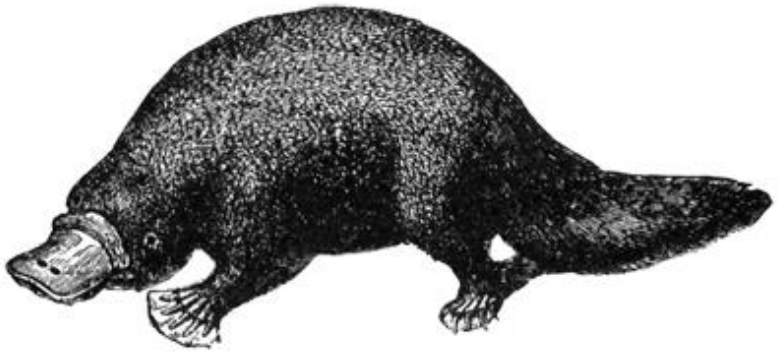
CS 3113



Introduction to Operating Systems at OU

CS 3113, Fall 2020

O RLY?

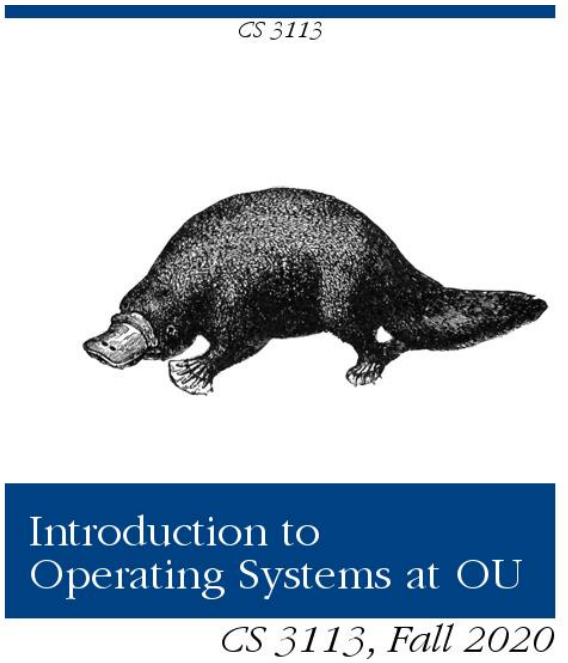
Andrew H. Fagg

** Includes slide material from Silberschatz, Galvin and Gagne (2018)

Teaching Staff

- Instructor: Andrew H. Fagg
  - Machine learning, robotics, computational neuroscience
- TAs:
  - Adrien Badre
  - Jake Williams

All of us can be reached at:
cs3113@googlegroups.com



What is an Operating System?

What is an Operating System?

A program that acts as an intermediary between a “user” of a computer and the computer hardware

…a ***User*** can really be a person, an application program or another computer

What are the Goals of an OS?

What are the Goals of an OS?

Operating system goals:

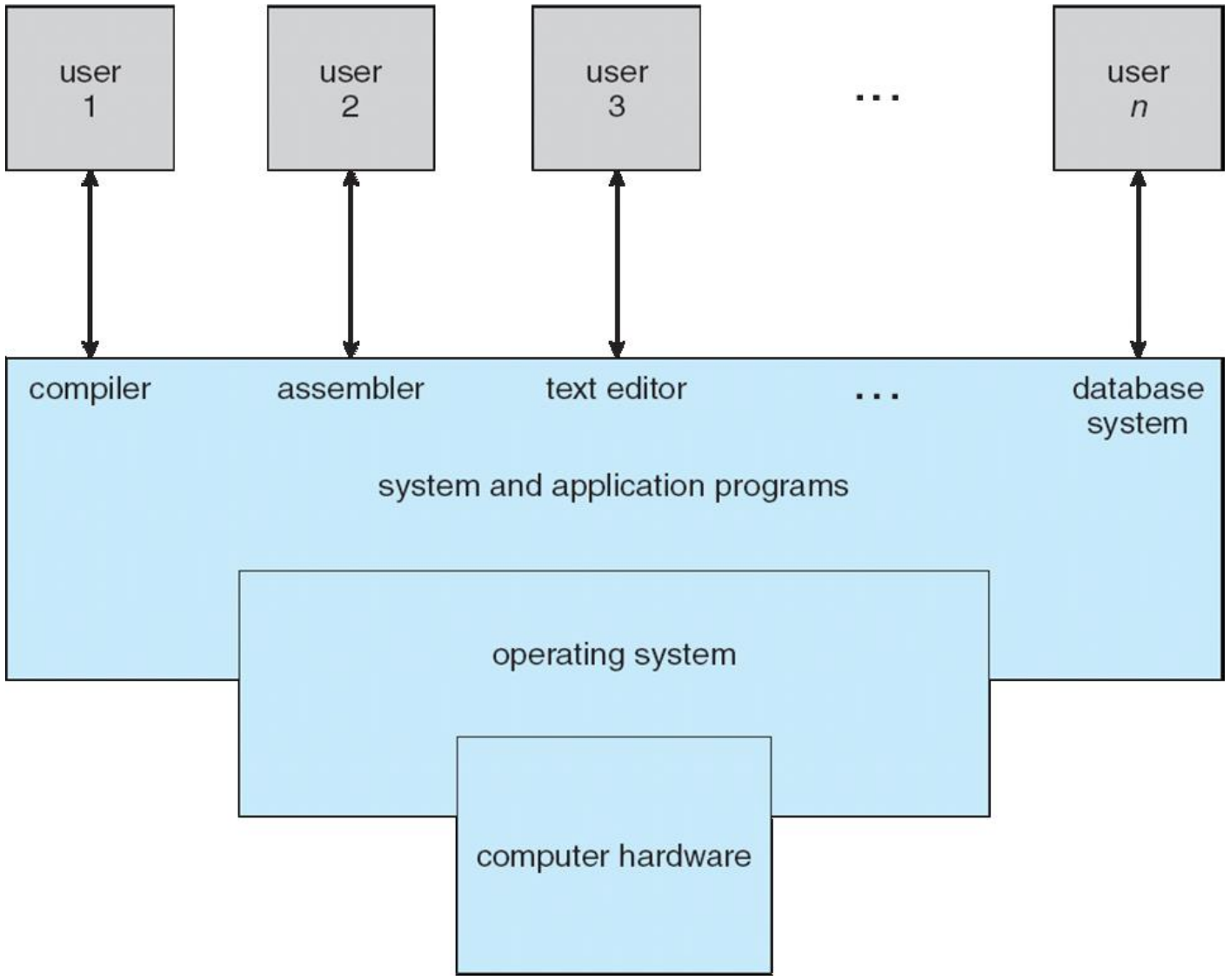
- Execute user programs
- Make the computer system convenient to use
- Use the computer hardware in an efficient and secure manner

Computer System Structure

Computer system can be divided into four components:

- Hardware – provides basic resources
  - CPU, memory, I/O devices
- Operating system
  - Controls and coordinates use of hardware among various applications and users
- Application programs – define the ways in which the system resources are used to solve computing problems
  - Word processors, compilers, web browsers, database systems, video games
- Users
  - People, other computers

Computer System Structure



What Operating Systems Do?

What Operating Systems Do?

It depends …

- Users want convenience, ease of use, and good performance
- Individual users don’t necessarily care about resource utilization
- A shared computer such as mainframe or minicomputer must keep all users happy
- Users of dedicate systems, such as workstations, have dedicated resources, but frequently use shared resources from servers
- Handheld computers are resource poor, and are optimized for usability and battery life
- Some computers have little or no user interface, such as embedded computers in devices and automobiles

Operating System Definition

- OS is a resource allocator
  - Manages all hardware resources
  - Decides between conflicting requests for efficient and fair resource use
- OS is a control program
  - Controls execution of programs to prevent errors and improper use of the computer
- OS provides abstractions
  - Hides the details of the hardware
  - Provides an interface that allows a consistent experience for application programs and users

Operating System Definition

What are common abstractions provided by the OS?

Operating System Definition

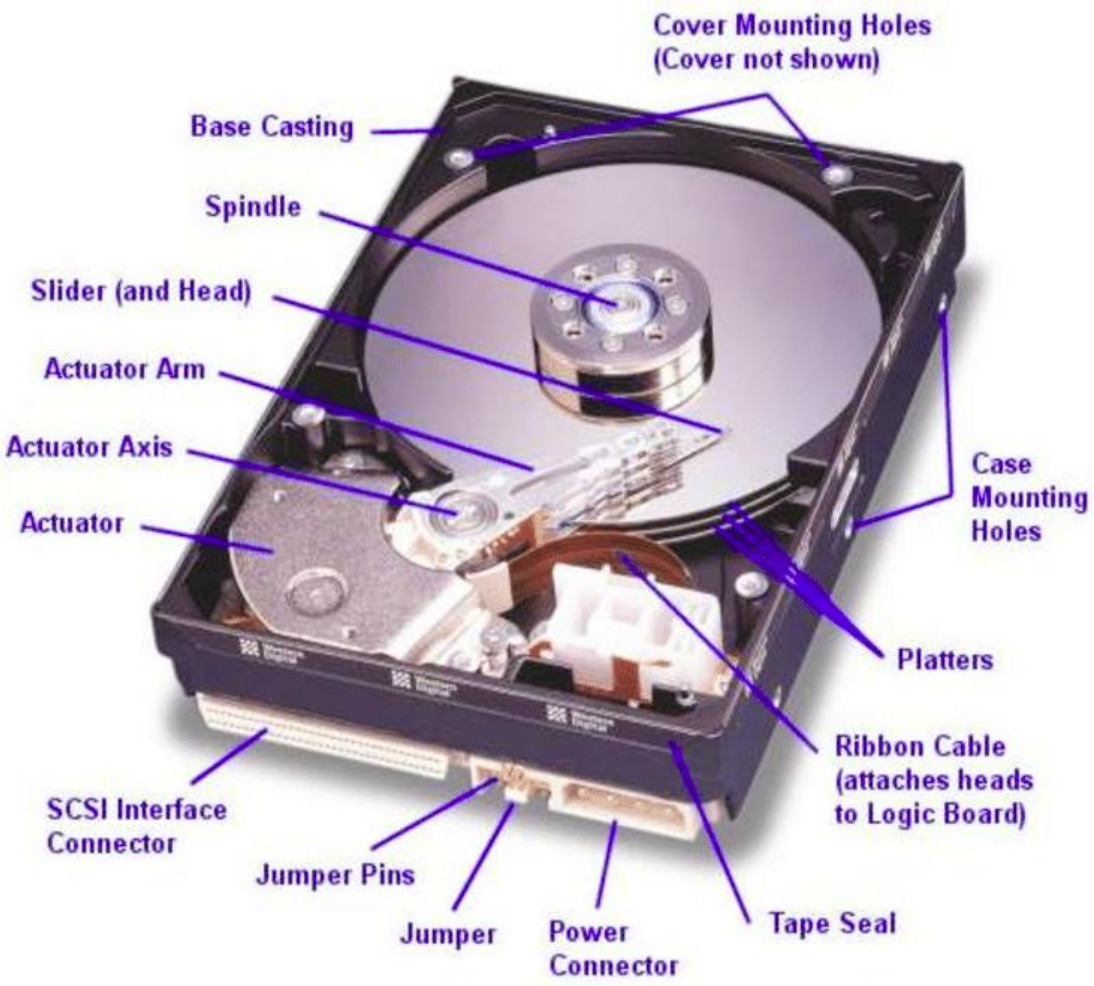
What are common abstractions provided by the OS?

- A program has exclusive access to the CPU(s) and other hardware devices
- A program has unbounded access to memory
- Directories and files
- Reliable communication between programs and computers
- No errors in: execution, communication, device interaction

Example: Hard Disks

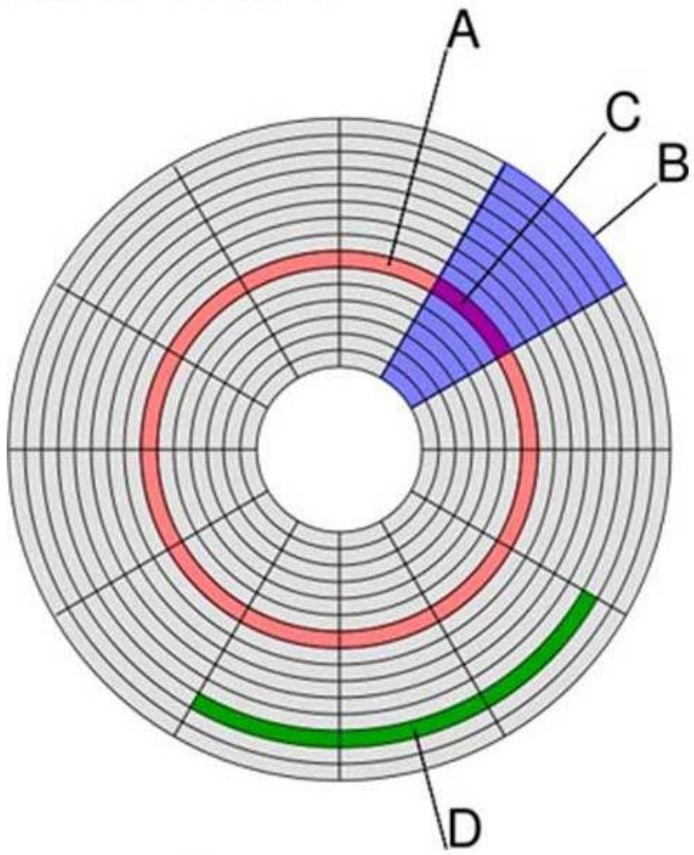
What are they and what do they provide?

Structure of a Hard Disk



www.researchgate.net

A = Track (Red)
B = Sector (Slice)
C = Sector Track
D = Cluster



ttrdatarecovery.com

Structure of a Hard Disk

- A sector of the disk is a sequence of bits
  - Encoded by orientation of localized magnetic fields
- Disk controller provides sector read/write operations
- Disk design varies
  - Sector size
  - Number of platters
  - Speed of spindle rotation
  - Protocol for the computer talking to the disk
- Job of the device driver: handle low level abstractions
- The OS then lays a file system on top

Files

How is a file stored on a disk?

Files

How is a file stored on a disk?

- Depending on size, a file is allocated some number of sectors (blocks)
- While data within a block is contiguous, the different blocks that are used to represent a file are not necessarily contiguous
- Need some way of tracking which blocks belong to a file and what their order is (e.g., ***inodes***)

A File System

Allows us to:

- Represent a set of files
- Organize these files in a useful way
  - Most common today: directory trees

Modern systems also enable:

- FS distributed across multiple disks and multiple computers
- Redundancy and automatic recovery

Example: Embedded Systems

Example: Random Access Memory

What is RAM and how is it organized?

Example: Random Access Memory

What is RAM and how is it organized?

- Data stored in a sequence of bytes
- Each byte has an address: 0, 1, 2, …
- ***Random***: can access any byte as fast as any other byte

RAM for Processes

- Process: executing program
- What does memory look like from the perspective of a process?

RAM for Processes

What does memory look like from the perspective of a process?

- Also addressable
- An individual variable is assigned to “live” in one or more bytes
- Overlay data structures (with some hardware support):
  - Stack: storage for locally defined variables
  - Heap: storage for dynamically allocated variables

OS Role in Memory

- Providing processes with the memory that they need as they are executing
  - A process doesn't usually need all of its memory available all of the time.
  - We can take advantage of this!
- Allowing multiple processes to co-exist safely
  - Usually, each has exclusive access to its own memory
  - But: memory can be shared across processes, if needed
- Providing buffering for I/O activities

Your Background

- Programming
  - Control structures & primitive data types
  - Substantial design and debugging experience
  - Building abstractions
- Algorithms and Theory
  - Building space and time efficient data structures
- Hardware
  - Computer Organization

Operating Systems

- The study of Operating Systems brings together your background in programming, algorithms, theory and hardware!

- And sets you up to study bigger things:
  - Databases
  - Communication networks
  - High performance computing
  - Embedded systems

CS 3113: Coverage

Mix of theory and practice:

- Systems-level programming in C
- *nix system calls
- File Systems: Properties and Implementation
- Processes and Threads: Pipes, Concurrency and Synchronization
- I/O and Process Scheduling
- Security
- Virtual Machines

Projects

The practice of OS requires real practice

- The projects are designed to exercise your algorithm and low-level programming skills
- Five 2-3 week projects over the semester
- You will need this time
- Projects are done individually

Project Procedures

- Programming, testing and debugging on a standard Linux instance running on your own laptop and/or desktop
  - Virtualbox to host the Linux instance
  - Practice using command line tools and available editor(s)
- Submission to Gradescope
  - Connected through Canvas
  - Automatic testing
  - We will provide coding feedback here, too

Computer System

Laptop or desktop for work during class and for projects and homework

Course Information

- Course web page: https://cs.ou.edu/~fagg/classes/cs3113
  - Includes schedule and syllabus
- Canvas: announcements, assignments, grading
- Textbook: Silberschatz, Galvin and Gagne (2018) Operating Systems Concepts, Tenth Edition, ISBN-13: 9781119320913 (electronic book)

Grading Distribution

- 5 Projects: 40%
- Exams: 25% (one midterm and a final)
- Homework: 20% (keep N-2 highest)
- In-class exercises: 15% (keep M-2 highest)

Official grades will be posted in Canvas

Homework Assignments

- Short-term (1-week)
- Mix of coding, algorithm simulation and short answers

Homework and In-Class Exercises

- Dropping the lowest of your grades is intended to mitigate unexpected situations, such as illness
- Even if you are late on an assignment, you should still take the time to complete it
  - They offer important experience that reinforces the lecture & readings and they prepare you for the exams

Projects

Detailed coding exercises that allow us to cover algorithms and data structures to very low level programming issues

- Projects will build on each other
- No project grades are dropped

Due Dates

- In-class exercises: due when asked for in class
- Homework and projects: due at 11:45pm on the date noted on the schedule
- Projects may be turned in late:
  - Up to 24 hours: 10% grade penalty
  - Up to 48 hours: 20% grade penalty

Due Dates

The reality: this is a strange semester (again)

- Some of you will likely be seriously ill or be caring for someone who is ill
- If ill, please make sure that you are communicating with OU about your status
- For either case, we will work with you to find a workable solution
  - Homework/in-class exercises: delayed deadline or excused all together
  - Projects: delayed deadlines

Grading Questions

- The graded assignment should be first brought to the person who graded it
- All grading questions must be brought to our attention within **one week** of when the item was returned
- Check your grades on Canvas

Honors College Students

This course can be taken for honors credit!

- You need to declare this this week
- Faster pace on projects + additional project

Proper Academic Conduct

Discussion about any topic with the instructors and/or TAs is always fine

- We can also look at code!

Proper Academic Conduct

Coding assignments (projects and coding homework assignments):

- Discussion about solutions with classmates is allowed
- Looking at network resources is allowed
- You must document these discussions / resources (classmates and network)
- **But: no looking at or copying code solutions for the assignments**

Proper Academic Conduct

Homework assignments, in-class exercises and exams:

- Unless otherwise specified: the work must be your own: **no looking at or copying solutions from other students or from the net**

Proper Academic Conduct

Code:

- Sharing solutions is penalized to the same degree as receiving solutions
- Make sure that your computer and account are properly protected. Use a secure password
- Do not give out access to your account or your computer system
- Do not leave printouts or mobile drives around a laboratory where others might access them

Proper Academic Conduct

- Programming projects will be checked by software designed to detect collaboration
- This software is extremely effective and has withstood repeated reviews by the campus judicial processes

Conduct Violations

- Upon the first documented occurrence of inappropriate collaboration, we will report the academic misconduct to the Campus Judicial Coordinator. The procedure to be followed is documented in the University of Oklahoma Academic Integrity Code
  - http://integrity.ou.edu/files/Academic_Misconduct_Code.pdf

- The appeals process for both admonitions and full complaints is described at:
  - http://integrity.ou.edu/

External Services

- Services such as Github have their place
  - If your repository is not configured properly, it can be searchable and visible to other people
- Services such as Chegg are more about inappropriately sharing information than they are about helping you

Time Commitment

- You will be developing software in this class
  - Time spent $\propto$ grade
  - Start early. You don't know how long it will take
- Plan before coding
- Write your own tests
  - Many of our tests will be hidden from you!
- Should rethink taking this class while taking another heavy class

Getting the Most out of Class

- Read materials ahead of time
- Ask questions
- Learn names of your fellow students (and use them)
- Participate in class discussions
- Attend class
- At the end of the semester, we should know your name

A Bit of Neuroscience …

- Your brain integrates information and problem solves over time
- Cramming assignments and studying into a very small number of sessions (especially when up against a deadline) works against this
- Instead, plan to block out time to work a little bit on the reading and the assignments every day or every other day

… Your brain will thank you

Appropriate Classroom Conduct

Key rule: **Respect**

- Yourself
- Your peers
- The teaching team
  - Keep in mind: we are human, too, and we have many obligations

Teaching Team

There are 73 of you and only three members of the teaching team

- Between the three of us, we only have 40 paid hours per week for this course
- We have to be efficient about the use of our time
  - Many aspects of the course are automated (e.g., grading projects, homework and exams) so we can maximize our time with you
  - Please take steps to help us with this

How to Find Me

Dr. Andrew H. Fagg: DEH 243 andrewhfagg@gmail

- Office hours are still to be announced
- Appointments can also be made

- The TAs and I can be reached simultaneously: cs3113@googlegroups.com

How to find the TAs

All TA office hours are on Zoom

Adrien Badre: Adrien.F.Badre-1@ou.edu

Jack Williams: j.williams@ou.edu

William Kerber Teaching Scholars: Zoom (I assume)

This and Next Week…

Reading and next classes: see the schedule!

- High-level view of OS
- OS Internals
- C Programming and Linux


COMPUTER HOLY WARS
HOLD IT RIGHT THERE, BUDDY.
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