The Computer System

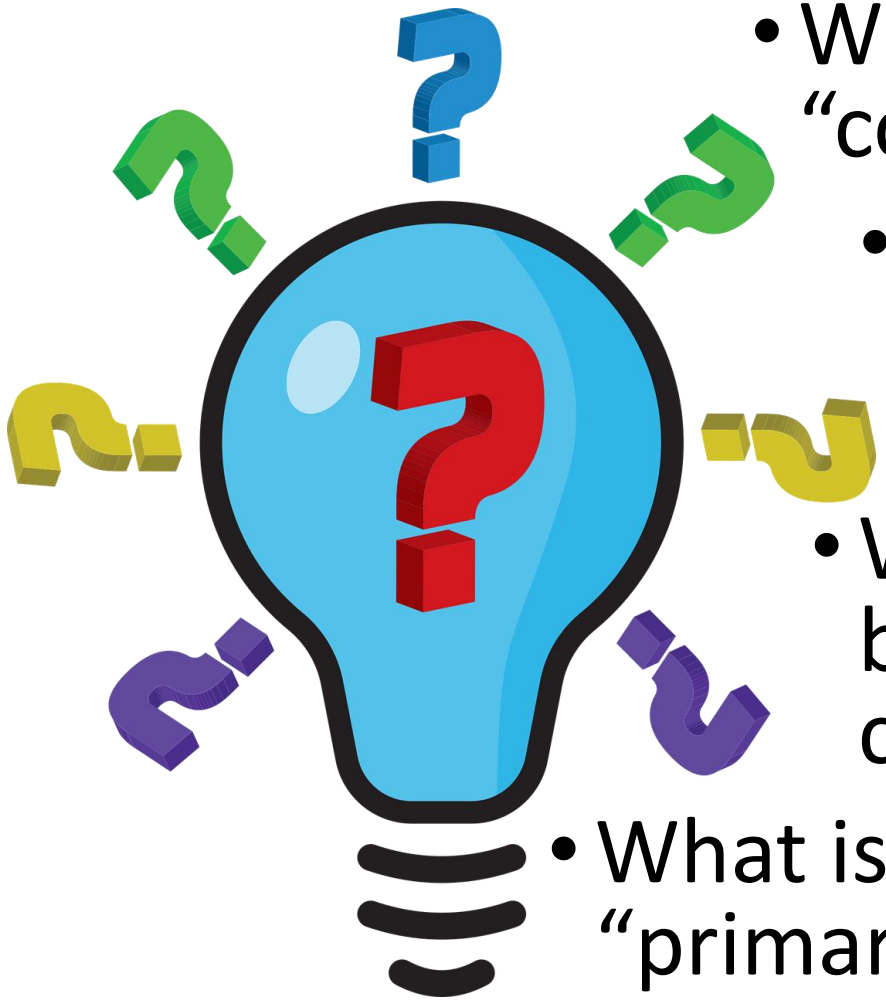
WEEK 02-2

Introduction

This introduce the students to the computer system. Alternatively, students who are familiar with its principles and concepts will be able to use it as a refresher.

Objective

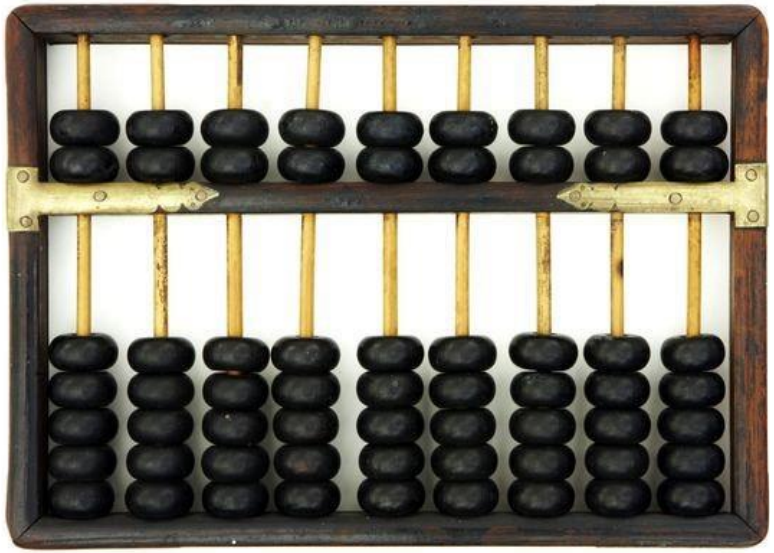
This aims to help the student understand the principles and concepts that are involved in a computer system.



- What could have been the first computer?
  - What comes to mind when the term “computer system” is mentioned?
    - What could be the function of a “central processing unit” in a computer system?
    - What is the possible difference between “input” and “output” in a computer system?
- What is the possible difference between “primary memory” and “secondary memory” in a computer system?

Abacus

A computing tool that has been used as early as the Mesopotamian period.



- able to perform the four basic arithmetic operations
- traders and merchants still use the abacus for their computational needs.
- aside from being needing no power source, the abacus is also useable by people who are visually impaired and cannot use calculators

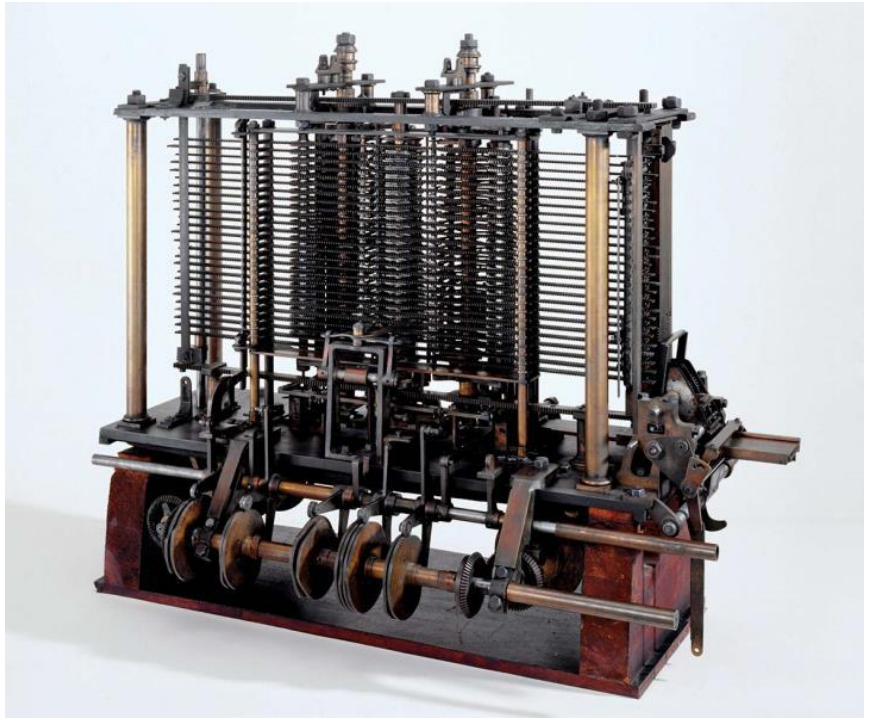
Astrolabe

A computing tool that was invented around the Hellenistic civilization.

- function as an inclinometer
- determine the altitude of any celestial body above the horizon
- determine the local latitude
- measure the time of day, night or year
- measure NPS (North Polar Sequence) orientation

Analytical Engine

Designed and partially built by **Charles Babbage**. It is considered as the first computer and was based on the Difference Engine which was a simple calculating machine.

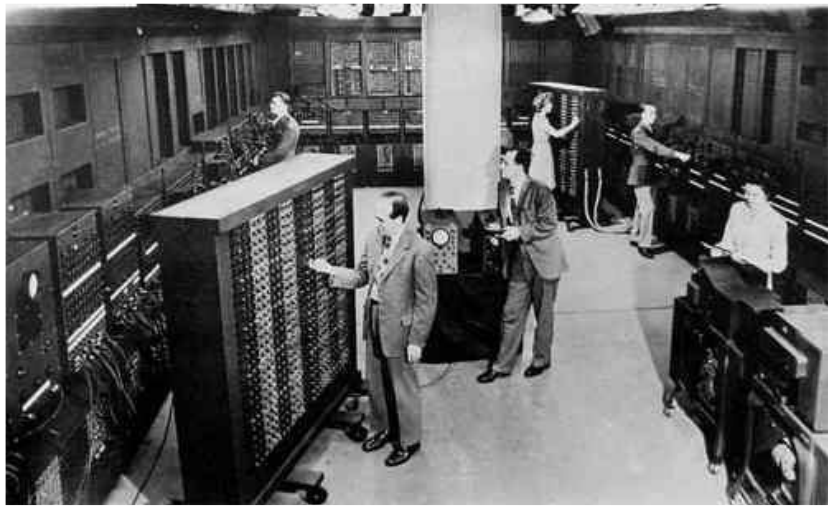


A portion of the Analytical Engine

- a general-purpose machine for computing
- composed of four components:
  - store (memory)
  - mill (processor)
  - reader (input device)
  - printer (output device)

Electronic Numerical Integrator and Calculator (ENIAC)

Built in 1943 and its invention led to the formation of the **Association for Computing Machinery (ACM)**.



The ENIAC room

- it was designed specifically to compute values for artillery range tables

List of significant persons in the history of Modern Computing:

- **Alan Shugart** - floppy disk
- **Alan Turing** - Turing machine, basis of modern computers
- **Douglas Engalbart** - mouse and graphical user interface
- **Grace Hopper** - first computer language: Common Business Oriented Language (COBOL).
- **Herman Hollerith** - punch card system and established International Business Machines (IBM).
- **Jack Kilby and Robert Noyce** - computer chip.

List of significant persons in the history of Modern Computing:

- **John Mauchly and J. Presper Eckert -** designers of the ENIAC and the Universal Automatic Computer (UNIVAC)
- **JV Atanasoff** - designer of the first computer that could store information in its main memory
- **Paul Allen and Bill Gates** - wrote software using the new programming language Beginner's All-purpose Symbolic Instruction Code (BASIC) and established Microsoft
- **Rob Barnaby** - creator of WordStar, the first word processor
- **Robert Metcalfe** - developer of the Ethernet

List of significant persons in the history of Modern Computing:

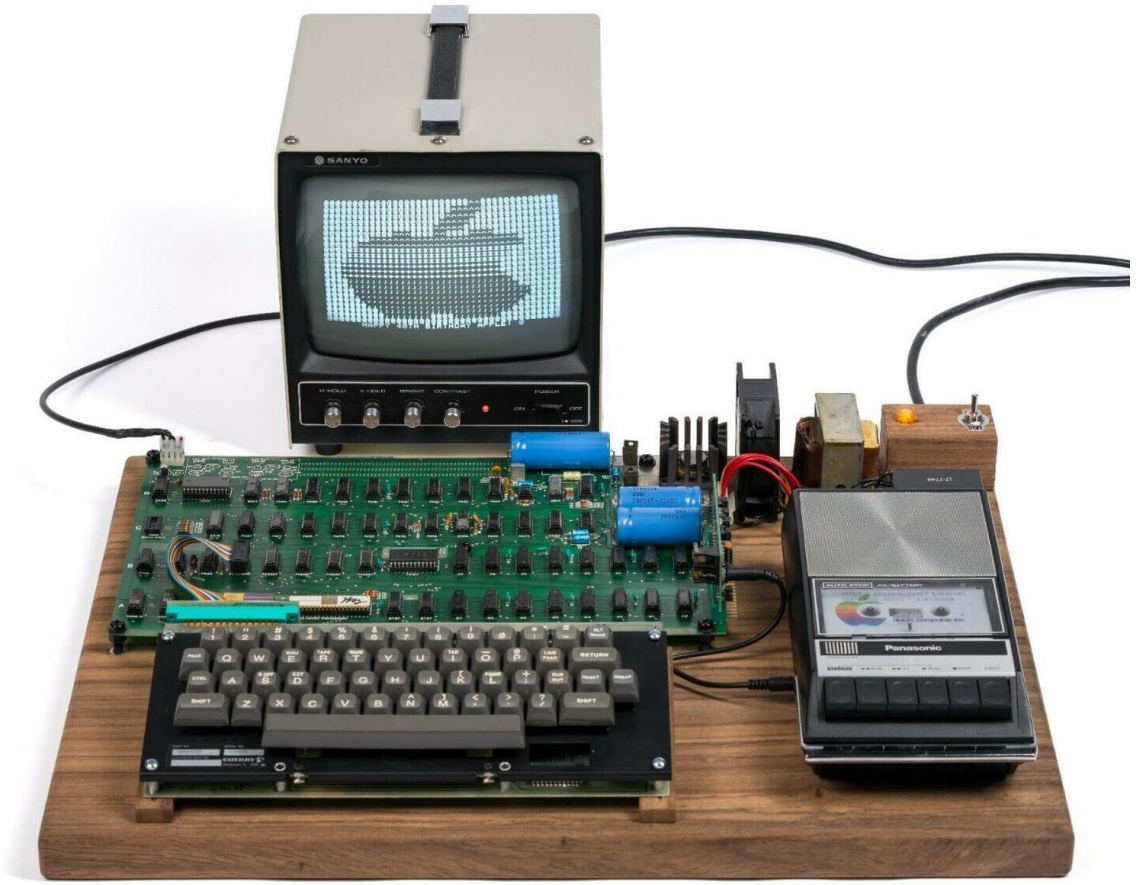
- **Sergey Brin and Larry Page** - developers of the Google search engine
- **Steve Jobs and Steve Wozniak** - creators of the first computer with a single-circuit board and established Apple Computers
- **Tim Berners-Lee** - developer of Hypertext Markup Language (HTML) and in turn, the World Wide Web (WWW)
- **William Shockley, John Bardeen and Walter Brattain** - inventors of the transistor

Category of Modern Digital Computers by Size

Microcomputer

- Referred to computers that used **microprocessors** – a small, integrated circuits that perform arithmetic and logical operations.
- Small-scale computers that are designed for personal or individual use.
- Also known nowadays as personal computers or PCs.

Category of Modern Digital Computers by Size



APPLE 1

Category of Modern Digital Computers by Size

Laptop

Desktop

Tablet

Smart Wearables

Smartphone

Category of Modern Digital Computers by Size

Mainframe

- It is an institutional computer that responds to multitudes of users at the same time.
- Mainframe uses cases include blockchain technology, private clouds and machine learning.
- Handle and process large volumes of data, typically for transaction processing, database management, and large-scale enterprise applications.
- Often used by banks, insurance companies, and government agencies to manage massive amounts of data and support thousands of users simultaneously.

Category of Modern Digital Computers by Size

Category of Modern Digital Computers by Size

Supercomputer

- designed for complex computational tasks that require immense processing power, such as scientific simulations, weather forecasting, quantum mechanics, and large-scale numerical calculations.
- Used in research and industries where high-performance computing is critical.

Computer System

- The working definition of a **computer system** posits that it is comprised of functional entities, namely the **hardware** and **software**, which together are able to accept data (**input**), process it and provide feedback (**output**) in a format that can be understood by the **user**.
- The computer system is a machine that cannot naturally understand human language. A **bit (binary digit)** is the basic unit of information that a computer system can understand. It is comprised of only two states:
  - **0 (Zero):** This value is False or Off.
  - **1 (One):** This value is True or On.

Category of Modern Digital Computers by Size

Mainframes are typically large, **cabinet-sized machines** with a modular design. They are composed of multiple racks that house processors, memory, storage, and other components. These racks can be expanded to increase capacity.

Supercomputers can vary in size but are often **larger than mainframes**, sometimes **occupying entire rooms or even multiple floors**. They consist of thousands or even millions of interconnected processors, often housed in multiple cabinets or racks.

What is a Computer System?

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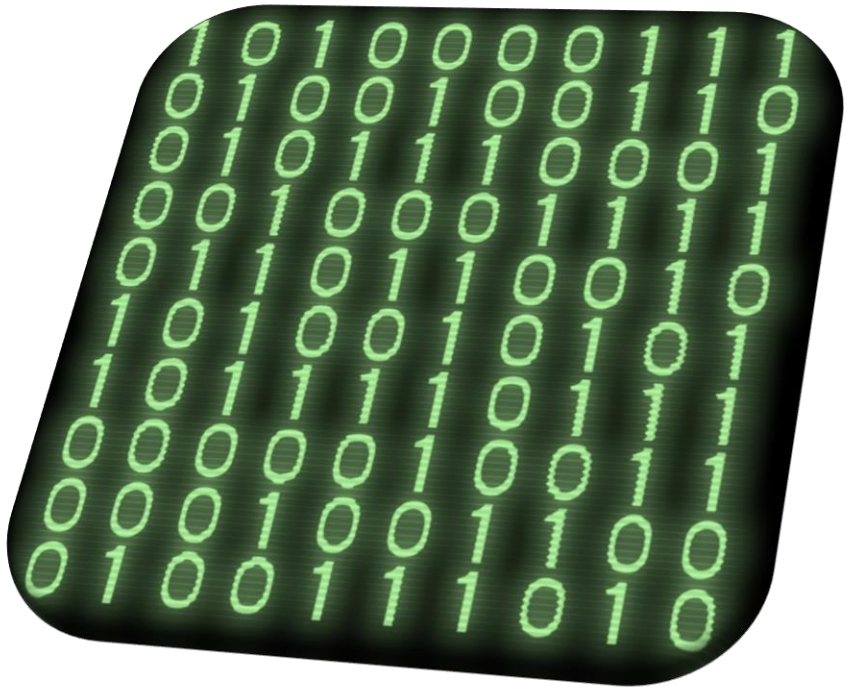


The **power button symbol** is a combination of the two states of a computer system: Off and On. It is a zero and a one.

Hardware

- tangible parts
- anything that the user can physically touch in the computer system

At this point, some questions may be raised such as:

- How does the computer system accept data from the user?
- How does the computer system process data from the user?
- How does the computer system provide feedback to the user?

Hardware

“How does the computer system accept data from the user?”

A computer system has hardware that can accept commands and data **(input)** from the user. These are called **input devices**.

An input device performs the following functions:

- It accepts the instructions and data from the user.
- It converts these instructions and data into a format that can be processed by the computer.
- It supplies the converted instructions and data to the computer system for further processing.

Hardware

“How does the computer system process data from the user?”

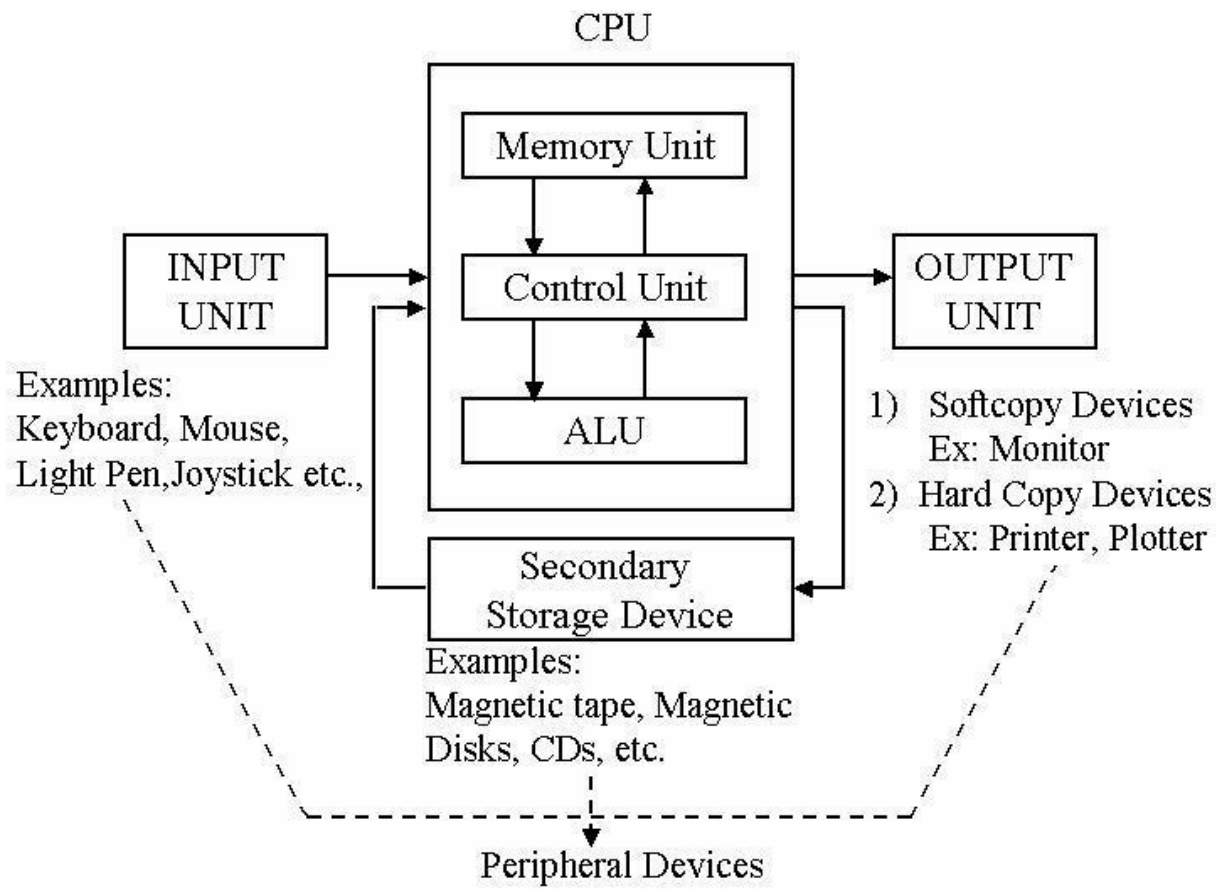
A computer system has hardware that acts as its brain. These are called **processors**.

- also called a **central processing unit** or **CPU**
- the **central component** of a computer unit
- responsible for **executing instructions** and **performing calculations**
- acts as the "**brain**" of the computer
  - carrying out tasks that enable the computer to operate and perform various functions. It contains all the circuitry needed to process input, store data, and output results.

Hardware

The three fundamental components of a central processing unit are:

- Memory unit
- Control unit
- Arithmetic logic unit (ALU)



Hardware

“How does the computer system provide feedback to the user?”

A computer system has hardware that can show the results of processing data **(output)** to the user. These are called **output devices.**

- responsible for **presenting** the **results** of processing to the **user**
- receives data from the computer and presents it to the user in a **human-readable form**
- provides the output in a format that **can be understood** by the **user**
- allow users to **receive feedback**, **view results**, or **interact** with the **processed information**.

Hardware

Show output of the computer operation.

Process the operation.

Enter the data.

Software

- intangible parts of the computer system
- commonly known as “programs” or “applications”

- in its most general sense, is a set of electronic instructions or programs instructing a computer to do specific tasks
- Software is a generic term used to describe computer programs.
- Two main categories of software are **Application** Software and **System** Software.

Software

- **Operating system** - consists of a set of software designed to handle computer resources and services and provides a platform for running other applications/software
- **Device driver** - enables device communication with the OS and other programs
- **Firmware** - enables device control and identification, stored in ROM
- **Program Language Translator** - translates high-level languages to low-level machine codes
- **Utility** - ensures optimum functionality of devices and applications

Memory

- responsible for **storing**, **managing**, and **retrieving** *data* and *instructions* either temporarily or permanently for the processor can access quickly
- store both input and output data and is divided into three types:
  - primary memory
  - secondary memory
  - cache memory

Memory

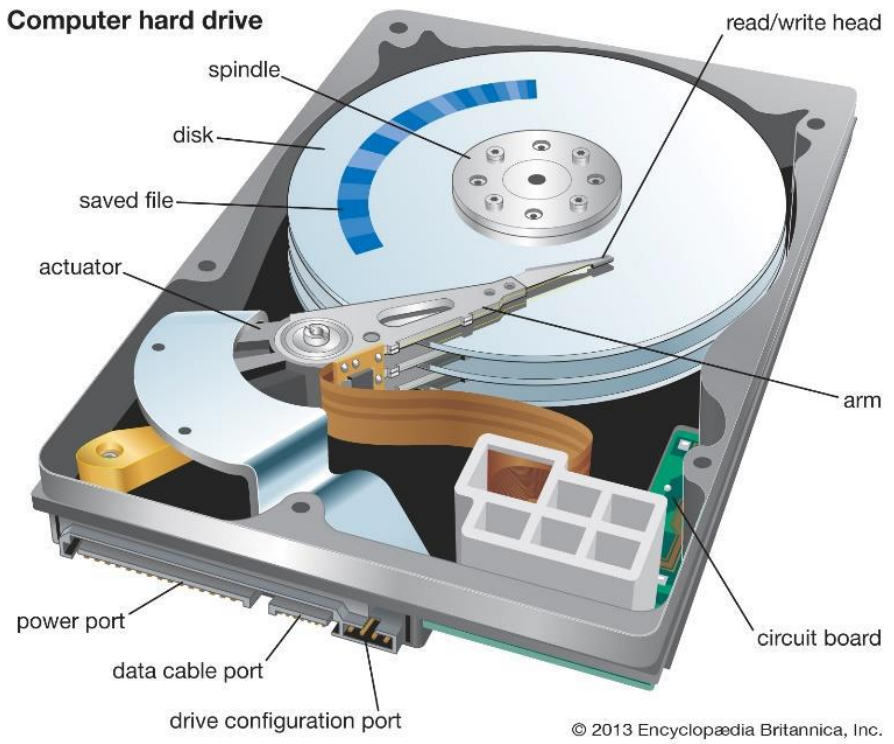
Primary memory – It is directly accessed by the CPU.

- **Random access memory (RAM)** – High-speed, volatile memory. Volatile means that the information which is stored will be erased when the computer system shuts down.
- **Read-only memory (ROM)** – Slower, non-volatile memory. Non-volatile means that the information is stored and not erased even when the computer system shuts down.

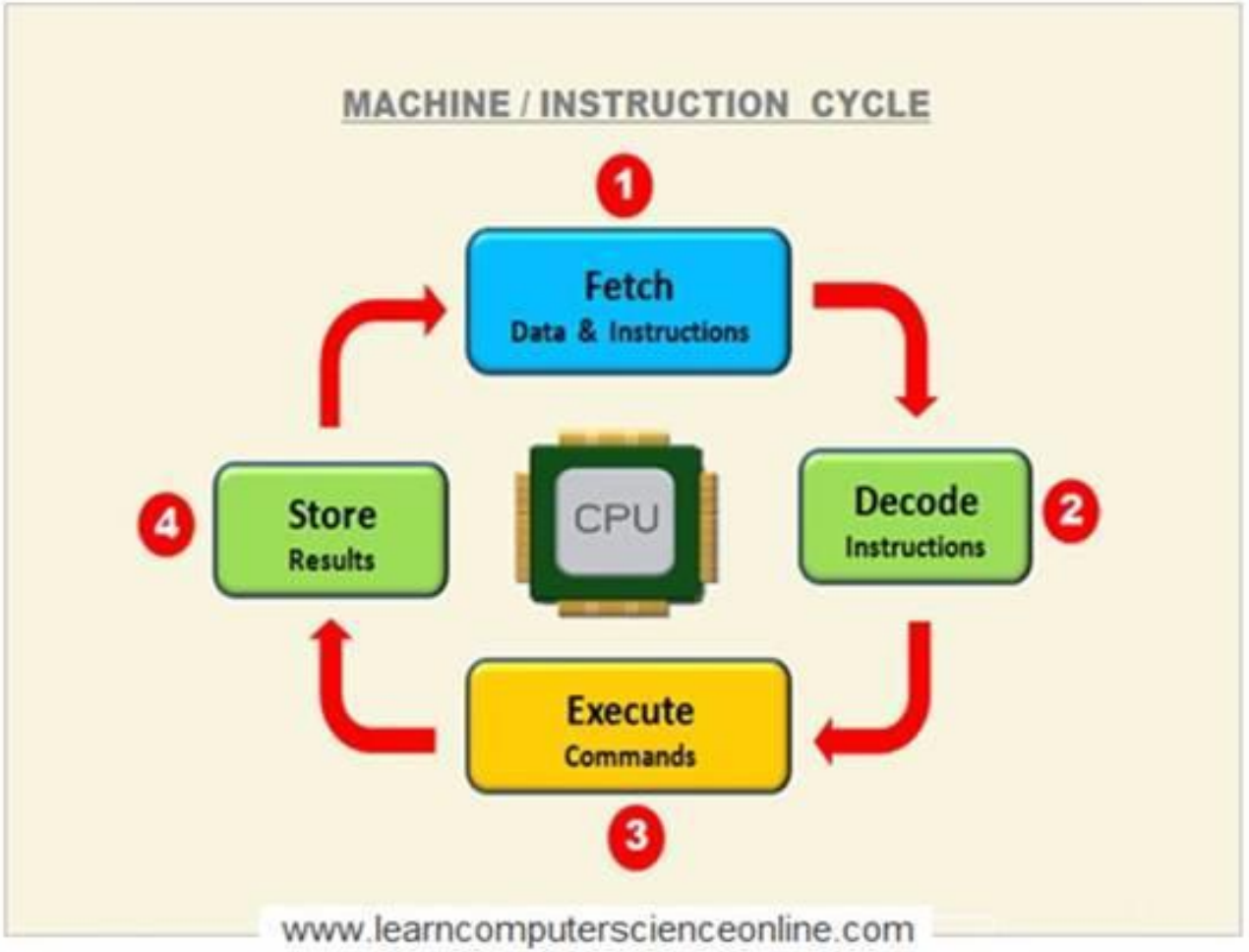
Memory

Secondary memory – It is not directly accessed by the CPU.

- For example: storage devices such as the hard disk drive (HDD).



CPU Machine Cycle



The CPU Machine Cycle

- **Fetch:** The CPU fetches data and instructions that are contained in its memory unit.
- **Decode:** The control unit within the CPU interprets the data and instructions.
- **Execute:** The arithmetic logic unit processes the interpreted data and instructions.
- **Store:** The CPU stores the results in its memory unit

Control Unit (CU)

The **control unit (CU)** directs the memory unit, arithmetic logic unit, input and output (I/O) devices and tells them how they should respond to commands. As the name implies, it controls the flow of data that is interchanged between the CPU and other computer system devices.

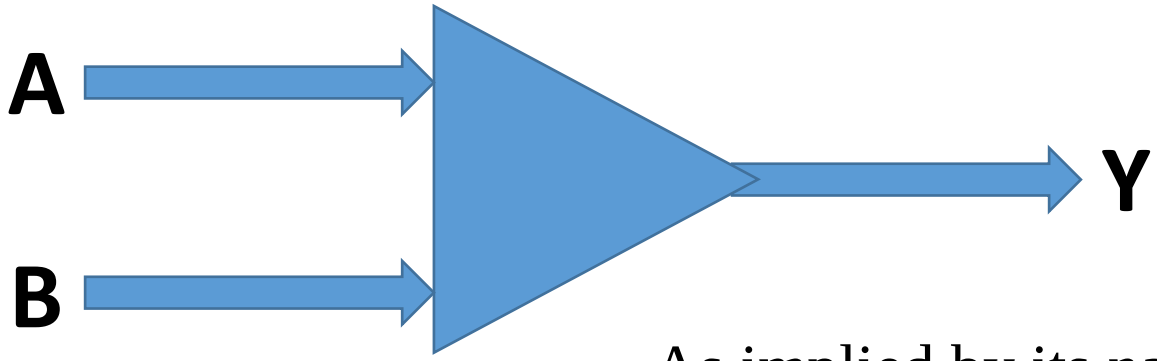
The control unit obtains instructions from the memory unit. It interprets those instructions and directs the operation of the other units.

Arithmetic Logic Unit (ALU)

The **arithmetic logic unit (ALU)** performs arithmetic and logical operations. Most ALUs use **bitwise operations** instead of **floating point operations** (real numbers). Bitwise operations are simple, fast actions. Some ALUs are able to process both bitwise and floating point operations.

Arithmetic Logic Unit (ALU)

Data given to the ALU for processing are called **operands**. The ALU receives two operands (A and B), processes it according to the operations chosen by the system or the user, and then it gives the result (Y) of the operation.



As implied by its name, ALU has two parts: an **arithmetic unit** and a **logic unit**.

Arithmetic Logic Unit (ALU)

The **arithmetic unit** can handle simple numerical operations such as:

- **Addition:** Adding two bits.
- **Addition with carry:** Adding two bits with a carry-in.
- **Subtraction:** Subtracting two bits.
- **Subtraction with borrow:** Subtracting two bits while borrowing from a carry-in.
- **Negation:** Changing a bit from + to – and vice versa.
- **Increment:** Adding one to a bit.
- **Decrement:** Subtracting one from a bit.

Arithmetic Logic Unit (ALU)

The **logic unit** can handle numerical tests to check if a number is negative, and logical operations such as:

- **And:** The operation returns True only if both inputs are True.
- **Or:** The operation returns False only if both inputs are False.
- **Not:** The operation returns True if the input is False; it returns False if the input is True.

CPU Front Panel

CPU Back Panel

The processor (CPU), graphics processing unit (GPU), storage devices and internal peripherals are contained in this enclosure. The correct terminology for this enclosure is "**system unit**".

Other parts of the computer system such as input devices are connected to the CPU via their respective units. They communicate by transferring data between components via **computer buses (bus)**.

Computer Buses (Bus)

A widely-known industry standard is the **universal serial bus (USB)**. External storage devices that use USB hardware for connectivity are mistakenly called “USBs”. The correct terminology for such devices is “**flash drive**”. They are storage drives that use flash memory.

Evolution of Computing

Modern society is currently in the 21st century's **Digital Era**, a shift from the Industrial Revolution of the late 1700s. There is great focus on the advancement of digital technology, proliferation of knowledge and information via digital methods, and the economic impact of information technology.

Evolution of Computing

In addition to static media, content can now be accessed through electronic means. This is called **electronic media**. Some examples of electronic media are video and audio recordings, slideshows and online content.

Evolution of Computing

Equipment that are used in electronic communication are also called electronic media. This includes televisions, smartphones and even game controllers. Most of these are also computer systems.

Electronic Media

Electronic media historically started when transmission was invented along with the **telegraph**. In telecommunications, a **transmission** is the process of sending a signal using a **transmission medium**. There are two kinds of signals:

- **Analog:** A continuous electrical signal in which a time-varying quantity such as voltage represents another time-based variable. It represents a real number.
- **Digital:** A signal that represents data as a sequence of discrete, finite values.

The Internet

The **Internet** is the system of globally interconnected computer networks. The networks communicate via the **internet protocol suite** (Transmission Control Protocol – TCP and Internet Protocol – IP).

The internet provides access to many sources of information such as the **World Wide Web (WWW)**, **voice over internet protocol (VOIP)**, **file sharing**, **cloud services** and **electronic mail (email)**.

The Internet

Many computer systems are now connected to the internet. Its proliferation is part of the Digital Era and contributed to the rise of electronic media, particularly online content. **Instant messaging**, **online shopping**, **social networking services** and **cryptocurrency** are some digital services and assets that became possible only because of the internet.

The Internet

Blockchain games such as CryptoKitties and Axie Infinity are currently on the rise. These are video games that uses some aspect of cryptographic blockchain technology.