

Overview of Computer Organization

What does this course do?

- Computers are used everywhere nowadays. Most of the time, they are a magic black box to us. They are so into our daily life. Sometimes we are so get used to it, and perhaps haven't had a chance to think about the components of this magic black box or how the magic black box works.
 - We are going to "open" this magic black box in this course, and figure out what inside this box, and how does it work.
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Why do we care?

- Why do we want to know beyond this is a required CS course?
 - We can build a PC. If you play video games like PUBG: BATTLEGROUNDS, you may be aware of the difference between a laptop and a PC. Building a PC by yourself costs only half of the price of a commercial PC with similar configuration or even less.
 - You would understand some technical article, like why is apple's M chips are so fast. [<https://debugger.medium.com/why-is-apples-m1-chip-so-fast-3262b158cba2>]
 - We can understand the code better.
 - Examples:
 - Is the following an infinite loop? [No]

```
int x = 1;

while(x > 0) {
    x++;
}
```

- Which of the following snippets will run faster? [1 on Ying's Mac]

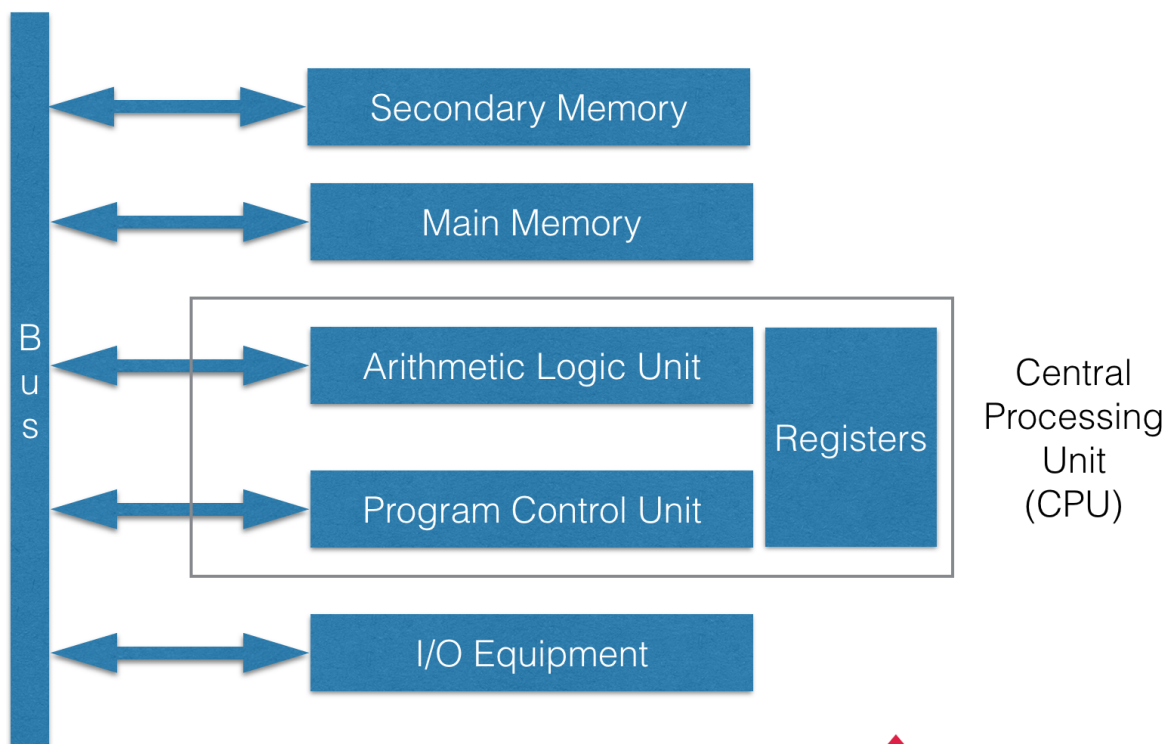
```
int[][] x = new int[5000][5000];
for (int r = 0; r < x.length; r++) {
    for (int c = 0; c < x[0].length; c++) {
        x[r][c] = 1;
    }
}

int[][] x = new int[5000][5000];
for (int r = 0; r < x.length; r++) {
    for (int c = 0; c < x[0].length; c++) {
        x[c][r] = 1;
    }
}
```

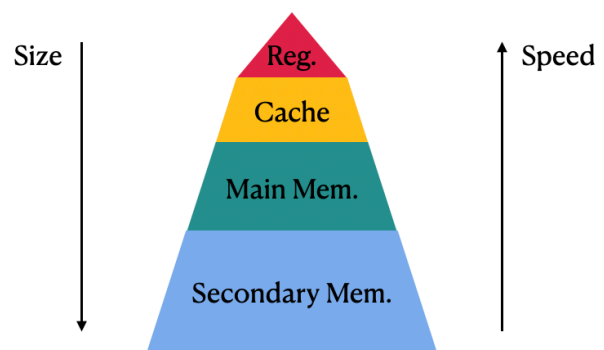
- Why did the above examples generate results different from what we expected?
 - It depends on how values are stored in a computer and how the CPU fetches them to do the calculation.
- Software runs on hardware. To write better software, we need to have some knowledge of hardware.
 - If you are interested in low-level software (e.g., operating system, compilers, drivers, etc.), you'd better to know hardware details.
 - If you are interested in data analysis, knowing hardware can help you write more efficient programs.

What Are the Various Hardware Parts of a Computer?

- CUP with registers, main memory, second memory, and I/O, all on bus.



- In between registers and main memory (RAM), there is the cache, a memory component faster and more expensive than the main memory.
- As shown in the right image, the speed of the different types of memory decrements top down, while the size increments. Register: 1000 bits, Cache: million bits, RAM: billion bits, disk: trillion bits



- All the storage locations just contain 0's and 1's as encoding of the data or programs.