Homework 1: Counting

For each problem, remember you must briefly explain/justify how you obtained your answer, as correct answers without an explanation will not receive full credit. Moreover, in the event of an incorrect answer, we can still try to give you partial credit based on the explanation you provide.

In general, your goal in an explanation is to write enough that a student from class who has attended lecture, but not thought about the problem yet, could understand your approach, verify your reasoning, and believe your answer is correct. While we do not usually need to see arithmetic, you must include enough work that in principle one could rederive your answer with only a scientific calculator.

Unless a problem states otherwise, you should leave your answer in terms of factorials, combinations, etc., for instance 26^7 or $26!/7!$ or $26 \cdot \binom{26}{7}$ are all good forms for final answers.

Remember that you must "select pages" to identify which problem is on which page as part of your gradescope upload.

Submission: There are four gradescope boxes for this homework:

- You must upload a **pdf** of your written solutions to Gradescope under "HW 1 [Written]". (Instructions as to how to upload your solutions to gradescope are on the course web page.) The use of *LaTeX* is *highly recommended*. (Note that if you want to hand-write your solutions, you'll need to scan them. We will not grade work that we are unable to read, so please write neatly if you handwrite.)
- Your code will be submitted under "HW 1 [Coding]" as files called `cse312_pset1_vars.py`, `cse312_pset1_loops.py`, `cse312_pset1_lists.py`, `cse312_pset1_functions.py`, and `cse312_pset1_classes.py`..
- You will do an "online assignment" on gradescope to complete problem 0.
- The feedback problem (problem 7) has a separate box.

Due Date: This assignment is due at 11:59 PM Wednesday October 1.
Please put each numbered problem on its own page of the pdf (this will make selecting pages easier when you submit), and ensure that your pdfs are oriented correctly (e.g. not upside-down or sideways).

Collaboration: Please read the full collaboration policy. If you work with others (and you should!), you must still write up your solution independently and name all of your collaborators somewhere on your assignment.

0. Mathematical Background [10 points]

Complete the mathematical background problems located in Problem 0 on gradescope. This assignment will operate much like a concept check—an explanation will appear when you get a problem right, and you may resubmit until you get all problems correct.

The material in those problems are things we expect you learned in prior courses (especially calculus courses). We'll do similar computations as part of bigger problems later in the quarter. If there are any topics you aren't comfortable with, you should carve some time out to review over the next few weeks.

1. Syllabus [5 points]

Read the Syllabus, especially the collaboration policy, late policy, and the policy on exam conflicts. If you have questions, please ask them on Ed!

On your homework submission write "I have read the syllabus, and agree to follow the collaboration policies." for full credit.

2. Softball [15 points]

Eleven people (7 students and 4 faculty) on CSE's softball team show up for a game.

(a) How many ways are there to choose which 4 players will be infielders (for this part, you should just account for who is playing and who is not)?

(b) How many ways are there to assign the 4 **different** infield positions by selecting players from the 11 people who show up (for this part, account for both who plays and which of the 4 different positions they are playing)?

(c) How many ways are there to choose which 4 players will be infielders if at least one of these players must be a faculty member (for this part, we select only who are infielders, not the positions, like part (a))?

3. Getting from here to there [20 points]

(a) How many paths are there from point (0,0) to (120,140) if every step increments one coordinate and leaves the other unchanged?

(b) How many paths are there from point (0,0) to (120,140) if every step increments one coordinate and leaves the other unchanged and you want the path to go through (70,90)?

(c) How many paths are there from point (0,0) to (120,140) if every step increments one coordinate and leaves the other unchanged and the path **cannot** go through (30, 40) or (70,90)? (Hint: Try inclusion-exclusion.)

(d) How many paths are there from point (0,0,0) to (20,40,30) if every step increments one coordinate and leaves the other two unchanged?

4. 5-suit-deck with 6-card-hands [10 points]

Suppose you are playing poker with a non-standard deck of cards. The deck has **5** suits, each of which contains **12** values (so the deck has 60 cards total).

How many 6-card hands are there, where you have at least one card from each suit? A hand of cards is an unordered set.

5. Sitting around [15 points]

Archer (A), Bilbo (B), Cersei (C), Dante (D), Eowyn (E), Frodo (F), Gollum (G), and Halbarad (H) are sitting in a row of ten seats (Note: there are only eight people). Archer and Bilbo are exes, so they cannot sit next to each other. Cersei and Dante are dating, so they must sit next to each other. Eowyn, Frodo, and Gollem are best friends, so they also must sit next to each other, but Frodo must be in the middle of Eowyn and Gollem (with no spaces between the three). Our goal is to figure out how many ways they can sit in a row.

We're going to build up to answering the full question described above by starting with a version we know how to solve and slowly adding on restrictions (the final answer is part e). In each of the following parts, account for **only** the restrictions listed in that part (for example, parts a, b, and c do not restrict whether Archer and Bilbo can be next to each other or not).

(a) How many ways are there to place the 8 people into the 10 chairs (with no other restrictions)? (This is not unlike the rearrangements of DOGGY that we discussed/will discuss in lecture, where the empty seats are like the two Gs)?

(b) How many ways are there to place the 8 people into the 10 chairs if EFG must sit together in that order and CD must sit together in that order?

(c) How many ways are there to place the 8 people into the 10 chairs if EFG must sit together but E and G can swap positions and CD must sit together in either order?

(d) How many ways are there to place the 8 people into the 10 chairs if EFG must sit together (but E and G can swap positions), CD must sit together in either order and AB must sit together in either order?

(e) How many ways are there to place the 8 people into the 10 chairs if EFG must sit together (but E and G can swap positions), CD must sit together in either order and A and B must not sit next to each other?

6. Coding and Reflection [15 points]

(a) Read the HW1 Python Tutorial and Coding Exercises lesson on Edstem and follow the directions to complete the 5 coding exercises. Then submit all required files to HW1 [Coding] on Gradescope. You may resubmit to gradescope as many times as you like. We do not have any hidden tests for this assignment; whatever score you see on gradescope on your last submission will be your final score.

(b) Read the Edstem lesson on Python's numpy library and write the reflection described below (be sure to finish part (a) before moving to this part). You do **not** need to complete the *coding* exercises for this part. The coding exercise that is there is optional, and intended only for practice if you want it. The goal of this part is to see some more advanced python features that will definitely be useful in the future, but you won't need to use frequently for this course.
After reading the lesson, write a reflection on what you felt was the most confusing numpy function and/or class to you and why. If nothing is confusing, explain which function and/or class is the most interesting to you. We will grade based on completion and effort (since this response can't be "correct" or "incorrect"). We expect most responses will be 2-4 sentences. **Include your reflections in the pdf you upload to gradescope with the other problems on this assignment.**

7. Feedback [1 point]

Answer these questions on the separate Gradescope box for this question.

Please keep track of how much time you spend on this homework and answer the following questions. This can help us calibrate future assignments and future iterations of the course, and can help you identify which areas are most challenging for you.

- Did you collaborate with anyone else on this assignment? If so, who?
- How many hours did you spend working on this assignment (excluding any extra credit questions, if applicable)? Report your estimate to the nearest hour.
- Which problem did you spend the most time on?
- Any other feedback for us?