Computer Science 226

Algorithms and Data Structures

Spring 2007

Instructors:
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Course Overview

- outline
- why study algorithms?
- usual suspects
- coursework
- resources (web)
- resources (books)

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, list, union-find, priority queue
sorting	quicksort, mergesort, heapsort, radix sorts
searching	hash table, BST, red-black tree, B-tree
graphs	DFS, Prim, Kruskal, Dijkstra, Ford-Fulkerson
strings	KMP, Rabin-Karp, 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. Hollywood movies, video games.

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

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

Transportation. Airline crew scheduling, map routing.

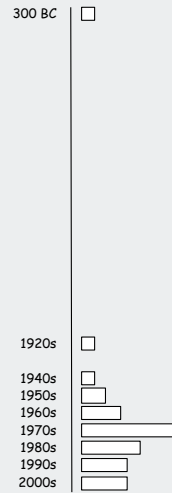Physics. N-body simulation, particle collision simulation.

...

Why study algorithms?

Old roots, new opportunities

Study of algorithms dates at least to Euclid

Some important algorithms were discovered
by undergraduates!

300 BC ☐

1920s ☐

1940s ☐
1950s
1960s
1970s
1980s
1990s
2000s

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

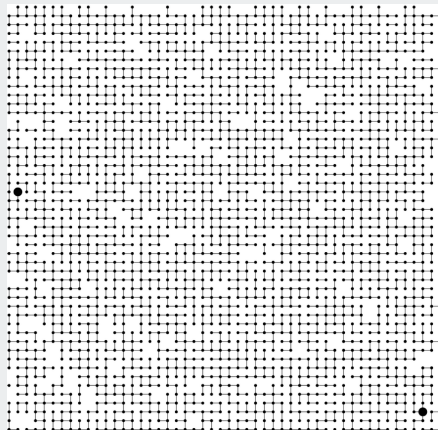> An algorithm must be seen to be believed.   - D. E. Knuth

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Why study algorithms?

To be able solve problems that could not otherwise be addressed

Example: Network connectivity

[stay tuned]

Why study algorithms?

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

Computational models are replacing mathematical models
in scientific enquiry

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

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

Nintendo · Adobe · Google · LUCASFILM ltd · D E Shaw & Co · Morgan Stanley · Microsoft · YAHOO! · PIXAR

Why study algorithms?

- Their impact is broad and far-reaching

- Old roots, new opportunities

- To be able 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: Bob Sedgewick
- MW 11-12:20, CS 104
- Office hours W 3-5 at Cafe Viv in Frist

Course management (everything else): Dave Walker

Precepts: Mohammad Mahmoody Ghidary, Jimin Song, Dave Walker
- Tuesdays.
  - 1A: 12:30 Friend 109
  - 1B: 12:30 CS 102
  - 2: 1:30 CS 102
  - 3: 3:30 CS 102
- Discuss programming assignments, exercises, lecture material.
- First precept meets tomorrow 2/6.

Need a precept time? Need to change precepts?
- see Prof. Walker (or mail dpw@cs.princeton.edu)

Check course web page for info

Coursework and Grading

7-8 programming assignments. 45%
- Due 11:55pm, starting Monday 2/12.
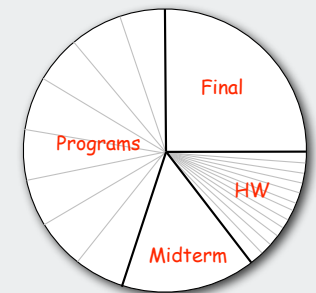- Available via course website.

Weekly written exercises. 15%
- Due at beginning of Wednesday lecture, starting 2/7.
- Available via course website.

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

Staff discretion. Adjust borderline cases.

Pie chart labels: Final, Programs, HW, Midterm

Challenge for the bored. Determine importance of 45-15-15-25 weights

Resources (web)

Course content.

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

- syllabus.
- exercises.
- lecture slides.
- programming assignments (description, code, test data, checklists)
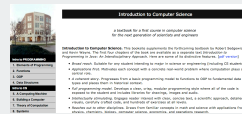
Course administration.

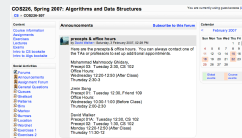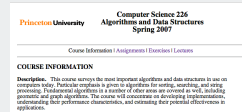`https://moodle.cs.princeton.edu/course/view.php?id=15`

- due dates.
- programming assignment submission.
- grades.
- discussion groups

Booksites.

`http://www.cs.princeton.edu/IntroCS`
`http://www.cs.princeton.edu/IntroAlgsDS`

- brief summary of content.
- code.
- links to web content.

Resources (books)

Algorithms in Java, 3rd edition.
- Parts 1-4. [sorting, searching]
- Part 5. [graph algorithms]

Introduction to Programming in Java.
- basic programming model
- elementary AofA and data structures

Algorithms in Pascal(!)/C/C++, 2nd edition.
- strings
- elementary geometric algorithms

Introduction to Algorithms and Data Structures.
(in preparation)