# 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,
ggtern

**Depends** R (>= 3.6.0)

**License** CC0

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 6.1.1

**Suggests** knitr,
rmarkdown

**VignetteBuilder** knitr

## R topics documented:

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

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## Description

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

## Usage

```
create_P(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 |
| `P13` | Probability of chosing object 1 when presented with objects 1 and 3 |

## Value

A Random Choice Structure

## Examples

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

## dDir *Dirichlet density*

### 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

## dDir3_quantile *Quantile of third order Dirichlet density value*

### 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

## dDir_max *Maximum density of a Dirichlet distribution*

### Description

max_dDir computes the maximum density of a Dirichlet distribution as a function of the parameter vector alpha.

### Usage

```
dDir_max(alpha, log = TRUE)
```

### Arguments

| | |
|---|---|
| alpha | vector of Dirichlet parameters. |
| log | logical; if TRUE, the log maximum density is returned. |

### Value

Density or log density value.

## dDir_moments *Moments of Dirichlet density values*

### Description

moments_dDi computes a vector of the first n raw moments of Dirichlet density values, under that Dirichlet distribution.

### Usage

```
dDir_moments(beta, n_mu, log = FALSE)
```

### Arguments

| | |
|---|---|
| n_mu | number of moments to compute. |
| log | logical; if true return log moments. |
| alpha | vector of Dirichlet parameters. |

### Value

vector of moments

## Dir3_HD_region — *Compute highest density (HD) region for a third order Dirichlet distribution*

### Description

This function computes a polygon approximating the highest density region of a third order Dirichlet distribution. This can be used to compute highest prior density and highest posterior density (HPD) regions.

### Usage

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

### Arguments

| | |
|---|---|
| alpha | a vector of three (positive) Dirichlet parameters. |
| HD_probability | probability of region to construct |

### Value

polygon approximation of HD region.

## Dir_mult_ML — *Marginal likelihood for Dirichlet-multinomial model*

### Description

Dir_mult_ML computes the marginal likelihood for a Dirichlet prior and multinomial data generating process.

### Usage

```
Dir_mult_ML(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

## Ind_Dir_mult_ML *Marginal likelihood for independent Dirichlet-multinomial model*

### Description

Ind_Dir_mult_ML computes the marginal likelihood for a model where rows of a count matrix are independent multinomial and the rows of the unknown random choice structure are a priori independent Dirichlet.

### Usage

```
Ind_Dir_mult_ML(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 for a universe of objects. |
| log | logical; if TRUE, return the log Bayes factor |

## 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
```

## 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_P(0.7, 0.6, 0.8, 0.6, 0.3, 0.1, names = c('x', 'y', 'z'))
multiplicative_X3(P)
```

## PC_counts *Counts*

### Description

A 32x26x5 matrix with count data.

### 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

`age` Age of subject in years

`location` Province or territory in Canada

## PC_raw *Population Choice experiment data*

### Description

Record of trials in population choice experiment

### Usage

```
PC_raw
```

### Format

A data frame with 17 variables:

`design`

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

## 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)
```

### Arguments

| | |
|---|---|
| `HD_probability` | probability of highest density region |
| `alpha` | vector of Dirichlet parameters |

### Examples

```
plot_HD_Dir_3(0.95, c(23, 13, 4))
```

## 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_P(0.7, 0.6, 0.8, 0.6, 0.3, 0.1, 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)
```

## 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

## RCD_prior_1 *One-parameter Dirichlet prior for a RCS*

### Description

RCS_prior_1 computes a matrix of Dirichlet parameters for a one-parameter Dirichlet prior for a random choice structure.

### Usage

```
RCD_prior_1(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.

## 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_P(0.7, 0.6, 0.8, 0.6, 0.3, 0.1, names = c('x', 'y', 'z'))
reg_region = regularity_X3(P)
```

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## YG_counts *Counts*

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### Description

A 3x16x15x4 matrix with count data.

### Usage

```
YG_counts
```

### Format

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

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## YG_demographics *Demographic information for subjects*

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### 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

Record of every choice made by every respondant.

## 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

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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