

Lecture 2

CSE 331

Aug 29, 2018

Enroll on Piazza

University at Buffalo - Fall 2018

CSE 331: Introduction to Algorithm Analysis and Design

+ Add Syllabus

Course Information

Staff

Resources

Description

Edit

Add a Class Description

Click the Edit button to add a class description.

General Information

Edit

One stop shop

For your CSE 331 needs go to <http://www-student.cse.buffalo.edu/~atri/cse331/fall18/>

Announcements

+ Add

Welcome to CSE 331!

Edit

Delete

8/19/15 11:00 AM

Welcome to the Fall 2018 edition of CSE 331. It'll be a fun course and I'm looking forward to it.

Please use the Q&A portion of Piazza to ask questions. In fact, unless your query is personal, we will not answer the question unless it is posted on Piazza.

Pretty much everything that you need to know about the course can be found on the [CSE 331 webpage](#).

In particular, I will draw your attention to the [syllabus](#), [HW policies](#) and the [support pages](#). Happy Reading!
[View on Piazza](#)

<https://piazza.com/buffalo/fall2018/cse331/>

Please do keep on asking Qs!

note ☆ stop following 119 views

Great job asking Questions

Today's lecture was probably the most interactive lecture 1 of CSE 331 ever, which was awesome! I hope the trend will continue throughout the semester :-)

Also a fair number of you stopped by my office hour today, which is also great! Please make full use of them for the rest of the semester too.

lectures

- An instructor (Mehmet Ozdemir) thinks this is a good note -

edit good note | 1 Updated 1 day ago by Atri Rudra

Anyone missing their umbrella?

note ☆ stop following 86 views

Missing umbrella found in Norton 112

An umbrella was found in Norton 112. If you had left it in the room by mistake please stop by Davis Hall and check with Diane VanNatter in the CSE department main office.

She'll hang on to it for a few days, and then have it sent to the UB Police's lost and found in Bissell Hall.

logistics

edit good note 0 Updated 11 hours ago by Abri Rudra

Read the syllabus CAREFULLY!

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

↑ > CSE381: Introduction to Algorithm Analysis and Design (718) > Syllabus Quiz

Syllabus Quiz

Admin Options


CA Options


Options

[View handin history](#)

[View writeup](#)

[Download handout](#)

 Due: **December 7th 2018, 9:06 pm**

 Last day to handin: **December 7th 2018, 9:06 pm**

You can submit the following now

🏠 » CSE331: Introduction to Algorithm Analysis and Design (f18)

Assignments

Homework 0
Q1 (Sorting)
Q2 (Number of Perfect Matchings)

Quiz
Syllabus Quiz

[Autolab Project](#) - [Contact](#) - [GitHub](#) - [Facebook](#) - [Logout](#)

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

• 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](#) [↗](#).
- [Dinic's algorithm](#) [↗](#).

TA Office hours finalized today

TA office hours (YOU decide!) closes in 4 day(s)

A total of 81 vote(s) in 61 hours

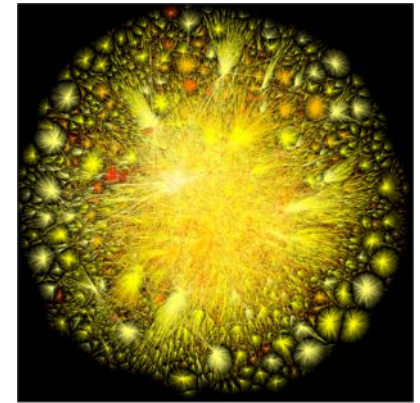
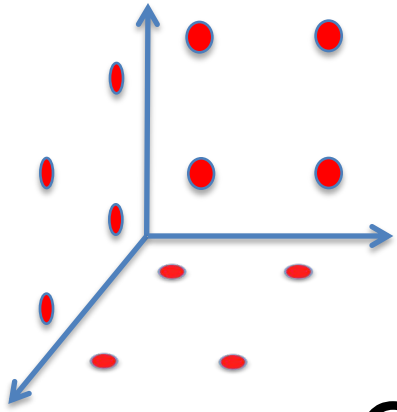


Questions/Comments?



Let the fun begin!





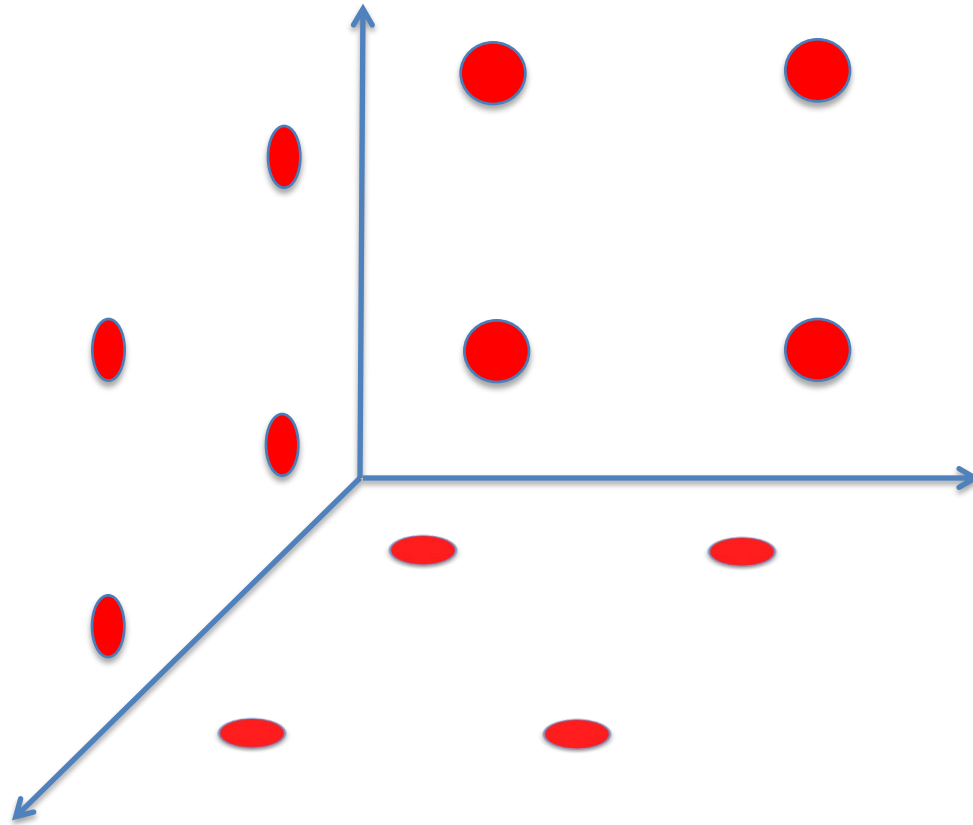
Combining Shadows to Understanding the network



LogicBlox

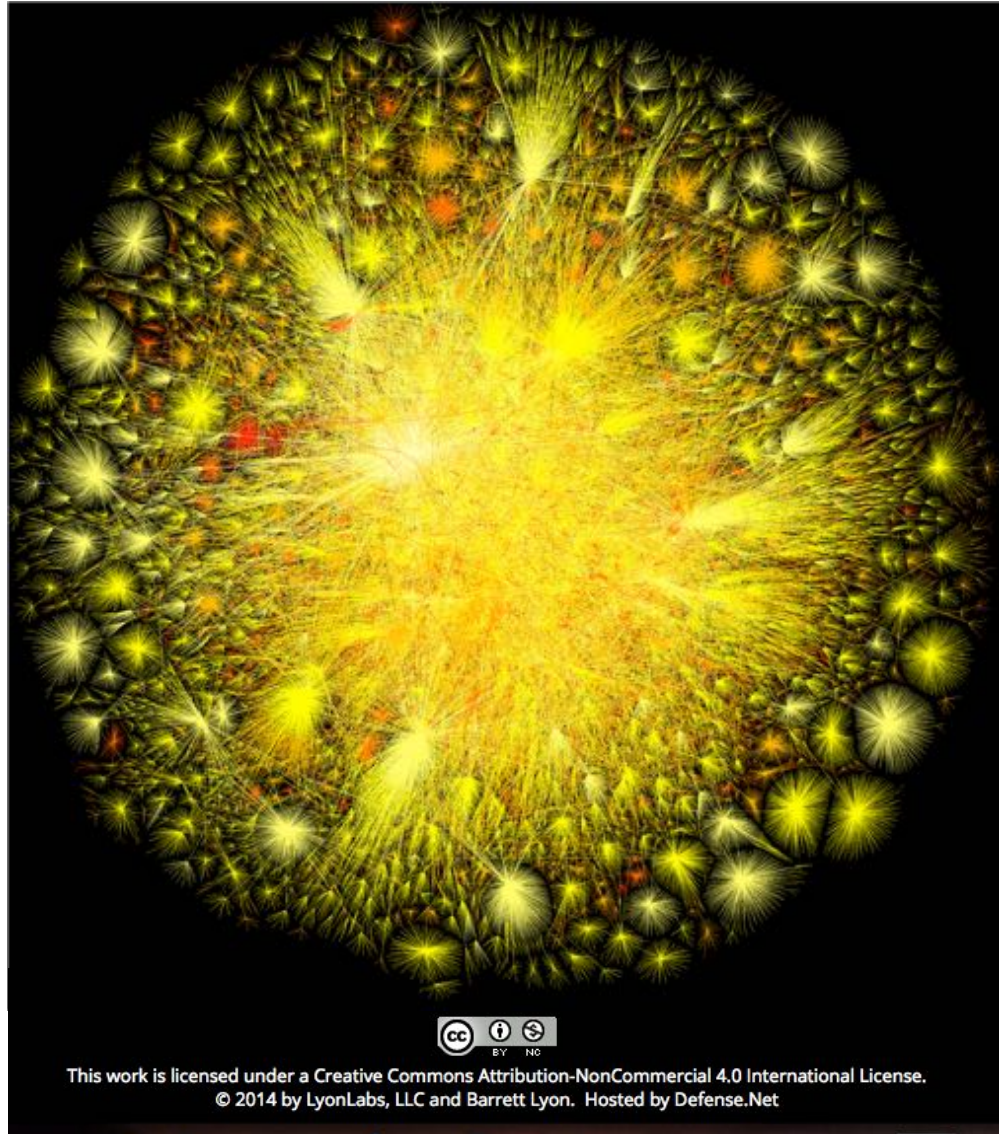
Stanford
University

The key technical problem



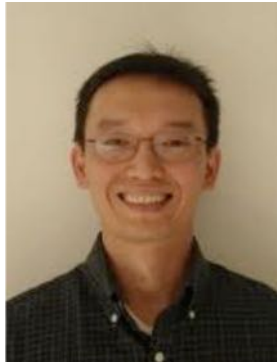
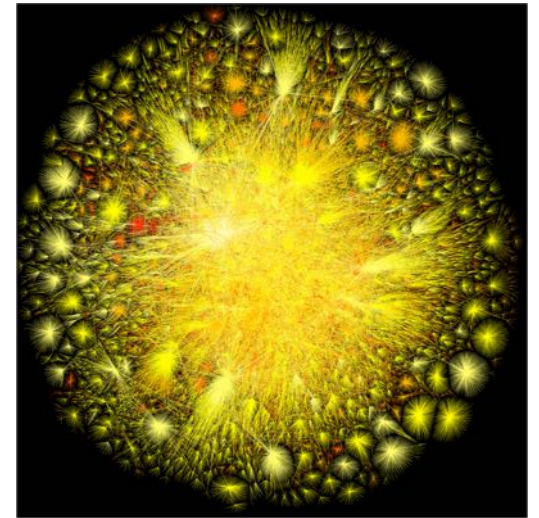
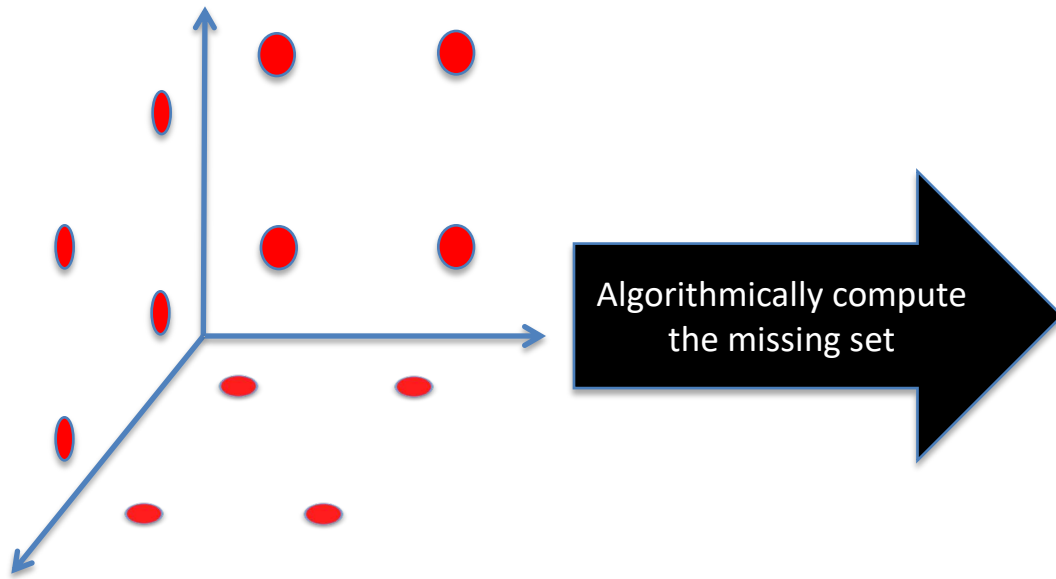
Given the three projections, what is the largest size of the original set of points?

Detecting Communities



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.
© 2014 by LyonLabs, LLC and Barrett Lyon. Hosted by Defense.Net

Conquering Shadows to Conquering the Internet



The proof is in the performance



EMPTYHEADED

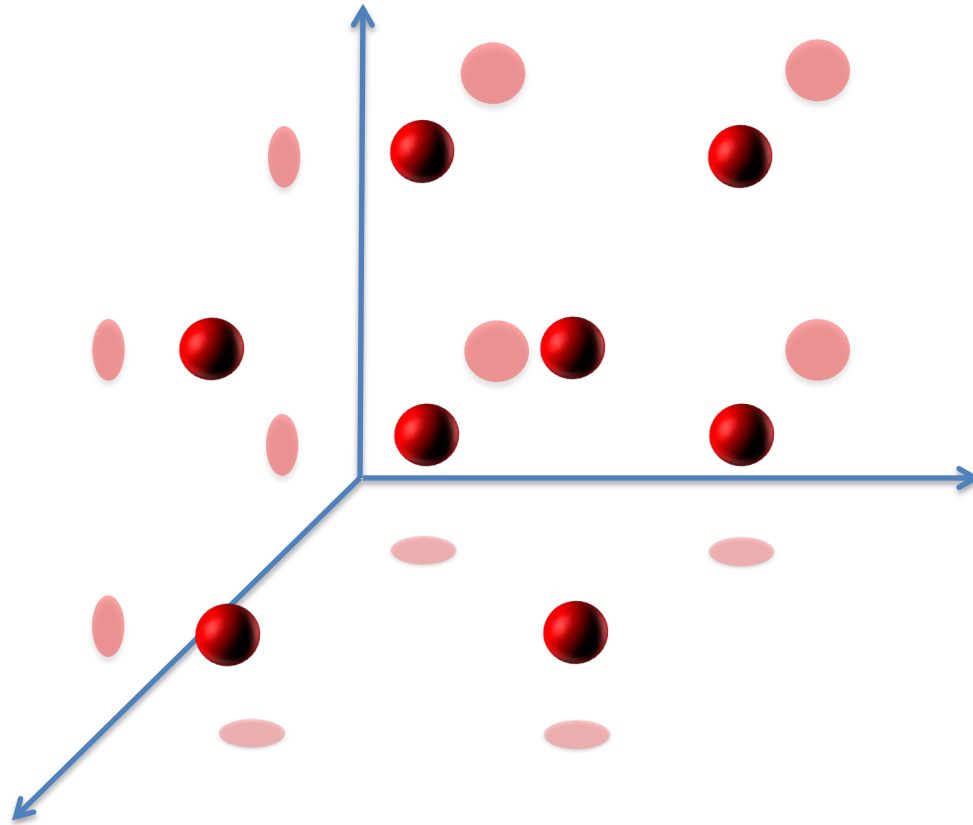


10x faster

A large, thick green arrow pointing from the EmptyHeaded side towards the Oracle side, indicating a performance advantage.

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: $4^{1.5} = 8$

If detecting communities is not for
you

Google™

Microsoft®



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.**”

Why care about algorithms?

Web Images Videos Maps News Shopping Gmail more ▾

atrudra@gmail.com | My Profile | News | Web History | My Account | Help | Sign out

Google maps seattle wa Search Maps Show search options

Get Directions My Maps

Driving directions to Buffalo, NY

I-90 E
2,587 mi 1 day 18 hours

This route has tolls.

Seattle, WA

1. Head southwest on Madison St toward 4th Ave 0.00 mi
2. Take the 1st right onto 4th Ave 0.02 mi
3. Take the 1st right onto Spring St 0.1 mi
4. Turn right onto the I-5 S ramp to Portland 0.3 mi
5. Follow signs for I-90 E/Bellevue/Spokane and merge onto I-90 E 0.17 mi
6. Take exit 510 for US-212 E toward Battlefield/Broadway/Little Bighorn 0.3 mi
7. Turn left at US-212 E 1.08 mi
8. Turn right at US-212 E/Park Ave 0.41 mi
9. Turn right at US-212 BUS BUS-45 S 0.4 mi
10. Turn left at S Dakota 34 E 17.5 mi
11. Turn left to merge onto S Dakota 34 E/I-90 E/US-14 E 0.47 mi
12. Take exit 196A to merge onto I-90 E 11.7 mi

seattle wa

Driving directions

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 Rathi. We have recommendations for you. (0/2,027)
Ari's Amazon.com | Today's Deals | Gifts & Wish Lists | Gift Cards

FREE Two-Day Shipping for College
Eligible 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. 26 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. 26 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

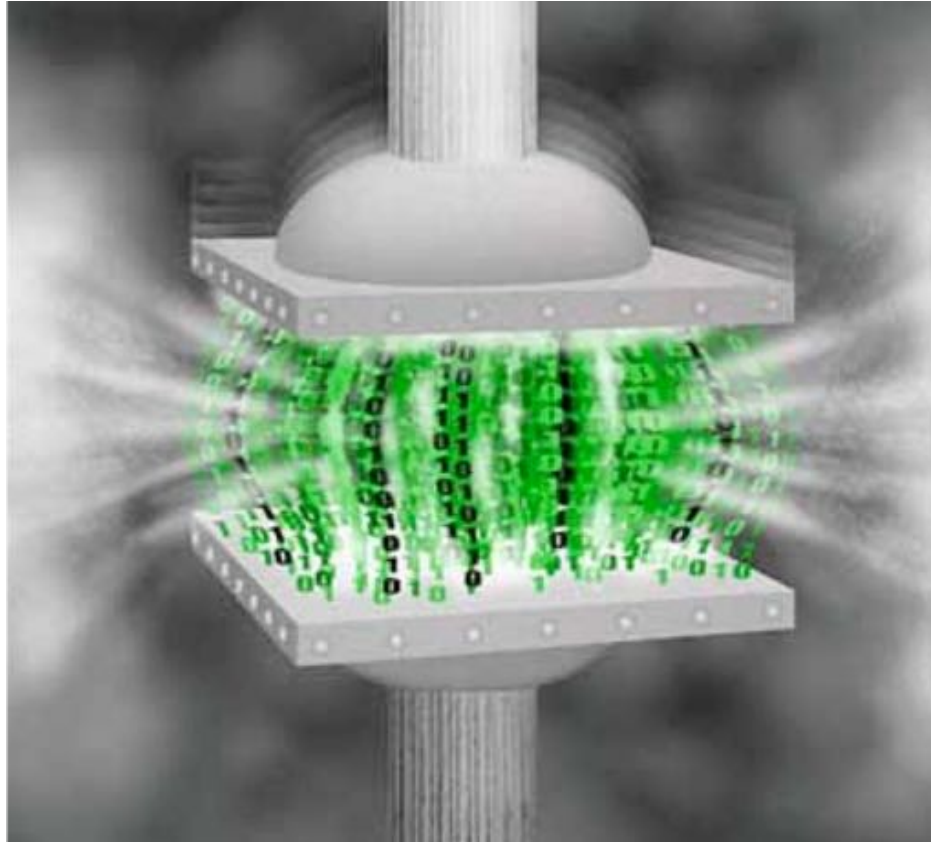
[How Google Works - Google Guide](#) ☆
Feb 2, 2007 ... For more information on how **Google works**, take a look at the following ...
How does Google collect and rank results?, [www.google.com/](#) ...
[www.googleguide.com](#) - Part II: Understanding Results - Cached - Similar

[How Does Google Work](#) ☆
Google is the undisputed king of the search engines. This leads to the question of **how does Google work**?
[www.marketingitan.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

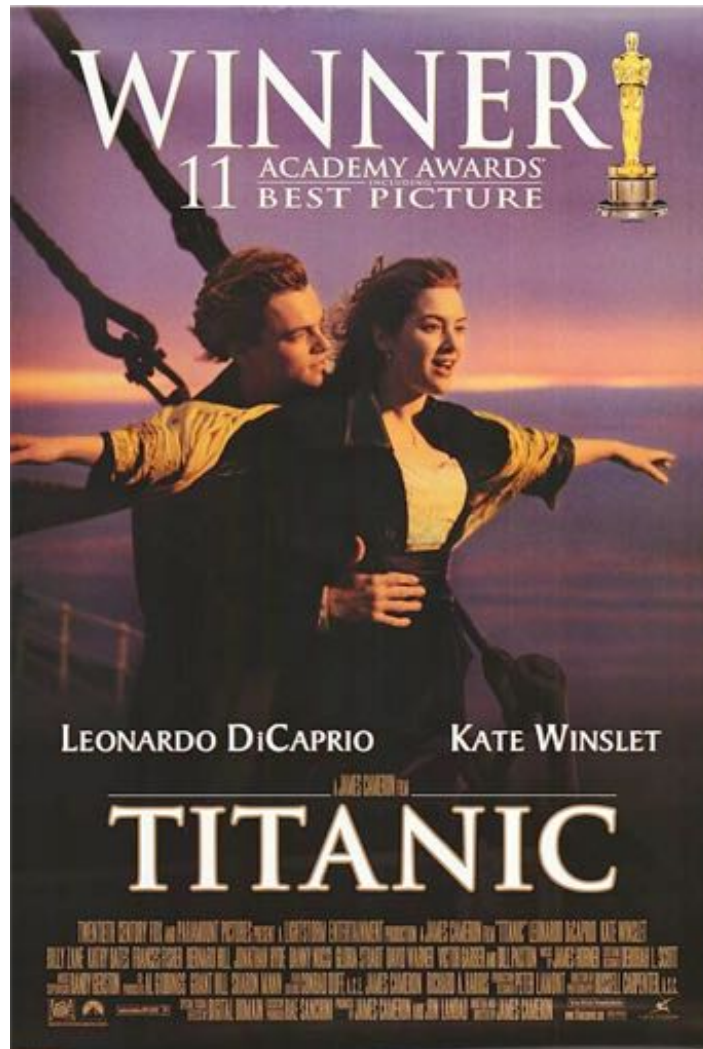
Why care about algorithms?



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

Error correction

(And I could) go on...



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

Find out for yourself

Mini project: Video on social impact of algorithm. Groups of size = 3

CSE 331 Mini Project

Fall 2018

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?



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”

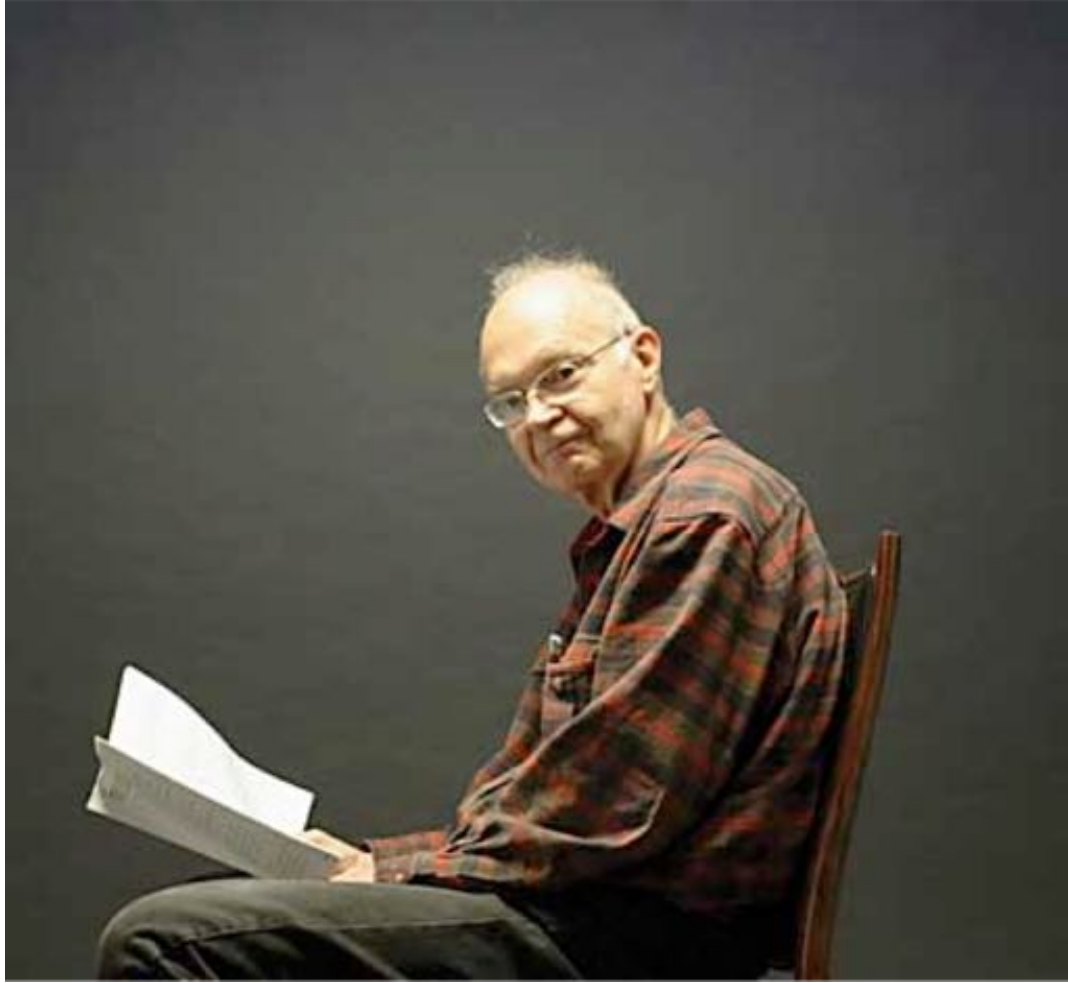


Latin translation 12th century

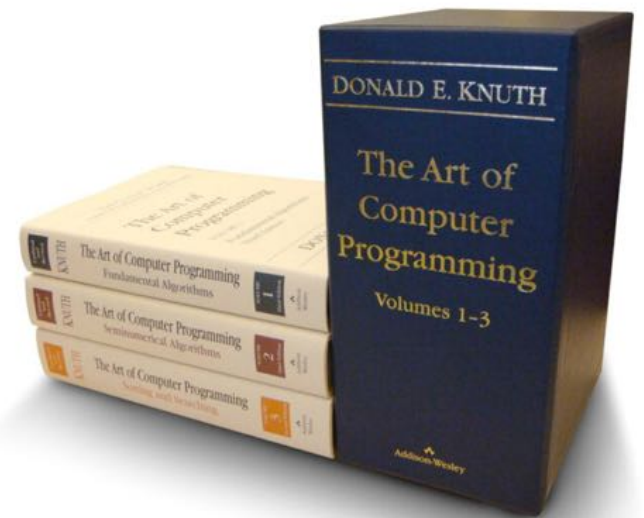
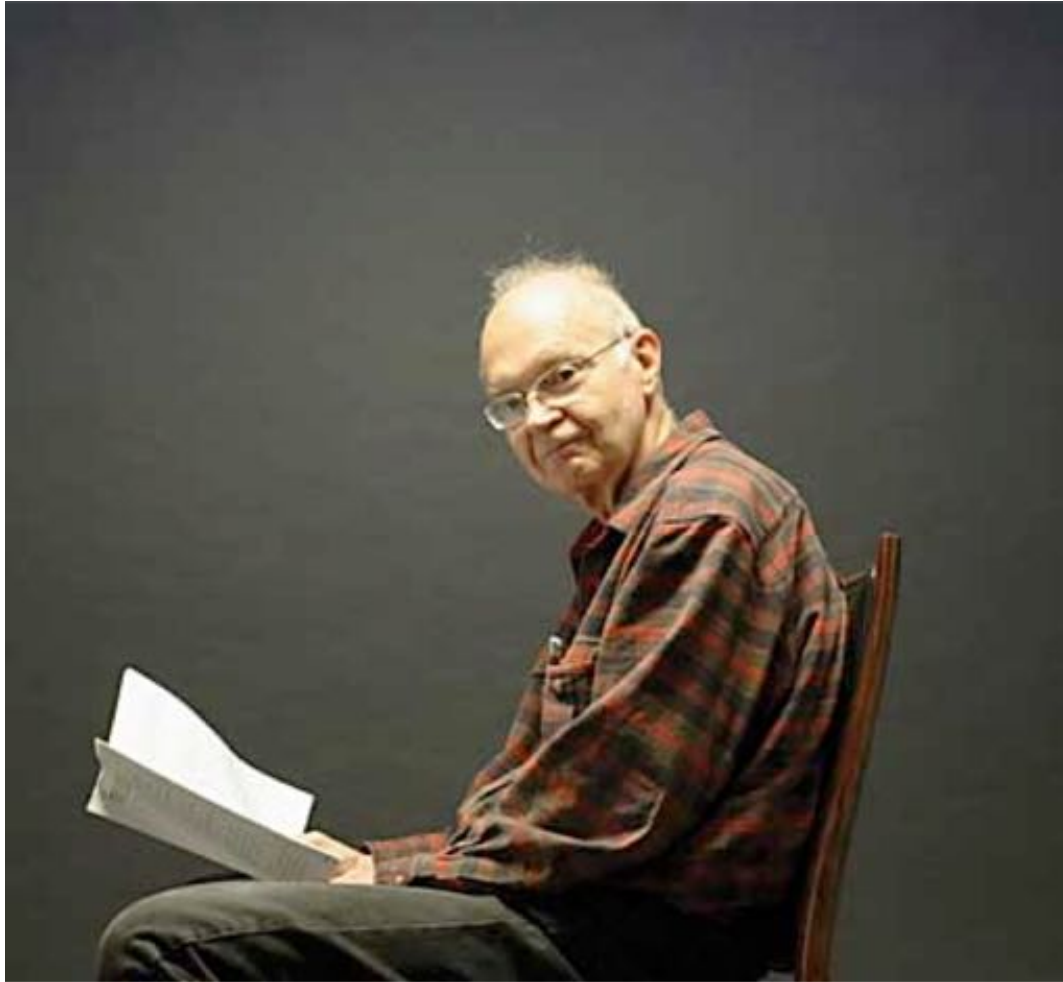
“Algorithmi de numero Indorum”




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 0x\$ 1.00

One and  100/256 HEXADECIMAL DOLLARS 

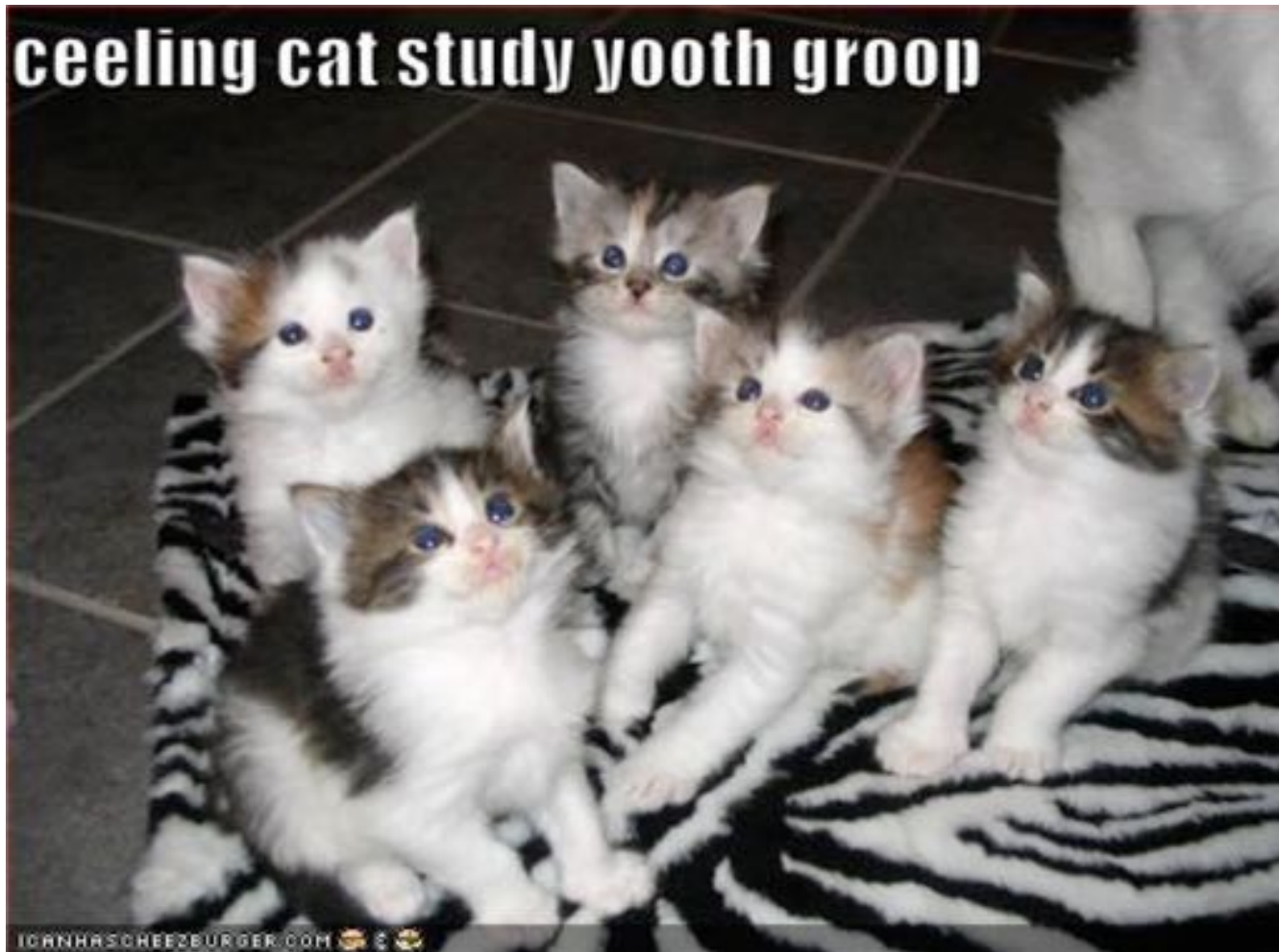
 BANK OF SAN SERRIFFE
Thirty Point, Caissa Inferiore
<http://www-cs-faculty.stanford.edu.ca/~knuth/boss.html>

MEMO f1b.135 Donald Knuth

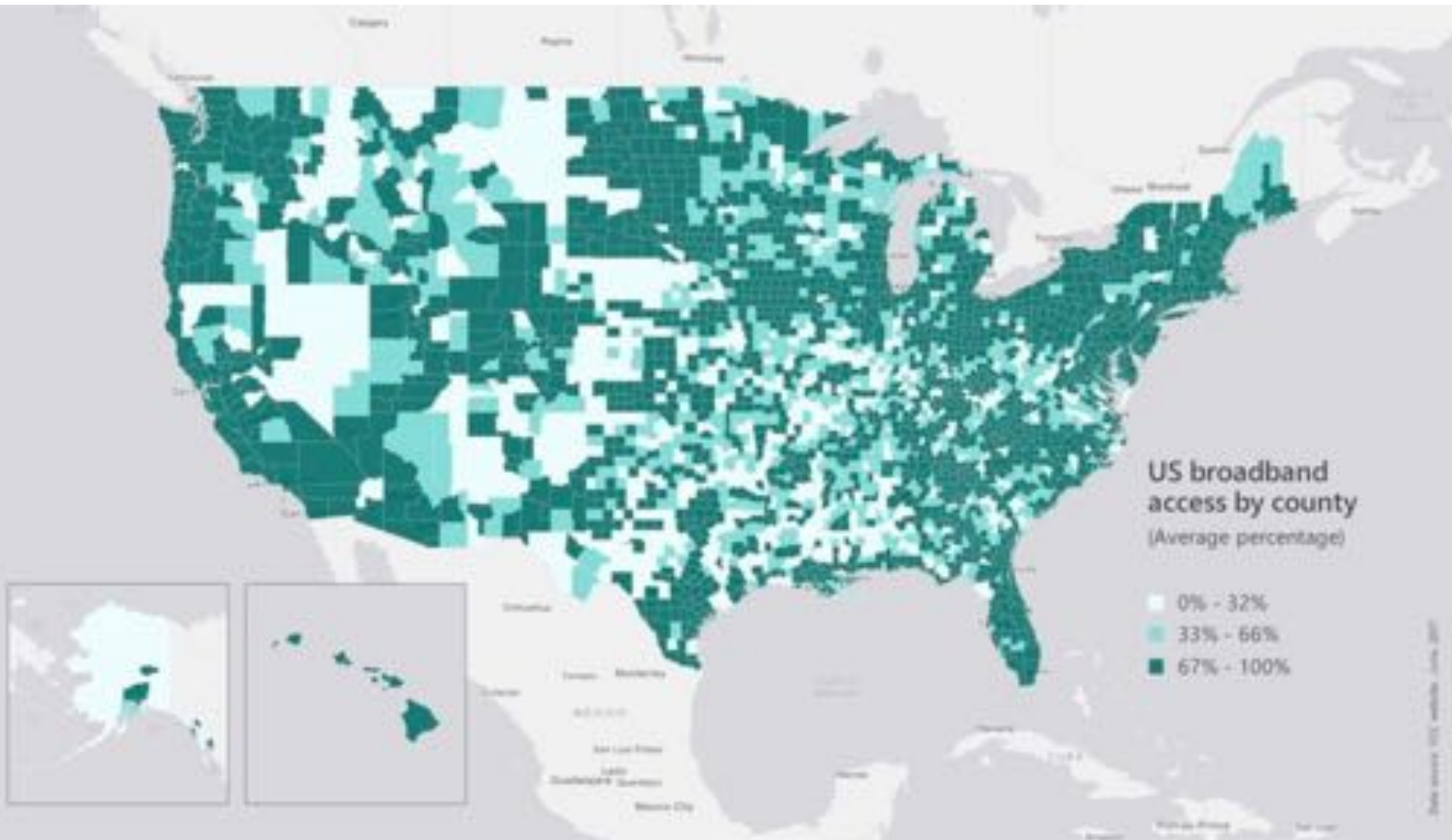
Knuth's Definition

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



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%

25 mbps+

10 mbps+

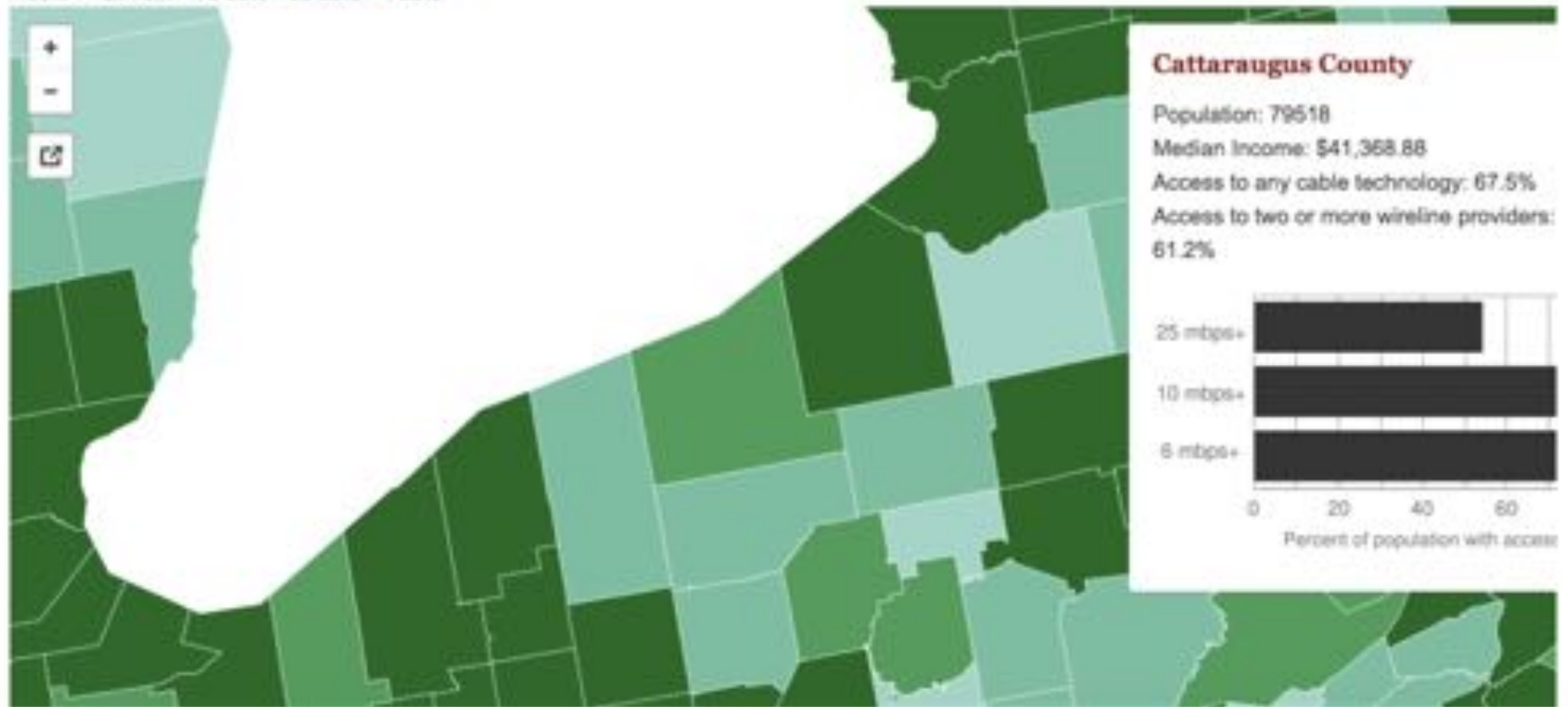
6 mbps+

0 20 40 60

Percent of population with access

One county over

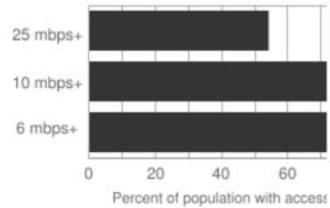
Population with access to advertised download speeds at least 6mbps



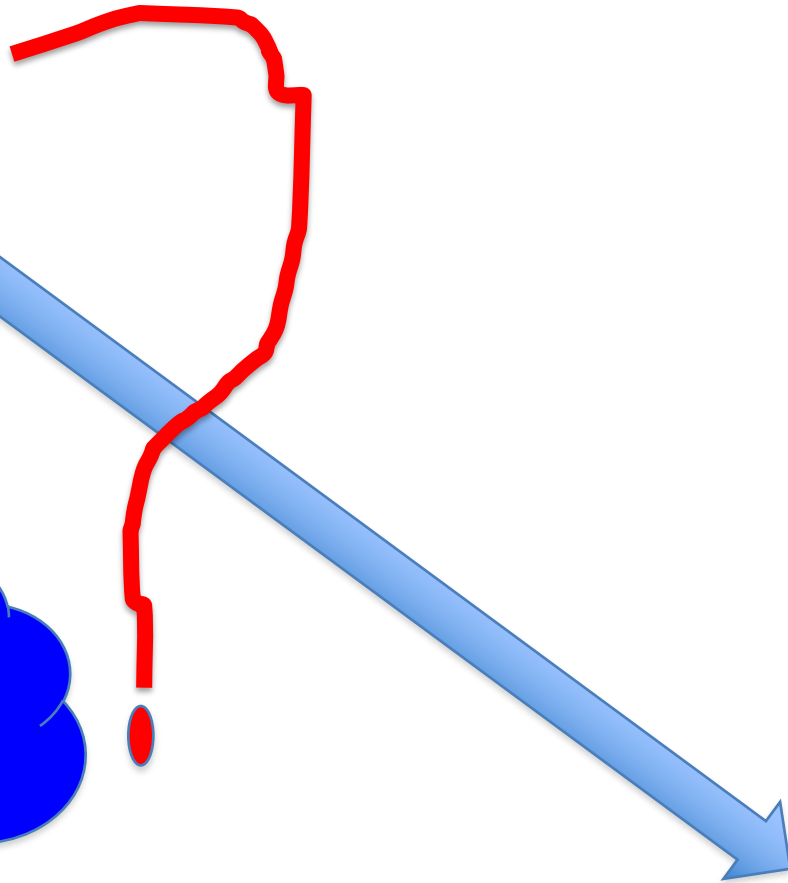
Make broadband more available

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%

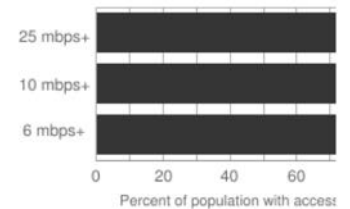


Say you are tasked to come up with the infrastructure

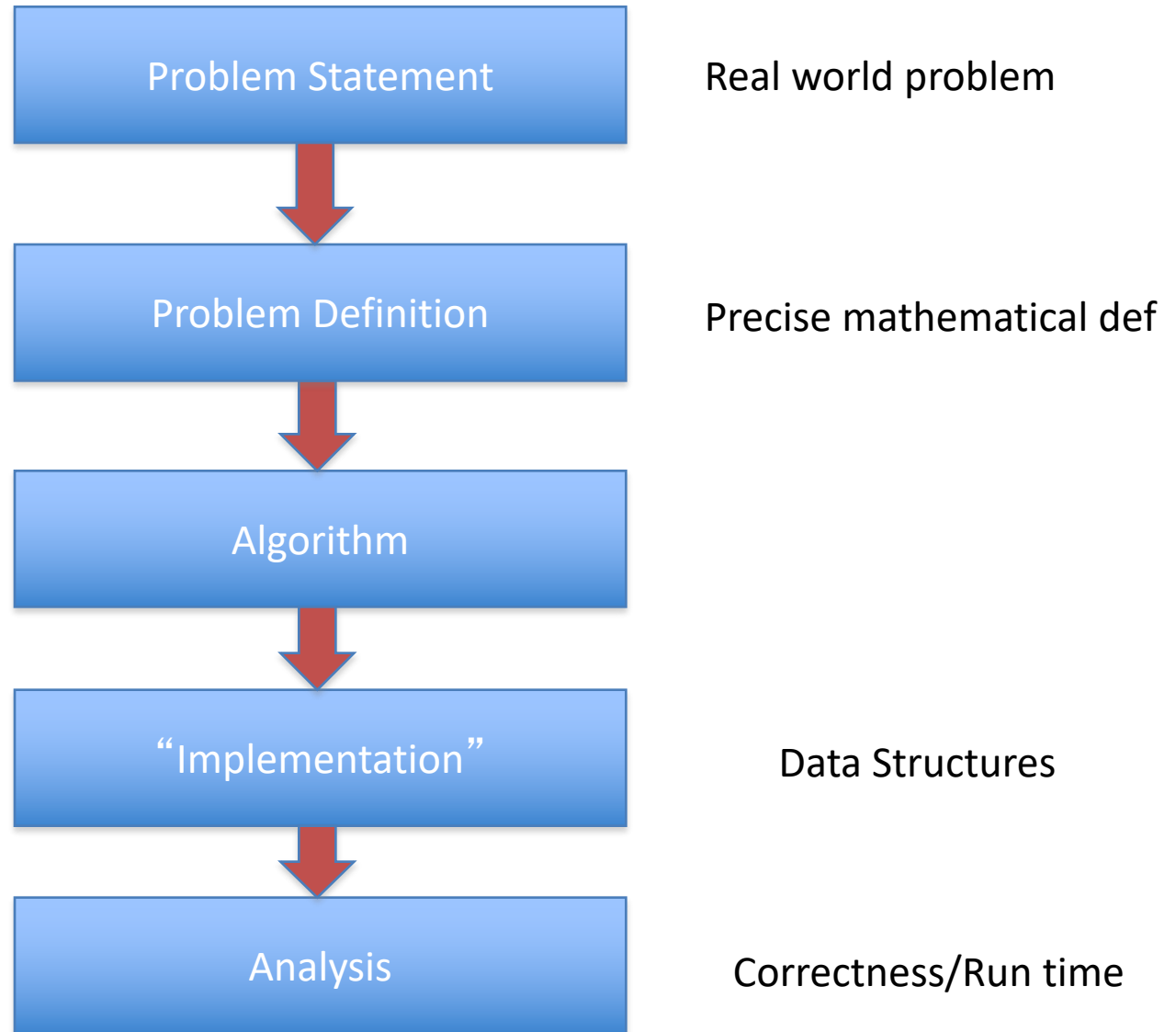


Erie County

Population: 913295
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

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](#)



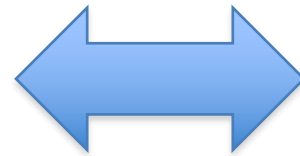
VIDEO: The Match Process for Applicants



(Screen) Docs are coming to BUF



Bailey (Grey's Anatomy)



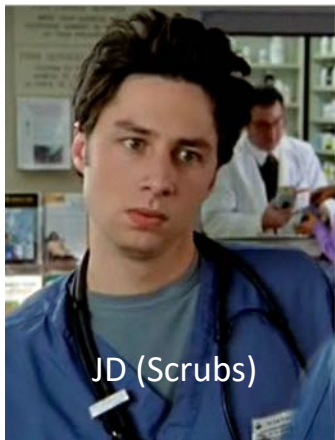
Buffalo General



Millard Filmore (Gates Circle)

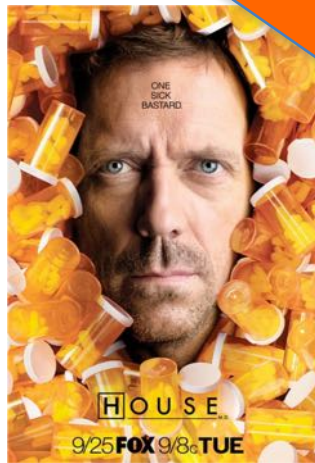


Millard Filmore (Suburban)



JD (Scrubs)

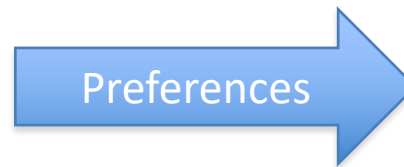
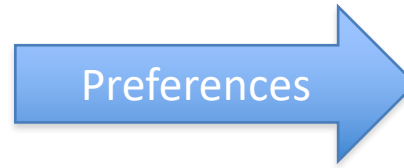
What can go wrong?



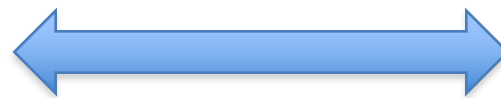
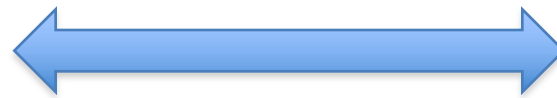
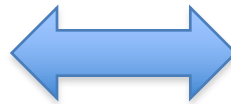
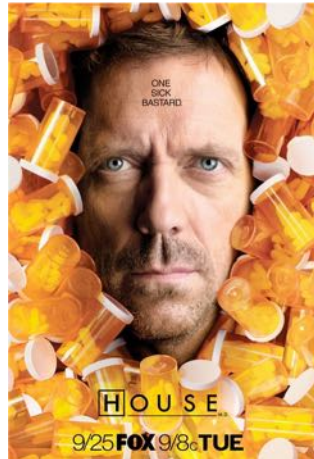
The situation is unstable!



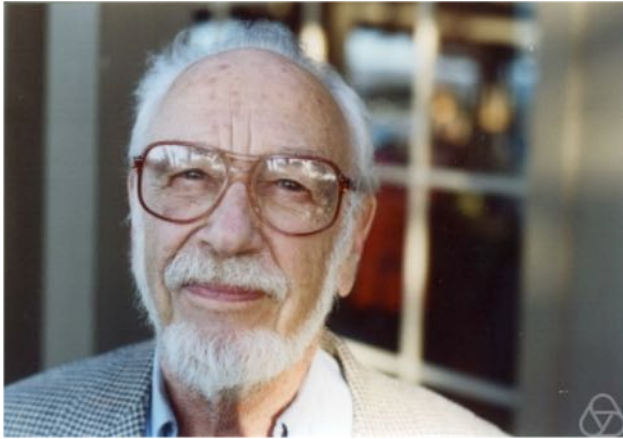
What happens in real life



NRMP plays matchmaker



Stable Matching Problem



David Gale



Lloyd Shapley