RanCh

July 10, 2019

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,
ggtern

Depends R (>= 3.6.0)

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Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

Suggests knitr,
rmarkdown

VignetteBuilder knitr

R topics documented:

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

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)
```

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]
```

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 giving the probability of choosing y when presented with x,y.
pyz	scalar giving the probability of choosing y when presented with 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 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
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
P13	Probability of chosing object 1 when presented with objects 1 and 3

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 = TRUE)
```

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

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 three 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.

`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, c(2,3,5))
P_abd = marginalize()
N
```

`MC_counts` *Choice counts in multiple choice experiment*

Description

A three dimensional array, 141 by 31 by 5, 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. Each digit (or bit) in the binary representation of j is an inclusion indicator: object k is in the set if and only if the k'th digit from the right is 1. For example, the set with b, c, d and e (but not a) is encoded as binary 11110 (decimal 30). 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.

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.

MC_trials *Tibble recording every choice trial in the multiple choice experiment*

Description

Tibble recording every choice trial in 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.

ML_DCE_Dir_mult — *Marginal likelihood for discrete choice experiment, Dirichlet-multinomial model*

Description

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

```
ML_DCE_Dir_mult(A, N, log = TRUE)
```

Arguments

A	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 A, pertaining to the same universe of objects.
log	logical; if TRUE, return the log Bayes factor

ML_Dir_mult — *Marginal likelihood for Dirichlet-multinomial model*

Description

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

Usage

```
ML_Dir_mult(alpha, N, log = TRUE)
```

Arguments

alpha	vector of Dirichlet parameters
N	vector of multinomial counts
log	logical; if TRUE, return the log Bayes factor.

Value

Marginal likelihood or log marginal likelihood

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, 0.1, names = c('x', 'y', 'z'))
multiplicative_X3(P)
```

PC_counts *Choice counts in Population Choice experiment*

Description

A three dimensional array, 32 by 31 by 5, 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. Each digit (or bit) in the binary representation of j is an inclusion indicator: object k is in the set if and only if the k'th digit from the right is 1. For example, the set with b, c, d and e (but not a) is encoded as binary 11110 (decimal 30) 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.

PC_demographics *Demographic information for population choice experiment*

Description

Demographic information for 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

PC_raw *Population Choice experiment data*

Description

Raw trial-by-trial 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."

`PC_trials` *Table of choice trials, population choice experiment*

Description

Table of choice trials, 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.

plot_HD_Dir3 *Plot highest density region for a third order Dirichlet distribution*

Description

This function plots the Dirichlet highest density region in barycentric coordinates.

Usage

```
plot_HD_Dir3(A, HD_probability, selection)
```

Arguments

HD_probability	probability of highest density region
alpha	vector of Dirichlet parameters

Examples

```
plot_HD_Dir3(A, 0.95, c(1,2,3))
```

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, 0.1, names = c('x', 'y', 'z'))
plot_P3(P)
```

prior_DCE_scalar_alpha *One-parameter Dirichlet prior for a RCS*

Description

prior_DCE_scalar_alpha computes a matrix of Dirichlet parameters for a one-parameter Dirichlet prior for a random choice structure.

Usage

```
prior_DCE_scalar_alpha(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 with the same dimensions as a count matrix for a universe of the same size.

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,,])
```

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

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, 0.1, 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, 0.1, names = c('x', 'y', 'z'))
reg_region = regularity_X3(P)
```

set_index *Compute set index*

Description

set_index takes a vector of object indices and constructs a set index, which is an index for the set of objects whose indices appear in the given vector. Each digit (or bit) in the binary representation of the resulting set index is an inclusion indicator: object j is in the set if and only if the j'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

Value

a integer index corresponding to the set of objects whose indices are in v

Examples

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

similarity_2_3 *Check if binary-ternary choice probabilities are in similarity effect region*

Description

similarity_2_3 returns TRUE if the specified binary and ternary choice probabilities in random choice structure P are in the specified similarity effect region.

Usage

```
similarity_2_3(P, target, competitor, decoy, weak = TRUE,
  two_sided = FALSE)
```

Arguments

P	A random choice structure
target	Index of target object
competitor	Index of competitor object
decoy	Index of decoy object
weak	Logical, whether similarity effect is weak or not

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, 0.1, names = c('x', 'y', 'z'))
similarity_2_3(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 giving the probability of choosing y when presented with x and z
pyz	scalar giving the probability of choosing y when presented with y and 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 x, y and 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)
```

YG_counts *Choice counts in 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. Each digit (or bit) in the binary representation of j is an inclusion indicator: object k is in the set if and only if the k'th digit from the right is 1. For example, the set with b, c, and d (but not a) is encoded as binary 1110 (decimal 14) 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.

YG_demographics *Demographic information for subjects*

Description

Demographic information for subjects

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

YG_raw *YouGov Experiment data*

Description

Raw trial-by-trial data from 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

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YG_trials *Table of choice trials, population choice experiment*

Description

Table of choice trials, population choice 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.

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