

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: 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`.

Version 2: Updated 2/29 9 AM. We added instructions for Question 1.

Due Date: This assignment is due at 11:59 PM Wednesday April 3

You will submit the written problems as a PDF to Gradescope. 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). The coding problem will also be submitted to Gradescope.

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.

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]

Twelve people (8 students and 4 faculty) on CSE’s softball team show up for a game.

- 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)?
- How many ways are there to assign the 4 infield positions by selecting players from the 12 people who show up (for this part, account for both who plays and which of the 4 different positions they are playing. There are four different infield positions)?
- 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 $(100,150)$ if every step increments one coordinate and leaves the other unchanged?
- (b) How many paths are there from point $(0,0)$ to $(100,150)$ if every step increments one coordinate and leaves the other unchanged and you want the path to go through $(80,70)$?
- (c) How many paths are there from point $(0,0)$ to $(100,150)$ if every step increments one coordinate and leaves the other unchanged and the path **cannot** go through $(40, 50)$ or $(80,70)$? (Hint: Try inclusion-exclusion.)
- (d) How many paths are there from point $(0,0,0)$ to $(200,20,30)$ 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), and Gollum (G) are sitting in a row of nine seats (Note: there are only seven 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 Gollum are best friends, so they also want to sit next to each other, but Frodo must be in the middle of Eowyn and Gollum (with no spaces between the three). Our goal is to figure out how many ways they can sit in a row. Build up to the answer by answering the following questions: In how many ways can they sit in a row? (Hint: We will start by grouping Eowyn, Frodo, and Gollum, as well as Cersei and Dante. Then we will work on placing Archer and Bilbo). Also, you will find the problem easier if you just call them, A,B,C,D, E, F, and G, as we do from now on.

- (a) How many ways are there to place the 7 people into the 9 chairs if EFG must sit together in that order and CD must sit together in that order (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 7 people into the 9 chairs if EFG must sit together but E and G can swap positions and CD must sit together in either order?
- (c) How many ways are there to place the 7 people into the 9 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?
- (d) How many ways are there to place the 7 people into the 9 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. Binomial Theorem applications [15 points]

For part (a) of this question (as with many others for 312), you could find the numerical answer in a few seconds by asking wolfram alpha (in this case, by asking it to expand the polynomial). We have learning goals associated

with this problem that mean we want you to practice solving this problem by hand even though you could easily answer it with computational power.

Remember that you must give an explanation of an answer such that another student would understand the **principles** that go into solving the problem, and such that they could find the answer with a simple calculator (that doesn't have an "expand a polynomial" operation)

You may find it beneficial to verify your answer using WolframAlpha, but you may not use the "show steps" option on WolframAlpha or any similar tool.

(a) What is the coefficient of x^5y^{10} in the expansion of $(2x - y^2)^{10}$?

(b) Use the binomial theorem to prove that

$$\sum_{i=0}^{100} \binom{100}{i} (-4)^{100-i} = 3^{100}$$

7. 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.