Package 'Barnard'

January 20, 2025

Type Package

Title Barnard's Unconditional Test

Version 1.8

Date 2016-10-20

Author Kamil Erguler

Maintainer Kamil Erguler <k.erguler@cyi.ac.cy>

Description Barnard's unconditional test for 2x2 contingency tables.

License GPL-2

URL

LazyLoad yes

NeedsCompilation yes

Repository CRAN

Date/Publication 2016-10-20 22:09:29

Contents

Barnard   *Barnard's Unconditional Test*

Description

This package implements the `barnard.test` function for performing Barnard's unconditional test of superiority. This is a more powerful alternative of Fisher's exact test for 2x2 contingency tables. The test, in its current implementation, uses Wald statistics as a measure of difference between two binomial proportions.

Author(s)

1. Kamil Erguler, Post-doctoral Fellow, EEWRC, The Cyprus Institute `<k.erguler@cyi.ac.cy>`

References

1. Barnard, G.A. (1945) A new test for 2x2 tables. *Nature*, 156:177.
2. Barnard, G.A. (1947) Significance tests for 2x2 tables. *Biometrika*, 34:123-138.

---

barnard.test	*Barnard's Unconditional Test*

Description

Barnard's unconditional test for superiority applied to 2x2 contingency tables using Score or Wald statistics for the difference between two binomial proportions.

Usage

```
barnard.test(n1, n2, n3, n4, dp = 0.001, pooled = TRUE)
```

Arguments

n1, n2, n3, n4	Elements of the 2x2 contingency table
dp	The resolution to search for the nuisance parameter
pooled	Z statistic with pooled (Score) or unpooled (Wald) variance

Details

For a 2x2 contingency table, such as $X = [n_1, n_2; n_3, n_4]$, the normalized difference in proportions between the two categories, given in each column, can be written with pooled variance (Score statistic) as

$$T(X) = \frac{\hat{p}_2 - \hat{p}_1}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{c_1} + \frac{1}{c_2})}},$$

where $\hat{p} = (n_1+n_3)/(n_1+n_2+n_3+n_4)$, $\hat{p}_2 = n_2/(n_2+n_4)$, $\hat{p}_1 = n_1/(n_1+n_3)$, $c_1 = n_1+n_3$ and $c_2 = n_2 + n_4$. Alternatively, with unpooled variance (Wald statistic), the difference in proportions can we written as

$$T(X) = \frac{\hat{p}_2 - \hat{p}_1}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{c_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{c_2}}}.$$

The probability of observing X is

$$P(X) = \frac{c_1!c_2!}{n_1!n_2!n_3!n_4!}p^{n_1+n_2}(1-p)^{n_3+n_4},$$

where p is the unknown nuisance parameter.

Barnard's test considers all tables with category sizes c_1 and c_2 for a given p. The p-value is the sum of probabilities of the tables having a score in the rejection region, e.g. having significantly large difference in proportions for a two-sided test. The p-value of the test is the maximum p-value calculated over all p between 0 and 1.

Value

`statistic.table`

The contingency tables considered in the analysis represented by 'n1' and 'n2', their scores, and whether they are included in the one-sided (1), two-sided (2) tests, or not included at all (0)

`nuisance.matrix`

Nuisance parameters, p, and the corresponding p-values for both one- and two-sided tests

`dp`   The resolution of the search space for the nuisance parameter

`contingency.matrix`

The observed 2x2 contingency table

`alternative`   One sided or two sided test

`statistic`   The standardized difference between the observed proportions

`nuisance.parameter`

The nuisance parameter where the p-value is maximized

`p.value`   The p-value for the observed contingency table

`pooled`   Variance estimator of the Z statistic

Note

I am indebted to Peter Calhoun for helping to test the performance and the accuracy of the code. I also thank Rodrigo Duprat, Long Qu, and Nicolas Sounac for their valuable comments. The accuracy has been tested with respect to the existing MATLAB and R implementations as well as the results of StatXact. I have largely been influenced by the works of Trujillo-Ortiz etal. (2004), Cardillo G. (2009), and Galili T. (2010).

Author(s)

Kamil Erguler, Post-doctoral Fellow, EEWRC, The Cyprus Institute <k.erguler@cyi.ac.cy>

References

1. Barnard, G.A. (1945) A new test for 2x2 tables. *Nature*, 156:177.

2. Barnard, G.A. (1947) Significance tests for 2x2 tables. *Biometrika*, 34:123-138.

3. Suissa, S. and Shuster, J. J. (1985), Exact Unconditional Sample Sizes for the 2x2 Binomial Trial, Journal of the Royal Statistical Society, Ser. A, 148, 317-327.

4. Cardillo G. (2009) MyBarnard: a very compact routine for Barnard's exact test on 2x2 matrix. URL http://www.mathworks.com/matlabcentral/fileexchange/25760

5. Galili T. (2010) URL http://www.r-statistics.com/2010/02/barnards-exact-test-a-powerful-alternativ

6. Lin C.Y., Yang M.C. (2009) Improved p-value tests for comparing two independent binomial proportions. *Communications in Statistics-Simulation and Computation*, 38(1):78-91.

7. Trujillo-Ortiz, A., R. Hernandez-Walls, A. Castro-Perez, L. Rodriguez-Cardozo N.A. Ramos-Delgado and R. Garcia-Sanchez. (2004). Barnardextest:Barnard's Exact Probability Test. A MATLAB file. [WWW document]. URL http://www.mathworks.com/

Examples

```
barnard.test(8,14,1,3)

## Plotting the search for the nuisance parameter for a one-sided test
bt<-barnard.test(8,14,1,3)
plot(bt$nuisance.matrix[,1:2],
     t="l",xlab="nuisance parameter",ylab="p-value")

## Plotting the tables included in the p-value
bt<-barnard.test(40,14,10,30)
bts<-bt$statistic.table
plot(bts[,1],bts[,2],
     col=hsv(bts[,4]/4,1,1),
     t="p",xlab="n1",ylab="n2")

## Plotting the difference between pooled and unpooled tests
bts<-barnard.test(40,14,10,30,pooled=TRUE)$statistic.table
btw<-barnard.test(40,14,10,30,pooled=FALSE)$statistic.table
plot(bts[,1],bts[,2],
     col=c("black","white")[1+as.numeric(bts[,4]==btw[,4])],
     t="p",xlab="n1",ylab="n2")
```

---

barnardw.test   *Barnard's Unconditional Test with Wald Statistics (obsolete)*

Description

Previous version of Barnard's unconditional test for superiority which used Z-statistic with pooled variance for the difference between two binomial proportions in a 2x2 contingency table. Please use the 'barnard.test' instead.

Index