Chapter 10

**Section 1**

In Exercises 10.9–10.14, hypothesis tests are proposed. For each hypothesis test,

a. identify the variable.  
b. identify the two populations.  
c. determine the null and alternative hypotheses.  
d. classify the hypothesis test as two tailed, left tailed, or right tailed.

**11.** Driving Distances. Data on household vehicle miles of travel (VMT) are compiled annually by the Federal Highway Administration and are published in National Household Travel Survey, Summary of Travel Trends. A hypothesis test is to be per- formed to decide whether a difference exists in last year’s mean VMT for households in the Midwest and South.

**a) Variable: Last year VMT  
b) Two populations: Households in the Midwest and households in the South  
c) h0 : mean(MW) = mean(S) -- ha : mean(MW) mean(S)  
d) two tailed**

**12**. Age of Car Buyers. In the introduction to this chapter, we mentioned comparing the mean age of buyers of new domestic cars to the mean age of buyers of new imported cars. Suppose that we want to perform a hypothesis test to decide whether the mean age of buyers of new domestic cars is greater than the mean age of buyers of new imported cars.

**a) Variable: Age of buyers  
b) Two populations: Buyers of new domestic cars and buyers of new imported cars  
c**) **h0 : mean(D) = mean(I) -- ha : mean(D) > mean(I)  
d) right tailed**

In each of Exercises 10.15–10.20, we have presented a confidence interval (CI) for the difference, μ1 − μ2, between two population means. Interpret each confidence interval.

**15.** 95% CI is from 15 to 20.

**We are 95% confident that the μ1 − μ2, lies in between 15 and 20, which means that the μ1 is greater than μ2, for something that lies within 15 and 20.**

**21**. A variable of two populations has a mean of 40 and a standard deviation of 12 for one of the populations and a mean of 40 and a standard deviation of 6 for the other population.

a. For independent samples of sizes 9 and 4, respectively, find the mean and standard deviation of x ̄1 − x ̄2.

**x1 – x2 = μ1 – μ2 = 40 – 40 = 0  
 x1 – x2 = =**

b. Must the variable under consideration be normally distributed on each of the two populations for you to answer part (a)? Explain your answer.

**No, it does not have to normally distributed. It is necessary just when we want to conclude that the x1-x2 is normally distributed.**

c. Can you conclude that the variable x ̄1 − x ̄2 is normally distributed? Explain your answer.

**No, we can’t conclude it, because we don’t know if the variable on the two populations is normally distributed or not.**

**23.** A variable of two populations has a mean of 40 and a standard deviation of 12 for one of the populations and a mean of 40 and a standard deviation of 6 for the other population. Moreover, the variable is normally distributed on each of the two populations.

a. For independent samples of sizes 9 and 4, respectively, determine the mean and standard deviation of x ̄1 − x ̄2.

**x1 – x2 = μ1 – μ2 = 40 – 40 = 0  
 x1 – x2 = =**

b. Can you conclude that the variable x ̄1 − x ̄2 is normally distributed? Explain your answer.

**Yes, we can conclude that the x1-x2 is normally distributed, because it is said that the variable on each of the two populations is normally distributed as well.**

c. Determine the percentage of all pairs of independent samples of sizes 9 and 4, respectively, from the two populations with the property that the difference x ̄1 − x ̄2 between the sample means is between −10 and 10.

**P(-10< x ̄1 − x ̄2 < 10)  
P(-10< < 10)** 🡪  **(2 standard deviations – 95.44%**

**Section 2**

In each of Exercises 10.33–10.38, we have provided summary statistics for independent simple random samples from two populations. In each case, use the pooled t-test and the pooled t- interval procedure to conduct the required hypothesis test and obtain the specified confidence interval.

**33**. *x* ̄1 =10, *s*1 =2.1, *n*1 =15, *x* ̄2 =12, *s*2 =2.3, *n*2 =15   
**a.** Two-tailed test, α = 0.05

**sp 2 = = 4.85 🡪 sp = 2.2  
t =**   
**α = 0.05 (two side 🡪 0.025)  & df = n1+n2 -2= 28** 🡪  
 **critical value = -+ 2.048; reject** **h0  
0.01< P < 0.025;**

**b.** 95% confidence interval   
(x1-x2) t α/2 \* sp  🡪 **-3.645 to -0.355**

(x1-x2) - t α/2 \* sp = -2 – (-2.048) \* 2.2 = - 0.355

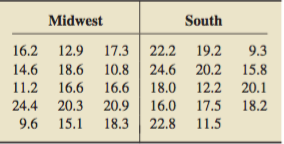
(x1-x2) - t α/2 \* sp = -2 + (-2.048) \* 2.2 = -3.645

**35**.x ̄1 =20,*s*1 =4,*n*1 =10,*x* ̄2 =18,*s*2 =5,*n*2 =15   
**a.** Right-tailed test, α = 0.05  
**sp 2 = 🡪 sp = 4.28  
t = 1.06  
α = 0.05 (right side)  & df = n1+n2 -2= 23** 🡪 **critical value = 1.714; do not reject h0  
P > 0.10;**

 **b.** 90% confidence interval   
(x1-x2) t α/2 \* sp  🡪 **0.995 to 4.995**(x1-x2) - t α/2 \* sp  = 2 – 1.714\* 4.28( = 0.995

(x1-x2) - t α/2 \* sp  = 2 + 1.714\* 4.28( = 4.995

**42.** Driving Distances. Data on household vehicle miles of travel (VMT) are compiled annually by the Federal Highway Ad- ministration and are published in National Household Travel Survey, Summary of Travel Trends. Independent random samples of 15 midwestern households and 14 southern households provided the following data on last year’s VMT, in thousands of miles.



At the 5% significance level, does there appear to be a difference in last year’s mean VMT for midwestern and southern households? (Note: x ̄1 = 16.23, s1 = 4.06, x ̄2 = 17.69, and s2 = 4.42.)

**sp 2 = 🡪 sp = 4.24  
t =   
α = 0.05 (two tailed 🡪 0.025)  & df = n1+n2 -2=27 🡪 critical value -+ 2.052; don’t reject h0  
0.1 < P < 0.025;**

**At the 5% significance level, the data don’t provide enough evidence to show that there was a difference in last year’s mean for Midwestern and southern households.**

**Section 3**

In each of Exercises 10.63–10.68, we have provided summary statistics for independent simple random samples from two populations. In each case, use the non-pooled t-test and the non-pooled t-interval procedure to conduct the required hypothesis test and obtain the specified confidence interval.

**63**. x ̄1 =10, s1 =2, n1 =15, x ̄2 =12, s2 =5, n2 =15

a. Two-tailed test, α = 0.05 b. 95% confidence interval

**t =   
  
Two-tailed test, α = 0.05 🡪 0.025  
df = = = 18.4 => 18  
critical value (0.025, 18) 🡪 -+ 2.101; do not reject h0  ; (0.1< P < 0.2)**

**(x1-x2) -+ t α/2 \*  => -4.92 – 0.92  
(10-12) – (-2.101)\* = -2 + 2.101\*1.39 = 0.92  
(10-12) + (-2.101)\* = -2 - 2.101\*1.39 = -4.92**

**65**. x ̄1 =20, s1 =4, n1 =10, x ̄2 =18, s2 =5, n2 =15

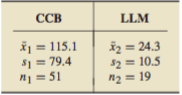
a. Right-tailed test, α = 0.05 b. 90% confidence interval

**t =1.105**

**Right-tailed test, α = 0.05**   
**df = = = 22.1 🡪 22  
critical value (0.05, 18) 🡪1.717; do not reject h0; (P > 0.1)**

**(x1-x2) -+ t α/2 \*  => -1.11 – 5.11  
(20-18) – (1.717)\* = 2 – 1.717\*1.81 = -1.11  
(20-18) + (1.717)\* = 2 + 1.717\*1.81 = 5.11**

**70**. Nitrogen and Seagrass. The seagrass *Thalassia testudinum* is an integral part of the Texas coastal ecosystem. Essential to the growth of *T. testudinum* is ammonium. Researchers K. Lee and K.

Dunton of the Marine Science Institute of the University of Texas at Austin noticed that the seagrass beds in Corpus Christi Bay (CCB) were taller and thicker than those in Lower Laguna Madre (LLM). They compared the sediment ammonium concentrations in the two locations and published their findings in *Marine Ecology Progress Series* (Vol. 196, pp. 39–48). Following are the summary statistics on sediment ammonium concentrations, in micromoles, obtained by the researchers.

At the 1% significance level, is there sufficient evidence to conclude that the mean sediment ammonium concentration in CCB exceeds that in LLM?

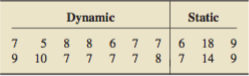
H0 : ; Ha :

**t =7.97**

**Right-tailed test, α = 0.01**   
**df = = = 54.5🡪 54  
critical value (0.01, 54) 🡪2.397; reject h0 ; (P > 0.01)**

**At 1% there is enough evidence to conclude that the mean sediment ammonium concentration in CCB exceeds that in LLM.**

**71**. Acute Postoperative Days. Refer to Example 10.6 on page 454. The researchers also obtained the following data on the number of acute postoperative days in the hospital using the dynamic and static systems.



At the 5% significance level, do the data provide sufficient evidence to conclude that the mean number of acute postoperative days in the hospital is smaller with the dynamic system than with the static system? (Note: x ̄1 = 7.36, s1 = 1.22, x ̄2 = 10.50, and s2 = 4.59.)

H0 : ; Ha :

**t =-1.65**

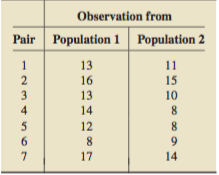
**Left-tailed test, α = 0.05**   
**df = = = 5.5🡪 5  
critical value (0.05, 5) 🡪-2.015; do not reject h0 ; (0.05< P < 0.01)**

**At 5% significance level, the data does not provide enough sufficient evidence that the mean number of acute postoperative days in the hospital is smaller with the dynamic system than with the static system.**

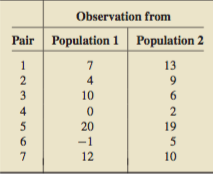
**Section 5**

In each of Exercises 10.135–10.140, the null hypothesis is H0: μ1 = μ2 and the alternative hypothesis is as specified. We have provided data from a simple random paired sample from the two populations under consideration. In each case, use the paired t-test to perform the required hypothesis test at the 10% significance level.

**135**. *H*a: μ1 ̸= μ2

**d = =   
sd = = = 2.19  
d  = 1 – 2  = 0t = = = 3.07  
df= n-1 = 6; two-tailed (0.1 🡪 0.05)  
critical value 🡪 -+1.943; reject h0    
(0.025 < P < 0.05)**

**136**. *H*a: μ1 < μ2

**d =** **= = -1.71  
sd = = = 4.11**

**d  = 1 – 2  = 0**

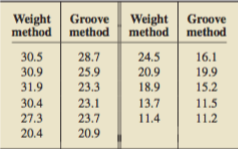
**t = = = -1.10**

**df= n-1 = 6; LEFT-tailed (0.1)  
critical value 🡪 -1.440; do not reject h0    
(P<0.1)**

Preliminary data analyses indicate that use of a paired t-test is reasonable in Exercises 10.141–10.146. Perform each hypothesis test by using either the critical-value approach or the P-value approach.

**144.** Measuring Treadwear. R. Stichler et al. compared two methods of measuring treadwear in their paper “Measurement of Treadwear of Commercial Tires” (Rubber Age, Vol. 73:2). Eleven tires were each measured for treadwear by two methods, one based on weight and the other on groove wear. The following are the data, in thousands of miles.

At the 5% significance level, do the data provide sufficient evidence to conclude that, on average, the two measurement methods give different results?

H0: μ1 = μ2  
Ha: μ1 ̸= μ2  
**d = = = 3.75  
sd = = = = 3.3  
t = = = 3.79  
df= n-1 = 10; two-tailed (0.05 🡪 0.025)   
critical value (10, 0.025) 🡪 -+2.228; reject h0**

**At the 5% significance level, the is enough evidence to conclude that on average two measurement methods give different results.**