CS 261
Fall 2019

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AN x64 PROCESSOR IS SCREAMING ALONG AT BILLIONS OF CYCLES PER SECOND TO RUN THE XNU KERNEL, WHICH IS FRANTICALLY WORKING THROUGH ALL THE POSIX-SPECIFIED ABSTRACTION TO CREATE THE DARWIN SYSTEM UNDERLYING OS X, WHICH IN TURN IS STRAINING ITSELF TO RUN FIREFOX AND ITS GECKO RENDERER, WHICH CREATES A FLASH OBJECT WHICH RENDERS DOZENS OF VIDEO FRAMES EVERY SECOND

BECAUSE I WANTED TO SEE A CAT JUMP INTO A BOX AND FALL OVER.

I AM A GOD.

Computer Systems I: Introduction

Welcome!

Please go to `socrative.com` on your phone or laptop,
choose "Login" then "Student Login" and join room "LAMJMU"
Use the suggested format and spell your name correctly!

Question

- What will be the output of this C program?

```c
#include <stdio.h>
int main() {
    int x = 40000;
    int y = 50000;
    if ((x * x) < (y * y)) {
        printf("Less than\n");
    } else {
        printf("Not less than\n");
    }
    return 0;
}
```

- A) "Less than"

- B) "Not less than"

- C) Neither of the above

Question

- What will be the output of this C program?

```c
#include <stdio.h>
int main() {
    double a = 1e20;
    double b = -a;
    double c = 3.14;
    if (((a+b) + c) == (a + (b+c))) {
        printf("Equal!\n");
    } else {
        printf("Not equal!\n");
    }
    return 0;
}
```

- A) "Equal!"

- B) "Not equal!"

- C) Neither of the above

Question

- Which of the following versions of a "matrix copy" routine will run the fastest?

  - A)
    ```
    for (int i = 0; i < 2048; i++) {
        for (int j = 0; j < 2048; j++) {
            dst[i][j] = src[i][j];
        }
    }
    ```

  - B)
    ```
    for (int j = 0; j < 2048; j++) {
        for (int i = 0; i < 2048; i++) {
            dst[i][j] = src[i][j];
        }
    }
    ```

  - C) Neither; they will always run at approximately the same speed.

What's happening?

- Something about our **mental model** of these programs does not match the **system** on which we're running them.

Systems

- What is a "system?"

Systems

- What is a "system?"
  - Set of interacting components
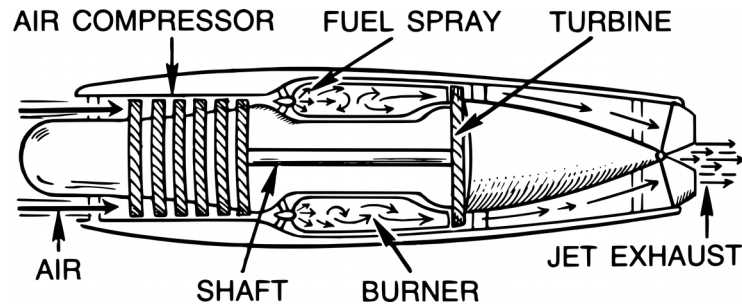 - More than the sum of its parts

Jet engine

Computer

Systems

- What is a "system?"
  - Set of interacting components
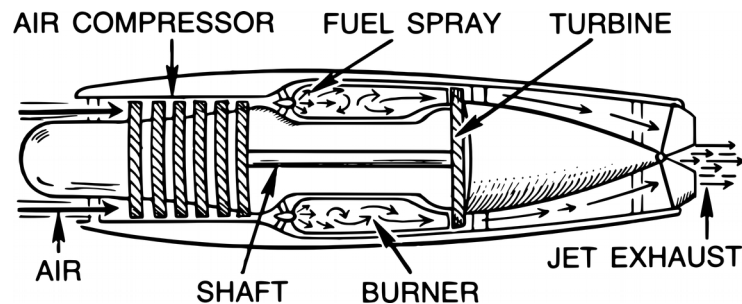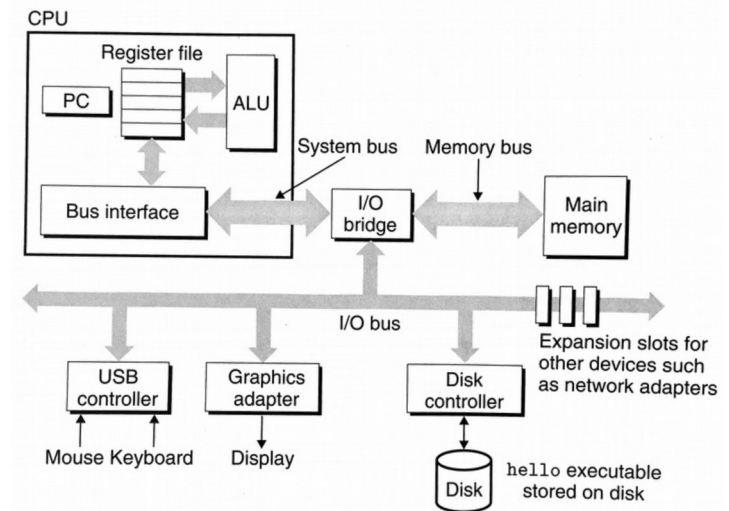 - More than the sum of its parts

Jet engine

Computer

Systems

- What is a "system?"
  - Set of interacting components
  - More than the sum of its parts

**Jet engine**

Computer

Systems

- A **computer system** consists of multiple hardware and software components that work together to run user applications.
  - We use complex computer systems every day
  - Our goal: peel back some of the complexity
    - See (some of) what's "under the hood"

Systems

- What is a *process*? What is a *file*?
  - These are examples of abstraction; "fake" views of reality that reduce complexity for users
  - Key ideas: **ignore details** and **focus on interfaces**
  - Especially important in large, complicated systems
  - Understanding abstractions can improve your ability to use them effectively
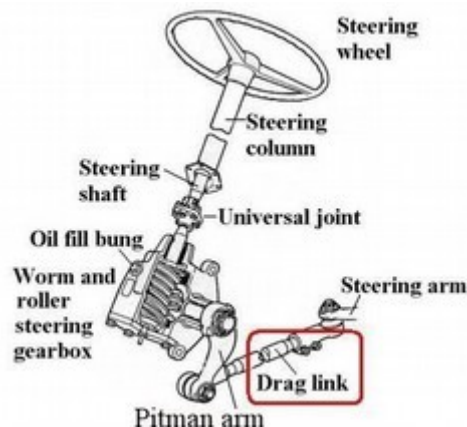

abstraction

Caveat

- Software system vs systems software
  - Former: interconnected software components
  - Latter: software providing services to other software
  - We are concerned with both!
    - Examples: multiprocessing, networking, operating systems, compilers, distributed systems

CS 261

- What this course is NOT:
  - Programming 101 – I will assume you can program
    - However, we will spend a few weeks learning C
  - Electronics 101 – we won't be going THAT deep
    - If you're interested, check out PHYS 240/250
  - Linux 101 – but you have the Unix Users Group
    - InstallFest on Wed, Sep 11 at 6:30 in ISAT/CS 246
    - Weekly meetings thereafter (same time and place)
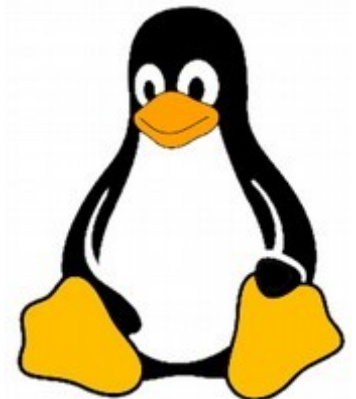
CS 261

- This is not an "**easy**" course
    - *But you **can** handle it!*
    - Be prepared to **read** and **work** a lot
    - Don't be afraid to experiment
    - Growth vs. fixed mindset
    - Some stuff is worth memorizing
        - (e.g., powers of two and hex characters)
    - For other stuff, **Google** is your friend
    - **Piazza** is also your friend (literally)
    - Start assignments **early** and <u>ask questions</u>
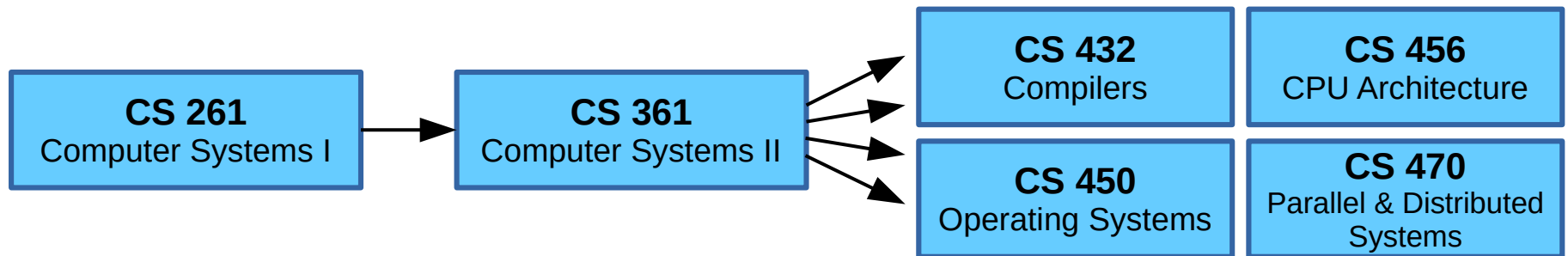

FALLING PENGUINS

Course Objectives

- Explain machine-level representation of data and code
- Summarize the architecture of a computer
- Explain how complex systems are built from simple components
- Translate high-level code into assembly and machine language
- Write code to emulate the functionality of a computer

- Cultivate a sense of control over computer systems
- Gain an appreciation for software development tools
- Develop a sense of play when writing code
- Appreciate the complexity of systems-level software

Systems courses

- CS 261 units:
  - C and Linux (3 weeks)
  - Binary Representations (2-3 weeks)
  - Assembly and Machine Code (2 weeks)
  - Computer Architecture (3 weeks)
  - Operating Systems Concepts (3 weeks)

CS 261 Computer Systems I	→	CS 361 Computer Systems II	→	CS 432 Compilers	CS 456 CPU Architecture
				CS 450 Operating Systems	CS 470 Parallel & Distributed Systems

Fundamentals of digital,
single-process systems

Multi-process systems
and networking

In-depth study of a particular
kind of complex system

Course Components

- **Public website** (`w3.cs.jmu.edu/lam2mo/cs261`)
  - Syllabus, **calendar**, assignments, and resources (links)
- **Canvas course**
  - Quizzes and unit tests
  - Grades and private files (e.g., lab solutions)
  - Piazza Q&A and discussion forum
- **Student server** (`stu.cs.jmu.edu`)
  - Project development and submission

- Make sure you can access all of these!

Course Grades

|	
Quizzes and Labs	20%
Programming Projects	30%
Online Unit Tests	20%
Written Exams	30%

- Quizzes and labs are **formative**
  - Designed to help you learn
- Projects and tests/exams are **summative**
  - Designed to assess what you have learned

Textbook(s)

- Required textbook: "Computer Systems"
  - "CS:APP" textbook from Carnegie-Mellon
  - A practical, example-filled introduction to systems
  - Reserve copy at the Rose library
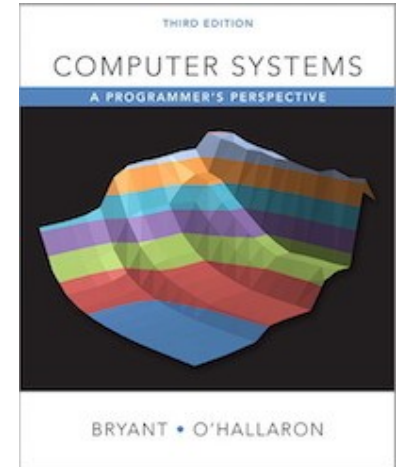
- Recommended book: "The C Programming Language"
  - **Brian Kernighan** and **Dennis Ritchie** (creator of C)
  - This is "the book" about C
  - Available on Safari Books through the library
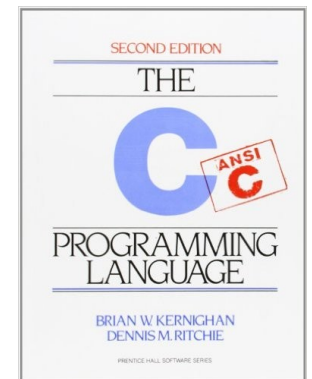
Class Policies

- Check Canvas daily for quizzes
- Class attendance is necessary
  - We will be "learning by doing" much of the time
  - Find a group (2-3 people) to work with consistently, or switch it up
- Slides will be posted on the website
  - No need to copy them to your notes
- Please silence your cell phones during class
  - Be respectful with laptop and tablet usage

Course Policies

- The projects in this course are VERY important!
  - One purpose of this course is to ensure you are ready to tackle harder projects in CS 361 and the system electives

- Projects are **individual** and **mandatory**
  - A "good faith" submission shows evidence of significant work and investment in writing a solution
  - A "good faith" submission gets you an "F" (50 or 60 points) instead of a zero!

Course Policies

- The JMU Honor Code applies on ALL assignments
  - Violations may be sent to the honor council
  - See relevant section in the syllabus
- All submitted project code must be YOUR work entirely
  - You may work in groups to discuss general approaches (in fact, I encourage this; use *pseudocode* if necessary)
  - However, the primary goal of the projects in this course is to develop individual competency, so **you may NOT share code**
  - This includes letting someone examine or take a photo of your code, or "talking it through" with them line-by-line
  - If you have questions about this, please ask!

Question

- Which of the following are honor code violations in this course when done in the presence of non-instructors? (Select all that apply.)
  - A) Writing English psuedocode of project solutions on a whiteboard
  - B) Storing project solutions in a public Github repo
  - C) Screen-sharing with project code visible on Skype
  - D) Writing C code of project solutions on a whiteboard
  - E) Discussing code design choices (e.g., "did you write a helper method for this part?")
  - F) Storing project solutions in a private Github repo
  - G) Taking a photo of project code on a computer screen

Course Policies

- There are a total of three sections of CS 261
  - Two Lam sections (T-Th) and one Weikle section (M-W)
  - Course materials are (mostly) in common
  - You are welcome to study with students from other sections, but you must attend and submit assignments to the section you are registered for

Intro lab

- Material from Chapter 1
- Front page: **Computer Organization**
- Back page: **C Compilation**
- Work in groups of 2-3 (no computer required)
- Submit at end of class

Office hours

- Tentative (finalized by end of week) office hours:
  - M 10:00-noon (**flex time**; I may not be there)
  - Tu/Th 3:30-5pm (regular)
  - W 10:00-noon (regular)
- Many general TAs have taken CS 261
  - ISAT/CS 248 and 250
  - 5pm-11pm on Mon-Thurs and Sunday 1-11 pm
- CS 261-specific TA: **Courtenay Taylor**
  - Sunday 1-3pm
  - Tuesday, Wednesday, Thursday 7-9pm

Have a great semester!

- If you haven't already:
  - **Take the intro and email disclosure surveys on Canvas**
  - **Take syllabus quiz on Canvas**

- Before Thursday:
  - **Read sections 1.1-1.4 and 1.8 in CS:APP and take quiz**
  - **Make sure you can log into `stu`**
  - Make sure you can access Piazza
  - Review these slides
  - Read project guide on website
    - For a real head start, read the Project 0 description