Concepts, Structure and Functions

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Outline

Syllabus

- Course resources will be available on D2L
- Also find them here:
  `http://cs.unb.ca/~jnanjeky/teaching/cs3853`
- Textbook: W. Stallings, Computer Organization and Architecture, Designing for Performance
- **Instructor's website will have more resources than D2L**

Tentative Schedule

Week	Lecture Topic	Assignment	Quiz	Lab
1	Computer evolution and performance			✓
2	Digital logic, Boolean Algebra, logic gates, combinational and sequential circuits	✓		✓
3	Processor architecture and structure	✓	✓	✓
4	Memory architecture	✓		✓
5	Interfacing and I/O strategies	✓		✓
6	Parallelism and parallel organizations, performance enhancements		✓	

Delivery

- Lectures
- Assignments (20%)
  - Four in total
  - No assignment in the first week
  - **Read the plagiarism policy**
- Quizzes (5%)
  - Two in total for 30 minutes
  - July 17 and 31
  - **Read the plagiarism policy**
- Labs (35%)
  - Wed. 13:00-15:50 PM Head Hall 301 Laboratory
  - You may be asked to present your solution
  - Group work is fine
  - Individual submissions are required
  - **Read the plagiarism policy**
- Final Exam (40%)
  - Monday, Aug. 12, 14:00 - 17:00

Delivery

- Email: jnanjeky@unb.ca
- **Office Hours: Mon. 11:30 - 12:30 ITC 321**
- You are free to use the internet for more resources
- Accommodations are handled by the registrar

Architecture and Organization

Architecture refers to attributes of a system that are visible to a programmer These atributes have direct impact on the logical execution of a program

Organization refers to the operational units and their interconnections that realize the architectural specifications

Architecture Examples

- Instruction set
- Bit representation for data types
- I/O mechanisms
- Memory addressing techniques

Organization Examples

- Control signals
- Interfaces
- Memory technology

Architecture vs. Organization

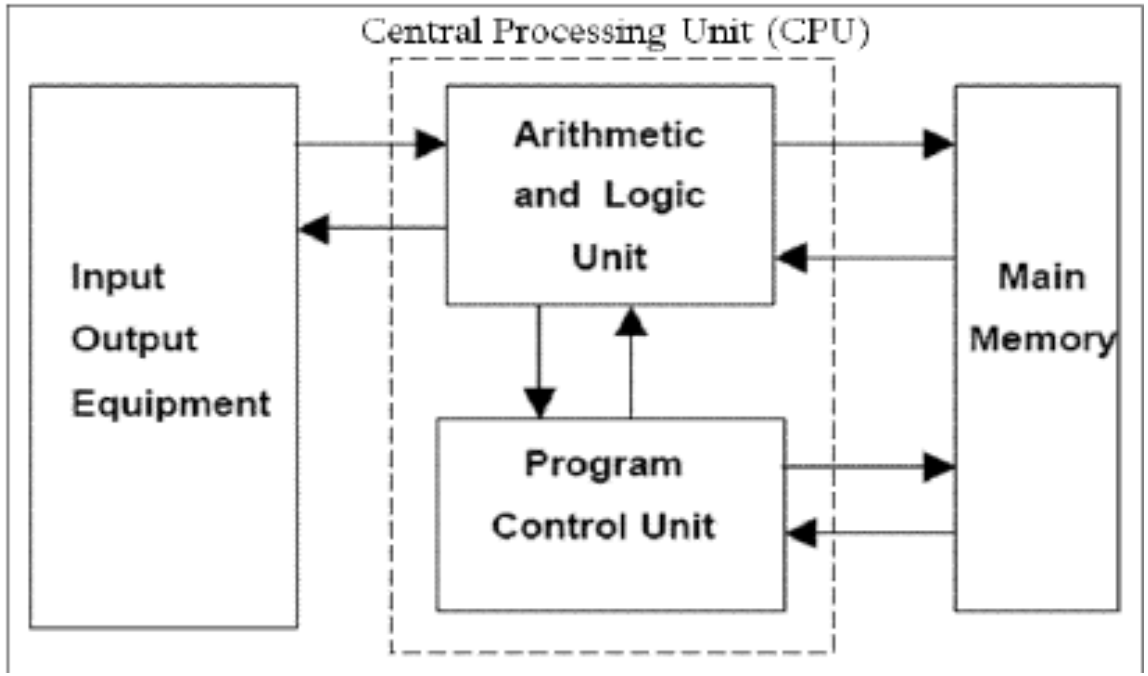
- The distinction is still important
- Architecture is usually more stable:
  - IBM System/370 architecture
  - Remains in use in the IBM main frames
- Organization keeps changing to appeal to:
  - Frequency of use
  - Speed
  - Cost and size

Structure and Function

Structure: The way in which the components are interrelated

Function: The operation of each individual component as part of the structure

The Von Neumann Computer Model



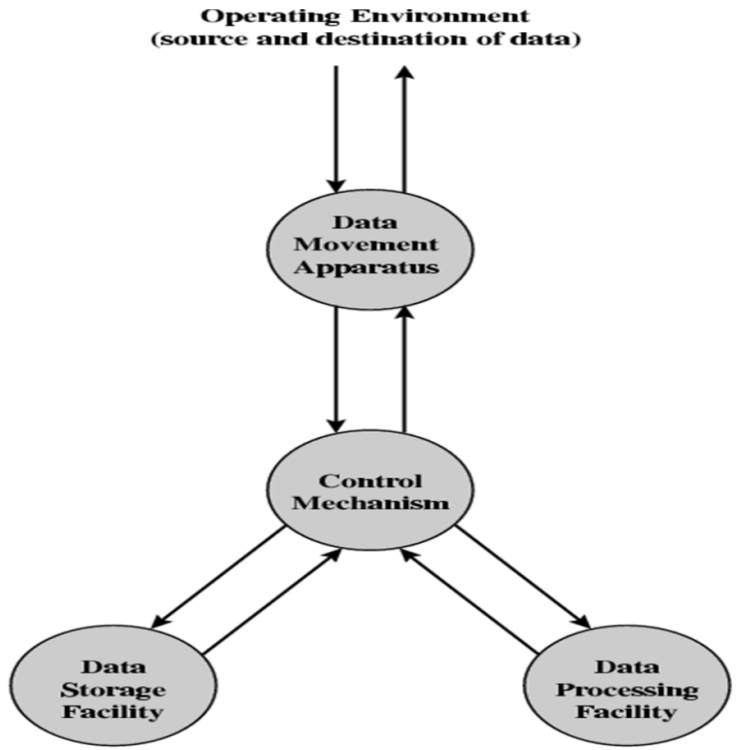
Features of the Von Neumann Architecture

1. The most common computer model
2. This model uses the stored program concept where:
   - Memory holds the program
   - And the data the instructions act on
3. Memory is addressed by location numbers (addresses) not the type of the contents
4. Execution and memory accessed is sequential/linear

Functions of a Computer

A computer has four core functions

- Data processing
- Data storage
- Data movement
- Control

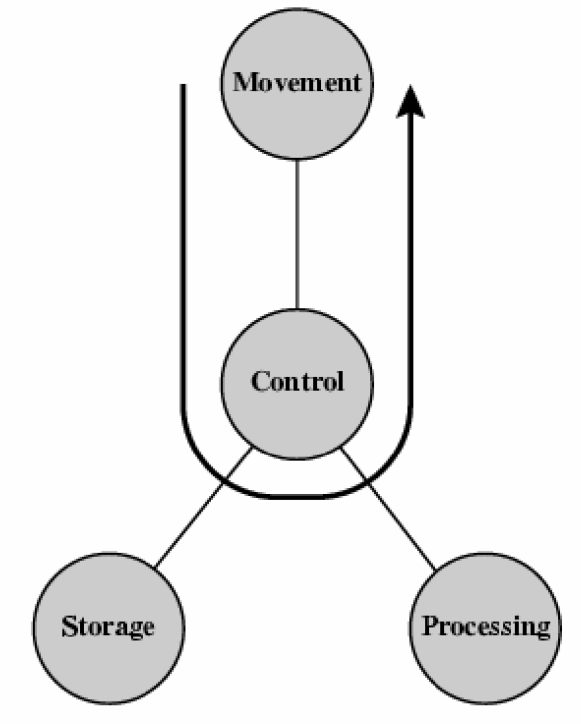


Control

- Monitors and manages computer's resources
- Maintains the operation of the functional components according to instructions
- Put simply the control unit orchestrates control of data processing, data storage, and data movement

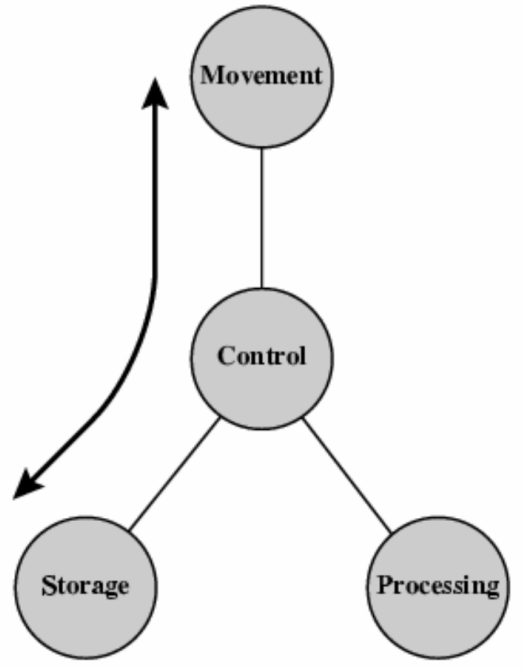
Data Movement

- The computer operating environment has data sources and destinations
- Data movement is in two forms:
  - **input/output:** when data is moved from a directly connected device, called a *peripheral*
  - **Data Communication:** when data is moved from a long distance or remote device



Storage

- Data storage is useful for all forms of life times:
  - **Short Term:** temporary storage for immediate processing like temporary and loop variables
  - **Long Term:** non-temporary storage of data for subsequent access e.g. logging and data records

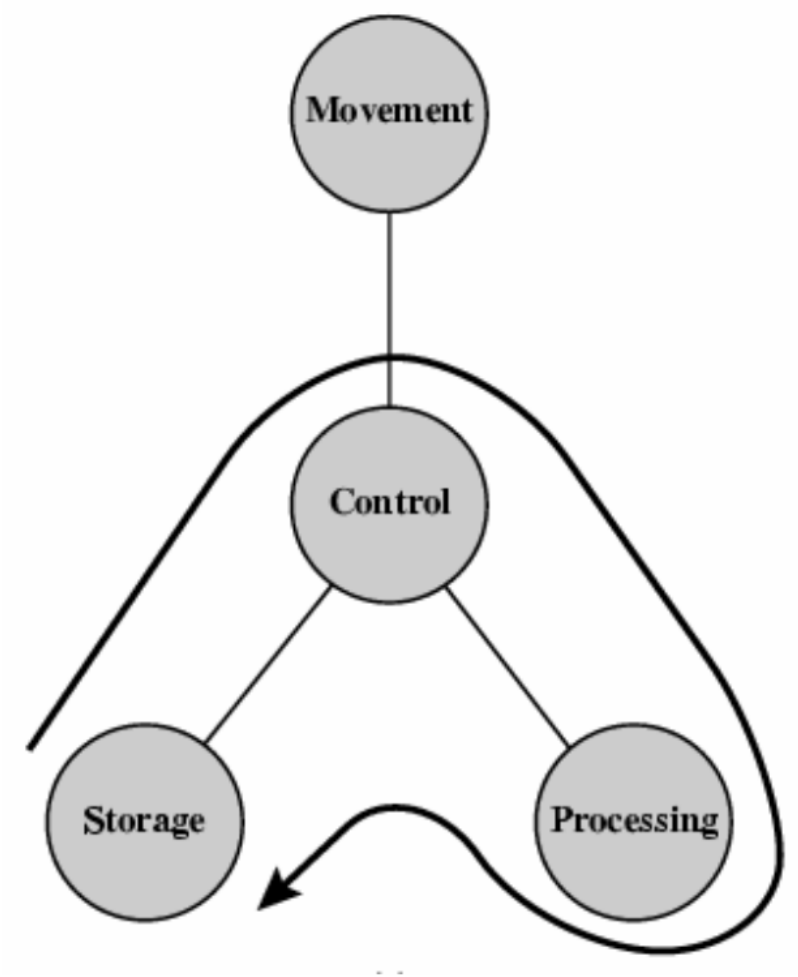


Data Processing

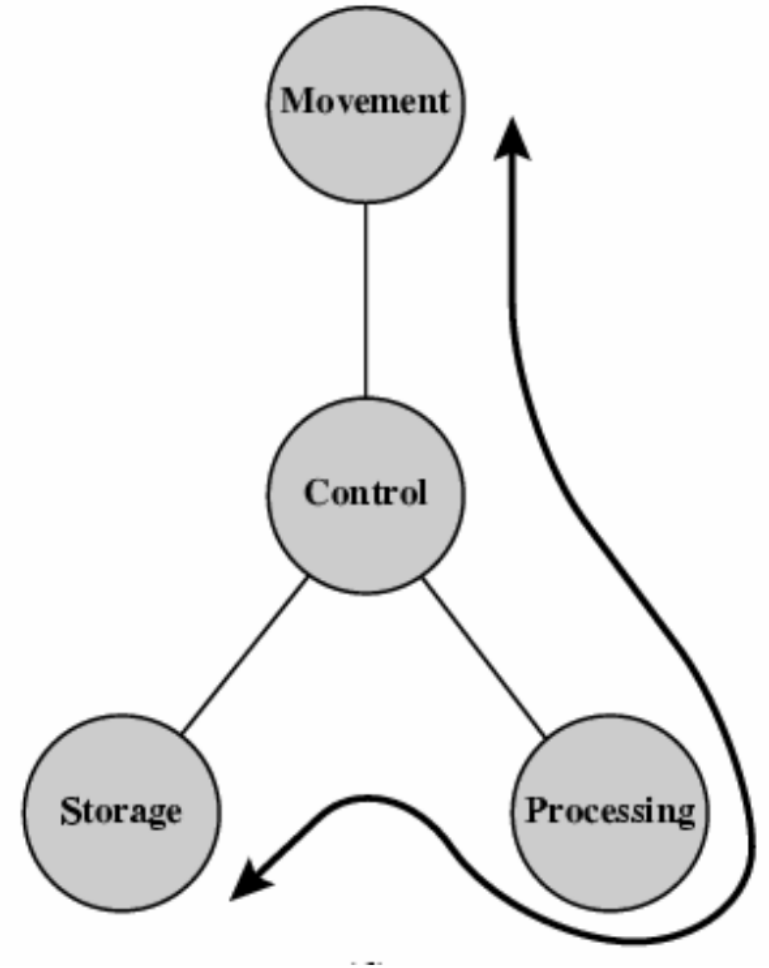
- This is a core function of the computer
- Processing is achieved with arithmetic and logical operations performed on data
- There are different mechanisms of data processing

Data Processing

Processing from/to storage



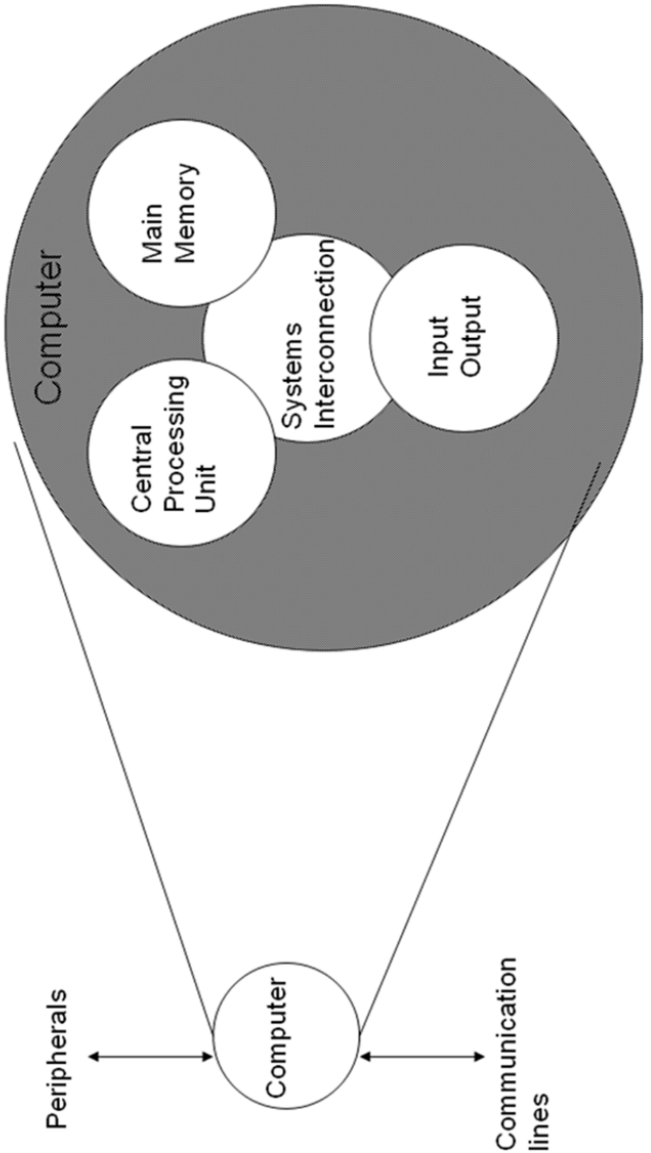
Processing from storage to I/O



Computer Structure

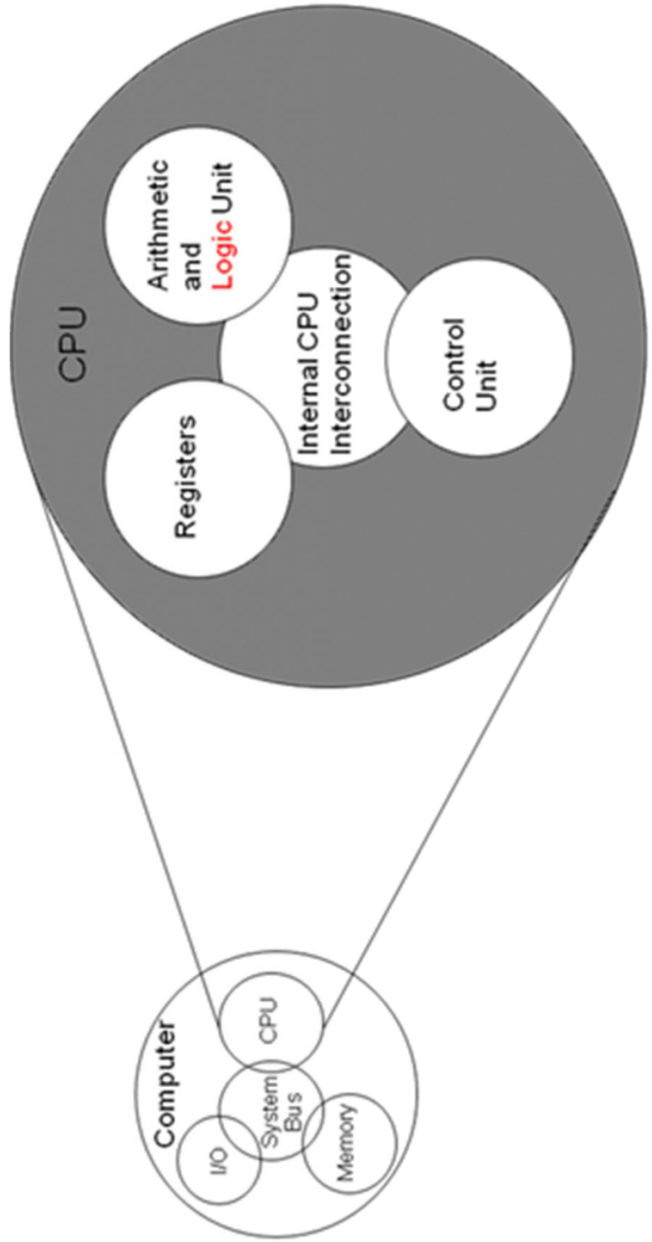
A computer has four main components

- **Central Processing Unit** (CPU): Known as a *processor*, responsible for controlling computer operations and performs data processing functions
- **Main Memory:** stores data
- **Input/Output:** Moves data between the computer and external environment
- **System Interconnection:** Achieves communication among CPU, main memory, and I/O, e.g. system bus



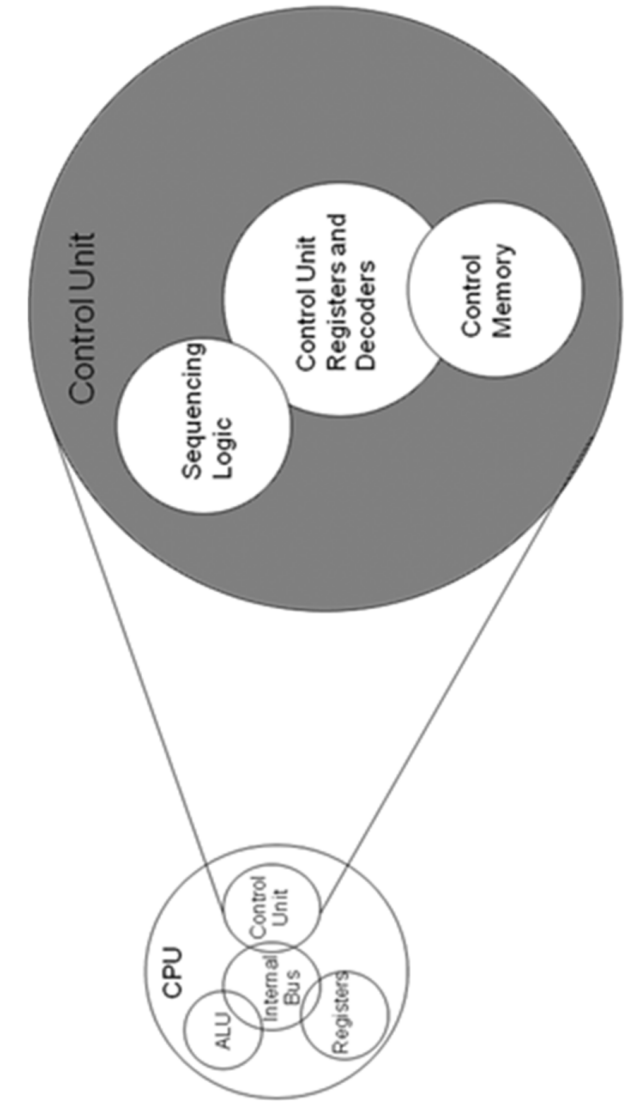
Central Processing Unit

- **Control Unit**: controls CPU operation which eventually controls the computer
- **Arithmetic and Logic Unit (ALU):** Performs data processing functions
- **Registers:** Provide CPU internal storage
- **CPU Interconnection:** Achieves communication among control unit, ALU and registers



Control Unit

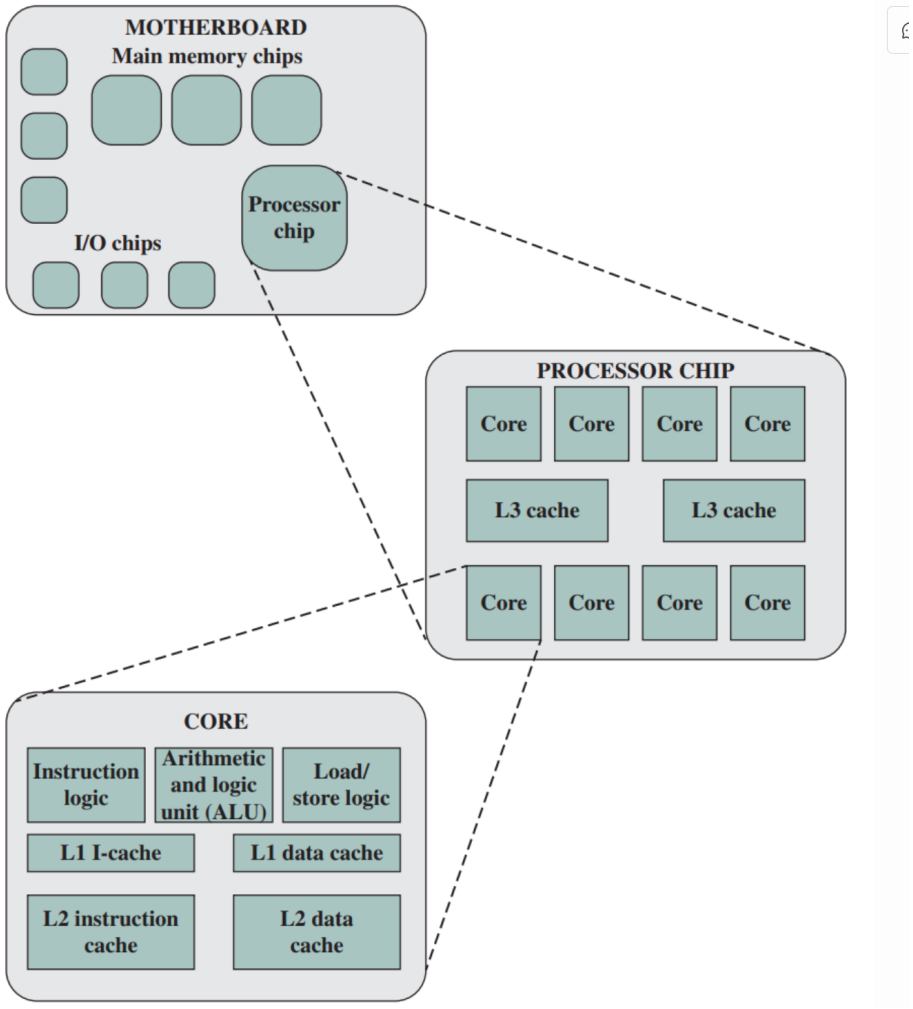
- Implementation of the control unit can vary
- The approach used in this example is the *microprogramming* approach
- Where microinstructions define the functionality of the control unit



Multicore Structure

- Consists of multiple processors residing on a single chip, *multicore computers*
- Each processing unit is called a core
- Terminology:
  - **Central Processing Unit (CPU):** consists of ALU. control unit and registers. This unit fetches and executes instructions
  - **Core:** An individual processing unit on a processor unit. Equivalent to a CPU of a single-CPU computer
  - **Processor:** A physical piece of silicon consisting of one or several cores.

Components in a Multicore Structure



Cache

- *Cache memory* refers to multiple layers of memory between the processor and main memory
- Cache is faster and smaller than main memory
- It is used to to speed up main memory by storing data from main memory
- Cache memory is used to store data that is likely to be accessed in the near future
- There are multiple levels of cache:
  - level 1 (L1)
  - level 2 (L2)
  - level 3 (L3)
  - L (n) is smaller and faster than L ($n + 1$)

Components of a Core

- **Instruction Logic:** Fetches instructions, decodes the instructions to determine the operation and the memory locations of associated operands
- **Arithmetic and Logic Unit (ALU):** Executes the operation specified by an instruction
- **Load/Store Logic:** Manages the movement of data between main memory via the cache

Lecture Resources

- Chapter 1