In Example 1, if we interchange the two sets of sample values and consider the pulse rates of females to be the first sample, then $R = 152.5$, $\mu_R = 132$, $\sigma_R = 16.248$, and $z = 1.26$, so the conclusion is exactly the same.

Example 2 Departure Delay Times

Table 13-1 from the Chapter Problem lists departure delay times (min) for samples from American Airlines Flights 19 and 21. In the Chapter Problem we noted that the parametric t test (Section 9-4) should not be used because the sample data violate this requirement: "The two sample sizes are both large (with $n_1 > 30$ and $n_2 > 30$) or both samples come from populations having normal distributions." Instead of using the t test, we can use the Wilcoxon rank-sum test. The accompanying STATDISK display results from the data in Table 13-1. We can see that the test statistic is $z = -1.44$ (rounded). The test statistic does not fall in the critical region bounded by the critical values of -1.96 and 1.96, so we fail to reject the null hypothesis of equal medians. Using the samples in Table 13-1, we do not have enough evidence to conclude that departure delay times for Flight 19 have a median different from the median of departure delay times for Flight 21.

STATDISK

```
Total Num Values: 24
Rank Sum 1:    125.0000
Rank Sum 2:    175.0000

Mean, μ:       150
St Dev:        17.32051
Test Statistic, z: -1.4434
Critical z:    ±1.959962

Fail to Reject the Null Hypothesis.
Data do not provide enough evidence to indicate that
the samples come from populations with different medians.
```

using TECHNOLOGY

STATDISK Enter the sample data in columns of the Statdisk data window. Select **Analysis** from the main menu bar, then select **Wilcoxon Tests,** followed by the option **Wilcoxon (Indep. Samples).** Select the columns of data, then click on **Evaluate** to get a display that includes the rank sums, sample size, test statistic, critical value, and conclusion. See the STATDISK display given with Example 2.

MINITAB First enter the two sets of sample data in columns C1 and C2. Then select the options **Stat, Nonparametrics,** and **Mann-Whitney,** and enter C1 for the first sample and C2 for the second sample. The confidence level of 95.0 corresponds to a significance level of $\alpha = 0.05$, and the "alternate: not equal" box refers to the alternative hypothesis, where "not equal" corresponds to a two-tailed hypothesis test. Minitab provides the P-value and conclusion.

EXCEL Excel is not programmed for the Wilcoxon rank-sum test, but XLSTAT can be used by selecting **Nonparametric tests,** then **Comparison of two samples.** Use the Mann-Whitney test, which is equivalent to the Wilcoxon rank-sum test.

TI-83/84 PLUS The TI-83/84 Plus calculator is not programmed for the Wilcoxon rank-sum test, but the program RSTEST can be used. The program RSTEST (by Michael Lloyd) can be downloaded from the CD-ROM included with this book or the web site www.addisonwesley.com/triola. First download and install the program. (Also download the program ZZRANK, which is used by the program RSTEST.) Next, enter the two sets of sample data as lists in L1 and L2. Press PRGM and select **RSTEST.** Press ENTER ENTER. When given the prompt of GROUP A = , enter **L1** and press ENTER. When given the prompt of GROUP B = , enter **L2** and press ENTER. The second rank sum will be displayed as the value of R. The mean and standard deviation based on that value of R will also be displayed. Press ENTER once again to get the z score based on the second rank sum.

STATCRUNCH Click on **Open StatCrunch.** First enter two columns of data or open a data set. Click on **Stat,** select **Nonparametrics,** then select **Mann-Whitney.** Identify the columns to be used, click on **Next** and enter the value of the claimed difference. Click on **Calculate** and the display will include the P-value.