



Welcome  
to  
CSE 331

# Let's do some introductions



[http://www.zazzle.com/warning\\_teaching\\_assistant\\_bag-149882665435161818](http://www.zazzle.com/warning_teaching_assistant_bag-149882665435161818)

# TAs first



Anand



Aishani



Adhish



Sravanika

Katie



Dhruv



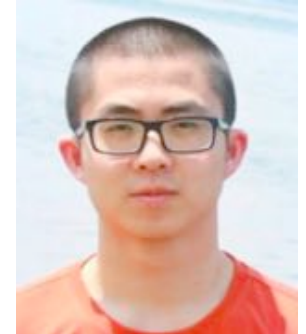
Kevin



Simran

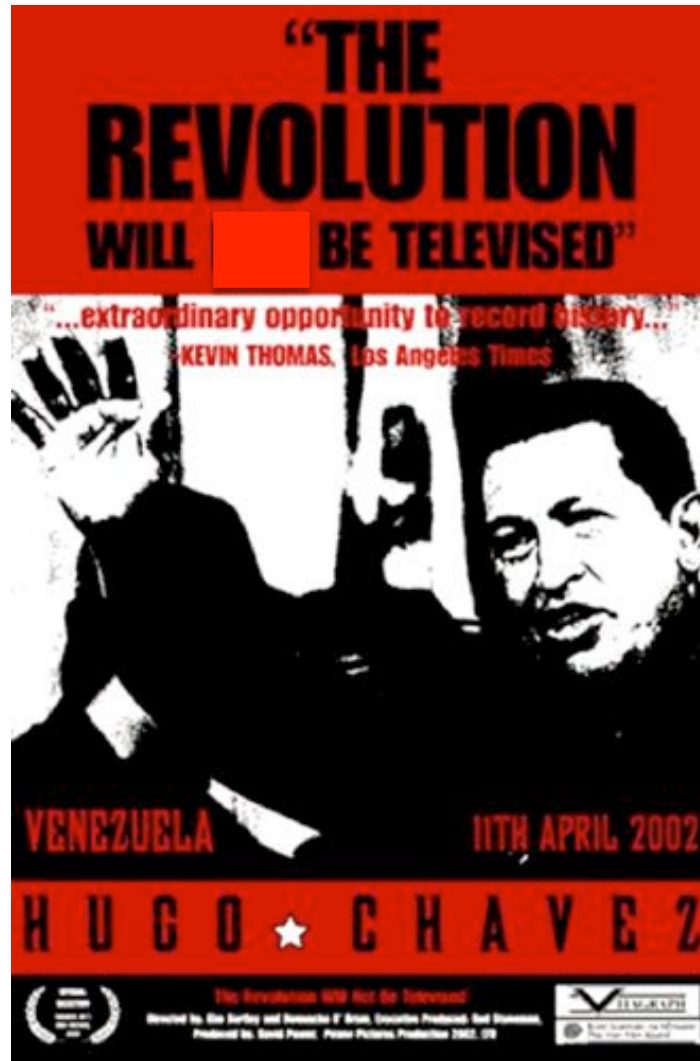


Emily



Zhenkang

# Lectures will be videotaped



# About Me

Atri Rudra

[atri@buffalo.edu](mailto:atri@buffalo.edu)

Office: 319 Davis

Office hours: Mon, 3:30-4:20pm; Wed 2:00-2:50pm

OH starts today

# Contact us all at



Or use piazza!

[cse-331-staff@buffalo.edu](mailto:cse-331-staff@buffalo.edu)

TAs will not respond to individual emails (except for re-grading requests)

# Handouts for today

Syllabus (online)

Homework Policy document (online)

Homework 0 (online)

# One Stop Shop for the Course



## CSE 331

Fall 2017

### CSE 331 events

Today Aug 27 - Sep 2, 2017 -

Print Week Month Agenda

	Sun 8/27	Mon 8/28	Tue 8/29	Wed 8/30	Thu 8/31	Fri 9/1	Sat 9/2
7am							
8am							
9am							
10am							
11am							
12pm							

<http://www-student.cse.buffalo.edu/~atri/cse331/fall17/index.html>



# Homework 0 (Optional)

## Homework 0

Due by 11:00am, Friday, September 1, 2017.

Make sure you follow all the [homework policies](#).

All submissions should be done via [Autolab](#)

*Submitting HW 0 is optional.* However, we do encourage you to submit to get familiar with [Autolab](#) and to get some feedback.

Due: this Friday

## What is a proof?

The goal of this question is to present a gentle start to proofs. In particular, the idea is to highlight a common mistake students make while writing proofs.

### The Problem

Consider the following "proof":

- Brad Pitt  has a beard:



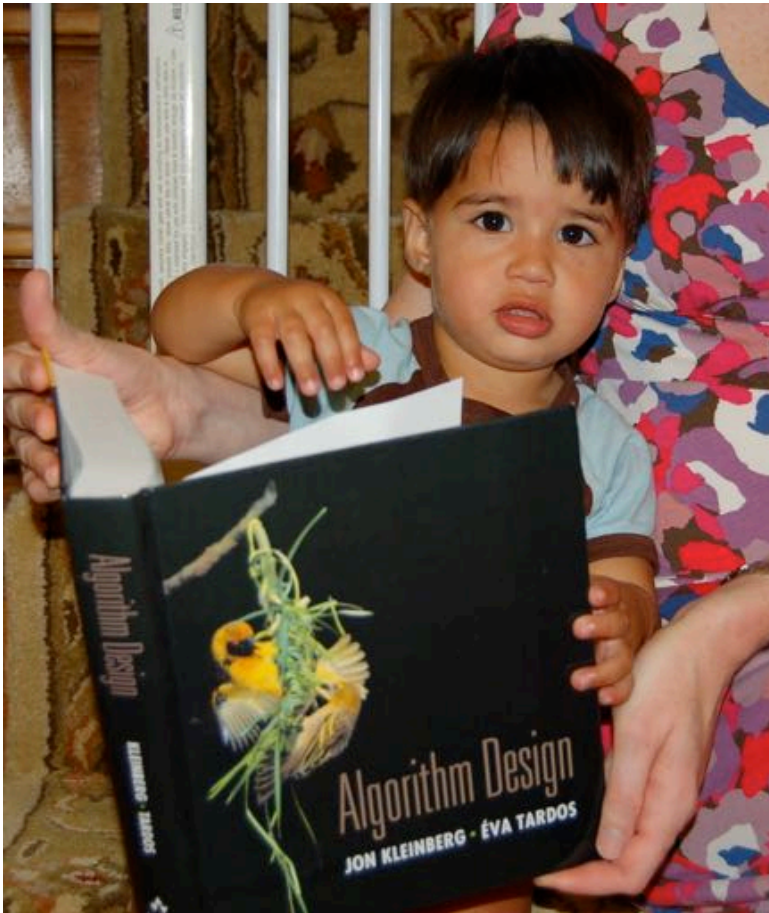
# Three things to remember

**WORK HARD!**

**DO NOT CHEAT!**

**READ CAREFULLY!**

# Wait.. What???



Make sure you follow submission instructions

Two most common ways of losing points

Make sure you read problem statements carefully

# Academic Dishonesty

All your submissions must be your own work

Penalty:

Minimum: An **grade reduction in course**

Possible: **F** (or higher penalty) if warranted

**YOUR** responsibility to know what is cheating, plagiarism etc.

If not sure, come talk to me

Excuses like “I have a job,” “This was OK earlier/in my country,” “This course is hard,” etc. **WON’ T WORK**

**I DO NOT HAVE ANY PATIENCE WITH ANY CHEATING :**  
**YOU WILL GET A GRADE REDUCTION IN THE COURSE**  
**FOR YOUR FIRST MISTAKE**

# Read the syllabus CAREFULLY!

No graded material will be handed back till you submit a signed form!

CSE 331

Introduction to Algorithm Analysis and Design

Fall 2017

**University at Buffalo**

*Department of Computer Science & Engineering*

CSE 331 — Introduction to Algorithm Analysis and Design

- 
- Make sure you fill in form **with a pen**.
  - After you have filled in the form, scan it and upload it to Autolab.
- 

I, \_\_\_\_\_ (PRINT name), acknowledge that I have read and understood the syllabus (and the homework policy document) for this course, CSE 331 *Introduction to Algorithm Analysis and Design*.

# Where to find the form

## CSE 331 Syllabus

Fall 2017

Mondays, Wednesdays and Fridays, 1:00-1:50pm, NSC [↗](#) 225.

### Under Construction

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

### Please note

It is **your responsibility** to make sure you read and understand the contents of this syllabus. If you have any questions, please contact the instructor.

### Acknowledgment

Once you have read the syllabus carefully, please sign [this form](#) and submit (a scan) to Autolab. As an incentive for you to fill in this form, you will not receive a grade on your assignments till you fill in the form.

# Autolab

AUTØLAB

You need to sign in or sign up before continuing.

## Autolab Homepage

SIGN IN WITH NYU@B

<https://autograder.cse.buffalo.edu/>

# You can submit the following now

🏠 ➤ CSE 331: Introduction to Algorithm Design (F17)

## Assignments

Homework 0

Q1 (Sorting)

Q2 (Perfect Matchings)

Syllabus Form

Upload form

If you were registered by 9pm on Sunday, Aug 27 you should be on Autolab



# Grading break-down

## Grading Policy

Here is the split of grades:

Course Component	% of grade
Mini project	6%
Homeworks	31%
Quizzes	3%
Exams	60%

# Pre-requisites

## Required (officially)

CSE 250, CSE 191 and MTH 142

At least a C-

## Required (for practical purposes)

Comfort with proofs

Willingness to work hard!

# Disabilities

Information included in the syllabus

In short, let me know and consult with Office of Disability Services


# Preferred Name

If you prefer using name diff from UB records

Let me know and we'll make a note of it.

# TA Office hours

YOU decide!

 poll ☆ 0 views  
Actions ▾

## Vote for TA office hours

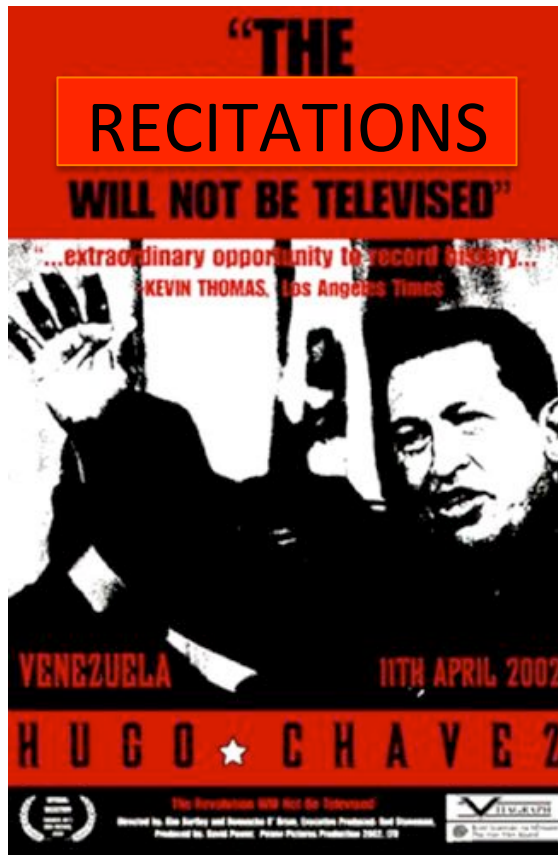
Please choose all the time slots below that you will be able to make to for a 331 office hour. There will be a total of 21 hours over a week and the slots below are where at least one TA is available. We will try to schedule office hours during the most popular times (based on availability of rooms etc.) Remember homeworks are due at 11am on Fridays and there will be no office hours on Friday.

I want to get this on the way soon as possible, so I will pick the most popular slots at **Wed 3pm**.

- Mon, 10-11am
- Mon, 11am-noon
- Mon, 2-3pm
- Mon 2:30-3:30pm
- Mon, 5-6pm
- Tue, 10am-11am
- Tue, 11am-noon
- Tue, noon-1pm
- Tue, 1-2pm
- Tue, 2-3pm
- Tue, 3-4pm
- Tue, 4-5pm
- Tue, 5-6pm
- Wed, 9-10am

# Recitations

Are on for this week!



# Exams

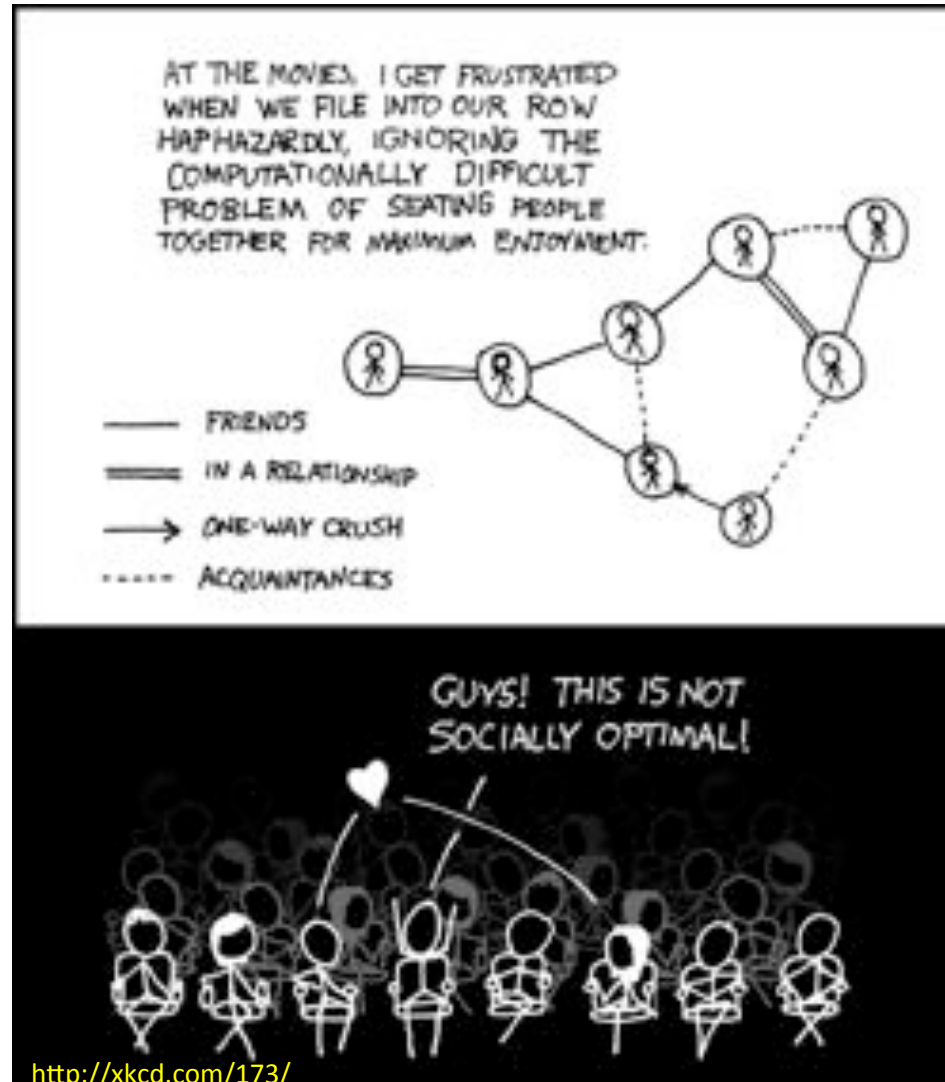
Mid term (two parts)

Mon, **Oct 16** and Wed, **Oct 18**, 2017. Usual place and time.

Final exam

Fri, **Dec 15**, 2017. NSC 225, **noon-2:30pm**

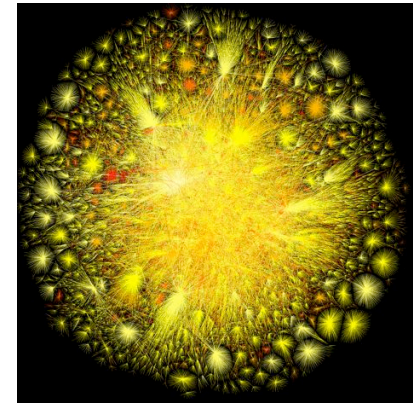
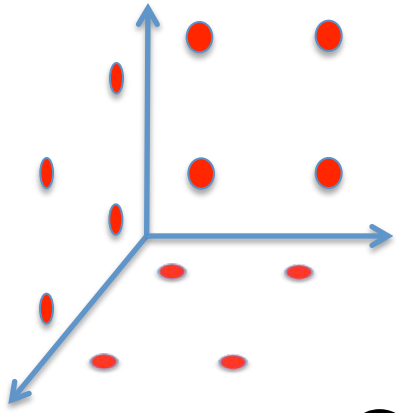
# This course: how to solve problems!





Why should I care ?





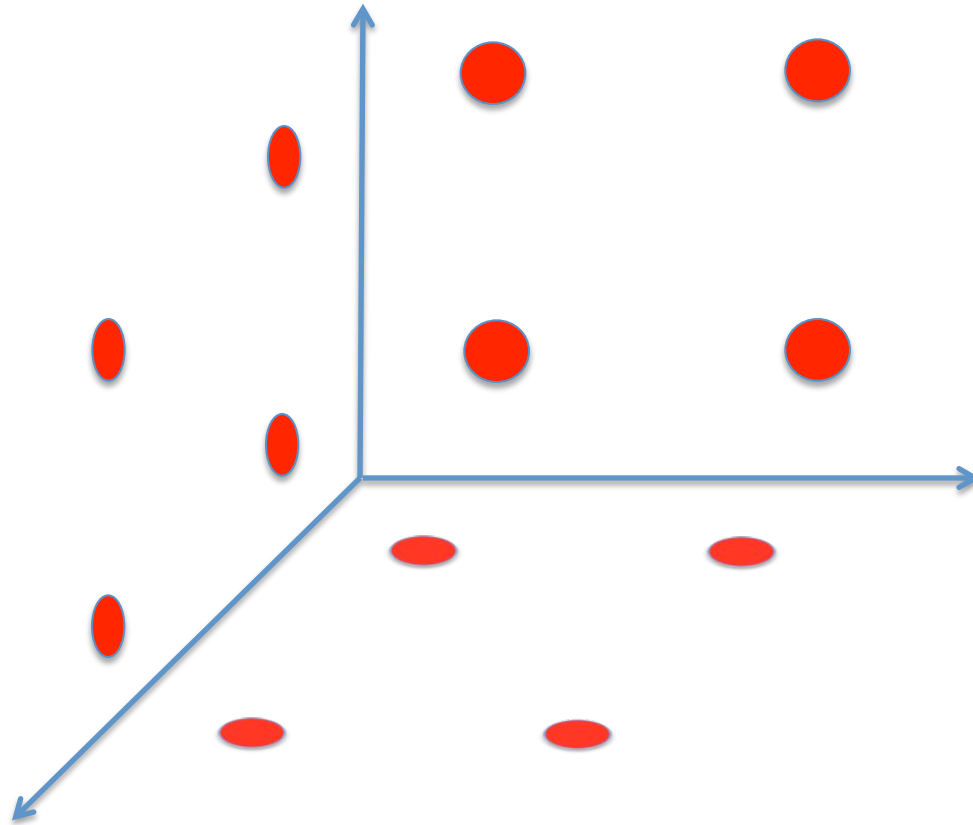
# Combining Shadows to Understanding the network



LogicBlox

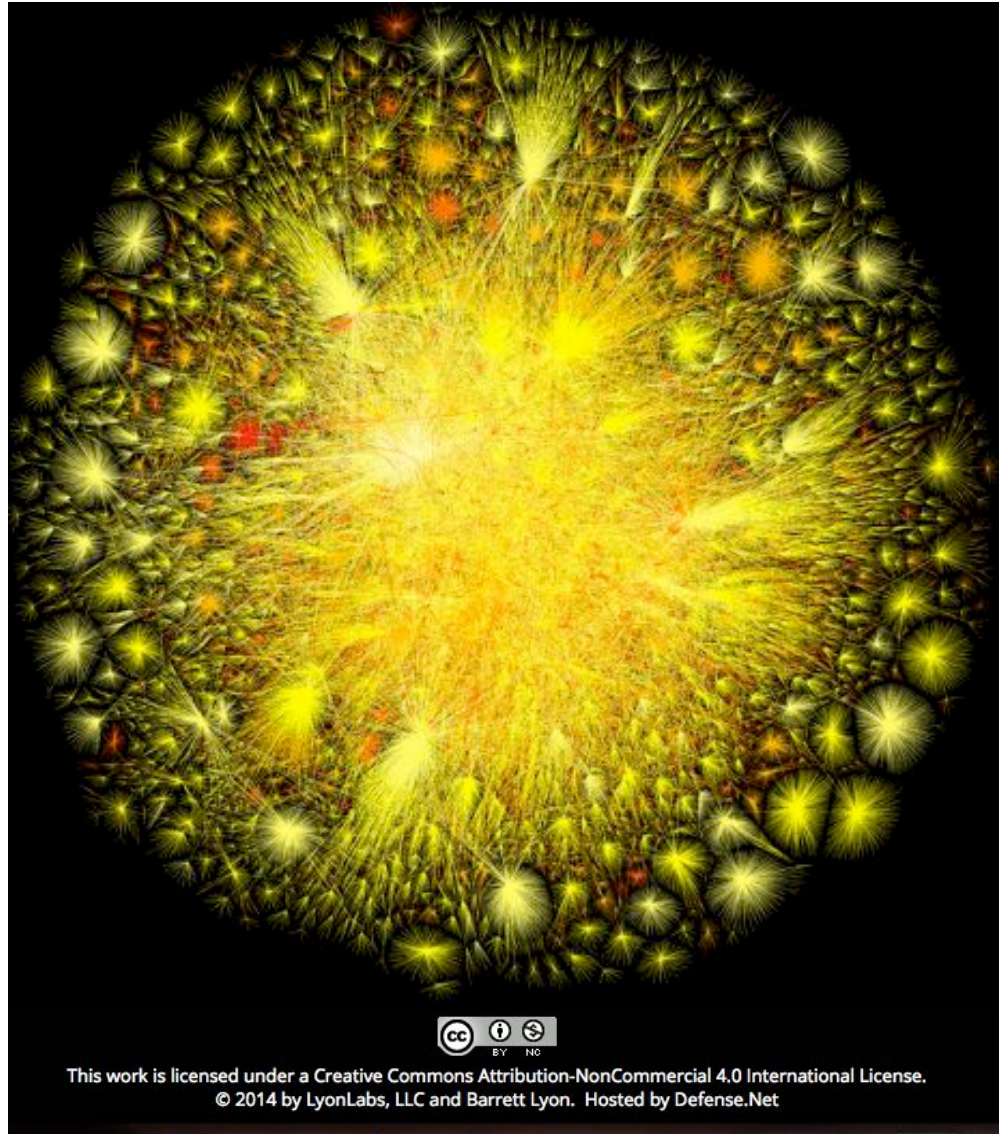
Stanford  
University

# The key technical problem

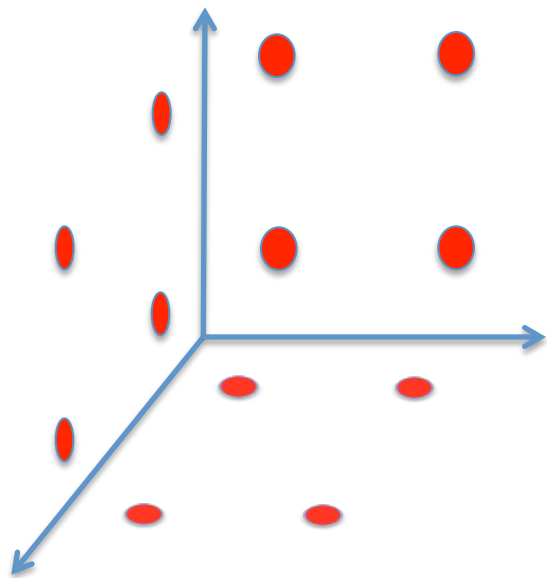


Given the three projections, what is the largest size of the original set of points?

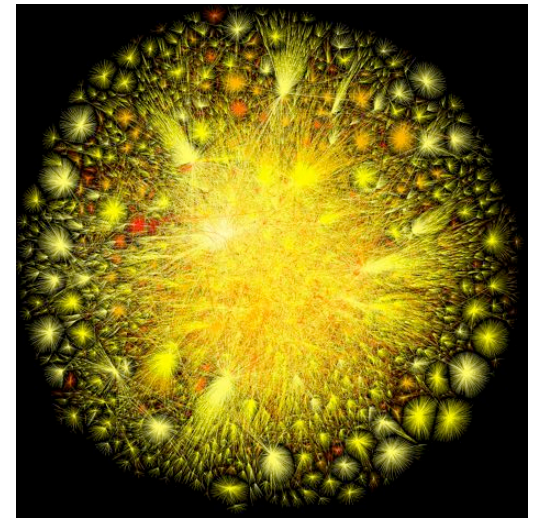
# Detecting Communities



# Conquering Shadows to Conquering the Internet



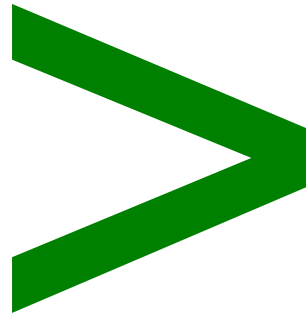
Algorithmically compute  
the missing set



# The proof is in the performance

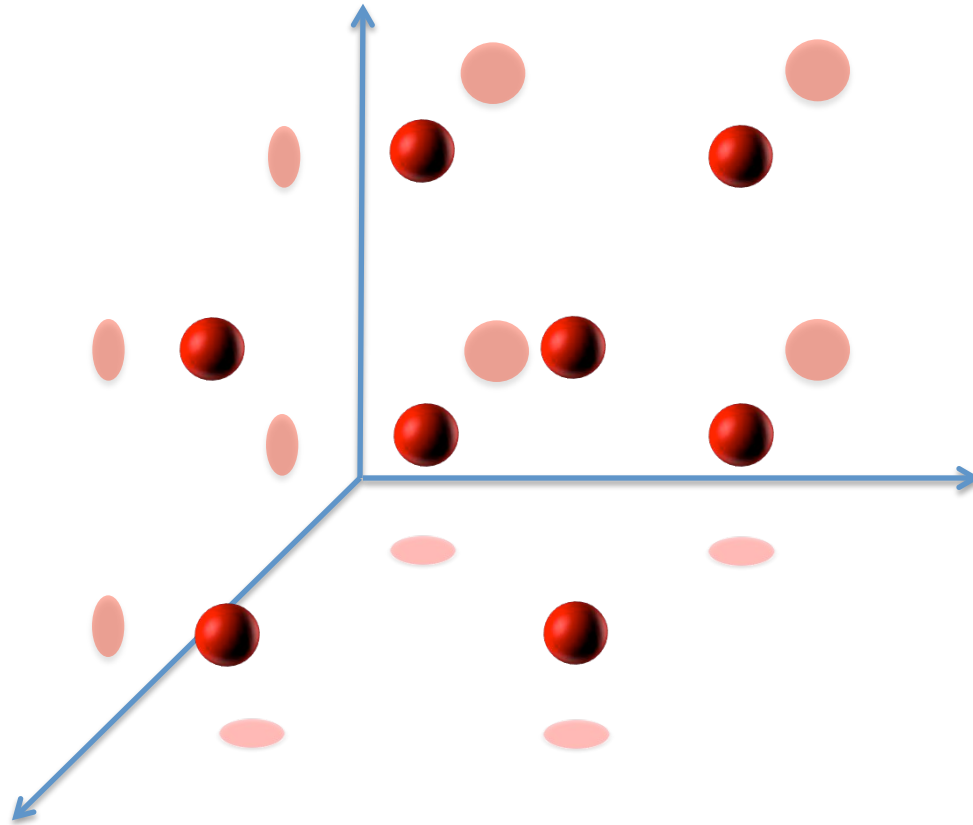


10x faster



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?

Google maps seattle wa Search Maps

Get Directions My Maps

Driving directions to Buffalo, NY

I-90 E 3,587 mi 1 day 18 hours

This route has tolls.

Seattle, WA

1. Head southwest on Madison St toward 4th Ave 0.0 mi
2. Take the 1st right onto 4th Ave 0.2 mi
3. Take the 1st right onto Spring St 0.1 mi
4. Turn right onto the I-5 S ramp to Portland 0.9 mi
5. Follow signs for I-90 E/Behaveus/Spokane and merge onto I-90 E 0.7 mi
6. Take exit 550 for US-212 E toward Battlefield/Broadus/Little Bighorn 0.3 mi
7. Turn left at US-212 E 1.08 mi
8. Turn right at US-212 E/Park Ave 0.4 mi
9. Turn right at US-212 BUS 605-85 S 0.4 mi
10. Turn left at S Dakota 34 E 17.9 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

200 mi 200 km

Traffic More Map Satellite Earth

Post Send Link

© 2010 Google - Map data © 2010 Google, GeoNames, DeLorme, NAVTEQ, Swirecity, © 2010

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".

**Electronics 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 100 000  

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 **NO FEES** 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	AirTran Airways	Delta	UNITED	Continental
Nonstop	from <del>\$274</del> \$295 total see below	—	from <del>\$274</del> \$295 total	from <del>\$283</del> \$305 total	—	—
1 stop	from <del>\$254</del> \$293 total see below	from <del>\$254</del> \$293 total	from <del>\$241</del> \$373 total	—	from <del>\$282</del> \$326 total	from <del>\$282</del> \$326 total

[Show more airlines >](#)

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!** [See details](#)

**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)

[Preview seat availability](#) [Select this departure](#)

**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)

**Change your search**

Departure airport:

Destination airport:

Departing: (mm/dd/yy)

Returning: (mm/dd/yy)

Airline:  [More info](#)

Class:

Nonstop flights only  
 Refundable flights only

**Change Travelers**


**1 Adult**  
[Change travelers](#)

\*% - Indicates flight is operated by another airline. Move your mouse over the icon for details.

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

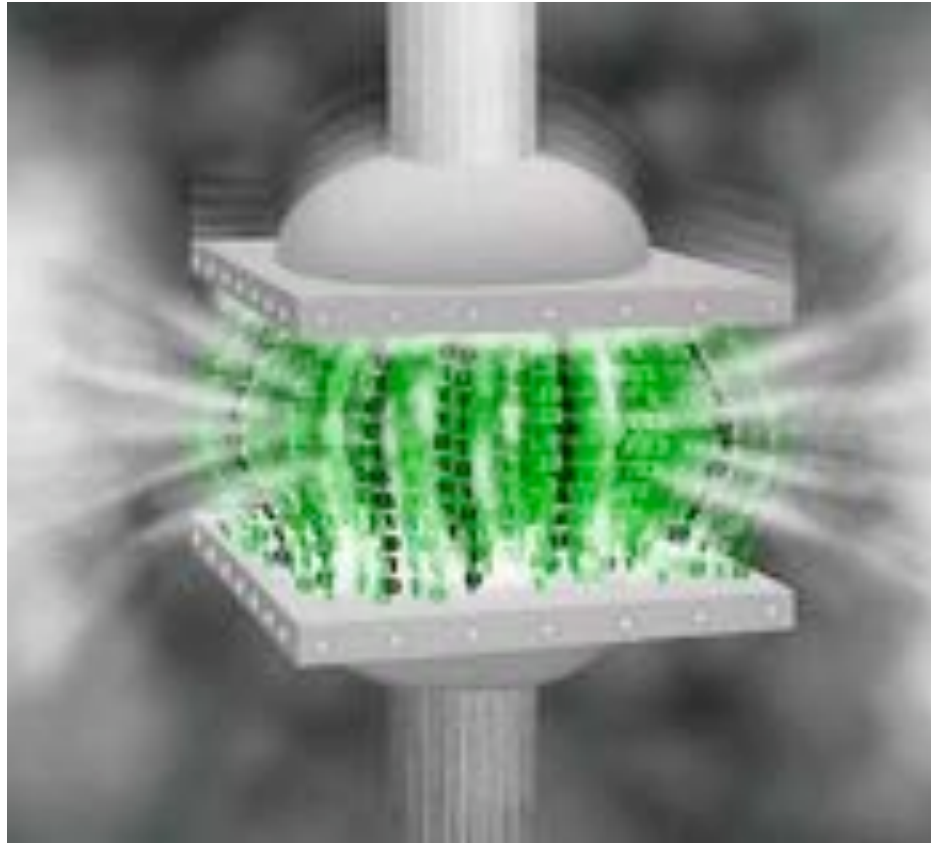
[How Google Works - Google Guide](#) ☆  
Feb 2, 2007 ... For more information on how **Google works**, take a look at the following ...  
**How does Google** collect and rank results?, [www.google.com/](#) ...  
[www.googleguide.com](#) - Part II: Understanding Results - Cached - Similar

[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

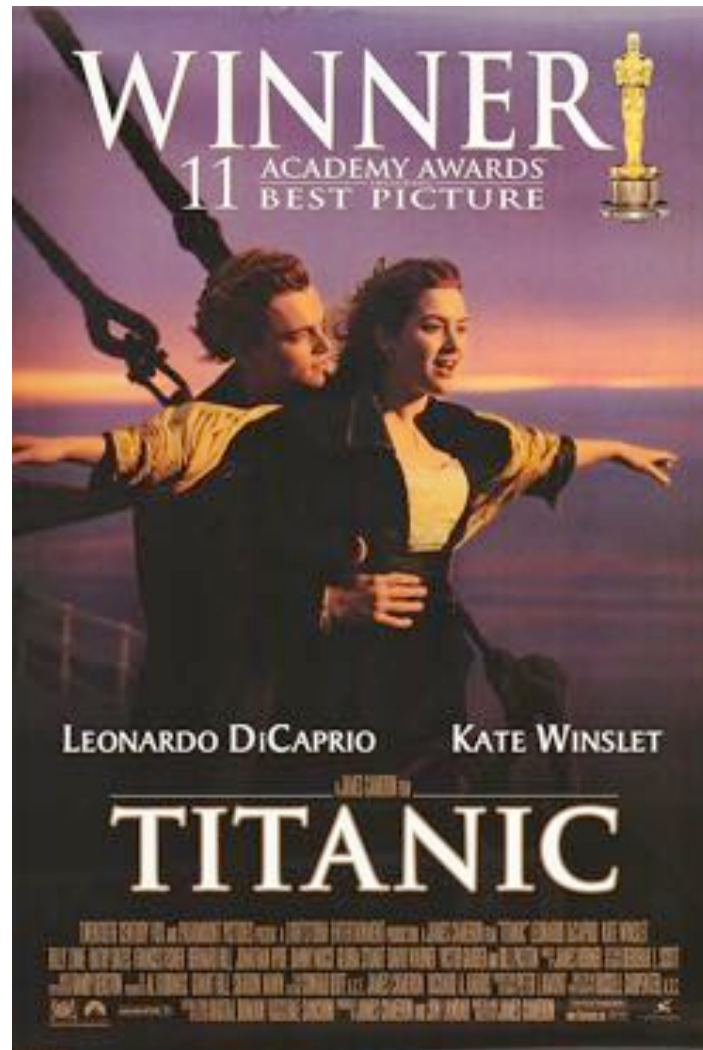
# Why care about algorithms?



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

## 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 Syllabus Piazza Schedule Homeworks - Autolab Mini Project - Support Pages -

## CSE 331 Mini Project

Fall 2017

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:

How algorithms shape our world - Kevin Slavin



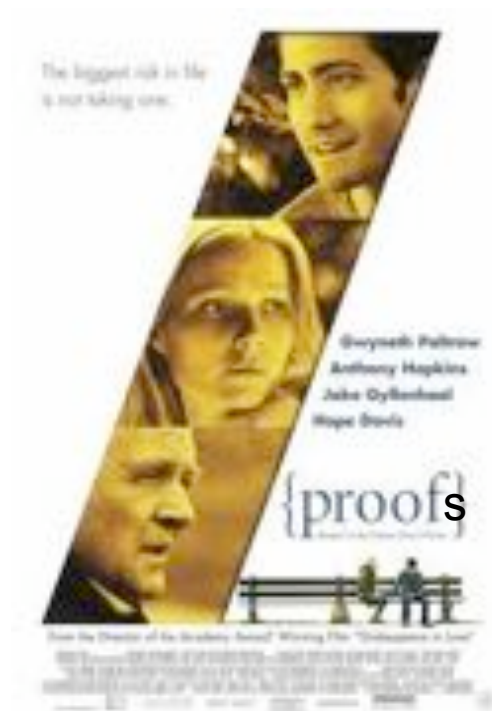
# Questions/Comments?



# Now about the course



# We'll do loads of



<http://www.impawards.com/2005/proof.html>

Writing down your thought process formally and precisely!

# The language of proofs

Brad Pitt had a beard



waleg.com

Every goat has a beard



animaldiversity.org

Hence, Brad Pitt is a goat.

# Why do proofs?

Makes you think logically about problems and solutions

From a friend 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 compute 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.

# A common complaint

Your examples in class look nothing like HW questions.



True because....



[zazzle.com](http://zazzle.com)

False because...

HWs and exams will test your **understanding** of the material

# To get an A in the class

Have to get at least 90.0000000000000000000000000000%

Rest graded on the curve

# A cautionary tale...

When I was an undergrad

    Took algorithms as a sophomore

Understood all the lectures

Did not study outside of lectures

    (We had no homeworks)

Did decent on the mid-term

Nearly flunked the finals

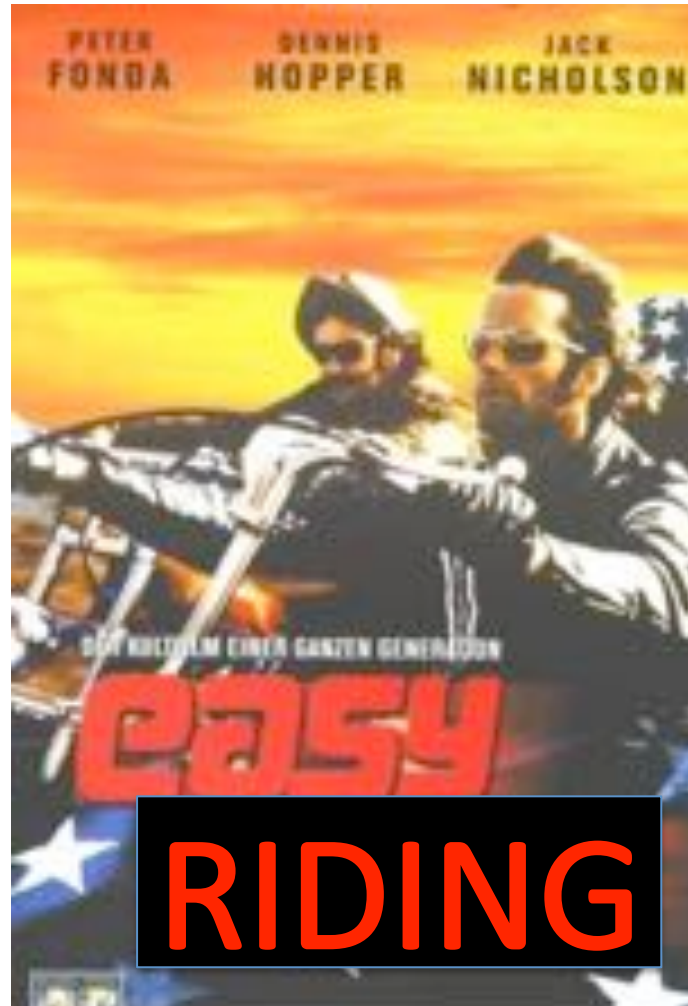
Got a **C**



# Questions/Comments?



# How we will make 331



# What we'll strive to do

Help you with your questions and/or doubts

If need be, email us for time outside of regular office hours

We're not mind readers





If you need it, ask for help



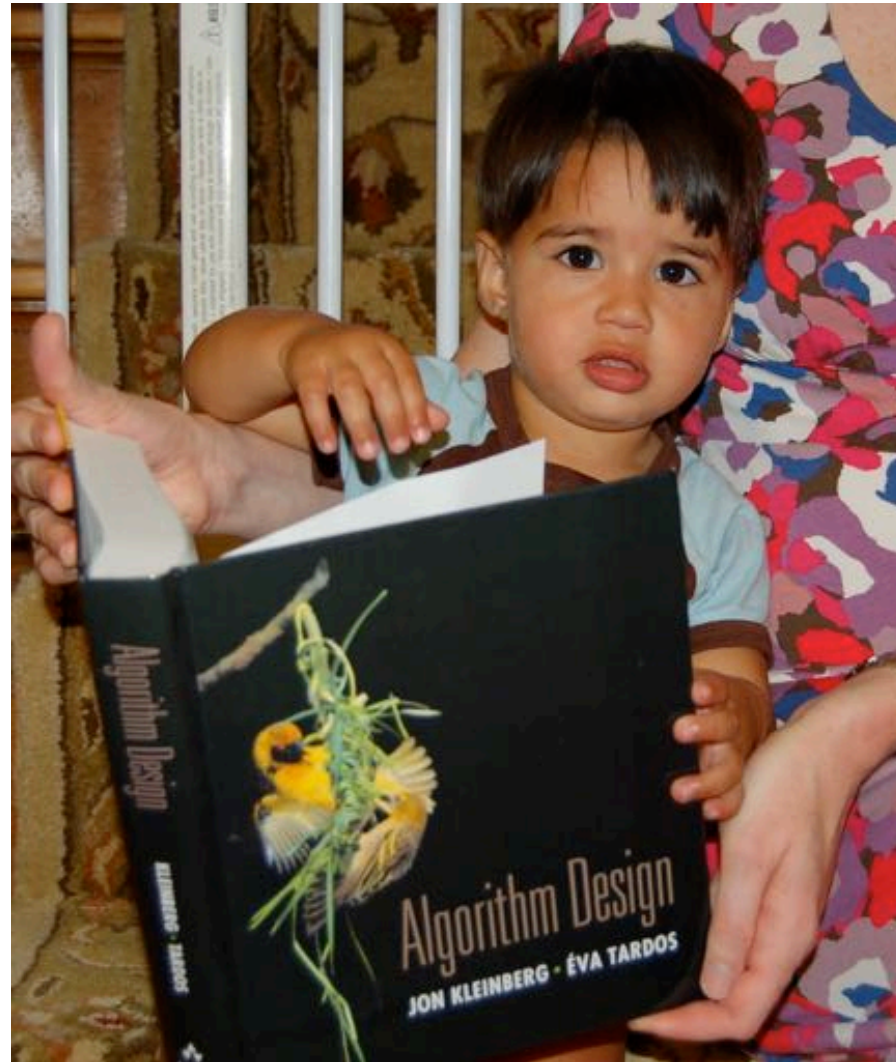
# More chances to recover

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. The rest of the

## 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](#).

<http://www-student.cse.buffalo.edu/~atri/cse331/support/index.html>

# The cautionary tale has a silver lining...



C in undergrad algorithms



Ph.D. in algorithms/complexity

The only way to do well is to work hard

