

COS 226, FALL 2017

ALGORITHMS
and
DATA STRUCTURES

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**PRINCETON
UNIVERSITY**



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

INTRO TO COS 226

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

COS 226 course overview

What is COS 226?

- Intermediate-level survey course.
- Programming and problem solving, with applications.
- **Algorithm:** sequence of instructions for solving a problem.
- **Data structure:** method to organize data in a computer.

topic	data structures and algorithms
data types	stack, queue, union-find, priority queue
sorting	quicksort, mergesort, heapsort, radix sorts
searching	BST, red-black BST, hash table
graphs	BFS, DFS, Prim, Kruskal, Dijkstra
strings	KMP, regular expressions, tries, data compression
advanced	k-d tree, suffix array, maxflow

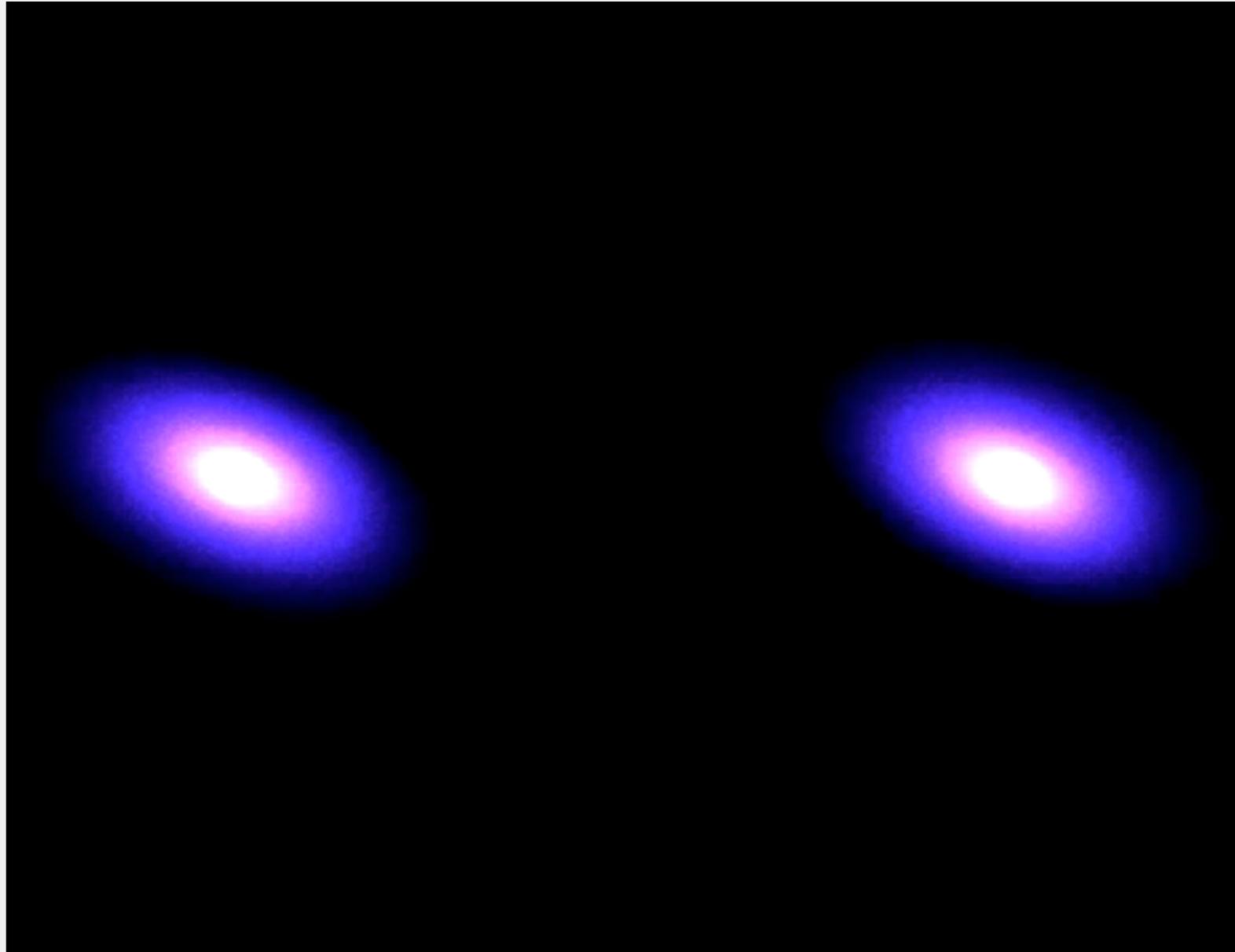
Why study algorithms and data structures?

Their impact is broad and far-reaching.



Why study algorithms and data structures?

To solve problems that could not otherwise be addressed.



http://www.youtube.com/watch?v=ua7YIN4eL_w

Why study algorithms and data structures?

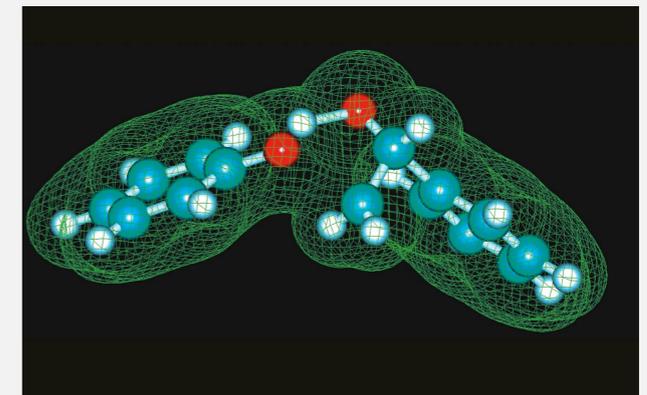
They may unlock the secrets of life and of the universe.

“Computer models mirroring real life have become crucial for most advances made in chemistry today.... Today the computer is just as important a tool for chemists as the test tube.”

— *Royal Swedish Academy of Sciences*
(Nobel Prize in Chemistry 2013)



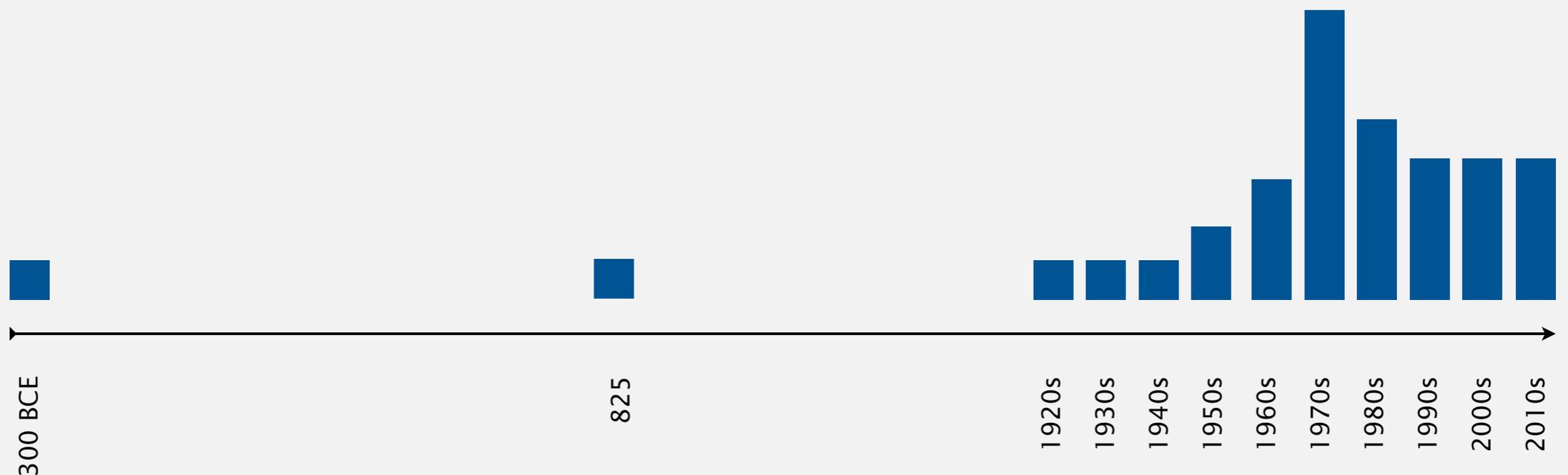
Martin Karplus, Michael Levitt, and Arieh Warshel



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 he considers his code or his data structures more important. Bad programmers worry about the code. Good programmers worry about data structures and their relationships.”

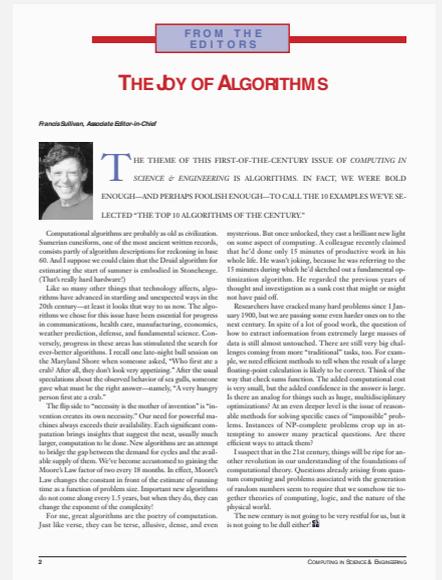
— Linus Torvalds (architect of Linux and git)



Why study algorithms and data structures?

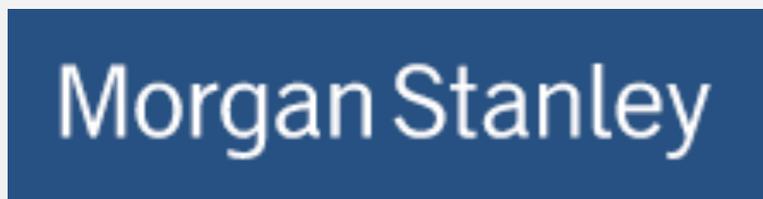
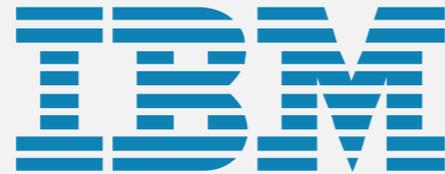
For intellectual stimulation.

“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 solve problems that could not otherwise be addressed.
- 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.

Why study anything else?





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INTRO TO COS 226

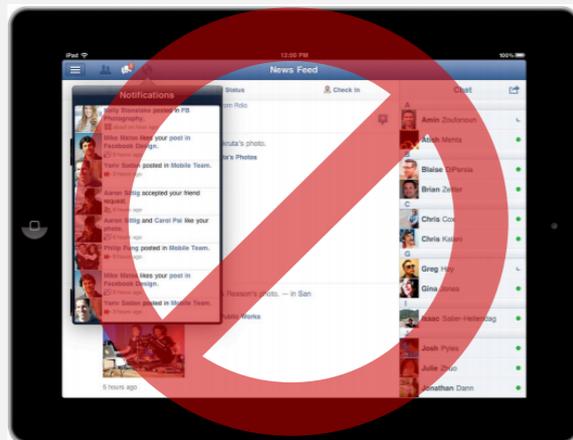
- ▶ *motivation*
- ▶ **course structure**
- ▶ *assessments*
- ▶ *resources*

Lectures

Live lectures. Introduce new material.

What	When	Where	Who	Office Hours
L01	TTh 11-12:20	Thomas Lab 003	Kevin Wayne	M 2-4pm

Electronic devices. Permitted *only* to support lecture (e.g., viewing slides and taking notes).



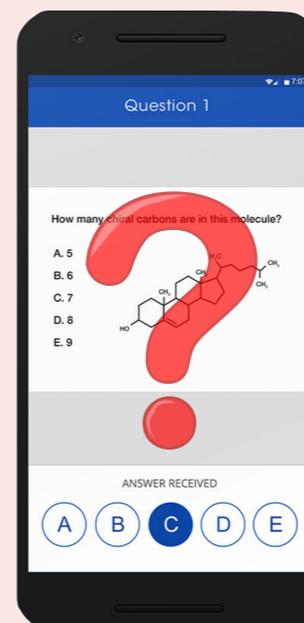
Student response system (required).

- Any hardware version of iClicker.
(use iClicker Reef at your own risk, WiFi issues?)
- Register your iClicker in Blackboard. 
- Available at Labyrinth Books (\$30).

save serial number
to maintain resale value

Which model of iClicker are you using?

- A. iClicker.
- B. iClicker+.
- C. iClicker 2.
- D. iClicker Reef.



Precepts

Discussion, problem-solving, assignment prep, ...



Maia Ginsburg ✉

Faculty
Lead Preceptor



Andy Guna ✉

Faculty
Lead Preceptor



Ross Teixeira ✉

Graduate Student
Preceptor



Qasim Nadeem ✉

Graduate Student
Preceptor

Precepts

Discussion, problem-solving, assignment prep, ...

What	When	Where	Who
P01	F 9–9:50am	Friend 009	Andy Guna
P02	F 10–10:50am	Friend 009	Andy Guna
P03	F 11–11:50am	Friend 009	Maia Ginsburg
P03A	F 11–11:50am	Friend 108	TBA
P04	F 12:30–1:20pm	Friend 009	Ross Teixeira
P05	F 1:30–2:20pm	Friend 009	Qasim Nadeem
P06	Th 3:30–4:20pm	Friend 009	Maia Ginsburg

Review sessions

- Recap of material discussed during the week.
- Q&A session.
- Active learning activities.



Q. Required?

A. No. Intended for students seeking extra help to keep up with the course.

When	Where	Who
F 2:30–3:20pm	TBA	Andy Guna



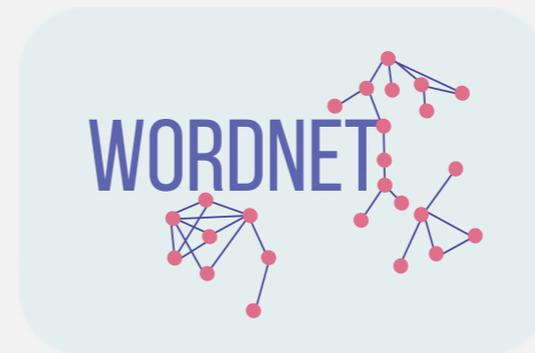
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INTRO TO COS 226

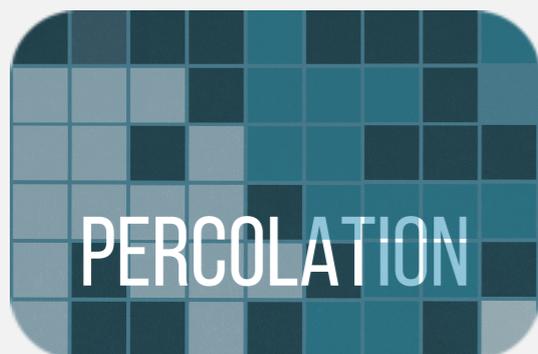
- ▶ *motivation*
- ▶ *course structure*
- ▶ ***assessments***
- ▶ *resources*
- ▶ *union-find*

Programming assignments

Implement an efficient algorithm or data structure.



Solve an interesting application using a “textbook” algorithm.





- 2–3 short questions per lecture.
- 3 attempts per question.
- Use pencil and paper.



Quizzera

wayne [Logout](#)

[Courses](#) / [Algorithms and Data Structures](#) / [Union Find](#)

Quick Find

Attempts Remaining: **1** Quiz Ends in **2 days**.

[New Attempt](#) [Attempts ▾](#)

Seed: [50233](#) (Provider: [QuickFindExercise](#))

Question

Give the `id[]` array that results from the following sequence of 6 union operations on a set of 10 items using the quick-find algorithm.

5-7 3-2 4-3 1-6 0-7 4-9

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](#)

[About](#)

Midterm and final

Written exams.

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

COS 226 Algorithms and Data Structures Fall 2014

Midterm

This test has 9 questions worth a total of 55 points. You have 80 minutes. The exam is closed book, except that you are allowed to use a one page cheatsheet. No calculators or other electronic devices are permitted. Give your answers and show your work in the space provided. **Write out and sign the Honor Code pledge just before turning in the test.**

"I pledge my honor that I have not violated the Honor Code during this examination."

Grading

Programming assignments. 45%

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

Quizzes. 10%

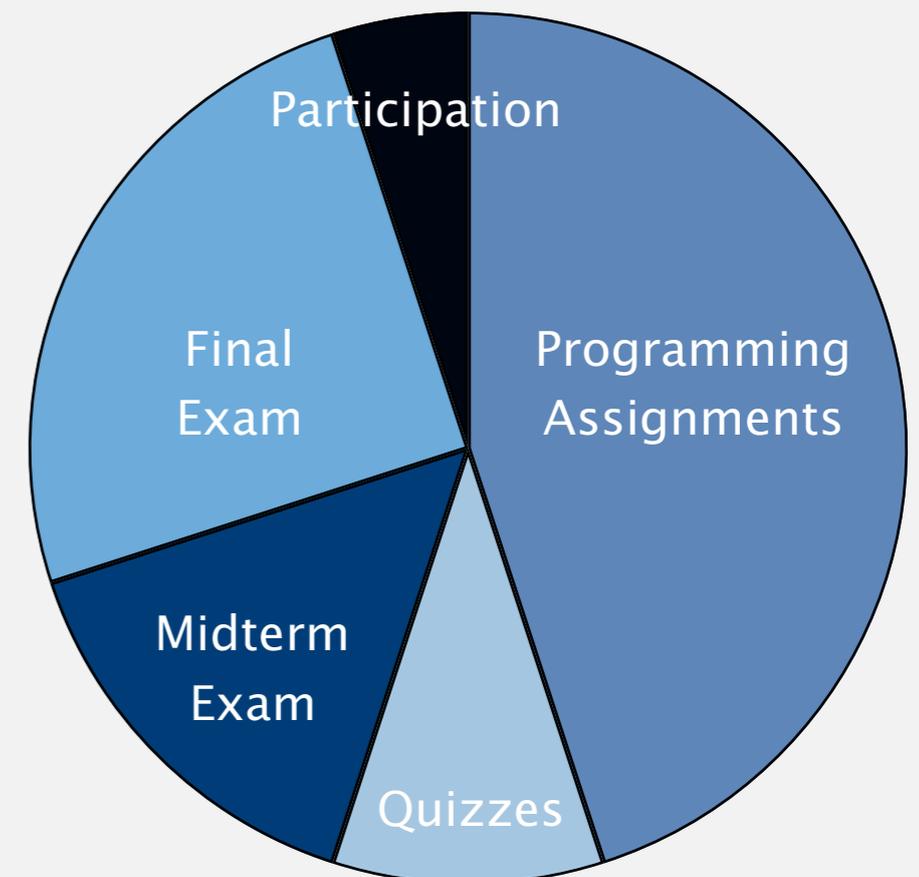
- Due at 11 pm on Fridays via Quizzera.
- Collaboration/lateness policies: see web.

Exams. 15% + 25%

- Midterm (in class on Tuesday, October 24).
- Final (to be scheduled by Registrar).

Participation. 5%

- Attend and participate in precept/lecture.
- Answer questions on Piazza.





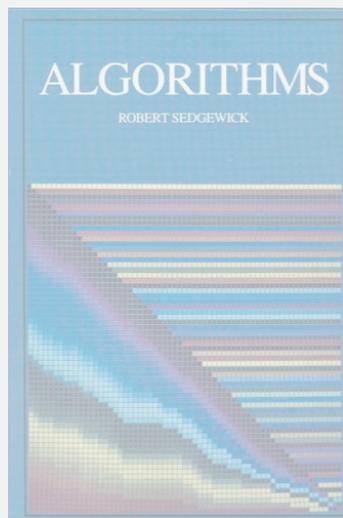
<http://algs4.cs.princeton.edu>

INTRO TO COS 226

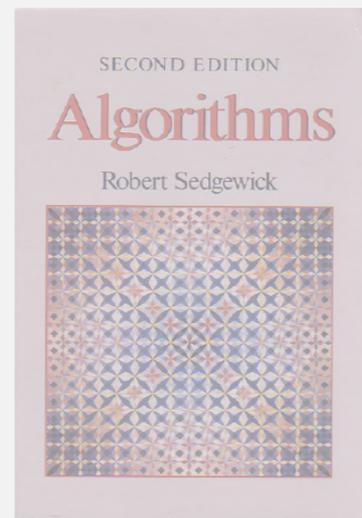
- ▶ *motivation*
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Resources (textbook)

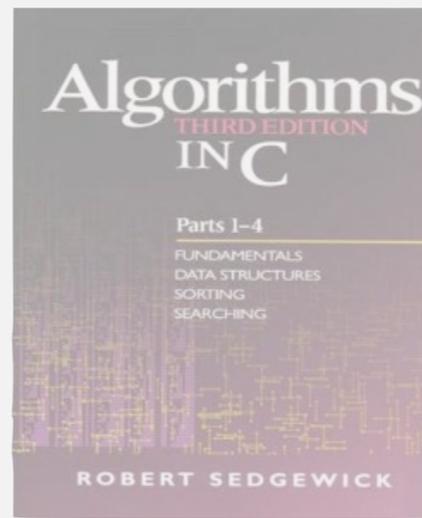
Readings (required). Algorithms 4th edition by R. Sedgwick and K. Wayne, Addison-Wesley Professional, 2011, ISBN 0-321-57351-X.



1st edition (1982)



2nd edition (1988)



3rd edition (1997)



4th edition (2011)

Available in hardcover and Kindle.

- Online: Amazon (\$70 hardcover, \$60 Kindle, \$40 rent), ...
- Brick-and-mortar: Labyrinth Books (\$60 hardcover).
- On reserve: Engineering library.

Resources (videos)

Lecture videos (optional).

- Missed lecture.
- Review for exams.

Algorithms ROBERT SEDGEWICK | KEVIN WAYNE

ALGORITHMS, PARTS I AND II

- ▶ *overview*
- ▶ *why study algorithms?*
- ▶ *resources*

Algorithms ROBERT SEDGEWICK | KEVIN WAYNE
<http://algs4.cs.princeton.edu>

Resources (videos)

Lecture videos (optional).

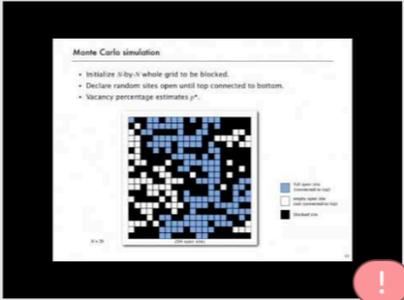
- Missed lecture.
- Review for exams.

CS Princeton Salon COS226 F2017 percolation

Welcome wayne

Search Results: "percolation" Include: everything 1 Results

1.E Applications



1.E Applications

0:55 So, the one we're going to talk about now is called **percolation**.

2:46 That's just a few examples of the **percolation** model.

6:16 So the **percolation** model on the left corresponds to the, connection model on the right, according to what we've been doing.

7:34 And that's where we get the result that, by running enough simulations for a big-enough n, that this, **percolation** threshold is about.

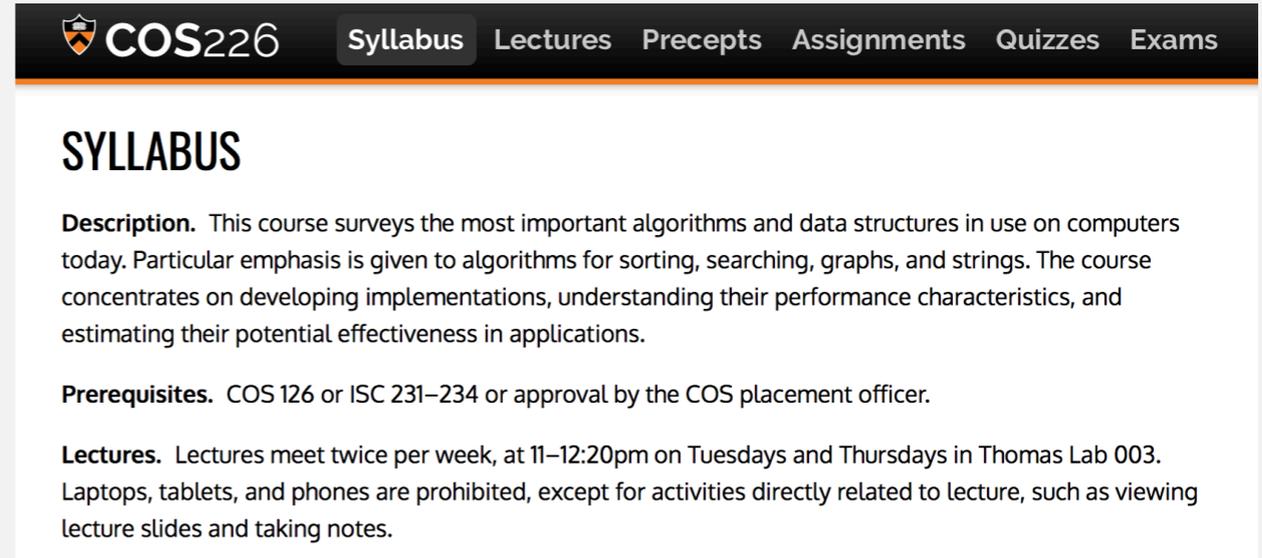
Resources (web)

Course content.

- Course info.
- Lecture slides.
- 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 the course surveys algorithms and data structures. 'Prerequisites' list COS 126 or ISC 231-234. 'Lectures' are held twice weekly in Thomas Lab 003.

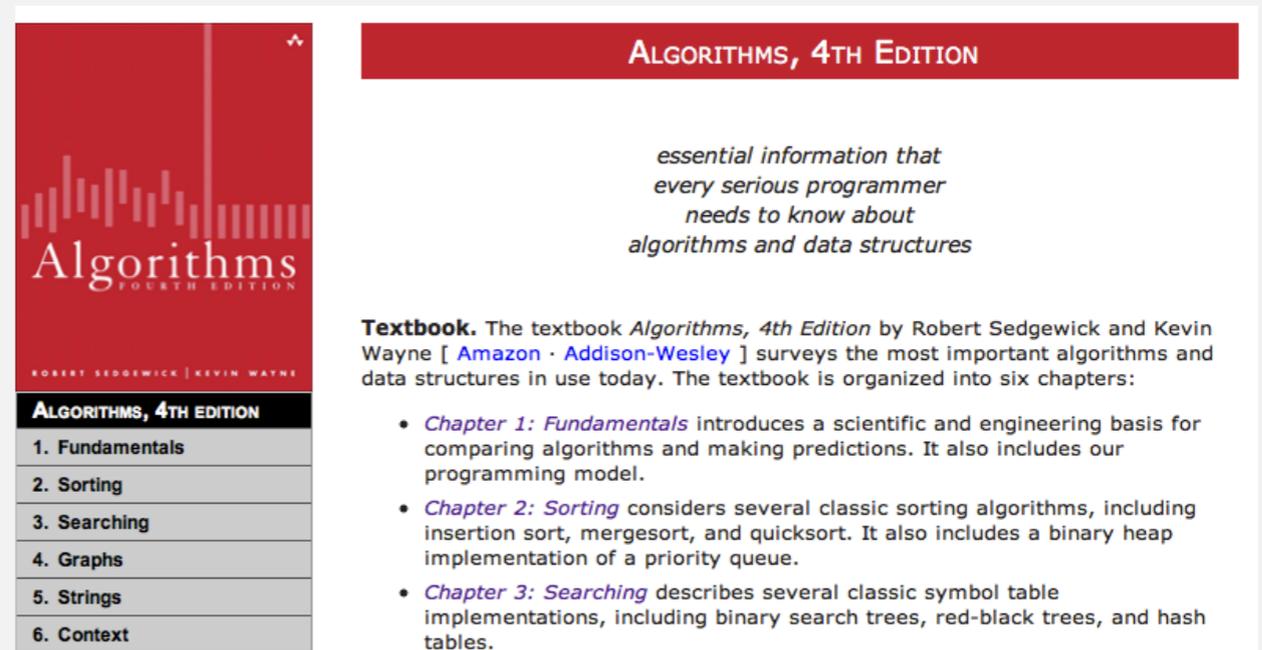
SYLLABUS

Description. 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.

Prerequisites. COS 126 or ISC 231–234 or approval by the COS placement officer.

Lectures. Lectures meet twice per week, at 11–12:20pm on Tuesdays and Thursdays in Thomas Lab 003. Laptops, tablets, and phones are prohibited, except for activities directly related to lecture, such as viewing lecture slides and taking notes.

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



The screenshot shows the book website for 'Algorithms, 4th Edition' by Robert Sedgewick and Kevin Wayne. It features the book cover on the left and a list of chapters on the right. The text describes the book as essential information for serious programmers.

ALGORITHMS, 4TH EDITION

essential information that every serious programmer needs to know about algorithms and data structures

Textbook. The textbook *Algorithms, 4th Edition* by Robert Sedgewick and Kevin Wayne [[Amazon](#) · [Addison-Wesley](#)] surveys the most important algorithms and data structures in use today. The textbook is organized into six chapters:

- **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.

ALGORITHMS, 4TH EDITION
1. Fundamentals
2. Sorting
3. Searching
4. Graphs
5. Strings
6. Context

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

Resources (people)

Piazza discussion forum.

- Low latency, low bandwidth.
- See Piazza for guidelines.

The logo for Piazza, featuring the word "piazza" in a lowercase, blue, sans-serif font.

<http://piazza.com/princeton/fall2017/cos226>

Office hours.

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



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

Computing laboratory.

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



<http://labta.cs.princeton.edu>

This week



Sun	Mon	Tue	Wed	Thu	Fri	Sat
10	11	12	13	14	15	16
				Lecture 1 (Union-Find)	Precept 1 Quiz 0 and 1	
17	18	19	20	21	22	23
	Assignment 1 (Percolation)					
24	25	26	27	28	29	30

you are here!

precept starts tomorrow (or today)
read Assignment 1 before precept

protip: start early

yes, really!

A typical week



Sun	Mon	Tue	Wed	Thu	Fri	Sat
10	11	12	13	14	15	16
17	18	19 Lecture 2 (Analysis)	20	21 Lecture 3 (Stacks)	22 Precept 2 Quiz 2 and 3	23
24	25 Assignment 2 (Deque+RQs)	26	27	28	29	30

support lecture material;
assignment prep

content based on
week's material

content based on
corresponding lectures

Q+A

Not registered? Go to any precept this week.

Change precept? Use TigerHub.

All possible precepts closed? See Colleen Kenny-McGinley in CS 210.

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

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

