

# 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](mailto:erkut@cs.hacettepe.edu.tr)
- Section II- Engin Demir
- [engindemir@cs.hacettepe.edu.tr](mailto:engindemir@cs.hacettepe.edu.tr)
- Lectures: Tuesday, 13:00-15:50 @Zoom
- Practicum (BBM204):  
Wednesday, 16:00-17:50@Zoom
- Exams: @Gradescope

# Instructor and Course Schedule

- Teaching Assistants
  - Nebi Yılmaz [yilmaz@cs.hacettepe.edu.tr](mailto:yilmaz@cs.hacettepe.edu.tr)
  - Alperen Çakın [alperencakin@cs.hacettepe.edu.tr](mailto:alperencakin@cs.hacettepe.edu.tr)
- Wednesday, 16:00-15:50@Zoom
- Programming Assignments: @Codepost
- Quizzes: @Gradescope & @Codepost

# 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.
- Grading based on
  - Midterm exam 30%
  - Final exam 40%
  - Quizzes (5 out of 6) 30%

# 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.
- Grading for BBM204 will be based on
  - Participation 4%
  - 4 programming assignments (done individually) 96%

# 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, ...

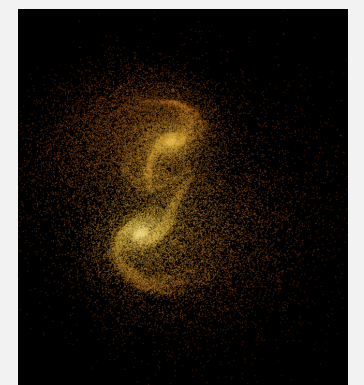
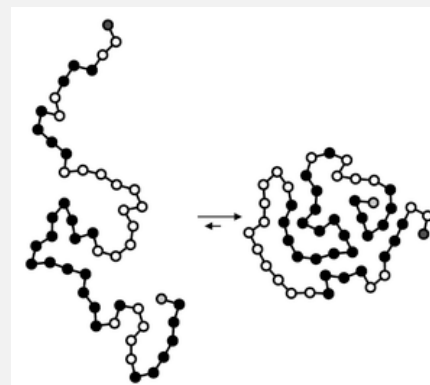
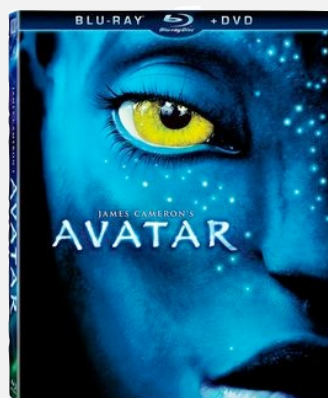
**Security.** Cell phones, e-commerce, voting machines, ...

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

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

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

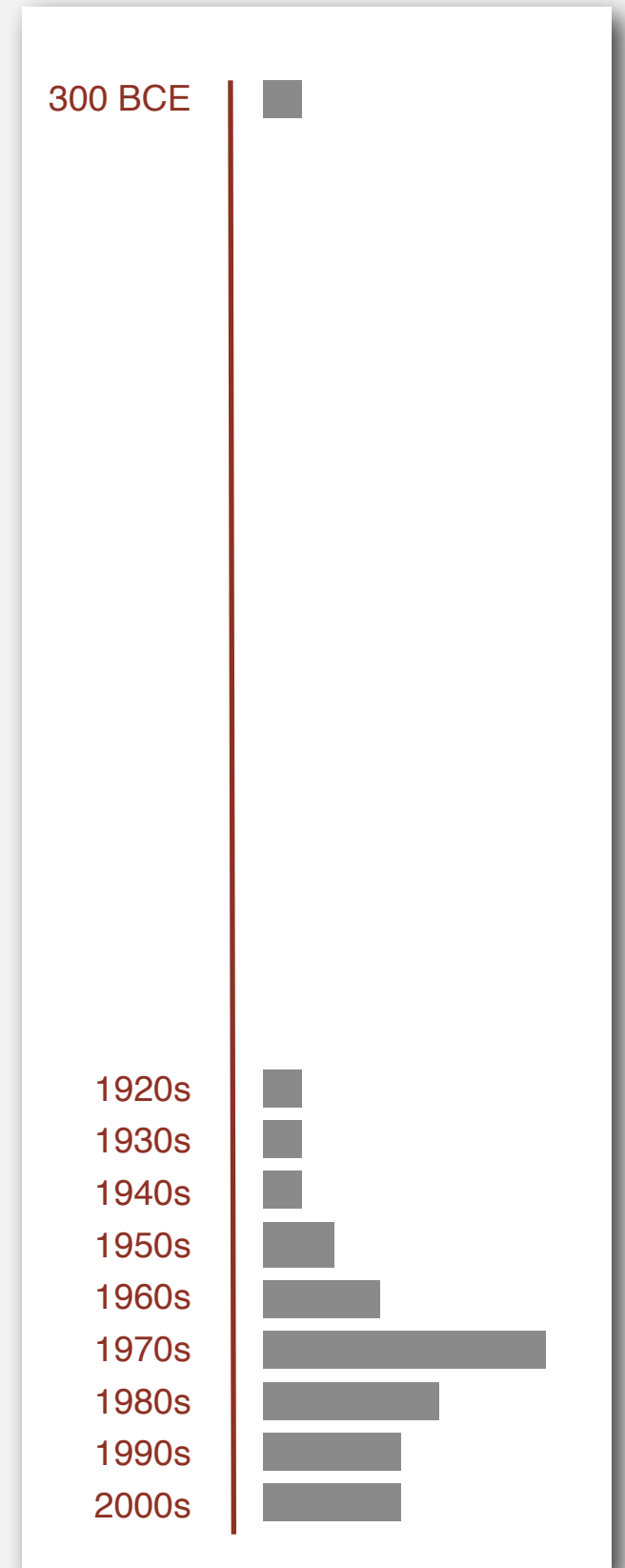
⋮



# 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!

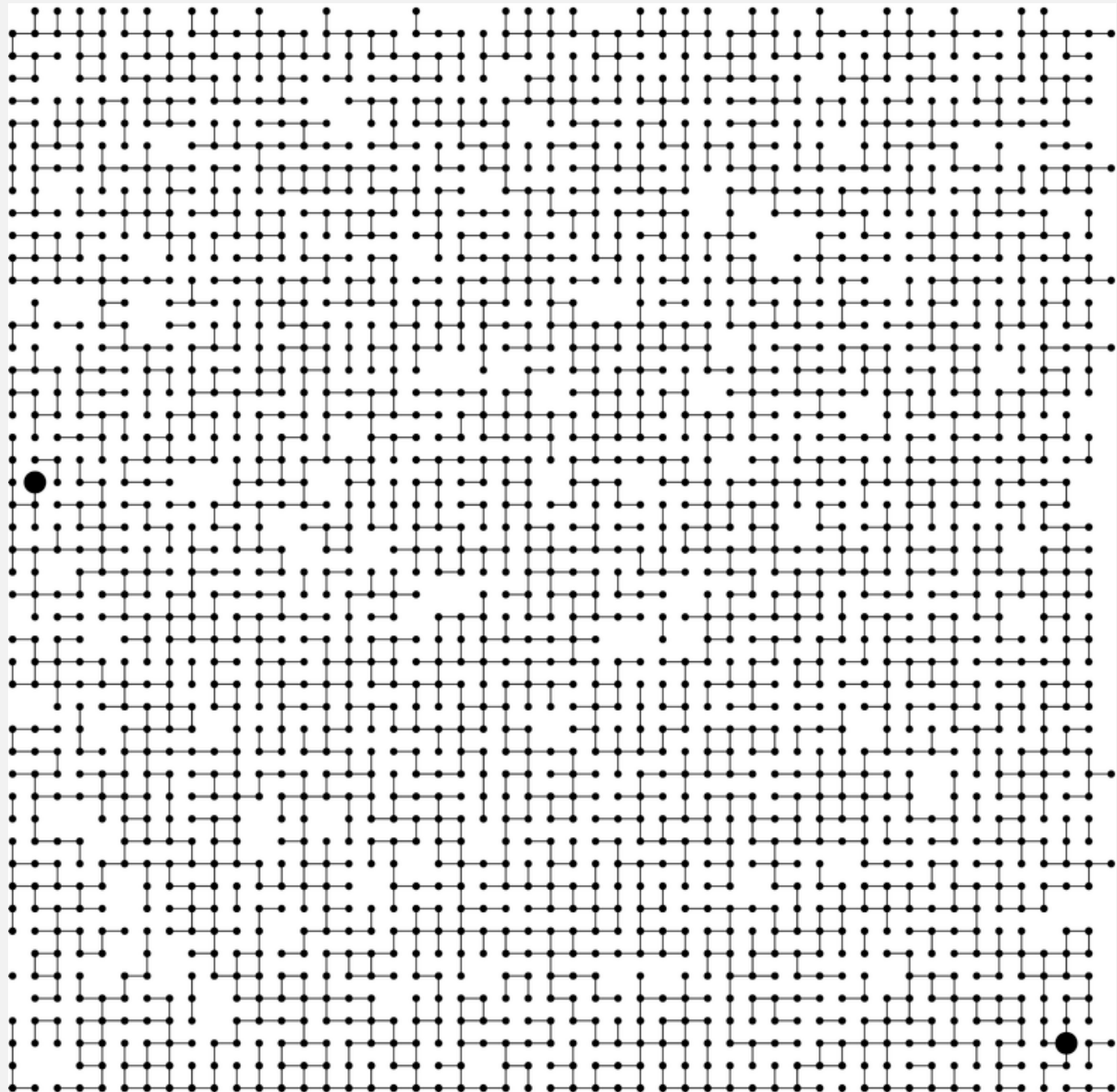




# Why study algorithms?

To solve problems that could not otherwise be addressed.

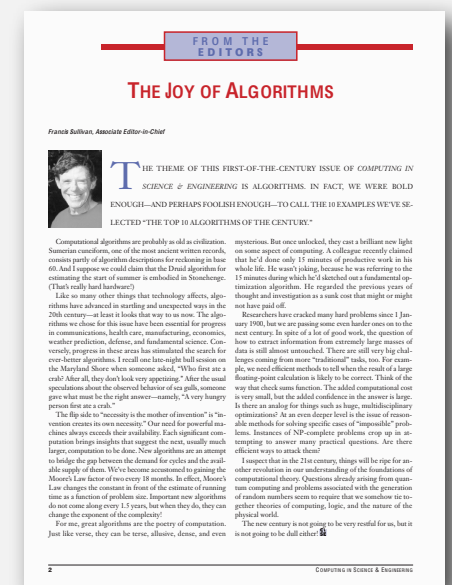
Ex. Network connectivity.



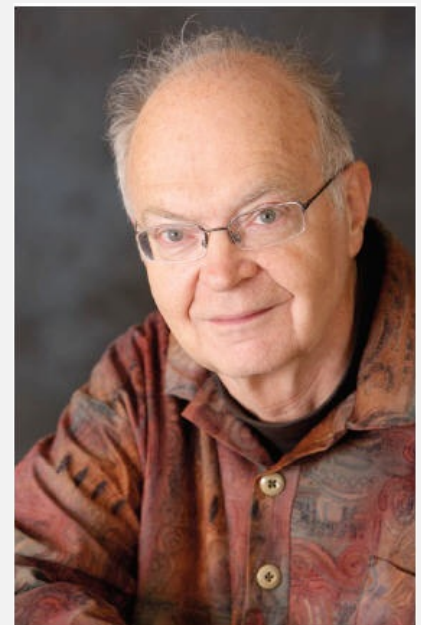
# Why study algorithms?

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.

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

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 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 company name in blue serif font with a green line graphic above it.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 a white background.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/spring2021/bbm202>

<https://piazza.com/hacettepe.edu.tr/spring2021/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/spring2021/bbm204>





# Coursework and grading

## Class participation/Attendance

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

## Midterm exam 30%

- Scheduled for week 9 (will be in class hours)

## Final exam 40%

- Scheduled by Registrar.

## Quizzes 30%

- 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    3 March
- Programming Assignment 2    31 March
- Programming Assignment 3    21 April
- Programming Assignment 4    12 May

# 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:

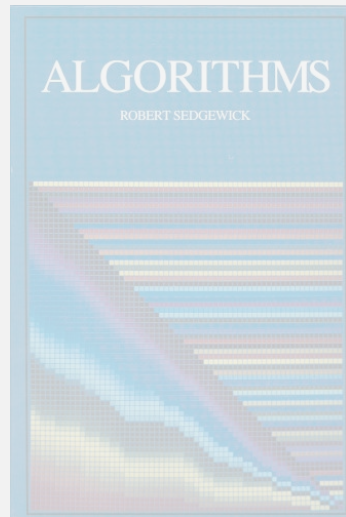
- A violation of academic integrity, disciplinary action

## Detection of cheating:

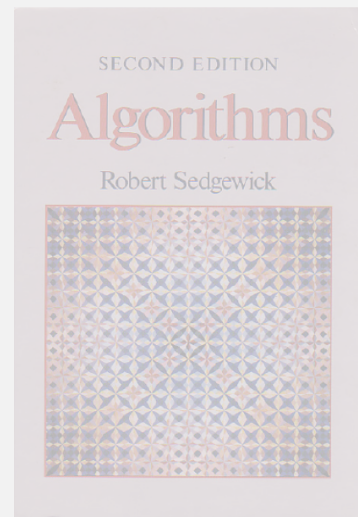
- We do check
- Our tools for doing this are much better than most cheaters think!

# Resources (textbook)

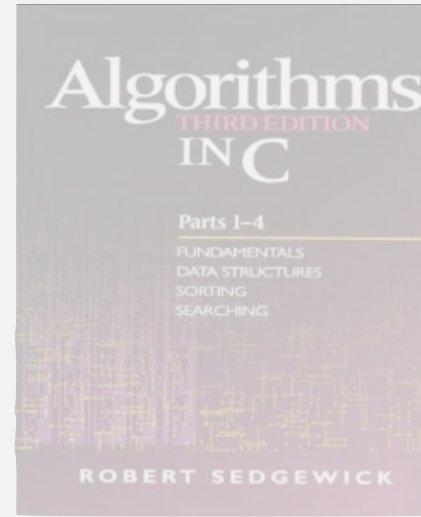
**Required reading.** Algorithms 4<sup>th</sup> edition by R. Sedgewick and K. Wayne, Addison-Wesley Professional, 2011, ISBN 0-321-57351-X.



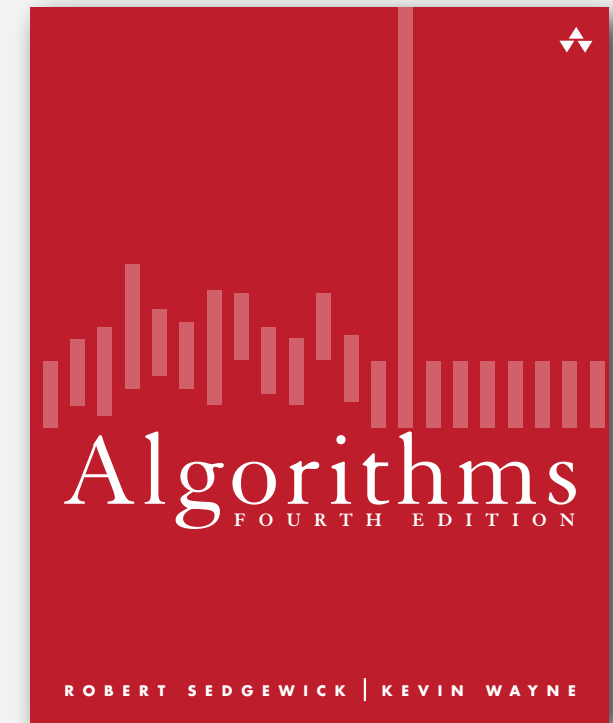
1<sup>st</sup> edition (1982)



2<sup>nd</sup> edition (1988)



3<sup>rd</sup> edition (1997)



## Booksite.

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

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.

ALGORITHMS, 4TH EDITION
1. Fundamentals
2. Sorting
3. Searching
4. Graphs
5. Strings
6. Context

<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