

# BBM 202 - ALGORITHMS



**HACETTEPE UNIVERSITY**

**DEPT. OF COMPUTER ENGINEERING**

## **INTRODUCTION**

**Acknowledgement:** The course slides are adapted from the slides prepared by R. Sedgwick 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- Adnan Ozsoy
- [adnan.ozsoy@hacettepe.edu.tr](mailto:adnan.ozsoy@hacettepe.edu.tr)
  
- Section III- Suat Ozdemir
- [ozdemir@cs.hacettepe.edu.tr](mailto:ozdemir@cs.hacettepe.edu.tr)
  
- Lectures: Wednesday, 09:40-12:30@Zoom
- Practicum (BBM204): Thursday, 14:40-16:30@Zoom

# Instructor and Course Schedule

- Teaching Assistants
  - Ali Burak Erdogan [burakerdogan@cs.hacettepe.edu.tr](mailto:burakerdogan@cs.hacettepe.edu.tr)
  - Alperen Çakın [alperencakin@cs.hacettepe.edu.tr](mailto:alperencakin@cs.hacettepe.edu.tr)
  - Selma Dilek [selma@cs.hacettepe.edu.tr](mailto:selma@cs.hacettepe.edu.tr)
- Student Assistants
  - Mehmet Berat Ersari [b21992943@cs.hacettepe.edu.tr](mailto:b21992943@cs.hacettepe.edu.tr)
  - Mohamed Hedi Elfkir [b21903585@cs.hacettepe.edu.tr](mailto:b21903585@cs.hacettepe.edu.tr)
  - Sura Nur Erturkmen [b21946127@cs.hacettepe.edu.tr](mailto:b21946127@cs.hacettepe.edu.tr)
- Thursday, 14:40-16:40@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.
- Grading will be based on
  - Midterm exam 35%,
  - Final exam 40%,
  - Six quizzes 25% (the lowest 1 quiz grade will be dropped).

# 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
  - 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, ...

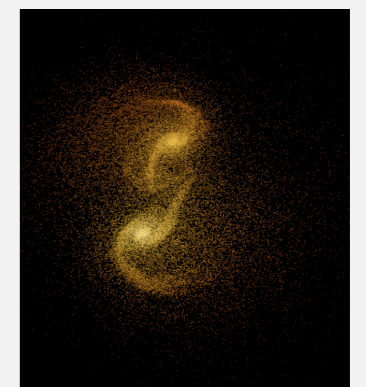
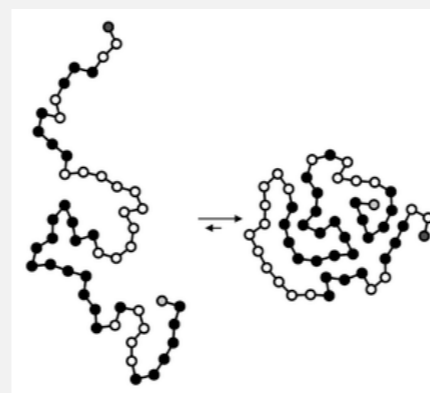
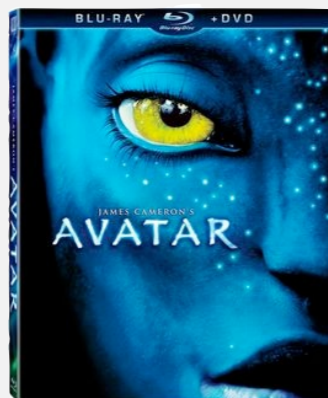
**Multimedia.** MP3, JPG, DivX, HDTV, face recognition, ...

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

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

⋮

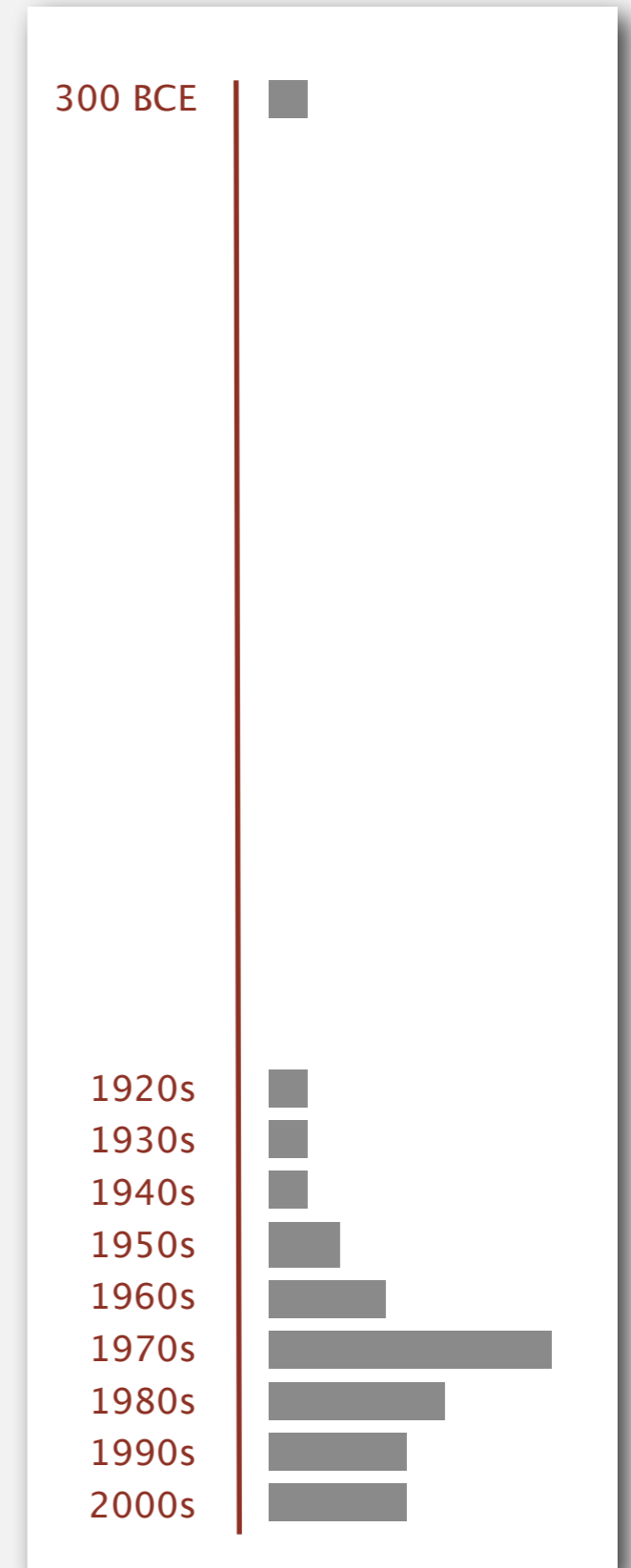
Google  
YAHOO!  
bing



# 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.

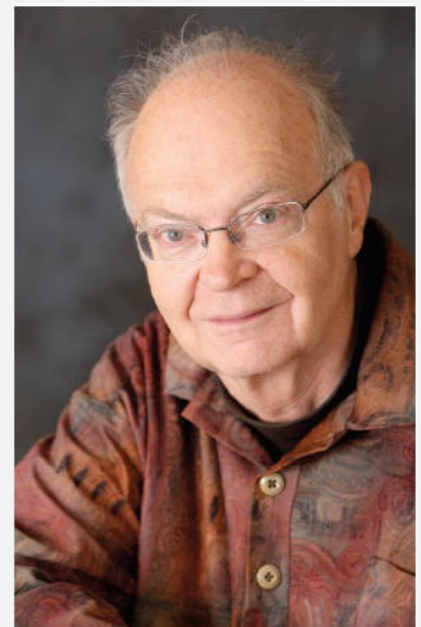
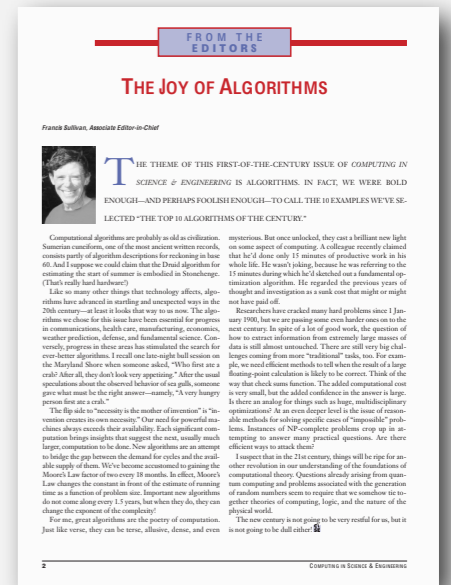


# Why study algorithms?

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?

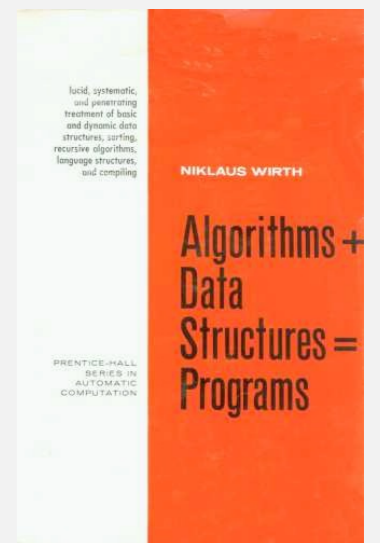
To become a proficient programmer.

*“ 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.

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

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)

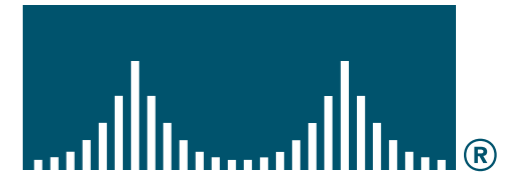
*“ Algorithms: a common language for nature, human, and computer. ” — Avi Wigderson*

# Why study algorithms?

For fun and profit.



Apple Computer



# Why study algorithms?

- 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 not mandatory but suggested.
- A student will fail BBM204 directly with an F I grade if he/she does not submit more than two assignments

# BBM204 Software Practicum

## 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    16 March
- Programming Assignment 2    5 April
- Programming Assignment 3    26 April
- Programming Assignment 4    17 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:

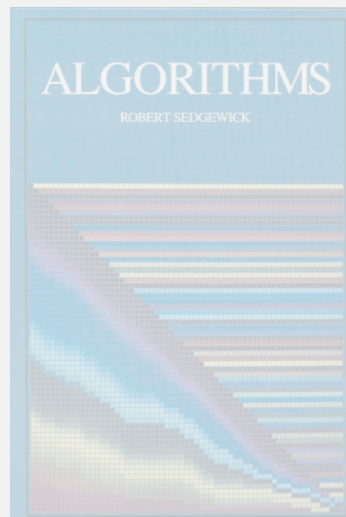
- A violation of academic integrity, disciplinary action

## Detection of cheating:

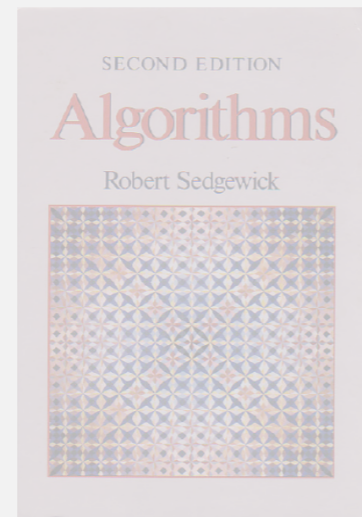
- We do check
- Our tools for doing this are much better than most cheaters think!

# Resources (textbook)

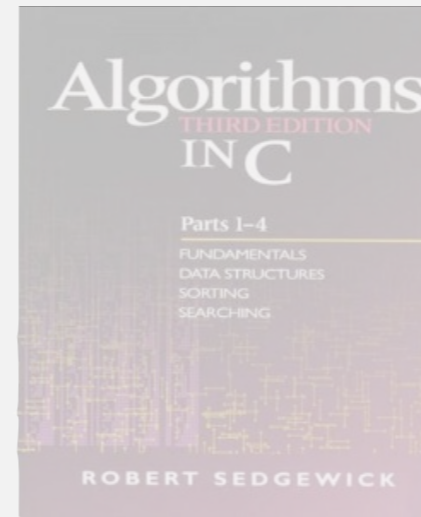
Required reading. Algorithms 4<sup>th</sup> edition by R. Sedgwick and K. Wayne, Addison-Wesley Professional, 2011, ISBN 0-321-57351-X.



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 Sedgwick 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

- 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