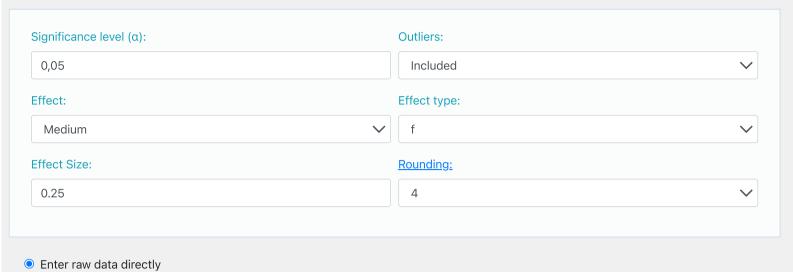
Statistics Kingdom

Home > Mean tests > One-Way ANOVA

ANOVA Calculator

One-Way ANOVA Calculator and Tukey HSD



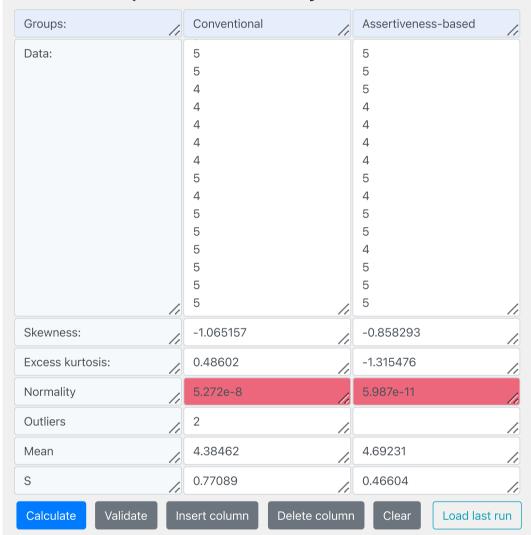
Tutorial ANOVA

Calculators

Kruskal-Wallis test
Two way ANOVA
Levene's test

Enter sample data directly

O Enter raw data from excel



Header: You may change groups' names to the real names.

Data: When entering data, press Enter or [,] (comma) after each value.

You may paste full column from excel.

The calculator ignores empty cells or non-numeric cells.

Group1 contains 52 values Group2 contains 52 values validation:success

Hover over the cells for more information.

The vertical over the delia for more information.					
Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between groups)	1	2.4615	2.4615	6.0669	0.01545
Error (within groups)	102	41.3846	0.4057		
Total	103	43.8461	0.4257		

R code.







One Way ANOVA test, using F distribution df(1,102) (right tailed)

1. H₀ hypothesis

Since p-value $<\alpha$, H₀ is rejected.

Some of the groups' averages consider to be not equal.

In other words, the difference between the averages of some groups is big enough to be statistically significant.

2. P-value

p-value equals 0.0154476, [p(x \leq F) = 0.984552]. It means that the chance of type1 error (rejecting a correct H₀) is small: 0.01545 (1.54%) The smaller the p-value the stronger it support H₁

3. The statistics

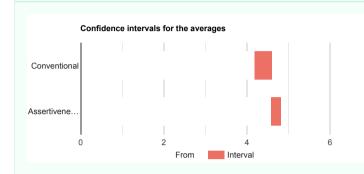
The test statistic F equals 6.066946, which is not in the 95% region of acceptance: $[-\infty: 3.9343]$

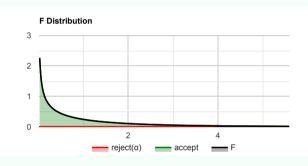
4 Effect size

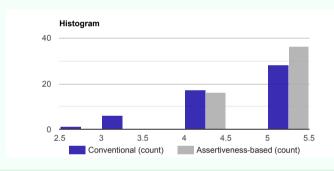
The observed effect size f is **medium** (0.24). That indicates that the magnitude of the difference between the averages is medium. The η^2 equals 0.056. It means that the **group** explains 5.6% of the variance from the average (similar to R² in the linear regression)

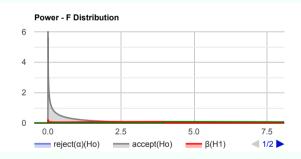
5. Tukey HSD / Tukey Kramer

The means of the following pair are significantly different: x1-x2.









<u>Validation</u>

Test power

Although the priori power is medium (0.7141), the H_0 is rejected.

Equality of variances

The tool used the Levene's test to assess the equality of variances.

The population's variances consider to be **not equal**. (p-value = 0.0154).

Levene's test power consider to be medium (0.71).

The groups' size consider similar. (The ratio between the bigger group and the smaller group is: 1)

The ANOVA test consider to be robust to the homogeneity of variances assumtion when the groups' sizes are similar.

It is suggested to consider the Kruskal-Wallis ANOVA. non-parametric test.

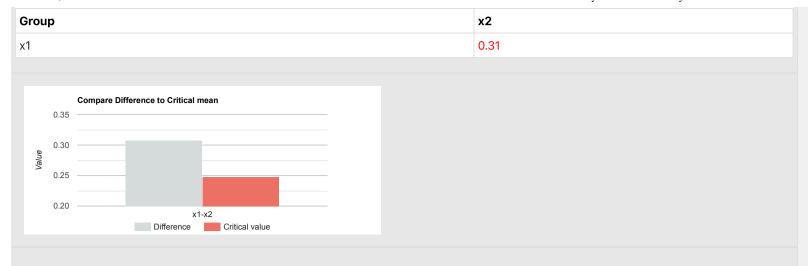
Normality assumption

The assumption was checked based on the Shapiro-Wilk Test. (α =0.05)

It is assumed that all the groups distribute normally or have a big sample size, at least 30.

Tukey HSD / Tukey Kramer

	Pair	Difference	SE	Q	Lower CI	Upper CI	Critical Mean	p-value
x1-x2 0.3077 0.08833 3.4834 0.05991 0.5555 0.2478 0.0154 8	x1-x2	0.3077	0.08833	3.4834	0.05991	0.5555	0.2478	0.01545



ANOVA

What is the ANOVA?

The ANOVA test checks if the difference between the averages of two or more groups is significant, using sample data.

ANOVA is usually used when there are at least three groups since for two groups, the *two-tailed* pooled variance t-test and the *right-tailed* ANOVA test have the same result.

The basic ANOVA test contains only one categorical value, one-way ANOVA. For example, if you compare the performence of three schools, the categorical variable is school, and the possible values of the categorical variable are School-A, School-B, School-C. There are more complex ANOVA tests that contain two categorical variables (Two-way ANOVA calculator), or more. When performing a one-way ANOVA test, we try to determine if the difference between the averages reflects a real difference between the groups, or is due to the random noise inside each group.

The F statistic represents the ratio of the variance between the groups and the variance inside the groups. Unlike many other statistic tests, the smaller the F statistic the more likely the averages are equal.

Example: Compare four fertilizers used in four fields

H₀: The average weight of crops per square meter is equal in all fields.

H₁: At least one field yields a different average per square meter.

Right-tailed, for ANOVA test you can use only the right tail. Why?

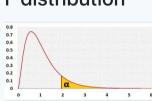
Hypotheses

$$H_0$$
: $\mu_1 = ... = \mu_k$
 H_1 : $not(\mu_1 = ... = \mu_k)$

ANOVA formula

$$F = \frac{MSG}{MSE}$$

F distribution



Assumptions

- Independent samples
- Normal distribution of the analyzed population
- Equal standard deviation, $\sigma_1 = \sigma_2 = ... = \sigma_k$

The assumption is more important when the groups' sizes not similar

Required Sample Data

• Sample data from all compared groups

Parameters

- **k** Number of groups.
- **n**_i Sample side of group i
- ${f n}$ Overall sample side, includes all the groups (Σn_i , i=1 to k)
- \mathbf{x}_{i} Average of group i.
- \vec{x} Overall average ($\Sigma x_{i,j}$ / n, i=1 to k, j=1 to n_i)
- $\mathbf{S_i}$ Standard deviation of group i

Results calculations

Source	Degrees of Freedom	Sum of Squares	Mean Square	F statistic	p-value
Groups (between groups)	k - 1	$SSG = \sum_{i=1}^{k} n_i (\bar{x}_i - \bar{x})^2$	MSG = SSG / (k - 1)	F = MSG / MSE	P(x > F)
Error (within groups)	n - k	$SSE = \sum_{i=1}^{k} (n_i - 1) S_i^2$	MSE = SSE / (n - k)		
Total	n - 1	SS(total) = SSG + SSE	Sample Variance = SS(total) / (n - 1)		

R Code

The following R code should produce the same results

value<-

my.dataframe<-data.frame(value, group1)

res.aov <- aov(value ~ group1, data = my.dataframe)

summary(res.aov) TukeyHSD(res.aov)