Agenda

1. Course Logistics / Introduction
   a. Syllabus
   b. Slack
   c. Enrollment
2. Small Groups: Sets
3. Together: Proof Writing

ACE Info

Website: **cs103ace.stanford.edu**
Slack: **cs103acespring2025.slack.com**

What you need to do to pass ACE

1. Get at least a C- in CS 103

2. Come to all the sections

   You can be absent / late no questions asked for one section

   Exceptions for extenuating circumstances (illness, emergencies, etc.), email me beforehand if possible for these absences

What to expect from ACE section

- **Concept review**
  - Will assume you are caught up on lecture
- **Practice problems**, focusing on **key strategies** relevant to the week's problem set
  - We will not be working directly on the problem set!
    - In 103, each exam is worth much more than each pset, so strategies are very important
- **Supportive community**
  - Everyone is here to learn!
  - Share your ideas and your questions
  - Unique chance to collaborate in groups on this material

Additional ACE resources

- **ACE-only office hours**
  - Ask me anything about 103 material
  - Office hours times: *Thursdays 11:30am-1:20pm Littlefield 107*
    - EXCEPT WEEK 2 & 5
    - *Week 2: Thursday 5-7pm, 200-219*
  - Would you rather have Wednesday before 1pm?
- **Exam review sessions & practice exams**
  - A few days before each midterm and the final
- **One-on-one meetings**
  - Optional check-ins throughout the quarter
- **Slack** for chat-based virtual help and announcements
  - I'll send any section follow-ups in the main channel
  - Feel free to ask conceptual questions to each other as a group!
  - I'll check every evening to answer questions

About me

I'm Elena (she/her or they/them)

- EE major (Information Theory) + CS coterm (AI)
- Contact me: Slack, email, office hours, before/after section
- Ask me about: anything CS 103, engineering majors, the CS coterm, section leading, bread baking, sustainability research / PhD

Intros!

- Pair up with someone you don't know
- Introduce yourselves to each other:
  - Where you're from, class year, what you're studying
  - Something you get excited about
- Find something interesting that you have in common
- Share w/ class

Myth-busting

- Some people are just good at math and I'm not one of them

- Some people already know how to do this so I will never catch up

- I don't know what's going on and if I ask questions I'll look silly

Myth-busting

- ~~Some people are just good at math and I'm not one of them~~
  Math is a skill! No one is born knowing how to write a proof, everyone has to learn and practice. You can do it!
- ~~Some people already know how to do this so I will never catch up~~
  Willingness to learn is more important to your success in this class than how much you already know
- ~~I don't know what's going on and if I ask questions I'll look silly~~
  I've been there. Please ask! We are all here to learn!
  - It's totally normal to ask "what is this even asking?" or "how do I start?"

Set Theory

Symbol	Read as	Meaning
$x \in S$	Element of	S contains x
$S \subseteq T$	Subset of	All the elements in S are also in T
$S \cup T$	Union	Set containing elements in <u>either</u> S or T
$S \cap T$	Intersection	Set containing elements in <u>both</u> S and T
$S - T$	Difference	Set containing elements in S, but not T
$S \mathbin{\Delta} T$	Symmetric difference	Set containing elements in one but not both
$\wp(S)$	Power set	Set of all subsets of S
$\varnothing$	Empty set	Set with no elements
$|S|$	Cardinality	Number of elements in S

Key facts about power sets

- To find the power set of a set with sets inside, try it with one-letter names for each of the elements
- If S is a finite set, $|\wp(S)| = 2^{|S|}$
- Because $\wp(S)$ is "the set of all subsets of S":
  - any <u>element</u> of $\wp(S)$ must be a <u>subset</u> of S
  - any <u>subset</u> of S must be an <u>element</u> of $\wp(S)$

Other set operations

For the sets S and T from problem 1, what is:

1. $S \cup T$
2. $S \cap T$
3. $S - T$
4. $T - S$
5. $S \triangle T$

Other set operations - answers

1. {0, 1, 2, 3, 4, 6, {1, 2}}
2. {1}
3. {0, 2, 3}
4. {4, 6, {1, 2}}
5. {0, 2, 3, 4, 6, {1, 2}}

Three Step Plan for Proofs

1. **What is this asking me to do?**
    - Write down all relevant definitions
    - (Optional: Come up with examples)
2. **What is the argument I'm going to make?**
    - The <u>structure</u> of the theorem → the structure of your proof
    - Write down your assume & want-to-show
      (Tip: use numbered lists)
3. **How do I explain my argument in a logical order?**
    - Apply a format from lecture
    - You may have to write "out of order": the logical order of facts might differ from how you came up with the proof

Proof Strategy: Proof by Contradiction

Prove X by showing that if X wasn't true, we get an impossible and silly outcome. **We are still trying to prove X**, even though we start from assuming "not X".

- Step 1: Figure out what "not X" is.
  - Key tip: When X is an implication "if P, then Q", the negation of X is "P and not Q".
- Step 2: We don't have an explicit "want to show". We just <u>assume</u> not X and want to eventually find something fishy.
- Step 3: "Assume for the sake of contradiction that…" then state your assumption

Three ways to introduce variables

See [the proofwriting checklist](#)

- Reader picked: pick any value (possibly under certain constraints)
  - "Pick an **arbitrary** odd integer x"
  - "Let z be **any** natural number"
- Writer picked: give a specific value
  - "Let x be **5**"
  - "Pick z to be **{137}**"
- "Existentially picked": when you know something exists, but you don't know what it is
  - "Since x is odd, we know **there is a** number k where x = 2k + 1"
  - "We know that [a fuzzy unicorn] **exists**. Let y be [a fuzzy unicorn]."

Proof Strategy: Proof by Contrapositive

We are going to prove P → Q by proving (not Q) → (not P)

- Step 1: Figure out what P, Q, not P, and not Q are
- Step 2: Set up the proof like with any implication:
  - <u>Assume</u> (not Q), <u>want to show</u> (not P)
- Step 3: "We will prove the contrapositive:" then state the contrapositive

But why is the contrapositive like that?

- I love puppies!
- "If it's a puppy, then I like it"
    - $P \rightarrow Q$: What are P and Q here?
- Let's say I have a secret thing that I **don't** like...
  What do you know about this thing?
  If I love all puppies, could this thing possibly be a puppy?
    - How does this relate to P and Q?

Key takeaway: **the contrapositive is equivalent to the original implication**

But why is the contrapositive like that?

Connective	Read Aloud As	C++ Version	Fancy Name	Negation
$\neg p$	"not"	!	Negation	p
$p \wedge q$	"and"	&&	Conjunction	$\neg p \vee \neg q$ $p \rightarrow \neg q$
$p \vee q$	"or"	||	Disjunction	$\neg p \wedge \neg q$
$\top$	"true"	**true**	Truth	$\perp$
$\perp$	"false"	**false**	Falsity	$\top$
$p \rightarrow q$	"implies"	*see PS2!*	Implication	$p \wedge \neg q$
$p \leftrightarrow q$	"if and only if"	*see PS2!*	Biconditional	$p \leftrightarrow \neg q$ $\neg p \leftrightarrow q$

~b ^ a

~b -> ~a

a -> b

~b ^ a

TODOs for ACE

- Enroll on Axess
- Get on Slack
- Watch out for food allergy form on Slack