Exam 2 Alternate

NAME:

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1 Permutation Tests and Experiments

(Based off of a consulting problem I once had) Pigs are known for becoming aggressive when their are hungry/not getting enough food. There are questions whether the aggression comes from a low caloric intake or if the aggression comes from nutrient deficiencies.

To test this, 5 pigs were put in a pen with 24 pens total. Each pen was assigned one of three levels of calories (low, medium, high) and one of two types of nutrition (standard, fortified) for a total of six possible diets. NOTE: pigs are allowed to roam freely and interact inside a pen and there is no way to differentiate which pig ate what.

At the end of three weeks each pig individually was measured for signs of aggression (bitten ears or tails, limps, sores, etc....) and the results recorded. The 12 pens with the highest aggression markers it turns out were all given the non-fortified diets. There are in total 2,704,156 ways to arrange the 24 pens and only two are as extreme as what we saw (the top 12 aggressive pens are all nutritionally fortified or all are not nutritionally fortified).

1. Please identify the experimental units in this experiment.

   ANS: the pens are the experimental units (what the diets were assigned to)

2. Please identify the observational units in this experiment.

   ANS: Each pig

3. Please identify the two factors in the experiment. ALSO please identify the levels of the two factors.

   ANS: Caloric intake (high, low, medium) and nutrition (fortified or not)

4. If the diets have no effect and the aggression of the pigs is random, what is the probability that the 12 most aggressive pens would come from the same nutrition group?

   ANS 2/2704156

5. Based on the above p-value and context of the question, what is your decision? What evidence is there the lack of nutrition causes aggression in pigs?

   ANS We have very strong evidence that the aggression markers are different between the nutrition group

2 Probability

I have a tupperware container with dice in it. The contain has a total of 26 dice in it. Some dice are d20's (ie they have 20 sides) and some dice are not. Some dice are blue and some dice are not. The below table gives the counts.

	d20	Not d20
Blue	3	11
Not Blue	3	9

1. If we randomly draw a dice, what is the probability it is blue?

   14/26

2. If we randomly draw a dice, what is the probability it is a d20, a 20-sided dice?

   6/26

3. If we randomly draw a dice, what is the probability we draw a dice that is blue OR we draw a d20?

   17/26

4. If we randomly draw a dice, what is the probability it is both not blue AND not a d20?

   HINT: This question deals with (not blue) and (not a d20) unlike the previous questions with were (blue) and/or (d20).

   ANS 9/26

5. If we randomly draw a dice and that dice is a d20, what is the probability that dice is blue?

   3/6

6. BONUS POINT: If we randomly draw a dice, what is the largest probability that drawing an orange dice can have? That is, what is the upper limit of the probability?

   12/26 (largest probability would be the case when all not-blue dice are orange)

3 General Knowledge

1. In your own words, what is a p-value?

   Probability we'd see a sample statistic that extreme if the null hypothesis was true. Or it's a measure of "incompatibility" with the response

2. What is the difference between standard deviation and standard error?

   SE is the st. dev. of a samplling distribution while st. dev. is the square root of variance

3. Sampling distributions for means often look normal when the sample size is sufficiently large because....

   A. The central limit theorem says the distribution of the mean is approximately normal for a large sample size

4. We believe the _____ distribution should look like the population distribution under ideal circumstances.

   A. Sample Distribution

5. We do not believe the _____ distribution will look like the population distribution.

   A. Sampling Distribution
   B. Geometric Distribution
   C. Normal Distribution

4 Sampling Methods

For each of the scenarios below please indicate which poor sampling technique or bias best describes the mistake. NOTE: More than one thing might be wrong and it's sufficient to list one of them to get full points but please try to pick the "best" answer. You do not need to justify your answer but explaining your reasoning on an incorrect answer can get partial credit.

1. Grinnell is interested in heroin usage among it's student body. To select students the college on 10 separate days randomly grabbed students from inside the library to question.

    1. Undercoverage

2. Grinnell is interested in heroin usage among it's student body. The college randomly selected students within the dining hall and asked them loudly at the table if the student had shot up with heroin in the last two weeks.

    1. Convenience Sampling
    2. Response Bias

3. Grinnell is interested in heroin usage among it's student body. Taking it upon myself to investigate this I discreetly ask the three students who sit in front of my desk in STA 209 if they have shot up with heroin in the last two weeks.

    1. Convenience Sampling
    2. Undercoverage
    3. Resonpse Bias

4. Grinnell is interested in heroin usage among it's student body. Being a vigilante professor I find one student buying heroin. To learn who else is a "druggy" I follow student to a party and then surveyed the students I found at the party.

    1. Snowball Sampling

5. Grinnell is interested in heroin usage among it's student body. They randomly select 100 students from a master list of students. The students received the email asking: "In the last two weeks, that is 14 days not exclusively business days, have you or have you not at some point in that time frame consumed a derived substance or product (or a synthetic of) the floral organism *Papaver somniferum* such as but not limited opiate narcotics which are broadly schedule 2 or 1 drugs according to the US Drug Enforcement Agency in cooperation with the Food and Drug Administration as established by Congress in Comprehensive Drug Abuse Prevention and Control Act of 1970?"

    1. Wording of questions

5 Hypothesis Test and Confidence

Please indicate the problems with the following statements dealing with hypothesis tests and confidence intervals generally.

1. "Since we are 95% confident that means there is a 95% probability the true proportion is inside our confidence interval."

   The true proportion is or isn't within the interval and there isn't a long term frequency that allows us to discuss probability.

2. "Since the p-value is .02 we think the null hypothesis only has a 2% probability of being true"

   If the null hypothesis is true, we think about 2% of our samples will produce a sample statistic as or more extreme than what we saw

3. "Since the p-value is large, that means we think the null hypothesis is true."

   "Absence of evidence is not the evidence of absence".

4. "My confidence interval for the mean price of a Dungeons and Dragons book is from $23 to $27 so most likely the next book I buy will be between those two numbers."

   Main problem is that the confidence interval talks about the long term behavior of the mean and NOT what the next observation will cost (which is called a prediction interval). As a side note there is the possible problem that we used DnD books in our sample but the statement was a more generic "next book I buy".

5. "A statistical analysis isn't complete until we have a p-value"

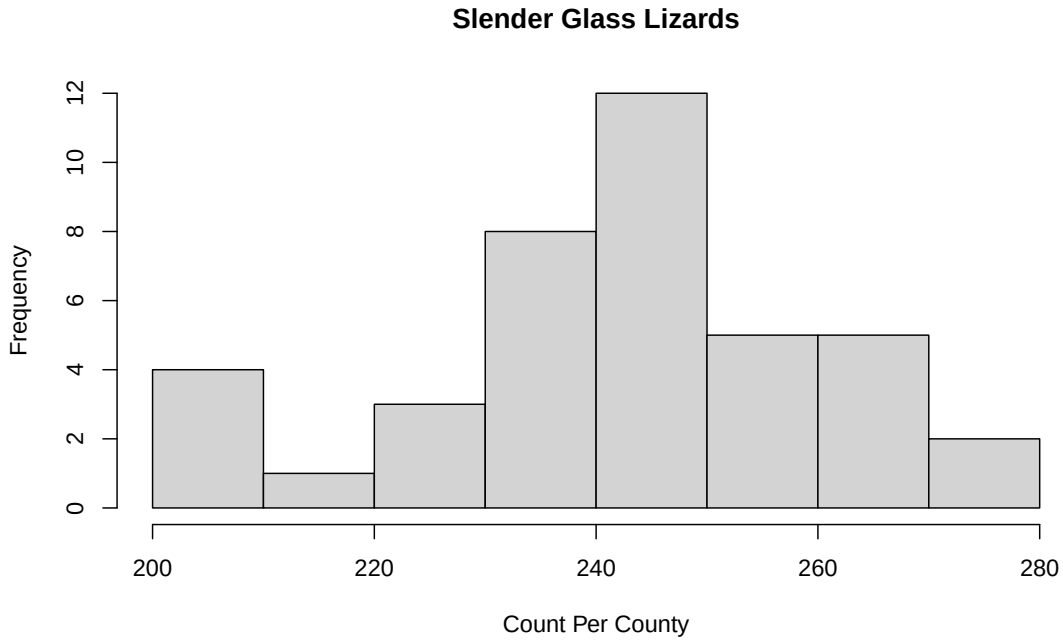
   counter example: confidence intervals

6 t-test and confidence interval

NOTE: The following is a fake study.

A researcher is interested in seeing if the current population of slender glass lizards in rural Iowa has decreased over the last decade. It is known that in 2015 the population of slender glass lizards was 250 lizards per county.

A random sample of 40 counties was collected with the slender glass lizard population having an average (mean) of 242 with a variance of 36. The sample distribution is plotted below as well as two different pieces of R output

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> t.test(lizards, alternative = 'less', mu = 250)

        One Sample t-test

data:  lizards
t = -9.1301, df = 39, p-value = 1.577e-11
alternative hypothesis: true mean is less than 250
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95 percent confidence interval:
 240.1855 243.7454
sample estimates:
mean of x
 241.9654
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Using the above information, please answer the following questions.

1. Please state your null and alternative hypothesis using math symbols. I have started both for you.

$$H_0 : \mu \geq 250$$

$$H_A : \mu < 250$$

2. Assume both the random assumption and the independent and identically distributed assumption were satisfied. Please check the remaining assumption, that is please check to see if the population is normal or if n is large. Justify your answer.

   The histogram is very roughly normal, enough for the assumption anyway

3. Please identify your test statistic. -9.1301

4. Please identify your degrees of freedom. 39

5. The p-value for this test is 1.57 x 10^{-11} (ie very nearly 0). Please give the decision for this test.

   We have very strong evidence that the mean population size of glass lizards in Iowa counties has decreased over the last decade.

6. Please give the 95% confidence interval for the sample mean. You do not need to check the assumptions.

   (240.2, 243.8)

7. Please formally interpret your confidence interval.

   We are 95% confidence the true mean number of glass lizards living in Iowa counties is between 240.2 and 243.8 lizards

7 Formula Page Stuff

Test Name	σ^2 known?	Assumptions	Relevant Distribution	Test Statistic	Conf. Interval
z-test	yes	(Random), (IID), (Large n or the pop is normal)	Normal	$\frac{\bar{x}-\mu}{\sqrt{\frac{\sigma^2}{n}}}$	$\bar{x} \pm z_{1-\alpha/2}\sqrt{\sigma^2/n}$
t-test	no	(Random), (IID), (Large n or the pop is normal)	t-distribution w/ df = n-1	$\frac{\bar{x}-\mu}{\sqrt{\frac{s^2}{n}}}$	$\bar{x} \pm t_{df=n-1}\sqrt{s^2/n}$

P-value	Strength of Evidence
$> .1$	Little to no evidence
.1 - .05	Weak evidence
.05 - .01	Moderate evidence
.01 -.001	Strong evidence
$< .001$	Very Strong evidence

For means:

Shape	How large for n?
Roughly symmetrical	20
Skewed or outliers	50
Most any distribution	100

For proportions:

$$\begin{aligned} np &\geq 10 \\ n(1-p) &\geq 10 \end{aligned}$$