In Example 4, the sign test of the claim that the median is below 98.6°F results in a test statistic of $z = -4.61$ and a P-value of 0.00000202. However, a parametric test of the claim that $\mu < 98.6$°F results in a test statistic of $t = -6.611$ with a P-value of 0.000000000813. Because the P-value from the sign test is not as low as the P-value from the parametric test, we see that the sign test isn't as sensitive as the parametric test. Both tests lead to rejection of the null hypothesis, but the sign test doesn't consider the sample data to be as extreme, partly because the sign test uses only information about the *direction* of the data, ignoring the *magnitudes* of the data values. The next section introduces the Wilcoxon signed-ranks test, which largely overcomes that disadvantage.

Rationale for the Test Statistic Used When $n > 25$ When finding critical values for the sign test, we use Table A-7 only for n up to 25. When $n > 25$, the test statistic z is based on a normal approximation to the binomial probability distribution with $p = q = 1/2$. In Section 6-7 we saw that the normal approximation to the binomial distribution is acceptable when both $np \geq 5$ and $nq \geq 5$. In Section 5-4 we saw that $\mu = np$ and $\sigma = \sqrt{npq}$ for binomial probability distributions. Because this sign test assumes that $p = q = 1/2$, we meet the $np \geq 5$ and $nq \geq 5$ prerequisites whenever $n \geq 10$. Also, with the assumption that $p = q = 1/2$, we get $\mu = np = n/2$ and $\sigma = \sqrt{npq} = \sqrt{n/4} = \sqrt{n}/2$, so the standard z score

$$z = \frac{x - \mu}{\sigma}$$

becomes

$$z = \frac{x - \left(\dfrac{n}{2}\right)}{\dfrac{\sqrt{n}}{2}}$$

We replace x by $x + 0.5$ as a correction for continuity. That is, the values of x are discrete, but since we are using a continuous probability distribution, a discrete value such as 10 is actually represented by the interval from 9.5 to 10.5. Because x represents the less frequent sign, we act conservatively by concerning ourselves only with $x + 0.5$; we get the test statistic z, as given in Figure 13-1.

using TECHNOLOGY

STATDISK Select **Analysis** from the main menu bar, then select **Sign Test.** Select the option **Given Number of Signs** if you know the number of positive and negative signs, or select **Given Pairs of Values** if paired data are in the data window. After making the required entries in the dialog box, the displayed results will include the test statistic, critical value, and conclusion.

MINITAB You must first create a single column of values. For matched pairs, enter a column consisting of the differences. For nominal data in two categories (such as boy/girl), enter a positive sign for each value of one category and enter a negative sign for each value of the other category; use 0 for the claimed value of the median. For a list of individual values to be tested with a claimed median, enter the sample values in a single column.

Select **Stat,** then **Nonparametrics,** then **1-Sample Sign.** Click on the button for **Test Median.** Enter the median value and select the type of test, then click **OK.** Minitab will provide the P-value, so reject the null hypothesis if the P-value is less than or equal to the significance level. Otherwise, fail to reject the null hypothesis.

EXCEL Excel does not have a built-in function dedicated to the sign test, but you can use Excel's BINOMDIST function to find the P-value for a sign test. Click ***fx*** on the main menu bar, then select the function category **Statistical** and then **BINOMDIST.** (In Excel 2013 or 2010, select **BINOM.DIST.**) In the dialog box, first enter x, then the number of trials n, and then a probability of 0.5. Enter **TRUE** in the box for "cumulative." The resulting

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