Overview of Computer Organization

Why Do We Care?
- Computers become popular 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.
- We are going to “open” this magic black box in this course, and figure out what inside this box, and how does it work.

- Why do we want to know beyond this is a required CS course?
  • We can build a PC. If you play computer games like PlayerUnknown's 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 M1 chip is 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]
      
      ```java
      int x = 1;
      while(x > 0) {
        x++;
      }
      ```

    • Which of the following snippets will run faster? [1 on Ying’s Mac]
      
      ```java
      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;
        }
      }
      ```

      ```java
      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.
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, and drivers), you need 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. (And power supplier)

- 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.