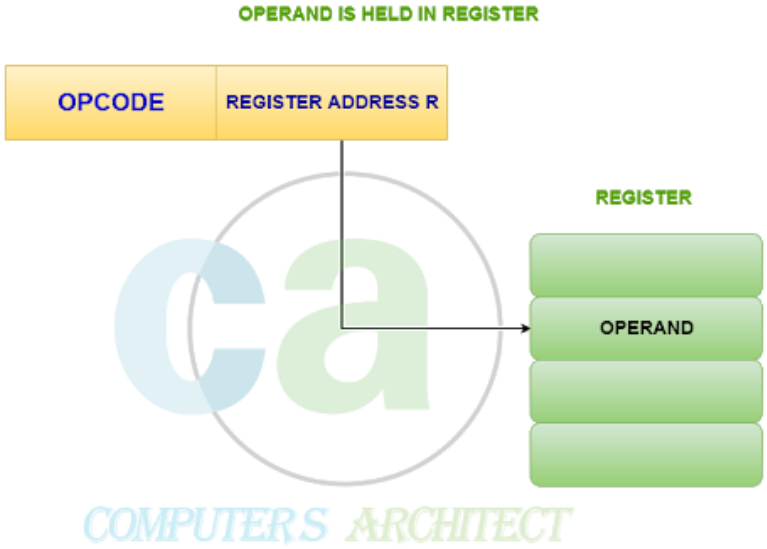
ساختار و زبان کامپیوتر

فصل چهارم

حالت‌های آدرس‌دهی



COMPUTER S ARCHITECT

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Parts (text & figures) of this lecture are adopted from:

- D. Patterson & J. Hennessey, "Computer Organization & Design, The Hardware/Software Interface", 5th Ed., MK publishing, 2014
- "Computer System Architecture", M. Morris Mano, Pearson, 1999

Definition

- Addressing Mode
  - A form for specifying one or more operands
- Effective Address
  - The address of the operand (in memory)

Addressing Modes

- Implicit
- Immediate
- Register (direct)
- Register indirect
- Base or displacement addressing
- Indexed addressing
- Auto-increment / Auto-decrement
- PC-relative
- Memory direct
- Memory indirect

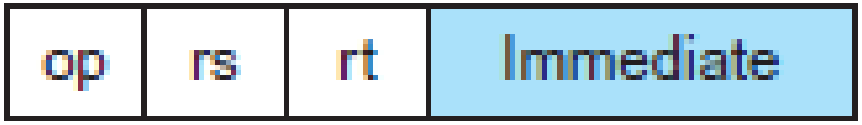
Implied Addressing

- The operand is specified *implicitly* in the instruction, such as:
  - Register-reference instructions that use an accumulator register
  - Zero-address instructions in a stack-organized computer
    - Operands are implied to be on top of stack

Immediate Addressing

- Operand is a constant within instruction
- MIPS-32 example:

```
addi $s0,$s1,10    # $s0 ← $s1 + 10
```



Register (Direct) Addressing

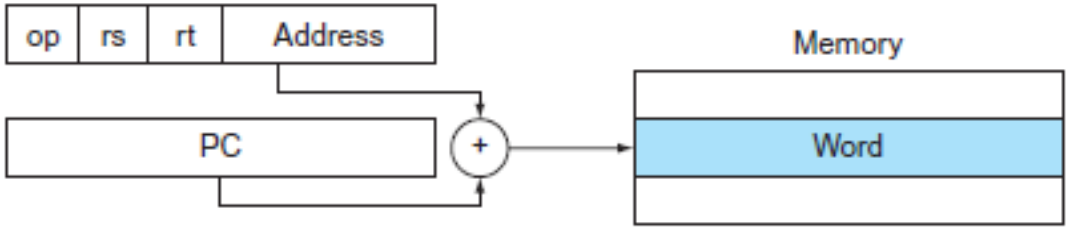
- Operand is a register
- MIPS-32 example:

```
add $s0,$s1,$s2    # $s0 ← $s1 + $s2
```

PC-Relative Addressing

- Address is sum of PC and a constant within instruction:
- MIPS-32 example:

```
bne $s1,$s2,L1   # if($s1!=$s2)
                 # goto PC+L1
```



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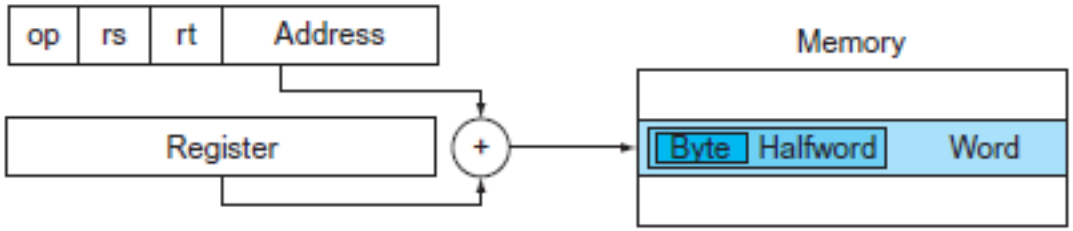
Base or Displacement Addressing

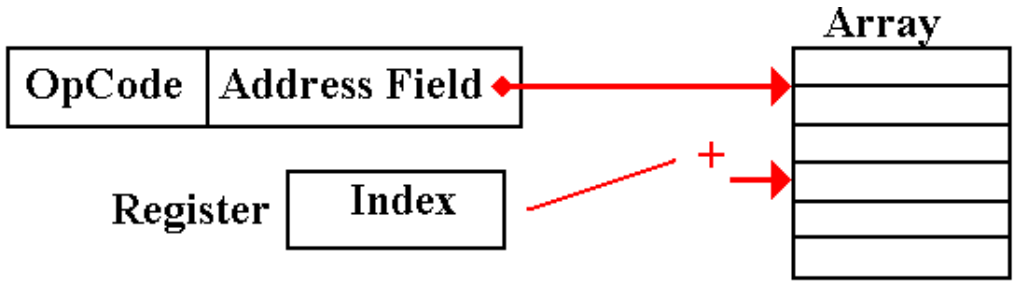
- Address of operand (in memory) is sum of a base register and a constant displacement within instruction
- MIPS-32 example:

```
lw $s1,10($sp)  # $s1 ← Mem[$sp+10]
```



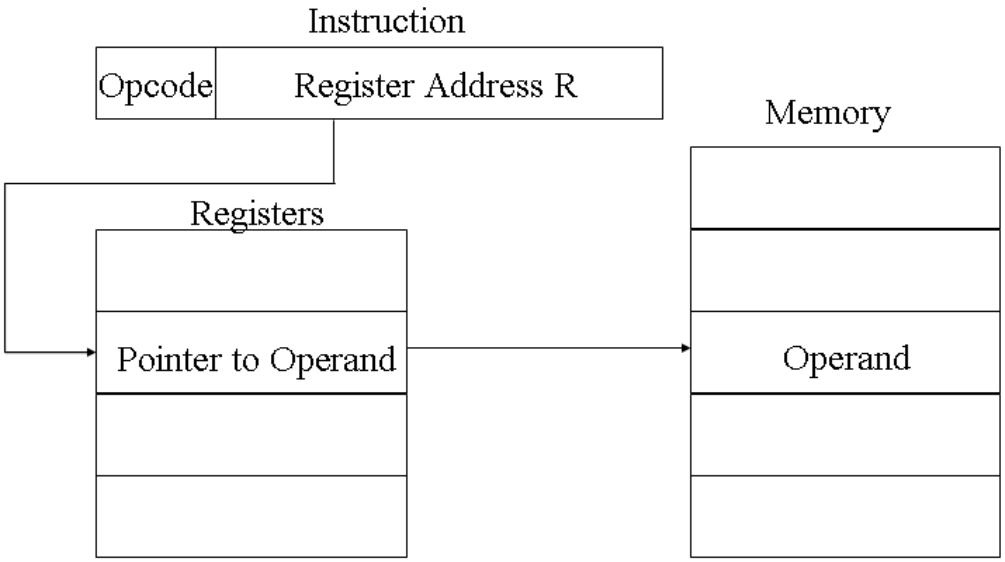
Indexed Addressing

- Address of operand (in memory) is sum of an index register and a constant within the instruction



Register Indirect Addressing

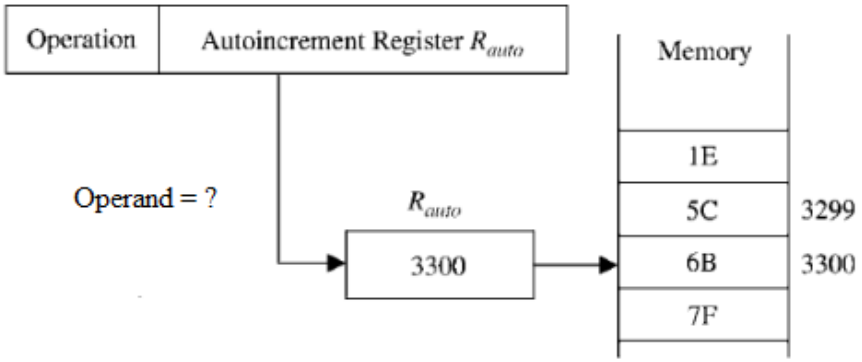
- Operand's address is in a register



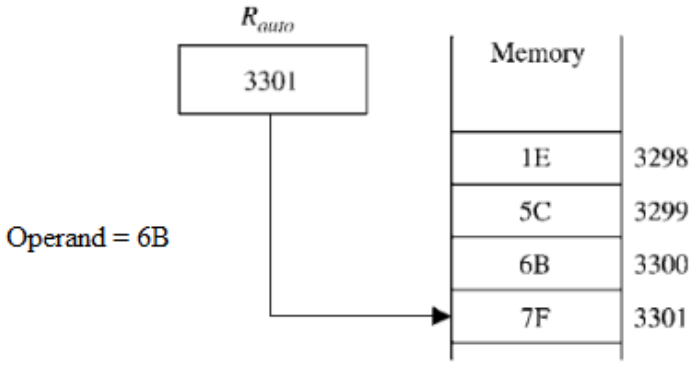
Auto-increment/Auto-decrement

- Same as Register Indirect, except that register value is incremented / decremented after / before instruction execution

Auto-increment Addressing Mode

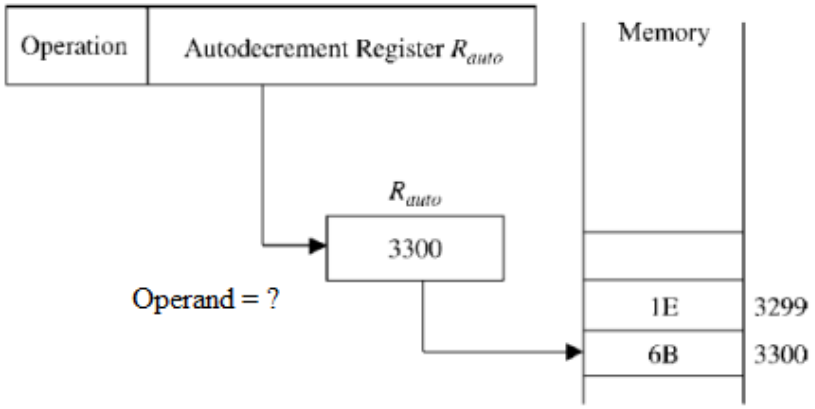


(a) Before execution

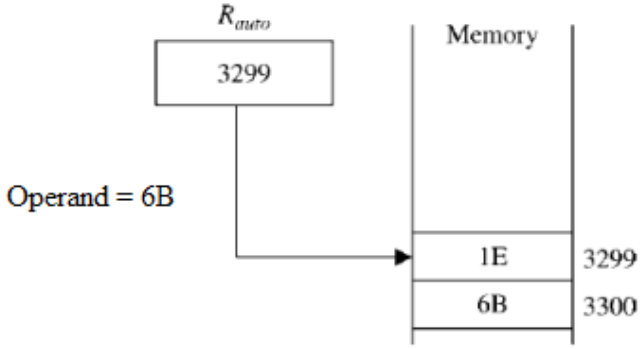


(b) After execution

Auto-decrement Addressing Mode



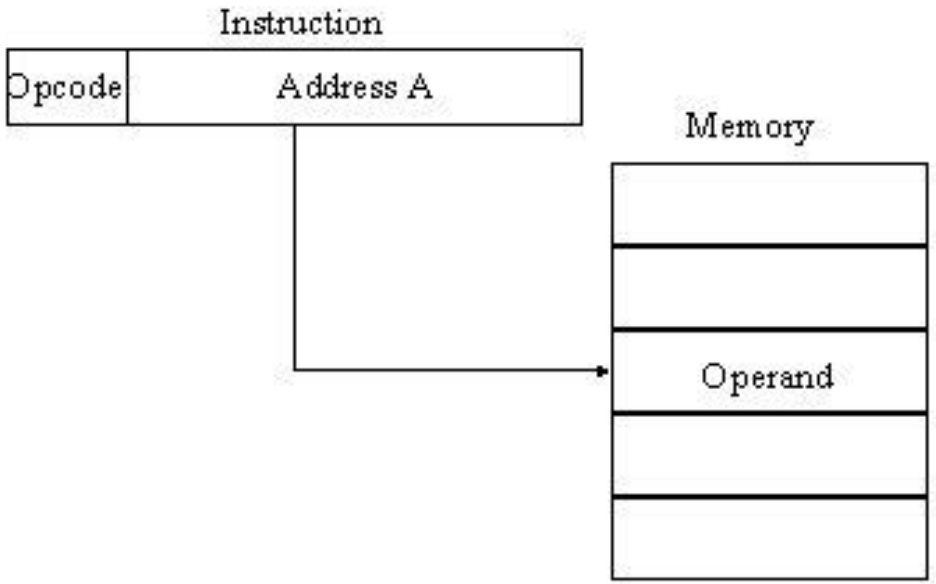
(a) Before execution



(b) After execution

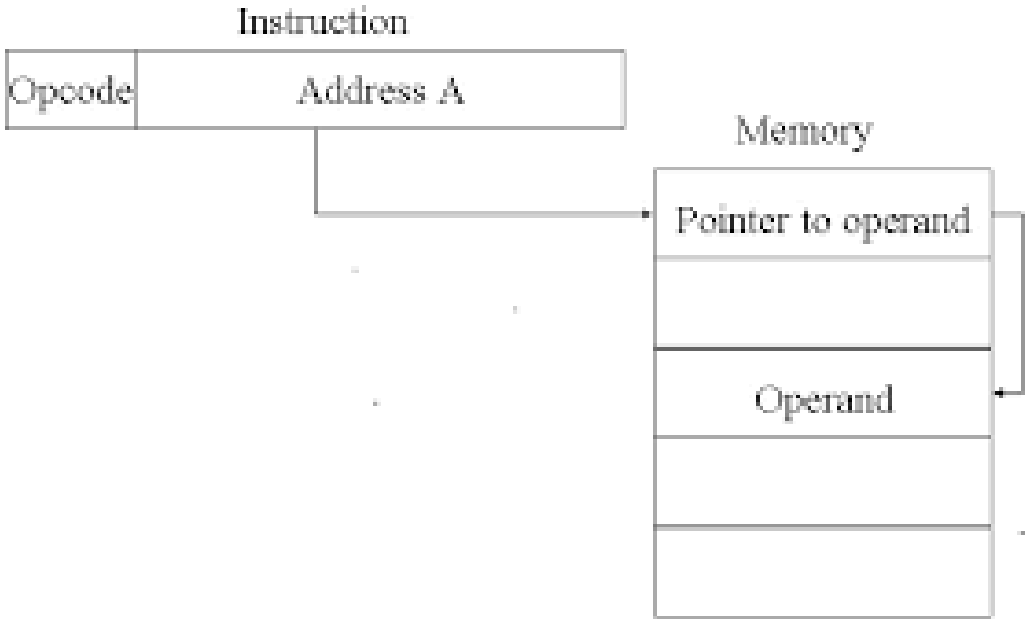
Memory Direct Addressing

- Operand is directly addressed in the instruction



Memory Indirect Addressing

- Operand's address is in a memory location addressed in the instruction



Summary

- **No address field in the instruction:**
  - *Implied Addressing*: Operand is an implied register
  - *Immediate Addressing*: Operand is a constant value named in the instruction
- **Register Addressing:**
  - *Direct*: Operand is in a register named in the instruction
  - *Indirect,autodec/inc*: Operand address is in a register named in the instruction
- **Memory Addressing:**
  - *Direct*: Operand is in the memory, its address is in the instruction
  - *Indirect*: Operand is in the memory, address of its address is in the instruction
- **Register & Memory Addressing:**
  - *Relative* Addressing: *Effective address* = (PC) + constant
  - *Base Register* Addressing: *Effective address* = (a base reg) + constant
  - *Indexed* Addressing: *Effective address* = (an index reg) + constant