



COS 226, SPRING 2024

ALGORITHMS
and
DATA STRUCTURES

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**PRINCETON
UNIVERSITY**

FINE PRINT



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<https://algs4.cs.princeton.edu>

INTRO TO COS 226

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



<https://algs4.cs.princeton.edu>


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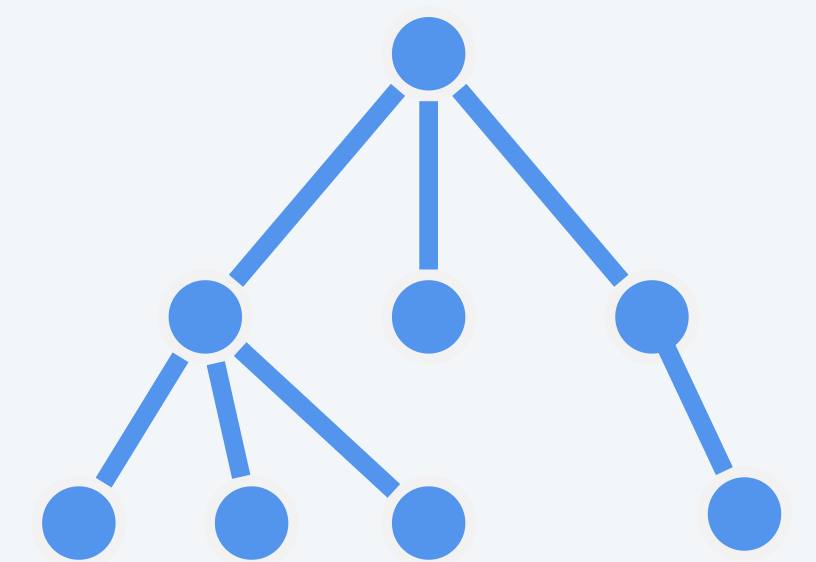
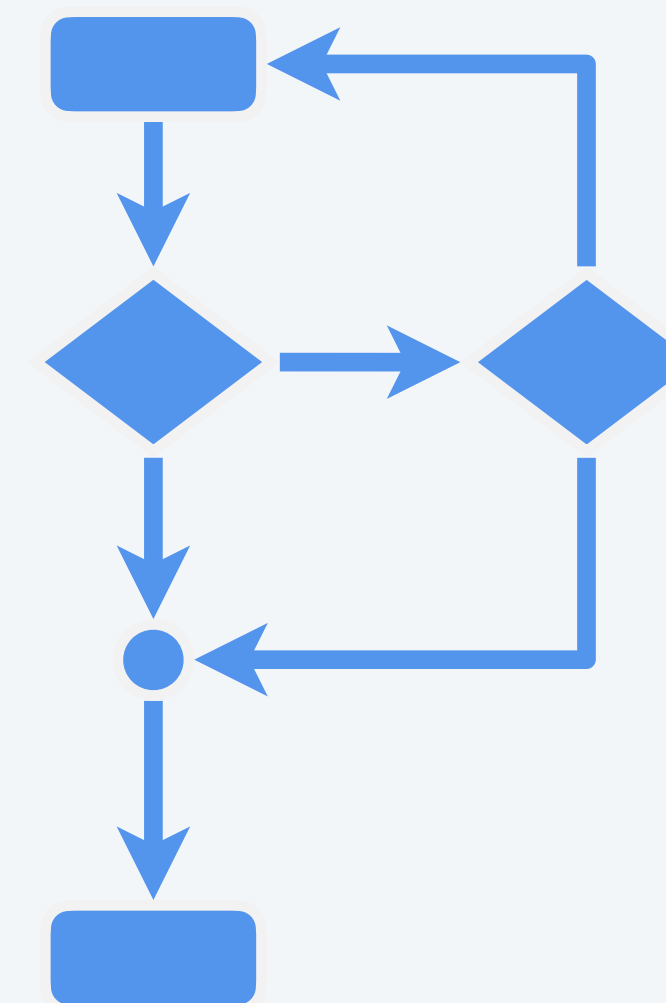
COS 226 course overview

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.

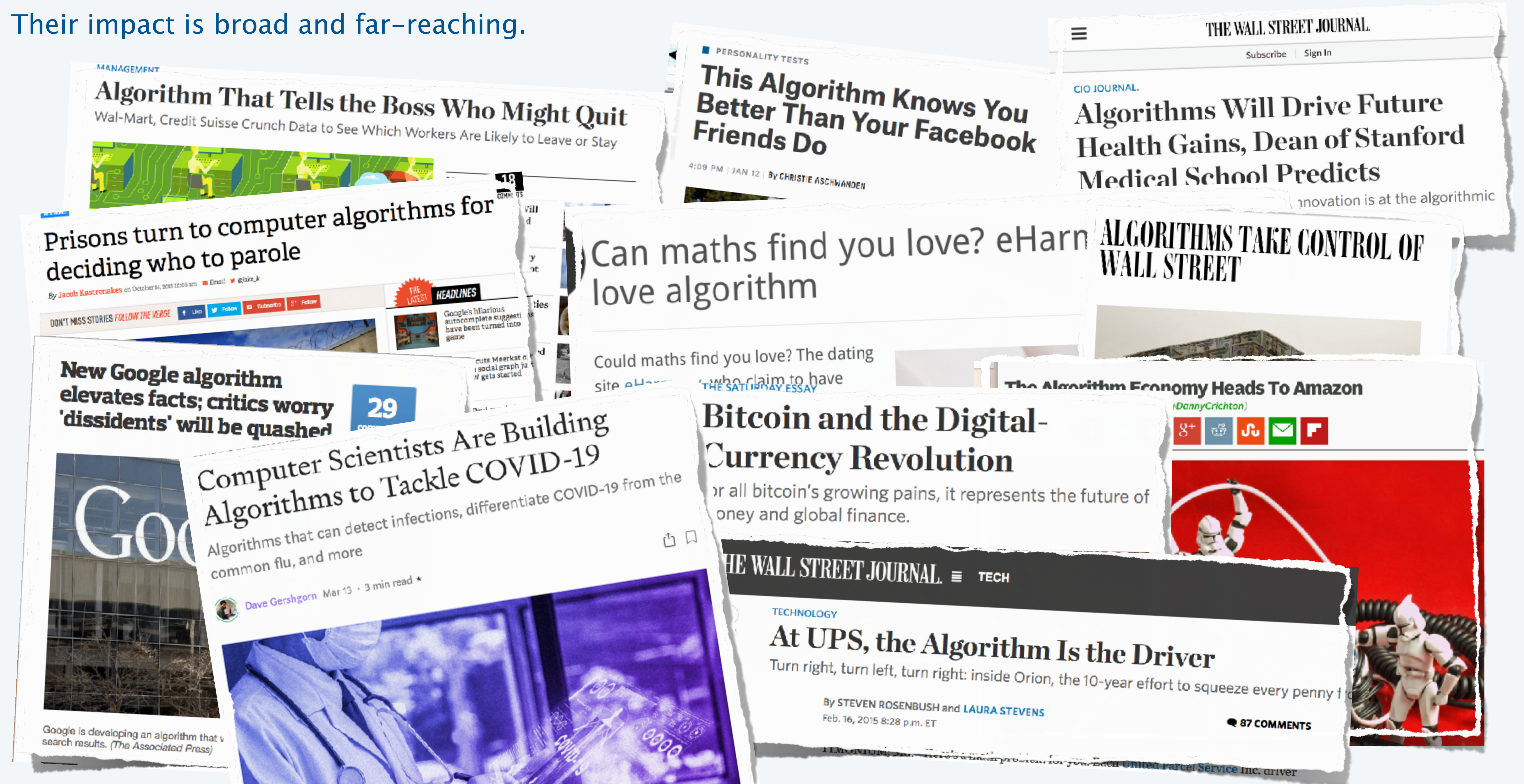
topic	algorithms and data structures 
data types	stack, queue, union-find
sorting	insertion sort, quicksort, mergesort, priority queue
searching	BST, red-black tree, hash table, k-d tree
graphs	BFS, DFS, Prim, Kruskal, Dijkstra
advanced	randomness, multiplicative weights, intractability

← *new this year*



Why study algorithms and data structures?

Their impact is broad and far-reaching.



Why study algorithms and data structures?

Their impact is broad and far-reaching.

Algorithm: any process which is a sequence of simple local steps on basic units, e.g.,

Bits in computers

Pixel on a screen

Atoms in matter

Cells in living tissue

Neurons in the brain

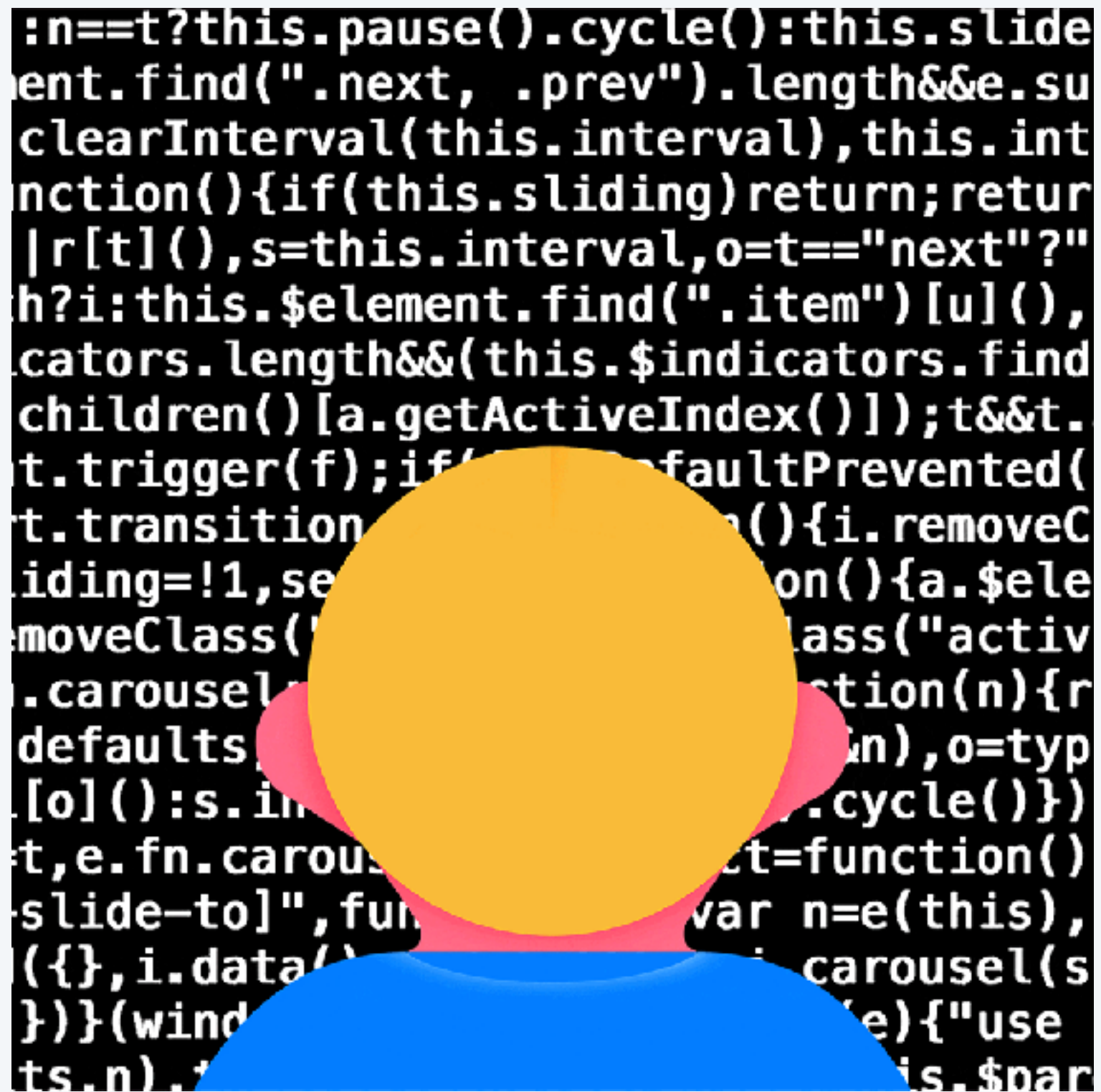
Stars in a galaxy

Individuals in populations (social network, stock market, evolution, ...)

⋮

Why study algorithms and data structures?

To become a proficient programmer.



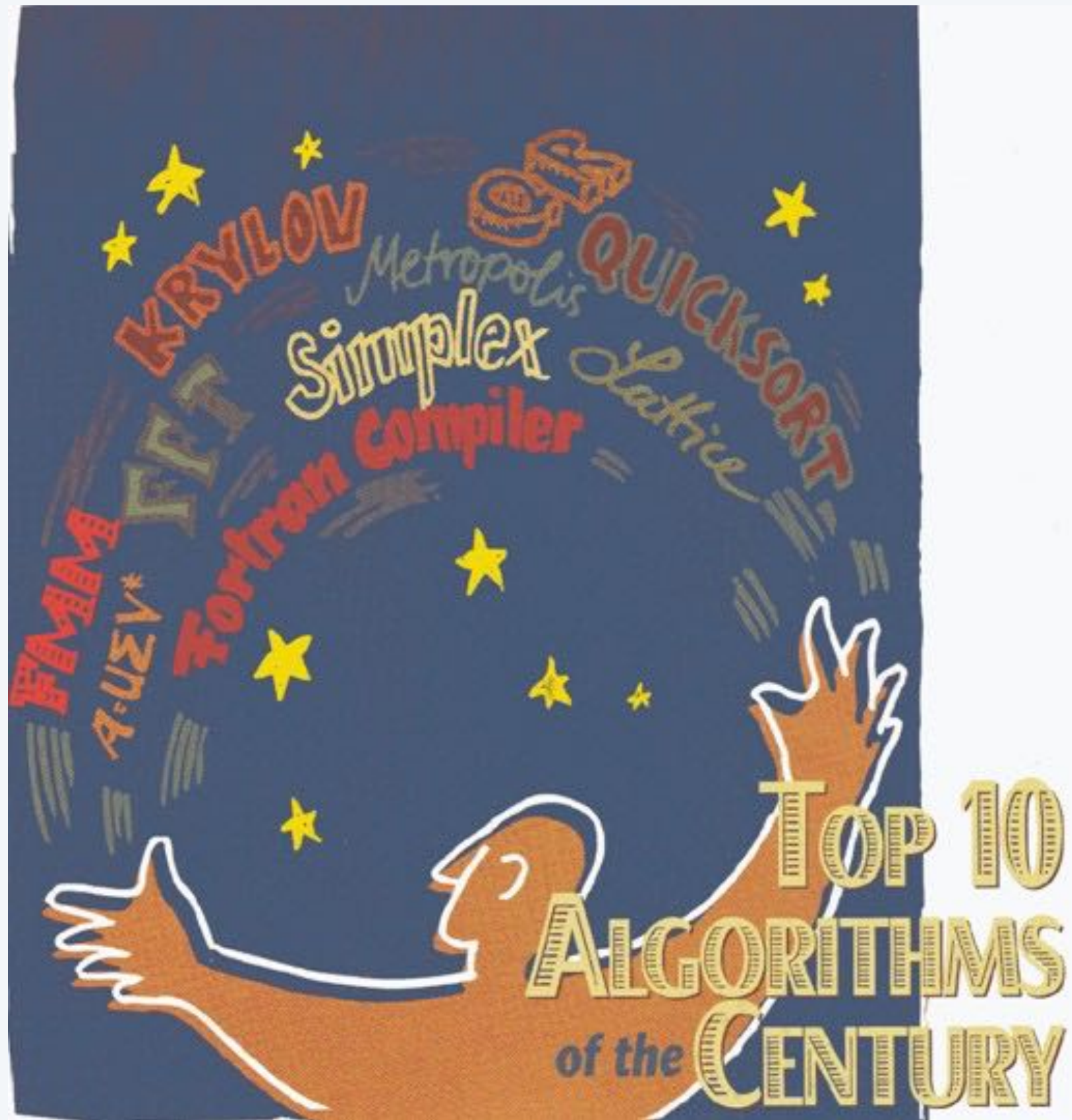
Why study algorithms and data structures?

For fun and profit.



Why study algorithms and data structures?

For intellectual stimulation.





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Lectures

Live lectures. Introduce new material.

What	When	Where	Who
L01	TTh 1:30-2:50pm	McCosh 10	Gillat Kol

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>

What's one thing you wish you had more of?

- A.** Fortune (\$\$)
- B.** Fame
- C.** Free time
- D.** Friends

Precepts

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

Anirudh Ajith

Sabhya Chhabria

Victor Chu

Malinda Huang

Xinran Liang

Dillon Lue

Wei Luo

Shuyao Zhou



Prof. Pedro Paredes



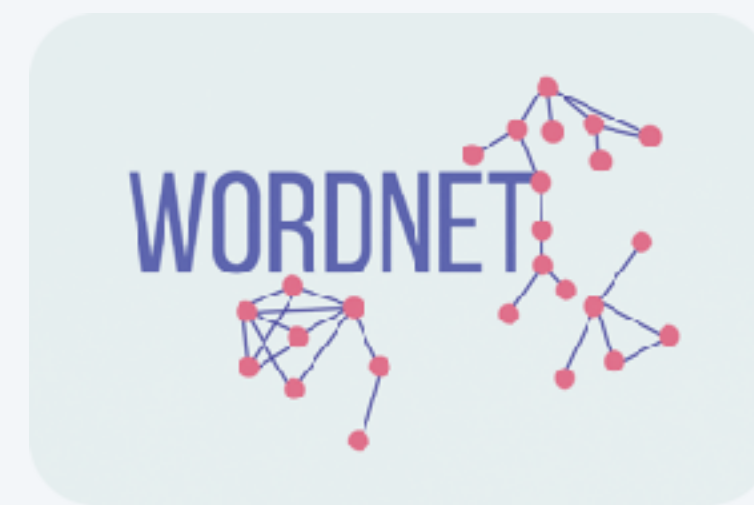
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INTRO TO COS 226

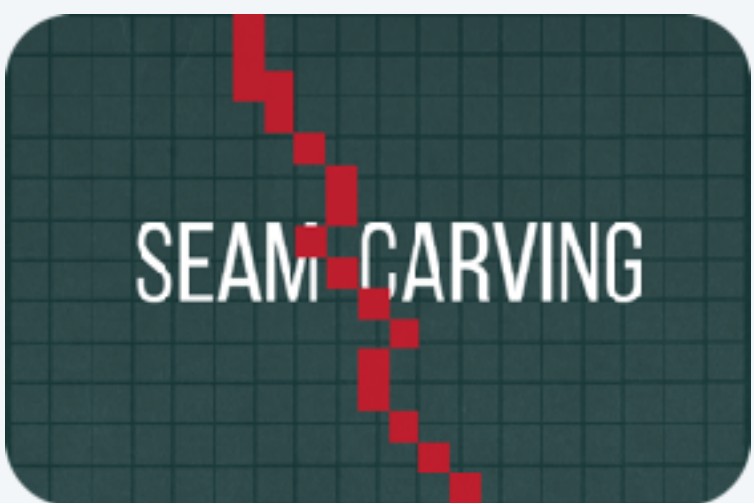
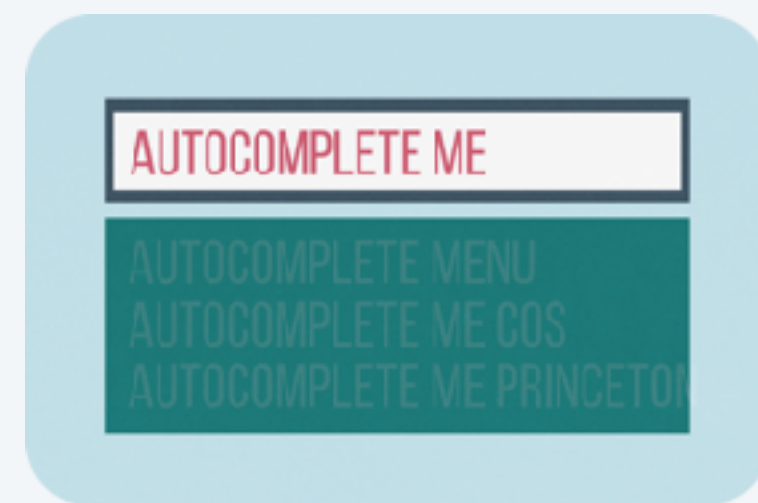
- ▶ *motivation*
- ▶ *course structure*
- ▶ ***assessments***
- ▶ *resources*
- ▶ *union-find*

Programming assignments

Implement an efficient **algorithm** or **data structure**:



Solve an interesting **application** using a “textbook” algorithm:



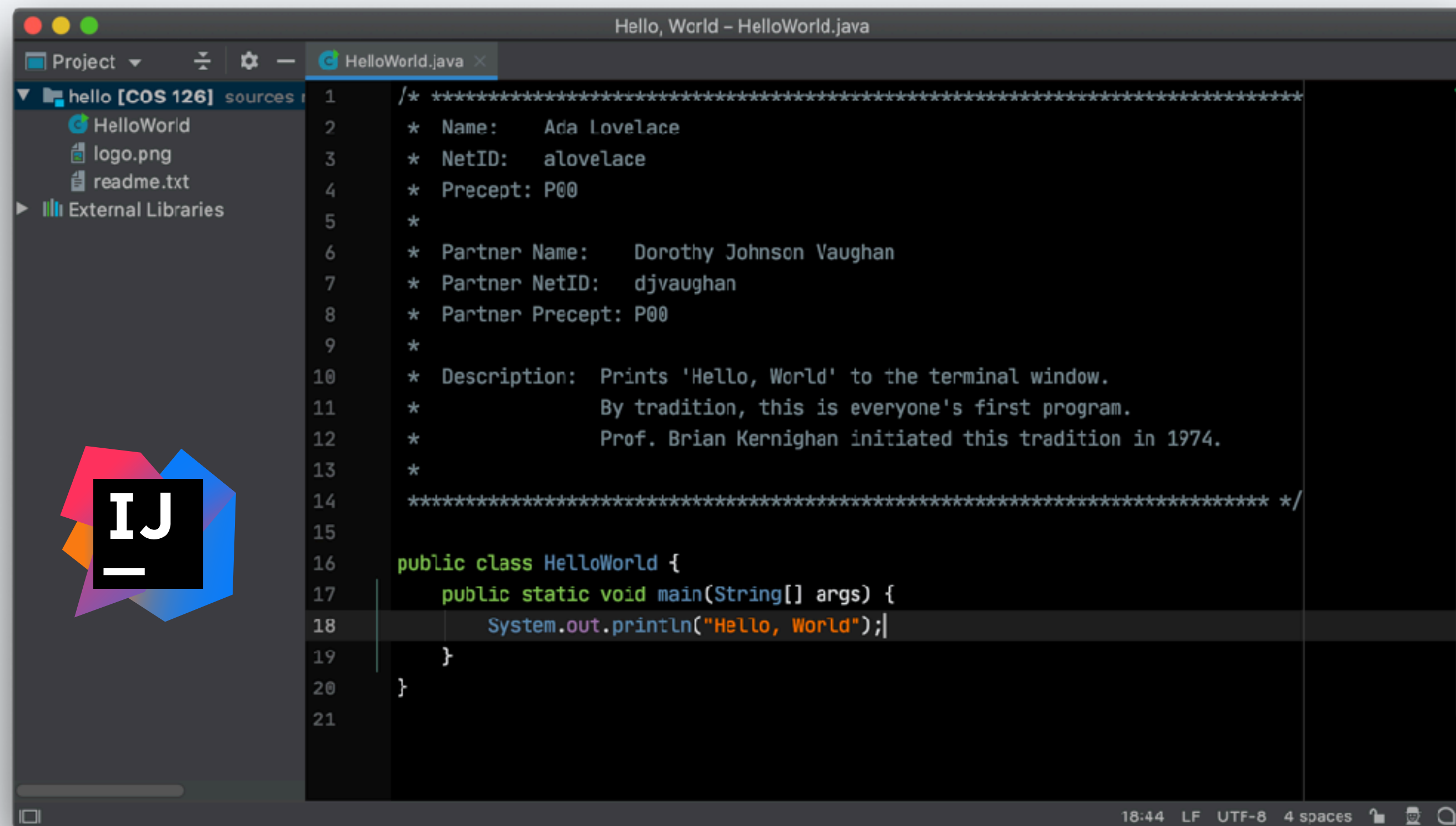
Pair programming encouraged on designated assignments.



Programming environment

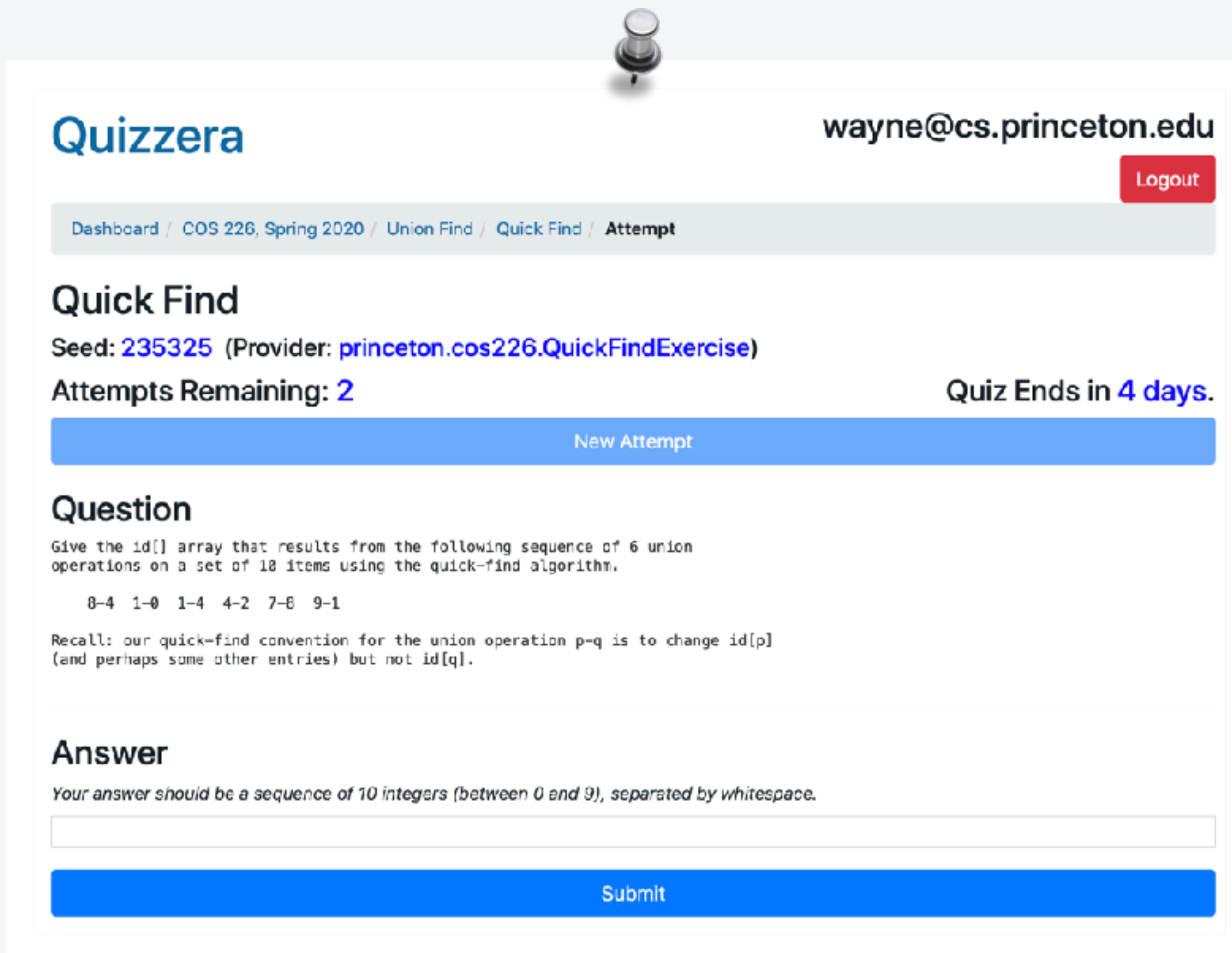
Recommended IDE. Custom IntelliJ 2023.2 environment.  *upgrade to Fall 2023 version*

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



Quizzera platform.

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



The screenshot shows the Quizzera interface for a user named wayne@cs.princeton.edu. The page title is "Quick Find". The user has 2 attempts remaining and the quiz ends in 4 days. The question asks for the id[] array after a sequence of 6 union operations on a set of 18 items. The operations are: 0-4, 1-0, 1-4, 4-2, 7-8, 9-1. A recall note states that the quick-find convention for the union operation p-q is to change id[p] (and perhaps some other entries) but not id[q]. The answer field is empty, and the "Submit" button is visible at the bottom.

Quizzera wayne@cs.princeton.edu [Logout](#)

[Dashboard](#) / [COS 226, Spring 2020](#) / [Union Find](#) / [Quick Find](#) / **Attempt**

Quick Find

Seed: 235325 (Provider: [princeton.cos226.QuickFindExercise](#))

Attempts Remaining: 2 Quiz Ends in 4 days.

[New Attempt](#)

Question

Give the `id[]` array that results from the following sequence of 6 union operations on a set of 18 items using the quick-find algorithm.

0-4 1-0 1-4 4-2 7-8 9-1

Recall: our quick-find convention for the union operation $p-q$ is to change `id[p]` (and perhaps some other entries) but not `id[q]`.

Answer

Your answer should be a sequence of 10 integers (between 0 and 9), separated by whitespace.

[Submit](#)

Written exams.

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

COS 226 MIDTERM, SPRING 2023

3

3. Data structures. (6 points)

- (a) Consider the following *parent-link* representation of a *weighted quick union* (link-by-size) data structure.

parent[]	4	5	4	5	?	5	2	5	8	5
	0	1	2	3	4	5	6	7	8	9

Which of the following values could be `parent[4]`?

Fill in all checkboxes that apply.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	1	2	3	4	5	6	7	8	9

Grading **A+**

Programming assignments. **45%**

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

Quizzes. **10%**

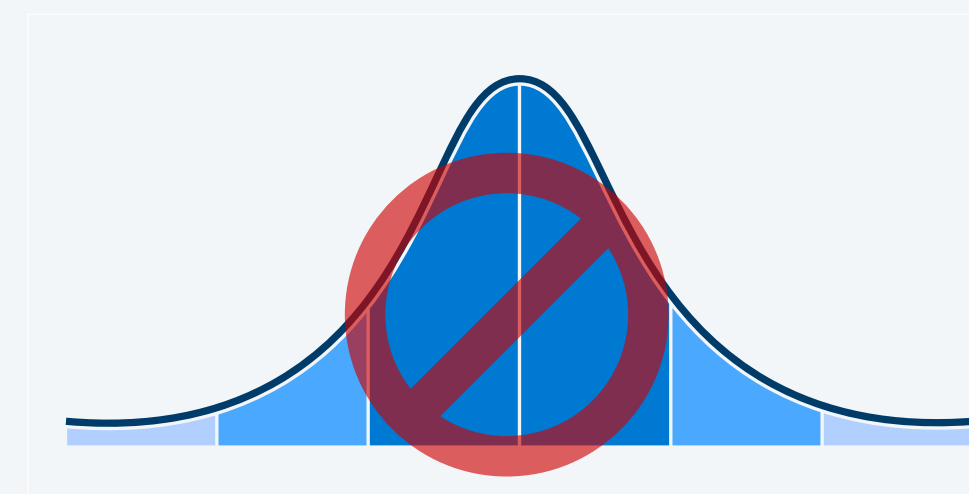
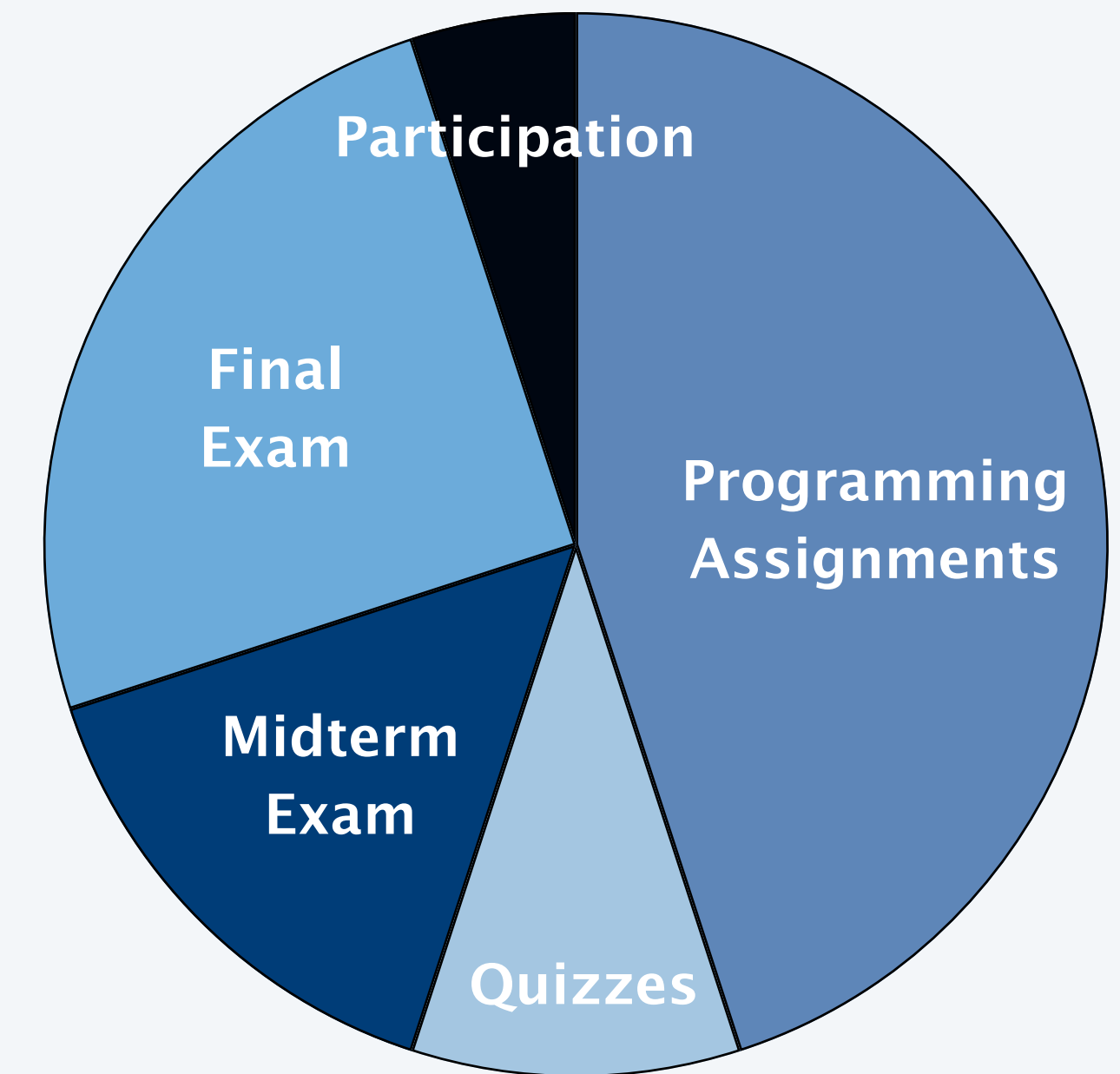
- Due at 11:59pm on Fridays via Quizzera.
- Collaboration/lateness policies: see web.

Exams. **15% + 25%**

- 80-minute midterm, in class.
- 3-hour final, in class.

Active participation. **5%**

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



grade	score
A	93.0%
A-	90.0%
B+	87.0%
⋮	⋮



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Resources (textbook)

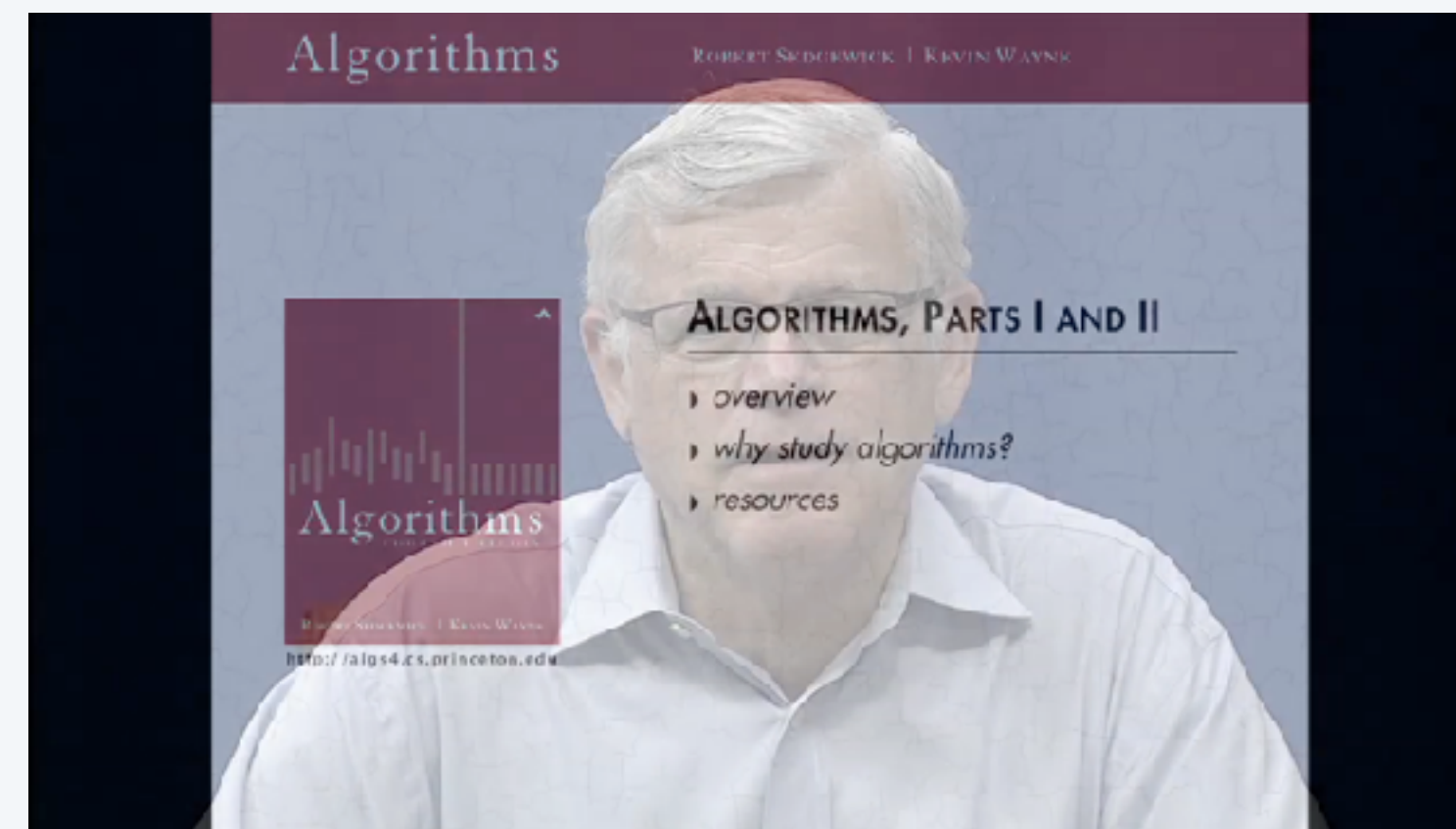


Readings (required). *Algorithms 4th edition* by R. Sedgwick and K. Wayne, ← *Labyrinth Books, Amazon, ...*
Addison–Wesley Professional, 2011, ISBN 0–321–57351–X.

Studio–produced videos (optional). By R. Sedgwick and K. Wayne.



4th edition (2011)



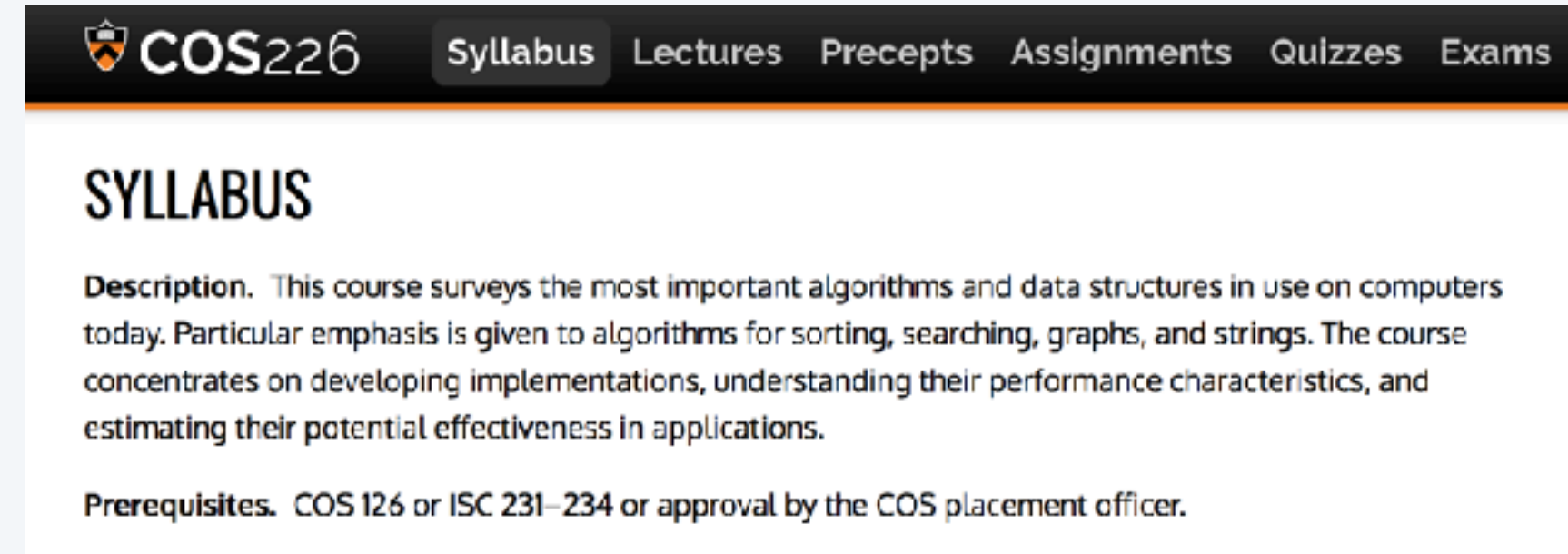
<https://www.cubits.ai>

Course content.

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

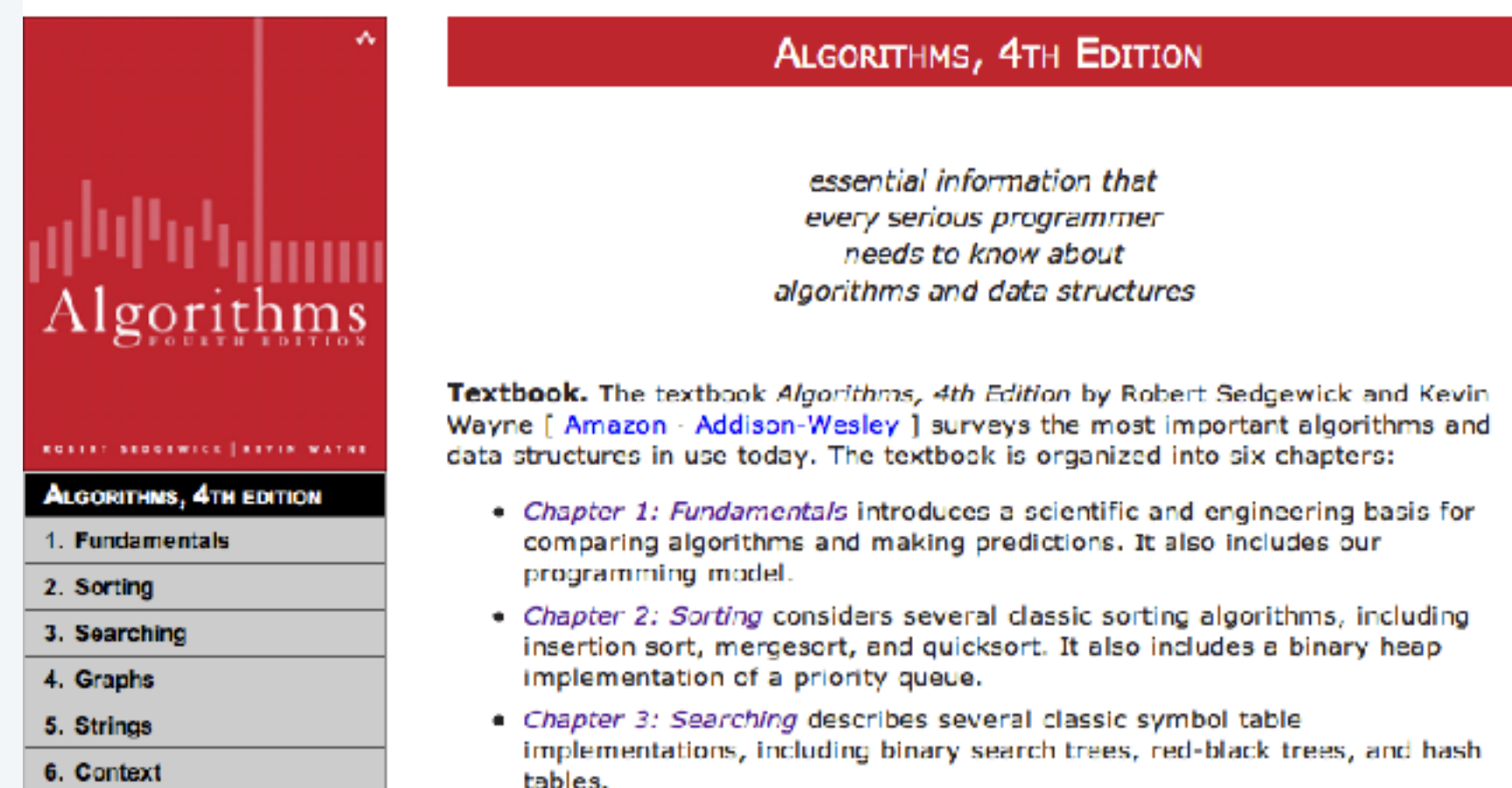
Booksite.

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



The screenshot shows the top navigation bar of the COS226 website with links for Syllabus, Lectures, Precepts, Assignments, Quizzes, and Exams. The main heading is 'SYLLABUS'. Below it, the 'Description' states: 'This course surveys the most important algorithms and data structures in use on computers today. Particular emphasis is given to algorithms for sorting, searching, graphs, and strings. The course concentrates on developing implementations, understanding their performance characteristics, and estimating their potential effectiveness in applications.' The 'Prerequisites' section lists: 'COS 126 or ISC 231-234 or approval by the COS placement officer.'

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



The screenshot shows the booksite for 'Algorithms, 4th Edition'. On the left is the book cover with the title 'Algorithms' and authors 'ROBERT SEDGEWICK | KEVIN WAYNE'. On the right, a red banner reads 'ALGORITHMS, 4TH EDITION' above the tagline: 'essential information that every serious programmer needs to know about algorithms and data structures'. Below this, the 'Textbook' description states: 'The textbook Algorithms, 4th Edition by Robert Sedgwick and Kevin Wayne [Amazon · Addison-Wesley] surveys the most important algorithms and data structures in use today. The textbook is organized into six chapters:'. A list of chapters follows:

- **Chapter 1: Fundamentals** introduces a scientific and engineering basis for comparing algorithms and making predictions. It also includes our programming model.
- **Chapter 2: Sorting** considers several classic sorting algorithms, including insertion sort, mergesort, and quicksort. It also includes a binary heap implementation of a priority queue.
- **Chapter 3: Searching** describes several classic symbol table implementations, including binary search trees, red-black trees, and hash tables.

<https://algs4.cs.princeton.edu>

Resources (people)

Online discussion forum.

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



<https://us.edstem.org/courses/41414>

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>



Platform	What
 Ed	<i>discussion forum, precept lessons</i>
 IntelliJ	<i>Java IDE</i>
 Quizzera	<i>quizzes</i>
 TigerFile	<i>assignment submissions</i>
 codePost	<i>assignment feedback</i>
 Gradescope	<i>exam feedback</i>
 Canvas	<i>grades</i>
 iClicker	<i>in-class polls</i>
 CUbits	<i>studio-produced videos</i>

← *also use for communication with course staff*

A typical week (including this one!)



Sun	Mon	Tue	Wed	Thu	Fri	Sat
						27
28	29	30 Lecture 1 (Union-Find)	31	1 Lecture 2 (Analysis)	2 Precept 1 Quiz 0, 1, 2	3
4	5 Assignment 1 (Percolation)	6	7	8	9	10

you are here!

*again on
Thursday*

*support lecture material;
assignment prep*

*content based on
week's material*

*content based on
corresponding lectures*

Administrative Q+A

Not registered? Register today.

Change precept? Use TigerHub.

All non-conflicting precepts closed? Contact our course admin, Sue Giranda.

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.



Sue Giranda



Credits

image	source	license
<i>THX Eclipse Deep Note</i>	<u>THX Ltd.</u>	
<i>Wireframe Tiger</i>	Audrey Cheng '20	by author
<i>Programmer</i>	<u>Wall Street Journal</u>	
<i>Student Raising Hand</i>	<u>classroomclipart.com</u>	<u>educational use</u>
<i>A is for Algorithms</i>	<u>comtechpass.com</u>	
<i>Assignment Logos</i>	Kathleen Ma '18	by author
<i>Normal Distribution</i>	<u>Adobe Stock</u>	<u>education license</u>
<i>Pair Programming</i>	<u>Adobe Stock</u>	<u>education license</u>
<i>Office Hours</i>	<u>clipground.com</u>	<u>CC BY 4.0</u>
<i>COS Lab TAs</i>	<u>Pulkit Singh '20</u>	by author
<i>Question Marks</i>	<u>pikpng.com</u>	<u>non-commercial use</u>
<i>Elbow Bump</i>	<u>The Noun Project</u>	<u>CC BY 3.0</u>
<i>Countdown Timer</i>	<u>YouTube</u>	