

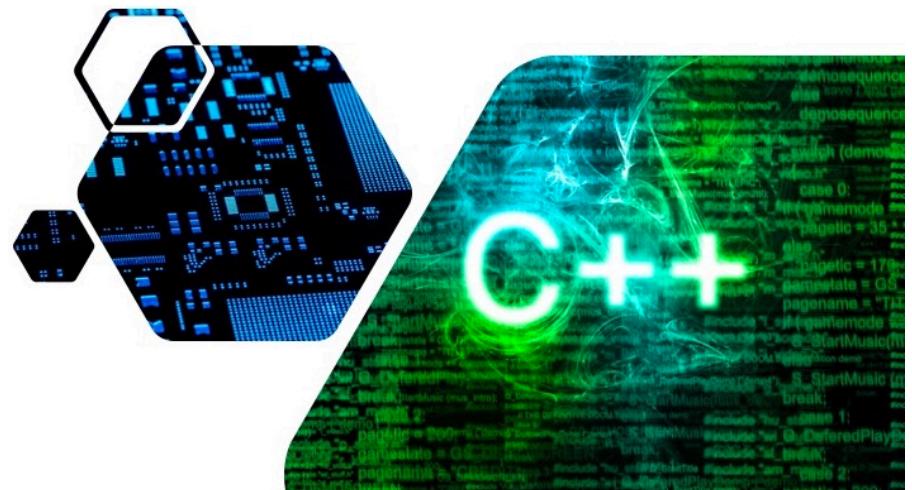
Lecture 1: Introduction to Programming

Dr. Tsung-Wei Huang

Department of Electrical and Computer Engineering
University of Utah, Salt Lake City, UT



The course teaches you how to write basic computer programs with a specific focus on the C++ programming language.



Class Logistics

❑ Staff

- ❑ Instructor: Dr. Tsung-Wei Huang (tsung-wei.huang@utah.edu)
- ❑ TA 1: Dian-Lun Lin (dian-lun.in@utah.edu)
- ❑ TA 2: Yasin Zamani (yasin.zamani@gmail.com)

❑ Main class

- ❑ 8:05 AM – 9:25 AM Mon/Wed (excluding holiday)
- ❑ Zoom: <https://utah.zoom.us/j/2468214418>

❑ Lab MEB 2555

- ❑ Friday Morning (8:30 AM – 1:45 PM over sections 41-45)

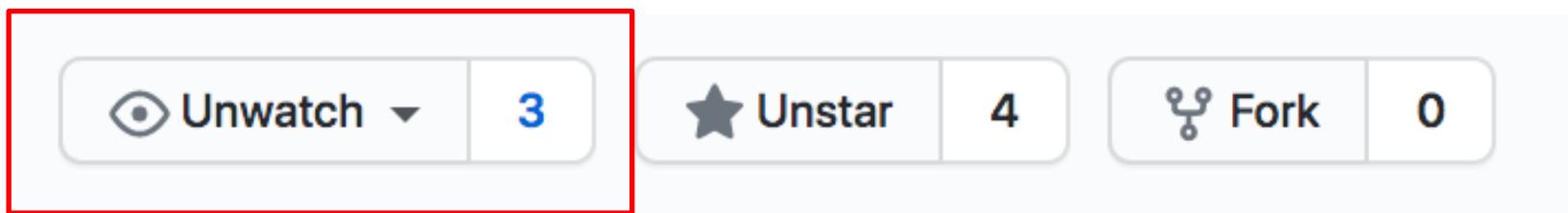
❑ Office hour

- ❑ 1-3 PM Wed at MEB 2124

❑ Web: <https://github.com/tsung-wei-huang/cs1410-40>

Watch the GitHub Repository

- ❑ <https://github.com/tsung-wei-huang/cs1410-40>
- ❑ You can receive all updates
 - ❑ New homework
 - ❑ New check-in data
 - ❑ New updates
 - ❑ ... (please register for a GitHub account)



- ❑ Canvas will be auxiliary

Scoring

- Total 120 points**
 - Weekly programming assignments (PA): 40%
 - Weekly lab participation (LA): 40%
 - Take-home exams: 40%
- Academic integrity**
 - We trust you but don't take it for granted
 - Violation will be recorded in your transcript
 - <https://regulations.utah.edu/academics/6-400.php>
- Textbook**
 - No need to buy any textbook

Learning Materials

- You **DON'T NEED** to buy any textbook
 - Slides will be available and are enough
 - Google can help you find literally all answers
 - I never use any textbook in learning C++
 - Programming requires “practice” not just reading
- Useful C++ reference
 - Cpp reference: <https://en.cppreference.com/w/>
 - CppCon: <https://www.youtube.com/user/CppCon>

C++ reference			
Compiler support	Freestanding implementations	Concepts library (C++20)	Iterators library
Language	Standard library headers	Diagnostics library	Ranges library (C++20)
Predefined concepts	General utilities library	General utilities library	Algorithms library
Keywords	Containers library	Numerics library	Memory library
Parsers	Date and time	Common math functions	Random number generation
Expressions	Filesystem library	Numeric special functions (C++17)	Periodic random number generation
Declarative	String conversion (C++11)	Pseudo-random number generation	Formatting and alignment (C++11)
Initialization	Utility library	Complex \times valarray	Complex numbers (C++11)
Forwards	past = tuple<C++11>	Input output library	basic_istream <C++20>
Statements	optional<C++17> = any<C++17>	Stream-based IO	basic_ostream <C++20>
Closures	variant<C++17> = format<C++20>	basic_iostream <C++20>	IO manipulators
Templates	basic_string_view<C++17>	Localization library	Regular expressions library (C++20)
Error	multibyte = wide	basic_localtime <C++20>	basic_regex = algorithms
Headers	Containers library	Atomic library (C++11)	atomic <atomic>
Named requirements	map = unordered_map<C++11>	atomic_flag <atomic>	atomic_cancel <atomic>
Function test macros	pair = unordered_pair<C++11>	atomic_flag::test_and_set<C++20>	atomic_cancel::cancel_if<atomic>
Language support library	Other containers	atomic_cancel::cancel_if<atomic>	atomic_cancel::cancel_if<atomic>
Type support traits (C++11)	unordered_associative = adaptors	Thread support library (C++11)	Filesystem library (C++17)
Relational comparators (C++20)			
Memory models (C++20)			
Initializer list (C++11)			
Technical specifications			
Standard library extensions	Library fundamentals TS1		
Library fundamentals TS1	Library fundamentals TS1		
Standard library extensions V2	Library fundamentals TS2		
prologue const = intrinsicJoiner = randist	Library fundamentals TS2		
decoy	Library fundamentals TS3		
Standard library extensions V3	Library fundamentals TS3		
clipper unique = unique	Library fundamentals TS3		
Concurrency library extensions	Concurrency TS		
Concurrent concepts (concurrent TS)			
Ranges			
Transactional Memory (TM TS)			



Class Philosophy

- ❑ **Focus on software programming**
 - ❑ With applications on ECE problems
 - ❑ With focus on the C++ programming language
- ❑ **NOT to trouble you with**
 - ❑ Difficult homework
 - ❑ Tricky exams
 - ❑ Unreasonable learning and scoring curve
- ❑ **At the end of the class, I want you to**
 - ❑ Understand important ECE programming problems
 - ❑ Improve your coding skills and algorithm knowledge
 - ❑ Have more job opportunities in software companies

To this end ...

- **Each class is organized as two parts**
 - Lecture
 - Programming practice
- **We will start from very basic stuff and then move up**
 - Important
 - Basic data structure and algorithms
 - C++ coding techniques and best practice
- **Solve real-world computer design problems in C++**
 - Program on microcontroller
 - Program circuit design problems
 - ...

Physical LAB at MEB 2555

- We have five LAB sections**
 - Section 1410-41: 09:40AM-10:30AM, Friday
 - Section 1410-42: 10:45AM-11:35AM, Friday
 - Section 1410-43: 11:50AM-12:40PM, Friday
 - Section 1410-44: 12:55PM-01:45PM, Friday
 - Section 1410-45: 08:35AM-09:25AM, Friday
- LAB gives you hands-on programming experience**
 - Participation counts 40% of your score
 - TA will go over
 - weekly programming assignment
 - weekly lab assignment

Please Wear Your MASK in LAB

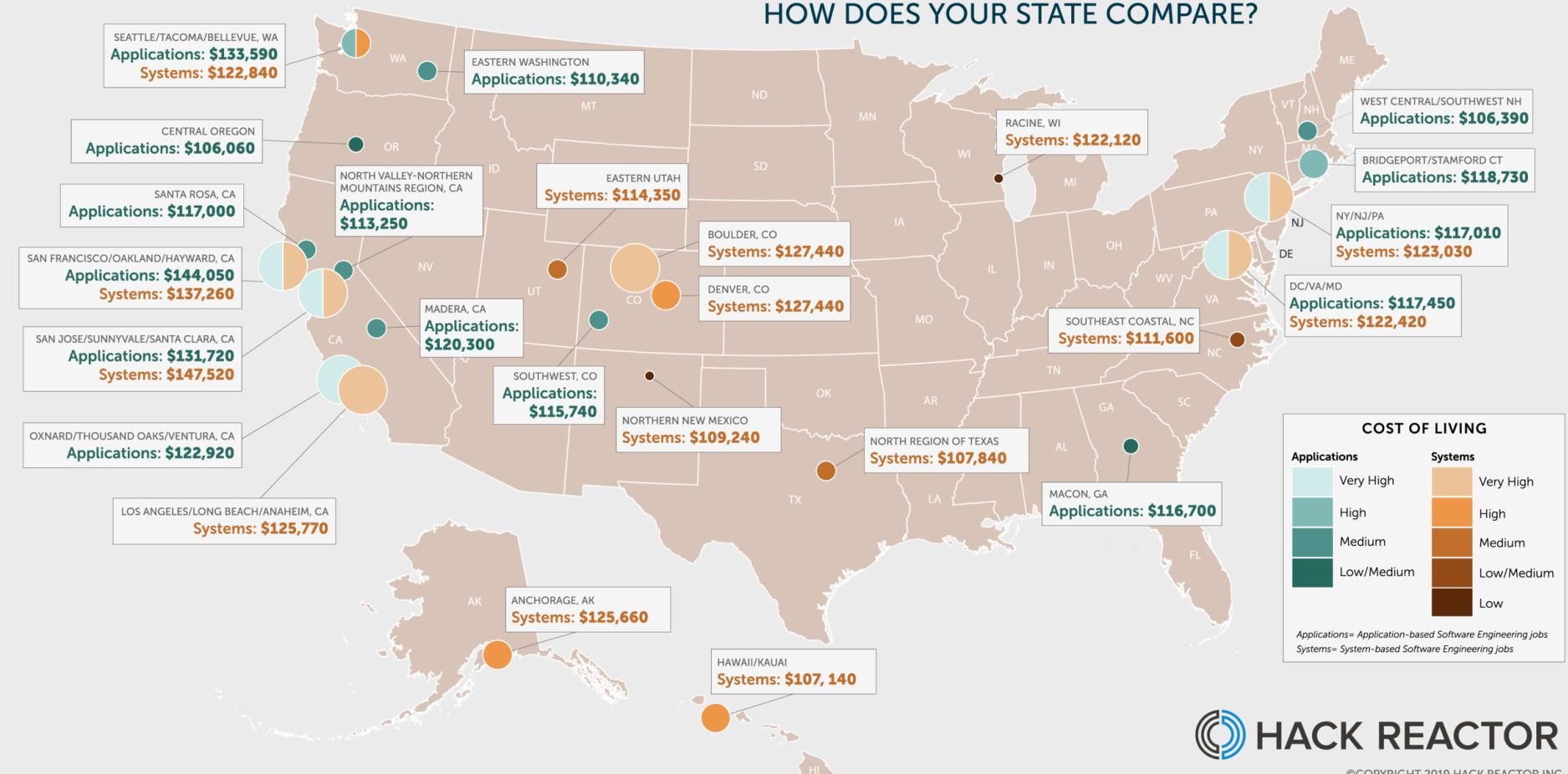


Utah CADE Machines

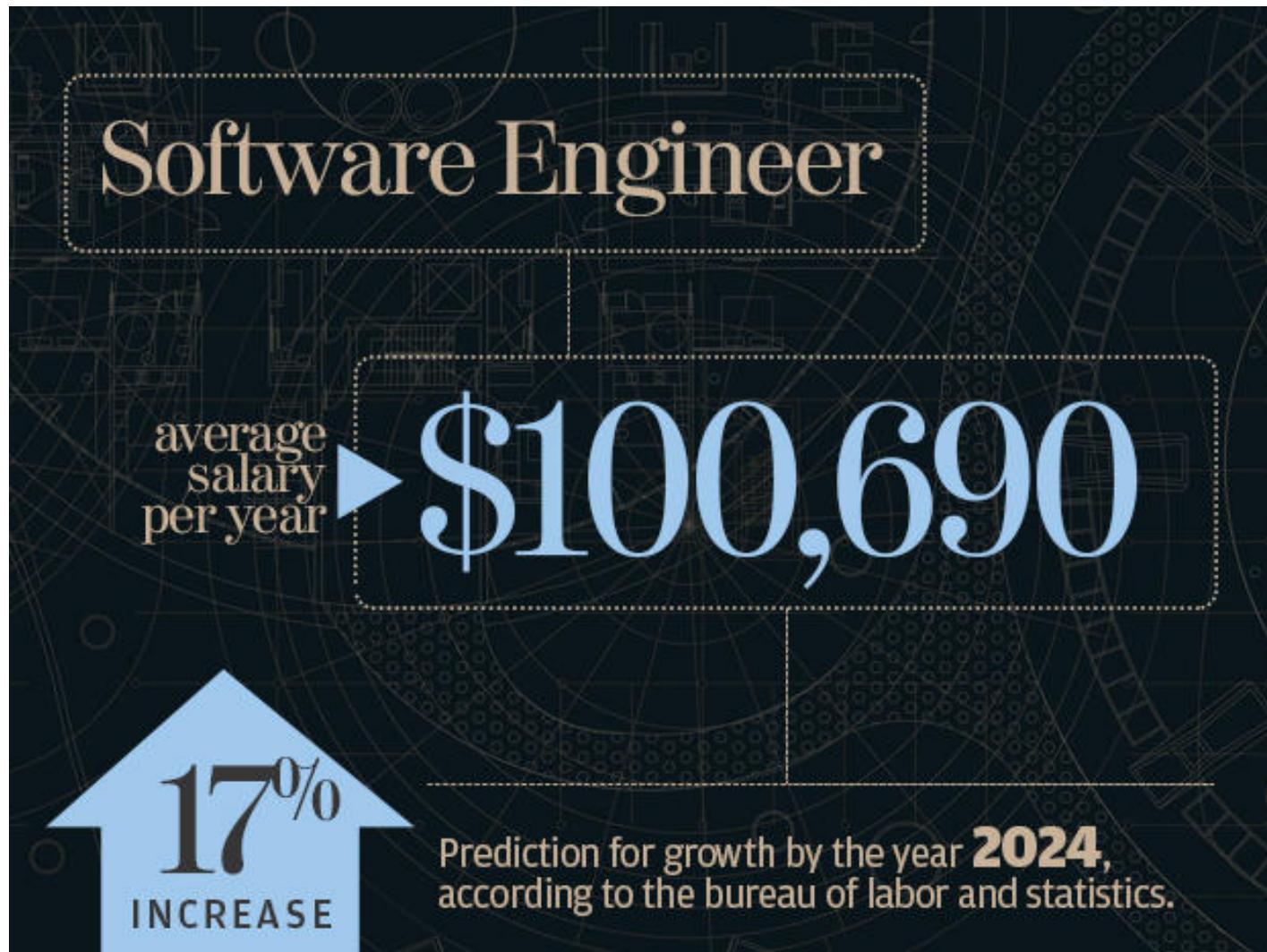
- **All of you should have access to CADE servers**
 - If not, go apply for one at: <https://www.cade.utah.edu/>
- **CADE machines have all the facilities we need**
 - Domain: labX-Y.eng.utah.edu
 - X = 1, 2, 3, ... (# of lab space)
 - Y = 1, 2, 3, 4, 5, ... (machine # of each lab space)
 - For example, lab2-20.eng.utah.edu
 - Account: your uid
 - Password: your uid login password
- **Remote login using ssh (the easiest way)**
 - ssh -x u6024634@lab2-20.eng.utah.edu

Software Engineer Job Landscape

SOFTWARE ENGINEER SALARY REVIEW 2019: HOW DOES YOUR STATE COMPARE?



Software Engineer Jobs are Growing!



Silicon Slope is right here in Utah!!!

A rainbow sampling of companies that make Utah Valley the #1 place for business and careers according to **Forbes magazine**.



"Topping our 14th annual list of **The Best Places for Business and Careers is Provo, Utah**. The **\$16 BILLION ECONOMY** is thriving largely on the back of **BRIGHAM YOUNG UNIVERSITY** ... Job growth was a robust **3%** in the Provo metro in 2011, **THIRD BEST IN THE U.S.** It enjoys – by far – the **LOWEST VIOLENT CRIME RATE IN THE U.S.** and ranks tenth lowest overall for crime, including property crime. The **METRO POPULATION** has doubled over the past two decades to **542,700**."
– **Forbes magazine**

We live in a highly connected world ...

Transmission and Interface

Connecting



Mobile Phone



Smart Mobile Phone



PDA

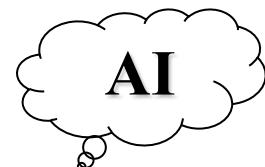


Palm PC

Screen Phone



Auto PC



AI



Set Top Box



Handheld Game



Game Console



DSC

Computing



Handheld PC



Thin Client



MP3

Data Processing

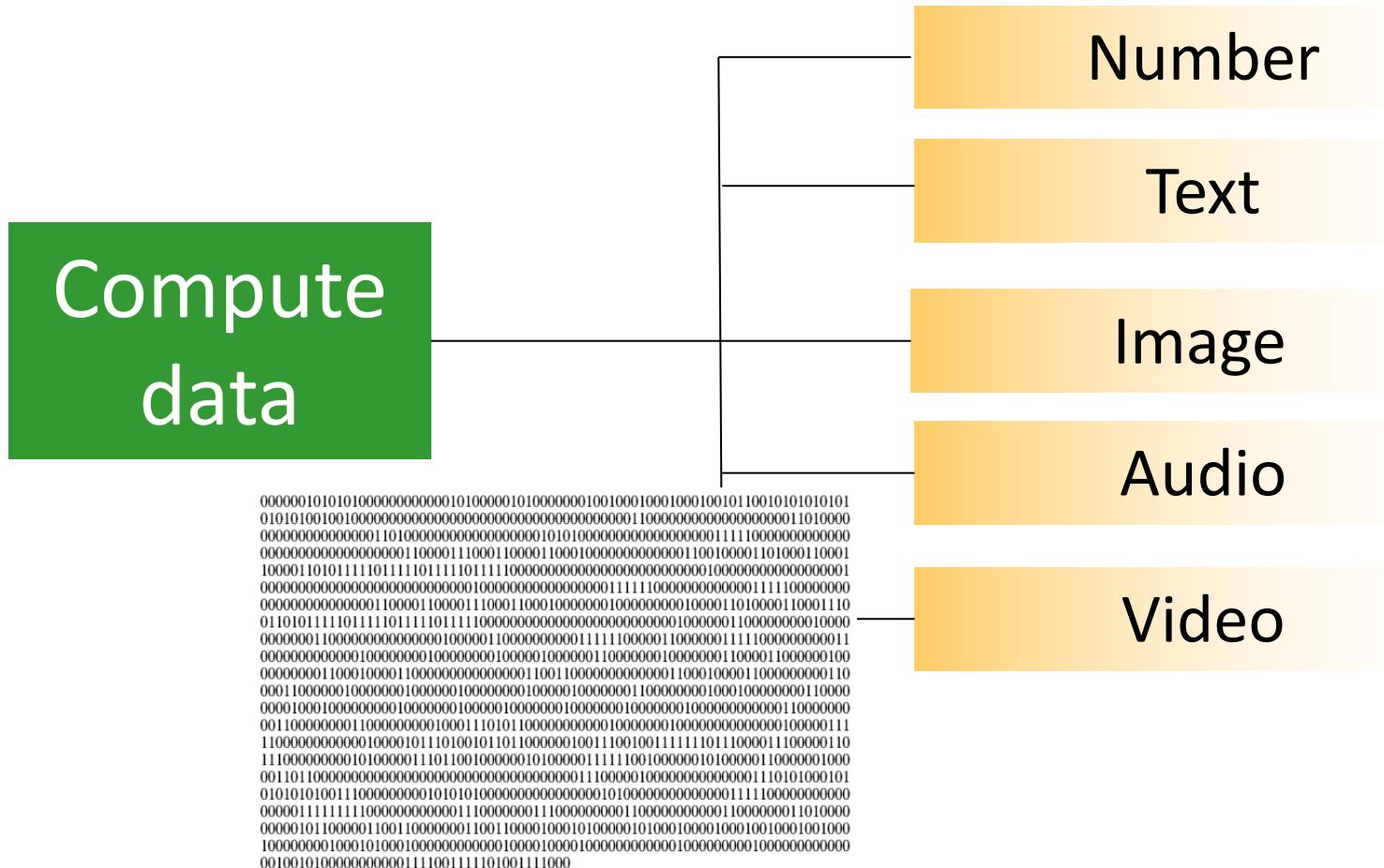
Consumer



Net TV

Data Processing

Computing Plays a Key Role

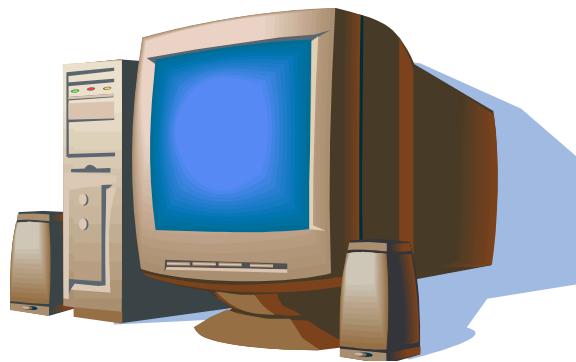


Computer see everything in binary (0 and 1)

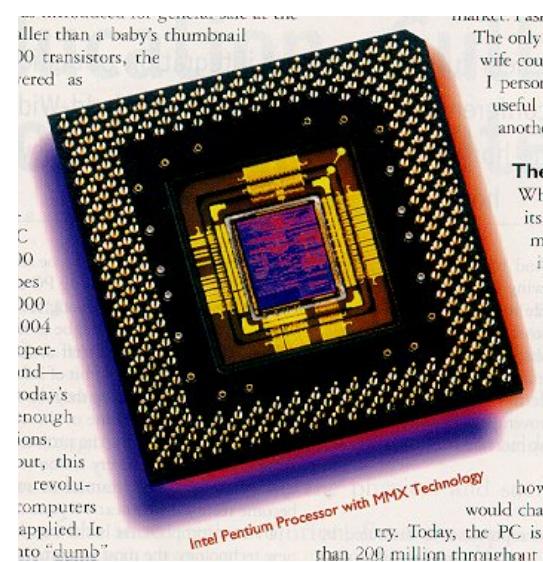
Hardware vs Software

The focus
of this
course

```
main ()  
{  
    say hello;  
    go to internet;  
    goodbye;  
}
```

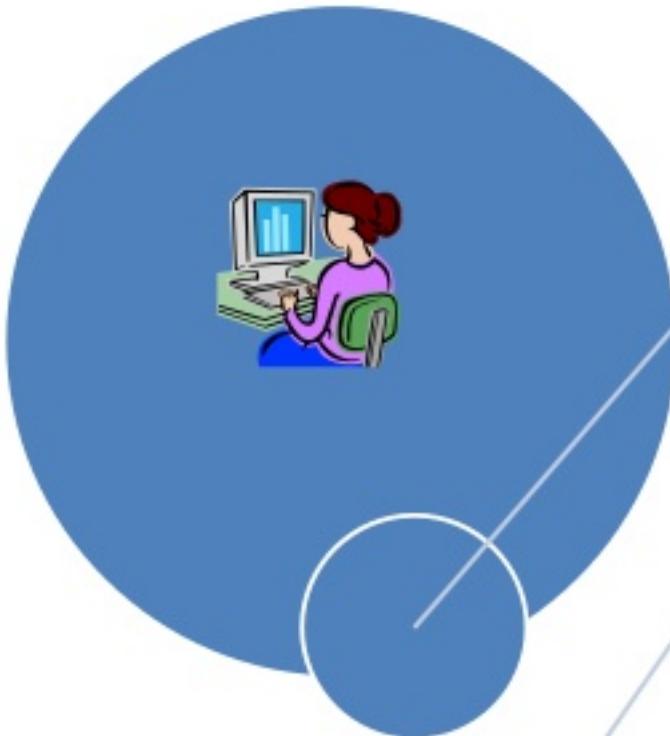


Software



Hardware

What is Software?



Software is a general term for the various kinds of programs used to operate computers and related devices. (The term hardware describes the physical aspects of computers and related devices.)

How do We Talk to Computers?

- Like we talk to human through “language”
 - English, Mandarin, Hindi, ... => depending on countries
 - C++, PHP, Python, JS, ... => depending on applications



Top 10 Programming Languages

Rank	Language	Type	Score
1	Python	🌐💻⚙️	100.0
2	Java	🌐📱💻	96.3
3	C	📱💻⚙️	94.4
4	C++	📱💻⚙️	87.5
5	R	💻	81.5
6	JavaScript	🌐	79.4
7	C#	🌐📱💻⚙️	74.5
8	Matlab	💻	70.6
9	Swift	📱💻	69.1
10	Go	🌐💻	68.0

1	Java	
2	C	
3	Python	
4	C++	
5	Visual Basic .NET	
6	Javascript	
7	C#	
8	PHP	
9	SQL	
10	Objective-C	
11	MATLAB	
12	R	
13	Perl	
14	Assembly Language	
15	Swift	
16	Go	
17	Delphi/Object Pascal	
18	Ruby	
19	PL/SQL	
20	Visual Basic	

An Often Asked Question



From an ECE undergraduate's perspective

- It doesn't matter
 - Unless you just want to get hacky programming experience and find a job quickly ...

**Learning “how computers think” and
“how you talk to computers through
one language” is more important!**

Let's Do an Example

- Find a power of a number
 - Input: a, b ($1 < a, b < 2147483647$)
 - Output: $x = a^b$
 - $a=3, b=4, x=3^4=81$
 - $a=2, b=5, x=2^5=32$
 - Assume you can only do multiplication one at a time
- Naïve method
 - $2^{16} = 2*2*2*2*2*2*2*2*2*2*2*2*2*2*2*2$ total 15 calculations
- Can we do better?

Divide and Conquer

- Naïve method

- $2^{16} = 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2 * 2$ total 15 calculations

- A better way as follows:

$$2^{16} = 2^8 * 2^8$$

$$2^8 = 2^4 * 2^4$$

$$2^4 = 2^2 * 2^2$$

$$2^2 = 2 * 2 \quad \text{We need only 4 calculations!!!}$$

How Efficient is it to Compute a^b ?

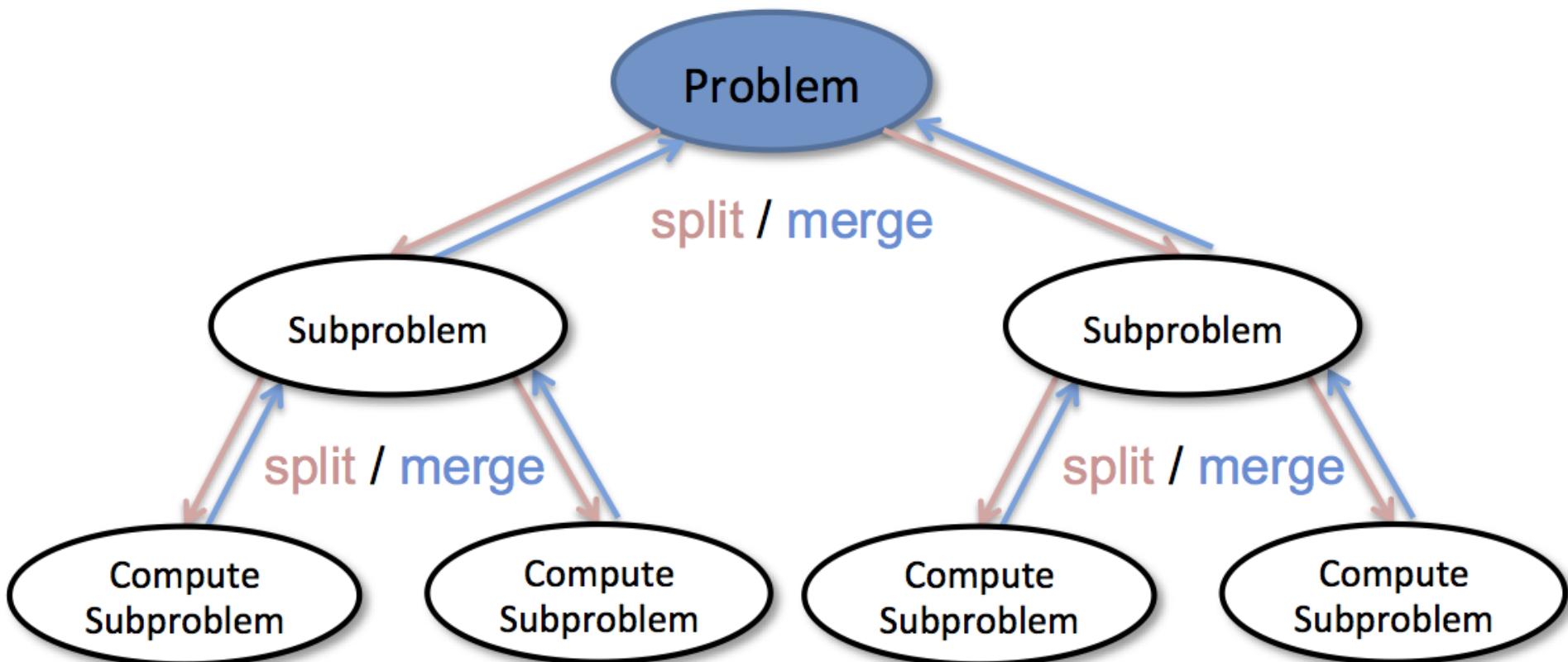
- Naïve method
 - # calculations: linear to b
- Divide and Conquer
 - # calculations: $\log_2(b)$
- Let's say $n = 2147483648$
 - Naïve method takes **2147483647** calculations ($\sim 10\text{-}30\text{s}$)
 - Divide and Conquer takes only **31** calculations ($\sim 1\mu\text{s}$)
 - 10000000x faster!
 - Indeed, this is a Goo__ interview question

In fact, there is a name for the refined method:

Divide and Conquer algorithm

*(used to solve >50% computer science problems,
including Google's distributed system solutions,
e.g., MapReduce)*

Divide and Conquer is the most basic building block to solve almost all difficult computer problems



Targeted Programming Language

- **We will be using C++ most of the time**
 - Most large-scale problems are written in C/C++
 - Most AI backend engines are written in C/C++
 - Most performance-critical blocks are written in C/C++
- **C++ is advantageous in**
 - Being both high-level and low-level
 - Linking to hardware and computer architecture
 - Understanding memory hierarchy and cache effect
- **We will talk a bit about Java at the end of the course**

Once You Master C++ ...

C++ and JAVA developer: learning
PYTHON



PYTHON developer: learning JAVA and
C++



Summary

- Class Logistics
- Software engineering
- Programming languages