CS 101
Computer Dissection

Lecture 8
Computer Dissection

- Thus far, we have talked about how computers solve problems, how they represent information, and we have just barely started programming.
- We have not yet learned about how computers are physically constructed.
- So let’s do so!
Computer Dissection

Computers come in many form factors... right?
Types of Computers

- Discuss in your groups . . .
  - Come up with at least 5 different kinds of devices that are, at their core, computers
  - What makes a “computer” a “computer”?
Desktop PC
Laptop PC

Apple Macbook Pro
All-In-One PC

Microsoft Surface Studio
Smart Phone

Samsung Galaxy S7 edge
Smart Watch

Sony SWR50 SmartWatch
Computer Dissection

- All of these are computers!
- *The core architecture and components inside of each of these devices is the same*
  - The shape, size, and form-factor are just cosmetic differences
- We will study the components and makeup of a standard desktop PC since it is the largest and easiest to “dissect”
- But first, what are the core components of a computer?
Logical Construction

- These are the main components of a computer:
  - a central processing unit (CPU)
  - primary memory
    - random access memory (RAM)
  - secondary memory
    - hard drive
  - input and output devices
    - display, keyboard, mouse, etc.
- All of these are connected by a bus that transmits information between them
Logical Construction

- a processor (the CPU)
  - the "brains" of the computer
  - does arithmetic
  - moves data around
  - controls the other components

- the CPU has a very limited set of instructions it can perform, but
  - it's very, very fast
Logical Construction

• A CPU uses an internal clock (like a heartbeat) to step through instructions
• We measure the speed in terms of the number instructions it can do in a second (the number of "beats" or "ticks" in a second)
• 1 beat (or tick) is one hertz (Hz)
CPU speed

- The processor speed is given in GHz, as in
  - 2.2 GHz, or 4.5 GHz

- What does G stand for?

- How many instructions (ticks) per second is 2.5 GHz?
CPU Speed

- Giga is a billion \((10^8)\)
- Therefore, 2.5GHz is

\[
1,000,000,000 \times 2.5 = 2,5000,000,000
\]

*instructions per second*
Logical Construction

- primary memory (RAM)
  - stores information being currently used by the CPU
  - stores data \textit{and} instructions
  - the CPU can change what's in RAM
    - store different instructions to change the computation
    - stores the instructions of the program currently active, i.e., Processing, Instagram, Word
Logical Construction

- primary memory (RAM)
  - random
    - can access any location in memory in the same amount of time
  - volatile
    - contents of RAM are lost when power is turned off
Logical Construction

- secondary memory
  - stores information even when power goes off
- two kinds of secondary storage
  - hard disk drive (HDD)
  - solid state disk (SSD)
- the technology for each is different
  - SSDs are faster, quieter, and more expensive
  - regardless, disk storage is about 100 times cheaper than RAM
Logical Construction

• input and output devices
  o display, keyboard, mouse, etc.
I/O devices

- Name five other devices that are examples of I/O devices for a computer
Computer Dissection

What does the inside of a computer look like?
The components of a Computer

- What are some of the key internal components of a computer? Can you name a few?
- What do each of these components do? What is their “job”?
Main Computer Components
Motherboard

The **Motherboard** (mobo) is the main printed circuit board (PCB) found in general purpose computers. It holds and allows communication between the crucial electronic components of a system, such as the central processing unit (CPU) and memory, and provides connectors for other peripherals. (wp)
Central Processing Unit (CPU)

The **central processing unit** (CPU) is the electronic circuitry within a computer that carries out the instructions of a computer program by performing the basic arithmetic, logical, control and input/output (I/O) operations specified by the instructions.
Central Processing Unit (CPU)

- Used to be one CPU
- Now, most have 2, 4, 6, 8, or even more!
- The word "core" has become a synonym for "processor"
- Core™ i3 is a marketing term
The Computer

Mobo

CPU
Why Multiple Cores?

- What is the point of having multiple “cores” in a CPU?
- What kinds of programs do you think benefit from having multiple cores?
- Is it better to have 1 really fast core, or many slower cores?
Hard Disk Drive (HDD)

The **hard disk drive** (HDD) is a non-volatile data storage device that uses magnetic storage to store and retrieve digital information using one or more rigid rapidly rotating disks (platters) coated with magnetic material. The platters are paired with magnetic heads on a moving actuator arm, which read and write data to the platter surfaces. (wp)
Solid State Drive (SSD)

A **solid-state drive** is a non-volatile, solid-state storage device that uses integrated circuit assemblies as memory to store data persistently. SSD technology primarily uses electronic interfaces compatible with traditional block input/output (I/O) hard disk drives (HDDs), which permit simple replacements in common applications. (wp)
HDD/SSD

- Why would it be beneficial to have both an SSD and an HDD in the same computer?
Random-access memory (RAM) is volatile computer data storage which stores frequently used program instructions to increase the general speed of a system. A random-access memory device allows data items to be read or written in almost the same amount of time irrespective of the physical location of data inside the memory. (wp)
Volatile and Non-Volatile

- **Volatile Memory (VM)** is storage that only persists while power is on. Once shut down, all stored info is gone.
- **Non-Volatile Memory (NVM)** (persistent storage) is storage that remains regardless of the power state.
The Computer

Mobo

RAM

CPU

HDD / SSD
HDD/SSD vs RAM

- Why do computers need both?
- What kinds of computer users could use a large amount of HDD/SSD capacity and a small amount of RAM?
  - And vice-versa?
Volatile and Non-Volatile

• Typically, data can be stored to and retrieved from volatile memory much faster than non-volatile memory
• However, volatile storage is often much more expensive for comparable capacity
  ○ A 16 GB stick of RAM costs ~ $120 on Amazon
  ○ A 1 TB (1000 GB) HDD costs ~ $50 on Amazon
• VM and NVM are typically combined, to get the best of both worlds!
A *wireless network interface controller* (WNIC) is a network interface controller which connects to a wireless radio-based computer network, rather than a wired network, such as Ethernet. This card uses an antenna to communicate via microwave radiation. These can connect via PCI, USB, and others. (wp)
A **video card** (also called **graphics card**) is an expansion card which generates a feed of output images to a display (such as a computer monitor). Frequently, these are advertised as discrete or dedicated graphics cards, emphasizing the distinction between these and integrated graphics. (wp)
Video Card

Some CPUs have built-in video cards. Typically these built-in video cards are not as capable as a high-end standalone video card, but are useful when there is a need to save space (such as in a laptop or tablet)
Video Card vs CPU vs Storage vs RAM

- For each use case, rank the importance of the components:
  a. A professional video/film editor
Video Card vs CPU vs Storage vs RAM

- For each use case, rank the importance of the components:
  a. A professional video/film editor
  b. A large database of information needing to be managed
Video Card vs CPU vs Storage vs RAM

- For each use case, rank the importance of the components:
  a. A professional video/film editor
  b. A large database of information needing to be managed
  c. A casual computer user (email, document editing, etc)
Video Card vs CPU vs Storage vs RAM

- For each use case, rank the importance of the components:
  a. A professional video/film editor
  b. A large database of information needing to be managed
  c. A casual computer user (email, document editing, etc)
  d. Someone who loves to game on their computer
Power Supply Unit (PSU)

A *power supply unit* (or PSU) converts mains AC to low-voltage regulated DC power for the internal components of a computer. Modern personal computers universally use switched-mode power supplies. Some power supplies have a manual switch for selecting input voltage, while others automatically adapt to the mains voltage. (wp)
Input Devices
- Mouse
- Keyboard
- Touch Sensor

The Computer
- CPU
- RAM
- HDD / SSD
- Audio Ctrl
- WNIC
- Video Card

Output Devices
- Speaker / Headset
- Monitor / Screen
Knowing how to build a kitchen, install high-end appliances, and sharpen knives does not make someone a great chef.

But it is important for a chef to know how to install appliances, understand how his appliances work, and how to use his kitchen.
Computer Dissection - Cheesy Example

- Knowing how to assemble, repair, and tune a high-end drum set does not make one a world-class drummer.
- But it is important for a world-class drummer to understand how to assemble his kit, how to tune the heads, and how to make repairs to the drums and cymbals.
Computer Dissection

- Knowing how to build a computer, what each component does, and how each component functions does not make one a computer scientist.
- But it is important for a computer scientist to understand how it all works, because this is the primary tool of a computer scientist.
Computer Dissection

- Building computers and designing computer hardware is not computer science!
- The physical computer is a tool of a computer scientist, so it is important to understand how it works
Problem Solving - Materials

- **Required Materials**
  - [How to Build a Computer](#) (17 mins)
  - [Overheating CPUs](#) (2 mins)
  - [PC Build Guide](#) (15 mins)
  - [Lots of Cores or a Faster CPU Clock speed?](#) (5 min read)
  - UTDW Chapter 1