ttest
One-sample t-test

Syntax

\[
\begin{align*}
\text{h} &= \text{ttest}(x) \\
\text{h} &= \text{ttest}(x,m) \\
\text{h} &= \text{ttest}(x,y) \\
\text{h} &= \text{ttest}(\ldots,\text{alpha}) \\
\text{h} &= \text{ttest}(\ldots,\text{alpha},\text{tail}) \\
\text{h} &= \text{ttest}(\ldots,\text{alpha},\text{tail},\text{dim}) \\
[\text{h},\text{p}] &= \text{ttest}(\ldots) \\
[\text{h},\text{p},\text{ci}] &= \text{ttest}(\ldots) \\
[\text{h},\text{p},\text{ci},\text{stats}] &= \text{ttest}(\ldots)
\end{align*}
\]

Description

\( h = \text{ttest}(x) \) performs a \( t \)-test of the null hypothesis that data in the vector \( x \) are a random sample from a normal distribution with mean 0 and unknown variance, against the alternative that the mean is not 0. The result of the test is returned in \( h \). \( h = 1 \) indicates a rejection of the null hypothesis at the 5% significance level. \( h = 0 \) indicates a failure to reject the null hypothesis at the 5% significance level.

\( x \) can also be a matrix or an \( N \)-dimensional array. For matrices, \( \text{ttest} \) performs separate \( t \)-tests along each column of \( x \) and returns a vector of results. For \( N \)-dimensional arrays, \( \text{ttest} \) works along the first non-singleton dimension of \( x \).

The test treats NaN values as missing data, and ignores them.

\( h = \text{ttest}(x,m) \) performs a \( t \)-test of the null hypothesis that data in the vector \( x \) are a random sample from a normal distribution with mean \( m \) and unknown variance, against the alternative that the mean is not \( m \).

\( h = \text{ttest}(x,y) \) performs a paired \( t \)-test of the null hypothesis that data in the difference \( x-y \) are a random sample from a normal distribution with mean 0 and unknown variance, against the alternative that the mean is not 0. \( x \) and \( y \) must be vectors of the same length, or arrays of the same size.

\( h = \text{ttest}(\ldots,\text{alpha}) \) performs the test at the \((100*\text{alpha})\)% significance level. The default, when unspecified, is \( \text{alpha} = 0.05 \).

\( h = \text{ttest}(\ldots,\text{alpha},\text{tail}) \) performs the test against the alternative specified by the string \( \text{tail} \). There are three options for \( \text{tail} \):

- ‘both’ — Mean is not 0 (or \( m \)) (two-tailed test). This is the default, when \( \text{tail} \) is unspecified.
- ‘right’ — Mean is greater than 0 (or \( m \)) (right-tail test)
- ‘left’ — Mean is less than 0 (or \( m \)) (left-tail test)

\( \text{tail} \) must be a single string, even when \( x \) is a matrix or an \( N \)-dimensional array.

\( h = \text{ttest}(\ldots,\text{alpha},\text{tail},\text{dim}) \) works along dimension \( \text{dim} \) of \( x \), or of \( x-y \) for a paired test. Use \([\ ]\) to pass in default values for \( m \), \( \text{alpha} \), or \( \text{tail} \).

\( [\text{h},\text{p}] = \text{ttest}(\ldots) \) returns the \( p \)-value of the test. The \( p \)-value is the probability, under the null hypothesis, of observing a value as extreme or more extreme of the test statistic

\[
t = \frac{\bar{x} - \mu}{s / \sqrt{n}}
\]

where \( \bar{x} \) is the sample mean, \( \mu = 0 \) (or \( m \)) is the hypothesized population mean, \( s \) is the sample standard deviation, and \( n \) is the sample size. Under the null hypothesis, the test statistic will have Student’s \( t \) distribution with \( n - 1 \) degrees of freedom.
[h,p,ci] = \texttt{ttest}(...) returns a 100\%(1 - \textit{alpha})% confidence interval on the population mean, or on the difference of population means for a paired test.

[h,p,ci,stats] = \texttt{ttest}(...) returns the structure \texttt{stats} with the following fields:

- \textit{tstat} — Value of the test statistic
- \textit{df} — Degrees of freedom of the test
- \textit{sd} — Sample standard deviation

**Example**

Simulate a random sample of size 100 from a normal distribution with mean 0.1:

\[ x = \text{normrnd}(0.1,1,1,100); \]

Test the null hypothesis that the sample comes from a normal distribution with mean 0:

\[ [h,p,ci] = \text{ttest}(x,0) \]
\[ h = 0 \]
\[ p = 0.8323 \]
\[ ci = [-0.1650 0.2045] \]

The test fails to reject the null hypothesis at the default \( \alpha = 0.05 \) significance level. Under the null hypothesis, the probability of observing a value as extreme or more extreme of the test statistic, as indicated by the \textit{p}-value, is much greater than \( \alpha \). The 95\% confidence interval on the mean contains 0.

Simulate a larger random sample of size 1000 from the same distribution:

\[ y = \text{normrnd}(0.1,1,1,1000); \]

Test again if the sample comes from a normal distribution with mean 0:

\[ [h,p,ci] = \text{ttest}(y,0) \]
\[ h = 1 \]
\[ p = 0.0160 \]
\[ ci = [0.0142 0.1379] \]

This time the test rejects the null hypothesis at the default \( \alpha = 0.05 \) significance level. The \textit{p}-value has fallen below \( \alpha = 0.05 \) and the 95\% confidence interval on the mean does not contain 0.

Because the \textit{p}-value of the sample \( y \) is greater than 0.01, the test will fail to reject the null hypothesis when the significance level is lowered to \( \alpha = 0.01 \):

\[ [h,p,ci] = \text{ttest}(y,0,0.01) \]
\[ h = 0 \]
\[ p = 0.0160 \]
\[ ci = [-0.0053 0.1574] \]

Notice that at the lowered significance level the 99\% confidence interval on the mean widens to contain 0.

This example will produce slightly different results each time it is run, because of the random sampling.

**See Also**