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Exact  Unconditional Exact Tests for 2x2 tables

Description

Uses Barnard’s or Boschloo’s test to compute the p-value of a given 2x2 table or calculate the power for known proportions and sample sizes.

Details
Barnard’s and Boschloo’s test can be used to test the independence of rows and columns in a 2x2 table. Unconditional tests are often more powerful than conditional tests, but require more computation time. P-values can be computed for 2x2 tables under the binomial and multinomial models using multiple different statistics and using an interval method. Power calculations can be done for known sample sizes and proportions. There are several different methods for finding as or more extreme tables than the one observed. Suissa and Shuster suggested using a Z-pooled statistic, which they showed is uniformly more powerful than Fisher’s test for balanced designs. Boschloo recommended using the p-value for Fisher’s test as the test statistic. This method became known as Boschloo’s test, which is always uniformly more powerful than Fisher’s test. In addition, Berger and Boos proposed considering only values of the nuisance parameter that are in a constructed confidence interval. They showed that for many cases, the interval approach often yields more powerful tests. All of these tests can be computed in this package for both models, where the appropriate model is based on the design.

Note

Throughout the years I have received help while creating this package. Special thanks goes to Philo Calhoun, Tal Galili, Kamil Erguler, Roger Berger, Karl Hufthammer, and the R community.

Author(s)

Peter Calhoun
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References


exact.test  

**Unconditional exact tests for 2x2 tables**

**Description**

Calculates Barnard’s or Boschloo’s unconditional exact test for binomial or multinomial models

**Usage**

```R
exact.test(data, alternative = "two.sided", npNumbers = 100, beta = 0.001, interval = FALSE, method = "Z-pooled", model = "Binomial", cond.row = TRUE, to.plot = TRUE, ref.pvalue=TRUE)
```

**Arguments**

- `data` A two dimensional contingency table in matrix form
- `alternative` Indicates the alternative hypothesis: must be either "less", "two.sided", or "greater"
- `npNumbers` Number: The number of nuisance parameters considered
- `beta` Number: Confidence level for constructing the interval of nuisance parameters considered. Only used if `interval=TRUE`
- `interval` Logical: Indicates if a confidence interval on the nuisance parameter should be computed
- `method` Indicates the method for finding tables as or more extreme than the observed table: must be either "Z-pooled", "Z-unpooled", "Santner and Snell", or "Boschloo"
- `model` The model being used: must be either "Binomial" or "Multinomial"
- `cond.row` Logical: Indicates if row margins are fixed in the binomial models. Only used if `model="Binomial"`
- `to.plot` Logical: Indicates if plot of p-value vs nuisance parameter should be generated. Only used if `model="Binomial"
- `ref.pvalue` Logical: Indicates if p-value should be refined by maximizing the p-value function after the nuisance parameter is selected. Only used if `model="Binomial"`
Details

Unconditional exact tests can be used for binomial or multinomial models. The binomial model assumes the row or column margins (but not both) are known in advance, while the multinomial model only assumes the total sample size is known beforehand. Conditional tests have both row and column margins fixed. Fisher’s test conditions on both margins to avoid estimating a nuisance parameter. Barnard’s test considers all possible values for the nuisance parameter and chooses the one that maximizes the p-value.

There are several statistics used to define tables as or more extreme than the observed table. The method variable lets the user choose the test statistic being used.

The null hypothesis is that the rows and columns are independent. Under the binomial model, the user will need to input which margin is fixed (default is rows). The null hypothesis can be interpreted as the probability of success given in the first group is equal to the probability of success given in the second group. There are many ways to define the two-sided p-value; this code uses the fisher.test() approach by summing the probabilities for both sides of the table.

Value

- **p.value**: The computed p-value
- **test.statistic**: The observed test statistic
- **np**: The nuisance parameter that maximizes the p-value. For multinomial models, both nuisance parameters are given
- **np.range**: The range of nuisance parameters considered. For multinomial models, both nuisance parameter ranges are given

Warning

Multinomial models may take a very long time, even for sample sizes less than 100.

Note

Multinomial models are much more computationally intensive due to more tables considered and maximizing over two nuisance parameters. I also have spent a greater amount of time making the computations for the binomial models more efficient; future work will be devoted to improving the multinomial models. Boschloo’s test also takes longer due to calculating Fisher’s p-value for every possible table; however, a created function that calculates Fisher’s test efficiently is utilized. Increasing the number of nuisance parameters considered and refining the p-value will increase the computation time.

Author(s)

Peter Calhoun

References

This code was influenced by the FORTRAN program located at www.stat.ncsu.edu/exact
See Also

fisher.test, Barnard, and exact2x2

Examples

data<-matrix(c(7,8,12,3),2,2,byrow=TRUE)
exact.test(data,alternative="less",to.plot=TRUE)

exact.test(data,alternative="two.sided",interval=TRUE,beta=0.001,npNumbers=100,method="Z-pooled",to.plot=FALSE)

exact.test(data,alternative="two.sided",interval=TRUE,beta=0.001,npNumbers=100,method="Boschloo",to.plot=FALSE)

data<-matrix(c(6,8,4,3),2,2,byrow=TRUE)
exact.test(data,model="Multinomial",alternative="less",method="Z-pooled")

power.exact.test

Power calculation for unconditional exact test

Description

Calculates the power of the design for known sample sizes and true probabilities.

Usage

power.exact.test(p1, p2, n1, n2, npNumbers = 100, alpha = 0.05, alternative = "two.sided", interval = FALSE, beta = 0.001, method = "Z-pooled", ref.pvalue = TRUE, simulation = FALSE, nsim = 100)

Arguments

p1 The probability of success given in group 1
p2 The probability of success given in group 2
n1 The sample size in group 1
n2 The sample size in group 2
npNumbers Number: The number of nuisance parameters considered
alpha Significance level
alternative Indicates the alternative hypothesis: must be either "less", "two.sided", or "greater"
interval Logical: Indicates if a confidence interval on the nuisance parameter should be computed
beta Number: Confidence level for constructing the interval of nuisance parameters considered. Only used if interval=TRUE
method Indicates the method for finding tables as or more extreme than the observed table: must be either "Z-pooled", "Z-unpooled", "Santner and Snell", or "Boschloo"
ref.pvalue Logical: Indicates if p-value should be refined by maximizing the p-value function after the nuisance parameter is selected.
simulation Logical: Indicates if the power calculation is exact or estimated by simulation
nsim Number of simulations run. Only used if simulation=TRUE

Details
The power calculations are for binomial models. The design must know the fixed sample sizes in advance. There are \((n1 + 1) \times (n2 + 1)\) possible tables that could be produced. There are two ways to calculate the power: simulate the tables under two independent binomial distributions or consider all tables and calculate the exact power. The calculations can be done for any exact.test computation or using Fisher’s exact test.

Value
The function returns the computed power.

Note
The code takes longer for Boschloo’s test. Not refining the p-value often yields similar results and decreases the computation time.

Author(s)
Peter Calhoun

References

See Also
statmod

Examples
power.exact.test(0.20,0.80,10,20)
power.exact.test(0.20,0.80,10,20,method="Fisher")
set.seed(218461)
power.exact.test(0.20,0.80,10,20,interval=TRUE,method="Boschloo",simulation=TRUE,nsim=100)
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