Poll Everywhere

pollev.com/cse333

About how long did Exercise 12 take you?

A. [0, 2) hours
B. [2, 4) hours
C. [4, 6) hours
D. [6, 8) hours
E. 8+ Hours
F. I didn't submit / I prefer not to say

Thinking About Systems

CSE 333 Summer 2023

Instructor: Timmy Yang

Teaching Assistants:

Jennifer Xu Leanna Nguyen Pedro Amarante

Sara Deutscher Tanmay Shah

Partially adapted from James Wilcox's Wi23 CSE452 lecture, "Performance and Queuing Theory"

Relevant Course Information

- Homework 4 due Wednesday (8/16)
  - Submissions accepted until Friday (8/18)
- Course evaluations (see Ed #404) due Friday night
  - Please fill them out. They help all staff members improve their skills as educators and allow us to improve the course for future offerings. ☺
- Quiz 4 open Wednesday (8/16), closes Friday (8/18)
- Next lecture (8/16) will be extra OH/workday.
- Check grades as Canvas assignments are released
  - Assignments with regrades closed will get transferred first.

Today's Goals

- We'll be trying to put the "System" in "Systems Programming"
- The systems motto is: Is the problem the system solves real?
  - Does the system solve the problem?
    - Is the system correct?
    - Is the system fast enough to be useful?
- Correctness is the most important part of system design, but **performance** is important too.
- Won't be explicitly covered on Quiz 4
  - More of a bonus lecture ☺

Aside: Talking about Performance

- Performance is a bit of a loaded term.
- What do we mean when we say something "performs well?"
  - Does it go fast?
    - Throughput? Latency?
  - Is it memory efficient?

- Ignores other important metrics:
  - Is the system accessible?
    - Is it easy for *everyone* to use?
  - Is it easy to understand?
  - If things go wrong, can a user fix it themselves (i.e., can you tolerate error)?
  - Is this system cost-effective (i.e., can we afford it)?
    - From space, size and monetary stand-points.

- When designing systems, it's important to consider more than just, "going fast."

So… What *is* a System?

- "A **system** is a group of interacting or interrelated entities that form a unified whole. A system is delineated by its spatial and temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning."
  - https://en.wikipedia.org/wiki/System
  - Still vague, maybe still confusing

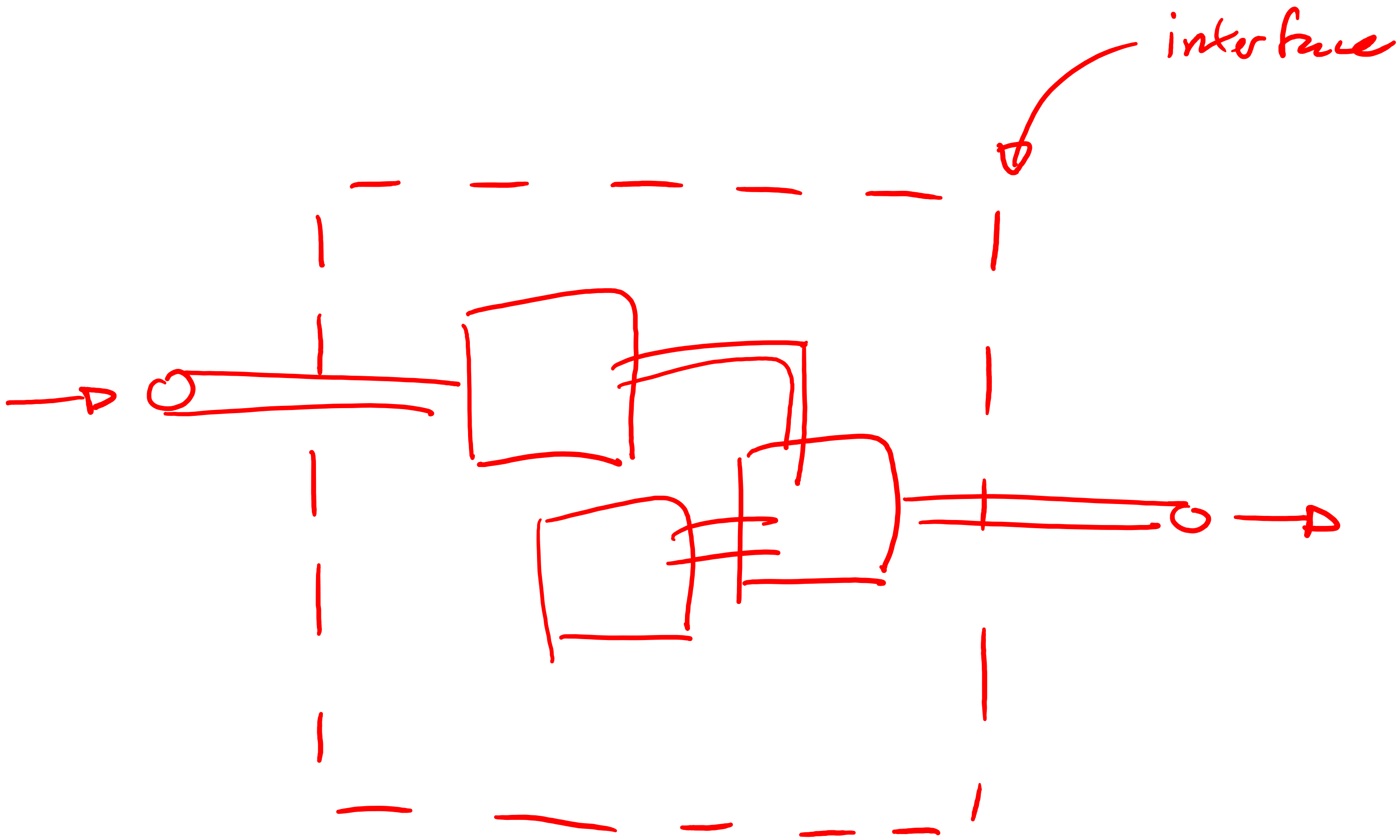
- Put a little more simply, "…a set of interconnected components whose joint behavior is observed at the interface with its environment."

Systems

- What kind of systems can you think of (computing or otherwise)?

- Operating System
- Ecosystem
- Digestive System
- Education system
- Domain Name system
- Judicial Systems

Systems from 10,000 Feet



Systems from 10,000 Feet

- The interface is a box separating the components of the system from "everything else"
  - Outside of the box is "the environment"
  - Inside the box is the system, including its components and connections
- We observe the system at its boundary with the environment
  - Observers don't look inside the box; they look at the behavior of the box.
- Notice that this definition does not contain the word "computer" or even "electrical signals"
  - Applies equally well to biological, mechanical and social systems

Systems from 10,000 Feet

- You largely interact and view systems from an observer perspective.
  - As a user, client, etc.
  - i.e., “outside looking in”

- “Systems Programming” is (ideally) all about starting to peel away the interface barrier.
  - We want to understand the inner workings of systems and how to build/design them.
  - All about understanding “the layer below.”

Analyzing Systems

- What have we thought about while developing systems?
  - Consider both the perspective of an observer and a developer

- On the Observer Side:
  - Inputs and Outputs
    - What do we give the system, what does the system give us?
  - Interface
    - How do we interact with the system?
  - Robustness and Error Messaging
    - What errors or unexpected behavior can we tolerate and how?
    - If something goes wrong, how do we let people know?

Analyzing Systems

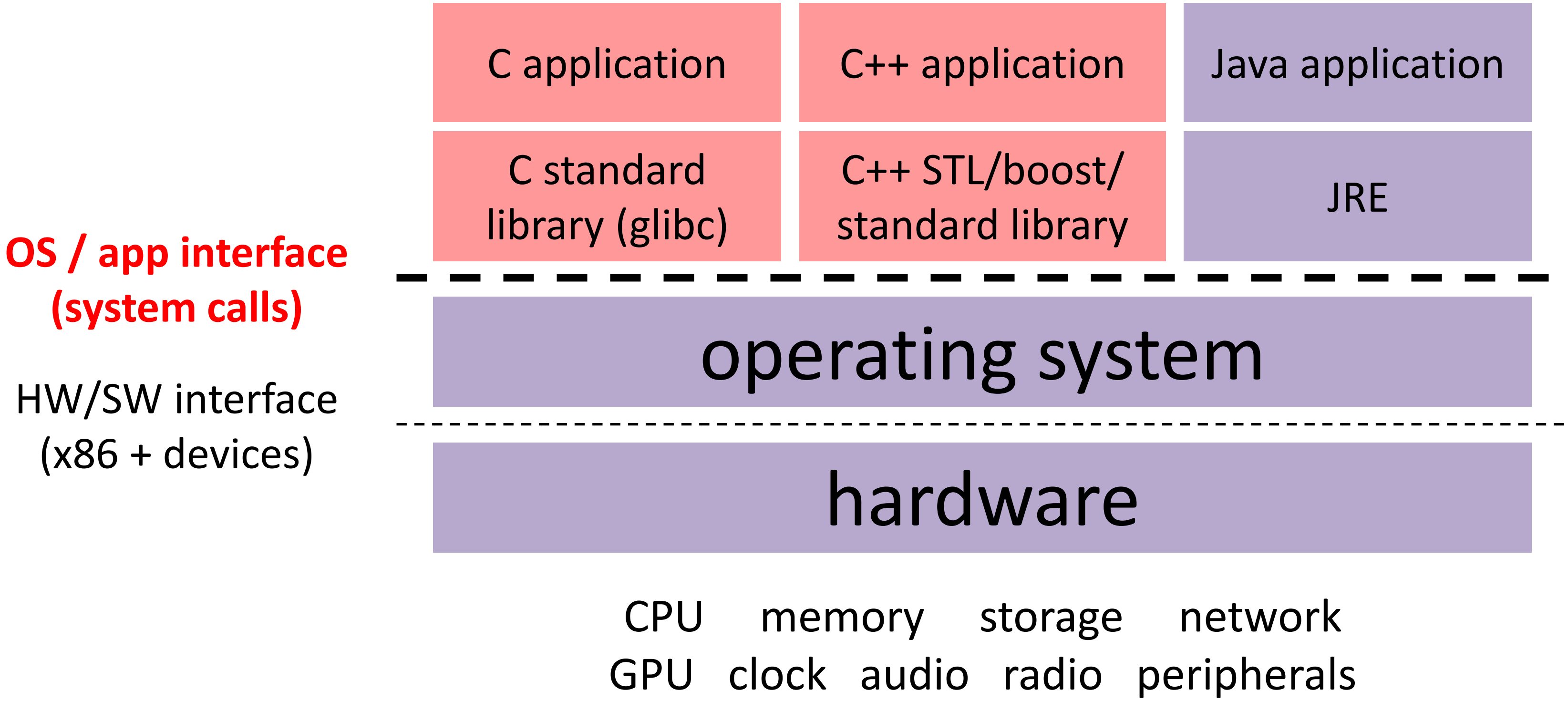
- What have we thought about while developing systems?
  - Consider both the perspective of an observer and a developer

- On the Maintainer/Developer side:
  - Everything from Observer side plus…
  - Interface (again)
    - What am I allowing the user to do or not to do?
  - Correctness and Performance*
    - Does the system do what we want it within time and resource constraints?
  - Maintainability
    - How easy is the system to fix and update?
  - Design and Changes
    - Who gets a say when designing and/or changing the system?

*Won't be focusing too much on this point, as it already gets plenty of discussion in the CS space.

The Computer as a System

- Modern computer systems are increasingly complex!
  - Networking, multiple CPU cores, various peripherals, etc.
  - Multitudes of operating systems, applications, etc.



The Computer as a System

- Let's analyze a computer as an observer!
  - What are our inputs?
    - Electricity, keystrokes, data from the network, etc.
  - What are our outputs?
    - Text on a terminal, video feed out, audio from speakers.
  - How do we interact with the system?
    - Keyboard, mouse, peripherals that can connect through ports.
  - What errors can we tolerate/handle?
    - Some memory corruption, bad components, etc.
  - If something goes wrong, how do we know?
    - "Blue Screen of Death"

The Computer as a System

- Now what about as a maintainer/developer?
  - Interface
    - Physical hardware, software tools, programming languages
  - Maintainability
    - Documentation, hardware specifications, software updates
  - Design and Changes
    - Hardware standards, various protocols
      - Aside: RFCs, and RFC 1149 – IP over Avian Carriers
    - Who has a say in all of this?
      - Tech companies
      - Hardware manufacturers

Allen School as a System

- Your turn! Let's think about the Allen School as a system.
  - Consider the system as both an observer and a maintainer.
  - Open-ended activity, no correct answers!

- As an observer:
  - Inputs and outputs
  - Interfaces
  - Robustness and Error Messaging
- As a maintainer:
  - Interfaces
  - Maintainability
  - Design and Changes

Allen School as a System

- As an observer:
  - Inputs and Outputs:

    · Information · Students · Money

    · Stats
  - Interfaces:

    · Classes - altu

    · Websites ·
  - Robustness and Error Messaging

    · Pandemic · Outage information

    · Advising

Allen School as a System

- As a maintainer:
  - Interfaces:
    - Bribery not allowed
    - Academic Integrity
  - Maintainability:
    - Course Outlines
    - CSE IT
    - TAs, Office Hours
  - Design and Changes:
    - Instructors/Professors
    - Students
    - Dean
    - Faculty

Interfaces

- We've talked a lot about interfaces this quarter.
  - What information can we give/get through the interface?
- Interface design is an important part of designing a system.
  - UX Designers exist for a reason!
- Interface and system design can also drive user behavior in interesting and surprising ways
  - HW1 vs STL: LinkedList vs std::list
  - HW2/HW3 vs HW4: Command-line vs web-based
  - Editors: VSCode vs. vi(m) vs. emacs

Real-World Systems and Interfaces

- Most of these ideas can be applied to many other real-world (non-computing related) systems.

- We'll be focusing on the US Electoral System
  - Specifically on voting.

- Note: Political topic by nature of subject matter. My own views do not reflect those of the Allen School.

Voting

- Elections are a complex topic, let's focus on how most people interact with this system: voting

- Voting generally conducted in-person, some states allow for sending in votes by mail.

- Mail-in Voting
  - 27 states and Washington D.C. offer "no-excuse" absentee voting
    - 8 states conduct elections entirely by mail (e.g., Washington)
  - Leaves 15 states that require you to be out-of-state, sick, etc. to vote by mail.

Voting

- 15 states where you must show up in-person to vote at a voting machine unless you have an acceptable excuse.

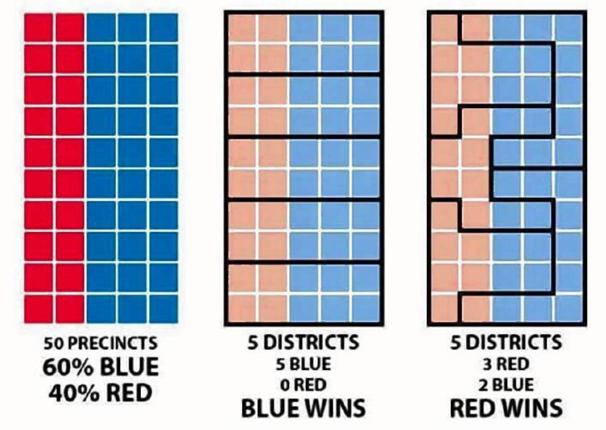
- Accessibility:
  - Must be able (and have the time) to show up to a voting location.
  - What happens if you don't feel safe at said voting location?
    - "GOP activist group instructs Michigan poll watchers to call 911"
    - https://www.politico.com/news/2022/08/02/michigan-poll-911-gop-00049332

- Design and Changes:
  - Once you're in a position of power, you can influence the drawing of electoral districts.
    - At best, things are fairer and represent the population well.
    - At worst…

Gerrymandering

- Manipulation of electoral district boundaries with the intent to create an advantage for a party, group or socioeconomic class within the constituency
  - https://en.wikipedia.org/wiki/Gerrymandering
  - CGP Grey on Gerrymandering: https://youtu.be/Mky11UJb9AY

- Manipulate how voting districts are decided to put others at a disadvantage, or to put yourself at an advantage.



Redlining

- "**Redlining** is a discriminatory practice in which services (financial and otherwise) are withheld from potential customers who reside in neighborhoods classified as "hazardous" to investment; these neighborhoods have significant numbers of racial and ethnic minorities, and low-income residents."
  - https://en.wikipedia.org/wiki/Redlining

- Push certain demographics into certain zones. Make it harder for them to access resources.
  - Easier time staying in office!

Electoral System Analysis

- With all of this in mind, let's analyze this a bit closer.

- First, as an observer:
  - Inputs and outputs
    - Votes, policies, elected officials
  - Interface
    - Ballots, voting machines
  - Robustness and Error Messaging
    - Must explicitly register to vote (citizenship, etc. checked then)
    - Recounts and audits when suspicion of fraud, miscounts, etc.

Electoral System Analysis

- With all of this in mind, let's analyze this a bit closer.

- As a maintainer:
  - Interfaces
    - Constituents can vote on subject matter, and government officials
    - Can also directly contact officials through various channels
  - Maintainability
    - *Very* hard to change, requires many people to agree, and then enough votes.
  - Design and Changes
    - Heavy influence by those that are already in power
    - Influence from those that aren't in government through votes…

Wrap-up

- Systems are complex, and there's a lot to think about.
  - Does it solve the problem?
    - Consistently and in a reasonable time?
  - Is it accessible and user-friendly?
    - Will people want to keep using it? Will people be *able* to use it?
  - Is it easy to understand and maintain?
    - Will people want to keep *updating* it?
  - Who gets a say in its design? Now? In the future?

- As programmers there is a high likelihood that you'll be designing some of your *own* systems in the future.
  - Keep some of these concepts in mind while designing systems ☺