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Computer

A computer is an electronic device that processes data by performing both **arithmetic** and **logical operations**. It follows a set of instructions (called **programs**) to **input**, **store**, **manipulate**, and **output** information.

Fundamental Principle:

Input → Process → Output

Basic Characteristics of a Computer

- It works in binary (0s and 1s).
- It consists of hardware and software.
- It performs three basic functions: input, processing, and output.
- It operates automatically once programmed.
- It executes tasks with high speed and accuracy.
- It stores and retrieves data quickly.
- It can perform multiple tasks at the same time.
- It does not get tired or bored.
- It follows instructions without understanding them.
- It produces consistent results for the same input.
- It can be connected to other devices for communication.
- It can handle large volumes of data.
- It can be upgraded for better performance.
- It requires electricity to function.
- It does not make decisions on its own.
- It performs logical and arithmetic operations.
- It supports various input and output devices.
- It can be programmed to solve complex problems.
- It maintains data integrity and accuracy.
- It enables automation of repetitive tasks.

Categories of Computer

1. **Analog Computer**

   - **Definition**: A computer that processes continuous data/Natural Process—like temperature, speed, or pressure.
   - **Working**: It represents physical quantities directly without converting them into numbers.
   - **Examples**: Speedometer, traditional thermometer, analog voltmeter.
   - **Applications**: Scientific simulations, control systems, industrial measurements.
   - **Key Traits**:
     - No need for binary conversion
     - Less precise than digital computers

2. **Digital Computer**

- **Definition**: A computer that processes data using binary digits (0s and 1s).
- **Working**: Converts input into binary form and performs logical and arithmetic operations.
- **Examples**: Desktop computers, laptops, smartphones.
- **Applications**: General-purpose computing, business, education, entertainment.
- **Key Traits**:
  - High accuracy and speed
  - Stores and processes data digitally
  - Most commonly used type today

3. Hybrid Computer

- **Definition**: A computer that combines features of both analog and digital systems.
- **Working**: Analog part handles continuous data; digital part processes it for accuracy and control.
- **Examples**: ECG machines, patient monitoring systems, scientific analyzers.
- **Applications**: Healthcare, research labs, weather forecasting.
- **Key Traits**:
  - Real-time data capture (analog) + precise processing (digital)
  - Used in specialized fields requiring both speed and accuracy

Components of Computer

1. Hardware

- It refers to the physical parts of a computer.
- It can be touched and seen.
- It includes input, output, processing, and storage devices.
- It works only when software is installed.
- It wears out over time due to physical usage.
- Examples: Keyboard, mouse, monitor, CPU, RAM, hard disk.

Types of Hardware

1. **Input Devices**
   - Used to enter data into the computer.
   - Examples: Keyboard, mouse, scanner, microphone.
2. **Output Devices**
   - Used to display or deliver processed data.
   - Examples: Monitor, printer, speakers, projector.
3. **Processing Devices/Cpu**
   - Perform calculations and control operations.
   - Examples: CPU, GPU.
4. **Memory Unit/Storage Device**
   - Used to store data permanently or temporarily.
   - Examples: Hard disk, SSD, USB drive, CD/DVD.
   - Two main types:
     Primary Memory: RAM (volatile), ROM (non-volatile).

Secondary Memory: Hard disk, SSD, USB drive.

2. **Software**
   - It refers to a set of instructions that tell the hardware what to do.
   - It cannot be touched or seen physically.
   - It is stored in memory and executed by the processor.
   - It controls the operation of hardware components.
   - It does not wear out but can become outdated or buggy.
   - Examples: Windows, MS Word, Chrome, Photoshop.

Types of Software

1. **System Software**
   - Manages and controls hardware so application software can function.
   - Examples: Operating systems (Windows, Linux), device drivers, utility programs.
2. **Application Software**
   - Designed to perform specific tasks for users.
   - Examples: MS Office, web browsers, media players, graphic editors.

Difference between Hardware and Software

Feature	Hardware	Software
Nature	Physical components	Digital instructions/programs
Tangibility	Can be touched and seen	Cannot be physically touched
Function	Performs tasks as directed by software	Directs hardware to perform tasks
Durability	Wears out over time	Can be updated or corrupted
Dependency	Needs software to function	Needs hardware to run
Examples	Keyboard, CPU, RAM	Windows OS, MS Word, Photoshop

Keyboard:

A **keyboard** is a primary input device used to enter textual, numerical, and symbolic data into a computer system. It consists of a matrix of keys that transmit electrical signals to the computer when pressed, enabling user interaction through command execution and data entry.

Key Classifications

Key Group	Function

Key Group	Function
Alphanumeric Keys	Letters, numbers, and basic symbols.
Function Keys (F1–F12)	Software-specific shortcuts.
Control Keys	Ctrl, Alt, Shift, Esc—used for command combinations.
Navigation Keys	Arrow keys, Home, End, Page Up/Down—used for cursor movement.
Numeric Keypad	Dedicated number entry block.
Multimedia Keys	Volume, brightness, play/pause—found in modern keyboards.

Functional Applications

- **Data Entry**: Text, numbers, and symbols for documents, coding, and databases.
- **Command Execution**: Shortcut combinations for system and software control.
- **Navigation**: Cursor movement and interface control.
- **Accessibility**: On-screen keyboards, large-print models, and assistive layouts.

Ascii Code:

ASCII stands for **American Standard Code for Information Interchange**. It's a **character encoding system** that assigns a unique numeric value to letters, digits, punctuation marks, and control characters—making it possible for computers to store and exchange text.

On a keyboard, **ASCII codes** are the invisible bridge between what you type and what the computer understands. Every key you press corresponds to a specific **ASCII value**, which the system translates into binary for processing

Key Pressed	ASCII Code	Description
`A`	65	Uppercase A
`a`	97	Lowercase a
`0`	48	Digit zero
`Enter`	13	Carriage Return (CR)
`Space`	32	Space character
`Tab`	9	Horizontal Tab
`Esc`	27	Escape
`Backspace`	8	Deletes previous character

Key Pressed	ASCII Code	Description
!	33	Exclamation mark
@	64	At symbol
.	46	Period

How It Works

When you press a key:

1. The keyboard sends the **ASCII code** for that character.
2. The operating system interprets it and displays the corresponding symbol.
3. For control keys (like Enter or Tab), the system performs an action instead of displaying a character.

ASCII Codes for "computer"

Character	ASCII Code	Binary Equivalent
c	99	01100011
o	111	01101111
m	109	01101101
p	112	01110000
u	117	01110101
t	116	01110100
e	101	01100101
r	114	01110010

When you type ‘computer’, each letter is instantly converted into its ASCII code, which the machine reads as binary. It’s like translating human language into machine

Mouse:

A **mouse** is a handheld pointing input device used to control the position of a cursor on a computer screen. It enables users to interact with graphical user interfaces (GUIs) by performing actions such as clicking, dragging, scrolling, and hovering.

Functional Applications

- **GUI Navigation**: Pointing, selecting, and activating interface elements.
- **Drag-and-Drop Operations**: Moving files, objects, or interface components.
- **Scrolling**: Navigating through long documents or webpages.
- **Gaming**: Real-time control, aiming, and interaction.
- **Design & Editing**: Precision control in graphic and video software.
- **Accessibility**: Trackballs and large-button mice for users with motor challenges.

Buttons on Mouse:

| Left Click /Button (Primary) |

- Used for **selecting**, **clicking**, and **dragging** items.
- **Single Click**: Selects an object or places the cursor.
- **Double Click**: Opens files or applications.
- **Drag-and-Drop**: Click and hold to move items across the screen.

| Right Click/ Button (Secondary) |

- Opens **contextual menus/ Option Menus** related to the selected item.
- Commonly used for accessing shortcuts, properties, or additional options.

| Scroll Wheel (Middle Button) |

- Located between the left and right buttons.
- Allows **vertical scrolling** through documents, web pages, and lists.
- Often clickable to act as a **third button** for opening links in new tabs or activating auto-scroll.

| Additional Buttons (Programmable) |

- Found on advanced or gaming mice.
- Used for **custom macros**, **navigation shortcuts** (e.g., back/forward in browsers), or **application-specific commands**.

Monitor:

A **monitor** is a visual output device that displays text, images, videos, and graphical data generated by a computer. It converts digital signals from the graphics card into human-readable visual output.

Functional Applications

- **Visual Output**: Text, images, videos, UI elements
- **Design & Editing**: High-resolution displays for creative work
- **Gaming & Simulation**: Fast response and immersive visuals
- **Accessibility**: Adjustable brightness, contrast, and scaling

Pixel:

A **pixel** (short for *picture element*) is the **smallest addressable unit** in a digital image or display. Each pixel represents a single point of color and brightness, and collectively, millions of pixels form the visual content seen on screens.

Key Characteristics

- **Shape**: Typically square or rectangular
- **Attributes**: Each pixel contains data for **color**, **brightness**, and sometimes **opacity**

- **Grid Arrangement**: Pixels are arranged in a 2D matrix(length & width) across the screen
- **Color Depth**: Determines how many colors a pixel can represent (e.g., 24-bit = 16.7 million colors)

Function

- Pixels are the **building blocks** of digital images and displays
- Higher pixel density leads to **sharper and more detailed visuals**
- Each pixel is identified by its **coordinates** (X, Y) on the screen

Example

A Full HD screen with resolution **1920 × 1080** contains **2,073,600 pixels**, each contributing to the overall image.

Resolution:

Resolution refers to the **number of pixels** displayed horizontally and vertically on a screen. It defines the **clarity, sharpness, and detail** of visual output.

Format

- Expressed as **Width × Height** (e.g., 1920 × 1080)
- Indicates the **total pixel count** used to render(load) images

Impact on Display Quality

- **Higher resolution** = more pixels = **greater detail and clarity**
- Affects **text readability**, **image sharpness**, and **video quality**
- Must be matched with appropriate **screen size** and **viewing distance** for optimal performance

Printer:

A **printer** is an output device that produces hard copies of digital documents, images, or graphics by transferring data from the computer onto physical media such as paper

Technical Architecture

Component	Function
Print Head	Applies ink or toner to paper
Cartridge/Toner	Contains ink (liquid or powder)
Paper Feed Mechanism	Moves paper through the printer

Component	Function
Controller Board	Processes print commands from the computer
Interface Ports	USB, Wi-Fi, Ethernet, Bluetooth
Power Supply	Powers internal components

Printers vary by **printing technology**, **speed**, **quality**, and **intended use**.

1. Inkjet Printers

- **Technology**: Sprays microscopic ink droplets onto paper using nozzles
- **Features**: High-quality color output, compact size
- **Use Cases**: Home use, photo printing, small offices
- **Pros**: Affordable upfront cost, excellent color reproduction
- **Cons**: Slower speed, expensive ink cartridges

2. Laser Printers

- **Technology**: Uses laser beam and toner powder to produce images via electrostatic charge
- **Features**: Fast, precise, ideal for text-heavy documents
- **Use Cases**: Offices, schools, high-volume printing
- **Pros**: High speed, low cost per page, sharp text
- **Cons**: Higher initial cost, bulkier size

3. Dot Matrix Printers (Impact)

- **Technology**: Pins strike an ink ribbon to form characters as a matrix of dots
- **Features**: Durable, can print multi-part forms
- **Use Cases**: Industrial settings, invoices, carbon copies
- **Pros**: Reliable in harsh environments, low running cost
- **Cons**: Noisy, low resolution

4. Thermal Printers

- **Technology**: Uses heat-sensitive paper or thermal transfer ribbon
- **Features**: Quiet, fast, no ink required
- **Use Cases**: POS systems, receipts, shipping labels
- **Pros**: Low maintenance, compact
- **Cons**: Fades over time, limited media compatibility

5. LED Printers

- **Technology**: Similar to laser but uses LED array instead of laser beam
- **Features**: Fewer moving parts, compact design

- **Use Cases**: Office environments, color printing
- **Pros**: Reliable, energy-efficient
- **Cons**: Less common, similar cost to laser

6. Solid Ink Printers

- **Technology**: Uses solid wax-like ink blocks melted during printing
- **Features**: Vivid colors, minimal waste
- **Use Cases**: Graphic design, marketing materials
- **Pros**: Eco-friendly, high-quality output
- **Cons**: Proprietary ink, slower warm-up time

7. Multifunction Printers (All-in-One)

- **Technology**: Combines printing, scanning, copying, and faxing
- **Features**: Space-saving, versatile
- **Use Cases**: Home offices, small businesses
- **Pros**: Cost-effective, centralized workflow
- **Cons**: Complex maintenance, slower than dedicated devices

8. 3D Printers

- **Technology**: Builds objects layer by layer using materials like plastic, resin, or metal
- **Features**: Precision modeling, prototyping
- **Use Cases**: Engineering, architecture, medical modeling
- **Pros**: Custom fabrication, innovation-friendly
- **Cons**: Expensive, slow, requires technical skill

Cpu:

The **Central Processing Unit (CPU)** is the core hardware component of a computer responsible for executing instructions, performing calculations, and managing data flow. Often referred to as the **"brain of the computer,"** it interprets and processes commands from software and hardware.

Working of the CPU: The Instruction Cycle

The CPU operates through a continuous cycle known as the **Fetch–Decode–Execute** cycle:

Step	Description
1. Fetch	Retrieves the next instruction from memory (RAM) using the **Program Counter (PC)**.
2. Decode	The **Control Unit (CU)** interprets the instruction and prepares necessary signals.
3. Execute	The **Arithmetic Logic Unit (ALU)** performs the required operation (e.g., arithmetic, logic, data

Step	Description
	movement).
4. Store	Results are written back to memory or registers. The cycle repeats for the next instruction.

Core Components of CPU Architecture

Component	Description
Control Unit (CU)	Directs the flow of data and instructions. It decodes instructions and signals other units to execute them.
Arithmetic Logic Unit (ALU)	Performs all arithmetic operations (addition, subtraction, etc.) and logical comparisons (AND, OR, NOT).
Registers	Small, high-speed memory locations inside the CPU used to store intermediate data and instructions.
Cache Memory	Fast, temporary storage located on the CPU chip. Stores frequently accessed data to reduce latency (Make things react faster).
Clock	Synchronizes all CPU operations. Measured in GHz, it determines how many instructions the CPU can process per second.
Buses	Pathways for data transfer:

- **Data Bus**: Carries actual data
- **Address Bus**: Carries memory addresses
- **Control Bus**: Carries control signals

Types of CPUs (Based on Core Architecture)

Type	Description
Single-Core CPU	Contains one processing core. Executes one instruction at a time. Example: Intel 4004
Dual-Core CPU	Two cores allow basic multitasking. Example: Intel Core 2 Duo
Quad-Core CPU	Four cores improve parallel processing. Ideal for multitasking and moderate workloads.

Type	Description
Hexa-Core CPU	Six cores offer high performance for gaming, editing, and multitasking.
Octa-Core CPU	Eight cores for advanced computing, rendering, and professional applications.
Multi-Core (10+ cores)	Found in servers and high-end workstations; optimized for parallel computing and virtualization.

Memory Unit:

The **Memory Unit** is a core component of a computer system responsible for **storing data, instructions, and intermediate results**. It acts as the **workspace for the CPU**, enabling fast access to information required during processing. Memory can be **temporary (volatile)** or **permanent (non-volatile)** depending on its function.

Functions of the Memory Unit

- **Stores instructions** for execution
- **Holds data** during processing
- **Preserves results** for output or future use
- **Facilitates communication** between CPU and other components

Types of Computer Memory

Primary Memory (Main Memory)

Type	Description
RAM (Random Access Memory)	Volatile memory used for temporary data storage during active tasks
DRAM (Dynamic RAM)	Requires periodic refreshing; used in most systems
SRAM (Static RAM)	Faster and more stable; used for cache memory
ROM (Read-Only Memory)	Non-volatile; stores firmware and boot instructions
PROM/EPROM/EEPROM	Programmable versions of ROM used in embedded systems

Secondary Memory (Storage Devices)

Type	Description
Hard Disk Drive (HDD)	Magnetic storage; large capacity, slower access
Solid State Drive (SSD)	Flash-based storage; faster and more reliable
Optical Discs (CD/DVD)	Used for media and backups
USB Drives & Memory Cards	Portable flash storage

Memory Hierarchy (Speed vs. Capacity)

Level	Type	Speed	Capacity
1	**Registers**	Fastest	Smallest
2	**Cache**	Very Fast	Small
3	**RAM**	Fast	Moderate
4	**Secondary Storage**	Slow	Large
5	**Cloud/External Storage**	Slowest	Very Large

Table of Memory Units

Unit	Symbol	Size in Bytes	Description / Common Use
Bit	b	—	Smallest unit; holds 0 or 1
Nibble	—	—	Half a byte; used in hexadecimal
Byte	B	1	Stores one character (e.g., 'A')
Kilobyte	KB	1,024	Small text files, basic documents

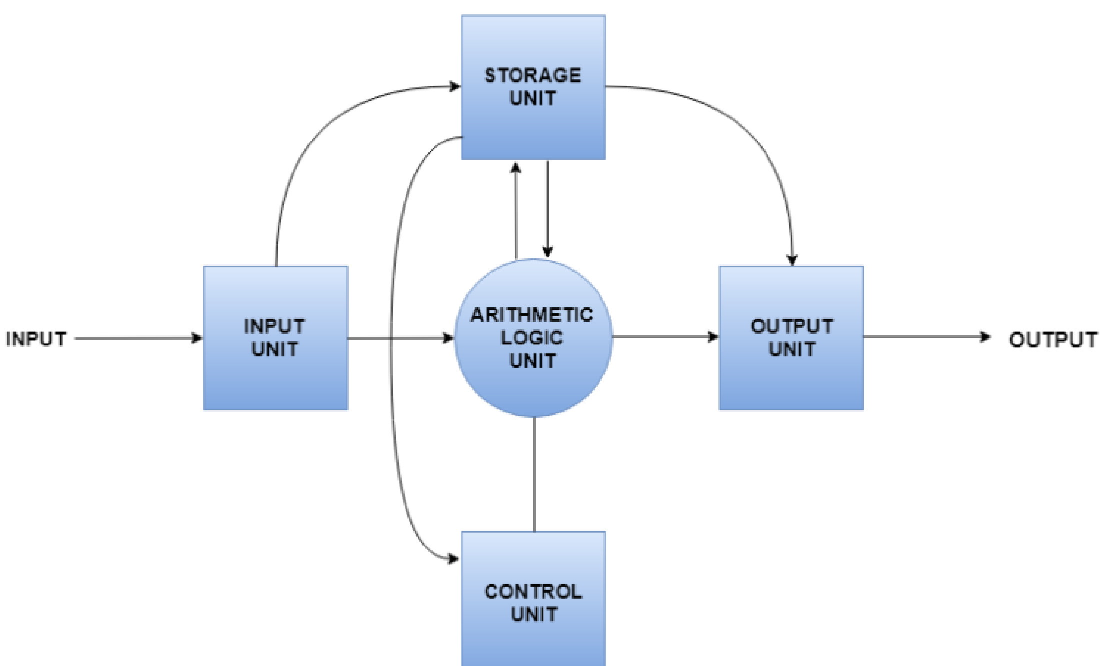
Unit	Symbol	Size in Bytes	Description / Common Use
Megabyte	MB	1,048,576	Images, PDFs, short audio/video files
Gigabyte	GB	1,073,741,824	Software, HD videos, RAM
Terabyte	TB	1,099,511,627,776	Hard drives, cloud storage
Petabyte	PB	1,125,899,906,842,624	Data centers, enterprise backups
Exabyte	EB	1,152,921,504,606,846,976	Global-scale data (e.g., internet traffic)
Zettabyte	ZB	1,180,591,620,717,411,303,424	Big data analytics, global archives
Yottabyte	YB	1,208,925,819,614,629,174,706,176	Theoretical future-scale storage

Computer architecture

A computer system is basically a machine that simplifies complicated tasks. It should maximize performance and reduce costs as well as power consumption. The different components in the Computer System Architecture are Input Unit, Output Unit, Storage Unit, Arithmetic Logic Unit, Control Unit etc.

Computer architecture is a specification describing how computer software and hardware connect and interact to create a computer network. It determines the structure and function of computers and the technologies it is compatible with – from the central processing unit (CPU) to memory, input/output devices, and storage units

A diagram that shows the flow of data between these units is as follows



S

The input data travels from input unit to ALU. Similarly, the computed data travels from ALU to output unit. The data constantly moves from storage unit to ALU and back again. This is because stored data is computed on before being stored again. The control unit controls all the other units as well as their data.

Von Neumann architecture:

Named after mathematician and computer scientist John von Neumann, the Von Neumann architecture features a single memory space for both data and instructions, which are fetched and executed sequentially. This means that programs and data are stored in the same memory, allowing for flexible and easy modification of programs.

the Von Neumann architecture remains highly relevant and influential in computer design. Von Neumann's architecture introduced the concept of stored-program computers, where both instructions and data are stored in the same memory, allowing for flexible program execution.

Figure of Von Neumann architecture: