K22 – Operating Systems: Design Principles and Internals

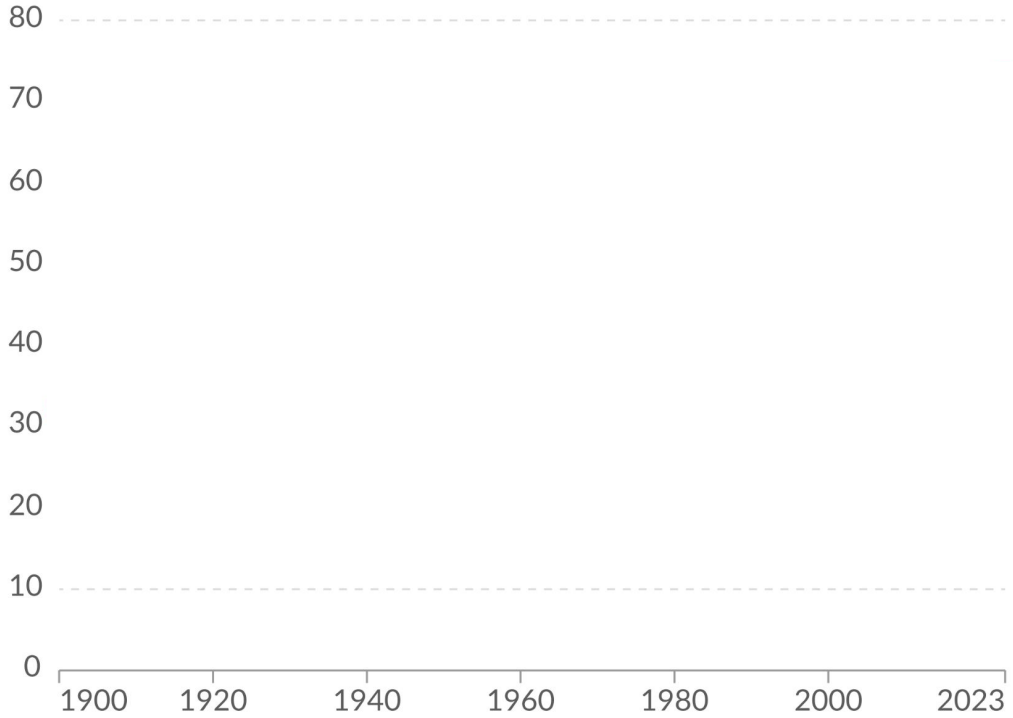
Fall 2026 @dit (α.μ. mod 2 = 1)

Vaggelis Atlidakis et al.

Lecture 01

References: Similar OS courses @Columbia, @Stanford, @UC San Diego, @Brown, @di (previous years); and textbooks: Operating Systems: Three Easy Pieces, Operating Systems: Principles and Practice, Operating System Concepts, Linux Kernel Development, Understanding the Linux Kernel

Period life expectancy (in years) at birth, in a given year.



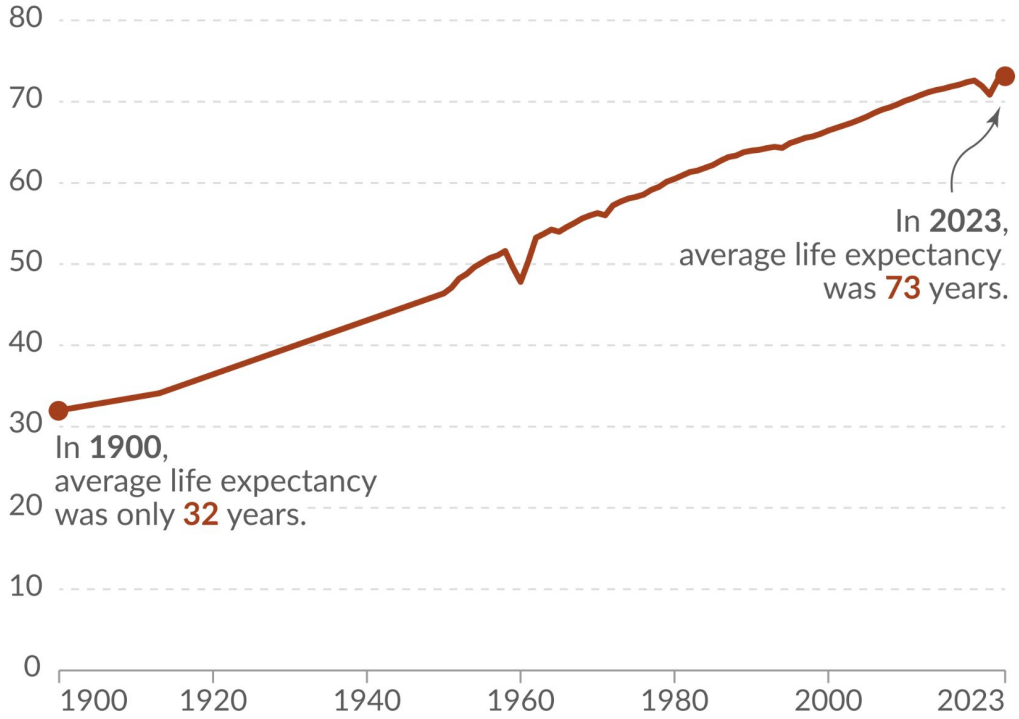
Data source: UN WPP (2024); HMD (2024); Zijdeman et al. (2015)

OurWorldinData.org/life-expectancy | CC BY

Global average life expectancy has more than doubled since 1900

Our World in Data

Period life expectancy (in years) at birth, in a given year.



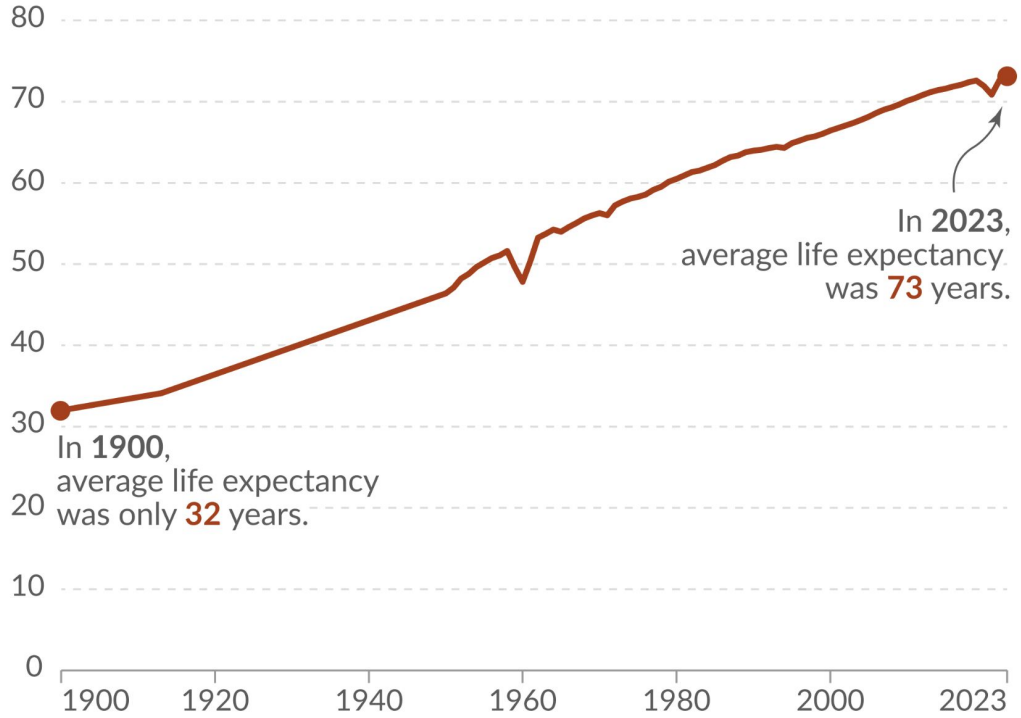
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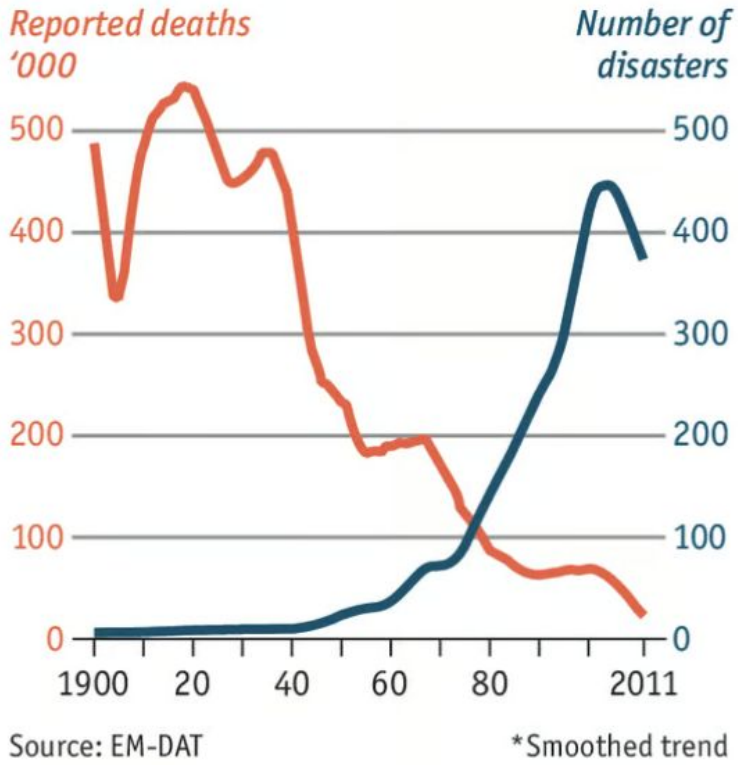


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More, but less deadly

Global deaths from natural disasters*

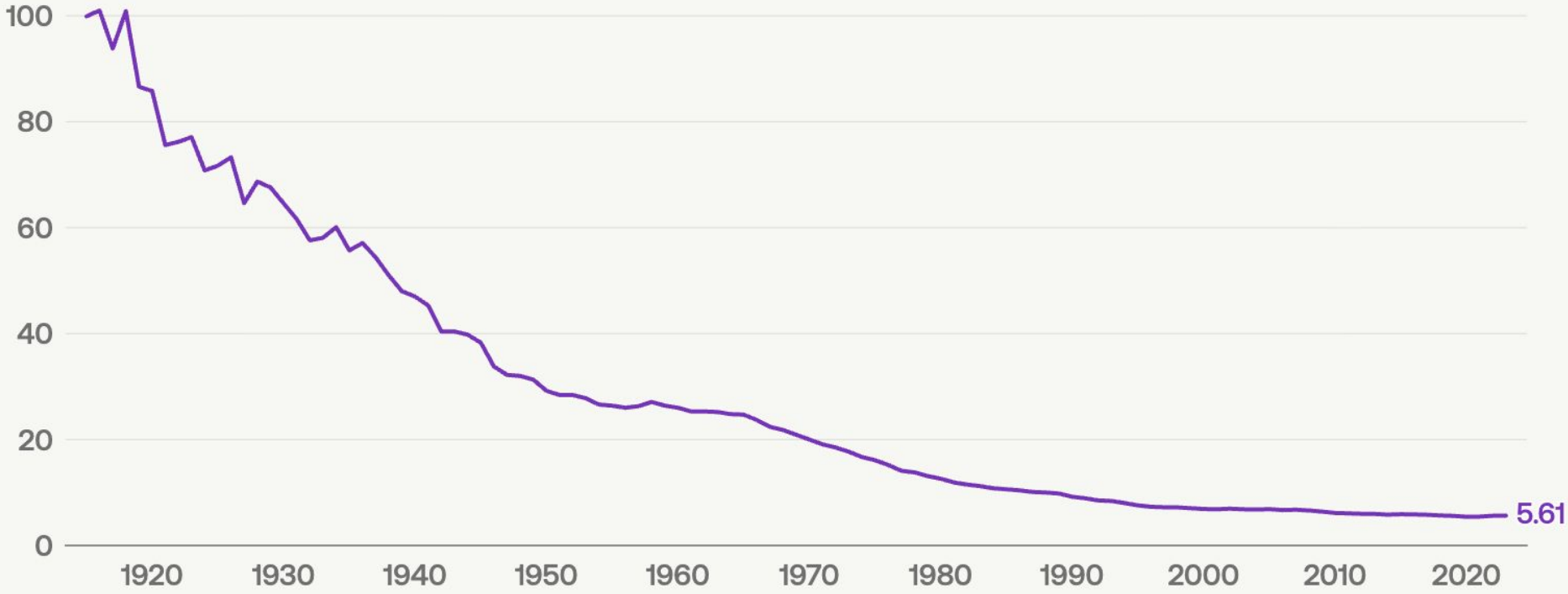


Source: EM-DAT

*Smoothed trend

Economist.com

Infant mortality rate per 1,000 live births, 1915–2023



Source: Centers for Disease Control and Prevention and National Center for Health Statistics

USAFacts



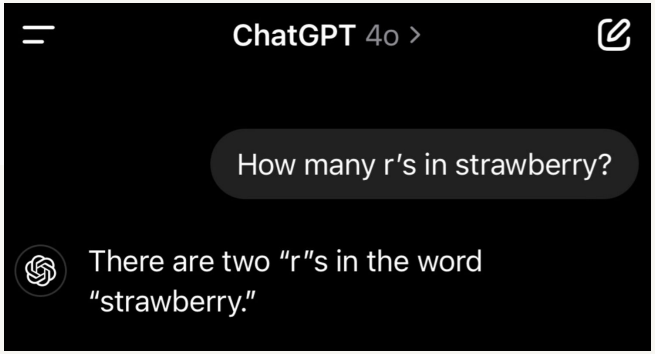

NASA Mars Rover, May 19, 2005

Dario Amodei Warned Against GPT-2 in 2019.

BLOG/DARIO-AMODEI-GPT2-OPENAI-OPEN-SOURCE-AI-CONTROVERSY-2026

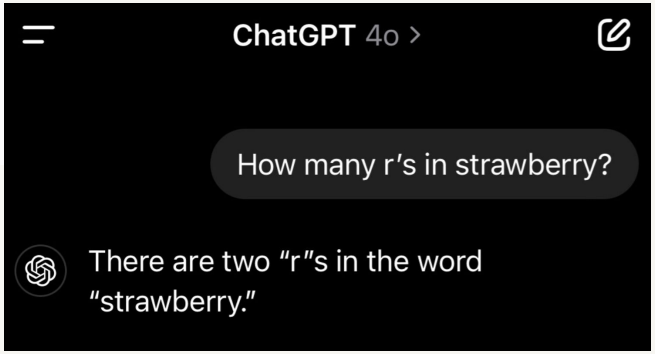
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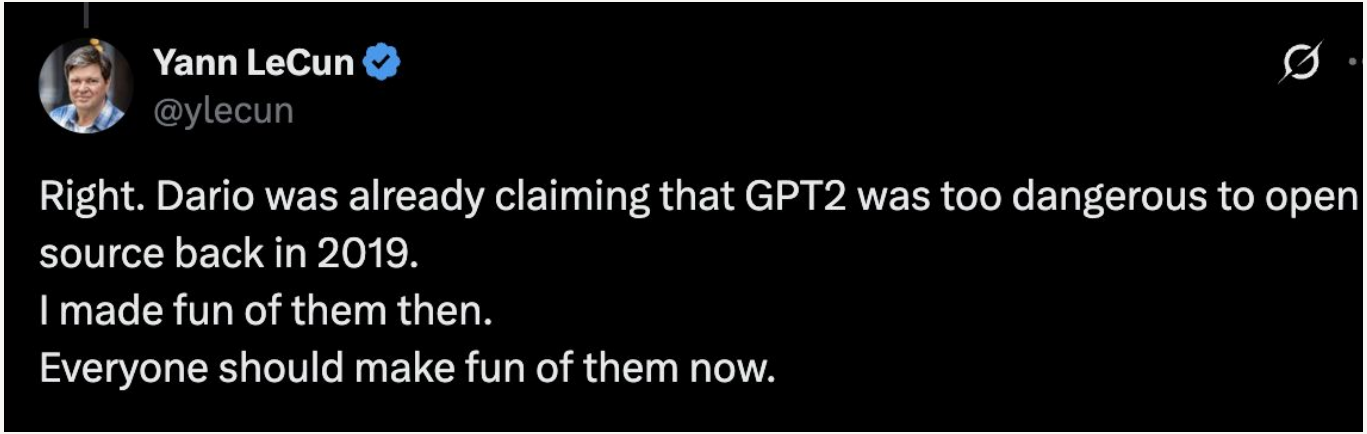
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Geoffrey Hinton

Professor emeritus, University of Toronto; Turing Award laureate

WHY THEY MATTER One of the 'godfathers of deep learning' and a Turing Award laureate

STATUS	PREDICTION MADE	PREDICTED ARRIVAL	INTERVAL
Closed	2016	2021	5 yrs

> *"People should stop training radiologists now. It's just completely obvious that within five years deep learning is going to do better than radiologists."*

ERAS applicants	2018	2019	2020	2021	2022	2023	Trendline	6y slope	3y slope	Trend category
Radiology-Diagnostic	2,033	1,893	1,839	1,991	2,232	2,409		4.3%	10.5%	rising
Dermatology	862	896	855	921	1,037	1,038		4.5%	6.4%	rising
Physical Medicine and Rehabilitation	966	901	877	968	1,049	1,092		3.4%	6.4%	rising
Child Neurology	336	312	329	352	345	391		3.4%	5.5%	rising
Orthopaedic Surgery	1,254	1,341	1,413	1,523	1,727	1,666		7.6%	4.7%	rising
Anesthesiology	2,721	2,991	3,015	3,287	3,348	3,599		6.0%	4.7%	rising
Urology	462	449	503	539	605	556		6.0%	1.6%	plateauing
Plastic Surgery - Integrated	304	301	358	416	420	405		8.6%	-1.3%	plateauing
Neurological Surgery	422	438	489	502	486	461		2.4%	-4.1%	pulling back
Otolaryngology - Head and Neck Surgery	398	532	569	631	644	549		8.3%	-6.5%	pulling back
Vascular Surgery - Integrated	148	178	222	265	237	227		11.9%	-7.2%	pulling back
Neurology	2,069	1,925	1,931	2,240	2,233	2,251		3.0%	0.2%	stable
Surgery	5,329	5,118	5,059	5,515	5,476	5,466		1.2%	-0.4%	stable
Internal Medicine	22,930	23,414	23,433	25,025	24,373	24,579		1.6%	-0.9%	stable
Thoracic Surgery - Integrated	185	209	175	210	189	205		1.2%	-1.2%	stable
Obstetrics and Gynecology	2,543	2,593	2,508	2,577	2,631	2,488		-0.1%	-1.7%	stable
Pathology-Anatomic and Clinical	1,556	1,507	1,472	1,580	1,573	1,497		0.0%	-2.6%	stable
Radiation Oncology	253	230	213	209	235	246		-0.3%	8.9%	rebounding
Interventional Radiology - Integrated	522	452	330	391	408	444		-2.5%	6.8%	rebounding
Psychiatry	4,914	4,559	4,246	4,583	4,162	4,052		-3.0%	-5.8%	falling
Pediatrics	5,707	5,403	5,330	5,698	5,202	4,959		-2.0%	-6.5%	falling
Internal Medicine/Pediatrics	961	935	967	961	842	824		-2.9%	-7.1%	falling
Family Medicine	12,648	12,383	12,217	12,538	11,606	10,681		-2.7%	-7.4%	falling
Emergency Medicine	3,576	3,584	3,788	4,391	3,632	3,282		-0.6%	-12.6%	falling

Data source: AAMC Electronic Residency Application Service Statistics, as of 2/23 of each year.

@francisdeng

Elon Musk

CEO, Tesla and SpaceX

WHY THEY MATTER CEO of Tesla, SpaceX and xAI

STATUS	PREDICTION MADE	PREDICTED ARRIVAL	INTERVAL
Closed	2020	2025	5 yrs

> *"We are headed toward a situation where AI is vastly smarter than humans. I think that time frame is less than five years from now."*



Elon Musk  

@elonmusk

Follow  ···

Our C/C++ training stack was written by humans. AI is not yet good enough for extremely high performance software (but it will be).

7:56 PM Sep 14, 2026 · **1.1M** Views

 540  750  10K  863 

Relevant  View quotes 

There was "Nothing left to discover" before

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Dawn of the 20th century

> Scientific community was certain nature laws were fully understood

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> Narrative: We reached the "end of tech/ innovation history"
- Obviously false then
- Most certainly false now

Motos of top-5 S&P-500 companies

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Rarely about worshiping the technology itself

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Instructions on how to use GenAI

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GenAI / Agents are tools: You **must** watch this end-to-end

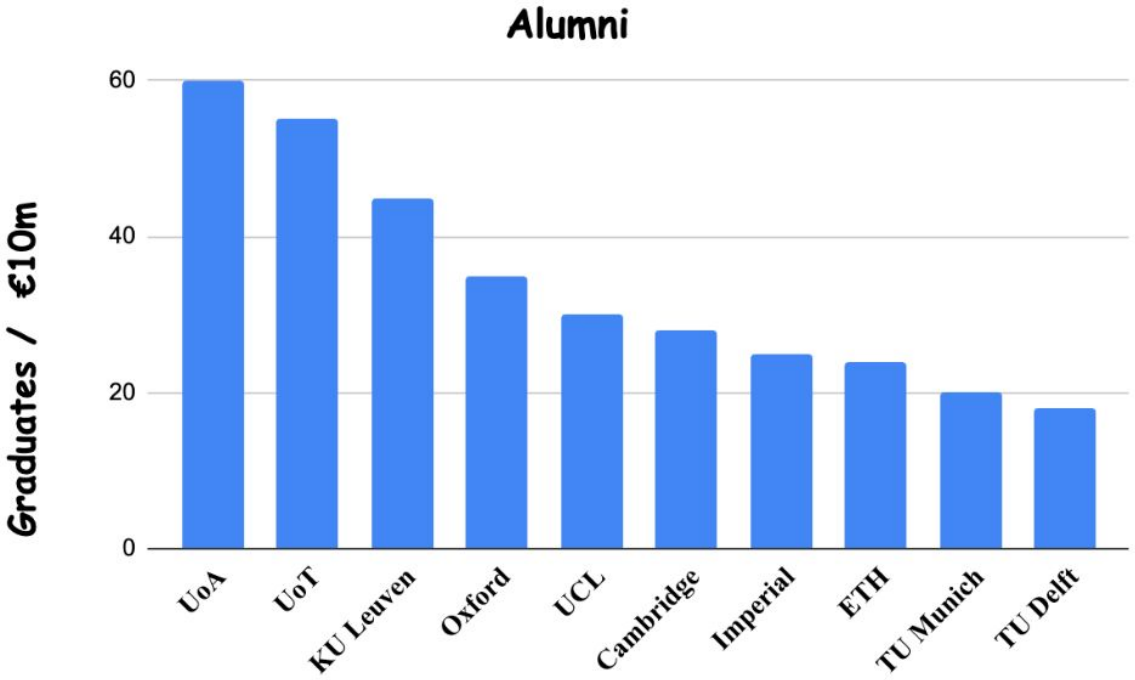
The role of the university

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To teach you how to **learn**

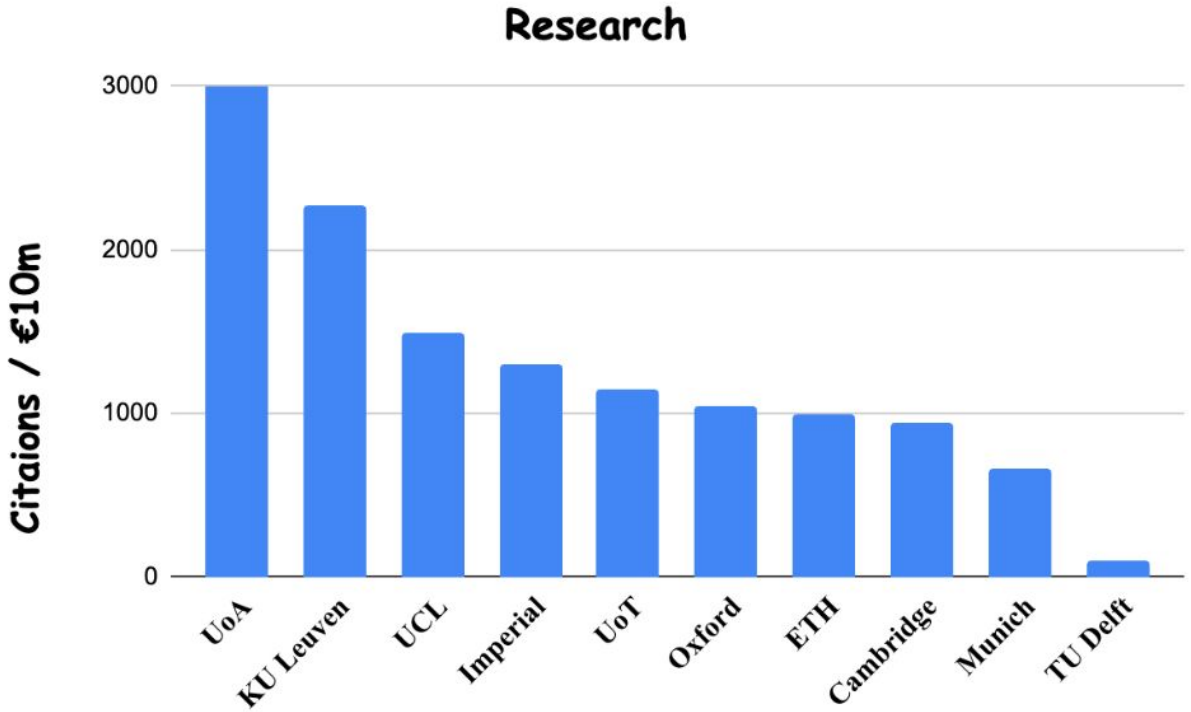
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To teach you how to **socialize**

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The role of the university

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- The Cooperative Eye Hypothesis



The role of this class

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No free lunch

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> Code developed with superficial understanding

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- Learn how to navigate complex codebases

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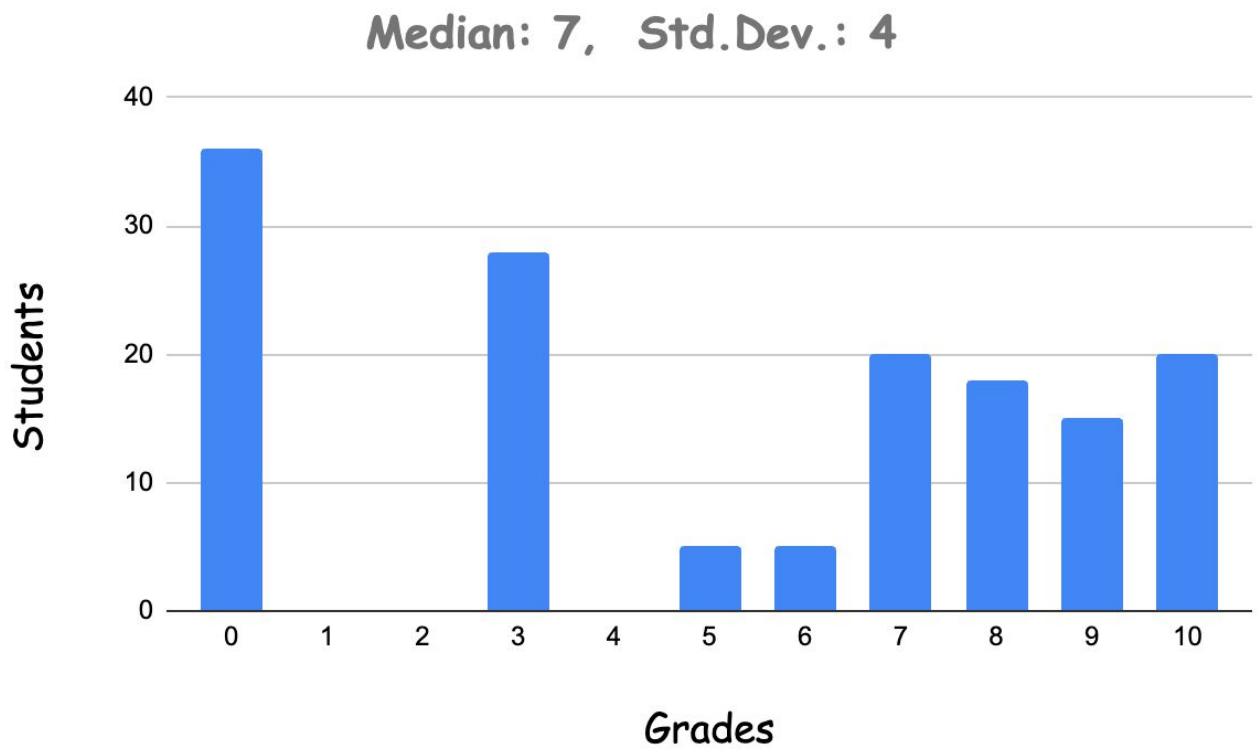
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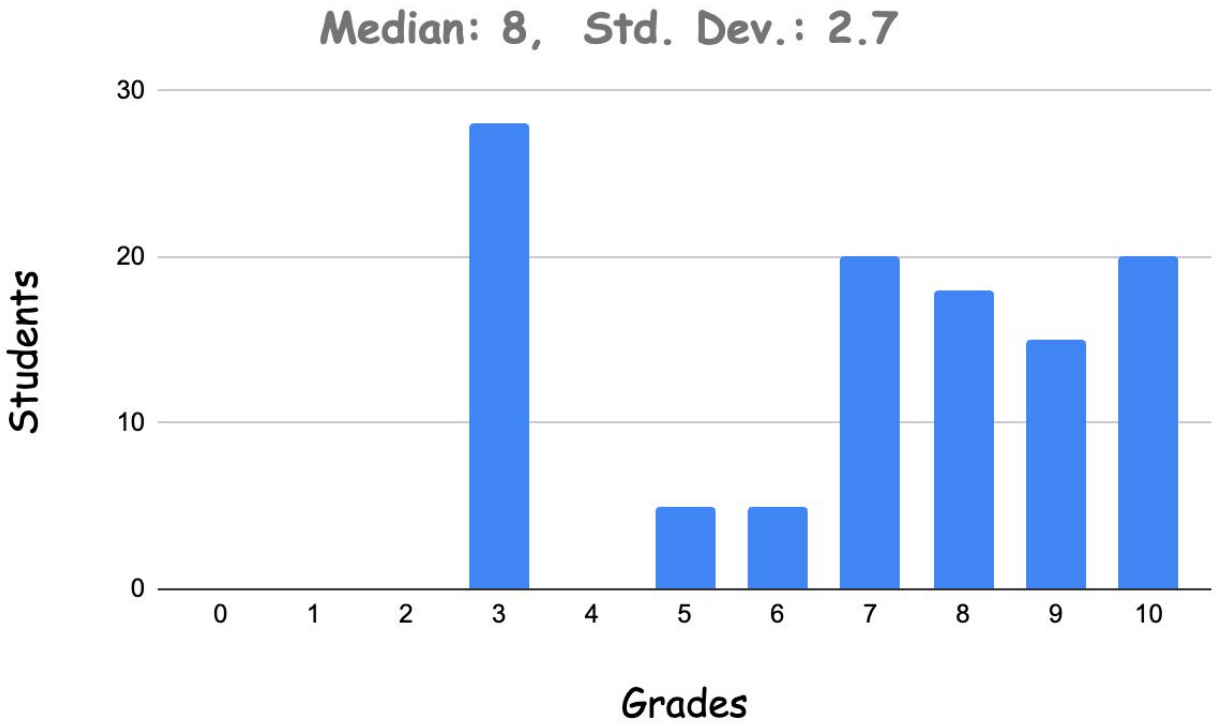
> A line of code is not just a line of code

- Learn how to navigate complex codebases
- Know your circle of competence (Warren Buffet 1996)

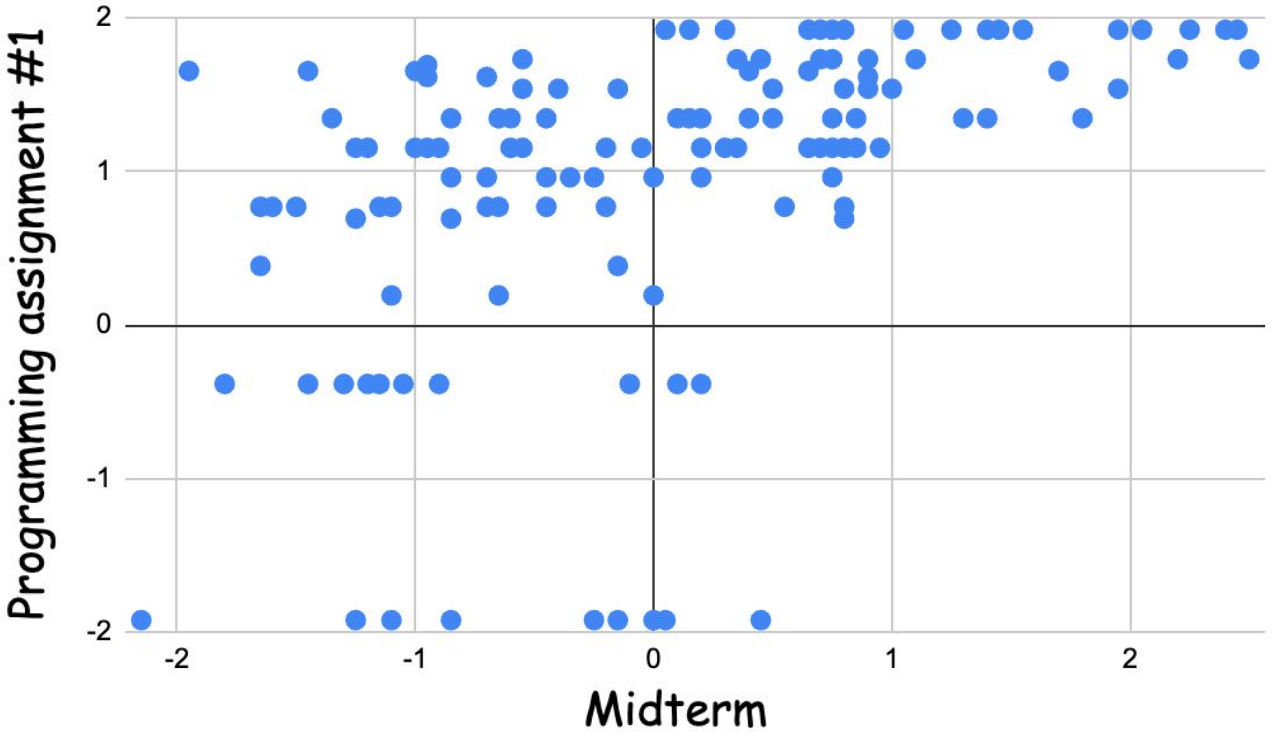
What happened last year



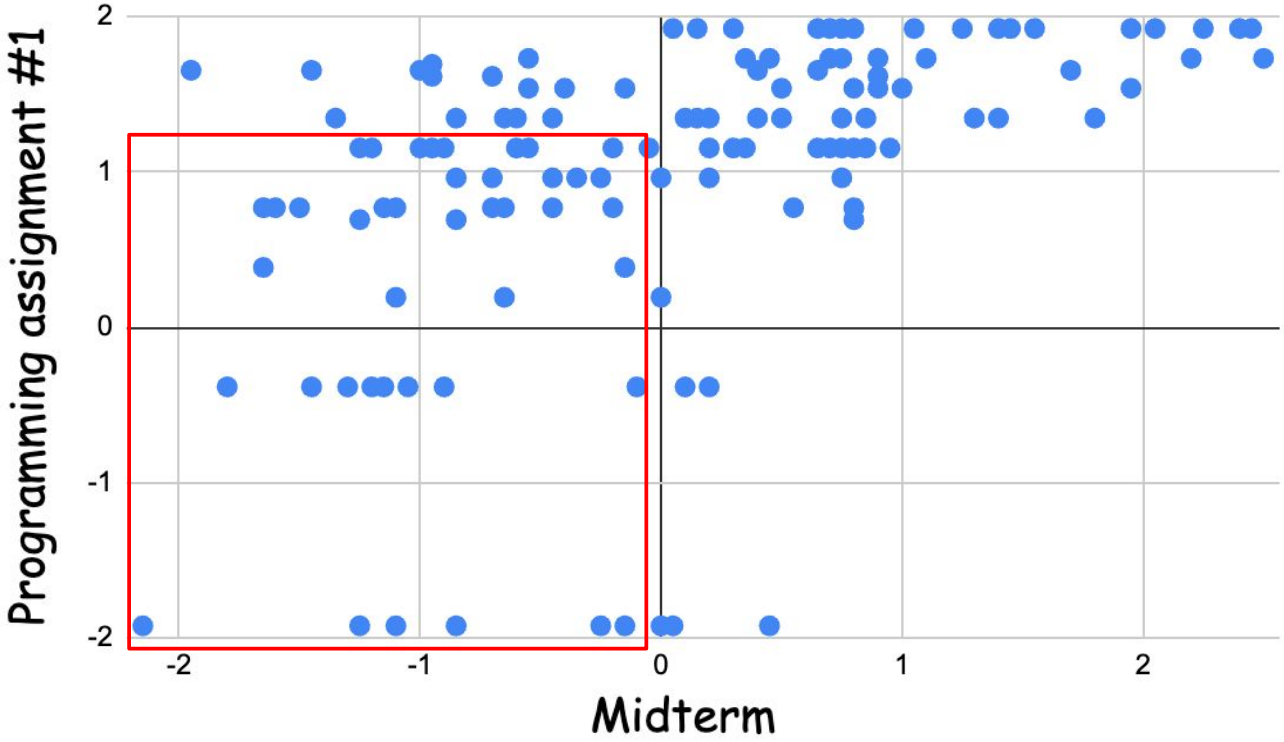
What happened last year



Midterm (median 51 / std.dev.: 21)



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Administrivia

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Programming assignments (50%)

Exams (50%)

Administrivia

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- Midterm (20%)
- Final exam (30%)

Administrivia

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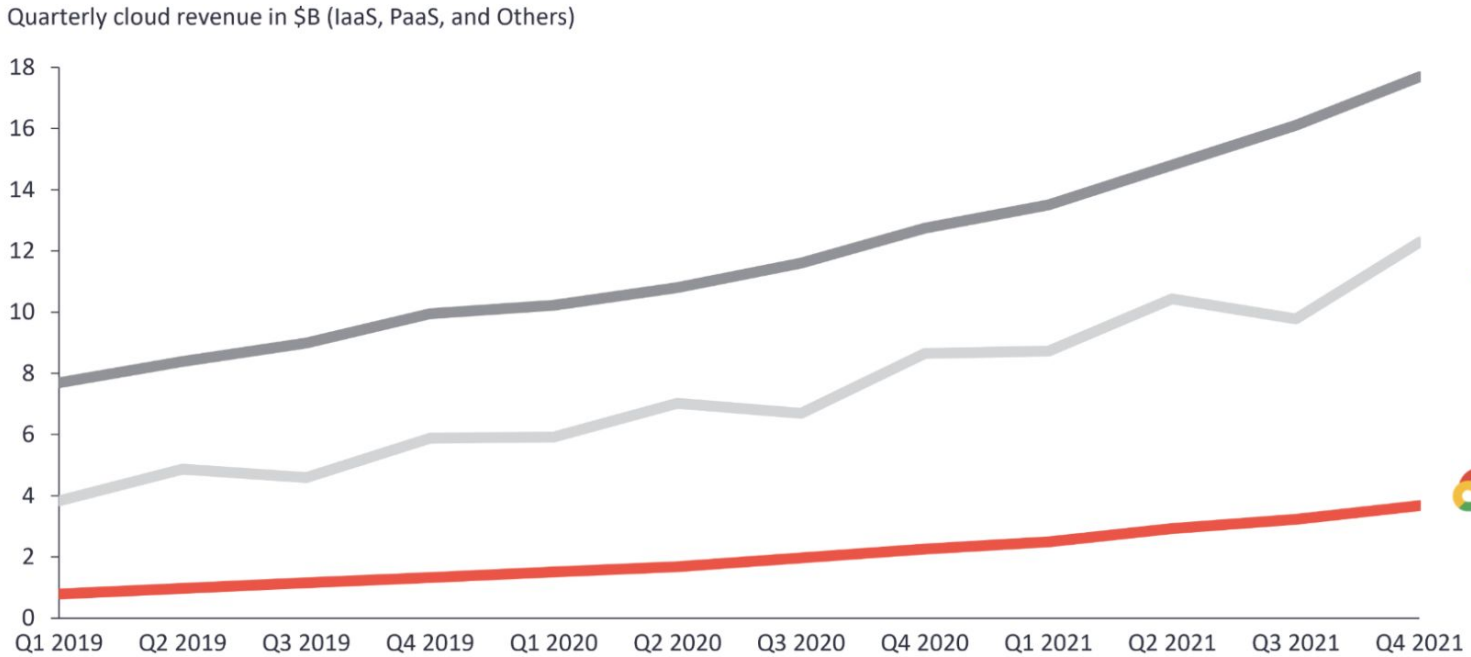
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Exams (50%)

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- Must get >= 50/100 in at least one exam

Why study OSes?

Revenue of leading cloud vendors (2019-21)



aws

Microsoft Azure

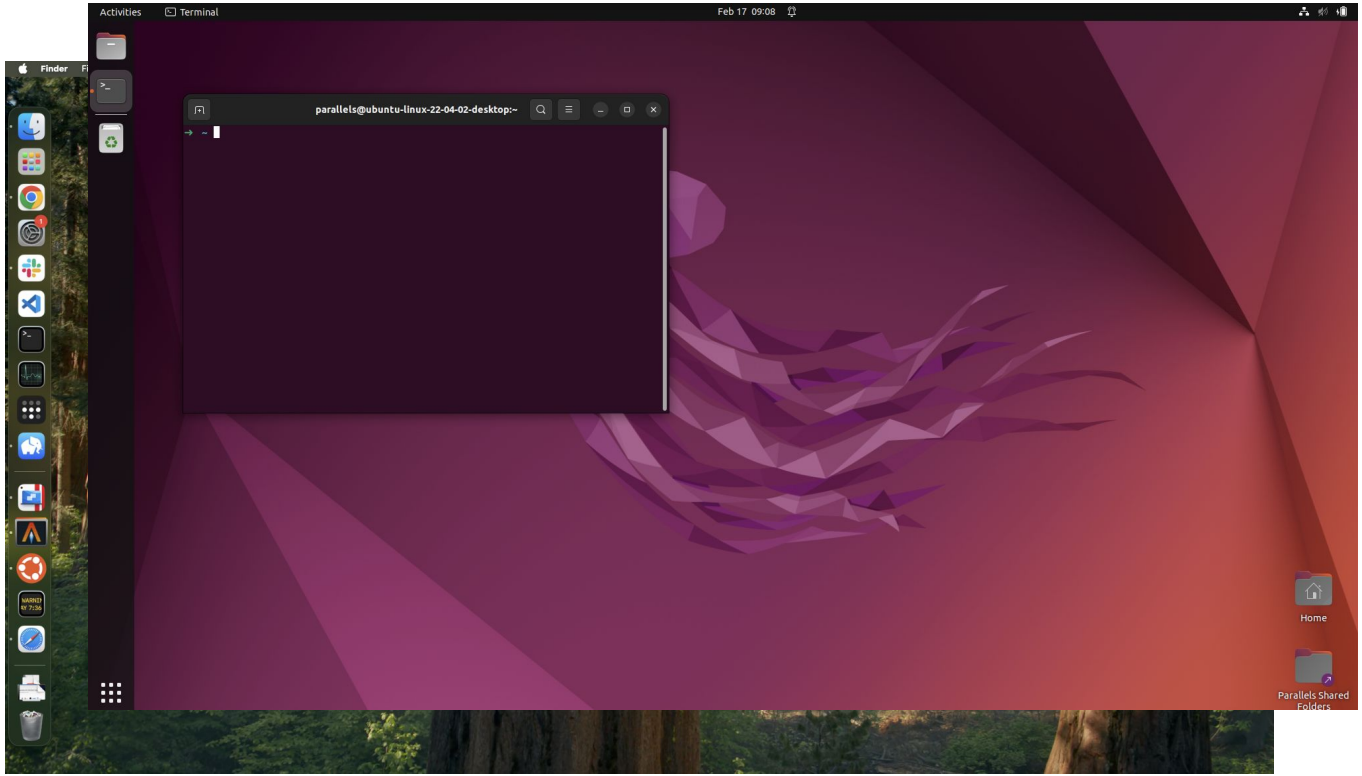
Google Cloud

[1] https://iot-analytics.com/cloud-market/

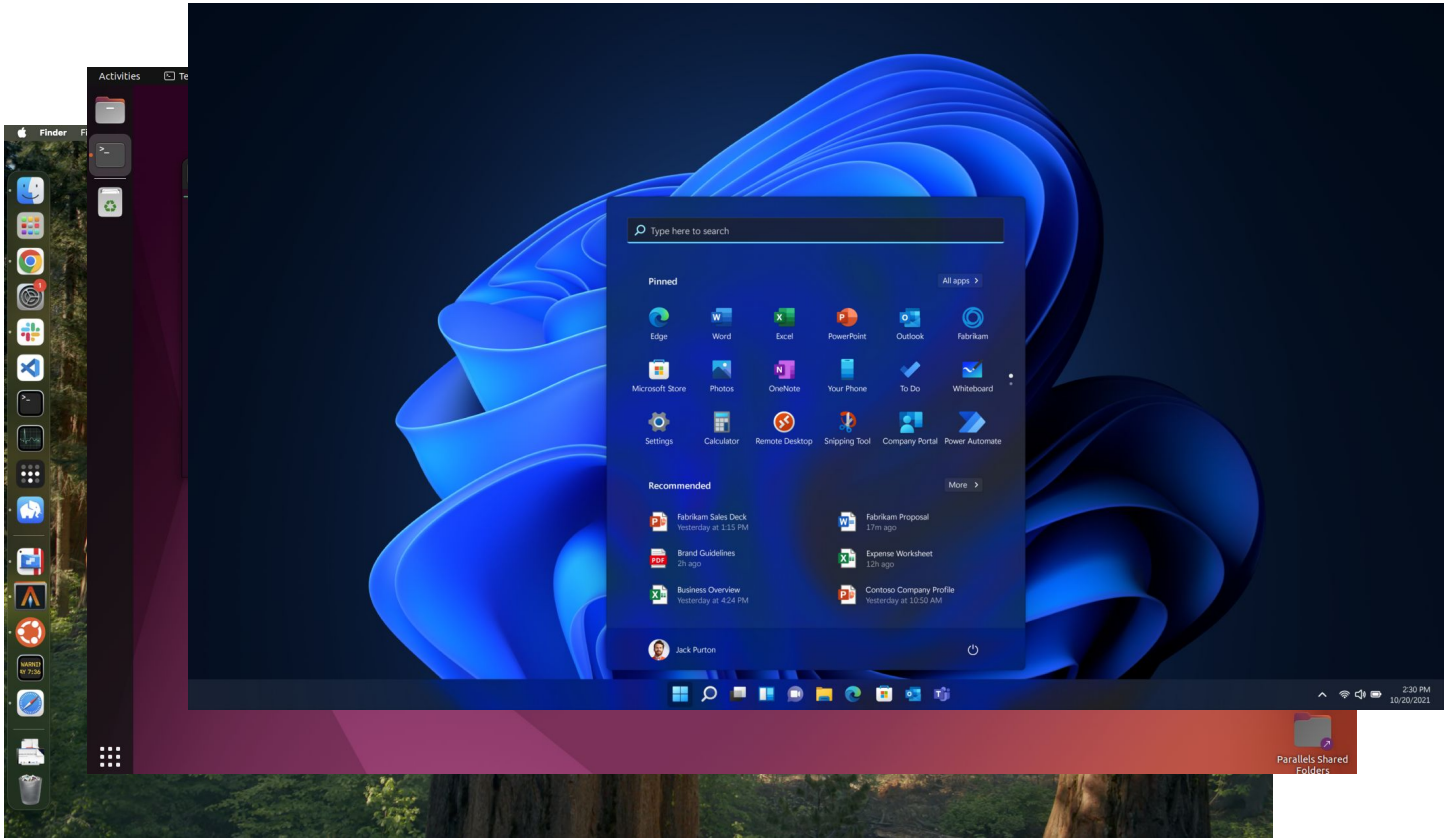
What is an OS?


Finder File Edit View Go Window Help
Mon Feb 17 9:07 AM
Alacritty
Recents
stuff

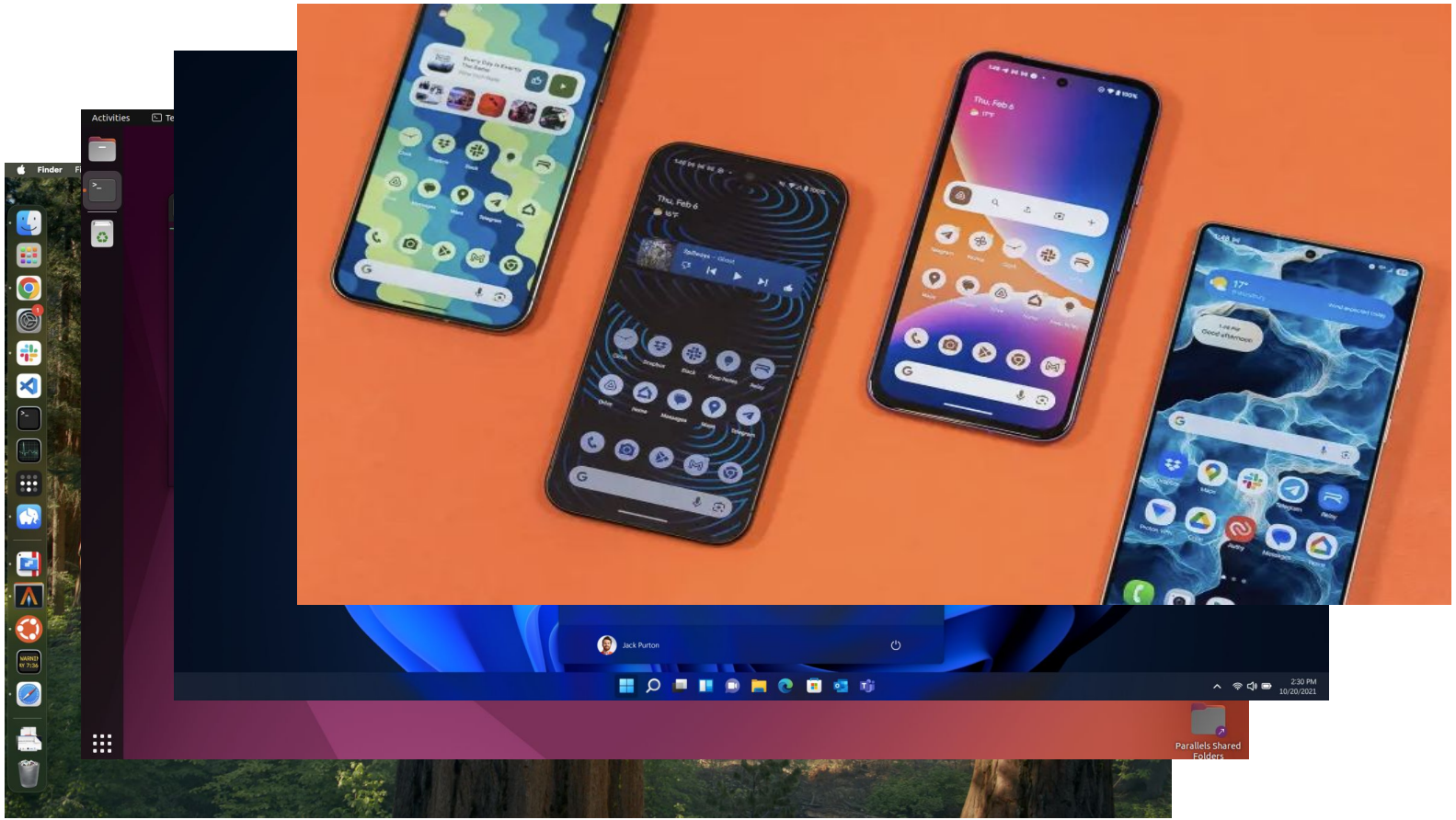
What is an OS?


Activities
Terminal
Feb 17 09:08
parallels@ubuntu-linux-22-04-02-desktop:~
Home
Parallels Shared Folders

What is an OS?


Activities
Finder
Type here to search
Pinned
All apps
Edge
Word
Excel
PowerPoint
Outlook
Fabrikam
Microsoft Store
Photos
OneNote
Your Phone
To Do
Whiteboard
Settings
Calculator
Remote Desktop
Snipping Tool
Company Portal
Power Automate
Recommended
More
Fabrikam Sales Deck
Yesterday at 1:15 PM
Fabrikam Proposal
17m ago
Brand Guidelines
2h ago
Expense Worksheet
12h ago
Business Overview
Yesterday at 4:24 PM
Contoso Company Profile
Yesterday at 10:50 AM
Jack Purton
2:30 PM
10/20/2021
Parallels Shared Folders

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- A layer of abstraction that translates the hardware of a machine into (standardized) software concepts that applications use

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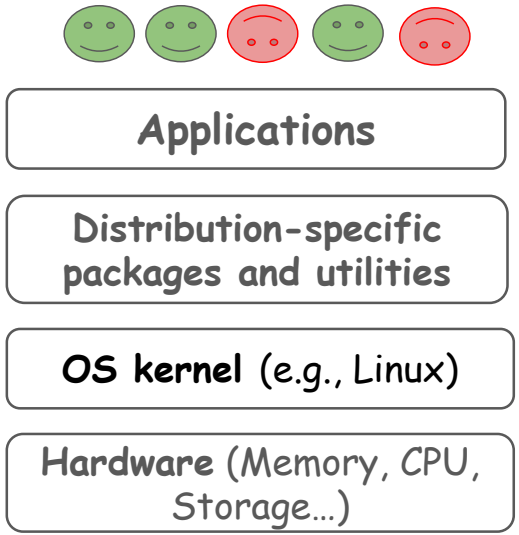
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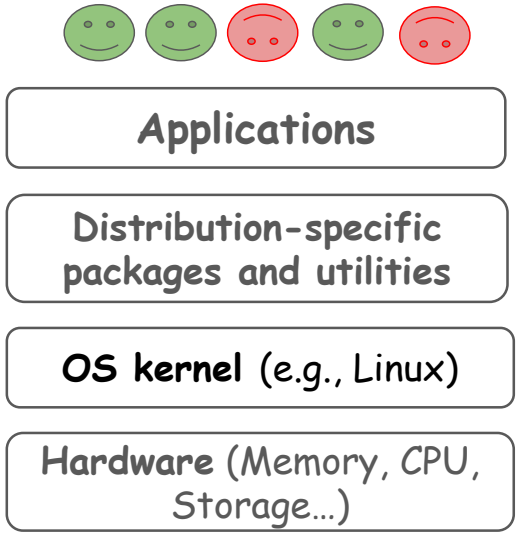


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Why need an OS?

- Multiple users not necessarily sane, build and run different applications, at the same time on shared hardware

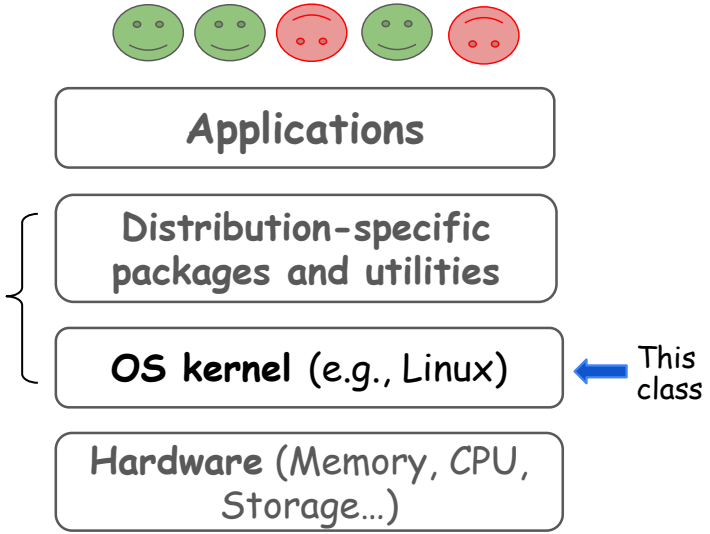


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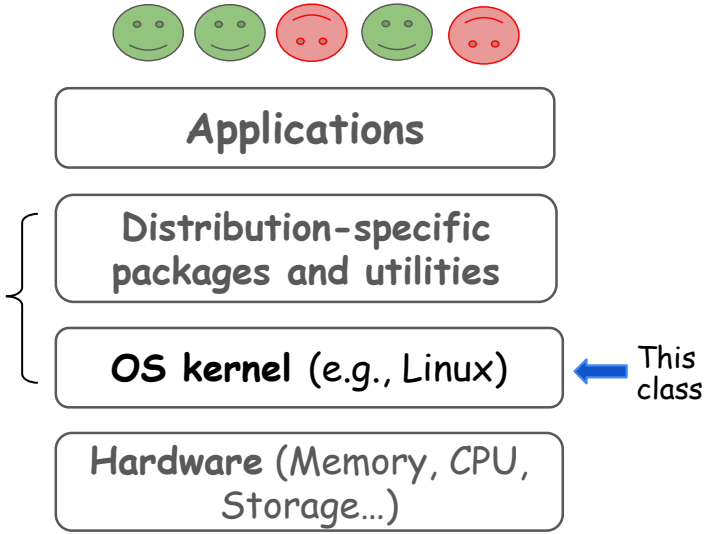


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Why need an OS?

- Multiple users not necessarily sane, build and run different applications, at the same time on shared hardware (design assumptions)



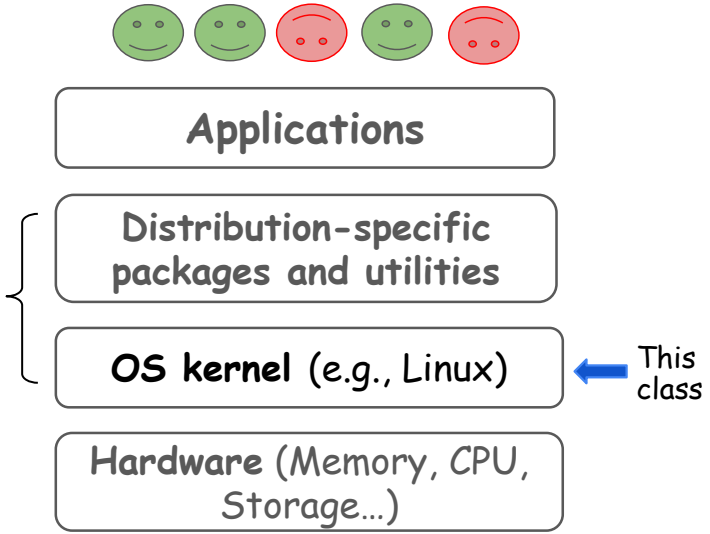
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- A layer of abstraction that translates the hardware of a machine into (standardized) software concepts that applications use

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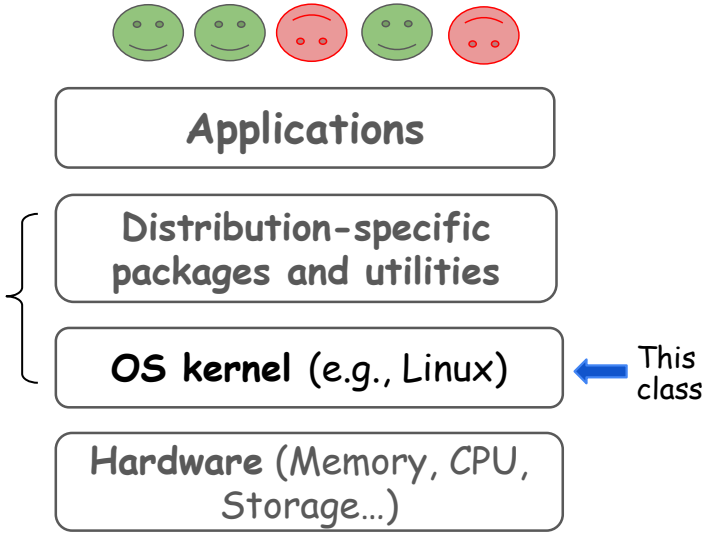
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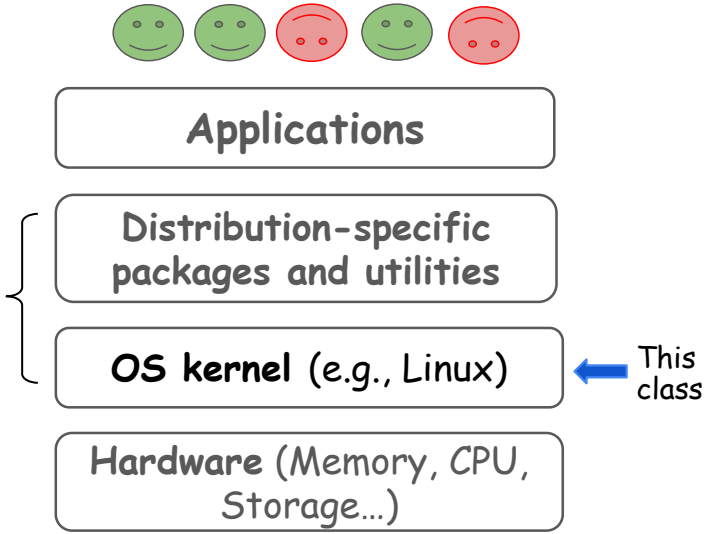
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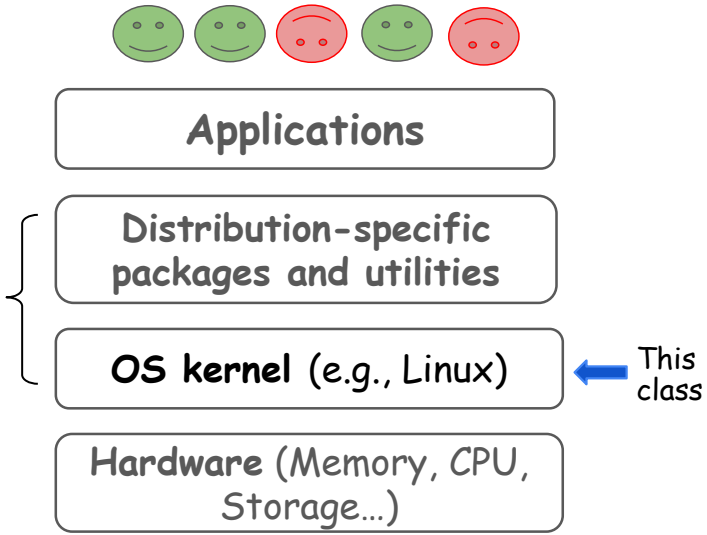
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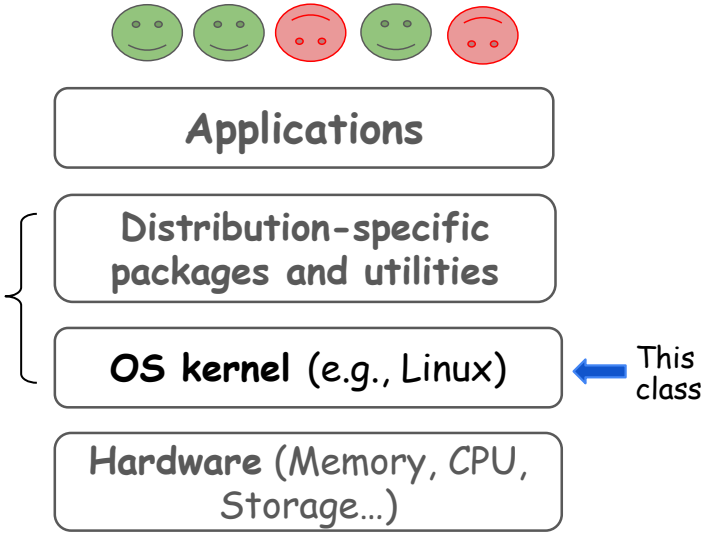
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- ***Portability***: Is it easy for developers to build and maintain apps?
- ***Performance & Responsiveness***: Is the system "pleasant" to use?



What is the hardware we build OSes for?

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Physical Memory (PM)

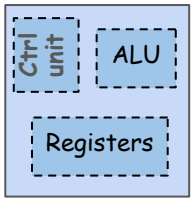
- Stores data addressable on byte granularity

Physical memory



What is the hardware we build OSes for?

Processor



Physical memory



Physical Memory (PM)

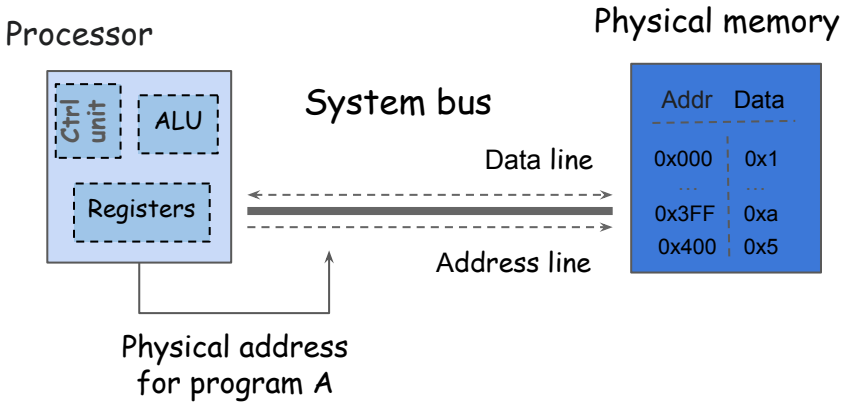
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Processor

> Reads data from memory to its registers

- Performs computations
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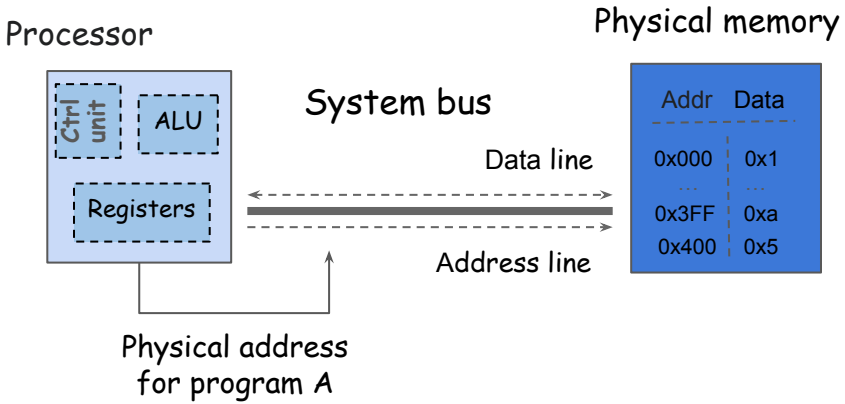
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- Is this model satisfactory?
- Reminds you of something?