Package ‘hyper2’

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Maintainer Robin K. S. Hankin <hankin.robin@gmail.com>
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**hyper2-package**

The Hyperdirichlet Distribution, Mark 2

**Description**

A suite of routines for the hyperdirichlet distribution; supersedes the `hyperdirichlet` package.

**Details**

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<td>Authors@R:</td>
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<tr>
<td>Author:</td>
<td>Robin K. S. Hankin [aut, cre] (<a href="https://orcid.org/0000-0001-5982-0415">https://orcid.org/0000-0001-5982-0415</a>)</td>
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as.ordertable

Tidy up a hyper2 object

New Zealand University ranking data

Results from the NOCS volleyball league

Race results from the 2014-2015 Volvo Ocean Race

Zap weak competitors

Pairwise comparisons

Zipf's law

A generalization of the Dirichlet distribution, using a more computationally efficient method than the hyperdirichlet package. The software is designed for the analysis of order statistics and team games.

Author(s)

NA

Maintainer: Robin K. S. Hankin <hankin.robin@gmail.com>

References


Examples

icons

maxp(icons)

as.ordertable

Convert an order table with DNS entries to a nice order table

Description

Given an ordertable such as F1_table_2017 which is a “wikitable” object, function as.ordertable() returns a nicified version in which entries such as DNS are replaced with zeros. Finishing competitors are assigned numbers 1 – n with no gaps; the function can be used to extract a subset of competitors.

Function ordertable2supp() offers similar functionality but returns a hyper2 object directly.

Usage

as.ordertable(w)

Arguments

w

A generalized ordertable, a wikitabke

Details

Operates columnwise, and treats any entry not coercible to numeric as DNF.
Value

Returns an ordertable suitable for coercion to a hyper2 object.

Author(s)

Robin K. S. Hankin

See Also

ordertable, ordertable2supp

Examples

as.ordertable(F1_table_2017)
ordertable2supp(as.ordertable(F1_table_2017[1:9,]))

B

Normalizing constant for the hyperdirichlet distribution

Description

Numerical techniques for calculating the normalizing constant for the hyperdirichlet distribution

Usage

B(H, disallowed=NULL, give=FALSE, ...)
probability(H, disallowed=NULL, ...)
mgf(H, powers, ...)
dhyper2(ip,H,...)
dhyper2_e(e,H,include.Jacobian=TRUE)
mean_hyper2(H, normalize=TRUE, ...)
Jacobian(e)
e_to_p(e)
p_to_e(p)

Arguments

H

Object of class hyper2
powers

Vector of length dim(x) whose elements are the powers of the expectation; see details section
disallowed

Function specifying a subset of the simplex over which to integrate; default NULL means to integrate over the whole simplex. The integration proceeds over p with disallowed(p) evaluating to FALSE
e,p

A vector; see details
ip

A vector of probabilities corresponding to indep(p) where p is vector with unit sum
include.Jacobian

Boolean, with default TRUE meaning to include the Jacobian transformation in the evaluation, and FALSE meaning to ignore it; use FALSE for likelihood work and TRUE for probability densities
give Boolean, with default FALSE meaning to return the value of the integral and TRUE meaning to return the full output of adaptIntegrate()

normalize Boolean, indicates whether return value of mean_hyper2() is normalized to have unit sum

... Further arguments passed to adaptIntegrate()

Details

• Function B() returns the normalizing constant of a hyperdirichlet likelihood function. Internally, p is converted to e (by e_to_p( )) and the integral proceeds over a hypercube. This function can be very slow, especially if disallowed is used.

• Function dhyper2(ip,H) is a probability density function on the independent components of a unit-sum vector, that is, ip=indep(p). This function calls B( ) each time so might be a performance bottleneck.

• Function probability() gives the probability of an observation from a hyperdirichlet distribution satisfying !disallowed(p).

• Function mgf() is the moment generating function, taking an argument that specifies the powers of p needed: the expectation of \( \prod_{i=1}^{n} p_i^{\text{powers}[i]} \) is returned.

• Function mean_hyper2() returns the mean value of the hyperdirichlet distribution. This is computationally slow (consider maxp( ) for a measure of central tendency). The function takes a normalize argument, not passed to adaptIntegrate(): this is Boolean with FALSE meaning to return the value found by integration directly, and default TRUE meaning to normalize so the sum is exactly 1

Value

• Function B() returns a scalar: the normalization constant

• Function dhyper2() is a probability density function over indep(p)

• Function mean() returns a k-tuple with unit sum

• Function mgf() returns a scalar equal to the expectation of p^power

• Functions is.proper() and validated() return a Boolean

• Function probability() returns a scalar, a (Bayesian) probability

Note

The adapt package is no longer available on CRAN; from 1.4-3, the package uses adaptIntegrate of the cubature package.

Author(s)

Robin K. S. Hankin

See Also

loglik
Examples

# Two different measures of central tendency:
# mean_hyper2(chess,tol=0.1)  # takes ~10s to run
maxp(chess)                    # faster

# Using the 'disallowed' argument typically results in slow run times;
# use high tol for speed:

# probability(chess,disallowed=function(p){p[1]>p[2]},tol=0.5)
# probability(chess,disallowed=function(p){p[1]<p[2]},tol=0.5)

# Above should sum to 1 [they are exclusive and exhaustive events]

character_to_number  Convert a character vector to a numeric vector

Description

Convert string descriptions of competitors into their number

Usage

character_to_number(char, pnames)
char2num(char, pnames)

Arguments

char   Character vector to be converted
pnames Names vector (usually pnames(H))

Details

In earlier versions of this package, the internal mechanism of functions such as ggr1(), and all the C++ code, operated with the competitors labelled with a non-negative integer; it is then natural to refer to the competitors as p1, p2, etc.

However, sometimes the competitors have names (as in, for example, the rowing dataset). If so, it is more natural to refer to the competitors using their names rather than an arbitrary integer.

Function character_to_number() converts the names to numbers. If an element of char is not present in pnames, an error is returned (function char2num() is an easy-to-type synonym). The function is here because it is used in ggr1().

Author(s)

Robin K. S. Hankin

See Also

rank_likelihood
**Examples**

```r
x <- sample(9)
names(x) <- sample(letters[1:9])
H <- rank_likelihood(x)
character_to_number(letters[1:3], pnames(H))
char2num(c("PB", "L"), pnames(icons))
```

---

**chess**

*Chess playing dataset*

**Description**

A tally of wins and losses for games between three chess players: Topalov, Anand, Karpov

**Usage**

```r
data(chess)
```

**Details**

This is a very simple dataset that can be used for illustration of `hyper2` idiom.

The players are:

- Grandmaster Veselin Topalov. FIDE world champion 2005-2006; peak rating 2813
- Grandmaster Anatoly Karpov. FIDE world champion 1993-1999; peak rating 2780

Observe that Topalov beats Anand, Anand beats Karpov, and Karpov beats Topalov (where “beats” means “wins more games than”).

The games thus resemble a noisy version of “rock paper scissors”.

The likelihood function does not record who played white; see `karpov_kasparov_anand` for such a dataset.

These objects can be generated by running script `inst/rock_paper_scissors.Rmd`, which includes some further discussion and technical documentation and creates file `chess.rda` which resides in the `data/` directory.

**References**

- [https://en.chessbase.com/](https://en.chessbase.com/)

**See Also**

- `karpov_kasparov_anand`
Examples

```r
data(chess)
maxp(chess)

mgf(chess,c(Anand=2),tol = 0.1)  # tolerance for speed
```

Description

Given a hyper2 object, calculate the maximum likelihood point in two ways and plot one against
the other to check for consistency.

Usage

```r
consistency(H, plot=TRUE, ...)
```

Arguments

- `H` A hyper2 object
- `plot` If TRUE (default), plot a comparison and return a matrix invisibly, and if FALSE
  return the matrix. Modelled on argument plot of hist
- `...` Further arguments, passed to `points()`

Details

Given a hyper2 object, calculate the maximum likelihood estimate of the players’ strengths using
maxp(); then reverse the pnames attribute and calculate the players’ strengths again. These two
estimates should be identical but small differences highlight numerical problems. Typically, the
differences are small if there are fewer than about 25 players.

Reversing the pnames() is cosmetic in theory but is a non-trivial operation: for example, it changes
the identity of the fillup from the last player to the first.

Value

Returns a named three-row matrix with first row being the direct evaluate, second row being the
reverse of the reversed evaluate, and the third being the difference

Author(s)

Robin K. S. Hankin

See Also

`ordertrans`
Examples

```r
# consistency(icons)
x <- icons
y <- icons
pnames(y) <- rev(pnames(y))
gradients(x, indep(equalp(x)))
gradients(y, indep(equalp(y)))
```

counterstrike Counterstrike

Description

A kill-by-kill analysis of a counterstrike game.

Usage

```r
data(counterstrike)
```

Details

E-sports are a form of competition using video games. E-sports are becoming increasingly popular, with high-profile tournaments attracting over 400 million viewers, and prize pools exceeding US$20m.

Counter Strike: Global Offensive (CS-GO) is a multiplayer first-person shooter game in which two teams of five compete in an immersive virtual reality combat environment. CS-GO is distinguished by the ability to download detailed gamefiles in which every aspect of an entire match is recorded, it being possible to replay the match at will.

Statistical analysis of such games files is extremely difficult, primarily due to complex gameplay features such as cooperative teamwork, within-team communication, and real-time strategic fluidity.

It is the task of the statistician to make robust inferences from such complex datasets, and here I discuss data from an influential match between “FaZe Clan” and “Cloud9”, two of the most successful E-sports syndicates of all time, when they competed at Boston 2018.

Dataset `counterstrike` is a loglikelihood function for the strengths of ten counterstrike players; `counterstrike_maxp` is a precomputed evaluate, and `zacslist` the observations used to calculate the loglikelihood function.

The probability model is similar to that of NBA: when a player kills (scores), this is taken to be a success of the whole team rather than the shooter.

File `inst/counterstrike.R` and `inst/counterstrike_random.R` include some further randomisation tests and discussion.

The objects documented here can be generated by running script `inst/counterstrike.Rmd`, which includes some further discussion and technical documentation and creates file `counterstrike.rda` which resides in the `data/` directory.

Counterstrike dataset kindly supplied by Zachary Hankin.
References

• [https://www.youtube.com/watch?v=XKWz1G4jDnI](https://www.youtube.com/watch?v=XKWz1G4jDnI)
• [https://en.wikipedia.org/wiki/FaZe_Clan](https://en.wikipedia.org/wiki/FaZe_Clan)

Examples

dotchart(counterstrike_maxp)

---

cplusplus

Wrappers to C calls

Description

Various low-level wrappers to C functions, courtesy of Rcpp

Usage

```r
overwrite(L1, powers1, L2, powers2)
accessor(L, powers, Lwanted)
assigner(L, p, L2, value)
addL(L1, p1, L2, p2)
identityL(L, p)
evaluate(L, powers, probs, pnames)
differentiate(L, powers, probs, pnames, n)
differentiate_n(L, powers, probs, pnames, n)
```

Arguments

- `L, L1, L2, Lwanted`: Lists with character vector elements, used to specify the brackets of the hyper-dirichlet distribution
- `p, p1, p2, powers, powers1, powers2`: A numeric vector specifying the powers to which the brackets are raised
- `value`: RHS in assignment, a numeric vector
- `probs`: Vector of probabilities for evaluation of log-likelihood
- `pnames`: Character vector of names
- `n`: Integer specifying component to differentiate with respect to

Details

These functions are not really intended for the end-user, as out-of-scope calls may cause crashes.

Value

These functions return a named List

Author(s)

Robin K. S. Hankin
Description

Data for women’s Olympic Curling at the 2002 Winter Olympics.

Usage

data(curling)

Details

There are five datasets loaded by data("curling"):

- `curling1`, a log likelihood function on the assumption that not attending (indicated by NA) is equivalent to a DNS in Formula 1
- `curling2`, a log likelihood function on the assumption that not attending is noninformative
- `curling1_maxp` and `curling2_maxp`, corresponding evaluates

These objects can be generated by running script `inst/curling.Rmd`, which includes some further discussion and technical documentation and creates file `curling.rda` which resides in the data directory.

Author(s)

Robin K. S. Hankin

References


Examples

data(curling)
dotchart(curling1_maxp)
Dirichlet distribution and generalizations

Description

The Dirichlet distribution in likelihood (for p) form, including the generalized Dirichlet distribution due to Connor and Mosimann.

Usage

dirichlet(powers, alpha)
GD(alpha, beta, beta0=0)
GD_wong(alpha, beta)
rdirichlet(n,H)
is.dirichlet(H)
rp_unif(n,H)

Arguments

powers In function dirichlet() a (named) vector of powers
alpha,beta A vector of parameters for the Dirichlet or generalized Dirichlet distribution
beta0 In function GD(), an arbitrary parameter
H Object of class hyper2
n Number of observations

Details

These functions are really convenience functions.

Function rdirichlet() returns random samples drawn from a Dirichlet distribution. If second argument H is a hyper2 object, it is tested [with is.dirichlet()] for being a Dirichlet distribution. If so, samples from it are returned. If not, (e.g. icons), an error is given. If H is not a hyper2 object, it is interpreted as a vector of parameters \( \alpha \) [not a vector of powers].

Function rp_unif() returns uniformly distributed vectors, effectively using \( H * 0 \); but note that this uses Dirichlet sampling which is much faster and better than the Metropolis-Hastings functionality documented at rp.Rd.

Functions GD() and GD_wong() return a likelihood function corresponding to the Generalized Dirichlet distribution as presented by Connor and Mosimann, and Wong, respectively. In GD_wong(), alpha and beta must be named vectors; the names of alpha give the names of \( x_1, \ldots, x_k \) and the last element of beta gives the name of \( x_{k+1} \).

Note

A dirichlet distribution can have a term with zero power. But this poses problems for hyper2 objects as zero power brackets are dropped.

Author(s)

Robin K. S. Hankin
References


See Also

hyper2, rp

Examples

```r
x1 <- dirichlet(c(a=1,b=2,c=3))
x2 <- dirichlet(c(c=3,d=4))
x1+x2

H <- dirichlet(c(a=1,b=2,c=3,d=4))
rdirichlet(10,H)
colMeans(rdirichlet(1e4,H))
```

eurodance  

Eurovision Dance contest dataset

Description

Voting patterns from Eurovision Dance Contest 2008

Usage

data(eurovision)

Format

A hyper2 object that gives a likelihood function.

Details

Object eurodance is a hyper2 object that gives a likelihood function for the skills of the 14 competitor countries in 2008 Eurovision Dance contest. Object eurodance_table gives the original dataset and eurodance_maxp the evaluate of the competitors’ Plackett-Luce strengths. The dataset is interesting because, in addition to the regular votes by each nation, there is an Expert jury vote as well. We may use Plackett-Luce likelihoods to compare the performance of the Expert jury with the national votes.

These objects can be generated by running script inst/eurodance.Rmd, which includes some further discussion and technical documentation and creates file eurodance.rda which resides in the data/ directory.
References


- P. M. E. Altham, personal communication

See Also
eurodance

Examples
data(eurodance)
dotchart(eurodance_maxp)

eurovision Eurovision Song contest dataset

Description

Voting patterns from Eurovision 2009

Usage

data(eurovision)

Format

A hyper2 object that gives a likelihood function.

Details

Object eurovision is a hyper2 object that gives a likelihood function for the skills of the 18 competitor countries in semi-final 1 of the 2009 Eurovision Song contest. Object eurovision_table gives the original dataset and eurovision_maxp the evaluate of the competitors’ Plackett-Luce strengths.

The motivation for choosing this particular dataset is that Pat Altham (Statistical Laboratory, Cambridge) considered it with a view to discover similarities between voters. In the current analysis, the likelihood function eurovision assumes their independence.

These objects can be generated by running script inst/eurovision.Rmd, which includes some further discussion and technical documentation and creates file eurovision.rda which resides in the data/ directory.

References


- P. M. E. Altham, personal communication
See Also
eurodance

Examples
data(eurovision)
dotchart(eurovision_maxp)

Extract or replace parts of a hyper2 object

Description
Extract or replace parts of a hyper2 object

Usage
## S3 method for class 'hyper2'
x[...]
## S3 replacement method for class 'hyper2'
x[index, ...] <- value
assign_lowlevel(x,index,value)
overwrite_lowlevel(x,value)

Arguments
x       An object of class hyper2
...      Further arguments, currently ignored
index   A list with integer vector elements corresponding to the brackets whose power is to be replaced
value   Numeric vector of powers

Details
These methods should work as expected, although the off-by-one issue might be a gotcha.
For the extract method, H[L], a hyper2 object is returned. The replace method, H[L] <- value, the index specifies the brackets whose powers are to be overwritten; standard disordR protocol is used.
If the index argument is missing, viz H1[] <-H2, this is a special case. Argument H1 must be a hyper2 object, and the idiom effectively executes H1[brackets(H2)] <-powers(H2), but more efficiently (note that this operation is well-defined even though the order of the brackets is arbitrary).
This special case is included in the package because it has a very natural C++ expression [function overwrite() in the src/ directory] that was too neat to omit.
Altering (incrementing or decrementing) the power of a single bracket is possible using idiom like H[x] <-H[x] + 1; this is documented at Ops.hyper2, specifically hyper2_sum_numeric() and a discussion is given at increment.Rd.
Functions assign_lowlevel() and overwrite_lowlevel() are low-level helper functions and not really intended for the end-user.
Value

The extractor method returns a \texttt{hyper2} object, restricted to the elements specified.

Note

Use \texttt{powers()} and \texttt{brackets()} to extract a numeric vector of powers or a list of integer vectors respectively.

Replacement idiom $H[x] <- val$ cannot use non-trivial recycling. This is because the elements of $H$ are stored in an arbitrary order, but the elements of `val` are stored in a particular order. Also see function \texttt{hyper2\_sum\_numeric()}.

Author(s)

Robin K. S. Hankin

See Also

\texttt{hyper2}, \texttt{Ops.hyper2}

Examples

data(chess)

chess["Topalov"]
chess[c("Topalov","Anand")]
chess[c("Anand","Topalov")]

# Topalov plays Anand and wins:
chess["Topalov"] <- chess["Topalov"]+1
chess[c("Topalov","Anand")] <- chess[c("Topalov","Anand")] - 1

# Topalov plays *Kasparov* and wins:
chess["Topalov"] %<>% inc
chess[c("Topalov","Kasparov")] %<>% dec

# overwriting idiom:
H <- hyper2(list("Topalov","X"), 6)
chess[] <- H
H <- icons

\begin{center}
\textbf{fillup} \\
\textit{Fillup function}
\end{center}

Description

Function \texttt{fillup()} concatenates a vector with a ‘fillup’ value to ensure a unit sum; if given a matrix, attaches a column so the rowsums are 1.

Function \texttt{indep()} is the inverse: it removes the final element of a vector, leaving only an independent set.
Usage

```r
fillup(x, total=1)
```
```r
indep(x)
```

Arguments

- `x`: Numeric vector
- `total`: Total value for probability

Details

Usually you want the total to be one, to enforce the unit sum constraint. Passing `total=0` constrains the sum to be zero. This is useful when considering $\delta p$; see the example at `gradient.Rd`.

Author(s)

Robin K. S. Hankin

See Also

`equalp`, `gradient`

Examples

```r
fillup(c(1/2,1/3))
indep(c(1/2,1/3,1/6))
```

---

**formula1**  
*Formula 1 dataset*

Description

Race results from 2017 Formula One World Championship

Usage

```r
data(formula1)
formula1_points_systems(top=11)
```

Arguments

- `top`: Number of drivers to retain in `formula1_points_systems()`

Format

A hyper2 object that gives a likelihood function
Details

Object `formula1` is a hyper object that gives a likelihood function for the strengths of the competitors of the 2017 Formula One World Championship. Object `F1_table_2017` is an order table: a data frame with rows being drivers, columns being venues, and entries being places. Thus looking at the first row, first column we see that Hamilton placed second in Austria.

Object `F1_table_2017` is simply the first 20 columns of `read.table(inst/formula1_2017.txt)` and object `F1_points_2017` is column 21. The likelihood function `formula1` is `ordertable2supp(F1_table_2017)`.

Function `formula1_points_system()` gives various possible points systems for the winner, second, third, etc. placing drivers.

References


See Also

`ordertable2supp`

Examples

```r
summary(formula1)
## Not run: #Takes too long
dotchart(maxp(formula1))
## End(Not run)
```

Description

Various functions for calculating the likelihood function for order statistics

Usage

```r
ggrl(H, ...)  
general_grouped_rank_likelihood(H, ...)  
choose_losers(H, all_players, losers)  
choose_winners(H, all_players, winners)  
elimination(all_players)  
rank_likelihood(M, times=1)  
rankveclikelihood(v)  
race(v)
```
Arguments

H Object of class `hyper2`

... Numeric or character vectors specifying groups of players with equal rank, with higher-ranking groups coming earlier in the argument list

`all_players, winners, losers`

Numeric or character vectors specifying competitors. See details

M In function `rank_likelihood()`, a matrix with each row corresponding to a race (or judge). The columns correspond to the finishing order; thus `a=M[i,j]` means that competitor `a` finished in place `j` in race `i`

times Vector specifying the number of times each row is observed

v A character vector specifying ranks. Thus `c("b","c","a")` means that `b` came first, `c` second, and a third

Details

These functions are designed to return likelihood functions, in the form of lists of `hyper2()` objects, for typical order statistics such as the results of rowing heats or MasterChef tournaments.

Function `ggrl()` is an easily-typed alias for `general_grouped_rank_likelihood()`.

Functions `choose_winners()` and `choose_losers()` take a `hyper2` object `H` (a likelihood function) and return a list of `hyper2` objects. The evaluate may be found with function `maxplist()`.

Function `elimination()` gives a likelihood function for situations where the weakest player is identified at each stage and subsequently eliminated from the competition. It is intended for situations like the Great British Bake-off and Masterchef in which the observation is which player was chosen to leave the show. In this function, argument `all_players` is sensitive to order, unlike `choose_winners()` and `choose_losers()` (an integer `n` is interpreted as `letters[seq_len(n)]`). Element `i` of `all_players` is the `i`th player to be eliminated. Thus the first element of `all_players` is the first player to be eliminated (and would be expected to have the lowest strength). The final element of `all_players` is the last player to be eliminated (or alternatively the only player not to be eliminated).

Function `rank_likelihood()` takes a matrix `M` with rows corresponding to a judge (or race); column names are interpreted as competitor names. A named vector is coerced to a one-row matrix. Each row of `M` is an order statistic: thus `c(3,4,2,1)` means that person 3 came first, person 4 came second, person 2 came third and person 1 came last. Note that in data frames like `F1_table_2017`, each column is a race.

Function `rankvec_likelihood()` takes a character vector of competitors with the order of elements corresponding to the finishing order; a Plackett-Luce likelihood function is returned. Thus `v=c("d","b","c","a")` corresponds to `d` coming first, `b` second, `c` third, and a fourth. Function `race()` is an arguably more memorable synonym.

An example of `race()` is given in `inst/rowing.Rmd`, and examples of `ggrl()` are given in `inst/loser.Rmd` and `inst/masterchef.Rmd`.

Author(s)

Robin K. S. Hankin

See Also

`rrank, ordetable2supp`
Examples

\begin{verbatim}
W <- hyper2(pnames=letters[1:5])
W1 <- ggrl(W, 'a', letters[2:4], 'e')  # 6-element list
W2 <- ggrl(W, 'b', letters[3:5], 'a')  # 6-element list

like_single_list(equalp(W1), W1)
like_series(equalp(W1), list(W1, W2))
\end{verbatim}

if(FALSE){  # takes too long
# run 10 races:
r1 <- rrank(10, p=(7:1)/28)
colnames(r1) <- letters[1:7]

# Likelihood function for r1:
W <- rank_likelihood(r1)

H <- hyper2()
for(i in 1:20){
    H <- H + race(sample(letters[1:5], sample(3, 1), replace=FALSE))
}
equalp.test(H)  # should not be significant (null is true)

H1 <- hyper2(pnames=letters[1:5])
H2 <- choose_losers(H1, letters[1:4], letters[1:2])  # {a,b} vs {c,d}; {a,b} lost
maxplist(H2, control=list(maxit=1))  # control set to save time
}

gradient Differential calculus

Description

Given a hyper2 object and a point in probability space, function gradient() returns the gradient of the log-likelihood; function hessian() returns the bordered Hessian matrix. By default, both functions are evaluated at the maximum likelihood estimate for \(p\), as given by maxp().

Usage

\begin{verbatim}
gradien(H, probs=indep(maxp(H)))
hessian(H, probs=indep(maxp(H)), border=TRUE)
hessian_lowlevel(L, powers, probs, pnames, n)
is_ok_hessian(M, give=TRUE)
\end{verbatim}

Arguments

- **H**: A hyper2 object
- **L, powers, n**: Components of a hyper2 object
- **probs**: A vector of probabilities
- **pnames**: Character vector of names
border

Boolean, with default TRUE meaning to return the bordered Hessian and FALSE meaning to return the Hessian (warning: this option does not respect the unit sum constraint)

M

A bordered Hessian matrix, understood to have a single constraint (the unit sum) at the last row and column; the output of hessian(border=TRUE)

give

Boolean with default FALSE meaning for function is_ok_hessian() to return whether or not M corresponds to a negative-definite matrix, and TRUE meaning to return more details

Details

Function gradient() returns the gradient of the log-likelihood function. If the hyper2 object is of size n, then argument probs may be a vector of length n−1 or n; in the former case it is interpreted as indep(p). In both cases, the returned gradient is a vector of length n−1. The function returns the derivative of the loglikelihood with respect to the n−1 independent components of (p1, ..., pn), namely (p1, ..., pn−1). The fillup value pn is calculated as 1 − (p1 + ... + pn−1).

Function gradientn() returns the gradient of the loglikelihood function but ignores the unit sum constraint. If the hyper2 object is of size n, then argument probs must be a vector of length n, and the function returns a named vector of length n. The last element of the vector is not treated differently from the others; all n elements are treated as independent. The sum need not equal one.

Function hessian() returns the bordered Hessian, a matrix of size n+1 × n+1, which is useful when using Lagrange’s method of undetermined multipliers. The first row and column correspond to the unit sum constraint, \( \sum p_i = 1 \). Row and column names of the matrix are the pnames() of the hyper2 object, plus “usc” for “Unit Sum Constraint”.

The unit sum constraint borders could have been added with idiom magic::adiag(0, pad=1, hess), which might be preferable.

Function is_ok_hessian() returns the result of the second derivative test for the maximum like-lihood estimate being a local maximum on the constraint hypersurface. This is a generalization of the usual unconstrained problem, for which the test is the Hessian’s being negative-definite.

Function hessian_lowlevel() is a low-level helper function that calls the C++ routine.

Further examples and discussion is given in file inst/gradient.Rmd. See also the discussion at man/maxp.Rd on the different optimization routines available.

Value

Function gradient() returns a vector of length n−1 with entries being the gradient of the loglikelihood with respect to the n−1 independent components of (p1, ..., pn), namely (p1, ..., pn−1). The fillup value pn is calculated as 1 − (p1, ..., pn−1).

If argument border is TRUE, function hessian() returns an n-by-n matrix of second derivatives; the borders are as returned by gradient(). If border is FALSE, ignore the fillup value and return an n−1-by-n−1 matrix.

Calling hessian() at the evaluate will not return exact zeros for the constraint on the fillup value; gradient() is used and this does not return exactly zeros at the evaluate.

Author(s)

Robin K. S. Hankin
Examples

```r
data(chess)
p <- c(1/2,1/3)
delta <- rnorm(2)/1e5 # delta needs to be quite small
deltaL <- loglik(p+delta,chess) - loglik(p,chess)
deltaLn <- sum(delta*gradient(chess,p + delta/2)) # numeric
deltaL - deltaLn # should be small [zero to first order]
H <- hessian(icons)
is_ok_hessian(H)
```

Description

Object `handover` is a likelihood function corresponding to a dataset arising from 69 medical malpractice claims and concerns handover (or hand-off) between physicians. This dataset was analysed by Lin et al. (2009), and further analysed by Altham and Hankin (2010). The computational methods are presented in the `hyperdirichlet` and `aylmer` packages and a further discussion is given in the “integration” vignette of the `hyper2` package. The original dataset is `handover_table`, a three-by-three matrix of counts.

Usage

```r
data(handover)
```

Details

These objects can be generated by running script `inst/handover.Rmd`, which includes some further discussion and technical documentation, and creates file `handover.rda` which resides in the `data/` directory.

References

Examples

data(handover)
maxp(handover)

head.hyper2

First few terms of a distribution

Description

First few terms in a hyperdirichlet distribution

Usage

## S3 method for class 'hyper2'
head(x, ...)

Arguments

x Object of class hyper2
...

Further arguments, passed to head()

Details

Function is x[head(brackets(x),...)]

Value

Returns a hyper2 object

Author(s)

Robin K. S. Hankin

Examples

p <- zipf(5)
names(p) <- letters[1:5]
H <- rank_likelihood(rrank(20,p))
head(H)
Description

Basic functions in the hyper2 package

Usage

hyper2(L=list(), d=0, pnames)
## S3 method for class 'hyper2'
brackets(H)
## S3 method for class 'hyper2'
powers(H)
## S3 method for class 'hyper2'
pnames(H)
## S3 method for class 'suplist'
pnames(H)
size(H)
as.hyper2(L,d,pnames)
is.hyper2(H)
is_valid_hyper2(L,d,pnames)
is_constant(H)

Arguments

H           A hyper2 object
L           A list of character vectors whose elements specify the brackets of a hyper2 ob-
dject
d           A vector of powers; hyper2() recycles only if d is of length 1
pnames      A character vector specifying the names of \( p_1 \) through \( p_n \).

Details

These are the basic functions of the hyper2 package. Function hyper() is the low-level creator function; as.hyper2() is a bit more user-friendly and attempts to coerce its arguments into a suitable form; for example, a matrix is interpreted as rows of brackets.

Functions pnames() and pnames<-() are the accessor and setter methods for the player names. Length-zero character strings are acceptable player names. The setter method pnames<-() can be confusing. Idiom such as pnames(H) <-value does not change the likelihood function of H (except possibly its domain). When called, it changes the pnames internal vector, and will throw an error if any element of c(brackets(H)) is not present in value. It has two uses: firstly, to add players who do not appear in the brackets; and secondly to rearrange the pnames vector (the canonical use-case is pnames(H) <-rev(pnames(H))). If you want to change the player names, use psubs() to substitute players for other players.

Function is_valid_hyper2() tests for valid input, returning a Boolean. This function returns an error if a bracket contains a repeated element, as in hyper2(list(c("a","a"),1)).

Note that it is perfectly acceptable to have an element of pnames that is not present in the likelihood function (this would correspond to having no information about that particular player).
Function `size()` returns the (nominal) length $n$ of nonnegative vector $p = (p_1, \ldots, p_n)$ where $p_1 + \cdots + p_n = 1$.

**Author(s)**

Robin K. S. Hankin

**See Also**

`Ops.hyper2`, `Extract.hyper2`, `loglik`, `hyper2-package` `psubs`

**Examples**

```r
o <- hyper2(list("a","b","c",c("a","b"),letters[1:3]),1:5)

# Verify that the MLE is invariant under reordering
pnames/icons) <- rev(pnames/icons))
maxp/icons) - icons_maxp # should be small
```

**icons**

*Dataset on climate change due to O’Neill*

**Description**

Object `icons_matrix` is a matrix of nine rows and six columns, one column for each of six icons relevant to climate change. The matrix entries show the number of respondents who indicated which icon they found most concerning. The nine rows show different classes of respondents who were exposed to different subsets (of size four) of the six icons.

The columns correspond to the different stimulus icons used, detailed below. An extensive discussion is given in West and Hankin 2008, and Hankin 2010; an updated analysis is given in theicons vignette.

Object `icons` is the corresponding likelihood function, which can be created with `saffy/icons_matrix`.

**Usage**

```r
data/icons
```

**Details**

The six icons were used in this study were:

- **PB** polar bears, which face extinction through loss of ice floe hunting grounds
- **NB** The Norfolk Broads, which flood due to intense rainfall events
- **L** London flooding, as a result of sea level rise
- **THC** The Thermo-haline circulation, which may slow or stop as a result of anthropogenic modification of the hydrological cycle
- **OA** Oceanic acidification as a result of anthropogenic emissions of carbon dioxide
- **WAIS** The West Antarctic Ice Sheet, which is calving into the sea as a result of climate change
Author(s)
Robin K. S. Hankin

Source
Data kindly supplied by Saffron O’Neill of the University of East Anglia

References
• S. O’Neill 2007. An Iconic Approach to Communicating Climate Change, University of East Anglia, School of Environmental Science (in prep)

See Also
matrix2supp

Examples
```r
data(icons)
pie(icons_maxp)
equalp.test(icons)
```

---

**increment**

**Increment and decrement operators**

**Description**
Syntactic sugar for incrementing and decrementing likelihood functions

**Usage**
```r
inc(H, val = 1)
dec(H, val = 1)
trial(winners, players, val = 1)
```

**Arguments**
- **H** A hyper2 object
- **winners, players** Numeric or character vectors specifying the winning team and the losing team
- **val** Numeric
Details

A very frequent operation is to increment a single term in a hyper2 object. If

```r
> H <- hyper2(list("b",c("a","b"),"c",c("b","c")),c(2,4,3,5))
> H
a * (a + b)^4 * b^2 * (b + c)^5 * c^3
```

Suppose we wish to increment the power of a+b. We could do:

```r
H[c("a","b")]<-H[c("a","b")]+1
```

(see the discussion of hyper2_sum_numeric at Ops.hyper2.Rd). Alternatively we could use magrittr pipes:

```r
H[c("a","b")]%<>%`+`(1)
```

But inc and dec furnish convenient idiom to accomplish the same thing:

```r
H[c("a","b")]%<>%inc
```

Functions inc and dec default to adding or subtracting 1, but other values can be supplied:

```r
H[c("a","b")]%<>%inc(3)
```

Or even

```r
H[c("a","b")]%<>%inc(H["a"])
```

The convenience function trial() takes this one step further and increments the 'winning team' and decrements the bracket containing all players. The winners are expected to be players.

```r
> trial(c("a","b"),c("a","b","c"))
> (a + b) * (a + b + c)^-1
```

Using trial() in this way ensures that the powers sum to zero.

The inc and dec operators are used in inst/rowing_analysis.R; and the trial() function is used in inst/kka_draws.R.

Author(s)

Robin K. S. Hankin

Examples

data(chess)

```r
## Now suppose we observe an additional match, in which Topalov beats
## Anand. To incorporate this observation into the LF:

trial("a",c("a","b"))
chess <- chess + trial("Topalov",c("Topalov","Anand"))
```
interzonal 1963 World Chess Championships

Description
Likelihood functions for players' strengths in the fifth Interzonal tournament which occurred as part of the 1963 Chess World Championships in Stockholm, 1962.

Details
The 1963 World Chess Championship was notable for allegations of Soviet collusion. Specifically, Fischer publicly alleged that certain Soviet players had agreed in advance to draw all their games. The championship included an “interzonal” tournament in which 23 players competed in Stockholm; and a “Candidates” tournament in which 8 players competed in Curacao.

Likelihood functions `interzonal` and `interzonal_collusion` are created by files `inst/interzonal.Rmd`, which is heavily documented and include some analysis. Object `interzonal` includes a term for drawing, (“draw”), assumed to be the same for all players; object `interzonal_collusion` includes in addition to draw, a term for the drawing in Soviet-Soviet matches, “coll”.

See Also
`chess`, `karpov_kasparov_anand`

Examples
```
pie(interzonal_maxp)

# samep.test(interzonal,c("Fischer","Geller")) # takes too long
```

jester Jester dataset

Description
A likelihood function for the Jester datasets

Usage
```
data(jester)
```

Details
Object `jester` is a likelihood function for the 91 jokes rated by the first 150 respondents in file ‘jester_dataset_1_3.zip’, taken from https://eigentaste.berkeley.edu/dataset/. Object `jester_maxp` is the result of running `maxp(jester)`.

Objects `jester` and `jester_maxp` can be generated by running script `inst/jester.Rmd`, which includes some further technical documentation. This file takes about 10 minutes to run.
The dataset is interesting because it has been analysed by many workers, including Goldberg, for patterns; here I assume that all the respondents behave identically (but randomly). It is included here because it is a very severe numerical challenge in the context of the hyper2 package. I am not convinced that \texttt{maxjest} is even close to the true evaluate.

**References**


**Examples**

```r
data(jester)
# maxp(jester)  # takes too long

loglik(indep(jester_maxp),jester)
```

---

**Karate dataset**

Dataset from the 2018 World Karate Championships, men’s 67kg. It is an example of a dataset with too many degrees of freedom to be analysed easily by the package.

**Usage**

```r
data(karate)
```

**Details**

Object \texttt{karate_table} is a dataframe of results showing results from the 2018 World Karate Championships, men’s 67kg; \texttt{karate} is the associated likelihood function. There are two maximum likelihood estimates given: \texttt{karate_maxp}, the evaluate as returned by \texttt{maxp()}, and \texttt{karate_maxp}, returned by \texttt{zermelo()} [the value given by \texttt{maxp()} itself is less likely].

These objects can be generated by running script \texttt{inst/karate.Rmd}, which includes some further discussion and technical documentation and creates file \texttt{karate.rda} which resides in the \texttt{data/} directory.

**Note**

Table \texttt{karate_table} misses uninformative matches, that is, competitions with 0-0 results.

**References**


**See Also**

\texttt{zapweak}
**karpov_kasparov_anand**

### Examples

```r
summary(karate)
```

---

**Description**

Data of three chess players: Karpov, Kasparov, and Anand. Includes two likelihood functions for the strengths of the players, and matrices of game results.

### Details

The strengths of chess players may be assessed using the generalized Bradley-Terry model. The *karpov_kasparov_anand* likelihood function allows one to estimate the players' strengths, propensity to draw, and also the additional strength conferred by playing white.

Likelihood functions *karpov_kasparov_anand*, *kka_3draws* and *kka_3whites* are created by files `inst/karpov_kasparov_anand.R`, `inst/kka_3draws` and `inst/kka_3whites`, which are heavily documented and include some analysis. Object *karpov_kasparov_anand* assumes that the draw potential is the same for all three players; likelihood function *kka_3draws* allows the propensity to draw to differ between the three players.

The reason that the players are different from those in the chess dataset is that the original data does not seem to be available any more.

Dataset *kka* refers to scorelines of matches between three chess players (Kasparov, Karpov, Anand). It is a list with names such as `’karpov_plays_white_beats_kasparov’` which has value 18: we have a total of 18 games between Karpov and Kasparov in which Karpov played white and beat Kasparov.

The three matrices *plays_white_wins*, *plays_white_draws*, and *plays_white_loses* tabulate this information in a coherent way; and array *kka_array* presents the same information in a 3D array (but the names of the dimnames are lost).

All data drawn from chessgames.com, specifically

https://www.chessgames.com/perl/ezsearch.pl?search=karpov+vs+kasparov

Note that the database allows one to sort by white wins or black wins (there is a ‘refine search’ tab at the bottom). Some searches have more than one page of results.

Numbers here downloaded 17 February 2019. Note that only ‘classical games’ are considered here (rapid and exhibition games being ignored).

These objects can be generated by running script `inst/kka.Rmd`, which includes some further discussion and technical documentation and creates file *kka.rda* which resides in the `data/` directory.

### See Also

*chess*

### Examples

```r
karpov_kasparov_anand
# pie(maxp(karpov_kasparov_anand))  # takes ~10s
```
**Description**

Flawed functionality to keep or discard subsets of the players in a `hyper2` object or order table.

**Usage**

```r
discard_flawed2(x, unwanted,...)  # keep or discard specified rows
keep_flawed(H, wanted)  # keep specified players
discard_flawed(H, unwanted)  # discard specified players
```

**Arguments**

- **H**: A `hyper2` object
- **x**: An order table
- **wanted,unwanted**: Players to keep or discard. May be character or integer or logical
- **...**: Further arguments passed to `wikitable_to_ranktable()`, notably `points`

**Details**

Do not use these functions. They are here as object lessons in poor thinking. To work with a subset of competitors, see the example at `as.ordertable.Rd`

Functions `keep_flawed2()` and `discard_flawed2()` take an order table and keep or discard specified rows, returning a reduced order table. This is not a trivial operation.

Functions `keep_flawed()` and `discard_flawed()` will either keep or discard players specified in the second argument. It is not clear to me that these functions have any reasonable probabilistic interpretation and file `inst/retain.Rmd` gives a discussion.

Given a wikitable or ordertable, it is possible to create a likelihood function based on a subset of rows using the `incomplete=TRUE` argument; see the example at `?ordertable2supp`. But this method is flawed too because it treats non-finishers as if they finished in the order of their rows.

Function `as.ordertable()` is the correct way to consider a subset of players in a wikitable.

**Author(s)**

Robin K. S. Hankin

**See Also**

`ordertable2supp,tidy`
Examples

```r
maxp(icons)
discard_flawed(icons,c("OA","WAIS"))

## Not run: # (takes too long)
data("skating")
maxp(skating)[1:4]     # numbers work, keep the first four skaters
maxp(keep_flawed(skating,pnames(skating)[1:4])) # differs!

## End(Not run)
```

---

### length.hyper2

**Length method for hyper2 objects**

#### Description

Length method for hyper2 objects, being the number of different brackets in the expression.

#### Usage

```r
## S3 method for class 'hyper2'
length(x)
```

#### Arguments

- **x**: hyper2 object

#### Author(s)

Robin K. S. Hankin

#### Examples

```r
data("oneill")
length(icons)
seq_along(icons)
```

---

### loglik

**Log likelihood functions**

#### Description

Returns a log-likelihood for a given hyper2 object at a specific point.

#### Usage

```r
loglik(p, H, log = TRUE)
loglik_single(p,H,log=TRUE)
like_single_list(p,Lsub)
like_series(p,L,log=TRUE)
```
Arguments

- **H**: An object of class `hyper2`
- **p**: A probability point. See details
- **log**: Boolean with default `TRUE` meaning to return the log-likelihood and `FALSE` meaning to return the likelihood
- **L, L_sub**: A list of `hyper2` objects, or a list of list of `loglik` objects

Details

Function `loglik()` is a straightforward likelihood function. It can take a vector of length \( n = \text{size}(H) \) or \( \text{size}(H) - 1 \); if given the vector \( p = (p_1, \ldots, p_{n-1}) \) it appends the fillup value, and then returns the (log) likelihood.

If \( p \) is a matrix, the rows are interpreted as probability points.

Function `loglik_single()` is a helper function that takes a single point in probability space. Functions `like_single_list()` and `like_series()` are intended for use with `ggrl()`.

Note

Likelihood is defined up to an arbitrary multiplicative constant. Log-likelihood (also known as support) is defined up to an arbitrary additive constant.

Currently, function `loglik()` interprets elements of a probability vector according to their position in the vector; if given a named vector, the names are ignored. This might change in a future release.

Empty brackets are interpreted consistently: that is, zero whatever the probability vector (although the print method is not perfect).

Author(s)

Robin K. S. Hankin

See Also

- `maxp`

Examples

```r
data(chess)
loglik(c(1/3,1/3),chess)

loglik(rp(14,icons),icons)
## Not run: # takes too long
like_series(masterchef_maxp,masterchef)
like_series(indep(equalp(masterchef)),masterchef)
## End(Not run)

W <- hyper2(pnames=letters[1:6])
W1 <- ggrl(W, 'a', letters[2:5],'f')  # 24-element list
W2 <- ggrl(W, c('a','b'), c('c','d'),c('e','f'))  # 2^3=8 element list

like_single_list(rep(1/6,5),W1)  # information from first observation
like_series(rep(1/6,5),list(W1,W2))  # information from both observations
```
masterchef

Description

Data from Australian Masterchef Series 6

Usage

data(masterchef)

Format

Object masterchef is a list of hyper2 objects; masterchef_pmax and masterchef_constrained_pmax are named vectors with unit sum.

Details

The object is created using the code in inst/masterchef.Rmd, which is heavily documented. Not all the information available is included in the likelihood function as some of the early rounds result in an unmanageably large list. Inclusion is controlled by Boolean vector doo.

The definitive source is the coloured table on the wiki page.

References


See Also

ggrl

Examples

a1 <- indep(equalp(masterchef[[1]])) # equal strengths
a2 <- indep(masterchef_maxp) # MLE
a3 <- indep(masterchef_constrained_maxp) # constrained MLE

## Not run: # takes too long
like_series(a1, masterchef)
like_series(a2, masterchef)
like_series(a3, masterchef)

## End(Not run)
Convert a matrix to a likelihood function

Description

Functions to convert matrix observations to likelihood functions. Each row is an observation of some kind, and each column a player.

Function \texttt{ordertable2supp()} is documented separately at \texttt{ordertable2supp}.

Usage

\begin{verbatim}
saffy(M) volley(M)
\end{verbatim}

Arguments

\begin{verbatim}
M  A matrix of observations
\end{verbatim}

Details

Two functions are documented here:

• \texttt{saffy()}, which converts a matrix of restricted choices into a likelihood function; it is named for Saffron O’Neill. The canonical example would be Saffron’s climate change dataset, documented at \texttt{icons}. Function \texttt{saffy()} returns the appropriate likelihood function for the dataset.

• \texttt{volley()}, which converts a matrix of winning and losing team members to a likelihood function. The canonical example is the volleyball dataset. Each row is a volleyball game; each column is a player. An entry of 0 means “on the losing side”; an entry of 1 means “on the winning side”, and an entry of \texttt{NA} means “did not play”.

Author(s)

Robin K. S. Hankin

See Also

\texttt{icons,volleyball}

Examples

\begin{verbatim}
icons == saffy(icons_table)  # should be TRUE
volley(volleyball_table) == volleyball # also should be TRUE
\end{verbatim}
**maxp**  

*Maximum likelihood estimation*

**Description**

Find the maximum likelihood estimate for \( p \), also equal probabilities

**Usage**

```r
maxp(H, startp=NULL, give=FALSE, fcm=NULL, fcv=NULL, SMALL=1e-6, n=10,
    show=FALSE, justlikes=FALSE, ...
)
maxplist(Hlist, startp=NULL, give=FALSE, fcm=NULL, fcv=NULL, SMALL=1e-6, ...)
maxp_single(H, startp=NULL, give=FALSE, fcm=NULL, fcv=NULL, SMALL=1e-6,
    maxtry=100, ...)
maxp_single2(H, startp=NULL, give=FALSE, fcm=NULL, fcv=NULL, SMALL=1e-6,
    maxtry=100, ...)
maxp_simplex(H, n=100, show=FALSE, give=FALSE, ...)
equalp(H)
```

**Arguments**

- **H** A hyper2 object
- **Hlist** A list with elements all hyper2 objects
- **startp** A vector of probabilities
- **give** Boolean, with default FALSE meaning to return just the evaluate (including fillup), and TRUE meaning to return the entire formal output of the optimization routine
- **fcm,fcv** Further problem-specific constraints
- **n** Number of start points to use
- **show** Boolean, with TRUE meaning to show successive estimates
- **justlikes** Boolean, with TRUE meaning to return just a vector of estimated likelihoods
- **SMALL** Numerical minimum for probabilities
- **maxtry** Integer specifying maximum number of times to try constrOptim() with slightly differing start points, to avoid a known R bug which reports `wmmin is not finite`, bugzilla id 17703
- **...** Further arguments which maxp() passes to constrOptim()

**Details**

Function `maxp()` returns the maximum likelihood estimate for \( p \), which has the unit sum constraint implemented.

Function `maxplist()` does the same but takes a list of hyper2 objects (for example, the output of `ggrl()`). Note that `maxplist()` does not have access to the gradient of the objective function, which makes it slow.

If function `maxp()` is given a suplist object it dispatches to `maxplist()`.

Functions `maxp_single()` and `maxp_single2()` are helper functions which perform a single constrained optimization using base::constrOptim() or alabama::constrOptim.nl() respectively. The functions should produce identical (or at least very similar) results. They are used by `maxp()`
and maxp_simplex() which dispatch to either maxp_single() or maxp_single2() depending on the value of option use_alabama. If TRUE, they will use (experimental) maxp_single2(), otherwise (default) maxp_single(). Function maxp_single() is prone to the “wmmin not finite” bug [bugzilla id 17703] but on the other hand is a bit slower. I am not sure which one is better at this time.

Function maxp_simplex() is intended for complicated or flat likelihood functions where finding local maxima might be a problem. It repeatedly calls maxp_single(), starting from a different randomly chosen point in the simplex each time. This function does not take fcm or fcv arguments, it operates over the whole simplex (hence the name). Further arguments, . . . , are passed to maxp_single().

The functions do not work for the masterchef_series6 likelihood function. These require a bespoke optimization as shown in the vignette.

Function equalp() returns the value of p for which all elements are the same.

In functions maxp() etc, arguments fcm and fcv implement linear constraints to be passed to constrOptim(). These constraints are in addition to the usual nonnegativity constraints and unit-sum constraint, and are added to the ui and ci arguments of constrOptim() with rbind() and c() respectively. The operative lines are in maxp_single():

\[
\begin{align*}
UI & \leftarrow \text{rbind(diag(nrow = n - 1), -1, fcm)} \\
CI & \leftarrow \text{c(rep(SMALL, n - 1), -1 + SMALL, fcv)}
\end{align*}
\]

where in UI, the first \(n - 1\) rows enforce nonnegativity of \(p_i, 1 \leq p < n\); row \(n\) enforces nonnegativity of the fillup value \(p_n\); and the remaining (optional) rows enforce additional linear constraints. Argument CI is a vector with corresponding elements.

Examples of their use are given in the “icons” vignette.

**Note**

In manpages elsewhere, \(n=2\) is used for speed reasons. Use the default \(n=10\) or greater in production work.

This functionality is peculiarly susceptible to off-by-one errors.

The built-in datasets generally include a pre-calculated result of running maxp(); thus hyper2 object icons and icons_maxp are included in the same .rda file.

Function maxp() can trigger a known R bug (bugzilla id 17703) which reports “wmmin is not finite”. Setting option use_alabama to TRUE makes the package use a different optimization routine.

**Author(s)**

Robin K. S. Hankin

**See Also**

gradient, fillup
Examples

```r
maxp(icons)

W <- hyper2(pnames=letters[1:5])
W1 <- ggrl(W, 'a', letters[2:3], 'd')  # W1 is a suplist object
## Not run: maxp(W1)  # takes a long time to maximize a suplist
```

---

**moto**  
*MotoGP dataset*

Description

Race results from the 2019 Grand Prix motorcycling season

Usage

```r
data(moto)
```

Details

Object **moto_table** is a dataframe of results showing ranks of 28 drivers (riders?) in the 2019 FIM MotoGP World Championship. The format is standard, that is, can be interpreted by function `ordertable2supp()` if the final points column is removed. The corresponding support function is `motoGP_2019`.

These objects can be generated by running script `inst/moto.Rmd`, which includes some further discussion and technical documentation and creates file `moto.rda` which resides in the `data/` directory.

Note

Many drivers have names with diacritics, which have been removed from the dataframe.

References


See Also

`ordertable2supp`

Examples

```r
pie(moto_maxp)
```
**mult_grid**

**Kronecker matrix functionality**

**Description**

Peculiar version of `expand.grid()` for matrices

**Usage**

```r
mult_grid(L)
pair_grid(a,b)
```

**Arguments**

- **L**: List of matrices
- **a, b**: Matrices

**Details**

Function `pair_grid(a,b)` returns a matrix with each column of `a` `cbind()`-ed to each column of `b`.

Function `mult_grid()` takes a list of matrices; it is designed for use by `ggrl()`.

**Author(s)**

Robin K. S. Hankin

**See Also**

- `ggrl`

**Examples**

```r
pair_grid(diag(2), diag(3))
mult_grid(lapply(1:4, diag))
```

---

**NBA**

**Basketball dataset**

**Description**

A point-by-point analysis of a basketball game

**Usage**

```r
data(NBA)
```
Details

Dataset NBA_table is a dataframe contains a point-by-point analysis of a basketball match. Each row corresponds to a point scored. The first column is the time of the score, the second is the number of points scored, the third shows which team had possession at the start of play, and the fourth shows which team scored. The other columns show the players. Table entries show whether or not that particular player was on the pitch when the point was scored.

Likelihood function NBA is a hyper2 object that gives the log-likelihood function for this dataset. There is a player named "possession" that is a reified entity representing the effect of possession.

Object NBA_maxp is not the result of running maxp(NBA); it was obtained by repeatedly running maxp_simplex() on a fault-tolerant system [it triggers a known R bug, bugzilla id 17703, giving a "wmmin not finite" error]. It is not clear to me that likelihood function NBA has a well-defined global maximum.

Note that function volley() is not applicable because we need to include possession.

These objects can be generated by running script inst/NBA.Rmd, which includes some further discussion and technical documentation and creates file NBA.rda which resides in the data/ directory.

References

https://www.espn.com/nba/playbyplay?gameId=400954514

See Also

volleyball

Examples

data(NBA)
dotchart(NBA_maxp)

Ops.hyper2

Arithmetic Ops Group Methods for hyper2 objects

Description

Allows arithmetic operators "+", "*" and comparison operators "==" and "!=", to be used for hyper2 objects.

Specifically, H1 + H2 implements addition of two log-likelihood functions, corresponding to incorporation of additional independent observational data; and n*H1 implements H1+H1+...+H1, corresponding to repeated independent observations of the same data.

There are no unary operations for this class.

Usage

## S3 method for class 'hyper2'
Ops(e1, e2 = NULL)
## S3 method for class 'hyper2'
sum(x,...,na.rm=FALSE)
hyper2_add(e1,e2)
hyper2_sum_numeric(H,r)
Arguments

- **e1, e2**: Objects of class `hyper2`, here interpreted as hyperdirichlet distributions.
- **x, ..., na.rm**: In the `sum()` method, objects to be summed; `na.rm` is currently ignored.
- **H, r**: In function `hyper2_sum_numeric()`, object `H` is a `hyper2` object and `r` is a length-one real vector (a number).

Details

If two independent datasets have `hyper2` objects `H1` and `H2`, then the R idiom for combining these would be `H1 + H2`; the additive notation “+” corresponds to addition of the support (or multiplication of the likelihood). So `hyper2` objects are better thought of as support functions than likelihood functions; this is reflected in the print method which explicitly wraps the likelihood function in a “log()”.

Idiom `H1 - H1` returns `H1 + (-1)*H2`, useful for investigating the difference between likelihood functions arising from two different observations, or different probability models. An example is given in `inst/soling.Rmd`.

Testing for equality is not straightforward for two implementation reasons. Firstly, the object itself is stored internally as a `std::map`, which does not store keys in any particular order; and secondly, the `std::set` class is used for the brackets. A set does not include information about the order of its elements; neither does it admit repeated elements. See examples.

Function `hyper2_sum_numeric()` is defined so that idiom like `icons["L"] + 5` works as expected. This means that `icons["L"] <- icons["L"] + 3` and `icons["L"] %<>% inc(3)` work (without this, one has to type `icons["L"] <- powers(icons["L"]) + 3`, which sucks).

Value

Returns a `hyper2` object or a Boolean.

Author(s)

Robin K. S. Hankin

Examples

```r
chess2 <- hyper2(list("Kasparov", "Karpov", c("Kasparov", "Karpov")), c(2, 3, -5))
chess + chess2
maxp(chess + chess2)
```

Order tables

Order tables
Details

The package makes extensive use of order tables and these are discussed here together with a list of order tables available in the package as data. See also ranktable.Rd.

Consider pentathlon_ordertable:

```r
> pentathlon_table

<table>
<thead>
<tr>
<th></th>
<th>shooting</th>
<th>fencing</th>
<th>swimming</th>
<th>riding</th>
<th>running</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moiseev</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Zadneprovskis</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Capalini</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Cerkovskis</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Meliakh</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Michalik</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Walther</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
```

Although pentathlon_table is a dataset in the package, the source dataset is also included in the inst/ directory as file pentathlon.txt; use idiom like read.table("inst/pentathlon.txt") to load the order table.

Object pentathlon_table is a representative example of an ordertable. Each row is a competitor, each column an event (venue, judge, . . . ). The first row shows Moiseev’s ranking in shooting (5th), fencing (1st), and so on. The first column shows the ranks of the competitors in shooting. Thus Moiseev came fifth, Zadneprovskis came 6th, and so on.

However, to create a likelihood function we need ranks, not orders. We need to know, for a given event, who came first, who came second, and so on (an extended discussion on the difference between rank and order is given at rrank.Rd). We can convert from an order table to a rank table using ordertable_to_ranktable() (see also ranktable.Rd):

```r
> ordertable_to_ranktable(pentathlon_table)

c1          c2          c3          c4          c5
shooting Meliakh  Michalik  Cerkovskis Capalini Moiseev
fencing  Moiseev  Zadneprovskis Cerkovskis Michalik Walther
swimming Moiseev  Capalini  Walther  Meliakh Zadneprovskis
riding  Meliakh  Michalik  Capalini  Walther Zadneprovskis
running Zadneprovskis Cerkovskis  Walther  Capalini Moiseev
c6          c7          
shooting  Zadneprovskis  Walther
fencing Capalini  Meliakh
swimming  Michalik  Cerkovskis
riding  Moiseev  Cerkovskis
running  Meliakh  Michalik
```

Above, we see the same data in a different format (an extended discussion on the difference between rank and order is given in rrank.Rd).

Many of the order tables in the package include entries that correspond to some variation on “did not finish”. Consider the volvo dataset:

```r
> volvo_table_2014

<table>
<thead>
<tr>
<th>leg1</th>
<th>leg2</th>
<th>leg3</th>
<th>leg4</th>
<th>leg5</th>
<th>leg6</th>
<th>leg7</th>
<th>leg8</th>
<th>leg9</th>
</tr>
</thead>
<tbody>
<tr>
<td>AbuDhabi</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Brunel</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
```
In the above order table, we have DNF for “did not finish” and DNS for “did not start”. The formula1 order table has other similar entries such as DSQ for “disqualified” and a discussion is given at ordertable2supp.Rd.

Links are given below to all the order tables in the package. Note that the table in inst/eurovision.Rmd (wiki_matrix) is not an order table because no country is allowed to vote for itself.

To coerce a table like the Volvo dataset shown above into an order table [that is, replace DNS with zeros, and also force nonzero entries to be contiguous], use as.ordertable().

Author(s)
Robin K. S Hankin

See Also
ordertable2supp, rrank, ranktable, as.ordertable

Examples
ordertable_to_ranktable(soling_table)
ordertable2supp(soling_table) == soling  # should be TRUE

ordertable2points  Calculate points from an order table

Description
Given an order table and a schedule of points, calculate the points awarded to each competitor.

Usage
ordertable2points(o, points, totals=TRUE)

Arguments
  o            Order table
  points       A numeric vector indicating number of points awarded for first, second, third, etc placing
  totals       Boolean, with default TRUE meaning to return the points for each player (row) and FALSE meaning to return the entire table but with orders replaced with points scored

Value
  Returns either an order table or a named numeric vector
ordertable2supp

Author(s)
Robin K. S. Hankin

See Also
ordertable

Examples
points <- c(25, 18, 15, 12, 10, 8, 6, 4, 2, 1, 0, 0)
o <- as.ordertable(F1_table_2017)
ordertable2points(o,points)

ordertable2points(ranktable_to_ordertable(rrank(9,volvo_maxp)),1)

ordertable2supp
Translate order tables to support functions

Description
Wikipedia gives a nice summary in table form of Formula 1 racing results on pages like https://en.wikipedia.org/wiki/2017_Formula_One_World_Championship (at World Drivers’ Championship standings) but the data format is commonly used for many sports [see ordertable.Rd] and function ordertable2supp() translates such tables into a hyper2 support function and also an order table.

Both functions interpret zero to mean “Did not finish” (wikipedia usually signifies DNF as a blank).

Usage
ordertable2supp(x, noscore, incomplete=TRUE)
ordervvec2supp(d)

Arguments
x Data frame, see details
d A named numeric vector giving order; zero entries are interpreted as that competitor coming last (due to, e.g., not finishing)
incomplete Boolean, with FALSE meaning to insist that each rank 1, 2, ..., n is present [zero meaning did not place] and default TRUE allowing for gaps. See examples.
noscore Character vector giving the abbreviations for a non-finishing status such as “did not finish” or “disqualified”. A missing argument is interpreted as c("Ret","WD","DNS","DSQ","DNP","NC")

Details
Function ordertable2supp() is intended for use on order tables such as found at https://en.wikipedia.org/wiki/2019_Moto3_season. This is a common format, used for Formula 1, motoGP, and other racing sports. Prepared text versions are available in the package in the inst/directory, for example inst/motoGP_2019.txt. Use read.table() to create a data frame which can be interpreted by ordertable2supp().
Function `ordervec2supp()` takes an order vector `d` and returns the corresponding Plackett-Luce loglikelihood function as a `hyper2` object. It requires a named vector; names of the elements are interpreted as names of the players. Use argument `pnames` to supply the players' names (see the examples).

```r
> x <- c(b=2,c=3,a=1,d=4,e=5) # a: 1st, b: 2nd, c: 3rd etc
> ordervec2supp(x)
log( a * (a + b + c + d + e)^-1 * (a + b + d + e)^-1 * b * (b + d + e)^-1 * c * (d + e)^-1 * e)
```

Note carefully the difference between `ordervec2supp()` and `rankvec_likelihood()`, which takes a character vector:

```r
> names(sort(x))
[1] "a" "b" "c" "d" "e"
> rankvec_likelihood(names(sort(x)))
log( a * (a + b + c + d + e)^-1 * b * (b + c + d + e)^-1 * c * (c + d + e)^-1 * d * (d + e)^-1)
> rankvec_likelihood(names(sort(x))) == ordervec2supp(x)
[1] TRUE
```

Function `order_obs()` was used in the integer-indexed paradigm but is obsolete in the name paradigm.

**Value**

Returns a `hyper2` object

**Author(s)**

Robin K. S. Hankin

**See Also**

`ordertable`

**Examples**

```r
ordertable2supp(soling_table)
```

```r
a1 <- c(a=2,b=3,c=1,d=5,e=4) # a: 2nd, b: 3rd, c: 1st, d: 5th, e: 4th
a2 <- c(a=1,b=0,c=0,d=2,e=3) # a: 2nd, b: DNF, c: DNF, d: 2nd, e: 3rd
a3 <- c(a=1,b=3,c=2) # a: 1st, b: 3rd, c: 2nd. NB only a,b,c competed
a4 <- c(a=1,b=3,c=2,d=0,e=0) # a: 1st, b: 3rd, c: 2nd, d,e: DNF

## ordervec2supp() may be added [if the observations are independent]:
```
H1 <- ordervec2supp(a1) + ordervec2supp(a2) + ordervec2supp(a3)
H2 <- ordervec2supp(a1) + ordervec2supp(a2) + ordervec2supp(a4)

## Thus H1 and H2 are identical except for the third race. In H1, 'd'
## and 'e' did not compete, but in H2, 'd' and 'e' did not finish (and
## notionally came last):

pmax(H1)
pmax(H2) # d,e not finishing affects their estimated strength

---

**ordertans**  
*Order transformation*

**Description**

Given an order vector, shuffle so that the players appear in a specified order.

**Usage**

```r
ordertans(x, players)
ordertansplot(ox, oy, ...)
```

**Arguments**

- `x`: A (generalized) order vector
- `players`: A character vector specifying the order in which the players will be listed; if
  missing, use `sort(names(x))`
- `ox, oy`: Rank vectors
- `...`: Further arguments, passed to `plot()`

**Details**

The best way to describe this function is with an example:

```r
> x <- c(d=2, a=3, b=1, c=4)
> x
d a b c
2 3 1 4
```

In the above, we see `x` is an order vector showing that d came second, a came third, b came first, and c came fourth. This is difficult to deal with because one has to search through the vector to find a particular competitor, or a particular rank. This would be harder if the vector was longer. If we wish to answer the question “where did competitor a come? where did b come?” we would want an `order` vector in which the competitors are in alphabetical order. This is accomplished by `ordertans()`:

```r
> o <- ordertans(x)
> o
a b c d
3 1 4 2
```
(this is equivalent to \( o \leftarrow \text{order}(\text{names}(x)) \)). Object \( o \) contains the same information as \( x \), but presented differently. This says that \( a \) came third, \( b \) came first, \( c \) came fourth, and \( d \) came second. In particular, the Plackett-Luce order statistic is identical:

\[
> \text{ordervc2supp}(x) == \text{ordervc2supp}(o)
> [1] \text{TRUE}
\]

There is a nice example of \texttt{ordertrans()} in \texttt{inst/eurovision.Rmd}, and file \texttt{inst/ordertrans.Rmd} provides further discussion and examples.

Function \texttt{ordertrans()} takes a second argument which allows the user to arrange an order vector into the order specified.

### Value

Returns a named vector

### Note

The argument to \texttt{ordertrans()} is technically an order vector because it answers the question “where did the first-named competitor come?” (see the discussion at \texttt{rrank.Rd}). But it is not a helpful order vector because you have to go searching through the names—which can appear in any order—for the competitor you are interested in. I guess “generalised order vector” might be a better description of the argument.

### Author(s)

Robin K. S. Hankin

### See Also

\texttt{rrank}

### Examples

```r
x <- c(e=4L,a=7L,c=6L,b=1L,f=2L,g=3L,h=5L,i=8L,d=9L)
\text{ordertrans}(x,\text{letters}[1:9])

o <- \text{skating\_table[,1]}
names(o) <- \text{rownames(skating\_table)}
\text{ordertrans}(o)

\text{ordertrans}(\text{sample(icons\_maxp)},\text{icons})
```

```r
rL <- \text{volvo\_maxp}  # rL is "ranks Likelihood"
rL[] <- \text{rank(-volvo\_maxp)}

r1 <- \text{volvo\_table[,1]}  # ranks race 1
names(r1) <- \text{rownames(volvo\_table)}
\text{ordertransplot}(rL,r1,\text{xlab="likelihood rank, all races"},\text{ylab="rank, race 1"})
```
Description

Results from the Men’s pentathlon at the 2004 Summer Olympics

Usage

data(pentathlon)

Format

A hyper2 object that gives a likelihood function

Details

Object pentathlon is a hyper2 object that gives a likelihood function for the strengths of the top seven competitors at the Modern Men’s Pentathlon, 2004 Summer Olympics.

Object pentathlon_table is an order table: a data frame with rows being competitors, columns being disciplines, and entries being places. Thus looking at the first row, first column we see that Moiseev placed fifth at shooting.

These objects can be generated by running script inst/pentathlon.Rmd, which includes some further discussion and technical documentation and creates file pentathlon.rda which resides in the data/ directory.

Note

Many of the competitors’ names have diacritics, which I have removed.

References


See Also

ordertable

Examples

data(pentathlon)
pie(pentathlon_maxp)
powerboat

Description

Race results from the 2018 F1 Powerboat World Championship

Usage

data(powerboat)

Details

Object `powerboat_table` is a dataframe of results showing ranks of 21 drivers in the 2018 F1 Powerboat World Championship. The format is standard, that is, can be interpreted by function `ordertable2supp()` and indeed `ordertable2supp(powerboat_table[,1:7])` gives the corresponding support function, `powerboat`.

File `inst/powerboat.txt` is the source text file; to create `powerboat_table` use

```r
read.table(system.file("powerboat.txt",package="hyper2"))
```

The dataset used here corrects an apparent typo in the wikipedia table (see github issue 37).

These objects can be generated by running script `inst/powerboat.Rmd`, which includes some further discussion and technical documentation and creates file `powerboat.rda` which resides in the `data/` directory.

Note

Many drivers have names with diacritics, which have been removed from the dataframe.

References


See Also

`ordertable2supp`

Examples

```r
pie(powerboat_maxp)
```
Print methods for `hyper2` objects

### Usage

```r
## S3 method for class 'hyper2'
print(x, ...)
```

### Arguments

- `x`: An object of class `hyper2`
- `...`: Further arguments, currently ignored

### Value

Returns the `hyper2` object it was sent, invisibly. Used mainly for its side-effect of printing the log-likelihood function. In the print method, a natural logarithm is indicated with “\(\log()\)”—not “\(\ln()\)”—consistent with R builtin terminology `base::log()`.

The print method is sensitive to option `give_warning_on_nonzero_power_sum`. If `TRUE`, a warning is issued if the powers have nonzero sum. This is usually what you want because observations are typically multinomial. If `FALSE`, the warning is suppressed. One often needs `hyper2` objects with nonzero sum as the following snippet attests:

```r
H1 <- hyper2(list('a'),1)
H2 <- hyper2(list('a', c('a', 'b')), c(1,-1))
```

Above, both objects are legitimate likelihood functions; both correspond to the observation “player a won once”. But they differ in that `H1` corresponds to “player a came first in a field of unspecified players” while `H2` corresponds to “player a came first in a field comprising a and b”. Sometimes you want `H1` but (in my experience) mostly it is a result of coding error. Also note the following snippet:

```r
icons["L"] %<>% inc
icons["L","NB"] %<>% dec
```

The above two lines correspond to “Take the `icons` likelihood function and add to it the (independent) observation that a correspondent found ‘London’ to be more concerning than ‘the Norfolk Broads’”. But after the first line and before the second, `icons` has a nonzero power sum, pending addition of another term. At this point, `icons` is arguably an incomplete likelihood function as the players have not been specified; its nonzero power sum is an indicator that it is a temporary object. That’s OK as long as we remember to add the denominator (as carried out in the next line) which would mean multiplying by \((L+NB)^{-1}\), restoring the zero power sum. If we forget to do this, the print method gives us a warning which should prompt us to check the coding.

### Author(s)

Robin K. S. Hankin
Examples

data(chess)
chess

profile

Profile likelihood and support

Description

Given a support function, return a profile likelihood curve

Usage

profsupp(H, i, p, relative=TRUE, ...)
profile_support_single(H, i, p, evaluate=FALSE, ...)

Arguments

H  hyper2 object
i  Name of player for which profile support is to be calculated
p  Strength of element i
evaluate  Boolean, with default FALSE meaning to return the maximal support for p_i=p and TRUE meaning to return the evaluate
relative  Boolean; if TRUE (default), return the support relative to the maximum support attained; if false, return the support as returned by profile_support_single().
...  Arguments passed to maxp()

Value

Returns the support at a particular value of p_i, or the evaluate conditional on p_i.

Author(s)

Robin K. S. Hankin

See Also

loglik

Examples

## Not run: # takes too long
p <- seq(from=0.5,to=0.4,len=10)
u <- profsupp(icons,"NB",p)
plot(p,u-max(u))
abline(h=c(0,-2))
## End(Not run)
**psubs**

*Substitute players of a hyper2 object*

**Description**

Given a hyper2 object, substitute some players

**Usage**

```
psubs(H, from, to)
psubs_single(H, from, to)
```

**Arguments**

- `H`  
  hyper2 object
- `from, to`  
  Character vector of players to substitute and their substitutes

**Details**

Function `psubs()` substitutes one or more player names, replacing player `from[i]` with `to[i]`. If argument `to` is missing, all players are substituted, the second argument taken to be the replacement: interpret `psubs(H, vec)` as `psubs(H, from=pnames(H), to=vec)`. Compare `pnames<-()` which can only add players, or reorder existing players.

Function `psubs_single()` is a low-level helper function that takes a single player and its substitute; it is not intended for direct use.

**Value**

Returns a hyper2 object

**Author(s)**

Robin K. S. Hankin

**Examples**

```
psubs(icons, c("L", "NB"), c("London", "Norfolk Broads"))
rhyper2() %>% psubs(letters, LETTERS)  # ignore i, j, k, ..., z
psubs(icons, tolower(pnames(icons)))
```
**pwa**

**Player with advantage**

**Description**

Commonly, when considering competitive situations we suspect that one player has an advantage of some type which we would like to quantify in terms of an additional strength. Examples might include racing at pole position, playing white in chess, or playing soccer at one’s home ground. Function `pwa()` ("player with advantage") returns a modified `hyper2` object with the additional strength represented as a reified entity.

**Usage**

```r
pwa(H, pwa, chameleon = "S")
```

**Arguments**

- **H** A `hyper2` object
- **pwa** A list of the players with the supposed advantage; may be character in the case of a named `hyper2` object, or an integer vector
- **chameleon** String representing the advantage

**Details**

Given an object of class `hyper2` and a competitor `a`, we replace every occurrence of `a` with `a+S`, with `S` representing the extra strength conferred.

However, the function also takes a vector of competitors. If there is more than one competitor, the resulting likelihood function does not seem to instantiate any simple situation.

Nice examples of `pwa()` are given in 'inst/cook.Rmd' and 'inst/universities.Rmd'.

**Value**

Returns an object of class `hyper2`.

**Note**

Earlier versions of this package gave a contrived sequence of observations, presented as an example of `pwa()` with multiple advantaged competitors. I removed it because the logic was flawed, but it featured a chameleon who could impersonate (and indeed eat) certain competitors, which is why the third argument is so named.

The aliases commemorate some uses of the function in the vignettes and markdown files in the 'inst/' directory.

**Author(s)**

Robin K. S. Hankin

**See Also**

`ordervc2supp`
Examples

```
summary(formula1 %>% pwa("Hamilton","pole"))

H <- ordervec2supp(c(a = 2, b = 3, c = 1, d = 5, e = 4))
pwa(H, 'a')

## Four races between a,b,c,d:
H1 <- ordervec2supp(c(a = 1, b = 3, c = 4, d = 2))
H2 <- ordervec2supp(c(a = 0, b = 1, c = 3, d = 2))
H3 <- ordervec2supp(c(a = 4, b = 2, c = 1, d = 3))
H4 <- ordervec2supp(c(a = 3, b = 4, c = 1, d = 2))

## Now it is revealed that a,b,c had some advantage in races 1,2,3 respectively. Is there evidence that this advantage exists?
## Not run: # takes ~10 seconds, too long for here
specificp.test(pwa(H1,'a') + pwa(H2,'b') + pwa(H3,'c') + H4,"S")
## End(Not run)
```

---

**ranktable**

*Convert rank tables to and from order tables*

**Description**

Convert rank tables (as generated by `rrank()`, for example) to order tables like the formula 1 tables; and convert back. Print and summary methods for rank tables are documented here. See also `ordertable.Rd`.

**Usage**

```
ranktable_to_ordertable(xrank)
ordertable_to_ranktable(xorder)
wikitable_to_ranktable(wikitable, strict=FALSE)
## S3 method for class 'ranktable'
summary(object, ...)
ranktable_to_printable_object(x)
## S3 method for class 'ranktablesummary'
print(x, ...)
```

**Arguments**

- `x,xrank,object` A rank table, an object with class `ranktable`, for example the value of `rrank()`
- `xorder,wikitable` Order tables. Argument `wikitable` refers to a generalized order table which can include entries such as DNF signifying did not finish.
- `strict` Controls for `wikitable_to_ranktable()`
- `...` Further arguments (currently ignored)
Details

Function `ranktable_to_ordertable()` is trivial; `ordertable_to_ranktable()` less so. The prototype for order tables would be `skating_table`.

Function `ordertable_to_ranktable(x)` checks for each column being a permutation of `seq_len(nrow(x))` and, if not, it stops. In particular, DNF entries are out of scope. To convert order tables such as `F1_table_2017`, which include DNF entries, use `wikitable_to_ranktable()` or `ordertable2supp()` to produce a likelihood function.

Function `ranktable_to_printable_object()` is a helper function that coerces a ranktable object to a matrix that prints nicely.

The print method is discussed in vignette `inst/ordertable_to_ranktable.Rmd`.

Value

An order table or rank table

Author(s)

Robin K. S. Hankin

See Also

`rrank`, `ordertable2supp`

Examples

```r
p <- (5:1)/15
names(p) <- letters[1:5]
xrank <- rrank(12,p,rnames=month.abb)
oxorder <- ranktable_to_ordertable(xrank)

## Can convert back and forth:
identical(xrank,ordertable_to_ranktable(ranktable_to_ordertable(xrank)))

# maxp(ordertable2supp(xorder)) # should be close to p
ordertable_to_ranktable(skating_table)
```

---

**rhyper2** 

*Random hyper2 objects*

Description

Random hyper2 loglikelihood functions, intended as quick “get you going” examples

Usage

`rhyper2(n = 8, s = 5, pairs = TRUE, teams = TRUE, race = TRUE, pnames)`
Arguments

n  Number of competitors, treated as even
s  Integer, Measure of the complexity of the log likelihood function
pairs,teams,race  Boolean, indicating whether or not to include different observations
pnames  Character vector of names, if missing interpret as letters; set to NA meaning no names

Note

Function rhyper2() returns a likelihood function based on random observations. To return a random probability vector drawn from a from a given (normalized) likelihood function, use rp().

Author(s)

Robin K. S. Hankin

See Also

rp

Examples

rhyper2()
rp(2,icons)

Description

Data from Men’s single sculls, 2016 Summer Olympics

Usage

data(rowing)

Format

Object rowing is a hyper2 object that gives a likelihood function for the 2016 men’s sculls.

Details

Object rowing is created by the code in inst/rowing.Rmd. This reads file inst/rowing.txt, each line of which is a heat showing the finishing order.

File inst/rowing_minimal.txt has the same data but with dominated players (that is, any group of players none of whom have beaten any player not in the group) have been removed. This is because dominated players have a ML strength of zero.
References


See Also
ggrl

Examples

dotchart(rowing_maxp)

---

rp

Random samples from the prior of a hyper2 object

Description

Uses Metropolis-Hastings to return random samples from the prior of a hyper2 object

Usage

rp(n, H, startp = NULL, fcm = NULL, fcv = NULL, SMALL = 1e-06, l=loglik,...)

Arguments

H Object of class hyper2
n Number of samples
startp Starting value for the Markov chain, with default NULL being interpreted as starting from the evaluate
fcm,fcv Constraints as for maxp()
SMALL Notional small value for numerical stability
l Log-likelihood function with default loglik()
... Further arguments, currently ignored

Details

Uses the implementation of Metropolis-Hastings from the MCE package to sample from the posterior PDF of a hyper2 object.

If the distribution is Dirichlet, use rdirichlet() to generate random observations: it is much faster, and produces serially independent samples. To return uniform samples, use rp_unif() (documented at dirichlet.Rd).

Value

Returns a matrix, each row being a unit-sum observation.
Note

Function rp() a random sample from a given normalized likelihood function. To return a likelihood function based on random observations, use rhyper2().

Author(s)

Robin K. S. Hankin

See Also

maxp, loglik, dirichlet, rhyper2

Examples

rp(10, icons)

plot(loglik(rp(30, icons), icons), type='b')

rrank

Random ranks

Description

A function for producing ranks randomly, consistent with a specified strength vector

Usage

rrank(n = 1, p, pnames=NULL, fill = FALSE, rnames=NULL)

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

Arguments

n
Number of observations

p
Strength vector

pnames
Character vector (“player names”) specifying names of the columns

rnames
Character vector (“row names” or “race names”) specifying names of the rows

fill
Boolean, with default FALSE meaning to interpret the elements of p as strengths, notionally summing to one; and TRUE meaning to augment p with a fillup value

x, ...
Arguments passed to the print method

Value

If n=1, return a vector; if n>1 return a matrix with n rows, each corresponding to a ranking. The canonical example is a race in which the probability of competitor i coming first is \( p_i / \sum p_j \), where the summation is over the competitors who have not already finished.

If, say, the first row of rrank() is c(2, 5, 1, 3, 4), then competitor 2 came first, competitor 5 came second, competitor 1 came third, and so on.

Note that function rrank() returns an object of class ranktable, which has its own special print method. The column names appear as “c1, c2, ...” which is intended to be read “came first”, “came second”, and so on. The difference between rank and order can be confusing.
In the above, rank() shows us that element \(a\) of \(x\) (viz 3.01) is the third largest, element \(b\) (viz 1.04) is the smallest, and so on; order\((x)\) shows us that the smallest element \(x\) is \(x[2]\), the next smallest is \(x[3]\), and so on. Thus \(x[\text{order}\(x\)] == \text{sort}\(x)\), and \(\text{rank}\(x)[\text{order}\(x\)] == \text{seq.along}\(x)\). In the current context we want ranks not orders; we want to know who came first, who came second, and so on:

```
R> rrank(2,(4:1)/10)
  c1 c2 c3 c4
[1,] 2 3 1 4
[2,] 1 3 2 4
R>
```

In the above, each row is a race; we have four runners and two races. In the first race (the top row), runner number 2 came first, runner 3 came second, runner 1 came third, and so on. In the second race (bottom row), runner 1 came first, etc. Taking the first race as an example:

**Rank:** who came first? runner 2. Who came second? runner 3. Who came third? runner 1. Who came fourth? runner 4. Recall that the Plackett-Luce likelihood for a race in which the rank statistic was 2314 (the first race) would be \(\frac{p_2}{p_2 + p_3 + p_1 + p_4} \times \frac{p_3}{p_3 + p_1 + p_4} \times \frac{p_1}{p_1 + p_4} \times \frac{p_4}{p_4}\).

**Order:** where did runner 1 come? third. Where did runner 2 come? first. Where did runner 3 come? second. Where did runner 4 come? fourth. Thus the order statistic would be 3124.

Function `rrank()` is designed for `rank_likelihood()`, which needs rank data, not order data. Vignette “skating_analysis” gives another discussion.

Note that function `rrank()` returns an object of class “rrank”, which has its own print method that returns NA, intentionally. This can be confusing.

**Author(s)**

Robin K. S. Hankin

**See Also**

`ordertrans`, `rank_likelihood`, `skating`

**Examples**

```r
ttrue <- (4:1)/10
names(ttrue) <- letters[1:4]
rrank(10,p=ptrue)

H <- rank_likelihood(rrank(40,p=ptrue))
```

## Following code commented out because they take too long:
skating

Describing

A likelihood function for the competitors at the Ladies' Free Skate at the 2002 Winter Olympics

Usage

data(skating)

Details

There are three datasets loaded by data("skating"): skating, a log-likelihood function for the competitors' strengths, skating_table, an order table for each of the 9 judges, and skating_maxp, the result of maxp(skating), which is included to save time in the examples.

These objects can be generated by running script inst/skating_analysis.Rmd, which includes some further discussion and technical documentation. The dataset is interesting because it has been analysed by many workers, including Lock and Lock, for consistency between the judges.

Note that file is structured so that each competitor is a row, and each judge is a column. Function rank_likelihood() requires a transpose of this to operate.

Object skating_table is an order table, taken from Lock and Lock. It corrects what appears to be an error in which judge 5 ranked both Butyrskaya and Kettunen 12; there is no 13. Using EM, I reckon that Butyrskaya should be ranked twelfth and Kettunen thirteenth.

Author(s)

Robin K. S. Hankin

References

- [https://en.wikipedia.org/wiki/Figure_skating_at_the_2002_Winter_Olympics#Full_results_2](https://en.wikipedia.org/wiki/Figure_skating_at_the_2002_Winter_Olympics#Full_results_2)
- Robin Lock and Kari Frazer Lock, Winter 2003. “Judging Figure Skating Judges”. STAT 36, ASA

Examples

data(skating)

dotchart(skating_maxp)

ordertable_to_ranktable(skating_table)

rl <- sort(skating_maxp, decreasing=TRUE)
rl[] <- seq_along(rl)
rO <- seq_len(nrow(skating_table))
names(rO) <- rownames(skating_table)
ordertransplot(rO,rL,
  xlab="official rank",ylab="likelihood rank",
  main="Ladies free skating, 2002 Winter Olympics")

soling

Sailing at the 2000 Summer Olympics - soling

Description
Race results from the 2000 Summer Olympics: soling

Usage
data(soling)

Format
A hyper2 object that gives a likelihood function

Details
The Soling three person keelboat event at the 2000 Summer Olympic games furnishes a rich dataset. An order table and likelihood function is given in the package as soling_table and soling respectively. Data from the round robins and the quarter final is given in matrices soling_rr1, soling_rr2, soling_qf respectively.

These objects can be generated by running script inst/soling.Rmd, which includes some further discussion and technical documentation, and creates file soling.rda which resides in the data/ directory.

References

See Also
ordertable2supp

Examples
data(soling)
ordertable_to_ranktable(soling_table)
pie(soling_maxp)
summary.hyper2  Summary method for hyper2 objects

Description
Give a summary of a hyper2 object, and a print method

Usage

## S3 method for class 'hyper2'
summary(object, ...)
## S3 method for class 'summary.hyper2'
print(x, ...)

Arguments

object, x  Object of class hyper2
...	Further arguments, currently ignored

Details
Mostly self-explanatory, based on the equivalent in the untb package.

Author(s)
Robin K. S. Hankin

See Also
hyper2

Examples

summary/icons

suplist  Methods for suplist objects

Description
Basic functionality for lists of hyper2 objects, allowing the user to concatenate independent observations which are themselves composite objects such as returned by ggr1().

Usage

## S3 method for class 'suplist'
Ops(e1, e2)
## S3 method for class 'suplist'
sum(x,...,na.rm=FALSE)
suplist_add(e1, e2)
as.suplist(L)
Arguments

e1, e2
Objects of class suplist, here interpreted as a list of possible likelihood functions (who should be added)

x, ..., na.rm
In the sum() method, objects to be summed; na.rm is currently ignored

L
A list of hyper2 objects

Details

A suplist object is a list of hyper2 objects. Each element is a hyper2 object that is consistent with an incomplete rank observation \( R \); the list elements are exclusive and exhaustive for \( R \). If \( S \) is a suplist object, and \( S = \text{list}(H_1, H_2, \ldots, H_n) \) where the \( H_i \) are hyper2 objects, then \( \text{Prob}(p|H_1) + \cdots + \text{Prob}(p|H_n) \). This is because the elements of a suplist object are disjoint alternatives.

It is incorrect to say that a likelihood function \( L_S(p) \) for \( p \) is the sum of separate likelihood functions. This is incorrect because the arbitrary multiplicative constant messes up the math, for example we might have \( L_{H_1}(p) = C_1 \text{Prob}(p|H_1) \) and \( L_{H_2}(p) = C_2 \text{Prob}(p|H_2) \) and indeed \( L_{H_1 \cup H_2}(p) = C_{12} (\text{Prob}(p|H_1) + \text{Prob}(p|H_2)) \) but

\[
L_{H_1}(p) + L_{H_2}(p) \neq C_1 \text{Prob}(p|H_1) + C_2 \text{Prob}(p|H_2)
\]

(the right hand side is meaningless).

Functions suplist_add() and sum.suplist() implement “\( S_1+S_2 \)” as the support function for independent observations \( S_1 \) and \( S_2 \). The idea is that the support functions “add” in the following sense. If \( S_1=\text{list}(H_1, \ldots, H_r) \) and \( S_2=\text{list}(I_1, \ldots, I_s) \) where \( Hx, Ix \) are hyper2 objects, then the likelihood function for “\( S_1+S_2 \)” is the likelihood function for \( S_1 \) followed by (independent) \( S_2 \). Formally

\[
\text{Prob}(p|S_1 + S_2) = (\text{Prob}(p|H_1) + \cdots + \text{Prob}(p|H_r)) \cdot (\text{Prob}(p|I_1) + \cdots + \text{Prob}(p|I_s))
\]

\[
\log \text{Prob}(p|S_1 + S_2) = \log (\text{Prob}(p|H_1) + \cdots + \text{Prob}(p|H_r)) + \log (\text{Prob}(p|I_1) + \cdots + \text{Prob}(p|I_s))
\]

However, \( S_1+S_2 \) is typically a large and unwieldy object, and can be very slow to evaluate. These functions are here because they provide slick R idiom.

Value

Returns a suplist object.

Author(s)

Robin K. S. Hankin

See Also

Ops.hyper2, Extract, loglik
Examples

```r
W <- hyper2(pnames=letters[1:5])
W1 <- ggrl(W, 'a', letters[2:3], 'd') # 2-element list
W2 <- ggrl(W, 'e', letters[1:3], 'd') # 6-element list
W3 <- ggrl(W, 'c', letters[4:5], 'a') # 2-element list

# likelihood function for independent observations W1, W2, W3:
W1+W2+W3 # A 2x6x2=24-element list
like_single_list(indep(equalp(W)), W1+W2+W3)

## Not run: dotchart(maxplist(W1+W1+W3), pch=16) # takes a long time
```

---

**surfing**  
*Surfing dataset*

**Description**

Data from the 2019 World Surf League (WSL) tour

**Usage**

```r
data(surfing)
```

**Details**

The package contains four datasets from WSL 2019:

- `surfing`, a log likelihood function for the strengths of the competitors
- `surfing_maxp`, corresponding precalculated evaluate
- `surfing_venuetypes`, a dataframe showing the beach types at the different venues of the tour

These objects can be generated by running script `inst/surfing.Rmd`, which includes some further discussion and technical documentation and creates file `surfing.rda` which resides in the `data/` directory.

**Author(s)**

Robin K. S. Hankin

**Examples**

`dotchart(surfing_maxp)`
**T20**

**Indian Premier League T20 cricket**

**Description**

Cricket dataset, T20 Indian Premier League 2008-2017

**Usage**

data(T20)

**Details**

Dataframe T20_table has one row for each T20 IPL match in the period 2008-2017 with the exception of seven drawn matches and three no-result matches which were removed. Object T20 is a likelihood function for the strengths of the 13 teams, and T20_toss is a likelihood function that also includes a toss strength term.

These objects can be generated by running script inst/T20.Rmd, which is based on Chandel and Hankin 2019. This includes some further discussion and technical documentation and creates file T20.rda which resides in the data/ directory.

**References**


**Examples**

summary(T20)
dotchart(T20_maxp)

table_tennis

**Match outcomes from repeated table tennis matches**

**Description**

Match outcomes from repeated singles table tennis matches

**Usage**

data(table_tennis)

**Format**

A likelihood function corresponding to the match outcomes listed below.
Details

There are four players, A, B, and C, who play singles table tennis matches with the following results:

- A vs B, A serves, 5-1
- A vs B, B serves, 1-3
- A vs C, A serves, 4-1
- A vs C, C serves, 1-2

As discussed in vignette table_tennis_serve, we wish to assess the importance of the serve. The vignette presents a number of analyses including a profile likelihood plot.

See vignette table_tennis_serve for an account of how to create table_tennis.

Examples

data(table_tennis)
dotchart(maxp(table_tennis))

---

tennis

Match outcomes from repeated doubles tennis matches

Description

Match outcomes from repeated doubles tennis matches

Usage

data(tennis)

Format

A hyper2 object corresponding to the match outcomes listed below.

Details

There are four players, \( p_1 \) to \( p_4 \). These players play doubles tennis matches with the following results:

<table>
<thead>
<tr>
<th>match</th>
<th>score</th>
</tr>
</thead>
<tbody>
<tr>
<td>{p_1,p_2} vs {p_3,p_4}</td>
<td>9-2</td>
</tr>
<tr>
<td>{p_1,p_3} vs {p_2,p_4}</td>
<td>4-4</td>
</tr>
<tr>
<td>{p_1,p_4} vs {p_2,p_3}</td>
<td>6-7</td>
</tr>
<tr>
<td>{p_1} vs {p_3}</td>
<td>10-14</td>
</tr>
<tr>
<td>{p_2} vs {p_3}</td>
<td>12-14</td>
</tr>
<tr>
<td>{p_1} vs {p_4}</td>
<td>10-14</td>
</tr>
<tr>
<td>{p_2} vs {p_4}</td>
<td>11-10</td>
</tr>
<tr>
<td>{p_3} vs {p_4}</td>
<td>13-13</td>
</tr>
</tbody>
</table>

It is suspected that \( p_1 \) and \( p_2 \) have some form of team cohesion and play better when paired than when either solo or with other players. As the scores show, each player and, apart from \( p_1-p_2 \), each
doubles partnership, is of approximately the same strength.

Dataset tennis gives the appropriate likelihood function for the players’ strengths; and dataset tennis_ghost gives the appropriate likelihood function if the extra strength due to team cohesion of \{p_1, p_2\} is represented by a ghost player.

These objects can be generated by running script inst/tennis.Rmd, which includes some further discussion and technical documentation and creates file tennis.rda which resides in the data/ directory.

Source

Doubles tennis matches at NOCS, Jan-May 2008

References


Examples

summary(tennis)

tennis %>% psubs(c("Federer","Laver","Graf","Navratilova"))

## Following line commented out because it takes too long:
# specificp.gt.test(tennis_ghost,"G",0)

---

tests

Hypothesis testing

Description

Tests different nulls against a free alternative

Usage

equalp.test(H, ...)
knownp.test(H, p, ...)
samep.test(H, i, give=FALSE, ...)
specificp.test(H, i, specificp=1/size(H),
   alternative = c("two.sided","less","greater"), ...)
specificp.ne.test(H, i, specificp=1/size(H), ...)
specificp.gt.test(H, i, specificp=1/size(H), delta=1e-5, ...)
specificp.lt.test(H, i, specificp=1/size(H), ...)
## S3 method for class 'hyper2test'
print(x, ...)
Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>A likelihood function, an object of class <code>hyper2</code></td>
</tr>
<tr>
<td>p</td>
<td>In <code>equalp.test()</code>, putative strength vector to be tested</td>
</tr>
<tr>
<td>...</td>
<td>Further arguments passed by <code>equalp.test()</code> to <code>maxp()</code> and ignored by <code>print.hyper2test()</code></td>
</tr>
<tr>
<td>i</td>
<td>A character vector of names</td>
</tr>
<tr>
<td>specificp</td>
<td>Strength, real number between 0 and 1</td>
</tr>
<tr>
<td>alternative</td>
<td>a character string specifying the alternative hypothesis, must be one of <code>two.sided</code> (default), <code>greater</code> or <code>less</code>. You can specify just the initial letter (taken from <code>t.test.Rd</code>)</td>
</tr>
<tr>
<td>give</td>
<td>Boolean, with TRUE meaning to return more detailed debugging information, and default FALSE meaning to return a more user-friendly object of class <code>equalp.test</code>, which has its own print method</td>
</tr>
<tr>
<td>x</td>
<td>Object of class <code>equalp.test</code>, the result of <code>equalp.test()</code></td>
</tr>
<tr>
<td>delta</td>
<td>Small value for numerical stability</td>
</tr>
</tbody>
</table>

Details

Given a `hyper2` likelihood function, there are a number of natural questions to ask about the strengths of the players; see the Hankin 2010 (JSS) for examples. An extended discussion is presented in vignette "hyper2" and the functions documented here cover most of the tests used in the vignette.

The tests return an object with class `hyper2test`, which has its own print method.

- Function `equalp.test(H,p)` tests the null that all strengths are equal to vector `p`. If `p` is missing, it tests $H_0: p_1 = p_2 = \cdots = p_n = \frac{1}{n}$, for example `equalp.test/icons`.
- Function `knownp.test()` tests the null that the strengths are equal to the elements of named vector `p`; it is a generalization of `equalp.test()`. Example: `knownp.test(icons, zipf(6))`.
- Function `specificp.test(H,i,p)` tests $H_0: p_i = p$, for example `specificp.test(icons,"NB",0.1)`.
- Function `samep.test()` tests $H_0: p_{i_1} = p_{i_2} = \cdots = p_{i_k}$, for example `samep.test(icons,c("NB","L"))`.
- Functions `specificp.ne.test(H,i,p)`, `specificp.gt.test(H,i,p)`, and `specificp.lt.test(H,i,p)` are low-level helper functions that implement one- or two-sided versions of `specificp.test()` via the alternative argument, following `t.test()`.

Value

The test functions return a list with class "hyper2test" containing the following components:

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>statistic</td>
<td>the difference in support between the null and alternative</td>
</tr>
<tr>
<td>p.value</td>
<td>the (asymptotic) p-value for the test, based on Wilks’s theorem</td>
</tr>
<tr>
<td>estimate</td>
<td>the maximum likelihood estimate for <code>p</code></td>
</tr>
<tr>
<td>method</td>
<td>a character string indicating what type of test was performed</td>
</tr>
<tr>
<td>data.name</td>
<td>a character string giving the name(s) of the data.</td>
</tr>
</tbody>
</table>
Note

Function `specificp.gt.test()` includes quite a bit of messing about to ensure that frequently-used idiom like `specificp.gt.test(Icons,"NB",0)` works as expected, testing a null of \( p_{NB}=0 \). In the case of testing a strength’s being zero, the support function is often quite badly-behaved near the constraint [think tossing a coin with probability \( p \) twice, observing one head and one tail, and testing \( p = 0 \); at the constraint, the likelihood is zero, the support negative infinity, and the gradient of the support is infinite].Numerically, the code tests \( p_{NB}=\delta \). Note that similar machinations are not required in `specificp.lt.test()` because a null of \( p_{NB}=1 \) is unrealistic.

Function `samep.test()` does not have access to gradient information so it is slow, inaccurate, and may fail completely for high-dimensional datasets. If `any(i==n)`, this constrains the fillup value; this makes no difference mathematically but the function idiom is involved.

See Also

`maxp`

Examples

```r
equalp.test(chess)

# samep.test(Icons,c("NB","L"))
# knownp.test(Icons,zipf(Icons))
```

### tidy

_tidy up a hyper2 object_

Description

Tidy up a hyper2 object by removing players about which we have no information

Usage

```r
tidy(H)
```

Arguments

- **H**
  - A hyper2 object

Details

Function `tidy(H)` returns a hyper2 object mathematically identical to \( H \) but with unused players (that is, players that do not appear in any bracket) removed. Players about which \( H \) is uninformative are removed from the `pnames` attribute.

Note that idiom `pnames(H) <- foo` can also be used to manipulate the `pnames` attribute.

Author(s)

Robin K. S. Hankin
Examples

```r
H <- hyper2(pnames=letters)
H["a"] <- 1
H["b"] <- 2
H[c("a","b")]<- -3

pnames(H)
pnames(tidy(H))

H == tidy(H)  # should be TRUE
```

---

**universities**  
*New Zealand University ranking data*

**Description**

Times Higher Education World University Rankings

**Usage**

data(universities)

**Format**

A hyper2 object that gives a likelihood function for ranking of NZ universities

**Details**

The data is taken directly from the THE website, specifying “New Zealand”:

Object `universities` is a hyper2 support function and `universities_table` a data frame.

These objects can be generated by running script inst/universities.Rmd, which includes some further discussion and technical documentation, and creates file `universities.rda` which resides in the data/ directory.

**See Also**

`ordertable`

**Examples**

```r
summary(universities)

psubs(universities,c("AUT","UoA"),c("University of Auckland","Auckland University of Technology"))

pie(universities_maxp)
```
Results from the NOCS volleyball league

Description

Results from the NOCS volleyball league. Object volleyball_table is a matrix in which each column corresponds to a player and each row corresponds to a volleyball set; volleyball is the corresponding likelihood function in the form of a hyper2 distribution.

Usage

data(volleyball)

Details

A volleyball set is a Bernoulli trial between two disjoint subsets of the players. The two subsets are denoted (after the game) as the “winners” and the “losers”; these are denoted by 1 and 0 respectively.

Thus the first line reads of volleyball_results reads:

<table>
<thead>
<tr>
<th>p1</th>
<th>p2</th>
<th>p3</th>
<th>p4</th>
<th>p5</th>
<th>p6</th>
<th>p7</th>
<th>p8</th>
<th>p9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>NA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
</tr>
</tbody>
</table>

showing that the teams were p1, p4 and p8 against p2, p5 and p6; players p3, p7 and p9 did not play.

These datasets illustrate the fact that such Bernoulli trials are only weakly informative.

These objects can be generated by running script inst/volleyball.Rmd, which includes some further discussion and technical documentation and creates file volleyball.rda which resides in the data/ directory.

Source

Volleyball games at NOCS, 2006-2008

References


Examples

volleyball == volley(volleyball_table)  # should be TRUE
Race results from the twelfth edition of the round-the-world Volvo Ocean Race.

Usage

data(volvo)

Format

A hyper2 object that gives a likelihood function

Details

Object volvo is a hyper2 object that gives a likelihood function for the strengths of the competitors of the 2014-2015 Volvo Ocean Race; volvo_maxp is a precomputed maximum likelihood estimate of the competitors' strengths. Object volvo_table is a data frame with rows being teams and columns being legs.

These objects can be generated by running script inst/volvo.Rmd, which includes some further discussion and technical documentation and creates file volvo.rda which resides in the data/directory.

References


See Also

ordertable2supp

Examples

pie(volvo_maxp)

# equalp.test(volvo)  # takes ~10 seconds to run
zapweak

Zap weak competitors

Description
Given a hyper2 object, discard competitors with a small estimated strength.

Usage
zapweak(H, minstrength = 1e-05, maxit, ...)

Arguments
- **H**: Object of class hyper2
- **minstrength**: Strength below which to discard competitors
- **maxit**: Maximum number of iterations; if missing, use size(H)-1
- **...**: Further arguments, passed to maxp()

Details
Iteratively discards the weakest player (if the estimated strength is less than minstrength) using discard_flawed(). maxp(..,n=1) for efficiency.

Value
Returns a slimmed-down hyper2 object with weak players removed.

Note
This function is experimental and appears to be overly aggressive. For some likelihood functions zapweak() removes all the players.
I now think that there is no consistent way to remove weaker players from a likelihood function. I think the only way to do it is to look at the dataset that generates the likelihood function, somehow weed out the players with the poorest performance, and generate a new likelihood function without them.

Author(s)
Robin K. S. Hankin

See Also
discard_flawed, maxp

Examples
zapweak/icons)  # removes noone
#Takes too long
zapweak(rowing)  # removes everyone...
**Description**

Function `pairwise()` takes a matrix of pairwise comparisons and returns a hyper2 likelihood function. Function `zermelo()` gives a standard iterative procedure for likelihood maximization of pairwise Bradley-Terry likelihoods (such as those produced by function `pairwise()`).

**Usage**

```
zermelo(M, maxit = 100, start, tol = 1e-10, give = FALSE)
```

**Arguments**

- `M` : Matrix of pairwise comparison results
- `maxit` : Maximum number of iterations
- `start` : Starting value for iteration; if missing, use `equalp()`
- `tol` : Numerical tolerance for stopping criterion
- `give` : Boolean with default FALSE meaning to return the evaluate and TRUE meaning to return all iterations

**Details**

In function `zermelo()`, the diagonal is disregarded.

**Note**

An extended discussion is given in `inst/zermelo.Rmd` and also `inst/karate.Rmd`.

**Author(s)**

Robin K. S. Hankin

**References**


**See Also**

- `maxp`
Examples

# Data is the top 5 players from Borozki's table 1

```r
M <- matrix(c(
0,10,0,2.5,
4,0,0,6.6,
0,0,0,15.0,
0,8.0,0,7,
1,0,3,0)
),5,5,byrow=TRUE)
players <- c("Agassi","Becker","Borg","Connors","Courier")
dimnames(M) <- list(winner=players,loser=players)
M
# e.g. Agassi beats Becker 10 times and loses 4 times
pairwise(M)
zermelo(M)
# maxp(pairwise(M)) # should be identical (takes ~10s to run)
```

zipf

**Zipf's law**

Description

A very short function that reproduces Zipf's law: a harmonic rank-probability distribution, formally

\[
p(i) = \frac{i^{-1}}{\sum_{i=1}^{N} i^{-1}}, \quad i = 1, \ldots, N
\]

Usage

`zipf(n)`

Arguments

- `n` Integer; if a hyper2 object is supplied this is interpreted as `size(n)`

Value

Returns a numeric vector summing to one

Author(s)

Robin K. S. Hankin

See Also

`knownp.test`

Examples

`zipf(icons)`
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