Chapter 11: Inference for Distributions

1. The weights of three adult males are (in pounds) 160, 215, and 195. The standard error of the mean of these three weights is
   A) 190.  B) 27.84.  C) 22.73.  D) 16.07.
   Ans: D
   Section: 11.1 Inference for the Mean of a Population

2. The one sample $t$ statistic from a sample of $n = 19$ observations for the two-sided test of
   $H_0$: $\mu = 6$
   $H_a$: $\mu \neq 6$
   has the value $t = 1.93$. Based on this information
   A) we would reject the null hypothesis at $\alpha = 0.10$.
   B) $0.025 < P$-value $< 0.05$.
   C) we would reject the null hypothesis at $\alpha = 0.05$.
   D) both (b) and (c) are correct.
   Ans: A
   Section: 11.1 Inference for the Mean of a Population

3. The heights (in inches) of males in the United States are believed to be normally distributed with mean $\mu$. The average height of a random sample of 25 American adult males is found to be $\bar{x} = 69.72$ inches and the standard deviation of the 25 heights is found to be $s = 4.15$. The standard error of $\bar{x}$ is
   A) 0.17.  B) 0.69.  C) 0.83.  D) 2.04.
   Ans: C
   Section: 11.1 Inference for the Mean of a Population

4. Scores on the Math SAT (SAT-M) are believed to be normally distributed with mean $\mu$. The scores of a random sample of three students who recently took the exam are 550, 620, and 480. A 95% confidence interval for $\mu$ based on these data is
   A) $550.00 \pm 173.88$.  
   B) $550.00 \pm 142.00$.
   C) $550.00 \pm 128.58$.  
   D) $550.00 \pm 105.01$.
   Ans: A
   Section: 11.1 Inference for the Mean of a Population
Use the following to answer questions 5-8:

An SRS of 100 postal employees found that the average amount of time these employees had worked for the U.S. Postal Service was $\bar{x} = 7$ years with standard deviation $s = 2$ years. Assume the distribution of the time the population has worked for the Postal Service is approximately normal with mean $\mu$. Are these data evidence that $\mu$ has changed from the value of 7.5 years of 20 years ago? To determine this we test the hypotheses

$H_0: \mu = 7.5, \ H_a: \mu \neq 7.5$

using the one-sample $t$ test.

5. The appropriate degrees of freedom for this test are
   Ans: C
   Section: 11.1 Inference for the Mean of a Population

6. The $P$-value for the one-sample $t$ test is
   A) larger than 0.10.    C) between 0.05 and 0.01.
   B) between 0.10 and 0.05.    D) below 0.01.
   Ans: C
   Section: 11.1 Inference for the Mean of a Population

7. A 95% confidence interval for the mean amount of time $\mu$ the population of Postal Service employees has spent with the postal service is
   A) 7 ± 2.    B) 7 ± 1.984.    C) 7 ± 0.4.    D) 7 ± 0.2.
   Ans: C
   Section: 11.1 Inference for the Mean of a Population

8. Suppose the mean and standard deviation obtained were based on a sample of 25 postal workers rather than 100. The $P$-value would be
   A) larger.
   B) smaller.
   C) unchanged, since the difference between $\bar{x}$ and the hypothesized value $\mu = 7.5$ is unchanged.
   D) unchanged, since the variability measured by the standard deviation stays the same.
   Ans: A
   Section: 11.1 Inference for the Mean of a Population
Chapter 11: Inference for Distributions

9. We wish to see if the dial indicating the oven temperature for a certain model oven is properly calibrated. Four ovens of this model are selected at random. The dial on each is set to 300°F; after one hour, the actual temperature of each is measured. The temperatures measured are 305°F, 310°F, 300°F, and 305°F. Assuming that the actual temperatures for this model when the dial is set to 300°F are normally distributed with mean \( \mu \), we test whether the dial is properly calibrated by testing the hypotheses

\[ H_0: \mu = 300, \quad H_a: \mu \neq 300 \]

Based on the data, the value of the one-sample \( t \) statistic is

A) 5. B) 4.90. C) 2.45. D) 1.23.

Ans: C

Section: 11.1 Inference for the Mean of a Population

Use the following to answer questions 10-11:

Bags of a certain brand of tortilla chips claim to have a net weight of 14 ounces. Net weights actually vary slightly from bag to bag and are normally distributed with mean \( \mu \). A representative of a consumer advocate group wishes to see if there is any evidence that the mean net weight is less than advertised and so intends to test the hypotheses

\[ H_0: \mu = 14, \quad H_a: \mu < 14 \]

To do this, he selects 16 bags of this brand at random and determines the net weight of each. He finds the sample mean to be \( \bar{x} = 13.88 \) and the sample standard deviation to be \( s = 0.24 \).

10. Based on the data above,

A) we would reject \( H_0 \) at significance level 0.10 but not at 0.05.
B) we would reject \( H_0 \) at significance level 0.05 but not at 0.025.
C) we would reject \( H_0 \) at significance level 0.025 but not at 0.01.
D) we would reject \( H_0 \) at significance level 0.01.

Ans: B

Section: 11.1 Inference for the Mean of a Population

11. Referring to the information above, suppose we were not sure if the distribution of net weights was normal. In which of the following circumstances would we not be safe using a \( t \) procedure in this problem?

A) The mean and median of the data are nearly equal.
B) A histogram of the data shows moderate skewness.
C) A stemplot of the data has a large outlier.
D) The sample standard deviation is large.

Ans: C

Section: 11.1 Inference for the Mean of a Population
12. The water diet requires the dieter to drink two cups of water every half hour from when he gets up until he goes to bed, but otherwise allows him to eat whatever he likes. Four adult volunteers agree to test the diet. They are weighed prior to beginning the diet and after six weeks on the diet. The weights (in pounds) are

<table>
<thead>
<tr>
<th>Person</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight before the diet</td>
<td>180</td>
<td>125</td>
<td>240</td>
<td>150</td>
</tr>
<tr>
<td>Weight after six weeks</td>
<td>170</td>
<td>130</td>
<td>215</td>
<td>152</td>
</tr>
</tbody>
</table>

For the population of all adults, assume that the weight loss after six weeks on the diet (weight before beginning the diet – weight after six weeks on the diet) is normally distributed with mean \( \mu \). To determine if the diet leads to weight loss, we test the hypotheses

\[ H_0: \mu = 0, \quad H_a: \mu > 0 \]

Based on these data we conclude that

A) we would not reject \( H_0 \) at significance level 0.10.
B) we would reject \( H_0 \) at significance level 0.10 but not at 0.05.
C) we would reject \( H_0 \) at significance level 0.05 but not at 0.01.
D) we would reject \( H_0 \) at significance level 0.01.

Ans: A

Section: 11.1 Inference for the Mean of a Population

13. Do students tend to improve their Math SAT (SAT-M) score the second time they take the test? A random sample of four students who took the test twice received the following scores.

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>First score</td>
<td>450</td>
<td>520</td>
<td>720</td>
<td>600</td>
</tr>
<tr>
<td>Second score</td>
<td>440</td>
<td>600</td>
<td>720</td>
<td>630</td>
</tr>
</tbody>
</table>

Assume that the change in SAT-M score (second score – first score) for the population of all students taking the test twice is normally distributed with mean \( \mu \). A 90% confidence interval for \( \mu \) is

A) \( 25.0 \pm 64.29 \).  B) \( 25.0 \pm 47.54 \).  C) \( 25.0 \pm 43.08 \).  D) \( 25.0 \pm 33.24 \).

Ans: B

Section: 11.1 Inference for the Mean of a Population
14. You are thinking of using a *t*-procedure to test hypotheses about the mean of a population using a significance level of 0.05. You suspect the distribution of the population is not normal and may be moderately skewed. Which of the following statements is correct?

A) You should not use the *t*-procedure since the population does not have a normal distribution.
B) You may use the *t*-procedure provided your sample size is large, say at least 50.
C) You may use the *t*-procedure, but you should probably only claim the significance level is 0.10.
D) You may not use the *t*-procedure. *t*-procedures are robust to nonnormality for confidence intervals but not for tests of hypotheses.

Ans: B

Section: 11.1 Inference for the Mean of a Population

15. To estimate \( \mu \), the mean salary of full professors at American colleges and universities, you obtain the salaries of a random sample of 400 full professors. The sample mean is \( \bar{x} = 73220 \) and the sample standard deviation is \( s = 4400 \). A 99% confidence interval for \( \mu \) is

A) 73,220 ± 11,440.  
B) 73,220 ± 572.  
C) 73220 ± 431.  
D) 73220 ± 28.6.

Ans: B

Section: 11.1 Inference for the Mean of a Population

16. Bags of a certain brand of tortilla chips claim to have a net weight of 14 ounces. Net weights actually vary slightly from bag to bag and are normally distributed with mean \( \mu \). A representative of a consumer advocate group wishes to see if there is any evidence that the mean net weight is less than advertised and so intends to test the hypotheses \( H_0: \mu = 14 \), \( H_a: \mu < 14 \) using a 5% significance level. To do this, he selects 16 bags of this brand at random, determines the net weight of each, and computes the mean of these 16 weights. If the standard deviation for the distribution of actual net weights for bags of this brand is \( \sigma = 0.25 \), the power of our test when \( \mu = 13.8 \) ounces is approximately

A) 0.975.  
B) 0.93.  
C) 0.2119.  
D) 0.0007.

Ans: B

Section: 11.1 Inference for the Mean of a Population
17. We wish to see if the dial indicating the oven temperature for a certain model oven is properly calibrated. Four ovens of this model are selected at random. The dial on each is set to 300° F; after one hour, the actual temperature of each is measured. Assuming that the actual temperatures for all ovens of this model when the dial is set to 300° are normally distributed with mean \( \mu \), we test whether the dial is properly calibrated by testing the hypotheses

\[
H_0: \mu = 300, \quad H_a: \mu \neq 300
\]

using a 1% significance level. If the standard deviation for the distribution of actual temperatures for all ovens of this model when the dial is set to 300° is \( \sigma = 4 \), the power of our test when \( \mu = 310° F \) is approximately

A) 0.0001.     B) 0.2.     C) 0.95.     D) 0.9987.

Ans: B

Section: 11.1 Inference for the Mean of a Population

18. Which of the following is an example of a matched-pairs design?

A) A teacher compares the pretest and posttest scores of students.
B) A teacher compares the scores of students using a computer-based method of instruction with the scores of other students using a traditional method of instruction.
C) A teacher compares the scores of students in her class on a standardized test with the national average score.
D) A teacher calculates the average of scores of students on a pair of tests and wishes to see if this average is larger than 80%.

Ans: A

Section: 11.1 Inference for the Mean of a Population

19. A medical researcher wishes to investigate the effectiveness of exercise versus diet in losing weight. Two groups of 25 overweight adults subjects are used, with a subject in each group matched to a similar subject in the other group on the basis of a number of physiological variables. One of the groups is placed on a regular program of vigorous exercise, but with no restriction on diet, and the other group is placed on a strict diet, but with no requirement to exercise. The weight losses after 20 weeks are determined for each subject and the difference between matched pairs of subjects (weight loss of subject in exercise group – weight loss of matched subject in diet group) is computed. The mean of these differences in weight loss is found to be \(-2\) pounds with standard deviation \( s = 6 \) pounds. Is this evidence of a difference in mean weight loss for the two methods? To test this, consider the population of differences (weight loss overweight adult would experience after 20 weeks on the exercise program) – (weight loss the same adult would experience after 20 weeks on the strict diet). Let \( \mu \) be the mean of this population of differences and assume their distribution is approximately normal. We test the hypotheses

\[
H_0: \mu = 0, \quad H_a: \mu \neq 0
\]

using the matched-pairs \( t \) test. The \( P \)-value for this test is

A) larger than .10.     C) between .05 and .01
B) between .10 and .05.     D) below .01.

Ans: A

Section: 11.1 Inference for the Mean of a Population
20. Which of the following transformations is useful for making data from a population with a distribution that is skewed to the right appear to have a more symmetric distribution?
   A) subtracting the mean from all the data; the data will now be centered at 0.
   B) standardizing the data by subtracting the mean and dividing the result by the standard deviation; the resulting data will be standard normal, hence symmetric.
   C) taking the logarithms of the data.
   D) all of the above.
   Ans:  C
   Section:  11.1 Inference for the Mean of a Population

21. The heights (in inches) of adult males in the United States are believed to be normally distributed with mean \( \mu \). The average height of a random sample of 25 American adult males is found to be \( \bar{x} = 69.72 \) inches, and the standard deviation of the 25 heights is found to be \( s = 4.15 \). A 90% confidence interval for \( \mu \) is
   A) 69.72 ± 1.09.   B) 69.72 ± 1.37.   C) 69.72 ± 1.42.   D) 69.72 ± 4.15.
   Ans:  C
   Section:  11.1 Inference for the Mean of a Population

22. We are interested in evaluating the effect of a natural product on reducing blood pressure. This is done by comparing the mean reduction in blood pressure of a treatment (natural product) group and a placebo group using a two-sample \( t \) test. The standard deviations are approximately the same, so the researchers will use a pooled \( t \) test; based on previous work the researchers are able to specify a common sample standard deviation. The researchers have specified \( \mu_2 - \mu_1 = 7 \) as an alternative they would like to be able to detect with \( \alpha = 0.01 \). Sample sizes of 50 in each group are selected and found to have a power of 80%. If the researchers now decide they are interested in the alternative \( \mu_2 - \mu_1 = 5 \) instead, then the power of the study for this alternative
   A) would be less than 80%.
   B) would be greater than 80%.
   C) would still be 80%.
   D) could be either less than or greater than 80%, depending on whether the natural product is effective.
   Ans:  A
   Section:  11.2 Comparing Two Means
Use the following to answer questions 23-25:

Some researchers have conjectured that stem-pitting disease in peach tree seedlings might be controlled with weed and soil treatment. An experiment was conducted to compare peach tree seedling growth with soil and weeds treated with one of two herbicides. In a field containing 20 seedlings, 10 were randomly selected throughout the field and assigned to receive Herbicide A. The remainder were to receive Herbicide B. Soil and weeds for each seedling were treated with the appropriate herbicide, and at the end of the study period the height (in centimeters) was recorded for each seedling. The following results were obtained:

Herbicide A: \( \bar{x}_1 = 94.5 \text{ cm} \quad s_1 = 10 \text{ cm} \)
Herbicide B: \( \bar{x}_2 = 109.1 \text{ cm} \quad s_2 = 9 \text{ cm} \)

23. Referring to the information above, a 90% confidence interval (use the conservative value for the degrees of freedom) for \( \mu_2 - \mu_1 \) is
   Ans: A
   Section: 11.2 Comparing Two Means

24. Referring to the information above, suppose we wished to determine if there tended to be a difference in height for the seedlings treated with the different herbicides. To answer this question, we decide to test the hypotheses
   \( H_0: \mu_2 - \mu_1 = 0, \quad H_a: \mu_2 - \mu_1 \neq 0 \)
   Based on our data, the value of the two-sample \( t \) is
   A) 14.60.  B) 7.80.  C) 3.43.  D) 2.54.
   Ans: C
   Section: 11.2 Comparing Two Means

25. Referring to the information above, suppose we wished to determine if there tended to be a difference in height for the seedlings treated with the different herbicides. To answer this question, we decide to test the hypotheses
   \( H_0: \mu_2 - \mu_1 = 0, \quad H_a: \mu_2 - \mu_1 \neq 0 \)
   The 90% confidence interval is 14.6 ± 7.80 cm. Based on this confidence interval,
   A) we would not reject the null hypothesis of no difference at the 0.10 level.
   B) we would reject the null hypothesis of no difference at the 0.10 level.
   C) the \( P \)-value is less than 0.10.
   D) both (c) and (d) are correct.
   Ans: B
   Section: 11.2 Comparing Two Means
26. Researchers compared two groups of competitive rowers: a group of skilled rowers and a group of novices. The researchers measured the angular velocity of each subject's right knee, which describes the rate at which the knee joint opens as the legs push the body back on the sliding seat. The sample size \( n \), the sample means, and the sample standard deviations for the two groups are given below.

<table>
<thead>
<tr>
<th>Group</th>
<th>( n )</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skilled</td>
<td>16</td>
<td>4.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Novice</td>
<td>16</td>
<td>3.2</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The researchers wished to test the hypotheses

\[ H_0: \text{the mean knee velocities for skilled and novice rowers are the same} \]
\[ H_a: \text{the mean knee velocity for skilled rowers is larger than for novice rowers} \]

The data showed no strong outliers or strong skewness, so the researchers decided to use the two-sample \( t \) test. The value of the \( t \) test statistic is

A) 1.0.  B) 1.25.  C) 2.0.  D) 4.0.

Ans: D

Section: 11.2 Comparing Two Means

Use the following to answer questions 27-30:

A researcher wished to test the effect of the addition of extra calcium to yogurt on the “tastiness” of yogurt. A collection of 200 adult volunteers was randomly divided into two groups of 100 subjects each. Group 1 tasted yogurt containing the extra calcium. Group 2 tasted yogurt from the same batch as group 1 but without the added calcium. Both groups rated the flavor on a scale of 1 to 10, 1 being “very unpleasant” and 10 being “very pleasant.” The mean rating for group 1 was \( \bar{x}_1 = 6.5 \) with a standard deviation \( s_1 = 1.5 \). The mean rating for group 2 was \( \bar{x}_2 = 7.0 \) with a standard deviation \( s_2 = 2.0 \). Assume the two groups are independent. Let \( \mu_1 \) and \( \mu_2 \) represent the mean ratings we would observe for the entire population represented by the volunteers if all members of this population tasted, respectively, the yogurt with and without the added calcium.

27. Referring to the information above, assuming two sample \( t \) procedures are safe to use, a 90% confidence interval for \( \mu_1 - \mu_2 \) is (use the conservative value for the degrees of freedom)

A) \(-0.5 \pm 0.25\).  B) \(-0.5 \pm 0.32\).  C) \(-0.5 \pm 0.42\).  D) \(-0.5 \pm 0.5\).

Ans: C

Section: 11.2 Comparing Two Means
28. Referring to the information above, suppose the researcher had wished to test the hypotheses

\[ H_0: \mu_1 = \mu_2, \quad H_a: \mu_1 < \mu_2 \]

The \( P \)-value for the test is (use the conservative value for the degrees of freedom)

A) larger than 0.10.  
B) between 0.10 and 0.05.  
C) between 0.05 and 0.01.  
D) below 0.01.

Ans: C  
Section: 11.2 Comparing Two Means

29. Referring to the information above, which of the following would lead us to believe that the \( t \) procedures were not safe to use here?

A) The sample medians and means for the two groups were slightly different.  
B) The distributions of the data were moderately skewed.  
C) The data are integers between 1 and 10 and so cannot be normal.  
D) Only the most severe departures from normality would lead us to believe the \( t \) procedures were not safe to use.

Ans: D  
Section: 11.2 Comparing Two Means

30. Referring to the information above, if we had used the more accurate software approximation to the degrees of freedom, we would have used which of the following for the number of degrees of freedom for the \( t \) procedures?

A) 199.  
B) 198.  
C) 184.  
D) 99.

Ans: C  
Section: 11.2 Comparing Two Means
A sports writer wished to see if a football filled with helium travels farther, on average, than a football filled with air. To test this, the writer used 18 adult male volunteers. These volunteers were randomly divided into two groups of nine subjects each. Group 1 kicked a football filled with helium to the recommended pressure. Group 2 kicked a football filled with air to the recommended pressure. The mean yardage for group 1 was $\bar{x}_1 = 30$ yards with a standard deviation $s_1 = 8$ yards. The mean yardage for group 2 was $\bar{x}_2 = 26$ yards with a standard deviation $s_2 = 6$ yards. Assume the two groups of kicks are independent. Let $\mu_1$ and $\mu_2$ represent the mean yardage we would observe for the entire population represented by the volunteers if all members of this population kicked, respectively, a helium- and an air-filled football.

31. Referring to the information above, assuming two sample $t$ procedures are safe to use, a 99% confidence interval for $\mu_1 - \mu_2$ is (use the conservative value for the degrees of freedom)
   A) $4 \pm 4.7$ yards.  B) $4 \pm 6.2$ yards.  C) $4 \pm 7.7$ yards.  D) $4 \pm 11.2$ yards.
   Ans: D
   Section: 11.2 Comparing Two Means

32. Referring to the information above, suppose the researcher had wished to test the hypotheses
   $$H_0: \mu_1 = \mu_2, \quad H_a: \mu_1 > \mu_2$$
   The $P$-value for the test is (use the conservative value for the degrees of freedom)
   A) larger than 0.10.  C) between 0.05 and 0.01.
   B) between 0.10 and 0.05.  D) below 0.01.
   Ans: A
   Section: 11.2 Comparing Two Means

33. Referring to the information above, to which of the following would it have been most important that the subjects be blind during the experiment?
   A) the identity of the sports writer.
   B) the direction in which they were to kick the ball.
   C) the method they were to use in kicking the ball.
   D) whether the ball they were kicking was filled with helium or air.
   Ans: D
   Section: 11.2 Comparing Two Means

34. Referring to the information above, if we had used the more accurate software approximation to the degrees of freedom, we would have used which of the following for the number of degrees of freedom for the $t$ procedures?
   Ans: A
   Section: 11.2 Comparing Two Means
Use the following to answer questions 35-37:

A researcher wished to compare the average amount of time spent in extracurricular activities by high school students in a suburban school district with that in a school district of a large city. The researcher obtained an SRS of 60 high school students in a large suburban school district and found the mean time spent in extracurricular activities per week to be $\bar{x}_1 = 6$ hours with a standard deviation $s_1 = 3$ hours. The researcher also obtained an independent SRS of 40 high school students in a large city school district and found the mean time spent in extracurricular activities per week to be $\bar{x}_2 = 4$ hours with a standard deviation $s_2 = 2$ hours. Let $\mu_1$ and $\mu_2$ represent the mean amount of time spent in extracurricular activities per week by the populations of all high school students in the suburban and city school districts, respectively.

35. Referring to the information above, assuming two sample $t$ procedures are safe to use, a 95% confidence interval for $\mu_1 - \mu_2$ is (use the conservative value for the degrees of freedom)
   A) 2 ± 0.5 hours.   B) 2 ± 0.84 hours.   C) 2 ± 1.01 hours.   D) 2 ± 1.34 hours.
   Ans: C
   Section: 11.2 Comparing Two Means

36. Referring to the information above, suppose the researcher had wished to test the hypotheses
   $H_0$: $\mu_1 = \mu_2$, $H_a$: $\mu_1 \neq \mu_2$

   The $P$-value for the test is (use the conservative value for the degrees of freedom)
   A) larger than 0.10.   B) between 0.10 and 0.05.   C) between 0.05 and 0.01.   D) below 0.01.
   Ans: D
   Section: 11.2 Comparing Two Means

37. Referring to the information above, if we had used the more accurate software approximation to the degrees of freedom, we would have used which of the following for the number of degrees of freedom for the $t$ procedures?
   A) 99.   B) 98.   C) 60.   D) 50.
   Ans: B
   Section: 11.2 Comparing Two Means
38. A researcher wished to compare the effect of two stepping heights (low and high) on heart rate in a step-aerobics workout. A collection of 50 adult volunteers was randomly divided into two groups of 25 subjects each. Group 1 did a standard step-aerobics workout at the low height. The mean heart rate at the end of the workout for the subjects in group 1 was $\bar{x}_1 = 90.00$ beats per minute with a standard deviation $s_1 = 9$ beats per minute. Group 2 did the same workout but at the high step height. The mean heart rate at the end of the workout for the subjects in group 2 was $\bar{x}_2 = 95.08$ beats per minute with a standard deviation $s_2 = 12$ beats per minute. Assume the two groups are independent and the data are approximately normal. Let $\mu_1$ and $\mu_2$ represent the mean heart rates we would observe for the entire population represented by the volunteers if all members of this population did the workout using the low or high step height, respectively. Suppose the researcher had wished to test the hypotheses

$H_0: \mu_1 = \mu_2$, $H_a: \mu_1 < \mu_2$

The $P$-value for the test is (use the conservative value for the degrees of freedom)

A) larger than 0.10. 
B) between 0.10 and 0.05. 
C) between 0.05 and 0.01. 
D) less than 0.01.

Ans: B

Section: 11.2 Comparing Two Means