Package ‘Barnard’

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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.
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

\[
\text{barnard.test}(n1, n2, n3, n4, dp = 0.001, \text{pooled} = \text{TRUE})
\]

Arguments

\begin{itemize}
  \item \textit{n1, n2, n3, n4} \quad \text{Elements of the 2x2 contingency table}
  \item \textit{dp} \quad \text{The resolution to search for the nuisance parameter}
  \item \textit{pooled} \quad \text{Z statistic with pooled (Score) or unpooled (Wald) variance}
\end{itemize}

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).

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References

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")[,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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