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CS141: Intermediate Data Structures and Algorithms

Introduction

Instructor: Amr Magdy
TAs: Mayur Patil and Tanmay Shah
Computer Science and Engineering

Welcome to CS 141

- **Instructor**: Amr Magdy
  Office: Tomas Rivera Library, 159B
  http://www.cs.ucr.edu/~amr/
  Email: amr@cs.ucr.edu
  (**Include [CS141] in the subject**)
  Office hours: MW: 2:00 - 4:00 PM
- **TAs**:
  - Mayur Patil Office hours: Tuesday: 9:00 – 11:00 AM
    Email: mpati005@ucr.edu Office: Chung Hall, room 110
  - Tanmay Shah Office hours: Tuesday: 2:00 – 3:00 PM
    Email: tshah015@ucr.edu Office: Chung Hall, room 110
    (**Include [CS141] in the subject**)
- Course Website: https://www.cs.ucr.edu/~amr/#teaching

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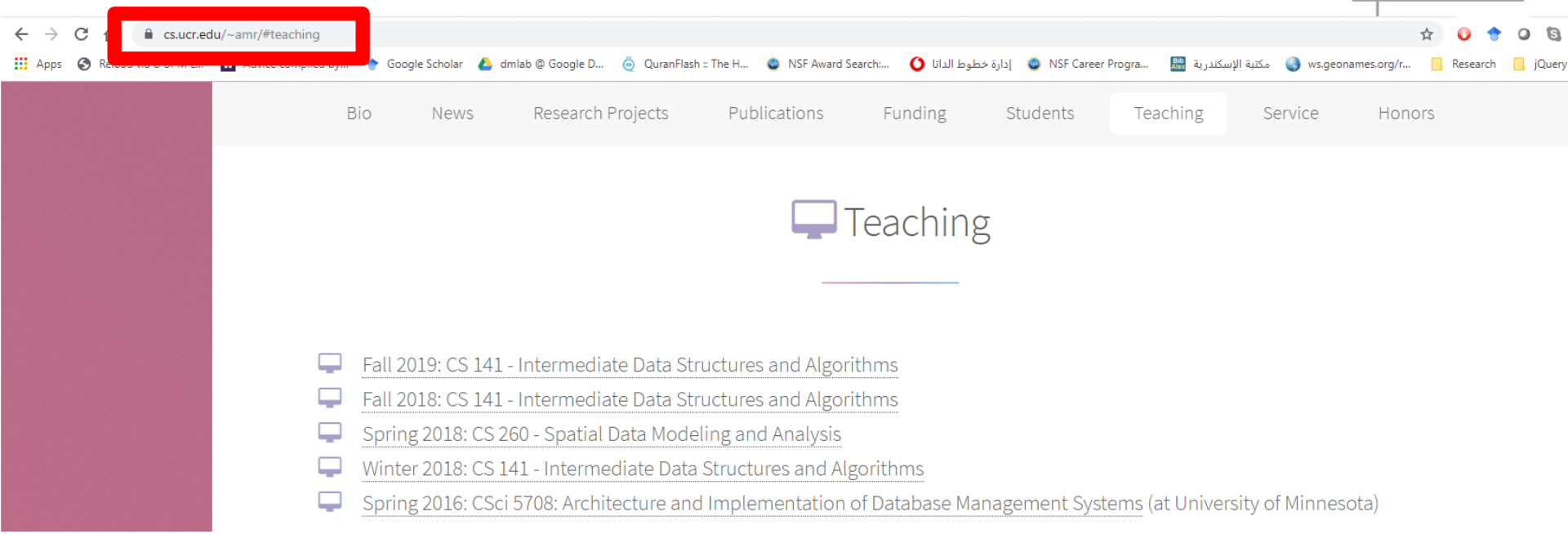

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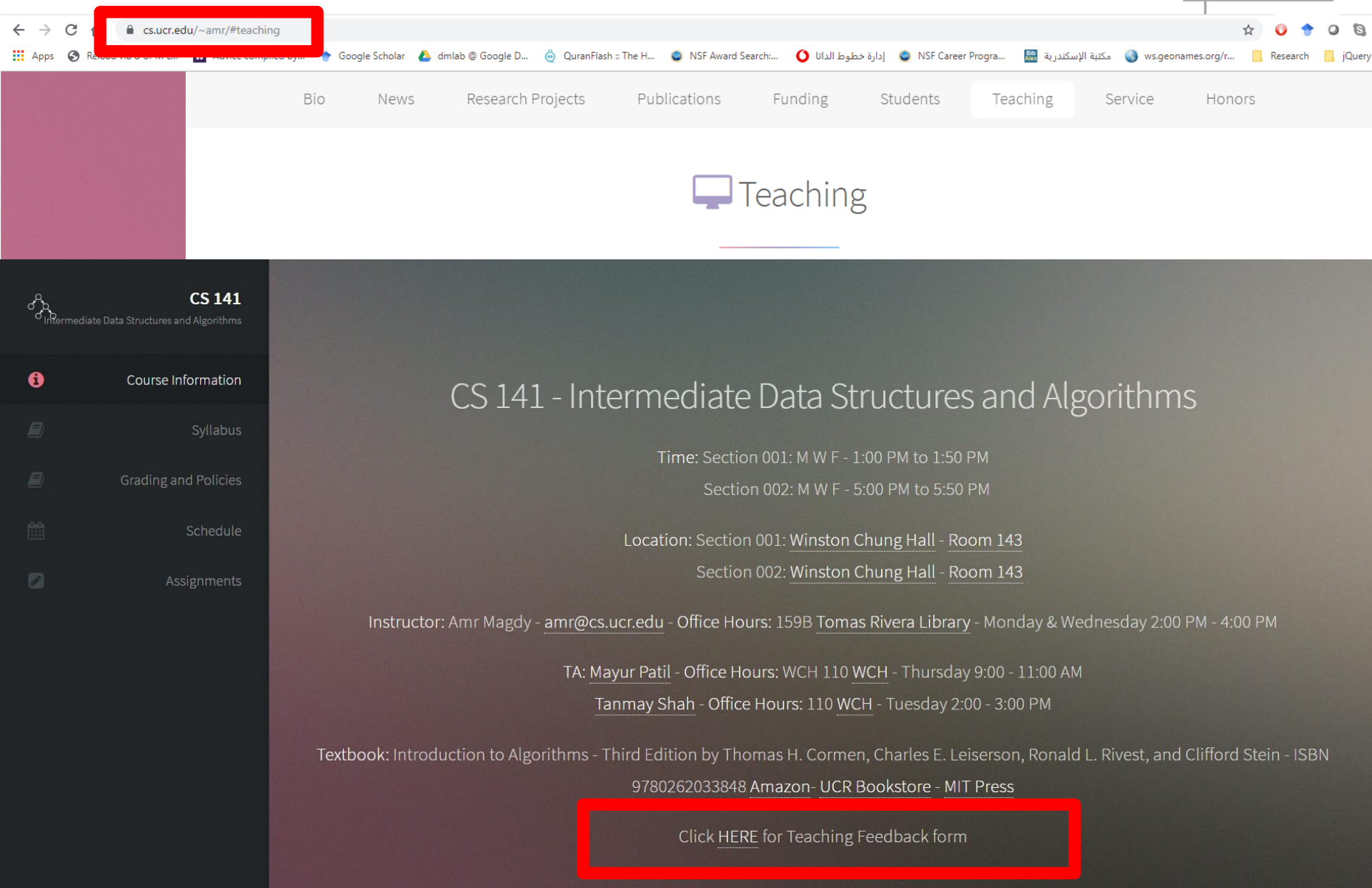

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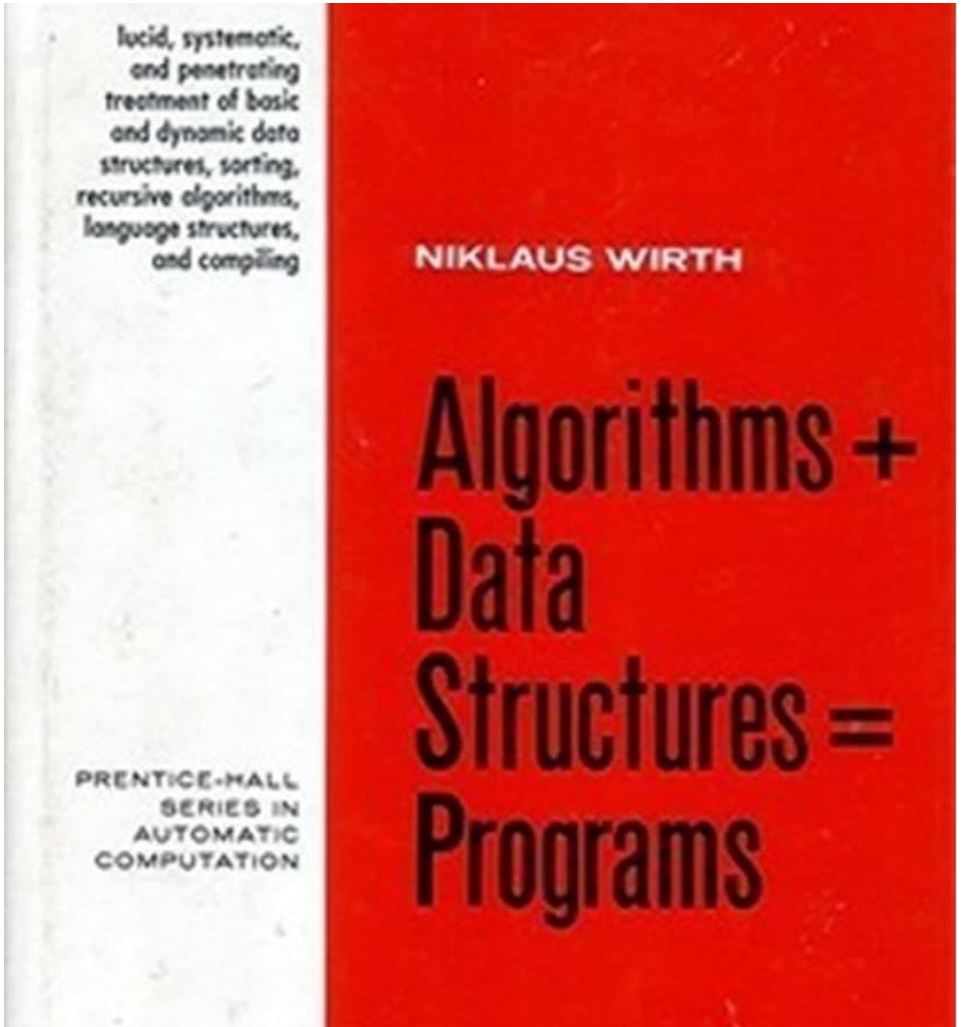
Introduction to Computational Algorithms

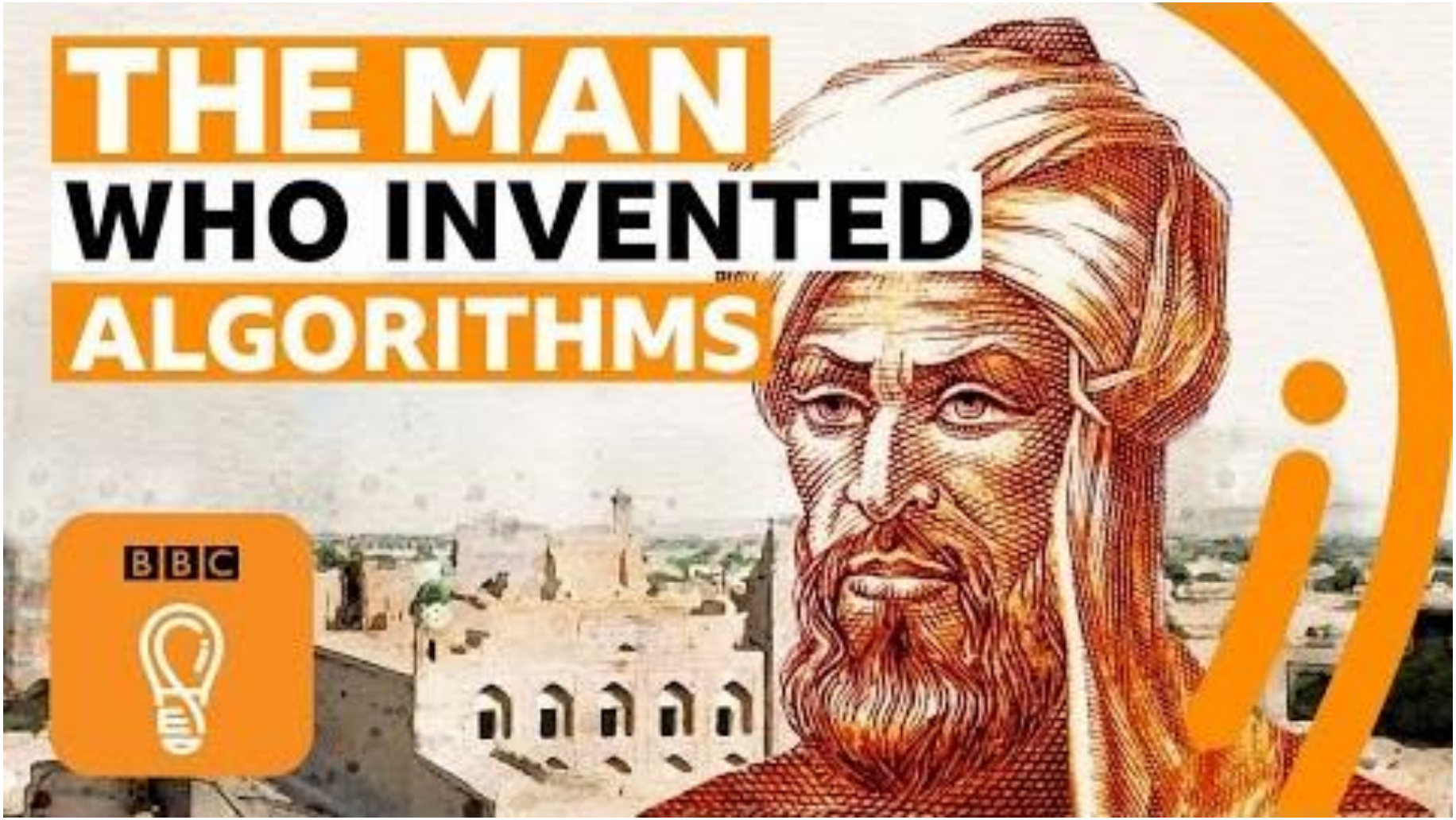
Computer Programs

- Algorithms + Data Structures = Programs
  - By Niklaus Wirth, Turing award winner 1984

- Note: this is not the course textbook.
  The textbook is provided later.



What is Algorithm?



https://www.youtube.com/watch?v=oRkNaF0QvnI

What is Algorithm?

- According to Merriam-Webster dictionary
  - a procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation;
    broadly : a step-by-step procedure for solving a problem or accomplishing some end especially by a computer.

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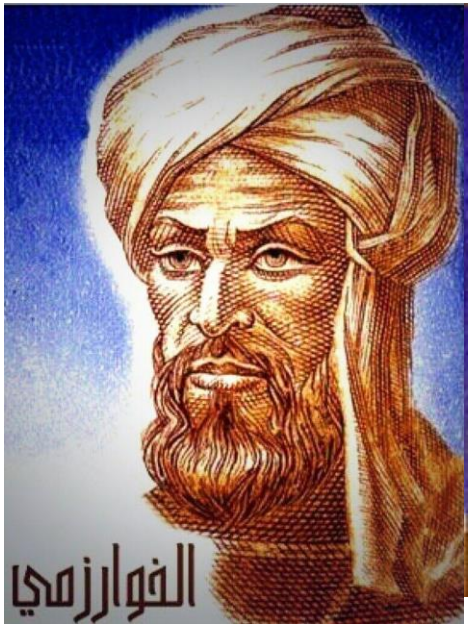
- The word originates from “Algorism”:
  a mathematical counting technique
  - Stemmed from the name of “Muhammad ibn Musa al-Khwarizmi”, an influencer mathematician



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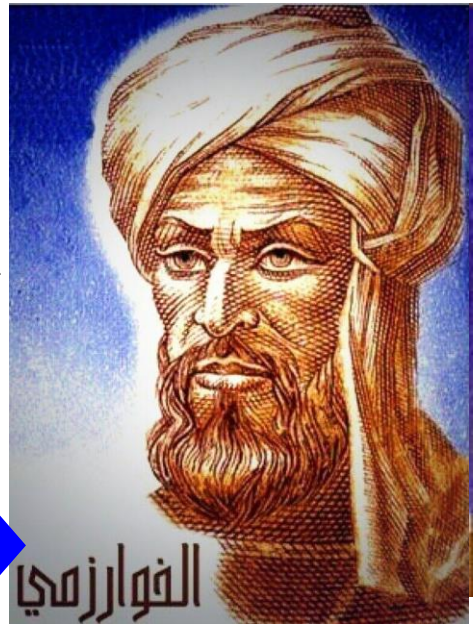
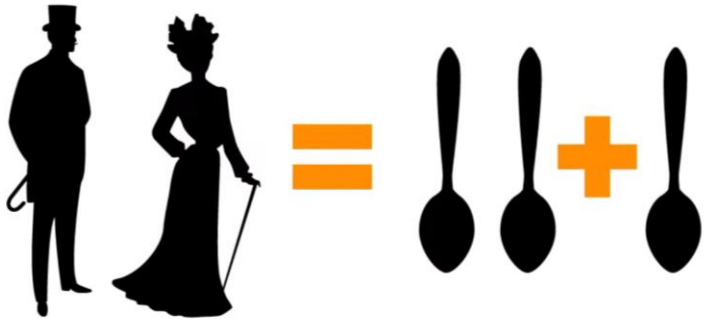


- “*Al-khorezmi his background, his personality his work and his influence*” by Heinz Zemanek, Springer LNCS, 1979, Algorithms in Modern Mathematics and Computer Science, pp 1-81
  (https://link.springer.com/chapter/10.1007/3-540-11157-3_25)

Example Algorithm

step 1

step 2



step 3

step 4

step 5

step 6

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Mathematics

How algorithms rule the world

The NSA revelations highlight the role sophisticated algorithms play in sifting through masses of data. But more surprising is their widespread use in our everyday lives. So should we be more wary of their power?

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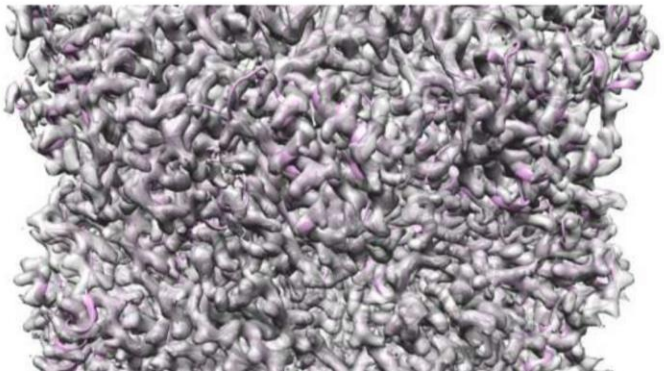

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By Leah Burrows | January 27, 2017

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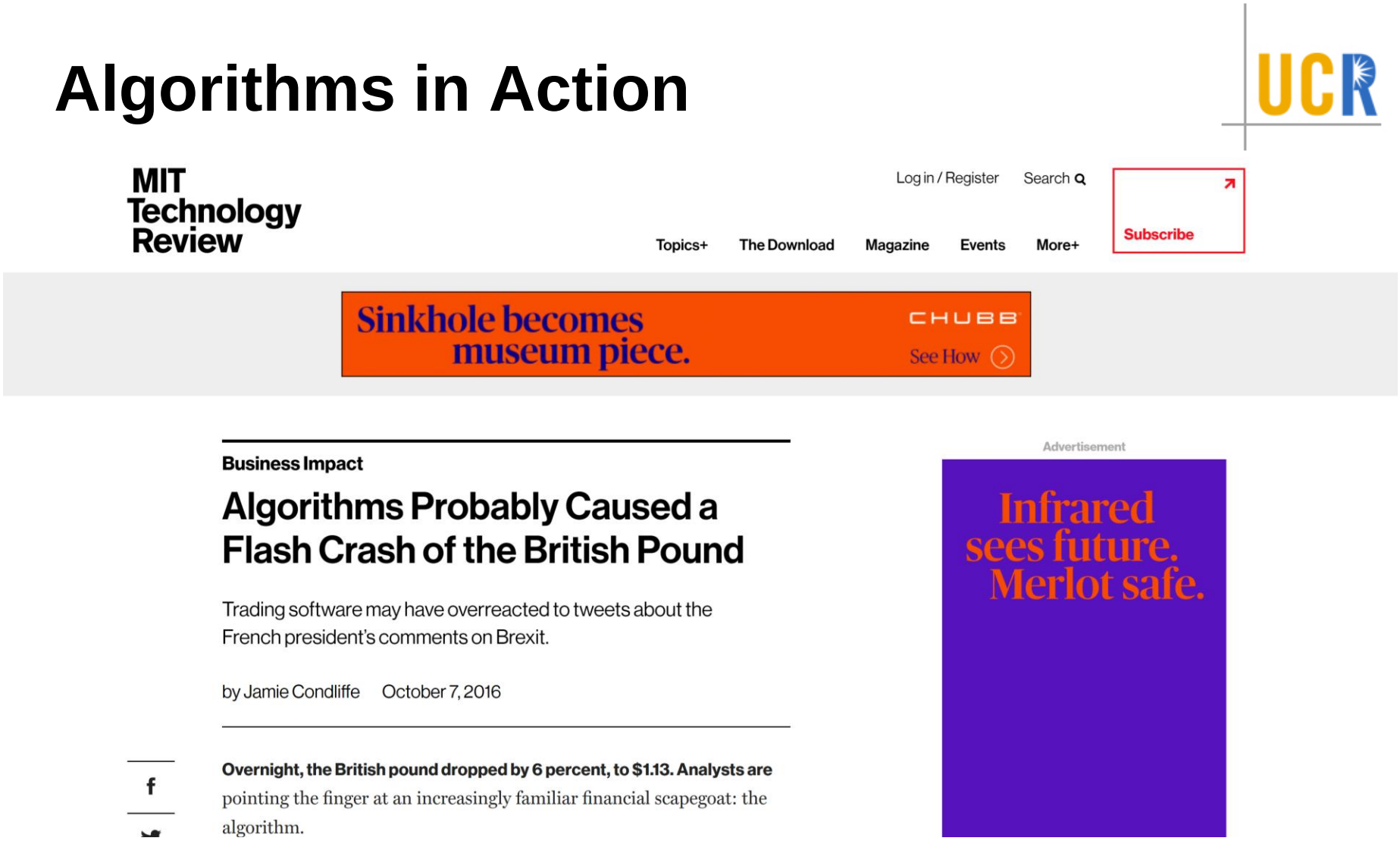

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by Jamie Condliffe October 7, 2016

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Scope of Computational Algorithms

Computability

Complexity

Scope of Computational Algorithms

Computability

Decide on problem computability:

- What problems can be solved by a computer?
- Can a computer solve any problem, given enough time and storage space?

Complexity

A computationally infeasible problem

```
input n
assume n>1
while (n != 1) {
        if (n is even) n = n/2
        else    n = 3*n+1
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        else    n = 3*n+1
}
```

- Is this problem terminates for all possible n>1?
  - We cannot write a computational algorithm to answer this question

Scope of Computational Algorithms

UCR

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Complexity

Analyze a computational algorithm performance:

- How fast can we solve a problem using a computer?
- How little storage space can we use to solve a problem?
- Design better algorithms.

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Correct Algorithm

- A correct algorithm has two conditions:
  - Halts/terminates
  - Produces a correct output set for all possible input sets

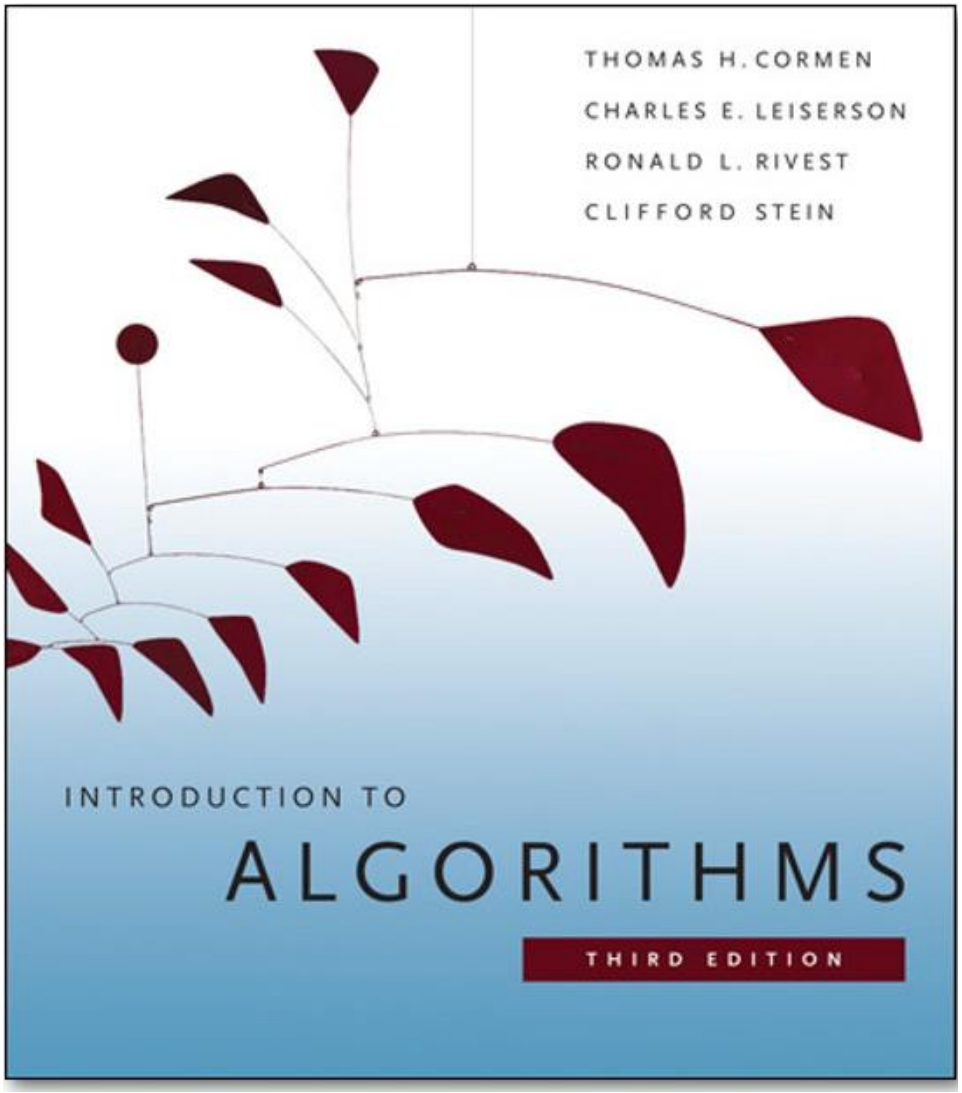
- Will detail later on analyzing correctness of algorithms.

Grading and Policies

- Course work
  - Class participation (3%)
  - Homework assignments (30%)
  - Two mid-term exams (33%)
  - Final inclusive exam (34%)
- Delivery policies:
  - The default late policy: submission allowed for 20% penalty for a calendar day.
  - Assignments should be computer-typed.
- Cheating is not allowed and will be reported
  - If you are using any external source, you must cite it and clarify what exactly got out of it.
  - You are expected to understand any source you use and solve problems in your own.

Reference Book

- Introduction to Algorithms, 3rd Edition, 2009, Thomas Cormen et. al.



Course Content

- Introduction to Computational Algorithms
- Analysis of Algorithms
- Design of Algorithms
  - Divide and Conquer
  - Greedy Algorithms
  - Dynamic Programming
- Advanced Data Structures: Graphs
- Introduction to Advanced Topics: NP-Completeness

Credits

- Prof. Guy Blelloch notes
  - https://www.cs.cmu.edu/~guyb/papers/Qatar17.pdf
- Prof. Donald Knuth book
  - The Art of Computer Programming, Volume 1
- Prof. Madhusudan Parthasarathy notes
  - https://courses.engr.illinois.edu/cs373/sp2010/lectures/slides-lec1.pdf
- BBC Ideas
  - https://www.youtube.com/watch?v=oRkNaF0QvnI