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.
- 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.

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**What Are the Various Hardware Parts of a Computer?**

- CPU 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.