now deviations, the *t* test for equality of means is actually a test comparing variation in the two samples. See Exercise 20.

In addition to the count five test and the Levene-Brown-Forsythe test, there are other alternatives to the *F* test, as well as adjustments that improve the performance of the *F* test. See "Fixing the *F* Test for Equal Variances," by Shoemaker, *American Statistician,* Vol. 57, No. 2.

using TECHNOLOGY

STATDISK Select **Analysis** from the main menu, then select either **Hypothesis Testing** or **Confidence Intervals,** then **StDev-Two Samples.** Enter the required items in the dialog box and click on the **Evaluate** button.

MINITAB Either obtain the summary statistics for both samples or enter the individual sample values in two columns. Select **Stat,** then **Basic Statistics,** then **2 Variances.**

In **Minitab 15** or earlier, a dialog box will appear. Either select the option of "Samples in different columns" and enter the column names or select "Summarized data" and enter the summary statistics. Click on the **Options** button and enter the confidence level. (Enter 0.95 for a hypothesis test with a 0.05 significance level.) Click **OK,** then click **OK** in the main dialog box. Minitab will return a *P*-value for a two-tailed test, so halve it for a one-tailed test.

In **Minitab 16,** a dialog box will appear: Either select the option of "Samples in different columns" and enter the column names or select "Sample standard deviations" or "Sample variances" and enter the summary statistics. Click on the **Options** button and enter the confidence level (enter 0.95 for a hypothesis test with a 0.05 significance level) and select the format of the alternative hypothesis. Click **OK,** then click **OK** in the main dialog box. Minitab will provide the *P*-value.

In **Minitab 16** you can also click on **Assistant,** then select **Hypothesis Tests,** then select the case for **2-Sample Standard Deviation.** Fill in the dialog box, then click **OK** to get three windows of results that include the *P*-value and much other helpful information.

EXCEL Excel requires entry of the original lists of sample data, so enter the data from the first sample in the first column A, then enter the values of the second sample in column B. Proceed to use either XLSTAT or Excel's Data Analysis add-in.

XLSTAT: Click on **XLSTAT** at the top. Click on **Parametric tests,** then select **Two sample comparison of variances.** In the dialog box that appears, enter the range of values for the first sample (such as A1:A13) and enter the range of values for the second sample. For "Data format," select the option of **One column per sample.** For the "Column labels" box, include a checkmark only if the first row of the sample data consists of names or labels. Put a checkmark next to **Fisher's F test.** Click on the **Options** tab and select the type of test. For a two-tailed test, select the case including the symbol $\neq$; for a left-tailed test, select the case including $<$; and for a right-tailed test, select the case including $>$. Enter a value in the "Significance level (%)" box. For example, enter 5 for a 0.05 significance level. Click **OK** to get results that include the test statistic and *P*-value.

Data Analysis Add-in: If using Excel 2013, 2010, or 2007, click on **Data,** then **Data Analysis;** if using Excel 2003, click on **Tools** and select **Data Analysis.** Now select **F-Test Two-Sample for Variances.** In the dialog box, enter the range of values for the first sample (such as A1:A40) and the range of values for the second sample. Enter the value of the significance level in the "Alpha" box. Excel will provide the *F* test statistic, the *P*-value for the one-tailed case, and the critical *F* value for the one-tailed case. For a two-tailed test, make two adjustments: (1) Enter the value that is half of the significance level, and (2) double the *P*-value given by Excel.

TI-83/84 PLUS Press the STAT key, then select **TESTS,** then **2-SampFTEST.** For the Inpt (input) line, you can select **Data** if the data are entered in two lists, or you can select **Stats** if you know the summary statistics.

STATCRUNCH Click on **Open StatCrunch.** Click on **Stat,** then select **Variance.** Select **Two sample,** then select **with data** (for a list of sample data) or **with summary** (for using known summary statistics). Click on **Next,** then select **Hypothesis Test** or **Confidence Interval.** Make the required entries. Click on **Calculate.**

9-5 Basic Skills and Concepts

Statistical Literacy and Critical Thinking

1. *F* Test Statistic

a. If s_1^2 represents the larger of two sample variances, can the *F* test statistic ever be less than 1?

b. Can the *F* test statistic ever be a negative number?