CSE 390 B Winter 2021

Compiler Wrap up & Design

Two-Tier Compilation, Design and Computing

Announcements

- Navigating CSE Guide: https://bit.ly/CSEnewstudentguide
- TA-Hosted Study Hour next week
- Project 5 Grades released

Agenda

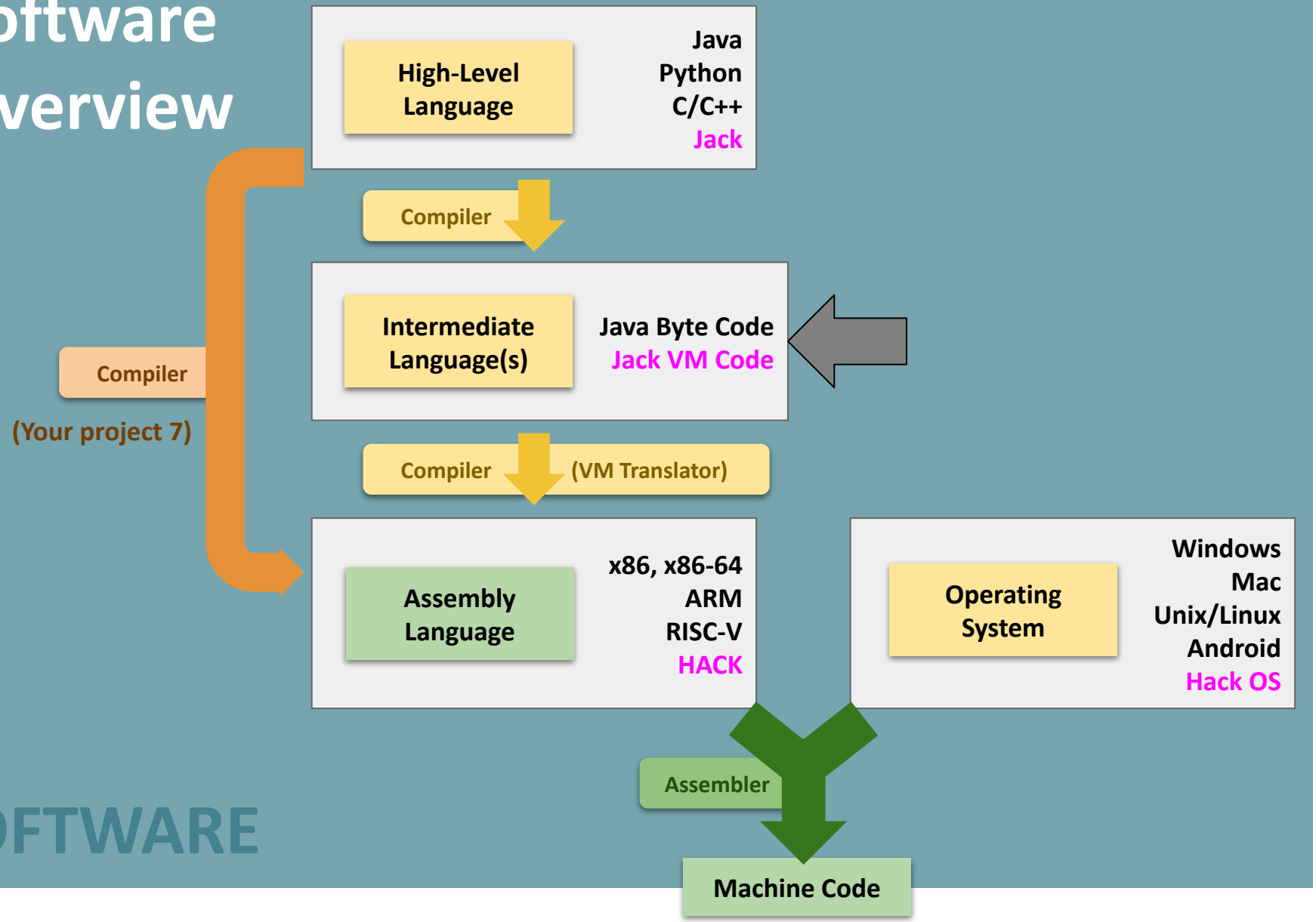
- Two tier compilation
- Design
  - What is design?
  - Design in computing

Agenda

- **Two tier compilation**

- Design
  - What is design?
  - Design in computing

Software Overview

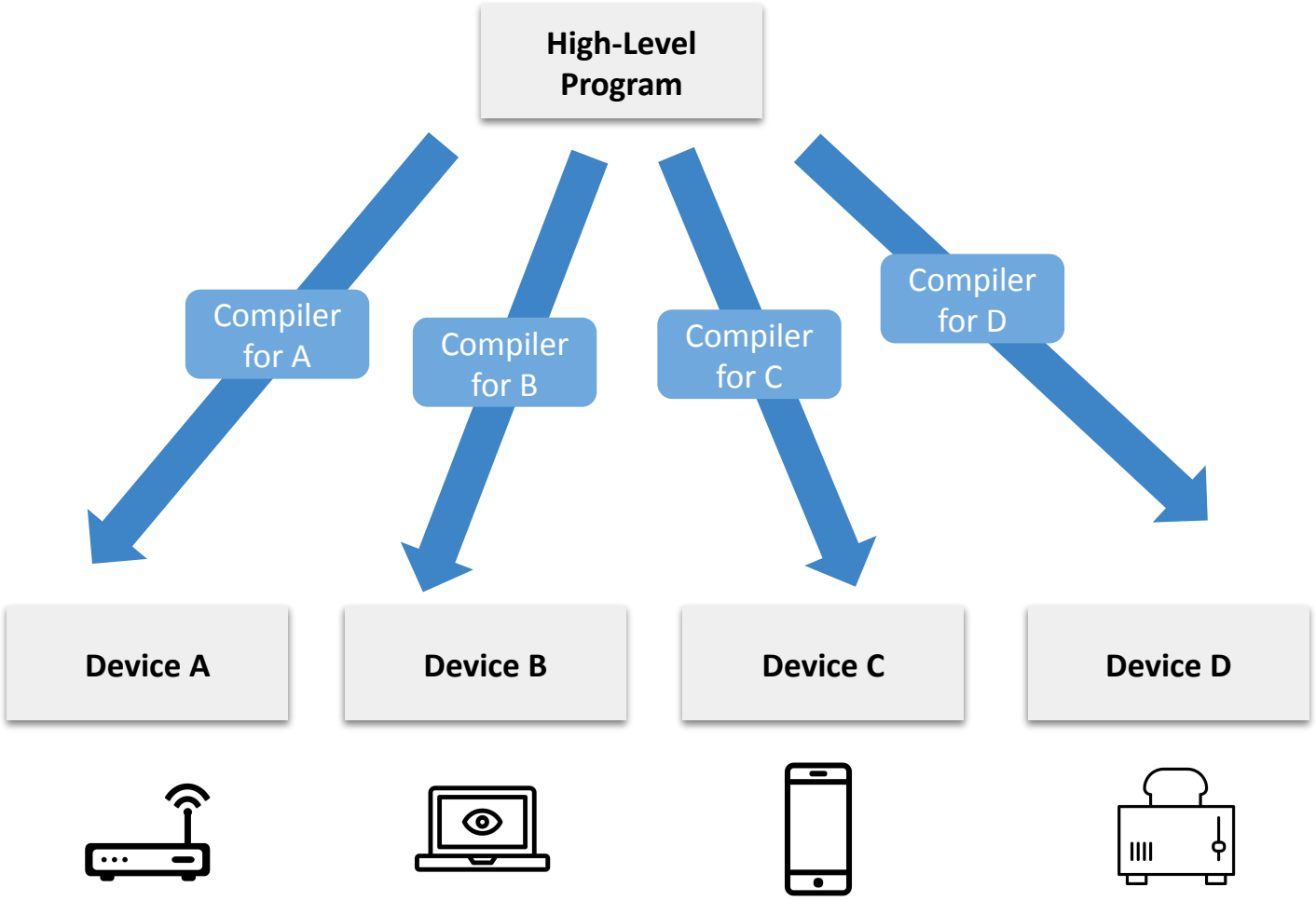


KEY: "Real-World" Examples
Our Computer

Compiling Code: Single Tier

- Compiler's job is to directly translate high-level language (e.g. Java) to machine specific instructions (e.g. x86-64 assembly)
- If a new machine architecture needs to be supported, have to reimplement entire compiler for that machine
- Programmer has to deal with any machine/system specific differences in their code

Compiling Code: Single Tier



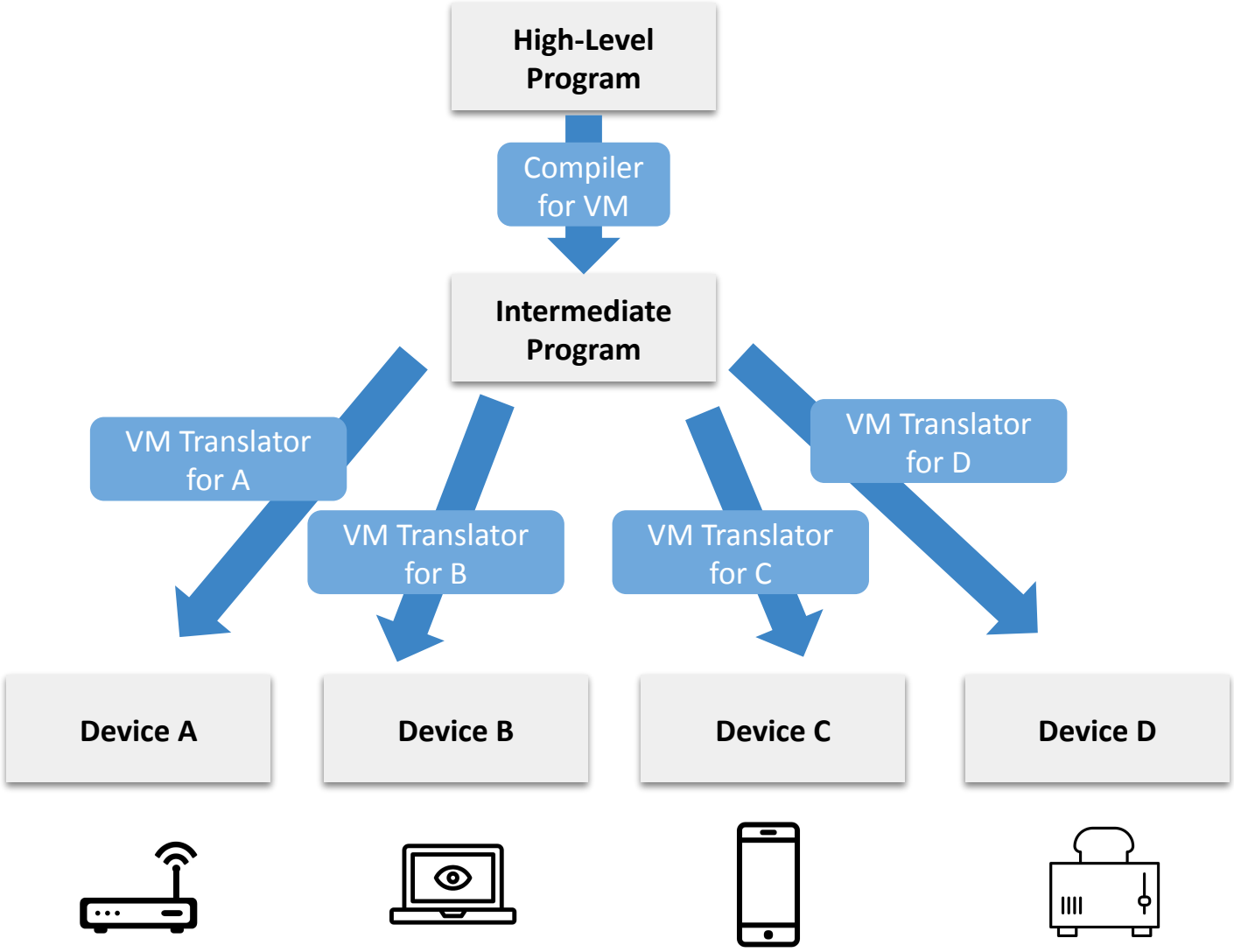
Compiling Code: Two tier

- Compiler's job is to translate high-level language (e.g. Java) to an intermediate language (e.g. JVM byte code) which is then run on a virtual machine

- If a new machine architecture needs to be supported, have to reimplement the virtual machine to run on the new hardware

- From the programmer's perspective, nothing changes at all between different architectures

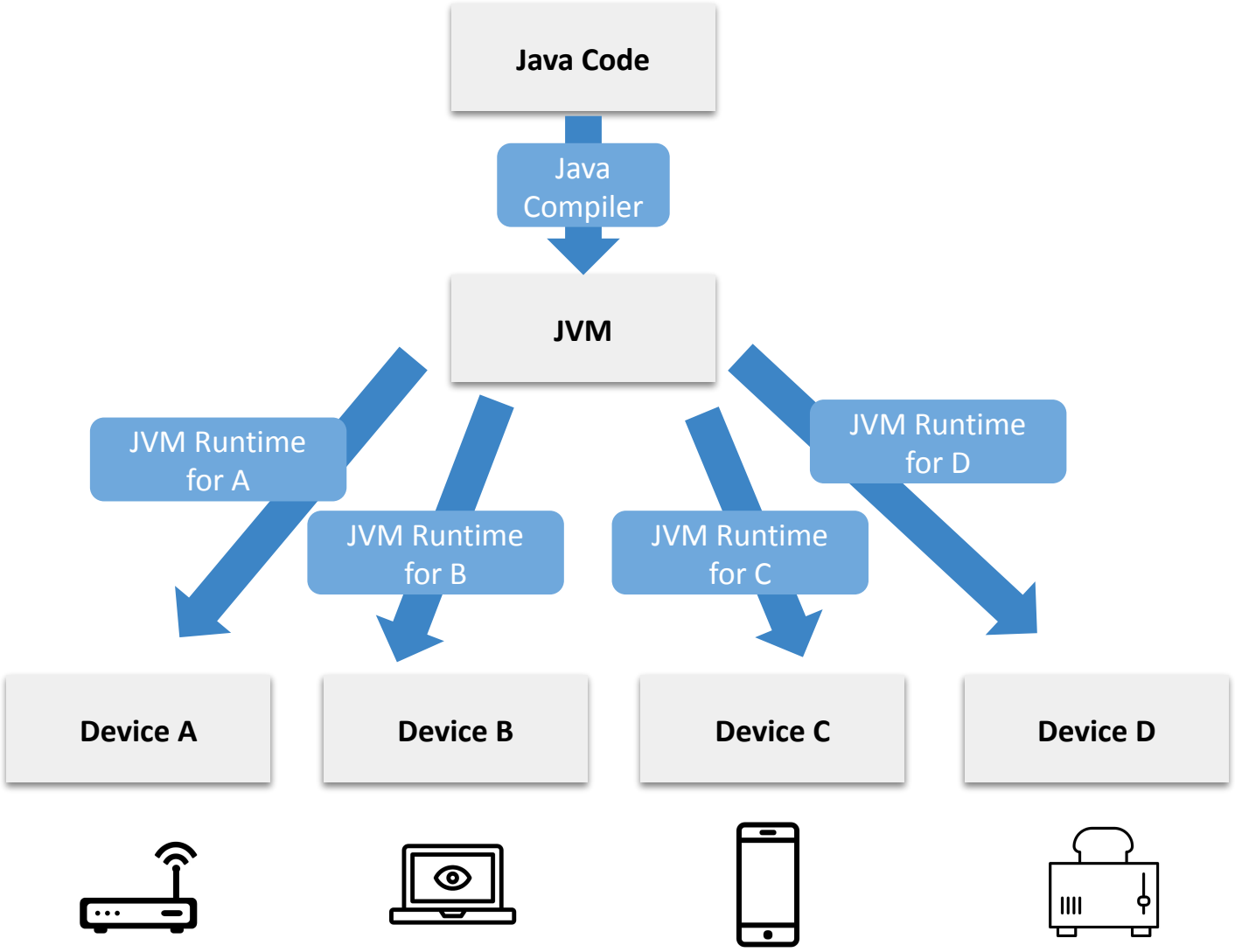
Compiling Code: Two Tier



JVM: Java virtual machine

- Since it is a "virtual" machine, it isn't actually the hardware on your laptop
  - There is further translation that happens between the JVM and your hardware
- Runs JVM Byte Code, an intermediate assembly-like set of instructions that Java is compiled into
- A "stack" machine, meaning operations/data revolve around heavy use of a stack
  - This is a bit different concept than our hardware's organization, which focuses on the use of registers
  - Read up on it if you are interested!! A different way of thinking about hardware

The JVM


Java Code
Java Compiler
JVM
JVM Runtime for A
JVM Runtime for B
JVM Runtime for C
JVM Runtime for D
Device A
Device B
Device C
Device D

Agenda

- Two tier compilation
- **Design**
  - **What is design?**
  - Design in computing

What is design?

- Could come up with thousands of different definitions!

- In breakout rooms, let's talk about what we think "design" is (not necessarily specific to computing)
  - Can come up with multiple different definitions
  - Draw from your personal experiences: what do you associate the word design with?
  - Try to pick out broad themes from specific thoughts!
  - It's ok if your broad themes aren't perfect or don't fit all situations, that would probably be an impossible task
  - Write these down so you can remember them when you share out!

What is design? Some thoughts

- One possible definition: the way something works, including how someone uses it
  - Almost always includes some element of interaction!
- Design could have different definitions/goals/interpretations in different contexts
  - It's also not always about the end-user of a product; for example, you might design a codebase so that it's easier to maintain
- Another idea: everything we create has design, but there is a range to how intentional the design of something is
  - Could be completely forgotten
  - Could be focused on throughout the creation of something

Why talk about design

- If design is "the way something works, including how someone uses it" then it dictates the interactions between us and, well, everything!

- Those interactions have a range of consequences
  - Some can be super positive: when you go to a website and you are easily able to find all the information you need
  - Some can be not ideal but fairly harmless: if a person can't easily drink from a certain cup
  - Some can be really harmful: if a person can't easily use emergency equipment

Why talk about design

- Even less than ideal but seemingly harmless interactions can have real impact on people, especially if repeated
  - Not being able to use one door might be annoying for that moment/day
  - Not being able to use almost any door you see is going to make you feel really unwelcome in society

- How can things be designed to create more positive reactions for more people while mitigating negative interactions?
  - Tough question in a world with so many different/diverse people!

- What accountability should there be for more harmful interactions caused by the design of something?
  - A big question w/a messy web of answers in our society

An Aside: Bias

- Biases are the beliefs we have, often formed by our experiences
  - Can be **explicit**: we consciously have a belief about something and it may intentionally impact us
  - Can be **implicit**: beliefs that are unconscious or impact us unintentionally

- We all have bias, and it is not inherently "good" or "bad"
  - Can have both potentially beneficial and potentially harmful consequences

- "Eliminating" bias is not a realistic goal
  - Attempting to mitigate negative consequences that come from bias is more realistic

Designer's Bias

- Things are usually designed for a "typical user"
- People often think of the "typical user" as someone who is similar to them or those they are close to
  - An example of the influence of their *biases*
  - This often happens subconsciously!
- Even if we try to think beyond what is comfortable/familiar to us, it is unlike we will remove bias from the design process
  - Opinions about what something "should" do are inherently biased
- Ideally we would develop processes that mitigate the negative effects of biases as much as possible
  - Remember that biases can be both known (explicit) and unknown (implicit)

A few ideas related to bias and design

- Following slides include some ideas and frameworks people have come up with related to bias and design

- Not meant to be the "most important" ideas
  - Think of it more as a few reference points that you can read/learn more about beyond this lecture
  - Discussions about bias and design are very nuanced and constantly evolving!

- None "solve" these issues
  - But they can be used to think about them and build better practices

Universal Design

- Big idea: design things that can be used by as many people as easily as possible
- Designing things that work well for a wide range of people includes those who might usually be excluded, but it also has the potential to benefit everyone
  - For example, some people might need captions to watch a video, others might not. Including captions with a video has the potential to benefit both groups!
- End goal of including "everyone" is nearly impossible, but it's the process that is produced by this goal that leads to better designed things
- One slide does not do this topic justice!

Inclusive Design

- Including as diverse a range of perspectives when designing something as possible
  - Similar to universal design, but you may offer different solutions for different types of people (rather than one solution for everyone)
  - "Including" a diverse perspective does not just mean having a diverse team of people. It means seriously acknowledging/valuing a diversity of opinions and experiences

- Idea is that if you prioritize diverse perspectives, especially those that have been typically excluded, it will lead to things that benefit more people

- One slide does not do this topic justice!

Affordance Theory

- Way of thinking about things around us
- Things provide different affordances to people
  - A way of defining what the capabilities of something are
- Can group these affordances into different categories:
  - What affordances does someone think/perceive something provides them?
  - What affordances does something actually provide someone?
- Four "types" of affordances (in reality it's more of a spectrum)
  - Perceptible affordance - something does what someone thinks it can
  - Hidden affordance - something does what someone thinks it can't
  - False affordance - something doesn't do what someone thinks it can
  - Correct rejection - something doesn't do what someone thinks it can't
- One slide does not do this topic justice!

Agenda

- Two tier compilation
- **Design**
  - What is design?
  - **Design in computing**

Design in Computing

- All of these discussions of design are relevant to computing and technology!
  - In fact, some of them were developed specifically thinking about design in computing
- Even though some think that technology is unbiased, there are a lot of examples that show otherwise
  - Design is part of almost everything in computing
  - Our biases influence the design of things!
- CSE has suffered from a lack of diversity, and from not valuing opinions outside of the status quo
  - This lack of diversity has led to many designs with harmful negative consequences!
  - Remember: not just about having a diverse group of people: also about valuing the thoughts and opinions of a diverse group of people

Design in Computing: Accessibility

- There is a large community in CSE focused on making technology more accessible for people
  - Example: making web pages easily navigable for people who are blind
  - Example: expanding internet access to remote populations

- Connection: elements of both universal design and inclusive design
  - Universal design: designing products that work for as many people as possible
  - Inclusive design: including more perspectives in the design process, and potentially developing specific solutions aimed at including different groups of people

- One slide does not do this topic justice!

Design in Computing: Bias in algorithms

- There has been a ton of research related to bias in AI/ML algorithms
  - Example: facial recognition technology not working as well on people of color (trained on primarily white datasets)
  - Example: racial bias in crime prediction algorithms (reflects the bias of our criminal justice system)

- These end result biases are a reflection of biased design decisions throughout development
  - Picking particular datasets that are biased towards certain groups of people
  - Testing applications in biased environments
  - Bias in what is prioritized within an algorithm

- One slide does not do this topic justice!

Design in Computing Activity

- In breakout rooms, create a short mini-presentation on the design of something related to computing
  - Could pick a technology or product and look at it from the perspective of design
  - Could pick an issue/article/event and look at it from the perspective of design

- Edit one of the following slides to have the information
  - Include a brief overview of what you are talking about
  - Include a section on how it relates to design (include as many things as you can think of!)
  - Include lingering questions or thoughts you all had as a group

- We'll give you 15 minutes! It's ok if what you come up with is a work in progress

Group/Topic 1: Accessibility in gaming

- Summary of topic

  Accessibility options have been considered a secondary priority in gaming for the longest time. Often seen as an 'extra', developers tend to overlook the needs of people with disabilities to favor mainstream appeal.

- Ways in which it relates to design

  A number of new initiatives, including a recent accessibility testing service offered by Microsoft, have been spearheaded with the goal of promoting more accessible design in games. Accessible design features include options for closed captioning and additional support features, remappable / adaptive controllers, Game Pass subscription, availability on PC and mobile apps, need for translations

- Lingering questions or thoughts you have

  Stop treating people's needs as a hypothetical and optional addition.

  How can gaming accessibility principles be applied to other fields?

Group/Topic 2: Androids vs iPhones

The two different phone OS approach what makes a good phone in different ways. Android has a bunch of different variants, is easy to customize, allows the user to adapt to own needs, and is somewhat open source in that they allow multiple companies to license the software for their hardware, while iPhones have software designed specifically for the hardware, and are built around the principles of being very easy to use and understand, simplicity, and effortless working with other Apple technology

- What Android uses could be called inclusive design, while what iPhones use could be called universal design
- Accessibility here comes in terms of what products they work with and what apps are available
- Some degree of technological literacy is required to work, but focus for both is on trying to make accessible
- Apple could be said to have bias in that kind of promotes idea of superiority with blue bubbles, etc.

Group/Topic 3: (Web Cookies in Advertising)

- Summary of topic
  - Privacy and targeted advertisements and cookies

- Ways in which it relates to design
  - algorithms are used to target consumers
  - Cookies play a discrete but indispensable role in facilitating targeted advertising in social media

- Lingering questions or thoughts you have
  - how are companies getting access to info so quickly…
    - buy something and it appears in an add
  - computers listening to people?

Ok so what can we do?

- Design is often categorized as being separate from other parts of the development process
  - In reality, it happens in almost every stage of developing something
- Even if you don't feel like your "job" is the design of something, you can still voice feedback and concerns with how something is being designed
  - You're working on a project, so you are ultimately contributing to the design of it
  - Start by figuring out what conversations/processes related to design are already occurring, then ask how can we do better?
- It may seem like a lot of "extra" work, but in reality it is a different vision of how to approach building technology
  - No longer "move fast and break things"
  - Alternative slogan offered by Animikii: "move slow and empower people"

Wrap up

- This was meant to be a brief overview of a few things related to design in computing
  - But it really only scratched the surface
- There are whole fields and majors related to design and computing
  - Human Computer Interaction (HCI)
  - User Experience (UX/UI)
  - Human Centered Design and Engineering (HCDE, major at UW)
- If you want to learn more, take a class, google, watch videos, etc.
  - CSE 340: Interactive computing
  - CSE 440: Intro to HCI
  - SOC 225: Data and society
  - HCDE department has some courses too!

Sources used that are worth checking out!

- Black People Have Always Been UX Designers: Space-making is an iterative design process
- Fundamentals of Inclusive HCI Design
- Kat Holmes: Rethink what inclusive design means
- Move Slow and Empower People: Animikii's Approach to Indigenous Technology
- CSE's inclusive community workshop
- The Theory of Affordances
- What is Universal Design? National Disability Authority
- Web Accessibility Initiative
- UNESCO report on world internet connectivity
- Racial Discrimintation in Face Recognition Technology
- Predictive policing algorithms are racist

Reminders

- Professor Meeting Report due **Tonight 3/2**
- Project 7 due **Thursday 3/4**
  - Please start if you haven't already!