COS 226, FALL 2021

Algorithms
and
Data Structures

Kevin Wayne · Dan Leyzberg · Jérémie Lumbroso

Fine print

I will be recording lectures and make them available to eligible students, as per university policy.

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

https://algs4.cs.princeton.edu

Intro to COS 226

- *motivation*
- *course structure*
- *assessments*
- *resources*

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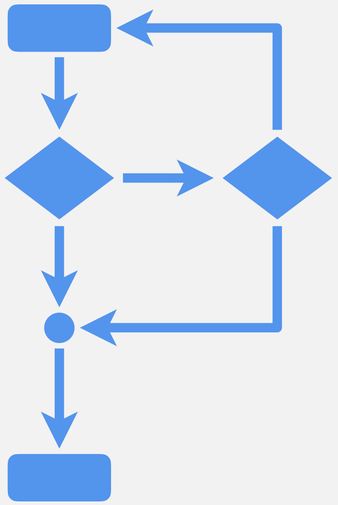
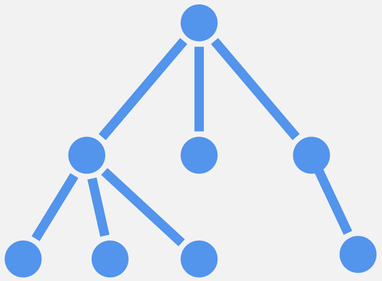
COS 226 course overview

What is COS 226?

- Intermediate-level survey course.
- Programming and problem solving, with applications.
- Algorithm: step-by-step procedure for solving a problem.
- Data structure: method for organizing data in a computer.

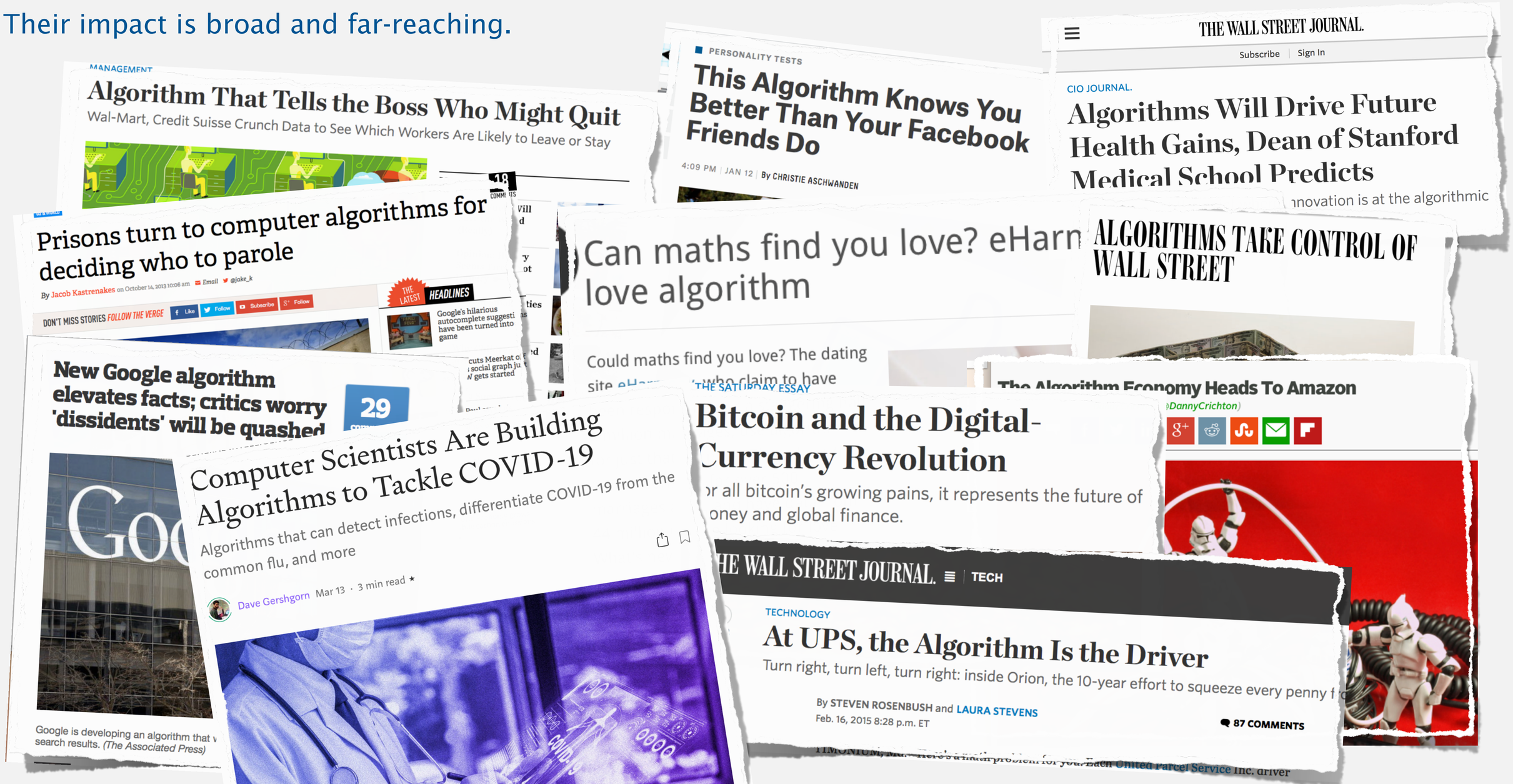




topic	algorithms and data structures 
data types	*stack, queue, union–find*
sorting	*quicksort, mergesort, heapsort, priority queue*
searching	*BST, red–black BST, hash table, k-d tree*
graphs	*BFS, DFS, Prim, Kruskal, Dijkstra, Bellman–Ford*
strings	*radix sorts, tries, suffix arrays, data compression*

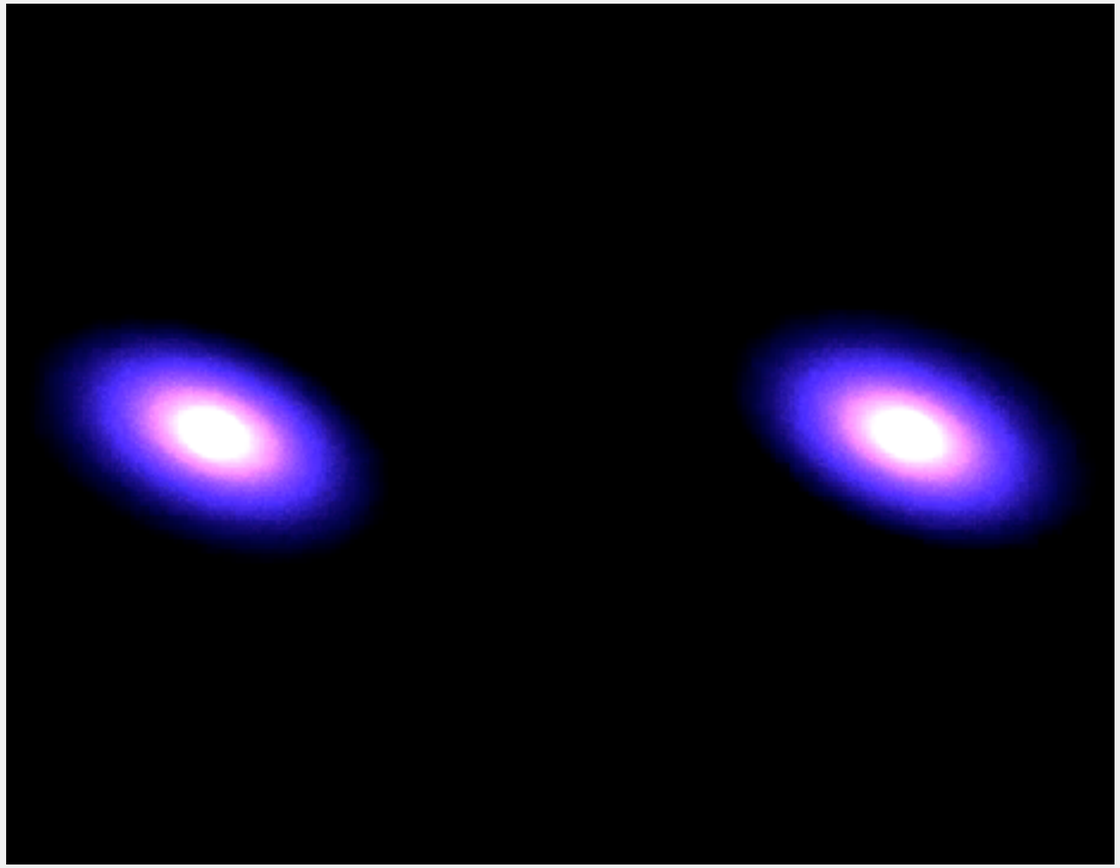
Why study algorithms and data structures?

Their impact is broad and far-reaching.



Why study algorithms and data structures?

They may unlock the secrets of life and of the universe.

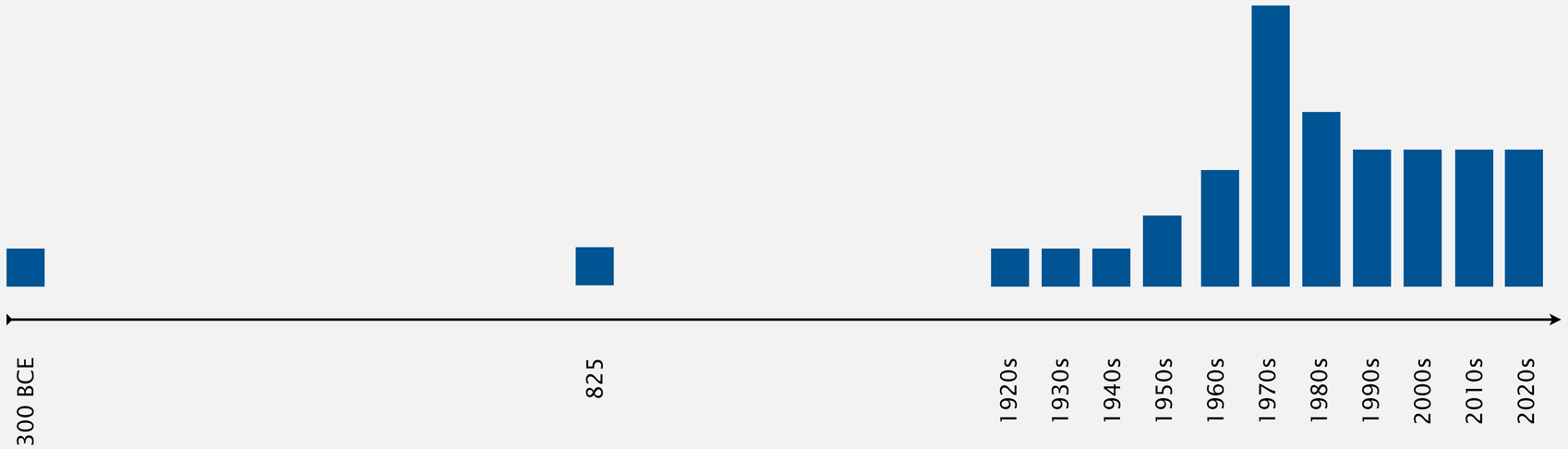


https://www.youtube.com/watch?v=ua7YlN4eL_w

Why study algorithms and data structures?

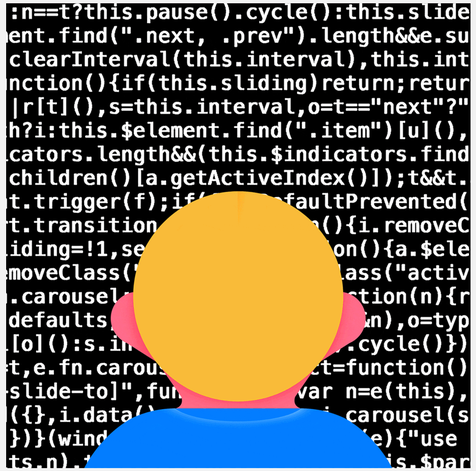
Old roots, new opportunities.

- Study of algorithms dates at least to Euclid.
- Named after Muḥammad ibn Mūsā al-Khwārizmī.
- Formalized by Church and Turing in 1930s.
- Some important algorithms were discovered by undergrads in a course like this!



Why study algorithms and data structures?

To become a proficient programmer.



> *“ I will, in fact, claim that the difference between a bad programmer and a good one is whether [they] consider [their] code or [their] data structures more important. Bad programmers worry about the code. Good programmers worry about data structures and their relationships.”* — *Linus Torvalds (architect of Linux and git)*

Why study algorithms and data structures?

For intellectual stimulation.

> *For me, great algorithms are the poetry of computation. Just like verse, they can be terse, allusive, dense, and even mysterious. But once unlocked, they cast a brilliant new light on some aspect of computing.* — *Francis Sullivan*

Why study algorithms and data structures?

For fun and profit.

Why study algorithms and data structures?

- Their impact is broad and far-reaching.
- They may unlock the secrets of life and of the universe.
- Old roots, new opportunities.
- To become a proficient programmer.
- For intellectual stimulation.
- For fun and profit.

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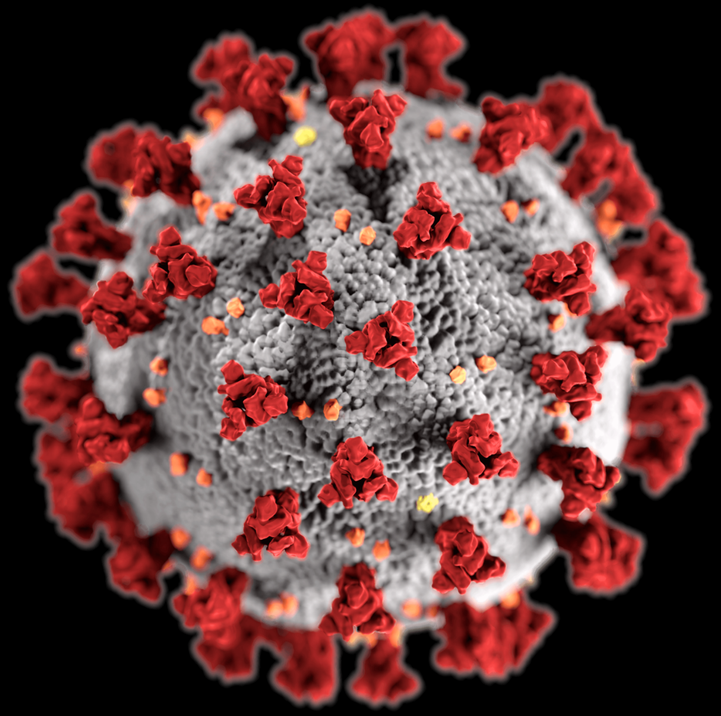
- *resources*



course format subject to change

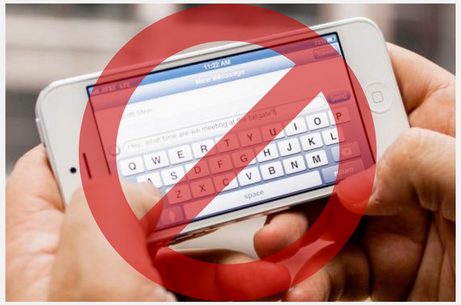
Lectures

Live lectures. Introduce new material.

What	When	Where	Who	Office Hours
L01	TTh 11–12:20pm	Friend 101	Kevin Wayne	*see web*

Electronic devices. Permitted *only* to support lecture.

viewing slides, taking notes, iClickers, ...



Student response system (required).

- Multiple choice questions to increase engagement.
- Must register either hardware remote or web/mobile app to receive credit.
- Caveat: use only one device per lecture.

free for Princeton students

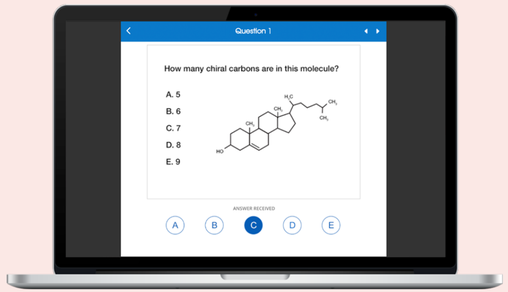
Which iClicker are you using?

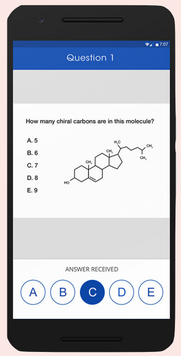
A. Web app.

B. iPhone app.

C. Android app.

D. Hardware remote.





Precepts

Active learning. Problem-solving, discussion, assignment prep, ...

Dan Leyzberg

Bob Tarjan

Chloe Qiu

Laura Leal

Max Tchouambe

Morgan Nanez

Yingxi Lin

Precepts

What	When	Where	Who
P01	Th 3-4:20pm	Friend 109	Dan Leyzberg
P02	Th 4:30-5:50pm	Friend 109	Dan Leyzberg
P03	Th 7:30-8:50pm	Friend 109	Morgan Nanez
P04	F 11-12:20pm	Friend 109	Laura Leal
P05	F 11-12:20pm	Friend 108	Max Tchouambe
P06	F 11-12:20pm	Friend 009	Bob Tarjan
P07	F 1:30-2:50pm	Friend 109	Yingxi Lin
P08	F 1:30-2:50pm	Friend 108	Chloe Qiu
P10	F 3-4:20pm	Friend 108	Chloe Qiu

Covid-19 policies

Face coverings. Abide by university rules. ← I will be masking through 9/9 (quarantine exception policy)

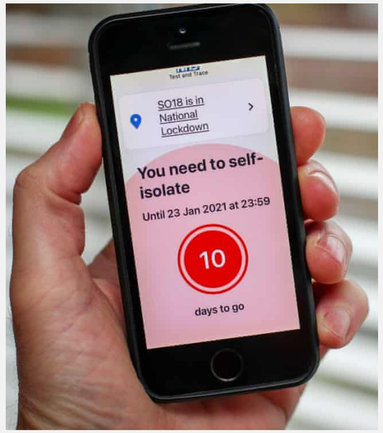
- You must wear a mask over nose and mouth.
- You may lift mask to sip beverage.
- If vaccinated, you may remove mask briefly to ask instructor a question.

← current rules (subject to change)

Symptomatic. Stay home and call UHS.

Self-isolation for students. Either lecture recordings or Zoom.

Self-isolation for course staff. Either substitute instructor/preceptor or Zoom.



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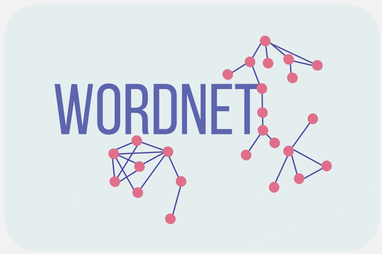
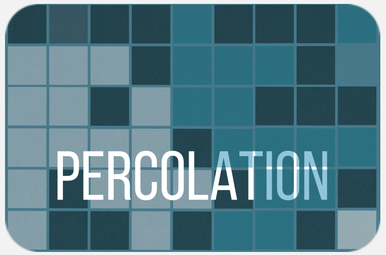
- *union–find*

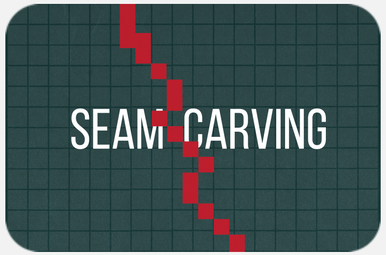
Programming assignments

Implement an efficient algorithm or data structure:



Solve an interesting application using a “textbook” algorithm:



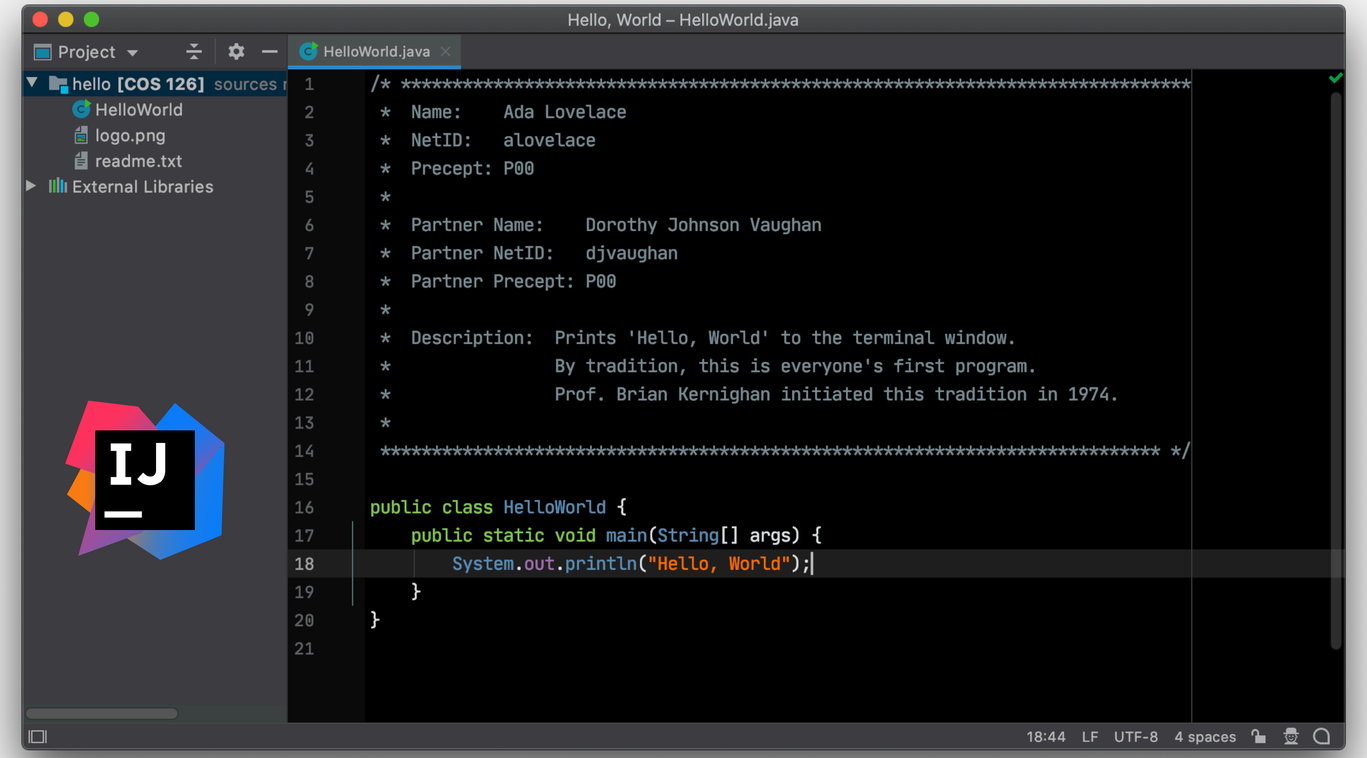


Pair programming encouraged on designated assignments.

Programming environment

Recommended IDE. Custom IntelliJ 2021.1 environment. ← upgrade to Fall 2021 version

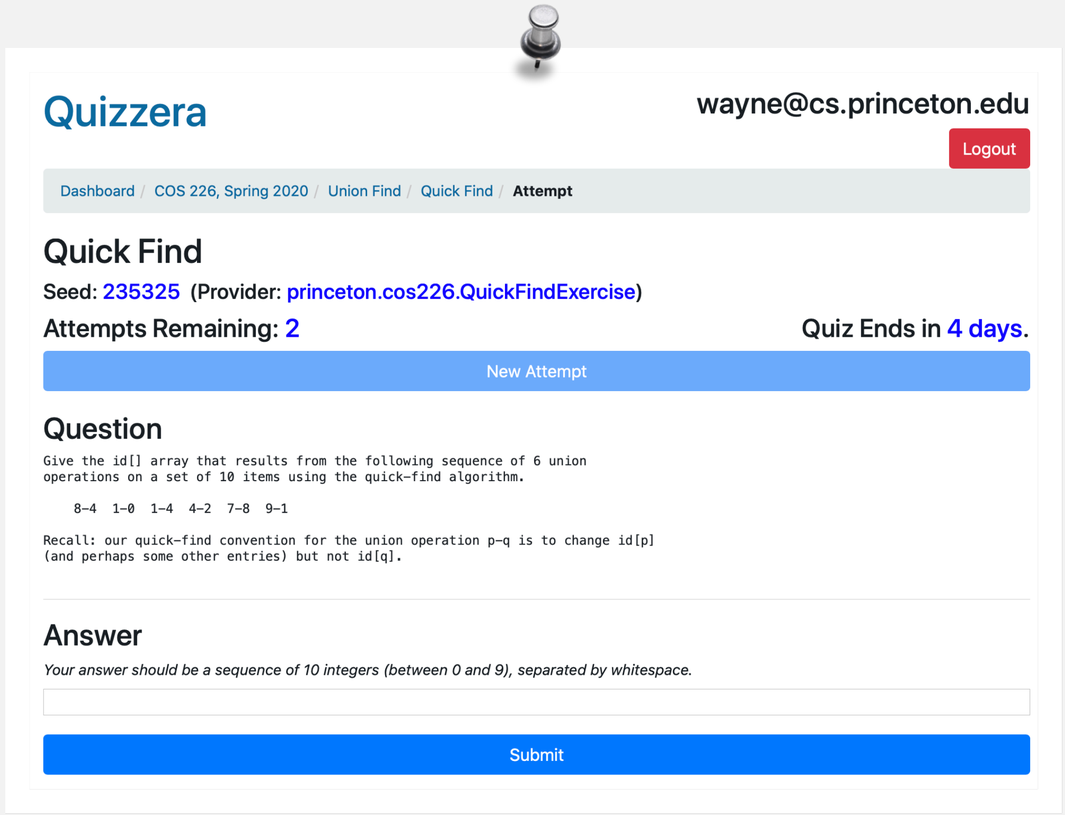
- Embedded Bash terminal.
- Autoformat, autoimport, autocomplete, ...
- Continuous code inspection; integrated Checkstyle and SpotBugs.
- ...



Quizzes

Quizzera platform.

- 2–3 short questions per lecture.
- Solve using pencil and paper.
- 3 attempts per question (score = max of each question).



Midterm and final

Written exams.

- Questions drawn from lectures, precepts, and quizzes.
- Emphasizes non-programming material.

Q4 Analysis of algorithms

8 Points

gradescope

Consider a *zig–zag array* that contains the integers 1 through $n/2$ in ascending order, interleaved with $n/2$ copies of the integer 0, where n is an even integer. For example, here is the array when $n = 16$:

```
0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8
```

Q4.1 Selection sort

2 Points

How many *compares* does *selection sort* make to sort a zig–zag array as a function of n?

- ○ $\sim \frac{1}{16}n^2$
- ○ $\sim \frac{1}{8}n^2$
- ○ $\sim \frac{1}{4}n^2$
- ◉ $\sim \frac{1}{2}n^2$
- ○ $\sim n^2$

Grading ~~A+~~

Programming assignments. 45%

- Due at 11:59pm on Mondays via TigerFile.
- Collaboration/lateness policies: see web.

Quizzes. 10%

- Due at 11:59pm on Fridays via Quizzera.
- Collaboration/lateness policies: see web.

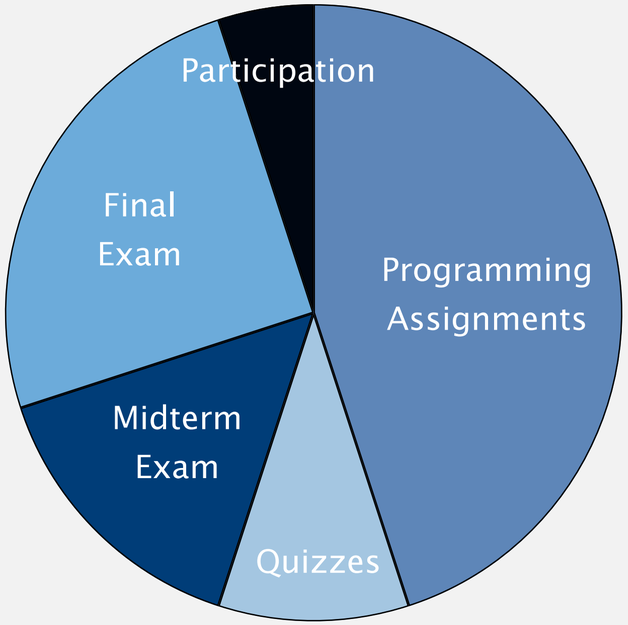
Exams. 15% + 25%

- 90-minute take-home midterm on Monday, October 25. ← 8-hour window
- 3-hour in-class final, as scheduled by Registrar.

Active participation. 5%

- Answer questions in online discussion forum.
- Participate in precept and lecture.

  [perfect attendance not required to earn 100% of participation points]



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Resources (textbook)

Readings (required). *Algorithms 4th edition* by R. Sedgewick and K. Wayne, Addison-Wesley Professional, 2011, ISBN 0–321–57351–X.

4th edition (2011)

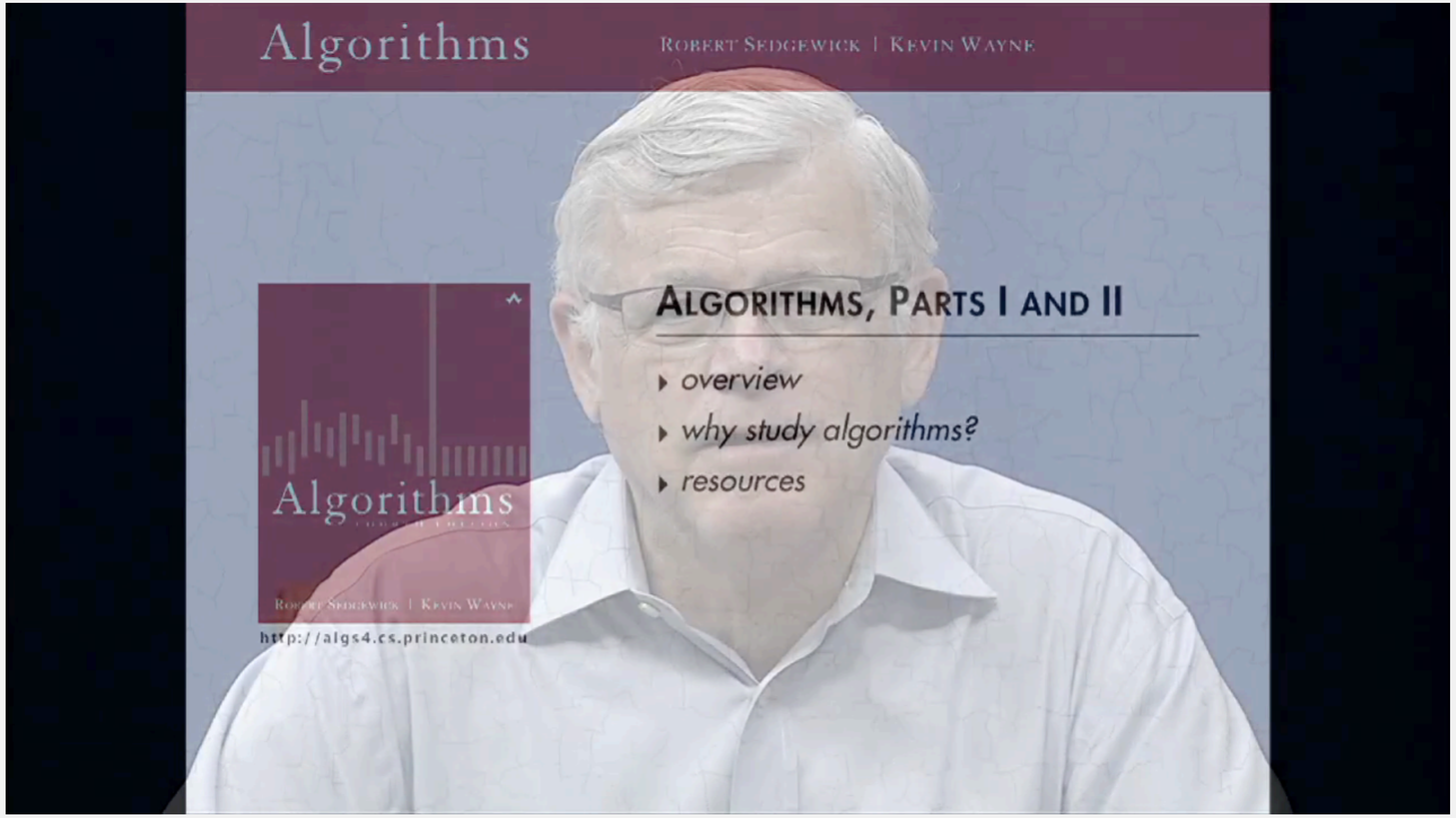
Available from various vendors and in different formats.

- Amazon: $75 hardcover, $55 Kindle, ...
- Labyrinth: $65 hardcover, $40 rent.
- ...

Resources (studio-produced videos)

Studio-produced videos (optional).

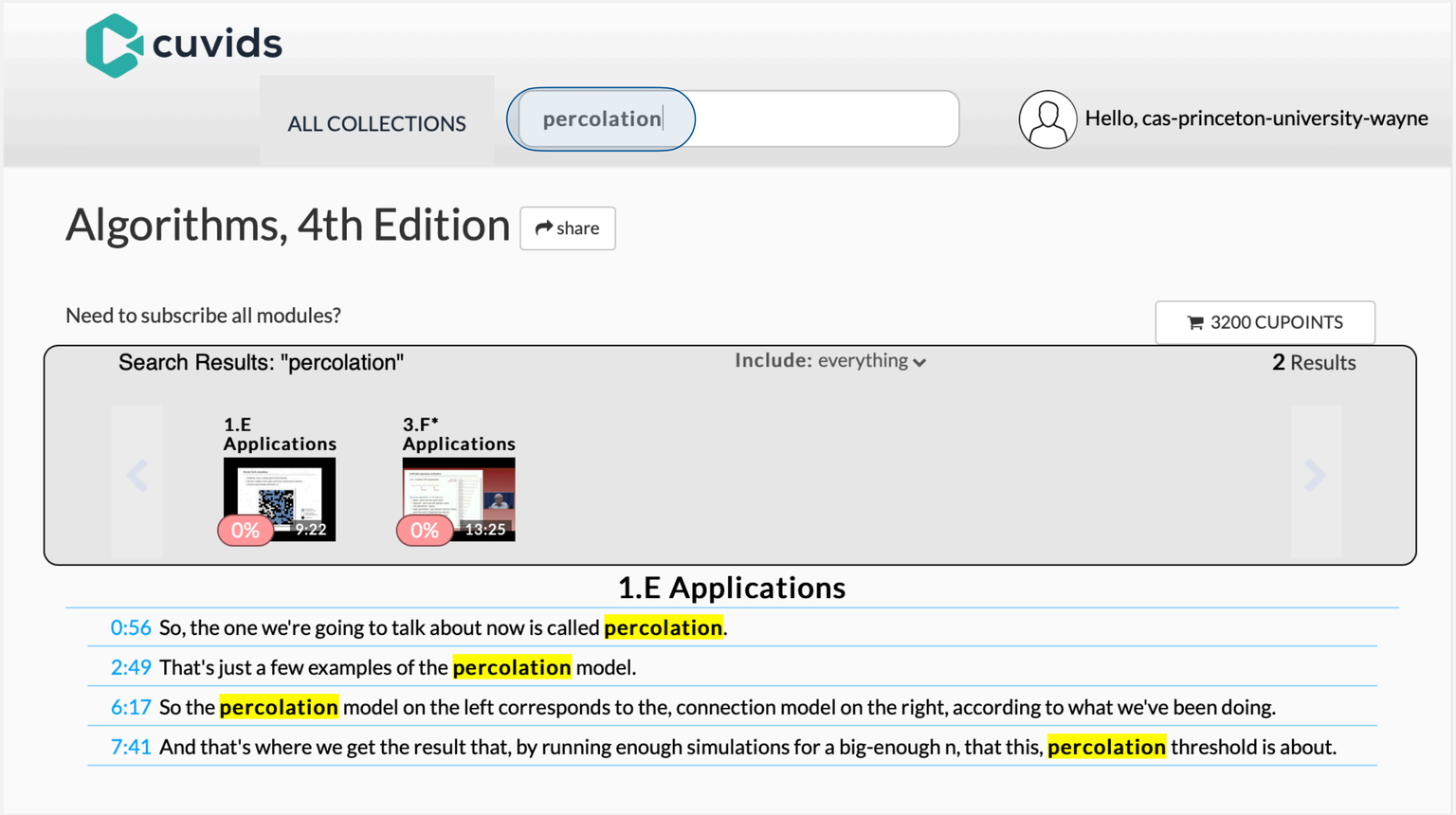
- Different perspective.



Resources (studio-produced videos)

Studio-produced videos (optional).

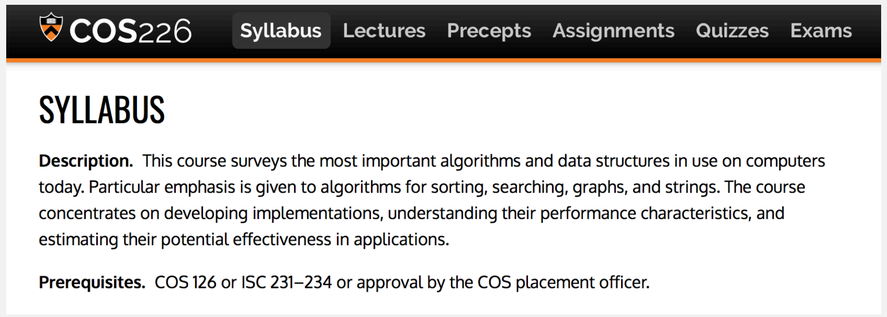
- Different perspective.
- Transcript search.



Resources (web)

Course content.

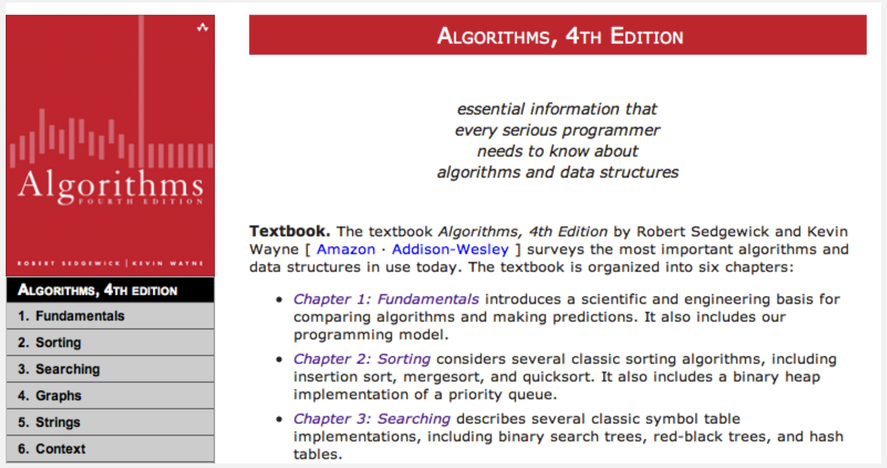
- Course info.
- Lecture slides.
- Precept lessons.
- Programming assignments.
- Quizzes.
- Exam archive.



https://www.princeton.edu/~cos226

Booksite.

- Brief summary of content.
- Download code from book.
- APIs and Javadoc.



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Resources (people)

Online discussion forum.

- Low latency, low bandwidth.
- Mark post private when necessary.
- See Ed FAQ for guidelines.

https://us.edstem.org/courses/7744

Office hours.

- High bandwidth, high latency.
- See web for schedule.

https://www.princeton.edu/~cos226

"Computing laboratory."

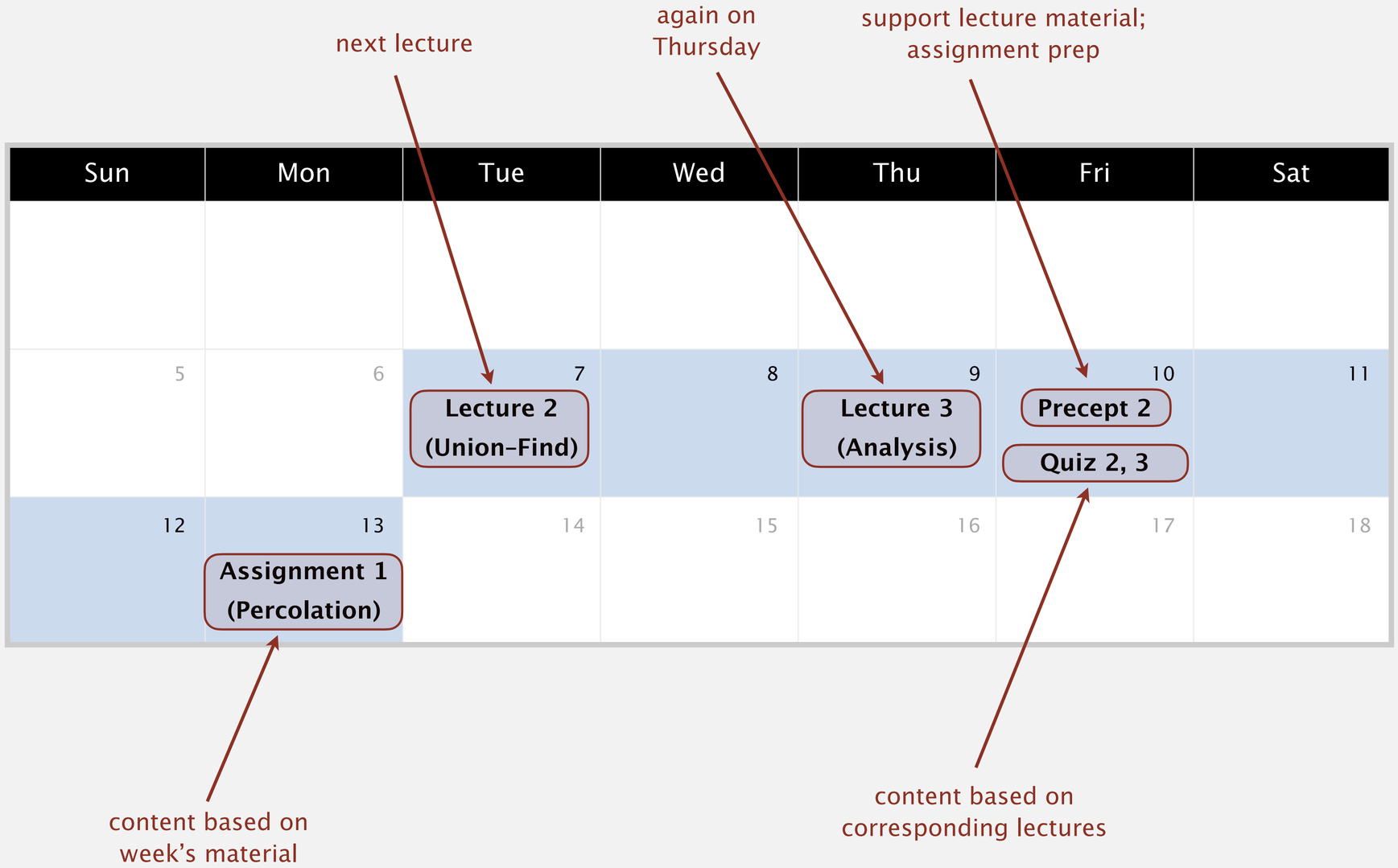
- Undergrad lab TAs.
- For help with debugging.
- See web for schedule.

https://labta.cs.princeton.edu

Resources (ed tech)

Platform	What
Ed	*discussion forum*
IntelliJ	*Java IDE*
Zoom	*some office hours*
Quizzera	*quizzes*
TigerFile	*assignment submissions*
codePost	*assignment grading*
Gradescope	*exams*
Canvas	*check grades*
iClicker	*in-class polls*
CUbits	*studio-produced videos*

A typical week (excluding this one!) 📆



Administrative Q+A

Not registered? Register ASAP; attend any precept this week.

Change precept? Use TigerHub.

All non-conflicting precepts closed? Contact Colleen Kenny.

Haven't taken COS 126? See COS placement officer.

Placed out of COS 126? Review Sections 1.1–1.2 of Algorithms 4/e.

Additional administrative questions. Ask now, after class, or any time in Ed Discussion.