

CS141: Intermediate Data Structures and Algorithms

Introduction

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TA: Tin Vu

Computer Science and Engineering

Welcome to CS 141

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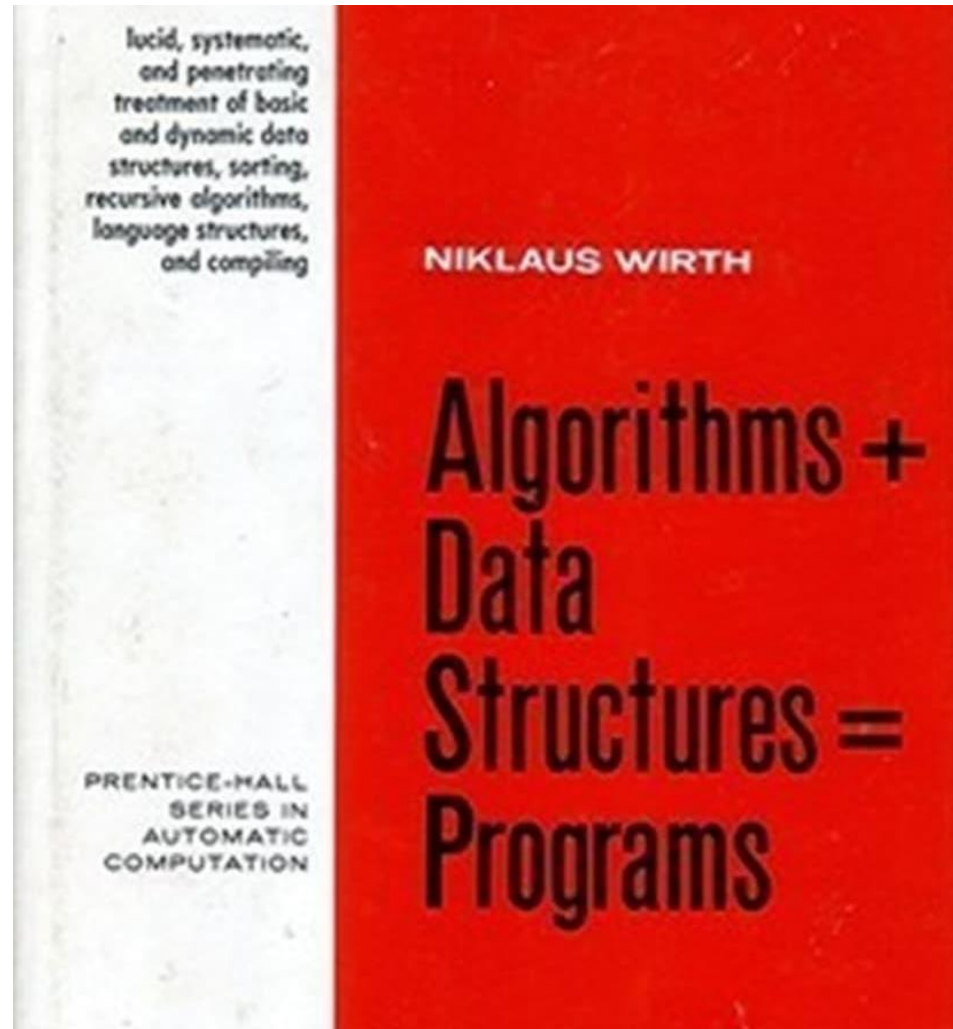
- › Course Website: <http://www.cs.ucr.edu/~tvu032/18WCS141/>

Introduction to Computational Algorithms



Computer Programs

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



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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- “*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



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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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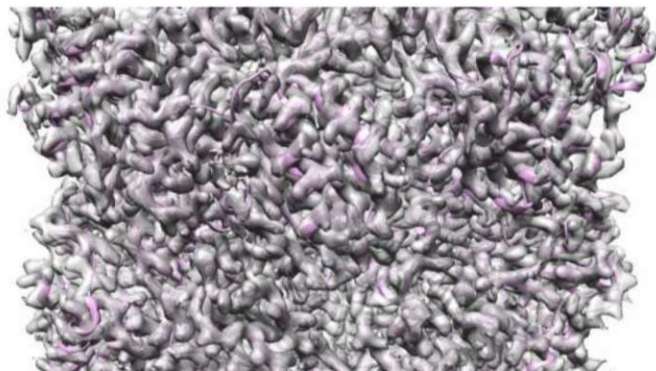
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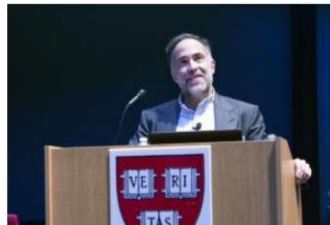
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An economy of algorithms

ComputeFest 2017 tackles the future of the computational economy

By Leah Burrows | January 27, 2017



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PROCESS AUTOMATION DESK

By Aaron Hand, Executive Editor, on July 7, 2016



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Big Data Algorithms Optimize Oil Wells

Ambyint has added a new product to a lineup geared toward taking the analysis out of data analytics, reducing labor costs associated with operating oil wells.

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Sinkhole becomes museum piece. **CHUBB**
[See How](#) 

Business Impact

Algorithms Probably Caused a Flash Crash of the British Pound

Trading software may have overreacted to tweets about the French president's comments on Brexit.

by Jamie Condliffe October 7, 2016



Overnight, the British pound dropped by 6 percent, to \$1.13. Analysts are pointing the finger at an increasingly familiar financial scapegoat: the algorithm.

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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 ($n \neq 1$) {

 if (n is even) $n = n/2$

 else $n = 3*n+1$

}

A computationally infeasible problem

input n

assume $n > 1$

```
while ( $n \neq 1$ ) {  
    if ( $n$  is even)  $n = n/2$   
    else  $n = 3*n+1$   
}
```

- › Is this problem terminates for all possible $n > 1$?

A computationally infeasible problem

input n

assume $n > 1$

```
while (n != 1) {  
    if (n is even) n = n/2  
    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

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

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.

Scope of Computational Algorithms

Computability

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Correct Algorithm

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

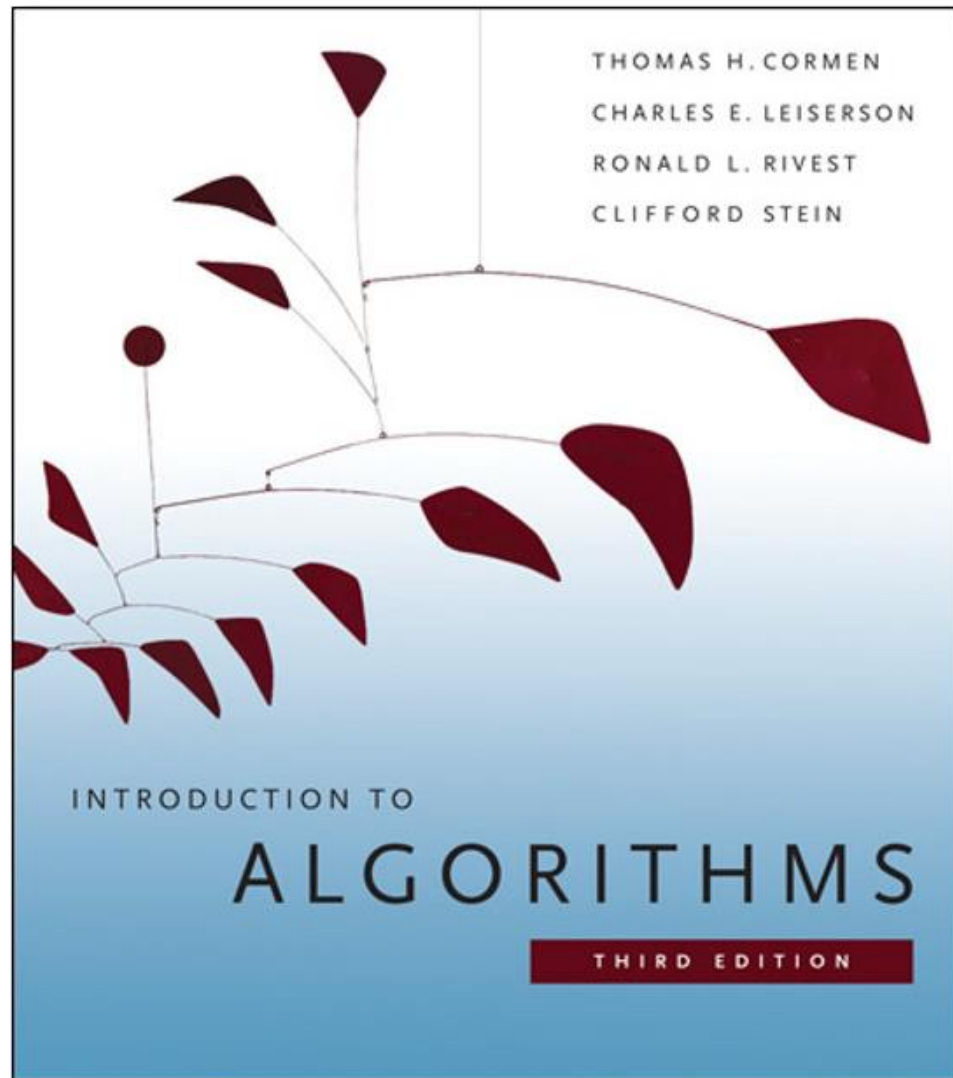
- › Will detail later on analyzing correctness of algorithms.

Grading and Policies

- ▶ Course work
 - ▶ Five homework assignments (33%)
 - ▶ Two quizzes (33%)
 - ▶ Final inclusive exam (34%)
- ▶ Delivery policies:
 - ▶ Late 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
- › Introduction to Advanced Topics

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](https://courses.engr.illinois.edu/cs373/sp2010/lectures/slides-lec1.pdf)