then find the confidence interval as described in this section. For example, if we use the methods of this section with $x = 10$ and $n = 20$, we get this 95% confidence interval: $0.281 < p < 0.719$. With $x = 10$ and $n = 20$ we use the adjusted Wald confidence interval by letting $x = 12$ and $n = 24$ to get this confidence interval: $0.300 < p < 0.700$. The chance that the confidence interval $0.300 < p < 0.700$ contains p is closer to 95% than the chance that $0.281 < p < 0.719$ contains p.

Wilson Score CI Another confidence interval that performs better than the one described in this section and the adjusted Wald confidence interval is the *Wilson score confidence interval:*

$$\frac{\hat{p} + \dfrac{z_{\alpha/2}^2}{2n} \pm z_{\alpha/2}\sqrt{\dfrac{\hat{p}\hat{q} + \dfrac{z_{\alpha/2}^2}{4n}}{n}}}{1 + \dfrac{z_{\alpha/2}^2}{n}}$$

It is easy to see why this approach is not used much in introductory courses. The complexity of the above expression can be overcome by using some technologies, such as STATDISK, that provide Wilson score confidence interval results. Using $x = 10$ and $n = 20$, the 95% Wilson score confidence interval is $0.299 < p < 0.701$.

For a discussion of these and other confidence intervals for p, see "Approximation Is Better than 'Exact' for Interval Estimation of Binomial Proportions," by Agresti and Coull, *American Statistician,* Vol. 52, No. 2.

using TECHNOLOGY

Confidence Intervals

STATDISK Select **Analysis,** then **Confidence Intervals,** then **Proportion One Sample,** and proceed to enter the requested items. The confidence interval will be displayed, as in the STATDISK results included with Example 3.

MINITAB Select **Stat, Basic Statistics,** then **1 Proportion.** In the dialog box, click on the button for **Summarized Data.** Also click on the **Options** button, and enter the desired confidence level (the default is 95%). Instead of using a normal approximation, Minitab's default procedure is to determine the confidence interval limits by using an exact method. To use the normal approximation method presented in this section, click on the **Options** button and then click on the box with this statement: "Use test and interval based on normal distribution."

EXCEL Use XLSTAT. Click on **XLSTAT** at the top, click on **Parametric Tests,** then select **Tests for one proportion.** Start in the lower left corner of the dialog box by selecting **Frequency** (if you know the number of successes x) or **Proportion** (if you know the sample proportion $\hat{p}$). Enter the frequency (number of successes) or the sample proportion, enter the sample size in the "Sample size" box, and enter 0.5 in the **Test Proportion** box. Be sure that the box next to "z test" is checked. For the "Range" box, enter A1 so that the results will start at cell A1. Click on the **Options** tab, to enter the desired "Significance level (%)." Enter 5 for a 95% confidence interval. For the "Variance (confidence interval)" options, select **Sample** (so that the sample proportion is used in the computation of the confidence interval). There are four options for the type of confidence interval; accept the default of **Wald.** Click **OK.** After the results are displayed, look for "confidence interval on the proportion (Wald)."

TI-83/84 PLUS Press STAT, select **TESTS,** then select **1-PropZInt** and enter the required items. The accompanying display shows the result for Example 3. Like many technologies, the TI-83/84 Plus calculator requires entry of the number of successes, so 856 (which is 85% of the 1007 people polled) was entered for the value of x. Also like many technologies, the confidence interval limits are expressed in the format shown on the second line of the display.

TI-83/84 PLUS