



<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, ...

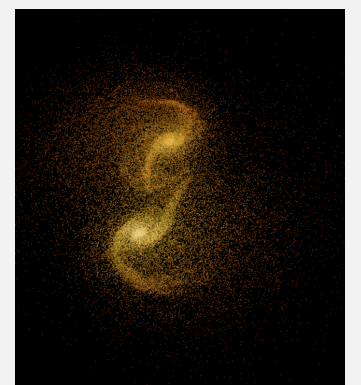
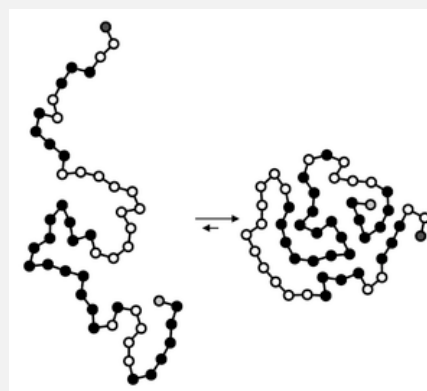
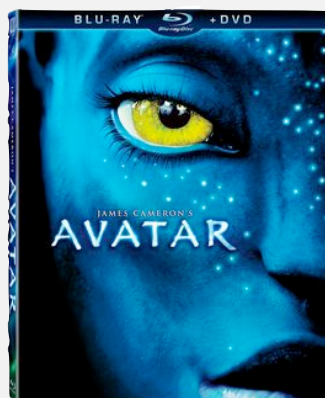
**Security.** Cell phones, e-commerce, voting machines, ...

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

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

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

⋮

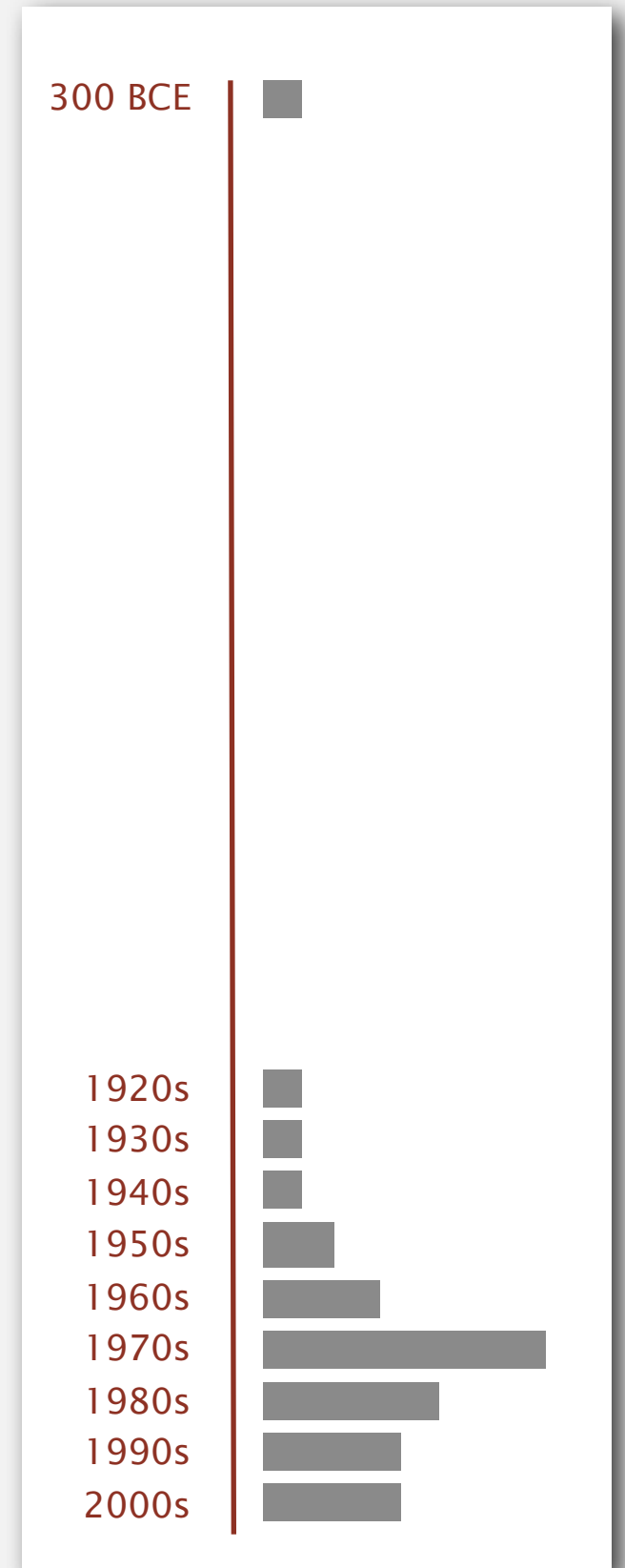


# Why study algorithms?

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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!

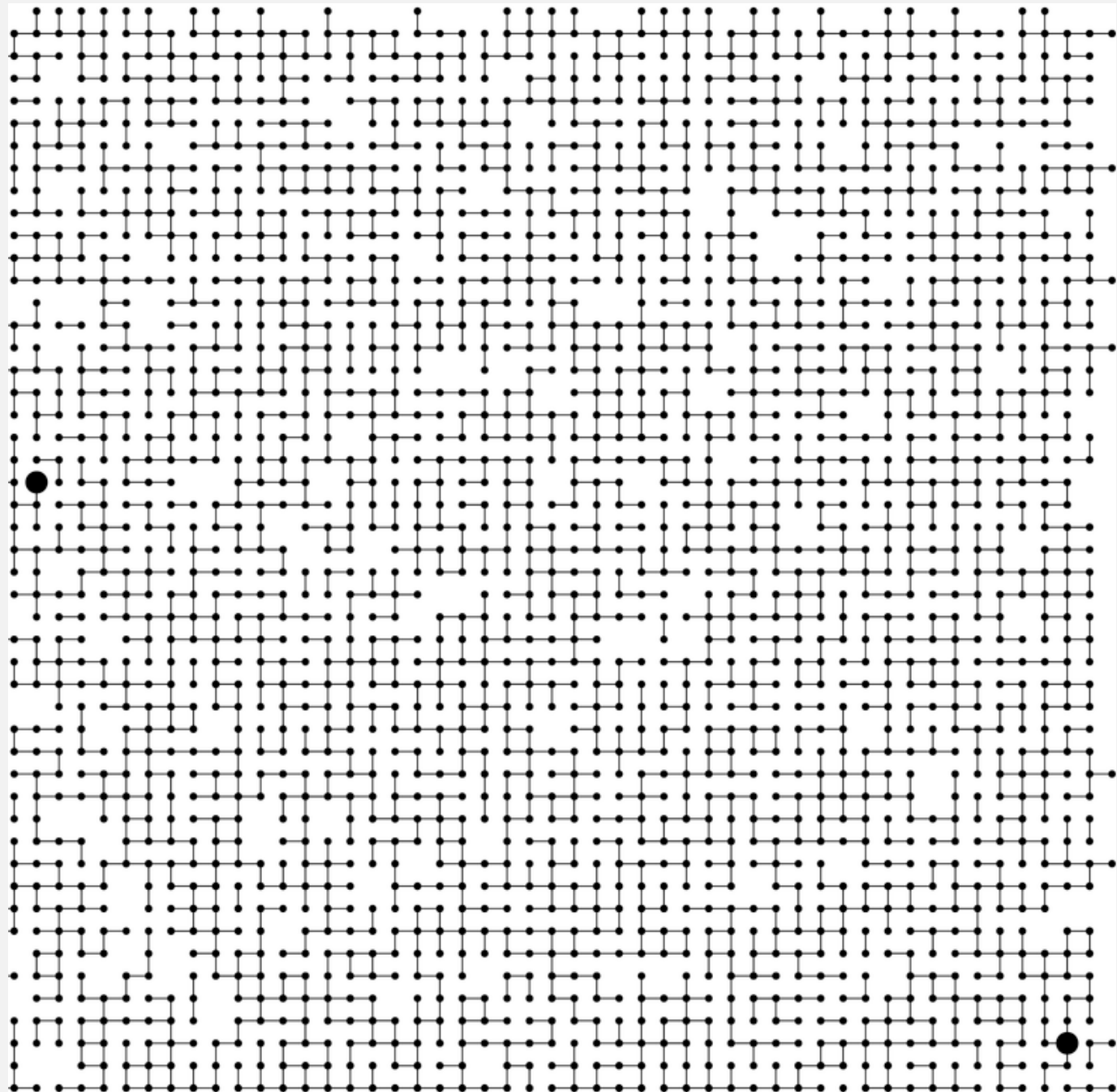


# Why study algorithms?

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To solve problems that could not otherwise be addressed.

Ex. Network connectivity. [stay tuned]

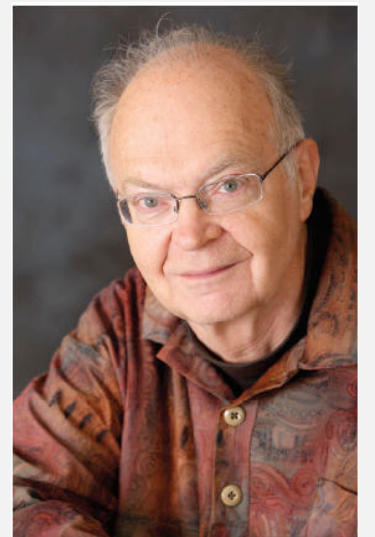
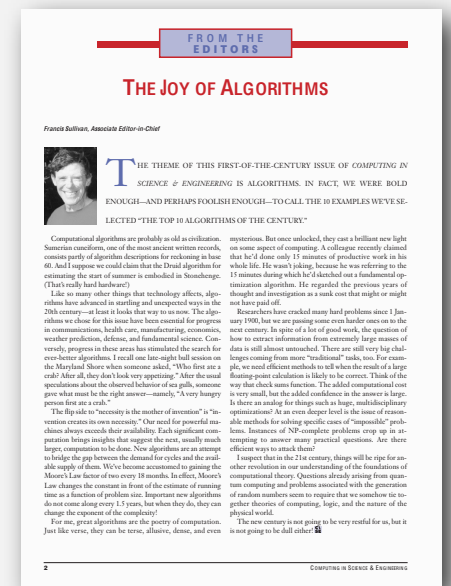


# Why study algorithms?

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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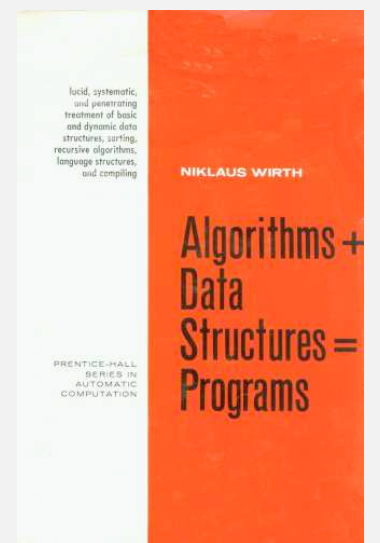
To become a proficient programmer.

*“ 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*

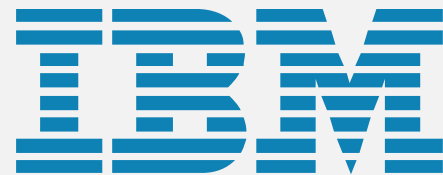



# Why study algorithms?

For fun and profit.



Apple Computer



# Why study algorithms?

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

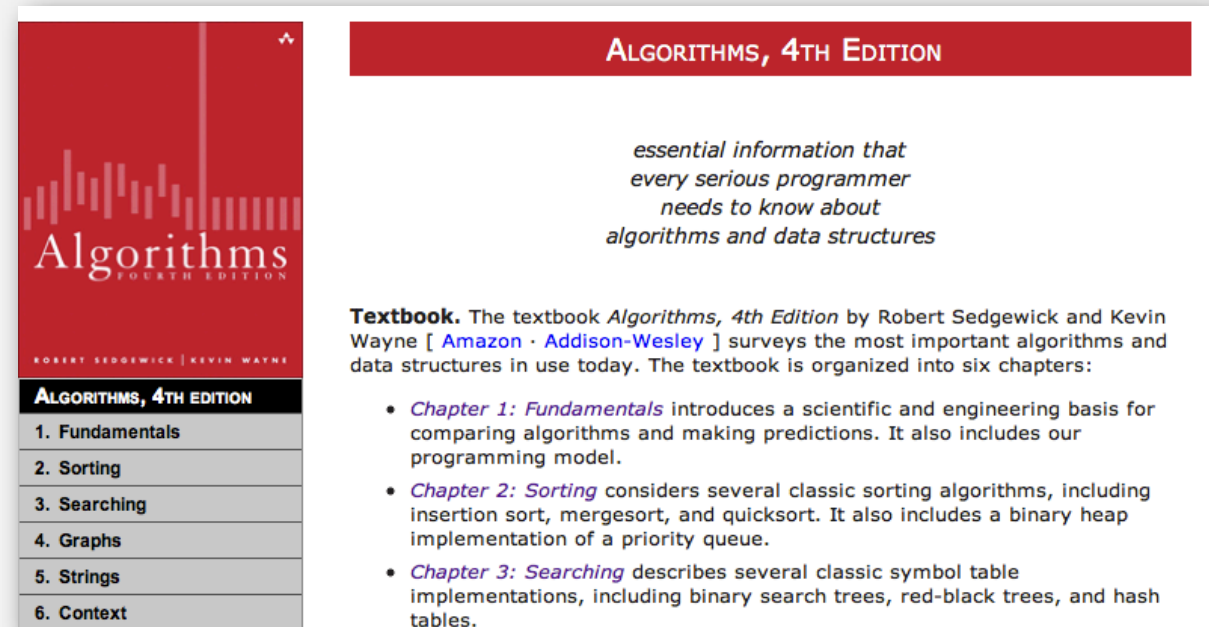
Why study anything else?



# Resources

## Booksite.

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



The screenshot shows the website for 'Algorithms, 4th Edition'. On the left is a red book cover with the title 'Algorithms' and 'FOURTH EDITION' in white. Below the title is a list of six chapters: 1. Fundamentals, 2. Sorting, 3. Searching, 4. Graphs, 5. Strings, and 6. Context. On the right, the text 'ALGORITHMS, 4TH EDITION' is at the top. Below it is a quote: 'essential information that every serious programmer needs to know about algorithms and data structures'. Further down, a 'Textbook' section describes the book by Robert Sedgewick and Kevin Wayne, mentioning its organization into six chapters. Three bullet points provide details about Chapter 1 (Fundamentals), Chapter 2 (Sorting), and Chapter 3 (Searching).

ALGORITHMS, 4TH EDITION

*essential information that  
every serious programmer  
needs to know about  
algorithms and data structures*

**Textbook.** The textbook *Algorithms, 4th Edition* by Robert Sedgewick and Kevin Wayne [ [Amazon](#) · [Addison-Wesley](#) ] surveys the most important algorithms and data structures in use today. The textbook is organized into six chapters:

- *Chapter 1: Fundamentals* introduces a scientific and engineering basis for comparing algorithms and making predictions. It also includes our programming model.
- *Chapter 2: Sorting* considers several classic sorting algorithms, including insertion sort, mergesort, and quicksort. It also includes a binary heap implementation of a priority queue.
- *Chapter 3: Searching* describes several classic symbol table implementations, including binary search trees, red-black trees, and hash tables.

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## 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.

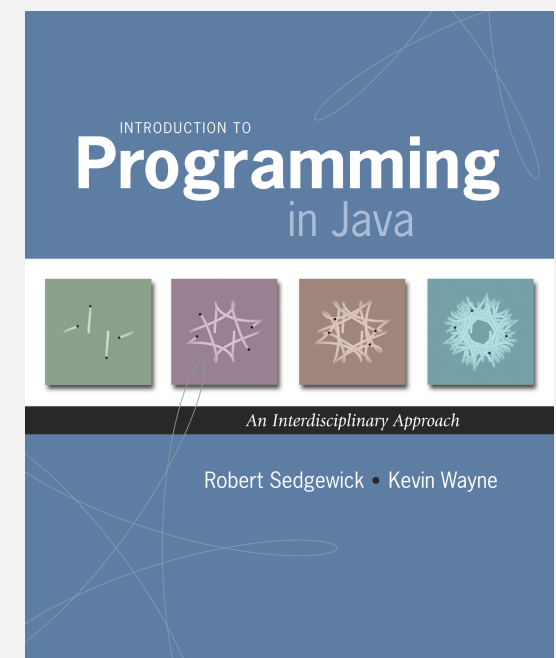
## Review of prerequisite material.

- 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.



ISBN 0-321-49805-4

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