FUNDAMENTALS OF ENGINEERING STATISTICAL ANALYSIS

ISE/DSA 5013

Assignment 5

Show your work for calculation problems. You will receive no credit if you only provide the answer. *As with all homework this semester, spend time to be neat and organized. Any disorganized submissions are subject to a zero grade.*

Problem 1

What does "empirical" mean as it applies to inferential statistics?

Problem 2

Do you need inferential statistics to answer each of the following questions? (for each question answer "yes" if inferential statistics is needed or "no" if not) (from khanacademy.com)

a. How old are you?
b. How old are the people in this class?
c. Do wolves weigh more than dogs?
d. Does your dog weigh more than that wolf?
e. Does it rain more in Seattle than Singapore?
f. What was the difference in rainfall between Seattle and Singapore in 2014?
g. In general, will I use less gas driving 55 mph than 70 mph?
h. Do English professors get paid less than engineering professors?
i. Does the most highly paid English professor at Harvard get paid less than the most highly paid engineering professor at MIT?

Problem 3

You're a human factors engineer studying the impact that helmets worn by operators on a factory floor might receive during a particular repair operation. A random sample of 50 helmets worn during the operation show that 18 had received damage of some sort.

a. Find a 95% confidence interval for the true proportion of helmets that receive damage during the repair operation. Note that this could serve as a proxy for describing how dangerous the current repair operation is.
b. Using the point estimate obtained by the preliminary sample of 50, how many helmets should be tested to be 95% confident that the error in estimating the true proportion is less than 0.02?
c. Repeat the approach in part b but without the preliminary point estimate to provide a more conservative sample size. Think about what value of $\hat{p}$ would do that.

Problem 4

The purpose of a gauge capability study is to describe the variability of a gauge in repeating its measurement (i.e., does the gauge produce the same result when measuring the same objective?). A gauge capability study was performed on a scale by repeating measurements of

the weight of one sheet of paper. Provide a 99% confidence interval for the standard deviation of weight for the following weight data.

3.481	3.448	3.485	3.475	3.472
3.477	3.472	3.464	3.472	3.470
3.470	3.470	3.477	3.473	3.474

Problem 5

You're a healthcare engineering consultant and you're analyzing the emergency room design at Pawhuska Hospital, Inc. In the Assignment 6 spreadsheet, you'll find sample data for the waiting time of non-critical patients entering the emergency room.

a. Find a 95% confidence interval for the mean waiting time for non-critical patients in the emergency room. Interpret.
b. Find a 99% confidence interval for the standard deviation of waiting time for non-critical patients. Interpret.
c. A metric that many of the hospital's competitors use is the proportion of non-critical patients waiting more than an hour. Find a 90% confidence interval to estimate this proportion.

Problem 6

A valve manufacturer produces a butterfly valve composed of two semicircular plates on a common spindle that is used to permit flow in one direction only (seen here: http://en.wikipedia.org/wiki/Butterfly_valve). The semicircular plates are supplied by a vendor with specifications that the plates be 2.37 millimeters thick and have a tensile strength of five pounds per millimeter. A random sample of 20 such plates is taken. Electronic calipers are used to measure the thickness of each plate. A universal testing machine was used to test the tensile strength. The sample data are found in the Assignment 6 spreadsheet.

a. Find point estimates of the thickness and tensile strength data. Compare with the specifications.
b. Construct a 95% confidence interval for mean thickness. Draw conclusions regarding the specification relative to the confidence interval.
c. Construct a 95% confidence interval for mean tensile strength. Draw conclusions regarding the specification relative to the confidence interval.
d. Construct a 95% confidence interval for the proportion of plates whose thickness is greater than the specification.

Problem 7

A new formulation of concrete has been designed for a particular building application. Naturally, the strength of concrete produced with the new formulation had to be tested for its strength capability. The compressive strength of 12 specimens were tested, as shown below.

2216	2237	2249	2204	2225	2301
2281	2263	2318	2255	2275	2295

a. With a simple histogram, draw conclusions about the normality of these observations. Assume normality regardless.
b. Calculate a 95% confidence interval for mean compressive strength.
c. Calculate a 95% confidence interval for standard deviation of compressive strength.

Problem 8

As a quality control engineer at an aircraft manufacturer, you investigated wiring errors on a particular model of commercial aircraft that may produce faulty information to the flight crew. Such a wiring error may have been responsible for at least one crash in recent decades wherein the pilot was encouraged by faulty information to shut down the incorrect engine. Of 1600 randomly selected aircraft, eight were found to have wiring errors that could display incorrect information to the flight crew. Find a 99% confidence interval on the proportion of aircraft that have such wiring errors.