Bachelor of Science in Computer Science
Bachelor of Science in Information Systems

SCS 1205 / IS 1102 – Computer Systems

History of Computer Systems

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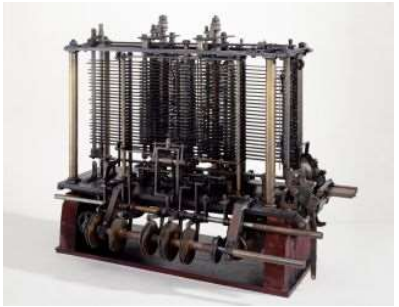
UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

Historical Development

- The **evolution of computing machinery** has taken place over **several centuries**. The evolution of computers is usually **classified into** different **generations** according to the **technology of the era**.
- The computer has **evolved from** a **large-sized simple** calculating machine to a **smaller** but much **more powerful** machine.
- The **evolution of computer** to the **current state** is defined in terms of the **generations of computer**.
- Each generation of computer is designed based on a **new technological development**, resulting in **better**, **cheaper** and **smaller** computers that are more **powerful, faster and efficient** than their predecessors.

*Charles Babbage designed a Victorian-era computer called the **Analytical Engine** (1880)*



Computer Museum @ UCSC & Other

http://emuseum.ucsc.cmb.ac.lk/

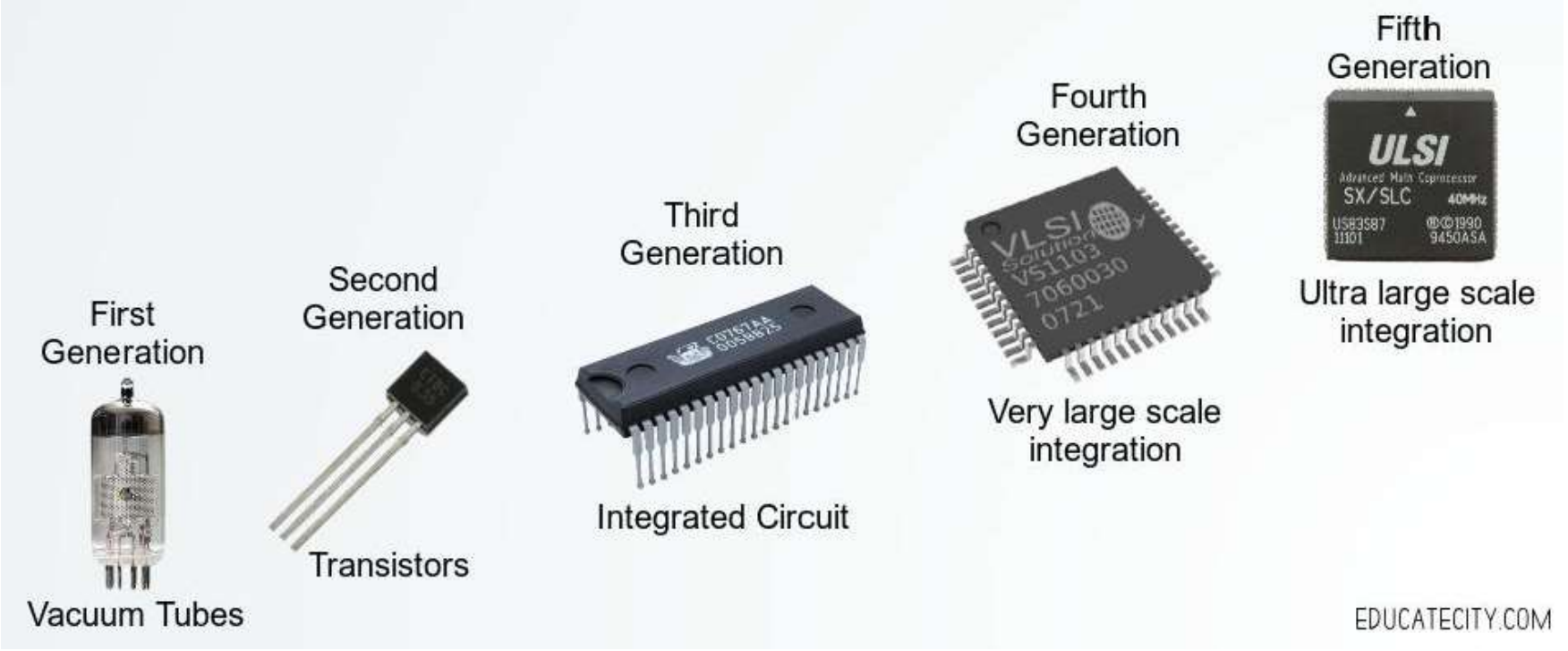
https://computerhistory.org/blog/the-neverending-quest-for-firsts/

Generations of Computer

- Currently, there are **five generations** of computer.
- In the following subsections, we will discuss the generations of computer in terms of
  - the **technology used** by them (hardware and software),
  - **computing characteristics** (speed, i.e., number of instructions executed per second),
  - **physical appearance**, and
  - their **applications**.

Generation	Period	Technology Used
1st Gen.	1946-1959	Vacuum Tubes
2nd Gen.	1959-1965	Transistors
3rd Gen.	1965-1971	Integrated Circuits
4th Gen.	1971-1980	Microprocessors
5th Gen.	1980-present	AI & ULSI

Generations of Computers



Zeroth Generation Computers - (1642-1940)

Generation Zero: **Mechanical Calculating Machines** (1620 - 1940)

- **Calculating Clock** - Wilhelm Schickard (1623)
- Pascaline, **Adding Machine** - Blaise Pascal (1642 - 1644)
- Difference Engine - **Automatic Mechanical Calculator designed to tabulate polynomial functions**, Charles Babbage (1819-1822)
- Many more till **1940**

Zeroth Generation Computers - (1642-1940)

World's first **Electronic Digital Computer**

- The **Atanasoff-Berry Computer** (ABC) was the world's first electronic digital computer.
- **John Vincent Atanasoff**, a former Iowa State professor of **physics** and **mathematics**, and **Clifford Berry**, a former physics **graduate student** and electrical engineering undergraduate, built the computer at **Iowa State University** from **1937 to 1942**.
- It was the size of a big desk, weighed **750 pounds**, and featured **rotating drums for memory**, **glowing vacuum tubes**, and a read/write system that recorded numbers by scorching marks on **cards**.

Zeroth Generation Computers - (1642-1940)

The Controversy of the **ABC**

- When **World War II** interrupted work on the ABC, Atanasoff and Berry moved on to other jobs and projects.
- J. Presper Eckert and John Mauchly, developers of the **ENIAC** machine at the **University of Pennsylvania**, were the first to **patent an electronic digital computer**.
- In **1973**, however, U.S. District Judge overturned the **ENIAC patents**, writing, "Eckert and Mauchly **did not themselves first invent** the automatic electronic digital computer, but instead derived that subject matter from one **Dr. John Vincent Atanasoff**."

https://youtu.be/d1pvc9Zh7Tg

First Generation Computers - (1940-1956)

- The first computers used **vacuum tubes** for **circuitry** and **magnetic drums** for **memory**.
- They were often **enormous** and taking up **entire room**.
- First generation computers relied on **machine language**.

- They were **very expensive** to operate and in addition to using a great deal of **electricity**, generated a lot of **heat**, which was often the cause of **malfunctions**.
- The **ENIAC** (Electronic Numerical Integrator and Computer) (1946) and **UNIVAC** (Universal Automatic Computer) (1951) computers are examples of first-generation computing devices.

First Generation Computers

ENIAC - First **general-purpose** electronic digital computer

UNIVAC - World's first **commercially** produced electronic digital computer

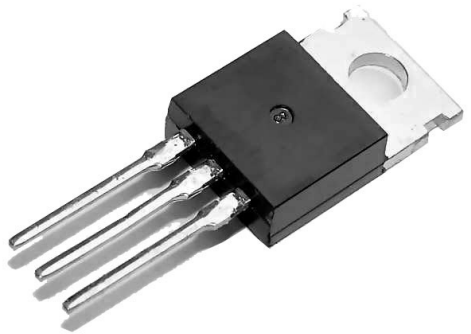
The **IBM 650** first **mass-produced** computer.

Disadvantages :

- Too bulky (large in size)
- Vacuum tubes burn frequently
- They were producing heat
- Maintenance problems

Second Generation Computers - (1956-1963)

- **Transistors** replaced vacuum tubes and ushered in the second generation of computers.
- Second-generation computers **moved from** cryptic binary machine language to **symbolic**.
- High-level programming languages were also being developed at this time, such as early versions of **COBOL** and **FORTRAN**.
- These were also the first computers that **stored their instructions** in their **memory**.

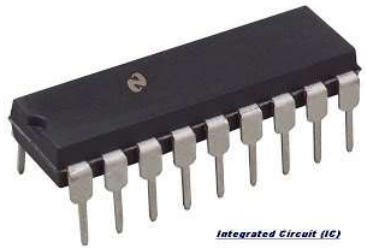


Second Generation Computers

- **Advantages :**
  - Size reduced considerably
  - The very fast (do not compare now!)
  - Very much reliable
- **Disadvantages :**
  - They over heated quickly
  - Maintenance problems

Third Generation Computers - (1964-1971)

- The development of the **integrated circuit** (IC) was the hallmark of the third generation of computers.
- Transistors were **miniaturized** and placed on **silicon chips**, called **semiconductors**.
- Instead of **punched cards** and **printouts**, users interacted with third generation computers through **keyboards** and **monitors** and interfaced with an **operating system**.
- Allowed the device to run **many different applications** at one time.



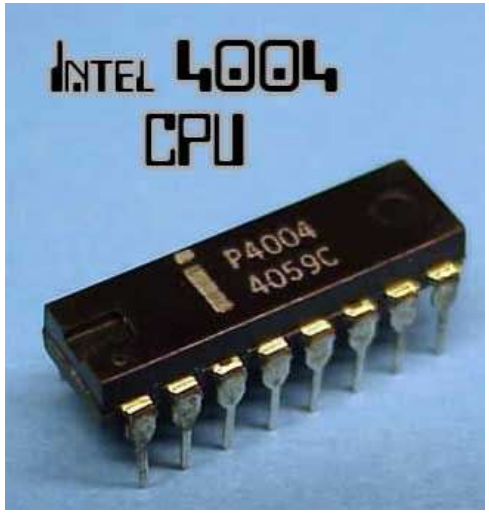
Third generation computers

e.g. IBM 360, DEC PDP-8 and PDP-11, Cray-1 supercomputer

- **Advantages :**
  - ICs are very small in size
  - Improved performance
  - Production cost cheap
- **Disadvantages :**
  - ICs are sophisticated

Fourth Generation Computers - (1971- Present)

- Very large scale integrated circuits (**VLSI**) have more than 10,000 components per chip.
- The **microprocessor** brought the fourth generation of computers, as thousands of integrated circuits were built onto a **single silicon chip**.
- The **Intel 4004** chip, developed in **1971**, located all the components of the computer.



Fourth Generation Computers

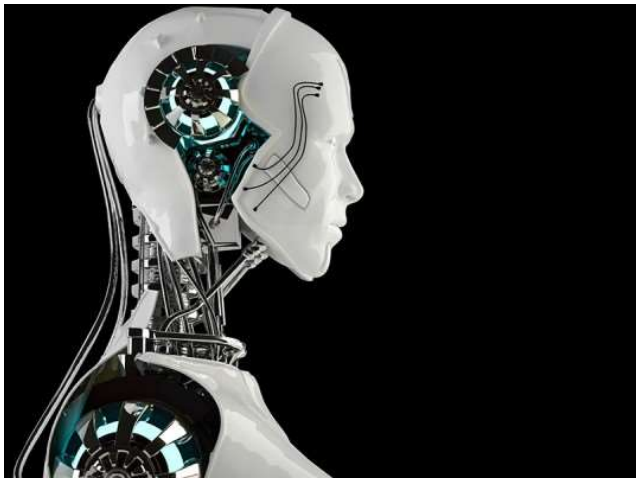
- From the **central processing unit** and **memory** to **input/output controls**—on a single chip.

- Fourth generation computers also saw the development of GUIs, the **mouse** and **handheld devices**.

Fifth Generation Computers (present and beyond)

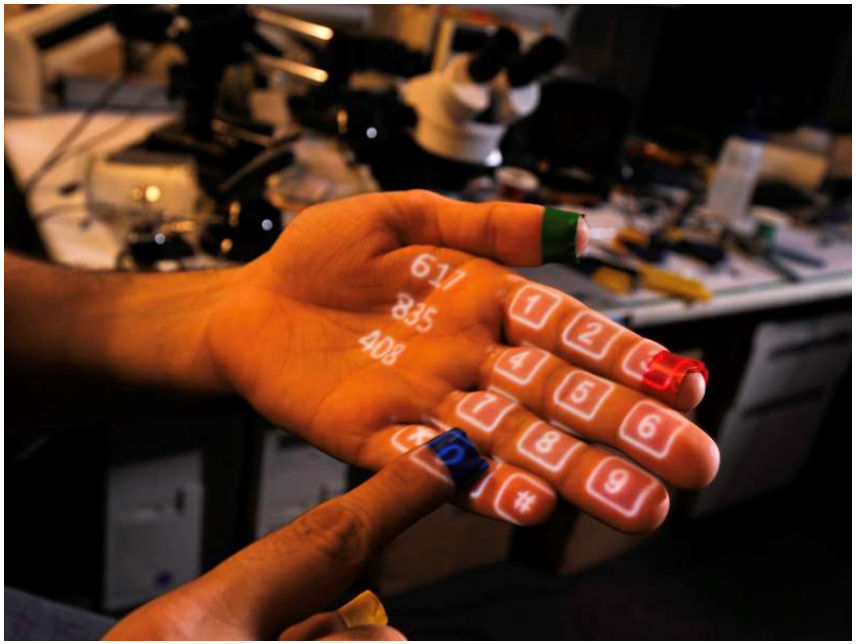
- Fifth generation computing devices, based on **artificial intelligence**.
- Are still in development, though there are some applications, such as **voice recognition**.
- The use of **parallel processing** and **superconductors** is helping to make **artificial intelligence a reality**.
- The goal of fifth-generation computing is to develop devices that respond to **natural language input** and are capable of **learning and self-organization**.
- This generation is based on **ULSI** (Ultra Large Scale Integration) technology.

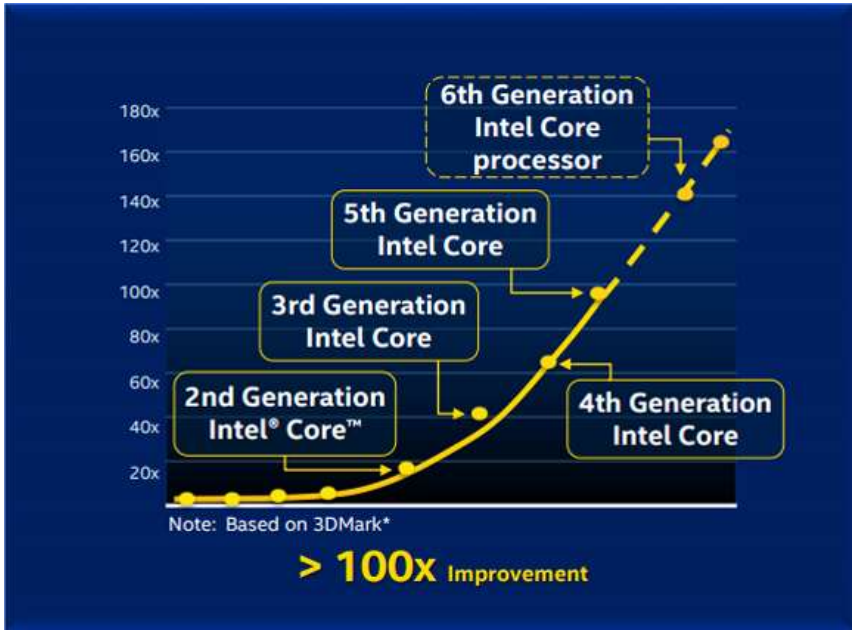
Fifth Generation Computers



Computer Generations

- Do we have **6th Generation** Computers?
- You should not get **confused** with **Intel Generations** with the above generations we discussed so far.



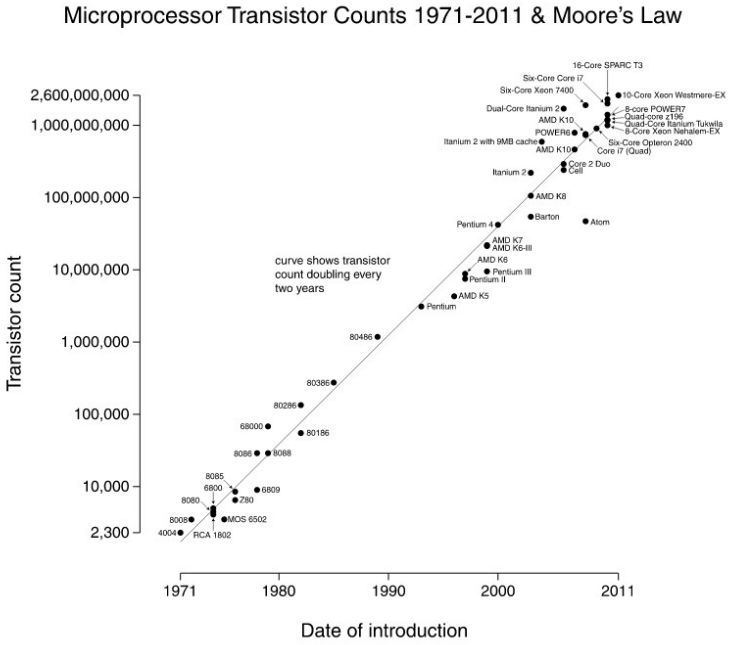


Sixth Generation Computers ...

- Scientists still needed **more computing capacity** to accomplish **advanced robotics** along with other language computations.
- Using **nanotechnology** is really a **sign of sixth generation** computers.
- This considerably boosts the processing duration of the PC which help consumers. Computers with **multiple CPUs** are capable of doing sophisticated calculations and multitask.
- When **quantum bits or qubits** process calculations, it is normally **quicker than** conventional computers. Computers are now able to understand and interpret numerous languages using the new advanced technology available.

Moore's Law

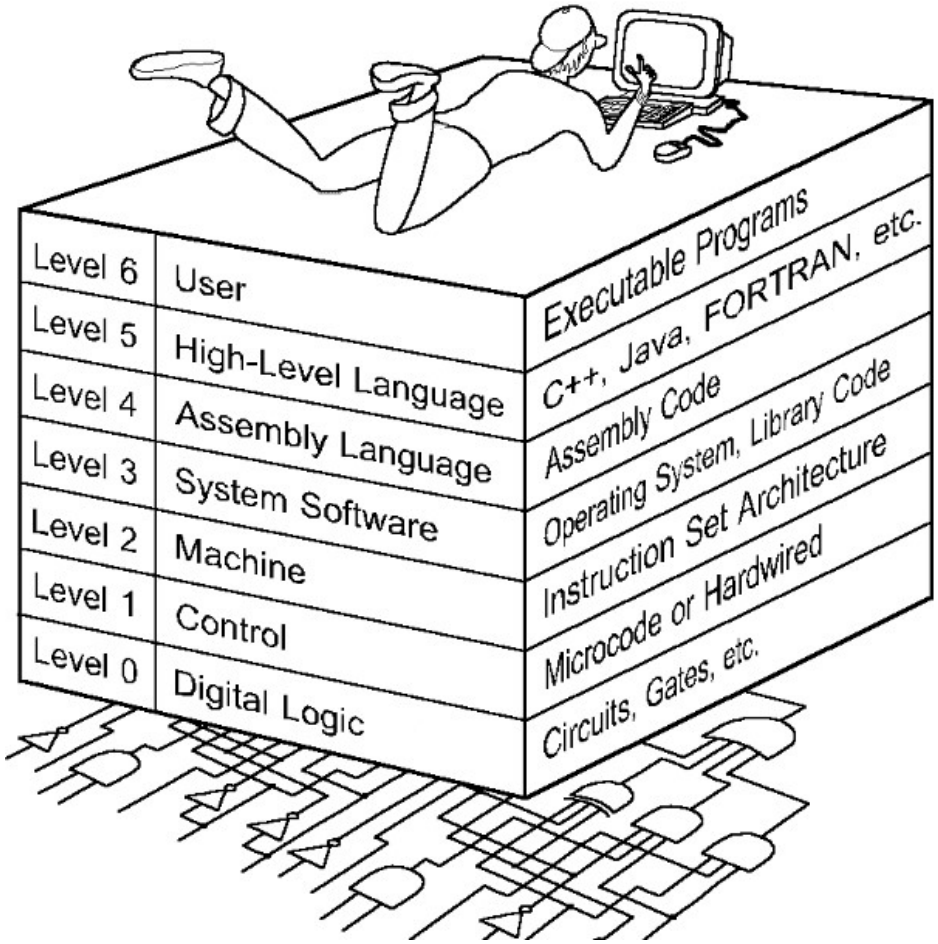
- In 1965, **Gordon Moore** noted that the number of transistors on a chip doubled every 18 to 24 months.
- Moore's Law ➔ "**Twice the number of transistors, approximately every two years**"
- Today, we call **Moore's observation** as **Moore's Law**. Despite the name, it's not really a law.
- There's **no fundamental rule** in the universe that guides how powerful a newly made integrated circuit will be at any given time.
- But Moore's Law has become something of a **self-fulfilling forecast** as chip manufacturers have pushed to keep up with the predictions Dr. Moore made way back in 1965.
- But this "law" cannot **hold forever** ...



Enlarge

The Computer Level Hierarchy

- Each machine (or appl^n) layer is an **abstraction** of the **level below it**.
- The machines at each level execute **their own particular instructions**, calling upon machines at lower levels to perform tasks as required.
- Computer **circuits** ultimately carry out the work.



The Computer Level Hierarchy

Level	Description
Level 6: The User Level	• Program **execution** and user interface level. • The level with which we are **most familiar**.
Level 5: High-Level Language Level	• The level with which we interact when we write programs in **languages** such as C, Pascal, Lisp, and Java, etc.
Level 4: Assembly Language Level	• Acts upon **assembly language** produced from Level 5, as well as instructions programmed directly at this level.

The Computer Level Hierarchy

Level	Description
Level 3: System Software Level	• Controls executing processes **on the system**. • Assembly language instructions often pass through Level 3 **without modification**.
Level 2: Machine Level	• Also known as the **Instruction Set Architecture** (ISA) Level. • Consists of instructions that **are particular to the architecture of the machine**. • Programs written in machine language **need no** compilers, interpreters, or assemblers.

The Computer Level Hierarchy

Level	Description
Level 1: Control Level	• A control unit **decodes and executes** instructions and moves data through the system. • Hardwired control units consist of hardware that directly **executes machine instructions**.
Level 0: Digital Logic Level	• This level is where we find **digital circuits** (chips). • Digital circuits consist of **gates and wires**. • These components implement the **mathematical logic** of all other levels.

Level 5 to Level 0


```
int main()
{
    int x, y, z;
    x = 7;
    y = 12;
    z = x * y;
    return 0;
}
```

compiler

```
main:
        pushl %ebp
        movl %esp,%ebp
        subl $12,%esp
        movl $7,-4(%ebp)
        movl $12,-8(%ebp)
        movl -4(%ebp),%eax
        imull -8(%ebp),%eax
        movl %eax,-12(%ebp)
        xorl %eax,%eax
        jmp .L1
        .align 4
        xorl %eax,%eax
        jmp .L1
```

assembler

high-level

low-level (assembly)

lowest-level (binary)

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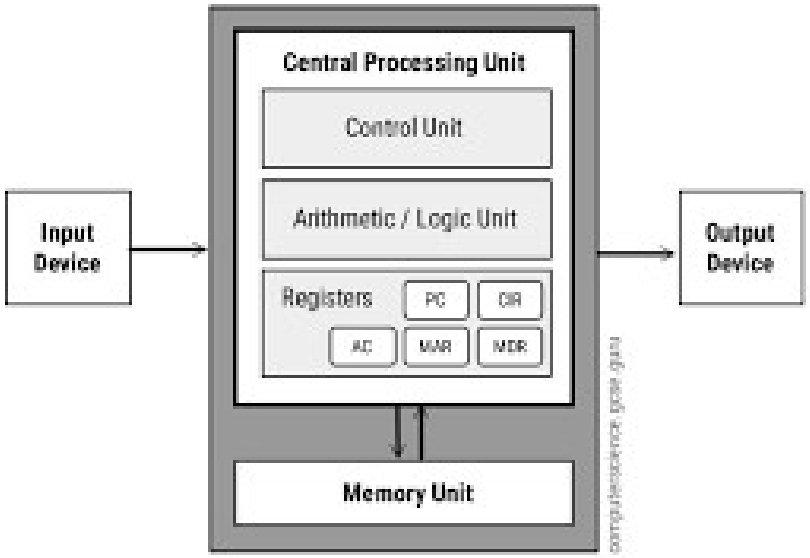
First Generation Computers ...

- On the ENIAC, **all programming** was done at the **digital logic level**. **Programming** the computer involved **moving** plugs and wires.
- A different **hardware configuration** was needed to solve every **unique problem type**.
- Configuring the ENIAC to solve a "**simple**" problem required **many** days labor by skilled technicians.
- The invention of **stored program computers** has been invented by a **mathematician** called **John von Neumann**.
- Stored-program computers have become known as **von Neumann Architecture systems**.

von Neumann Architecture

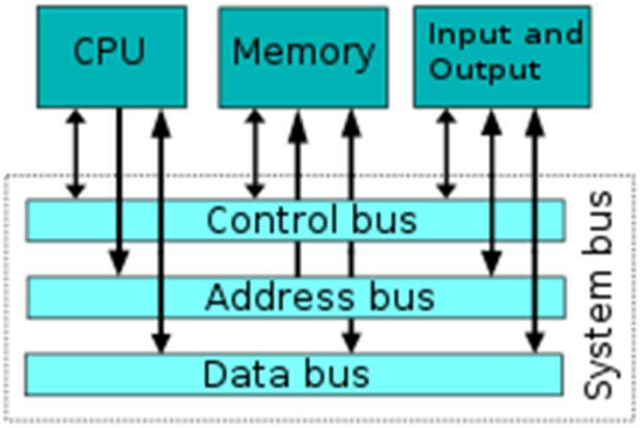
Today's stored-program computers have the following characteristics:

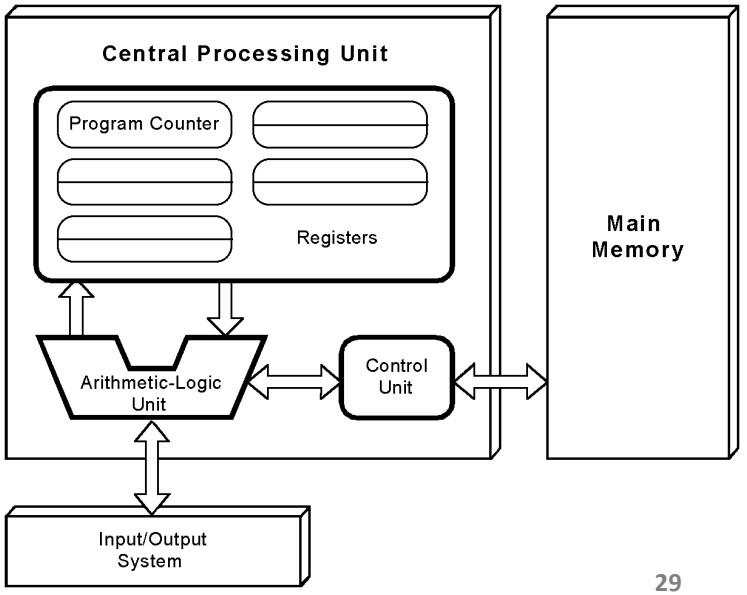
- **Three hardware systems**:
  - A central processing unit (CPU)
  - A main memory system
  - An I/O system
- The capacity to carry out **sequential instruction processing**.
- A **single data path** between the CPU and main memory.
  - This single path is known as the **von Neumann bottleneck**.



von Neumann Architecture

- These computers employ a **fetch-decode-execute** cycle to run programs.
- Conventional stored-program computers have undergone **many incremental improvements** over the years.
- But enormous improvements in computational power **require departure from the classic von Neumann architecture**.





Exercise

- Do you think that the Von Neumann Architecture will be diminished in the future?
- Write your own model that may be declared as the “Sixth Generation of Computers” in the future.
- By 2050, what computers will be able to do?
- Could a computer predict the next (2023 and beyond) pandemic?

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End of Lecture
Any Questions?