TEST 2

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Spring 2009

print name: ____________________________

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED ANY AID ON THIS WORK, NOR AM I AWARE OF ANY BREACH OF THE HONOR CODE THAT I SHALL NOT IMMEDIATELY REPORT.

pledged: ____________________________

Part I. Multiple Choice. True/False. Short Answer. Each problem is worth 3 points.

Use the following scenario for questions 1 through 4: Can the race of a telephone pollster influence the responses given by subjects? A simple random sample (SRS) of 1200 subjects were selected for a telephone poll in October of 2008. Each subject was asked the question “If the presidential election were held today, who would you most likely vote for, John McCain, Barack Obama, or someone else?” About one third of the subjects were interviewed by a white pollster, about one-third were interviewed by an African-American pollster, and one-third were interviewed by an Asian pollster. (Each pollster had an accent that was described as mild by focus groups that were conducted prior to the poll.) For each pollster, the study recorded the percent support for each candidate. The study focused on how Barack Obama’s support varied among the three pollsters.

1. True or False: This is an observational study, not an experiment.
2. Why is this either an observational study or an experiment?
   a. This is an observational study, because subjects are being asked their opinions.
   b. This is an observational study, because no treatment is being imposed on subjects.
   c. This is an experiment, because a treatment is being imposed.
   d. This is an experiment, because a simple random sample was used to avoid bias.
   e. None of these is the correct explanation.
3. Which of the following is an explanatory variable in this study?
   a. the percent that supported McCain  b. the percent that supported Obama
   c. the race of the pollster  d. the random assignment of subjects to pollsters
   e. none of these
4. Which of the following is the response variable of interest in this study?
   a. the percent that supported McCain  b. the percent that supported Obama
   c. the race of the pollster  d. the random assignment of subjects to pollsters
   e. none of these
5. How is randomization being used to avoid bias in this study?
   a. in the selection of the 1200 subjects  b. in the assignment of subjects to pollsters
   c. in the responses given by the subjects  d. both a. and b.
   e. none of these
Use the following scenario for questions 6 through 8: An administrator at an all-female college wants to know how current students at the college would feel about the college going co-educational in 2011. The administrator mails a questionnaire to an SRS of 600 current students at the college. Out of these, 500 questionnaires are returned, of which 378 are opposed to the proposed change to co-ed status.

6. The population in this study is
   a. all students at the college
   b. the 600 students receiving the questionnaire
   c. the 500 students who returned the questionnaire
   d. the 378 students who are opposed
   e. none of these

7. The sample in this study is
   a. all students at the college
   b. the 600 students receiving the questionnaire
   c. the 500 students who returned the questionnaire
   d. the 378 students who are opposed
   e. none of these

8. What is the non-response rate for this study?
   Answer: \[
   \frac{100}{600} = 16.67 \%
   \]

9. Which of the following is an example of a voluntary response sample?
   a. a telephone survey of 1000 randomly selected voters.
   b. a survey that is mailed out to 1000 randomly selected households (only 325 surveys were returned).
   c. A poll posted on the CNN website asking people to vote on whether AIG executives should have their bonuses confiscated or not.
   d. both b. and c.
   e. none of these

10. A radio talk show host asks his audience “In light of the severe economic downturn, should the federal government be running up huge deficits on an stimulus package whose main beneficiaries appear to be the fat-cat executives who got us into this mess in the first place?” The phones light up, and almost all callers are strongly against the stimulus program. The results of this “study” cannot be trusted because
   a. It’s a poorly worded question, which is slanted towards a desired response.
   b. The question is confusing, and not clearly worded.
   c. The callers to the radio show are a voluntary response sample, not representative of the general population.
   d. Both a. and c.
   e. none of these

11. You have one hundred subjects, labeled from 1 to 100. You select a SRS of size \( n = 3 \) using the TI-8x randInt function, using a seed value of 13. The selected subject labels are
   a. 13, 10, 93
   b. 1, 100, 6
   c. 10, 93, 11
   d. 70, 13, 93
   e. none of these
Use the following scenario for questions 12 through 15: Does cell phone use while driving lower reaction times? A 2003 study by University of Utah Psychology department measured reaction time in a driving simulator for subjects randomly assigned to three different treatment groups: subjects at the maximum legal blood alcohol level of 0.08%, subjects involved in cell phone conversations, and subjects in a control group (no alcohol, no cell phone). The average reaction times for each group were compared. Driving difficulty was controlled for by having all subjects drive in the same simulated environment. The study concluded that cell phone drivers exhibited slower reaction times than intoxicated drivers, and that both these groups had slower reaction times than the control group.

12. This is an example of a
   a. observational study  b. completely randomized design  c. block design  d. matched pairs design  e. none of these

13. Which of the following are factors in this study? (circle all that apply)
   a. blood alcohol level  b. cell phone usage  c. reaction time  d. driving difficulty  e. none of these

14. The response variables in this study are (circle all that apply)
   a. blood alcohol level  b. cell phone usage  c. reaction time  d. driving difficulty  e. none of these

15. Potential confounding variables in this study are (circle all that apply)
   a. blood alcohol level  b. cell phone usage  c. reaction time  d. driving difficulty  e. none of these

16. Two variables are said to be confounded if
   a. they are inconsistent with each other, and with the response variable.
   b. knowing the value of one variable has no effect on the distribution of the other.
   c. their effects on the response variable cannot be separated.
   d. they are highly correlated.
   e. none of these

17. An 4-sided die has 4 faces, labeled from 1 to 4. Take a pair of these 4-sided dice, toss them, and record the label that appears on each die. How many outcomes are in the sample space of this random experiment?
   a. 1  b. 4  c. 8  d. 16  e. none of these

18. A club consists of 2 women and 2 men. Take an SRS of size 2 from the club. What is the probability that the sample contains no men?
   a. 1/2  b. 1/4  c. 1/6  d. 1/8  e. none of these

19. Suppose you have an unfair coin, whose probability of heads is 0.6. Toss the coin 4 times in a row. What is the probability that the outcome is HTHH?
   a. 0.0864  b. 0.0384  c. 0.0576  d. 0.1296  e. none of these

20. IQ is normally distributed in the population, with mean 100 and standard deviation 15. Pick a person at random, give them an IQ test, and let X be the score that person makes on the test. \( P(X > 110) \) is about
   a. 4%  b. 0.0038  c. 0.2525  d. 0.0228  e. none of these
21. IQ is normally distributed in the population, with mean 100 and standard deviation 15. Pick 9 people at random, give them an IQ test, and let \( \overline{x} \) be the sample average IQ score. \( P(\overline{x} > 110) \) is about

a. 4%  

b. 0.0038  

c. 0.2525  

d. 0.0228  

e. none of these

22. At the right is the density curve for a population variable \( X \). The mean of the density curve is approximately \( \mu = 55.8 \). We take a random sample of size \( n = 14 \) from this population and compute the sample mean. Which of the density curves below best represents the distribution of the sample mean?

23. The average time that it takes a college student to memorize a string of 12 random digits is \( \mu = 15 \) seconds. Researchers believe that a new memory-enhancing drug will significantly improve these times. The alternative hypothesis for a significance test of the researchers’ belief is

a. \( H_a : \mu = 15 \)  

b. \( H_a : \mu \neq 15 \)  

c. \( H_a : \mu < 15 \)  

d. \( H_a : \mu > 15 \)  

e. none of these

24. The measurement errors for a precision scale are normally distributed, with a standard deviation of \( \sigma = 4 \) grams. To get an accurate measurement of the weight of a penny, you decide to weigh the penny repeatedly, and report the sample average of your measurements. If the standard deviation of the sample average must be 1, how many times must you repeat the measurement?

a. 2  

b. 4  

c. 8  

d. 16  

e. none of these

25. In the year 2003, the average weight of a new automobile was 4020 lbs \( \pm 50 \) lbs, for 96% confidence. The confidence interval was calculated based on a random sample of \( n = 502 \) new cars sold at dealerships nationwide. Which of the following is true?

a. 96% of all new automobiles sold in 2003 weighed between 3970 and 4070 pounds.  

b. 96% of all samples of size \( n = 502 \) will give a confidence interval that contains the true mean weight \( \mu \).  

c. The probability that the true mean weight is between 3970 and 4070 is 96%.  

d. all of these are true  

e. none of these are true

26. In doing a hypothesis test of \( H_0 : \mu = 5 \) versus \( H_a : \mu > 5 \) a test statistic of \( z = 1.5 \) was obtained. At which level is this result statistically significant?

a. \( \alpha = 0.10 \)  

b. \( \alpha = 0.05 \)  

c. \( \alpha = 0.01 \)  

d. both a. and b.  

e. none of these

27. A margin of error \( m \) for a confidence interval was computed using a certain sample size \( n \). If we wanted to reduce the margin of error by a factor of 2, we would have to increase the sample size by a factor of

a. 2  

b. 3  

c. 4  

d. 5  

e. none of these
28. The critical value $z^*$ for a 97% confidence interval is $z^* = 2.576$

a. $z^* = 1.881$  b. $z^* = 2.000$  c. $z^* = 2.170$  d. $z^* = 2.576$  e. none of these

29. **True or False**: If the population variable $X$ is normally distributed, then a sample mean from the population will also be normally distributed.

30. **True or False**: If the sample size is very large, then the sample mean is very likely to be close to the population mean $\mu$.

**Part II. Analysis and Written Response.** Show your work. Each problem is worth 20 points.

1. The mean time (in number of days) until maturity of a certain variety of tomato plant is normally distributed with mean $\mu$ and standard deviation $\sigma = 2.4$ days. I select a random sample of four plans of this variety and measure the time until maturity. The four times, in days, are

   63, 69, 62, 66

Based on these data, find a 99% confidence interval for $\mu$, the true population mean time until maturity.

\[
\bar{x} = 65 \\
\begin{align*}
z^* &= \text{invNorm}(0.995) \\
&= 2.576 \\
\sigma_{\bar{x}} &= \frac{2.4}{\sqrt{4}} = 1.2
\end{align*}
\]

99% C.I. is $65 \pm 3.1$ or $(61.9, 68.1)$

2. Acme Inc. makes ball bearings. If the production machinery is operating normally, ball bearings coming off the assembly line have diameters that are normally distributed, with mean $\mu = 4$ millimeters (mm) and standard deviation $\sigma = 0.01$ mm. The job of a quality control engineer is to monitor the production machinery, looking for evidence that a problem exists. To do this, the engineer periodically takes a random sample of $n = 10$ ball bearings off the line, and computes their average diameter of the sample. On one such occasion, he finds that the sample average is $\bar{x} = 4.008$ mm. Is this statistically significant evidence at the $\alpha = 0.01$ level that the average diameter of the ball bearings is different from the nominal value of 4 mm? State your hypotheses, give your test statistic, report the P-value you obtain, and state your conclusions in clear English.

\[
\begin{align*}
H_0 &: \mu = 4 \\
H_a &: \mu \neq 4
\end{align*}
\]

\[
\begin{align*}
\text{Test Stat} &= \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \\
&= \frac{4.008 - 4}{0.01/\sqrt{10}} \\
&= 2.530 \\
\text{P-value} &= P(Z \text{ normal cdf}(2.53, \infty)) \\
&= 0.0114
\end{align*}
\]

Since $P > \alpha = 0.01$, we fail to reject $H_0$. This evidence is not significant at the $\alpha = 0.01$ level that the average diameter is different than 4 mm.
3. Powdered laundry detergent comes in a standard box that is labeled as containing 64 ounces of detergent. Due to variability in the manufacturing process, the actual amount of detergent is normally distributed, with a mean \( \mu \) and a standard deviation \( \sigma = 0.5 \) ounces. How much detergent should the put in the boxes on average (\( \mu \)) in order for the probability that a box contains less than 64 ounces be only 1%?

\[
\begin{align*}
\text{Density of } X &= \text{weight of a box} \\
\text{Standardize} \\
\text{St. Normal density} \\
z &= \frac{64 - \mu}{0.5}
\end{align*}
\]

Since 1% of the st. normal distribution is to the left of \( z \), we have

\[
z = \text{inv Norm}(0.01) = -2.326
\]

So

\[
\frac{64 - \mu}{0.5} = -2.326
\]

Solving

\[
64 - \mu = -1.163
\]

\[
\mu = 65.163
\]

So the manufacturer should calibrate the equipment to put 65.163 ounces of detergent in the boxes on average