Package ‘Barnard’

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Title Barnard's Unconditional Test

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

License GPL-2

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R topics documented:

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)

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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)

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References

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

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