Problem set 1

S520

Upload your answers as ONE file (PDF preferred) through the Assignments tab on Canvas by 11:59 pm, Thursday 5th September.

1. For each of the following scientific questions, state whether the question is better answered using a randomized 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?

2. According to a study done at Kaiser Permanente in Walnut Creek, California, women who use oral contraceptives ("the pill") have a higher rate of cervical cancer than women who do not use the pill, even after adjusting for age, education, and marital status.

   (a) Was this study a blind randomized experiment or an observational study?

   (b) Does the study prove that the pill causes cervical cancer? Explain why or why not.

   (c) Besides age, education, and marital status, what other factor(s) related to cervical cancer are different (on average) between women who use the pill and women who don't?

3. 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 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.

4. (a) Draw a graph of the following piecewise function $F(y)$:

$$F(y) = \begin{cases} 0 & y < -2 \\ \frac{y+2}{4} & -2 \leq y < 2 \\ 1 & y \geq 2 \end{cases}$$

If you draw the graph by hand, scan it and insert it into your document (don't include it as a separate file.)

(b) Write down a formal mathematical expression for the piecewise function $F(y)$ pictured in Figure 1 below.

5. I toss two fair coins: a penny and a quarter. The penny is tossed 10 times and the quarter is tossed 5 times, so there are 2^{15} possible ordered sequences of tosses.

(a) How many ordered sequences of 15 tosses result in a total of exactly 6 heads?

(b) How many ordered sequences of 15 tosses result in exactly 2 heads in 10 tosses of the penny and exactly 4 heads in 5 tosses of the quarter?

6. 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.

(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.

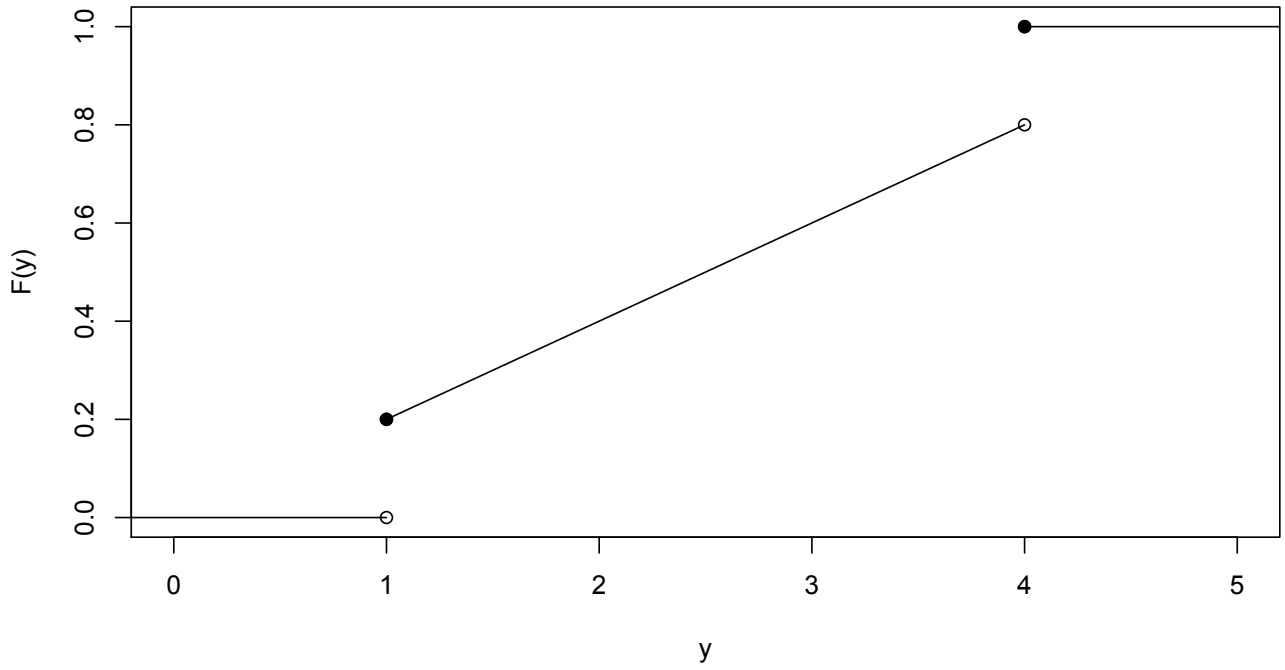

Figure 1: Piecewise function for question 4(b).