

Package: dstat2x2xk (via r-universe)

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Type Package

Title Demonstrated Insensitivity to Bias in 2x2xK Contingency Tables

Version 0.2.0

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Description For an observational study with binary treatment, binary outcome and K strata, implements a d-statistic that uses those strata most insensitive to unmeasured bias in treatment assignment.<doi:10.1093/biomet/asaa032> The package has one function, dstat2x2xk.

License GPL-2

Encoding UTF-8

Imports stats, BiasedUrn

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Details

The DESCRIPTION file:

```
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Type:         Package
Title:        Demonstrated Insensitivity to Bias in 2x2xK Contingency Tables
Version:      0.2.0
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Encoding:     UTF-8
LazyData:    true
Imports:     stats, BiasedUrn
```

Index of help topics:

```
dstat2x2xk          Sensitivity Analysis in 2x2xK Tables with
                    Demonstrated Insensitivity to Unmeasured Bias
dstat2x2xk-package  Demonstrated Insensitivity to Bias in 2x2xK
                    Contingency Tables
```

There is one function, `dstat2x2xk`, intended to increase design sensitivity when analyzing a 2x2xk table, treatment x binary outcome x strata, from an observational study. See Rosenbaum (2022).

Author(s)

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References

Rosenbaum, P. R. (2020) <doi:10.1093/biomet/asaa032> A conditional test with demonstrated insensitivity to unmeasured bias in matched observational studies. *Biometrika*, 107(4): 827–840.

Rosenbaum, P. R. (2022) A Mantel-Haenszel-Birch statistic with demonstrated insensitivity to unmeasured bias in observational studies. Manuscript.

Examples

```
cataract<-c(33,8,356,65,23,6,222,35,
           139,19,477,82,114,30,451,45,
           76,33,210,23,99,26,282,27,
           172,121,133,25,364,165,237,32)

cataract<-array(cataract,c(2,2,8))
dimnames(cataract)<-list(light=c("less","more"),
                        status=c("case","referent"),
                        str=c("M20-44","F20-44","M45-64","F45-64","M65-74","F65-74","M75+","F75+"))
```

```
)
cataract2<-cataract[,2:1,]

dstat2x2xk(cataract2,gamma=2.365,kappa=1)
```

dstat2x2xk *Sensitivity Analysis in 2x2xK Tables with Demonstrated Insensitivity to Unmeasured Bias*

Description

The function dstat2x2xk performs a sensitivity analysis for an observational study that produced a 2x2xk contingency table recording binary treatment x binary outcome x k strata defined by covariates. The d-statistic uses only those strata that demonstrate a degree of insensitivity to unmeasured biases in treatment assignment.

Usage

```
dstat2x2xk(tab, gamma = 1, kappa = NULL, lambda = NULL, rnd = 2, warn = TRUE)
```

Arguments

tab	A 2x2xK contingency table, with K greater than or equal to two. That is, tab is a 3-dimensional array of nonnegative integers, with dimensions 2, 2 and K.
gamma	Sensitivity parameter. A number greater than or equal to 1.
kappa	An optional parameter. The d-statistic truncates the extended hypergeometric distribution at kappa times its expectation. A sensible value of kappa is kappa = 1. An error will result if both kappa and lambda are not NULL; give a value to either kappa or lambda, not both. If lambda and kappa are both NULL, then the result is a sensitivity analysis using the Mantel-Haenszel-Birch test.
lambda	An optional parameter. The d-statistic truncates the extended hypergeometric distribution at its lambda quantile. Sensible values of lambda are lambda = 0.25 for the lower quartile or lambda = .5 for the median. A cautious value of lambda is lambda = 0.10. An error will result if both kappa and lambda are not NULL; give a value to either kappa or lambda, not both. If lambda and kappa are both NULL, then the result is a sensitivity analysis using the Mantel-Haenszel-Birch test. Values of kappa strictly greater than 1 are not recommended: they will generate a warning.
rnd	Certain output is rounded to rnd digits for attractive display.
warn	If one of the 2x2 subtables is degenerate – if its conditional distribution given its margins has only one support point – then that subtable is removed before the analysis begins. If warn=TRUE, then a harmless but informative warning is displayed when one or more subtables is removed.

Details

There are $(2^K)-1$ nontrivial subtables of a $2 \times 2 \times K$ table, and the d-statistic considers them all, searching for the subtable least sensitive to unmeasured bias, paying a limited price for multiple testing.

The method is described in Rosenbaum (2022). A related method for continuous responses in matched pairs is described in Rosenbaum (2020) and is implemented in package `dstat`. Adaptation between 2 Mantel-Haenszel statistics, rather than $(2^K)-1$ statistics, is discussed in Rosenbaum and Small (2017) and implemented in `adaptmh`.

Value

<code>tstat</code>	Value of the test statistic. See below.
<code>pval</code>	Upper bound on the on-sided P-value testing the null hypothesis of no treatment effect in the presence of a bias in treatment assignment of magnitude at most γ .
<code>detail</code>	A dataframe showing detailed results, stratum by stratum. If the strata have dimnames, then the rows of detail are labeled with these names. Column <code>n11</code> is the observed count in the 11 upper left corner cell of a 2×2 subtable of the $2 \times 2 \times K$ table. Column <code>E(n11)</code> is the null expectation of <code>n11</code> in the upper bounding extended hypergeometric distribution with parameter γ . Column <code>cut</code> is the lower truncation point for <code>n11</code> , and column <code>use</code> is 1 if <code>n11</code> \geq <code>cut</code> ; otherwise <code>use</code> =0. The test statistic, <code>tstat</code> , is the sum of <code>n11</code> for strata with <code>use</code> =1, and columns <code>E(n11 use=1)</code> and <code>var(n11 use=1)</code> give moments of its conditional distribution given that it is used. Column <code>OR</code> is simply the sample odds ratio for a 2×2 subtable. In the notation of Rosenbaum (2022), the column labeled <code>cut</code> is t_s and the column labeled <code>use</code> is A_s .

Note

The concept of a d-statistic is introduced in Rosenbaum (2020) for matched pairs with continuous responses, and this version of a d-statistic is implemented in the package "dstat". Rosenbaum (2022) extends the idea to contingency tables, and `dstat2x2xk` implements this extension.

Author(s)

Paul R. Rosenbaum

References

- Birch, M. W. (1964) <doi:10.1111/j.2517-6161.1964.tb00564.x> The detection of partial association, I: the 2×2 case. *Journal of the Royal Statistical Society: Series B (Methodological)*, 26(2), 313-324.
- Hiller, R., Giacometti, L., and Yuen, K. (1977) <doi:10.1093/oxfordjournals.aje.a112404> Sunlight and cataract: an epidemiologic investigation. *American Journal of Epidemiology*, 105(5), 450-459.
- Mantel, N., and Haenszel, W. (1959) <doi:10.1093/jnci/22.4.719> Statistical aspects of the analysis of data from retrospective studies of disease." *Journal of the National Cancer Institute* 22(4): 719-748.

Rosenbaum, P. R. and Small, D. S. (2015) <doi:10.1111/biom.12591> An adaptive Mantel-Haenszel test for sensitivity analysis in observational studies. *Biometrics* 73, no. 2 (2017): 422-430.

Rosenbaum, P. R. (2020) <doi:10.1093/biomet/asaa032> A conditional test with demonstrated insensitivity to unmeasured bias in matched observational studies. *Biometrika*, 107(4): 827-840.

Rosenbaum, P. R. (2022) A Mantel-Haenszel-Birch statistic with demonstrated insensitivity to unmeasured bias in observational studies. Manuscript.

Examples

```
# Data from Hiller et al. (1977)

cataract<-c(33,8,356,65,23,6,222,35,
           139,19,477,82,114,30,451,45,
           76,33,210,23,99,26,282,27,
           172,121,133,25,364,165,237,32)

cataract<-array(cataract,c(2,2,8))
dimnames(cataract)<-list(light=c("less","more"),
                        status=c("case","referent"),
                        str=c("M20-44","F20-44","M45-64","F45-64",
                             "M65-74","F65-74","M75+","F75+"))
)
cataract2<-cataract[,2:1,]

# The following example compares the d-statistic and the usual
# Mantel-Haenszel-Birch exact statistic.
# With kappa=1, the d-statistic truncates at the expectation
# of the null distribution, eliminating three strata.
# With kappa=0, the d-statistic does no truncation and
# equals the Mantel-Haenszel-Birch exact statistic.
# The d-statistic reports greater insensitivity to unmeasured bias in
# this example.

# Truncation at the expectation
dstat2x2xk(cataract2,gamma=2.365,kappa=1)

# Truncation at the lower quartile and median
dstat2x2xk(cataract2,gamma=2.49,lambda=.25)
dstat2x2xk(cataract2,gamma=2.50,lambda=.25)

# No truncation = exact, usual Mantel-Haenszel-Birch (MHB) test
dstat2x2xk(cataract2,gamma=2.365,kappa=0)
# The same usual untruncated MHB answer is
# produced by the mh() function in package sensitivity2x2xk
# mh(cataract2,Gamma=2.365)
```

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