

STAT 305 D Homework 1 Solutions

Due January 24, 2012 at 12:40 PM in class

EXTRA CREDIT: complete the survey at <http://www.surveymonkey.com/s/M7WK3PG> before you hand in this assignment.

1. Vardeman and Jobe Chapter 1 Section 2 Exercise 1 (page 13):

Describe a situation in your field where an observational study might be used to answer a question of real importance. Describe another situation where an experiment might be used.

Observational study—you might be interested in assessing the job satisfaction of a large number of manufacturing workers; you could administer a survey to measure various dimensions of job satisfaction. Experimental study—you might want to compare several different job routing schemes to see which one achieves the greatest throughput in a job shop.

2. Vardeman and Jobe Chapter 1 Section 2 Exercise 2 (page 13):

Describe two different contexts in your field where, respectively, qualitative and quantitative data might arise.

Qualitative data—rating the quality of batches of ice cream as either poor, fair, good, or exceptional. Quantitative data—measuring the time (in hours) it takes for each of 1000 integrated circuit chips to fail in a high-stress environment.

3. Vardeman and Jobe Chapter 1 Section 2 Exercise 6 (page 14):

Explain why it is safer to infer causality from an experiment than from an observational study.

Variables can be manipulated in an experiment. If changes in the response coincide with changes in factor levels, it is usually safe to infer that the changes in the factor caused the changes in the response (as long as other factors have been controlled and there is no source of bias). There is no control or manipulation in an observational study. Changes in the response may coincide with changes in another variable, but there is always the possibility that a *third* variable is causing the correlation. It is therefore risky to infer a cause-and-effect relationship between any variable and the response in an observational study.

In addition, the randomization of sample units to treatment groups ensures that the treatment variable is uncorrelated with all experimental conditions, which is another condition necessary for deducing causality.

4. Vardeman and Jobe Chapter 1 Section 3 Exercise 1 (page 19):

Why might it be argued that in terms of producing useful measurements, one must deal first with the issue of validity, then the issue of precision, and only then the issue of accuracy?

Even if a measurement system is accurate and precise, if it is not truly measuring the desired dimension or characteristic, then the measurements are useless. If a measurement system is valid and accurate, but imprecise, it may be useless because it produces too much variability (and this cannot be corrected by calibration). If a measurement system is valid and precise, but inaccurate, it might be easy to make it accurate (and thus useful) by calibrating it to a standard.

5. Vardeman and Jobe Chapter 1 Section 3 Exercise 2 (page 19): Often, in order to evaluate a physical quantity (for example, the mean yield of a batch chemical process run according to some standard plant operating procedures), a large number of measurements of the quantity are made and then averaged. (The alternative is just to use an individual measurement in place of an average.) Explain which of the three aspects of measurement quality - validity, precision, and accuracy - this averaging of many measurements can be expected to improve and which it cannot.

If the measurement system is not valid, then taking an average will still produce a measurement that is invalid. If the individual measurements are inaccurate, then the average will be inaccurate. Averaging many measurements only improves precision. Suppose that the long-run average yield of the process is stable over time. Imagine making 5 yield measurements every hour, for 24 hours. This produces 120 individual measurements, and 24 averages. Since the averages are "pulled" to the center, there will be less variability in the 24 averages than in the 120 individual measurements, so averaging improves precision.

6. A group of chemists and chemical engineers tested their newly-designed Type I Diabetes medication on rats. The goal was to figure out if the medicine would improve the conditions of Type I Diabetes-afflicted rats in general (future work will be on humans). 18 rats with Type I diabetes were randomly selected for the study. Half of these 18 rats were randomly selected to be given the medicine, and the others were not given any medicine. For each rat, the investigators recorded the improvement of the rat's physical fitness over the duration of the experiment (measured according to initial and final stress tests). The weight of each rat on the first day of the study was passively recorded. The investigators made sure that the distribution of food, room temperature, opportunity for exercise, etc., was the same for each rat for the duration of the study.

- a. What is the population of interest for this study? What is the sample?
- Population: All Type I Diabetes-afflicted rats.
 - Sample: the 18 diabetes-afflicted in the study.
- b. Is this study an experiment or an observational study? Why?

Experiment: the investigators applied the medication (treatment) themselves while keeping experimental conditions constant for each rat (and thus for each level of treatment).

- c. Identify and classify all the variables in this study.

- Treatment: medication level
- Response: improvement in rat fitness

d. Identify the treatment groups, if any, and state how many there are.

There are 2 experimental groups: one with the rats who were given the medication, one with the rats who were not given the medication.

7. Weekly feedback. You get full credit as long as you write something.
1. Is there any aspect of the subject matter that you currently struggle with? If so, what specifically do you find difficult or confusing? The more detailed you are, the better I can help you. You got full credit as long as you wrote something.
 2. Do you have any questions or concerns about the material, class logistics, or anything else? If so, fire away. You got full credit as long as you wrote something.