Package 'mdsdt'

September 30, 2014

Version 1.0

Date 2014-09-27

Title Functions for Analysis of Data with General Recognition Theory

Author Robert X.D. Hawkins <rxdh@stanford.edu>, Joe Houpt <joseph.houpt@wright.edu>, Noah Silbert <noahpoah@gmail.com>, Leslie Blaha <Leslie.Blaha@wpafb.af.mil>, Thomas D. Wickens <twickens@socrates.berkeley.edu>

Maintainer Robert X.D. Hawkins <rxdh@stanford.edu>

Depends R (>= 1.8.0), ellipse, mnormt, polycor

Description This package contains a series of tools associated with General Recognition Theory (Townsend & Ashby, 1986), including Gaussian model fitting of 4x4 and more general confusion matrices, associated plotting and model comparison tools,and tests of marginal response invariance and report independence.

License GPL (>= 2)

Collate 'grt-data.R' 'grt_base.R'

NeedsCompilation no

Repository CRAN

Date/Publication 2014-09-30 07:50:30

R topics documented:

`fit.grt` *Fit full Gaussian GRT model*

Description

Use Newton-Raphson gradient descent to fit the mean and covariance of a bivariate Gaussian distribution for each stimulus class, subject to given constraints. Standard case uses confusion matrix from a 2x2 full-report identification experiment, but will also work in designs with N levels of confidence associated with each dimension (e.g. in Wickens, 1992).

Usage

```
fit.grt(freq, PS_x = FALSE, PS_y = FALSE, PI = "none")
```

Arguments

`freq`	Can be entered in two ways: 1) a 4x4 confusion matrix containing counts, with each row corresponding to a stimulus and each column corresponding to a response. row/col order must be aa, ab, ba, bb. 2) A three-way 'xtabs' table with the stimuli as the third index and the NxN possible responses as the first two indices.
`PS_x`	if TRUE, will fit model with assumption of perceptual separability on the x dimension
`PS_y`	if TRUE, will fit model with assumption of perceptual separability on the y dimension
`PI`	'none' by default, imposing no restrictions and fitting different correlations for all distributions. If 'same_rho', will constrain all distributions to have same correlation parameter. If 'all', will constain all distribution to have 0 correlation.

Value

An S3 `grt` object

Examples

```
# Fit unconstrained model
data(thomasB);
grt_obj <- fit.grt(thomasB);

# Use standard S3 generics to examine
print(grt_obj);
summary(grt_obj);
plot(grt_obj);

# Fit model with assumption of perceptual separability on both dimensions
grt_obj_PS <- fit.grt(thomasB, PS_x = TRUE, PS_y = TRUE);
summary(grt_obj_PS);
plot(grt_obj_PS);

# Compare models
GOF(grt_obj, teststat = 'AIC');
GOF(grt_obj_PS, teststat = 'AIC');
```

GOF *Goodness of fit tests*

Description

Includes a number of common goodness of fit measures to compare different models.

Usage

```
GOF(bb, teststat = "X2", observed = NULL)
```

Arguments

`bb` a `grt` object

`teststat` a string indicating which statistic to use in the test. May be one of the following:

- 'X2'for a chi-squared test
- 'G2'for a likelihood-ratio G-test
- 'AIC'for Akaike information criterion score
- 'AIC.c'for the AIC with finite sample size correction
- 'BIC'for Bayesian information criterion score

`observed` optional, to provide a matrix of observed frequencies if no fit conducted.

Examples

```
data(thomasA)
fit1 <- fit.grt(thomasA)
fit2 <- fit.grt(thomasA, PI = 'same_rho')

# Take the model with the lower AIC
GOF(fit1, teststat = 'AIC')
GOF(fit2, teststat = 'AIC')
```

`mriTest` *Tests marginal response invariance at both levels on each dimension*

Description

Tests marginal response invariance at both levels on each dimension

Usage

```
mriTest(x)
```

Arguments

`x`	four-by-four confusion matrix

Details

If the p value for either level of the x dimension is significant, we are justified in rejecting the null hypothesis of perceptual separability on the x dimension. Similarly for the y dimension.

The estimator is derived in a footnote of Thomas (2001).

Value

data frame containing z-scores and p-values for all four tests

Source

Ashby, F. G., & Townsend, J. T. (1986). Varieties of perceptual independence. Psychological review, 93(2), 154.

Thomas, R. D. (2001).Perceptual interactions of facial dimensions in speeded classification and identification. Perception \& Psychophysics, 63(4), 625–650.

Silbert, N. H., & Thomas, R. D. (2013). Decisional separability, model identification, and statistical inference in the general recognition theory framework. Psychonomic bulletin & review, 20(1), 1-20.

Examples

```
data(thomasA)
mriTest(thomasA)
```

plot.grt — *Plot the object returned by fit.grt*

Description

Plot the object returned by fit.grt

Usage

```
## S3 method for class 'grt'
plot(x, level = 0.5, xlab = NULL,
  ylab = NULL, ...)
```

Arguments

`x`	a grt object, as returned by fit.grt
`level`	number between 0 and 1 indicating which contour to plot (defaults to .5)
`xlab`	optional label for the x axis (defaults to NULL)
`ylab`	optional label for the y axis (defaults to NULL)
`...`	Arguments to be passed to methods, as in generic plot function

print.grt — *print.grt*

Description

Print the object returned by fit.grt

Usage

```
## S3 method for class 'grt'
print(x, ...)
```

Arguments

`x`	An object returned by fit.grt
`...`	further arguments passed to or from other methods, as in the generic print function

riTest — *Tests report independence for each stimulus response distribution*

Description

Tests report independence for each stimulus response distribution

Usage

```
riTest(x)
```

Arguments

`x`	four-by-four confusion matrix

Details

If p value is sufficiently low, we're justified in rejecting the null hypothesis of sampling within that factor. p values come from a chi-squared test on the confusion matrix, as explaned in a footnote of Thomas (2001).

Value

data frame containing z-scores and p-values for all four tests

Source

Ashby, F. G., & Townsend, J. T. (1986). Varieties of perceptual independence. Psychological review, 93(2), 154.

Thomas, R. D. (2001).Perceptual interactions of facial dimensions in speeded classification and identification. Perception \& Psychophysics, 63(4), 625–650.

Silbert, N. H., & Thomas, R. D. (2013). Decisional separability, model identification, and statistical inference in the general recognition theory framework. Psychonomic bulletin & review, 20(1), 1-20.

Examples

```
data(thomasA)
riTest(thomasA)
```

`silbert09a` *Frequency vs. Duration confusion matrix*

Description

Confusion matrix from auditory perception experiment, in which listeners identified noise stimuli varying across frequency range and duration (Experiment 1, Observer 3 in Ref.)

Format

A `matrix` instance, containing counts for all stimulus-response combinations. Rows correspond to stimuli, columns to responses

Author(s)

Noah H. Silbert

Source

Silbert, N. H., Townsend, J. T., & Lentz, J. J. (2009). Independence and separability in the perception of complex nonspeech sounds. Attention, Perception, & Psychophysics, 71(8), 1900-1915.

`silbert09b` *Pitch vs. Timbre confusion matrix*

Description

Confusion matrix from auditory perception experiment, in which listeners identified 13-component harmonic stimuli varying across fundamental frequency and location of spectral prominence (Experiment 2, Observer 7 in Ref..

Format

A `matrix` instance, containing counts for all stimulus-response combinations. Rows correspond to stimuli, columns to responses

Author(s)

Noah H. Silbert

Source

Silbert, N. H., Townsend, J. T., & Lentz, J. J. (2009). Independence and separability in the perception of complex nonspeech sounds. Attention, Perception, & Psychophysics, 71(8), 1900-1915.

silbert12 *Phoneme confusion matrix*

Description

Confusion matrix from speech perception experiment probing confusions between noise-masked tokens of English [p],[b],[f], and [v] (observer 3 in Ref.)

Format

A `matrix` instance, containing counts for all stimulus-response combinations. Rows correspond to stimuli, columns to responses

Author(s)

Noah H. Silbert

Source

Silbert, N. H. (2012). Syllable structure and integration of voicing and manner of articulation information in labial consonant identification. Journal of the Acoustical Society of America, 131(5), 4076-4086.

summary.grt *summary.grt*

Description

Summarize the object returned by fit.grt

Usage

```
## S3 method for class 'grt'
summary(object, ...)
```

Arguments

`object`	An object retrned by fit.grt
`...`	additional arguments affecting the summary produced, as in the generic summary function

thomasA — *Face recognition confusion matrix for Observer A*

Description

This data set contains the results of a full-report face recognition experiment reported in Thomas (2001). For Observer A, the two channels are degree of eye separation and nose length.

Format

a `matrix` instance, containing counts for all stimulus-response combinations. Each row corresponds to a different stimulus presentation (in the order aa, ab, ba, bb) and each column in that row represents the frequency of each response (in the order aa, ab, ba, bb).

Author(s)

Robin D. Thomas

Source

Thomas, R. D. (2001). Characterizing perceptual interactions in face identification using multidimensional signal detection theory. In M.Wenger & J.T. Townsend (Eds.) Computational, geometric, and process perspectives on facial cognition: Contexts and challenges. Hillsdale, NJ: Erlbaum.

thomasB — *Face recognition confusion matrix for Observer B*

Description

This data set contains the results of a full-report face recognition experiment reported in Thomas (2001). For Observer B, the two channels are degree of eye separation and mouth width.

Format

a `matrix` instance, containing counts for all stimulus-response combinations. Each row corresponds to a different stimulus presentation (in the order aa, ab, ba, bb) and each column in that row represents the frequency of each response (in the order aa, ab, ba, bb).

Author(s)

Robin D. Thomas

Source

Thomas, R. D. (2001). Characterizing perceptual interactions in face identification using multidimensional signal detection theory. In M.Wenger & J.T. Townsend (Eds.) Computational, geometric, and process perspectives on facial cognition: Contexts and challenges. Hillsdale, NJ: Erlbaum.

`wo89xt` *Cross-tabulated concurrent detection data*

Description

This data set contains a slightly coarse-grained version of Table 1 from Wickens and Olzak (1989). For each of four possible combinations of stimuli, participants gave a graded confidence judgement (collapsed here to 1-4) on both dimensions concurrently. A rating of 1 corresponded to "definitely absent" and a rating of 4 corresponded to "definitely present".

Format

an `xtabs` instance, containing counts for all stimulus-response combinations. For each of 4 Stim levels (where NN = absent+absent, LN = low-frequency signal+absent, NH = absent+high-frequency signal, LH = low-frequency signal+high-frequency signal), there is a 4x4 table giving the frequency of each rating.

Author(s)

Thomas D. Wickens and Lynn A. Olzak

Source

Wickens, T. D., & Olzak, L. A. (1989). The statistical analysis of concurrent detection ratings. Perception & psychophysics, 45(6), 514-528.

Index