RanCh

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Title Tools for abstract discrete Random Choice

URL http://github.com/mccauslw/RanCh

BugReports http://github.com/mccauslw/RanCh/issues

Version 0.0.0.9000

Description This package provides tools for a research project whose purpose is to help us better understand the foundations of stochastic discrete choice. It includes datasets compiled from the literature on context effects and stochastic intransitivity and from some recent experiments. It provides graphical tools to display likelihood function and posterior density contours, as well as regions, in the space of choice probabilities, defined by various stochastic choice axioms, context effects and other conditions.

Imports klaR,
MASS,
bitops,
Smisc,
knitr,
rmarkdown

Depends R (>= 3.6.0)

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Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

Suggests

VignetteBuilder knitr

R topics documented:

`binary2ternary` *Transform 2nd order barycentric coordinates to 3rd order*

Description

`binary2ternary` transforms the 2nd order barycentric coordinates of the rows of `binary_points` into the 3rd order barycentric coordinates of the rows of `ternary_points`. This is useful for plotting points and line segments of binary choice probabilities on the sides of the 3rd order barycentric coordinate system. The two non-zero columns of the result are specified in the 2-vector ternary_cols.

Usage

```
binary2ternary(binary_points, ternary_cols)
```

Arguments

binary_points	matrix of points, with each row a 2-vector on the 1-simplex
ternary_cols	2-vector specifying the columns of the result corresponding to the two columns of binary_points

Value

matrix of points, with each row a 3-vector on the 2-simplex. The first element of ternary_cols gives the column of the result that takes the values of the first column of binary_points; the second element gives the column of the result taking the values of the second column of binary_points. The remaining column of the result is set to zero.

Examples

```
binary2ternary(matrix(c(0.6, 0.4), nrow=1), c(2,3)) # returns 1x3 matrix [0 0.6 0.4]
binary2ternary(matrix(c(0.6, 0.4), nrow=1), c(3,2)) # returns 1x3 matrix [0 0.4 0.6]
```

BM_terms *Compute Block-Marschack terms from a random choice structure*

Description

BM_terms returns a matrix of the same dimensions as the input matrix, a random choice structure P. The non-NA terms are all non-negative if and only if the random choice structure P satisfies random utility.

Usage

```
BM_terms(P)
```

Arguments

P	A random choice structure. Element P[A,x] is the probability that x is chosen when choice set A is presented.

Value

A matrix of Block-Marschak terms. If Q is the result, then for all random rankings of the elements of the universe of objects than induce the random choice structure P, element Q[A,x] is the probability that x is ranked higher than any other element of choice set A and lower than any element in the complement of A in the universe of objects. If $x \notin A$, then Q[A,x] has value NA. The RCS P satisfies random utility if and only if for all $x \in A \subseteq T$, $Q_A(x) \geq 0$

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
Q <- BM_terms(P)
Q
```

compromise *Check if choice probabilities exhibit compromise effect*

Description

compromise returns TRUE if the specified binary and ternary choice probabilities in random choice structure P are in the specified compromise effect region.

Usage

```
compromise(P, target, competitor, decoy, two_sided = FALSE)
```

Arguments

P	matrix, random choice structure
target	index of target object
competitor	index of competitor object
decoy	index of decoy object
two_sided	logical value indicating whether the compromise inequality is to hold also for competitor and decoy exchanged.

Value

A logical value indicating whether the appropriate choice probabilities are in the similarity effect region.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
compromise(P, target=1, competitor=2, decoy=3)
```

compromise_X3 *Compromise effect regions*

Description

compromise_X3 constructs six regions (all polygons) associated with binary-ternary compromise effects. Below, x and z are the extreme choice objects and y is the between (or compromise) object. The interior of each polygon gives the set of ternary choice probabilities consistent with (1) the two specified binary choice probabilities and (2) one of six compromise effect conditions.

Usage

```
compromise_X3(pyx, pyz)
```

Arguments

pyx	scalar, probability $p(y, x)$ of choosing y when presented with choice set $\{x, y\}$.
pyz	scalar, probability $p(y, z)$ of choosing y when presented with choice set $\{y, z\}$.

Value

named list of six polygons in a barycentric coordinate system. Each polygon is a matrix, with one row for each polygon vertex and one column for each of the three choice objects x, y and z. Element i, j gives the probability of choosing j when presented with choice set $\{x, y, z\}$, at the i'th polygon vertex. The six polygons—triangles except for `Cxz`, a quadrilateral—are:

`Cxyz` region where there is a compromise effect with y as target, x as competitor and z as decoy

`Czyx` region where there is a compromise effect with y as target, z as competitor and x as decoy

`Co` region where there is neither compromise effect

`Cx` region with only the x effect

`Cz` region with only the z effect

`Cxz` region with both effects

See Also

`similarity_X3` for an analogous function for the similarity effect.

Examples

```
C <- compromise_X3(0.5, 0.6)
```

`create_P3` *Random Choice Structure for a three-object universe*

Description

`create_P3` creates a random choice structure for a three-object universe from

Usage

```
create_P3(p12, p23, p13, P1, P2, names = c("x", "y", "z"))
```

Arguments

`p12`	Probability of chosing object 1 when presented with objects 1 and 2
`p23`	Probability of chosing object 2 when presented with objects 2 and 3
`p13`	Probability of chosing object 1 when presented with objects 1 and 3
`P1`	Probability of chosing object 1 when presented with objects 1, 2 and 3
`P2`	Probability of chosing object 2 when presented with objects 1, 2 and 3
`names`	character vector giving names to the three objects

Value

A Random Choice Structure

Examples

```
P <- create_P3(21/40, 37/40, 28/40, 19/40, 15/40, names=c('Red', 'Purple', 'Pink'))
P
```

dDir *Dirichlet density function*

Description

dDir computes the Dirichlet density at a point p in the regular simplex, for a vector alpha of Dirichlet parameters.

Usage

```
dDir(p, alpha, log = FALSE)
```

Arguments

p	vector of probabilities on the regular simplex
alpha	vector of Dirichlet parameters
log	logical; if TRUE, the log density is returned

Value

density or log density value

Examples

```
f <- dDir(c(0.1, 0.3, 0.6), c(2.5, 0.5, 1.0))
```

dDir3_quantile *Quantile of density value for third order Dirichlet*

Description

dDir3_quantile computes an approximation of the given quantile of a third order Dirichlet density value, under that Dirichlet distribution.

Usage

```
dDir3_quantile(quantile, alpha, normalized = FALSE)
```

Arguments

quantile	the quantile of the desired density value
alpha	a vector of Dirichlet parameters
normalized	binary; if TRUE, return the quantile as a fraction of the maximum density value; if FALSE, return the unnormalized quantile.

Value

The value of the quantile, normalized or not

Dir2_HD_region — *Highest Density (HD) region for a second order Dirichlet distribution*

Description

Dir2_HD_region constructs a line segment approximating the highest density region of a second order Dirichlet distribution. The line segment is in a second order barycentric coordinate system. This can be used to compute highest prior density and highest posterior density (HPD) regions for a second order Dirichlet-multinomial model (i.e. a beta-binomial model).

Usage

```
Dir2_HD_region(alpha, HD_probability)
```

Arguments

alpha	vector of three (positive) Dirichlet parameters.
HD_probability	scalar in $[0, 1]$ giving the probability of the HD region

Value

matrix giving polygon approximation of HD region. Each row gives a polygon vertex. The three columns correspond to coordinates in a barycentric coordinate system.

Dir3_HD_region — *Highest Density (HD) region for a third order Dirichlet distribution*

Description

Dir3_HD_region constructs a polygon approximating the highest density region of a third order Dirichlet distribution. The polygon is in a three-dimensional barycentric coordinate system. This can be used to construct approximate highest prior density and highest posterior density (HPD) regions for a Dirichlet-multinomial model.

Usage

```
Dir3_HD_region(alpha, HD_probability)
```

Arguments

alpha	vector of three (positive) Dirichlet parameters.
HD_probability	scalar in [0,1] giving the probability of the HD region

Value

matrix giving polygon approximation of HD region. Each row gives a polygon vertex. The three columns correspond to coordinates in a barycentric coordinate system.

log_L_DCE_Dir_mult *Log likelihood for DCE, multiple Dirichlet-multinomial model*

Description

log_ML_DCE_Dir_mult computes the marginal likelihood for a model where choice count vectors are independent multinomial across choice sets and choice probability vectors are independent Dirichlet across choice sets.

Usage

```
log_L_DCE_Dir_mult(Alpha, N, log = TRUE)
```

Arguments

Alpha	matrix of Dirichlet parameters, each row giving the Dirichlet distribution of the corresponding row of a random choice structure.
N	count matrix with the same dimensions as Alpha, pertaining to the same universe of objects.
log	logical; if TRUE, return the log Bayes factor

log_L_DCE_multinomial *Log likelihood for DCE, multiple multinomial model*

Description

log_L_DCE_multinomial computes the log likelihood function for a count matrix as a function of a RCS.

Usage

```
log_L_DCE_multinomial(P, N, log = TRUE)
```

Arguments

P	matrix containing a random choice structure (RCS)
N	matrix containing counts from a discrete choice experiment (DCE)
log	logical; if TRUE, return the log likelihood; if FALSE, the likelihood. log=FALSE is usually not recommendend, as underflow is likely.

Value

log likelihood or likelihood

log_L_Dir_mult *Log likelihood, Dirichlet-multinomial model*

Description

log_L_Dir_mult computes the log marginal likelihood for a multinomial data generating process and a Dirichlet prior over choice probabilities.

Usage

```
log_L_Dir_mult(alpha, n, log = TRUE)
```

Arguments

alpha	vector of Dirichlet parameters
n	vector of multinomial counts
log	logical; if TRUE, return the log likelihood; if FALSE, the likelihood. log=FALSE is usually not recommendend, as underflow is likely.

Value

Marginal likelihood or log marginal likelihood

log_L_multinomial *Log likelihood for multinomial model*

Description

log_L_multinomial computes the log likelihood function for a multinomial model

Usage

```
log_L_multinomial(p, n, log = TRUE)
```

Arguments

p	vector of probabilities
n	vector of counts
log	logical; if TRUE, return the log likelihood; if FALSE, the likelihood. log=FALSE is usually not recommendend, as underflow is likely.

Value

log likelihood or likelihood

log_ML_DCE_vector_alpha_Dir_mult

Marginal likelihood for DCE, vector Dirichlet multinomial model

Description

`log_ML_DCE_vector_alpha_Dir_mult` computes the marginal likelihood for a model where choice probability vectors P_A are mutually independent, and

$$P_A(x_1, \ldots, x_{|A|}) \sim \mathrm{Di}(u_1, \ldots, u_|A|)$$

, and choices are conditionally independent multinomial.

Usage

```
log_ML_DCE_vector_alpha_Dir_mult(u, N, log = TRUE)
```

Arguments

`u`	vector determining Dirichlet parameters
`N`	count matrix
`log`	logical; if `TRUE`, return the log marginal likelihood; if `FALSE`, the marginal likelihood. `log=FALSE` is usually not recommendend, as underflow is likely.

marginalize

Routines for simple manipulations of count matrices and random choice structures.

Description

Marginalize a count matrix or random choice structure

Usage

```
marginalize(input_N, objects)
```

Arguments

`input_N`	A count matrix
`objects`	A vector of objects to retain

Details

This function takes as input a count matrix or random choice structure on a universe of objects and returns a marginalization of it to a universe that is a subset of the original universe.

Value

A count matrix

Examples

```
N_bce <- marginalize(PC_counts['Beer',,], c(2, 3, 5)) # Marginalize data first
P_bce_1 <- proportions(N_bce)                         # then compute proportions
P <- proportions(PC_counts['Beer',,])   # Compute proportions first
P_bce_2 <- marginalize(P, c(2, 3, 5))   # then marginalize. Gives same result.
```

MC_counts *Choice counts in multiple choice experiment*

Description

A 141 by 31 by 5 array of count data. Element i, j, k gives the number of times subject i chose object k when presented with choice set j. The choice set index j=1,...,31 encodes a non-empty subset of the universe of the five choice objects a, b, c, d and e, numbered 1, 2, 3, 4, 5. Whenever k is not an element of j, the value is NA.

Usage

```
MC_counts
```

Format

An object of class array of dimension 141 x 31 x 5.

See Also

RanCh, under Datasets for a description of the experiment. Other data objects for the experiment include MC_trials, a table of choice trial data, and MC_raw, a table of raw data. set_index describes how the choice set index encodes the choice set.

MC_raw *Multiple Choice experiment data*

Description

Raw trial-by-trial data from Multiple Choice experiment

Usage

```
MC_raw
```

Format

A data frame with 53 variables generated in (WJM) We do not provide documentation, although the variable names are suggestive.

See Also

RanCh, under Datasets for a description of the experiment. Other data objects for the experiment include MC_trials, a table of choice trial data, and MC_counts, an array of choice count data.

MC_trials *Table of choice trial data from the Multiple Choice experiment*

Description

Table of choice trial data from the Multiple Choice experiment

Usage

```
MC_trials
```

Format

A tibble with 18 variables

`subject` subject identifier

`trial` trial identifier (gives the order in which a subject sees choice sets)

`set` factor, name of choice set presented: 'ab', 'cde', etc., with objects in alphabetical order

`choice` factor, choice made by subject: 'a', 'b', 'c', 'd' or 'e'

`set_perm` factor, order of presentation of objects on screen, left to right

`set_card` integer, cardinality of choice set (i.e. number of available options)

`set_bin` binary representation of choice set (binary digits indicate object membership in choice set)

`choice_int` integer, code for chosen object: a=1, b=2, ..., e=5

`ab`, `ac`, `...`, `de` revealed preference indicator: taking column ab as an example, the value is 1 if a is revealed preferred to b, -1 if b is revealed preferred to a, 0 otherwise.

See Also

`RanCh`, under `Datasets` for a description of the experiment. Other data objects for the experiment include `MC_counts`, an array of choice count data, and `MC_raw`, a table of raw data.

multiplicative_X3 *Compute a cross section of the multiplicative inequality region*

Description

`multiplicative_X3` computes the region (a triangle) of ternary probabilities consistent with given binary probabilities and the multiplicative inequality.

Usage

```
multiplicative_X3(P)
```

Arguments

`P`	A random choice structure

Value

A 3x3 matrix where each row gives one of the three vertices, in barycentric coordinates, of the triangular region where the multiplicative inequality holds.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
multiplicative_X3(P)
```

PC_counts *Array of choice count data from the Population Choice experiment*

Description

A 32 by 31 by 5 array of count data. Element i, j, k gives the number of subjects that chose object k when presented with choice set j of domain i. The choice set index j=1,...,31 encodes a non-empty subset of the universe of the five choice objects a, b, c, d and e, numbered 1, 2, 3, 4, 5. Whenever k is not an element of j, the value is NA.

Usage

```
PC_counts
```

Format

An object of class array of dimension 32 x 31 x 5.

See Also

RanCh, under Datasets for a description of the experiment. Other data objects for the experiment include PC_trials, a table of choice trial data, PC_demographics, a table of demographic information, and PC_raw, a table of raw data. set_index describes how the choice set index encodes the choice set.

PC_demographics *Table of demographic information from the Population Choice experiment*

Description

Table of demographic information from the Population Choice experiment

Usage

```
PC_demographics
```

Format

A data frame with demographic information on subjects

`sex` Sex of subject: 1 for male, 2 for female

`age` Age of subject in years

`location` Province or territory in Canada, 1=Alberta, 2=British Columbia, 3=Manitoba, 4=New Brunswick, 5=Newfoundland/Labrador, 6=Northwest Territories, 7=Nova Scotia, 8=Ontario, 9=Prince Edward Island, 10=Quebec, 11=Saskatchewan, 12=Yukon

See Also

`RanCh`, under `Datasets` for a description of the experiment. Other data objects for the experiment include `PC_trials`, a table of choice trial data, `PC_counts`, a matrix of choice count data, and `PC_raw`, a table of raw data.

PC_raw *Table of raw data from Population Choice experiment*

Description

Table of raw data from Population Choice experiment

Usage

```
PC_raw
```

Format

A data frame with 23 variables

`responseid` Unused subject identifier

`gender` Sex of subject: 1 for male, 2 for female

`age` Age of subject in years

`location` Province or territory in Canada, 1=Alberta, 2=British Columbia, 3=Manitoba, 4=New Brunswick, 5=Newfoundland/Labrador, 6=Northwest Territories, 7=Nova Scotia, 8=Ontario, 9=Prince Edward Island, 10=Quebec, 11=Saskatchewan, 12=Yukon

`set`

`block` Index (1,...,1024) of pre-constructed random design assigned to subject

`consent` Whether or not subjects gives consent (1) or not(2). All subjects give consent.

`domain` Index of choice domain

`counts` Cardinality of choice set presented

`obj1` Object in position 1

`obj2` Object in position 2

`obj3` Object in position 3, possibly NA

`obj4` Object in position 4, possibly NA

`obj5` Object in position 5, possibly NA

`obj1_text` Complete text describing object 1

`obj2_text` Complete text describing object 2

`obj3_text` Complete text describing object 3

`obj4_text` Complete text describing object 4

`obj5_text` Complete text describing object 5

`choice` Position of object chosen

`expdur` Trial duration in ms

`intdur` Survey duration in minutes

`feedback` Subject's response to "Please provide any additional feedback about the survey you have just completed."

See Also

`RanCh`, under `Datasets` for a description of the experiment. Other data objects for the experiment include `PC_trials`, a table of choice trial data, `PC_counts`, a matrix of choice count data, and `PC_demographics`, a table of demographic information

---

`PC_trials` *Table of choice trial data from the Population Choice experiment*

Description

Table of choice trial data from the Population Choice experiment

Usage

```
PC_trials
```

Format

A tibble with 20 variables

`domain` factor, name of choice domain

`subject` subject identifier

`trial` trial identifier (gives the order in which a subject sees choice sets)

`duration` duration of trial in seconds

`set` factor, name of choice set presented: 'ab', 'cde', etc., with objects in alphabetical order

`choice` factor, choice made by subject: 'a', 'b', 'c', 'd' or 'e'

`set_perm` factor, order of presentation of objects on screen, left to right

`set_card` Integer, cardinality of choice set (i.e. number of available options)

`set_bin` Binary representation of choice set (binary digits indicate object membership in choice set)

`choice_int` Integer code for chosen object: a=1, b=2, ..., e=5

`ab`, `ac`, `...`, `de` revealed preference indicator: taking column ab as an example, value is 1 if a is revealed preferred to b, -1 if b is revealed preferred to a, 0 otherwise.

See Also

`RanCh`, under `Datasets` for a description of the experiment. Other data objects for the experiment include `PC_counts`, an array of choice count data, `PC_demographics`, a table of demographic information, and `PC_raw`, a table of raw data.

plot_HD_Dir3 *Plot highest density regions for RCS with 3 objects*

Description

This function plots the Dirichlet highest density (HD) regions in barycentric coordinates for the three binary choice probability and one ternary choice probability vectors of a random RCS

Usage

```
plot_HD_Dir3(Alpha, HD_probability, selection)
```

Arguments

Alpha	matrix of Dirichlet parameters specifying the distribution of an RCD
HD_probability	scalar in $[0, 1]$ giving the probability of the HD region
selection	3-vector specifying the three columns of A to use for plotting

Examples

```
library(klaR)
N_bce <- marginalize(PC_counts['Beer', , ], c(2, 3, 5)) # Counts for objects 2, 3, 5
prior_Alpha <- RCS_scalar_alpha_prior(2.0, 3) # Parameters of simple conjugate prior
post_Alpha <- prior_Alpha + N_bce             # Posterior parameters
triplot(label=c('b', 'c', 'e'))               # Set up ternary plot
plot_HD_Dir3(post_Alpha, 0.90, c(1,2,3))      # Plot HPD regions
```

plot_P3 *Plot a Random Choice Structure in barycentric coordinates*

Description

plot_P3 plots four points specifying a Random Choice Structure for a universe of three objects.

Usage

```
plot_P3(P, perm = c(1, 2, 3), binary_pch = 1, ternary_pch = 20)
```

Arguments

P	A random choice structure for a universe of three objects
perm	A permutation of $(1, 2, 3)$ specifying which objects in the universe correspond to the bottom left, top, and bottom right vertex, respectively of the ternary plot.
binary_pch	Plotting character (pch) for binary choice probabilities. Defaults to a hollow circle.
ternary_pch	Plotting character (pch) for ternary choice probability. Defaults to a solid circle. The convention established with the defaults for binary_pch and ternary_pch allow one to distinguish between a binary choice probability and a ternary choice probability that happens to be on the boundary of the triangle.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
plot_P3(P)
```

---

proportions *Random Choice Structure from count proportions*

Description

proportions takes a count matrix as input, and returns choice proportions as a random choice structure.

Usage

```
proportions(N)
```

Arguments

N	A count matrix.

Value

A random choice structure.

Examples

```
PC_P <- proportions(PC_counts[1,,])
```

P_Luce *P_Luce*

Description

P_Luce constructs a random choice structure (RCS) from a Luce model.

Usage

```
P_Luce(v)
```

Arguments

v	postive vector, Luce weights

Value

RCS with choice probabilities given by Luce weights

P_uniform *P_uniform*

Description

P_uniform constructs a random choice structure (RCS) where all choice probabilities are discrete uniform

Usage

```
P_uniform(n_objects)
```

Arguments

n_objects	integer, number of objects in universe

Value

RCS where all choice probabilities are discrete uniform

RanCh *RanCh: A package for abstract discrete Random Choice*

Description

The RanCh package provides data, graphical tools and inference tools for abstract discrete random choice analysis.

Data sets

NA

random_utility *Check if random choice structure satisfies random utility*

Description

random_utility returns TRUE if the random choice structure P satisfies random utility and FALSE otherwise.

Usage

```
random_utility(P)
```

Arguments

P	A random choice structure

Value

A logical value indicating whether P satisfies random utility.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
random_utility(P)
```

RCS_scalar_alpha_prior *Scalar alpha prior for a RCS*

Description

RCS_scalar_alpha_prior constructs a matrix of Dirichlet parameters for a one-parameter Dirichlet prior for a random choice structure.

Usage

```
RCS_scalar_alpha_prior(alpha, n_objects)
```

Arguments

alpha	univariate parameter for the one-parameter Dirichlet prior.
n_objects	number of objects in the universe.

Value

a matrix of Dirichlet parameters for the scalar alpha prior

RCS_uniform_prior *Uniform prior for a RCS*

Description

RCS_uniform_prior constructs a matrix of Dirichlet parameters for the uniform prior over a random choice structure.

Usage

```
RCS_uniform_prior(n_objects)
```

Arguments

n_objects	number of objects in the universe.

Value

a matrix of Dirichlet parameters all set to one, so that all choice probability vectors are uniformly distributed.

RCS_vector_alpha_prior *Vector alpha prior for a RCS*

Description

RCS_vector_alpha_prior computes a matrix of Dirichlet parameters for a vector Dirichlet prior for a random choice structure.

Usage

```
RCS_vector_alpha_prior(alpha, v)
```

Arguments

alpha	scalar, prior precision parameter
v	vector, object weights for the vector Dirichlet prior.

Value

a matrix of Dirichlet parameters for the vector Dirichlet prior.

rDir *Dirichlet random variates*

Description

rDir draws from the Dirichlet distribution

Usage

```
rDir(n, alpha)
```

Arguments

n	number of draws
alpha	vector of Dirichlet parameters

Value

matrix with n rows, each a draw from the Dirichlet distribution

Examples

```
library(klaR)
p <- rDir(1000, c(1, 1, 1)) # Uniform distribution on 2-simplex
triplot(label=c('x', 'y', 'z'))
plot(tritrafo(p))
```

RDS_2011_counts *Choice count data from the Regenwetter, Dana and Davis-Stober (2011) experiment*

Description

A 3 by 18 by 31 by 5 array of count data. Element h, i, j, k gives the number of times subject i chose object k when presented with choice set j of domain h. Domain names are "Cash 1", "Cash 2" and "Noncash", explained in the paper. The choice set index $j \in \{1, ..., 31\}$ encodes a non-empty subset of the universe of the four choice objects a, b, c, d, and e, numbered 1, 2, 3, 4, 5. Whenever k is not an element of j, the value is NA.

Usage

```
RDS_2011_counts
```

Format

An object of class array of dimension 3 x 18 x 31 x 5.

See Also

RanCh, under Datasets for a description of the experiment. set_index describes how the choice set index encodes the choice set.

regularity *Check if random choice structure satisfies regularity*

Description

regularity returns TRUE if the random choice structure P satisfies regularity and FALSE otherwise.

Usage

```
regularity(P)
```

Arguments

P	A random choice structure

Value

A logical value indicating whether P satisfies regularity.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
regularity(P)
```

regularity_X3 *Compute a cross section of the regularity region*

Description

regularity_X3 computes the region (a triangle or the empty set) of ternary probabilities consistent with given binary probabilities and the regularity condition.

Usage

```
regularity_X3(P)
```

Arguments

P	A random choice structure.

Value

If the region is empty, the output is NULL. Otherwise, a 3x3 matrix where each row gives one of the three vertices in barycentric coordinates.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
reg_region <- regularity_X3(P)
```

ru *Helper function for random_utility and BM_terms, below.*

Description

ru tests whether or not a random choice structure satisfies random utility

Usage

```
ru(P, compute_Q)
```

Arguments

P	matrix, a random choice structure
compute_Q,	a logical value indicating whether or not to compute Q, the matrix of Block-Marschak terms corresponding to P. If compute_Q is true, output is a list with elements Q and is_ru, where is_ru is a boolean value that is TRUE or FALSE according to whether or not P satisfies random utility If compute_Q is FALSE, output is TRUE or FALSE according to whether or not P satisfies random utility.

Value

A logical value indicating whether P satisfies random utility.

set_index *Compute set index*

Description

set_index takes a vector v of object indices and constructs a set index, an index for the set of objects whose indices are elements of v. Each digit (or bit) in the binary representation of the resulting set index is an inclusion indicator: object i is in the set if and only if the i'th digit from the right is 1. For example, the set with objects 1, 3, and 4 has index equal to binary 1101, or decimal 13. The set with elements 1, 3 and 4 can be specified as the input vector c(1,3,4) or any permutation thereof, such as c(3,4,1).

Usage

```
set_index(v)
```

Arguments

v	vector of object indices, in any order

Details

Note that the singleton set with object i is represented as 2^{i-1}. The bitwise "or" (bitwOr) of the set indices of two sets is the set index of their union; the bitwise "and" (bitwAnd), the set index of their intersection.

Value

An integer index corresponding to the set of objects whose indices are elements of v.

Examples

```
A <- set_index(c(1,3,4)) # Returns (decimal) 13, equal to binary 1101.
```

similarity *Check if choice probabilities exhibit similarity effect*

Description

similarity returns TRUE if the specified binary and ternary choice probabilities in random choice structure P are in the specified similarity effect region.

Usage

```
similarity(P, target, competitor, decoy, two_sided = FALSE)
```

Arguments

P	matrix, random choice structure
target	index of target object
competitor	index of competitor object
decoy	index of decoy object
two_sided	logical value indicating whether the similarity inequality is to hold also for target and decoy exchanged.

Value

A logical value indicating whether the appropriate choice probabilities are in the similarity effect region.

Examples

```
P <- create_P3(0.7, 0.6, 0.8, 0.6, 0.3, names = c('x', 'y', 'z'))
similarity(P, target=1, competitor=2, decoy=3)
```

---

similarity_X3 *Similarity effect regions*

Description

similarity_X3 constructs six regions (all polygons) associated with binary-ternary similary effects. Below, x and y are "similar" choice objects and object z is dissimilar to both x and y. The interior of each polygon gives the set of ternary choice probabilities consistent with (1) the two specified binary choice probabilities and (2) one of six similarity effect conditions.

Usage

```
similarity_X3(pxz, pyz)
```

Arguments

pxz	scalar, probability of choosing y when presented with choice set $\{x, z\}$
pyz	scalar, probability of choosing y when presented with choice set $\{y, z\}$

Value

named list of six polygons in a barycentric coordinate system. Each polygon is a matrix, with one row for each polygon vertex and one column for each of the three choice objects x, y and z. Element i, j gives the probability of choosing j, when presented with choice set $\{x, y, z\}$, at the i'th polygon vertex. The six polygons—triangles except for Sxy, a quadrilateral—are:

Sxyz region where there is a similarity effect with object x as target, y as decoy and z as competitor

Syxz region where there is a similarity effect with object x as target, y as decoy and z as competitor

So region where there is neither similarity effect

Sx region with only the x effect

Sy region with only the y effect

Sxy region with both effects

See Also

compromise_X3 for an analogous function for the compromise effect.

Examples

```
S <- similarity_X3(0.5, 0.6)
```

T_1969_counts *Choice count data from the Tversky (1969) experiment*

Description

An 8 by 31 by 5 array of count data. Element i, j, k gives the number of times subject i chose object k when presented with choice set j. The choice set index $j \in \{1, ..., 7\}$ encodes a non-empty subset of the universe of the three choice objects x, y, and z, numbered 1, 2, 3. Whenever k is not an element of j, the value is NA.

Usage

```
T_1969_counts
```

Format

An object of class array of dimension 8 x 31 x 5.

See Also

RanCh, under Datasets for a description of the experiment. set_index describes how the choice set index encodes the choice set.

T_1972_counts *Choice count data from the Tversky (1972) experiment*

Description

A four dimensional array, 3 by 8 by 7 by 3, of count data. Element h, i, j, k gives the number of times subject i chose object k when presented with choice set j of domain h. Domain names are "Dots", "Gambles" and "Applicants", explained in the paper. The choice set index $j \in \{1, ..., 7\}$ encodes a non-empty subset of the universe of the three choice objects x, y, and z, numbered 1, 2, 3. Whenever k is not an element of j, the value is NA.

Usage

```
T_1972_counts
```

Format

An object of class array of dimension 3 x 8 x 7 x 3.

See Also

RanCh, under Datasets for a description of the experiment. set_index describes how the choice set index encodes the choice set.

YG_counts *Array of choice count data from the YouGov experiment*

Description

A four dimensional array, 16 by 2 by 15 by 4, of count data. Element h, i, j, k gives the number of subjects who chose object k when presented with choice set j of domain h, in their i'th block of 16 trials. The choice set index $j = 1, ..., 15$ encodes a non-empty subset of the universe of the four choice objects a, b, c, and d, numbered 1, 2, 3, 4. Whenever k is not an element of j, the value is NA.

Usage

```
YG_counts
```

Format

An object of class array of dimension 16 x 2 x 15 x 4.

See Also

RanCh, under Datasets for a description of the experiment. Other data objects for the experiment include YG_trials, a table of choice trial data, YG_demographics, a table of demographic information, and YG_raw, a table of raw data. set_index describes how the choice set index encodes the choice set.

YG_demographics *Table of demographic information from the YouGov experiment*

Description

Table of demographic information from the YouGov experiment

Usage

```
YG_demographics
```

Format

A data frame with demographic information on subjects

sex Sex of subject

educ Educational attainment by subject

region Region of subject's residence in US

race Race of subject

age_range Age range of subject

See Also

RanCh, under Datasets for a description of the experiment. Other data objects for the experiment include YG_trials, a table of choice trial data, YG_counts, a matrix of choice count data, and YG_raw, a table of raw data.

YG_raw *Table of choice trial data from the YouGov experiment*

Description

Table of choice trial data from the YouGov experiment

Usage

```
YG_raw
```

Format

A data frame with 17 variables:

`design`

`card`

`domain`

`combo`

`perm`

`choiceset` Choice set as a character string

`option_1` Object presented in first position: 1, 2, 3 or 4

`option_2` Object presented in second position

`option_3` Object presented in third position

`option_4` Object presented in fourth position

`response` Object chosen: 1, 2, 3 or 4

`order`

`gender` Sex of respondant: 1 for male, 2 for female

`educ` Education of respondant: 1 for No high school, 2 for High school graduate, 3 for Some college, 4 for 2-year college, 5 for 4-year college, 6 for post-graduate

`region` Region of respondant: 1 for northeast, 2 for midwest, 3 for south, 4 for west

`race` Race of respondant: 1 for White, 2 for Black, 3 for Hispanic, 4 for Asian, 5 for Native American, 6 for Mixed, 7 for Other, 8 for Middle Eastern

`age_cross` Age category of respondant: 1 for 18-34, 2 for 35-54, 3 for 55 and over

See Also

RanCh, under `Datasets` for a description of the experiment. Other data objects for the experiment include YG_trials, a table of choice trial data, YG_counts, a matrix of choice count data, and YG_demographics, a table of demographic information

YG_trials *Table of choice trials data from the YouGov experiment*

Description

Table of choice trials data from the YouGov experiment

Usage

```
YG_trials
```

Format

A tibble with 17 variables

`domain` factor, name of choice domain

`subject` subject identifier

`block` block, equal to 1 or 2, identifying the first or second pass a subject makes through the domains.

`trial` trial identifier (gives the order in which a subject sees choice sets)

`duration` duration of trial in seconds

`set` factor, name of choice set presented: 'ab', 'bcd', etc., with objects in alphabetical order

`choice` factor, choice made by subject: 'a', 'b', 'c', or 'd'

`set_perm` factor, order of presentation of objects on screen, left to right

`set_card` Integer, cardinality of choice set (i.e. number of available options)

`set_bin` Binary representation of choice set (binary digits indicate object membership in choice set)

`choice_int` Integer code for chosen object: a=1, b=2, ..., d=4

`ab`, `ac`, `...`, `cd` revealed preference indicator: taking column ab as an example, value is 1 if a is revealed preferred to b, -1 if b is revealed preferred to a, 0 otherwise.

See Also

`RanCh`, under `Datasets` for a description of the experiment. Other data objects for the experiment include `YG_counts`, an array of choice count data, `YG_demographics`, a table of demographic information, and `YG_raw`, a table of raw data.

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