

Building to a Computer

CS 2130: Computer Systems and Organization 1

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Announcements

- Homework 2 due Monday

Need one more thing to build computers

We need a place to store stuff.

Memory and Storage

$B = \text{Bytes} = 8 \text{ bits}$

Registers

1 bit register need 6 gates.

- 6 gates each, ≈ 24 transistors
- Efficient, fast *Down to the clock cycle.*
- Expensive! *Take a lot of power*
- Ex: local variables

These do not persist between power cycles

$\approx \text{KiB}$

You have registers in the order of kilobytes.

1 KiB = 1024 bytes ≈ 1000 bytes

Memory and Storage

everything is in power of 2

→ human reads base-10 easier

Value based on how many wires	base-10	Short form	Pronounced
2^{10} I have.	1024	Ki	Kilo
2^{20}	1,048,576	Mi	Mega
2^{30}	1,073,741,824	Gi	Giga
2^{40}	1,099,511,627,776	Ti	Tera
2^{50}	1,125,899,906,842,624	Pi	Peta
2^{60}	1,152,921,504,606,846,976	Ei	Exa

$$2^{27} = 2^7 \times 2^{20} = 128 \text{ M}$$

$$2^3 = 2^3 \cdot 2^0 = 8$$

$$2^{39} = 2^9 \cdot 2^{30} = 512 \text{ G}$$

Memory and Storage *One level up, SRAM and DRAM are still ones we use today*

Memory

- Two main types: SRAM, DRAM *faster, cache memory sticks (outside the processor usually, depending how we're building our system).*
- DRAM: 1 transistor, 1 capacitor per bit *on the order of \approx GiB*
- DRAM is cheaper, simpler to build
- Ex: data structures, local variables

These do not persist between power cycles

RAM: Random access memory

Old: Not random.

*paper tape where there were holes.
punched for zeros and ones.*

*a certain part \Rightarrow unroll the tape to
a certain spot and figure out.*

Memory and Storage

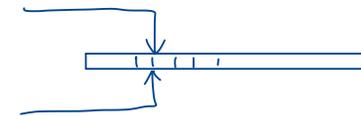
Disk

record player is a kind of disk.

terabytes
≈ GiB-TiB

- Two main types: flash (solid state), magnetic disk
- Magnetic drive
 - Platter with physical arm above and below
 - Cheap to build
 - Very slow! Physically move arm while disk spins
- Ex: files

Data on disk does persist between power cycles



It can apply high voltage to it and make the magnet change its position and do other things to change the values.

Putting it all together

- Information modeled by voltage through wires (1 vs 0)
- Transistors
- Gates: $\&$ $|$ \sim \wedge
- Multi-bit values: representing integers, floating point numbers
- Multi-bit operations using circuits
- Storing results using registers, clocks
- Memory

Code

How do we run code? What do we need?

Consider the following code:

...

8: $x = 16$

9: $y = x$ $y = 16$

10: $x += y$ $x = 32$

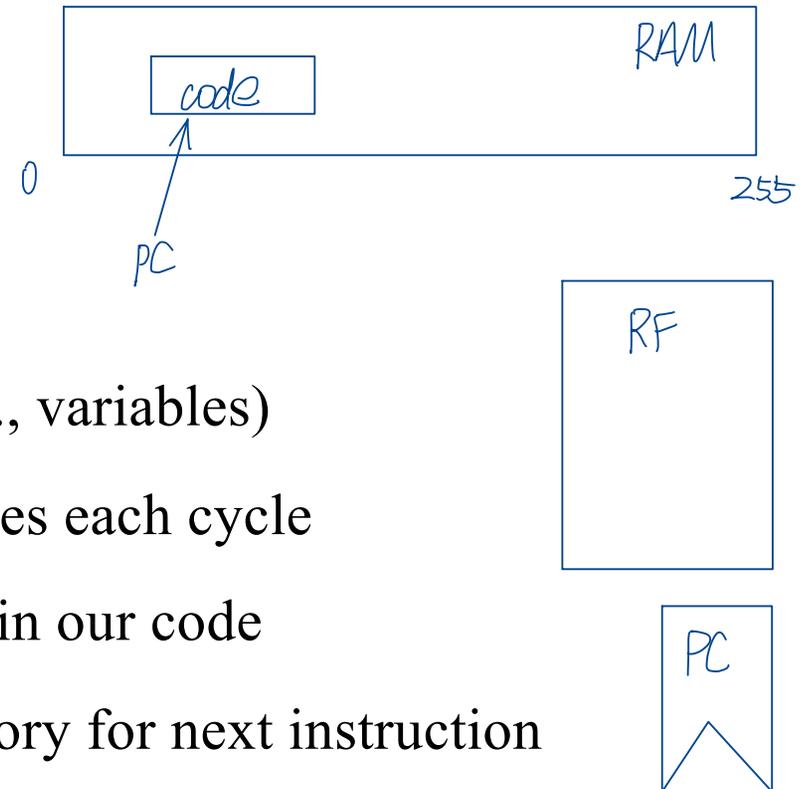
...

What is the value of x after line 10? 32

Bookkeeping

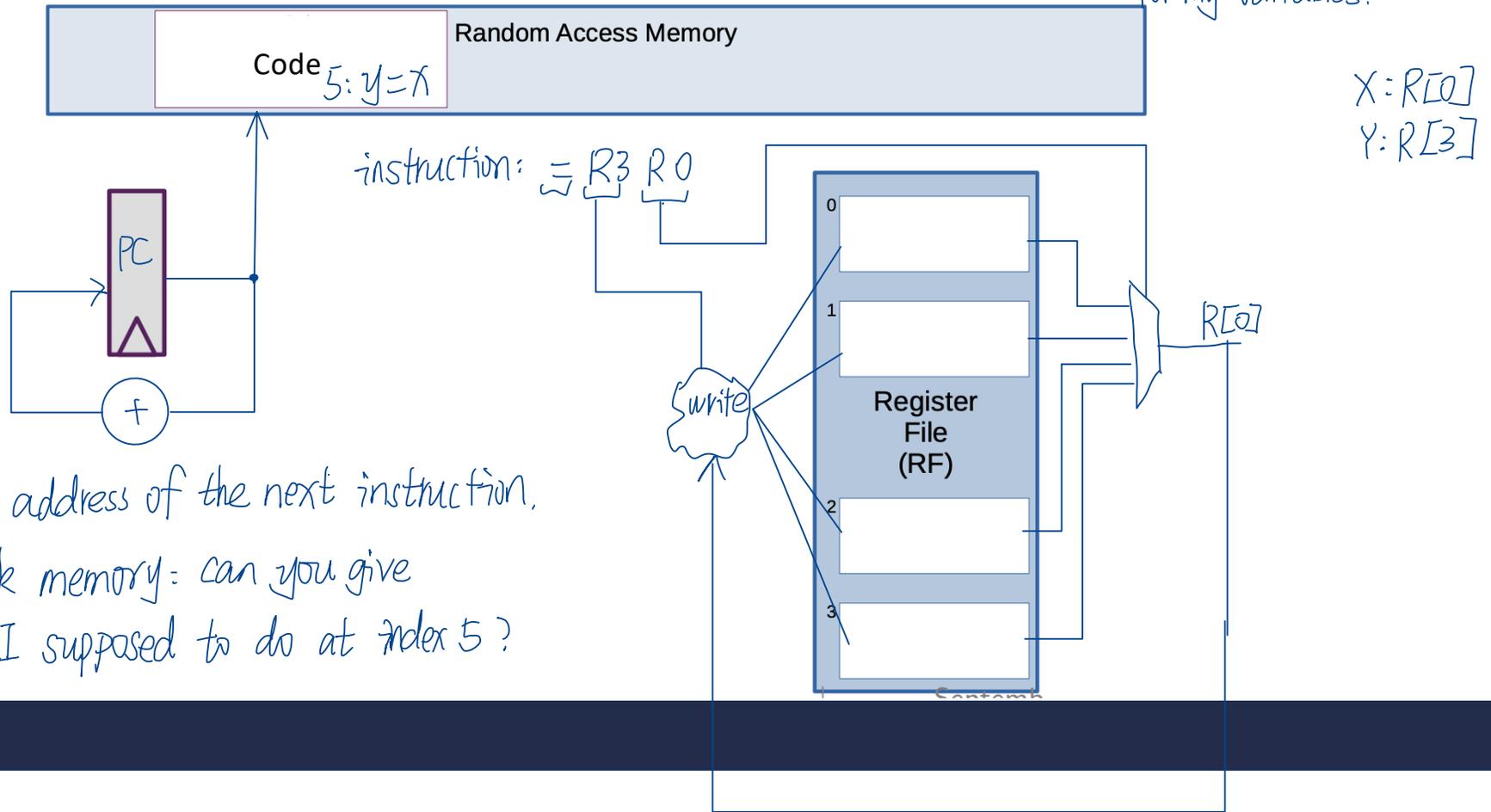
What do we need to keep track of?

- **Code** - the program we are running
 - RAM (Random Access Memory)
- **State** - things that may change value (i.e., variables)
 - Register file - can read and write values each cycle
- **Program Counter (PC)** - where we are in our code
 - Single register - byte number in memory for next instruction



Building a Computer

y=x : I only have set of bytes in my memory, I work with zeros and ones. I don't know *x* and *y*. Instead of *x, y*, I have 4 possible slots for my variables.



PC has the address of the next instruction, we can ask memory: can you give me what I supposed to do at index 5?

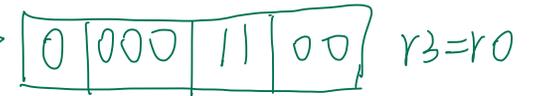
Encoding Instructions

Encoding of Instructions (icode or opcode)

- Numeric mapping from icode to operation

icode	meaning
0	rA = rB
1	rA &= rB
2	rA += rB
...	...

list out all the things that we could possibly do in our machine.



keep this bit for future newer things

