

## CS1800

Fall 2025

### Homework 5

**Assigned:** October 28, 2025

**Deadline:** November 4, 2025 at 9pm eastern

**Late Deadline:** November 6, 2025 at 9pm eastern

#### Submission Format

CS1800 Homeworks must be neatly handwritten, on physical paper or a tablet. **Typed submissions will not be accepted.**

Submit a PDF or images to Gradescope. If you submit images, make sure they are JPEG, JPG, or PNG. (Don't submit iPhone HEIC images!) Each problem starts on a new page. Problem 1 is on a different page than Problem 2. Problems 1A and 1B can be on the same page.

#### Collaboration and Academic Integrity

We encourage you to work with classmates on these problems; list all collaborators on the first page of your submission. You may also consult outside sources, including generative AI; list all outside sources you referenced and how you used them on the first page of your submission.

However, **you must write all your solutions yourself, in your own words.** Do not submit anything you can't explain. Copying solutions from another person or an outside source is a violation of our academic integrity policy.

#### Deadline and Late Submissions

You can submit any/all homeworks up to 48 hours late with no penalty. However, **once the late deadline has passed, no submissions will be accepted.** This policy exists so you take extra time when you're especially busy, not feeling well, tending to your family, etc.; we won't make any exceptions to this policy.

Second-Chance Homework: You will have an opportunity at the end of the semester to submit one homework (HWs 1-6 only) for a new grade. If you miss both the deadline *and* the late deadline on a homework, use the Second-Chance to submit it.

#### For full credit

- select which pages go with which questions on Gradescope, and
- show ALL your work including intermediate steps.

**Your Name**

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**Your Collaborators (Classmates)**

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**Outside References and How You Used Them**

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**Problem #1 - Counting (Pigeonhole)** ( $3+3+3+3=12$  points)

There are 511 students registered in CS1800/1802 and 6 professors (true story).

- 1A** There must be at least one birthday (month/day, excluding year) that is shared by at least how many students?

- 1B** Suppose that you're given additional information: A maximum of 2 people (we're including students and/or profs) share any one birthday. At least how many dates must have exactly two people?

- 1C** The 6 CS1800 instructors need to record a total of 23 videos and write 11 recitations. What is the minimum number of new materials (recitation or videos) that the hardest-working instructor will create?

- 1D** Suppose an intrepid band of CS1800 students set up in-person study groups on campus. They create 57 different study groups, set a maximum of 9 people per group, and assign every CS1800 student to exactly one group. With this arrangement, there must be a minimum of how many people in **every** group?

**Problem #2 - Conditional Probability** ( $3+3+3+3=12$  points)

You find two buckets of Halloween candy at President Aoun's office, with a note to help yourself<sup>1</sup>.

- Bucket One contains 90 chocolate candies (e.g., Rolos) and 180 fruit candies (e.g., Starburst).
- Bucket Two contains 50 chocolate candies and 30 fruit candies.

For the questions below, give your answer as a decimal (.XX) or a percent (XX.YY%). For full credit, show all of your work.

- 2A** You draw 3 candies at random from Bucket One. What is the probability you got at least one chocolate candy?



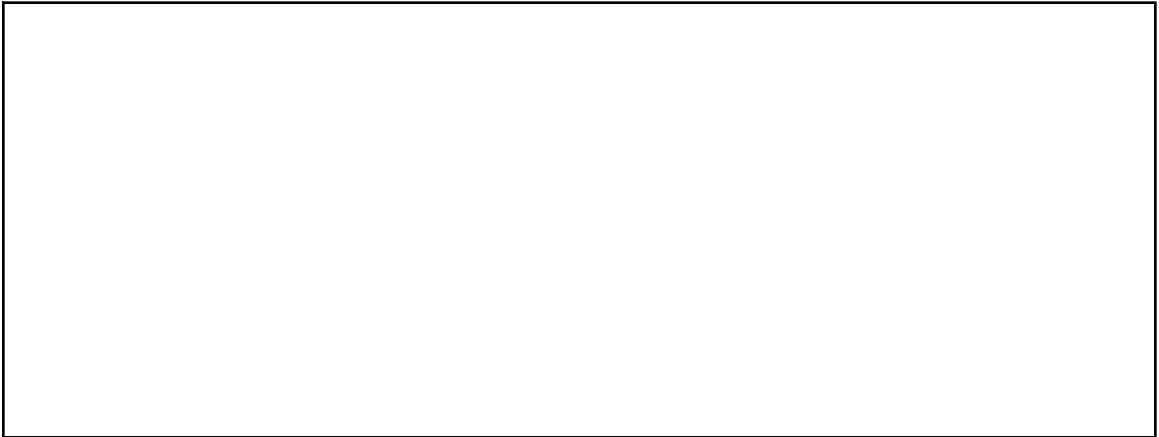
- 2B** You draw 3 candies at random from Bucket One. You see that one of them is a chocolate candy. What is the probability that you got exactly two chocolate candies, given that you know you got at least one chocolate candy?



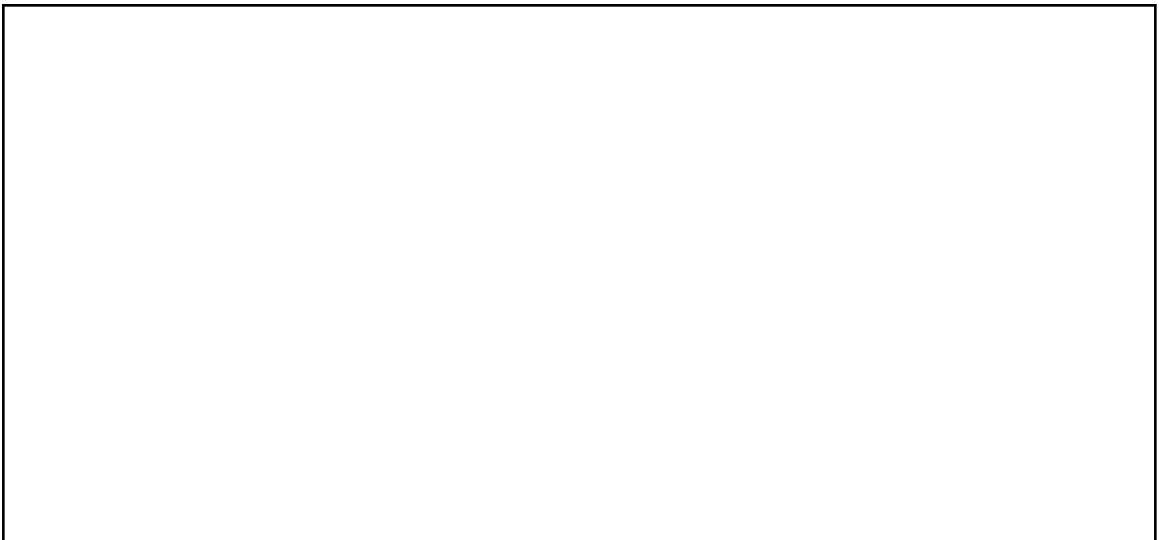
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<sup>1</sup> Made-up scenario; as far as we know, no such candy bucket exists :(

**2C** You flip a biased coin to decide which bucket to choose from. If it is heads you choose Bucket One, if tails Bucket Two. The coin shows tails 60 percent of the time. You flip the coin, then choose a candy at random from the corresponding bucket. What is the probability you got a chocolate candy?



**2D** You flip a biased coin to decide which bucket to choose from. If it is heads you choose Bucket One, if tails Bucket Two. The coin shows tails 60 percent of the time. You flip the coin, then choose a candy at random from the corresponding bucket. It's chocolate! What is the probability you got it from Bucket One?



**Problem #3 - Expected Value** ( $3+3+3=9$  points)

You are given the chance to play a carnival game. You have 4 indistinguishable balls to throw into 4 colored pots. The pots are colored red, blue, green, and pink. You will throw each ball one at a time into these pots. However, you must play this game blindfolded.

The game pays out as follows:

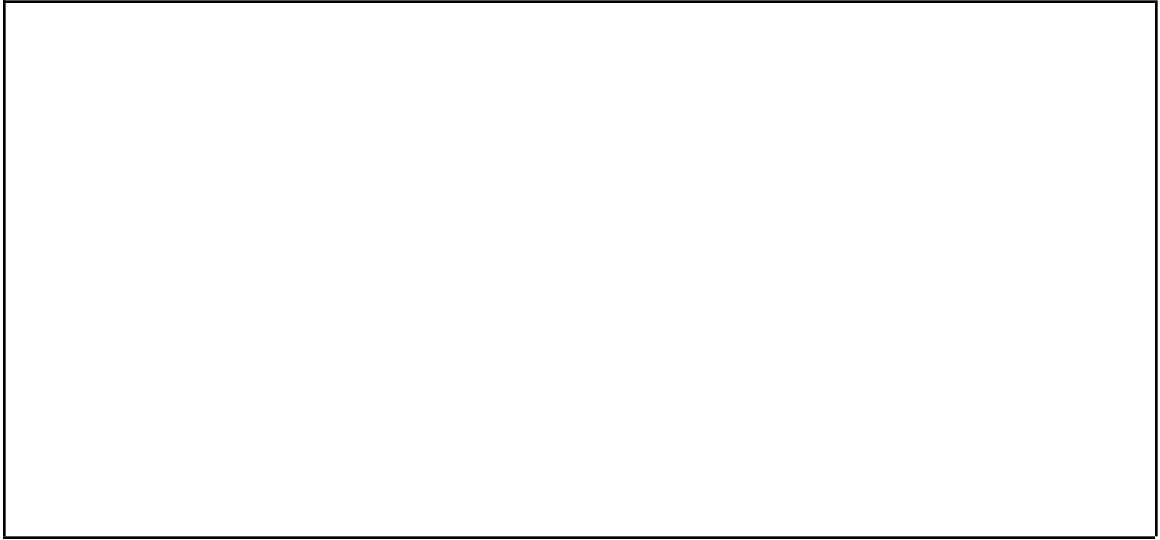
- \$1 for each ball in the red pot
- \$2 for each ball in the blue pot
- \$3 for each ball in the green pot
- \$4 for each ball in the pink pot

How much do you expect to win...

**3A** Assuming every ball is equally likely to land in any pot?

**3B** Assuming every ball has a 1 in 3 chance of not landing in *any* pot (you get \$0 in that case) but IF it lands in a pot all pots are equally likely?

**3C** Assuming every ball lands in some pot but the Pink Pot is twice as likely as any other.



**Problem #4 - Bayes Rule** ( $3+3+3=9$  points)

For each subproblem below, show all of your work including identifying specific events/cases and applying the correct formulas. Give your answer as a decimal (.XX) or a percent (XX.YY%).

On his way into work every day, Prof. Patterson gets an iced coffee. Yes, even in the winter. He uses a reusable insulated travel cup, so sometimes he'll end up getting hot coffee by mistake, but he drinks it anyway. He gets his coffee either from Dunkin' Donuts or from Pavement.

For the questions below, give your answer as a decimal (.XX) or a percent (XX.YY%). For full credit, show all of your work.

- 4A** Prof. Patterson normally wears a long-sleeved shirt, but on 2 of every 5 days he'll wear short sleeves instead (regardless of coffee status). Sometimes he drinks hot coffee AND wears short sleeves, and that happens on 1 of every 5 days.

You see Prof. Patterson one day in a short-sleeved shirt. What is the probability he had hot coffee that day?

**4B** But what about that hot coffee when he orders iced? There is a 20% chance of Prof. Patterson accidentally getting hot coffee from Dunkin' and a 15% chance of accidentally getting hot coffee from Pavement.

Out of every 5 days, Prof. Patterson goes to Dunkin 2 days and Pavement 3 days. What is the probability of his getting a hot coffee?



**4C** One day you observe Prof. Patterson in class one day, taking a sip of coffee and then saying “oh no, hot coffee!!!” What is the probability that Prof. Patterson got his coffee at Dunkin' that day, given that he got hot by mistake?

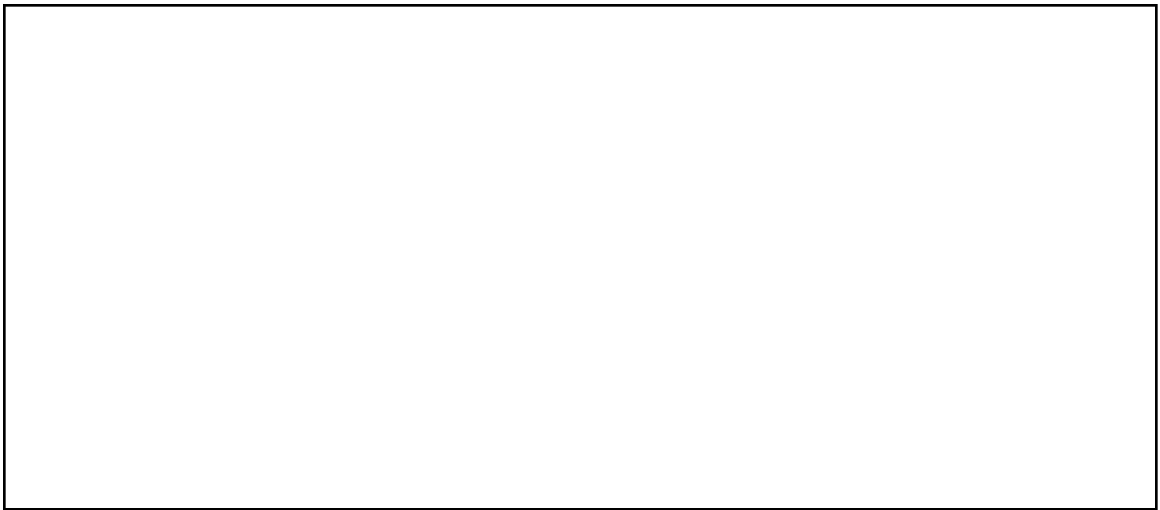


**Problem #5 - Probability w/Counting** ( $3+3+3+4=13$  points)

A gumball company produces gumballs of 13 different colors and sells them in 5-packs, carefully packed so that every color assortment is equally likely when a pack is selected at random.

For the questions below, give your answer as a decimal (.XX) or a percent (XX.YY%). For full credit, show all of your work.

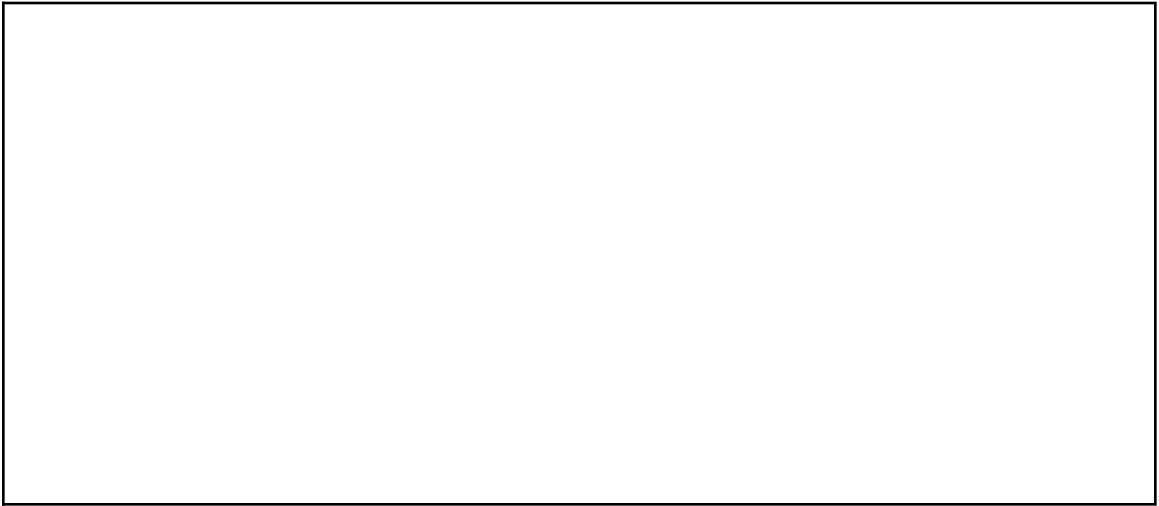
**5A** What is the probability that a pack selected at random has gumballs of only one color?



**5B** What is the probability that a pack selected at random has gumballs of 5 different colors?



**5C** What is the probability that a pack selected at random has gumballs of exactly three colors?



**5D** What is the expected number of distinct colors in a pack? *Hint:* Your solutions for Parts A-C will be helpful!

