

BBM 202 - ALGORITHMS



HACETTEPE UNIVERSITY

DEPT. OF COMPUTER ENGINEERING

INTRODUCTION

Acknowledgement: The course slides are adapted from the slides prepared by R. Sedgewick and K. Wayne of Princeton University.

INTRODUCTION

- ▶ **Introduction**
- ▶ Why study algorithms?
- ▶ Coursework
- ▶ Resources
- ▶ Outline

Instructor and Course Schedule

- Section I- Erkut ERDEM
- erkut@cs.hacettepe.edu.tr
- Section II- Adnan Ozsoy
- adnan.ozsoy@hacettepe.edu.tr
- Section III- Suat Ozdemir
- ozdemir@cs.hacettepe.edu.tr
- Lectures: Wednesday, 13:00-15:50 @D8,D9,D10
- Practicum (BBM204): Wednesday, 16:00-18:00@Zoom

Instructor and Course Schedule

- Teaching Assistants
 - Alperen Çakın alperencakin@cs.hacettepe.edu.tr
 - Selma Dilek selma@cs.hacettepe.edu.tr
- Student Assistants
 - Desmin Alpaslan b21945795@cs.hacettepe.edu.tr
 - Kaan Tuncer b21946644@cs.hacettepe.edu.tr
 - Vedat Baday b21945867@cs.hacettepe.edu.tr
- Wednesday, 16:00-18:00@Zoom

About BBM202

- This course concerns programming and problem solving, with applications.
- The aim is to teach student how to develop algorithms in order to solve the complex problems in the most efficient way.
- The students are expected to develop a foundational understanding and knowledge of key concepts that underly important algorithms in use on computers today.
- (Tentative) Grading based on
 - Midterm exam 35%
 - Final exam 40%
 - Quizzes (5 out of 6) 25%

About BBM204

- The students are also be expected to gain hand-on experience via a set of programming assignments supplied in the complementary BBM 204 Software Practicum.
- (Tentative) Grading for BBM204 will be based on
 - 4 programming assignments (done individually - 25% each)

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, ...

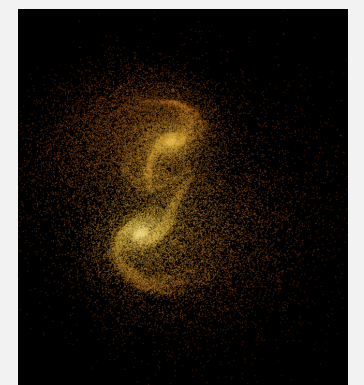
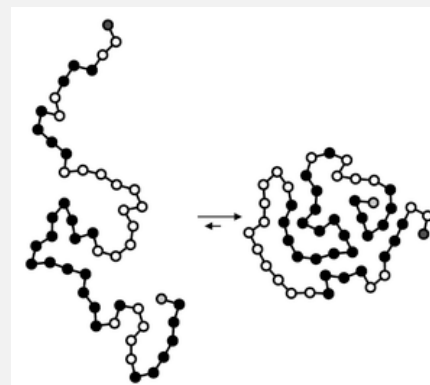
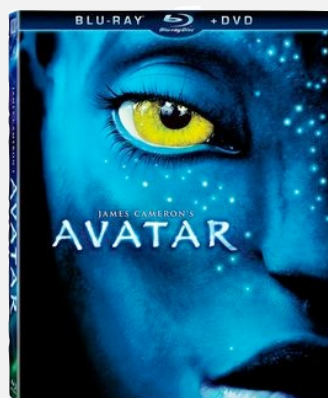
Security. Cell phones, e-commerce, voting machines, ...

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

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

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

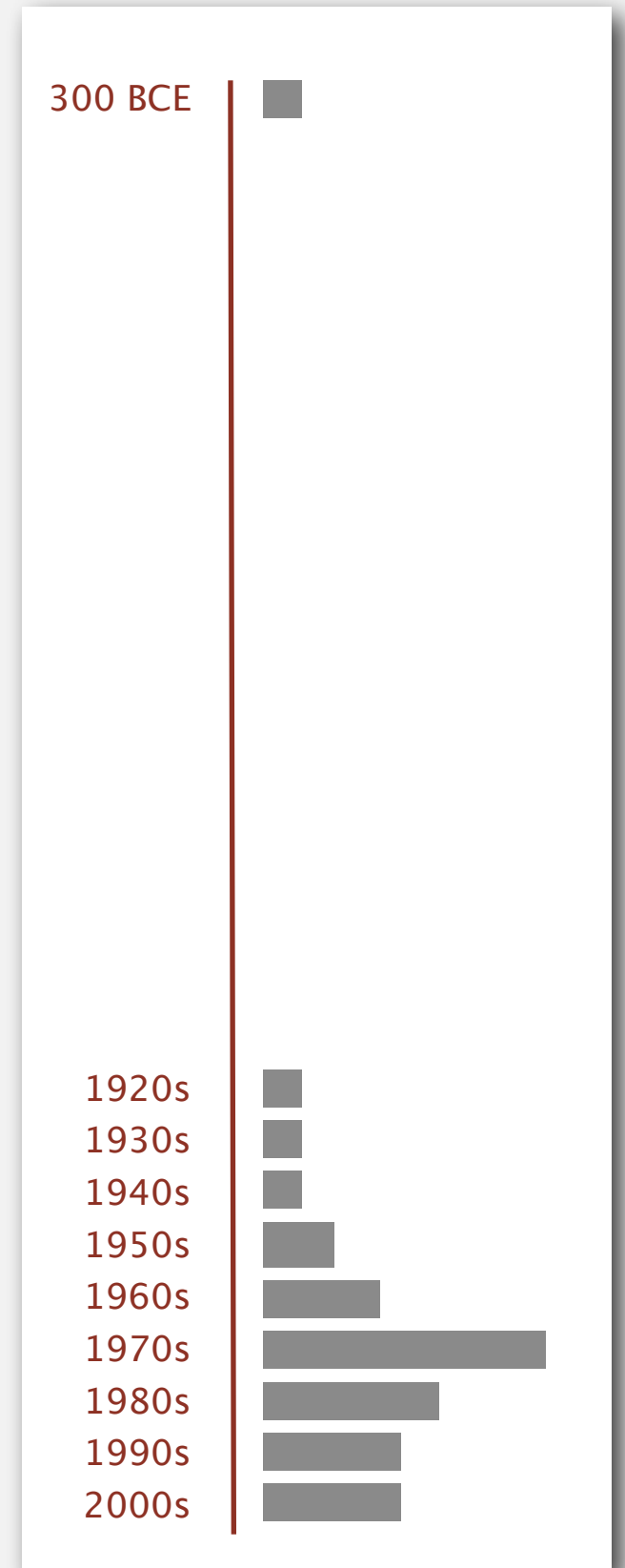
⋮



Why study algorithms?

Old roots, new opportunities.

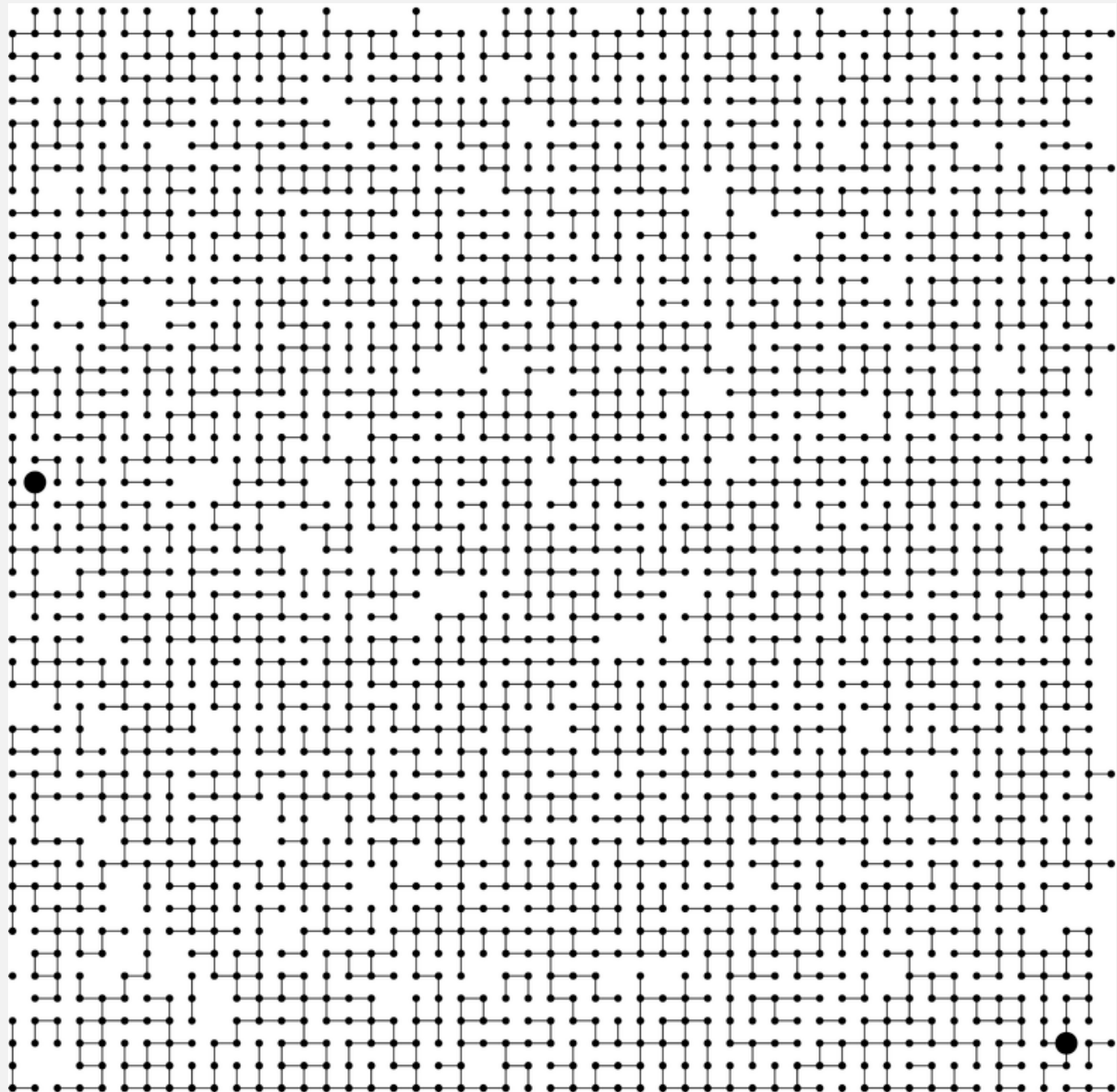
- Study of algorithms dates at least to Euclid.
- Formalized by Church and Turing in 1930s.
- Some important algorithms were discovered by undergraduates in a course like this!



Why study algorithms?

To solve problems that could not otherwise be addressed.

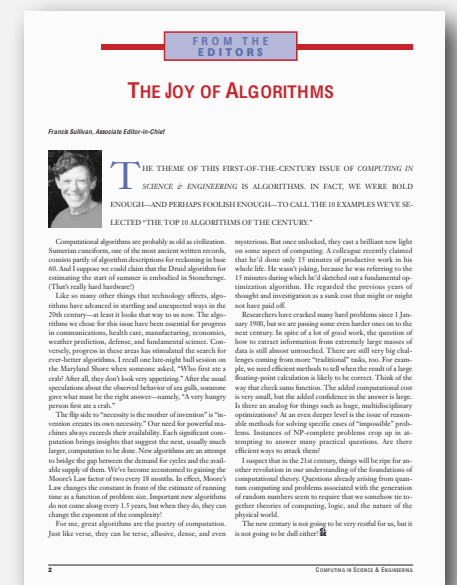
Ex. Network connectivity.



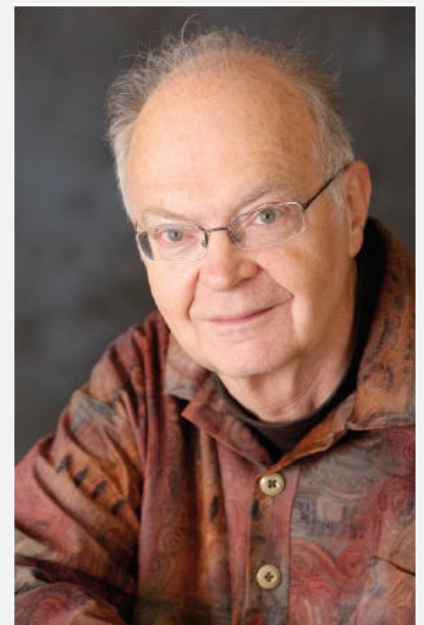
Why study algorithms?

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



“ It has often been said that a person does not really understand something until he teaches it to someone else. Actually a person does not really understand something until he can teach it to a computer, i.e. express it as an algorithm The attempt to formalise things as algorithms lead to a much deeper understanding than if we simply try to comprehend things in the traditional way. algorithm must be seen to be believed. ” — Donald Knuth



Why study algorithms?

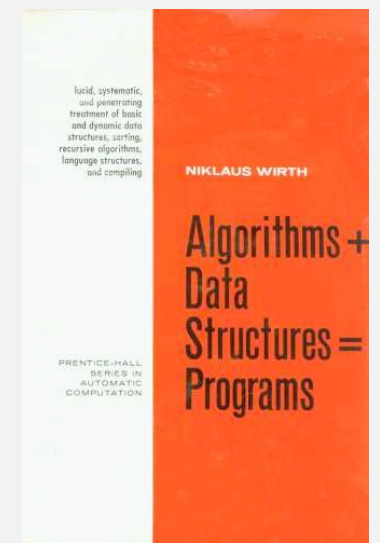
To become a proficient programmer.

“ 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 mathematical models in scientific inquiry.

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

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.

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 dark blue rectangle containing a white bar chart.The Nintendo logo, with the word "Nintendo" in white inside a red rounded rectangle.The Jane Street logo, featuring a stylized yellow circular pattern on the left and the words "JANE STREET" in yellow on a dark blue background.The IBM logo, consisting of the letters "IBM" in a blue, horizontally-striped font.The Morgan Stanley logo, with the words "Morgan Stanley" in white on a dark blue rectangular background.The Netflix logo, with the word "NETFLIX" in white, bold, sans-serif capital letters on a red background.The Adobe logo, featuring a stylized red "A" with a white triangle inside, followed by the word "Adobe" in black.The RSA Security logo, with the letters "RSA" in white on a red square background, and the word "SECURITY" in black below it.The DE Shaw & Co logo, featuring the words "DE Shaw & Co" in blue, with a green line graph element above the text.The Oracle logo, with the word "ORACLE" in red, outlined, sans-serif capital letters.The Akamai logo, with a stylized blue wave icon on the left and the word "Akamai" in yellow on the right.The Yahoo! logo, with the word "YAHOO!" in red, bold, sans-serif capital letters.The Amazon.com logo, with the text "amazon.com" in black, featuring a yellow curved arrow underneath the word "amazon".The Microsoft logo, with the word "Microsoft" in a bold, black, sans-serif font.The Pixar Animation Studios logo, featuring the word "PIXAR" in large letters with a small character holding a lightbulb in the "I", and "ANIMATION STUDIOS" in smaller letters below.

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.

Why study anything else?



Communication

- The course webpage <http://web.cs.hacettepe.edu.tr/~bbm202>
- Piazza for discussions and questions. Also it will be updated regularly throughout the semester with lecture notes, programming assignments and important deadlines.

<https://piazza.com/hacettepe.edu.tr/spring2022/bbm202>

<https://piazza.com/hacettepe.edu.tr/spring2022/bbm204>

Getting help

- Office Hours
- BBM204 Software Practicum
 - Course related recitations, practice with algorithms, etc.
- Communication
 - Announcements and course related discussions
 - through piazza : <https://piazza.com/hacettepe.edu.tr/spring2022/bbm204>



Coursework and grading (Tentative)

Class participation/Attendance

- Contribute to Piazza discussions.
- Attend and participate in lecture.

Midterm exam 35%

- Scheduled for week 9

Final exam 40%

- Scheduled by Registrar.

Quizzes 25%

- Theoretical and practical aspects
- Top 5 grades out of 6 will be considered

Attendance Policy

- Attendance to lectures is mandatory.
- A student who do not attend the lectures more than 4 weeks will fail BBM202 directly with an FI grade.
- A student will fail BBM204 directly with an FI grade if he/she does not submit more than two assignments

Programming assignments (PAs)

- Four assignments throughout the semester.
- Each assignment has a well-defined goal such as solving a specific problem.
- You must work alone on all assignments stated unless otherwise.
- Unless stated otherwise 2 weeks to work on each assignment

Important Dates

- Programming Assignment 1 23 February
- Programming Assignment 2 16 March
- Programming Assignment 3 6 April
- Programming Assignment 4 27 April

Cheating

What is cheating?

- Sharing code: by copying, retyping, looking at, or supplying a file
- Coaching: helping your friend to write a programming assignment, line by line
- Copying code from previous course or from elsewhere on WWW

What is NOT cheating?

- Explaining how to use systems or tools
- Helping others with high-level design issues

Penalty for cheating:

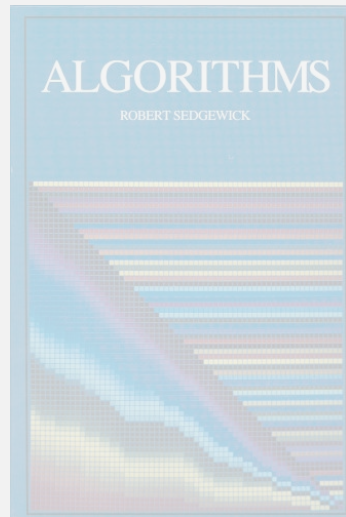
- A violation of academic integrity, disciplinary action

Detection of cheating:

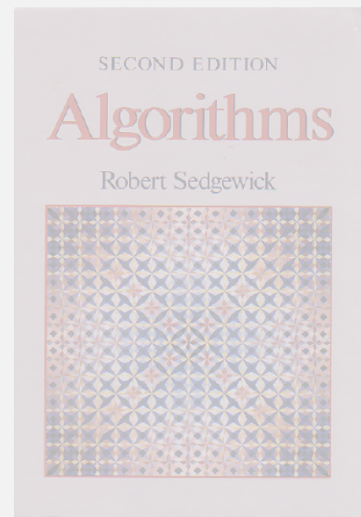
- We do check
- Our tools for doing this are much better than most cheaters think!

Resources (textbook)

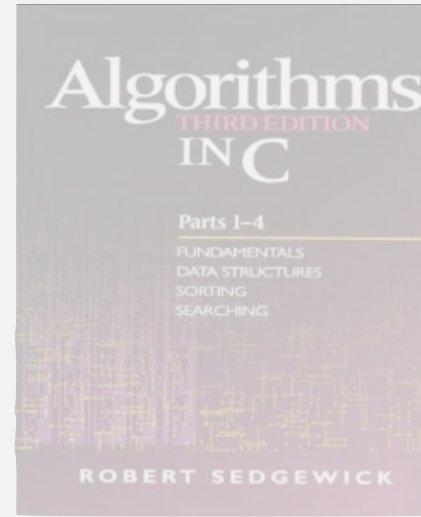
Required reading. Algorithms 4th edition by R. Sedgwick and K. Wayne, Addison-Wesley Professional, 2011, ISBN 0-321-57351-X.



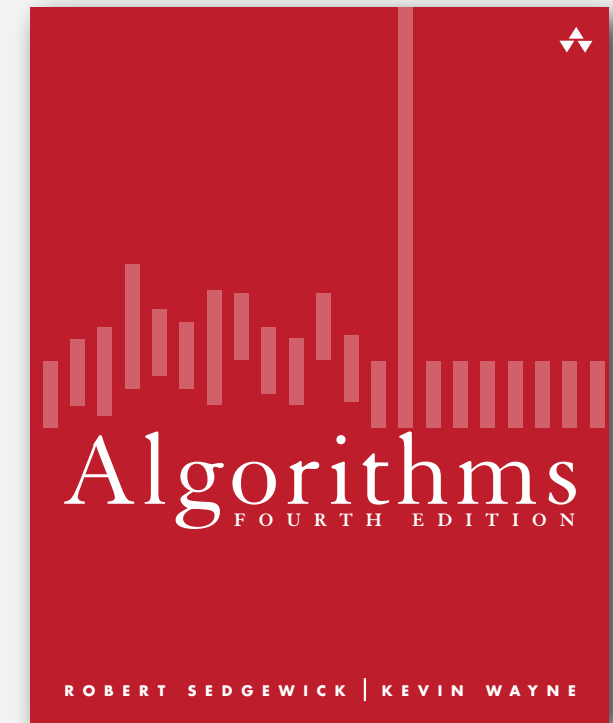
1st edition (1982)



2nd edition (1988)

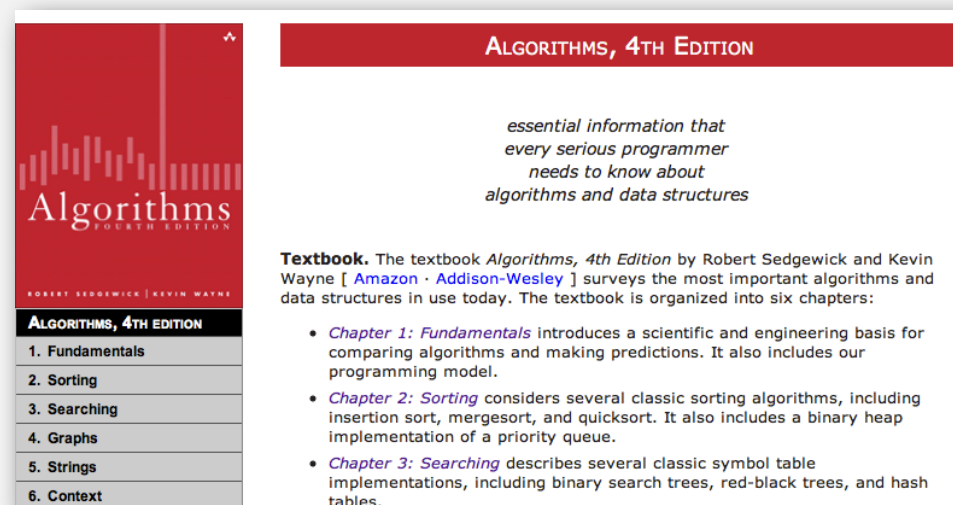


3rd edition (1997)



Booksite.

- Brief summary of content.
- Download code from book.



<https://algs4.cs.princeton.edu/home/>

Course outline

Introduction

Analysis of Algorithms

- Computational Complexity
- Decidability

Sorting

- Elementary Sorting Algorithms,
- Mergesort,
- Quicksort,
- Priority Queues and HeapSort

Searching

- Sequential Search
- Binary Search Trees
- Balanced Trees
- Hashing,
- Search Applications

Course outline

Algorithm Design Techniques

- Dynamic Programming
- Greedy Programming

Graphs

- Undirected Graphs,
- Directed Graphs,
- Minimum Spanning Trees,
- Shortest Path

Strings

- String Sorts, Tries,
- Substring Search,
- Regular Expressions,
- Data Compression

Reductions & Intractability