Welcome to CSE 20: Discrete Math for Computer Science in Fall 2021!

Themes and applications for CSE 20

- **Technical skepticism**: Know, select and apply appropriate computing knowledge and problem-solving techniques. Reason about computation and systems. Use mathematical techniques to solve problems. Determine appropriate conceptual tools to apply to new situations. Know when tools do not apply and try different approaches. Critically analyze and evaluate candidate solutions.
- **Multiple representations**: Understand, guide, shape impact of computing on society/the world. Connect the role of Theory CS classes to other applications (in undergraduate CS curriculum and beyond). Model problems using appropriate mathematical concepts. Clearly and unambiguously communicate computational ideas using appropriate formalism. Translate across levels of abstraction.

Applications: Numbers (how to represent them and use them in Computer Science), Recommendation systems and their roots in machine learning (with applications like Netflix), "Under the hood" of computers (circuits, pixel color representation, data structures), Codes and information (secret message sharing and error correction), Bioinformatics algorithms and genomics (DNA and RNA).

Introductions

Class website: http://cseweb.ucsd.edu/classes/fa21/cse20-a

Pro-tip: the URL structure is your map to finding your course website for other CSE classes.

Instructor: Prof. Mia Minnes "Minnes" rhymes with Guinness, minnes@eng.ucsd.edu, http://cseweb.ucsd.edu/ minnes

Our team: Four TAs and 10 tutors + all of you

Fill in contact info for students around you, if you'd like:

On an average week, MWF Lectures + review quizzes, W Discussion, T HW due, Office hours, Piazza. Project parts will be due some weeks.

Due dates: Review quizzes, HW, and Project, see course calendar and Canvas.

Education research: CSE 20 is participating in a project on retention and sense of community in UCSD majors; see research plan. If you consent to participate in this study, no action is needed. If you DO NOT consent to participate in this study, or you choose to opt-out at any time during the a cademic year, sign and submit this form to the research contact at retentionstudy@cs.ucsd.edu.

Friday September 24

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

In machine learning, clustering can be used to group similar data for prediction and recommendation. For example, each Netflix user's viewing history can be represented as a n-tuple indicating their preferences about movies in the database, where n is the number of movies in the database. People with similar tastes in movies can then be clustered to provide recommendations of movies for one another. Mathematically, clustering is based on a notion of distance between pairs of n-tuples.

Monday September 27

Term	Notation Example(s)	We say in English
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
sequence	$x_1, \ldots, x_n$	A sequence x_1 to x_n
	$x_1, \ldots, x_n$ where $n = 0$	An empty sequence
	$x_1, \ldots, x_n$ where $n = 1$	A sequence containing just x_1
	$x_1, \ldots, x_n$ where $n = 2$	A sequence containing just x_1 and x_2 in order
	x_1, x_2	A sequence containing just x_1 and x_2 in order
set		Unordered collection of objects. The set of ...
all integers	$\mathbb{Z}$	The (set of all) integers (whole numbers including negatives, zero, and positives)
all positive integers	$\mathbb{Z}^+$	The (set of all) strictly positive integers
all natural numbers	$\mathbb{N}$	The (set of all) natural numbers. **Note**: we use the convention that 0 is a natural number.
roster method	$\{43, 7, 9\}$	The set whose elements are 43, 7, and 9
	$\{9, \mathbb{N}\}$	The set whose elements are 9 and $\mathbb{N}$
set builder notation	$\{x \in \mathbb{Z} \mid x > 0\}$	The set of all x from the integers such that x is greater than 0
	$\{3x \mid x \in \mathbb{Z}\}$	The set of all integer multiples of 3 **Note**: we use the convention that writing two numbers next to each other means multiplication.
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
absolute value	$\lvert -3 \rvert$	The absolute value of -3
square root	$\sqrt{9}$	The non-negative square root of 9
summation notation	$\displaystyle\sum_{i=1}^{n} i$	The sum of the integers from 1 to n, inclusive
	$\displaystyle\sum_{i=1}^{n} i^2 - 1$	The sum of $i^2 - 1$ (i squared minus 1) for each i from 1 to n, inclusive
quotient, integer division	n **div** m	The (integer) quotient upon dividing n by m; informally: divide and then drop the fractional part
modulo, remainder	n **mod** m	The remainder upon dividing n by m

Term	**Examples**: (add additional examples from class)
set unordered collection of elements *Equal means agree on membership of all elements*	$7 \in \{43, 7, 9\}$ $\quad 2 \notin \{43, 7, 9\}$
n-**tuple** ordered sequence of elements with n "slots" *Equal means corresponding components equal*	
string ordered finite sequence of elements each from specified set *Equal means same length and corresponding characters equal*	

$$\{-1, 1\} \qquad \{0, 0\} \qquad \{-1, 0, 1\} \qquad \mathbb{Z} \qquad \mathbb{N} = \{x \in \mathbb{Z} \mid x \geq 0\} \qquad \emptyset \qquad \mathbb{Z}^+ = \{x \in \mathbb{Z} \mid x > 0\}$$

Which of the sets above are defined using the roster method? Which are defined using set builder notation?

Which of the sets above have 0 *as an element?*

Can you write any of the sets above more simply?

RNA is made up of strands of four different bases that match up in specific ways.
The bases are elements of the set $B = \{\mathtt{A}, \mathtt{C}, \mathtt{G}, \mathtt{U}\}$.

Definition The set of RNA strands S is defined (recursively) by:

Basis Step:	$\mathtt{A} \in S, \mathtt{C} \in S, \mathtt{U} \in S, \mathtt{G} \in S$
Recursive Step:	If $s \in S$ and $b \in B$, then $sb \in S$

where sb is string concatenation.

Examples:

To define a set we can use the **roster method**, the **set builder notation**, and also ...
New! Recursive Definitions of Sets: The set S (pick a name) is defined by:

Basis Step:	Specify finitely many elements of S
Recursive Step:	Give a rule for creating a new element of S from known values existing in S, and potentially other values.

The set S then consists of all and only elements that are put in S by finitely many (a nonnegative integer number) of applications of the recursive step after the basis step.

Wednesday September 29

Friday October 1