COS 226

ALGORITHMS
and
DATA STRUCTURES

Arvind Narayanan • Maia Ginsburg • Ibrahim Albluwi
Intro to COS 226

» motivation

» course details and policies
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.

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

Their impact is broad and far-reaching.

Prisons turn to computer algorithms for deciding who to parole.

Can maths find you love? eHarmony's love algorithm.

New Google algorithm elevates facts; critics worry 'dissidents' will be quashed.

Algorithm That Tells the Boss Who Might Quit.

Algorithms Will Drive Future Health Gains, Dean of Stanford Med...
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)
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.

“\textit{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.
Algorithms can be misused.

New Google algorithm elevates facts; critics worry 'dissidents' will be quashed

Prisons turn to computer algorithms for deciding who to parole

The Algorithm Economy Heads To Amazon

Google is developing an algorithm that would elevate "trustworthiness" in its search results. (The Associated Press)

Algorithm That Tells the Boss Who Might Quit

Wal-Mart, Credit Suisse Crunch Data to See Which Workers Are Likely to Leave or Stay

Rural Parts Will Save the World

The Algorithm Economy Heads To Amazon

Posted Nov 30, 2014 by Danny Crichton (@DannyCrichton)

1,796 shares
Why study algorithms and data structures?

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- To solve problems that could not otherwise be addressed.
- They may unlock the secrets of life and of the universe.
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- To become a proficient programmer.
- For intellectual stimulation.
- For fun and profit.
INTRO TO COS 226

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- course details and policies
Laptops Are Great. But Not During a Lecture or a Meeting.
Laptop use — even for note taking — negatively impacts learning

Lots of peer-reviewed research on this topic


*In-class laptop use and its effects on student learning* by Carrie B. Fried, *Computers & Education*, 2007


*The impact of laptop-free zones on student performance and attitudes in large lectures* by Nancy Aguilar-Roca, Adrienne Williams, and Diane O’Dowd, *Computers & Education*, 2012

*Laptop multitasking hinders classroom learning for both users and nearby peers* by Faria Sana, Tina Weston, Nicholas J. Cepeda, *Computers & Education*, 2013

*The pen is mightier than the keyboard: Advantages of longhand over laptop note taking* by Pam A. Mueller and Daniel M. Oppenheimer, *Psychological Science*, 2014


Laptop use harms other students

Computers & Education

Volume 62, March 2013, Pages 24-31

Laptop multitasking hinders classroom learning for both users and nearby peers

Faria Sana a, Tina Weston b, c, Nicholas J. Cepeda b, c

Show more

https://doi.org/10.1016/j.compedu.2012.10.003

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open access
Policy: no laptops/phones/tablets in class
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). 🛍️

We’ll start using them on Thursday.
## Course staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arvind Narayanan</td>
<td>Faculty Instructor</td>
</tr>
<tr>
<td>Maia Ginsburg</td>
<td>Faculty Lead Preceptor</td>
</tr>
<tr>
<td>Ibrahim Albluwi</td>
<td>Faculty Lead Preceptor</td>
</tr>
<tr>
<td>Ross Teixeira</td>
<td>Graduate Student Preceptor</td>
</tr>
<tr>
<td>Qasim Nadeem</td>
<td>Graduate Student Preceptor</td>
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<tr>
<td>Lisa Jian</td>
<td>Graduate Student Preceptor</td>
</tr>
<tr>
<td>Matthew Weaver</td>
<td>Graduate Student Preceptor</td>
</tr>
<tr>
<td>Mohamed El-Dirany</td>
<td>Graduate Student Preceptor</td>
</tr>
<tr>
<td>Alberto Mizrahi Benmaman</td>
<td>Graduate Student Preceptor</td>
</tr>
</tbody>
</table>
Precepts:
Discussion, problem solving, assignment prep
A note about division of responsibility

For assignment help, go to precepts, preceptor office hours, labs
Programming assignments

Implement an efficient algorithm or data structure.

Solve an interesting application using a “textbook” algorithm.
Programming assignments

IntelliJ-based programming environment (highly recommended).
- Continuous inspection; integrated Checkstyle and Findbugs.
- Autoformat, autoimport, and autocomplete.
- Embedded bash terminal.
2–3 short questions per lecture.
3 attempts per question.
Use pencil and paper.
Written exams.

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

Programming assignments.  45%
  • Due at 6pm on Mondays via TigerFile.
  • Collaboration/lateness policies: see web.

Quizzes.  10%
  • Due at 6pm on Fridays via Quizzera.
  • Collaboration/lateness policies: see web.

Exams.  15% + 30%
  • Midterm (in class on Thursday, March 14).
  • Final (to be scheduled by Registrar).
Resources (textbook)


Available in various formats.

- Online: Amazon ($85 hardcover, $60 Kindle, $40 rent), ...
- Brick–and–mortar: Labyrinth Books ($60 hardcover).
- On reserve: Engineering library.
The creator gods of COS 226

Robert Sedgewick

Kevin Wayne
Resources (videos)

Lecture videos (optional).

- Missed lecture.
- Review for exams.
cos(226 radians) = 0.98111135433

COS 226 Syllabus (Spring 2019)
www.princeton.edu/~cos226/
Syllabus. Description. This course surveys the most important algorithms and data structures in use on computers today. Particular emphasis is given to ...
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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.

https://algs4.cs.princeton.edu
Resources (people)

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

Office hours.
- High bandwidth, high latency.
- See web for schedule.
- For assignment questions, go to preceptor office hours

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

http://www.princeton.edu/~cos226
http://labta.cs.princeton.edu