COS 226

Algorithms and Data Structures
Princeton University
Spring 2010

Robert Sedgewick

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, ...

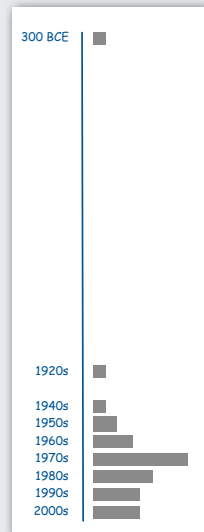Physics. N-body simulation, particle collision simulation, ...

...

Why study algorithms?

Old roots, new opportunities.
- Study of algorithms dates at least to Euclid.
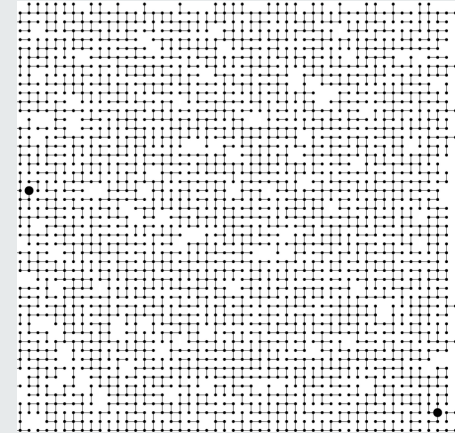- Some important algorithms were discovered by undergraduates!

300 BCE	■
1920s	■
1940s	■
1950s	■
1960s	■
1970s	■
1980s	■
1990s	■
2000s	■

Why study algorithms?

To solve problems that could not otherwise be addressed.

Ex. Network connectivity. [stay tuned]

Why study algorithms?

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

---

Why study algorithms?

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

Computational models are replacing mathematical models in scientific inquiry.

$$E = mc^2$$
$$F = ma$$
$$F = \frac{Gm_1 m_2}{r^2}$$
$$\left[-\frac{h^2}{2m}\nabla^2 + V(r) \right] \Psi(r) = E\,\Psi(r)$$

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. ← "all questions answered" during break

Precepts. Discussion, problem-solving, background for programming assignment.
↳ first precept meets this week

What	When	Where	Who	Office Hours
L01	MW 11-12:20	CS 104	Prof. Sedgewick	W 1:30-2:30
P01	Th 12:30	Friend 108	Charlse Vaske	Th 3-4
P01A	Th 12:30	Friend 109	Maia Ginsburg (lead)	see web page
P03	Th 3:30	Friend 108	Prof. Rusinkiewicz	M 2-3
P02	F 11	Friend 108	Berk Kapicioglu	see web page
P02A	F 11	Friend 109	Linjie Luo	F 1:30-2:30

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

Orientation precept (if you have not taken COS 126): W 2/3 5PM room TBA

Coursework and grading

8 programming assignments. 45%
- Electronic submission.
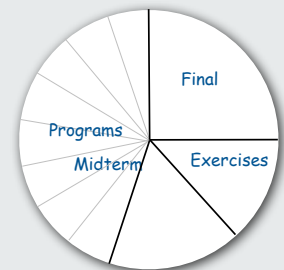- Due 11pm, starting Tuesday 2/9.

Exercises. 15%
- Due at beginning of lecture, starting Monday 2/8.

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

Staff discretion. To adjust borderline cases.
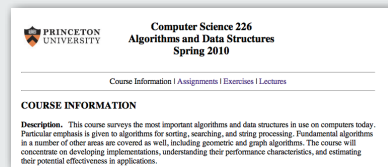↳ everyone needs to meet me in office hours
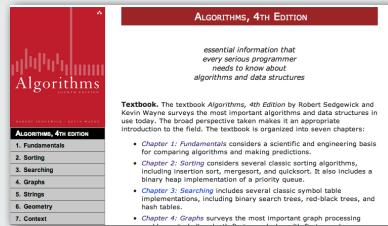
Final / Exercises / Midterm / Programs

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`
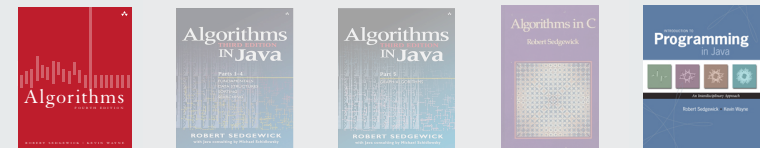`http://www.cs.princeton.edu/algs4`

Resources (books)

Required readings.

- Algorithms 4th edition, preliminary edition.   [Labyrinth books]
- Algorithms in Java, 3rd edition, Parts 1–5. [stay tuned for selections online]
- Algorithms in C, 2nd edition. [stay tuned for selections online]

Recommended Java reference.

- Introduction to Programming in Java.   [Labyrinth books]