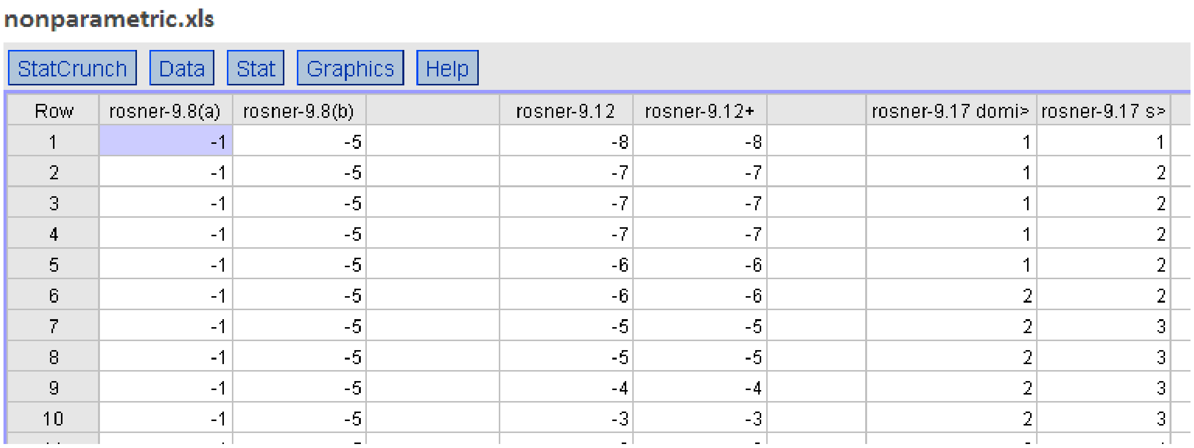
StatCrunch and Nonparametric Statistics

You can use StatCrunch to calculate the values of nonparametric statistics. It may not be obvious how to enter the data in StatCrunch for various data sets that require the use of nonparametric statistics. This document and the spreadsheet NONPARAMETRIC.XLS use data from several examples in chapter 9 of Rosner. Hopefully, it will help you when you try some of the problems assigned from chapter 9. Note, you can only use StatCrunch when you have all the data. Problems 9.4 through 9.6 give you summary values, not real data, so you cannot use StatCrunch to get answers to those problems (if you figure out some way to do it, let us know !!!).

If you load the data in NONPARAMETRIC.XLS, you should see the data shown below. You probably will not see the full names for the columns involved with example 9.17 unless you change the column widths (just drag to the right the bar to the right of each column).


nonparametric.xls

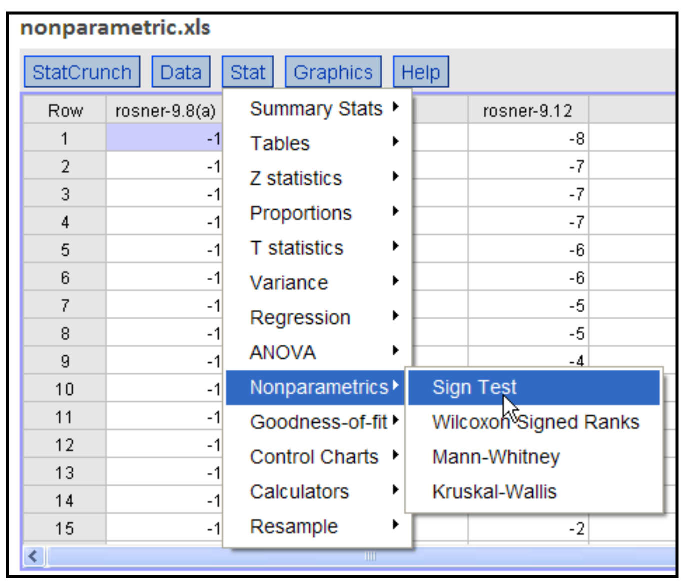
StatCrunch | Data | Stat | Graphics | Help

Row	rosner-9.8(a)	rosner-9.8(b)		rosner-9.12	rosner-9.12+		rosner-9.17 domi>	rosner-9.17 s>
1	-1	-5		-8	-8		1	1
2	-1	-5		-7	-7		1	2
3	-1	-5		-7	-7		1	2
4	-1	-5		-7	-7		1	2
5	-1	-5		-6	-6		1	2
6	-1	-5		-6	-6		2	2
7	-1	-5		-5	-5		2	3
8	-1	-5		-5	-5		2	3
9	-1	-5		-4	-4		2	3
10	-1	-5		-3	-3		2	3

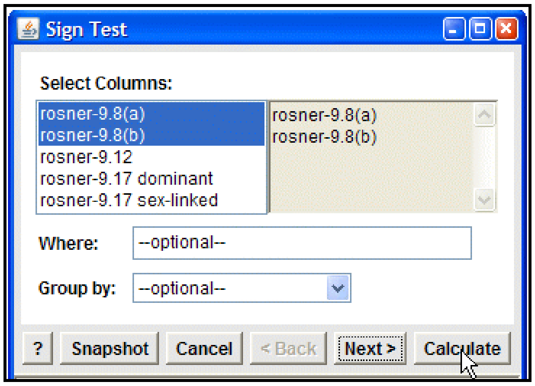
Example 9.8

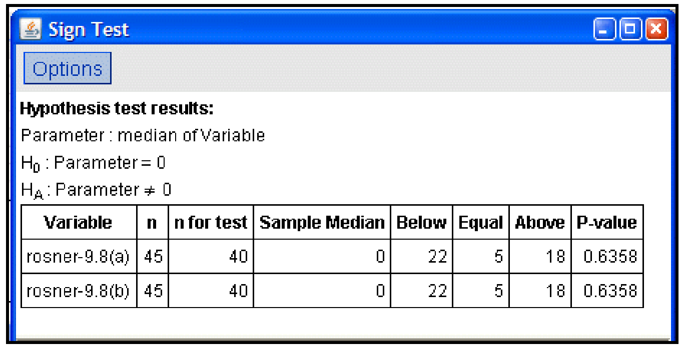
The data used in example 9.8 is described in example 9.7 (Dermatology). Two columns of data are provided in the spreadsheet to show you that the magnitude of the numbers does not matter when using the Sign Test. Only the signs (negative, zero, positive) matter (thus, the Sign Test). The data described in example 9.7 require that you enter the following in a column in StatCrunch: 22 negative numbers (arm A not as red as arm B); five zeros, no difference between arm A and arm B; 18 positive numbers (arm B not as red as arm A). The magnitude of the negative and positive numbers does not matter, just the sign.

After loading the data into the spreadsheet, choose STAT/NONPARAMETRICS/SIGN TEST (as shown on the right).



Then click on the names of the first two columns. After those names appear in the gray window on the right, click on CALCULATE. You should see a box that shows the same p-value as computed in Rosner for both columns of data from the spreadsheet. Only the signs mattered, not the magnitude of the numbers.

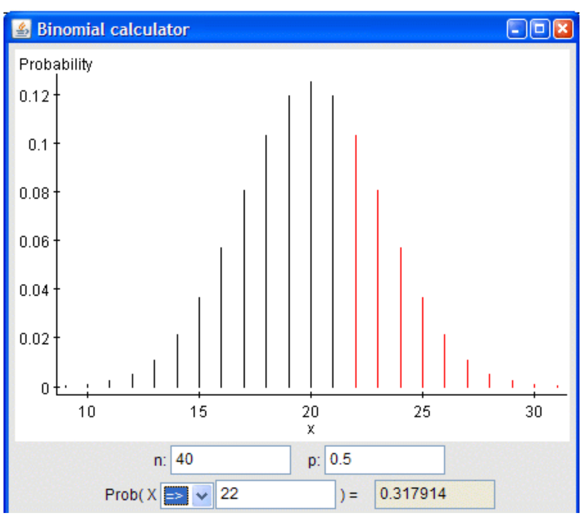


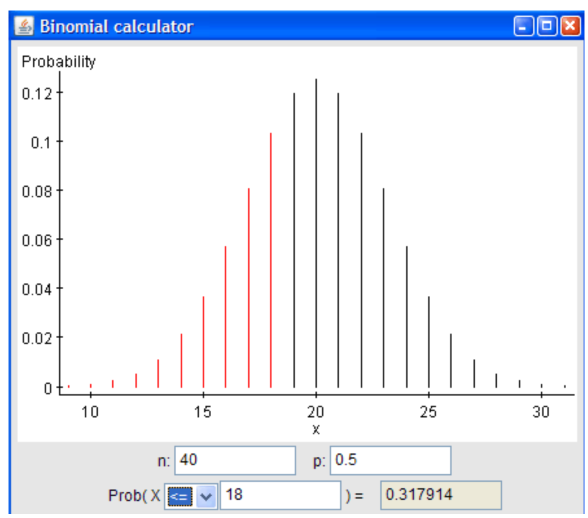


NOTE: Rosner states that when N < 20 , you should use an exact method. Actually, you can use the exact method any time since the Sign Test is really just a binomial test with P=0.50. Look at equation 9.3, page 365. In that box, you see three situations: C > n/2; C < n/2; C = n/2. First, n=40, the number of untied pairs. The value of C from example 9.8 (the one just used for the Sign Test) is either 18 or 22, you have a choice as to what to use: arm A not as red as arm B, C=22; arm B not as red as arm A, C=18. We can try both (we have a computer !!!).

The output on the left represents C=22, or C > n/2 (22 > 20). Based on equation 9.3, calculate the probability that C is 22 or more and then multiply it by 2. The probability shown is 0.3179 and if you multiply that by 2, you get P=0.6358, the SAME p-value as found in the Sign Test.

The output on the right represents C=18, or C < n/2 (18 < 20). Based on equation 9.3, calculate the probability that C is 18 or less and then multiply it by 2. The probability shown is 0.3179 and if you multiply that by 2, you get P=0.6358, the SAME p-value as found in the Sign Test.

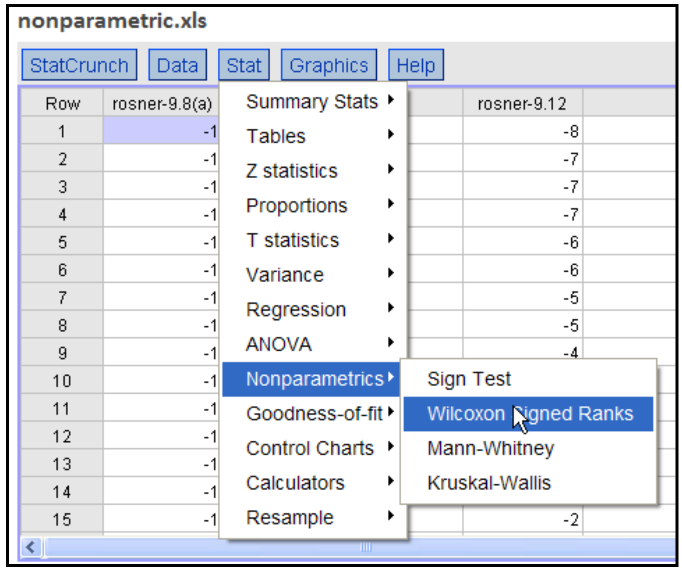




CONCLUSION: You never really have to do the Sign Test if you understand that all you are doing is using a binomial distribution with P=0.50, plus what to do when C < n/2 and C > n/2. If C = n/2, you don't have to do any test since in that situation the p-value is ALWAYS 1.

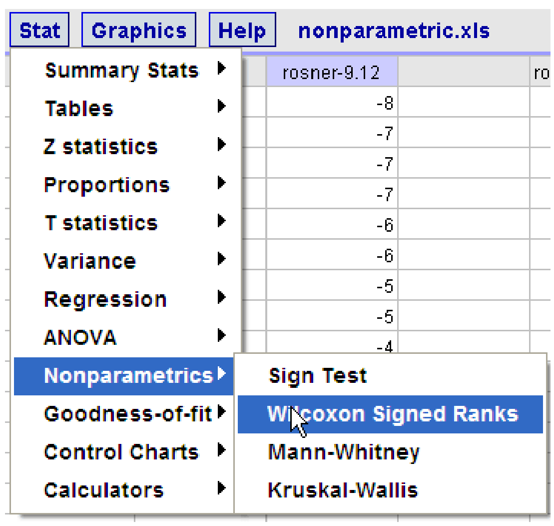
Example 9.12

The data for example 9.12 are in table 9.1 in Rosner and in the fourth column of the spreadsheet. Now, both the signs and values are important. The values in the spreadsheet show how many times a given value occurs in the data in table 9.1. Ignore the first column in table 9.1 (labeled |d|) and look at the next four columns. In column 2, find -8 and to the right of that you see a 1. That indicates that there is one occurrence of -8. If you follow that logic, you can see that there are three occurrences of -7, two occurrences of -6, ... , six occurrences of 2,and ending with ten occurrences of 1. Below are the data from table 9.1 rearranged so it can be used to enter data in StatCrunch (already done for you in column "rosner-9.12" in spreadsheet NONPARAMETRIC.XLS). If you look at column "rosner-9.12" in StatCrunch, you will see that it has 40 values (the sum of the "occurrences" row in the table).

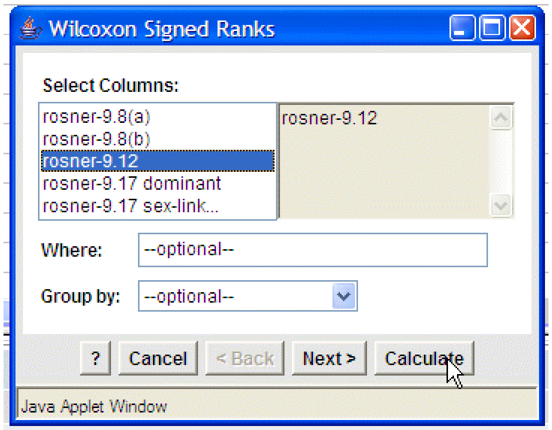


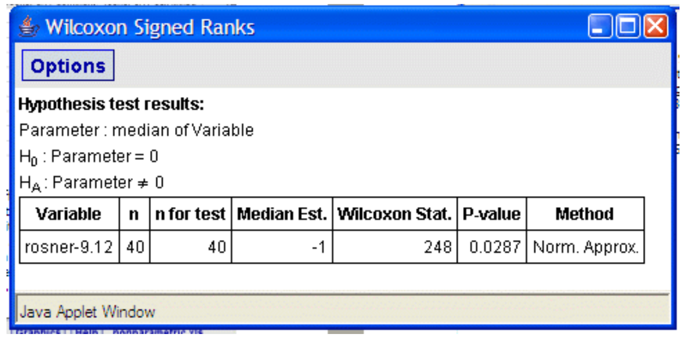
Value	-8	-7	-6	-5	-4	-3	-2	-1	3	2	1
Occurrences	1	3	2	2	1	5	4	4	2	6	10

Choose STAT/NONPARAMETRICS/WILCOXON SIGNED RANKS (as shown on the right).



Then click on "rosner-9.12". After that name appears in the gray window on the right, click on CALCULATE. You should see a box that shows the same p-value as computed in Rosner (the value in Rosner is rounded to .029).





NOTE: As pointed out in Rosner on the top of page 371, the conclusion you would reach from using the Signed-Ranks Test differs from that with the Sign-Test. Why might that occur? The Sign Test has LESS POWER than the Signed-Ranks Test, meaning that you have more of a chance of making a TYPE II error, not rejecting a false null hypothesis. With the Sign Test, since the p-value is > 0.05 (by quite a bit), the null was not rejected (no difference found between arm A and arm B). With the Signed-Ranks Test, since the p-value is < 0.05, the null is rejected (there is a difference between arm A and arm B).

Here is an excerpt from a table found in another biostatistics book (Triola).

Application	Parametric Test	Nonparametric Test	Efficiency Rating of Nonparametric versus Parametric
Matched Pairs	t test or z test	Sign Test	0.63
		Signed-Ranks	0.95
Two Independent Samples	t test or z test	Rank-Sum	0.95

The efficiency column is best explained by example. So, if you were analyzing data with a Sign Test, you would require 100 observations to achieve the same result as only 65 if you were using a parametric test. Remember that N (sample size) is directly related to power, the larger the N, the higher the power. So, you can also interpret the efficiency column has an indirect estimate of power. This helps to explain why no difference was found between arm A and arm B with the Sign Test (efficiency = 0.63) while a difference was found with the Signed-Ranks Test (efficiency = 0.95).

To complete the discussion ... the Signed-Ranks is a nonparametric verison of the paired-t test. What would the results be if you just treated the data in column "rosner-9.12" as you did the data in table 8.1 in Rosner, page 298. In that table, there is a column of differences between SBP readings on 10 women before and after using oral contraceptives (OC). The data in the last column, the differences, are used in a paired t-test is used to test the hypothesis of no difference before and after OC.

In the table NONPARAMETRIC.XLS, there is a column labeled "rosner-9.12+" and if you scroll to the bottom of that column, you will notice that there are five additional rows filled with zeroes. Remember, you do not leave out the zero differences when you perform a paired-t test.

One sample T statistics with data

Options

Hypothesis test results:

μ : mean of Variable

$H_0 : \mu = 0$

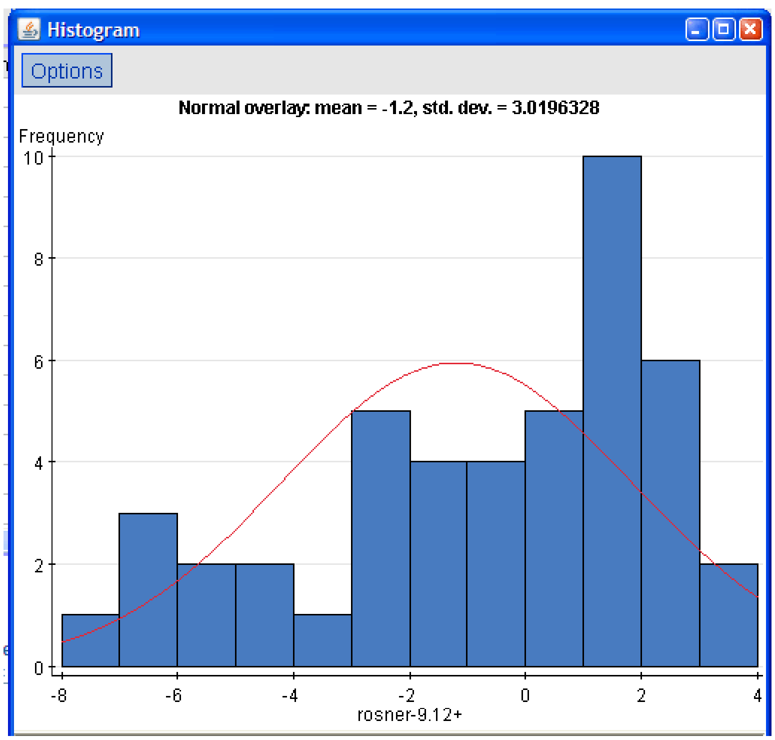
$H_A : \mu \neq 0$

Variable	Sample Mean	Std. Err.	DF	T-Stat	P-value
rosner-9.12+	-1.2	0.45014027	44	-2.6658356	0.0107

A paired t-test is used to test the hypothesis of no difference with results shown on the right. Notice that there are 44 degrees of freedom since we used all 45 people involved in the study. We did not remove the 5 with no difference between arm A and arm B as was done for BOTH the Sign Test and the Signed-Ranks Test.

So, if you could assume that the differences are distributed normally, a paired-t test is appropriate. The conclusion would be to reject the null hypothesis of no difference (arm A is different from arm B), the p-value is < 0.05. This result matches that found with the Signed-Ranks Test, not the one found with the Sign Test.

How could you check to see if you could assume that the differences are distributed normally ... you could create a histogram, shown on the right. Looking at the shape of the distribution and the plot of a normal curve overlayed on the bars, it appears skewed, not normal. You are better of not making the assumption of normally distributed differences and using the Signed-Ranks Test, not a paired-t test.



Example 9.17
The data for example 9.17 are in table 9.3 in Rosner. Example 9.17 refers to the Wilcoxon Rank-Sum Test. However, if you look at table 9.4 and the text that is just above it, you can see that this test is also called the Mann-Whitney Test. Look at table 9.3 and the data in the spreadsheet. You can see that there are no values for the level of visual acuity (column 1 in table 9.3). The only data you need from this table are in the columns labeled "Dominant" and Sex-Linked".

To use StatCrunch with these data all you have to do is ...

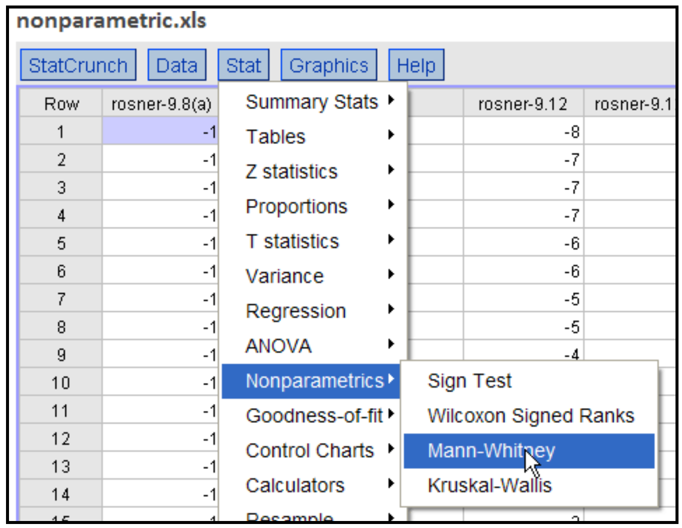
#1 count the number of groups ... there are eight different visual acuity groups, so the data you enter in StatCrunch will be numbers ranging from 1 to 8

#2 look at the "Dominant" column and you can see that there are 5 people in group 1 (acuity 20-20), 9 people in group 2 (acuity 20-25), 6 people in group 3 (acuity 20-30), ... , 0 people in group 8 (acuity 20-80)

so, in StatCrunch, in column "rosner-9.17 dominant" you see five 1s, nine 2s, six 3s, etc.

#3 the same logic from part#2 is used to create the "rosner-9.17 sex-linked column

Choose STAT/NONPARAMETRICS/MANN-WHITNEY (the other name for the Rank-Sum Test).



Then select "rosner-9.17 dominant" and "rosner-9.17 sex-linked" from the drop-down menus. After that selection, click on CALCULATE. You should see a box that shows the same p-value as computed in Rosner in table 9.4. The value of the test statistic is 479, identical to that shown in Rosner on page 375. The p-value is 0.0002 (Rosner just says that < .001).