Package 'tcl'

September 20, 2019

Type Package

Title Testing in Conditional Likelihood Context

Version 0.1.0

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Description An implementation of extended Rasch modeling hypothesis testing in R. Provides 4 statistical tests, i.e. gradient test (GR), likelihood ratio test (LR), Rao score or Lagrange multiplier test (RS), and Wald test, for testing a number of hypotheses referring to the Rasch model (RM), linear logistic test model (LLTM), rating scale model (RSM), and partial credit model (PCM).

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Depends R (>= 3.1)

Imports eRm, numDeriv, graphics, grDevices, stats, methods, MASS, splines, Matrix, lattice

Suggests knitr, rmarkdown

Encoding UTF-8

LazyData true

LazyLoad true

NeedsCompilation no

RoxygenNote 6.1.1

VignetteBuilder knitr

Repository CRAN

Date/Publication 2019-09-20 10:10:02 UTC

R topics documented:

`change_test` *Tests in context of measurement of change using LLTM.*

Description

Computes gradient (GR), likelihood ratio (LR), Rao score (RS) and Wald (W) test statistics for hypotheses on parameters expressing change between two time points.

Usage

```
change_test(X)
```

Arguments

`X`	data matrix containing the responses of n persons to 2k binary items. Columns 1 to k contain the responses to k items at time point 1, and columns (k+1) to 2k the responses to the same k items at time point 2.

Details

Assume all items be presented twice (2 time points) to the same persons. The data matrix X has n rows (number of persons) and 2k columns considered as virtual items. Assume a constant shift of item difficulties of each item between the 2 time points represented by one parameter. The shift parameter is the only parameter of interest. Test of hypothesis that shift parameter equals zero against the two-sided alternative that shift parameter is not equal to zero.

Value

A list of test statistics, degrees of freedom, and p-values.

`test`	a numeric vector of gradient (GR), likelihood ratio (LR), Rao score (RS), and Wald test statistics.
`df`	degrees of freedom.
`pvalue`	a numeric vector of corresponding p-values.
`call`	the matched call.

References

Fischer, G. H. (1995). The Linear Logistic Test Model. In G. H. Fischer & I. W. Molenaar (Eds.), Rasch models: Foundations, Recent Developments, and Applications (pp. 131-155). New York: Springer.

Fischer, G. H. (1983). Logistic Latent Trait Models with Linear Constraints. Psychometrika, 48(1), 3-26.

See Also

`invar_test`, and `LLTM_test`.

Examples

```
# Numerical example with 400 persons and 4 items
# presented twice, thus 8 virtual items

# Data y generated under the assumption that shift parameter equals 0
# (no change from time point 1 to 2)

# design matrix W used only for exmaple data generation
#     (not used for estimating in change_test function)
W <- rbind(c(1,0,0,0,0),
  c(0,1,0,0,0),
  c(0,0,1,0,0),
  c(0,0,0,1,0),
  c(1,0,0,0,1),
  c(0,1,0,0,1),
  c(0,0,1,0,1),
  c(0,0,0,1,1))

# eta Parameter, first 4 are nuisance
# (easiness parameters of the 4 items at time point 1),
# last one is the shift parameter
eta <- c(-2,-1,1,2,0)

y <- eRm::sim.rasch(persons = rnorm(400), items = colSums(eta * t(W)))

res <- change_test(X = y)

res$test # test statistics
res$df # degrees of freedoms
res$pvalue # p-values
```

`invar_test` *Test of invariance of item parameters between two groups.*

Description

Computes gradient (GR), likelihood ratio (LR), Rao score (RS) and Wald (W) test statistics for hypothesis of equality of item parameters between two groups of persons against a two-sided alternative that at least one item parameter differs between the two respected groups.

Usage

```
invar_test(X, splitcr = "median", model = "RM")
```

Arguments

`X`	data matrix.
`splitcr`	split criterion which is either "mean", "median" or a numeric vector x.

"mean" corresponds to division of the sample according to the mean of the person score.

"median" corresponds to division of the sample according to the median of the person score.

x has length equal to number of persons and contains zeros and ones indicating group membership of the persons.

`model` RM, PCM, RSM

Value

A list of test statistics, degrees of freedom, and p-values.

`test`	a numeric vector of gradient (GR), likelihood ratio (LR), Rao score (RS), and Wald test statistics.
`df`	degrees of freedom.
`pvalue`	a numeric vector of corresponding p-values.
`call`	the matched call.

References

Draxler, C. (2010). Sample Size Determination for Rasch Model Tests. Psychometrika, 75(4), 708–724.

Draxler, C., & Alexandrowicz, R. W. (2015). Sample Size Determination Within the Scope of Conditional Maximum Likelihood Estimation with Special Focus on Testing the Rasch Model. Psychometrika, 80(4), 897–919.

Draxler, C., Kurz, A., & Lemonte, A. J. (2019). The Gradient Test and its Finite Sample Size Properties in a Conditional Maximum Likelihood and Psychometric Modeling Context. Submitted for publication.

Glas, C. A. W., & Verhelst, N. D. (1995a). Testing the Rasch Model. In G. H. Fischer & I. W. Molenaar (Eds.), Rasch Models: Foundations, Recent Developments, and Applications (pp. 69–95). New York: Springer.

Glas, C. A. W., & Verhelst, N. D. (1995b). Tests of Fit for Polytomous Rasch Models. In G. H. Fischer & I. W. Molenaar (Eds.), Rasch Models: Foundations, Recent Developments, and Applications (pp. 325-352). New York: Springer.

Lemonte, A. J. (2016). The Gradient Test. Another Likelihood-Based Test. London:Academic Press.

Terrell, G. R. (2002). The Gradient Statistic. Computing Science and Statistics, 34(34), 206–215.

See Also

`change_test`, and `LLTM_test`.

Examples

```
##### Rasch Model #####
y <- eRm::sim.rasch(persons = rnorm(400), c(0,-3,-2,-1,0,1,2,3))
x <- c(rep(1,200),rep(0,200))

res <- invar_test(y, splitcr = x, model = "RM")

res$test # test statistics
res$df # degrees of freedoms
res$pvalue # p-values
```

`LLTM_test` *Testing linear restrictions on parameter space of item parameters of RM.*

Description

Computes gradient (GR), likelihood ratio (LR), Rao score (RS) and Wald (W) test statistics for hypotheses defined by linear restrictions on item parameters of RM.

Usage

```
LLTM_test(X, W)
```

Arguments

`X`	data matrix.
`W`	design matrix of LLTM.

Details

The RM item parameters are assumed to be linear in the LLTM parameters. The coefficients of linear functions are specified by a design matrix W. In this context, the LLTM is considered as a more parsimonous model than the RM. The LLTM parameters can be interpreted as the difficulties of certain cognitive operations needed to respond correctly to psychological test items. The item parameters of the RM are assumed to be linear combinations of these cognitive operations. These linear combinations are defined in the design matrix W.

Value

A list of test statistics, degrees of freedom, and p-values.

`test`	a numeric vector of gradient (GR), likelihood ratio (LR), Rao score (RS), and Wald test statistics.
`df`	degrees of freedom.
`pvalue`	a numeric vector of corresponding p-values.
`call`	the matched call.

References

Fischer, G. H. (1995). The Linear Logistic Test Model. In G. H. Fischer & I. W. Molenaar (Eds.), Rasch models: Foundations, Recent Developments, and Applications (pp. 131-155). New York: Springer.

Fischer, G. H. (1983). Logistic Latent Trait Models with Linear Constraints. Psychometrika, 48(1), 3-26.

See Also

change_test, and invar_test.

Examples

```
# Numerical example assuming no deviation from linear restriction

# design matrix W defining linear restriction
W <- rbind(c(1,0), c(0,1), c(1,1), c(2,1))

# assumed eta parameters of LLTM for data generation
eta <- c(-0.5, 1)

# assumed vector of item parameters of RM
b <- colSums(eta * t(W))

y <- eRm::sim.rasch(persons = rnorm(400), items = b - b[1])  # sum0 = FALSE

res <- LLTM_test(X = y, W = W )

res$test # test statistics
res$df # degrees of freedoms
res$pvalue # p-values
```

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tcl_hessian *Computation of Hessian matrix.*

Description

Uses function `hessian()` from numDeriv package to compute (approximate numerically) Hessian matrix evaluated at arbitrary values of item easiness parameters.

Usage

```
tcl_hessian(X, eta, W, model = "RM")
```

Arguments

X	data matrix.
eta	numeric vector of item easiness parameters.
W	design matrix.
model	RM, PCM, RSM, LLTM.

Value

Hessian matrix evaluated at eta

References

Gilbert, P., Gilbert, M. P., & Varadhan, R. (2016). numDeriv: Accurate Numerical Derivatives. R package version 2016.8-1.1. url: https://CRAN.R-project.org/package=numDeriv

Examples

```
# Rasch model with beta_1 restricted to 0
y <- eRm::raschdat1
res <- eRm::RM(X = y, sum0 = FALSE)
mat <- tcl_hessian(X = y, eta = res$etapar, model = "RM")
```

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tcl_scorefun *Computation of score funtion.*

Description

Uses function jacobian() from numDeriv package to compute (approximate numerically) score function (first order partial derivatives of conditional log likelihood function) evaluated at arbitrary values of item easiness parameters.

Usage

```
tcl_scorefun(X, eta, W, model = "RM")
```

Arguments

X	data matrix.
eta	numeric vector of item easiness parameters.
W	design matrix.
model	RM, PCM, RSM, LLTM.

Value

Score function evaluated at eta

References

Gilbert, P., Gilbert, M. P., & Varadhan, R. (2016). numDeriv: Accurate Numerical Derivatives. R package version 2016.8-1.1. url: https://CRAN.R-project.org/package=numDeriv

Examples

```
# Rasch model with beta_1 restricted to 0
y <- eRm::raschdat1
res <- eRm::RM(X = y, sum0 = FALSE)
scorefun <- tcl_scorefun(X = y, eta = res$etapar, model = "RM")
```

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