CSE 112: Computer Organization (Section A)

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Lecture 4

Architecture vs. Organization

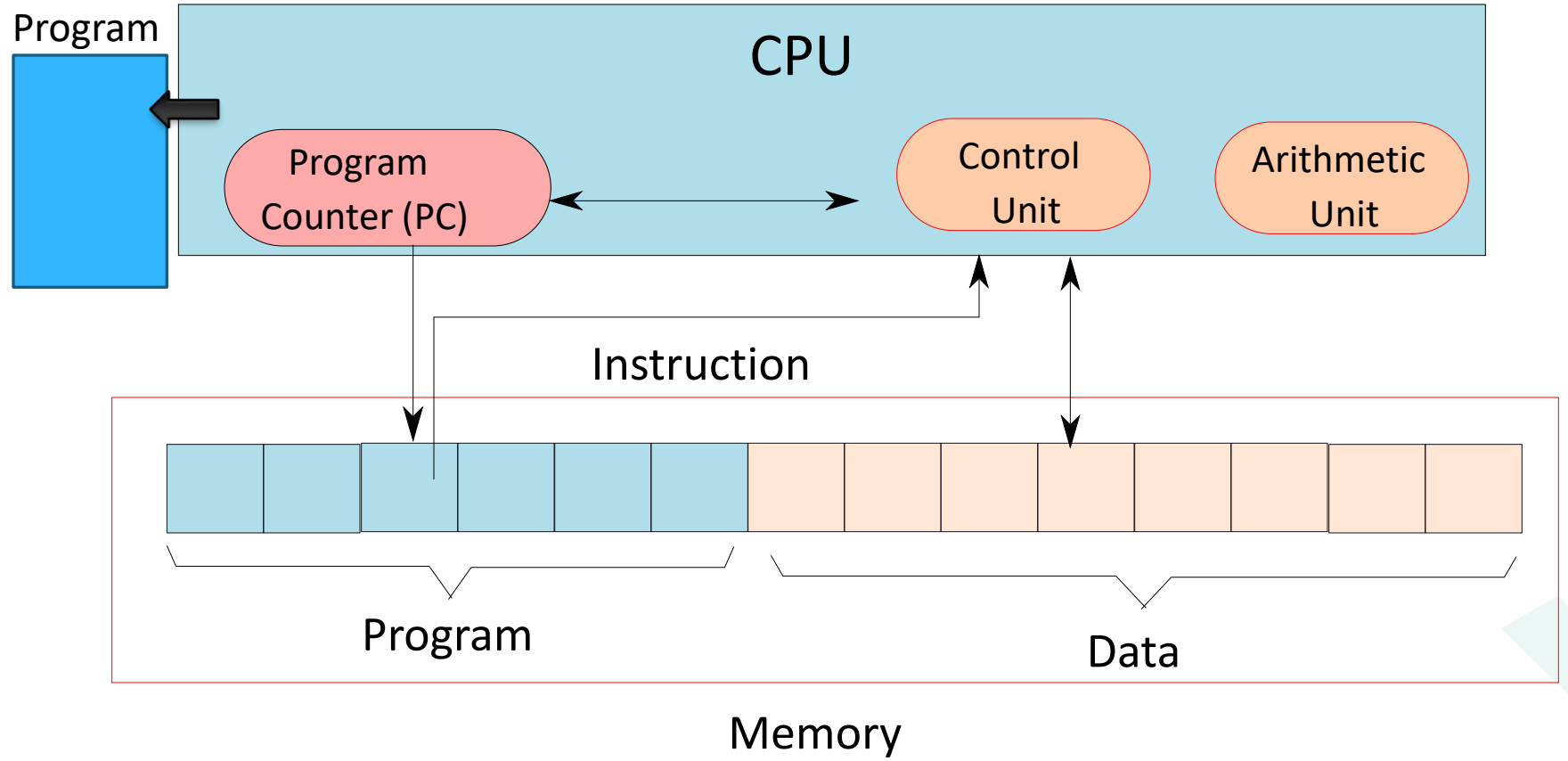
"Architecture"/ Instruction Set Architecture:

- Programmer visible state (Memory & Register)
- Operations (Instructions and how they work)
- Execution Semantics (interrupts)
- Input/Output
- Data Types/Sizes

Microarchitecture/ Organization:

- Tradeoffs on how to implement ISA for some metric (Speed, Energy, Cost)
- Examples: Pipeline depth, number of pipelines, cache size, silicon area, peak power, execution ordering, bus widths, ALU widths

Elements of a Computer



Elements of a Computer

- Memory (array of bytes) contains
  - The program, which is a sequence of instructions
  - The program data → variables, and constants
- The program counter(PC) points to an instruction in a program
  - After executing an instruction, it points to the next instruction by default
  - A branch instruction makes the PC point to another instruction (not in sequence)
- CPU (Central Processing Unit) contains the
  - Program counter, instruction execution units

Let us now design an ISA …

- Single Instruction ISA
  - sbn – subtract and branch if negative
- Add (a + b) (assume temp = 0)

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1: sbn temp, b, 2
2: sbn a, temp, exit
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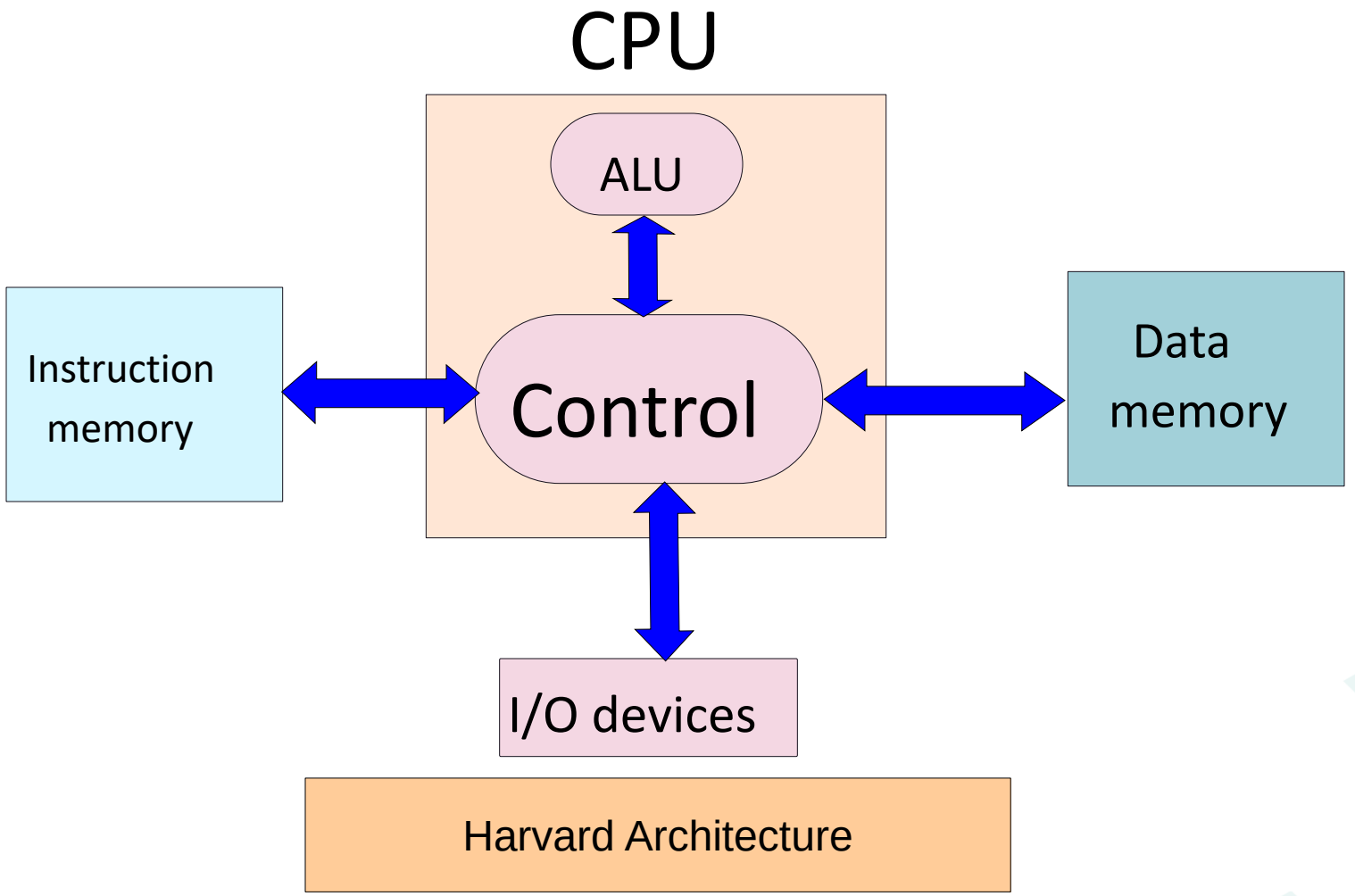
Multiple Instruction ISA

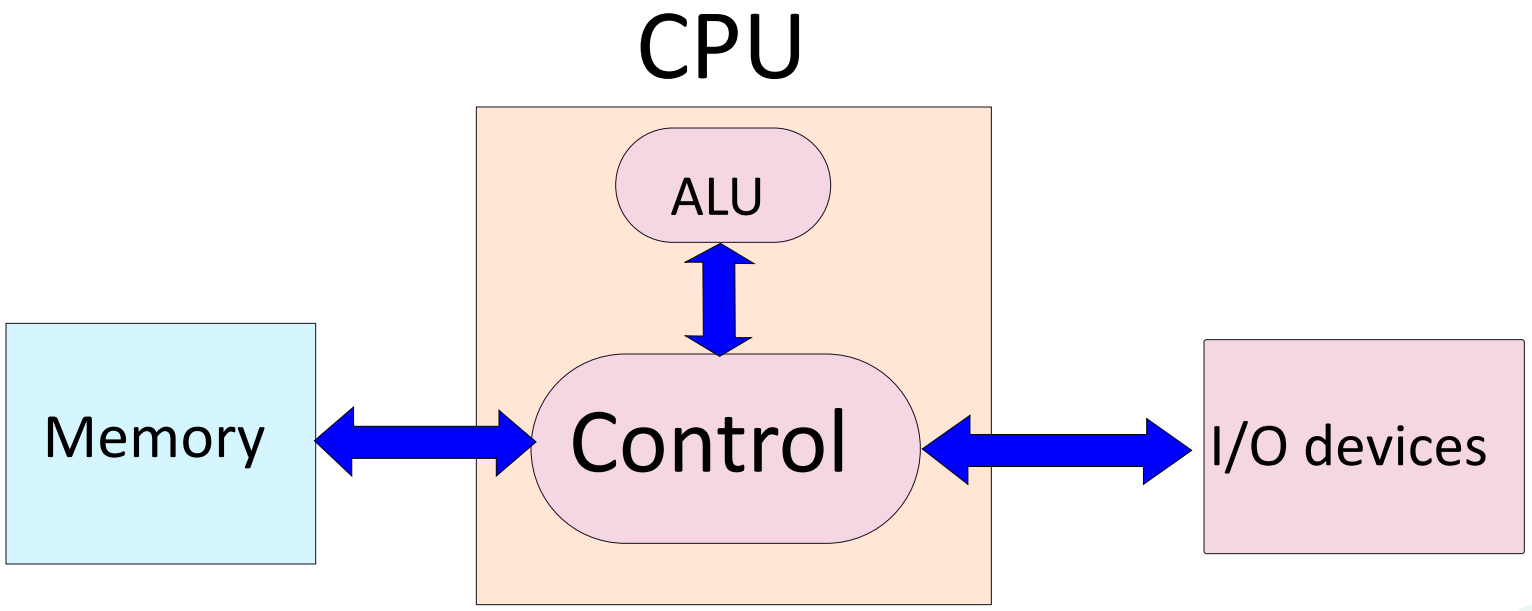
- Arithmetic Instructions
  - add, subtract, multiply, divide
- Logical Instructions
  - or, and, not
- Move instructions
  - Transfer values between memory locations
- Branch instructions
  - Move to a new program location, based on the values of some memory locations

Class Interaction # 4

Designing Practical Machines



Von-Neumann Architecture



Problems with Harvard/ Von-Neumann Architectures

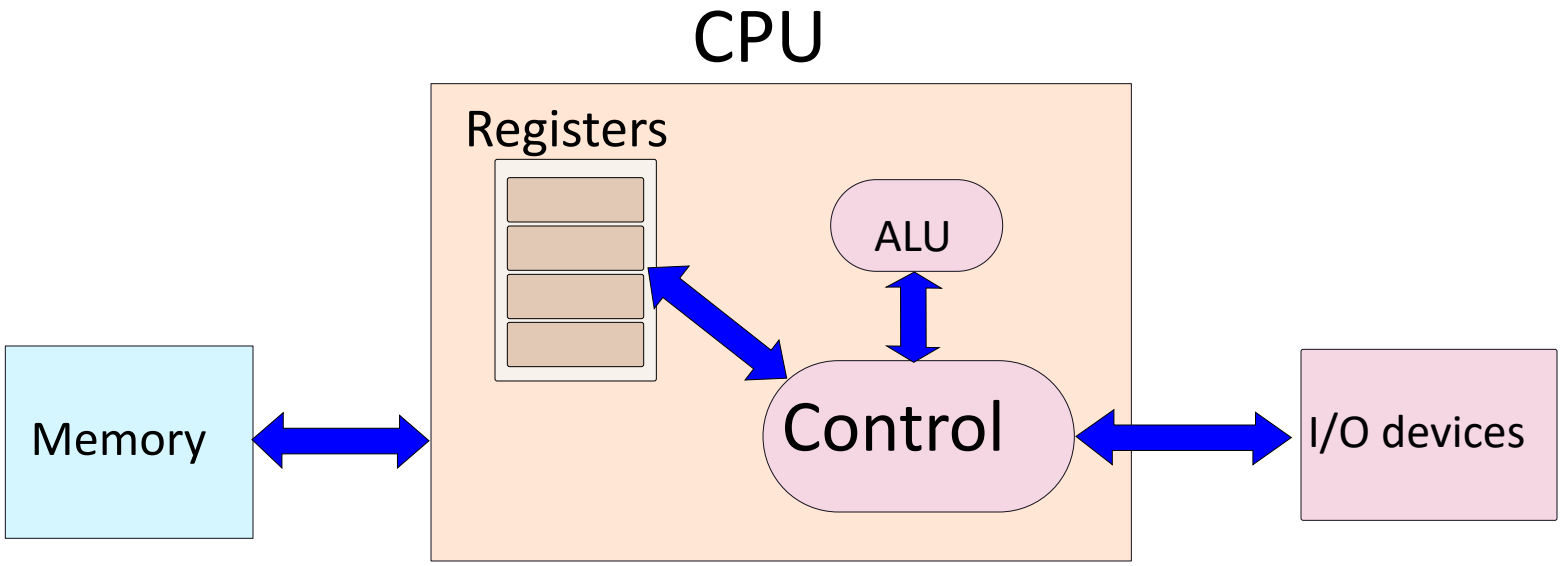
- The memory is assumed to be one large array of bytes
  - It is very very slow

General Rule: Larger is a structure, slower it is

- Solution:
  - Have a small array of named locations **(registers)** that can be used by instructions
  - This small array is very fast

Insight: Accesses exhibit locality (tend to use the same variables frequently in the same window of time)

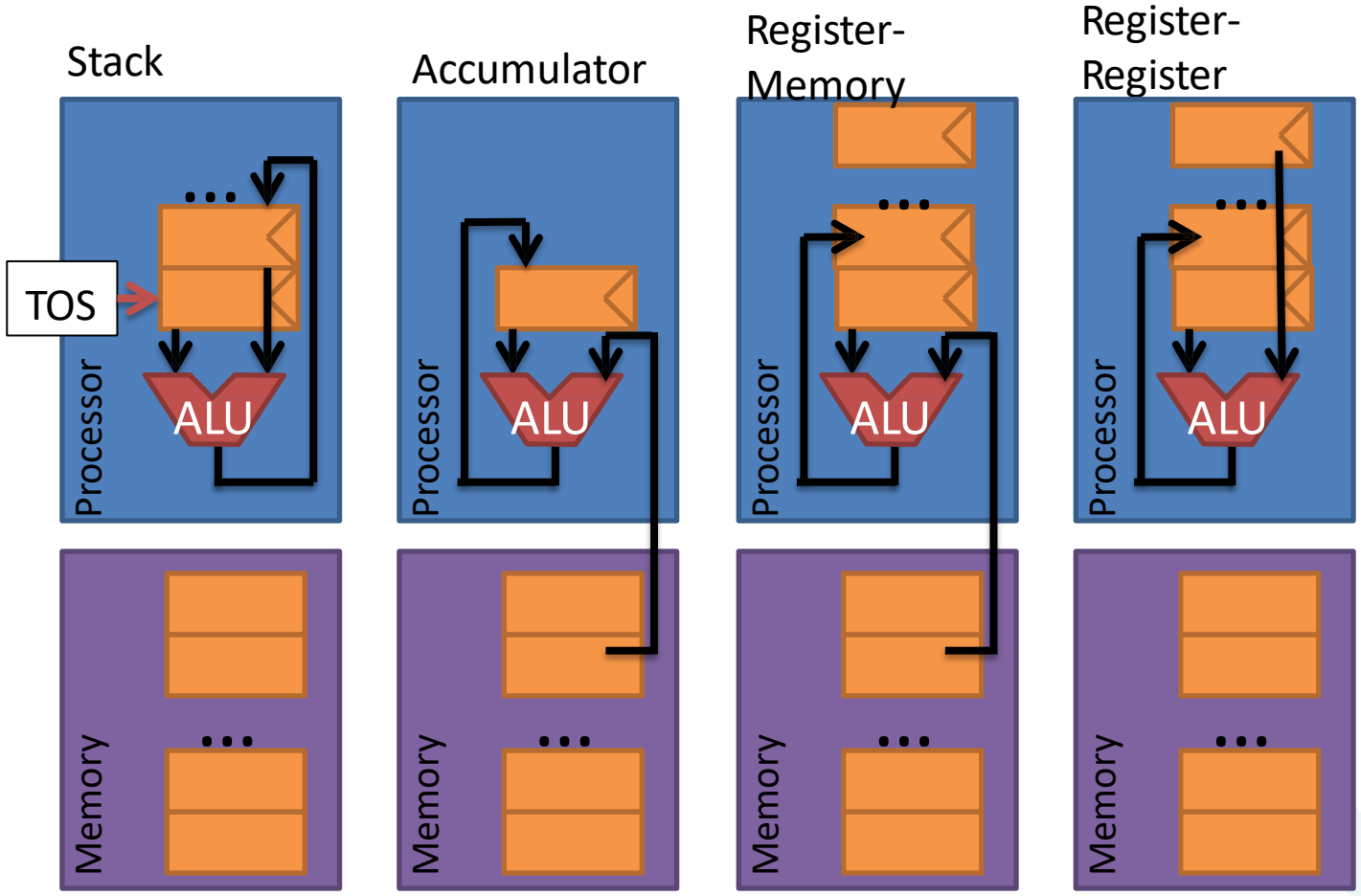
Machine with Registers



Uses of Registers

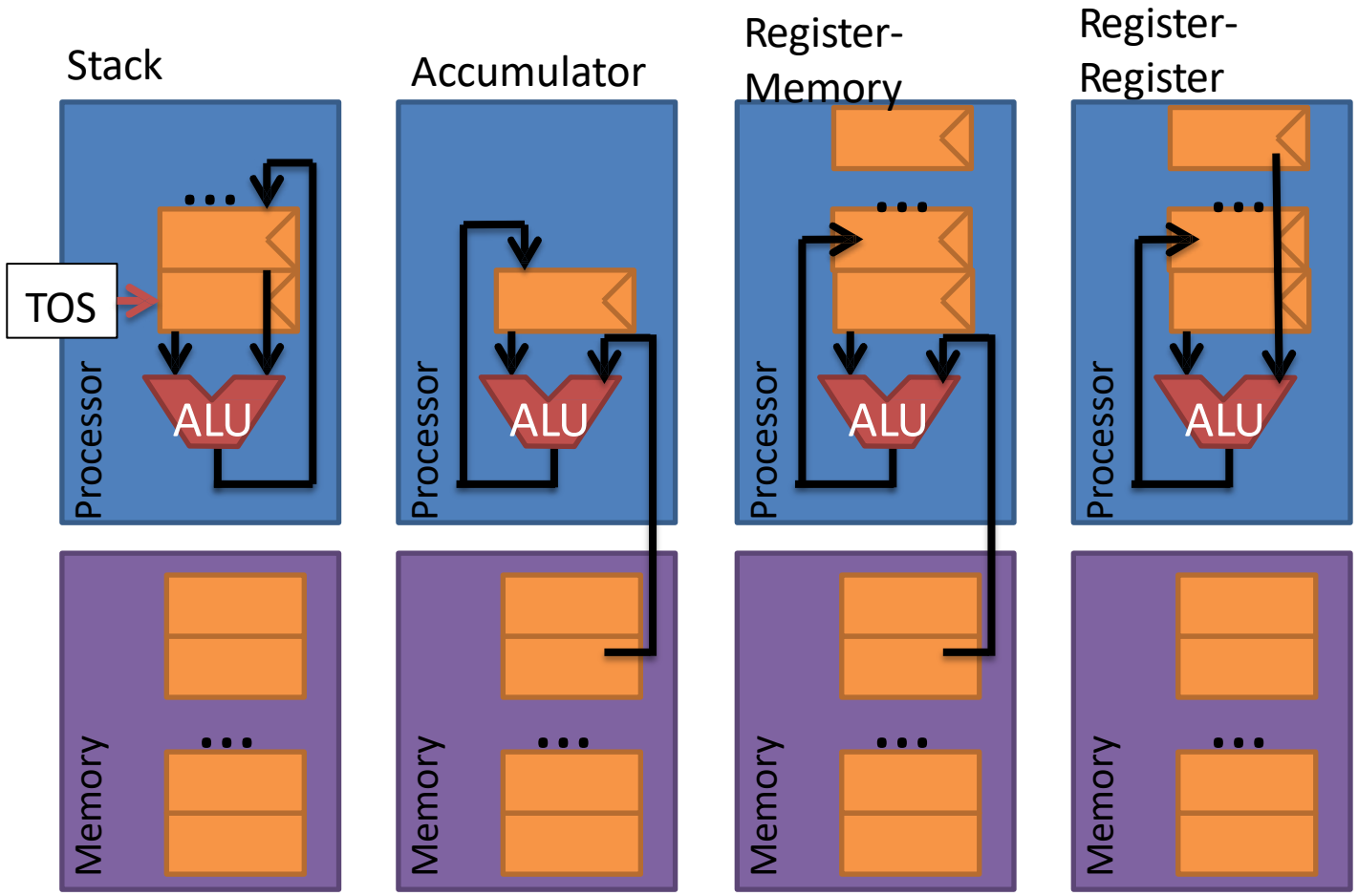
- A CPU (Processor) contains set of registers (16-64)
- These are named storage locations.
- Typically values are loaded from memory to registers.
- Arithmetic/logical instructions use registers as input operands
- Finally, data is stored back into their memory locations.

Where Do Operands Come from And Where Do Results Go?



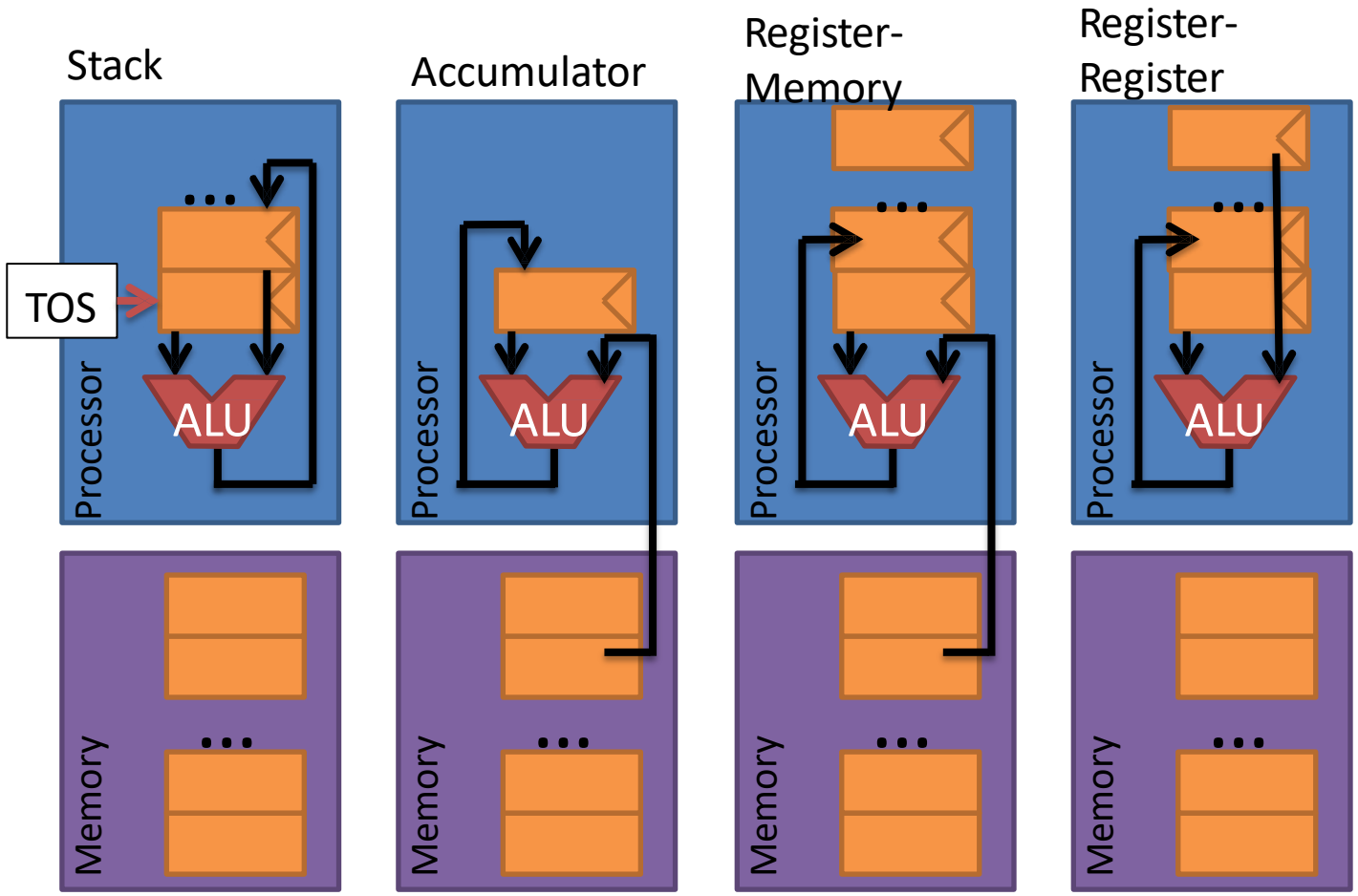
Number Explicitly Named Operands:	0	1	2 or 3	2 or 3

Machine Model Summary



Machine Model Summary

C = A + B



Machine Model Summary

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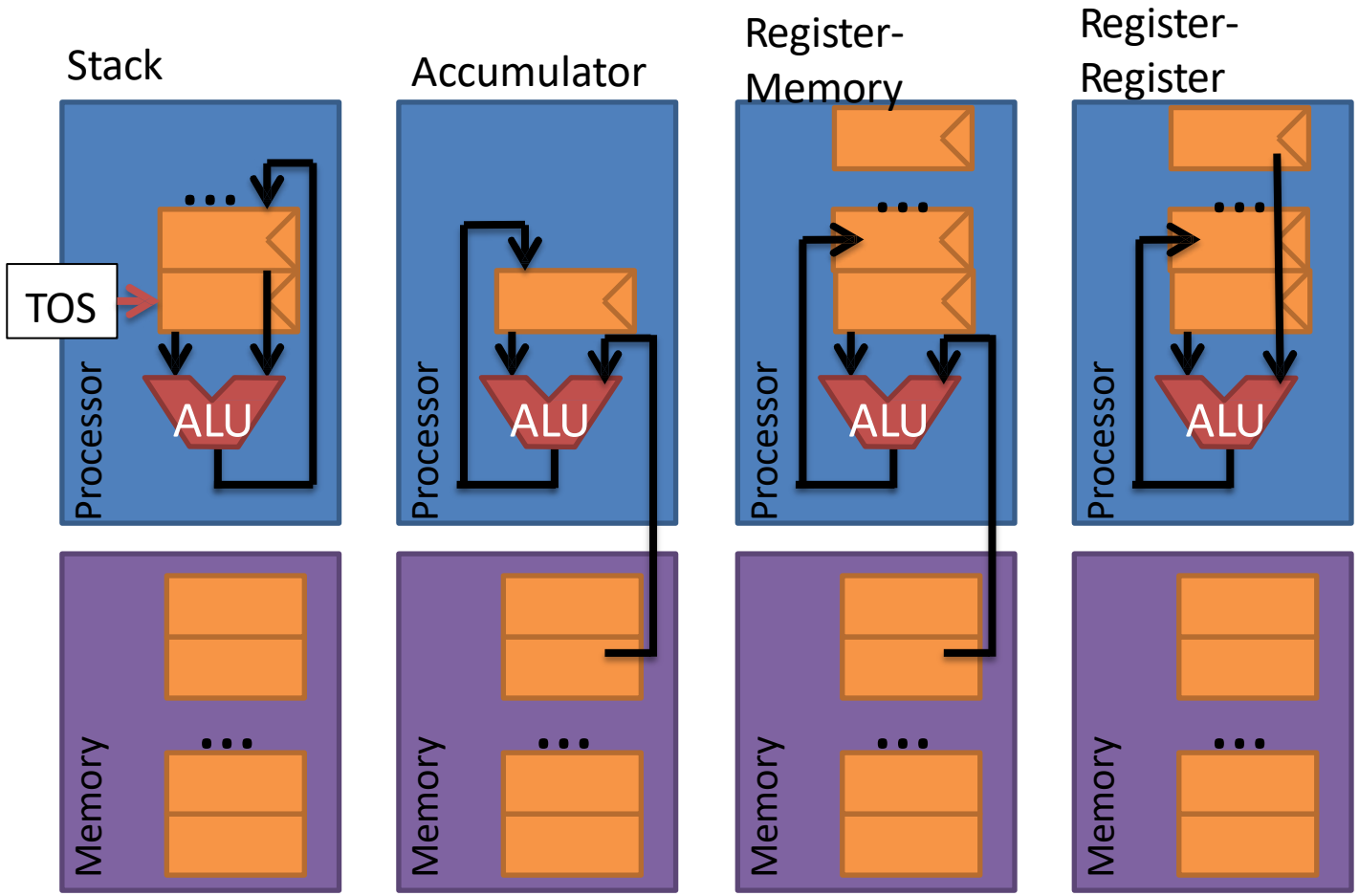

Class Interaction #5