Problem set 1

S350 Spring 2020

Upload your answers through the Assignments tab on Canvas by 11:59 pm, Thursday 23rd January.

Notes: Answer all questions. In general in this course, give explanations and/or working for all answers unless otherwise stated.

1. Math review (No need to show working for this question. Talk to us at office hours as soon as possible if you have trouble with any of these):

   (a) Round the following number to 3 significant figures:

   $$0.0345678$$

   (b) Let the set A consist of the numbers $\{-2, -1, 0, 1, 2\}$.
   Write down the elements of A that have absolute value greater than 0.5.

   (c) What does the following expression equal?

   $$\sum_{i=1}^{6} i^2$$

   (d) A straight line $y = ax + b$ goes through the points $(0, 3)$ and $(1, 5)$. What are a and b?

   (e) Suppose $\log_e c = 2$. Using a calculator or otherwise, give c to 3 significant figures.

2. For each of the following scientific questions, state whether the question is better answered using a randomized controlled experiment or an observational study, and briefly explain why.

   (a) Does the flu vaccine prevent the flu?

   (b) Has support for same-sex marriage increased over time?

   (c) Does banning laptops in class improve exam scores?

   (d) Are Democrats with college degrees more likely to support Elizabeth Warren than Democrats without college degrees?

   (e) Does bacon cause colorectal cancer?

3. As part of an early study of early detection of breast cancer in the 1960s, 31,000 women in New York were offered screening mammograms. Of these women, 20,200 accepted the screening, while 10,800 refused. Of those that chose to have screening, 23 died from breast cancer in the five years following screening. Of those that refused screening, 16 died of breast cancer in the five years following screening.

   Does the above data prove that screening reduces women's deaths from breast cancer? Explain why or why not.

4. The Center for American Progress to study public attitudes toward sports teams that expressed opinions on issues that could be controversial, such as LGBT issues. One research question they were interested in was: "To what degree do people believe that professional sports teams should take public stances on social causes?"

   > In general, respondents either "somewhat agreed" (33.2 percent) or "strongly agreed" (19.3 percent) that "professional sports teams should utilize their platforms to advocate for causes they believe in." One in three respondents (30 percent) stated they were neutral on this issue or had "no opinion." Among respondents who identified as men, 46.5 percent either "somewhat agreed" or "strongly agreed" that sports teams should use their platforms to advocate for causes, while 33 percent had "no opinion." Among respondents who identified as women, 60.4 percent either "somewhat agreed" or "strongly agreed" with that statement, with another 25.6 percent stating that they were neutral or had "no opinion."

   The study also gave the following information about their survey:

   > The results presented above are from a convenience sample of 367 respondents recruited using Amazon Mechanical Turk, an online platform that allows for the purposeful sampling of respondents who meet relevant criteria. This survey-hosting website has been shown to be an efficient platform for gathering reliable data from diverse populations... 44.1 percent of respondents were between the ages of 18 and 29, 38.3 percent were between the ages of 30 and 44, and 17.8 percent were above the age of 44. 10.4 percent of respondents identified as "strong Democrat," 26.0 percent as "Democrat," 16.7 percent as "independent-lean Democrat," 18.9 percent as "independent," 8.7 percent as "independent-lean Republican," 10.4 percent as "Republican," and 4.6 as "strong Republican."

   (a) Was this survey a statistically unbiased answer to the question "To what degree do people believe that professional sports teams should take public stances on social causes?" If so, explain why; if not, describe and explain the likely direction of the bias.

   (b) Suppose an interested party gives you a reasonable budget to carry out a more rigorous study of the Center for American Progress' research question. Describe briefly the study you would perform.

5. A deck of cards contains 52 different cards. For each of the following situations, give the number of equally likely outcomes.

   (a) I draw the top card (i.e. the card that's literally on top of the deck.)

   (b) I draw the top two cards. The order matters.

   (c) I draw the top two cards. The order doesn't matter.

   (d) I draw the top card. Without replacing the card, I reshuffle the remaining cards in the deck, and draw the top card. (The order matters.)

   (e) I draw the top card. Then I replace the card, reshuffle the deck, and draw the top card.