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ALGORITHMS, PARTS I AND II

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

Course overview

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?

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, ...

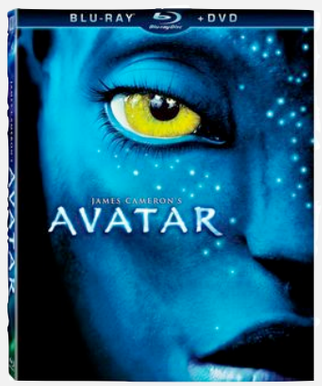
Security. Cell phones, e-commerce, voting machines, ...

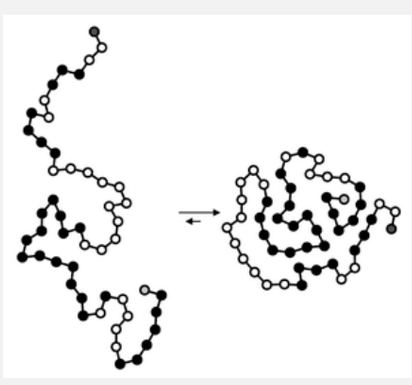
Multimedia. MP3, JPG, DivX, HDTV, face recognition, ...

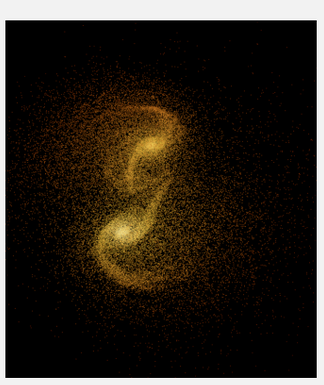
Social networks. Recommendations, news feeds, advertisements, ...

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

⋮



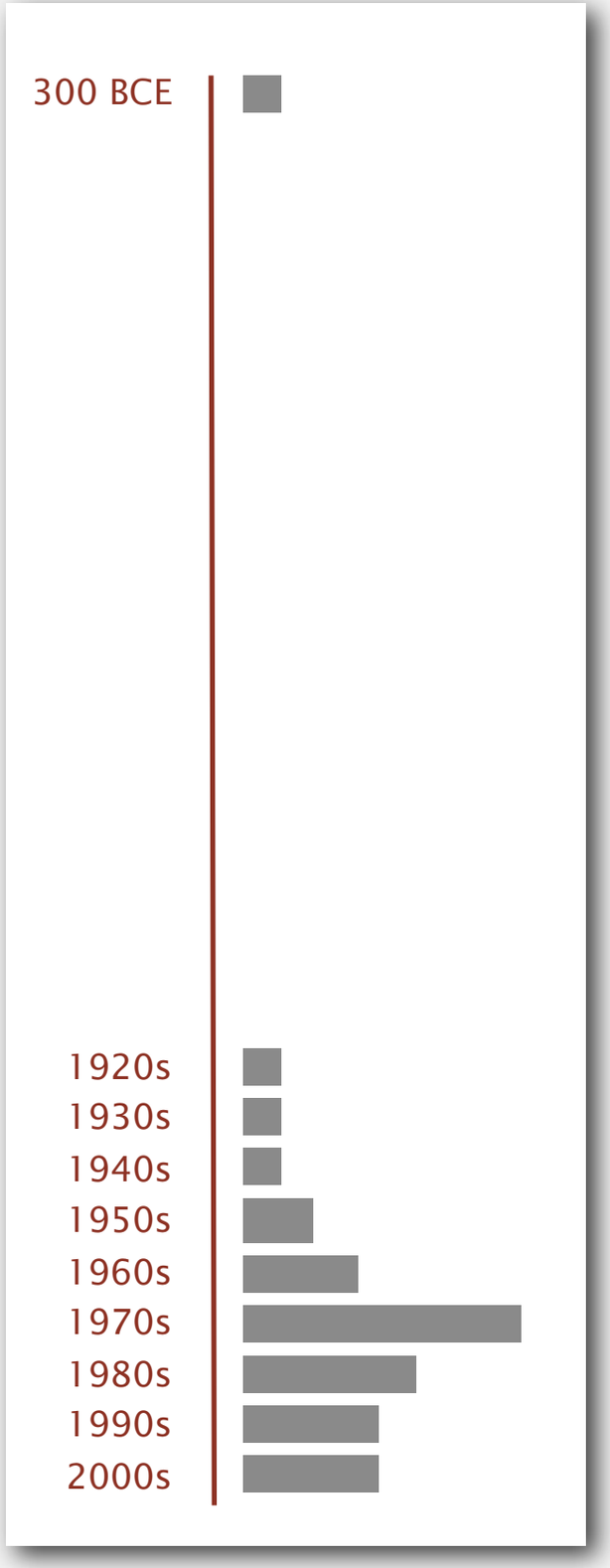




Why study algorithms?

Old roots, new opportunities.

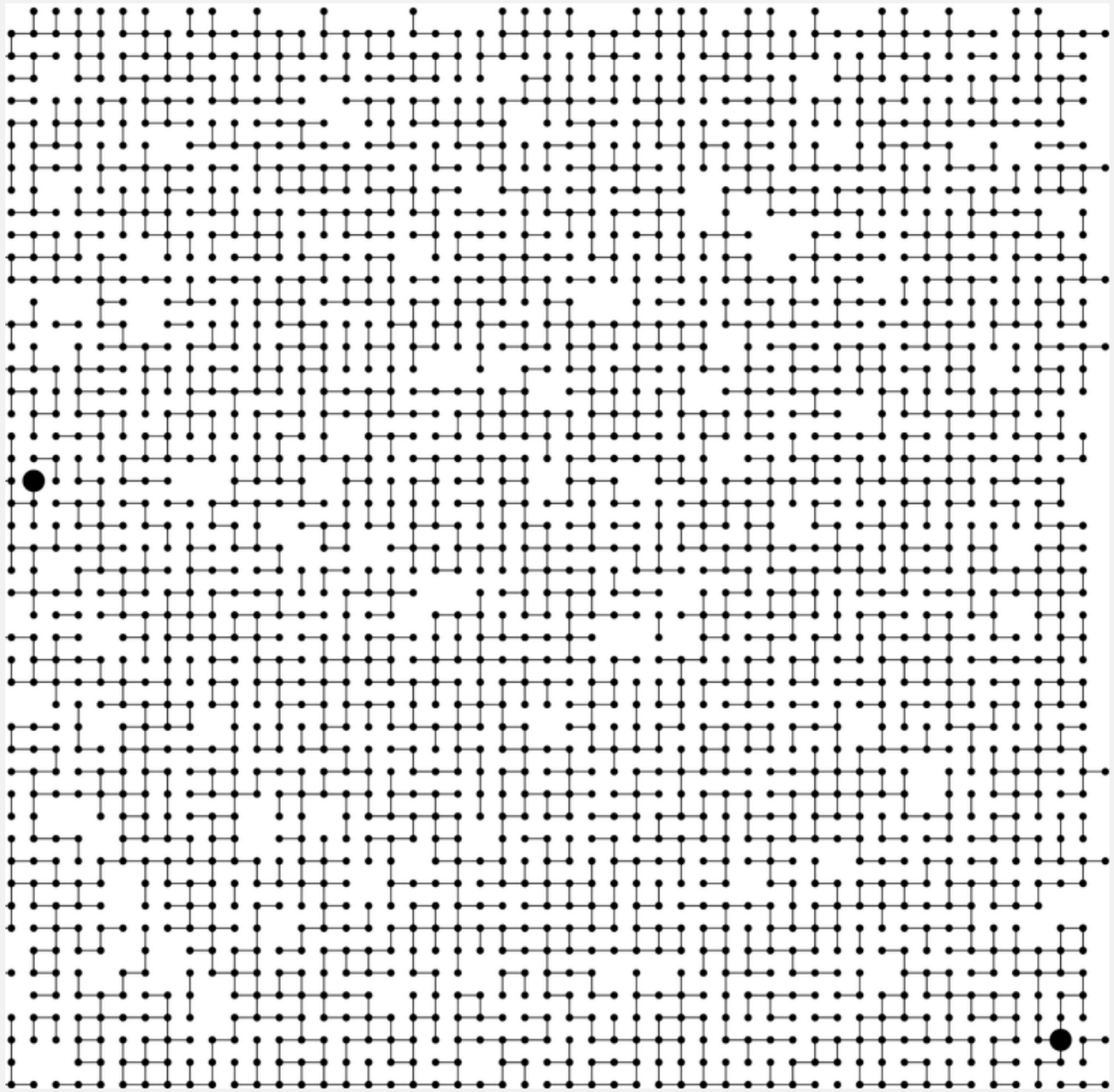
- Study of algorithms dates at least to Euclid.
- Formalized by Church and Turing in 1930s.
- Some important algorithms were discovered by undergraduates in a course like this!



Why study algorithms?

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

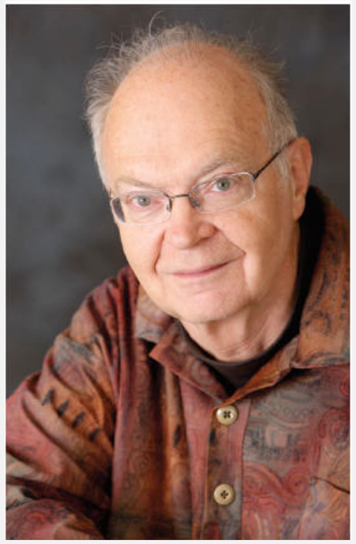

FROM THE EDITORS

THE JOY OF ALGORITHMS

Francis Sullivan, Associate Editor-in-Chief

THE THEME OF THIS FIRST-OF-THE-CENTURY ISSUE OF COMPUTING IN SCIENCE & ENGINEERING IS ALGORITHMS. IN FACT, WE WERE BOLD ENOUGH—AND PERHAPS FOOLISH ENOUGH—TO CALL THE 10 EXAMPLES WE'VE SELECTED "THE TOP 10 ALGORITHMS OF THE CENTURY."

> " *An algorithm must be seen to be believed.* " — Donald Knuth

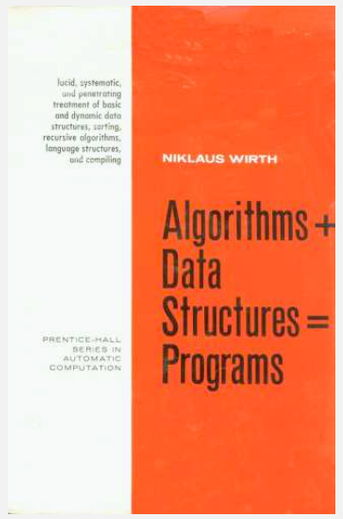


Why study algorithms?

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?

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

Computational models are replacing math models in scientific inquiry.

$$E = mc^2$$

$$F = ma$$

$$F = \frac{Gm_1m_2}{r^2}$$

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

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.

Google

Apple Computer

facebook

Cisco Systems

IBM

Nintendo

Jane Street

Morgan Stanley

NETFLIX

Adobe

RSA Security

D E Shaw & Co

ORACLE

Pandora

Akamai

YAHOO!

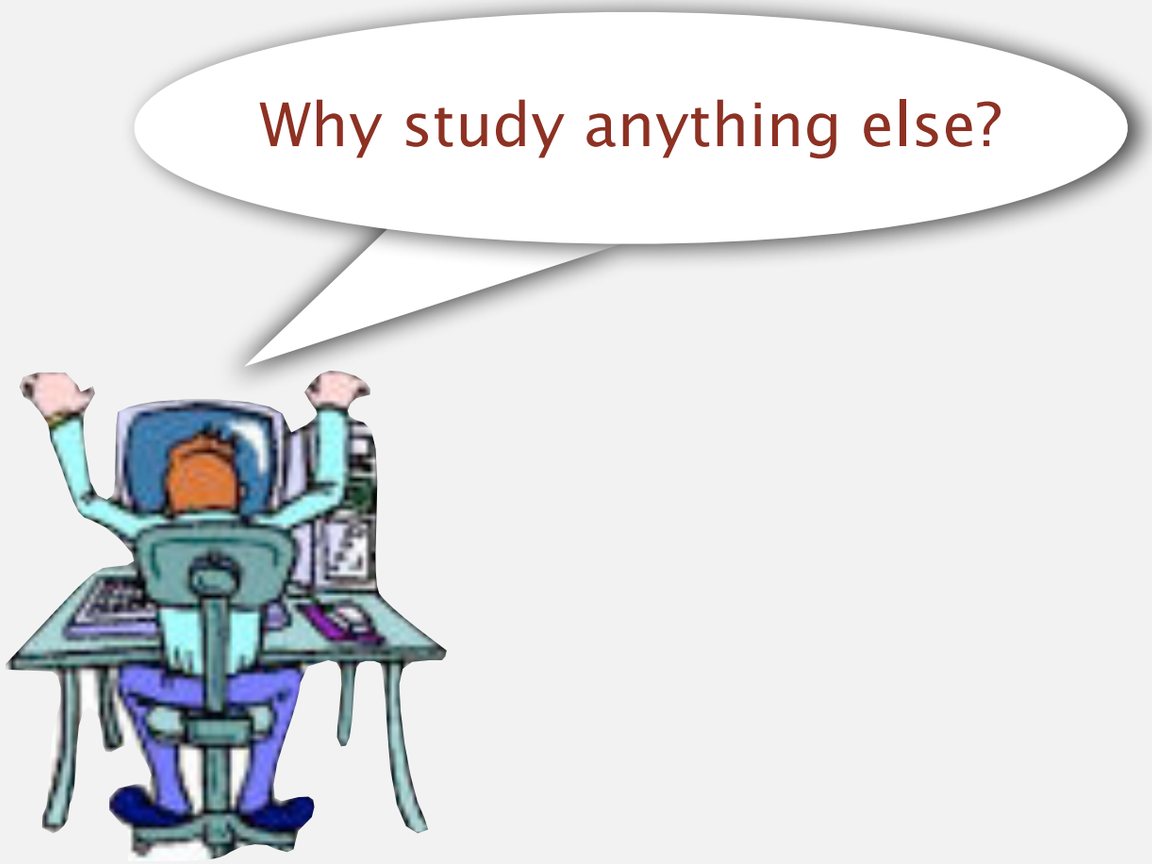
amazon.com

Microsoft

PIXAR Animation Studios

Why study algorithms?

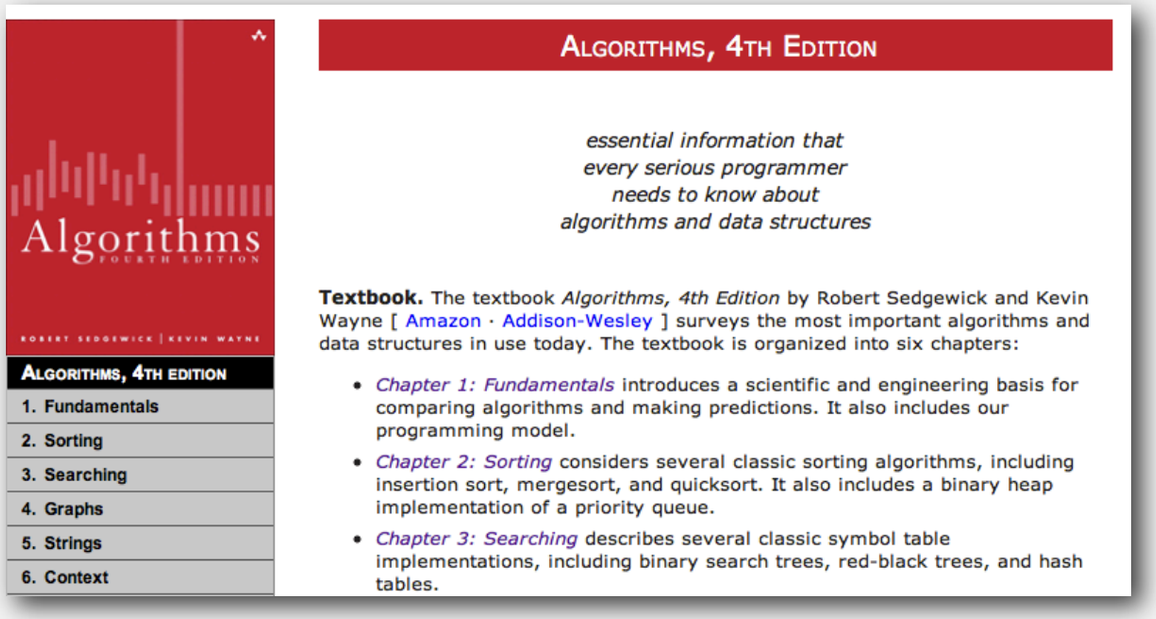
- Their impact is broad and far-reaching.
- Old roots, new opportunities.
- To solve problems that could not otherwise be addressed.
- For intellectual stimulation.
- To become a proficient programmer.
- They may unlock the secrets of life and of the universe.
- For fun and profit.



Resources

Booksite.

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



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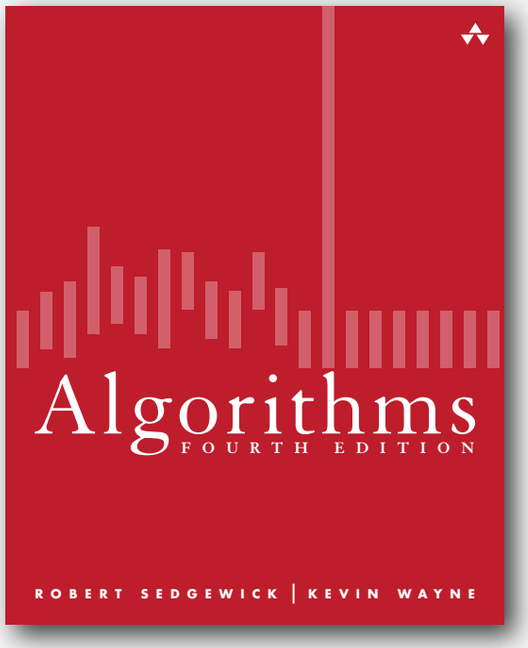
Textbook (optional).

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



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Prerequisites

Prerequisites.

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

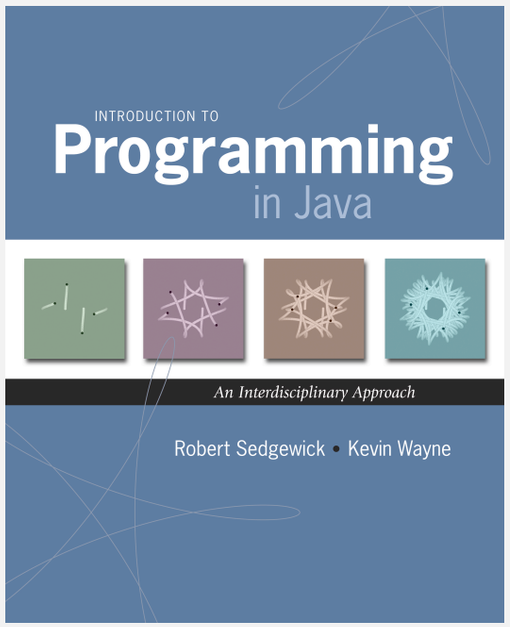
Review of prerequisite material.

- Quick: Sections 1.1 and 1.2 of *Algorithms, 4th 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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