

Package ‘owANOVA’

2016

Type Package

Title One Way ANOVA

Version 1.2

Date 2016

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Description This package is useful to calculates one way analysis of variance.

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NeedsCompilation no

R topics documented:

owANOVA-package	1
ANOVA_table	2
effect	4
Fc	5
MSbetween	6
MSwithin	7
p_value	8
SSbetween	9
SStot	10
SSwithin	11

Index	13
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owANOVA-package	<i>One Way ANOVA</i>
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Description

This package is useful to calculates one way analysis of variance.

Details

The DESCRIPTION file:

```

Package:    owANOVA
Type:      Package
Title:     One Way ANOVA
Version:   1.2
Date:     2016
Author:    Olga Rivera. Asesores: Jorge Domínguez D. y Jonás Velazco A.
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```

Index of help topics:

ANOVA_table	One way analysis of variance table
Fc	Ratio F
MSbetween	Mean Squares between groups
MSwithin	Mean Squares within groups
SSbetween	Sum Squares between groups
SStot	Sum Squares total
SSwithin	Sum Squares within groups
effect	Effect
owANOVA-package	One Way ANOVA
p_value	P value

Author(s)

Olga Rivera

Asesores: Jorge Domínguez D. y Jomás Velazco A.

Maintainer: jordomdm@gmail.com u olga <olga@holmail.com>

ANOVA_table	<i>One way analysis of variance table</i>
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Description

Compute analysis of variance tables for unifactorial design experiments

Usage

```
ANOVA_table(res.list, res.vec, ni)
```

Arguments

res.list	This is a list where each element contains the responses of different treatments.
res.vec	This is a vector with all the responses.
ni	This is a vector that contains the number of observations for each treatment.

Details

Analysis of variance (ANOVA) is a collection of statistical models used to analyze the differences among group means and their associated procedures (such as "variation" among and between groups), developed by statistician and evolutionary biologist Ronald Fisher. In the ANOVA setting, the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are equal, and therefore generalizes the t-test to more than two groups. As doing multiple two-sample t-tests would result in an increased chance of committing a statistical type I error, ANOVAs are useful for comparing (testing) three or more means (groups or variables) for statistical significance.

One-way analysis of variance In statistics, one-way analysis of variance (abbreviated one-way ANOVA) is a technique used to compare means of three or more samples (using the F distribution). This technique can be used only for numerical data. The ANOVA tests the null hypothesis that samples in two or more groups are drawn from populations with the same mean values. To do this, two estimates are made of the population variance. These estimates rely on various assumptions:

- * Response variable residuals are normally distributed (or approximately normally distributed).
- * Samples are independent.
- * Variances of populations are equal.
- * Responses for a given group are independent and identically distributed normal random variables (not a simple random sample (SRS)).

The ANOVA produces an F-statistic, the ratio of the variance calculated among the means to the variance within the samples. If the group means are drawn from populations with the same mean values, the variance between the group means should be lower than the variance of the samples, following the central limit theorem. A higher ratio therefore implies that the samples were drawn from populations with different mean values. Typically, however, the one-way ANOVA is used to test for differences among at least three groups, since the two-group case can be covered by a t-test (Gosset, 1908). When there are only two means to compare, the t-test and the F-test are equivalent; the relation between ANOVA and t is given by $F = t^2$. An extension of one-way ANOVA is two-way analysis of variance that examines the influence of two different categorical independent variables on one dependent variable.

Value

tab	a data frame with the analysis of variance
effects	a vector of effects of treatments

Note

The statistical model for which one-way ANOVA is appropriate is that the (quantitative) outcomes for each group are normally distributed with a common variance (σ^2). The errors (deviations of individual outcomes from the population group means) are assumed to be independent. The model places no restrictions on the population group means.

Author(s) y Asesores

Olga Rivera
Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

ni<-c(3,2,3,2,3) #observations

ANOVA_table(experiment,experiment.v,ni)
```

effect	<i>Effect</i>
--------	---------------

Description

Calculates the effects of treatments

Usage

```
effect(res.list, res.vec)
```

Arguments

res.list	This is a list where each element contains the responses of different treatments.
res.vec	This is a vector with all the responses.

Details

This function returns the effect of each treatment at the order that they are given.

Value

y	a vector with the effect for each treatment
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Author(s)

Olga Rivera.
Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

effect(experiment,experiment.v)
```

Fc

*Ratio F***Description**

Calculates the F ratio

Usage

```
Fc(res.list, res.vec, ni)
```

Arguments

res.list	This is a list where each element contains the responses of different treatments.
res.vec	This is a vector with all the responses.
ni	This is a vector that contains the number of observations for each treatment.

Details

A statistic for which we can compute the null sampling distribution and that tends to fall in a different region for the alternative than the null hypothesis we use the F-statistic for ANOVA.

It might seem that we only need MSbetween to distinguish the null from the alternative hypothesis, but that ignores the fact that we don't usually know the value of σ^2 . So instead we look at the ratio

$$F = \text{MSbetween} / \text{MSwithin}$$

to evaluate the null hypothesis. Because the denominator is always (under null and alternative hypotheses) an estimate of σ^2 , and the numerator is either another estimate of σ^2 (under the null hypothesis) or is inflated (under the alternative hypothesis), it is clear that the (random) values of the F-statistic (from experiment to experiment) tend to fall around 1.0 when the null hypothesis is true and are bigger when the alternative is true. So if we can compute the sampling distribution of the F statistic under the null hypothesis, then we will have a useful statistic for distinguishing the null from the alternative hypotheses, where large values of F argue for rejection of H_0 .

We can quantify large for the F-statistic, by comparing it to its null sampling distribution which is the specific F-distribution which has degrees of freedom matching the numerator and denominator of the F-statistic.

Value

f	an object with value of the F ratio
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Author(s)

Olga Rivera.
Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

ni=c(3,2,3,2,3) #observations

Fc(experiment,experiment.v,ni)
```

MSbetween

Mean Squares between groups

Description

Calculates mean of squares for treatments

Usage

```
MSbetween(res.list, res.vec, ni)
```

Arguments

res.list	This is a list where each element contains the responses of different treatments.
res.vec	This is a vector with all the responses.
ni	This is a vector that contains the number of observations for each treatment.

Details

A sample variance is calculated as SS/df where SS is sum of squared deviations from the mean and df is degrees of freedom. In ANOVA we work with variances and also variance-like quantities which are not really the variance of anything, but are still calculated as SS/df . We call all of these quantities mean squares or MS.

For one-way ANOVA we will work with two different MS values called mean square within-groups, MS_{within} , and mean square between-groups, $MS_{between}$.

Because of the way $SS_{between}$ is defined, $MS_{between}$ is a good estimate of σ^2 only if H_0 is true. Otherwise it tends to be larger. $SS_{between}$ (and therefore $MS_{between}$) has $k-1$ degrees of freedom.

Value

y an object with the mean of squares for treatments

Note

Note that these are not really means, because the denominator is the df, not n.

Author(s)

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Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

ni=c(3,2,3,2,3) #observations

MSbetween(experiment,experiment.v,ni)
```

MSwithin	<i>Mean Squares within groups</i>
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Description

Calculates mean of squares within groups

Usage

```
MSwithin(res.list, ni)
```

Arguments

res.list This is a list where each element contains the responses of different treatments.
ni This is a vector that contains the number of observations for each treatment.

Details

A sample variance is calculated as SS/df where SS is sum of squared deviations from the mean and df is degrees of freedom. In ANOVA we work with variances and also variance-like quantities which are not really the variance of anything, but are still calculated as SS/df . We call all of these quantities mean squares or MS.

For one-way ANOVA we will work with two different MS values called mean square within-groups, MS_{within} , and mean square between-groups, $MS_{between}$.

MS_{within} is a good estimate of σ^2 (from our model) regardless of the truth of H_0 . This is due to the way SS_{within} is defined. SS_{within} (and therefore MS_{within}) has $N-k$ degrees of freedom with n_i-1 coming from each of the k groups.

Value

`y` an object with the mean of squares from error

Note

Note that these are not really means, because the denominator is the df , not n .

Author(s)

Olga Rivera.
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References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

ni=c(3,2,3,2,3) #observations

MSwithin(experiment,ni)
```

p_value

P value

Description

Calculates the p value

Usage

```
p_value(res.list, res.vec, ni)
```


Arguments

- res.list This is a list where each element contains the responses of different treatments.
- res.vec This is a vector with all the responses.
- ni This is a vector that contains the number of observations for each treatment.

Details

This function returns the probability of the observation F_c , with treatment degree freedom $(k-1)$ and error degree freedom $(N-k)$, where k is the number of treatments and N is the experiment size. When p is bigger than the confidence level α it means that all treatments are equal statistically.

The p -value is calculated as the area under the appropriate null sampling distribution of F that is bigger than the observed F -statistic.

Value

- P An object with value p

Author(s)

Olga Rivera.
Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

ni=c(3,2,3,2,3) #observations

p_value(experiment,experiment.v,ni)
```

SSbetween

Sum Squares between groups

Description

Calculates sum of squares between groups.

Usage

```
SSbetween(res.list, res.vec, ni)
```

Arguments

res.list This is a list where each element contains the responses of different treatments.
 res.vec This is a vector with all the responses.
 ni This is a vector that contains the number of observations for each treatment.

Details

sum of squares between treatments takes every effect from the treatments squared and multiplies by ni.

Value

y an object with the sum of squares for treatments.

Author(s)

Olga Rivera.
 Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment<-list(v1,v2,v3,v4,v5) #experiment as a list

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

ni=c(3,2,3,2,3) #observations

SSbetween(experiment,experiment.v,ni)
```

 SStot

Sum Squares total

Description

Calculates sum of squares total

Usage

```
SStot(res.vec)
```

Arguments

res.vec This is a vector with all the responses of the experiment.

Details

this function calculates the sum of every element squared from res.vec.

Value

t an object with the sum of squares total

Author(s)

Olga Rivera.
Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments

experiment.v<-c(v1,v2,v3,v4,v5) #experiment as a vector

SStot(experiment.v)
```

SSwithin	<i>Sum Squares within groups</i>
----------	----------------------------------

Description

Calculates sum of squares within groups

Usage

```
SSwithin(res.list, ni)
```

Arguments

res.list This is a list where each element contains the responses of different treatments.
ni This is a vector that contains the number of observations for each treatment.

Details

Sum of squares within is a function that calculates that through variance of each treatment and its freedom degrees.

Value

y An object with the sum of squares from error

Author(s)

Olga Rivera.

Asesores: Jorge Domínguez D. y Jomás Velazco A.

References

DOMINGUEZ DOMINGUEZ J. y CASTANO TOSTADO E. . Diseno de Experimentos: Estrategias y Analisis en Ciencia y Tecnologia. 2016, Alfaomega, México.

Examples

```
v1<-c(80,78,82); v2<-c(71,77); v3<-c(71,73,72)
v4<-c(88,86); v5<-c(58,62,64) #treatments
```

```
experiment<-list(v1,v2,v3,v4,v5) #experiment as a list
```

```
ni=c(3,2,3,2,3) #observations
```

```
SSwithin(experiment,ni)
```

Index

*Topic **\textasciitildekwd1**

Fc, [5](#)

*Topic **\textasciitildekwd2**

Fc, [5](#)

*Topic **anova**

ANOVA_table, [2](#)

effect, [4](#)

MSbetween, [6](#)

MSwithin, [7](#)

p_value, [8](#)

SSbetween, [9](#)

SStot, [10](#)

SSwithin, [11](#)

*Topic **package**

owANOVA-package, [1](#)

ANOVA_table, [2](#)

effect, [4](#)

Fc, [5](#)

MSbetween, [6](#)

MSwithin, [7](#)

owANOVA (owANOVA-package), [1](#)

owANOVA-package, [1](#)

p_value, [8](#)

SSbetween, [9](#)

SStot, [10](#)

SSwithin, [11](#)