



Welcome
to
CSE 331

Let's do some introductions



http://www.zazzle.com/warning_teaching_assistant_bag-149882665435161818

TAs first



Iman



Mark



Steven



Chris



Charles



Alejandro



Stephen



Aniruddha



Mehmet

Lectures will be videotaped



About Me

Atri Rudra

atri@buffalo.edu

Office: 319 Davis

Office hours: Mon and Wed, 1:00-1:50pm

OH starts today

Contact us all at



Or use piazza!

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 [Syllabus](#) [Piazza](#) [Schedule](#) [Homeworks](#) [Autolab](#) [Mini Project](#) [Support Pages](#) [Youtube channel](#)

CSE 331

Fall 2018

<http://www-student.cse.buffalo.edu/~atri/cse331/fall18/index.html>

CSE 331 events

Today: [←](#) [▶](#) **Aug 26 – Sep 1, 2018** [↕](#)

[Print](#) [Week](#) [Month](#) [Agenda](#) [⌵](#)

	Sun 8/26	Mon 8/27	Tue 8/28	Wed 8/29	Thu 8/30	Fri 8/31	Sat 9/1
6am							
7am							
8am		8 – 8:50 331 lecture		8 – 8:50 331 lecture		8 – 8:50 331 lecture	
9am							
10am							
11am							

Homework 0 (Optional)

Homework 0

Due by **11:59pm, Thursday, August 30, 2018**

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 Thursday

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.



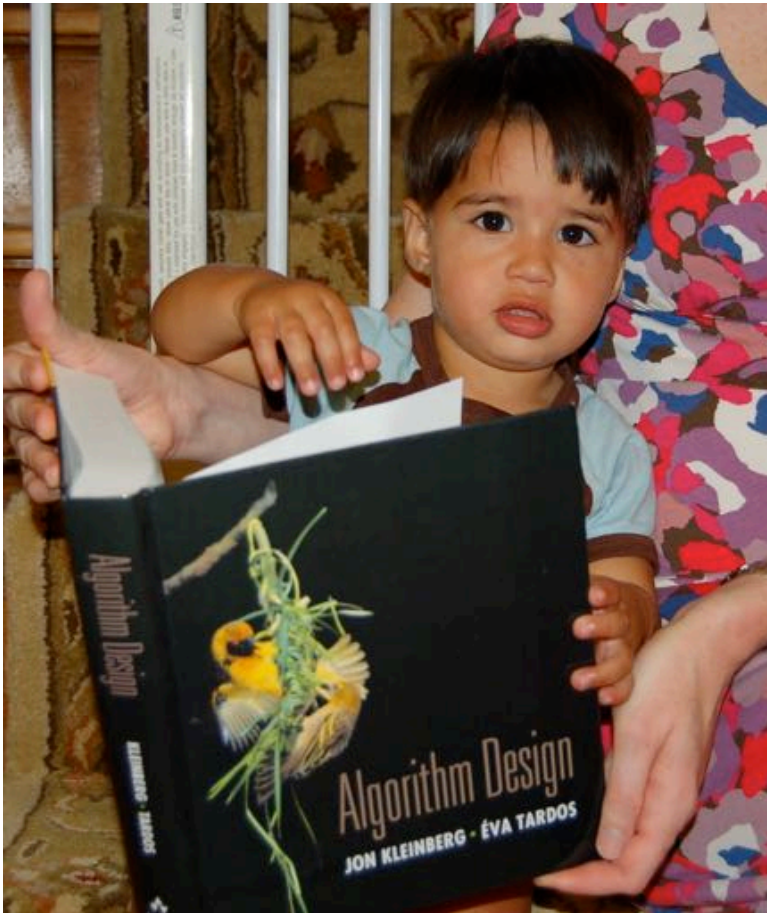
Three things to remember

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!

Syllabus Quiz


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


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

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

More information on the quiz

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

CSE 331 Syllabus

Fall 2018

Mondays, Wednesdays and Fridays, 8:00-8:50am, Norton [↗](#) 112.

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 fill in the Syllabus quiz on Autolab. As an incentive for you to fill in this form, **you will not receive any feedback on your assignments till you successfully answer AT LEAST 18 out of the 20 questions in the quiz.** (You can attempt the quiz as many times as you want.) Note that in addition to this syllabus, the quiz will also ask questions based on the [homework policies](#) as well as the [mini project details](#).

Academic Integrity

Autolab

AUTOLAB

You need to sign in or sign up before continuing.

Autolab Homepage

SIGN IN WITH MYUIB

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

You can submit the following now

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

Assignments

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

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

If you were registered by 9pm on Monday, Aug 20 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!

Accessibility Resources

Information included in the syllabus

In short, let me know and consult with Accessibility Resources

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 ☆

stop following

55 views

Actions ▾

TA office hours (YOU decide!)

This is your chance to influence when the TA office hours are scheduled for this semester. Listed below are slots for which a TA is available to host their office hours. (The slots marked with (*) currently do not have any TA available but I'm putting those in case there is a lot of demand and we can look into it.)

Please note that the final office hour slots will depend on the individual TA availability and we might not be able to schedule all the popular slots.

Finally, note that the TA office hours will start from the second week.

- Mon, 10-10:50am
- Mon, 11-11:50am
- Mon, 2-2:50pm (*)
- Mon, 5-5:50pm (*)
- Tue, 12:30-1:20pm
- Tue, 1-1:50pm
- Tue, 2-2:50pm
- Tue, 3-3:50pm
- Tue, 4-4:50pm
- Tue, 5-5:50pm
- Wed, 9-9:50am
- Wed, 10-10:50am

Recitations

Are on for this week!



Exams

Mid term (two parts)

Mon, **Oct 15** and Wed, **Oct 17**, 2018. Usual place and time.

Final exam

Mon, **Dec 10**, 2018. Norton 112, **8:30-11:00am**

Things new to HWs in Fall 18

Proof based questions (Q2 + 3) will have part (a) and part (b)

Recitations will essentially show you how to solve part (a)

You can feedback on your part (a) solutions in TA office hours

Part (b) you are on your own

HWs due by 11:59pm on Thursdays

Other new things in Fall 18

1-on-1 meeting slots with TA (details later in the week)

Some of the algorithms we will develop via examples in lectures

C++ vs Java/Python

Use Java/Python if as you just as comfortable with as C++

Use a VM with g++ installed for Ubuntu

We recommend that you install a VM that runs `g++` on Ubuntu. In particular, we recommend that you use [Jaric Zola's](#) VM system that he created for his CSE 250 course. If you have questions on Jaric's setup, please do **NOT** contact him: email cse-331-staff@buffalo.edu instead.

If you still prefer using your own system, we would still recommend that you test your code in the VM system above before submitting to Autolab.



poll ☆

stop following

24 views

Actions ▾

Help with installing VM for C++ (special office hours)

If you need some help installing the VM setup for submitting in C++:

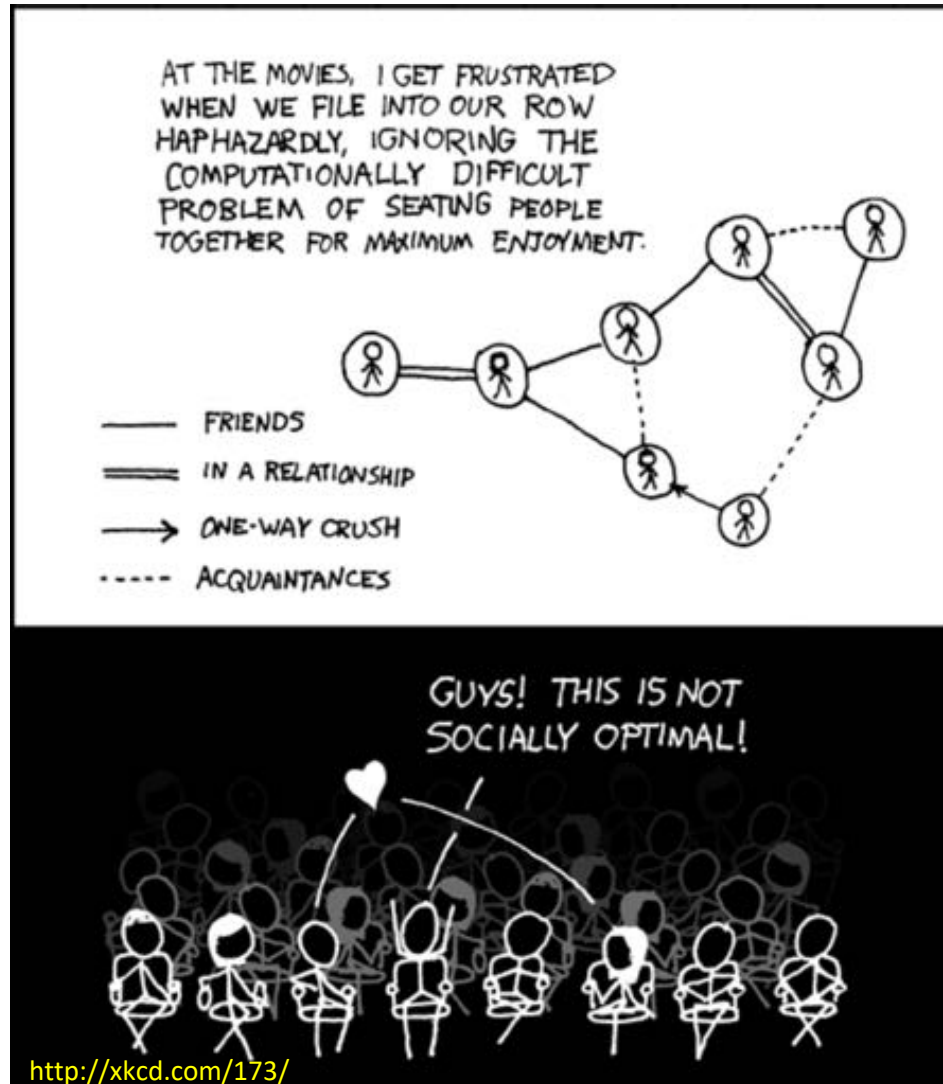
<http://www-student.cse.buffalo.edu/~atri/cse331/fall18/autolab.html>

please select the times below that would work for you for some extra office hours. We will pick some of the most popular hour-long slots for Tuesday (August 28) and Wednesday (August 29). I would highly recommend that you try to install the vagrant system before you come to these office hours so that you can use the office hours to get help with trouble-shooting.

These slots are especially meant for transfer students who might not have had much practice working with linux/unix systems and have primarily use Windows as their main OS. Of course, these slots are open to anyone who needs help with this (even if you are not a transfer student!)

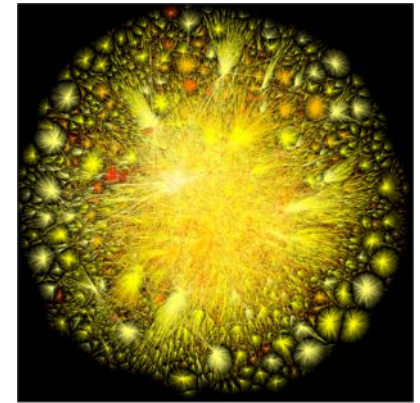
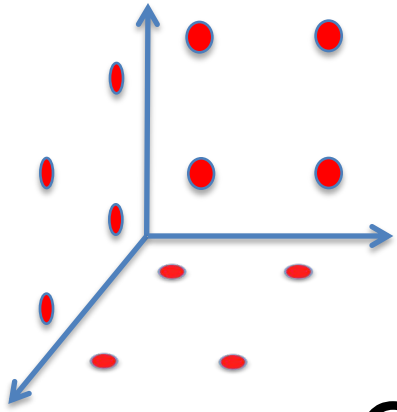
Please note that these office hours are just for help in installing the VM to run C++. The regular office hours will start from next week

This course: how to solve problems!



Why should I care ?





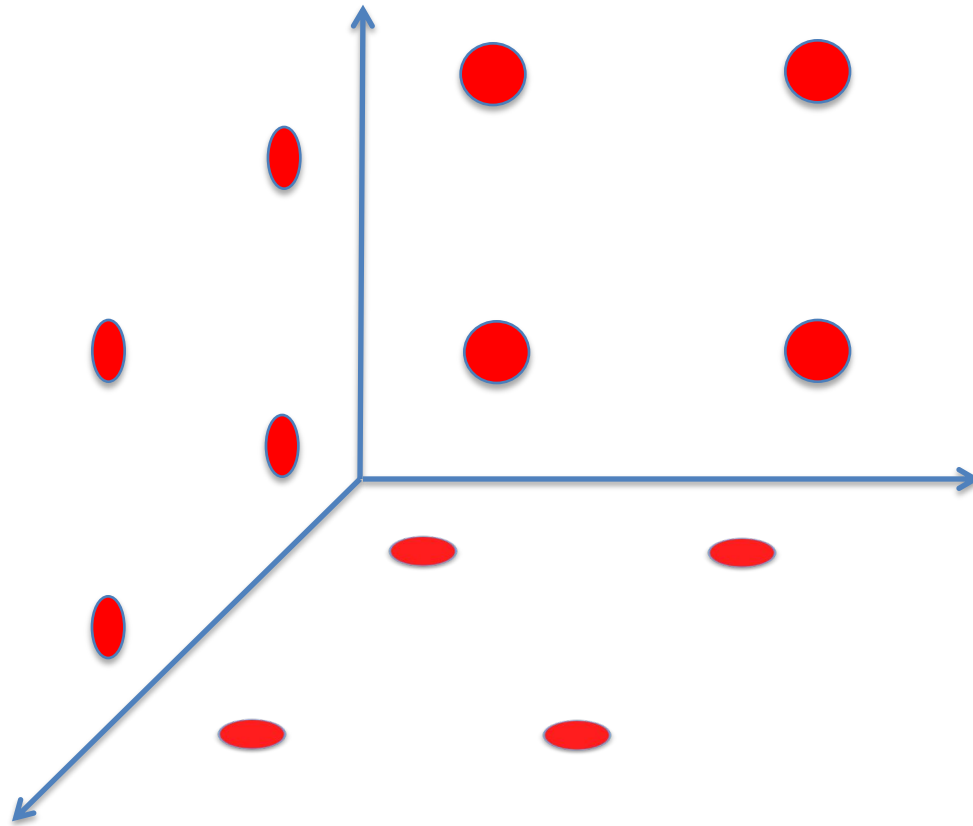
Combining Shadows to Understanding the network



LogicBlox

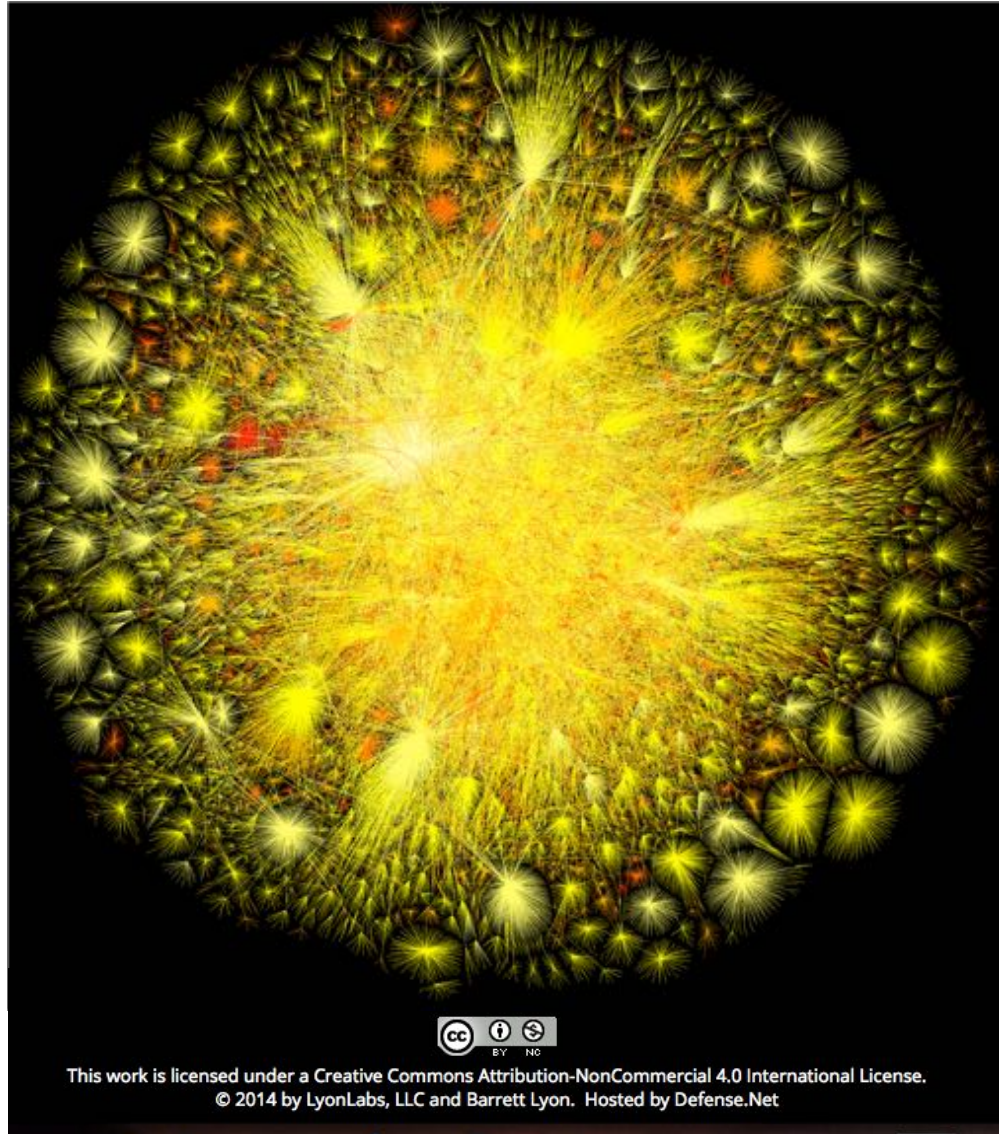
Stanford
University

The key technical problem

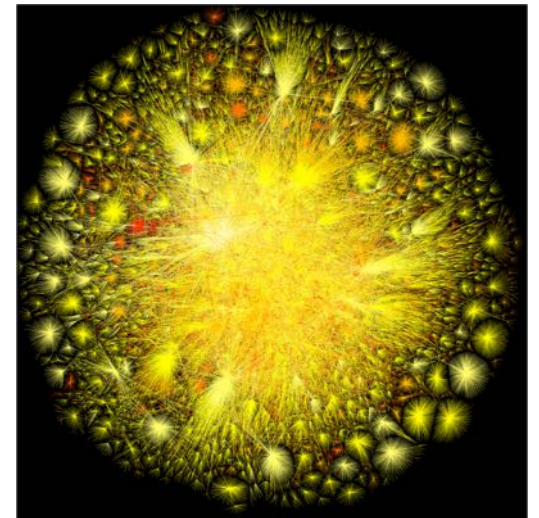
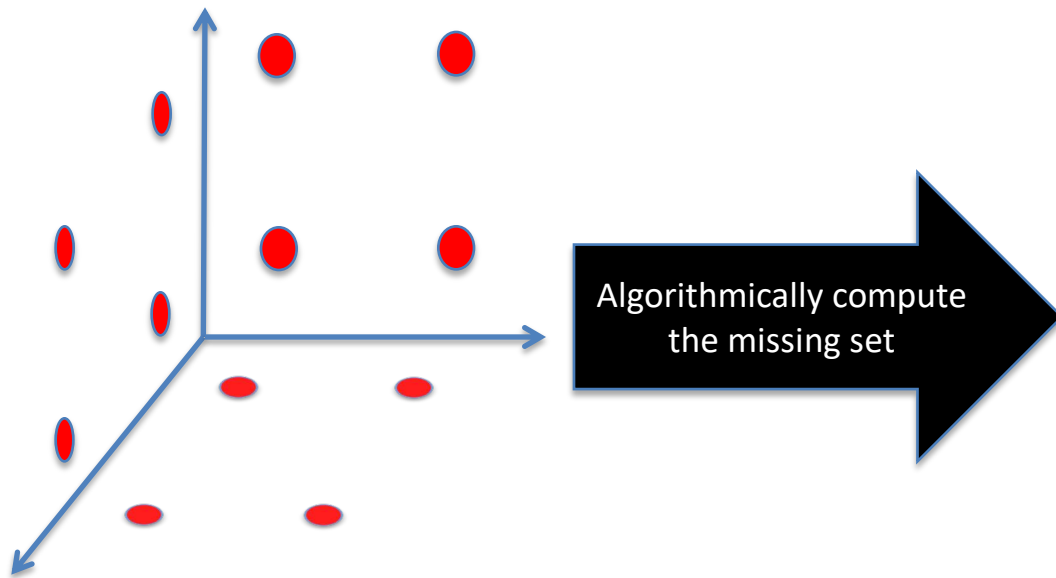


Given the three projections, what is the largest size of the original set of points?

Detecting Communities



Conquering Shadows to Conquering the Internet



The proof is in the performance



EMPTYHEADED

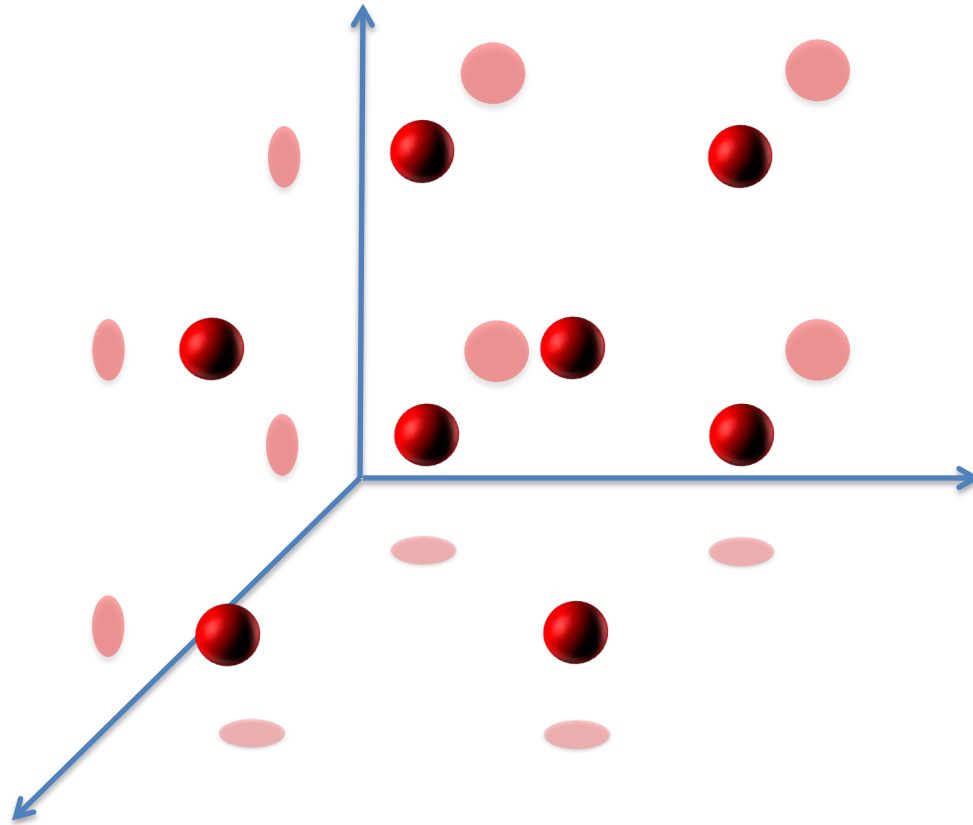


10x faster

A large, thick green arrow pointing from the EmptyHeaded logo towards the Oracle logo.

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 04.1 mi
9. Turn right at US-212 BUS BUS-85 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 047 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 Rattan. We have recommendations for you. (0/21,827)
Ari'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 **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 \$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 \$273 total	—	from \$282 \$326 total	from \$282 \$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:
BUF (Buffalo)

Destination airport:
ATL (Atlanta)

Departing: (mm/dd/yy)
11/21/2010
Anytime

Returning: (mm/dd/yy)
11/23/2010
Anytime

Airline: More info
No Preference

Class:
Economy / Coach

Nonstop flights only
 Refundable flights only

[Go](#)

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](#)

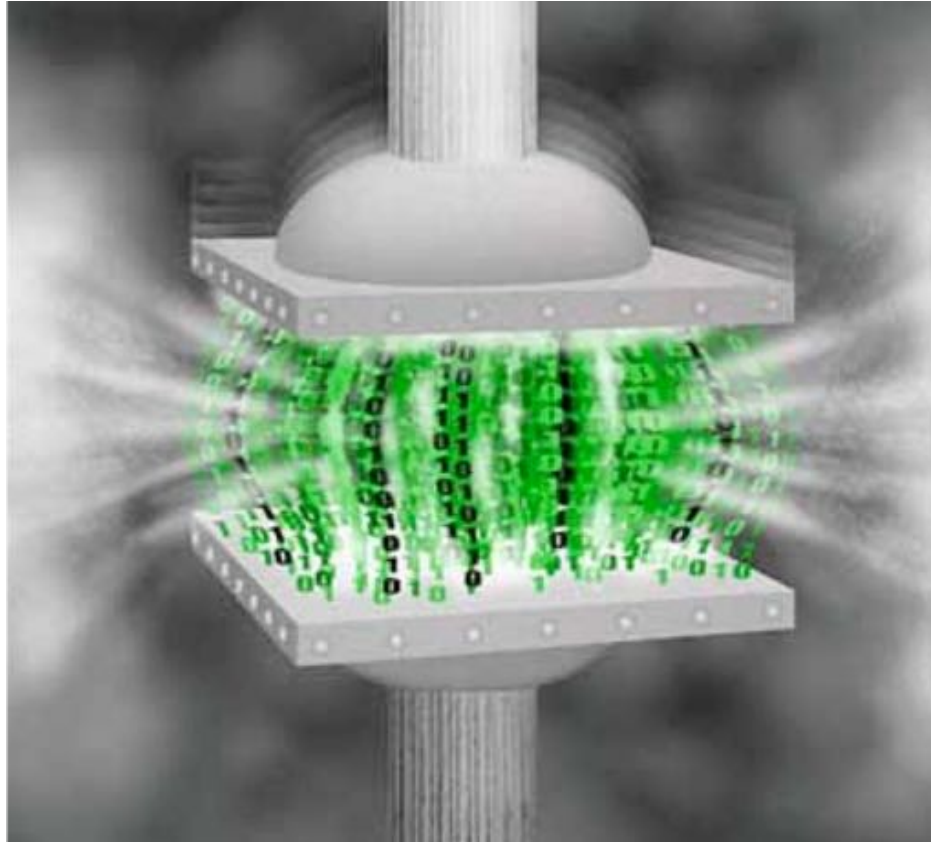
[How Google Works - Google Guide](#) ☆
Feb 2, 2007 ... For more information on how **Google works**, take a look at the following ...
How does Google collect and rank results?, [www.google.com/](#) ...
[www.googleguide.com](#) - Part II: Understanding Results - [Cached](#) - [Similar](#)

[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

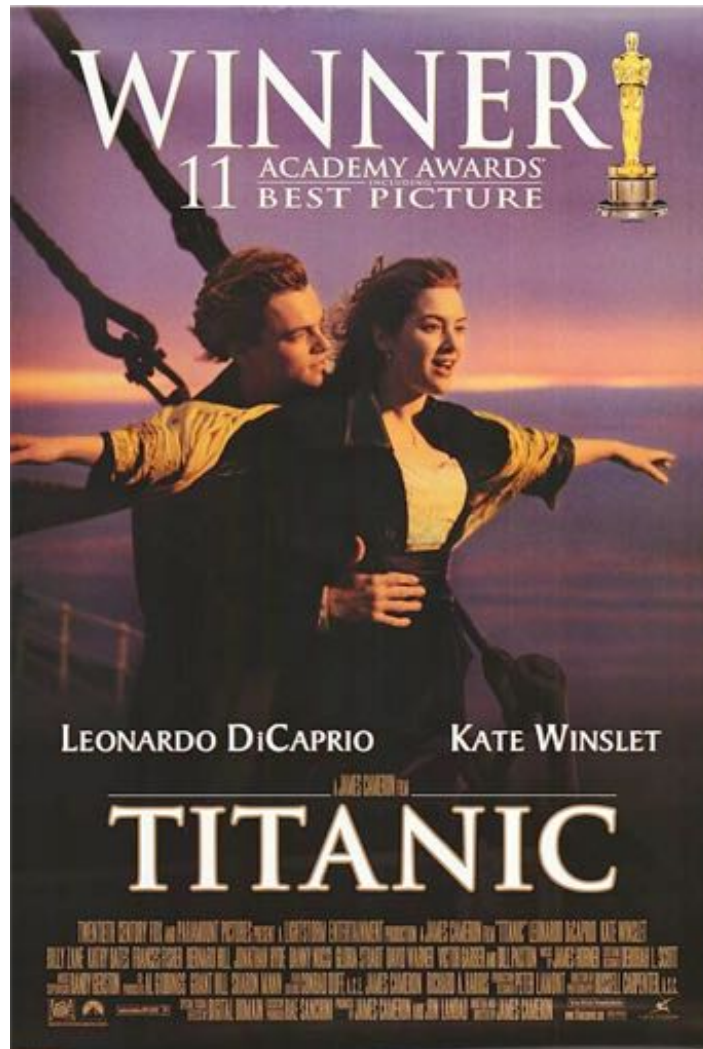
Why care about algorithms?



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

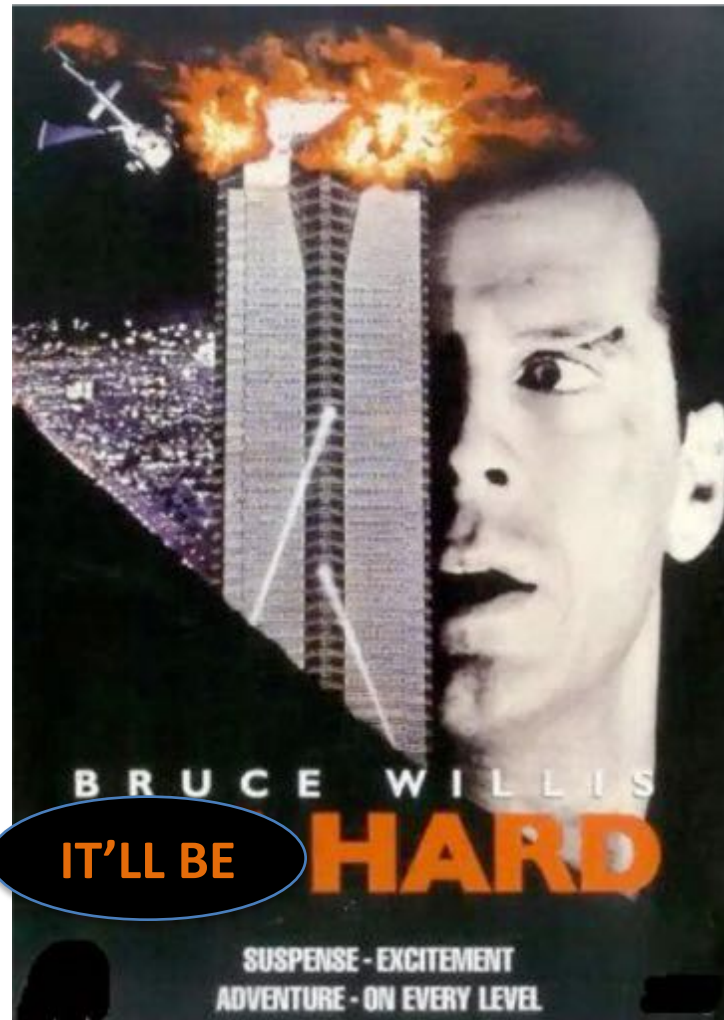
- Algorithms are pervasive in financial transactions and these algorithms have consequences beyond just trading;



Questions/Comments?



Now about the course

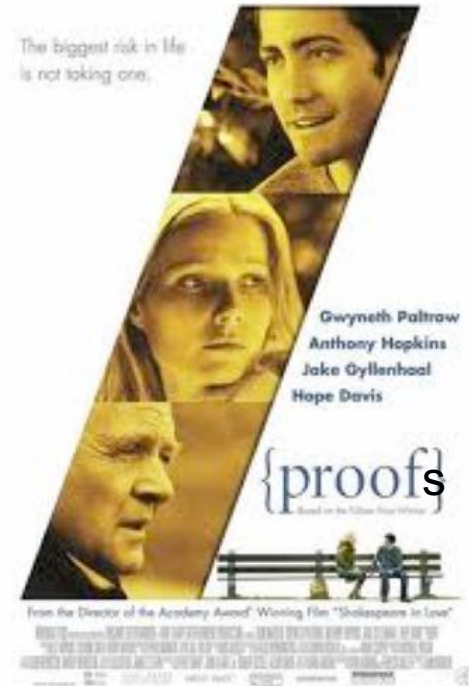


IT'LL BE

HARD

SUSPENSE - EXCITEMENT
ADVENTURE - ON EVERY LEVEL

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* [\[1\]](#), 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* [\[2\]](#) 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* [\[3\]](#) high level description of *Shor's algorithm* [\[2\]](#).) The reason why factoring large numbers [\[4\]](#) is important is that if one can solve this problem efficiently then one can break the *RSA cryptosystem* [\[5\]](#). 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

False because...

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

To get an A in the class

Have to get at least 90.000000000000000000000000000000%

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



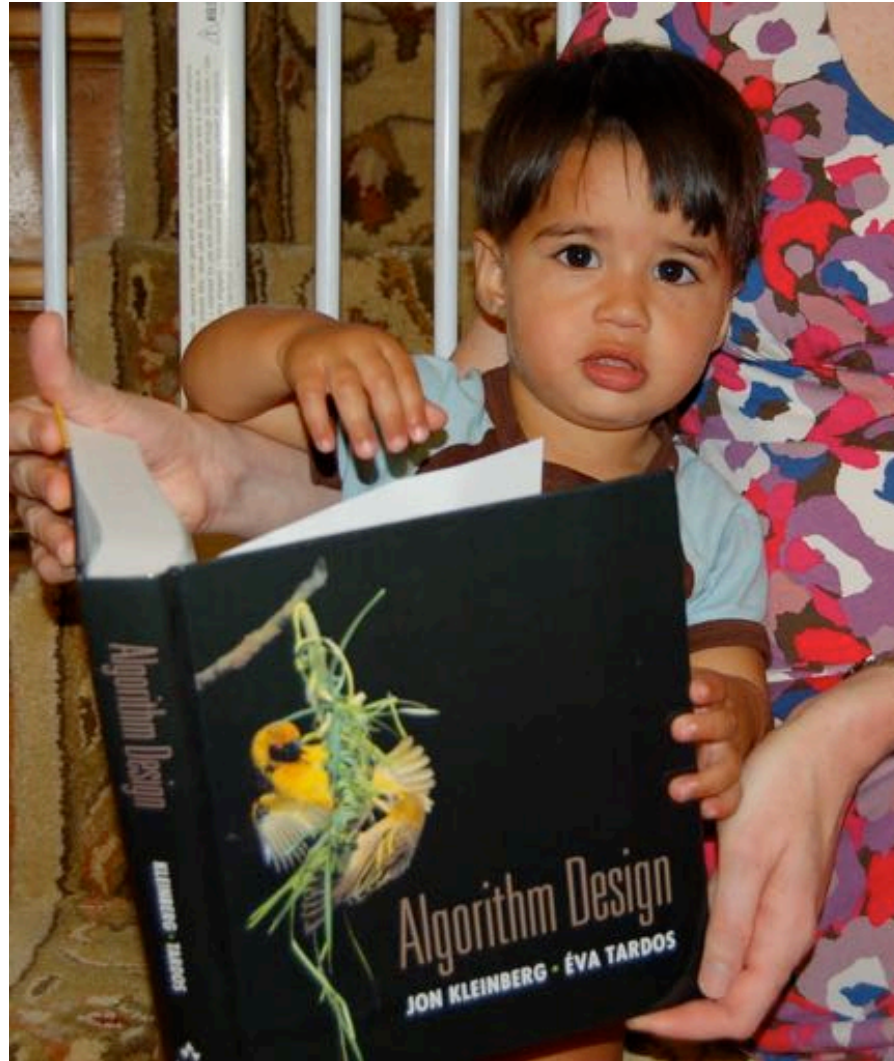
More chances to recover

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 page 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

