Spearman's Rank Correlation Coefficient

http://geographyfieldwork.com/SpearmansRank.htm

The Spearman's Rank Correlation Coefficient is used to discover the strength of a link between two sets of data. This example looks at the strength of the link between the price of a convenience item (a 50cl bottle of water) and distance from the Contemporary Art Museum in El Raval, Barcelona.

Example: The hypothesis tested is that prices should decrease with distance from the key area of gentrification surrounding the Contemporary Art Museum. The line followed is Transect 2 in the map below, with continuous sampling of the price of a 50cl bottle water at every convenience store.

Map to show the location of environmental gradients for transect lines in El Raval, Barcelona

Hypothesis

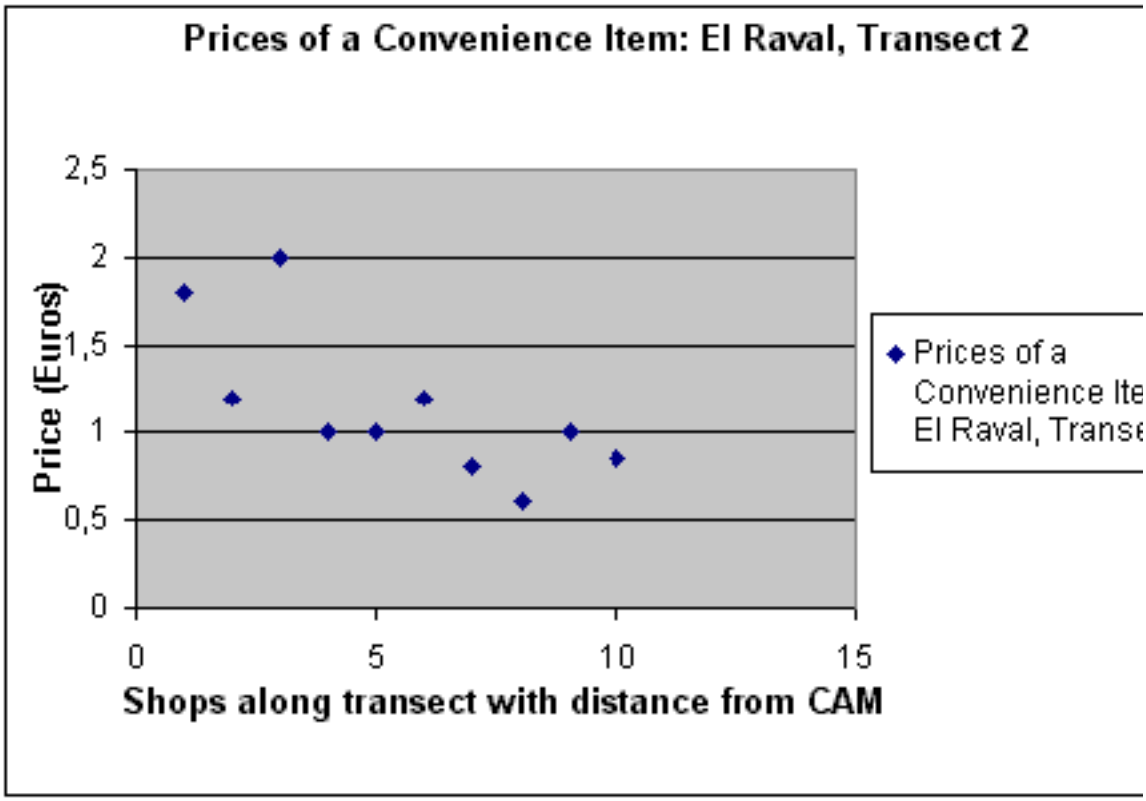
We might expect to find that the price of a bottle of water decreases as distance from the Contemporary Art Museum increases. Higher property rents close to the museum should be reflected in higher prices in the shops.

The hypothesis might be written like this:

The price of a convenience item decreases as distance from the Contemporary Art Museum increases.

The more objective scientific research method is always to assume that no such price-distance relationship exists and to express the **null hypothesis** as:
there is no significant relationship between the price of a convenience item and distance from the Contemporary Art Museum.

Data collected (see data table below) suggests a fairly strong negative relationship as shown in this scatter graph:



Scatter graph to show the change in the price of a convenience item with distance from the Contemporary Art Museum.

The scatter graph shows the possibility of a negative correlation between the two variables and the Spearman's rank correlation technique should be used to see if there is indeed a correlation, and to test the strength of the relationship.

Spearman's Rank correlation coefficient

A correlation can easily be drawn as a scatter graph, but the most precise way to compare several **pairs of data** is to use a statistical test - this establishes whether the correlation is really significant or if it could have been the result of chance alone.

Spearman's Rank correlation coefficient is a technique which can be used to summarize the strength and direction (negative or positive) of a relationship between two variables. (In the case of the Spearman's Rank coefficient, we rank the data in order to calculate the coefficient. There are other types of correlation coefficients, such as the Pearson correlation coefficient, in which the data are not ranked.)

Calculating the coefficient

Calculate the coefficient (***R***) using the method below:

- Create a table from your data.
- Rank the two data sets. Ranking is achieved by giving the ranking '1' to the biggest number in a column, '2' to the second biggest value and so on.

- Find the difference in the ranks (d). To do this, the rank of the second value *(price)* is subtracted from the rank of the first *(distance from the museum)*.
- Square the differences (d^2).

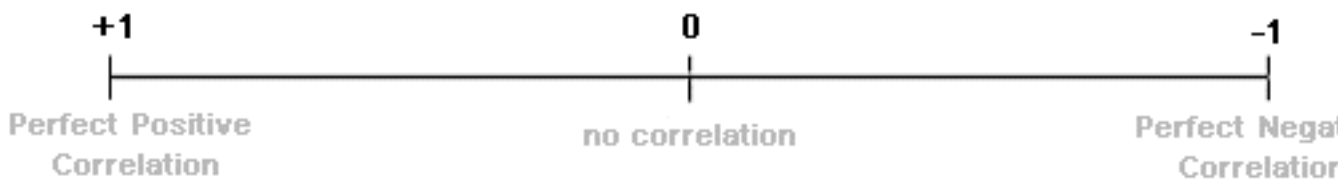
onvenience Store	Distance from CAM (m)	Rank distance	Price of 50cl bottle (€)	Rank price	Difference between ranks (d)	d^2
a	50	10	1.80	2	8	64
b	175	9	1.20	3.5	5.5	30.25
c	270	8	2.00	1	7	49
d	375	7	1.00	6	1	1
e	425	6	1.00	6	0	0
f	580	5	1.20	3.5	1.5	2.25
g	710	4	0.80	9	-5	25
h	790	3	0.60	10	-7	49
i	890	2	1.00	6	-4	16
0 j	980	1	0.85	8	-7	49
						Σ d^2 = 285.5

When written in mathematical notation, the Spearman Rank formula looks like this:

$$(R) = 1 - \frac{6\sum d^2}{n^3 - n}$$

What does the resulting *R* value of -0.73 mean?

The answer will always be between 1.0 (a perfect positive correlation) and -1.0 (a perfect negative correlation). The closer ***R*** is to +1 or -1, the stronger the likely correlation. A perfect positive correlation is +1 and a perfect negative correlation is -1. The ***R*** value of -0.73 suggests a fairly strong negative relationship.

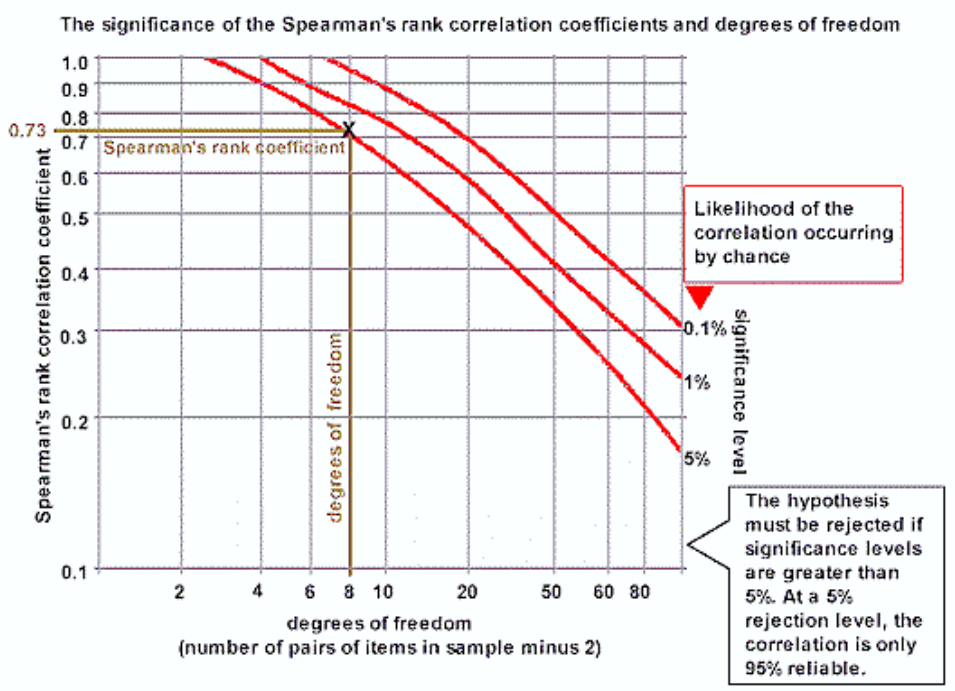


A further technique is now required to test the **significance** of the relationship.

The ***R*** value of **-0.73** must be looked up on the Spearman Rank significance table below as follows:

- Work out the 'degrees of freedom' you need to use. This is the number of pairs in your sample minus 2 (n-2). In the example it is 8 (10 - 2).
- Now plot your result on the table.
- If it is below the line marked 5%, then it is possible your result was the product of chance and you must reject the hypothesis.
- If it is above the 0.1% significance level, then we can be 99.9% confident the correlation has not occurred by chance.
- If it is above 1%, but below 0.1%, you can say you are 99% confident.
- If it is above 5%, but below 1%, you can say you are 95% confident (i.e. statistically there is a 5% likelihood the result occurred by chance).

In the example, the value 0.73 gives a significance level of slightly less than 5%. That means that the probability of the relationship you have found being a chance event is **about 5 in a 100**. You are 95% certain that your hypothesis is correct. The reliability of your sample can be stated in terms of how many researchers completing the same study as yours would obtain the same results: 95 out of 100.



Note that:

- The fact two variables correlate cannot prove anything - only further research can actually prove that one thing affects the other.
- Data reliability is related to the size of the sample. The more data you collect, the more reliable your result.