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Second Midterm Exam

Statistical Reasoning 90-707 Fall 2021 Dr. Nancy Pfenning

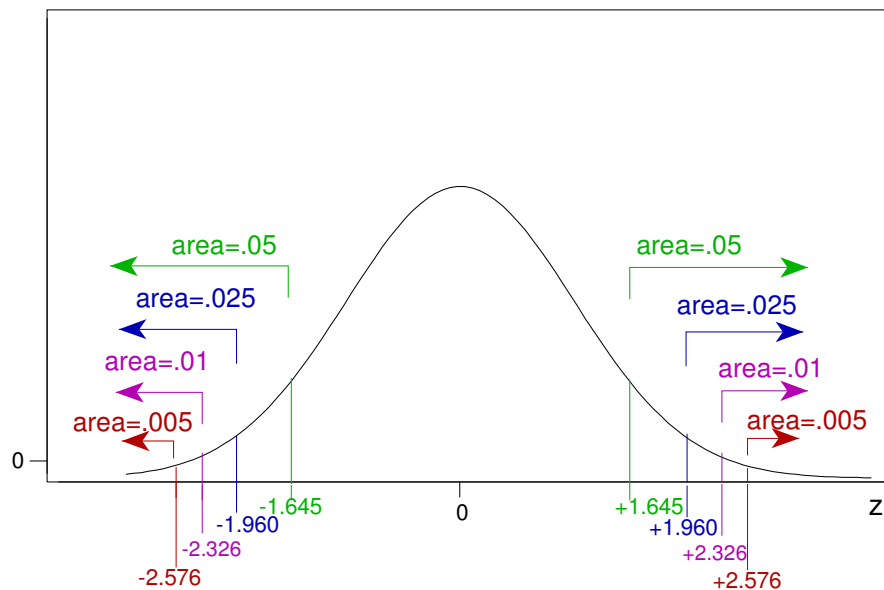
This is a closed book exam worth 150 points. You are allowed to bring a calculator and two two-sided sheets of notes. There are 9 problems, with point values as shown. If you want to receive partial credit for wrong answers, show your work. Don't spend too much time on any one problem.

1. (25 pts.) In Pittsburgh, the percentage of all Jewish people who attend a Passover seder is assumed to be 0.75. Suppose we take a random sample of 115 Jewish people from Pittsburgh.
 - (a) The expected number of sampled Jewish people who do and don't attend a Passover seder are both at least 10. Thus, we are justified in
 - i. claiming that the distribution of sample proportions is centered at 0.75
 - ii. using our formula for standard deviation of sample proportion
 - iii. finding probabilities based on the normal distribution
 - (b) The population of interest is more than 1150. Thus, we are justified in
 - i. claiming that the distribution of sample proportions is centered at 0.75.
 - ii. using our formula for standard deviation of sample proportion
 - iii. finding probabilities based on the normal distribution
 - (c) For samples of 115 Jewish people taken from a population where 0.75 attend a Passover seder, what is the standard deviation of sample proportion? _____

- (d) Find the z score if, in a sample of 115 Jewish people from Pittsburgh, the proportion who attend a Passover seder is found to be 0.80: _____

- (e) Suppose that in a sample of 115 Jewish people from Pittsburgh, the proportion who attend a Passover seder is 0.80. This is
 - i. so low that the sample clearly wasn't random
 - ii. on the low side, but not unusual
 - iii. on the high side, but not unusual
 - iv. so high that the sample clearly wasn't random

2. (10 pts.) The number rolled on an ordinary die is a random variable with mean 3.5 and standard deviation 1.7.
- (a) Suppose each student rolls 8 dice, records the sample mean number rolled, and uses this to test the true null hypothesis that population mean equals 3.5. If there are 100 students altogether, about how many of their tests should reject at the $\alpha = 0.05$ level?
 (i) 0 (ii) 3.5 (iii) 5 (iv) 8 (v) 17 (vi) 83 (vii) 92 (viii) 95 (ix) 96.5 (x) 100
- (b) For each set of 8 rolls, students set up a 95% confidence interval for the mean of all dice rolls. About how many of the 100 confidence intervals should contain the true population mean, 3.5?
 (i) 0 (ii) 3.5 (iii) 5 (iv) 8 (v) 17 (vi) 83 (vii) 92 (viii) 95 (ix) 96.5 (x) 100
3. (15 pts.) Blood glucose level (as a percent) in healthy adults is approximately normally distributed with mean 5.00 and standard deviation 0.50.
- (a) What percentage of blood glucose levels are above 5.50? _____
- (b) Report the blood glucose level if its z -score is -1.82: _____
- (c) The highest 1% of blood glucose levels are greater than _____.



4. (10 pts.) A Type I Error is rejecting the null hypothesis, even though it is true; a Type II Error is failing to reject the null hypothesis, even though it is false.
- (a) In a recent phenomenon of fake news propagated on the Internet, a Harvard study supposedly discovered that Peppa Pig videos were the leading cause of autism. Believing these claims would be an example of committing a
 - (i) Type I Error (ii) Type II Error (iii) neither
 - (b) When a drug is tested for harmful side effects, which one of these would be more likely to lead to committing a Type II Error?
 - i. testing the drug on a very small sample of patients
 - ii. testing the drug on a very large sample of patients
 - iii. neither of the above: sample size does not play a role in this context
5. (20 pts.) A study compared typical home prices for a sample of U.S. cities, classified according to whether they were East or West of the Mississippi.

	N	Mean	StDev	SE Mean
East	16	272500	155825	38956
West	8	377625	306170	108248

Difference = μ East minus West

Estimate for difference: -105125

T-Test of difference = 0 (vs not =): T-Value = -0.91 P-Value = XXXX

- (a) Considering the size of the t -statistic, we can estimate the P -value for a two-sided test to be (i) very small (ii) borderline (iii) not small at all
- (b) What should we conclude from the output?
 - i. Typical home prices were higher in the East but the difference was not at all significant.
 - ii. Typical home prices were higher in the East and the difference was clearly significant.
 - iii. Typical home prices were higher in the East and the difference was borderline: either just barely or not quite significant.
 - iv. Typical home prices were higher in the West but the difference was not at all significant.
 - v. Typical home prices were higher in the West and the difference was clearly significant.
 - vi. Typical home prices were higher in the West and the difference was borderline: either just barely or not quite significant.
- (c) Considering the size of the t -statistic and the P -value, would a confidence interval for the difference between population means contain zero? (No calculations necessary.) (i) Yes, definitely. (ii) No, not even close. (iii) Borderline: either just barely or not quite.
- (d) From the output we can conclude that the distribution of typical home prices in the West was (i) roughly normal (ii) skewed left (iii) skewed right (iv) none of the above: there is not enough information to determine the shape

6. (15 pts.) Rating on a scale of 0 to 5 for males whose attractiveness was rated by females on the online dating site okcupid is a random variable X with a mean of 1.4 and a standard deviation of 1.2.

- (a) What are the mean _____ and standard deviation _____ of sample mean rating for a random sample of 4 males?
- (b) Consider the shape of the probability distribution of X :

X	0	1	2	3	4	5
Prob	0.28	0.25	0.35	0.06	0.03	0.03

The shape of the distribution of sample mean rating \bar{X} for samples of 4 men would be

- i. the same as the shape of the distribution of X
 - ii. somewhat left-skewed
 - iii. somewhat right-skewed
 - iv. normal
7. (15 pts.) Blood glucose levels in healthy adults (measured as a percent) average approximately 5.
- (a) Which one of these sample mean glucose levels would provide the **most** evidence against the null hypothesis $H_0 : \mu = 5$ **in favor of the one-sided** alternative $H_a : \mu > 5$? (i) $\bar{x} = 3.5$ (ii) $\bar{x} = 4.5$ (iii) $\bar{x} = 5.5$
- (b) Which one of these sample means would provide the **most** evidence against the null hypothesis $H_0 : \mu = 5$ **in favor of the two-sided** alternative $H_a : \mu \neq 5$? (i) $\bar{x} = 3.5$ (ii) $\bar{x} = 4.5$ (iii) $\bar{x} = 5.5$
- (c) A sample of blood glucose levels taken from diabetic patients is used to test if the mean level is significantly higher than 5, and the resulting P -value is found to be 0.012. What would the P -value have been if a two-sided test had been carried out? _____

8. (25 pts.) In a 2020 survey of 400 randomly chosen people in the U.S., 0.51 said someone in their household had lost their job or had work hours reduced because of the pandemic.
- (a) Construct a 95% confidence interval for the proportion of all people in the U.S. who had someone in their household lose their job or have work hours reduced because of the pandemic:
- (b) Which of these would produce a narrower interval?
- i. sample fewer people
 - ii. use a lower level of confidence
 - iii. both (i) and (ii)
 - (iv) neither (i) nor (ii)
- (c) Should the confidence interval in part (a) convince us that a majority (more than 0.50) of all people in the U.S. had someone in their household lose their job or have work hours reduced because of the pandemic?
- (i) yes (ii) no (iii) borderline
- (d) Which one of these is the correct interpretation of your interval?
- i. 95% is our level of confidence that p falls in this interval.
 - ii. 95% is our level of confidence that \hat{p} falls in this interval.
 - iii. 95% is the probability that p falls in this interval.
 - iv. 95% is the probability that \hat{p} falls in this interval.
- (e) A test is carried out to see if just half of all people in the U.S. had someone in their household lose their job or have work hours reduced because of the pandemic, against the alternative that the proportion was more than 0.50, and the p-value is found to be 0.36. What does this mean? (Choose one:)
- i. If the population proportion is **equal to** 0.50, then 0.36 is the probability that in a random sample of 400 people, the sample proportion is **equal to** 0.51.
 - ii. If the population proportion is **greater than** 0.50, then 0.36 is the probability that in a random sample of 400 people, the sample proportion is **equal to** 0.51.
 - iii. If the population proportion is **equal to** 0.50, then 0.36 is the probability that in a random sample of 400 people, the sample proportion is **at least as high as** 0.51.
 - iv. If the population proportion is **greater than** 0.50, then 0.36 is the probability that in a random sample of 400 people, the sample proportion is **at least as high as** 0.51.

9. (15 pts.) A sample of weddings was taken to test at the $\alpha = 0.05$ level if the overall mean cost of a wedding is 25 thousand dollars, as claimed by an online report. Decide what conclusion (if any) should be drawn in each of the following situations. You may refer to either of the curves below, as needed.

(a) A representative sample of **4** weddings had a standardized mean cost of $t = 2.1$. There was a **high outlier** because one of the weddings was extremely expensive.

- Conclude 25 thousand dollars is a plausible value for the overall mean.
- Conclude the overall mean differs from 25 thousand dollars.
- No conclusions should be drawn.

(b) A representative sample of **4** weddings had a standardized mean cost of $t = 2.1$. We have reason to believe that the distribution of all costs is **normal**.

- Conclude 25 thousand dollars is a plausible value for the overall mean.
- Conclude the overall mean differs from 25 thousand dollars.
- No conclusions should be drawn.

(c) A representative sample of **100** weddings had a standardized mean cost of $t = 2.1$. There was a **high outlier** because one of the weddings was extremely expensive.

- Conclude 25 thousand dollars is a plausible value for the overall mean.
- Conclude the overall mean differs from 25 thousand dollars.
- No conclusions should be drawn.

