Problem set 1

S520

Upload your answers as one PDF file through the Assignments tab on Canvas by 11:59 pm, Thursday 31st August.

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 registered voters in the U.S. who earn over $100,000 per year more likely to vote Democratic than registered voters in the U.S. who earn less than $100,000 per year?

   (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.

(a) Does this survey give a statistically unbiased picture of how much of the general U.S. adult public would agree or disagree with the statement: "Professional sports teams should utilize their platforms to advocate for causes they believe in"? If not, describe and explain the likely direction of the bias—is the survey likely overestimating the proportion of the public who agree, or the proportion who disagree?

(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 deck of cards contains 52 different cards.

   (a) I draw the top card. What is the probability it is the ace of hearts?

   (b) I draw the top two cards, in order. What is the probability the first card is the ace of hearts and the second is the queen of spades?

   (c) I draw the top two cards. What is the probability that one of the cards I draw is the ace of hearts and the other is the queen of spades (in any order)?

   (d) I draw the top card. Then I replace the card, reshuffle the deck, and draw the top card of the reshuffled deck. What is the probability that one of the cards I draw is the ace of hearts and the other is the queen of spades (in any order)?

   (e) I draw the top card. Without replacing the card, I reshuffle the remaining cards in the deck, and draw the top card of the reshuffled deck. What is the probability this card is the ace of hearts?

5. I roll four fair six-sided dice.

   (a) What is the probability all four of the dice show an even number?

   (b) What is the probability at least one of the dice shows six?

   (c) What is the probability the sum of the dice is at least 6?

6. Trosset chapter 3.7 exercise 6, parts (a) and (b). Hint: Part (a) is a combinations question...