Computer Science

Chapter 1

Introduction to computer science

What is Computer Science?

Computer science: *The study of information, protocols and algorithms for idealized and real automata.*

- ✓ automaton: "self moving" – in our context, self "deciding" or autonomous mechanism with bounded resources (time and space).
- ✓ information: knowledge represented in a form suitable for transmission, manipulation, etc.
- ✓ protocol: rules for exchanging information without problems.
- ✓ algorithm: an unambiguous, finite description in simple steps or actions.

I. Introduction

Computer systems:

A Computer is an electronic device which performs operations such as accepts data As an input, store the data, manipulate or process the data and produce the results an output.

Main task performed by a computer

- Accept the data
- Process or manipulate the data
- Display or store the result in the form of human understanding
- Store the data, instructions and results.

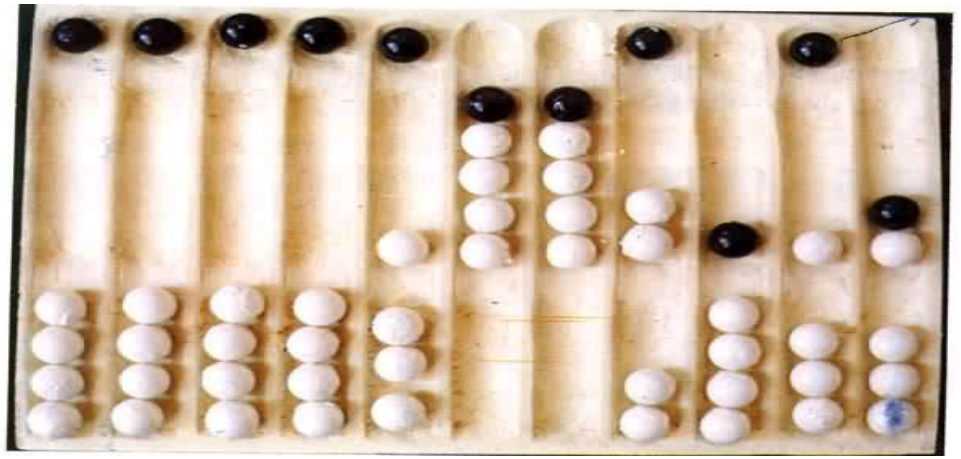
I. Introduction

Evolution of computer

- From the simple calculator to a modern day powerful data processor, computing devices have evolved in a relatively short span of time.
- Originally calculations were computed by humans, whose job title was computers.

Abacus: is a mechanical device used to aid an individual in performing mathematical calculations.

The abacus was invented in Babylonia in 2400 B.C.



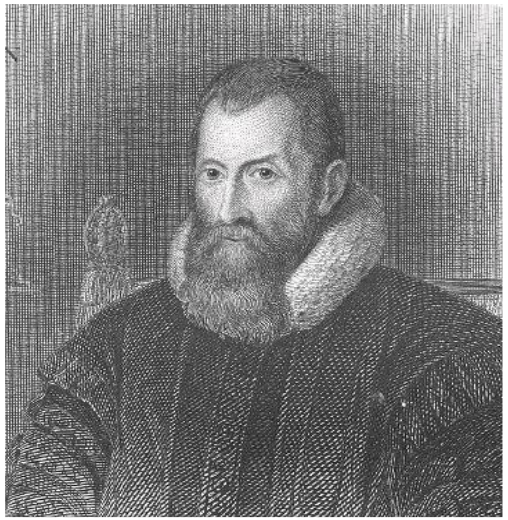
I. Introduction

Evolution of computer

Napier's Bones:

- ✓ Invented by John Napier in 1614.
- ✓ Allowed the operator to multiply, divideand calculate squareand cube rootsby moving the rods around and placing them in specially constructed boards.

John Napier



Napier's Bones

I. Introduction

Evolution of computer

Slide Rule:

- ✓ Invented by William Oughtred in1622.
- ✓ Is based on Napier's ideas about logarithms.
- ✓ Used primarily for
  - –multiplication
  - –division
  - –roots
  - –logarithms
  - –Trigonometry
- ✓ Not normally used for addition or subtraction.

William Oughtred

Slide Rule

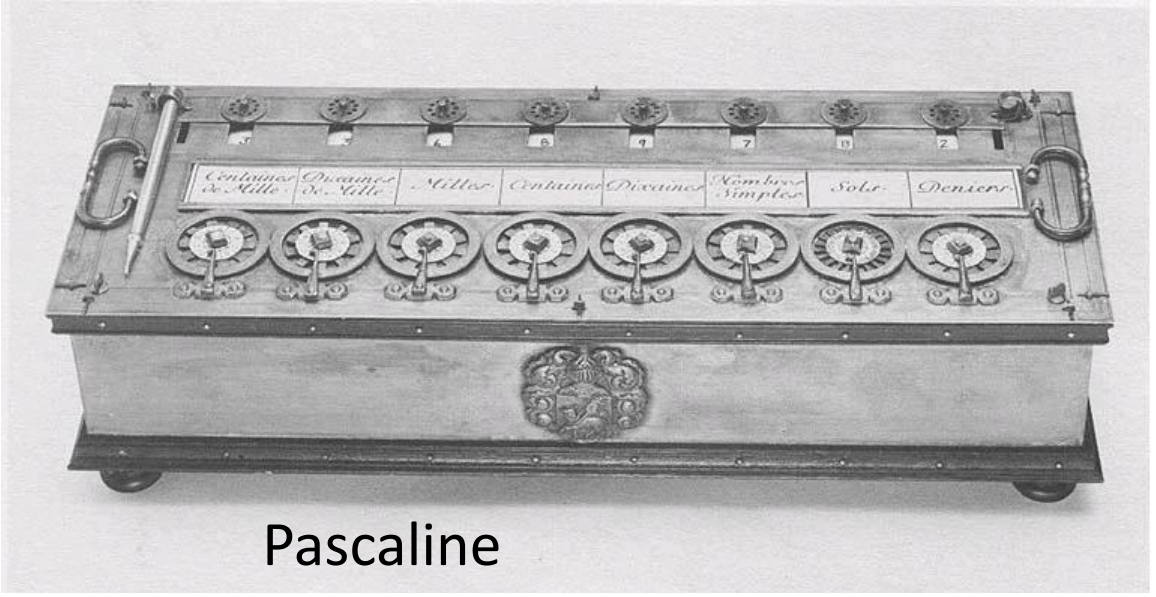
I. Introduction

Evolution of computer

Blaise Pascal

Pascaline:

- ✓ Invented by Blaise Pascal in 1642.
- ✓ It was its limitation to addition and subtraction.
- ✓ It is too expensive.



Pascaline

I. Introduction

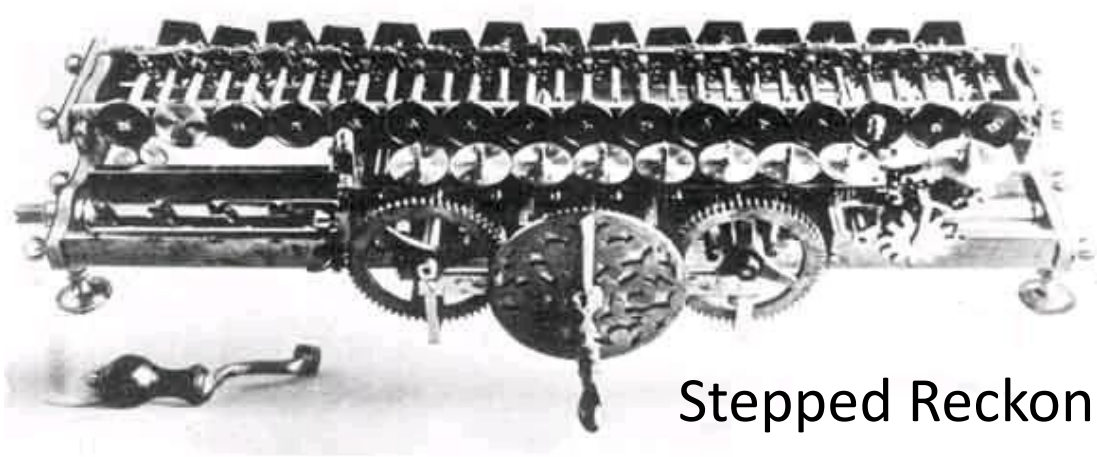
Evolution of computer

Gottfried Wilhelm Leibniz

Stepped Reckoner:

- ✓ Invented by Gottfried Wilhelm Leibniz in 1672.

- ✓ The machine that can add, subtract, multiply and divide automatically.



Stepped Reckoner

I. Introduction

Evolution of computer

Thomas de Colmar

Arithmometer:

- ✓ A mechanical calculator invented by Thomas de Colmar in 1820,
- ✓ The first reliable, useful and commercially successful calculating machine.
- ✓ The machine could perform the four basic mathematic functions.
- ✓ The first mass-produced calculating machine.

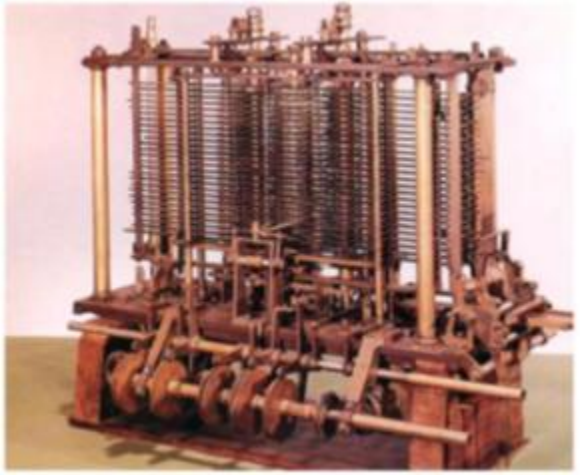
I. Introduction

Evolution of computer

Difference Engine and Analytical Engine:

- ✓ It an automatic, mechanical calculator designed to tabulate polynomial functions.
- ✓ Invented by Charles Babbage in1822 and 1834
- ✓ It is the first mechanical computer.

Charles Babbage



I. Introduction

Evolution of computer

First Computer Programmer:

- ✓ In 1840, Augusta Ada Byron suggests to Babbage that he use the binary system.

- ✓ She writes programs for the Analytical Engine.

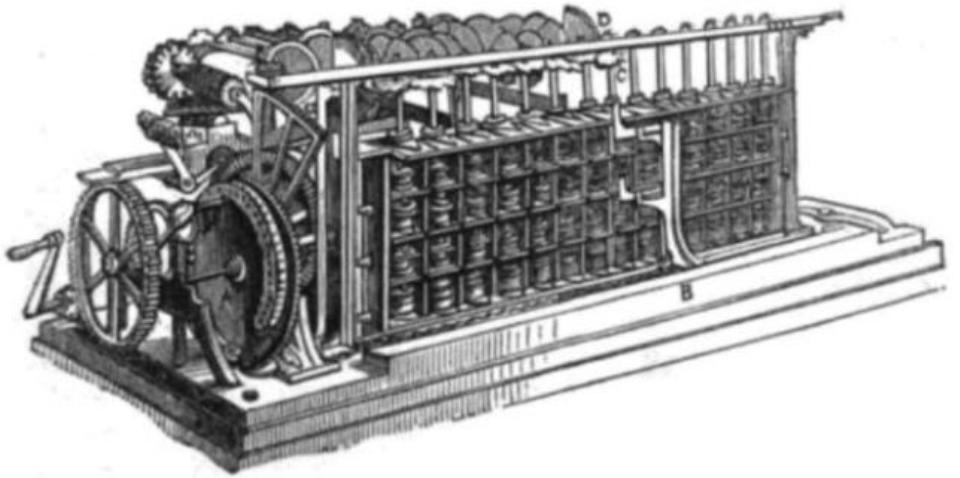
Augusta Ada Byron

I. Introduction

Evolution of computer

Scheutzian Calculation Engine:

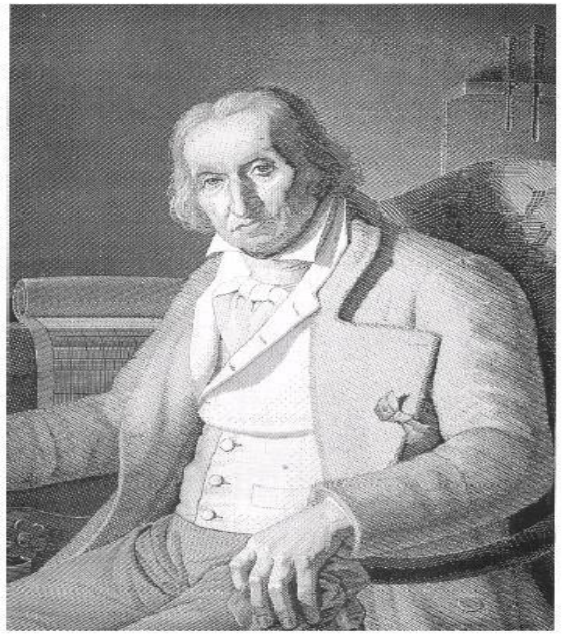
- ✓ Invented by Per Georg Scheutz in 1843.
- ✓ Based on Charles Babbage's difference engine.
- ✓ The first printing calculator.



I. Introduction

Evolution of computer

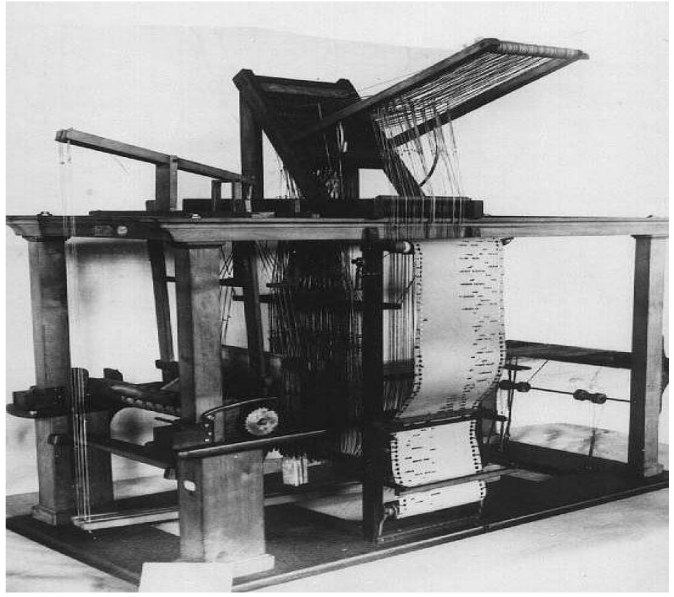
Joseph-Marie Jacquard



Jacquard Loom:

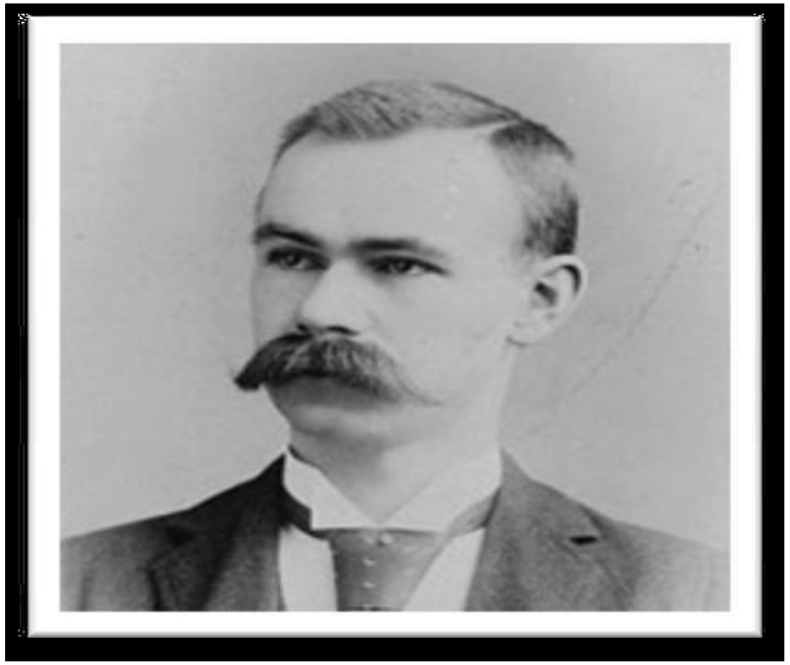
- ✓ The Jacquard loom is a mechanical loom, invented by Joseph-Marie Jacquard in 1881.

- ✓ It an automatic loom controlled by punched cards.



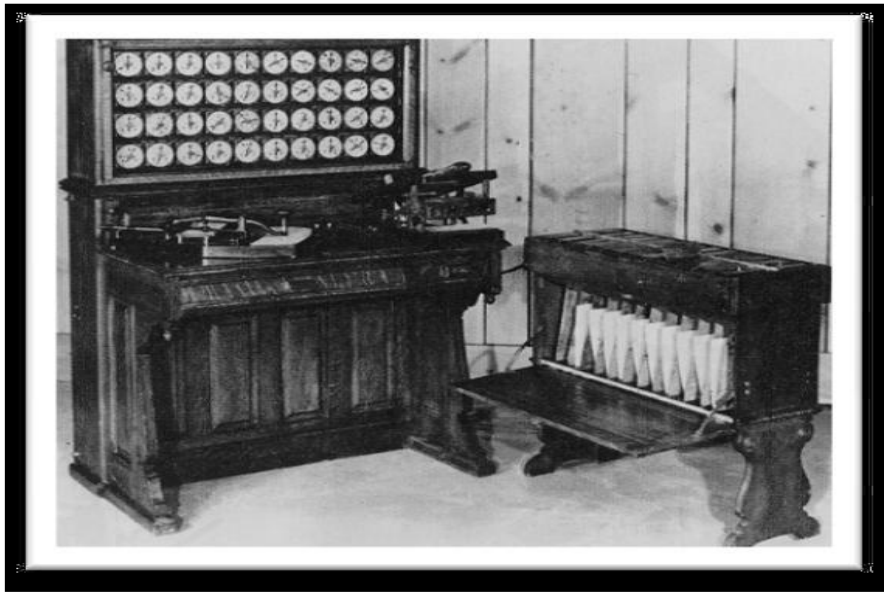
I. Introduction

Evolution of computer



Tabulating Machine:

- ✓ Invented by Herman Hollerith in 1890.
- ✓ To assist in summarizing information and accounting.

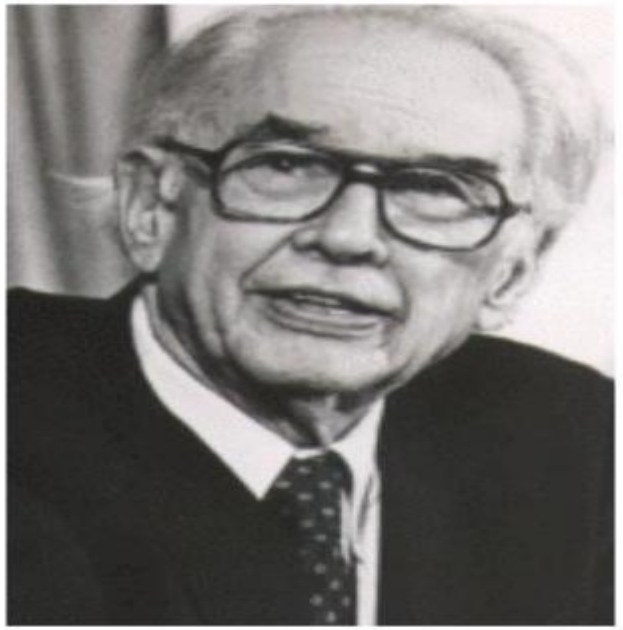


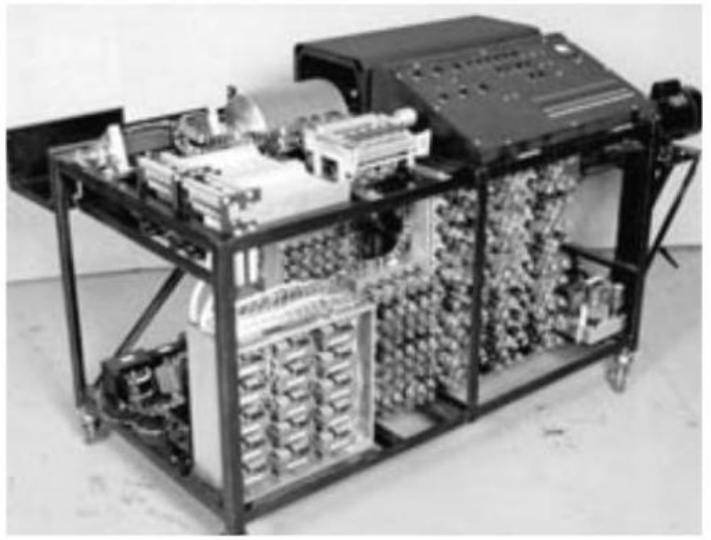
I. Introduction

Evolution of computer

Atanasoff-Berry Computer(ABC):

- ✓ It was the first electronic digital computing device.
- ✓ Invented by **Professor John Atanasoff** and graduate student Clifford Berry at Iowa State University between 1939 and 1942.





I. Introduction

Evolution of computer

Havard Mark 1:

- ✓ Also known as IBM Automatic Sequence Controlled Calculator (ASCC).
- ✓ Invented by Howard H. Aiken in 1943.
- ✓ The first electro-mechanical computer.

I. Introduction

Evolution of computer

The First Computer Company

- ✓ The first computer company was the Electronic Controls Company.
- ✓ Founded in 1949 by J. Presper Eckert and John Mauchly.

I. Introduction

Evolution of computer

Computer Generations

There are five generations of computer:

1. **First generation**–1946 -1958
2. **Second generation**–1959 -1964
3. **Third generation**–1965 -1970
4. **Fourth generation**–1971 -today
5. **Fifth generation**–Today to future

I. Introduction

Evolution of computer

The First Generation

- ✓ The first computers used **vacuum tubes** for circuitry and **magnetic drums** for memory, and were often enormous, taking up entire rooms.
- ✓ 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.

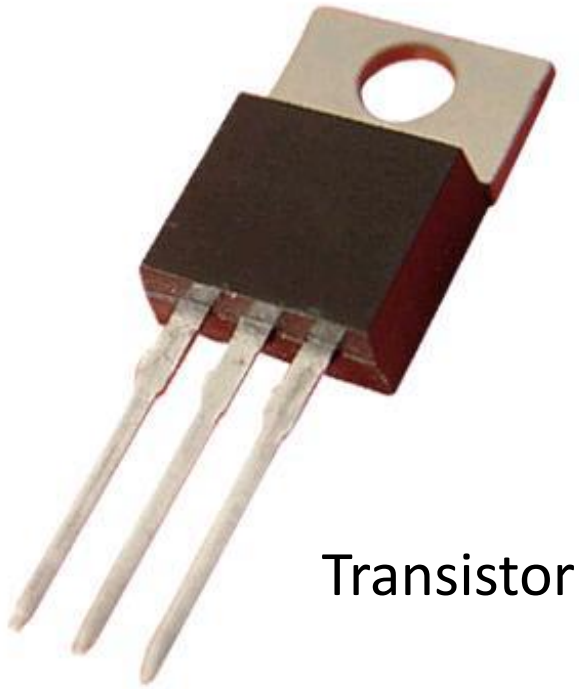
vacuum tubes

I. Introduction

Evolution of computer

The Second Generation

- ✓ Transistors replaced vacuum tubes and ushered in the second generation of computers.
- ✓ One transistor replaced the equivalent of **40 vacuum tubes**.
- ✓ Allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable.
- ✓ Still generated a great deal of heat that can damage the computer.



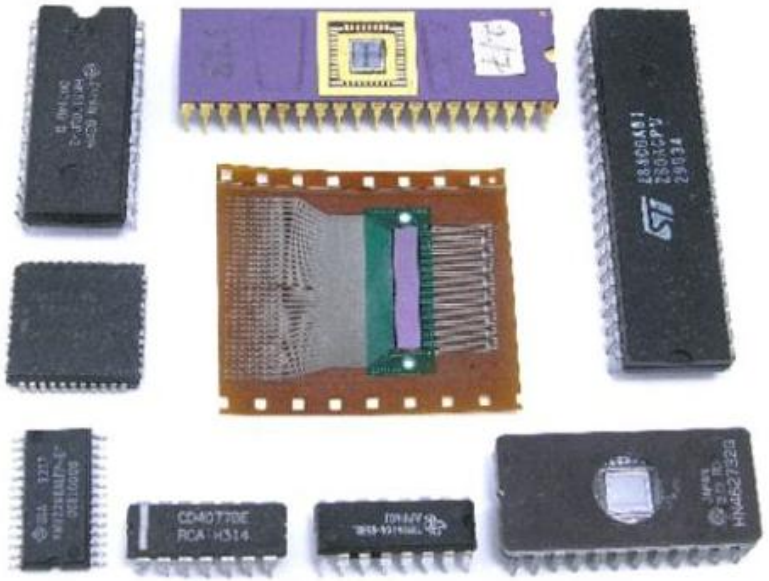
Transistor

I. Introduction

Evolution of computer

The Third Generation

- ✓ The development of the **integrated circuit** was the hallmark of the third generation of computers.
- ✓ Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.
- ✓ Much smaller and cheaper compare to the second generation computers.
- ✓ It could carry out instructions in billionths of a second.



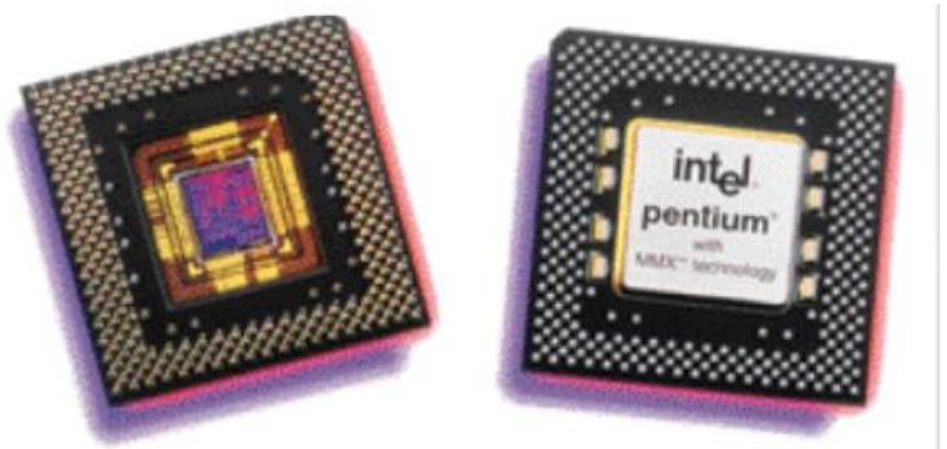
integrated circuit

I. Introduction

Evolution of computer

The Fourth Generation

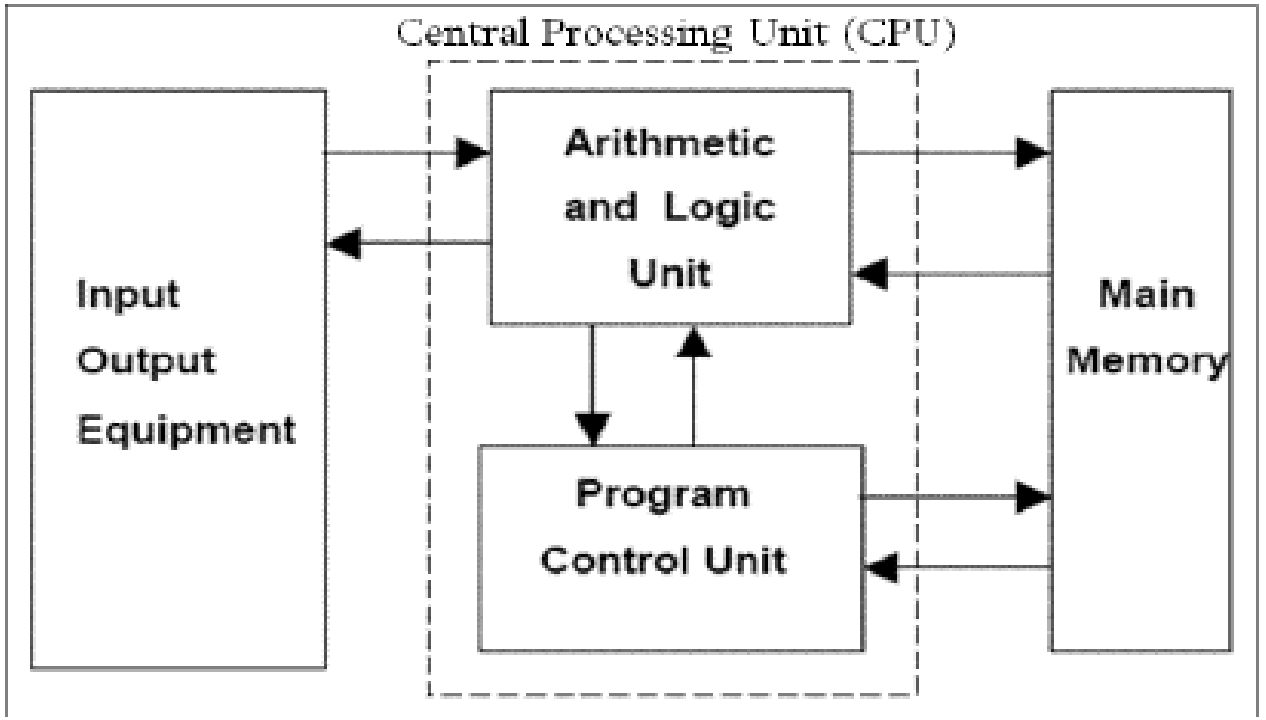
- ✓ The **microprocessor** brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip.
- ✓ As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet.
- ✓ Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.



Microprocessor

II. Computer system

The **Von Neumann model** and **Princeton architecture**, is the first model to represent the stored-program concept that has fundamentally changed computing. In the 1940s, a mathematician called John Von Neumann described the basic arrangement (or architecture) of a computer system. Most computers in use are designed based on the concept described by him although there are other types of architecture.



Components of a computer system

II. Computer system

A. Central Processing Unit (CPU)

A CPU is brain of a computer. It is responsible for all functions and processes. Regarding computing power, the CPU is the most important element of a computer system.

The CPU is comprised of three main parts :

Arithmetic Logic Unit (ALU): Executes all arithmetic and logical operations. Arithmetic calculations like as addition, subtraction, multiplication and division. Logical operation like compare numbers, letters, or special characters.

II. Computer system

A. Central Processing Unit (CPU)

Control Unit (CU): controls and co-ordinates computer components.

- ✓ Read the code for the next instruction to be executed.
- ✓ Increment the program counter so it points to the next instruction.
- ✓ Read whatever data the instruction requires from cells in memory.
- ✓ Provide the necessary data to an ALU or register.
- ✓ If the instruction requires an ALU or specialized hardware to complete, instruct the hardware to perform the requested operation.

II. Computer system

A. Central Processing Unit (CPU)

Registers: Stores the data that is to be executed next, "very fast storage area".

B. Primary Memory

ROM (Read Only Memory): ROM is a permanent form of storage. ROM stays active regardless of whether power supply to it is turned on or off. ROM devices do not allow data stored on them to be modified.

II. Computer system

B. Primary Memory

RAM: Random Access Memory (RAM) is a memory scheme within the computer system responsible for storing data on a temporary basis, so that it can be promptly accessed by the processor as and when needed. It is volatile in nature, which means that data will be erased once supply to the storage device is turned off. RAM stores data randomly and the processor accesses these data randomly from the RAM storage. RAM is considered "random access" because you can access any memory cell directly if you know the row and column that intersect at that cell.

II. Computer system

C. Input / Output

The input/output component of the Von Neumann architecture handles devices that allow a computer system to communicate with other devices such as a screen(or monitor), keyboard, printer, etc. It also allows a computer system to store information via storage devices such as internal and external hard-drives, CD-ROMs, Memory stick(flash disks), etc.

II. Computer system

Principle of Operation

All processing performed by a computer is done through the execution of a program at the CPU (Central Processing Unit) level. This execution follows the following steps:

- ✓ Before its execution, a program is first loaded into the central memory; (a program consists of two parts: data and instructions).
- ✓ The microprocessor retrieves the first instruction of the program, decodes it, and executes it. This execution may optionally retrieve data from central memory or write data to this memory.
- ✓ The microprocessor performs the same process for the second instruction, and so on, until the last instruction of the program.
- ✓ Once the program is finished (the execution of the last instruction), the space in central memory occupied by that program will be released.

All data manipulated by a program is loaded into central memory, and as we have seen, this memory is volatile. Therefore, programs generally perform input/output operations to external disks (saving and loading files).

II. Computer system

Any kind of computers consists of **HARDWARE** AND **SOFTWARE**.

Hardware:

Computer hardware is the collection of physical elements that constitutes a computer system. Computer hardware refers to the physical parts or components of a computer such as the monitor, mouse, keyboard, computer data storage, hard drive disk (HDD), system unit (graphic cards, sound cards, memory, motherboard and chips), etc. all of which are physical objects that can be touched.

II. Computer system

II. Computer system

Software:

Software is a generic term for organized collections of computer data and instructions, often broken into two major categories: system software that provides the basic non-task-specific functions of the computer, and application software which is used by users to accomplish specific tasks.

Operating System: set of programs which manages the operation of the microcomputer with respect to its peripherals and which provides a "bridge" between the user and the physical machine
Examples: MS-DOS, Windows, Mac-OS, Linux, etc

II. Computer system

Software:

Application programs: Programs that perform tasks that users expect from computers, these are programs developed usually by software companies (groups of engineers) or by users themselves (in the case of simple programs).

Examples:

- ✓Office software: Word processing (Word), Spreadsheet (Excel)…
- ✓Messaging and communication software via a network, the Internet.
- ✓Programming software: Dev C++, Eclipse (for Java), Delphi, etc.

III. Encoding system in computer

- The ICs (Integrated Circuits) in a computer are made up of a large number of transistors which are activated by the electronic signals (low/high) they receive.

- Any kind of information manipulated by a computer (numerical, textual, images, sounds, videos, etc.) is represented by sequences of two digits: 0 and 1.
- These two digits are referred to as **bit**(**bi**nary digi**t**).
- **bit** is either 0 or 1, which is represented by the computer through two electronic states: either there is an electrical pulse (this is state 1), or there is an absence of an electrical pulse (this is state 0).

III. Encoding system in computer

A. Binary Coding of Numerals

Decimal system: It's a base 10 number system.

Characteristic: 10 different symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

Example: representation of a number (2354):

$2354 = 2x1000 + 3x100 + 5x10 + 4x1$

$2354 = 2x10^3 + 3x10^2 + 5x10^1 + 4x10^0$

Binary System: It's a base 2 number system.

Characteristic: 2 different symbols: 0, 1.

Example: representation of a number $(101101)_2$:

$(101101)_2 = 1x2^5 + 0x2^4 + 1x2^3 + 1x2^2 + 0x2^1 + 1x2^0$

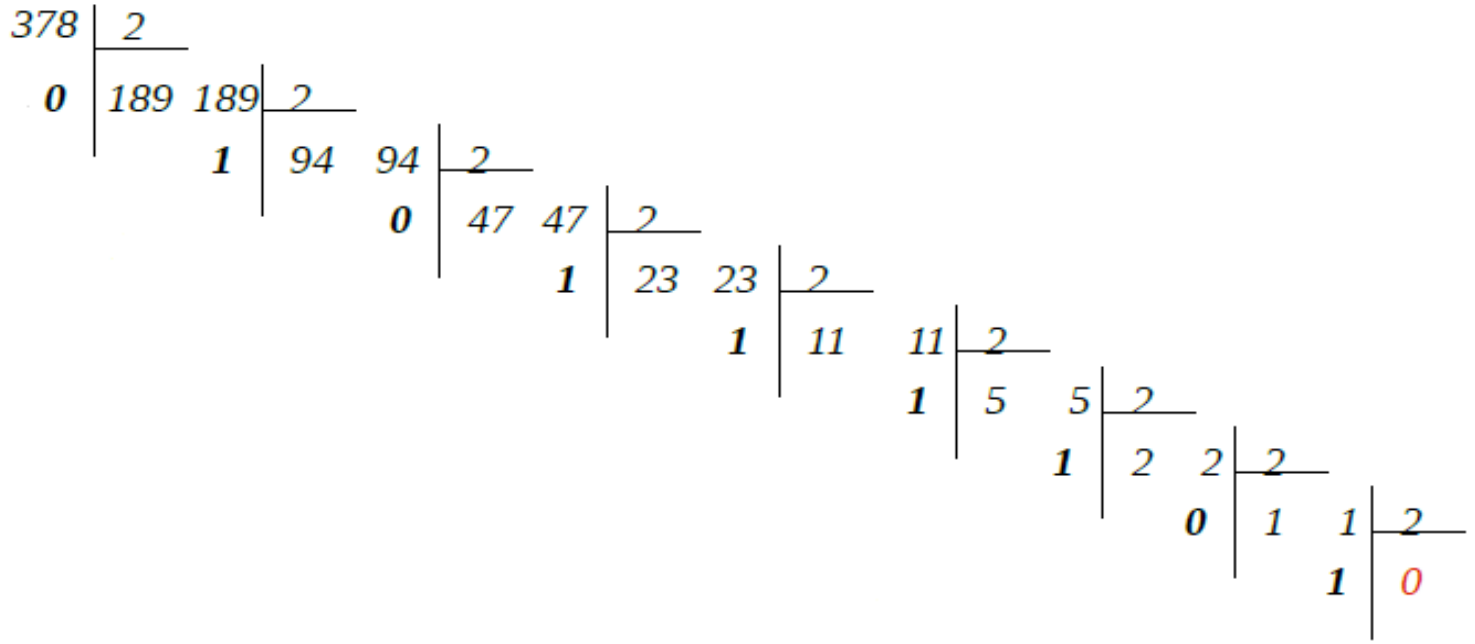
III. Encoding system in computer

A. Binary Coding of Numerals

Number System Conversion: Decimal to Binary System

This conversion is obtained through successive divisions by 2, and the remainders are taken in reverse order.

Example:



$$(378)_{10} = (101111010)_2$$

III. Encoding system in computer

A. Binary Coding of Numerals

Number System Conversion: Binary to Decimal System

Step 1 – Determine the column (positional) value of each digit (this depends on the position of the digit and the base of the number system).

Step 2 – Multiply the obtained column values (in Step 1) by the digits in the corresponding columns.

Step 3 – Sum the products calculated in Step 2. The total is the equivalent value in decimal.

Example: Find decimal codes of (1101011)2

$1x2^6 + 1x2^5 + 0x2^4 + 1x2^3 + 0x2^2 + 1x2^1 + 1x2^0$

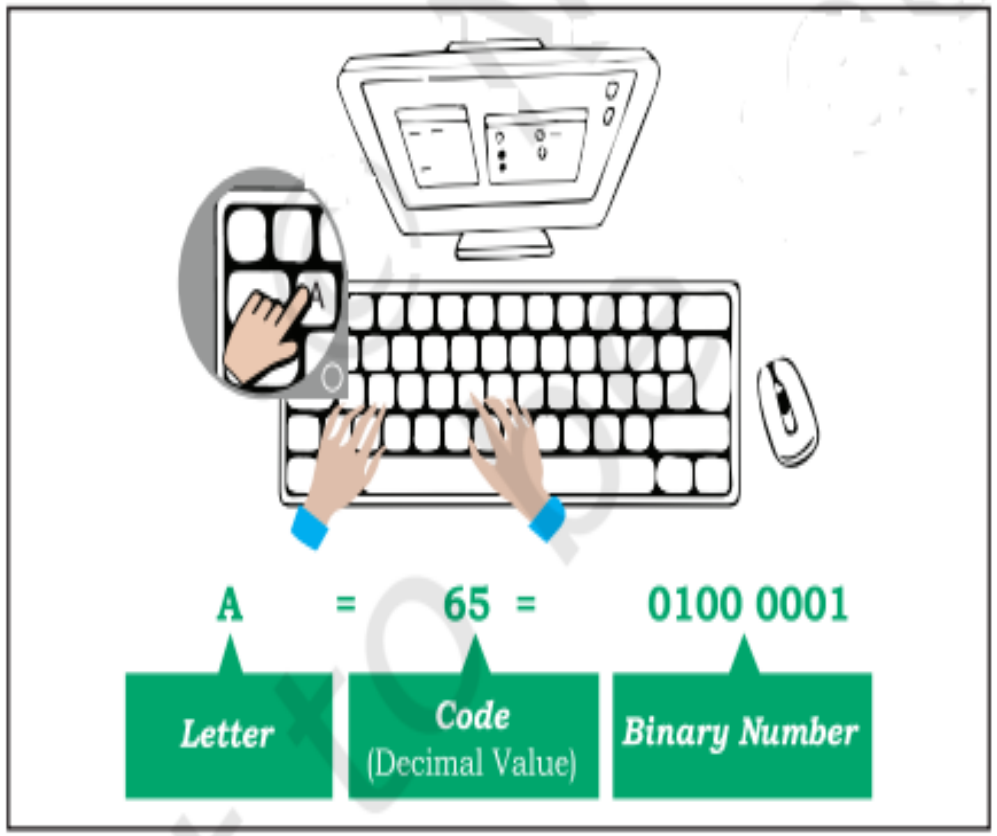
= 64 + 32 + 0 + 8 + 0 + 2 + 1

= 107

III. Encoding system in computer

B. The ASCII codes

ASCII (American Standard Code for Information Interchange) is the most common character encoding format for text data in computers and on the internet. In standard ASCII-encoded data, there are unique values for 128 alphabetic, numeric or special additional characters and control codes.



III. Encoding system in computer

B. The ASCII codes

Example:

Character	ASCII code	Decimal code
A	01000001	65
B	01000010	66
C	01000011	67
D	01000100	68
E	01000101	69
Z	01011010	90
a	01100001	97
b	01100010	98
c	01100011	99
d	01100100	100
e	01100101	101
z	01111010	122

For the characters, a coding system was developed using **eight** 1s and 0s for each character.

III. Encoding system in computer

B. The ASCII codes

Example:

"Hello, world"

	Binary	Decimal
H	01001000	72
e	01100101	101
l	01101100	108
l	01101100	108
o	01101111	111
,	00101100	44
	00100000	32
w	01110111	119
o	01100111	103
r	01110010	114
l	01101100	108
d	01100100	100