

Lab 7: OS Summary

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Note: The provided examples are in blue.

Tables

Identify and summarize issues of this course in the following tables. Some cells have already been filled to serve as an example.

- [Interesting terms and concepts \(aka new fancy words you learned or revisited in this course\)](#)

Term and/or brief summary	Computer system examples	Examples from different academic areas (including other branches of CS)	Examples from everyday life
Caching (storing a copy of recently accessed data in a storage that's faster than the primary storage).	<ul style="list-style-type: none"> - Processor cache maintains small subset of data from main memory. - Flash drive is used as cache for HDD. 		Putting your most worn coats back at the front of the closet each time.
Kernel/User Mode (The CPU has two primary modes of operation, kernel and user mode. Kernel mode is privileged, meaning that the hardware and memory can be accessed, while user mode is not, requiring user processes to use system calls for privileged operations).	A bit that determines whether the CPU has privileged access to the hardware of the system.	Security permissions for users of a website who have accounts/are "logged in" versus those who are just guests.	Disney World's Star Wars: Galaxy's Edge originally allowed guests to only have a limited time to be inside the area. During their time window, they are privileged; before or after, though, they do not have access to restricted activities/attractions
CPU Schedulers	First In First Out Shortest Job First Shortest Time to Completion First Round Robin Multilevel Feedback Queue	In business/economics, first in first out (FIFO) can be understood as an assumption that the oldest inventory/packages/supply will be sold or shipped to consumers before newer product.	Deciding what homework should be done first (based on difficulty, due date, etc).

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Multi-threaded programming/Concurrency (parts of some thread of execution/ multiple processes running at the same time, sharing information and data while sharing the same address space).	Dining Philosophers Problem Producer/Consumer Problem	Members of a lab group splitting up individual tasks to then combine the results of once they are each complete	Cooking: focusing on assembling one part of a meal while another cooks
Locks (a variable that can either be available/unlocked meaning no thread holds it or held/locked meanings that the thread holds the lock and is in a critical section. Locks ensure that a resource cannot be accessed by several concurrent threads).	Spin locks Pthread locks Ticket locks	Vacuum chamber to do work with gravity; prevents outside factors, such as wind/air resistance, from disturbing the event/situation that is being studied	Turning off one's phone when studying so as to not be distracted/interrupted
Virtualization (take a physical resource and turn it into the virtual form or creating a virtual space to run software in to separate it from its physical form)	Memory Virtualization CPU Virtualization Processes unaware that they are sharing the CPU, process think has complete access to memory		Multitasking: Trying to do homework while also trying to watch a basketball game.
Limited Direct Execution (idea of controlling the scope of executing user processes, such as loading up registers, set IP to main, swap processes, access hardware directly, or begin I/O)	System Calls Traps/Tables Kernel/User mode – prevent a process from having too much access within a system Enabling time sharing – context switches and timer interrupts	Psychology: preventing a subject/volunteer from modifying, altering, or affecting more than one independent variable at a time (depends on the type of experiment)	Don't let a child have access to all tools. Ex: an oven, a car, cookie jar, credit card, kitchen knives Using an ATM – a user is only given access to their money supply, rather than the whole system's
Context Switching (a low-level code that the OS uses to stop running one program and start running another. The currently running processes' state is saved,	Queued by timer interrupts from various system calls Forced by CPU scheduling algorithm	Performing arithmetic in one's head until a math problem that requires a calculator is encountered; one must stop using mental math/the flow of their work, perform another process	Changing the channel on a TV when ads begin (regular show/programming is the "process")

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and the other processes' machine state is loaded).		to compute the calculation, and then resume the original process (may happen more than once during a single problem!)	
Eviction Policy (Algorithm used by the OS to prevent an overflow of pages in the TLB)	The TLB cache in memory can only hold so many different pages to quickly access; if it held all pages, then it wouldn't be convenient or quick! Different eviction policies include: Optimal (accessed furthest in the future) FIFO RANDOM LRU	Heating up 5 different chemical combinations to test their boiling points while only using 3 different hot plates	Deleting photos/apps/data from a phone when attempting to take new pictures/download a new app/etc. when the phone's storage is full Only carrying specific textbooks/notebooks in a backpack when they are necessary, rather than all of them at once due to their weight
Starvation (when there are too many interactive jobs in a system, processes may starve if they are continually denied the ability to run on the CPU. Processes may starve if they are constantly held at a lower scheduling priority than other processes).	A poor CPU scheduling algorithm may accidentally prevent one or more processes from having time on the CPU	(Poli Sci) House/Senate filibuster - shorter tasks (the people filibustering) are repeatedly completed, taking time away from a longer, perhaps more important, task. Good example of a "process" that is specifically designed to "starve" other processes	Repeatedly working on the shortest piece of homework to inevitably never touch the long essay due in a month Living on the top floor of a dorm, if people are constantly getting on the elevator at lower floors and having the elevator go down it may never get to your floor
Memory Bus (hard wires/cords through which information/data is passed from different parts of the hardware, such as the CPU, graphics card, memory locations)	Parts of the hardware that require greater CPU processing power are located physically closer to the CPU than others, such as RAM and graphics, and I/O devices/chip	Algorithm to find the shortest path in between two places (google maps).	Car keys near a door, kitchen appliances in the kitchen, bathroom near the bedroom

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- Useful problem-solving approaches

Brief statement	Computer system examples	Examples from different academic areas (including other branches of CS)	Examples from everyday life
Periodically check the system status in order to detect errors early.	<p>Periodically checking that there is still enough free space in the physical memory to avoid needing to evict data to the hard disk, which allows us to avoid thrashing.</p> <p>Using conditionals to ensure that a certain condition is being checked and met each time before starting a certain part of a process so that if the condition is false, we stop before the error would have occurred.</p>	Periodically check the status of a biological experiment to catch obvious problems early.	<p>Going to the doctor for an annual physical to check up on your general health and catch any developing issues early.</p> <p>Continually check the weather to avoid getting caught out in a storm</p>
Using print statements in order to identify where an error is occurring in the code or to see in what order different processes are running	<p>Putting print statements after the child in <code>exec()</code> to make sure that <code>exec()</code> is working properly (it's a good sign if those print statements never print)</p> <p>Printing in both the child and parent function after calling <code>fork()</code> to see which process is running first</p>	Repeatedly plugging in a random number for a variable in a mathematical expression when attempting to simplify it (ensure that the expression continually outputs the same value)	Periodically tasting food when cooking to make sure it's "just right" or checking the temperature of a turkey/steak/etc. when cooking it
Lock Implementation Evaluation metrics (Correctness, Performance, Fairness)	Placing locks around the critical section of code to ensure that it is not being interrupted in the middle of one thread running.	Economics/Business: to be successful, businesses interact with customers quickly/efficiently, fairly (to not give any customer advantage over others), and correctly to follow through with product/service promises	Fast food restaurants must meet all these requirements; the orders must be fulfilled correctly, quickly, and fairly to see that each order is actually completed

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Considering an unrealistic, yet “optimal” algorithm for a task to compare realistic implementations to	Considering an impossible to implement algorithm for CPU scheduling or page swapping	STEM labs: a 100% percent yield or 0% error would be optimal, but unrealistic. So, other values that are slightly off of the theoretical/desired values are accepted and compared to the “perfect” values.	Finding gifts for people: a perfect gift would be nice, but it also could be too expensive/out of reach. Other gifts could be compared to this “optimal” gift
Preventing software from directly accessing hardware to avoid security mishaps	Kernel and user mode indicates when processes can access hardware or memory and when system calls are necessary for user processes to use privileged operations. Kernel mode indicates that the software can execute and access hardware and memory, whereas user mode prevents software that might either accidentally or maliciously access hardware that might lead to corruption or a computer crash.	Sealed historical archives/ records - sealing a document can legally prevent access without a court order. This can be the case with court cases or other legal or historical records that the public for some reason should not have access to for security or other interests.	Having parental controls on a smartphone or iPad so that children do not have access to inappropriate content or any other potentially harmful apps and websites that they would otherwise be able to access while using a device (parents are privileged “kernel mode” and have access, whereas children are the users that are denied access and can only gain access by asking the parent like through system calls)

- Neat solutions, hacks, design tricks

Brief statement	Computer system examples	Examples from different academic areas (including other branches of CS)	Examples from everyday life
Devising separate solutions for initial system startup, system resume, and normal system operation.	Different types of actions are performed at OS booting, standard OS operation, and OS shutdown.	When writing an essay, there are different elements that must be present in the introduction, the body paragraphs, and the conclusion. Therefore, our layout	Similarly, different types of actions are performed at starting a car, continuous running of a car, and car shutoff.

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		and our approach to writing each of these segments must be different.	
Making access faster to specific pieces of information that are more likely to be needed.	Using the TLB to store most recently accessed pages so that there are less accesses to the disk, which is slow.	Chemistry: a scientist dealing with specific atoms, molecules, reactions, etc. may remember those which are relevant to them, rather than those pertaining to another unrelated field	Similarly, Spotify puts our most used playlists at the top of our home page but stores the rest of our playlist in a long list of all of them that takes longer to scroll through.
Using one tool to accomplish different problems	Semaphores can be used as a lock or condition variable.	Integration can be used to find area under a curve, but can be also used to find relationship between acceleration/velocity/position	Spork, one tool that can be used as a spoon or a fork.
Being proactive about issues	In memory management, the OS moves pages to hard disk preemptively so that the computer doesn't start thrashing as quickly	Wearing safety goggles/equipment while doing experiments	Starting big projects early on so that it makes the whole experience easier and less stressful.

- Other (optional, bonus points)

If there are other interesting ideas from the course that don't fit into the above categories, name them and provide examples here. Essentially, you're looking to create a cheat-sheet that you could use as a reference for most essential course content in the future.

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References

1) <https://pages.cs.wisc.edu/~remzi/OSTEP/>

Operating Systems: Three Easy Pieces

Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau

Arpaci-Dusseau Books

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2) Notes from lecture