CSE 120: Principles of Operating Systems
Lecture 1: Introduction

Prof. J. Pasquale
University of California, San Diego
January 7, 2019

Welcome

- In this class, we will explore
  - Basic concepts of operating systems (OS)
  - Design, implementation, structure
  - Principles that apply to all operating systems
- Today
  - Introductions
  - Class organization
  - Topic overview

Introductions: Teaching Staff

Instructor: Prof. J. Pasquale

Teaching Assistants

- Ujwal Bachiraju
- Walker Carlson
- Vijay Viswanath
- Ziying Xue

Tutors

- Ajeya Rengarajan
- Litao Qiao
- Tejas Gopal
- Ken Lin
- Zaki Siddiqui
- Lin Zhou
- Emily Chou
- Susmitha Kalidindi
- Shawn Gu
- Rohan Bhargava
- Curtis Tong
- Lihao He

Course Organization

- Lectures on Mondays and Wednesdays
- Discussion Sections on Fridays
- Programming Assignments: 4
- Exams: Midterm and Final

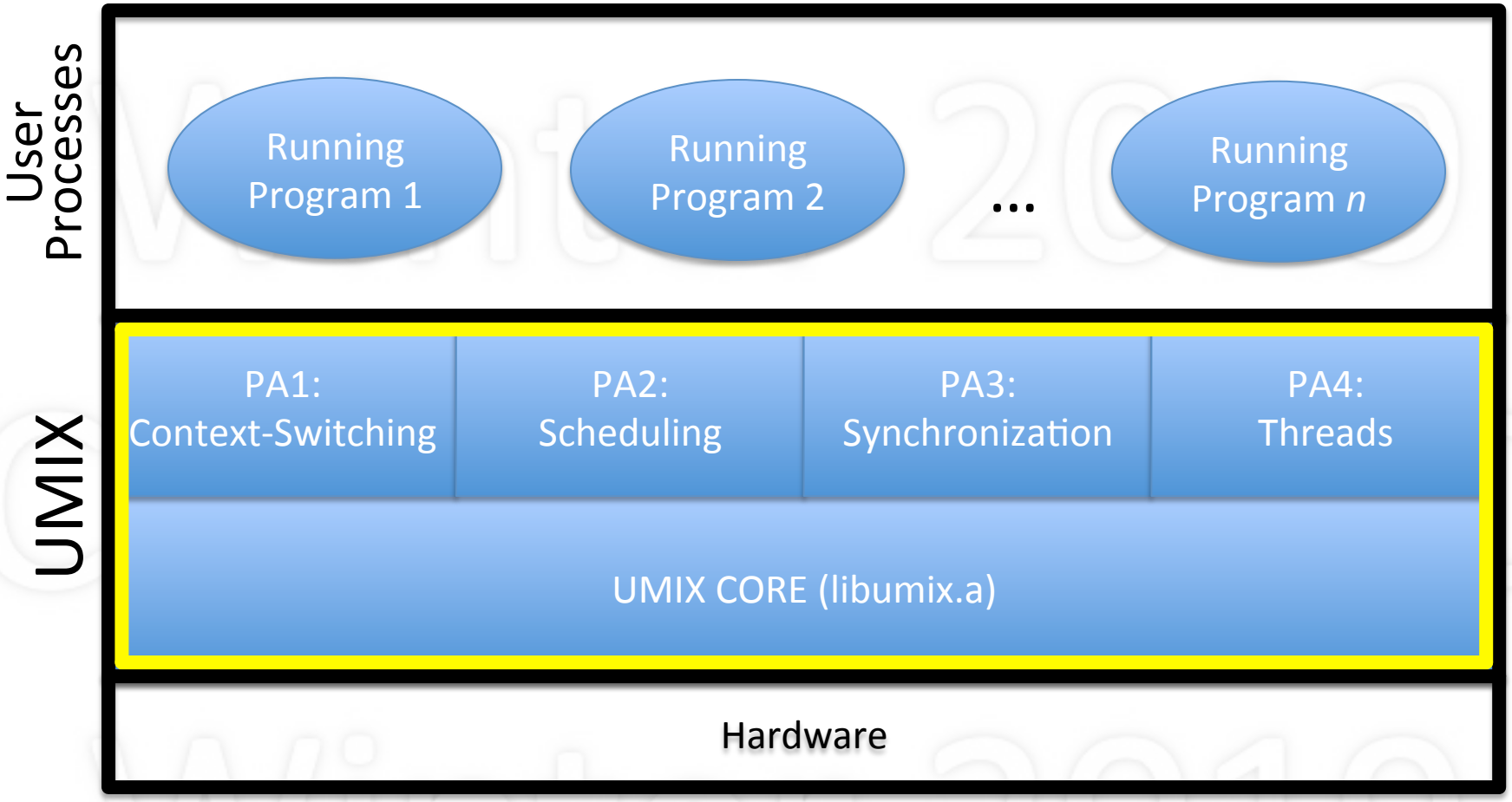
Lectures

- Lectures are key: Don't miss them
  - Designed to motivate topics
  - Highlight what is most important
- Exam questions come directly from lectures
  - Lecture notes + what is said in class
- Book is important as a back-up reference
  - To fill in details
  - Provide an alternative explanation

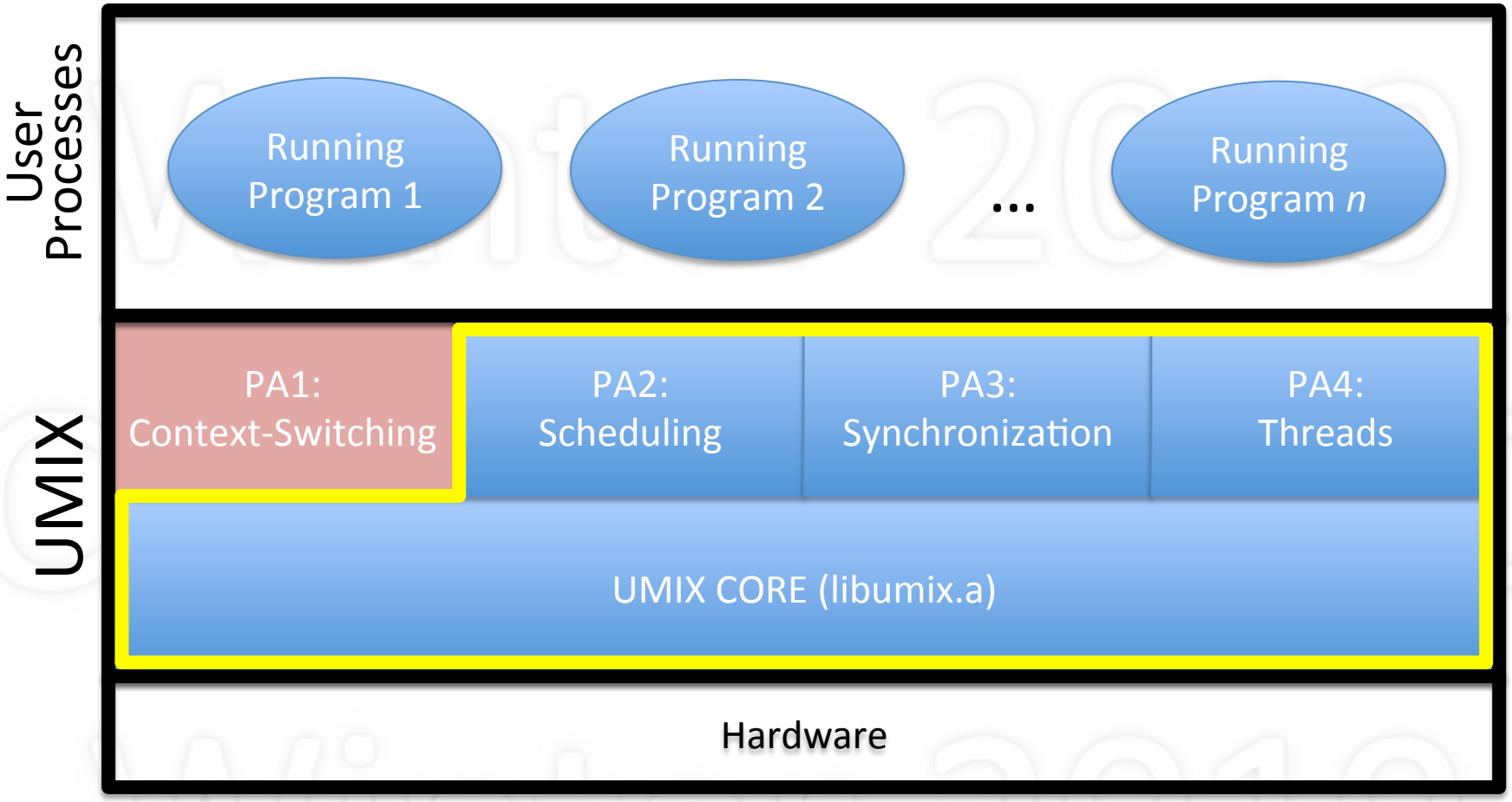
Programming Assignments (PAs)

- Based on pedagogical OS: UMIX
  - UMIX = **U**ser-**M**ode UN**IX**
  - Developed specifically for this class
- 4 assignments on building parts of UMIX OS
  - Each builds on previous, of increasing complexity
- Only works on ieng9.ucsd.edu
  - If you are enrolled, you should have an account
  - Log in as soon as possible to make sure

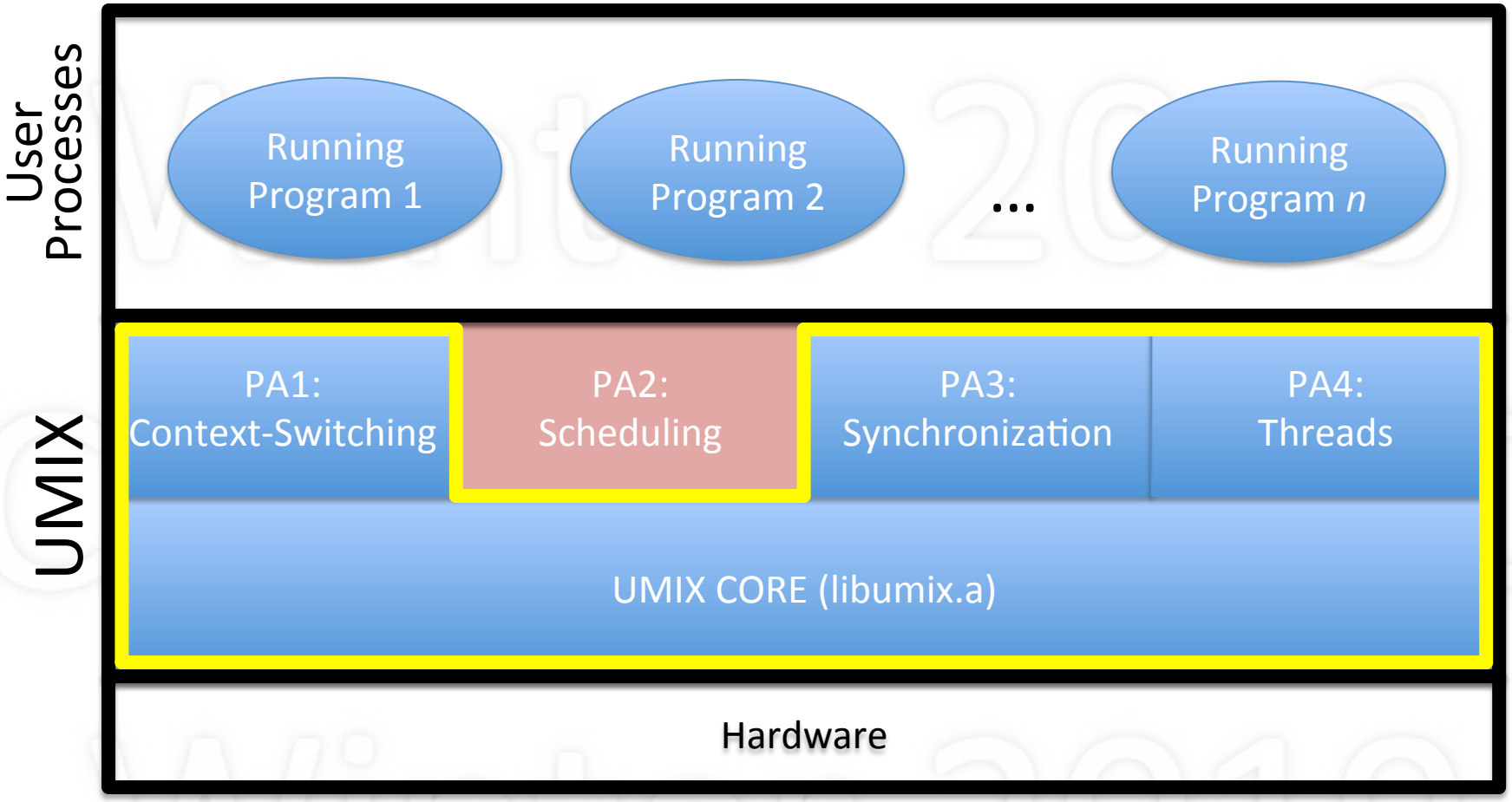
UMIX Structure



UMIX Structure: Working on PA1



UMIX Structure: Working on PA2



All Work on ieng9 / cs120w

- To get credit, you must do **all** of your work:
  - on **ieng9** server (OK to remotely connect, e.g., ssh)
  - in your **cs120w** partition (prep cs120w)
  - in the **pa<N>** folder of your ieng9/cs120w account

```
[cs120w@ieng9]:~:$ getprogram1
     Creating Programming Assignment 1 directory
     Installing Programming Assignment 1's files
     Installation complete
[cs120w@ieng9]:~:$ ls
     CSE120-Results      pa1
[cs120w@ieng9]:~:$ cd pa1
[cs120w@ieng9]:pa1:$ ls
     Makefile       mycode1.h      pa1b.c         pa1e.c         umix.h
     aux.h          pa1.txt        pa1c.c         pa1f.c
     mycode1.c      pa1a.c         pa1d.c         sys.h
```

PA Deadlines

- Generally at 11:59PM on Sundays
  - PA1 Jan 13 end of week 1
  - PA2 Jan 27 end of week 3
  - PA3 Feb 17 end of week 6
  - PA4 Mar 10 end of week 9
- Note: ITS may not be available on weekend
- PA deadlines are absolute: *no exceptions*
  - Due to required UMIX updates for next PA

How Your PAs Are Graded

- Programs are graded by UMIX Autograder
  - Runs a series of tests
  - At least one test per requirement in specification
- Results will be deposited in CSE120-Results
  - Output of test
  - Score
- You can appeal if you think score incorrect

Appealing Your PA Grade

- Must be based on your contentions that
  - Autograder made a mistake
  - Your program's behavior is actually correct
- State clearly, explicitly, and in detail
  - **What** you believe the Autograder got wrong
  - **Why** your program's behavior is actually correct
- You have 3 days to make an appeal
  - After that, no appeals will be accepted

After Your Appeal

- Your program will then be *manually* graded
  - You are liable for any/all problems found
  - Including ones missed by Autograder
- Clerical errors are still errors
  - A stray print statement can cause total failure
  - A bad character can cause a compile failure
- Can only grade what you hand in (no changes)
- Cost of appeal: 1 point (but can gain it back)

Collaboration Policy

- OK to discuss approaches, design, algorithms
- What is NOT OK: sharing any actual code
- What you submit must be **your own work**
- The only non-personally developed code you are allowed to use is what is provided to you via the getprogram**N** script

What Constitutes Cheating?

- Using ANY code that you did not come up with
  - other than what you're given (official W19 copy)
- Producing *virtually* similar code
  - line-level similarity
  - even from common pseudo-code
  - factoring out renaming, moving, comments, ...

You Must Protect Your Code

- Making code available to others is cheating
  - Intentionally or unintentionally
  - Allowing your code to be viewed: not allowed
- It is your responsibility to protect your code
- You must not allow your account to be shared

No Code from External Sources

- Downloading code from websites is cheating
- Code *derived* from such code is still cheating
- Any *amount* of such code is cheating
  - even "just a few lines" is cheating
- Any *kind* of such code is cheating
  - even "just a basic data structure" is cheating
- Any evidence of having downloaded code will be considered cheating, regardless of use

Consequences of Cheating

- You will be sent to Academic Integrity Office
- You will get an F if violation is confirmed
- Don't expect a warning
- Don't expect a second chance
- You may ask to withdraw your work, but only before it is graded; result is no credit (NQA)
- Checking will only be done at end of quarter

Exams

- Midterm will be in class, at mid-quarter (TBD)
- Final is on Saturday *before* start of finals week
- Both multiple-choice with justifications

17. As the quantum gets increasingly larger, round-robin scheduling performs more and more like (a) shortest remaining time first; (b) shortest job first; (c) first-come-first-served; (d) priority

Question 17 

Justification: the quantum increases, likelihood that a process will complete within a quantum increases. If each process completes before the next is run, this is effectively first-come-first served.

Grading

- 4 Programming Assignments 30%
  - progressive in value: 3 + 6 + 9 + 12
- Midterm Exam (insurance) 30% or 0%
- Final Exam 40% or 70%

- Your final grade will be based *solely* on above
- Grading is on an absolute scale

Resources

- Class website
  - cseweb.ucsd.edu/classes/wi19/cse120-a
- Piazza online discussion website
  - piazza.com/ucsd/winter2019/cse120/home
- Lecture notes
  - available on Piazza evening before lecture
- Computer system (for programming labs)
  - ieng9.ucsd.edu

Textbook

- Silberschatz, P. B. Galvin, G. Gagne: *Operating System Concepts*, 10th Ed., Wiley, 2019
- If you are registered, also enrolled in eBook
  - Free first 2 weeks; then $48 *automatically*
  - You can OPT OUT up to end of 2nd week
- Lectures coordinated with this book
- Has good sample questions/answers
  - Some exam questions will come from these!

Advice For Getting a Good Grade

- For lecture material
  - Study book-related material (*after* lecture)
  - Make list of questions; use Piazza, office hours
  - Do lecture R&R (review and research) questions
  - Organize a study group
- Programming assignments
  - Start early (as soon as assignment comes out)
  - Do extensive testing – *testing is your responsibility*

Asking Questions is OK

- During lecture
  - I like questions, just raise your hand
- Piazza
  - All questions OK, except for solution code
- Office hours
  - Can go over any code and exam questions
- Email
  - Limited to private matters (and no code)

Piazza

- Online forum for asking / answering questions
- Depository for all class documents
  - Lectures
  - Programming assignment specifications
- To be enrolled on Piazza, you MUST:
  - register your FULL name: first AND last name
  - register your UCSD email account: xxx@ucsd.edu
  - be officially enrolled in the class

Etiquette on Piazza

- Before you post a question on Piazza
  - Is it answered in a lecture slide? … In the book?
- When you ask a question
  - Try to be specific, focused, precise, clear
  - Attempt an answer, show your reasoning
  - Reference the relevant slide or pages in the book
- A good question will get a good fast response
- DO NOT POST SOLUTION CODE ON PIAZZA

We Want You to Get an A

- Everything is designed towards this goal
  - Lectures are continually revised, with added R&R
  - Programming assignments have hints, exercises
  - Exams based directly on lectures and PAs
  - Lots of help available via Piazza and office hours
- No curve: it's possible *everyone* can get A
- Keys: take seriously, start early, get help

Any Questions?

Why Study Operating Systems?

- To know how your computer works
  - What may be wrong, how to enhance
- Systems programmers get respect
  - Understand OS → understand anything
- Operating systems is a classic area of CS
  - Roots in early 60's, but still very relevant today
- Intellectually very challenging
  - Programming, structure, new technologies, …

What is an Operating System?

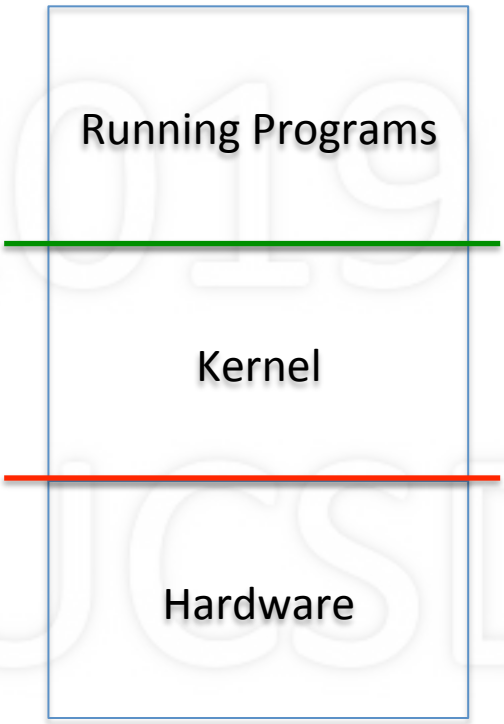
- Software that makes computer easier to use
  - Broadly, for the user to interact with programs
  - For the programmer to use machine's resources
  - Resources: CPU, memory, storage, I/O devices, …
- Improves the computer's capabilities
  - Performance: speed, efficiency
  - Reliability: correctness, fault tolerance
  - Security: privacy, authenticity, integrity

Operating System vs. the Kernel

- "Operating system" has many interpretations
  - E.g., all software on machine minus applications
- Our focus is much more limited: the *kernel*
  - All programs depend on it, accessed via sys calls
- Works closely with hardware
  - Accesses device registers, responds to interrupts
- Allocates basic resources
  - CPU time, memory space, use of I/O devices

Two Purposes of the Kernel

- To provide abstract machine
  - Interface for the programmer
  - Functions and resources
  - Goals: simplicity, convenience
- To manage resources
  - All the mechanisms and policies
  - Allocates usage: space and time
  - Goals: performance, reliability, security



Turn Undesirable into Desirable

- Undesirable inconveniences of reality …
  - Complexity of hardware
  - Single/limited number of processors
  - Small/limited amount of memory
- Desirable conveniences: *illusions*
  - Simple, easy-to-use resources
  - Multiple/unlimited number of processors
  - Large/unlimited amount of memory

From Programmer's Point of View

- Algorithm/program design is hard enough!
  - Allow programmer to focus on algorithm design
  - Not how to make machine run the algorithm
- Minimize accounting for computer limitations
  - Introduces unnecessary complexity
  - May lead to modifying the algorithm
  - May make the program not portable

Three Key Ideas

- Abstraction
  - *What* is the desired illusion
- Mechanism
  - *How* to create illusion: basic functionality
  - Fixed: works one way, the only way
- Policy
  - *Which* way to use mechanism, to meet a goal
  - Variable: many possible, select best for situation

Overview of Course Topics

- Resources: abstraction, mechanism, policy
  - CPU
  - Memory
  - Storage
  - I/O
- Operating system structure
- Advanced topics: security, distributed systems

Summary

- What is an operating system?
  - Software that is integral part of computer system
  - Makes it easy for user to use system
  - Keeps system running smoothly
- This course
  - Fundamental aspects of operating systems
  - Covering virtualization of CPU, memory, storage, I/O devices, and advanced topics

Textbook

- Chapters 1 and 2
  - Lecture-related: 1.1, 1.12, 2.1, 2.3, 2.8, 2.11
  - Hardware background : 1.2, 1.3
  - Recommended: 1.4-1.11, 2.2, 2.4-2.7, 2.9-2.10
- Do the sample exercises
  - Especially the ones with answers
  - I will likely use some for exams

Don't Forget

- Activate your Piazza account for CSE 120
  - You must include your full name and UCSD email
- Check that your account on ieng9 is working
  - If not, contact ACMS – this is *your* responsibility!
- Get started on Programming Assignment 1

R&R: Review & Research

- These are questions that pertain to lecture
- Some review lecture concepts
- Some require research beyond the lecture
- Of varying levels of difficulty
  - Three stars *** A - most difficult
  - Two stars ** B
  - One star * C
  - No star D - least difficult

R&R

- What is an operating system (OS)?
- How does an OS make it easier to use?*
- What is an example of a difficulty a user would have in using a computer that had no OS?**
- What is the difference between a user and a programmer?*

R&R

- What is meant by the term *resource*?*
- How does a computer's OS improve its capabilities?**
- What is meant by a computer's *efficiency*?**
- Why are *speed* and *efficiency* measures of *performance*?***
- How is *speed* different from *efficiency*?**
- What is meant by a computer's *correctness*?*

R&R

- What does it mean for a computer system to be *fault tolerant*?*
- Why are *correctness* and *fault tolerance* aspects of *reliability*?**
- What is meant by each of the terms: *privacy*? *authenticity*? *integrity*?**
- Why are *privacy*, *authenticity*, and *integrity* considered aspects of *security*?**

R&R

- How is the *operating system* different from the *kernel*?
- What is an example of something that might be part of the operating system that would not be part of the kernel?*
- What are two actions a kernel can take that should not be allowed by a user program, and why should they not be allowed?**

R&R

- What does it mean to allocate a *resource* (given your earlier definition for resource)?*
- What is meant by *allocating CPU time*?**
- Why is meant by *allocating memory space*?**
- What about *memory time*: what is meant by this, and does it make sense to allocate it?***
- What about *CPU space*: what might be meant by this, and how might it be allocated?***

R&R

- What is meant by the term *abstract* (as in *abstract machine*)?**
- Why is the term *interface* relevant when discussing an abstract machine?**
- Why are functions and resources relevant when discussing an abstract machine?**
- What is a mechanism?*
- What is a policy?*

R&R

- Are *mechanisms* and *policies* aspects of an abstract machine: why or why not?***
- In what way are the goals, *simplicity and convenience*, as a class (i.e., not individually, but when viewed as a group and its characteristics), different from the goals, *performance, reliability, and security*, again when viewed as a class?***

R&R

- Why are the following considered to be "undesirable inconveniences of reality":
  - complexity of hardware (provide an example)?**
  - limited number of processors? …memory?*
- Why are the following considered "illusions":
  - simple, easy-to-use resources?**
  - unlimited number of processors? …memory?*

R&R

- Should concerns about the operating system enter into the programmer's mind when designing and implementing a program: why or why not?**
- What are three examples of why the programmer should or shouldn't take the operating system into account when designing a program?*

R&R

- What is meant by each of the following, and provide an example for each:
  - abstraction?*
  - mechanism?**
  - policy?**