Quiz I

STAT 305, Section 3
FALL 2019

Instructions

- The quiz is scheduled for 80 minutes, from 09:30 to 10:50 AM. At 10:50 AM the exam will end.
- Total points for the exam is 60. Points for individual questions are given at the beginning of each problem. Show all your calculations clearly to get full credit. Put final answers in the box at the right (except for the diagrams!).
- A forumula sheet is attached to the end of the exam. Feel free to tear it off.
- Normal quantile table is attached to the end of the exam. Feel free to tear it off.
- You may use a calculator during this exam.
- Answer the questions in the space provided. If you run out of room, continue on the back of the page.
- If you have any questions about, or need clarification on the meaning of an item on this exam, please ask your instructor. No other form of external help is permitted attempting to receive help or provide help to others will be considered cheating.
- **Do not cheat on this exam.** Academic integrity demands an honest and fair testing environment. Cheating will not be tolerated and will result in an immediate score of 0 on the exam and an incident report will be submitted to the dean's office.

Name: _____

Student ID: _____

1. (2 points) Circle the **bold face** term that makes the following statement true:

   A measurement device that reports the measurements which are close to each other when repeatedly measuring the same thing is (**precise** or **accurate**).

2. (2 points) A number of issues concerning measurement must be addressed in the following order:

   (1) precision, validity, accuracy
   (2) accuracy, precision, validity
   (3) validity, accuracy, precision
   (4) validity, precision, accuracy

3. (2 points) For a complete(full) factorial study with three factors, each with 4 levels, the number of all possible combinations (i.e the least number of observation) is:

   (1) 12 (2) 64 (3) 81 (4) none of these

   (# of levels)$^{\#\text{ of Factors}} = 4^3 = 64$

4. (2 points) In a series of experiments to study the priority of a chemical product, the reactor temperature is set fixed at 550°C. The variable "reactor temperature" is a

   (1) response variable
   (2) controlled variable
   (3) blocking variable
   (4) experimental variable

5. A sample of size 5 was drawn from a population and the resulting observations are reported below.

110, 100, 105, 103, 105, 115

Using these observed values, report the following:

sorted data 8 100, 103, 105, 105, 110, 115

(a) (2 points) the mean x_1 x_2 x_3 x_4 x_5 x_6

$\bar{x} = 106.33$

$\bar{x} = \frac{1}{6}(x_1+x_2+x_3+x_4+x_5+x_6) = \frac{1}{6}(100+103+105+105+110+115)$

$= 106.33$

(b) (3 points) the median

$Med. = 105$

$Q(.25)$ $Q(.75)$

$\frac{i-0.5}{n}$: 0.08 | 0.25 | 0.41 | 0.58 | 0.75 | 0.91

$Q(.5) = ?$ $np + 0.5 = 6(0.5) + 0.5 = 3.5$, $[3.5] = 3 = i$

$Q(.5) = x_3 + (np - i + 0.5)(x_4 - x_3)$

$= 105 + (0.5)(105 - 105) = 105$

(c) (5 points) the variance

$s^2 = 28.66$

$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 = \frac{1}{6-1}\left((100-106.33)^2 + (103-106.33)^2 + (105-106.33)^2 + (105-106.33)^2 + (110-106.33)^2 + (115-106.33)^2\right)$

$= \frac{143.33}{5} = 28.66$

(d) (2 points) the standard deviation

$s = 5.35$

$s = \sqrt{s^2} = \sqrt{28.66} = 5.35$

(e) (3 points) the value of $Q(.75)$

$Q(.75) = 110$

① Note: you could have found it just by looking at $\frac{i-0.5}{n}$ values. Then $Q(.75) = 110$.

② $np + 0.5 = 6(.75) + 0.5 = 5$, $[5] = 5 = i$

$Q(.75) = x_5$

$= 110$

(f) (4 points) the interquartile range

$IQR =$ 7

IQR = Q(.75) − Q(.25)

Q(.25) = ?

$np + 0.5 = 6(.25) + 0.5 = 2$, $[2] = 2 \equiv i$

$Q(.25) = x_2 = 1.3$

$\Rightarrow IQR = 110 - 103 = 7$

(g) (5 points) give the coordinates (on a regular graph paper) of the upper right and lower left point that would appear on a normal plot of the data.

upper right point = (.91 , 115)

lower left point = (.08 , -1.41)

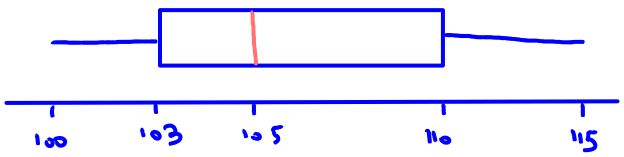
upper right: $\frac{6-0.5}{6} = 0.91 \rightarrow Q(.9) = 115$

lower left on normal graph $\Rightarrow$ Normal quantile of $\frac{1-0.5}{6} = .08$

by normal quantile table: $Q_N(.08) = -1.41$

(h) (5 points) draw a boxplot for this data. Carefully label numbers on the plot

whiskers : $1.5 * IQR = 1.5 * 7 = 10.5$



6. An environmental engineer is testing four methods for reducing the concentration of a certain lake pollutant found in Iowa lakes. To do this he first randomly selected 20 Iowa lakes from which he took water samples, then split each of the 20 samples into 4 portions, and randomly labeled the four portions 1, 2, 3, and 4. Finally, he attempted to reduce the concentration of each of the portions labeled 1 using the the first method, of each of the portions labeled 2 using the second method, of each of the portions labeled 3 using the third method, and of each of the portions labeled portion 4 using the fourth method. After the methods had been applied, he measured the change in concentration.

(a) (3 points) Is this an experiment or an observational study? Explain.

Experimental.
The engineer is taking an active role in manipulation of the system under study by intentionally changing the cleaning methods

(b) (2 points) What is the population under study?

Iowa lakes

(c) (2 points) What is the sample under study?

20 selected Iowa lakes

(d) Identify the following (if there was not one, simply put "not used").

i. (2 points) Response variable(s):

Change in the concentration is the only response var.

ii. (2 points) Experimental variable(s):

The method used to clean the polution is the only experimental variable

iii. (2 points) What type of variable was (were) the experimental variable(s) in previous question (circle one):

Quantitative **Qualitative**

(Four methods of cleaning)

iv. (2 points) Blocking variable(s):

The lakes from which the samples are taken are acting as a blocking variable. We are not interested in studying the effect of the lake on the response, but we can reasonably believe that the portions from the same lake's sample will be similar. So we are treating the lake the sample came from as a smaller, homogenous environment in our experiment. We also use all the methods on each lake's sample which is another indication that it is working as a block

(e) (4 points) Was replication used in this experiment? If so, where was it applied? If not, how could we have applied it?

No replication was used. While each cleaning method was used multiple times across the entire experiment, they were never used in the same block (meaning, for each of the 20 lakes we only used each method once). This means that we did not truly replicate.