

# Lecture 2

CSE 331

Aug 28, 2019

# Enroll on Piazza

The screenshot displays the Piazza interface for the CSE 331 course. The top navigation bar includes the Piazza logo, course name 'CSE 331', and various menu items like 'Q & A', 'Resources', 'Statistics', and 'Manage Class'. Below the navigation, there's a sidebar with a 'New Post' button and a search bar. The main content area features a 'Class at a Glance' summary with three green checkmarks indicating 'no unread posts', 'no unanswered questions', and 'no unresolved followups'. To the right of these checkmarks, statistics are listed: 30 total posts, 183 total contributions, 24 instructors' responses, 2 students' responses, and a 10 min average response time. Below this, a 'Student Enrollment' section shows a progress bar for 223 enrolled students out of 280 estimated. At the bottom, there are three video thumbnails for lecture series: 'Driving Student Engagement in Large Classes with Piazza', 'Engaging Women in STEM Fields on Piazza', and 'Engaging Small Discussion Based Classes on Piazza'. Logos for Spotify, Apple Podcasts, and YouTube Music are visible at the bottom right.

<https://piazza.com/buffalo/fall2019/cse331/>

# Read the syllabus CAREFULLY!

No graded material will be handed back till you pass the syllabus quiz!

## Syllabus Quiz

### Options

[View handin history](#)

[View writeup](#)

[Download handout](#)

 Due: December 12th 2019, 4:05 pm

 Last day to handin: December 12th 2019, 6:05 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

# You can submit the following now

» CSE331: Algorithms and Complexity (f19)

## Assignments

### Homework 0

Q1 part (a) [Number of perfect matchings]

Q1 part (b)

Q3 (Structured Matrix Vector Multiplication)

### Quiz

Syllabus Quiz

You should be on Autolab now

# Autolab FAQ

CSE 331 Syllabus Piazza Schedule Homeworks - Autolab Mini Project - Support Pages - Youtube channel

## Autolab

Details on Autolab, which will be used for all homework submissions in CSE 331.

### The main link

We will be using the UB CSE extension to [Autolab](#) for submission and (auto)grading of CSE 331 homeworks. You can access Autolab via <https://autograder.cse.buffalo.edu/>.

## Signing up

Follow these steps to setup an account on Autolab (unless you already have one in which case you'll use your existing account):

1. Go to [this page](#) and click on the [Sign in with MyUB link](#). A new account will automatically be created for you.
2. By default, AutoLab will use your official UB first and last name. **If you have a different preferred name, please let us know ASAP.**
3. We will have leader boards for all the programming assignments. For anonymity, all students are identified by their chosen nicknames. So please make sure you pick an appropriate one (you can change your nickname at any point of time).
4. After you have done the above steps, you wait.

## What happens next

# 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

For 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

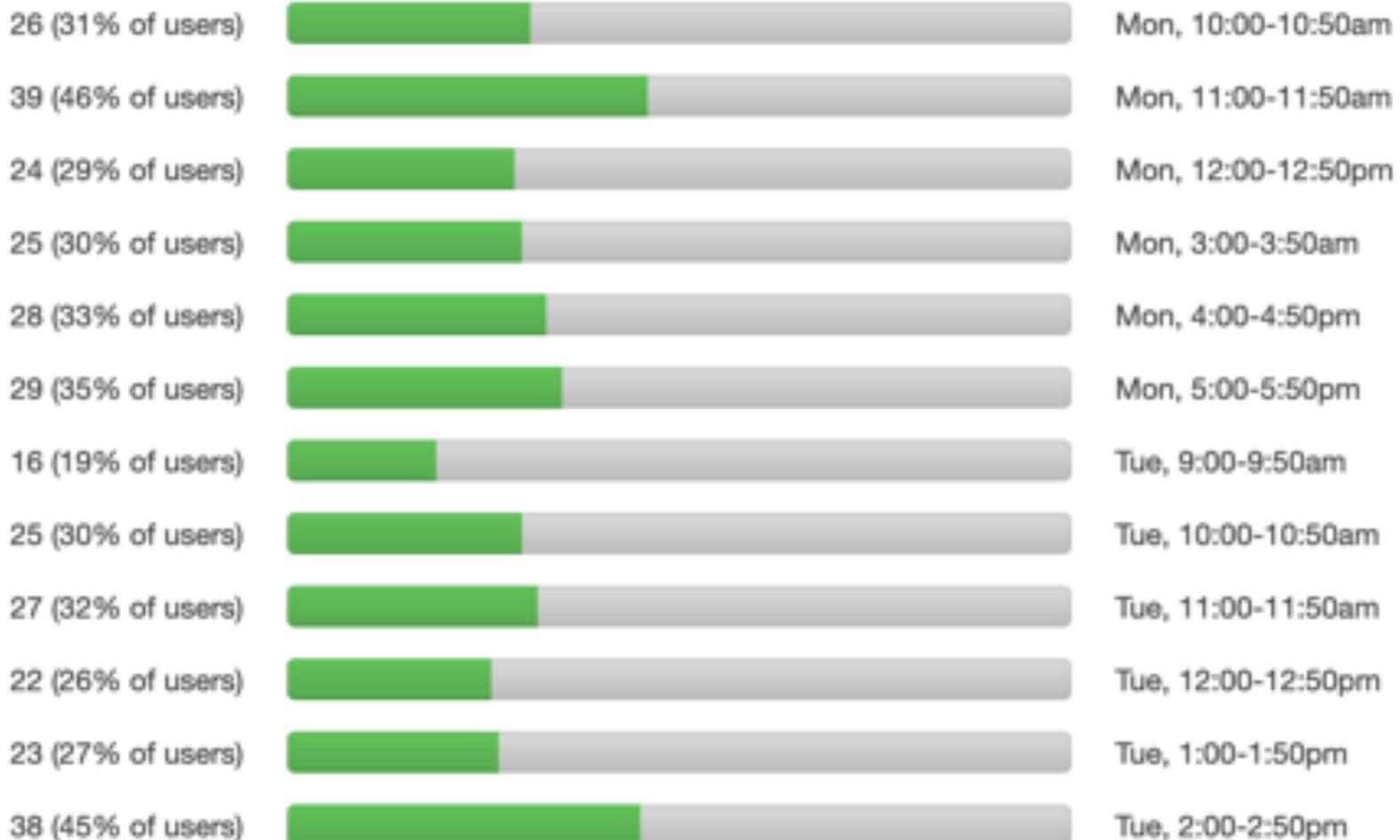
Below are some approved Wikipedia pages (in addition to those that are already linked to in other pages in the [CSE 331 Fall 2018 web page](#)).

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

# TA Office hours finalized today

## TA office hours (YOU decide!) closes in 5 day(s)

A total of 84 vote(s) in 47 hours



# Questions/Comments?



Why should I care ?



# 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.

[8,6,7,5,3,0,9] );

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.

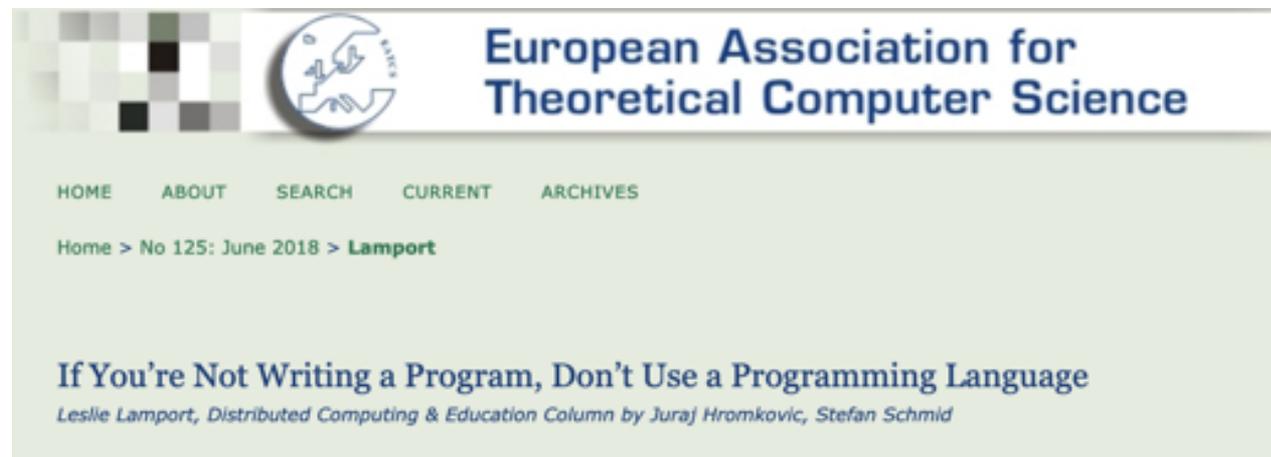
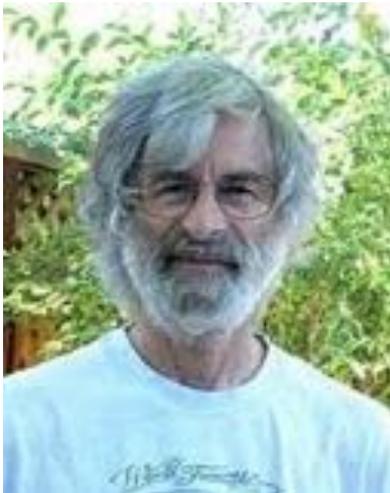
Photo: Kim Martineau

## 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!

A screenshot of the European Association for Theoretical Computer Science website. The header features a logo on the left, a navigation menu with links for HOME, ABOUT, SEARCH, CURRENT, and ARCHIVES, and the title "European Association for Theoretical Computer Science" on the right. Below the navigation, there is a breadcrumb trail: "Home > No 125: June 2018 > Lamport". The main content area displays the title "If You're Not Writing a Program, Don't Use a Programming Language" and the author information "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.***

Let the fun begin!





# Why care about algorithms?

The screenshot shows the Amazon.com homepage with a navigation bar at the top. The main content area is divided into two sections: Electronics Bestsellers and Toys & Games Bestsellers. The Electronics section lists three Kindle devices, and the Toys & Games section lists three items: a yellow banana, a toy set with two children, and a bag of colorful candies.

**amazon.com** Hello, Ash Rattan. We have recommendations for you. (0/21,827)  
Ad's Amazon.com | Today's Deals | Gifts & Wish Lists | Gift Cards

FREE Two-Day Shipping for College  
Reviewed by Amazon  
Your Account | Help

Shop All Departments Search All Departments Cart Wish List

Bestsellers Hot New Releases Movers & Shakers Most Gifted Most Wanted For

**Any Category:**  
Amazon Video On Demand  
Automotive  
Baby  
Beauty  
Books  
Camera & Photo  
Cell Phones & Service  
Clothing  
Computer & Accessories  
Electronics  
Grocery & Gourmet Food  
Health & Personal Care  
Home & Garden  
Home Improvement  
Industrial & Scientific  
Jewelry  
Kindle Store  
Kitchen & Dining  
Magazines  
Movies & TV  
MP3 Downloads  
Music  
Musical Instruments  
Office Products  
Patio, Lawn & Garden

**Bestsellers**  
The most popular items on Amazon.com (Updated hourly)

**Electronics Bestsellers**

1. 26 days in the top 100  
  
Kindle Wireless Reading Device, Wi-Fi, 6" Display, Graphite... Latest Generation by Amazon
2. 28 days in the top 100  
  
Kindle 3G Wireless Reading Device, Free 3G + Wi-Fi, 6" Display, Graphite, 3G Works Globally... Latest Generation by Amazon
3. 24 days in the top 100  
  
Kindle 3G Wireless Reading Device, Free 3G + Wi-Fi, 6" Display, White, 3G Works Globally... Latest Generation by Amazon

[See all bestsellers in Electronics](#)

**Toys & Games Bestsellers**

1. 712 days in the top 100  

2. 2 days in the top 100  

3. 112 days in the top 100  


Computing Bestsellers on the fly

# Why care about algorithms?

Welcome - Already a member? | Sign In | My Itineraries | My Account | Customer Support | Feedback

Home Vacation Packages Hotels Cars **Flights** Cruises Activities DEALS & OFFERS Maps Business Travel

### Buffalo, NY (BUF) to Atlanta, GA (ATL)

These results cover a metro area with several airports. Review your choices carefully.

	Mix & Match Airlines	US Airways	Go! from AirTran Airways	Delta	UNITED	Continental
Nonstop	from \$274 \$295 total see below	—	from \$274 \$295 total	from \$283 \$305 total	—	—
1 stop	from \$254 \$293 total see below	from \$254 \$293 total	from \$241 \$373 total	—	from \$282 \$326 total	from \$282 \$326 total

Prices are per person for roundtrip travel; they are e-ticket prices and include all flight taxes and fees. Prices do not include baggage fees or other fees charged directly by the airline.

**No Expedia booking fees on flights PLUS you still earn airline miles!**

**1 Choose a departing flight** or view complete roundtrips

Sort by: Price Duration Departure time Arrival time

**Roundtrip: from \$254.00 + \$39.80 taxes & fees = \$293.80**

6:25 am Depart Buffalo (BUF)  
Arrive Atlanta (ATL) 10:39 am  
Sun 21-Nov  
Duration: 4hr 14min  
US Airways 1656 / 29  
Connect in Charlotte (CLT)

Don't spend too much on this flight. Book as a package and save up to \$450\*. Shop Now

**Roundtrip: from \$254.00 + \$39.80 taxes & fees = \$293.80**

7:05 pm Depart Buffalo (BUF)  
Arrive Atlanta (ATL) 11:27 pm  
Sun 21-Nov  
Duration: 4hr 22min  
US Airways 959 / 1897  
Connect in Charlotte (CLT)

Booking cheapest air tickets

# Why care about algorithms?

Web [Images](#) [Videos](#) [Maps](#) [News](#) [Shopping](#) [Gmail](#) [more](#) ▼



About 176,000,000 results (0.19 seconds) [Advanced search](#)

**Everything**  
▼ [More](#)

**Any time**  
[Past 2 months](#)  
▼ [More search tools](#)

[How Does Google Work? Learn How Google Works: Search Engine + AdWords](#) ☆  
OMG infographic shows the search process, from indexing right on through to search result ranking & delivery.  
[ppcblog.com/how-google-works/](#) - [Cached](#)

[Google Technology](#) ☆  
How exactly **does Google** manage to find the right results for every query as quickly as ...  
Building upon the breakthrough **work** of B. F. Skinner, ...  
[www.google.com/technology/pigeonrank.html](#) - [Cached](#) - [Similar](#)

[How Google Works](#) ☆  
How **Google Works**. As a company, **Google** focuses on three key areas: Search, ... (See also  
How the **Google Ad Auction Works** or learn more about **Google ads**.) ...  
[www.google.com/howgoogleworks/](#) - [Cached](#)  
✚ [Show more results from www.google.com](#)

[How Does Google Work? | SEO Book.com](#) ☆  
Jun 30, 2010 ... This image might need updated in the years to come, but it **does** a great job  
laying out how **Google works** when you type a query into their ...  
[www.seobook.com/how-does-google-work](#) - [Cached](#)

[How does Google work - PageRank explained | Switch I.T.](#) ☆  
How **does Google work** - PageRank explained. Ben Richardson - March 2005. Many people  
are under the impression that if they create a web site with a catchy ...  
[www.switchit.com/news/improve-pagerank.asp](#) - [Cached](#) - [Similar](#)

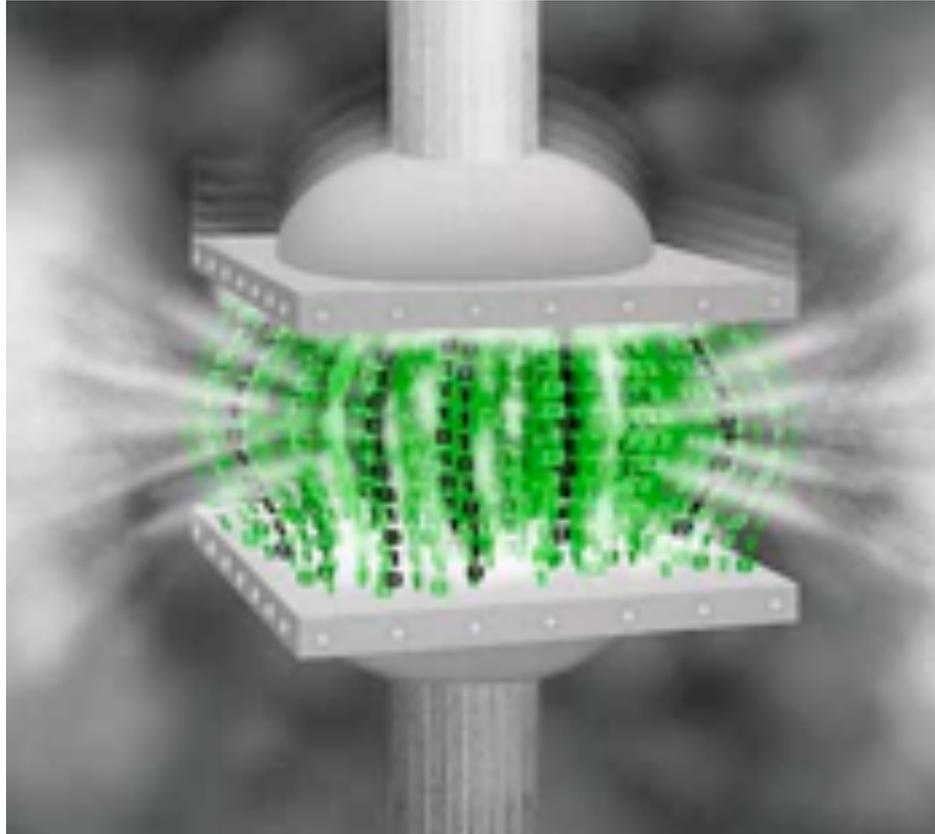
[How Google Works - Google Guide](#) ☆  
Feb 2, 2007 ... For more information on how **Google works**, take a look at the following ...  
**How does Google** collect and rank results?, [www.google.com/](#) ...  
[www.googleguide.com](#) - Part II: Understanding Results - [Cached](#) - [Similar](#)

[How Does Google Work](#) ☆  
Google is the undisputed king of the search engines. This leads to the question of **how does  
Google work?**  
[www.marketingllan.com/how\\_does\\_google\\_work](#) - [Cached](#) - [Similar](#)

[Google: How does it work? by Jon Burgess of RedFusion Media](#) ☆

Google searches

# Why care about algorithms?



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

## Data compression

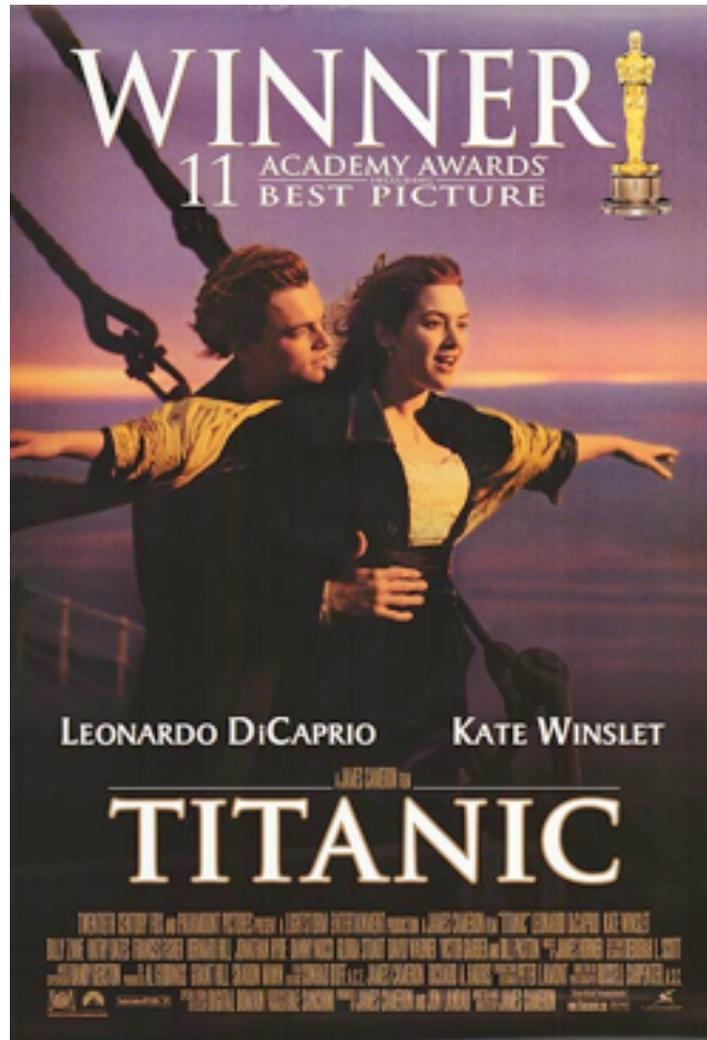
# Why care about algorithms?



<http://www.switched.com/2010/02/11/fix-dvd-scratches-using-a-banana-and-toothpaste/> courtesy: Unliggs

## Error correction

(And I could) go on...



<http://www.movieposter.com/poster/MPW-33672/Titanic.html>

# Find out for yourself

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

## CSE 331 Mini Project

Fall 2019

Details and motivations for the mini project.

### Under Construction

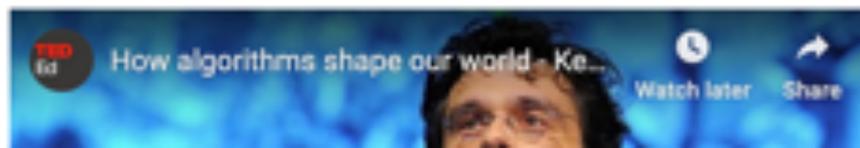
This page is still under construction. In particular, nothing here is final while this sign still remains here.

## 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?



# Who is Algorithm named after?

Abū ‘Abd Allāh Muhammad ibn Mūsā al-Khwārizmī

9<sup>th</sup> century Persian astronomer/mathematician

825 AD: “On Calculation with Arabic Numerals”



Latin translation 12<sup>th</sup> century

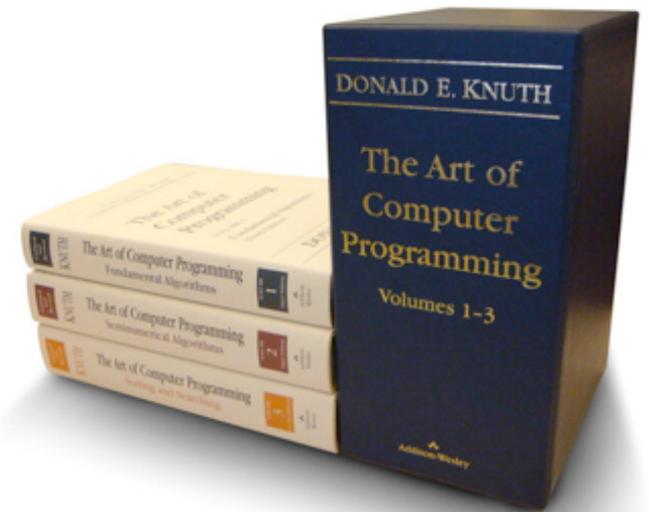
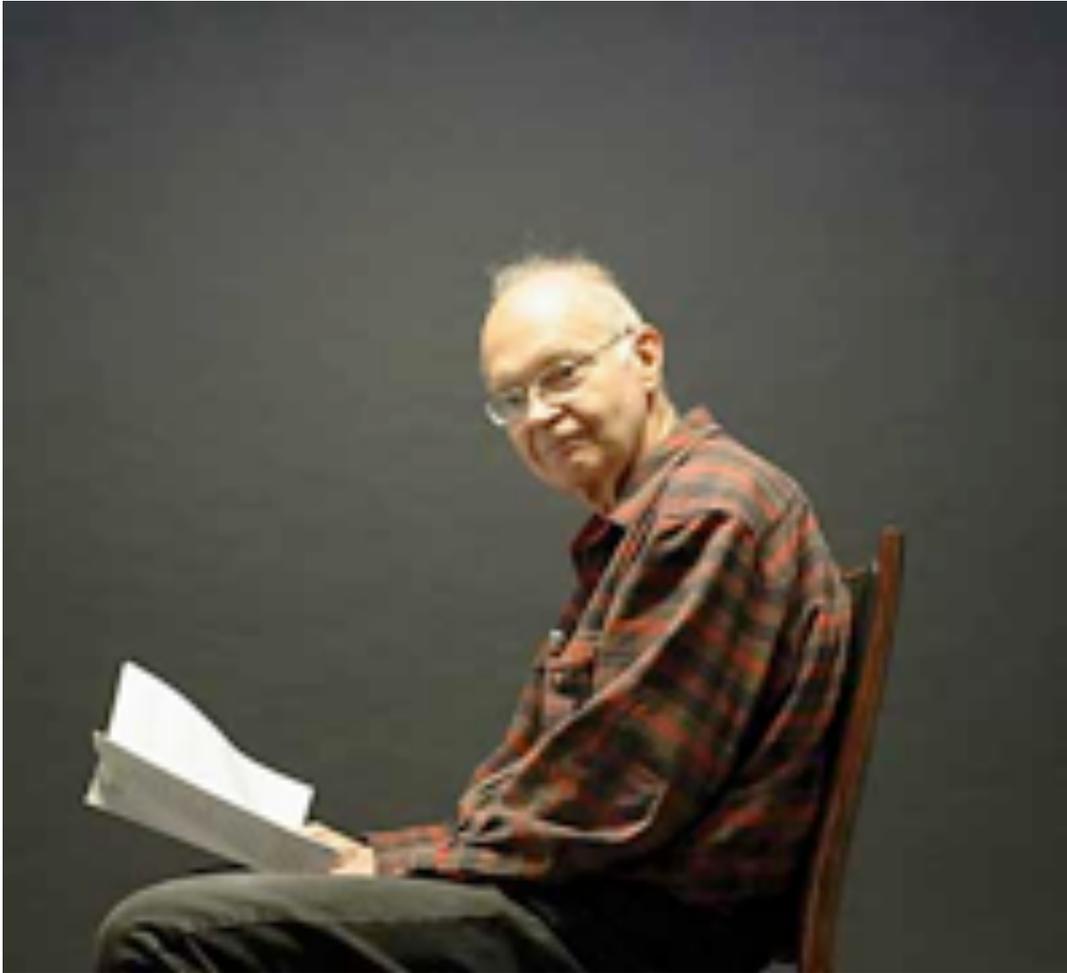
“Algorithmi de numero Indorum”



# What are Algorithms?



# Don Knuth



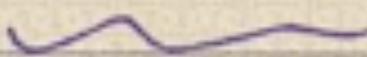
# Don Knuth Reward Checks

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

432

DATE 29 Oct 2008

DEPOSIT TO THE ACCOUNT OF Tony Lu 0x\$ 1.00

One and  100/256 HEXADECIMAL DOLLARS 

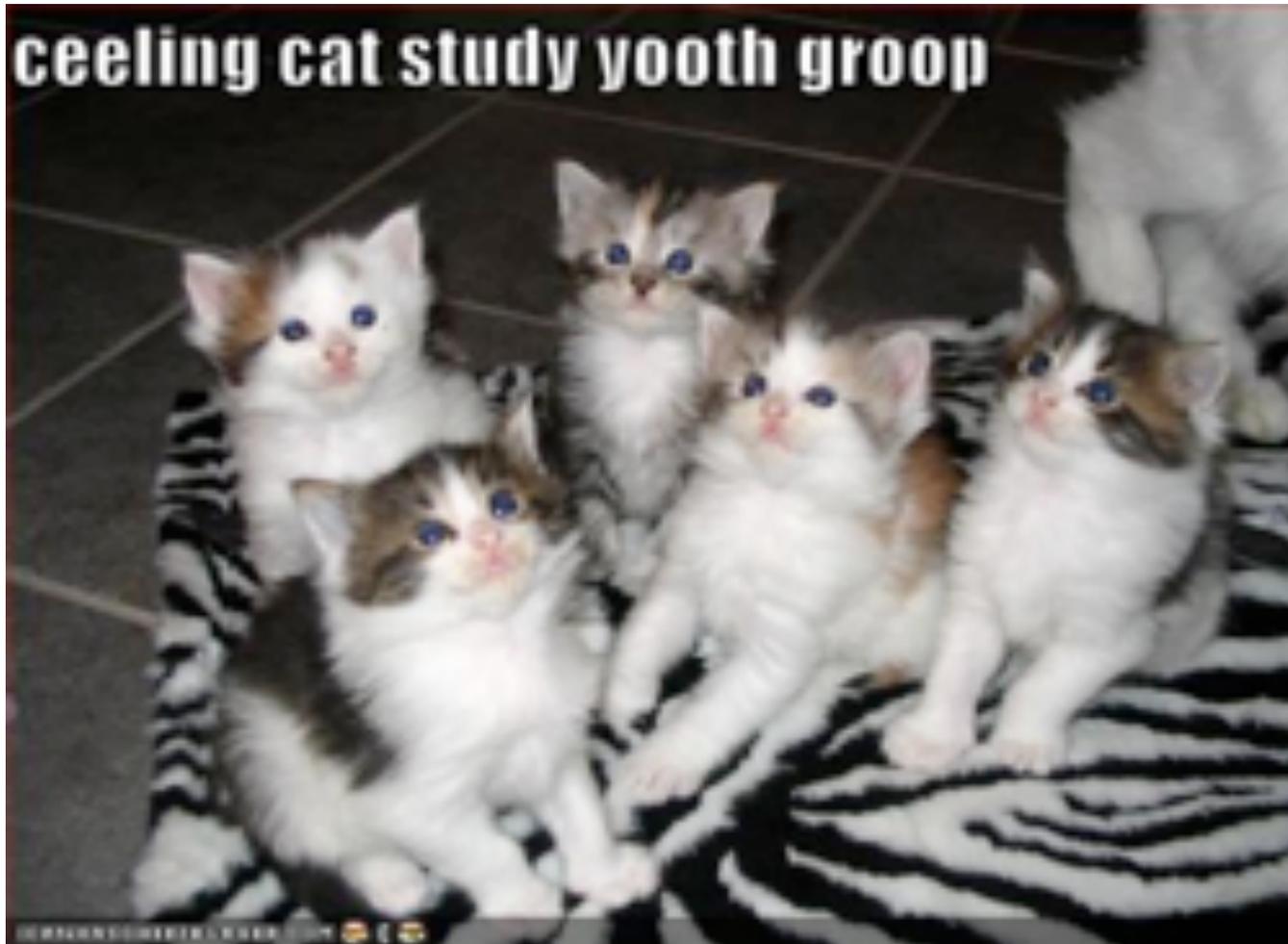
 BANK OF SAN SERRIFFE  
Thirty Points, Calissa Inferiore  
<http://www-cs-faculty.stanford.edu/~knuth/booss.html>

MEMO f2b.135 Donald Knuth

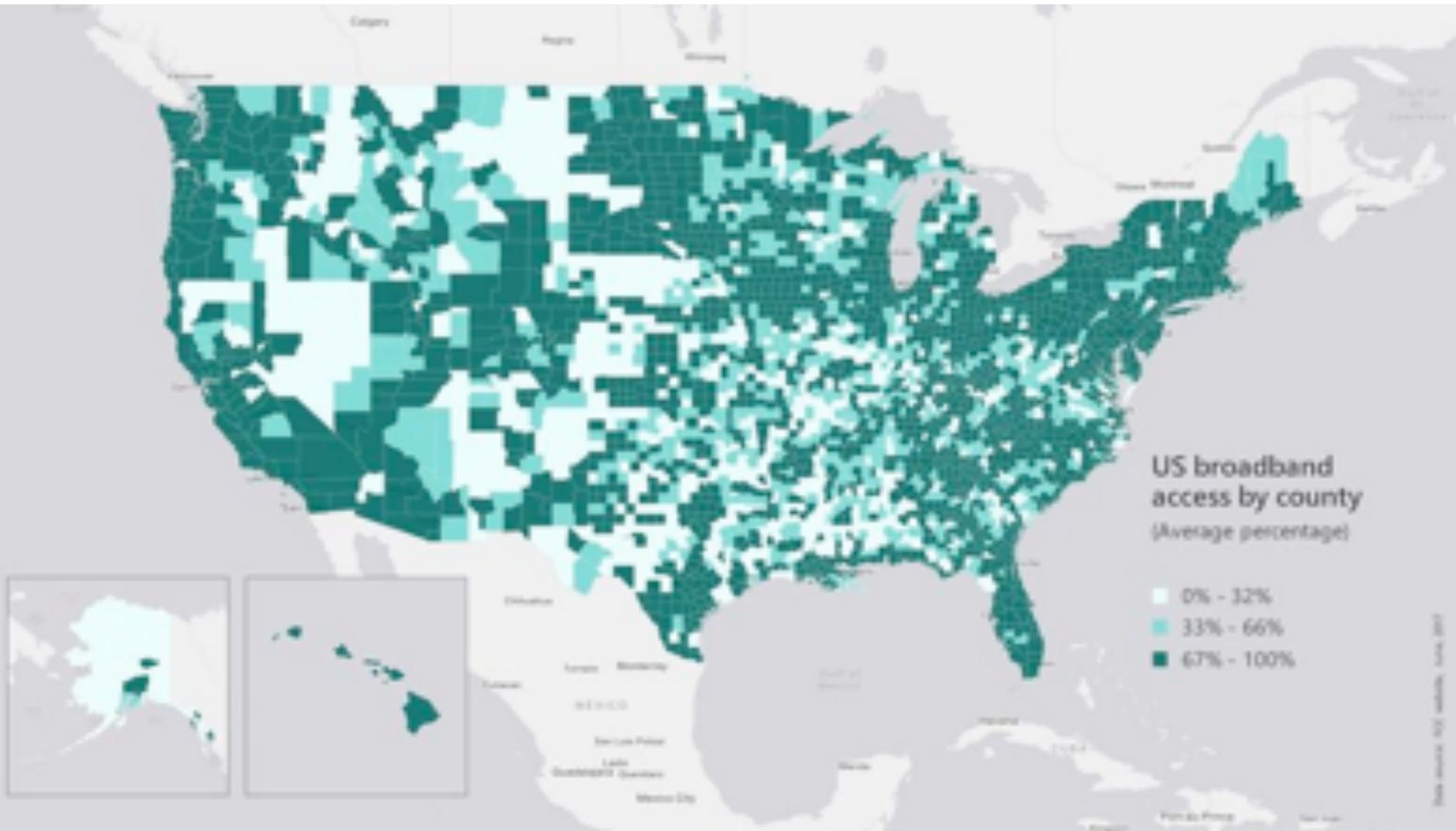
# Knuth's Definition

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

Remember: Stick with your group

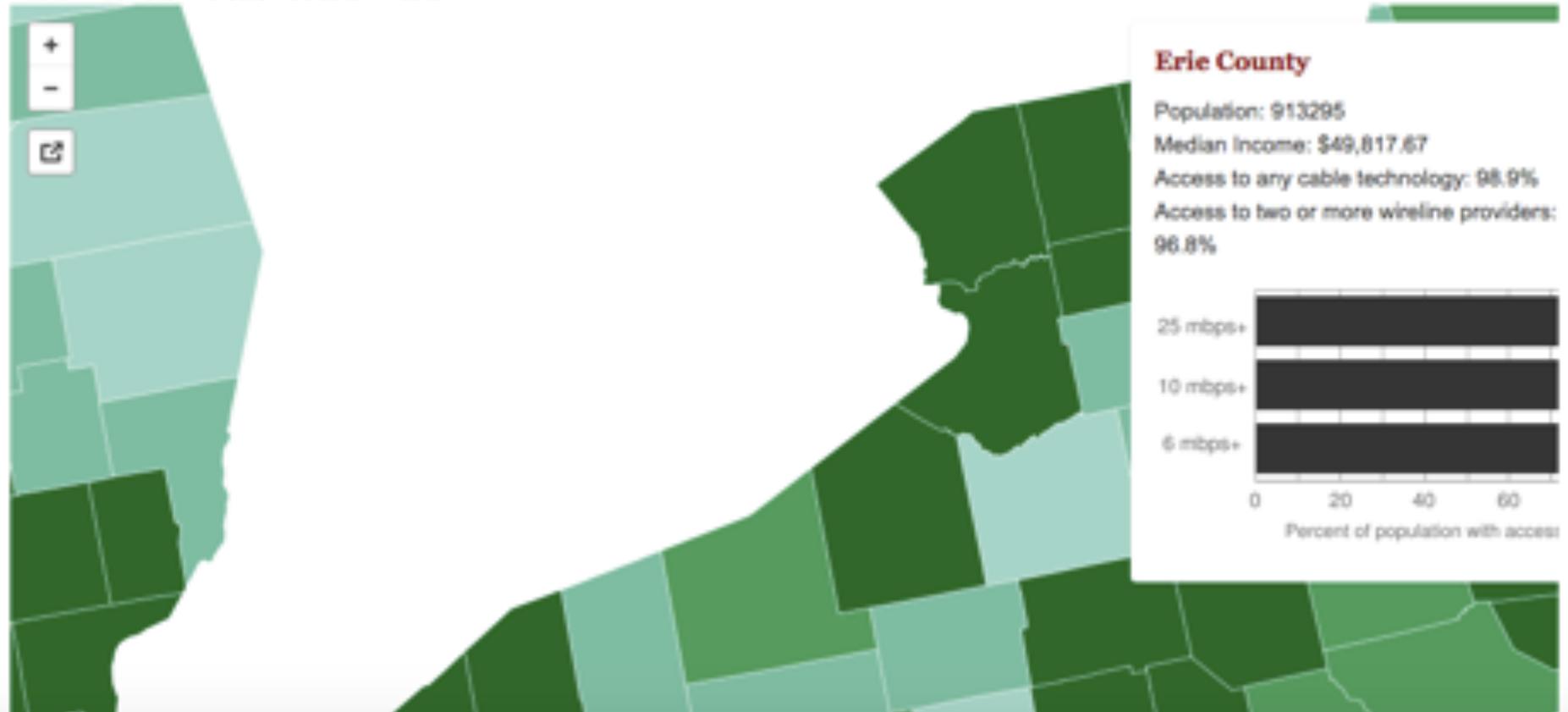


# Broadband access



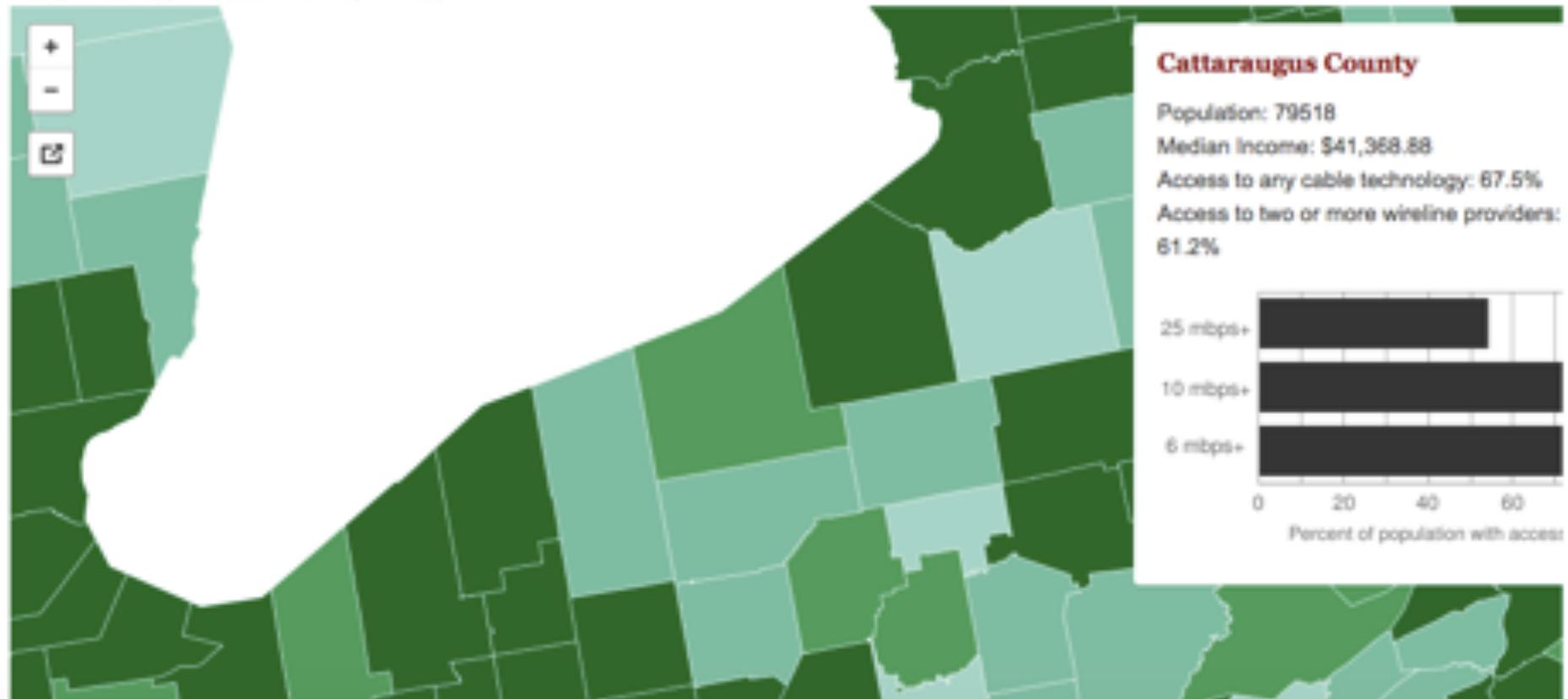
# Erie county is reasonably good

Population with access to advertised download speeds at least 6mbps



# One county over

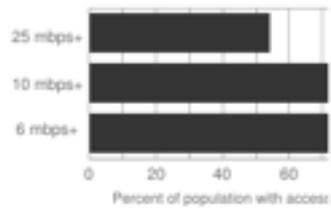
Population with access to advertised download speeds at least 6mbps



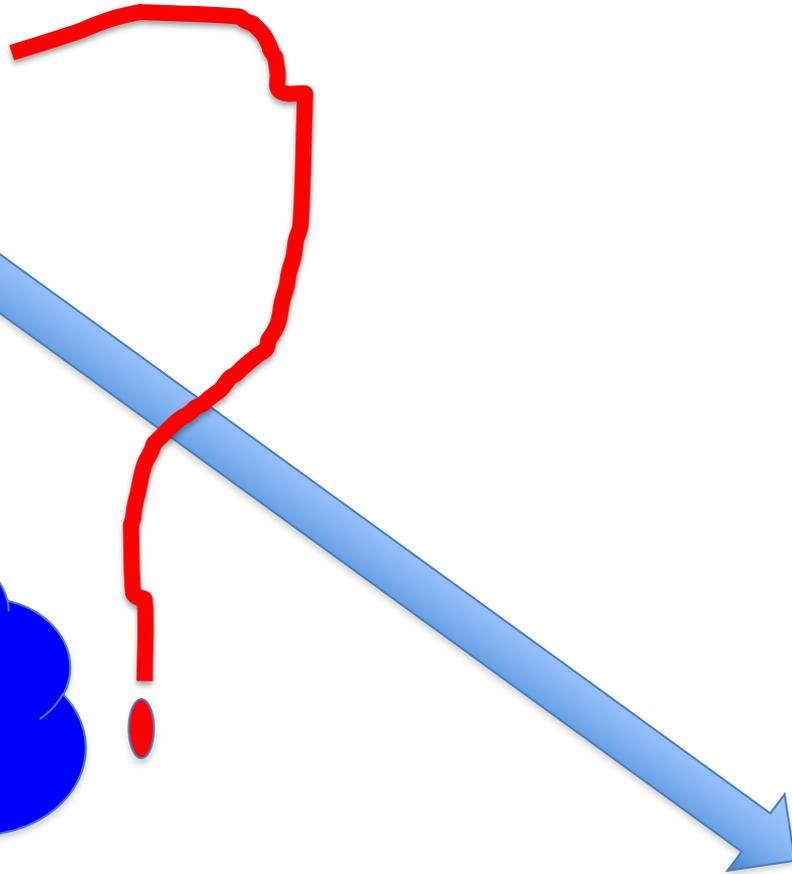
# Make broadband more available

## 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%

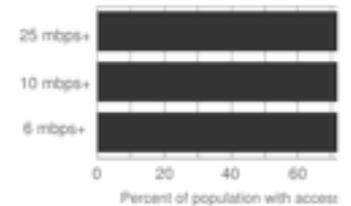


Say you are tasked to come up with the infrastructure

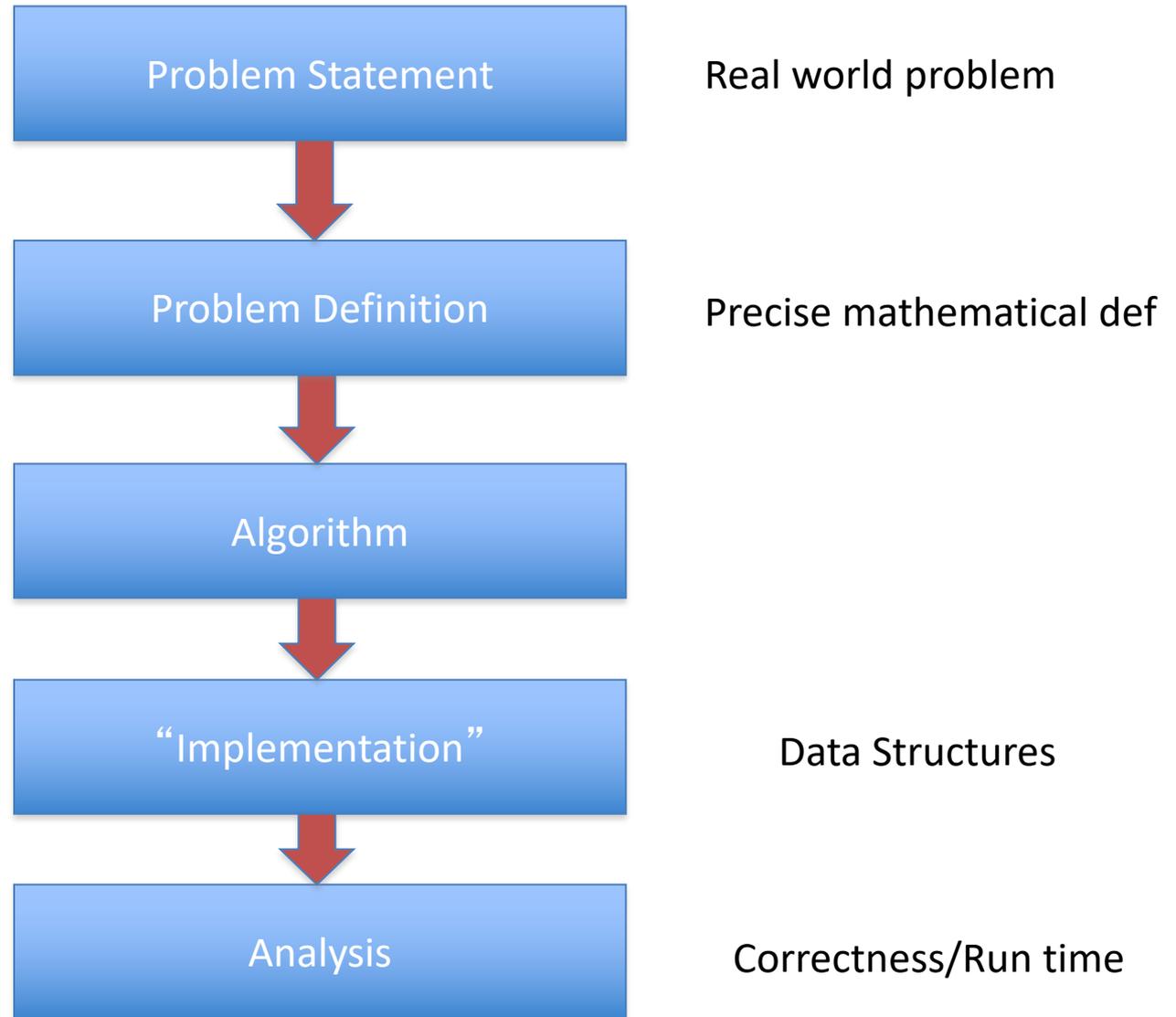


## Erie County

Population: 913296  
Median Income: \$49,817.67  
Access to any cable technology: 98.9%  
Access to two or more wireline providers: 96.8%



# Main Steps in Algorithm Design



# Worst-case analysis

Correctness should hold for every valid input



Why worst-case?

Resource usage by the worst-possible input



What  
resources?

# Questions/Comments?



# National Resident Matching

**THE MATCH**  
NATIONAL RESIDENT MATCHING PROGRAM

RESIDENCY

FELLOWSHIP

POLICIES

DATA AND REPORTS

ABOUT

Search

MATCH CALENDARS

LOGIN/REGISTER

## Preparing for #Match2018?

**Frequently  
Asked  
Question**

**An NRMP ID is  
NOT Required for  
Submitting Your  
Applications**

[>> Learn more](#)

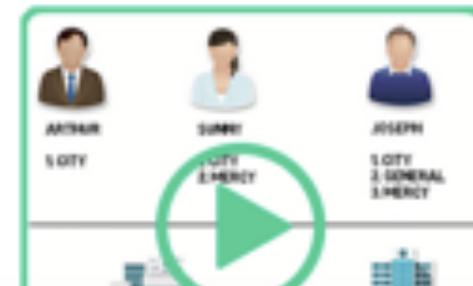
### WHAT'S HAPPENING

- Check the Eligibility of Applicants
- Registration Open for Adolescent Medicine, Medical Toxicology, and Headache Medicine
- Timely Residency Applicant Resources
- Registration Open for Colon & Rectal Surgery, Medical Genetics, Sleep Medicine, and Spinal Cord Injury

[READ MORE](#)



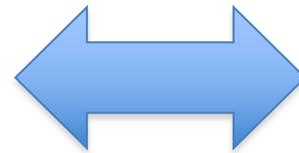
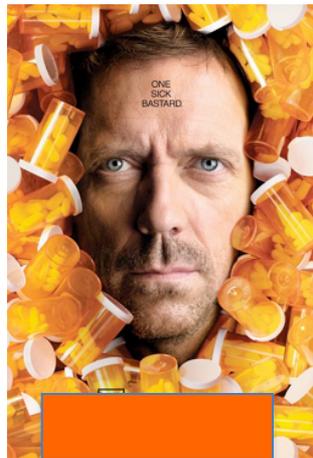
**VIDEO: The Match Process for Applicants**



# (Screen) Docs are coming to BUF



Bailey (Grey's Anatomy)



Buffalo General



Millard Filmore (Gates Circle)

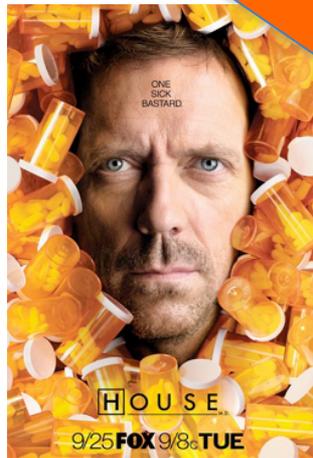


Millard Filmore (Suburban)

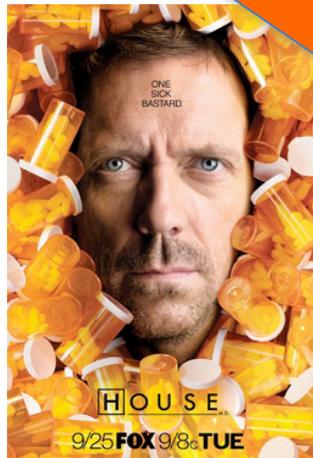


JD (Scrubs)

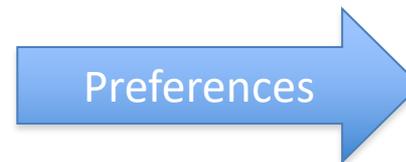
# What can go wrong?



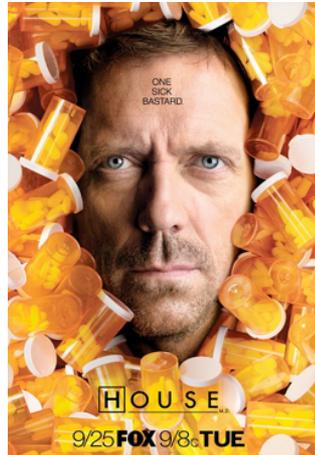
# The situation is unstable!



# What happens in real life



# NRMP plays matchmaker



# Stable Matching Problem



David Gale



Lloyd Shapley