

What test should I select?

Normality of the population

There are basically two types of tests: *parametric* and *nonparametric*.

Parametric tests can be used if we can suppose that the population from which we take sample is normal. In practice it means that the histogram of the data has a shape similar to that on Fig. 1.

Nonparametric tests are used for data, where the normality cannot be assumed, their histogram can be like in Fig. 2 or Fig. 3.

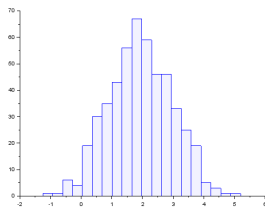


Fig. 1

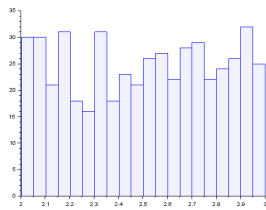


Fig. 2

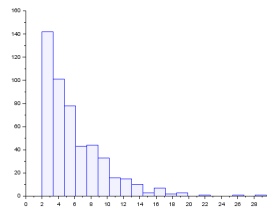


Fig. 3

Remark

If we have not so large data sample to produce histogram, we need to ask: do the data have one dominant frequency and do the frequencies to the left and right fall down similarly to a Gaussian curve? If yes, the data can be assumed normal.

How many samples do I have

The tests can deal with just *one sample* (here I am mostly interested in some parameter of the population) or *two samples* (here I test either equality of populations from which the samples have been taken or independency of these populations) or *more than two samples* (where we want to detect differences between the populations).

What is to be tested

The most important question is what I am going to test. Basically it can be some *parameter* of the distribution of population or *independence* of two populations or a *type* of distribution.

Choice of a correct test

Testing of a parameter with normality assumption

Here the situation is straightforward: If the population is normal, it can have as parameters only *expectation* or *variance*; in case of discrete (categorical) population the parameter is *proportion* (which corresponds to the expectation)¹

- one sample
 - **test of expectation** testing some average value of population (either *z*-test if the variance is known or *t*-test if the variance is not known and computed from the sample)
 - **test of variance** testing variability of data
 - **test of proportion** testing a ratio of positive results in the whole sample (e.g. ratio of drivers who exceed the admitted speed)
- two samples
 - **test of two expectations** comparing two populations (it can be either independent or paired²)
 - **test of two variances**
 - **test of two proportions**
- many samples
 - **ANOVA** (analysis of variance)

Testing of a parameter without normality assumption

Here, instead of expectation, the median (or two medians) are tested. Median does not depend of the shape of distribution, it depends only on the order of data.

- one sample
 - **test of population median** Wilcoxon test
- two samples
 - **test of two medians**
 - * Mann Whitney test - independent
 - * Wilcoxon test - paired

¹If we have e.g. the data 0 1 1 0 1 1 0 1, then the average is 5/8 which is the proportion of ones in the dataset.

²In independent samples the data are taken first from one population and then from the other. The measurements are not related. The numbers of data in each sample can differ.

In paired samples the measurements are related. We take one object and measure first and second property. Then we take another object and measure the same properties, and so on. The numbers of data in both samples must be equal.

- many samples
 - Kruskal Wallis test - nonparametric ANOVA
 - Friedman test - block design

Testing of independence

Here we test independence of the two populations from which the samples have been taken.

- **Pearson test** - parametric test for continuous data
- **Spearman test** - nonparametric test for continuous data
- **Chisquare test of independence** - nonparametric test for discrete or discretized continuous data

Testing of distribution type

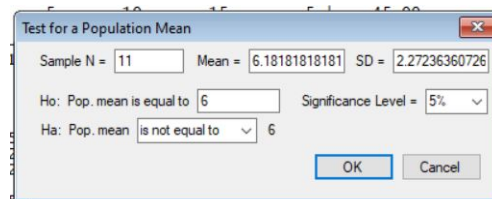
- **Normality test** - tests normality of population
- **Chisquare test of goodness-of-fit test** - tests the type of population distribution using O (observed) and E (expected) frequencies
- **Chisquare test of homogeneity** - tests equality of two populations from frequencies of data on equal intervals

Difficult situations

Setting the evidence into Statext

The evidence (data) is mostly set into Statext by pasting (or writing) data samples into to Data window of Statext.

If instead of samples we have computed characteristics (expectation or variance) we can run the test with any data and to fill in the characteristics directly into the window opened through menu. For example: With data sample $x = \{5\ 8\ 9\ 4\ 9\ 5\ 7\ 5\ 9\ 4\ 3\}$ testing the expectation we get the window like this



Here, Mean and SD are computed from data, H0 should be set as expectation according to H0. This case corresponds to testing expectation with unknown variance (variance is computed from data). In the result window we look for p-value will correspond to t distribution.

If we have the same example, but we know the variance (from technology or long observation) we can insert our standard deviation into the SD field. The resulting p-value will correspond z distribution.

If we have no data, but computed mean and standard deviation, we can set them both into the fields Mean and SD. The resulting p-value will correspond to t distribution (the variance is computed from data).

Testing two expectations as one-sided test

Let us have two samples A and B . We want to test H0: The population with sample A has greater expectation than the other.

Here it is important, that A is the first sample and B the second one. What we test is the difference $\bar{A} - \bar{B}$ (first minus second).

Now, according to H0: $\bar{A} > \bar{B}$ from which we have $\bar{A} - \bar{B} > 0$.

The direction is set according to HA:³ $\bar{A} - \bar{B} < 0$ which leads to left-sided test.

Chisquare tests

Chisquare tests work not with data but their frequencies of their values. If the data are discrete (categorical), we simply count how many times the individual values repeat. If they are continuous, we must choose some proper intervals of their values and count frequencies of the intervals.

So, in all cases of chisquare test we work with frequencies.

Chisquare test of goodness-of-fit needs one vector of observed frequencies (constructed from sample realization) and the second one with expected frequencies (such frequencies that exactly correspond to the tested form of distribution).

Chisquare test of homogeneity needs two vectors of frequencies. Each one from one population which are tested for equality.

Chisquare test of independence needs two vectors of frequencies. Each one from one population which are tested for independence.

³HA is the opposite to H0.