



<http://algs4.cs.princeton.edu>

## ALGORITHMS, PARTS I AND II

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- ▶ *overview*
- ▶ *why study algorithms?*
- ▶ *resources*

# Course overview

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## What is this course?

- 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, bag, union-find, priority queue	part 1
sorting	quicksort, mergesort, heapsort	
searching	BST, red-black BST, hash table	
graphs	BFS, DFS, Prim, Kruskal, Dijkstra	part 2
strings	radix sorts, tries, KMP, regexps, data compression	
advanced	B-tree, suffix array, maxflow	

# Why study algorithms?

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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, ...

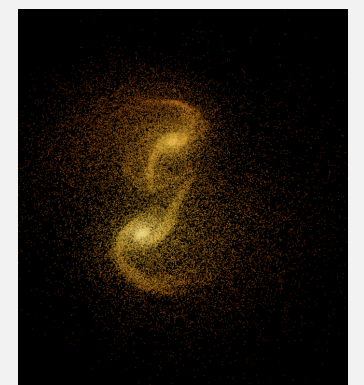
**Security.** Cell phones, e-commerce, voting machines, ...

**Multimedia.** MP3, JPG, DivX, HDTV, face recognition, ...

**Social networks.** Recommendations, news feeds, advertisements, ...

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

⋮



# Why study algorithms?

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## Old roots, new opportunities.

- Study of algorithms dates at least to Euclid.
- Formalized by Church and Turing in 1930s.
- Some important algorithms were discovered by undergraduates in a course like this!



# Why study algorithms?

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To solve problems that could not otherwise be addressed.

Ex. Network connectivity. [stay tuned]

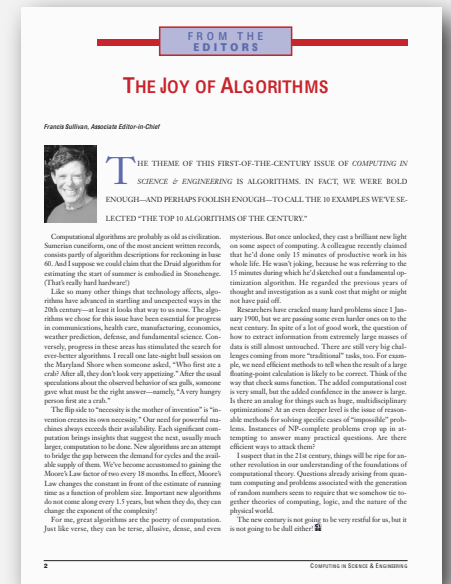


# Why study algorithms?

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. ” — Donald Knuth*





# Why study algorithms?

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To become a proficient programmer.

*“ 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 (creator of Linux)*



*“ Algorithms + Data Structures = Programs. ” — Niklaus Wirth*



# Why study algorithms?

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

Computational models are replacing math models in scientific inquiry.

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

20<sup>th</sup> 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]);
  }
```

21<sup>st</sup> century science  
(algorithm based)

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




# Why study algorithms?

For fun and profit.

The Google logo, featuring the word "Google" in its signature multi-colored font.

Apple Computer

The Facebook logo, consisting of the word "facebook" in white lowercase letters on a blue rectangular background.The Cisco Systems logo, featuring the words "CISCO SYSTEMS" in red above a stylized bridge graphic.The IBM logo, consisting of the letters "IBM" in a blue, horizontally-striped font.The Nintendo logo, featuring the word "Nintendo" in white inside a red rounded rectangle.The Jane Street logo, featuring a stylized circular pattern next to the words "JANE STREET" in gold.The Morgan Stanley logo, consisting of the words "Morgan Stanley" in white on a dark blue background.The Netflix logo, featuring the word "NETFLIX" in white on a red background.The Adobe logo, featuring a stylized red "A" above the word "Adobe" in black.The RSA Security logo, featuring the letters "RSA" in white on a red background, with "SECURITY" in black below.The DE Shaw & Co logo, featuring the words "DE Shaw & Co" in blue with a green line above.The Oracle logo, featuring the word "ORACLE" in red.The Pandora logo, featuring a large blue "P" inside a rounded square, with "PANDORA" in smaller letters below.The Akamai logo, featuring a stylized blue wave next to the word "Akamai" in yellow.The Yahoo! logo, featuring the word "YAHOO!" in red.The Amazon.com logo, featuring the word "amazon.com" in black with a curved arrow below.The Microsoft logo, featuring the word "Microsoft" in black.The Pixar Animation Studios logo, featuring the word "PIXAR" in large letters with a small character between the 'I' and 'X', and "ANIMATION STUDIOS" below.

# Why study algorithms?

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- To solve problems that could not otherwise be addressed.
- For intellectual stimulation.
- To become a proficient programmer.
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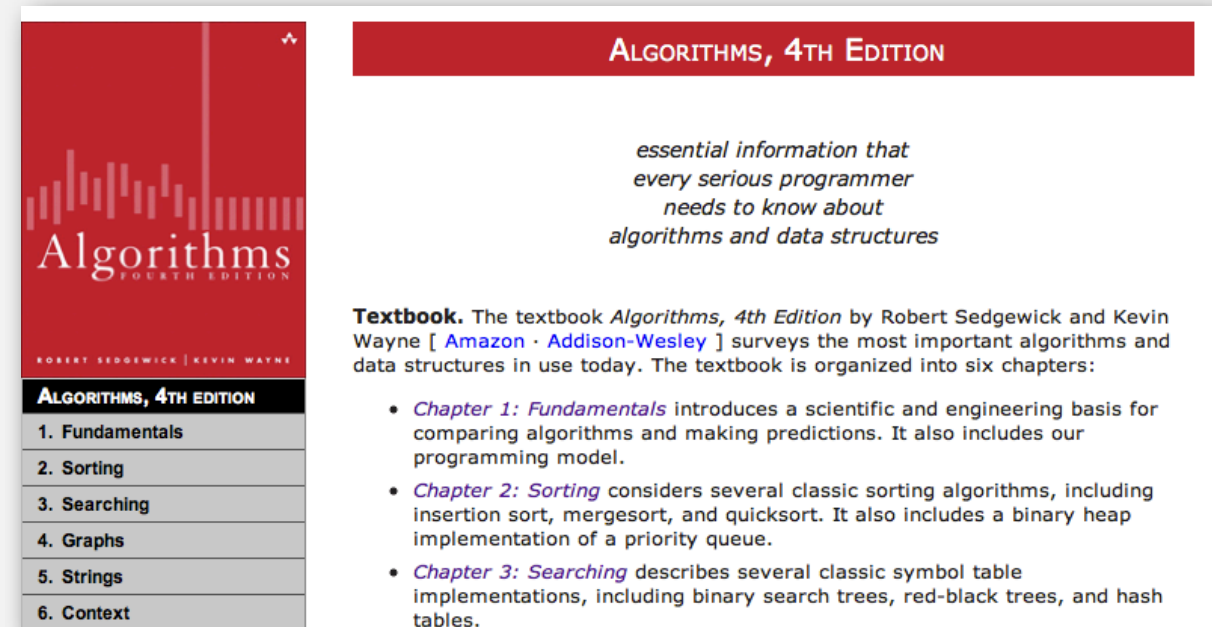
Why study anything else?



# Resources

## Booksite.

- Lecture slides.
- Download code.
- Summary of content.



<http://algs4.cs.princeton.edu>

## Textbook (optional).

- *Algorithms, 4<sup>th</sup> edition* by Sedgewick and Wayne.
- More extensive coverage of topics.
- More topics.



ISBN 0-321-57351-X

# Prerequisites

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## Prerequisites.

- Programming: loops, arrays, functions, objects, recursion.
- Java: we use as expository language.
- Mathematics: high-school algebra.

## Review of prerequisite material.

- Quick: Sections 1.1 and 1.2 of *Algorithms, 4<sup>th</sup> edition*.
- In-depth: *An Introduction to programming in Java: an interdisciplinary approach* by Sedgewick and Wayne.

## Programming environment.

- Use your own, e.g., Eclipse.
- Download ours (see instructions on web).

**Quick exercise.** Write a Java program.



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