



Pearson Product-Moment Correlation

Pearson Product-Moment Correlation is one of the measures of correlation which quantifies the strength as well as direction of such relationship. It is usually denoted by Greek letter ρ .

In the study of relationships, two variables are said to be correlated [1] if change in one variable [2] is accompanied by change in the other - either in the same or reverse direction.

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Conditions

This coefficient is used if two conditions are satisfied

1. the variables are in the interval or ratio scale of measurement [3]
2. a linear relationship [4] between them is suspected

Positive and Negative Correlation

The coefficient (ρ) is computed as the ratio of covariance between the variables to the product of their standard deviations [5]. This formulation is advantageous.

First, it tells us the direction of relationship. Once the coefficient is computed, $\rho > 0$ will indicate positive relationship, $\rho < 0$ will indicate negative relationship while $\rho = 0$ indicates non existence of any relationship.

Second, it ensures (mathematically) that the numerical value of ρ range from -1.0 to +1.0. This enables us to get an idea of the strength of relationship - or rather the strength of linear relationship

[4] between the variables. Closer the coefficients are to +1.0 or -1.0, greater is the strength of the linear relationship.

As a rule of thumb, the following guidelines are often useful (though many experts could somewhat disagree on the choice of boundaries).

Range of ?

Value of ?	Strength of relationship
-1.0 to -0.5 or 1.0 to 0.5	Strong
-0.5 to -0.3 or 0.3 to 0.5	Moderate
-0.3 to -0.1 or 0.1 to 0.3	Weak
-0.1 to 0.1	None or very weak

Properties of ?

This measure of correlation has interesting properties, some of which are enunciated below:

1. It is independent of the units of measurement. It is in fact unit free. For example, ? between highest day temperature (in Centigrade) and rainfall per day (in mm) is not expressed either in terms of centigrade or mm.
2. It is symmetric. This means that ? between X and Y is exactly the same as ? between Y and X.
3. Pearson's correlation coefficient is independent of change in origin and scale. Thus ? between temperature (in Centigrade) and rainfall (in mm) would numerically be equal to ? between temperature (in Fahrenheit) and rainfall (in cm).
4. If the variables are independent of each other, then one would obtain ? = 0. However, the converse is not true. In other words ? = 0 does not imply that the variables are independent - it only indicates the non existence of a non-linear relationship [6].



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Caveats and Warnings

While ? is a powerful tool, it is a much abused one and hence has to be handled carefully.

1. People often tend to forget or gloss over the fact that r is a measure of linear relationship. Consequently a small value of r is often interpreted to mean non existence of relationship when actually it only indicates non existence of a linear relationship or at best a very weak linear relationship.

Under such circumstances it is possible that a non linear relationship exists.

A scatter diagram can reveal the same and one is well advised to observe the same before firmly concluding non existence of a relationship. If the scatter diagram points to a non linear relationship, an appropriate transformation can often attain linearity in which case r can be recomputed.

2. One has to be careful in interpreting the value of r .

For example, one could compute r between size of a shoe and intelligence of individuals, heights and income. Irrespective of the value of r , such a correlation makes no sense and is hence termed chance or non-sense correlation.

3. r should not be used to say anything about cause and effect relationship [8]. Put differently, by examining the value of r , we could conclude that variables X and Y are related.

However the same value of r does not tell us if X influences Y or the other way round - a fact that is of grave import in regression analysis [9].

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[1] <https://explorable.com/statistical-correlation>, [2] <https://explorable.com/research-variables>, [3] <https://explorable.com/measurement-scales>, [4] <https://explorable.com/linear-relationship>, [5] <https://explorable.com/calculate-standard-deviation>, [6] <https://explorable.com/non-linear-relationship>, [7] [#creativecommons](#), [8] <https://explorable.com/cause-and-effect>, [9] <https://explorable.com/linear-regression-analysis>, [10] <https://explorable.com/>, [11] <https://explorable.com/pearson-product-moment-correlation>