Computer Architecture

Instruction Sets:
Addressing modes and formats

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(April- 2010)

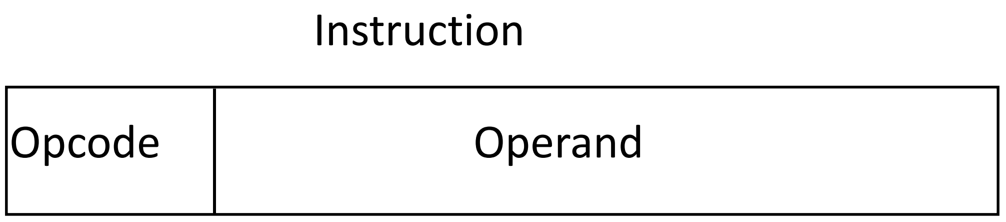
Addressing Modes

- Immediate
- Direct
- Indirect
- Register
- Register Indirect
- Displacement (Indexed)
- Stack

Immediate Addressing

- Operand is part of instruction
- Operand = address field
- e.g. ADD 5
  - Add 5 to contents of accumulator
  - 5 is operand
- No memory reference to fetch data
- Fast
- Limited range

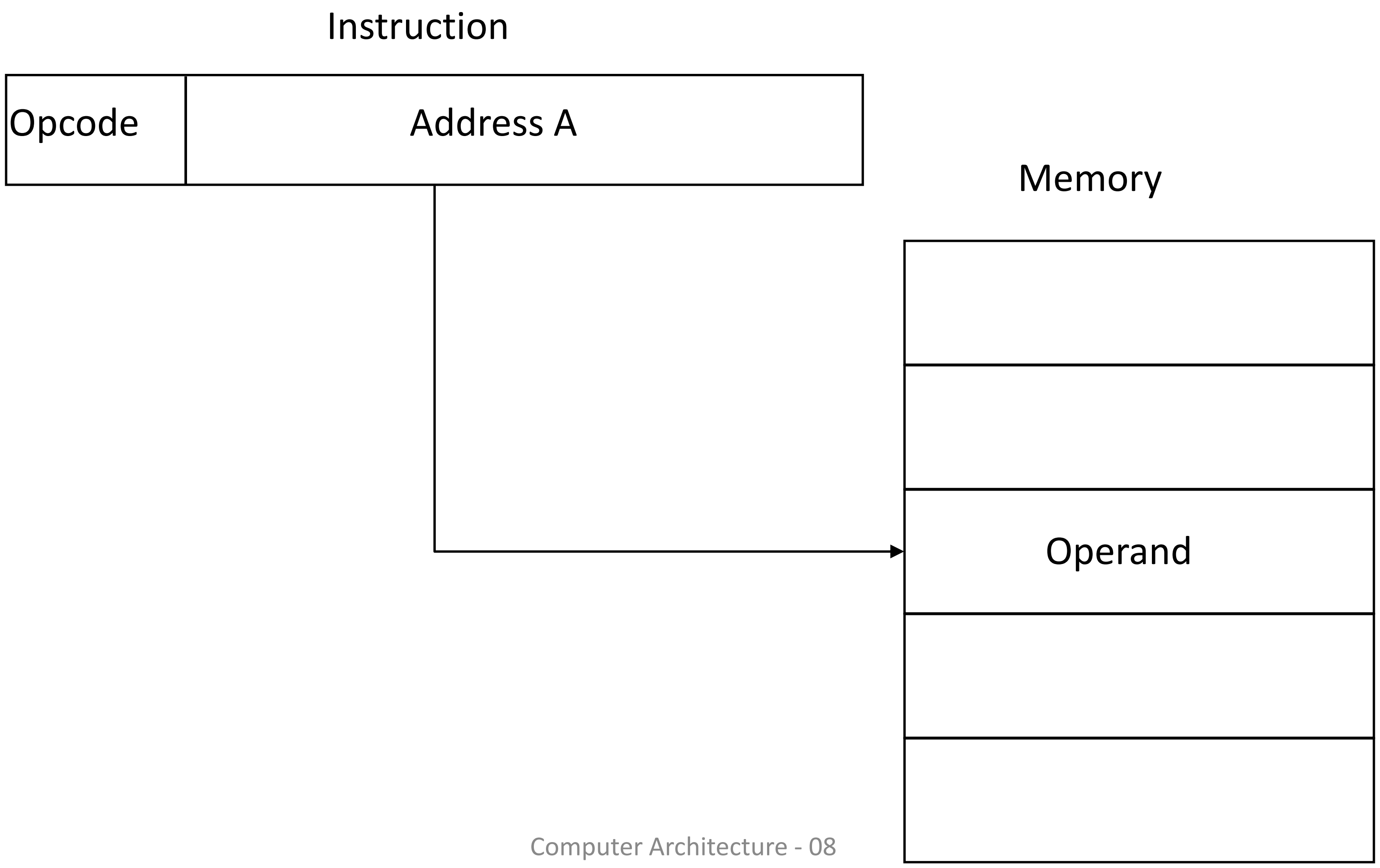
Immediate Addressing Diagram



Direct Addressing

- Address field contains address of operand
- Effective address (EA) = address field (A)
- e.g. ADD A
  - Add contents of cell A to accumulator
  - Look in memory at address A for operand
- Single memory reference to access data
- No additional calculations to work out effective address
- Limited address space

Direct Addressing Diagram



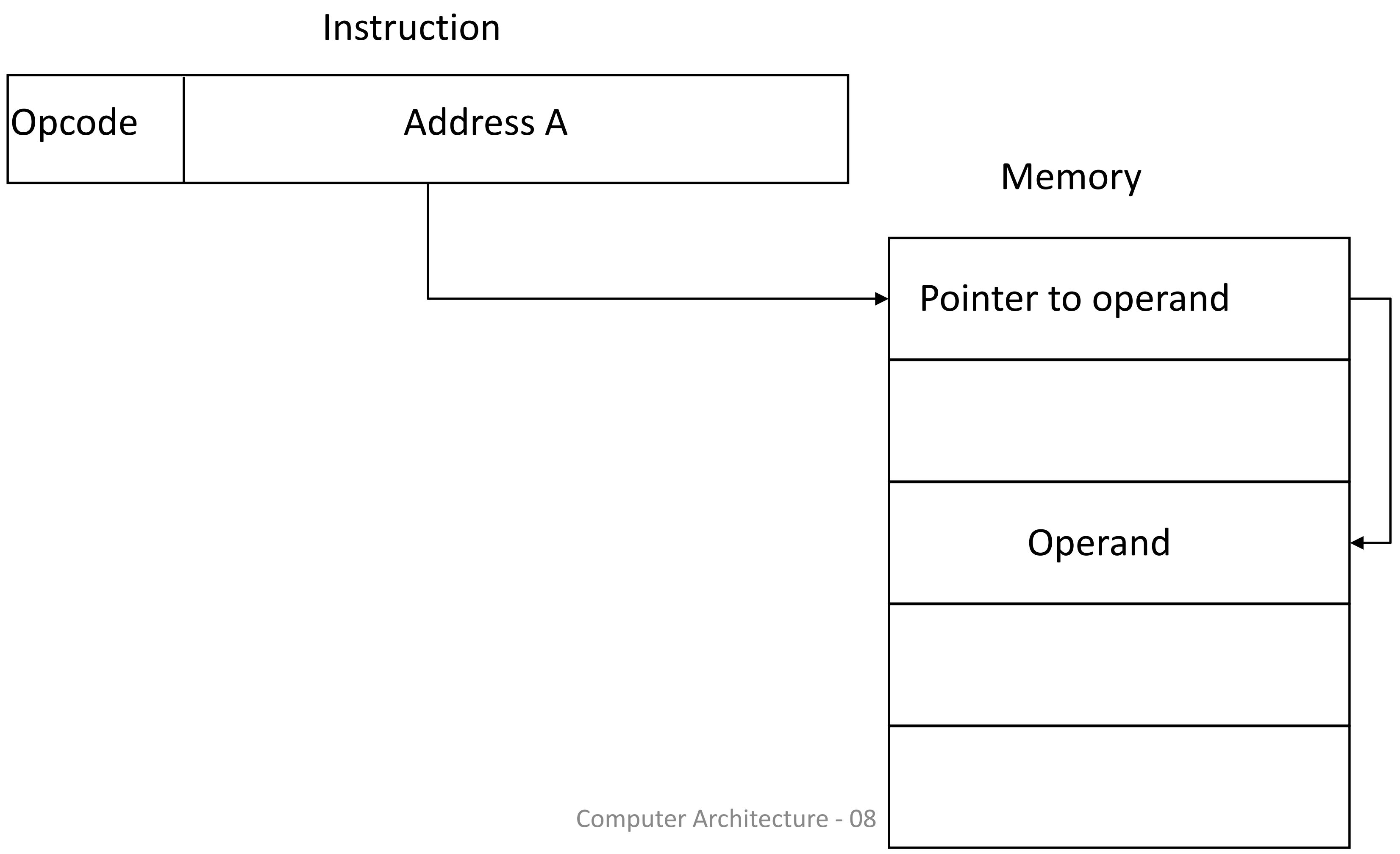
Indirect Addressing (1)

- Memory cell pointed to by address field contains the address of (pointer to) the operand
- EA = (A)
  - Look in A, find address (A) and look there for operand
- e.g. ADD (A)
  - Add contents of cell pointed to by contents of A to accumulator

Indirect Addressing (2)

- Large address space
- 2^n where n = word length
- May be nested, multilevel, cascaded
  - e.g. EA = (((A)))
    - Draw the diagram yourself
- Multiple memory accesses to find operand
- Hence slower

Indirect Addressing Diagram



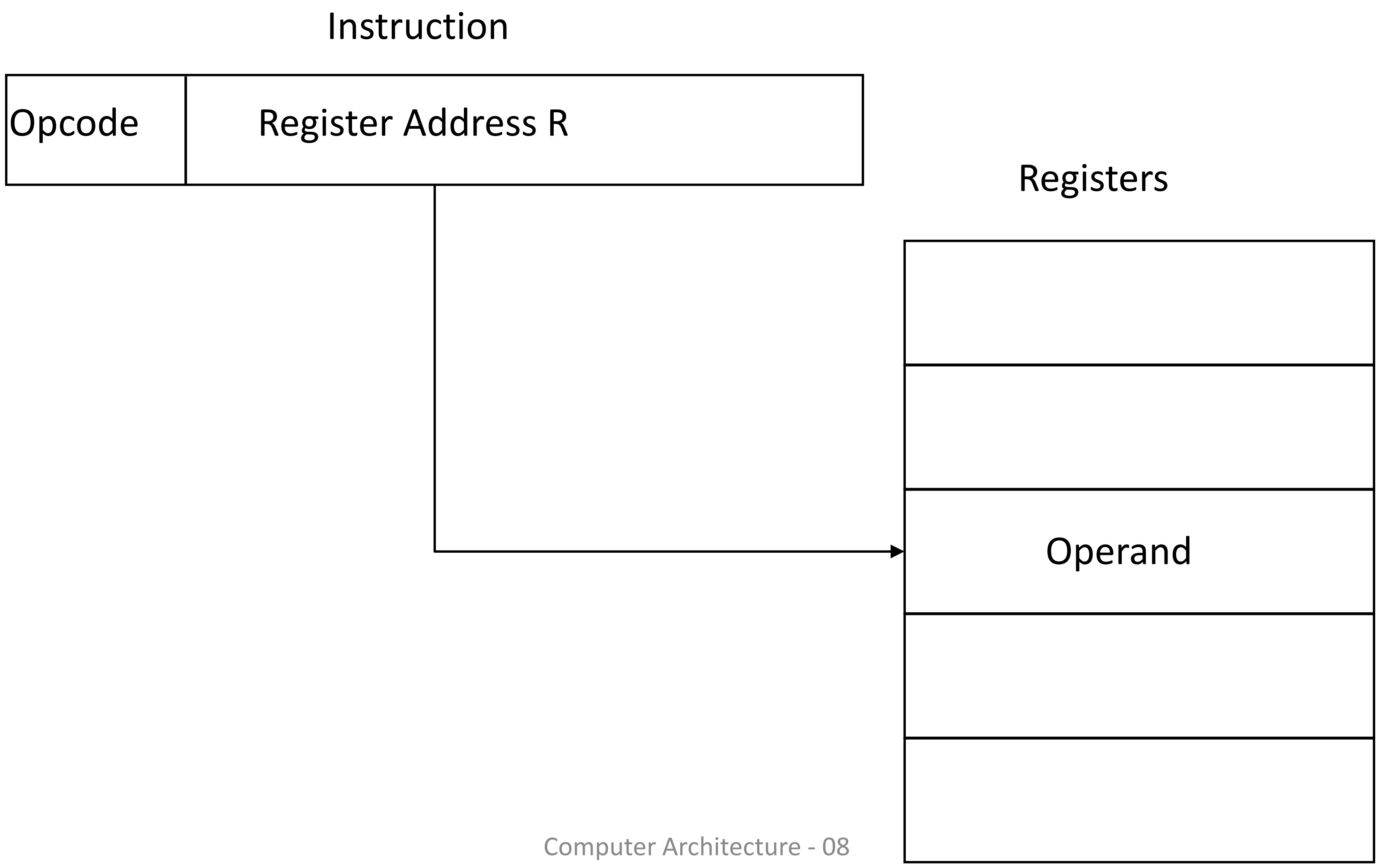
Register Addressing (1)

- Operand is held in register named in address filed
- EA = R
- Limited number of registers
- Very small address field needed
  - Shorter instructions
  - Faster instruction fetch

Register Addressing (2)

- No memory access
- Very fast execution
- Very limited address space
- Multiple registers helps performance
  - Requires good assembly programming or compiler writing
  - N.B. C programming
    - register int a;
- c.f. Direct addressing

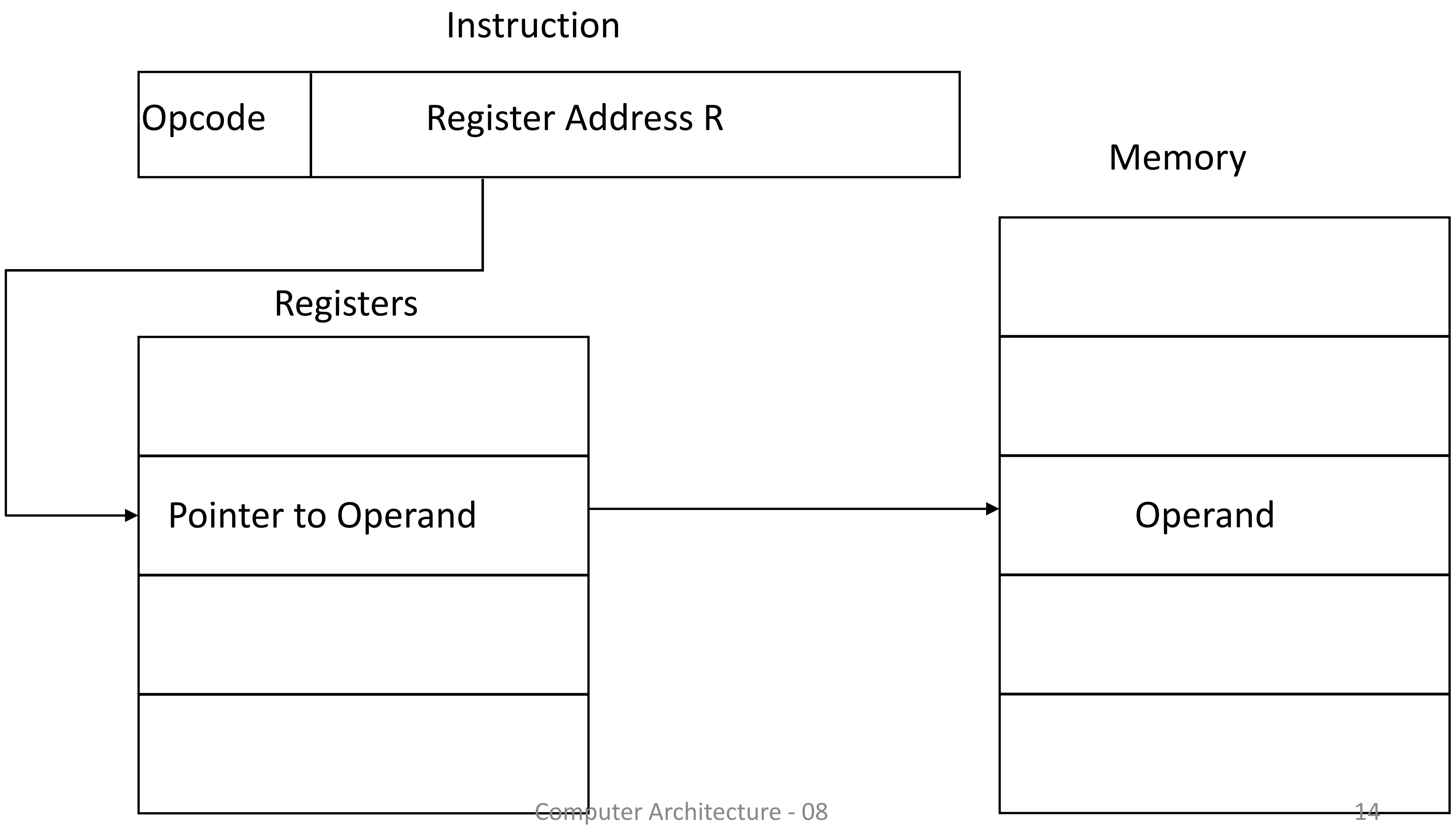
Register Addressing Diagram



Register Indirect Addressing

- C.f. indirect addressing
- EA = (R)
- Operand is in memory cell pointed to by contents of register R
- Large address space (2^n)
- One fewer memory access than indirect addressing

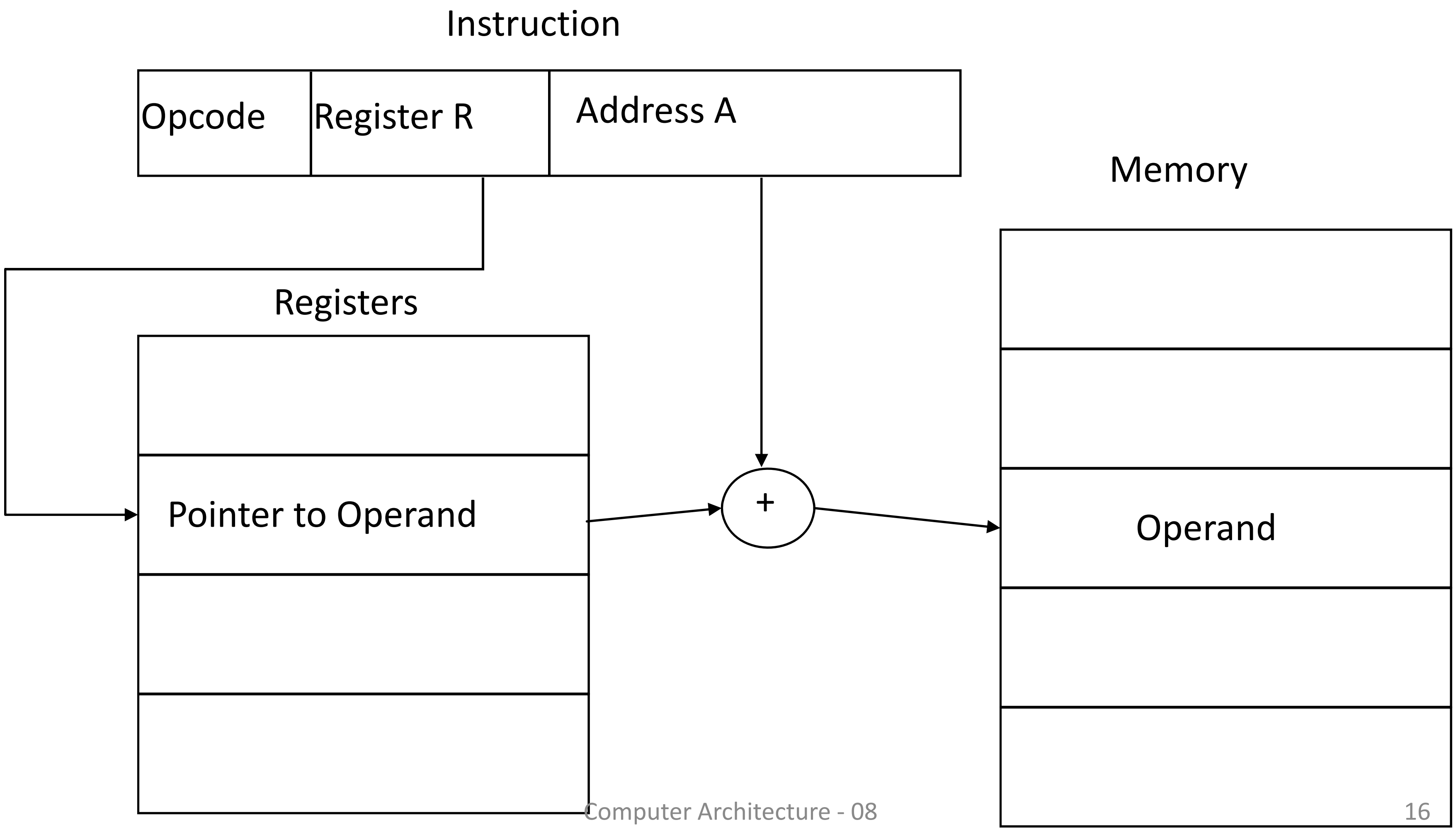
Register Indirect Addressing Diagram



Displacement Addressing

- EA = A + (R)
- Address field hold two values
  - A = base value
  - R = register that holds displacement
  - or vice versa

Displacement Addressing Diagram



Relative Addressing

- A version of displacement addressing
- R = Program counter, PC
- EA = A + (PC)
- i.e. get operand from A cells from current location pointed to by PC
- c.f locality of reference & cache usage

Base-Register Addressing

- A holds displacement
- R holds pointer to base address
- R may be explicit or implicit
- e.g. segment registers in 80x86

Indexed Addressing

- A = base
- R = displacement
- EA = A + R
- Good for accessing arrays
  - EA = A + R
  - R++

Combinations

- Postindex
- EA = (A) + (R)

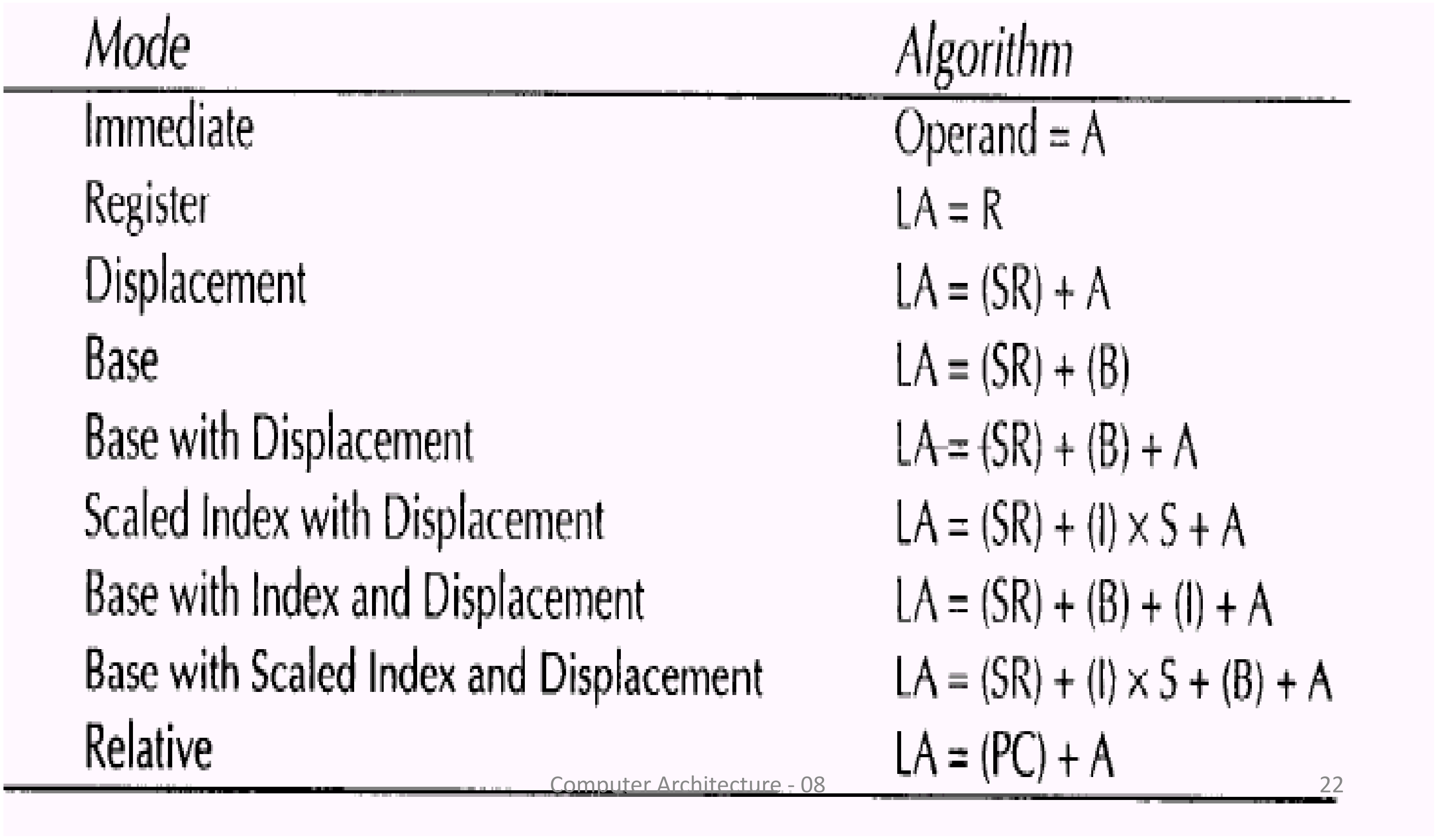
- Preindex
- EA = (A+(R))

- (Draw the diagrams)

Stack Addressing //

- Operand is (implicitly) on top of stack
- e.g.
  - ADD Pop top two items from stack and add

Pentium Addressing Modes



Mode	*Algorithm*
Immediate	Operand = A
Register	LA = R
Displacement	LA = (SR) + A
Base	LA = (SR) + (B)
Base with Displacement	LA = (SR) + (B) + A
Scaled Index with Displacement	LA = (SR) + (I) × S + A
Base with Index and Displacement	LA = (SR) + (B) + (I) + A
Base with Scaled Index and Displacement	LA = (SR) + (I) × S + (B) + A
Relative	LA = (PC) + A

Questions

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