

Lecture 1: Course overview

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601.229 Computer Systems Fundamentals



Welcome!

- ▶ Welcome to CSF!
- ▶ Today:
 - ▶ Administrative stuff
 - ▶ Course overview
 - ▶ Binary data representation

Administrative stuff

About the course

- ▶ Instructor
 - ▶ David Hovemeyer, daveho@cs.jhu.edu, Malone 240A
- ▶ CAs
 - ▶ Coming soon, see course web page for details

Where to find stuff

- ▶ Course website: <https://jhucsf.github.io/fall2021>
 - ▶ Syllabus, schedule, lecture notes, assignments, etc.
 - ▶ All public course information will be here
- ▶ Campuswire <https://campuswire.com>
 - ▶ Non-public course information such as homework/exam solutions
 - ▶ Discussion forum, Q/A: please post questions here!

Syllabus highlights

- ▶ Please read the syllabus carefully:
<https://jhucsf.github.io/fall2021/syllabus.html>
- ▶ Highlights:
 - ▶ Grades: 55% homework, 40% exams, 5% participation
 - ▶ 6 or 7 assignments, mostly programming based, expect them to be challenging!
 - ▶ Late policy: you have 120 late hours to use as needed (assignment submissions which exceed the late hour limit receive no credit)
 - ▶ Three exams (two during semester, one during final exam period)
 - ▶ Exams will be in-class
 - ▶ Location will be announced in class and posted on Campuswire (we will use a large lecture hall to permit social distancing)
 - ▶ Will focus on recently-covered material

Participation

- ▶ What counts as participation?
 - ▶ In both sections: asking and answering questions on Campuswire, attending office hours, watching lecture recordings
 - ▶ Section 01: participating in clicker quizzes
 - ▶ Section 02: participating in synchronous Zoom meetings
- ▶ I would like to see *reasonably consistent* participation

Academic integrity

- ▶ Please read the academic integrity policy in the syllabus carefully
- ▶ Highlights:
 - ▶ Follow the CS Academic Integrity Code:
<https://www.cs.jhu.edu/academic-integrity-code/>
 - ▶ Homework assignments
 - ▶ Individual: code sharing is not allowed
 - ▶ Pair: you can work with one partner
 - ▶ Exams are (obviously) individual effort
 - ▶ Violations of academic integrity will be reported to the Student Conduct office
- ▶ Be careful about using web as a resource
 - ▶ Do *not* copy code
 - ▶ *Always* cite sources used

Class meetings

- ▶ Typical class meeting: lecture/discussion, peer instruction questions, occasional group activities, discussion of current assignment, time for free-form Q&A
- ▶ *Do the reading in advance!*
- ▶ Come prepared to actively engage with the material!
 - ▶ Learning is not passive
 - ▶ More productive class time → better outcomes
 - ▶ Ask questions!

Peer instruction

- ▶ How peer instruction works:
 - ▶ Slide with a multiple choice question
 - ▶ Answer individually, discuss with peers, then answer again
 - ▶ Shown to improve outcomes!
 - ▶ Questions may be challenging
 - ▶ Graded for participation only
- ▶ You may have done this in other courses

Peer instruction etiquette

- ▶ Be respectful:
 - ▶ Let everyone participate
 - ▶ Don't put down anyone else's ideas
- ▶ Work together and think carefully about the question!

First clicker quiz!

Clicker quiz omitted from public slides

Computing requirements

- ▶ All assignments will be done using x86-64 Linux
- ▶ Autograders will use Ubuntu 18.04
- ▶ **You will need an x86-64 Linux development environment!**
- ▶ Recommendations:
 - ▶ Ugrad machines (different version of Linux, but should work fine)
 - ▶ Run Linux on your laptop or PC
 - ▶ Run Ubuntu 18.04 using WSL2 under Windows (great option!)
 - ▶ Run an Ubuntu virtual machine image using VirtualBox
- ▶ I'm not aware of any way to set up a usable development environment on an M1 Mac

Course overview

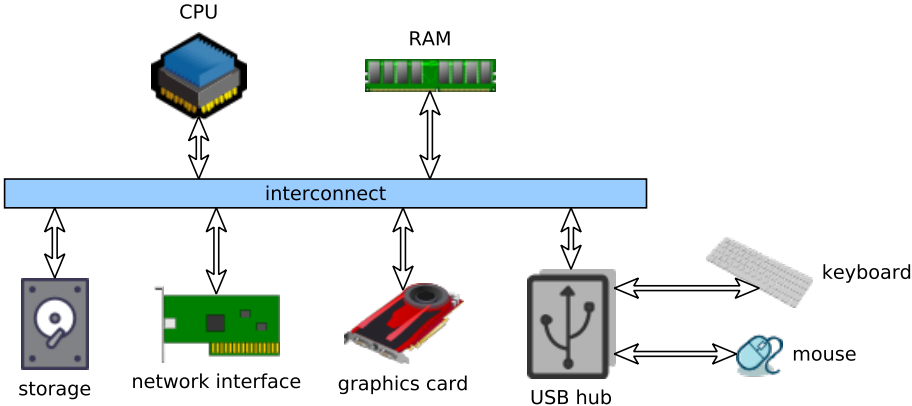
What the course is about

- ▶ Course is about *computer systems* from the *programmer's perspective*
- ▶ Computer system = hardware + software
 - ▶ Much of our concern is the interaction between hardware and software — how they work together

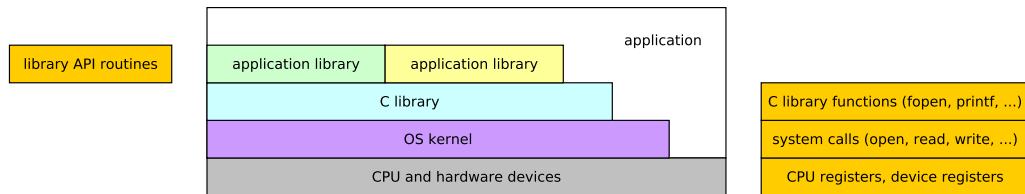
Goals of course

- ▶ “Deep” understanding of how computers work (down to hardware)
 - ▶ OS and runtime library interfaces
 - ▶ Machine-level ISA / assembly language
 - ▶ Processor features
 - ▶ Operating system features
- ▶ Apply this understanding to...
 - ▶ Optimize application performance
 - ▶ Avoid pitfalls such as security vulnerabilities
 - ▶ Take full advantage of the computer’s and operating system’s capabilities

A computer system (hardware)

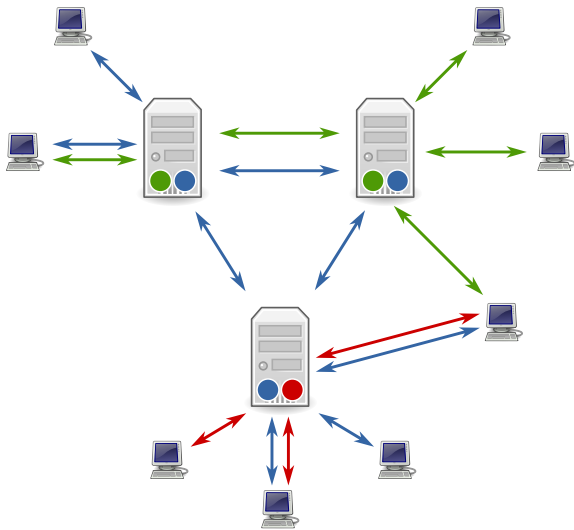


A computer system (software)



- ▶ Your application program is supported by lower layers of software and hardware
- ▶ Each layer provides an interface to the layer above

A computer network



Computer networks allow your program to communicate with peer systems.

Thanks to the global Internet, the peer systems could be anywhere on earth!

Binary data representation

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- ▶ Consider a representation of a number:
 - ▶ A *continuous* representation would allow the number to have *any* value
 - ▶ We think of physical phenomena (mass, velocity, etc.) as being continuous
 - ▶ A *discrete* representation would allow the number to have one of a set of possible values, where the set of possible values is *enumerable*
 - ▶ Often we think of discrete values as corresponding to a range of integers

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 - ▶ Digital circuits (with discrete high vs. low voltages) have many advantages over *analog* circuits, where voltages can vary continuously

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- ▶ OK, let's think about what discrete data representations will look like...
 - ▶ Starting with *integers* (if you can represent integers, you can represent anything)

Decimal numbers

- ▶ We're all familiar with decimal (base 10) numbers
- ▶ E.g.,

$$42 = 4 \cdot 10^1 + 2 \cdot 10^0$$

- ▶ Digits are 0–9
- ▶ Places are powers of 10

Other bases

- ▶ Base 10 is arbitrary!
- ▶ Representing decimal 42 using base 5:

$$42_{10} = 132_5 = 1 \cdot 5^2 + 3 \cdot 5^1 + 2 \cdot 5^0$$

- ▶ “Digits” are 0–4
- ▶ Places are powers of 5

Try it!

How to express decimal 42 using base 6?

$$\underline{\quad} \cdot 6^2 + \underline{\quad} \cdot 6^1 + \underline{\quad} \cdot 6^0$$

How to express decimal 79 using base 6?

$$\underline{\quad} \cdot 6^2 + \underline{\quad} \cdot 6^1 + \underline{\quad} \cdot 6^0$$

Reference:

$$6^2 = 36$$

$$6^1 = 6$$

$$6^0 = 1$$

- ▶ Binary = base 2
- ▶ Representing decimal 42 using base 5:

$$\begin{aligned}42_{10} &= 101010_2 \\ &= 1 \cdot 2^5 + 0 \cdot 2^4 + 1 \cdot 2^3 + 0 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0\end{aligned}$$

- ▶ “Digits” are 0 and 1
- ▶ Places are powers of 2
- ▶ Computers use binary representations for all data, because
 - ▶ *Digital circuits* use two voltage levels, high and low
 - ▶ By convention, 1=high voltage, 0=low voltage
 - ▶ So, computer hardware fundamentally operates on binary data

Try it!

How to express decimal 29 using base 2?

$$\underline{\quad} \cdot 2^5 + \underline{\quad} \cdot 2^4 + \underline{\quad} \cdot 2^3 + \underline{\quad} \cdot 2^2 + \underline{\quad} \cdot 2^1 + \underline{\quad} \cdot 2^0$$

Reference:

$$2^5 = 32$$

$$2^4 = 16$$

$$2^3 = 8$$

$$2^2 = 4$$

$$2^1 = 2$$

$$2^0 = 1$$