

AP Statistics Exam Questions about Conditions and Assumptions

2000 #2:

2. Anthropologists have discovered a prehistoric cave dwelling that contains a large number of adult human footprints. To study the size of the adults who used the cave dwelling, they randomly selected 20 of the footprints from the population of all footprints in the cave and measured the length of those footprints. Some statistics resulting from this random sample are as follows.

Sample size	20	Minimum	15.2 cm
Mean	24.8 cm	First quartile	18.7 cm
Standard deviation	7.5 cm	Median	21.5 cm
		Third quartile	30.0 cm
		Maximum	37.0 cm

The anthropologists would like to construct a 95 percent confidence interval for the mean foot length of the adults who used the cave dwelling.

- (a) What assumptions are necessary in order for this confidence interval to be appropriate?

- (b) Discuss whether each of the assumptions listed in your response to (a) appears to be satisfied in this situation.

2007 #5

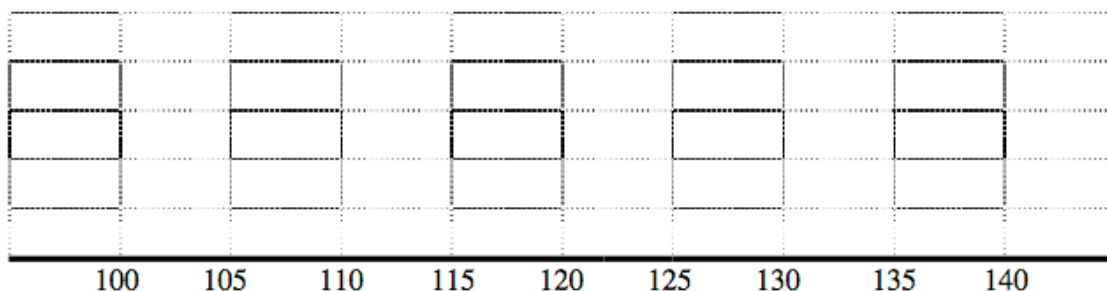
5. Researchers want to determine whether drivers are significantly more distracted while driving when using a cell phone than when talking to a passenger in the car. In a study involving 48 people, 24 people were randomly assigned to drive in a driving simulator while using a cell phone. The remaining 24 were assigned to drive in the driving simulator while talking to a passenger in the simulator. Part of the driving simulation for both groups involved asking drivers to exit the freeway at a particular exit. In the study, 7 of the 24 cell phone users missed the exit, while 2 of the 24 talking to a passenger missed the exit.
- Would this study be classified as an experiment or an observational study? Provide an explanation to support your answer.
 - State the null and alternative hypotheses of interest to the researchers.
 - One test of significance that you might consider using to answer the researchers' question is a two-sample z -test. State the conditions required for this test to be appropriate. Then comment on whether each condition is met.
 - Using an advanced statistical method for small samples to test the hypotheses in part (b), the researchers report a p -value of 0.0683. Interpret, in everyday language, what this p -value measures in the context of this study and state what conclusion should be made based on this p -value.

2004B #5

5. A researcher thinks that modern Thai dogs may be descendants of golden jackals. A random sample of 16 animals was collected from each of the two populations. The length (in millimeters) of the mandible (jawbone) was measured for each animal. The lower quartile, median, and upper quartile for each sample are shown in the table below, along with all values below the lower quartile and all values above the upper quartile.

Sample	Values Below Q_1	Q_1	Median	Q_3	Values Above Q_3
Modern Thai dog	114, 116, 116, 120	121	125	128	129, 130, 130, 132
Golden jackal	104, 104, 105, 106	107	108	112	114, 122, 124, 125

- (a) Display parallel boxplots of mandible lengths (showing outliers, if any) for the modern Thai dogs and the golden jackals on the grid below.



Based on the boxplots, write a few sentences comparing the distributions of mandible lengths for the two types of dogs.

- (b) Is it reasonable to use the sample of mandible lengths of modern Thai dogs to construct an interval estimate of the mean mandible length for the population of modern Thai dogs? Justify your answer. (Note: You do not have to compute the interval.)
- (c) Is it reasonable to use the sample data of mandible lengths of modern Thai dogs and the sample data of mandible lengths of golden jackals to perform a two-sample t -test for the difference in mean mandible lengths for the two types of dogs? Justify your answer. (Note: You do not have to conduct the test.)
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SOLUTIONS:

2000 #2:

Solution

- a. The population of interest is adults who used the cave and the assumptions are:
1. the 20 measurements constitute a random sample **from the population of adults who used the cave.**
 2. the adult foot length distribution is normal or approximately normal. (Some may state this assumption as “the population distribution is normal or the sample from the population is large (e.g., $n > 30$).” This is acceptable.)
- b. **Random sample is not reasonable:** This sample was not taken from the population of interest since the anthropologists took a random sample of footprints, not a random sample of adults who used the cave. There may be several different ways to explain that the sample was not taken from the population of interest. For example:
- the 20 observations may include several footprints from the same adult
 - the footprints may be from children
 - some of the original footprints may have eroded in time

Normality: Either of the responses below is acceptable.

Normality is not reasonable:

1. A boxplot or an analysis of the given summary statistics can be used to show that the distribution is skewed.

OR

2. The range of the data is 21.8, which is only 2.91 standard deviations, which is smaller than would be expected for a normal distribution.

OR

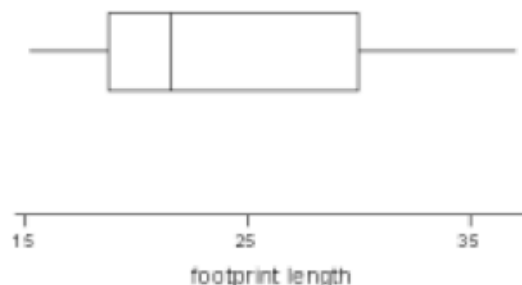
3. The minimum value is only 1.28 standard deviations below the mean, which is smaller than would be expected for a normal distribution.

OR

4. The maximum is only 1.63 standard deviations above the mean, which is smaller than would be expected for a normal distribution.

Normality is reasonable:

A boxplot shows that the distribution is not too skewed.



2007 #5:

Solution

Part (a):

This is an experiment because the researchers imposed treatments by randomly assigning drivers to the two different conditions (simulated driving while talking on a cell phone versus simulated driving while talking to a passenger).

Part (b):

Let p_{cell} denote the proportion of drivers who miss an exit while using a cell phone and p_{pass} denote the proportion of drivers who miss an exit while talking to a passenger.

$$H_0: p_{cell} = p_{pass}$$

$$H_A: p_{cell} > p_{pass}$$

Part (c):

The conditions required for a two-sample z-test of equal proportions are:

(1) independent random samples or random assignment, and

(2) large sample sizes $[n_1 \hat{p}_1 \geq 10, n_1(1 - \hat{p}_1) \geq 10, n_2 \hat{p}_2 \geq 10, n_2(1 - \hat{p}_2) \geq 10]$.

Random assignment is stated in the stem so the first condition is met. However, the numbers of successes

($n_{cell} \hat{p}_{cell} = 7$ and $n_{pass} \hat{p}_{pass} = 2$) are both smaller than 10, so the large sample condition is not met in this

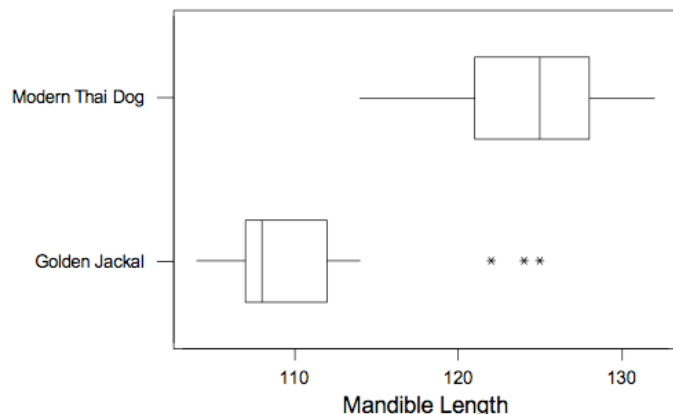
situation. Note: If the student uses the rule of thumb with 10 replaced by 5, then the number of successes for the second sample is still too small.

Part (d):

Interpretation: Assuming that talking on a cell phone and talking to a passenger are equally distracting (there is no difference in the two population proportions of drivers who will miss the exit), the p -value measures the chance of observing a difference in the two sample proportions as large as or larger than the one observed.

Conclusion: Since the p -value 0.0683 is larger than 0.05, we cannot reject the null hypothesis. That is, we do not have statistically significant evidence to conclude that using a cell phone is more distracting to drivers than talking to another passenger in the car.

Notice that if we increase the significance level to 0.1, then we could reject the null hypothesis and conclude that drivers are significantly more distracted when using a cell phone.

Part (a):

The distributions of mandible lengths for Modern Thai Dogs and Golden Jackals are not similar. The distribution of mandible lengths for Modern Thai Dogs is approximately symmetric and a typical value is about 125, whereas the distribution of mandible lengths for Golden Jackals has a typical value that is much smaller, around 108, and the distribution appears to be skewed to the right with outliers (relative to likely samples from a normal distribution) on the high end. The variability in the lengths is roughly the same for both types of dogs.

Part (b):

Yes, the boxplot for this random sample is roughly symmetric and there are no outliers. It is reasonable to assume that the distribution of mandible lengths for Modern Thai Dogs is approximately normal, and it is okay to construct a t-confidence interval for the mean mandible length for Modern Thai Dogs.

Part (c):

No, it would not be reasonable to use this data to perform a two-sample t-test. The boxplot for mandible lengths of Golden Jackals is not symmetric, and there are three outliers in a sample of size 16. This indicates that the distribution of mandible lengths for Golden Jackals is not approximately normal, and so it would not be appropriate to use the data to perform a two-sample t-test.