

# **PRINCETON** UNIVERSITY

https://www.princeton.edu/~cos126



Spring 2025

COMPUTER

SCIENCE

#### Senior Staff



Kobi Kaplan



Donna Gabai



Alan Kaplan



Adam Finkelstein

#### Assistant Instructors



Tanvi Namjoshi



Ruyu Yan



Kylie Zhang



Nicholas Alexander Sudarsky



Owen Zhang



Kathryn Wantlin



Berlin Chen



Nobline Yoo



Jane Castleman



Abhishek Joshi



Max Gonzalez-Saez



Beza Desta



Lecture slides available from Schedule page on course website: https://www.cs.princeton.edu/courses/cos126/schedule

We will be recording lectures and posting in Canvas.

Because of privacy, compliance, and legal considerations, you may not record or redistribute recordings of this class.

# FINE PRINT

# Computer Science

# COS 126, SPRING 2025

# digital revolution

course mechanics

course resources

# OMPUTER CIENCE

An Interdisciplinary Approach

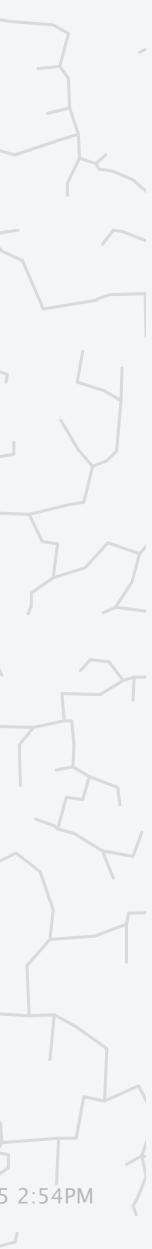
ROBERT SEDGEWICK KEVIN WAYNE

https://introcs.cs.princeton.edu

978-0-321-90575-8 0-321-90575-X 5 7 9 9 9 5 7 9 9 9 5 7 9 9 9

#### ROBERT SEDGEWICK | KEVIN WAYNE





# COS 126 course objectives

Goal 1. Read, write, and reason about computer programs.

Goal 2. Apply concepts to science, engineering, and beyond.

Goal 3. Understand key ideas underlying computation and computer systems.

topic	ex
elements of programming	built-in data types, con
functions	user-defined function
object-oriented programming	user-defined types, e
algorithms and data structures	sorting, sea
computer science	theory of compu
design of computers	machine language

#### xamples

onditionals, loops, arrays, I/O

ions, modularity, recursion

encapsulation, immutability

arching, collections

uting, machine learning

ge, boolean logic, circuits

#### :n==t?this.pause().cycle():this.slide ent.find(".next, .prev").length&&e.su clearInterval(this.interval),this.int nction(){if(this.sliding)return;retur |r[t](),s=this.interval,o=t=="next"?" h?i:this.\$element.find(".item")[u]() cators.length&&(this.\$indicators.find children()[a.getActiveIndex()]);t&&t. t.trigger(f);if faultPrevented( t.transition (){i.removeC iding=!1,se on(){a.\$ele moveClass( ass("activ tion(n){ .carouse defaults 'n),o=ty .[o]():s.in cycle( ,e.fn.carou =function( ar n=e(this) slide-to]",fu {},i.data/ carousel(s })}(wind





# COS 126, SPRING 2025

# digital revolution

- course mechanics

course resources

OMPUTER SCIENCE

An Interdisciplinary Approach

ROBERT SEDGEWICK KEVIN WAYNE

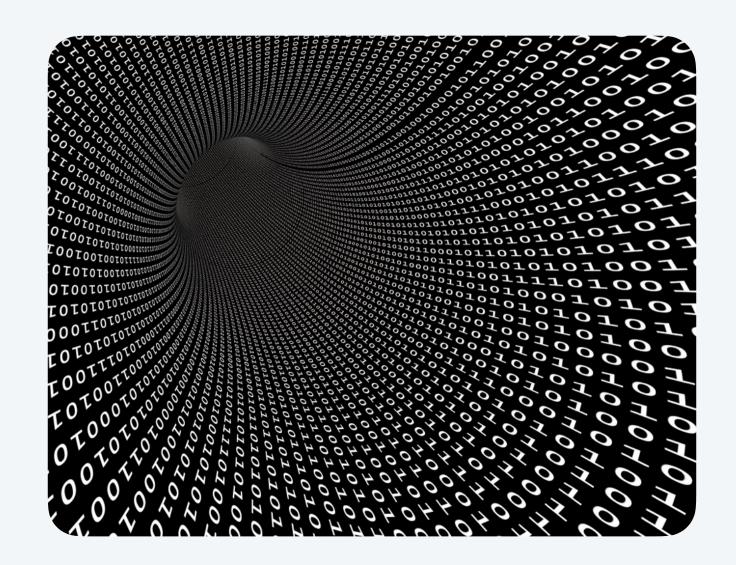
https://introcs.cs.princeton.edu

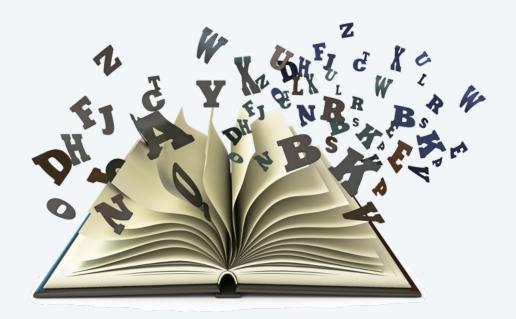


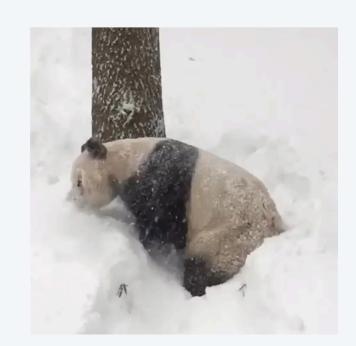
# The digital revolution

Key idea. "Everything" can be encoded as a sequence of bits (0s and 1s).

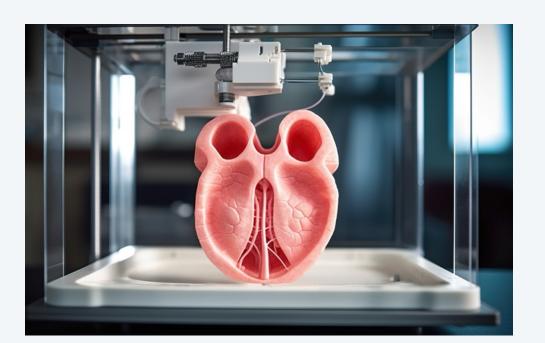
- Numbers and text.
- Pictures, songs, and movies.
- Biometrics.
- 3D objects.
- Computer programs.
- $\bullet$ . . .

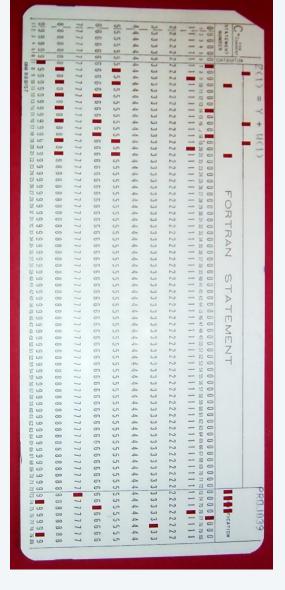










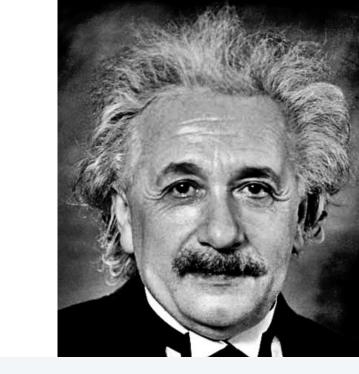




Key idea. "Everything" can be encoded as a sequence of bits (0s and 1s).Innovation 1. You can program computers to process bits.Innovation 2. Devices can use the Internet to send and receive bits.

" Computers are incredibly fast, accurate, and stupid; humans are incredibly slow, inaccurate, and brilliant; together they are powerful beyond imagination."

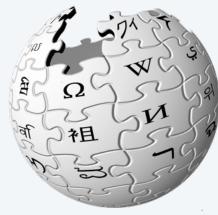
- widely misattributed to Albert Einstein



From the way we work ...











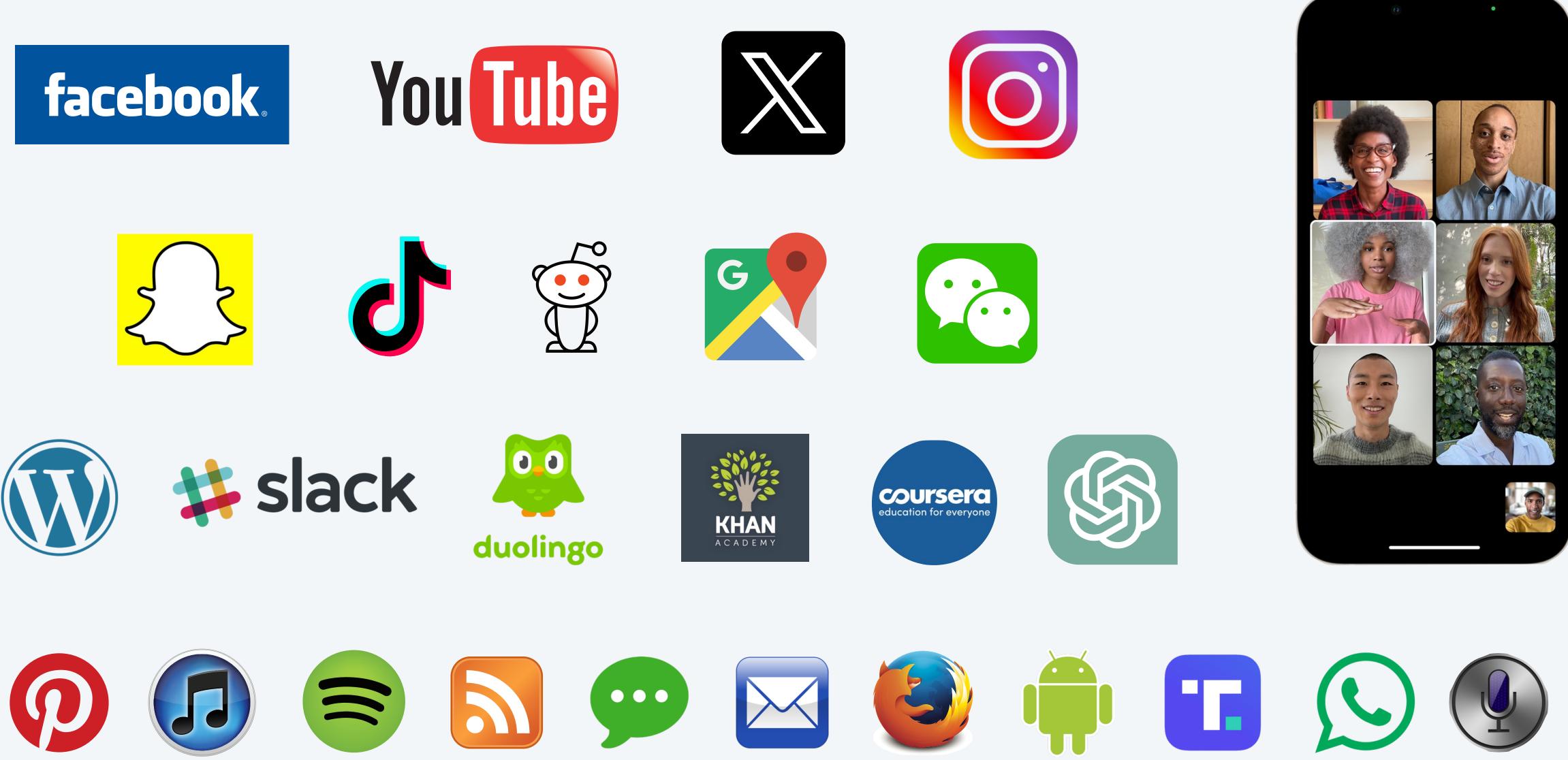


... to the way we live.















From the "new" economy ...



NETFLIX



DOORDASH

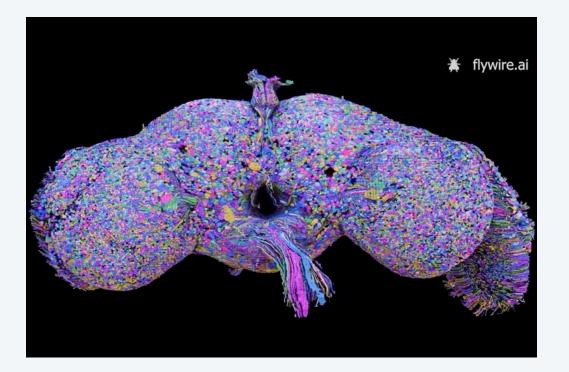
ALGORITHMS TAKE CONTROL OF WALL STREET

Today Wall Street is ruled by thousands of little algorithms, and they've created a new market—volatile, unpredictable, and impossible for humans to comprehend. Photo: Mauricio

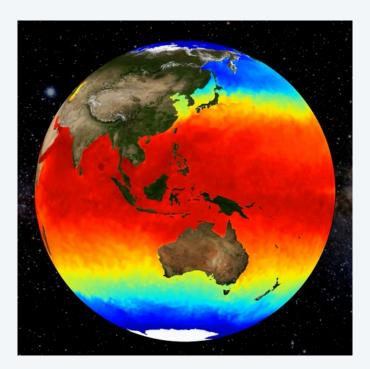




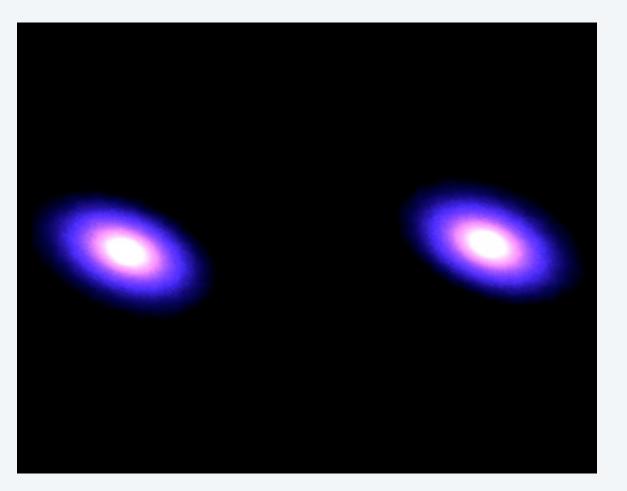
### ... to the way we do science and engineering.



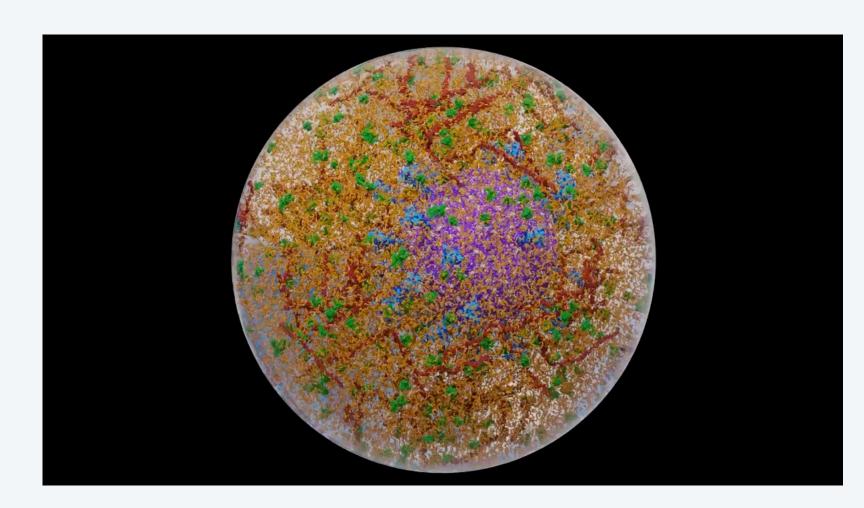
diffusion MRI of brain



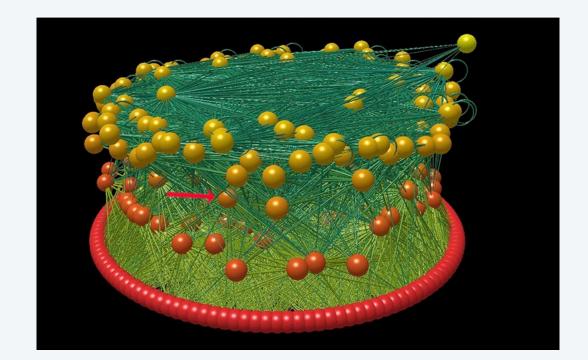
ocean modeling



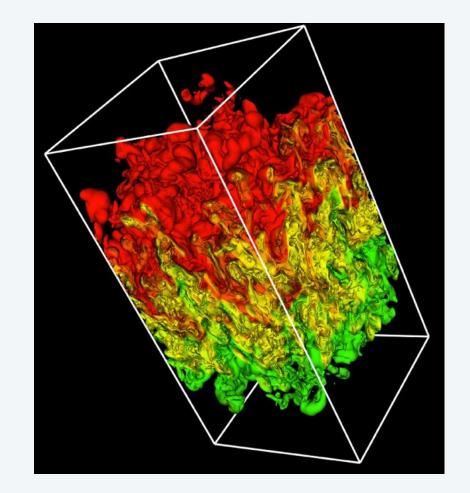




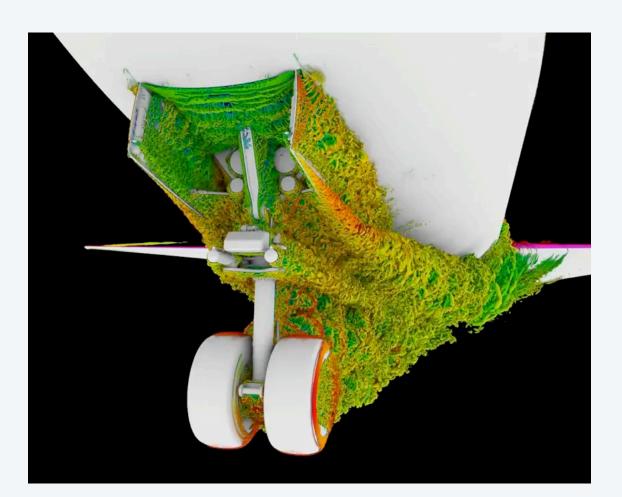
an aerosol droplet containing coronavirus



ancestral Pueblo food web



nuclear physics



airflow over landing gear

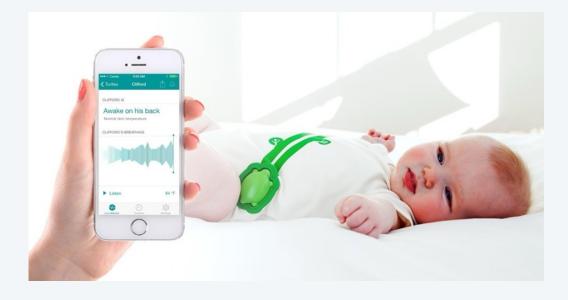
# The digital revolution has only just begun

### In 2020. 50 billion + smart connected devices, all developed to collect, analyze, and share data.



Source: Google

Raoul Rañoa / @latimesgraphics



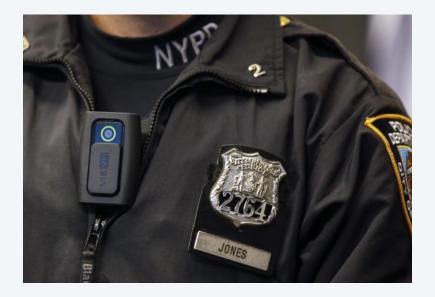
























# The digital revolution has only just begun

Welcome aboard. You're already a consumer. Now, become a creator! In the service of humanity. Use your new superpower responsibly!



OVERBOOKED Airlines are price gouging in the path of Hurricane Irma—and algorithms are to blame

Against Black Patients, New Research

Health care software prioritizes white patients, even when they're not

Student proves Twitter algorithm 'bias' toward lighter, slimmer, younger faces

New York Eimes

#### An Algorithm That Grants Freedom, or Takes It Away

Across the United States and Europe, software is making probation decisions and predicting whether teens will commit crime. Opponents

# COS 126, SPRING 2025

# digital revolution

# course mechanics

course resources

## OMPUTER SCIENCE

An Interdisciplinary Approach

ROBERT SEDGEWICK KEVIN WAYNE

https://introcs.cs.princeton.edu

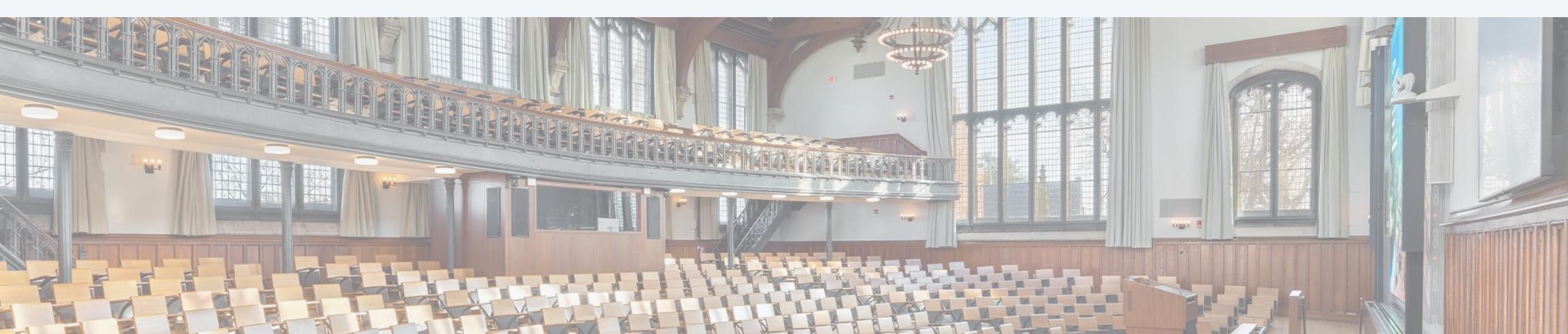


Live lectures. [MW 1:30-2:50pm] Introduce new material.

Questions. You are encouraged and expected to participate.

- Raise your hand and ask a question. *carpe diem*!
- Ask (anonymous or not) in Ed. *course staff will monitor forum*

Electronic devices. Permitted *only* to support lecture. viewing slides, taking notes, iClickers, ...



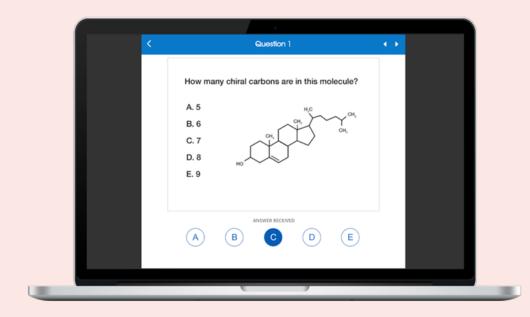
(may answer or share with class)

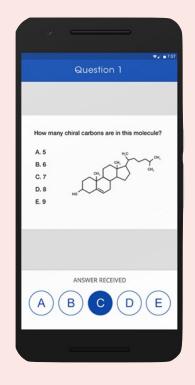
# Intro to COS 126: quiz 1

iClicker. To earn participation credit:

- Register for course.
- Answer multiple choice questions during lecture.

### Which iClicker device are you using?







B. iPhone





https://www.iclicker.com









# Precepts

Active learning. Discussion, problem solving, pair programming, ...

• 50-minute precepts.

*— same content; different pace* 

- 80-minute precepts.
- Raspberry Pi 🍑 precept (P14).

if interested, see Prof. Alan Kaplan after class



Tanvi Namjoshi



Max Gonzalez-Saez



Beza Desta



Ruyu Yan



Kylie Zhang



Nicholas Alexander Sudarsky



Donna Gabai



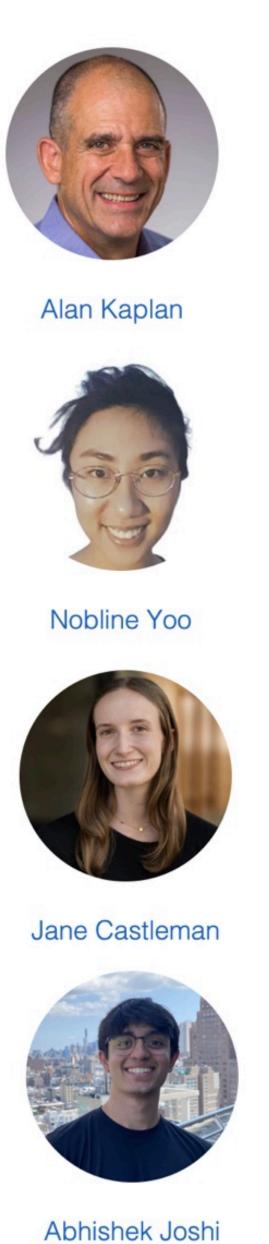
Owen Zhang

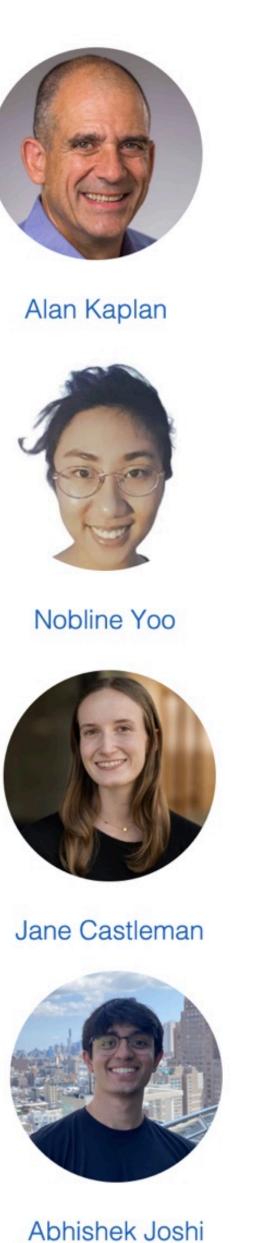


Kathryn Wantlin

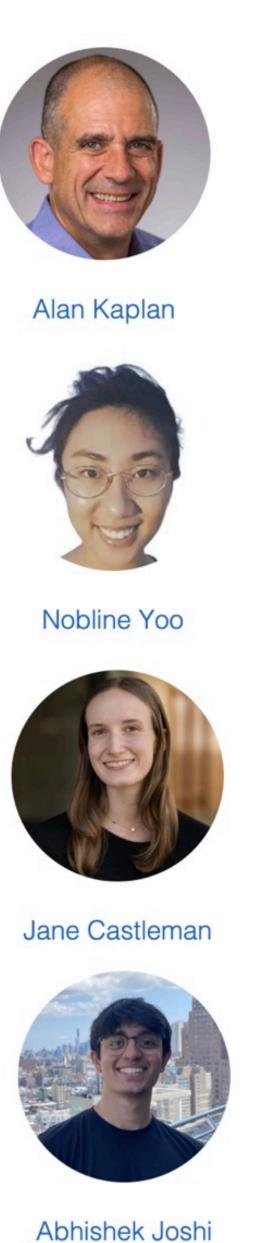


**Berlin Chen** 

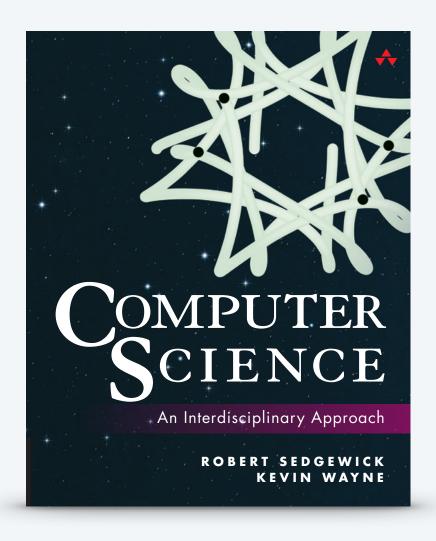








Textbook readings (required). *Computer Science: An Interdisciplinary Approach* by R. Sedgewick and K. Wayne, Addison–Wesley Professional, 2016.



ISBN-13: 978-0-321-90575-8 ISBN-10: 0-321-90575-X ISBN-10: 0-321-90575-X 9: 780331: 9057:38



Programming assignments (37.5%). Assigned weekly.

Final project (7.5%). Capstone programming assignment.

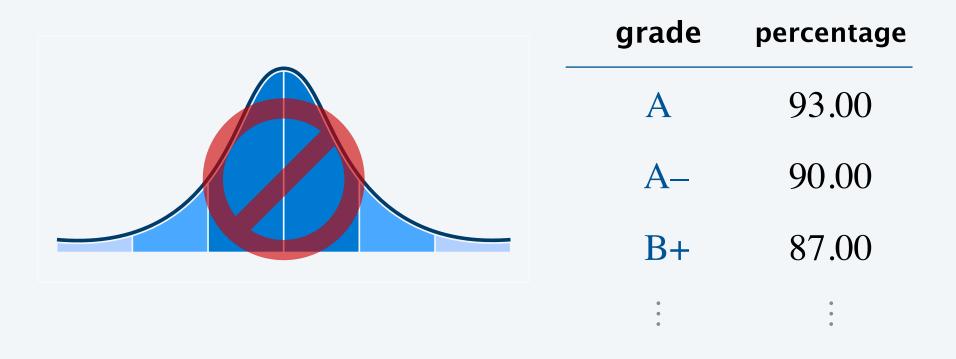
Exams (50%) – equal weights:

- Two written exams.
- One programming exam.

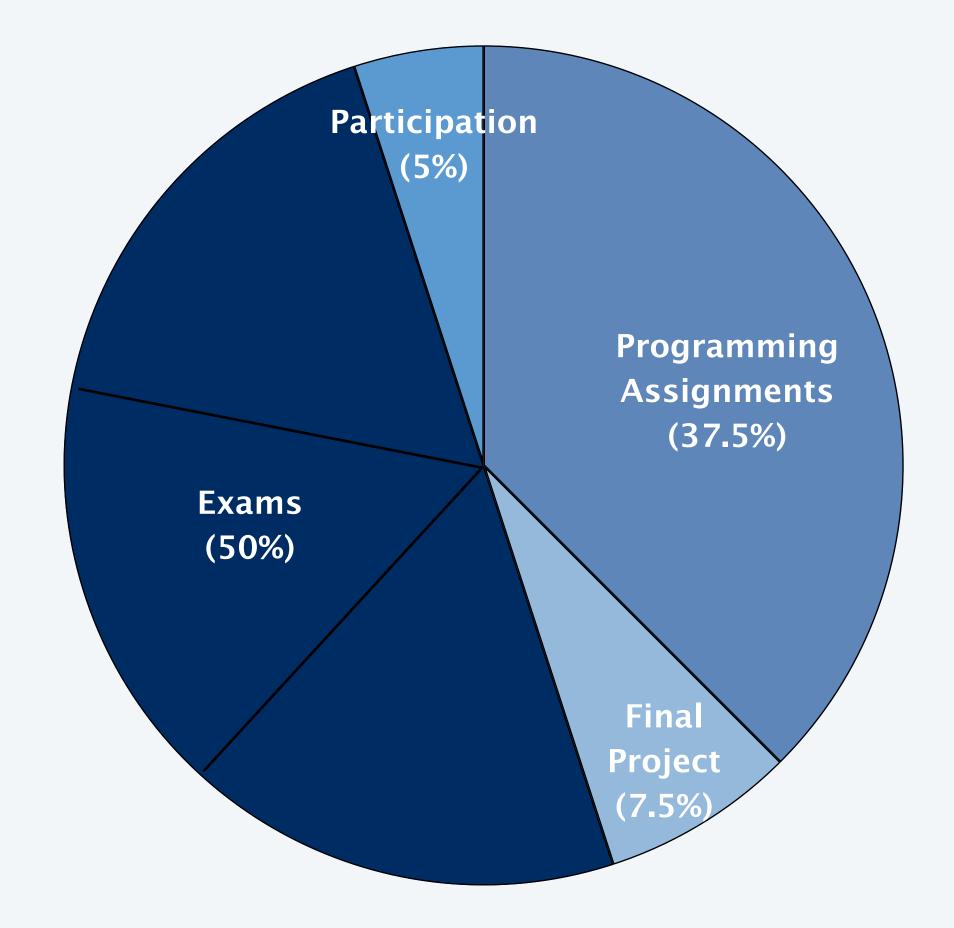


Participation (5%). Participate in lectures/precepts.

Course grades. Uncurved (no rounding).











**Programming.** An essential part of the experience in learning CS.

### Desiderata.

- Illustrate a fundamental CS concept.
- Apply a new programming construct.
- Highlight the role of computation in an important domain.
- You solve the problem from scratch, on your own computer!

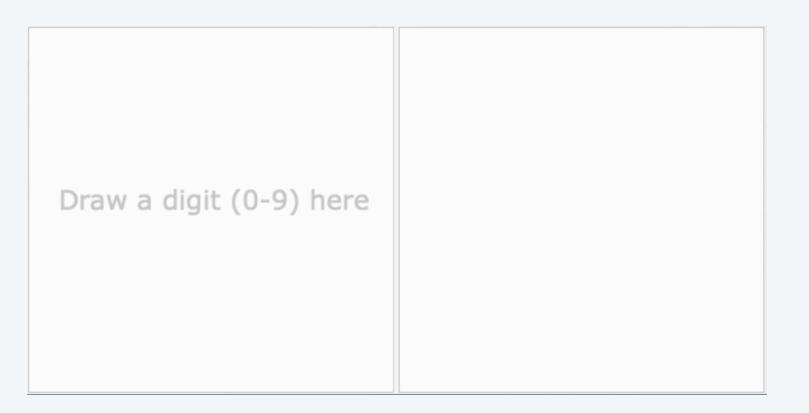


Image Classifier (assignment 6)



**Guitar Hero** (assignment 7)

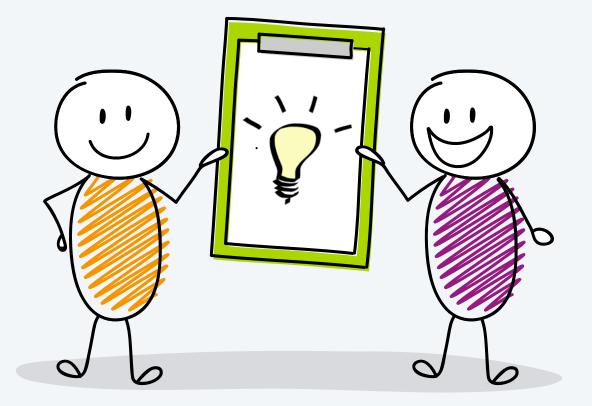




### Executive summary.

- Do discuss concepts with others.
- Do acknowledge any collaboration with others.
- Do partner with a classmate (on designated assignments).
- Do not copy code from others (or generative AI tools).

Full details. See course syllabus.



share ideas





not code

# COS 126, SPRING 2025

# digital revolution

- course mechanics

### course resources

## OMPUTER CIENCE

An Interdisciplinary Appro

ROBERT SEDGEWICK KEVIN WAYNE

https://introcs.cs.princeton.edu



Resources (web)

### Course website.

Syllabus and course policies.

- Lecture slides.
- Programming assignments.
- Exam archive.
- Getting help.
- $\bullet$ . . .

### Booksite.

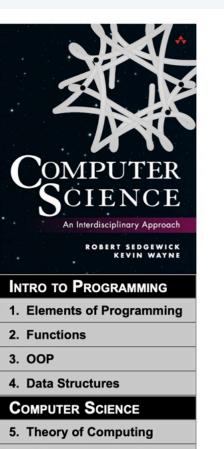
- Download code from book.
- Brief summary of content.
- For use while online.

#### Syllabus

#### **Course Description**

This course is an introduction to computer science in the context of scientific, engineering, and commercial applications. The goal of the course is to teach basic principles and practical issues, while at the same time preparing students to use computers effectively for applications in computer science, physics, biology, chemistry, engineering, and other disciplines. Topics include: programming in Java; hardware and software systems; algorithms and data structures; fundamental principles of computation; and scientific computing, including simulation, optimization, and data analysis.

#### https://www.princeton.edu/~cos126



6. A Computing Machine

7. Building a Computer

PROGRAMMING IN JAVA · COMPUTER SCIENCE · AN INTERDISCIPLINARY APPROACH

textbooks for a first course in computer science for the next generation of scientists and engineers

**Online content.** This booksite contains tens of thousands of files, fully coordinated with our textbook and also useful as a standalone resource. It consists of the following elements:

- Excerpts. A condensed version of the text narrative, for reference while online.
- Lectures. Curated studio-produced online videos, suitable for remote instruction.
- Java code. Hundreds of easily downloadable Java programs and our I/O libraries for processing text, graphics, and sound.
- Data. Real-world data sets for testing code (ours and yours).
- Exercises. Selected exercises from the book and "web exercises" developed since its publication, along with solutions to selected exercises

#### https://introcs.cs.princeton.edu

Ed Discussion forum. ← please use Ed, not email

- Access via link in Canvas
- Read Ed Discussion FAQ for etiquette.

**Office hours.** ← *protip: attend* 

- Longer discussions.
- See course website for schedule.

Intro COS Lab. ← opens Friday

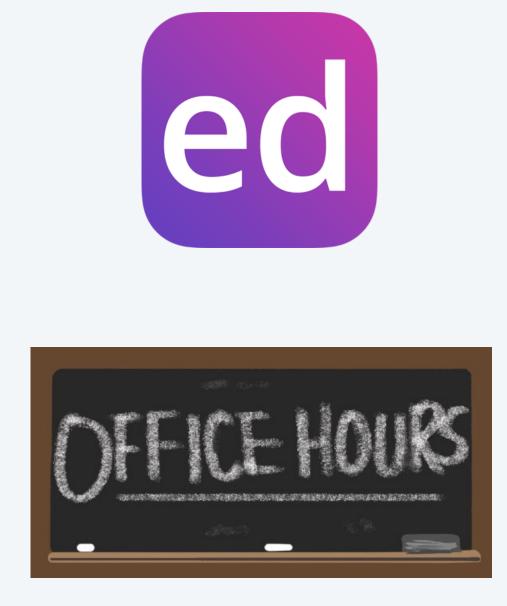
- Run by undergrads.
- For help with debugging.

McGraw group drop-in study halls.

- Led by undergrads.
- For help with concepts.

WHAT THEY LOOK LIKE





https://www.princeton.edu/~cos126



# The McGraw Center for Teaching & Learning

https://mcgraw.princeton.edu/undergraduates

https://introlab.cs.princeton.edu



# Resources (programming environment)



←

### Recommended IDE. Custom IntelliJ environment.

- Embedded Bash terminal.
- Autoformat, autoimport, autocomplete, ...
- Continuous code inspection.
- Alassistant. *not in this course*
- ...

Project ~	Project $\sim$	🔁 logo.j	ong	🕑 HelloWo
Project	✓ Cahello [COS 126] sources root, ~	1	publ	lic class
<ul> <li> &gt; <ul> <li>google</li> <li>people</li> <li>siri</li> <li>HelloWorld</li> <li>logo.png</li> <li>acknowledgments.txt</li> <li>CREDITS</li> </ul> </li></ul>		2		/******
		3		* This µ
		4		* first
		5		******
	6		public st	
	≡ readme.txt	7		Syste
	>	8		}
		9	}	
		10		
	Terminal Terminal ×			
	~/Desktop/hello> javac H	lelloWor	∿ld.ja	ava
>_	~/Desktop/hello> java He	lloWorl	d	
Terminal	Hello, World			
() Problems	~/Desktop/hello>			

Use the newest COS126 version!

- See Assignment 0 installation instructions.
- See Lab TAs for troubleshooting.

ava ×	:
<pre>lloWorld { ************************************</pre>	
out.println("Hello, World");	
7:44 LF UTF-8 4 spaces	ං

Resources (ed tech)



	Platform	What
ed	Ed	discussion forum, precept exercises ←
IJ	IntelliJ	Java IDE
	TigerFile	programming assignment submissions
	codePost	programming assignment feedback
alt	Gradescope	written exam feedback
a	Canvas	grades, lecture recordings
	iClicker	in-class polls



### If I don't understand a fundamental programming concept, what should I do?

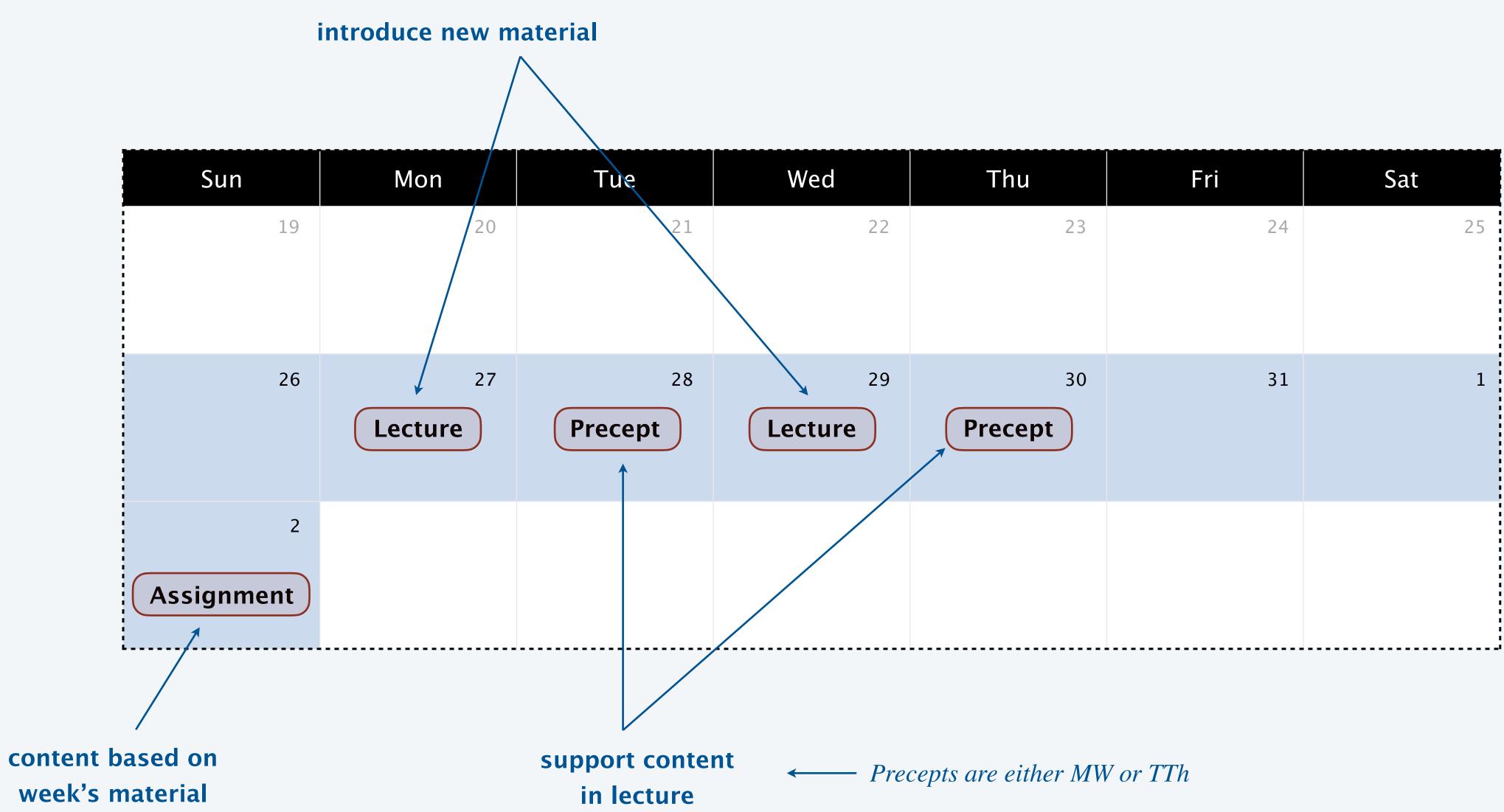
- A. Attend office hours.
- **B.** Get help from a lab TA.
- C. Post a question on Ed Discussion.
- **D.** Email/text my preceptor.
- E. Copy a classmate's solution.

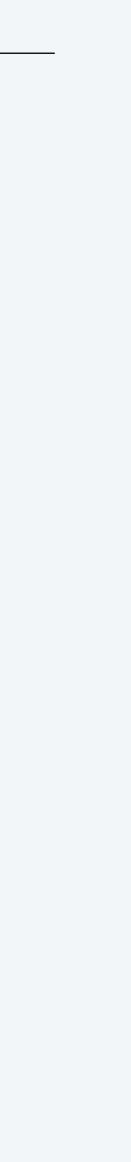






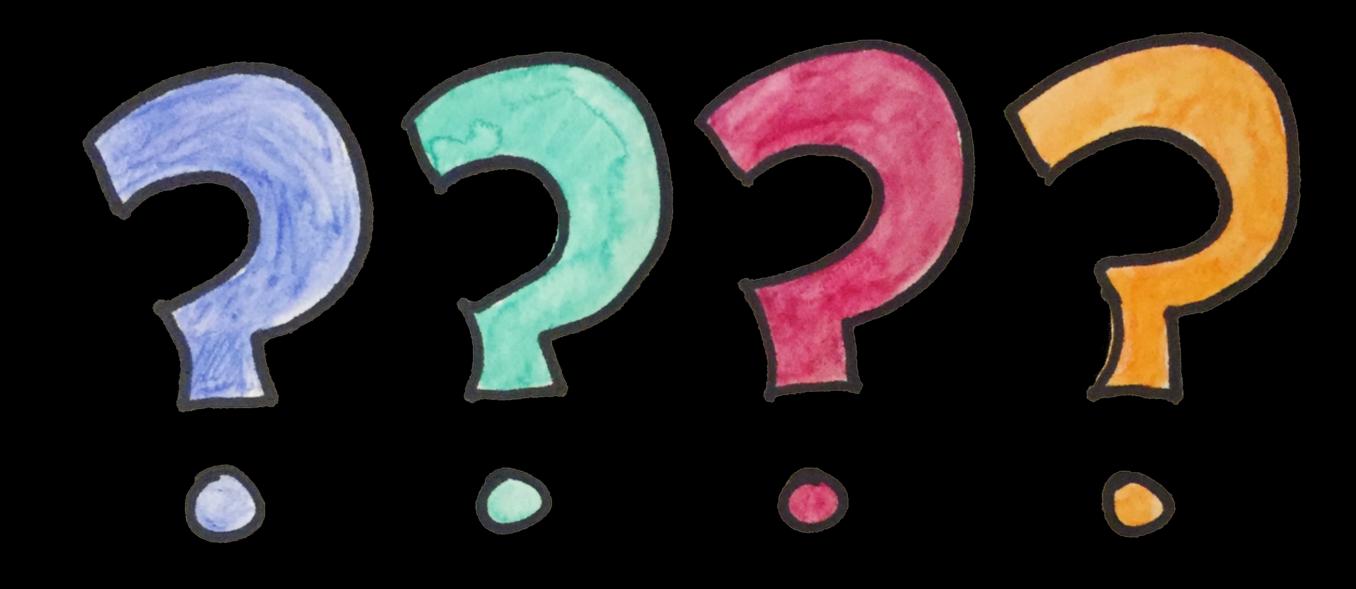








#### raise your hand and ask





or ask on Ed (use 🎔 to upvote)

# Credits

#### media

Crowd Cheering Wireframe Tiger Programmer Albert Einstein Binary Tunnel Open Book with Letters Panda in Snow DNA Sequencing 3D Printer

Fortran Punch Card

### Lecture Slides © Copyright 2025 Robert Sedgewick and Kevin Wayne

source	license	
YouTube		
Audrey Cheng '20	by author	
Wall Street Journal		
<u>Wikimedia</u>	public domain	
Adobe Stock	education license	
Adobe Stock	education license	
Smithsonian National Zoo	public domain	
Adobe Stock	education license	
Adobe Stock	education license	
<u>Wikimedia</u>	<u>CC BY-SA 2.5</u>	

# Credits

#### media

Ocean Modeling Fruit Fly Brain Pueblo Food Web Nuclear Physics Colliding Galaxies Airflow Over Landing Gear <u>NA</u> Coronavirus Simulation McCosh 50 Normal Distribution Handwritten Digit Demo

Stairway to Heaven

source	license
JPL / NASA	<u>public domain</u>
<u>FlyWire Brain</u>	<u>CC BY-NC 4.0</u>
Stefani Crabtree	
FLASH Center	
YouTube	
ASA Ames Research Center	public domain
New York Times	
Figueras Seating	
Adobe Stock	education license
Adam Smith	
Led Zeppelin	

#### Lecture Slides © Copyright 2025 Robert Sedgewick and Kevin Wayne

# Credits

#### media

Collaborating Hands

Cartoon People Sharing

Light Bulb Idea

<u>Clk</u>

Ice Breaker

Countdown Timer

Office Hours

COS Lab TAs

McGraw Center

Student Raising Hand

Question Marks

### Lecture Slides © Copyright 2025 Robert Sedgewick and Kevin Wayne

source	license
Flaticon	Flaticon license
Adobe Stock	education license
ker-Free-Vector-Images	<u>Pixabay</u>
Adobe Stock	education license
<u>YouTube</u>	
<u>clipground.com</u>	<u>CC BY 4.0</u>
Pulkit Singh '20	by author
McGraw Center	
classroomclipart.com	educational use
<u>pikpng.com</u>	non-commercial use