

# CIT592

## Welcome

### Intro

# CIT 592

- Mathematical Foundations of Computer Science
- Primary focus = discrete math
- Does not cover Linear Algebra, Optimization, Calculus etc

# Topics

- Sets
  - Functions, relations
- Permutations and Combinations
- Discrete Probability and Expectations
- Logic/Proofs
- Mathematical Induction
- Recursion
- Graph Theory

# Additional *potential* 'side' topic

- Some aspects of programming with recursion.
- More on this after the first exam.

# Math is needed for programming?

One of the most commonly asked questions in 592 is ...

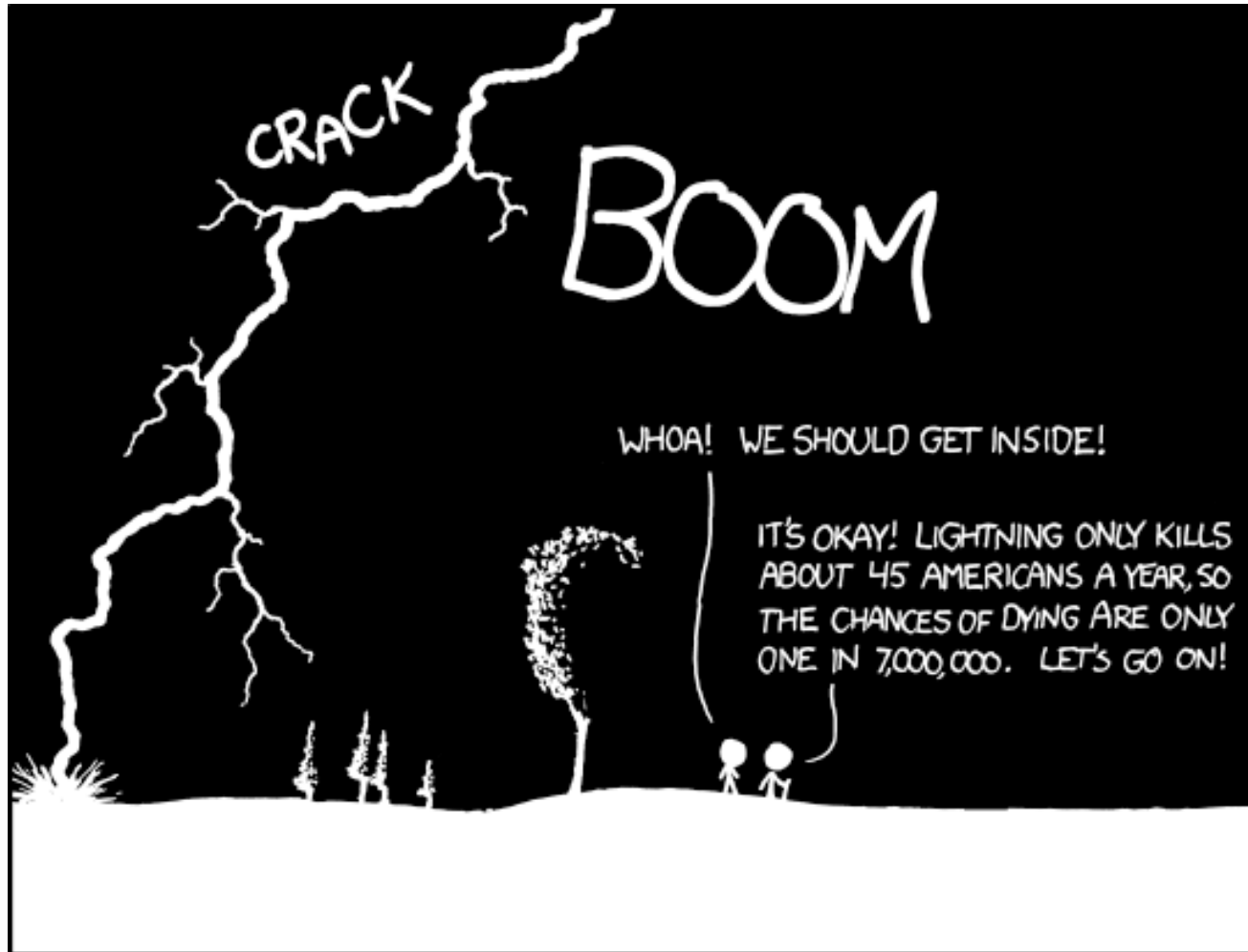
‘Where will I ever use this????’

Think of these topics as tools in your toolbox.

# Tools in toolbox(??)

- But I thought the computer was the only tool I needed!
- Computers are dumb. They need humans to “think” for them.
- Math gives you the structured approach that is most directly associated with the way computer programs/algorithms are written

# Discrete math saves lives!



THE ANNUAL DEATH RATE AMONG PEOPLE WHO KNOW THAT STATISTIC IS ONE IN SIX.

$$x^2 = \underbrace{x + x + \cdots + x}_{(x \text{ times})}$$

$$\frac{d}{dx}x^2 = \frac{d}{dx} \underbrace{[x + x + \cdots + x]}_{(x \text{ times})}$$

$$2x = 1 + 1 + \cdots + 1 = x$$

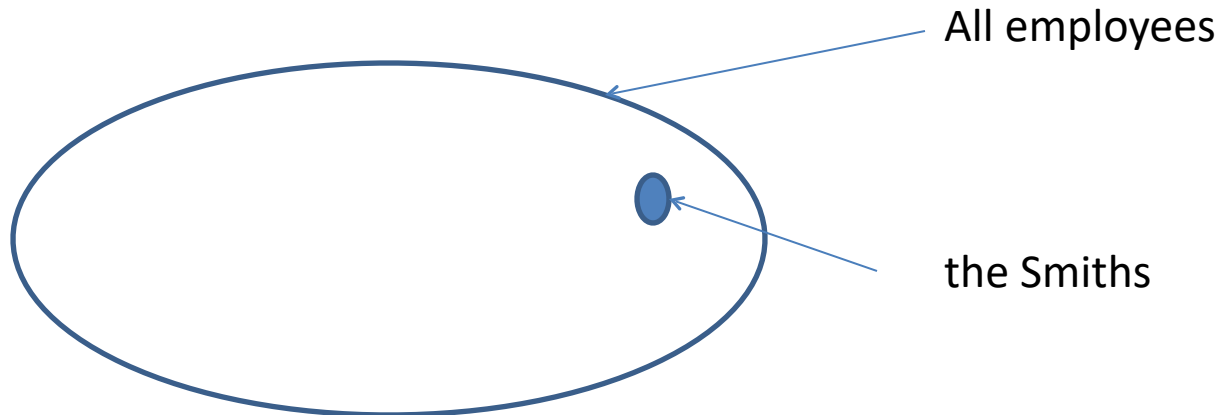
$$2 = 1$$



# Sets

- Databases

```
SELECT EMP_ID, LAST_NAME FROM  
EMPLOYEE_TBL WHERE LAST_NAME = 'Smith';
```



# Logic

- Day to day logical reasoning does incorporate aspects of ‘formal logic’
  - All 592 students are in MCIT
  - All MCIT students have met Beyonce
  - Therefore Beyonce will know about any 592 student I talk about ....
- You can greatly simplify code if you can simplify logical statements.
- Imperative for digital circuit design.

# Mathematical proof

- The most controversial topic taught in this course because ...
- ‘I’ve never proven anything in the software industry’
  - Maybe you haven’t programmed airplanes/rockets/medical devices
- The ability to write a good proof is not too far removed from the ability to write a program with  $v$  few bugs
- Very useful for an Algorithms course

# Counting/combinatorics usages

- How long is my program going to take?
  - Anyone can write inefficient code
  - A good programmer is able to analyze their program
- Analysis of programs almost always begins with having some idea of the ‘number of operations’
- Larger the data, longer the time taken. But how does it scale?
- Computing probabilities often involves solving two counting problems.

# Probability usages

- Where is probability used?
  - Machine learning
  - Las Vegas, Atlantic City, Monte Carlo, Macau
  - Making<sub>(and losing)</sub> millions and billions on Wall Street
  - Randomized algorithms
    - what is the 'expected' running time of quicksort

# Mathematical induction

- Breaking up a problem into smaller problems
- Use the smaller problem solutions to solve the big problem
- When used in proofs = induction
- When used in programming = recursion!

# Graph Theory

- Graph theory + probability + 2 PhD students + the internet = ....



- Navigation applications
  - What is the shortest route from point A to point B?
- Any social networking site will have to use graph theory.
- Lots more ...

# Administrivia

- Intro to Canvas and Piazza
- Sign up for Piazza (link also on website)
  - [piazza.com/upenn/fall2019/cit592](https://piazza.com/upenn/fall2019/cit592)
- All HW and HW submissions on canvas
- All syllabus and readings on canvas



# Grading

You final grade will be based on

Weekly HWs - 50%

Exams - 45%

Academic honesty and professionalism – 5%

There will be 3 exams. One of them will be during the final exam period but will not be any lengthier or “scarier”.

17, 15, 13

Your best exam will be worth 17%, second best 15%, and worst exam is worth 13% of your grade.

Trying to strike some balance between rewarding consistency and also not penalizing one bad day too much.

# Academic honesty and professionalism

- Everyone starts off with 5 points.
- Do not commit acts of academic dishonesty.
- Be nice to your fellow students.
- Do not harass a TA into providing you answers.
  - We cannot check your answer before you submit it.

# Extra credit opportunities

- An endorsed question/ endorsed answer (endorsed by course staff) on Piazza gets you an extra credit point.
- Threshold on extra credit = 2 points.
- All extra credit will be applied at the end of the semester.
- Please continue to read and respond to Piazza posts even if you are not getting extra credit.
- There are no extra credit opportunities outside of this.

# Grading

- My courses tend to require work.
- Grading is lenient in the end.
- Don't commit an act of academic dishonesty.
  - More on this when HW comes out

# Office hours

All of us (myself included) will have 2 hrs of office hours.

See Piazza post for hours and locations  
(coming up by end of week)

# Book

- Zybook – interactive textbook
- The zybook is mandatory!
  - Please see Piazza for how to sign up
- **If you cannot afford it please let me know.** We might be able to make some arrangements.
- I will type up basic notes for each class and post them in the syllabus section in canvas
- Relevant portions of other textbooks will be scanned and put on canvas as readings

# Latex

- Most popular tool for writing math
- <http://en.wikibooks.org/wiki/LaTeX>
- overleaf.com
- Useful to have a local installation as well
  - Texmaker is my personal recommendation
- Check the piazza post

# HW submission

- **Latex**
- **Only in pdf form and all on canvas**
- **NO IMAGES OF HANDWRITTEN SOLUTION**
- **Homeworks will generally be due on Wednesday night.**



# Recitation

TAs will run the recitation.

You will be doing practice problems in the recitations.

They will let you know more about the format next Tuesday.

**No recitation today!**

# Collaboration policy

- You are allowed to collaborate on HW with 1 other person.
- Write the name of your collaborator at the top of your HW.
- In the end you have to write your own solution. **NO COPY PASTE ALLOWED.**
- Individual submission
- You and your collaborator can and usually will get different scores on HW.
- You are allowed to change collaborators.

# A suggested approach to collaboration

1. Identify collaborator
  1. Pick someone who has roughly the same skill set.
  2. Someone with a similar schedule
2. Do it yourself first
  1. Come to office hours if stuck (or Piazza post)
3. Meet and discuss with your collaborator
  1. Come to office hours again if needed.
4. Write the answers by yourself. DO NOT copy from your collaborator.

# Internet search for a question = plagiarism

- The internet does not consist of a bunch of 592 TAs.
- Ask us, not them.
- We have 14 hours of office hours between the 7 of us. Please come see us!
  - If you cannot make ANY of those 14 hrs please let us know ASAP.
- Piazza exists as well!

# Basic math background







- This might be the only first semester MCIT course that DOES assume something
- Basic algebra
- Most of you have seen it in some form. Might be rusty.
- HW0 is designed to give you practice
- Does not contribute to your grade
- Please try and do these by yourself.
- Watch Khan academy videos to get a review


# Course Syllabus

Material covered in the lecture is primarily taken from the following repository.

<https://github.com/abhusnumath/592Notes>

You are welcome to follow that repository, but the most up to date version of the notes will also be posted here.

#	Date	Topics	Lecture notes	Readings from the text / other sources. Also recordings
1	8/27	Intro stuff	<a href="#">592Intro.pptx</a> 	
2	8/29	Sets, set operations	<a href="#">1_Sets.pdf</a> 	Chapter 1 of the zybook
3	9/3	relations and functions	<a href="#">2_SetsOperations.pdf</a> 	
4	9/5	More example of relations intro to permutations and combinations	<a href="#">3_functions.pdf</a> 	
5	9/10	counting (permutations and combinations)	<a href="#">4_SumNProduct.pdf</a> 	Chapter 4 of zybook. <a href="#">Sept10.mp3</a>
6	9/12	more counting	<a href="#">5_permutations.pdf</a> 	<a href="#">Sept12.mp3</a>
7	9/17	combinatorics with repeats	<a href="#">6_TrickyCombinatorics.pdf</a>	<a href="#">Sept17.mp3</a>

		stars and bars.		
8	9/19	basic probability	<a href="#">7_ProblIntro.pdf</a> 	<a href="#">Sept19.mp3</a>
9	9/24	probability with unions. Conditional probability		<a href="#">Sept24.mp3</a>
10	9/26	Bayes theorem	<a href="#">9_CondProb.pdf</a> 	<a href="#">Sept26.mp3</a>
11	10/1	Intro to random variables. Expectation.	<a href="#">10_Expectation.pdf</a> 	this did not record :(
	10/3	midterm 1		
12	10/8	Indicator random variables.	^same notes as above	<a href="#">Audio_10_08_2019_13_33_24.mp3</a>
	10/10	<b>Fall break</b>		
13	10/15	Logic	<a href="#">11_BasicLogic.pdf</a> 	<a href="#">venn diagrams.pdf</a>  <a href="#">Audio_10_15_2019_13_37_05.mp3</a>
14	10/17	Logic	<a href="#">12_LogicalEnglish.pdf</a> 	<a href="#">Oct17.mp3</a>
15	10/22	Proofs	<a href="#">Proof_lecture.pdf</a> 	<a href="#">Oct23.mp3</a> Zybook chapter 6
16	10/24	Proofs	<a href="#">proofs - part 2.pdf</a> 	<a href="#">Oct29.mp3</a>

17	10/29	Weak induction	<a href="#">15_Induction1.pdf</a> 	Zybook chapter 7 <a href="#">Oct31.mp3</a>
18	10/31	Weak induction		
19	11/5	Induction	<a href="#">16_Induction2.pdf</a> 	Zybook chapter 7
20	11/7	Strong induction		
21	11/12	Strong induction		
	11/14	midterm2		
22	11/19	Strong induction examples	<a href="#">ChangeRecursion.java</a> 	
23	11/21	Graphs. Basic definitions	<a href="#">20_graphtheory.pdf</a> 	Zybook chapter 9 <a href="#">Audio 11 21 2019 13 41 31.mp3</a>
23	11/26	Graph isomorphisms. Theorems involving graphs.		<a href="#">Audio 11 26 2019 14 12 00.mp3</a>
24	11/28	thanksgiving - no class		
25	12/2	graph theory	<a href="#">21_graphtheorypart2.pdf</a> 	<a href="#">Audio 12 03 2019 14 45 11.mp3</a>
26	12/5	graph theory		
	12/19	Final exam (12 -2am)		



## Course Summary:

Date	Details	
Wed Sep 11, 2019	<input type="checkbox"/> <a href="#">HW1</a>	due by 11:59pm
Wed Sep 18, 2019	<input type="checkbox"/> <a href="#">HW2</a>	due by 11:59pm
Thu Sep 26, 2019	<input type="checkbox"/> <a href="#">HW3</a>	due by 6am
Tue Oct 1, 2019	<input type="checkbox"/> <a href="#">HW4</a>	due by 11:59pm
Wed Oct 23, 2019	<input type="checkbox"/> <a href="#">HW5</a>	due by 11:59pm
Wed Oct 30, 2019	<input type="checkbox"/> <a href="#">HW6</a>	due by 11:59pm
Fri Nov 8, 2019	<input type="checkbox"/> <a href="#">HW7</a>	due by 11:59pm
Wed Nov 13, 2019	<input type="checkbox"/> <a href="#">HW8</a>	due by 11:59pm
Wed Nov 27, 2019	<input type="checkbox"/> <a href="#">HW9</a>	due by 11:59pm
Wed Dec 11, 2019	<input type="checkbox"/> <a href="#">HW10</a>	due by 11:59pm

[exam1](#)

[exam2](#)

[exam3](#)

[GetAFullScore](#)

[Piazza](#)

[Proofs recitation](#)

August 2020						
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5