Package ‘mdsdt’

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Title Functions for Analysis of Data with General Recognition Theory

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

Description Tools associated with General
Recognition Theory (Townsend & Ashby, 1986), including Gaussian model fitting of 2x2 and more
general designs, associated plotting and model comparison tools,
and tests of marginal response invariance and report independence.

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

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R topics documented:

`anova.grt` *Compare nested GRT models*

Description

Conducts a likelihood-ratio G-test on nested GRT models. Currently only accepts pairs of nested models, not arbitrary sequences.

Usage

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

Arguments

`object`	A fitted GRT model returned by fit.grt
`...`	A larger GRT model, with model1 nested inside

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

Description

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", method = NA)
```

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 a_1b_1, a_1b_2, a_2b_1, a_2b_2. 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 (FALSE by default)
`PS_y`	if TRUE, will fit model with assumption of perceptual separability on the y dimension (FALSE by default)
`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.
`method`	The optimization method used to fit the Gaussian model. Newton-Raphson gradient descent by default, but may also specify any method available in `optim`, e.g. "BFGS".

Value

An S3 `grt` object

Examples

```
# Fit unconstrained model
data(thomas01b);
grt_obj <- fit.grt(thomas01b);

# 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(thomas01b, 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` *Conduct goodness of fit tests*

Description

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

Usage

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

Arguments

grtMod	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(thomas01a)
fit1 <- fit.grt(thomas01a)
fit2 <- fit.grt(thomas01a, PI = 'same_rho')

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

---

mriTest *Test marginal response invariance*

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(thomas01a)
mriTest(thomas01a)
```

`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,
  marginals = F, main = "", plot.mu = T, ...)
```

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)
`marginals`	Boolean indicating whether or not to plot marginals (only available for 2x2 model; defaults to FALSE)
`main`	string to use as title of plot (defaults to empty string)
`plot.mu`	Boolean indicating whether or not to plot means (defaults to T)
`...`	Arguments to be passed to methods, as in generic plot function

print.grt — *Print the object returned by fit.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 — *Test report independence*

Description

Test 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(thomas01a)
riTest(thomas01a)
```

`silbert09a` *2x2 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.)

Usage

```
data(silbert09a)
```

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 *2x2 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..

Usage

```
data(silbert09b)
```

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 *2x2 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.)

Usage

```
data(silbert12)
```

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` *Summarize the object returned by fit.grt*

Description

Summarize the object returned by fit.grt

Usage

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

Arguments

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

---

`thomas01a` *2x2 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.

Usage

```
data(thomas01a)
```

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.

`thomas01b` *2x2 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.

Usage

```
data(thomas01b)
```

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.

`thomas15a` *3x3 face recognition confusion matrix for Observer A*

Description

This data set contains the results of a 3x3 full-report face recognition experiment reported in Thomas et al (2015). The two channels are degree of eye separation and nose width, with three levels on each dimension.

Usage

```
data(thomas15a)
```

Format

an `xtabs` instance, containing counts for all stimulus-response combinations. The first two dimensions consist of the response counts on each level of nose width and eye separation, respectively, and the third dimension indexes the stimulus.

Author(s)

Robin D. Thomas

Source

Thomas, R. D., Altieri, N. A., Silbert, N. H., Wenger, M. J., & Wessels, P. M. (2015). Multidimensional signal detection decision models of the uncertainty task: Application to face perception. Journal of Mathematical Psychology, 66, 16-33.

`thomas15b` *3x3 face recognition confusion matrix for Observer B*

Description

This data set contains the results of a 3x3 full-report face recognition experiment reported in Thomas et al (2015). The two channels are degree of eye separation and nose width, with three levels on each dimension.

Usage

```
data(thomas15b)
```

Format

an `xtabs` instance, containing counts for all stimulus-response combinations. The first two dimensions consist of the response counts on each level of nose width and eye separation, respectively, and the third dimension indexes the stimulus.

Author(s)

Robin D. Thomas

Source

Thomas, R. D., Altieri, N. A., Silbert, N. H., Wenger, M. J., & Wessels, P. M. (2015). Multidimensional signal detection decision models of the uncertainty task: Application to face perception. Journal of Mathematical Psychology, 66, 16-33.

`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".

Usage

```
data(wo89xt)
```

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.

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