

# CAO: Lecture 15

## Addressing modes

# Topics Covered

- Central Processing Unit Addressing modes
- Numerical example
- Immediate Mode
- Indirect Mode
- Indexing Mode
- Relative Mode

# Central Processing Unit

## Addressing modes

- The addressing mode specifies a rule for interpreting or modifying the **address field** of the instruction before the operand is actually executed.
- Computers use addressing mode techniques for the purpose of accommodating one of the following provisions:
  1. To give programming versatilities to the user to be more flexible.
  2. To reduce the number of bits in the addressing field of the instruction.
- In some some computers, the addressing mode of the instruction is specified with **distinct binary code**.

Instruction format with mode field

Opcode	Mode	Address
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# Central Processing Unit

## Addressing modes

- Other computers use a single binary for operation & Address mode.
- The mode field is used to locate the operand.
- Address field may designate a memory address or a processor register.
- There are 2 modes that need no address field at all (Implied & immediate modes).

# Central Processing Unit

## Addressing modes

- The most well known addressing mode then are:
  - Implied mode.
  - Immediate mode
  - Register mode
  - Register Indirect mode
  - Auto-increment or Auto-decrement mode
  - Direct Mode
  - Indirect Mode
  - Relative Address Mode
  - Index Addressing Mode

# Central Processing Unit Addressing modes

## Numerical Example

PC=200      R1=400

XR=100      AC

Addressing mode	eff. Add	Content of AC
Direct Address	500	800
Immediate operand	201	500
Indirect Address	800	300
Relative Address	702 (PC=PC+2)	325
Indexes Address	600 (XR+500)	900
Register	---	400
Register Indirect	400	700
Auto-increment	400	700
Auto-decrement	399	450

Tabular list

Address	Memory
200	Load to AC   Mode
201	Address=500
202	Next Instruction
399	450
400	700
500	800
600	900
702	325
800	300

# Central Processing Unit Addressing modes

- Different ways in which the address of an operand is specified in an instruction is referred to as addressing modes.
- **Register mode**
  - Operand is the contents of a processor register.
  - Address of the register is given in the instruction.
  - E.g. *Clear R1*
- **Absolute mode**
  - Operand is in a memory location.
  - Address of the memory location is given explicitly in the instruction.
  - E.g. *Clear A*
  - Also called as “Direct mode” in some assembly languages
- **Register and absolute modes can be used to represent variables**

# Central Processing Unit Addressing modes

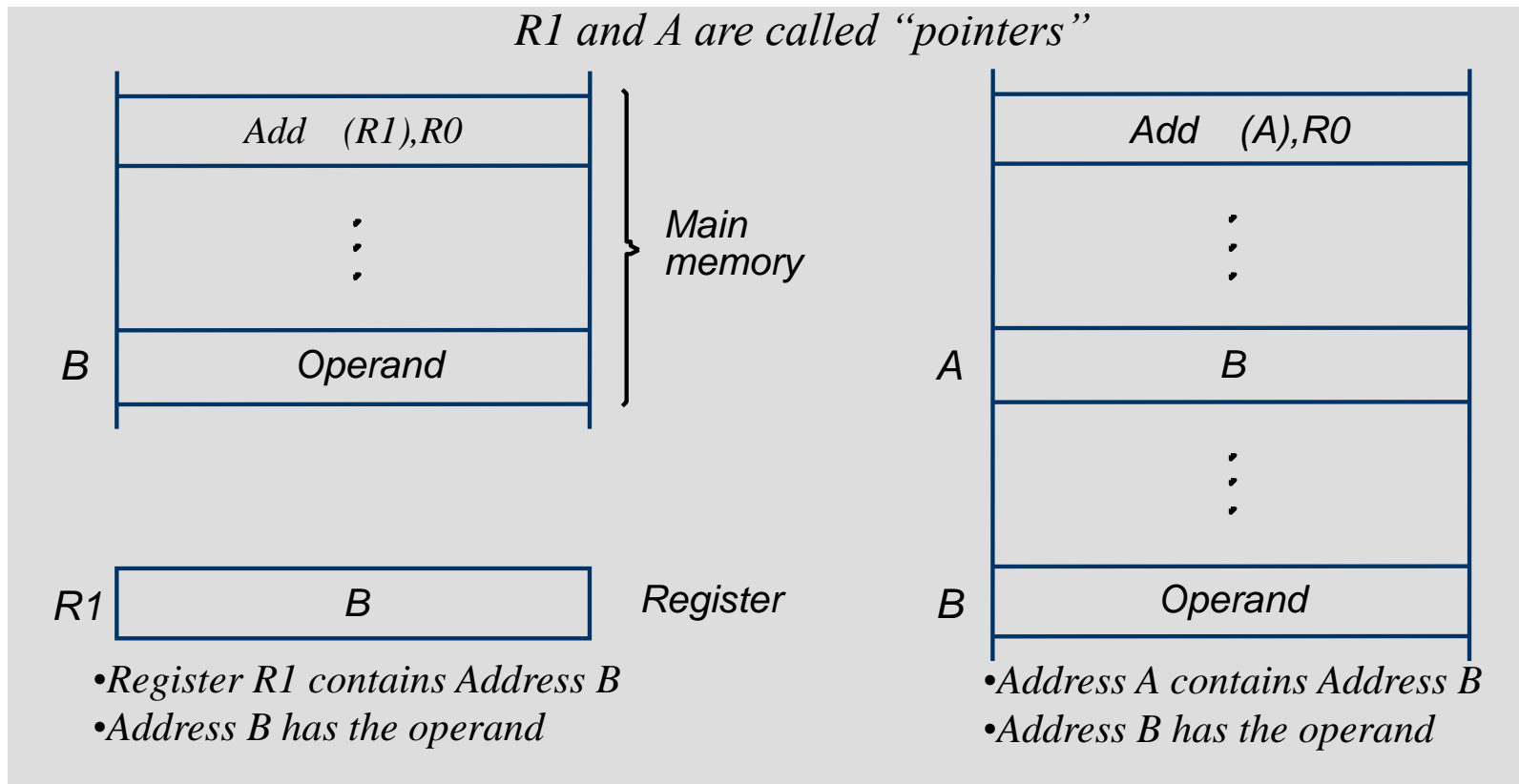
## Immediate mode

- Operand is given explicitly in the instruction.
- E.g. *Move #200, R0*
- Can be used to represent constants.
- Register, Absolute and Immediate modes contained either the address of the operand or the operand itself.
- Some instructions provide information from which the memory address of the operand can be determined
  - That is, they provide the “Effective Address” of the operand.
  - They do not provide the operand or the address of the operand explicitly.
- Different ways in which “Effective Address” of the operand can be generated.



# Central Processing Unit Addressing modes

## Indirect Mode

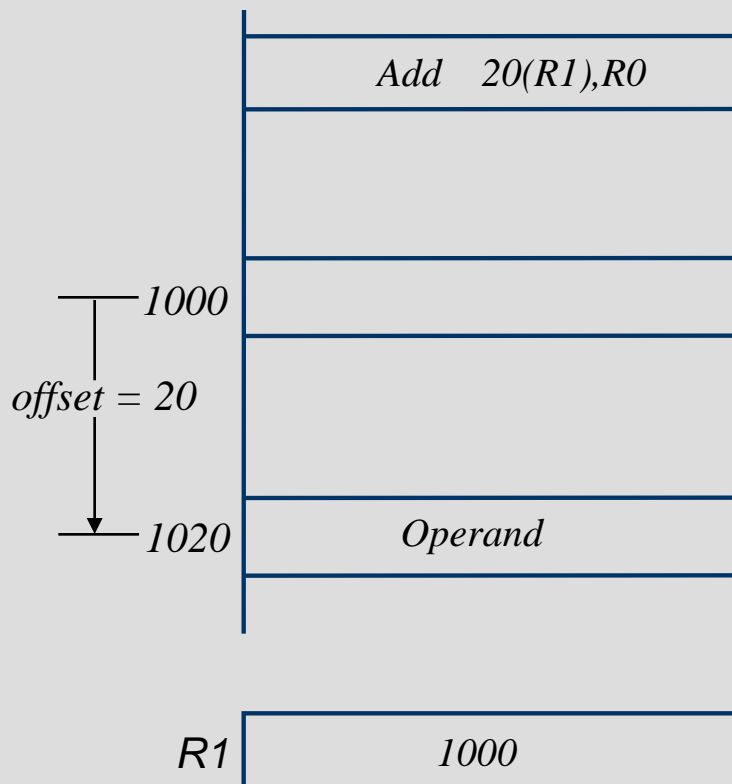


Effective Address of the operand is the contents of a register or a memory location whose address appears in the instruction.

# Central Processing Unit Addressing modes

## Indexing Mode

Effective Address of the operand is generated by adding a constant value to the contents of the register



- *Operand is at address 1020*
- *Register R1 contains 1000*
- *Offset 20 is added to the contents of R1 to generate the address 20*
- *Contents of R1 do not change in the process of generating the address*
- *R1 is called as an “index register”*

*What address would be generated by `Add 1000(R1), R0` if R1 had 20?*

# Central Processing Unit Addressing modes

## Relative mode

- Effective Address of the operand is generated by adding a constant value to the contents of the Program Counter (PC).
- Variation of the Indexing Mode, where the index register is the PC instead of a general purpose register.
- When the instruction is being executed, the PC holds the address of the next instruction in the program.
- Useful for specifying target addresses in branch instructions.

Addressed location is “relative” to the PC, this is called “Relative Mode”

# Central Processing Unit Addressing modes

- **Autoincrement mode:**
  - Effective address of the operand is the contents of a register specified in the instruction.
  - After accessing the operand, the contents of this register are automatically incremented to point to the next consecutive memory location.
  - $(RI)+$
- **Autodecrement mode**
  - Effective address of the operand is the contents of a register specified in the instruction.
  - Before accessing the operand, the contents of this register are automatically decremented to point to the previous consecutive memory location.
  - $-(RI)$
- **Autoincrement and Autodecrement modes are useful for implementing “Last-In-First-Out” data structures**