NAME:_____

# MATH 150 MIDTERM #3

April 14, 2016

INSTRUCTIONS: This is a closed book, closed notes exam (with one exception described below). You are not to provide or receive help from any outside source during the exam.

- You may NOT use a calculator (except for the one provided).
- You may NOT use your smartphone for any purpose. Please silence it or turn it off.
- You are allowed to use a "cheat sheet" with formulas and examples on one page (it can only be one side of the sheet).
- Show all of your work.

| Question | Points | Score |
|---|---|---|
| 1 | 12 | |
| 2 | 8 | |
| 3 | 8 | |
| 4 | 6 | |
| 5 | 8 | |
| 6 | 18 | |
| 7 | 14 | |
| 8 | 4 | |
| Total: | 78 | |

1. A food safety inspector is called upon to investigate a restaurant with a few customer reports of poor sanitation practices. The food safety inspector uses a hypothesis testing framework to evaluate whether regulations are not being met. If he decides the restaurant is in gross violation, its license to serve food will be revoked.

   (a) [2 points] Write the hypotheses in words.

   Null: The regulations are met.
   Alt.: The regulation are not met.

   (b) [2 points] What is a Type 1 Error in this context?

   The inspector says the regulations are not met, but the restaurant is sanitary

   (c) [2 points] What is a Type 2 Error in this context?

   The inspector says the regulations are met, but the restaurant is unsanitary.

   (d) [2 points] Which error is more problematic for the restaurant owner? Why?

   Type 1 because it affects the restaurant unfairly.

   (e) [2 points] Which error is more problematic for the diners? Why?

   Type 2 because it means it's unsanitary to eat there

   (f) [2 points] As a diner, would you prefer that the food safety inspector requires strong evidence or very strong evidence of health concerns before revoking a restaurant's license? Explain your reasoning.

   Strong evidence. Since a Type 2 error is more for diners, it's better to minimize the chances of a Type 2 error.

2. Determine if the following statements are true or false, and **explain your reasoning.**

   (a) [2 points] If a given value (for example, the null hypothesized value of a parameter) is within a 95% confidence interval, it will also be within a 99% confidence interval.

   TRUE because the 99% CI is wider.

   (b) [2 points] Decreasing the significance level ($\alpha$) will increase the probability of making a Type 1 Error.

   FALSE the smaller the $\alpha$, the smaller the chance of a type 1 error.

   (c) [2 points] Suppose the null hypothesis is $\mu = 5$ and we fail to reject $H_0$. Under this scenario, the true population mean is 5.

   FALSE, it means 5 is plausible but we can't guarantee it's 5.

   (d) [2 points] With large sample sizes, even small differences between the null value and the true value of the parameter, a difference often called the effect size , will be identified as statistically significant.

   True, because the larger the sample size the more you can detect.

3. Write the null and alternative hypotheses in words and using symbols for each of the following situations.

   (a) [4 points] Since 2008, chain restaurants in California have been required to display calorie counts of each menu item. Prior to menus displaying calorie counts, the average calorie intake of diners at a restaurant was 1100 calories. After calorie counts started to be displayed on menus, a nutritionist collected data on the number of calories consumed at this restaurant from a random sample of diners. Do these data provide convincing evidence of a difference in the average calorie intake of a diners at this restaurant?

Null: The average calorie intake is the same before menus with cal/counts and after menus with calorie counts.

Alt: The average calorie intake is different.

$H_0: \mu = 1100$

$H_A: \mu \neq 1100$ where $\mu$ is the average calorie intake after cal. count menus.

   (b) [4 points] Based on the performance of those who took the GRE exam between July 1, 2004 and June 30, 2007, the average Verbal Reasoning score was calculated to be 462. In 2011 the average verbal score was slightly higher. Do these data provide convincing evidence that the average GRE Verbal Reasoning score has changed since 2004?

Null: The average GRE Verbal score is the same now as in 2004.

Alt.: The average GRE Verbal score has changed since 2004

$H_0: \mu = 462$

$H_A: \mu \neq 462$.

4. [6 points] A study suggests that the average college student spends 10 hours per week communicating with others online. You believe that this is an underestimate and decide to collect your own sample for a hypothesis test. You randomly sample 60 students from your dorm and find that on average they spent 13.5 hours a week communicating with others online. A friend of yours, who offers to help you with the hypothesis test, comes up with the following set of hypotheses. Indicate any errors you see, and write the correct set of hypotheses (in symbols).

$$H_0 : \bar{x} < 10 \ hours$$
$$H_A : \bar{x} > 13.5 \ hours$$

It should be $H_0: \mu = 10$

$H_A: \mu > 10$.

Errors: $\bar{x}$ instead of $\mu$, 13.5 instead of 10, "<" instead of "=" in $H_0$.

5. An independent random sample is selected from an approximately normal population with unknown standard deviation. Find the degrees of freedom and the critical $t$-value ($t^*$) for the given sample size and confidence level.
   (a) [2 points] $n = 8$, CL = 90% 1.89
   df=7
   (b) [2 points] $n = 21$, CL = 80% 1.33
   df=20
   (c) [2 points] $n = 29$, CL = 99% 2.76
   df=28
   (d) [2 points] $n = 12$, CL = 95% 2.20
   df=11

6. Georgianna claims that in a small city renowned for its music school, the average child takes at least 5 years of piano lessons. We have a random sample of 20 children from the city, with a mean of 4.6 years of piano lessons and a standard deviation of 2.2 years.
   (a) [10 points] Evaluate Georgianna's claim using a hypothesis test. That is, write out the hypotheses in symbols, calculate the $p$-values and make a decision. You need not check for validity.

$H_0: \mu = 5$

$H_A: \mu < 5$

$SE = \frac{2.2}{\sqrt{20}} \approx 0.491935$

$t = \frac{4.6-5}{0.491935} = \frac{-0.4}{0.491935} \approx 0.8131116.$

Since $0.813116 < 1.33$, then p-val $> 0.10$.

Therefore we fail to reject the null.

   (b) [6 points] Construct a 95% confidence interval for the number of years students in this city take piano lessons, and interpret it in context of the data.

$ME = t^* \times SE$ $t^* = 2.09$ (df=19)

$4.6 \pm 2.09(0.491935) = 4.6 \pm 1.028$

$(3.572, 5.628).$

We are 95% confident the number of years taking piano is between 3.572, 5.628

   (c) [2 points] Do your results from the hypothesis test and the confidence interval agree? Explain your reasoning.

Yes, because 5 is a plausible value.

7. In each of the following scenarios, determine if the data are paired.

   (a) [2 points] Compare pre- (beginning of semester) and post-test (end of semester) scores of students. Paired

   (b) [2 points] Assess gender-related salary gap by comparing salaries of randomly sampled men and women. Not-paired

   (c) [2 points] Compare artery thicknesses at the beginning of a study and after 2 years of taking Vitamin E for the same group of patients. Paired

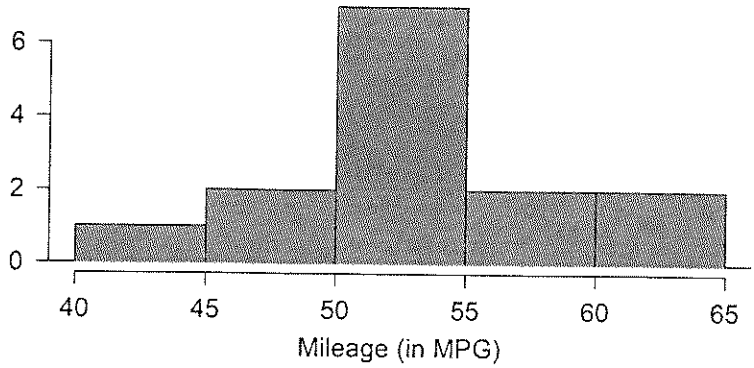
   (d) [2 points] Assess effectiveness of a diet regimen by comparing the before and after weights of subjects. Paired

   (e) [2 points] We would like to know if Intel's stock and Southwest Airlines' stock have similar rates of return. To find out, we take a random sample of 50 days, and record Intel's and Southwest's stock on those same days. Paired

   (f) [2 points] We randomly sample 50 items from Target stores and note the price for each. Then we visit Walmart and collect the price for each of those same 50 items. Paired

   (g) [2 points] A school board would like to determine whether there is a difference in average SAT scores for students at one high school versus another high school in the district. To check, they take a simple random sample of 100 students from each high school. Not paired

8. Fueleconomy.gov, the official US government source for fuel economy information, allows users to share gas mileage information on their vehicles. The histogram below shows the distribution of gas mileage in miles per gallon (MPG) from 14 users who drive a 2012 Toyota Prius. The sample mean is 53.3 MPG and the standard deviation is 5.2 MPG. Note that these data are user estimates and since the source data cannot be verified, the accuracy of these estimates are not guaranteed.




   (a) [4 points] We would like to use these data to evaluate the average gas mileage of all 2012 Prius drivers. Do you think this is reasonable? Why or why not?

The histogram shows near-normality.

The sample is less than 10% of the population, however we don't know if the sample is a random sample.