

# **CS 326:** Operating Systems

Lecture 1

# Welcome to CS 326!

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- Looking forward to a great semester!
- *Lecture: **MWF*** · 10:30am – 11:35am · **GL** 213
- *Lab Session: **Monday*** · 11:40am – 1:10pm · **GL** 213

# Staff

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- **Instructor:** Matthew Malensek
  - [mmalensek@usfca.edu](mailto:mmalensek@usfca.edu)
  - Office Hours: **W, F** 12:00pm – 1:00pm in **HR** 407B
- **TA:** Heran (Steven) Zhang
  - Office Hours:
    - **T** 6:00pm – 7:00pm and **Th** 12:00pm – 1:00pm (via [Zoom](#))
    - **Th** 12:00pm – 1:00pm in **HR** 411

- Chances are, you already know of at least one operating system...
  - ...or even a few...
- ...but what do they do? And more importantly, what's the point of having one? Why should we even care?

# Operating Systems

- The OS abstracts the underlying hardware and exposes a clean, easy-to-use interface to software applications
- What's the point of having one?
  - Without the OS, you don't have things like:
    - Multitasking
    - Hardware drivers
    - File systems
- Why should we even care?!
  - If you understand how the OS works, you will work more efficiently, and the *software you write for it* will be better!

# Today's Agenda

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- Syllabus
- Introduction to Operating Systems

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- **Syllabus**
- Introduction to Operating Systems

# Quick Note: Prerequisites

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- CS 220 or CS 221 with a C or better
  - If it's been a while since you've programmed in C, plan on spending some time refreshing your memory!
- CS 245 with a C or better
  - Strictly enforced



# Communication

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- If you need help, our main mode of communication is [CampusWire](#)
  - Q&A link on the website takes you there
  - You can post anonymously if you wish

# Staying up to Date

- I will regularly update the **schedule** page on the course website
  - Upcoming topics, readings, due dates
  - Lecture slides, videos
  - <https://www.cs.usfca.edu/~mmalensek/cs326>
- Grades will be posted on Canvas
- Project submissions: GitHub

# You Will Learn

- How to configure a Linux-based operating system and work from the command line
- Operating system components and their implementations
  - Threads, processes, synchronization primitives, system calls, scheduling, virtual memory, file systems
- How to develop UNIX systems software
- Debugging complex systems and low-level software
- UNIX tools such as `make` and `git`

# Course Overview

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1. VMs, general command line, C refresher
2. Booting up and processes
3. System calls
4. Inter-process communication
5. CPU Scheduling
6. Memory management
7. Disk I/O
8. Networking, containers, distributed systems, etc...

# Books

- *xv6: a simple, Unix-like teaching operating system.*  
Russ Cox, Frans Kaashoek, and Robert Morris.
- *Operating Systems: Three Easy Pieces*
  - Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau
  - Free and available online as a PDF!
    - <http://pages.cs.wisc.edu/~remzi/OSTEP>
- *Extreme C.* Kamran Amini.
- *The C Programming Language, 2nd Edition.* Brian W. Kernighan and Dennis M. Ritchie

# Course Structure

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- There's a decent amount of theory in CS 326, but we'll spend a lot of time applying it in practical situations
  - We'll be writing low-level code and working with the command line extensively
- Assignments: labs and ~4 **large** projects
- Assessment: quizzes every ~3 weeks
- And there's also a lab session on Mondays...

# Lab Session

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- Lab time gives us the opportunity to work on labs/projects as a class and get feedback
- We'll review concepts as a class, answer questions, check your lab assignments, etc.

# Grade Distribution

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- Labs: 30%
- Quizzes: 30%
- Projects: 40%



# Lab Assignments

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- Small assignments that we start or complete in class
- Grading is fairly simple, you either get credit or you don't.
- Use class time, lab time, or office hours to check your work.

# Quizzes

- Given roughly every three weeks
- Helps us go back and review what we've covered
- The strategy to do well is:
  - 1.** Take note of concepts that are demoed in class. These are most important.
    - Sometimes questions are even revealed in advance...
  - 2.** Review the slides.
  - 3.** If something isn't clear, review the lecture videos and book chapters

# Group Quiz

- After the regular quiz, you'll take it again
  - this time as a group (probably 4-5 students)
- Good way to review and discuss the problems
- Afterward, your group will prepare project questions to discuss
  - (assuming we have a project going on at the time... which we probably will 😊)

# Final ~~Exam~~ Quiz

- There is no final exam, but there *is* a final quiz
  - Slightly larger than the usual quizzes
- Review only (no new material)
- I will drop your lowest quiz score
  - Do well throughout the semester and you won't have to take the final quiz!

# Projects

- CS 326 projects are large and time-consuming
  - Start them early
- Remember, C can be much more difficult to work with
  - You might only need to implement, X, Y, and Z. Really, that's not too
  - BUS ERROR
- *Plan* out your design, work methodically, and debug as you go

# Academic Honesty

- **Do not cheat.** Review the [Honor Code](#), and if in doubt about whether or not something is cheating, ask the professor.
  - The course staff will run cheat detection software that includes past assignments.
  - “Collaboration” that involves sharing code/solutions is considered cheating.
  - If you cheat, **you will get a 0 on the assignment or an F in the class.**
- Submit code via GitHub. Commit your changes frequently as you work on the assignments.

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# Virtual Machines

- We'll be using Linux extensively in CS 326 to develop an OS of our own
  - Everybody gets to make a new OS! (...by standing on the shoulders of giants)
  - You'll run your OS in a Virtual Machine (VM)
- VMs will be hosted on `gojira` in the CS network



# gojira

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- Dual 16-core AMD Epyc CPUs
  - 32 cores
  - 64 hardware threads
- 128 GB of RAM
  - Laser-guided missile defense system
  - Dual cupholders

# So, Operating Systems

- I mentioned earlier that you all probably know of a few OS. Let's see how many we've all used.
- Dust off your CS credentials and log into stargate:
  - `ssh username@stargate.cs.usfca.edu`
- Next, `ssh gojira`
- If your login credentials don't work, it's time to email [support@cs.usfca.edu](mailto:support@cs.usfca.edu)
- Ok, let's create our list of operating systems...

# OS List

- `cd` to `/tmp/cs326`
  - I will create this now
- Create a file named after your CS username with:
  - `touch $(whoami)`
- Open it in an editor (`vim`, `nano`, `emacs`, ...)
- List each OS you've used, one per line
  - If you want to explain what you used it for, add a comment after it with `#`

# An Example

```
MS-DOS
Windows 3.11    # Trying to impress my friends
Windows 95
Windows 98      # Mostly for Space Cadet Pinball
Windows 10      # After my friends were not impressed
macOS 11
```

# Next

- After you're finished, see if you can figure out how to:
  1. View who is logged into `gojira`
  2. See the *processes* currently running on the machine
- Then we'll do some thorough and very scientific analysis on the files to see what kind of OS users this class has

# Wow Nice Job, Matthew

- Well, that was pointless
  - or was it?
- We just saw:
  - UNIX's multi-user capabilities
  - Remote logins
  - The command line
  - File creation, modification
  - Shell pipelines
  - Permissions handling
  - And a whole bunch of processes running it all

# Operating Systems

- Let's get back to business. What **is** an OS?
  - An OS provides a layer of abstraction between your computer's hardware and software
- Computer science is all about layers of abstraction
  - Nobody wants to program in binary, so we have assembly
    - Nobody wants to program in assembly, so we have C
      - Nobody wants to manage their own memory, so there's Java
        - Nobody wants to write another AbstractFactoryBuilderPattern, so there's Python

# Virtualization

- The basic concept of OS is **virtualization**
- Rather than exposing the hardware directly to programs, a nice set of virtual interfaces are provided
  - Razer Viper Ultimate Mouse → USB Mouse
  - Samsung Evo 1 TB SSD → Mass storage device
  - etc.
- Programs don't have to worry about what's going on in the system
  - Appear to have their own CPU, memory, etc.



# Our Focus

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- This course will cover two domains:
  - User space – most OS include bundled programs. These really aren't much different than programs we've already written
  - Kernel space – provides the functionality that makes **virtualizing** the hardware possible
    - Exposes an API to user space: **system calls**
- We'll write code for both!

# Wrapping Up

- Welcome to class (again!)
  - Ask questions, and come to instructor/TA office hours. We're here to make sure you succeed.
  - Don't take the projects in this course lightly (especially if you haven't taken a 300-level yet)
- We do have one last thing to take care of today: **Lab 0**
  - Find it on the assignments page here:
  - <https://www.cs.usfca.edu/~mmalensek/cs326/>