two steps:
  - Fetch
  - Execute



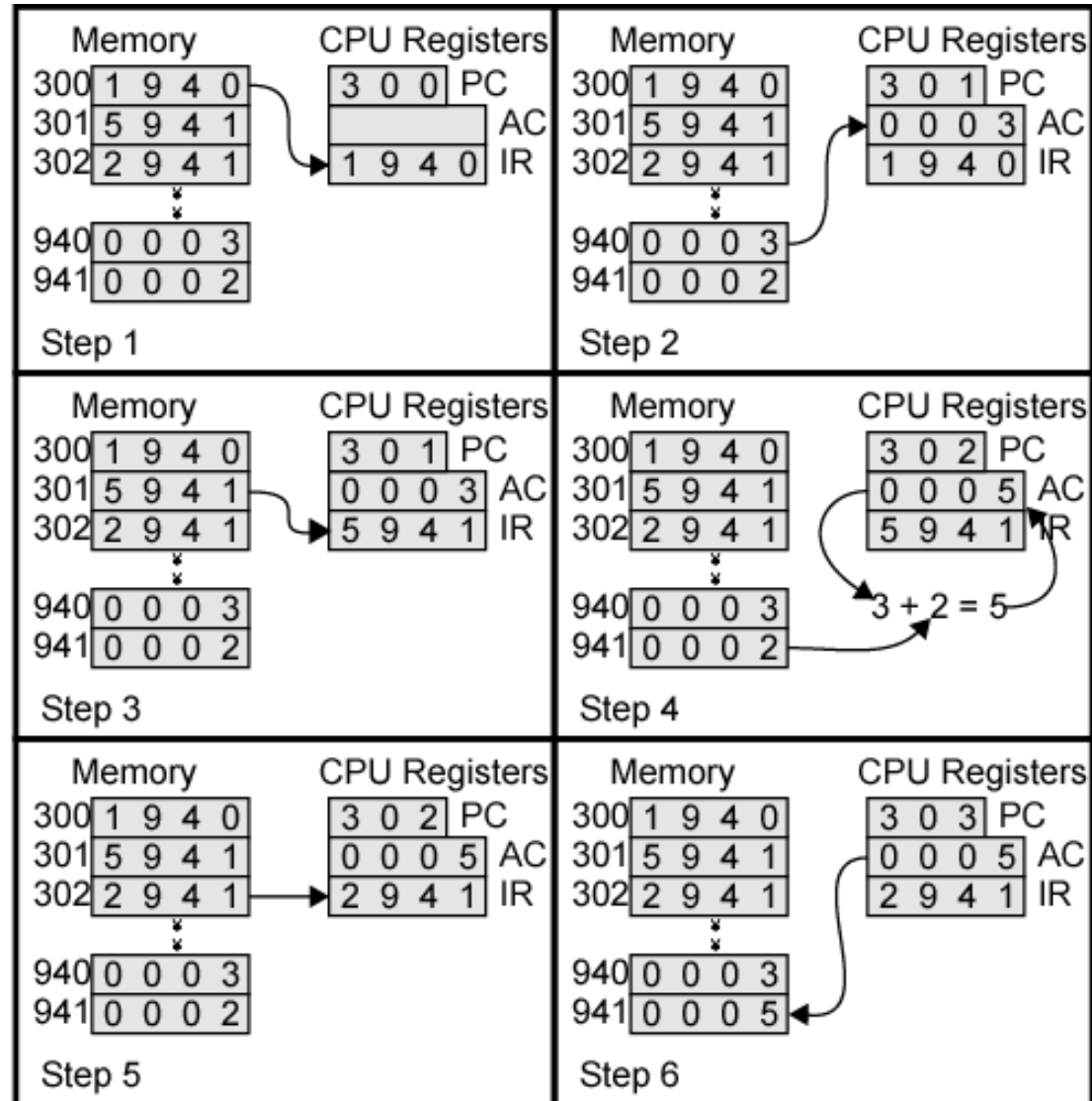
## Fetch Cycle

- Program Counter (PC) holds address of next instruction to fetch
- Processor fetches instruction from memory location pointed to by PC
  - Send PC to address bus
  - Read memory content, address bus located
- Increment PC (To next Instruction)
  - Unless told otherwise
- Instruction loaded into Instruction Register (IR)
- Processor (Control Unit) interprets (Decode) instruction and performs required actions

## Execute Cycle

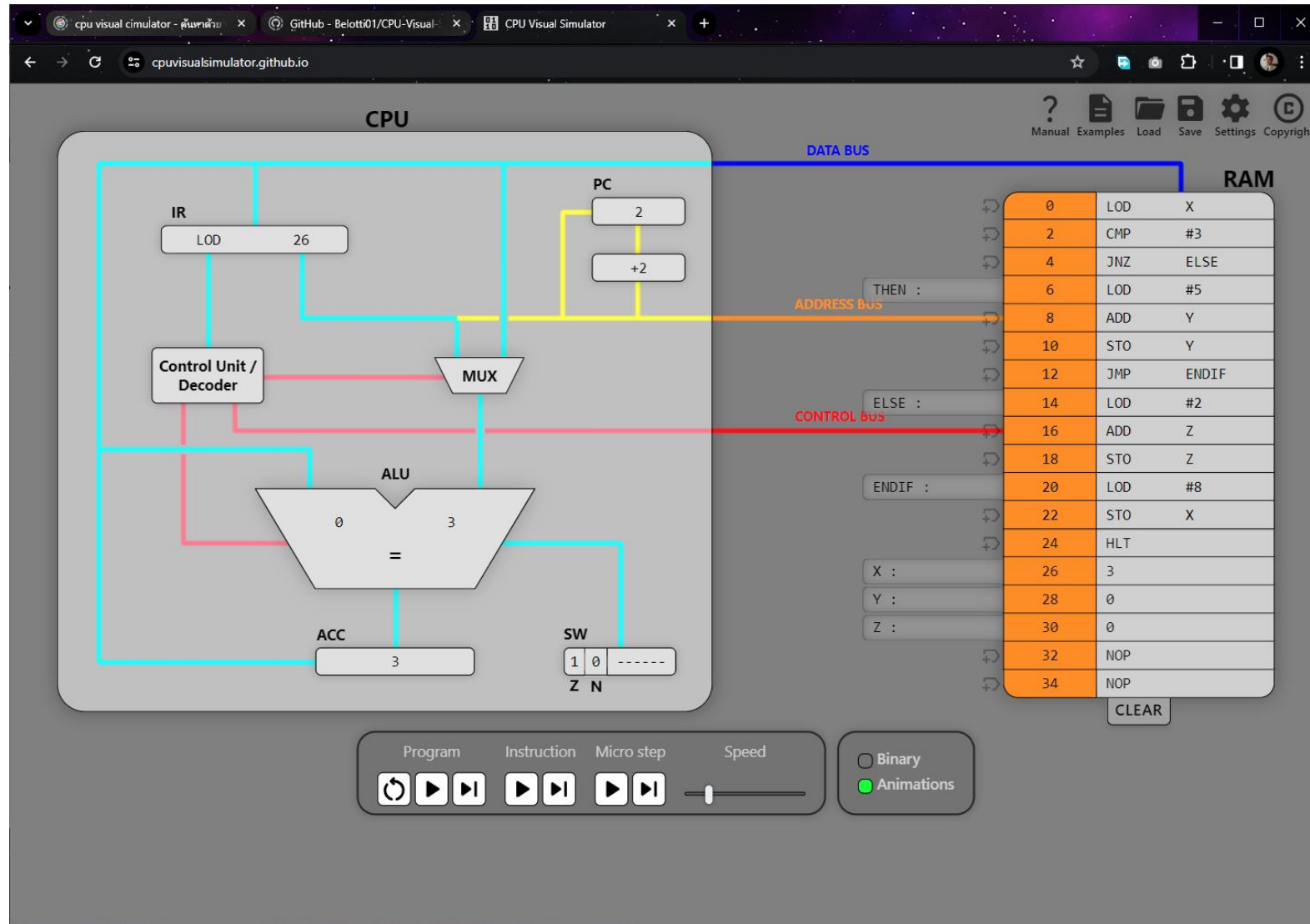
- Control Unit sends control signals to activate working modules
- Working types:
  - Processor-memory - data transfer between CPU and main memory
  - Processor I/O - Data transfer between CPU and I/O module
  - Data processing - Some arithmetic or logical operation on data
  - Control - Alteration of sequence of operations
    - e.g. jump
  - Combination of above

# Example of Program Execution



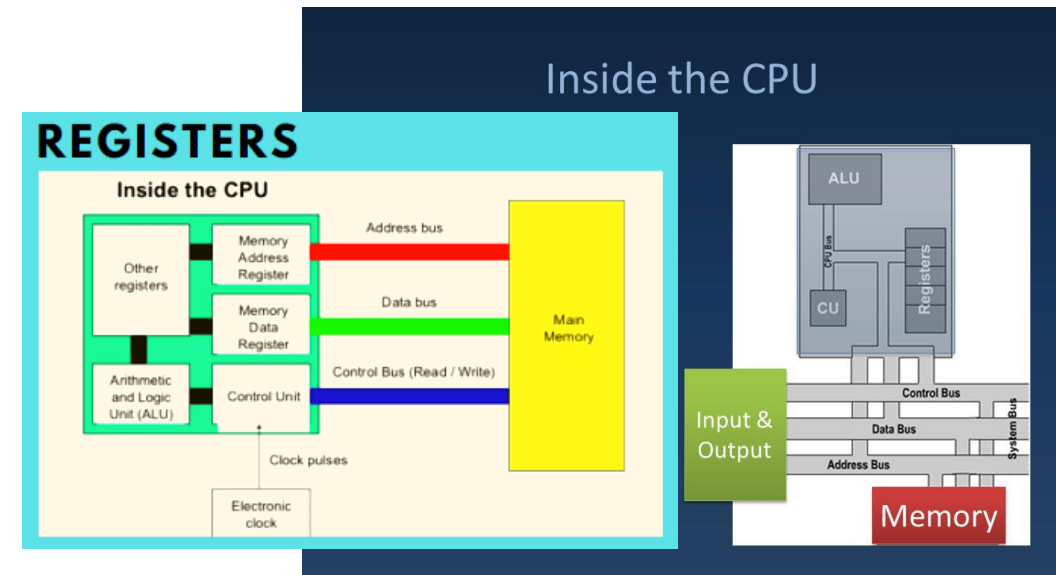
# Computer Program Execution

- <https://cpuvisualsimulator.github.io/>

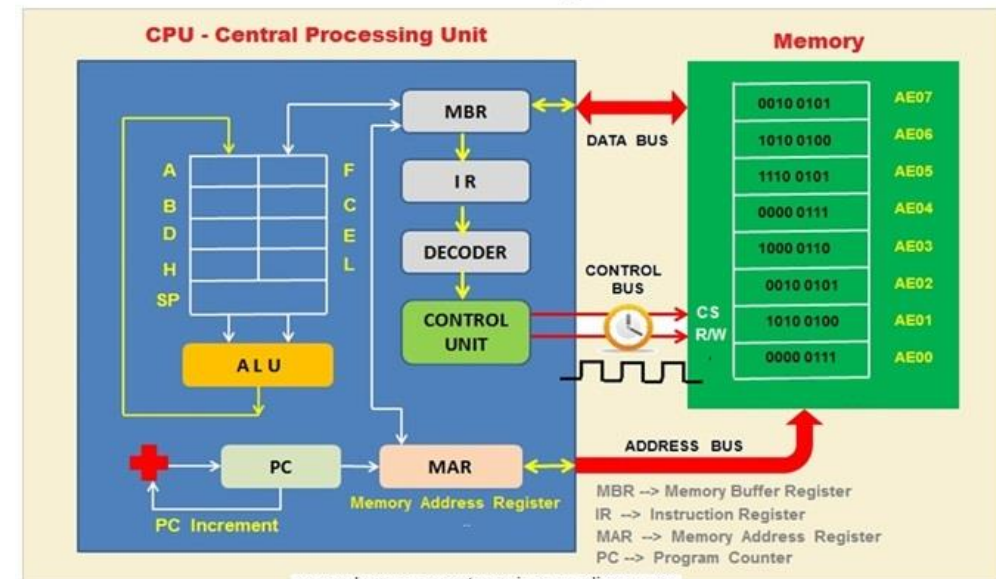


# Conclusion

- Computer Functions
  - Data Processing, Data Storage, Data Movement, Control
- Computer Architecture
  - Processor, Memory, Input/Output, Interconnection (Bus vs Switch)
- CPU Architecture
  - Registers, Arithmetic and Logic Unit (ALU), Control Unit, Interconnection
- Control Unit
  - Control by control signals
  - Sequencing Unit, Decoder, Controllers
- Computer Program Execution
  - Program – a set/sequence of instructions/steps
  - Instruction execution – Loop of fetch and execute cycles
  - Instructions (program) will be executed forever, until halted.



## How CPU Executes Program Instructions ?



# END

Questions?