Wilcoxon Signed-Ranks Procedure To see how the following steps are applied, refer to the sample of matched pairs listed in the first two rows of Table 13-4.

Step 1: For each pair of data, find the difference d by subtracting the second value from the first value. Discard any pairs that have a difference of 0.

EXAMPLE: The third row of Table 13-4 lists the differences found by subtracting the taxi-in times from the taxi-out times, and the difference of 0 will be ignored in the following steps.

Step 2: *Ignore the signs of the differences,* then sort the differences from lowest to highest and replace the differences by the corresponding rank value (as described in Section 13-1). When differences have the same numerical value, assign to them the mean of the ranks involved in the tie.

EXAMPLE: The fourth row of Table 13-4 shows the ranks of the values of $|d|$. Ignoring the difference of 0, the smallest value of $|d|$ is 4, so it is assigned the rank of 1. The next smallest value of $|d|$ is 5, so it is assigned a rank of 2. There are two $|d|$ values of 6, so we find the mean of the ranks of 3 and 4, which is 3.5. Each of the $|d|$ values of 6 is assigned a rank of 3.5. The next $|d|$ value is 11, and it is assigned a rank of 5, and so on.

Step 3: Attach to each rank the sign of the difference from which it came. That is, insert the signs that were ignored in Step 2.

EXAMPLE: The bottom row of Table 13-4 lists the same ranks found in the fourth row, but the signs of the differences shown in the third row are inserted.

Step 4: Find the sum of the ranks that are positive. Also find the absolute value of the sum of the negative ranks.

EXAMPLE: The bottom row of Table 13-4 lists the signed ranks. The sum of the positive ranks is $7 + 3.5 + 3.5 + 6 + 9 + 10 + 11 + 5 = 55$. The sum of the negative ranks is $(-1) + (-2) + (-8) = -11$, and the absolute value of this sum is 11. The two rank sums are 55 and 11.

Step 5: Let T be the *smaller* of the two sums found in Step 4. Either sum could be used, but for a simplified procedure we arbitrarily select the smaller of the two sums.

EXAMPLE: The data in Table 13-4 result in the rank sums of 55 and 11, so 11 is the smaller of those two sums.

Step 6: Let n be the number of pairs of data for which the difference d is not 0.

EXAMPLE: The data in Table 13-4 have 11 differences that are not 0, so $n = 11$.

Step 7: Determine the test statistic and critical values based on the sample size, as shown in the preceding box.

EXAMPLE: For the data in Table 13-4 the test statistic is $T = 11$. The sample size is $n = 11$, so the critical value is found in Table A-8. Using a 0.05 significance level with a two-tailed test, the critical value from Table A-8 is 11.

Step 8: When forming the conclusion, reject the null hypothesis if the sample data lead to a test statistic that is in the critical region—that is, the test statistic is less than or equal to the critical value(s). Otherwise, fail to reject the null hypothesis.