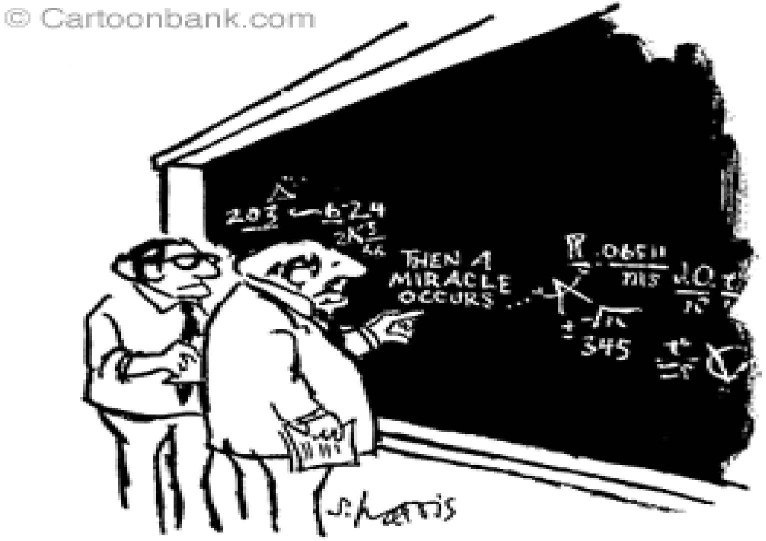
# CSE 20
# DISCRETE MATH

Fall 2020

http://cseweb.ucsd.edu/classes/fa20/cse20-a/

# Learning goals

Technical Skepticism




"I think you should be more explicit here in step two."

Multiple Representations

# The team - instructor

- Prof. Shachar Lovett

- A bit about me: I study algorithms, how to make them run faster, and why sometimes we cannot (complexity theory)

# The team - TAs

- Yihang Cheng
- Yuanjun Huang
- Gaurav Mahajan
- Ritwik Vatsyayan

# The team - tutors

- Nirmal Agnihotri
- Benny Cai
- Rachel Cai
- Stefanie Dao
- Yinxuan Du
- Roger Ji
- Ethan Lan
- Yiming Zhao

# Logistics

**Weekly activities:**
Pre-class reading + Class + Discussion Section + Reading quizzes + Homework

**Textbook:** Rosen 7th Edition other editions ok; on reserve

**Exams** 2 Midterms
Final

**Website:** Lecture slides, homework
**Canvas:** reading quizzes
**Gradescope**: Homework submission, HW & exam return
**Piazza**: Q&A and discussion
**Office hours**: instructor, TAs and tutors

# Grading

- All exams are asynchronous, within a 24-hour window

- Final: 30%
- Midterms: 30%, best out of 2
- Homework: 30%, can be done in groups, challenging!
- Reading quizzes: 10%, individual, easier

# Tools

- Live demonstration!

- **Website**: https://cseweb.ucsd.edu/classes/fa20/cse20-a/

(even though this class is now cse20-b, we still use the original URL; the cse20-b one points to the cse20-a one)

- **Piazza**: https://piazza.com/class/kfisjnv0it35d5

- **Gradescope**: https://www.gradescope.com/courses/192406

- **Canvas:** https://canvas.ucsd.edu/courses/20941

# Class structure

- First two weeks: exploring examples
  - Netflix ratings and machine learning
  - RNA and DNA: genomics and bioinformatics
  - Codes: secret messages and error correction
  - “Under the hood” of computers (e.g. circuits, color representation, data structures)

- Rest of the quarter: learning the math language needed to understand these

# I don’t know if you noticed…

- But I have a strong accent
- Nothing I can do about it, but it might make it harder for you to understand me (in particular as the topics we learn will be new to you)

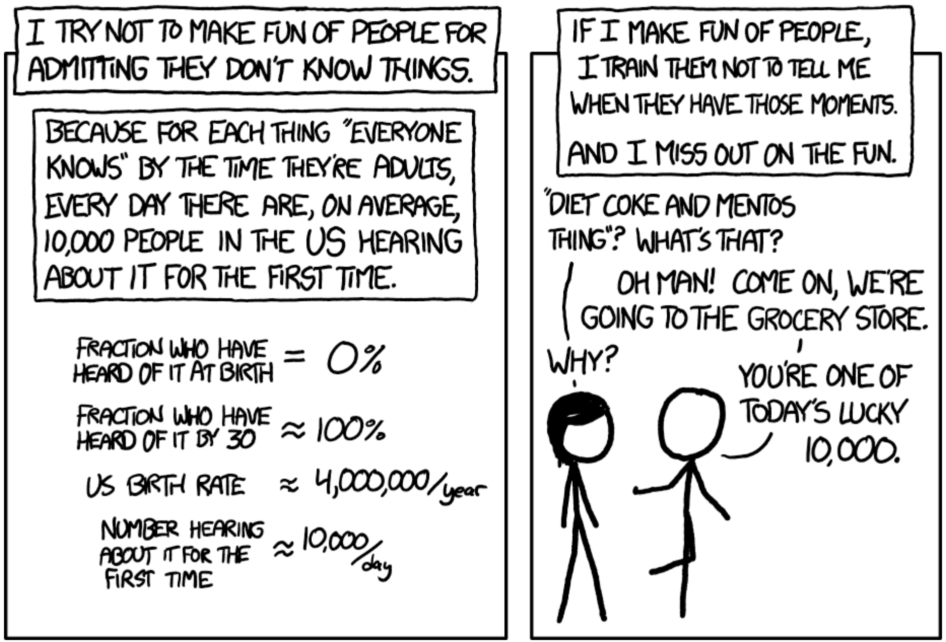
BUT:

- Educational research shows that students who have a professor with a strong accent actually learn better (maybe because they need to focus more)

- Lectures are recorded, so you can always go back watch them

- If you don’t understand something, don’t wait – come to office hours. Sometimes one small clarification can make all the difference.

# Introductions




xkcd.com

# Today's learning goals

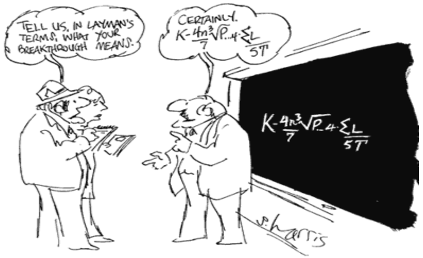
- Practice with some **definitions** and **notation**

- Explore mathematical **definitions** related to a specific **application** (Netflix)

# n-tuples, preferences, and Netflix

NETFLIX

Multiple Representations




What data should we encode about each Netflix account holder to help us make effective recommendations?

# n-tuples, preferences, and Netflix

| | | |
|---|---|---|
| $n$-tuple | $(x_1, x_2, x_3)$ | The 3-tuple of $x_1$, $x_2$, and $x_3$ |
| | $(3, 4)$ | The 2-tuple or ordered pair of 3 and 4 |

| Person | Fyre | Frozen II | Picard |
|---|---|---|---|
| $P_1$ | ✗ | • | ✓ |
| $P_2$ | ✓ | ✓ | ✗ |
| $P_3$ | ✓ | ✓ | ✓ |
| $P_4$ | • | ✗ | ✓ |

✗ Did not like
• No preference
✓ Liked

# n-tuples, preferences, and Netflix

| | | |
|---|---|---|
| $n$-tuple | $(x_1, x_2, x_3)$ | The 3-tuple of $x_1$, $x_2$, and $x_3$ |
| | $(3, 4)$ | The 2-tuple or ordered pair of 3 and 4 |

| Person | Fyre | Frozen II | Picard | Ratings written as a 3-tuple |
|---|---|---|---|---|
| $P_1$ | ✗ | • | ✓ | $(-1, 0, 1)$ |
| $P_2$ | ✓ | ✓ | ✗ | $(1, 1, -1)$ |
| $P_3$ | ✓ | ✓ | ✓ | $(1, 1, 1)$ |
| $P_4$ | • | ✗ | ✓ | |

✗ Did not like: represent with -1
• No preference: represent with 0
✓ Liked: represent with 1

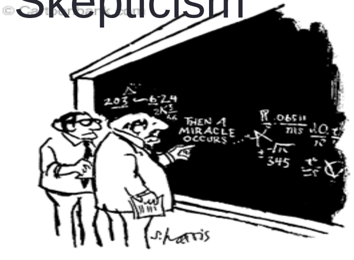
# How similar are people's preferences?

Which of $P_1$, $P_2$, $P_3$ has movie preferences most similar to $P_4$?

A: P1
B: P2
C: P3
D: There is a tie

| Person | Fyre | Frozen II | Picard |
|---|---|---|---|
| $P_1$ | ✗ | • | ✓ |
| $P_2$ | ✓ | ✓ | ✗ |
| $P_3$ | ✓ | ✓ | ✓ |
| $P_4$ | • | ✗ | ✓ |

Technical Skepticism




"I think you should be more explicit here in step two."

# One approach: functions

| | | |
|---|---|---|
| function definition | $f(x) = x + 4$ | Define $f$ of $x$ to be $x + 4$ |
| function application | $f(7)$ | $f$ of 7 **or** $f$ applied to 7 **or** the image of 7 under $f$ |
| | $f(z)$ | $f$ of $z$ **or** $f$ applied to $z$ **or** the image of $z$ under $f$ |
| | $f(g(z))$ | $f$ of $g$ of $z$ **or** $f$ applied to the result of $g$ applied to $z$ |

Page 2 of worksheet:

This page has some useful notation that will be used throughout the course. Find the definitions for each of these terms by looking in the index of the course textbook.

Define the following functions whose inputs are ordered pairs of 3-tuples each of whose components comes from the set $\{-1, 0, 1\}$

$$d_1(\ (x_1, x_2, x_3), (y_1, y_2, y_3)\ ) = \max_{1 \le i \le 3} |x_i - y_i|$$

| Person | Fyre | Frozen II | Picard | Ratings written as a 3-tuple |
|---|---|---|---|---|
| $P_1$ | ✗ | • | ✓ | $(-1, 0, 1)$ |
| $P_2$ | ✓ | ✓ | ✗ | $(1, 1, -1)$ |
| $P_3$ | ✓ | ✓ | ✓ | $(1, 1, 1)$ |
| $P_4$ | • | ✗ | ✓ | |

$$d_1(P_4, P_1)$$

| | | |
|---|---|---|
| roster method | $\{43, 7, 9\}$ | The set whose elements are 43, 7, and 9 |

Define the following functions whose inputs are ordered pairs of 3-tuples each of whose components comes from the set $\{-1, 0, 1\}$

| Person | Fyre | Frozen II | Picard | Ratings written as a 3-tuple |
|---|---|---|---|---|
| $P_1$ | ✗ | • | ✓ | $(-1, 0, 1)$ |
| $P_2$ | ✓ | ✓ | ✗ | $(1, 1, -1)$ |
| $P_3$ | ✓ | ✓ | ✓ | $(1, 1, 1)$ |
| $P_4$ | • | ✗ | ✓ | |

$$d_2(\ (x_1, x_2, x_3), (y_1, y_2, y_3)\ ) = \sqrt{\sum_{i=1}^{3} (x_i - y_i)^2}$$

$$d_2(P_4, P_1)$$

| Define the following functions whose inputs are ordered pairs of 3-tuples each of whose components comes from the set $\{-1, 0, 1\}$ | |
|---|---|
| $d_1(\ (x_1, x_2, x_3), (y_1, y_2, y_3)\ ) = \max_{1 \leq i \leq 3} \lvert x_i - y_i \rvert$ | $d_2(\ (x_1, x_2, x_3), (y_1, y_2, y_3)\ ) = \sqrt{\sum_{i=1}^{3} (x_i - y_i)^2}$ |

| | | |
|---|---|---|
| $d_1(P_4, P_1)$ | $d_1(P_4, P_2)$ | $d_1(P_4, P_3)$ |
| $d_2(P_4, P_1)$ | $d_2(P_4, P_2)$ | $d_2(P_4, P_3)$ |

# Next Steps

- Read the website carefully

- Make sure you can access canvas, piazza, gradescope

- Pre-class reading for Monday
  - Section 5.3, Definition 1 (Strings), Example 5 (p. 349), and Example 7 (p. 350)