

Problem of the Day

Design a circuit with these 2 inputs and 4 outputs

A_1	A_0	X_3	X_2	X_1	X_0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

Computer Architecture

The basics

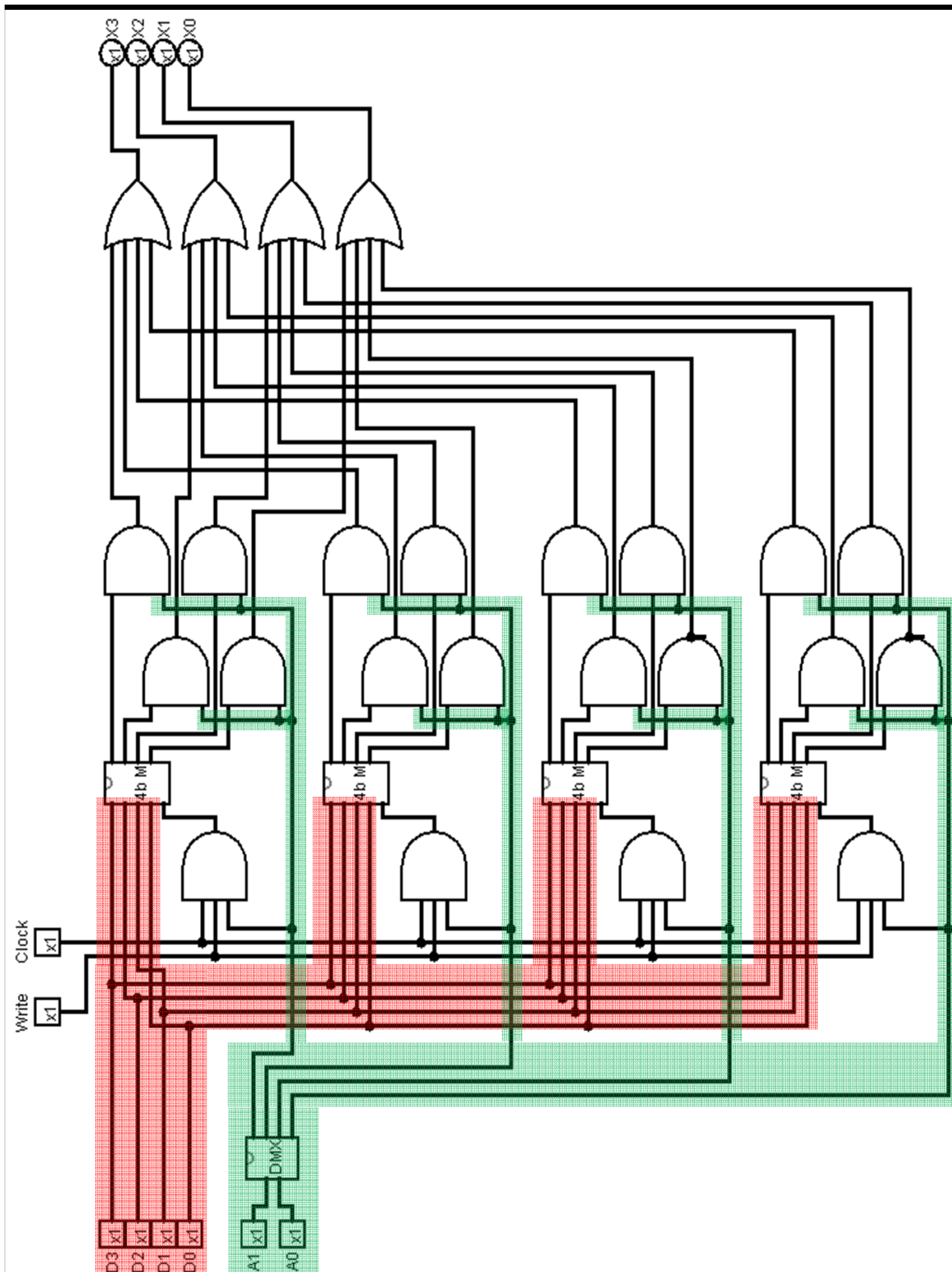


Memory

Memory is a collection of cells, each with a unique physical address

Address	Contents
00000000	11100011
00000001	10101001
:	:
.	.
11111100	00000000
11111101	11111111
11111110	10101010
11111111	00110011







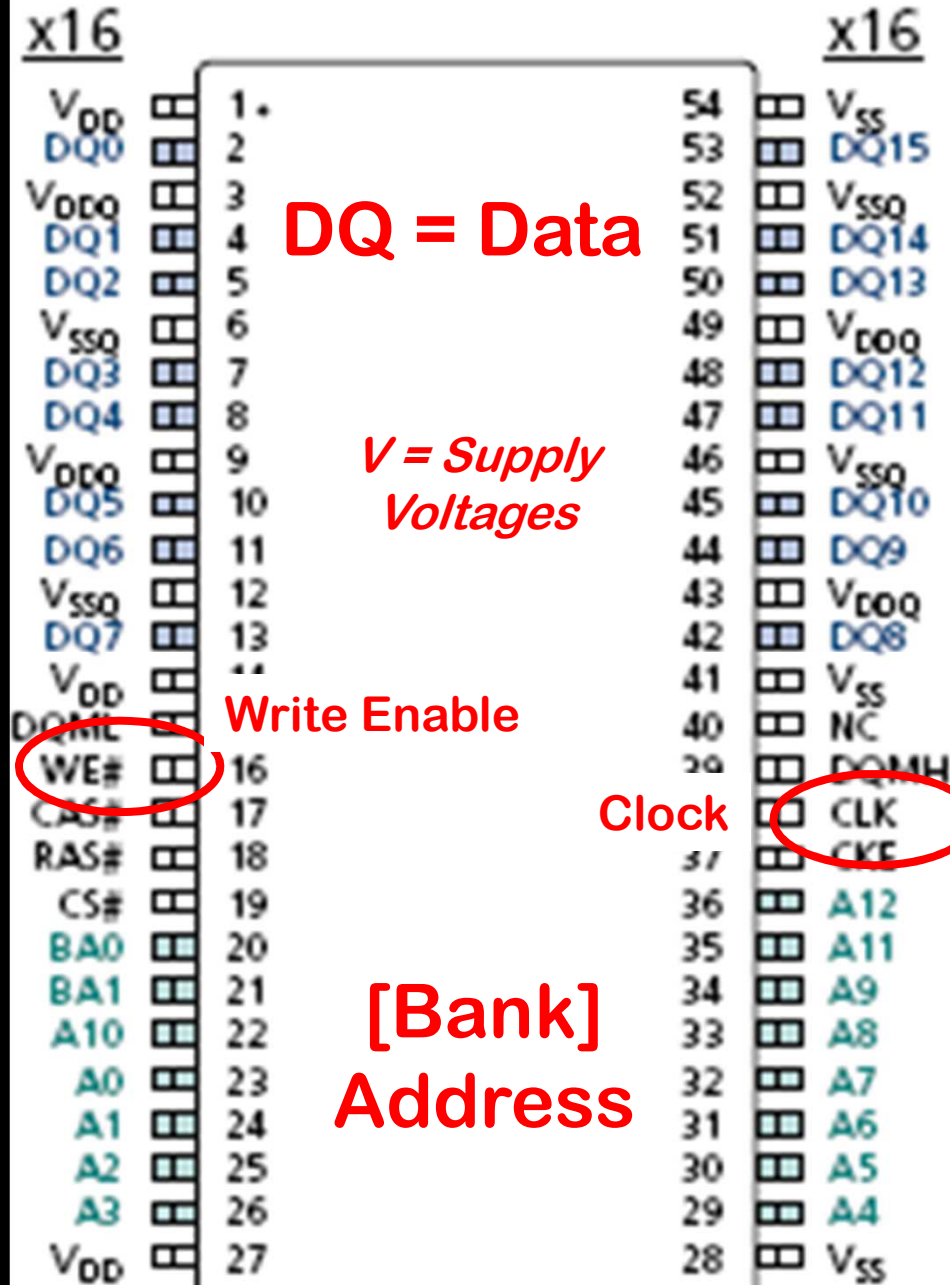
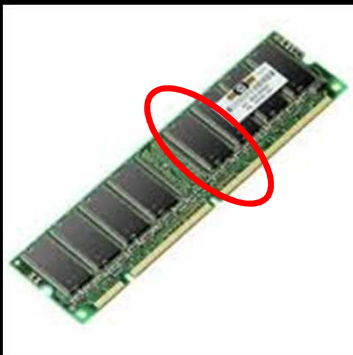
SDR SDRAM

MT48LC128M4A2 – 32 Meg x 4 x 4 banks

MT48LC64M8A2 – 16 Meg x 8 x 4 banks

MT48LC32M16A2 – 8 Meg x 16 x 4 banks

DQ0-15 16 bits
BA0-1 4 banks
A0-A12 $2^{13} = 8K$
+A0-A9 $2^{10} = 1K$



Types of Memory

- RAM - **Random Access Memory**
 - Write and read every location
 - Lose everything when power goes off
 - DRAM (Dynamic) has to "refresh" periodically
 - SRAM (Static) doesn't, but more expensive



Types of Memory

- RAM - **Random Access Memory**
- ROM - **Read Only Memory**
 - Permanent – can't be changed



Types of Memory

- RAM - **Random Access Memory**
- ROM - **Read Only Memory**
- FLASH –
 - Latest version of "Programmable ROM"
 - Erase big blocks, write bits
 - "Wears out" (100K – 1M cycles)



The Insight

The memory that stores **DATA** can also store **INSTRUCTIONS** that describe how to process the data!



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Stored Program Computer



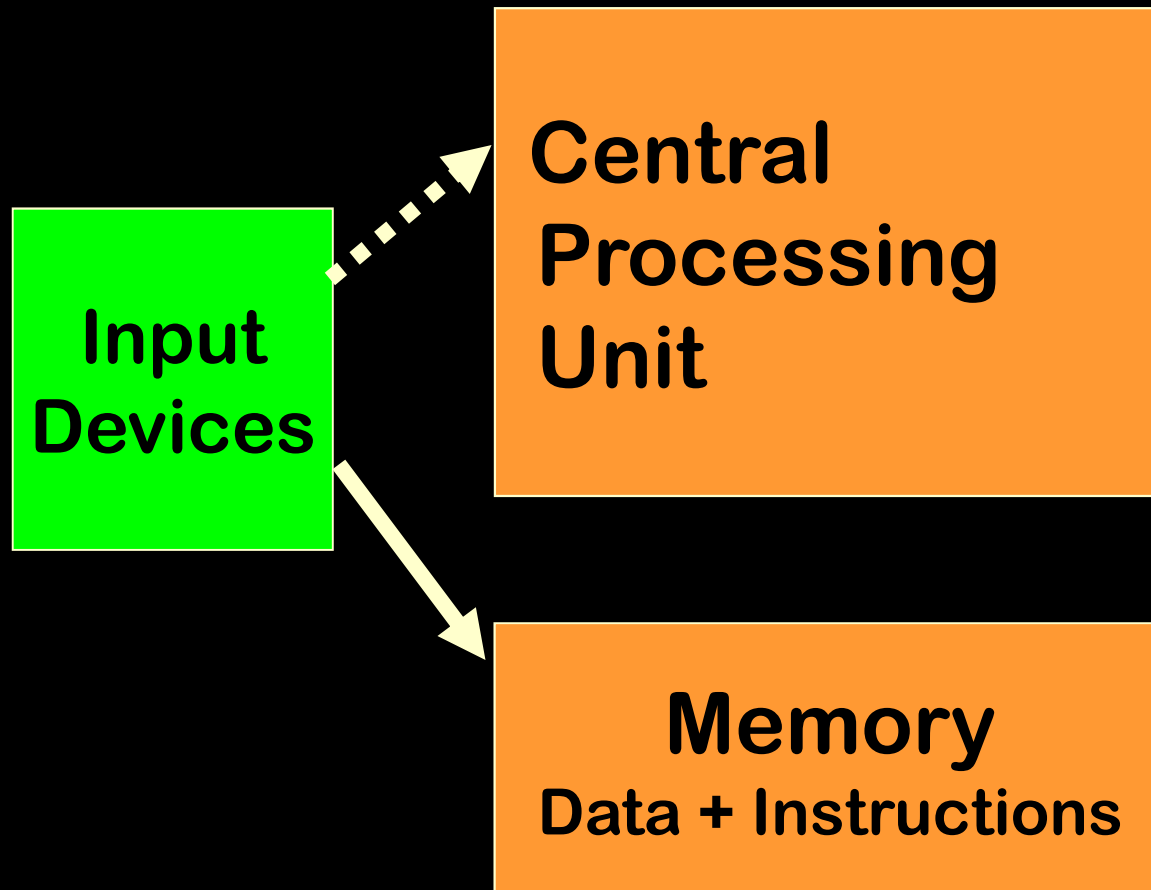
von Neumann Architecture

**Central
Processing
Unit**

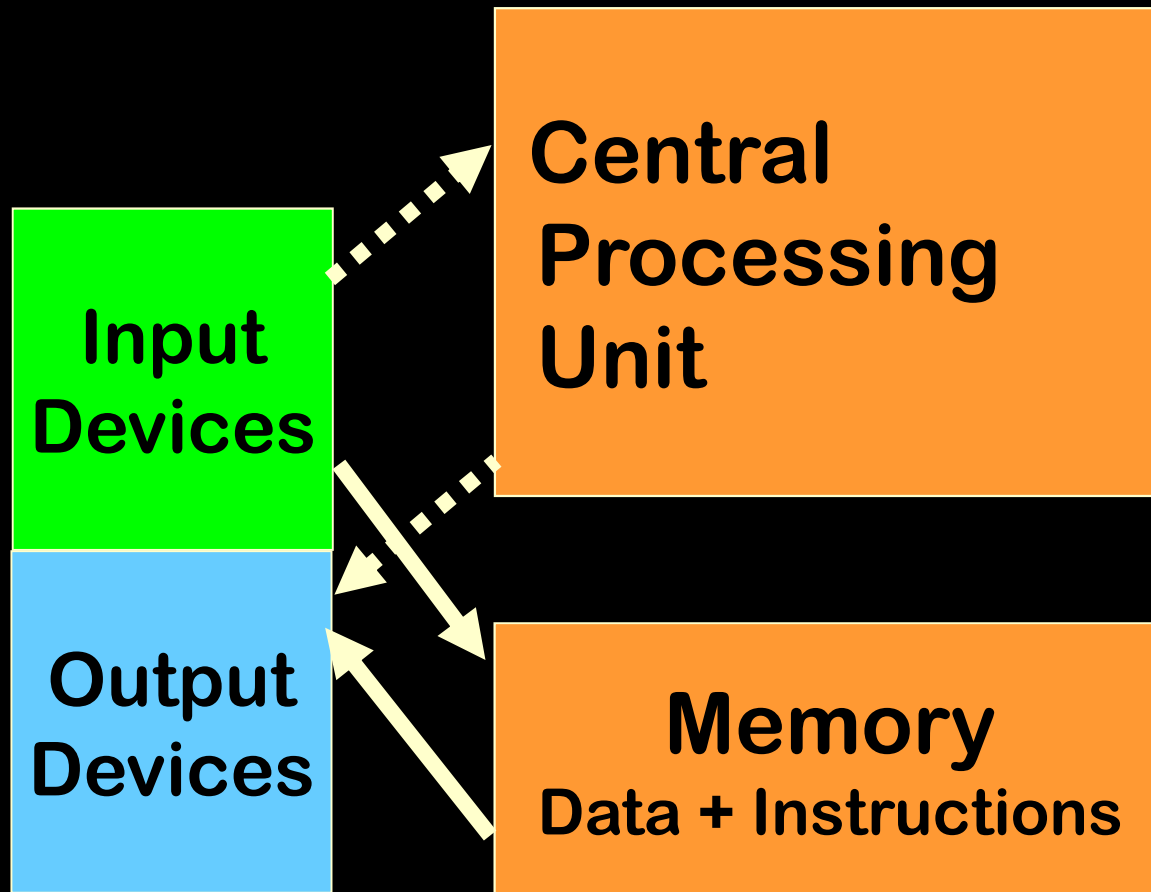
**Memory
Data + Instructions**



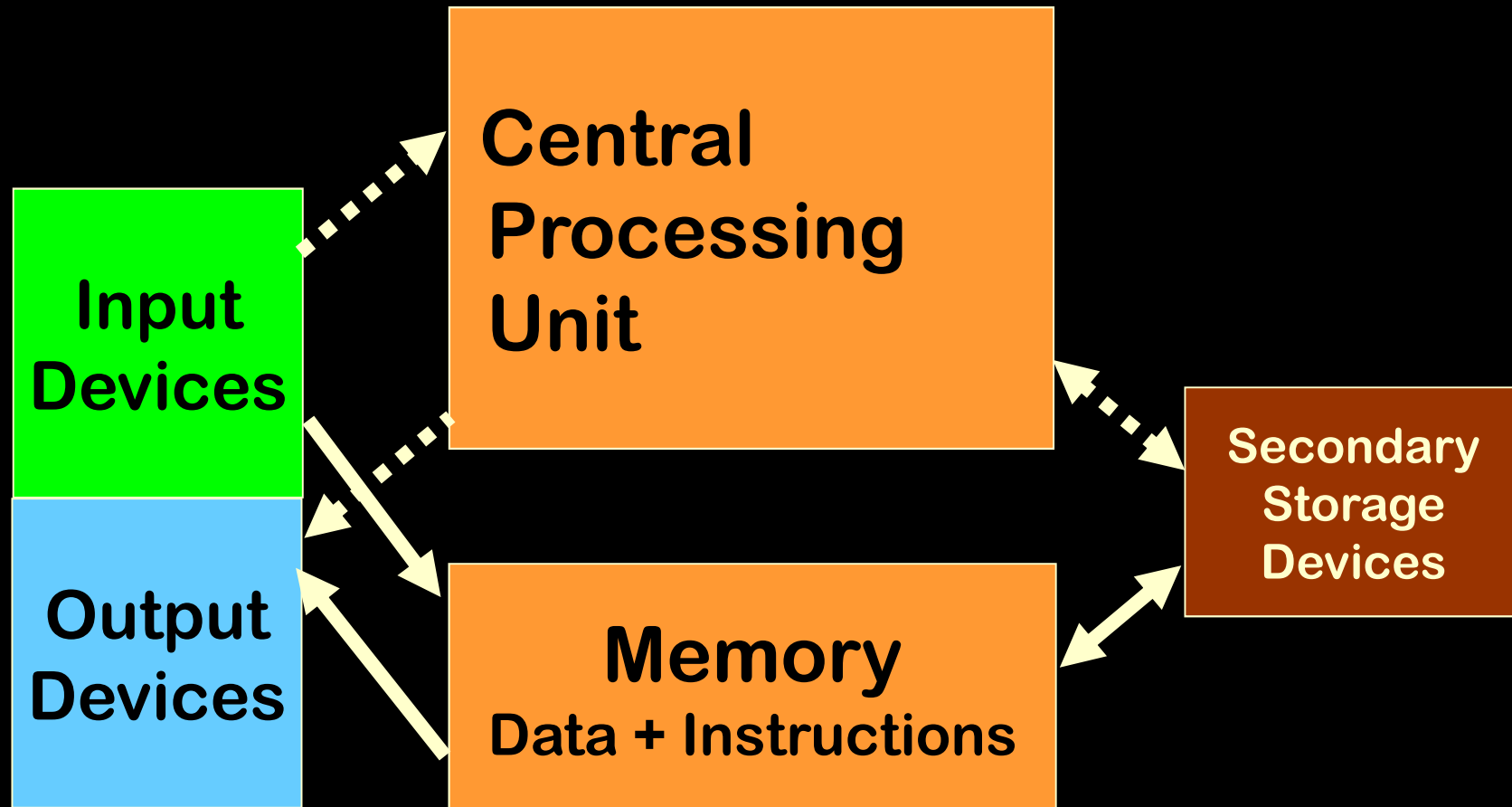
von Neumann Architecture



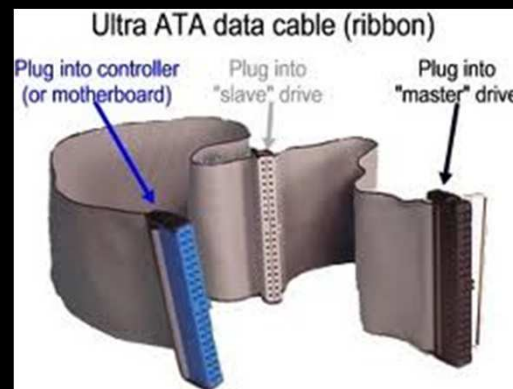
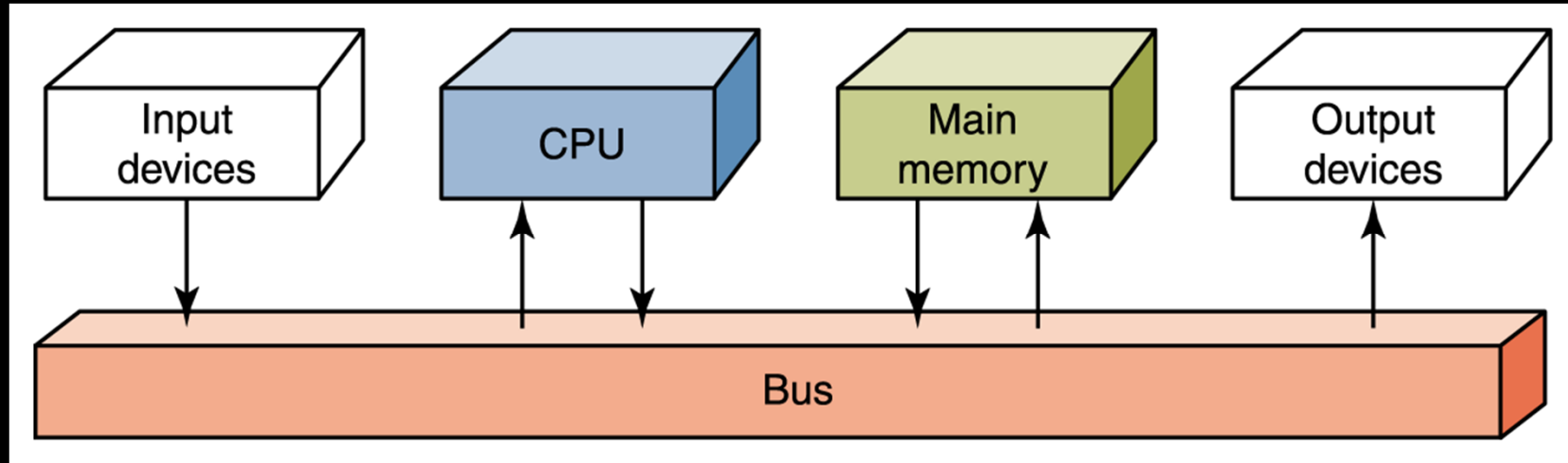
von Neumann Architecture



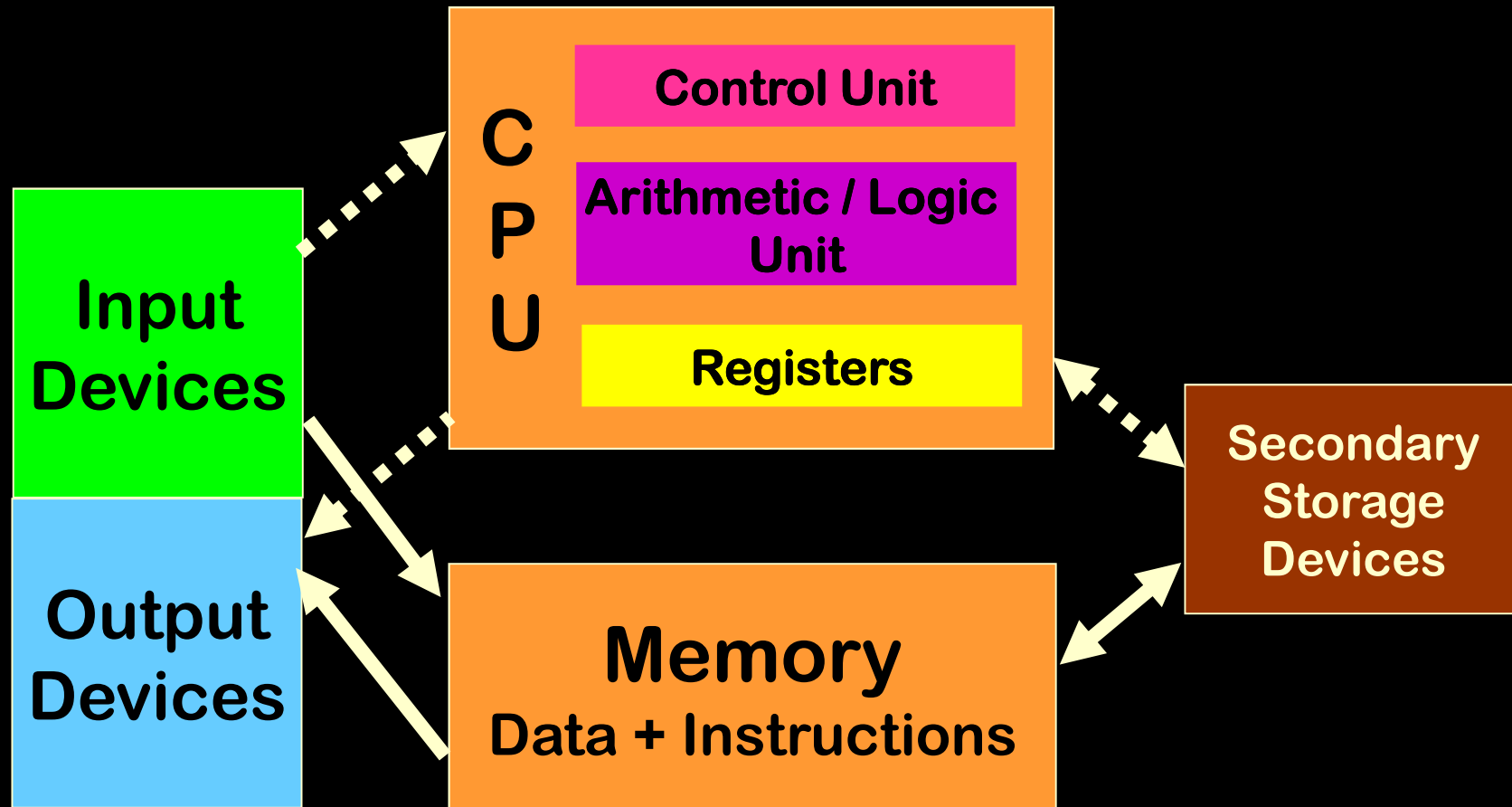
von Neumann Architecture



Connected with a "Bus"

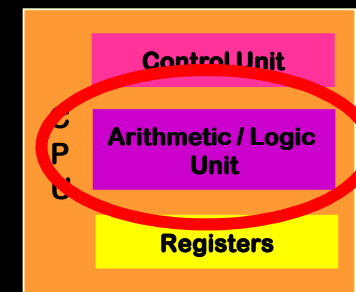


von Neumann Architecture



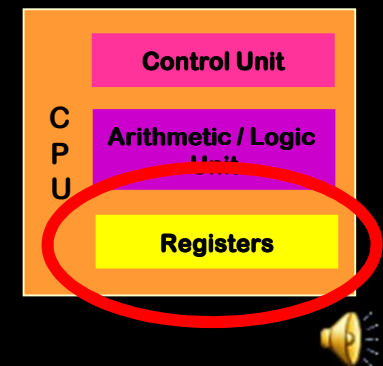
Arithmetic / Logic Unit

- Adds, subtracts, multiplies, divides integers, signed integers, floating point
- Boolean operations like AND, OR, NOT
- Operates on data from memory and in **REGISTERS**



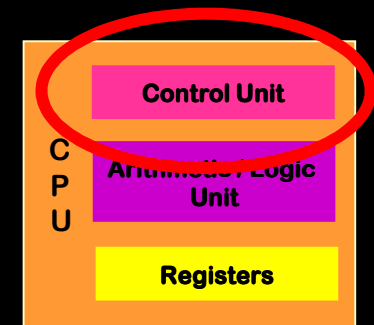
Registers

- Very high speed, special purpose memory
 - Only a few (16 in Intel 80x86)
- Connected directly to ALU
- **Accumulator** is the source and/or destination of (most) ALU operations



Control Unit

- The organizing force in the computer
- Uses two special registers
 - The **Instruction Register** (IR) contains the instruction that is being executed
 - The **Program Counter** (PC) contains the address of the next instruction to be executed



Super Simple CPU

CPU

INPUT

OUTPUT

PC

ACC

TEMP

IR

binary

MEMORY



0

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

binary



Processing Each Instruction:

- **Fetch** the instruction from memory
- **Decode** the instruction
 - figure out what to do
 - get any "operands"
 - memory location ("direct addressing")
 - number or other value to use ("immediate addressing")
- **Execute** the instruction

