COS 226

Algorithms and Data Structures
Princeton University
Fall 2009

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Course Overview

▸ outline
▸ why study algorithms?
▸ usual suspects
▸ coursework
▸ resources

COS 226 course overview

What is COS 226?

- Intermediate-level survey course.
- Programming and problem solving with applications.
- Algorithm: method for solving a problem.
- Data structure: method to store information.

topic	data structures and algorithms
data types	stack, queue, union-find, priority queue
sorting	quicksort, mergesort, heapsort, radix sorts
searching	hash table, BST, red-black tree
graphs	BFS, DFS, Prim, Kruskal, Dijkstra
strings	KMP, regular expressions, TST, Huffman, LZW
geometry	Graham scan, k-d tree, Voronoi diagram

Why study algorithms?

Their impact is broad and far-reaching.

Internet. Web search, packet routing, distributed file sharing, ...

Biology. Human genome project, protein folding, ...

Computers. Circuit layout, file system, compilers, ...

Computer graphics. Movies, video games, virtual reality, ...

Security. Cell phones, e-commerce, voting machines, ...

Multimedia. CD player, DVD, MP3, JPG, DivX, HDTV, ...

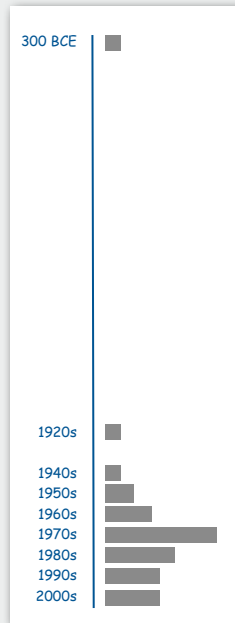Transportation. Airline crew scheduling, map routing, ...

Physics. N-body simulation, particle collision simulation, ...

...

Old roots, new opportunities.

- Study of algorithms dates at least to Euclid.
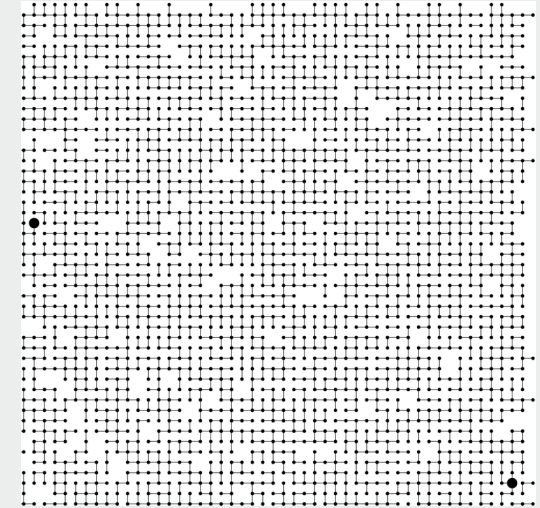- Some important algorithms were discovered by undergraduates!

300 BCE	▪
1920s	▪
1940s	▪
1950s	▬
1960s	▬▬
1970s	▬▬▬▬
1980s	▬▬▬
1990s	▬▬
2000s	▬▬

To solve problems that could not otherwise be addressed.

Ex. Network connectivity. [stay tuned]

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

" *An algorithm must be seen to be believed.* " — D. E. Knuth

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

Computational models are replacing mathematical models in scientific inquiry.

$$E = mc^2$$
$$F = ma$$
$$F = \frac{G m_1 m_2}{r^2}$$
$$\left[-\frac{\hbar^2}{2m} \nabla^2 + V(r) \right] \Psi(r) = E\ \Psi(r)$$

20th century science
(formula based)

```
for (double t = 0.0; true; t = t + dt)
    for (int i = 0; i < N; i++)
    {
        bodies[i].resetForce();
        for (int j = 0; j < N; j++)
            if (i != j)
                bodies[i].addForce(bodies[j]);
    }
```

21st century science
(algorithm based)

" *Algorithms: a common language for nature, human, and computer.* " — Avi Wigderson

Why study algorithms?

For fun and profit.

Why study algorithms?

- Their impact is broad and far-reaching.
- Old roots, new opportunities.
- To solve problems that could not otherwise be addressed.
- For intellectual stimulation.
- They may unlock the secrets of life and of the universe.
- For fun and profit.

Why study anything else?

The usual suspects

Lectures. Introduce new material, answer questions.

Precepts. Answer questions, solve problems, discuss programming assignment.

first precept meets today!

What	When	Where	Who	Office Hours
L01	TTh 11-12:20	Bowen 222	Kevin Wayne	see web page
P01	Th 12:30	Friend 109	Anu Venugopalan	see web page
P02	Th 3:30	Friend 111	Berk Kapicioglu	see web page
P03	TBA	TBA	Corey Toler-Franklin	see web page

FAQ.
- Not registered? Change precept? Use SCORE.
- See Donna O'Leary (CS 210) to resolve serious conflicts.

Coursework and grading

8 programming assignments. 45%
- Electronic submission.
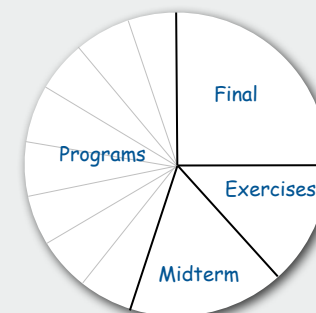- Due 11pm, starting Wednesay 9/23.

Exercises. 15%
- Due in lecture, starting Tuesday 9/22.

Exams.
- Closed-book with cheatsheet.
- Midterm. 15%
- Final.   25%

Staff discretion. To adjust borderline cases.

everyone needs to meet me in office hours (at least) once this month!

Resources (web)

Course content.
- Course info.
- Exercises.
- Lecture slides.
- Programming assignments.
- Submit assignments.

`http://www.princeton.edu/~cos226`

Booksites.
- Brief summary of content.
- Download code from lecture.

`http://www.cs.princeton.edu/IntroProgramming`
`http://www.cs.princeton.edu/algs4`
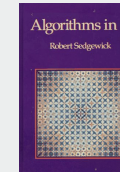
Resources (books)

Required readings.
- Algorithms 4th edition. [selected chapters available at Triangle copy]
- Algorithms in Java, 3rd edition, Part 5. [Labyrinth books]
- Algorithm in Java, 3rd edition, Part 1–4. [selected chapters online]
- Algorithm in C, 2nd edition. [selected chapters online]

Recommended Java reference.
- Introduction to Programming in Java. [Labyrinth books]