Package ‘LBI’

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Version 0.1.2

Title Likelihood Based Inference

Description Maximum likelihood estimation and likelihood ratio test are essential for modern statistics. This package supports in calculating likelihood based inference.
Reference: Pawitan Y. (2001, ISBN:0-19-850765-8).

Depends R (>= 3.0.0)

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Contents

`LBI-package` *Likelihood Based Inference*

Description

It conducts likelihood based inference.

Details

Modern likelihood concept and maximum likelihood estimation are established by RA Fisher, while Likelihood Ratio Test (LRT) is established by Neyman J. Post-Fisher methods - generalized linear model, survival analysis, and mixed effects model - are all likelihood based. Inferences from the perspective of Fisherian and pure likelihoodist are suggested here.

Author(s)

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References

1. Wilks SS. The Large-sample Distribution of the Likelihood Ratio for Testing Composite Hypotheses. Ann Math Stat. 1938;9(1):60-62.
2. Fisher RA. Statistical Methods and Scientific Inference. 3e. 1973.
3. Edwards AWF. Likelihood. 1972.
4. Ruppert D, Cressie N, Carroll RJ. A Transformation/Weighting Model for Estimating Michaelis-Menten Parameters. Cornell University Technical Report 796. 1988.
5. Lehmann EL. Fisher, Nayman, and the Creation of Classical Statistics. 2011.
6. Royall R. Statistical Evidence. 1997.
7. Pawitan Y. In All Likelihood: Statistical Modelling and Inference Using Likelihood. 2001.
8. Rohde CA. Introductory Statistical Inference with the Likelihood Function. 2014.
9. Held L, Bove DS. Likelihood and Bayesian Inference. 2020.

`LIbin` *Likelihood Interval for a Proportion or a Binomial Distribution*

Description

Likelihood interval of a proportion in one group

Usage

```
LIbin(y, n, k, conf.level=0.95, eps=1e-8)
```

Arguments

`y`	positive event count of a group
`n`	total count of a group
`k`	1/k likelihood interval will be calculated
`conf.level`	approximately corresponding confidence level. If k is specified, this is ignored.
`eps`	Values less than eps are considered as 0.

Details

It calculates likelihood interval of a proportion in one group. The likelihood interval is asymmetric and there is no standard error in the output. If you need percent scale, multiply the output by 100.

Value

`y`	positive (concerning) event count
`n`	total trial count
`PE`	point estimation for the proportion
`LL`	lower limit of likelihood interval
`UL`	upper limit of likelihood interval

Author(s)

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References

Fisher RA. Statistical methods and scientific inference. 3e. 1973. pp68-76.

See Also

`binom.test`, `prop.test`

Examples

```
  LIbin(3, 14, k=2)
  LIbin(3, 14, k=5)
  LIbin(3, 14, k=15)
  LIbin(3, 14)
# binom.test(3, 14)
# prop.test(3, 14)
```

LInorm *Likelihood Interval of mean, sd and variance assuming Norml Distribution*

Description

Likelihood interval of mean and sd assuming normal distribution. This is estimated likelihood interval, not profile likelihood interval.

Usage

```
LInorm(x, k, conf.level=0.95)
```

Arguments

`x`	a vector of observation
`k`	1/k likelihood interval will be calculated
`conf.level`	approximately corresponding confidence level. If k is specified, this is ignored.

Details

It calculates likelihood interval of mean and sd assuming normal distribution in one group. There is no standard error in the output.

Value

`PE`	point estimation for the proportion
`LL`	lower limit of likelihood interval
`UL`	upper limit of likelihood interval

Author(s)

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Examples

```
x = c(-5.3, -4.5, -1.0, -0.7, 3.7, 3.9, 4.2, 5.5, 6.8, 7.4, 9.3)
LInorm(x, k=1/0.15) # Pawitan Ex10-9 p289
LInorm(x)
```

`LInormVar` *Likelihood Interval of sd and variance assuming Norml Distribution*

Description

Likelihood interval of sd and variance assuming normal distribution. This is estimated likelihood interval, not profile likelihood interval.

Usage

```
LInormVar(x, k, conf.level=0.95)
```

Arguments

`x`	a vector of observation
`k`	1/k likelihood interval will be calculated
`conf.level`	approximately corresponding confidence level. If k is specified, this is ignored.

Details

It calculates likelihood interval of sd and variance assuming normal distribution in one group. The likelihood interval is asymmetric and there is no standard error in the output.

Value

`PE`	point estimation for the proportion
`LL`	lower limit of likelihood interval
`UL`	upper limit of likelihood interval

Author(s)

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Examples

```
x = c(-5.3, -4.5, -1.0, -0.7, 3.7, 3.9, 4.2, 5.5, 6.8, 7.4, 9.3)
LInormVar(x, k=1/0.15) # Pawitan Ex10-9 p289
LInormVar(x)
```

LIpois *Likelihood Interval of the Mean assuming Poisson Distribution*

Description

Likelihood interval of lambda assuming Poisson distribution.

Usage

```
LIpois(x, k, conf.level=0.95, eps=1e-8)
```

Arguments

x	mean or lambda, the count in a time unit.
k	1/k likelihood interval will be calculated
conf.level	approximately corresponding confidence level. If k is specified, this is ignored.
eps	Values less than eps are considered as 0.

Details

It calculates likelihood interval of mean(lambda) assuming Poisson distribution. The likelihood interval is asymmetric and there is no standard error in the output.

Value

PE	point estimation for the lambda
LL	lower limit of likelihood interval
UL	upper limit of likelihood interval

Author(s)

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Examples

```
  LIpois(4, k=1/0.15) # Pawitan
  LIpois(4, k=exp(2)) # Edwards
  LIpois(4, k=8)      # Rhode
  LIpois(4)           # Bae
  LIpois(4, k=15)     # Fisher
#  poisson.test(4)
  LIpois(4, k=32)     # 0.7454614 11.7893612
```

LRT	*Likelihood Ratio Test*

Description

Likelihood ratio test with given fitting results, sample size, number of parameters, log-likelihoods, and alpha

Usage

```
LRT(n, pFull, pReduced, logLikFull, logLikReduced, alpha=0.05, Wilks=FALSE)
```

Arguments

`n`	number of observations
`pFull`	number of parameters of full model
`pReduced`	number of parameters of reduced model
`logLikFull`	log likelihood of full model
`logLikReduced`	log likelihood of reduced model
`alpha`	alpha value for type I error, significance level
`Wilks`	if TRUE, Wilks theorem (chi-square distribution) will be used, otherwise F distribution will be used.

Details

It performs likelihood ratio test with given fitting results. The default test is using F distribution. For small n (i.e. less than 100), you need to use F distribution. If the residuals are normally distributed, the delta -2 log likelihood (the difference between -2LL, the objective function value of each model) follows exactly an F-distribution, independent of sample size. When the distribution of the residuals is not normal (no matter what the distribution of the residuals is), it approaches a chi-square distribution as sample size increases (Wilks' theorem). The extreme distribution of the F-distribution (when the degrees of freedom in the denominator go to infinity) is chi-square distribution. The p-value from the F-distribution is slightly larger than the p-value from the chi-square distribution, meaning the F-distribution is more conservative. The difference decreases as sample size increases.

Value

`n`	number of observations
`paraFull`	number of parameters of full model
`paraReduced`	number of parameters of reduced model
`deltaPara`	difference of parameter counts
`cutoff`	cutoff, threshold, critical value of log-likelihood for the test
`deltaLogLik`	difference of log likelihood, if negative 0 is used.
`Chisq` or `Fval`	statistics according to the used distribution Chi-square of F
`pval`	p-value of null hypothesis. i.e. the reduced model is better.
`Verdict`	the model preferred.

Author(s)

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References

1. Ruppert D, Cressie N, Carroll RJ. A Transformation/Weighting Model For Estimating Michaelis-Menten Parameters. School of Operations Research and Industrial Engineering, College of Engineering, Cornell University. Technical Report No. 796. May 1988.
2. Scheffé H. The Analysis of Variance. Wiley. 1959.
3. Wilks SS. The Large-Sample Distribution of the Likelihood Ratio for Testing Composite Hypotheses. *Annals Math. Statist.* 1938;9:60-62

Examples

```
LRT(20, 4, 2, -58.085, -60.087)
LRT(20, 4, 2, -58.085, -60.087, Wilks=TRUE)
LRT(20, 4, 2, -57.315, -66.159)
LRT(20, 4, 2, -57.315, -66.159, Wilks=TRUE)

r1 = lm(mpg ~ disp + drat + wt, mtcars)
r2 = lm(mpg ~ disp + drat, mtcars)
anova(r2, r1)
LRT(nrow(mtcars), r1$rank, r2$rank, logLik(r1), logLik(r2))
```

OneTwo — *Likelihood Ratio Test for One group vs Two group gaussian mixture model*

Description

With a given vector, it performs likelihood ratio test which model - one or two group - is better.

Usage

```
OneTwo(x, alpha=0.05)
```

Arguments

`x`	a vector of numbers
`alpha`	alpha value for type I error, significance level

Details

It performs likelihood ratio test using both F distribution and Chi-square distribution (by Wilks' theorem).

Value

`Estimate`	n, Mean, SD for each group assumption and prior probability of each group in two group model
`Delta`	delta number of parameters and log-likelihoods
`Statistic`	Statistics from both the F distribution and Chi-square distribtuion. Cutoff is in terms of log-likelihood not the statistic.

Author(s)

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Examples

```
OneTwo(c(7, 5, 17, 13, 16, 5, 7, 3, 8, 10, 8, 14, 14, 11, 14, 17, 2, 12, 15, 19))
OneTwo(c(5, 3, 0, 6, 5, 2, 6, 6, 4, 4, 15, 13, 18, 18, 19, 14, 19, 13, 19, 18))
```

ORLI — *Odds Ratio and its Likelihood Interval between two groups without strata*

Description

Odds ratio and its likelihood interval between two groups without stratification

Usage

```
ORLI(y1, n1, y2, n2, conf.level=0.95, k, eps=1e-8)
```

Arguments

`y1`	positive event count of test (the first) group
`n1`	total count of the test (the first) group. Maximum allowable value is 1e8.
`y2`	positive event count of control (the second) group
`n2`	total count of control (the second) group. Maximum allowable value is 1e8.
`conf.level`	approximate confidence level to calculate k when k is missing.
`k`	1/k likelihood interval will be provided
`eps`	absolute value less than eps is regarded as negligible

Details

It calculates risk (proportion) difference and its likelihood interval between the two groups. The likelihood interval is asymmetric, and there is no standard error in the output. This does not support stratification.

Value

There is no standard error.

`odd1`	odd from the first group, y1/(n1 - y1)
`odd2`	odd from the second group, y2/(n2 - y2)
`OR`	odds ratio, odd1/odd2
`lower`	lower likelihood limit of OR
`upper`	upper likelihood limit of OR

Author(s)

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Examples

```
ORLI(7, 10, 3, 10)
ORLI(3, 10, 7, 10)
```

RDLI — *Risk (Proportion) Difference and its Likelihood Interval between two groups without strata*

Description

Risk difference and its likelihood interval between two groups without stratification

Usage

```
RDLI(y1, n1, y2, n2, conf.level=0.95, k, eps=1e-8)
```

Arguments

`y1`	positive event count of test (the first) group
`n1`	total count of the test (the first) group. Maximum allowable value is 1e8.
`y2`	positive event count of control (the second) group
`n2`	total count of control (the second) group. Maximum allowable value is 1e8.
`conf.level`	approximate confidence level to calculate k when k is missing.
`k`	1/k likelihood interval will be provided
`eps`	absolute value less than eps is regarded as negligible

Details

It calculates risk (proportion) difference and its likelihood interval between the two groups. The likelihood interval is asymmetric, and there is no standard error in the output. This does not support stratification.

Value

There is no standard error.

`p1`	proportion from the first group, y1/n1
`p2`	proportion from the second group, y2/n2
`RD`	risk difference, p1 - p2
`lower`	lower likelihood limit of RD
`upper`	upper likelihood limit of RD

Author(s)

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Examples

```
RDLI(7, 10, 3, 10)
RDLI(3, 10, 7, 10)
```

RRLI *Relative Risk and its Likelihood Interval between two groups without strata*

Description

Relative risk and its likelihood interval between two groups without stratification

Usage

```
RRLI(y1, n1, y2, n2, conf.level=0.95, k, eps=1e-8)
```

Arguments

`y1`	positive event count of test (the first) group
`n1`	total count of the test (the first) group. Maximum allowable value is 1e8.
`y2`	positive event count of control (the second) group
`n2`	total count of control (the second) group. Maximum allowable value is 1e8.
`conf.level`	approximate confidence level to calculate k when k is missing.
`k`	1/k likelihood interval will be provided
`eps`	absolute value less than eps is regarded as negligible

Details

It calculates relative risk and its likelihood interval between the two groups. The likelihood interval is asymmetric, and there is no standard error in the output. This does not support stratification.

Value

There is no standard error.

`p1`	proportion from the first group, y1/n1
`p2`	proportion from the second group, y2/n2
`RR`	relative risk, p1/p2
`lower`	lower likelihood limit of RR
`upper`	upper likelihood limit of RR

Author(s)

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Examples

```
RRLI(7, 10, 3, 10)
RRLI(3, 10, 7, 10)
```

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