

Computers, Programs, and Programming Languages

A Basic Model of a Computer

1. Memory

- Addressable storage space for data.
- Billions of tiny cells to store numbers and letters.
- Complex data like words, sentences, and pictures are stored in memory by treating many cells grouped as a single *data structure*.

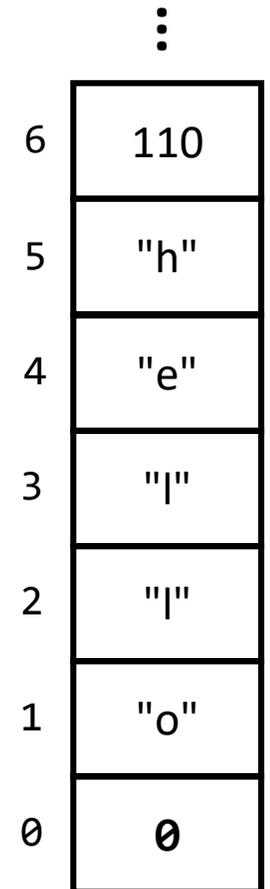
2. Processor (*Central Processing Unit*)

- Follow instructions like computations and memory storage/retrieval
- Far fewer and much simpler kinds of instructions than you'd think!
 - Add, subtract, load, store, compare two numbers, etc.
- A processor's magic is that it can run *billions* of instructions *per second*.

3. Programs

- A sequence of simple instructions the processor follows one-by-one.
- As a programmers, *you* are authoring these instructions!

Memory



What is a program?

- A program is a series of *instructions* that *load*, *compute changes to*, and *store* data in *memory*
- Computer chips understand *machine code* instructions in a *binary* code format
 - It's *very* painful for humans to author directly
- Humans can write machine-level code in a *slightly* nicer format called *assembly code* that is *assembled*, or translated, into machine code.



```
add $t1, $s3, $s3 # Temp reg $t1 = 2 * i
add $t1, $t1, $t1 # Temp reg $t1 = 4 * i
add $t1, $t1, $s6 # $t1 = address of save[i]
lw $t0, 0($t1) # Temp reg $t0 = save[i]
bne $t0, $s5, Exit # go to Exit if save[i] ≠ k
add $s3, $s3, $s4 # i = i + j
add $t1, $s3, $s3 # Temp reg $t1 = 2 * i
add $t1, $t1, $t1 # Temp reg $t1 = 4 * i
add $t1, $t1, $s6 # $t1 = address of save[i]
lw $t0, 0($t1) # Temp reg $t0 = save[i]
beq $t0, $s5, Loop # go to Loop if save[i] = k
```

What is a programming language?

- Programming languages enable you to write programs in a more humane way than writing assembly code.
 - They're designed by humans to be human-readable
 - A concrete medium for expressing processes
- The first English-like programming language was FLOW-MATIC, invented in 1955 by Grace Hopper
- Languages, like written ones, have **syntax rules** and **semantics**
- High-level programs are *interpreted or compiled into* the much more rudimentary, binary machine code which the processor can then follow



Grace Hopper

Programming Language: JavaScript/TypeScript

- In this course you will use a special dialect of the JavaScript language
 - TypeScript is just JavaScript with a few extra features
- The concepts you learn will apply to *any* programming language
- You will be build apps that run in browsers on your computer and phone!

