Von-Neumann Architecture Vs Harvard Architecture

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Abdullatif Baba
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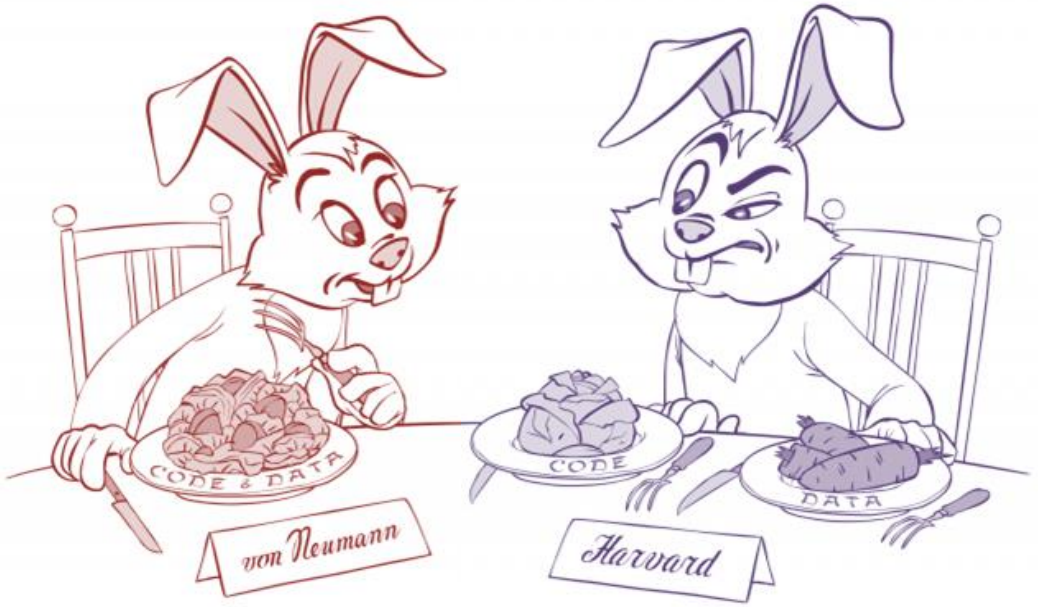

Mechatronics Engineering Department
Dr. Eng. Abdullatif BABA
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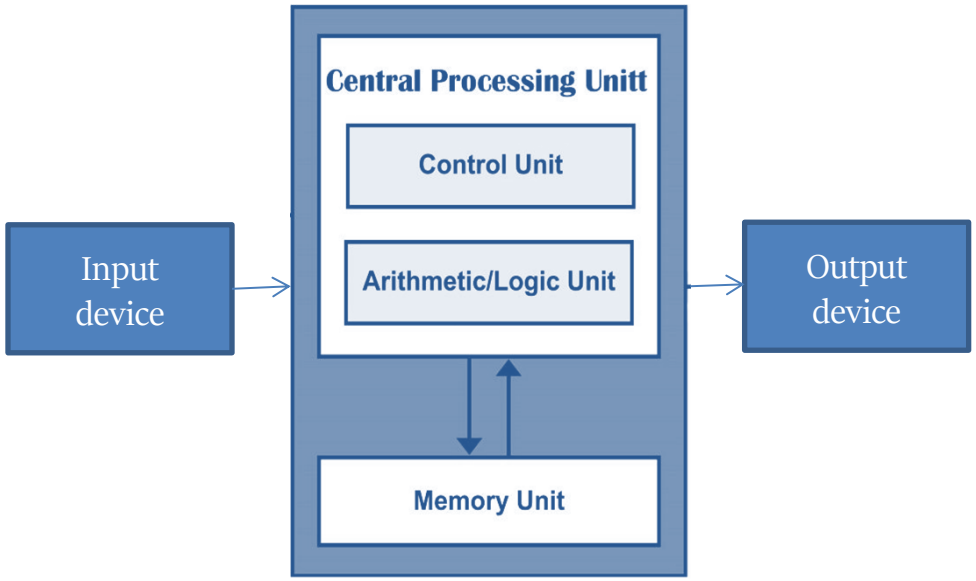
Computer Architecture
Von-Neumann *vs* Harvard

Computer Architecture refers to the internal design of a computer with its CPU, which includes:

- Arithmetic and logic unit,
- Control unit,
- Registers,
- Memory for data and instructions,
- Input/output interface and
- External storage functions.



Von-Neumann architecture and Harvard architecture

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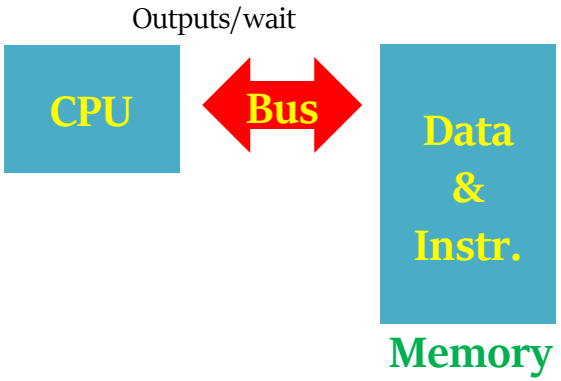
Von-Neumann architecture:

The same memory and bus are used to store both Data and Instructions



The main drawback:

CPU is unable to access program memory and data memory simultaneously. This case is called the "**bottleneck**" that affects system performance.

The bottleneck

- If a Von-Neumann machine wants to perform an instruction (already fetched from the memory) on some data in memory, it has to move the data across the bus into the CPU.
- When the computation is done, it needs to move outputs of the computation to memory across the same bus; this operation will be completed if the bus is not used by another operation to fetch another instruction or data from the shared memory; otherwise the outputs of the computation has to wait.

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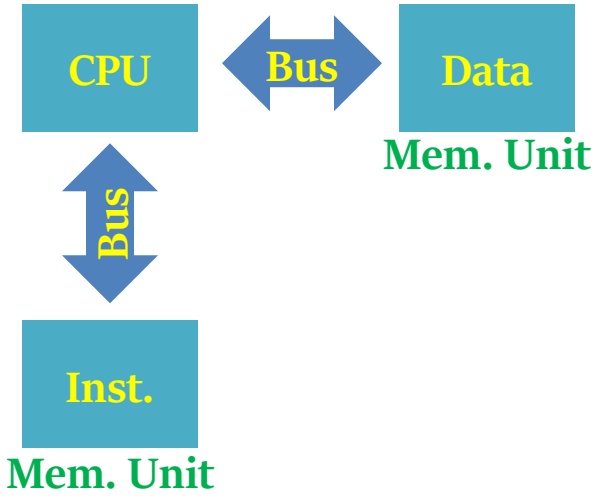
Harvard architecture:

The Harvard architecture stores machine instructions and data in separate memory units using different buses.

The main advantage:

Computers designed with the Harvard architecture are able to run a program and access data independently, and therefore simultaneously.



Harvard architecture is more complicated but separate pipelines remove the **bottleneck** that Von-Neumann creates.

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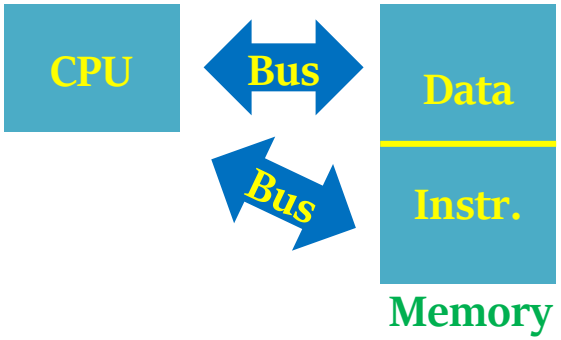
Modified Harvard Architecture

The majority of modern computers have no physical separation between the memory spaces used by both data and instructions, therefore could be described technically as Von-Neumann.



But as they have two separate address spaces, different buses and special instructions that keep data from being mistaken for code, this architecture is called "Modified Harvard Architecture".

Ex. some initial data values or constants can be accessed by the running program directly from instruction memory without taking up space in data memory.