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Session 1

What is and Why Programming

Ringa K.R

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Session objectives

- Understand the two computer models: data processor and programmable data processor.
- Define the von Neumann model and name its components: memory, arithmetic/logic unit, control unit and input/output.
- Name the components of a computer: hardware, software and data.
- Define the concept of programming.
- Explain why programming is necessary.

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The Computer as a black box

Data Processor model

You can think of 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.

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The Computer as a black box

- Problems with the data processor model
  - It defines the functionality of a computer yes but in very general terms.
  - It does not specify the type of processing or whether more than one type of processing is possible.
- This model could represent a specific – purpose computer (or processor) that is designed to do some specific job such as controlling temperature of a building or controlling the fuel usage in a car. However, computers, as the term is used today, are general purpose machines.

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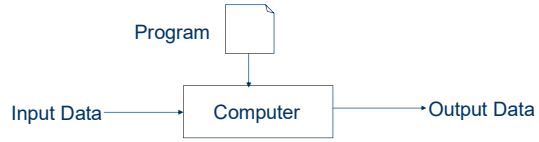
The Computer as a black box

Programmable Data Processor model

A better model for a general – purpose computer is shown in the figure below. This model adds one extra element to the computer: the program. A program is a set of instructions that tells the computer what to do with data.



With this model, the output data depend on the combination of two factors: the input data and the program.

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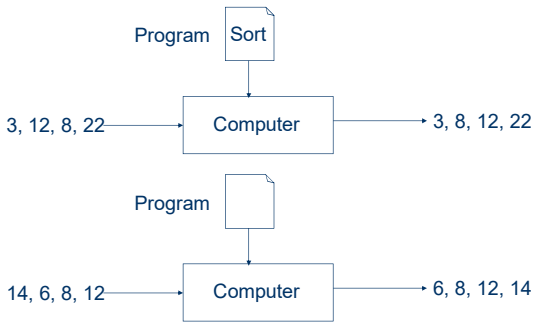
Same program, different data



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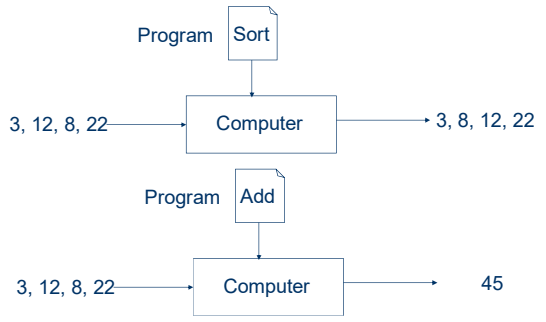
Same data, different programs



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von Neumann Model

This model looks at the inside of the computer (black box) and defines how processing is done. It based on three ideas:

- four subsystems,
- stored program concept, and
- sequential execution of instructions.

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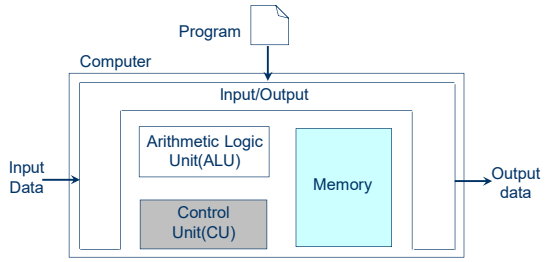
Four subsystems

The model defines a computer as four subsystems: memory, arithmetic logic unit, control unit, and input/output. The figure below depicts this model.



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Four subsystems

- **Memory:** memory is the storage area. It is where programs and data are stored during processing.
- **Arithmetic Logic Unit (ALU):** The arithmetic logic unit is where calculation and logical operations take place.
- **Control unit:** The control unit controls the operations of the memory, ALU, and input/output subsystem.
- **Input/Output:** The input subsystem accepts data and the program from the outside the computer; the output subsystem sends the result of processing to the outside. The definition of the input/output subsystem is very broad; it also includes the secondary storage devices such as disk or tape that stores data and programs for processing.

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Stored Program Concept

- The von Neumann model states that the program must be stored in memory.
- 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. They are, in fact, stored as binary patterns in memory.

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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 fetches one instruction from memory, interprets it, and then executes it.
- Instructions are executed one after the another.

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Components of a Computer

1. **Computer Hardware**: This is physical component of the computer which includes all the four subsystems we have just discussed.
2. **Data**: This model clearly defines a computer as a data processing machine that accepts the input data, processes it, and outputs the result.
   - Storing data – the von Neumann model does not define how data must be stored in a computer. If a computer is an electronic device, the best way to store data is in the form of an electrical signal, specifically the presence or absence. This implies that a computer can store data in one of the two states.
   - Organizing data – although data should be stored in one form inside a computer, data outside a computer can take many forms, hence the need to organize it in different forms and formats.

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Components of a Computer

3. **Computer Software**: The main feature of the von Neumann model is the concept of the stored program.
   - The von Neumann model changed the meaning of the term "programming". In this model, there are two aspects of programming that must be understood
     - programs must be stored.
     - A sequence of instructions
   - Algorithms
   - Languages
   - Software engineering
   - Operating systems

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What is Programming

- This is the process of writing a program.
- It involves specifying task in a way that is understood by the computer.
- The process involves the human being – who is you and me.
- It is the only process that makes us (computing fellows – you and me) important in the computing world.

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Why Programming

"You may be asking yourself why is programming important?"

- From the programmable data processor model, note that there is a component that is introduced – the *program.*
- This component is introduced to define the 'how' part, specifying how the computer can process data.
- Hence, from a computing perspective; we need programming to define *how data* is *processed* in the computer.