

CMPE 242, SPRING 2021

DATA STRUCTURES AND ALGORITHMS

CMPE 242 course overview

What is CMPE 242?

- 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
sorting	quicksort, mergesort, heapsort, radix sorts
searching	BST, red-black BST, hash table
graphs	BFS, DFS, Prim, Kruskal, Dijkstra
strings	KMP, regular expressions, tries, data compression
advanced	B-tree, k-d 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, ...

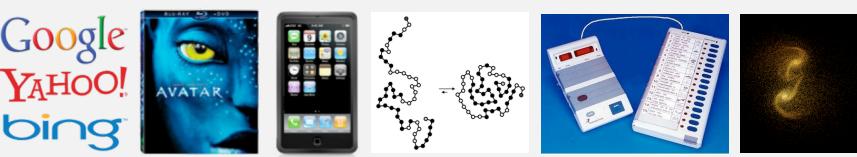
Security. Cell phones, e-commerce, voting machines, ...

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

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

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

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3

Why study algorithms?

Their impact is broad and far-reaching.

Mysterious algorithm was 4% of trading activity last week

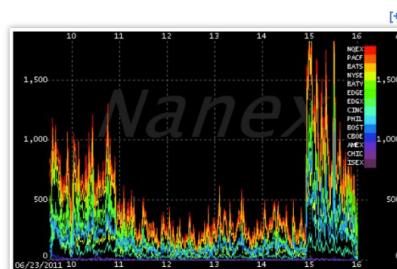
October 11, 2012

A single mysterious computer program that placed orders — and then subsequently canceled them — made up 4 percent of all quote traffic in the U.S. stock market last week, according to the top tracker of [high-frequency trading activity](#).

The motive of the algorithm is still unclear, [CNBC](#) reports.

The program placed orders in 25-millisecond bursts involving about 500 stocks, according to Nanex, a market data firm. The algorithm never executed a single trade, and it abruptly ended at about 10:30 a.m. ET Friday.

"My guess is that the algo was testing the market, as high-frequency frequently does," says Jon Najarian, co-founder of TradeMonster.com. "As soon as they add bandwidth, the HFT crowd sees how quickly they can top out to create latency." ([Read More: Unclear What Caused Kraft Spike: Nanex Founder.](#))



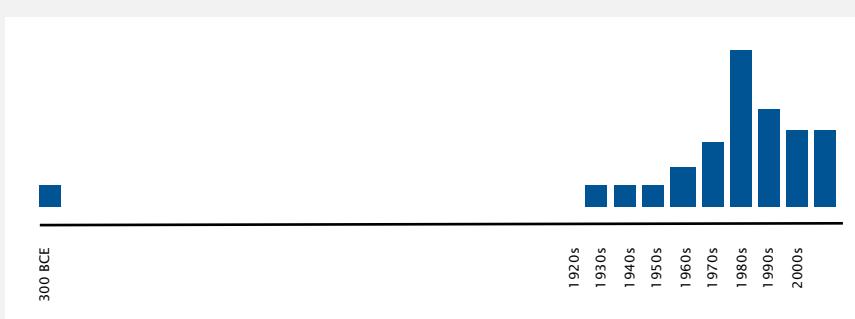
Generic high frequency trading chart (credit: Nanex)

4

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!



5

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



6

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



7

Why study algorithms?

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

Scientists are replacing mathematical models with computational models.

$$E = mc^2$$

$$F = ma$$

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

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

```
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]);
    }
```

20th century science
(formula based)

21st century science
(algorithm based)

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



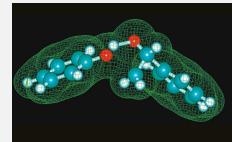
8

Why study algorithms?

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

“ Computer models mirroring real life have become crucial for most advances made in chemistry today.... Today the computer is just as important a tool for chemists as the test tube. ”

— Royal Swedish Academy of Sciences
(Nobel Prize in Chemistry 2013)

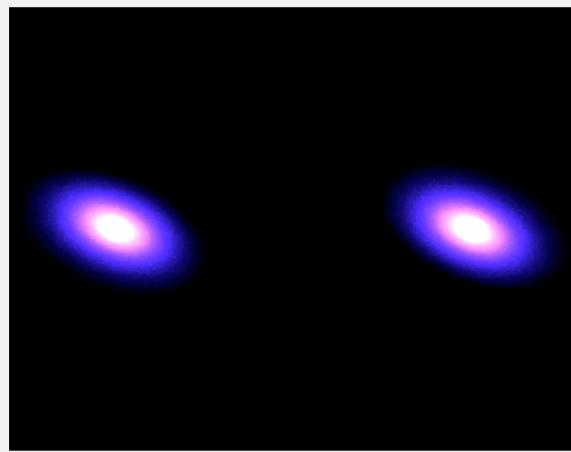


Martin Karplus, Michael Levitt, and Arieh Warshel

9

Why study algorithms?

To solve problems that could not otherwise be addressed.



http://www.youtube.com/watch?v=ua7YIN4eL_w

10

Why study algorithms?

For fun and profit.

11

Why study algorithms?

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

Why study anything else?

12

Lectures

Traditional lectures. Introduce new material.

Electronic devices. Permitted, but only to enhance lecture.



no

no

no

What	When	Where	Who	Office Hours
Section 01		Zoom	Tolga Çapın	see Moodle
Section 02		Zoom	Tolga Çapın	see Moodle
Section 03		Zoom	Tolga Çapın	see Moodle
Section 04		Zoom	Ulaş Güleç	see Moodle
Section 05		Zoom	Ulaş Güleç	see Moodle

13

Lectures

Traditional lectures. Introduce new material.

Flipped lectures.

- Watch videos online **before** lecture.
- Link: <https://www.coursera.org/course/algs4partI>



14

Coursework and Grading

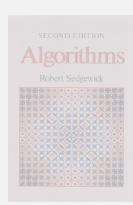
Please check the syllabus!

Resources (textbook)

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



1st edition (1982)



2nd edition (1988)



3rd edition (1997)



4th edition (2011)

3rd book scanned
by Google books

Available in hardcover at bookstore.

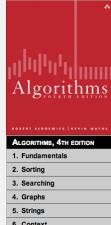
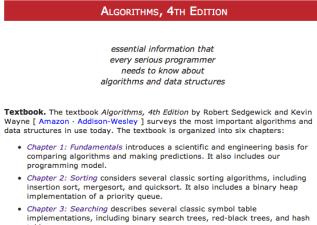
Resources (web)

Moodle

- Course info.
- Lecture slides.
- Programming assignments.
- Exercises.
- Exam study questions.

Booksites

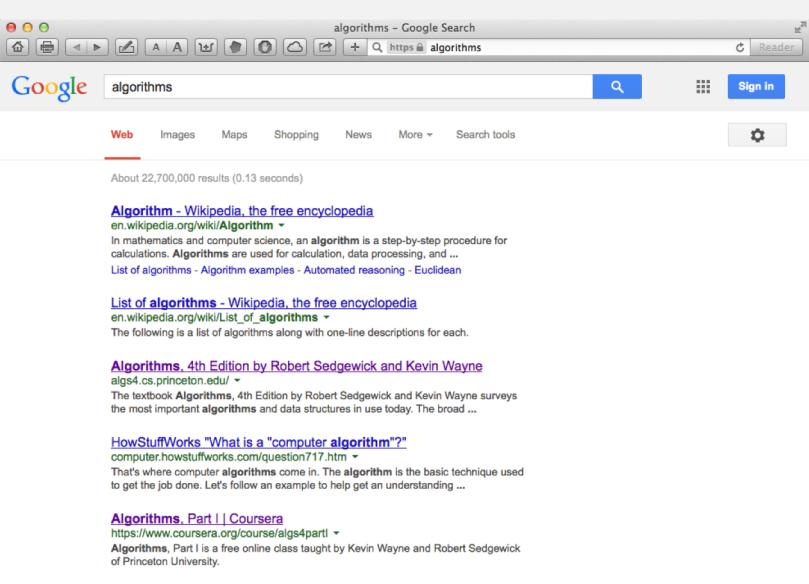
- Brief summary of content.
- Download code from book.
- APIs and Javadoc.

<http://algs4.cs.princeton.edu>

17

Resources (web)



18

Where to get help?

Course instructors

Office hours.

- High bandwidth, high latency.
- Knock door

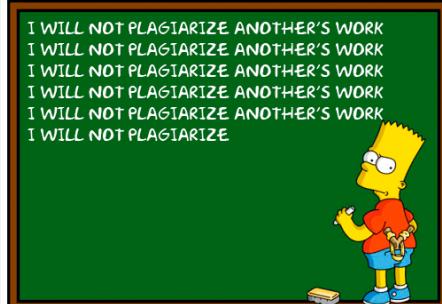


Teaching assistant.

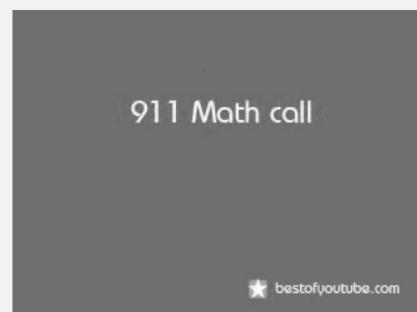
- TA: Hamid Ahmadlouei and ibrahim ileri
- For help with debugging.
- See Moodle for schedule.

19

Where not to get help?



<http://world.edu/academic-plagiarism>



<http://www.youtube.com/watch?v=FT4NOe4vt0M>

20

What's ahead?

Lecture 1. [this week] Abstract Data Types, Review of Java

Lecture 2. [next week] Stacks and Queues.



- ! Reading Assignment 1. Read SECTION 1.1 of the textbook.
- ! Programming Assignment 0, due Monday (not graded). **Install a Java Programming Environment; study code in <http://introcs.cs.princeton.edu/java/home/>, Sections 1.1 to 1.6.** You can ask me for help.
- ! Programming Assignment 1. [out in two weeks] (details later).