

# Package ‘cocron’

September 5, 2013

**Type** Package

**Title** Statistical comparisons of two or more alpha coefficients

**Author** Birk Diedenhofen <mail@birkdiedenhofen.de>

**Maintainer** Birk Diedenhofen <mail@birkdiedenhofen.de>

**Depends** methods

**Suggests** testthat

**Description** This package provides functions to statistically compare two or more alpha coefficients based on either dependent or independent groups of individuals.

**License** GPL (>= 3)

**Encoding** UTF-8

**LazyLoad** yes

**URL** <http://r.birkdiedenhofen.de/pckg/cocron/>

**Version** 1.0-0

**Date** 2013-09-05

**Collate** 'cocron.n.coefficients.r' 'cocron-package.R' 'cocron.r' 'cocron.two.coefficients.r'  
'cronbach.alpha.CI.r' 'cronbach.alpha.r' 'helper.r'

## R topics documented:

|                                   |    |
|-----------------------------------|----|
| cocron-package . . . . .          | 2  |
| cocron . . . . .                  | 2  |
| cocron.n.coefficients . . . . .   | 4  |
| cocron.two.coefficients . . . . . | 5  |
| cronbach.alpha . . . . .          | 7  |
| cronbach.alpha.CI . . . . .       | 8  |
| knowledge . . . . .               | 10 |

|              |           |
|--------------|-----------|
| <b>Index</b> | <b>11</b> |
|--------------|-----------|

---

cocron-package

*The cocron Package*

---

### Description

Statistical comparisons of two or more alpha coefficients.

### Details

Package: cocron  
Type: Package  
Version: 1.0-0  
Date: 2013-09-05  
Depends: methods  
Encoding: UTF-8  
License: GPL (>= 3)  
LazyLoad: yes  
URL: <http://r.birkdiedenhofen.de/pkg/cocron/>

This package provides functions to statistically compare two or more alpha coefficients based on either dependent or independent groups of individuals.

### Author(s)

Birk Diedenhofen <[mail@birkdiedenhofen.de](mailto:mail@birkdiedenhofen.de)>

---

cocron

*Statistical comparisons of  $n$  alpha coefficients*

---

### Description

Performs a test of significance for the difference between  $n$  alpha coefficients (Cronbach, 1951). The function expects raw data input from which the alpha coefficients are calculated.

### Usage

```
cocron(data, dep = FALSE, standardized = FALSE,  
       los = 0.05, conf.level = 0.95)
```

### Arguments

|                           |   |
|---------------------------|---|
| <code>data</code>         | A list holding two or more <code>data.frames/matrices</code> with rows and columns corresponding to individuals and items, respectively. From each <code>data.frame/matrix</code> an alpha coefficients is determined.  |
| <code>dep</code>          | A logical indicating whether the alpha coefficients are based on dependent groups of individuals  |
| <code>standardized</code> | A logic indicating whether a standardized Cronbach alpha should be calculated (default is FALSE).   |
| <code>los</code>          | A number indicating the level of significance (default is .05).   |
| <code>conf.level</code>   | A number defining the level of confidence for the confidence intervals of the alpha coefficients (default is .95; see <a href="#">cronbach.alpha.CI</a> ). The confidence intervals serve as additional information only, they are not used for the test of significance. |

### Details

To compare  $n$  dependent or independent alpha coefficients (Cronbach, 1951), the methods by Feldt, Woodruff, and Salih (1987) implemented in [cocron.n.coefficients](#) are used.

### Value

Returns an object of the class "cocron.n.coefficients" (see [cocron.n.coefficients](#)).

### References

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334.
- Feldt, L. S., Woodruff, D. J., & Salih, F. A. (1987). Statistical inference for coefficient alpha. *Applied Psychological Measurement*, *11*, 93-103.

### See Also

[cocron.n.coefficients](#), [cocron.two.coefficients](#)

### Examples

```
data("knowledge")

# independent alpha coefficients
cocron(knowledge, dep=FALSE)

# dependent alpha coefficients
cocron(knowledge, dep=TRUE)
```

---

cocron.n.coefficients *Statistical comparisons of  $n$  alpha coefficients*

---

### Description

Performs a test of significance for the difference between  $n$  alpha coefficients (Cronbach, 1951). The function expects alpha coefficients as input.

### Usage

```
cocron.n.coefficients(alpha, n, items = NULL,
  dep = FALSE, r = NULL, los = 0.05, conf.level = 0.95)
```

### Arguments

|            |   |
|------------|---|
| alpha      | A numeric vector containing the alpha coefficients.   |
| n          | A numeric vector containing the number of individuals who provided the data for the test for which alpha coefficients were determined.  |
| items      | A numeric vector containing the number of items the alpha coefficients are based on.  |
| dep        | A logical indicating whether the alpha coefficients are based on dependent groups of individuals (default is FALSE).  |
| r          | A matrix that contains in the upper triangle all correlations between the scores the alpha coefficients are based on (see examples). Only required if the alpha coefficients are computed for dependent groups of individuals (dep = TRUE).                               |
| los        | A number indicating the level of significance (default is .05).   |
| conf.level | A number defining the level of confidence for the confidence intervals of the alpha coefficients (default is .95; see <a href="#">cronbach.alpha.CI</a> ). The confidence intervals serve as additional information only, they are not used for the test of significance. |

### Details

To compare  $n$  dependent or independent alpha coefficients (Cronbach, 1951), the methods by Feldt, Woodruff, and Salih (1987) are implemented.

### Value

Returns an object of the class "cocron.n.coefficients" with the following slots:

|       |                 |
|-------|-----------------|
| alpha | Input parameter |
| n     | Input parameter |
| items | Input parameter |
| dep   | Input parameter |
| r     | Input parameter |

|              |  |
|--------------|--|
| los          | Input parameter  |
| conf.level   | Input parameter  |
| statistic    | The value of the test statistic                                  |
| distribution | The distribution of the test statistic                           |
| df           | The degrees of freedom of the distribution of the test statistic |
| p.value      | The p-value of the test  |
| conf.int     | The confidence intervals of the alpha coefficients               |

## References

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334.
- Feldt, L. S., Woodruff, D. J., & Salih, F. A. (1987). Statistical inference for coefficient alpha. *Applied Psychological Measurement*, *11*, 93-103.

## See Also

[cocron](#), [cocron.two.coefficients](#)

## Examples

```
# independent alpha coefficients
cocron.n.coefficients(alpha=c(.784, .875, .936), items=c(5,5,5), n=c(51,101,151),
dep=FALSE)

# dependent alpha coefficients
r <- rbind(
  c(1, .8, .6, .75),
  c(NA, 1, .65, .7),
  c(NA, NA, 1, .55),
  c(NA, NA, NA, 1)
)
cocron.n.coefficients(alpha=c(.857, .875, .800, .833), items=c(50,40,35,25), n=100,
dep=TRUE, r=r)
```

---

cocron.two.coefficients

*Statistical comparisons of two alpha coefficients*

---

## Description

Performs a test of significance for the difference between two alpha coefficients (Cronbach, 1951). The function expects alpha coefficients as input.

**Usage**

```
cocron.two.coefficients(alpha, n, dep = FALSE, r = NULL,
  los = 0.05, alternative = "two.sided")
```

**Arguments**

|             |   |
|-------------|---|
| alpha       | A numeric vector containing the two alpha coefficients.   |
| n           | A numeric vector containing the number of individuals who provided the data for the test for which alpha coefficients were determined.  |
| dep         | A logical indicating whether alpha coefficients are based on dependent groups of individuals (default is FALSE).  |
| r           | A single number specifying the correlation between the scores the alpha coefficients are based on. Only required if the alpha coefficients are computed for dependent groups of individuals (dep = TRUE). |
| los         | A number indicating the level of significance (default is .05).   |
| alternative | A character string specifying the alternative hypothesis; must be "two.sided" (default), "greater", or "less" (or just the initial letter).   |

**Details**

For comparing two dependent or independent alpha coefficients (Cronbach, 1951), the methods described in Charter and Feldt (1996) are available, which were originally introduced in Feldt (1969) and Feldt (1980).

**Value**

Returns an object of the class "cocron.two.coefficients" with the following slots:

|              |  |
|--------------|--|
| alpha        | Input parameter  |
| n            | Input parameter  |
| dep          | Input parameter  |
| r            | Input parameter  |
| los          | Input parameter  |
| alternative  | Input parameter  |
| statistic    | The value of the test statistic                                  |
| distribution | The distribution of the test statistic                           |
| df           | The degrees of freedom of the distribution of the test statistic |
| p.value      | The p-value of the test  |

## References

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334.

Charter, R. A., & Feldt, L. S. (1996). Testing the equality of two alpha coefficients. *Perceptual and Motor Skills*, *82*, 763-768.

Feldt, L. S. (1969). A test of the hypothesis that Cronbach's alpha or Kuder-Richardson coefficient twenty is the same for two tests. *Psychometrika*, *34*, 363-373.

Feldt, L. S. (1980). A test of the hypothesis that Cronbach's alpha reliability coefficient is the same for two tests administered to the same sample. *Psychometrika*, *45*, 99-105.

## See Also

[cocron](#), [cocron.n.coefficients](#)

## Examples

```
# independent alpha coefficients
cocron.two.coefficients(alpha=c(.78,.71), n=c(41,151), dep=FALSE)

# dependent alpha coefficients
cocron.two.coefficients(alpha=c(.82,.89), n=27,dep=TRUE, r=.74)
```

---

|                |                         |
|----------------|-------------------------|
| cronbach.alpha | <i>Cronbach's Alpha</i> |
|----------------|-------------------------|

---

## Description

Calculates Cronbach's alpha (Cronbach, 1951), a coefficient of internal consistency. The coefficient typically serves as an estimate of the reliability of a psychometric test.

## Usage

```
cronbach.alpha(x, standardized = FALSE)
```

## Arguments

|              |   |
|--------------|---|
| x            | A numeric data.frame/matrix with rows and columns corresponding to individuals and items, respectively. |
| standardized | A logic indicating whether a standardized Cronbach alpha should be calculated (default is FALSE).       |

**Details**

For a test consisting of  $k$  items that measures a quantity  $X$ , Cronbach's alpha is defined as

$$\alpha = \frac{k}{k-1} \left( 1 - \frac{\sum_{i=1}^k \sigma_{Y_i}^2}{\sigma_X^2} \right)$$

with  $X = Y_1 + Y_2 + \dots + Y_k$ .  $\sigma_{Y_i}^2$  is the variance of item  $i$ , and  $\sigma_X^2$  the variance of the total test score for a sample of individuals that completed the test.

The standardized Cronbach's alpha is defined as

$$\alpha_s = \frac{k\bar{r}}{(1 + (k-1)\bar{r})}$$

where  $k$  is the number of items and  $\bar{r}$  the mean correlation between the items.

Cases that have missing values on any of the items are excluded.

**Value**

Returns Cronbach's alpha as a numeric object.

**References**

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297-334.

**See Also**

[cocron](#), [cocron.n.coefficients](#), [cocron.two.coefficients](#)

**Examples**

```
data("knowledge")

cronbach.alpha(knowledge$test1)
cronbach.alpha(knowledge$test2)
```

---

`cronbach.alpha.CI`      *Confidence interval for Cronbach's Alpha*

---

**Description**

Calculates a confidence interval for Cronbach's alpha (Cronbach, 1951).

**Usage**

```
cronbach.alpha.CI(alpha, n, items, conf.level = 0.95)
```



**Arguments**

|            |   |
|------------|---|
| alpha      | A numeric specifying the alpha coefficient.   |
| n          | A numeric defining the number of individuals who provided the data for the test for which the alpha coefficient was determined. |
| items      | A numeric specifying the number of items the alpha coefficient is based on.   |
| conf.level | A number defining the level of confidence for the confidence interval (default is .95).   |

**Details**

The lower bound of a confidence interval for an  $\alpha$  that is based on the data of  $n$  individuals who responded to  $k$  items is defined as

$$L = 1 - ((1 - \alpha)F(1 - c/2))$$

where  $c$  is the level of confidence and  $F(1 - c/2)$  the  $100(1 - c/2)$  percentile of the F-distribution with  $df_1 = n - 1$  and  $df_2 = (n - 1)(k - 1)$  (Feldt, Woodruff, & Salih, 1987, p. 95, formula 6). The upper bound of the confidence interval is computed as

$$U = 1 - ((1 - \alpha)F(c/2))$$

(Feldt et al., 1987, p. 95, formula 7).

**Value**

Returns a confidence interval for Cronbach's alpha as a numeric vector.

**References**

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334.
- Feldt, L. S., Woodruff, D. J., & Salih, F. A. (1987). Statistical inference for coefficient alpha. *Applied Psychological Measurement*, *11*, 93-103.

**See Also**

[cronbach.alpha](#)

**Examples**

```
cronbach.alpha.CI(alpha=.83, n=100, items=20, conf.level=.95)
```

---

`knowledge`*Sample dataset: knowledge*

---

**Description**

Data of 312 testees who completed two tests on general knowledge consisting of 30 questions each.

**Usage**

```
data(knowledge)
```

**Format**

A list that contains a matrix for each of the two tests holding 312 observations (rows) on the 30 questions (columns) presented. The ones and zeros stand for correct and incorrect responses, respectively.

**Examples**

```
data(knowledge)
```

# Index

\*Topic **datasets**

knowledge, [10](#)

\*Topic **package**

cocron-package, [2](#)

cocron, [2](#), [5](#), [7](#), [8](#)

cocron-package, [2](#)

cocron.n.coefficients, [3](#), [4](#), [7](#), [8](#)

cocron.two.coefficients, [3](#), [5](#), [5](#), [8](#)

cronbach.alpha, [7](#), [9](#)

cronbach.alpha.CI, [3](#), [4](#), [8](#)

knowledge, [10](#)