COS 226, Spring 2023

Algorithms
and
Data Structures

Kevin Wayne · Dan Leyzberg · Jérémie Lumbroso

Fine print

I will be recording lectures and make them available in Canvas.

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

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Intro to COS 226

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

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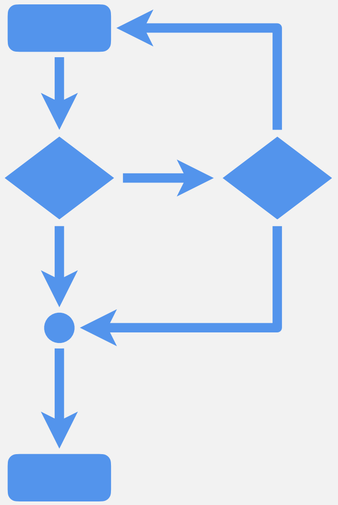
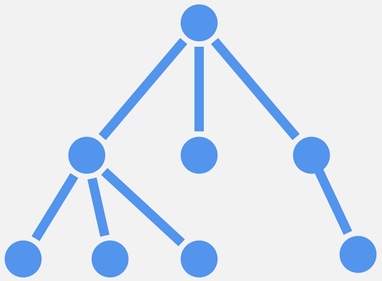
COS 226 course overview

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.

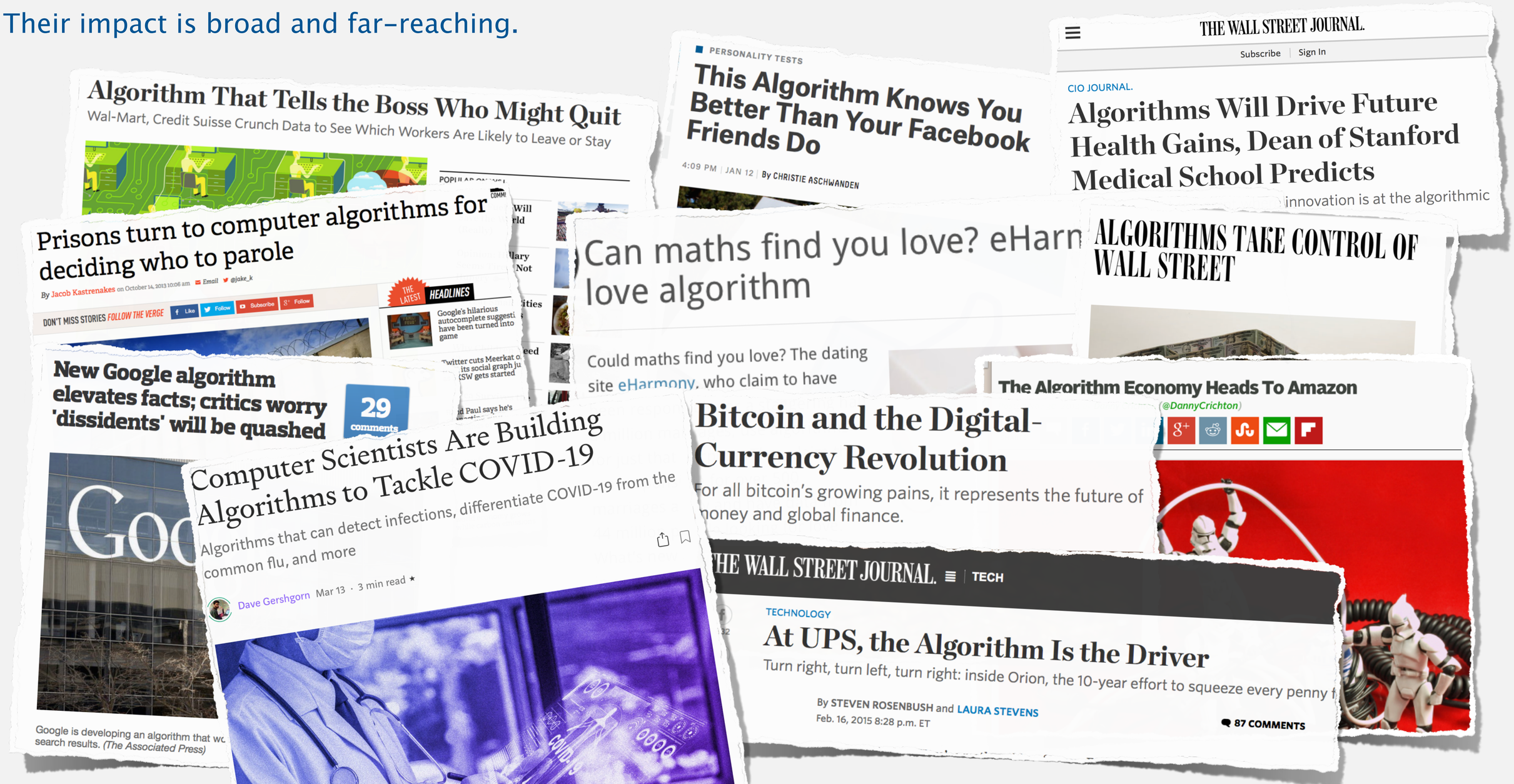




topic	algorithms and data structures 
data types	*stack, queue, union–find*
sorting	*quicksort, mergesort, heapsort, priority queue*
searching	*BST, red–black BST, hash table, k-d tree*
graphs	*BFS, DFS, Prim, Kruskal, Dijkstra, Bellman–Ford*
strings	*radix sorts, tries, suffix arrays, data compression*

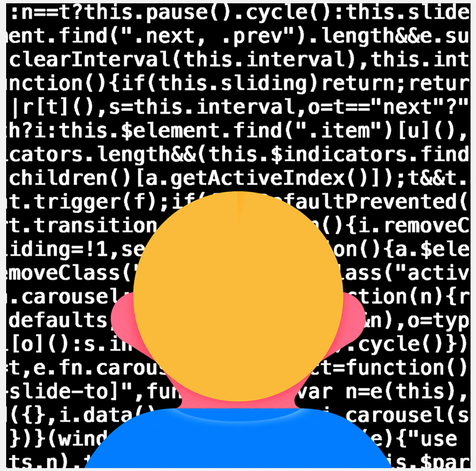
Why study algorithms and data structures?

Their impact is broad and far-reaching.



Why study algorithms and data structures?

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.
- To become a proficient programmer.
- For intellectual stimulation.
- For fun and profit.

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Lectures

Live lectures. Introduce new material.

What	When	Where	Who	Office Hours
L01	TTh 11–12:20pm	McCosh 50	Kevin Wayne	*see web*

Questions. Raise your hand and ask a question. ← carpe diem!

Electronic devices. Permitted *only* to support lecture.

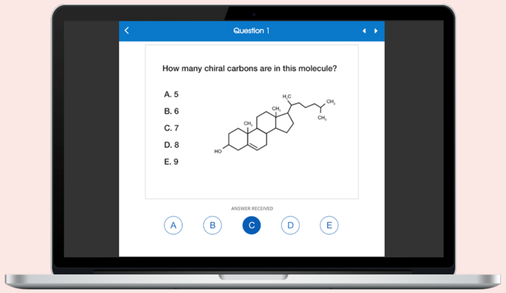
viewing slides, taking notes, iClickers, ...

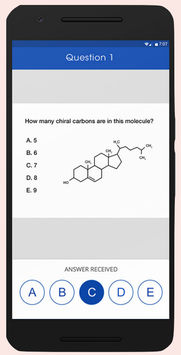
iClicker (required). To earn participation credit:

- Create iClicker Cloud account using Princeton email. ← free for Princeton students
- Answer multiple choice questions during lecture.

https://www.iclicker.com

Which iClicker device are you using?





A. Web

B. iPhone

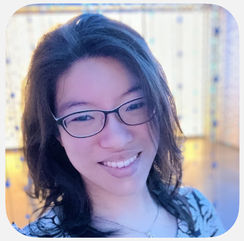
C. Android

Precepts

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


Dan Leyzberg


Gabriel Contreras


Jennifer Lam


Ross Texeira

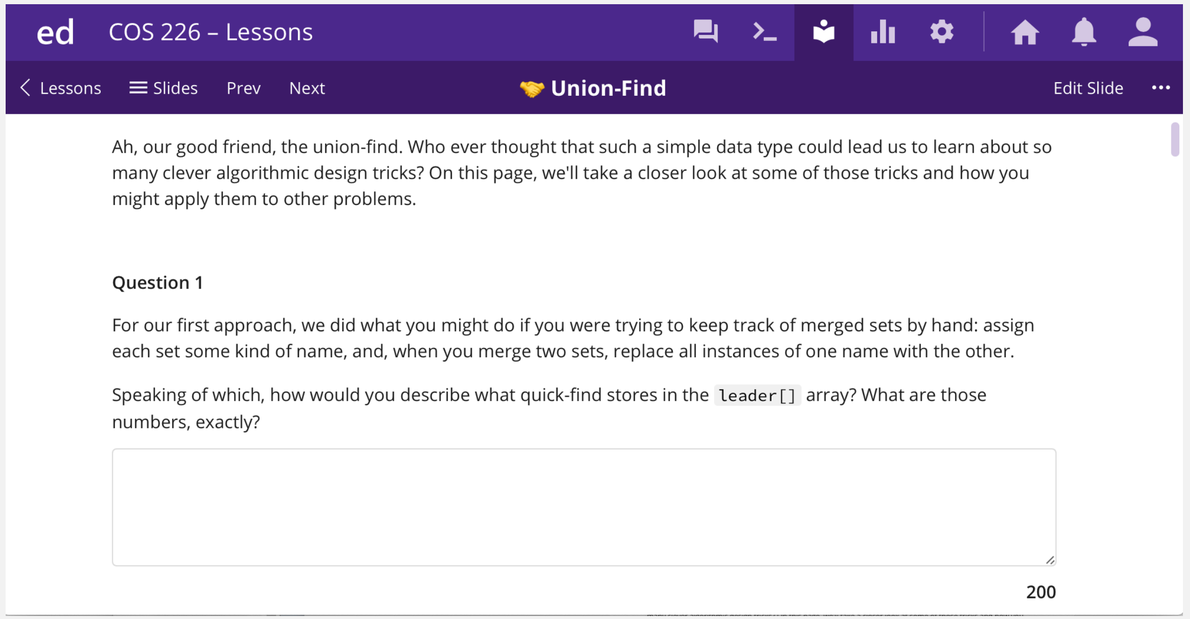

Yingxi Lin


Morgan Nanez


Yiming Zuo


Shelley Xia


Sabhya Chhabria



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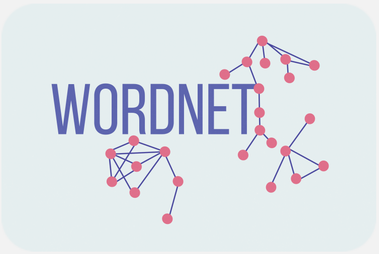
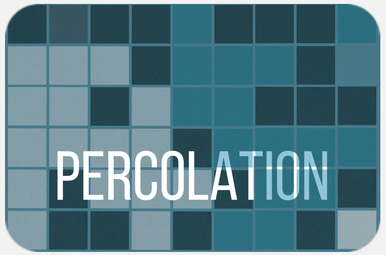
- *union–find*

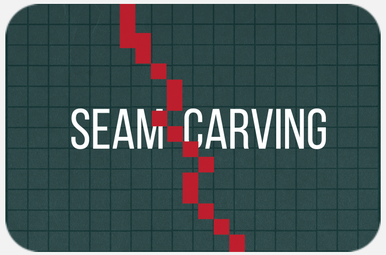
Programming assignments

Implement an efficient algorithm or data structure:



Solve an interesting application using a “textbook” algorithm:



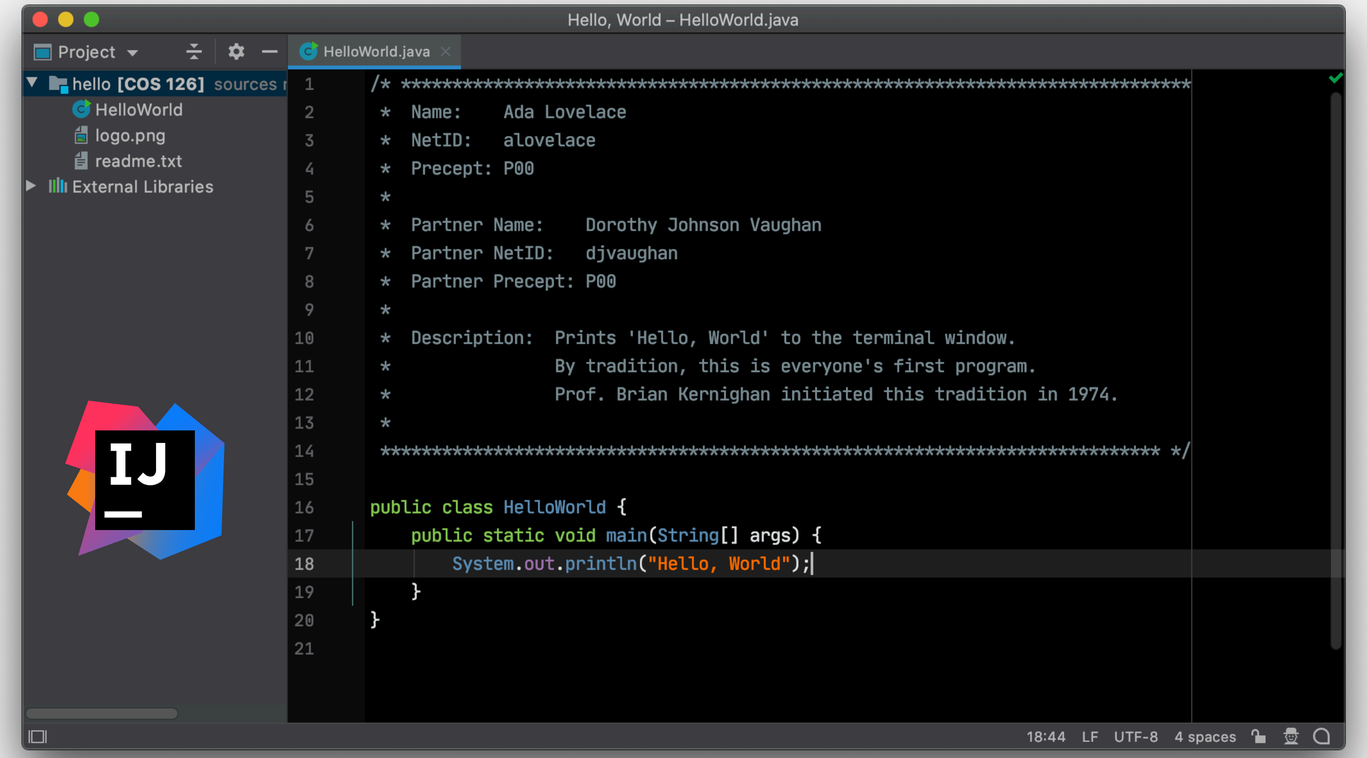


Pair programming encouraged on designated assignments.

Programming environment

Recommended IDE. Custom IntelliJ 2022.2 environment. ← upgrade to Fall 2022 version

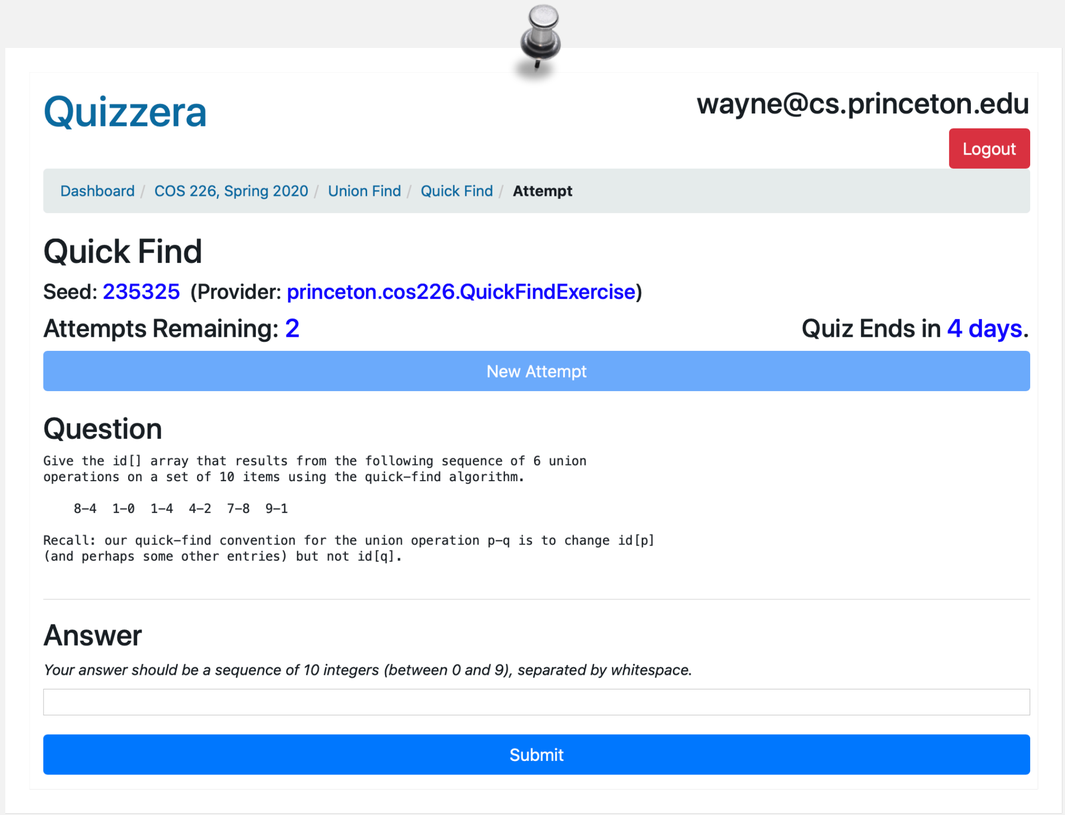
- Embedded Bash terminal.
- Autoformat, autoimport, autocomplete, ...
- Continuous code inspection; integrated Checkstyle and SpotBugs.
- ...



Quizzes

Quizzera platform.

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



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%

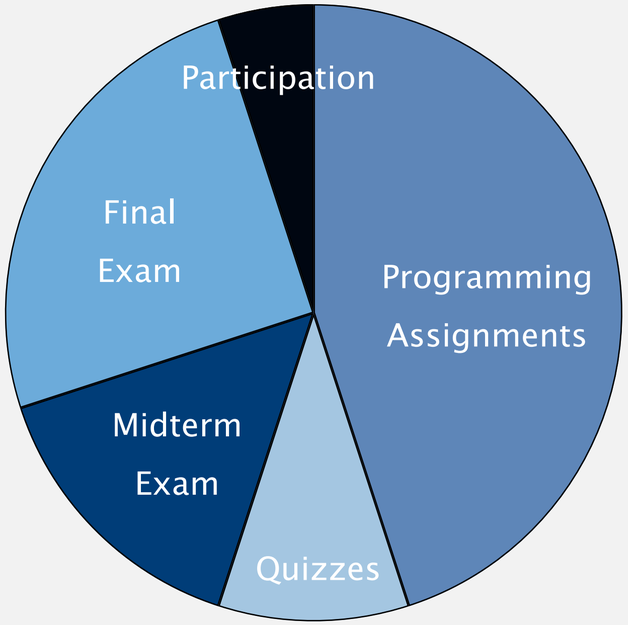
- Due at 11:59pm on Fridays via Quizzera.
- Collaboration/lateness policies: see web.

Exams. 15% + 25%

- 80-minute midterm on Thursday, March 9.
- 3-hour final, as scheduled by Registrar.

Active participation. 5%

- iClicker participation in lecture.
- Collaborative participation in precept.



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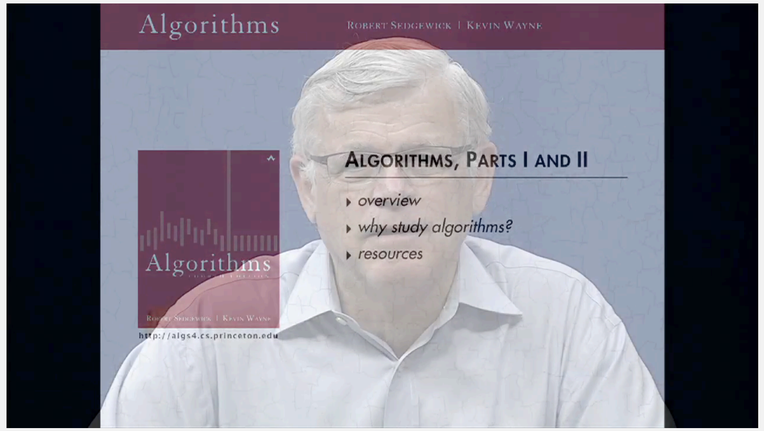
Resources (textbook)

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

Studio-produced videos (optional). By R. Sedgewick and K. Wayne.

4th edition (2011)

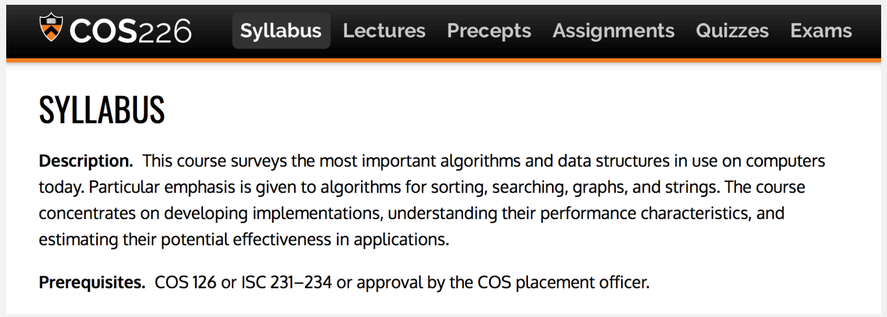


https://www.cubits.ai/collections/42

Resources (web)

Course content.

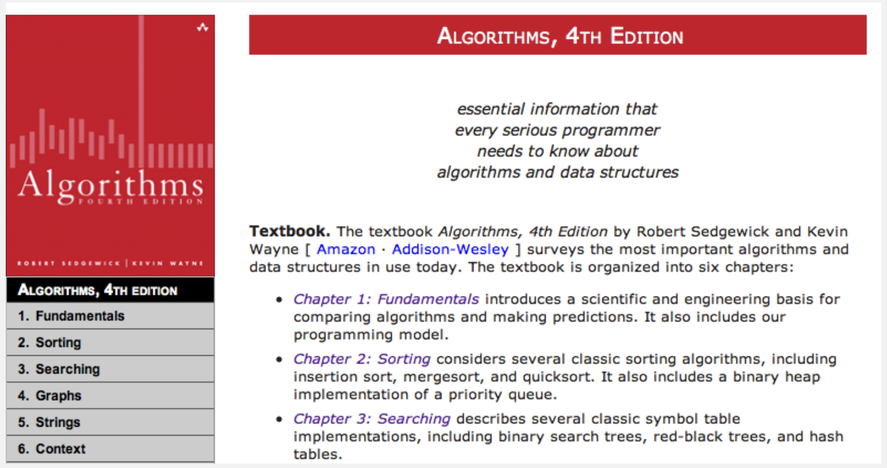
- Course info.
- Lecture slides.
- Precept lessons.
- Programming assignments.
- Quizzes.
- Exam archive.



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 only when necessary.
- See Ed FAQ for guidelines.

https://us.edstem.org/courses/31649

Office hours.

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

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

Intro COS lab.

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

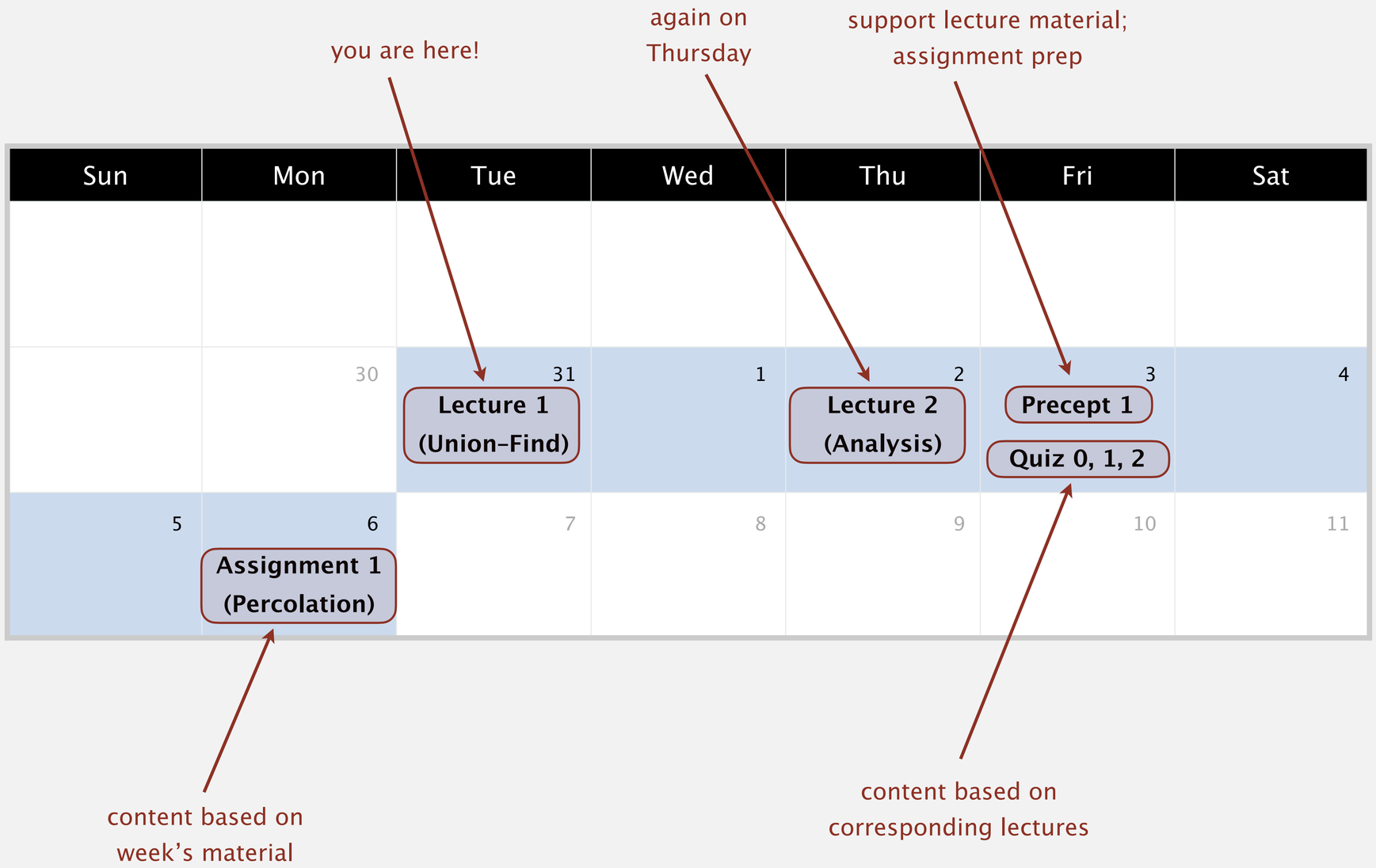
https://introlab.cs.princeton.edu

Resources (ed tech)

Platform	What
Ed	*discussion forum, precept lessons*
IntelliJ	*Java IDE*
Zoom	*some office hours*
Quizzera	*quizzes*
TigerFile	*assignment submissions*
codePost	*assignment feedback*
Gradescope	*exam feedback*
Canvas	*grades, lecture recordings*
iClicker	*in-class polls*
CUbits	*studio-produced videos*

← also use for communication with course staff

A typical week (including this one!)



Administrative Q+A

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

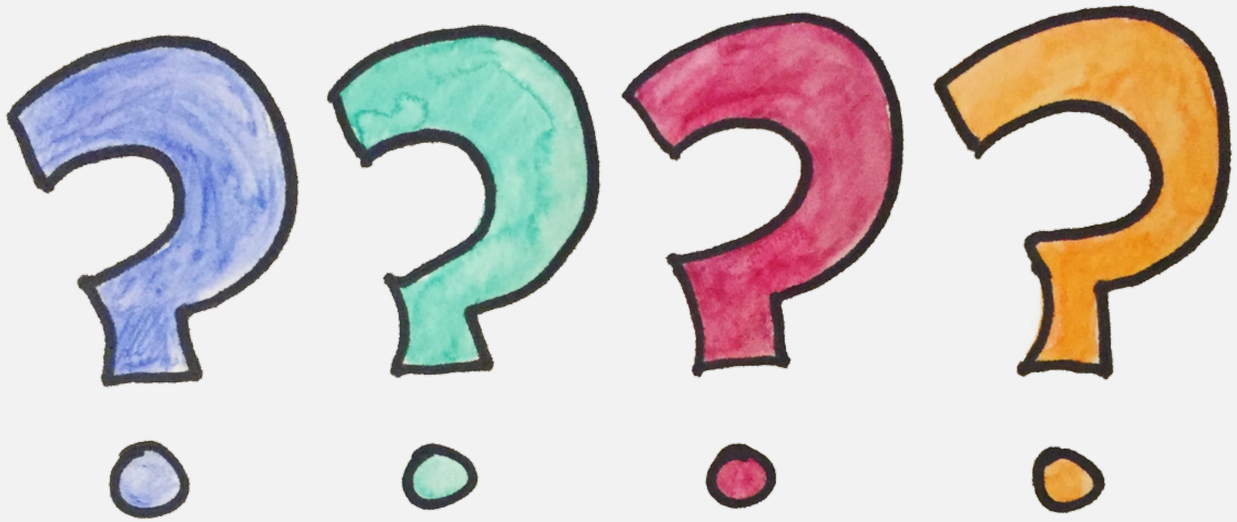
Change precept? Use TigerHub.

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.

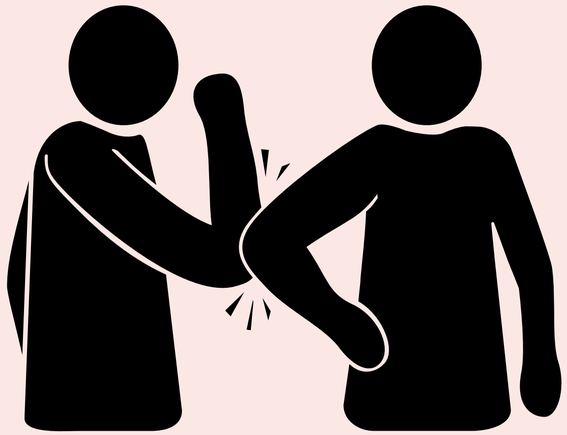


Introduction quiz 2

Have you met the person sitting next to you?

A. Yes.

B. No.



Created by Daniel Rohloff
from the Noun Project