

Lecture 2

CSE 331

Jan 29, 2020

Enroll on Piazza

The screenshot shows the Piazza mobile app interface. At the top, there are tabs for 'Unread', 'Updated', and 'Following'. Below that is a 'New Post' button and a search bar. The main content is a list of posts, categorized by time periods: 'PINNED', 'YESTERDAY', and 'THIS WEEK'. Each post includes a title, a timestamp, and a status icon (e.g., 'Unresolved Followup').

- Search for Teammates!** (12/15/19)
- Q3 times out? please help!** (6:57PM) - 2 unread, 1 unresolved followup
- Confused on autolab result f...** (10:49AM) - 1 unresolved followup
- Just enrolled in AutoLab** (3:31AM) - 1 unread
- q3 timed out** (Mon) - 1 unresolved followup
- Python version** (Mon) - 2 unread, 1 unresolved followup
- Plugins for IntelliJ** (Mon) - 1 unresolved followup
- Leaderboard for autograder** (Mon) - 1 unread, 1 unresolved followup
- Homework 0** (Mon) - 1 unread, 1 unresolved followup
- Textbook** (Mon) - 1 unread, 1 unresolved followup
- Sources** (Mon) - 1 unread, 1 unresolved followup

Class at a Glance

Updated 14 seconds ago. [Reload](#) [Request stickers for my students](#)

no unread posts	28 total posts
1 unanswered questions	146 total contributions
3 unresolved followups	16 instructors' responses
	7 students' responses
	3 min avg. response time

Student Enrollment .out of 200 (estimated) [Edit](#)

Download us in the app store:

Share Your Class

Professors appreciate Piazza best when they see how it is being used.

Allow colleagues to view your class through a demo link - a restricted, read only version of your class where all students' names are anonymized and all student information hidden.

https://piazza.com/demo_login?nid=k46nhotornzaw&auth=52c96d2

Opening this link in the same browser will log you out as erdem@buffalo.edu

Product Updates: Dec 11, 2019

We've created this space in your home screen to inform you of product updates that our team is working on.

- [Released]** Duplicate post detection when asking a question, to help reduce redundant posts
- [Released]** Released ability to revoke a student's posting privileges, temporarily or permanently
- [Released]** Easier access to drafts via the folder bar
- [Released]** 'Disable post history' feature now located next to history slider bar for easier access
- [Released]** Improved helper text on add/drop functionality when uploading an updated student roster
- [Released]** Improved helper text to change private posts to anonymous public posts
- [Released]** Ability to request Piazza stickers for students in your class!
- [In queue]** Ability to tag posts as must-read so students can more easily discover critical information about their class
- [In queue]** Ability to add additional instructors and students to a private post
- [In queue]** Ability to create a new folder while creating a post

<https://piazza.com/buffalo/spring2020/cse331>

Read the syllabus CAREFULLY!

No graded material will be handed back till you pass the syllabus quiz!
Only 70 of you (out of 150) completed!


Syllabus Quiz


Options

[View handin history](#)

[View writeup](#)

[Download handout](#)

 Due: May 8th 2020, 12:14 pm

 Last day to handin: May 8th 2020, 2:14 pm

Academic Integrity

Question 1: Sharing my answers to this syllabus quiz with other 331 students

- Is OK if I do it to help out a friend
- It does not matter since there is no grade attached with it
- Is an academic integrity violation and should not be done
- Is an academic integrity violation but I can take the chance

Question 2: Penalty for academic violation in CSE 331 is an automatic

- Warning and a chance to make-up
- A zero in the assignment AND a letter grade reduction (for first violation across all CSE courses) and an F in the course (for 2nd violation across all CSE courses)
- A zero in the corresponding assignment and nothing else
- Expulsion from UB

You can submit the following now

CSE331: Algorithms and Complexity (s20)

Assignments

Homework 0

Q1 part (a) [Number of perfect matchings]

Q1 part (b)

Q3 (Structured Matrix Vector Multiplication)

Quizzes

Syllabus Quiz

You should be on Autolab now

Allowed Sources

Allowed sources

You can **ONLY** use the following sources for reference once you start working on the homework problems:

1. the Kleinberg-Tardos textbook,

Other textbooks are not allowed

While you can use other textbooks (e.g. those listed in the [syllabus](#)) to better understand the lecture material, you **cannot** use them once you start working on the homeworks.

2. any material linked from this webpage or the CSE 331 piazza page (including any discussion in the Q&A section),

One-click rule

When using webpages that are allowed as sources, you **cannot** click on link on that source. (Otherwise within a constant number of clicks one can reach any webpage one wants.)

3. specific *mathematical* result from a previous course,
4. anything discussed in the lectures, recitations and/or office hours and
5. any notes that you might have taken during class or recitation.

Everything else is not allowed

Note that the above list covers all the allowed sources and **everything else is not allowed**. In particular, *YOU ARE NOT SUPPOSED TO SEARCH FOR SOLUTIONS ON THE*

... even for programming Q

- All discussions and posts on [piazza](#).

Basic programming references

C++ Sources

- [cppreference.com](#) (and all pages within the website).

Java Sources

- [Oracle Java Documentation](#) (and all pages within the website).

Python Sources

- [Python 3.5.2 documentation](#) (and all pages within the website).

Asymptotic Analysis

- [Big-O cheat sheet](#).

Wikipedia Pages

Below are some approved Wikipedia pages (in addition to those that are already linked to in other pages in the [CSE 331 Fall 2018 web page](#)).

- [Gale Shapley algorithm](#).
- [DFS](#).
- [Dijkstra's Algorithm](#).
- [Prim's algorithm](#).

TA Office hours finalized today



My Office hours finalized today

~~Mon 3:00-3:50 and Wed 3:00-3:50~~

Mon 4:00-4:50 and Wed 3:00-3:50

(or by appointment iff you cannot make either)

Why do proofs?

Makes you think logically about problems and solutions

From an engineer who works on Google Maps:

Proving that the algorithm I am implementing is correct helps me identify corner cases

Why should we do proofs?

We will focus a lot on proofs in CSE 331. In this document I will motivate why doing proofs is good even though you might not do proofs for a living. While doing this, we will also go through examples of how to write algorithm ideas and details as well as proof ideas and details (which you will need to write in your homework solutions).

Some reasons to do proofs

In this section, I will lay out some reasons why I think it is beneficial for you guys to do proofs. The first two are probably more along the lines of "if you do proofs for a living" situation. The rest of the reasons should be valid for all of you. I will try and make the reasons as concrete as possible: in the next section, we will consider algorithms for the specific problem of generating all permutations (recall that we [previously](#) had punted on designing an algorithm for this problem).

Sometimes you might not have a choice

One of the easiest way to verify an algorithm idea you have is to code up the algorithm and then test it on some (say random) inputs. However, sometimes this might not be a choice. E.g. if you work on [Quantum Computing](#), then you do not have a quantum computer to run your quantum code on! So currently pretty much the only choice you have is to *prove* that your algorithm is indeed correct. For example, one of the crowning achievements of quantum computing is [Shor's algorithm](#) to computes the factors of large numbers efficiently on a quantum computer (that recall does not exist yet!). (You might also want to read [Scott Aaronson's high level description of Shor's algorithm](#).) The reason why [factoring large numbers](#) is important is that if one can solve this problem efficiently then one can break the [RSA cryptosystem](#). RSA is used everywhere (e.g. when you use your credit card online, RSA is used to make the transaction secure), so this is a big deal.

<https://cse.buffalo.edu/~erdem/cse331/support/proofs/index.html>

A more subtle incorrect “proof”

Brad Pitt had a beard



waleg.com

Every goat has a beard



animaldiversity.org

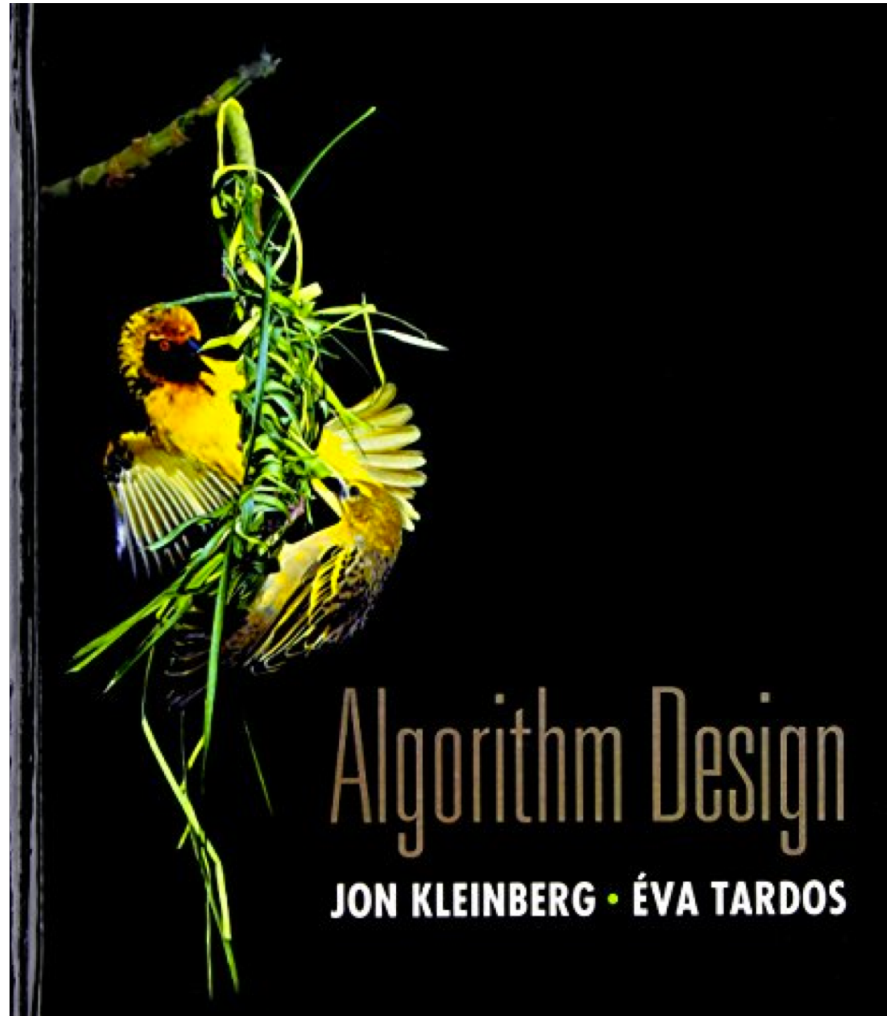
Hence, Brad Pitt is a goat.

More chances to recover

Lowest three HW scores will be dropped

If you do better on the final exam than the mid-term exam then only final exam score will count

Follow the Textbook



CSE 331 Support Page

This page contains certain webpages that students taking CSE 331 might find useful.

The material is roughly divided into two parts: one on (primarily mathematical) background material and one of common mistakes that students generally make.

Disclaimer

Please note that this material is intended as a support material. It is not meant as a replacement for actually having taken background courses like CSE 116, 191 or 250 nor is this meant to be exhaustive. I'll try my best to make these as comprehensive as possible but that might take some time.

Background material

CSE 331 will need a fair bit of math: most of which you must have seen earlier. However, if you have not used those material for a bit then you might be a bit rusty. The pages linked below are some notes that I wrote up that might help you refresh the material that you might have seen in CSE 116, 191 or 250. Also some of the pages are meant to motivate why we do some things a certain way in CSE 331. Finally sometimes (but not often!) we will use material that might not have been covered in previous courses and we did not have much time to cover in class: these pages will fill in those gaps.

Common Mistakes

Here we collect some common mistakes that students make in CSE 331 material (and sometimes more than once). The hope is to list these common pitfalls so that you can avoid them!

Other Resources

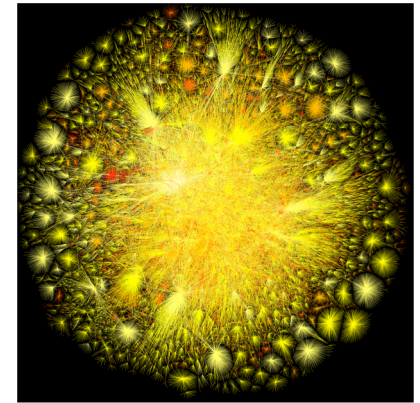
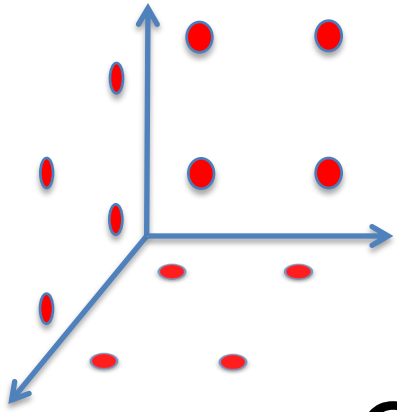
Below we collect other 331 related material that do not neatly fall into the two left category:

- [Visualizing Algorithms.](#)
- [Algorithms via Examples.](#)

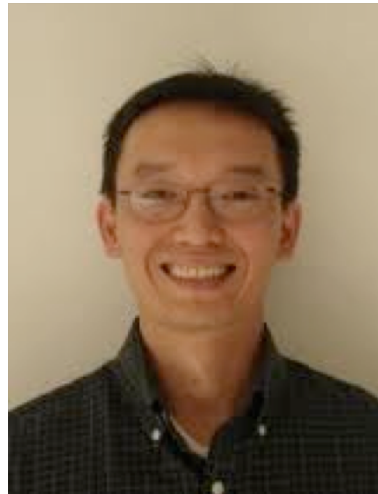
<https://cse.buffalo.edu/~erdem/cse331/support/index.html>

Questions/Comments?

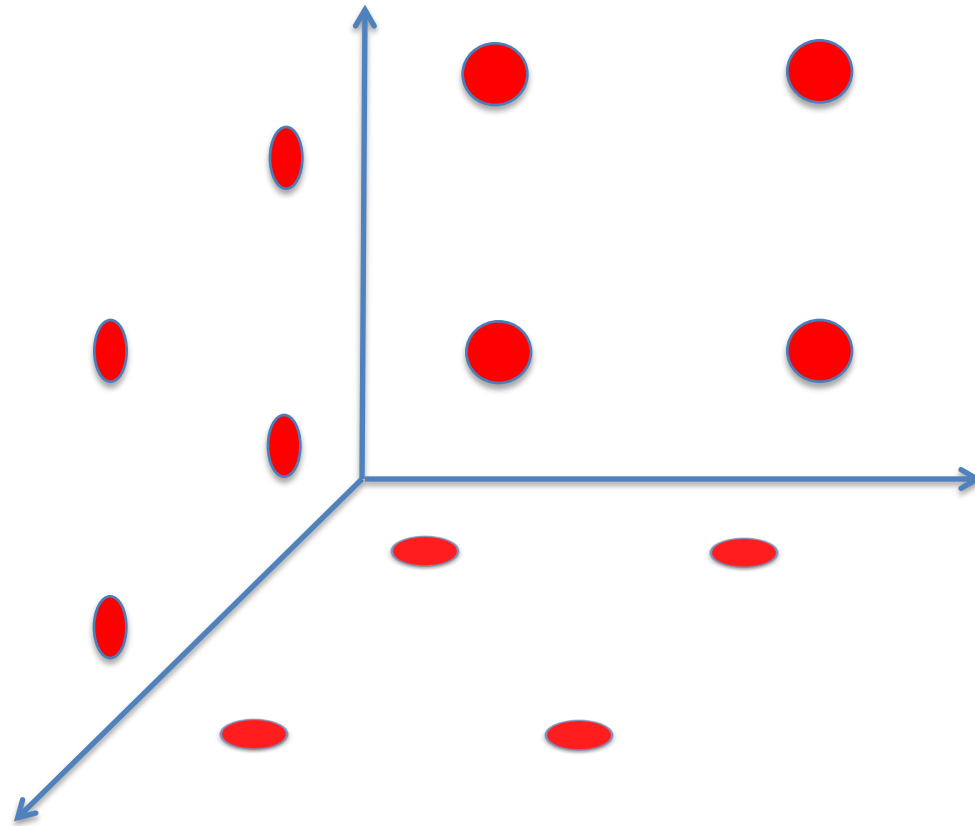
Why should I care ?



Combining Shadows to Understanding the network

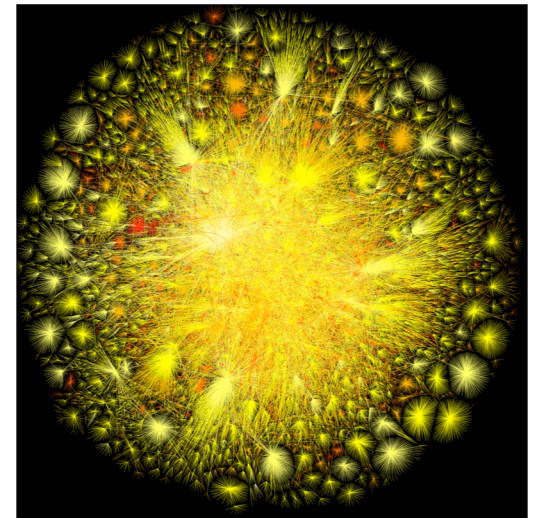
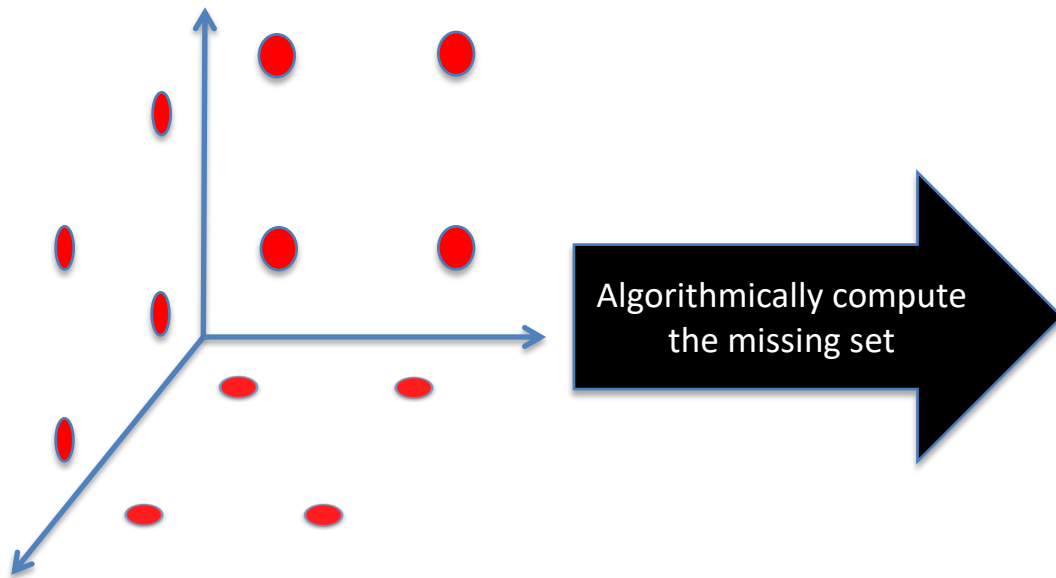


The key technical problem



Given the three projections, what is the largest size of the original set of points?

Conquering Shadows to Conquering the Internet



The proof is in the performance



EMPTYHEADED

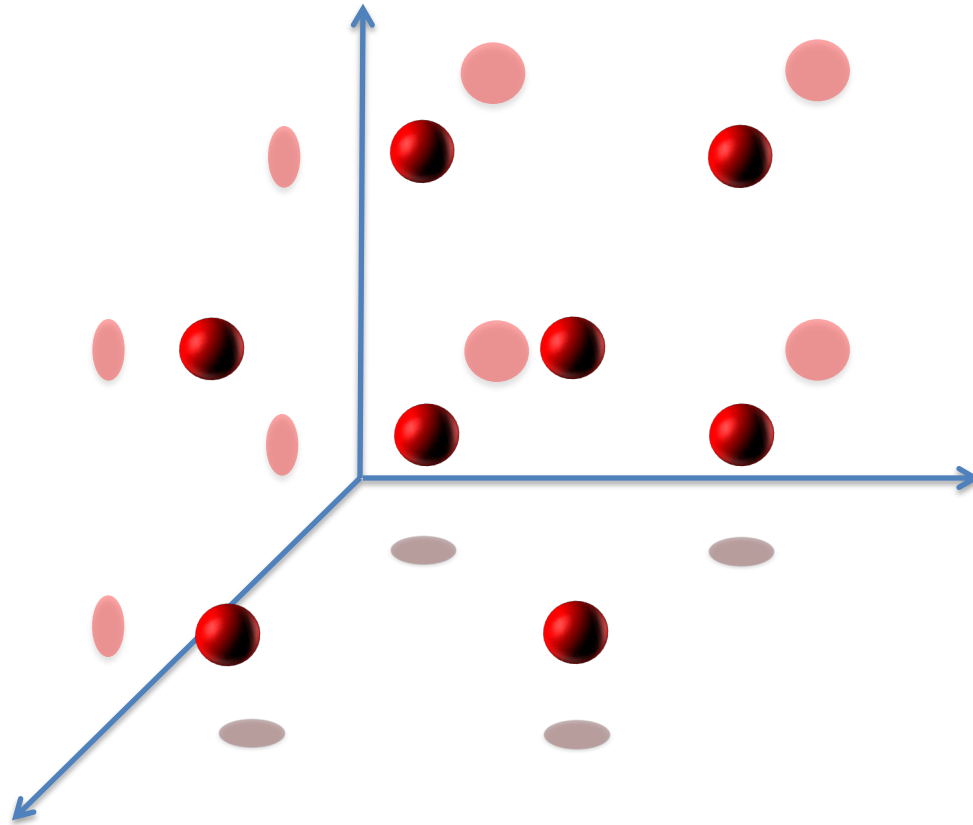


10x faster

A large, thick green arrow pointing from left to right, indicating a comparison or performance gain.

Better algorithm with little hacking will beat a worse algorithm with tons of hacking

The key technical problem



Highly trivial: $4^3 = 64$

Still trivial: $4^2 = 16$

Correct answer: $4^{1.5} = 8$

From someone who got a Google job

“You can let your algorithms class know that the phone interviews are essentially like **a difficult algorithms test.**”

Lots of data structures, specifying the algorithm, analyzing the run time and space requirements... And all on the phone and **you're supposed to talk through your thought process.**”

Coding jobs will be done by AI



stacksort

In a [recent xkcd's](#) alt text, Randall Munroe suggested **stacksort**, a sort that searches StackOverflow for sorting functions and runs them until it returns the correct answer. So, I made it. If you like running arbitrary code in your browser, try it out.

Like (or hate) it? Comment on HackerNews

stackoverflow_sort(

Try a list of numbers, a string, a list of words or json.

);

Sort

var output =

Output from the function.

;

output console

Coding jobs will be done by AI

MIT News


ON CAMPUS AND AROUND THE WORLD

Browse

or

Search



 FULL SCREEN

Researchers have developed a flexible way of combining deep learning and symbolic reasoning to teach computers to write short computer programs. Here, Armando Solar-Lezama (left), a professor at CSAIL, speaks with graduate student Maxwell Nye.


Photo: Kim Martineau

Toward artificial intelligence that learns to write code

Researchers combine deep learning and symbolic reasoning for a more flexible way

So am I doomed?

There will still be room for high level *algorithmic* thinking!



European Association for
Theoretical Computer Science

HOME ABOUT SEARCH CURRENT ARCHIVES

Home > No 125: June 2018 > **Lamport**

If You're Not Writing a Program, Don't Use a Programming Language
Leslie Lamport, Distributed Computing & Education Column by Juraj Hromkovic, Stefan Schmid

*Today, programming is generally equated with coding. It's hard to convince students who want to write code that they should learn to think mathematically, above the code level, about what they're doing. Perhaps the following observation will give them pause. **It's quite likely that during their lifetime, machine learning will completely change the nature of programming. The programming languages they are now using will seem as quaint as Cobol, and the coding skills they are learning will be of little use. But mathematics will remain the queen of science, and the ability to think mathematically will always be useful.***

Why care about algorithms?

← from Virginia Beach, Virginia
to Buffalo, New York

9 h 39 min (582 miles)
via I-95 N
Fastest route, the usual traffic
⚠️ This route has tolls.

Virginia Beach
Virginia

- Take Arctic Ave and 22nd St to I-264 W/Norfolk Virginia Beach Expy/Virginia Beach Expy
4 min (0.8 mi)
- Take I-64 W, I-295 N, I-95 N, I-270 N, ... and I-80 W to PA-153 N in Penfield. Take exit 111 from I-80 W
6 h 49 min (432 mi)
- Get on US-219 N in Ashford from PA-153 N
2 h 21 min (113 mi)
- Continue on US-219 N. Drive to Church St in Buffalo. Take exit 7 from I-190 N
35 min (36.1 mi)
- Take Delaware Ave to your destination
2 min (0.4 mi)

Buffalo
New York

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause

Map details: Satellite view, Live traffic, Fast/Slow indicators, and various city labels like Detroit, Cleveland, Columbus, Philadelphia, Baltimore, Washington, Richmond, and Virginia Beach.

Driving directions

Why care about algorithms?

- Any Department
- Electronics
 - Camera & Photo
 - Video
 - Body Mounted Cameras
 - Camcorder Accessories
 - Camcorder Bundles
 - Camcorder Lenses
 - Camcorders**
 - Camera Supports & Stabilizers
 - Lighting
 - Professional Video Accessories
 - Professional Video Cameras
 - Quadcopters & Accessories
 - Sports & Action Video Cameras
 - Video Studio



Best Sellers in Camcorders

#1



Video Camera Camcorder Digital YouTube Vlogging Camera Recorder kicteck Full HD 1080P...
★★★★★ 1,601
\$63.99 ✓prime

#2



Video Camera Camcorder with Microphone YouTube Camera Recorder 2.7K Ultra HD 20FPS...
★★★★★ 119
\$75.99 ✓prime

#3



GoPro Hero5 Session (Renewed)
★★★★☆ 241
\$139.99 ✓prime

#4



Canon Video 1960C002 Canon VIXIA HF R800 Camcorder (Black)
★★★★★ 428

#5



Video Camera Camcorder Full HD 1080P 30FPS 24.0 MP IR Night Vision Vlogging Camera...
★★★★★ 197

#6



Video Camera Camcorder Vlogging Camera for Youtube Full HD 2.7K 30FPS 30 MP IR Night...
★★★★★ 214

Computing Bestsellers on the fly

Why care about algorithms?

Buffalo, NY, United States (B) Cape Town, South Africa (C) 02/02/2020 02/23/2020 Search

Nearby airports Nearby airports

1 Traveler, All Airlines, Economy / Coach Show options

Select your departure to Cape Town Sun, Feb 2

Prices are roundtrip per person, include all taxes and fees, but do not include baggage fees.

Sort & Filter Clear Show flexible dates

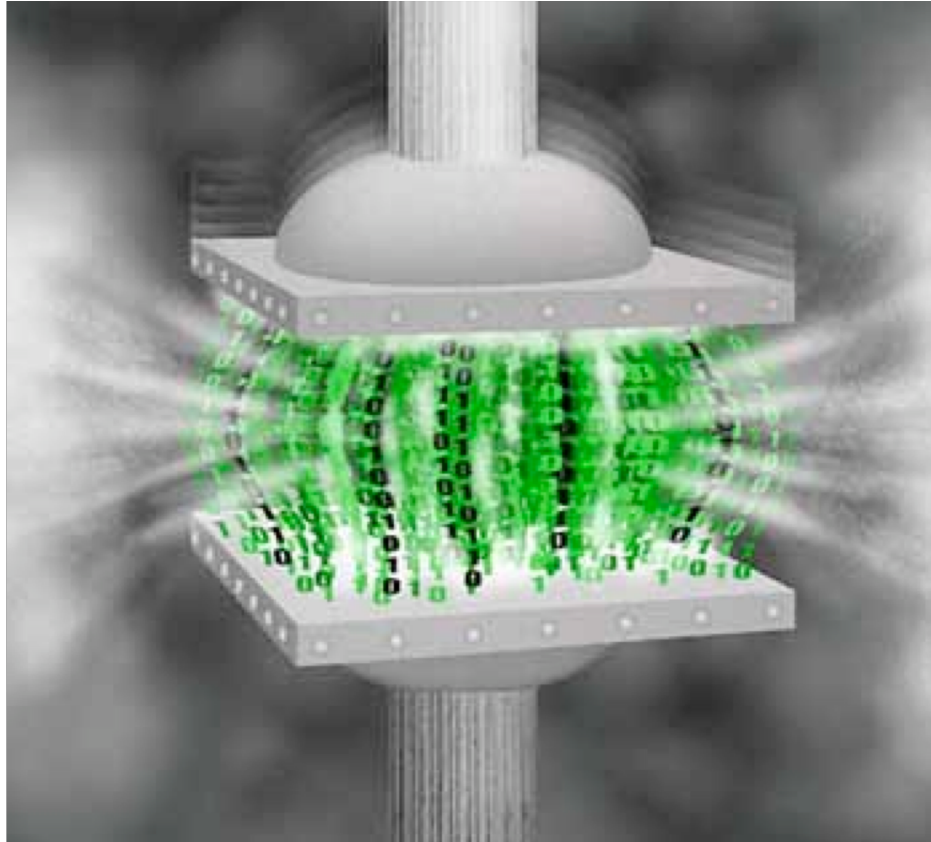
Sort by Price (Lowest)

Save up to \$420* when you book your Flight and Hotel together. Shop Flight + Hotel

Stops	From:	Cheapest flight
<input type="checkbox"/> 1 Stop (4)	\$1,544	4:45pm - 6:00pm +1 18h 15m (1 stop) 4 left at \$1,543.72 Select
<input type="checkbox"/> 2+ Stops (69)	\$1,549	United BUF - 2h 5m in EWR - CPT Excellent Flight (8.6/10) United 4306 operated by Expressjet Airlines DBA ... Earn \$15.44
Airlines included	From:	Details & baggage fees
<input type="checkbox"/> Delta (37)	\$1,891	
<input type="checkbox"/> United (17)	\$1,544	2:30pm - 6:00pm +1 20h 30m (1 stop) 4 left at \$1,543.72 Select
<input type="checkbox"/> Air France (13)	\$2,403	United BUF - 4h 20m in EWR - CPT Excellent Flight (8.6/10) United 5012 operated by CommutAir DBA United ... Earn \$15.44
<input type="checkbox"/> South African Airways (11)	\$1,891	2:45pm - 6:00pm +1 20h 15m (2 stops) 4 left at \$1,548.22 Select
<input type="checkbox"/> KLM (10)	\$3,440	United BUF - IAD - EWR - CPT Excellent Flight (8.5/10) United 3908 operated by Air Wisconsin DBA Unite... Earn \$15.48
<input type="checkbox"/> British Airways (5)	\$4,794	
<input type="checkbox"/> American Airlines (4)	\$5,318	

Booking cheapest air tickets

Why care about algorithms?



<http://www.di.ens.fr/~cherniav/teaching.html>

Data compression

(And I could) go on...

Find out for yourself

Mini project: Video on ethical impacts of algorithm. Groups of size = 3

CSE 331 Mini Project

Spring 2020

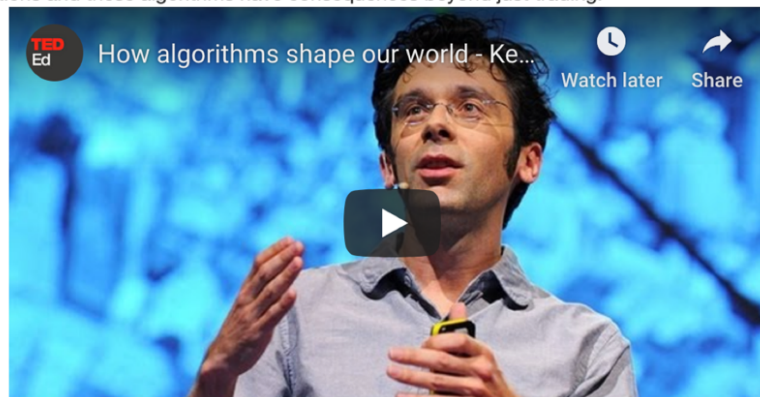
Details and motivations for the mini project.

Motivation

CSE 331 is primarily concerned with the technical aspects of algorithms: how to design them and then how to analyze their correctness and runtime. However, algorithms are pervasive in our world and is common place in many aspects of society. The main aim of the mini-project is to have you explore in some depth social implications of algorithms.

Just to give two examples for such implications:

- Algorithms are pervasive in financial transactions and these algorithms have consequences beyond just trading:



Questions/Comments?

Let the fun begin!

Who is Algorithm named after?

Abū ‘Abd Allāh Muhammad ibn Mūsā al-Khwārizmī

9th century Persian astronomer/mathematician

825 AD: “On Calculation with Arabic Numerals”

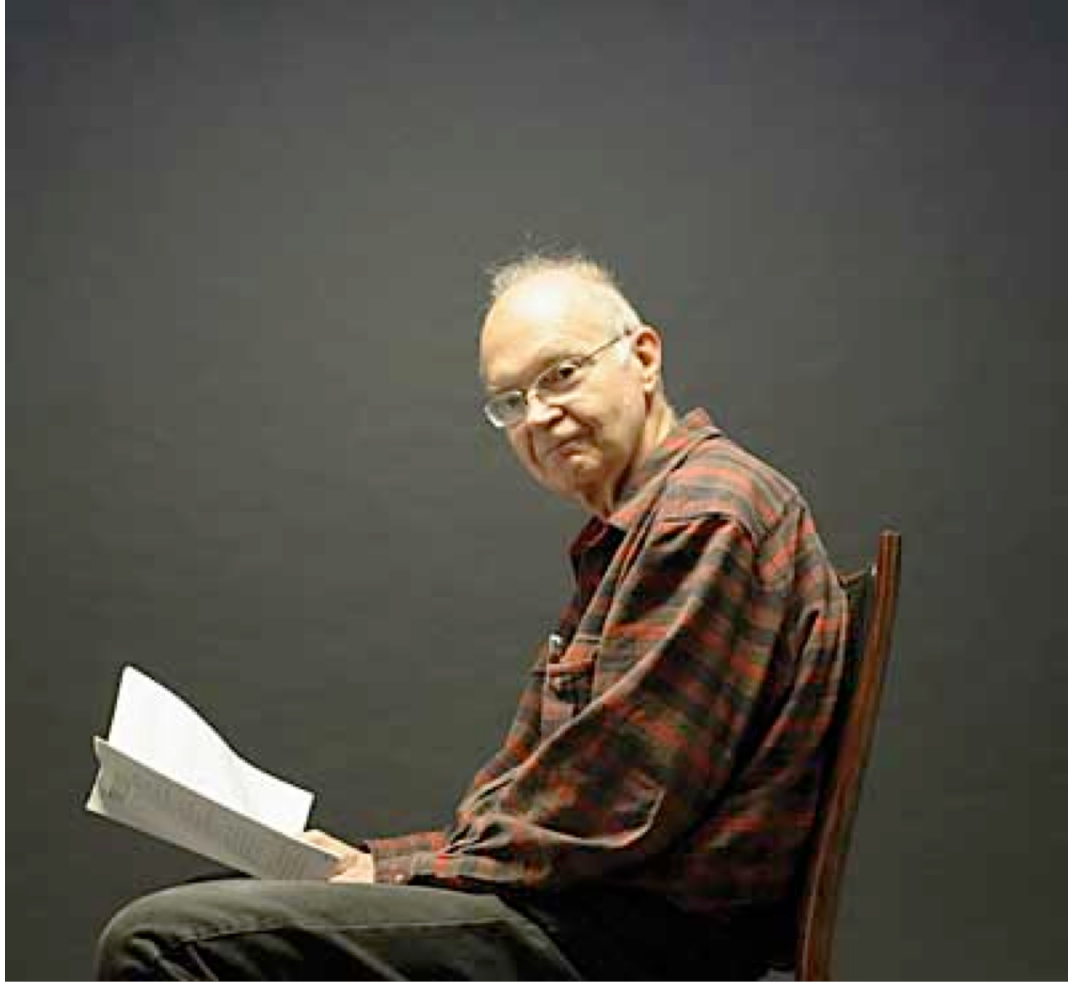


Latin translation 12th century

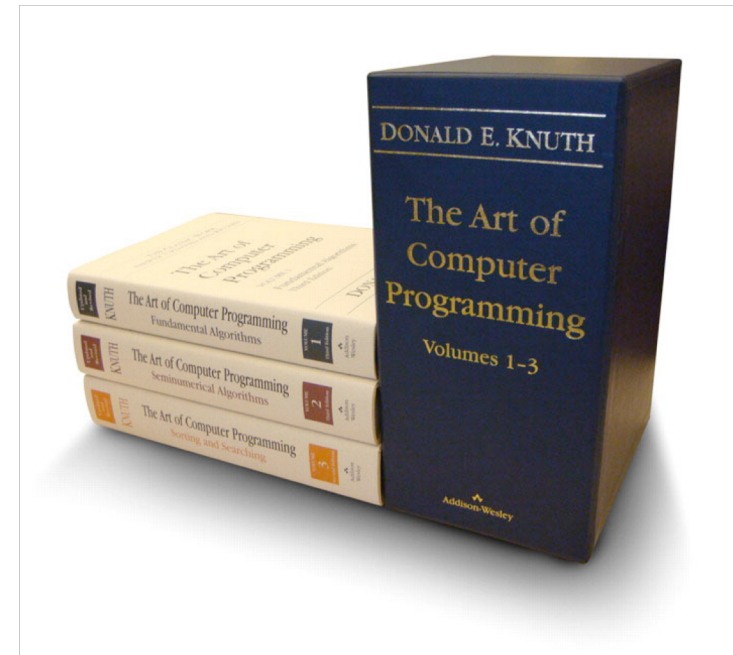
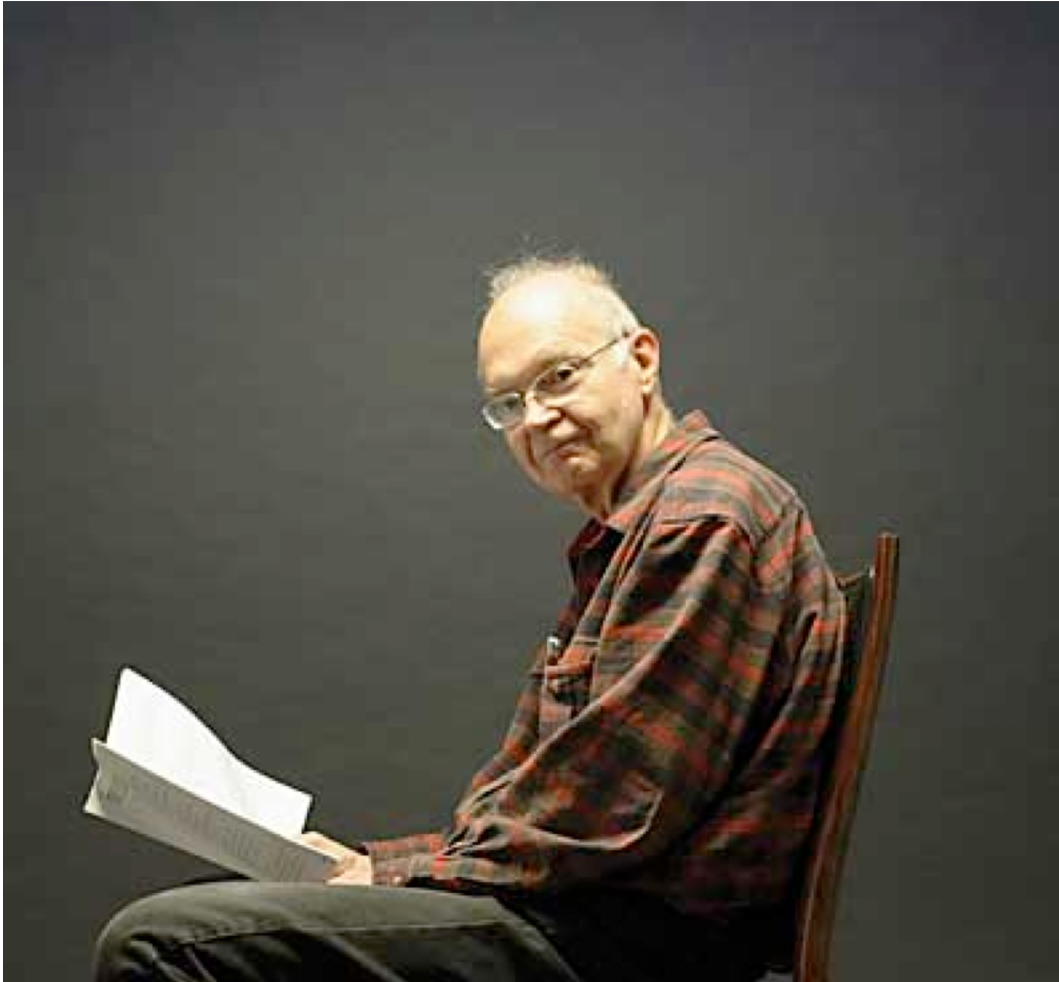
“Algorithmi de numero Indorum”



What are Algorithms?



Don Knuth



Don Knuth Reward Checks



DONALD E. KNUTH
COMPUTER SCIENCE DEPARTMENT
STANFORD UNIVERSITY
STANFORD, CA 94305-9045

432

DATE 29 Oct 2008

DEPOSIT TO THE
ACCOUNT OF

Tony Lu

OX\$ 1.00

One and  100/256

HEXADECIMAL DOLLARS



BANK OF SAN SERRIFFE
Thirty Point, Calssa Inferiore
<http://www-cs-faculty.stanford.edu.ca/~knuth/boss.html>

MEMO

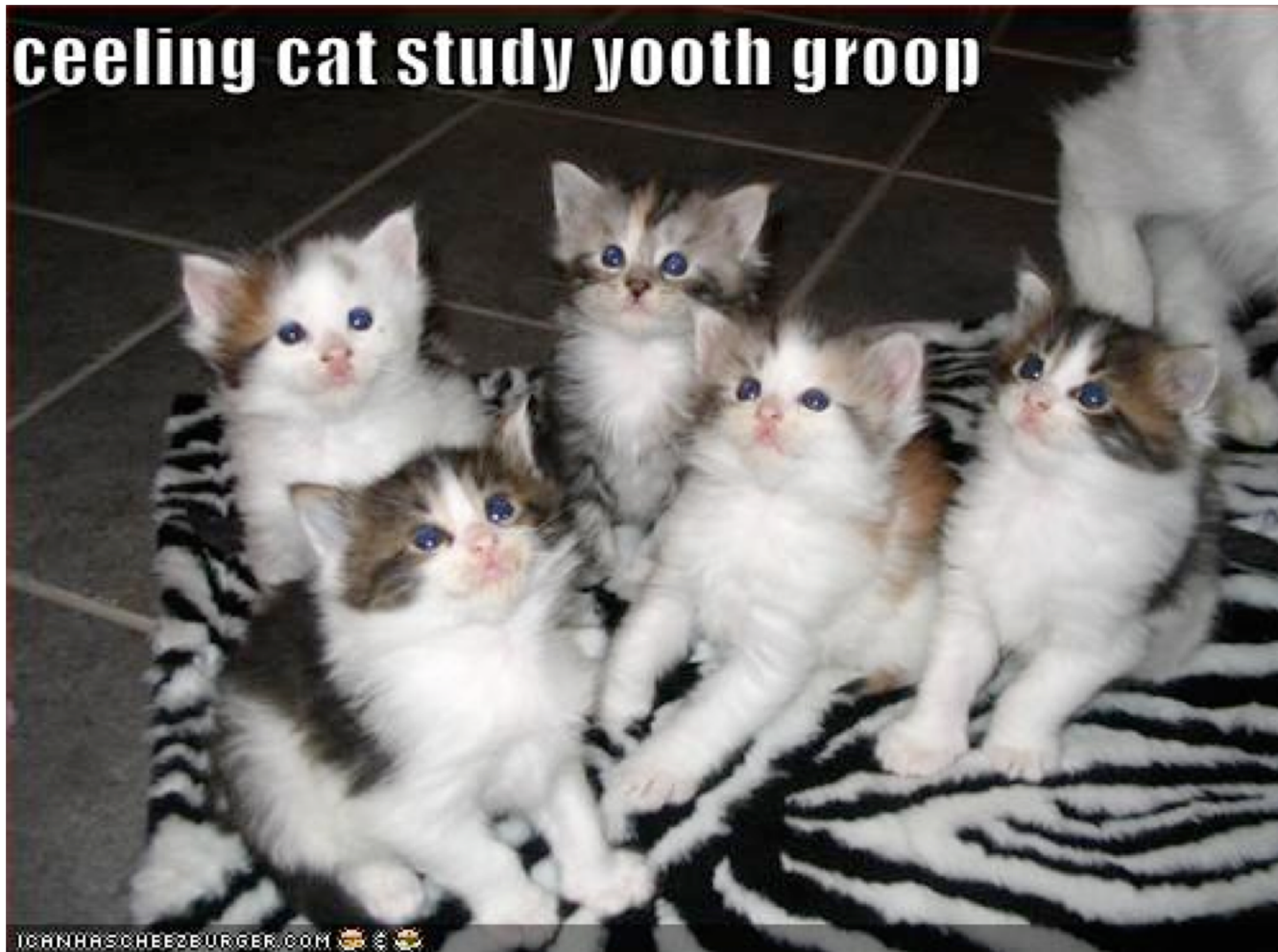
f1b.135

Donald Knuth

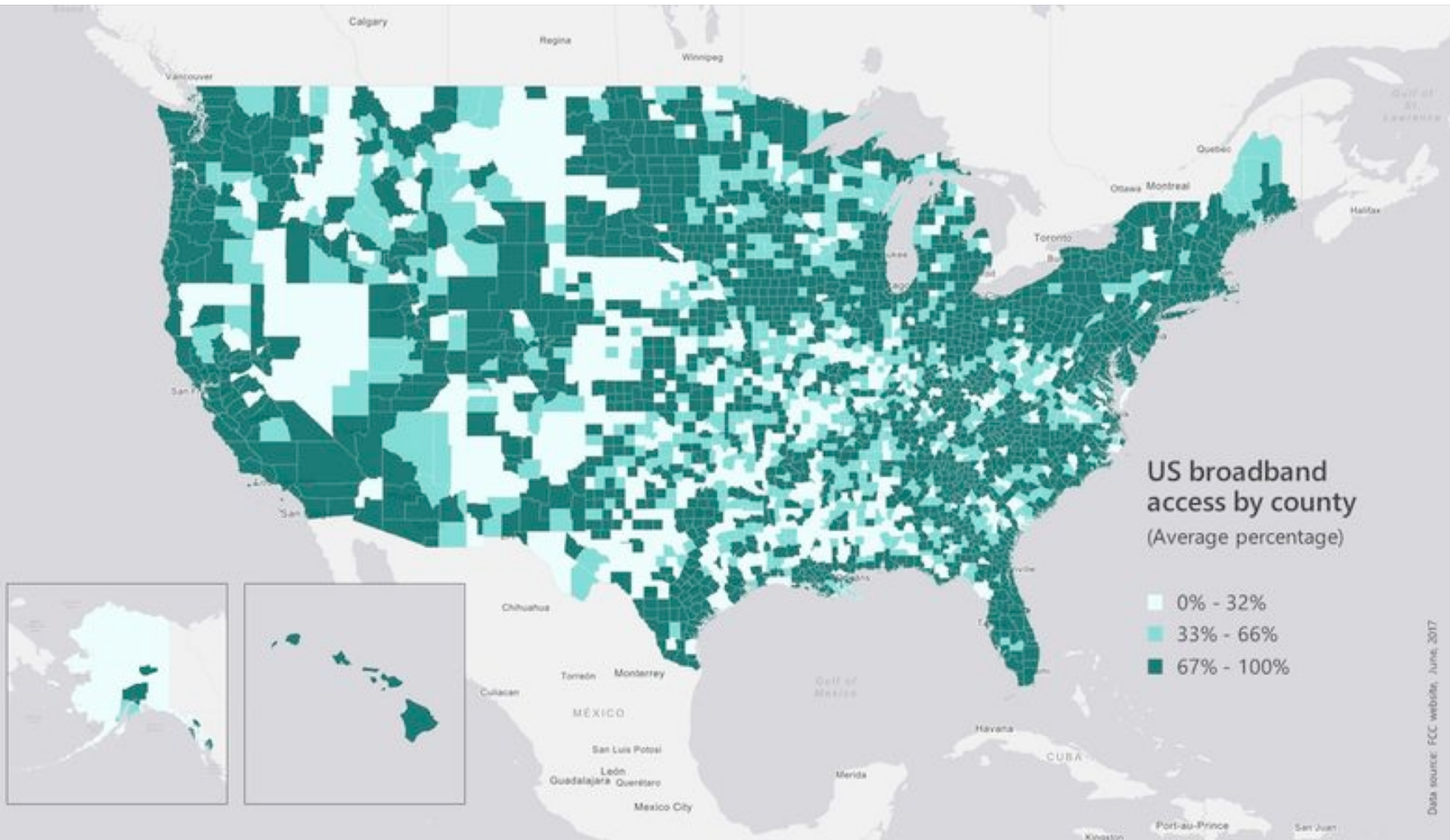
Knuth's Definition

An algorithm is a finite, definitive, effective procedure with some input and some output

Remember: Stick with your group

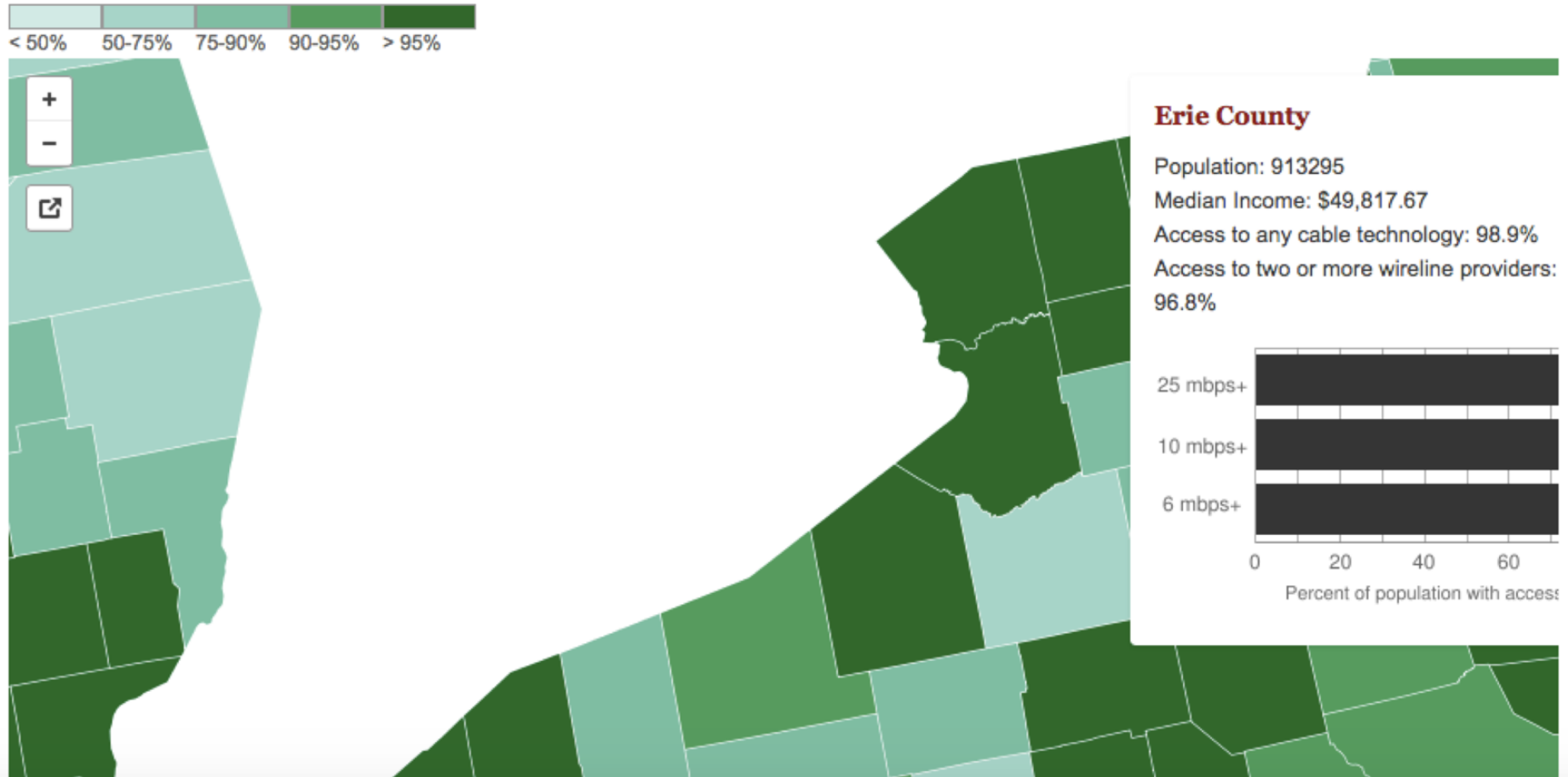


Broadband access



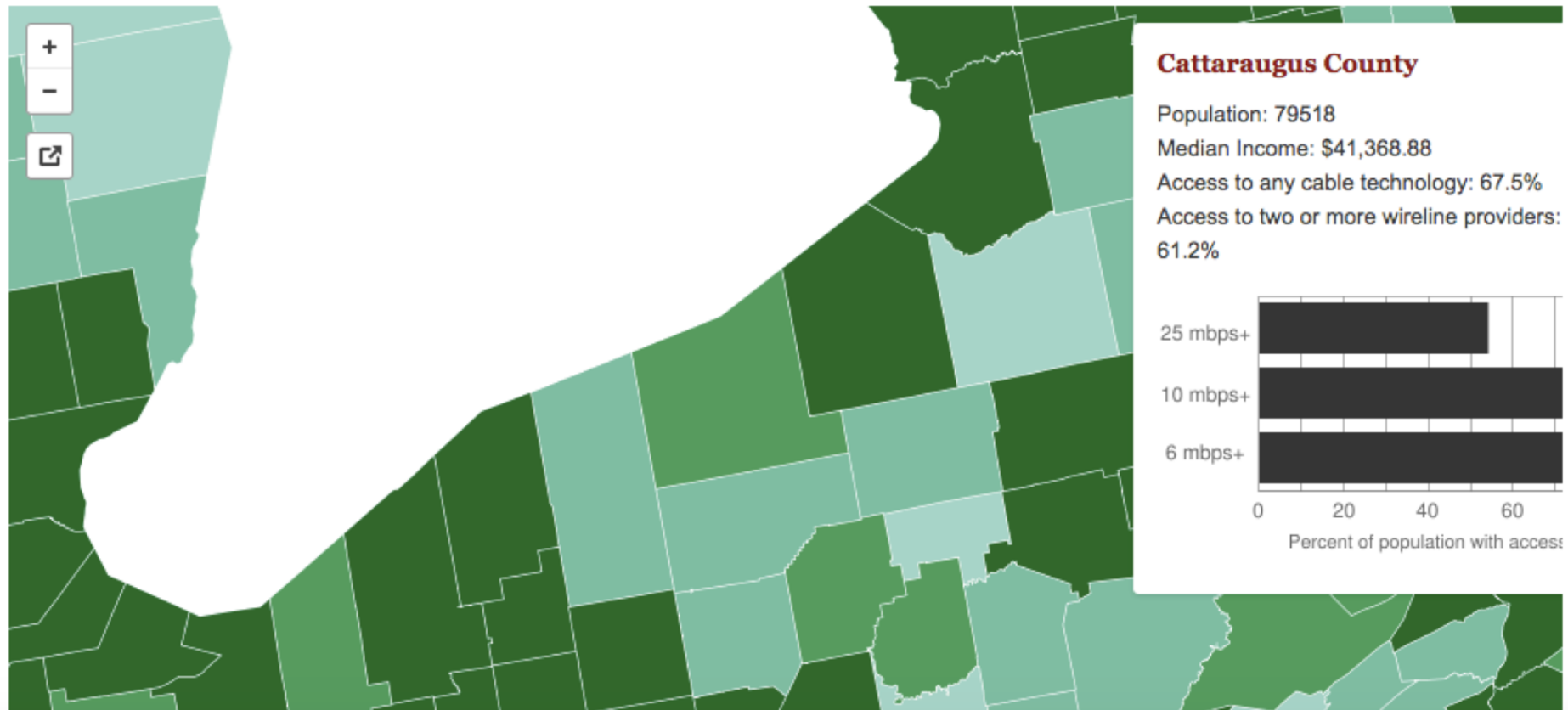
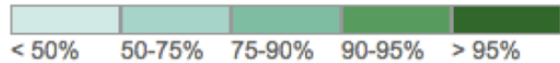
Erie county is reasonably good

Population with access to advertised download speeds at least 6mbps



One county over

Population with access to advertised download speeds at least 6mbps



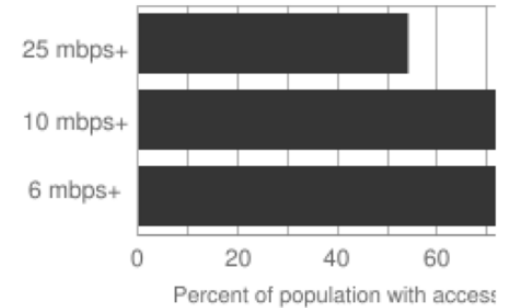
Cattaraugus County

Population: 79518

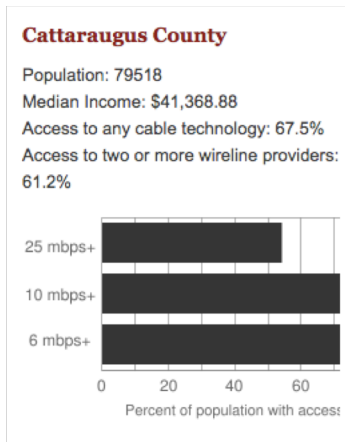
Median Income: \$41,368.88

Access to any cable technology: 67.5%

Access to two or more wireline providers: 61.2%



Make broadband more available



Say you are tasked to come up with the infrastructure

