

CSE 312 Section 1

Combinatorics

Administrivia & Introductions



Announcements & Reminders

- Office Hours
 - We started holding office hours today!
 - Times posted on the calendar on the course website
- HW1
 - Due Wednesday 7/2 @ 11:59pm
- Quiz 1
 - Tomorrow in lecture, start at 12:00, 15 mins long
 - Covers Monday and Wednesday content

Section

- Materials
 - Handouts will be provided in at each section
 - Worksheets and sample solutions will be available on the course calendar later after section
- Participation
 - Participations are recorded
 - "Participated" means you're working on the problems and talking with those around you.
 - If you cannot attend section in-person, do the section problems and email your TA(s) for credit
 - **Section {AA/AB}: email: ...**

Homework

- Submissions
 - LaTeX (highly encouraged)
 - overleaf.com
 - template and LaTeX guide posted on course website!
 - Word Editor that supports mathematical equations
 - Handwritten neatly and scanned
- Homework will typically be due on Wednesdays at 11:59pm on Gradescope

Homework

- Late Days
 - 2 penalty free late days with meaningful attempt submitted by the original deadline
 - Meaningful Attempt
 - You have thought about and worked through the majority of every problems on the homework
 - Failing to submit a meaningful attempt would result in 25% deduction per day after original deadline

Your TAs

- TA 1
 - Intro
- TA 2
 - Intro

Our Office Hours

- TA 1
 - OH
- TA 2
 - OH

Icebreaker

- Small groups of 4-6ish
- Please share with your group
 - Your name
 - Number of years in department/ at UW
 - What was something fun you did over Winter break?
 - What are you concerned about for 312 / what are you excited about?
- Then, share how you like to eat your potatoes (baked, fried, chips,
- We'll go around and see what style of potato is most popular!



Review



What have we learned so far?

- Sum Rule
- Product Rule
- Picking objects
 - Permutations: $P(n, k) = \frac{n!}{(n-k)!}$
 - Combinations: $C(n, k) = \binom{n}{k} = \frac{n!}{k!(n-k)!}$
- Overcounting
- Complementary counting

Any lingering questions from this last week?

Each week in section, we'll be reviewing the main concepts from this week by going through some practice problems together. But before that, we'll try to start off each section with some time for you to ask questions.

Was anything particularly confusing this week? Is there anything we can clarify before we dive into the review? This is your chance to clear things up!

Sum and Product Rule

- Sum Rule

- An experiment can **either** end up being one of N outcomes, **or** one of M outcomes (where there is no overlap)
- The total number of possible outcomes is **$N + M$** .
- Outcomes: A, B, C
- Total outcomes: $A \cup B \cup C$

- Product Rule

- Sequential process, where step i has n_i options
- For k steps, The total number of possible outcomes is $\prod n_i = n_1 \cdot n_2 \cdots n_k$

Picking objects

- Picking k objects from n objects
- Permutations
 - Arranging k objects: Order matters
 - $P(n, k) = \frac{n!}{(n-k)!}$
- Combinations
 - Choosing k objects: Order doesn't matter
 - $C(n, k) = \binom{n}{k} = \frac{n!}{k!(n-k)!}$

Picking objects


- Picking k objects from n objects

		Repeats	
		with	without
Order	matters	n^k	$P(n, k)$
	Doesn't matter		$C(n, k)$

Overcounting

- Example from class

Overcounting

How many anagrams are there of RHUBARB 

Final answer $\frac{7!}{2! \cdot 2!}$

One more piece of notation – “multinomial coefficient”

$\binom{7}{2,2}$ is alternate notation for $\frac{7!}{2!2!}$.

In general: $\binom{n}{k_1, k_2, \dots, k_\ell} = \frac{n!}{k_1! \cdot k_2! \cdot \dots \cdot k_\ell!}$

Popular notation among mathematicians.

Complementary Counting

- All possible outcome is Ω
- We want $A \subseteq \Omega$
- It might be hard to count the number of outcome in A . Instead, it could be easier to count \bar{A} .

$$|A| = |\Omega \setminus \bar{A}|$$

Problem 9 – Rabbits!



9 – Rabbits!

Rabbits Peter and Pauline have three offspring: Flopsie, Mopsie, and Cotton-tail. These five rabbits are to be distributed to four different pet stores so that no store gets both a parent and a child. It is not required that every store gets a rabbit. In how many different ways can this be done?

Work on this problem with the people around you, and then we'll go over it together!

Problem 5 – Birthday Cake



5 – Birthday Cake

A chef is preparing desserts for the week, starting on a Sunday. On each day, only one of five desserts (apple pie, cherry pie, strawberry pie, pineapple pie, and cake) may be served. On Thursday there is a birthday, so cake must be served that day. On no two consecutive days can the chef serve the same dessert. How many dessert menus are there for the week?

Work on this problem with the people around you, and then we'll go over it together!

Problem 1 - Seating



1 – Seating

How many ways are there to seat 10 people, consisting of 5 couples, in a row of 10 seats if ...

- a) ... all couples are to get adjacent seats?
- b) ... anyone can sit anywhere, except that one couple insists on not sitting in adjacent seats?

Work on this problem with the people around you, and then we'll go over it together!

Problem 4 – Escape the Professor



4 – Escape the Professor

There are 6 security professors and 7 theory professors taking part in an escape room. If 4 security professors and 4 theory professors are chosen and paired off, how many pairings are possible?

Work on this problem with the people around you, and then we'll go over it together!

Problem 11 - Subsubset



11 – Subsubset

Let $[n] = \{1, 2, \dots, n\}$ denote the first n natural numbers. How many (ordered) pairs of subsets (A, B) are there such that $A \subseteq B \subseteq [n]$?

Work on this problem with the people around you, and then we'll go over it together!

Problem 7 – Paired Finals



7– Paired Finals

Suppose you are to take a CSE 312 final in pairs. There are 100 students in the class and 8 TAs, so 8 lucky students will get to pair up with a TA. Each TA must take the exam with some student, but two TAs cannot take the exam together. How many ways can they pair up?

Work on this problem with the people around you, and then we'll go over it together!

Problem 10 – Extended Family Portrait



10 – Extended Family Portrait

A group of n families, each with m members, are to be lined up for a photograph. In how many ways can the nm people be arranged if members of a family must stay together?

Work on this problem with the people around you, and then we'll go over it together!

That's All, Folks!

**Thanks for coming to section this week!
Any questions?**