

Computer Science 226
Algorithms and Data Structures
Fall 2007

Instructors:
Bob Sedgwick
Kevin Wayne

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	BFS, DFS, Prim, Kruskal, Dijkstra
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. 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.

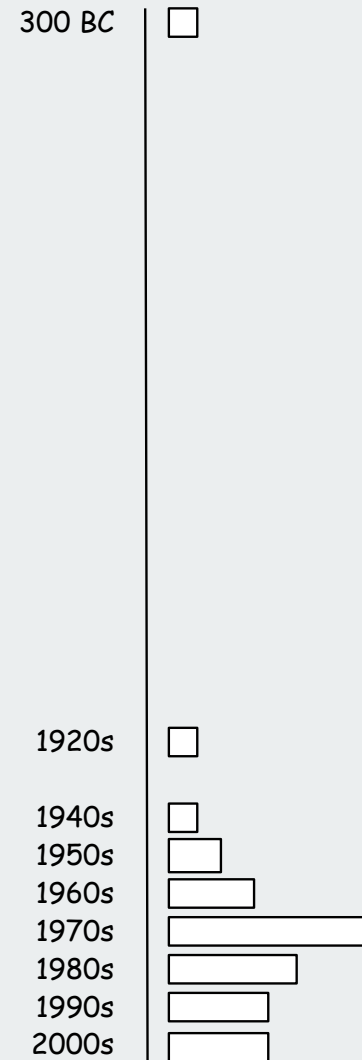
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Why study algorithms?

Old roots, new opportunities

Study of algorithms dates at least to Euclid

Some important algorithms were discovered by undergraduates!

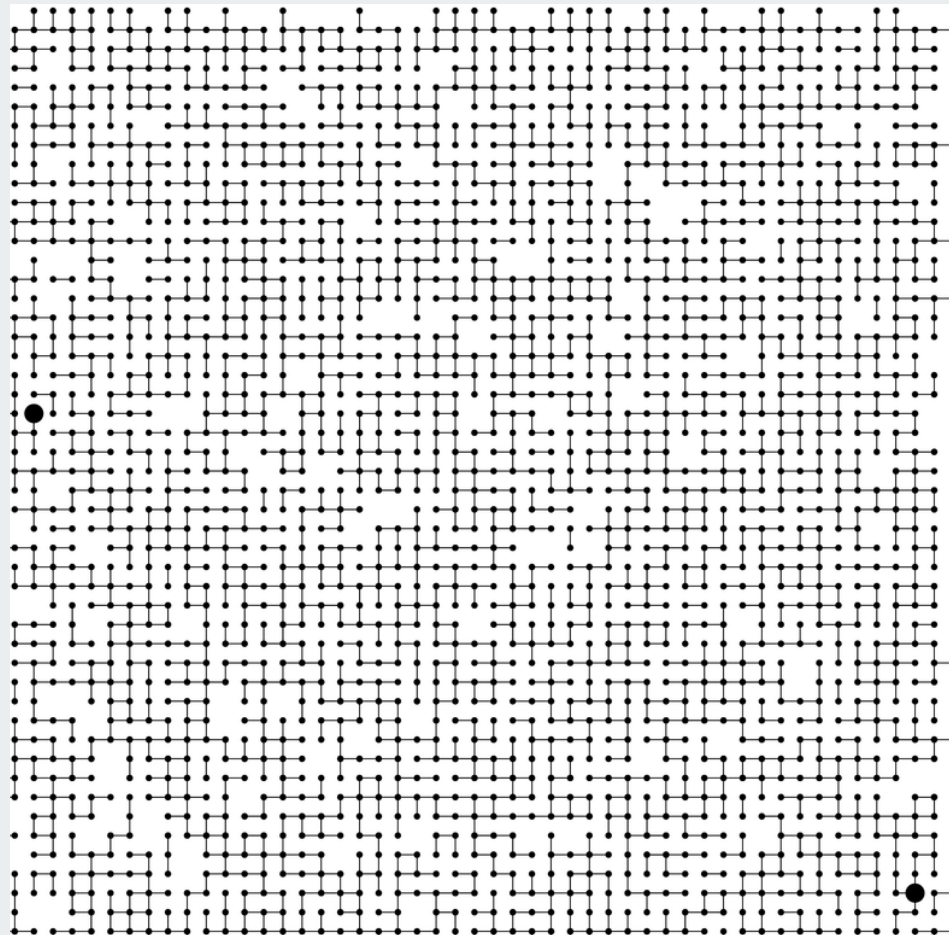


Why study algorithms?

To be able solve problems that could not otherwise be addressed

Example: 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 enquiry

$$\begin{aligned} E &= mc^2 \\ F &= ma \end{aligned} \quad F = \frac{Gm_1m_2}{r^2}$$
$$\left[-\frac{\hbar^2}{2m} \nabla^2 + V(r) \right] \Psi(r) = E \Psi(r)$$

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 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**

- TTh 11-12:20, Bowen 222
- Office hours T 3-5 at Cafe Viv in Frist

Course management (everything else): **Kevin Wayne**

Precepts: **Kevin Wayne**

- Thursdays.
 - 1: 12:30 Friend 110
 - 2: 3:30 Friend 109
- Discuss programming assignments, exercises, lecture material.
- First precept meets **Thursday** 9/20
- Kevin's office hours TBA

Need a precept time? Need to change precepts?

- email Donna O'Leary (CS ugrad coordinator)
doleary@cs.princeton.edu

Check course web page for up-to-date info

Coursework and Grading

7-8 programming assignments. 45%

- Due 11:55pm, starting Monday 9/24.
- Available via course website.

Weekly written exercises. 15%

- Due at beginning of Wednesday lecture, starting 9/24.
- Available via course website.

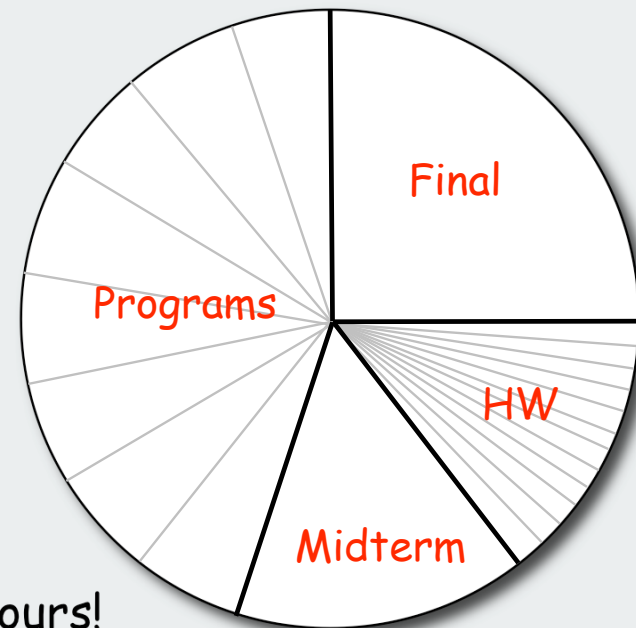
Exams.

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

Staff discretion. Adjust borderline cases.

- Participation in lecture and precepts
- Everyone needs to meet us **both** at office hours!

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=24>

- programming assignment submission.
- grades.

Booksites.

<http://www.cs.princeton.edu/IntroCS>

<http://www.cs.princeton.edu/IntroAlgsDS>

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

Princeton University Computer Science 226
Algorithms and Data Structures
Spring 2007

Course Information | Assignments | Exercises | Lectures

COURSE INFORMATION

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, and string processing. Fundamental algorithms in a number of other areas are covered as well, including geometric and graph algorithms. The course will concentrate on developing implementations, understanding their performance characteristics, and estimating their potential effectiveness in applications.

COS226, Spring 2007: Algorithms and Data Structures

CS - COS226-987

Course information
Assignments
Exercises
Lectures
Exams
Intro to CS booksite
Intro to Algs booksite

Announcements

precepts & office hours
to David Walker - Saturday, 3 February 2007, 12:28 PM

Here are the precepts & office hours. You can always contact one of the TAs or professors to set up additional appointments.

Mohammad Mahmoody Chidary
Precept 03: Tuesday 2:30, CS 102
Office Hours
Wednesday 12:20-12:50 (After Class)
Thursday 2:30-3

Jimin Song
Precept 01: Tuesday 12:30, Friend 109
Office Hours
Wednesday 10:30-11:00 (Before Class)
Thursday 2:00-2:30

David Walker
Precept 01A: Tuesday 12:30, CS 102
Precept 02: Tuesday 1:30, CS 102
Monday 12:20-12:50 (After Class)
Thursday 11:30-12

Programming

INTRODUCTION TO PROGRAMMING IN JAVA

a textbook for a first course in computer science for the next generation of scientists and engineers

Welcome to our website!

Textbook. Our textbook *Introduction to Programming in Java: An Interdisciplinary Approach* (Amazon - [Amazon Review](#)) is an interdisciplinary approach to the traditional CS curriculum. We teach all of the classic elements of programming, using an "objects-in-the-middle" approach that emphasizes data abstraction. The book is organized around four stages of learning to program:

- **Chapter 1: Elements of Programming** introduces variables, assignment statements, built-in types of data, conditions and loops, arrays, and input/output, including graphics and sound.
- **Chapter 2: Functions** introduces modular programming. We stress the fundamental idea of dividing a program into components that can be independently debugged, maintained, and reused.
- **Chapter 3: Object Oriented Programming** introduces data abstraction. We emphasize the concept of a data type and its implementation using Java's class mechanism.
- **Chapter 4: Algorithms and Data Structures** introduces classical algorithms for sorting and searching, and fundamental data structures, including stacks, queues, and symbol tables.

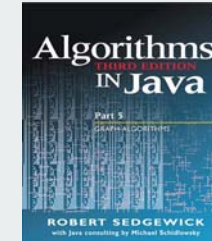
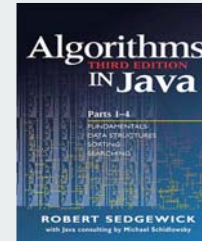
A key feature of the book is the manner in which we motivate each programming concept that we address by examining its impact on specific applications, taken from fields ranging from materials science to genomics to astrophysics to internet commerce. This approach highlights the essential idea that mathematics, science, engineering, and computing are intertwined in the modern world.

To preview our material, you can download the [preface](#) and [Chapter 1](#).

Resources (books)

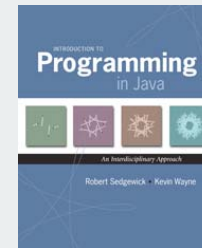
Algorithms in Java, 3rd edition

- 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



Algorithms, 4th edition (in preparation)

Union-Find