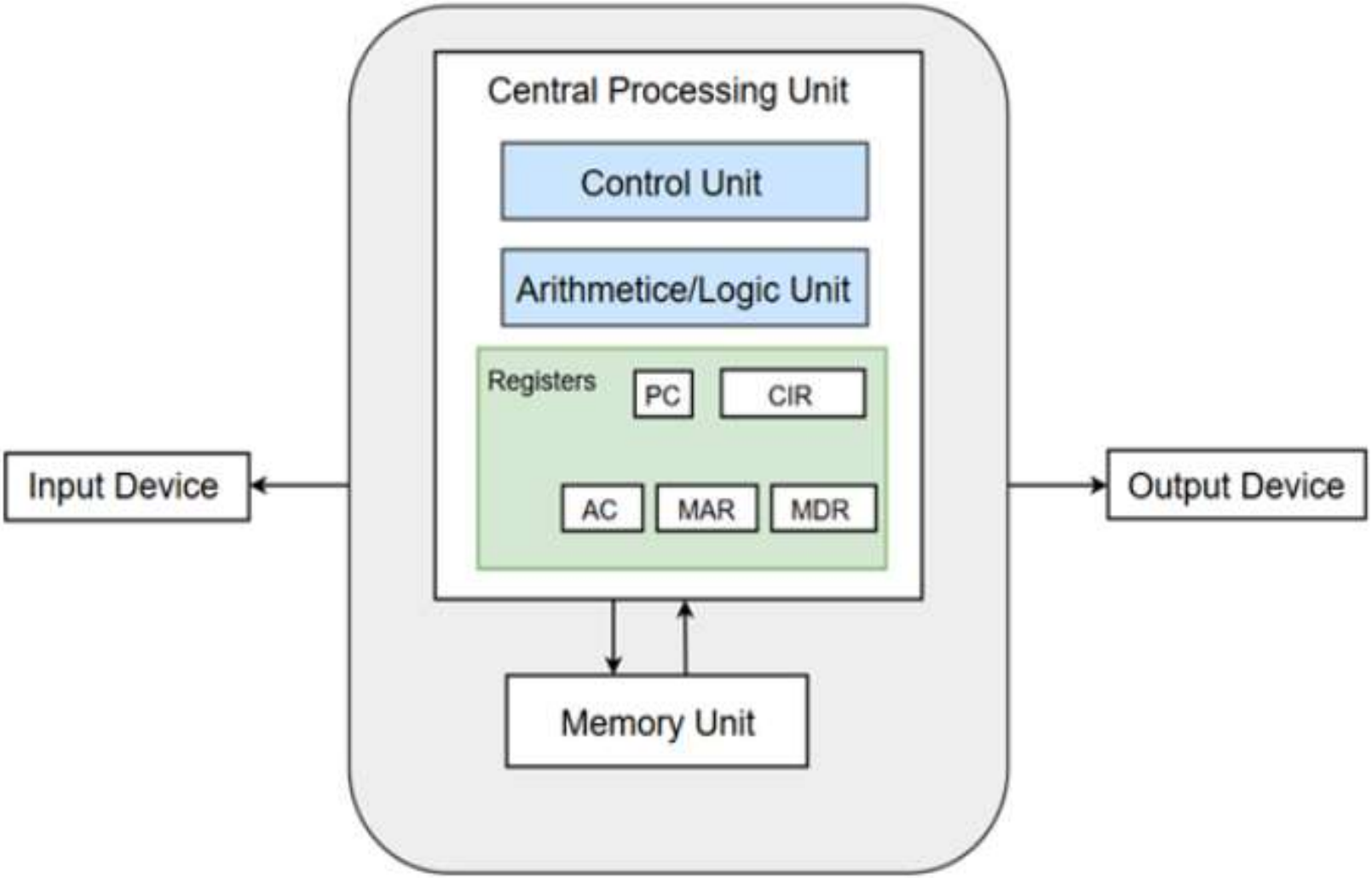
HNDIT1032 Computer and Network Systems

Week 07- Registers & Instructions

Von Neumann Model

- Von-Neumann proposed his computer architecture design in 1945 which was later known as Von-Neumann Architecture.
- It consisted of a Control Unit, Arithmetic, and Logical Memory Unit (ALU), Registers and Inputs/Outputs.

Von Neumann Model



Components of CPU

- ALU
- Control Unit
- Registers

Registers

- Registers are high-speed storage areas within the CPU, but have the least storage capacity.
- Registers store data, instructions, addresses and intermediate results of processing.
- Registers are often referred to as the CPU's working memory.

Registers

- The data and instructions that require processing must be brought in the registers of CPU before they can be processed.
- For example, if two numbers are to be added, both numbers are brought in the registers, added and the result is also placed in a register.
- Registers are used for different purposes, with each register serving a specific purpose.

Registers inside the CPU

Registers	Description
MAR (Memory Address Register)	This register holds the memory location of the data that needs to be accessed.
MDR (Memory Data Register)	This register holds the data that is being transferred to or from memory.
AC (Accumulator)	This register holds the intermediate arithmetic and logic results.
PC (Program Counter)	This register contains the address of the next instruction to be executed.
CIR (Current Instruction Register)	This register contains the current instruction during processing.

Size of the Registers

- The size of register, also called word size, indicates the amount of data with which the computer can work at any given time.
- The bigger the size, the more quickly it can process data.
- The size of a register may be 8, 16, 32 or 64 bits.
- For example, a 32–bit CPU is one in which each register is 32 bits wide and its CPU can manipulate 32 bits of data at a time.
- Nowadays, PCs have 32–bit or 64–bit registers.

Stored Program Concept

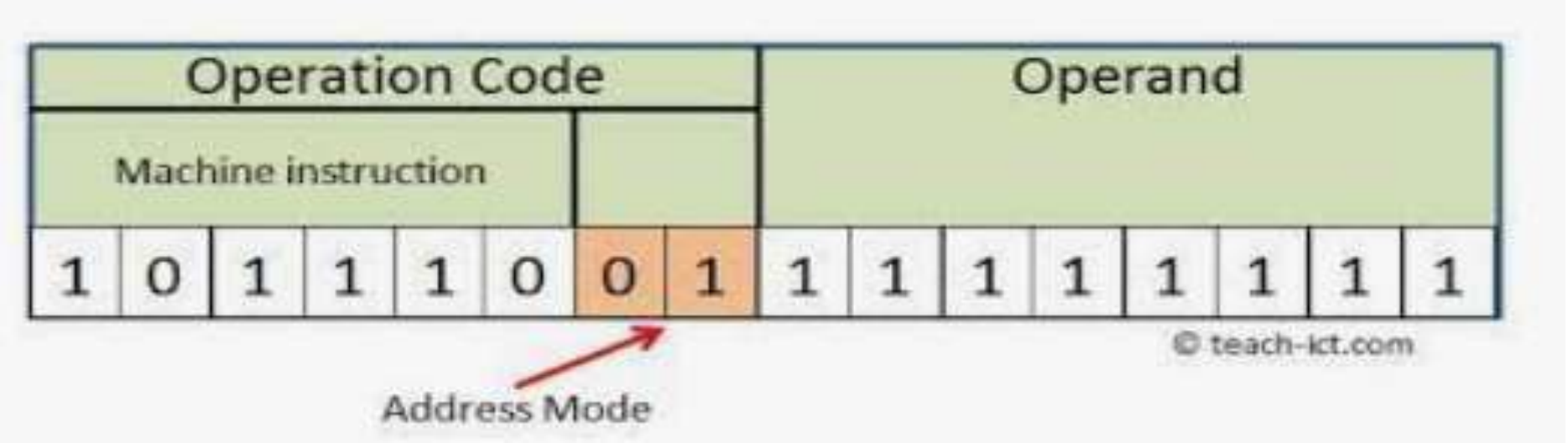
- The program and the data, on which the program operates, are stored in main memory, waiting to be processed by the processor.
- This is also called the stored program concept.
- Instructions are key concept.

What are Instructions?

- A computer program is a set of instructions that describe the steps to be performed for carrying out a computational task.
- An instruction is designed to perform a task and is an elementary operation that the processor can accomplish.

Structure of Instructions

- An instruction is divided into groups called fields. The common fields of an instruction are
  - Operation code
  - Operand code



Opcode & Operands

- The operation code represents action
- that the processor must execute.
- It tells the processor what basic operations to perform.
- The operand code defines the parameters of the action and depends on the operation.

Example

Opcode	Operand
MOV	C, A
ADD	B
MVI	A, 32H
MVI	B, F2H

Example of instruction ADD

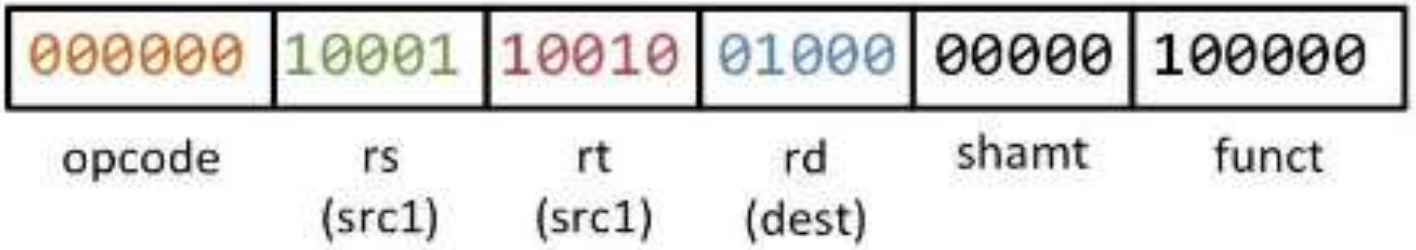
Machine Language

- Computers do not understand "add R8, R17, R18"
- Instructions are translated to machine language (1s and 0s)

Example:

```
add R8, R17, R18 →
00000010 00110010 01000000 00100000
```

MIPS instructions have logical fields:



Instruction Set

- A processor has a set of instructions that it understands, called as instruction set.
- An instruction set or an instruction set architecture(ISA) is a part of the computer architecture.
- It relates to programming, instructions, registers, addressing modes, memory architecture, etc.

Examples ISA

Intel	(8086, 80386, Pentium, ...)
MIPS	(MIPS I, II, III, IV, V)
PowerPC	(601, 604, ...)

Microarchitecture

- Microarchitecture is the processor design technique used for implementing the Instruction Set.
- Computers having different microarchitecture can have a common Instruction Set.
- Pentium and Athlon CPU chips implement the x86 instruction set, but have different internal designs.

CISC vs RISC

On the basis of the instruction set, microprocessors are classified as—Reduced Instruction Set Computer (RISC)

Complex Instruction Set Computer (CISC)-the x86 instruction set of the original Intel 8086 processor is of the CISC type. The PCs are based on the x86 instruction set.

CISC

- CISC has a large instruction set .
- Instructions are of variable lengths, using 8, 16 or 32 bits for storage.
- Need more transistors.
- AMD and Cyrix are based on CISC.

RISC

- RISC has simple, single-cycle instructions, which performs only basic instructions.
- RISC has fewer instructions and requires fewer transistors.
- The instruction size is fixed (32 bits).
- RISC processors can handle multiple instructions simultaneously.
- Apple Mac G3 and PowerPC are based on RISC.

Next week

Instruction fetch/execute life cycle

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.