

IT111 - Introduction to Information Technology

Bachelor of Science in Information Technology

Lecture 1 Introduction

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Introduction

CHAPTER 1 *Introduction*



Objectives

After studying this chapter, the student should be able to:

- ☐ Define the Turing model of a computer.
- ☐ Define the von Neumann model of a computer.
- ☐ Describe the three components of a computer: hardware, data, and software.
- ☐ List topics related to computer hardware.
- ☐ List topics related to data.
- ☐ List topics related to software.
- ☐ Give a short history of computers.



1-1 TURING MODEL

- The idea of a universal computational device was first described by **Alan Turing** in 1937.
- He proposed that all computation could be performed by a special kind of a machine, now called a **Turing machine**.
- He based the model on the actions that people perform when involved in computation.
- He abstracted these actions into a model for a computational machine that has really changed the world.



1.1.1 Data processors

Define a computer as a **data processor**. Using this definition, a computer acts as a **black box** that accepts input data, processes the data, and creates output data (Figure 1.1).

Figure 1.1 A single purpose computing machine



Problem with the Data processors Definitions

- 1- It is too general. In this model, a pocket calculator is also a computer.
- 2- Is it a specific-purpose machine or a general-purpose machine?

This model could represent a specific-purpose computer (or processor) that is designed to do a single job, such as controlling the temperature of a building or controlling the fuel usage in a car.



1.1.2 Programmable data processors

- The **Turing model** is a better model for a general-purpose computer. This model adds an extra element to the specific computing machine: **the program**.
- **A program** is a set of instructions that tells the computer what to do with data.

Figure 1.2 A computer based on the Turing model

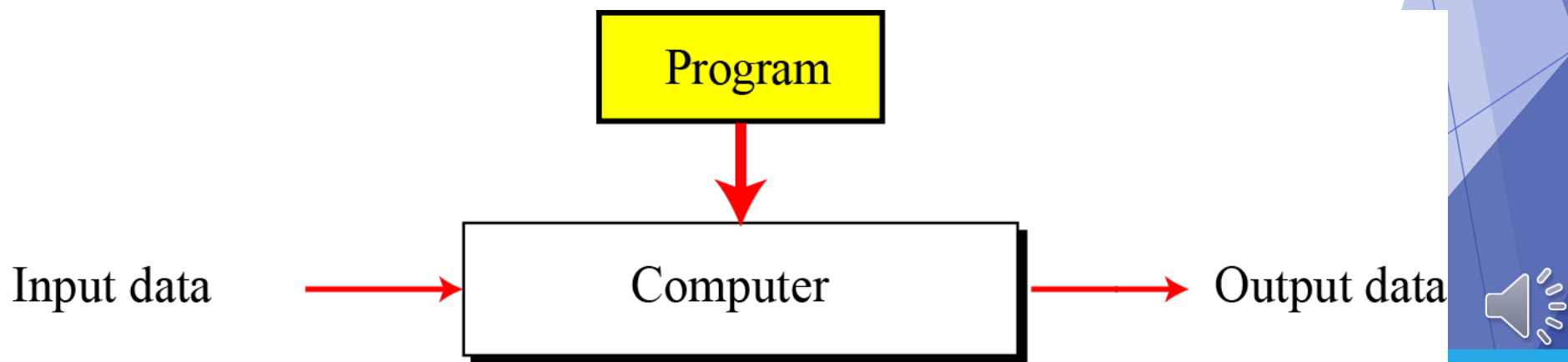


Figure 1.3 The same program, different data

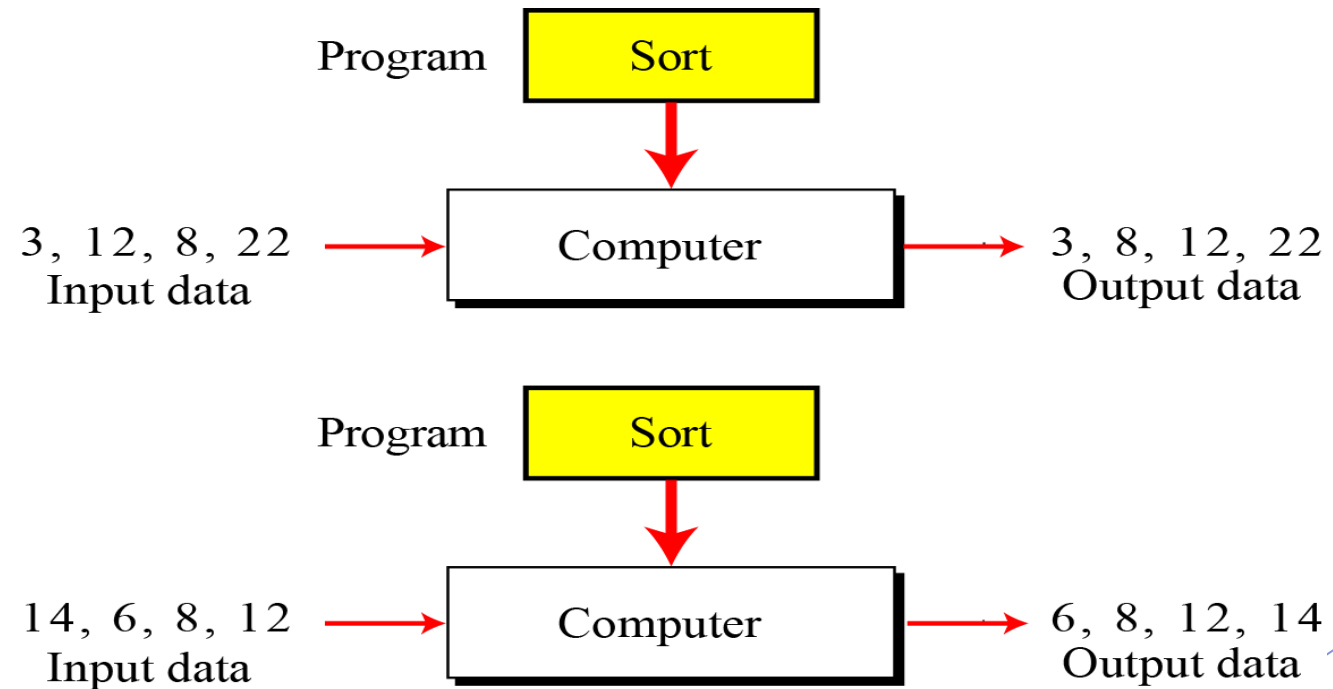
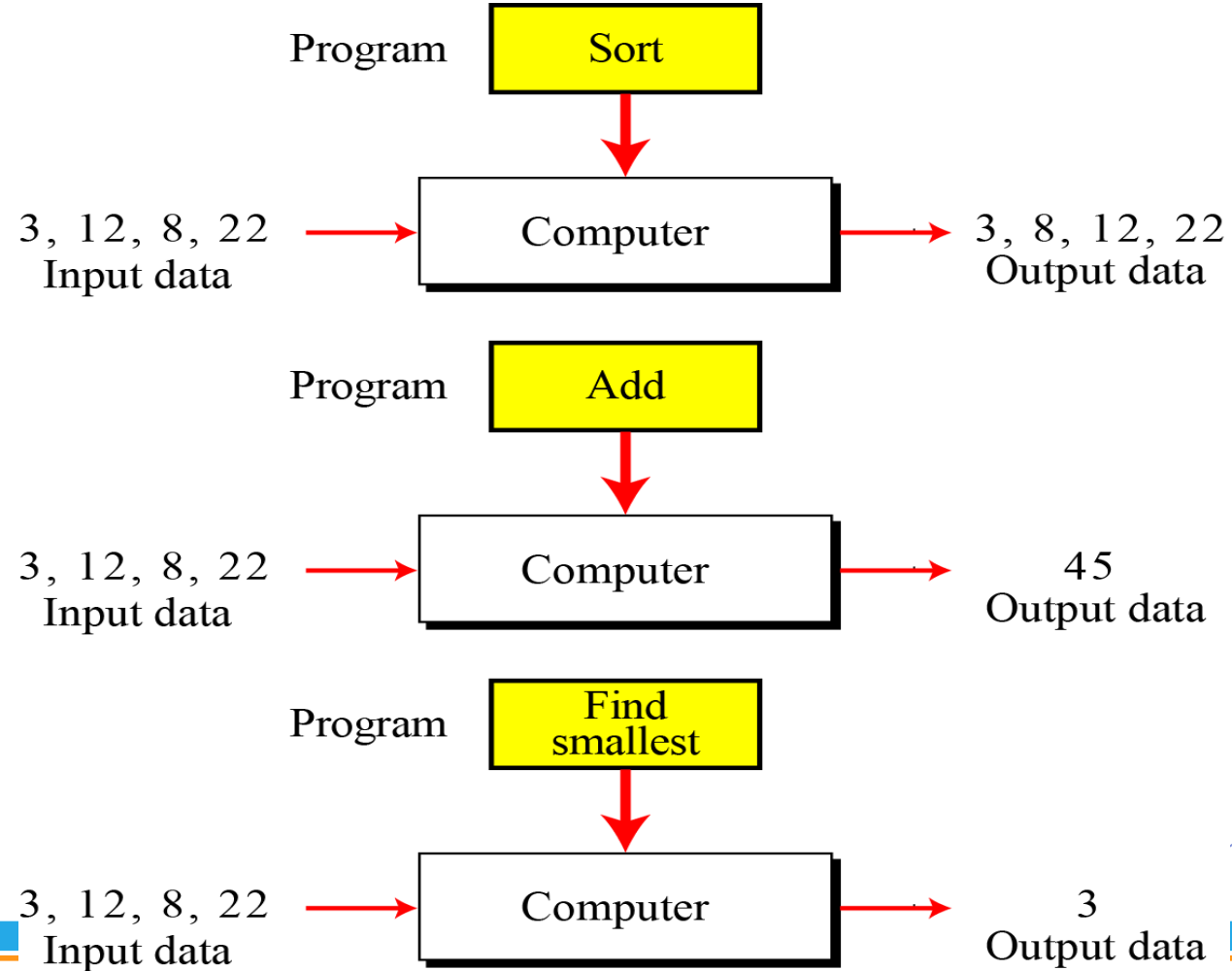


Figure 1.4 The same data, different programs



The same program, different data → different output

The same data, different programs → different output

The same data, same programs → same output



1.1.3 The universal Turing machine

- A **universal Turing machine**, a machine that can do any computation if the appropriate program is provided, was the first description of a **modern computer**.
- It can be proved that a very powerful computer and a universal Turing machine can compute the same thing. We need only provide the data and the program—the description of how to do the computation—to either machine.
- In fact, a universal Turing machine is capable of computing anything that is computable.



1-2 VON NEUMANN MODEL

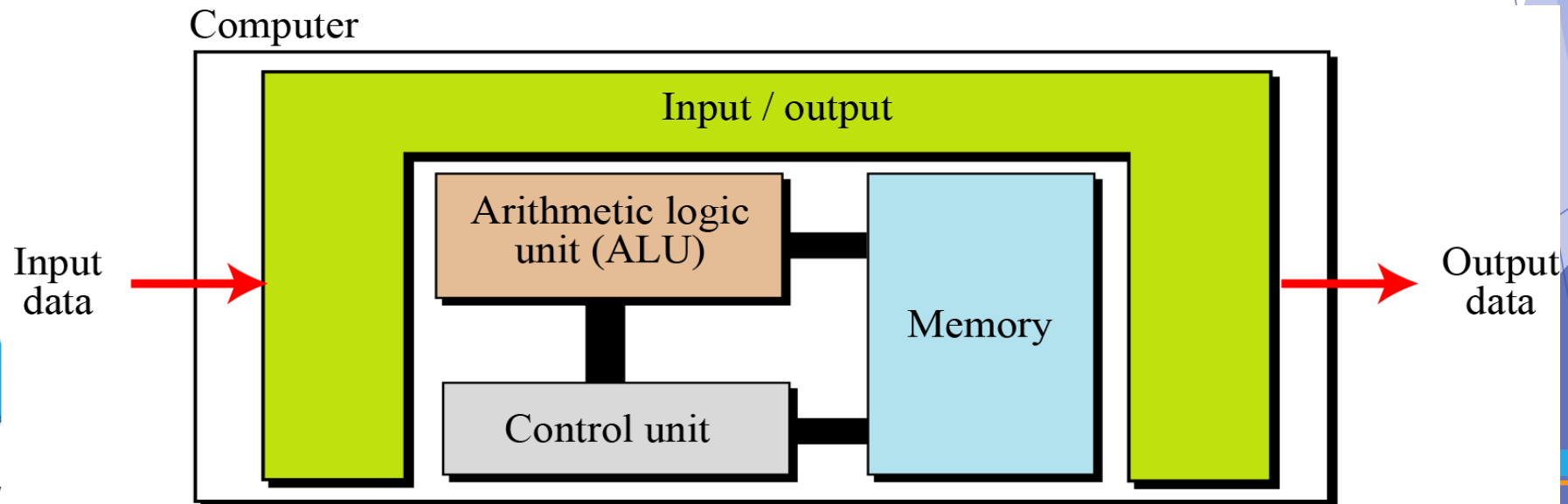
- Computers built on the Turing universal machine store data in their memory.
- Around 1944–1945, John von Neumann proposed that, since program and data are logically the same, programs should also be stored in the memory of a computer.



1.2.1 Four subsystems

Computers built on the **von Neumann model** divide the computer hardware into four subsystems: **memory**, **arithmetic logic unit**, **control unit**, and **input/output** (Figure 1.5).

Figure 1.5 The von Neumann model



Memory

Memory is the storage area. This is where programs and data are stored during processing.

The arithmetic logic unit (ALU) is where calculation and logical operations take place. For a computer to act as a data processor, it must be able to do arithmetic operations on data (such as adding a list of numbers). It should also be able to do logical operations on data.

Control unit The control unit controls the operations of the memory, ALU, and the input/output subsystem.



Input / output The input subsystem accepts input data and the program from outside the computer, while the output subsystem sends the result of processing to the outside world. The definition of the input/output subsystem is very broad: it also includes secondary storage devices such as disk or tape that stores data and programs for processing. When a disk stores data that results from processing, it is considered an output device: when it reads data from the disk, it is considered an input device.



1.2.2 The stored program concept

The von Neumann model states that the program must be stored in memory. This is totally different from the architecture of early computers in which only the data was stored in memory: the programs for their task was implemented by manipulating a set of switches or by changing the wiring system.

The memory of modern computers hosts both a program and its corresponding data. This implies that both the data and programs should have the same format, because they are stored in memory. In fact, they are stored as binary patterns in memory—a **sequence of 0s and 1s**.



1.2.3 Sequential execution of instructions

A program in the von Neumann model is made of a finite number of instructions.

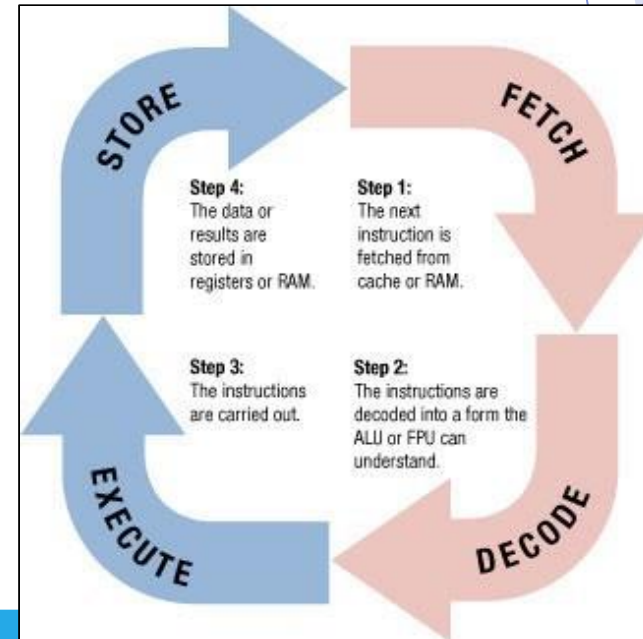
In this model, the control unit:

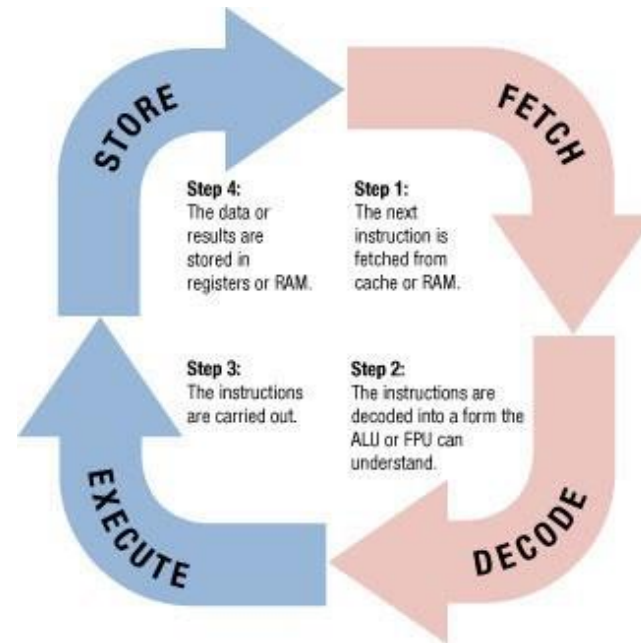
- 1- fetches one instruction from memory,
- 2- decodes it,
- 3- then executes it.



The System Clock and the Machine Cycle

- Machine cycle: The series of operations involved in the execution of a single machine level instruction
 - Fetch: The program instruction is fetched
 - Decode: The instructions are decoded so the control unit, ALU, and FPU can understand them
 - Execute: The instructions are carried out
 - Store: The original data or the result from the ALU execution is stored in the CPU's registers





Add A , B, C
Sub A, B, D

1.2.3 Sequential execution of instructions

In other words, the instructions are executed one after another. Of course, one instruction may request the control unit to jump to some previous or following instruction, but this does not mean that the instructions are not executed sequentially. Sequential execution of a program was the initial requirement of a computer based on the von Neumann model. Today's computers execute programs in the order that is the most efficient.



1-3 COMPUTER COMPONENTS

We can think of a computer as being made up of three components: computer hardware, data, and computer software.



1.3.1 Computer hardware

Computer hardware today has four components under the von Neumann model, although we can have different types of memory, different types of input/output subsystems, and so on. We discuss computer hardware in more detail in Chapter 5.

1.3.2 Data

The von Neumann model clearly defines a computer as a data processing machine that accepts the input data, processes it, and outputs the result.

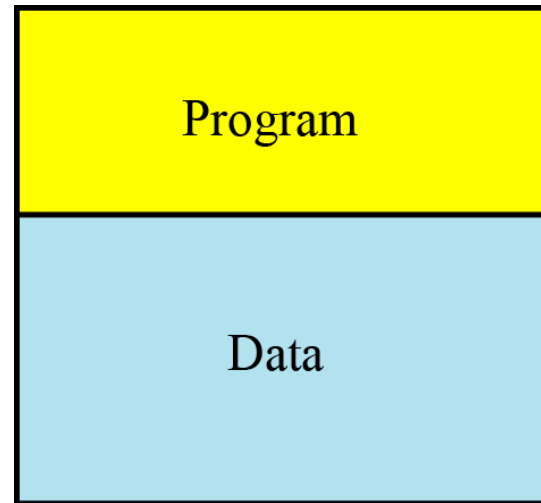


1.3.3 Computer software

The main feature of the Turing or von Neumann models is the concept of the program. Although early computers did not store the program in the computer's memory, they did use the concept of programs. Programming those early computers meant changing the wiring systems or turning a set of switches on or off. Programming was therefore a task done by an operator or engineer before the actual data processing began.



Figure 1.6 Program and data in memory



Memory



Figure 1.7 A program made of instructions

1. Input the first number into memory.
2. Input the second number into memory.
3. Add the two together and store the result in memory.
4. Output the result.

Program



COMPUTER SOFTWARE

Requirements ...

1. **Programs must be stored in memory.**
2. A **Sequence of instructions** should be used in a program.
Why should a program have made by instructions? “reusability”
3. **Algorithms:** a step-by-step solution to solve a problem before implement a program.
4. **Languages:** using symbols and words to write instructions rather than binary (0 and 1).
5. **Software Engineering** :is the design and writing of structured programs.
6. **Operating Systems:** working as a manager to facilitate access of the computer components by a program.



1-4 HISTORY

In this section we briefly review the history of computing and computers. We divide this history into three periods.



1.4.1 Mechanical machines (before 1930)

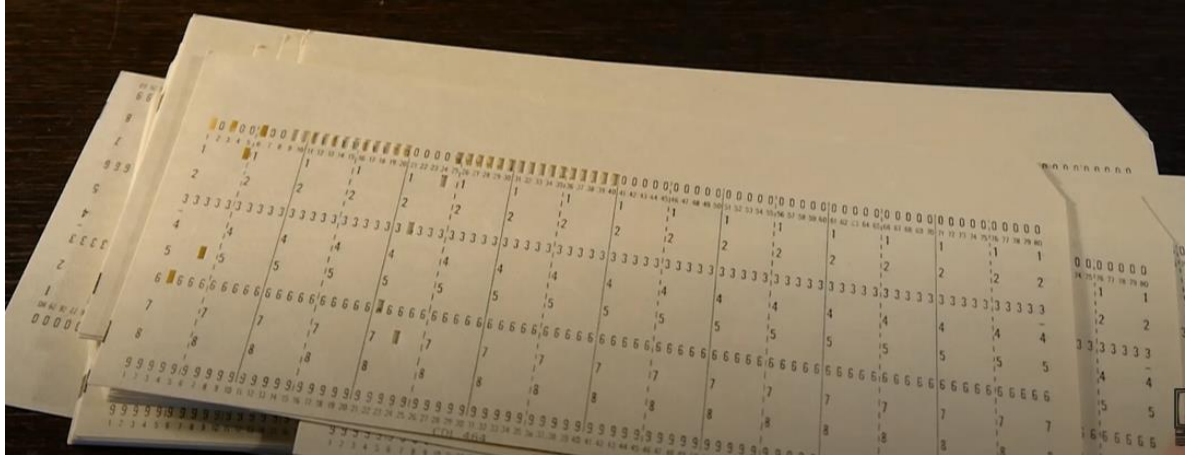
During this period, several computing machines were invented that bear little resemblance to the modern concept of a computer.

- ❑ In the 17th century, Blaise Pascal, a French mathematician and philosopher, invented **Pascaline**.
- ❑ In the late 17th century, German mathematician Gottfried Leibnitz invented **Leibnitz' Wheel**.
- ❑ The first machine that used the idea of storage and programming was the **Jacquard loom**, invented by Joseph-Marie Jacquard at the beginning of the 19th century.



- ❑ In 1823, Charles Babbage invented the **Difference Engine**. Later, he invented a machine called the **Analytical Engine** that parallels the idea of modern computers.
- ❑ In 1890, **Herman Hollerith**, working at the US Census Bureau, designed and built a programmer machine that could automatically read, tally, and sort data stored on punched cards.





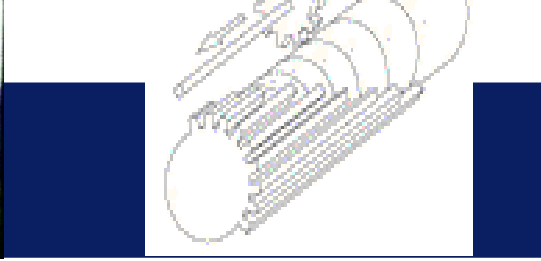
1.4 HISTORY

A. MECHANICAL MACHINES (before 1930)

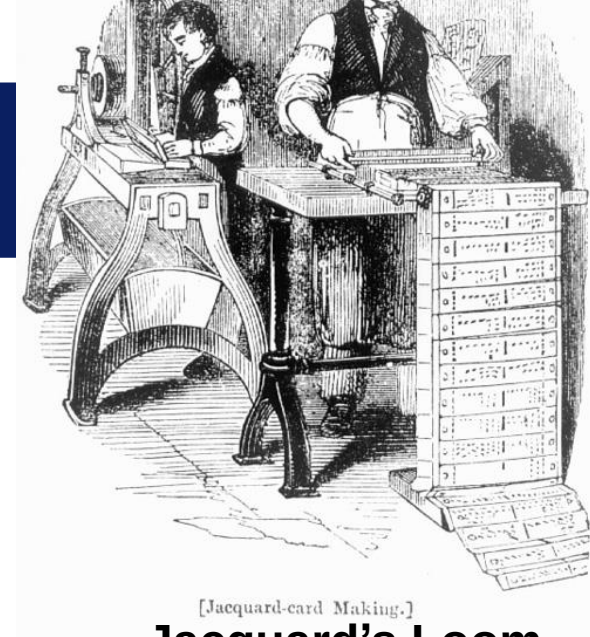
Century	Inventor	Invention	Function
17 th	Pascal	Pascaline	ADD, SUB Calculator
Late 17 th	Leibnitz's	Leibnitz's Wheel	ADD, SUB, MUL, DIV Calculator
19 th	Jacquard	Jacquard Loom	Controlling Textiles Machine
1823	<u>Babbage</u>	Difference Engine	Advanced calculator
		Analytical Engine	Semi computer Four components: (Mill, Store, Operator, Output)
1890	Hollerith	Programmer machine, can read, tally, and sort data on punched cards	



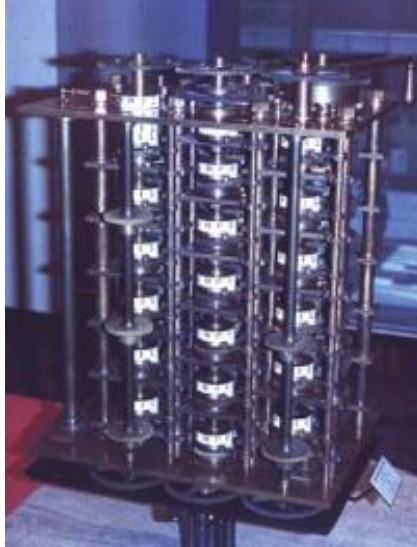
Pascaline



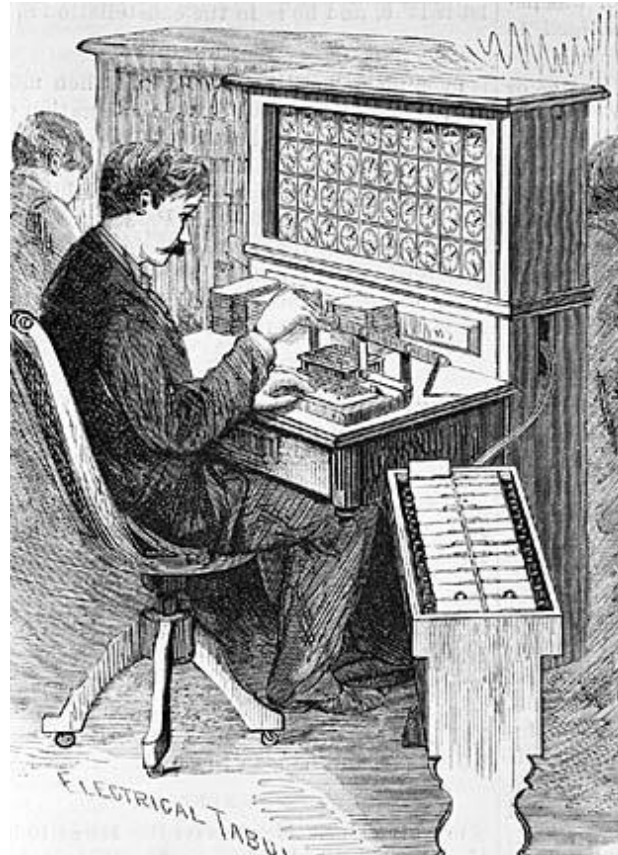
Leibnitz's Wheel



Jacquard's Loom



Difference Engine



Hollerith Desk



1.4.2 The birth of electronic computers (1930–1950)

Between 1930 and 1950, several computers were invented by scientists who could be considered the pioneers of the electronic computer industry.

Early Electronic Computers (Turing Model)

The early computers of this period did not store the program in memory—all were programmed externally. Five computers were prominent during these years:

- ☐ ABC (solve a system of linear equations)
- ☐ Z1
- ☐ Mark1 (used both electrical and mechanical components)
- ☐ Colossus
- ☐ ENIAC (first general-purpose, totally electronic computer)



Computers based on the von Neumann model

The preceding five computers used memory only for storing data, and were programmed externally using wires or switches. John von Neumann proposed that the program and the data should be stored in memory. That way, every time we use a computer to do a new task, we need only change the program instead of rewiring the machine or turning hundreds of switches on and off.

The first computer based on von Neumann's ideas was made in 1950 at the University of Pennsylvania and was called **EDVAC**. At the same time, a similar computer called **EDSAC** was built by Maurice Wilkes at Cambridge University in England.



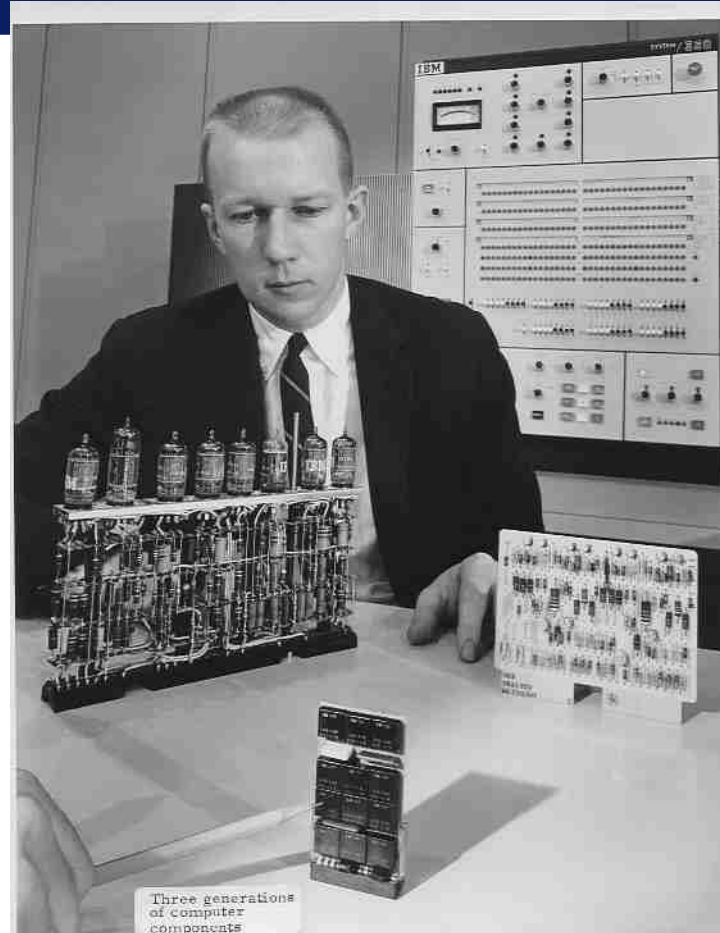
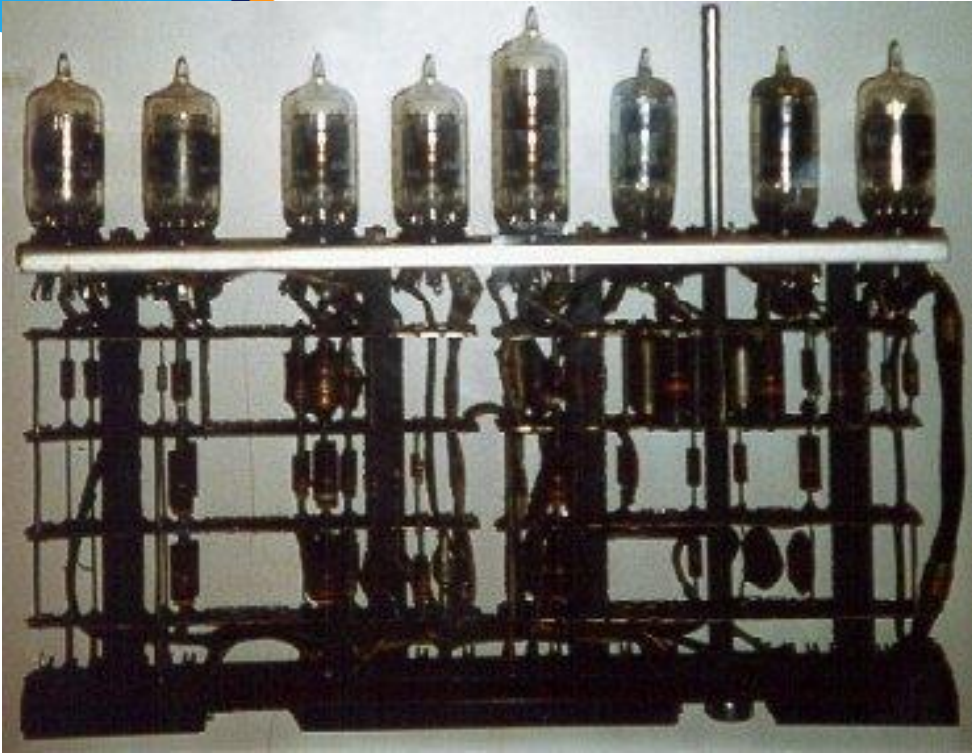
1.4.3 Computer generations (1950–present)

Computers built after 1950 more or less follow the von Neumann model. They have become faster, smaller, and cheaper, but the principle is almost the same. Historians divide this period into generations, with each generation witnessing some major change in hardware or software (but not in the model).

First generation

The first generation (roughly 1950–1959) is characterized by the emergence of commercial computers. It used vacuum tubes as electronic switches





vacuum tubes



Second generation

Second-generation computers (roughly 1959–1965) used **transistors** instead of vacuum tubes. Two high-level programming languages, FORTRAN and COBOL invented and made programming easier. This reduced the size of computers, as well as their cost, and made them affordable to small and medium-size corporations.

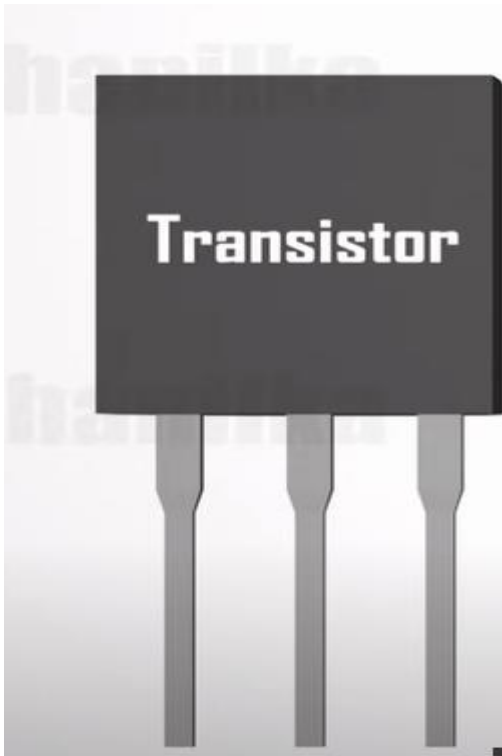


Third generation

The invention of the **integrated circuit** reduced the cost and size of computers even further. Minicomputers appeared on the market. Canned programs, popularly known as **software packages**, became available. This generation lasted roughly from 1965 to 1975. A small corporation could buy a package.



transistors



integrated circuit

(transistors, wiring, and other components on a single chip)



Fourth generation

The fourth generation (approximately 1975–1985) saw the appearance of **microcomputers**. The first desktop calculator, the Altair 8800, became available in 1975. This generation also saw the emergence of **computer networks**.

Fifth generation

This open-ended generation started in 1985. It has witnessed the appearance of **laptop** and **palmtop** computers, improvements in secondary storage media (**CDROM**, **DVD** and so on), the use of multimedia, and the phenomenon of virtual reality.





microcomputers.



1.5 Ethical issues

Computers have created some ethical issues. We introduce some of these here.

Privacy

Computers allow communication between two parties to be done electronically. However, much needs to be done to make this type of communication private. Society is paying a big price for private electronic communication.

Copyright

Another ethical issue in a computerized society is copyright: who owns data? The internet has created opportunities to share ideas, but has also brought a further ethical issue: electronic copyright.

Computer crime

Like any innovation, computers and information technology have created new types of crime.

- Hackers have been able to access many computers in the world and have stolen a lot of money.
- Virus creators design new viruses to be sent through the internet and damage the information stored in computers. Although there are many anti-virus programs in use today, society is paying a big price for this type of crime, which did not exist before the computer and internet era.



1-6 COMPUTER SCIENCE AS A DISCIPLINE

With the invention of computers, a new discipline has evolved: computer science. Like any other discipline, computer science has now divided into several areas. We can divide these areas into two broad categories:

- systems areas and
- applications areas.



COMPUTER SCIENCE AS A DISCIPLINE

Systems areas cover those areas that directly related to the creation of hardware and software, such as computer architecture, computer networking, security issues, operating systems, algorithms, programming languages, and software engineering.

Applications areas cover those that are related to the use of computers, such as databases and artificial intelligence.



1-6 OUTLINE OF THE COURSE

After this introductory chapter, the book is divided into five parts.

1.6.1 Part I: Data representation and operation

This part includes Chapters 2, 3, and 4.

Chapter 2 discuss number systems, how a quantity can be represented using symbols.

Chapter 3 discusses how different data is stored inside the computer.

Chapter 4 discusses some primitive operations on bits.



1.6.2 Part II: Computer hardware

This part includes Chapters 5 and 6.

Chapter 5 gives a general idea of computer hardware, discussing different computer organizations.

Chapter 6 shows how individual computers are connected to make computer networks, and internetworks (internets).



1.6.3 Part III: Computer software

This part includes Chapters 7, 8, 9, and 10.

Chapter 7 discusses operating systems.

Chapter 8 shows how problem solving is reduced to writing an algorithm for the problem.

Chapter 9 programming languages.

Chapter 10 is a review of software engineering.



1.6.4 Part IV: Data organization and abstraction

Part IV includes Chapters 11, 12, 13, and 14.

Chapter 11 discuss data structure, collecting data of the same or different type under one category.

Chapter 12 discusses abstract data types.

Chapter 13 shows how different file structures can be used for different purposes.

Chapter 14 discusses databases.



1.6.5 Part V: Advanced topics

This part covers Chapters 15, 16, 17, and 18.

Chapter 15 discusses data compression.

Chapter 16 explores some issues to do with security.

Chapter 17 discusses the theory of computation.

Chapter 18 gives some idea of artificial intelligence, a topic with day-to-day challenges in computer science.



SUMMARY

- A computer is a programmable data processor that accepts input data and programs and outputs data.
- A program is a set of instructions executed sequentially that tells the computer what to do with data.
- Every computer today is based on the von Neumann model.



SUMMARY

- The von Neumann model specifies a memory subsystem, an arithmetic logic unit subsystem, a control unit subsystem, and an input/output subsystem.
- Data and programs are stored in computer memory.
- A step-by-step solution to a program is called an algorithm.
- A program is written in a computer language.
- Software engineering is the design and writing of programs in a structured form





THANK YOU

