

Package ‘TeachBayes’

March 25, 2017

Type Package

Title Teaching Bayesian Inference

Version 1.0

Depends LearnBayes, ggplot2, gridExtra, dplyr, shiny

Suggests knitr, rmarkdown

VignetteBuilder knitr

Author Jim Albert

Maintainer Jim Albert <albert@bgsu.edu>

Description Several functions for communicating Bayesian thinking including Bayes rule for deciding among spinners, visualizations for Bayesian inference for one proportion and for one mean, and comparison of two proportions using a discrete prior.

License GPL (>= 2)

Encoding UTF-8

LazyData true

NeedsCompilation no

Repository CRAN

Date/Publication 2017-03-25 10:58:44 UTC

R topics documented:

bar_plot	2
bayesian_crank	3
beta_area	3
beta_data	4
beta_draw	5
beta_interval	5
beta_prior_post	6
beta_quantile	7
ChooseBeta	7
draw_two_p	8
dsampling	8

dspinner	9
many_normal_plots	10
many_spinner_plots	10
normal_area	11
normal_draw	12
normal_interval	12
normal_quantile	13
normal_update	14
prior_post_plot	14
prob_plot	15
spinner_data	16
spinner_likelihooods	16
spinner_plot	17
spinner_probs	18
testing_prior	18
two_p_summarize	19
two_p_update	20

Index 21

bar_plot	<i>Bar plot of numeric or character data</i>
----------	--

Description

Constructs frequency bar plot of a vector of numeric data or a vector of character data

Usage

```
bar_plot(y, ...)
```

Arguments

y	vector of outcomes
...	title of the graph

Value

A frequency bar graph of the outcomes

Author(s)

Jim Albert

Examples

```
s <- spinner_data(c(1, 2, 2, 1), nsim=100)
bar_plot(s, "Spinner Data")
y <- c(rep("a", 10), rep("b", 5), rep("c", 8))
bar_plot(y)
```

bayesian_crank	<i>Computes Posterior Probabilities for Discrete Models</i>
----------------	---

Description

Given a data table with columns Prior and Likelihood, computes posterior probabilities

Usage

```
bayesian_crank(d)
```

Arguments

d data frame with columns Prior and Likelihood

Value

data frame with new columns Product and Posterior

Author(s)

Jim Albert

Examples

```
df <- data.frame(p=c(.1, .3, .5, .7, .9),
                 Prior=rep(1/5, 5))
y <- 5
n <- 10
df$Likelihood <- dbinom(y, prob=df$p, size=n)
df <- bayesian_crank(df)
```

beta_area	<i>Displays Areas Under a Beta Curve</i>
-----------	--

Description

Computes and Displays Areas Under a Beta Curve

Usage

```
beta_area(lo, hi, shape_par)
```

Arguments

lo lower bound of interval
hi upper bound of interval
shape_par vector of shape parameters of the beta curve

Value

Probability that beta random variable falls between two values

Author(s)

Jim Albert

Examples

```
lo <- .2  
hi <- .4  
parameters <- c(2, 5)  
beta_area(lo, hi, parameters)
```

beta_data

Simulate random data from a beta curve

Description

Simulate random data from a beta curve

Usage

```
beta_data(shape_par, nsim=1000)
```

Arguments

shape_par vector of shape parameters of the beta curve
nsim number of simulations

Value

A vector of random spins from the spinner

Author(s)

Jim Albert

Examples

```
shape_par <- c(12, 8)  
beta_data(shape_par, 10)
```

beta_draw	<i>Draw a Beta Curve</i>
-----------	--------------------------

Description

Draw a Beta Curve

Usage

```
beta_draw(shape_pars)
```

Arguments

shape_pars	vector of shape parameters of the beta curve
...	add a title to the graph if desired

Value

Displays the beta curve

Author(s)

Jim Albert

Examples

```
parameters <- c(2, 5)
beta_draw(parameters)
```

beta_interval	<i>Probability Interval for a Beta Curve</i>
---------------	--

Description

Computes Probability Interval for a Beta Curve

Usage

```
beta_interval(prob, shape_par)
```

Arguments

prob	value of coverage probability
shape_par	vector of shape parameters of the beta curve

Value

Computes and displays the "equal tails" interval that contains the beta curve with the specified probability

Author(s)

Jim Albert

Examples

```
parameters <- c(2, 5)
beta_interval(.5, parameters)
```

beta_prior_post *Plot of Two Beta Curves*

Description

Plot of Two Beta Curves

Usage

```
beta_prior_post(prior_shapes, post_shapes,
  label_1="Prior", label_2="Posterior")
```

Arguments

prior_shapes	vector of shape parameters of the beta prior
post_shapes	vector of shape parameters of the beta posterior
label_1	title for the first beta curve
label_2	title for the second beta curve

Value

Displays the two beta curves on the same panel

Author(s)

Jim Albert

Examples

```
beta_prior_post(c(4, 6), c(19, 16))
```

beta_quantile	<i>Displays a Quantile of a Beta Curve</i>
---------------	--

Description

Displays a Quantile of a Beta Curve

Usage

```
beta_quantile(prob, shape_par)
```

Arguments

prob	probability value of interest
shape_par	vector of shape parameters of the beta curve

Value

Displays the quantile of a beta curve corresponding to the probability value

Author(s)

Jim Albert

Examples

```
# find the .50 quantile (the median)
prob <- 0.5
parameters <- c(2, 5)
beta_quantile(prob, parameters)
# find the .90 quantile (90th percentile)
prob <- 0.9
beta_quantile(prob, parameters)
```

ChooseBeta	<i>Shiny App to Choose a Beta Curve</i>
------------	---

Description

Interactively choose beta curve by selecting the .5 and .9 quantiles

Usage

```
ChooseBeta()
```

Author(s)

Jim Albert

draw_two_p	<i>Plot of Distribution of Two Proportions</i>
------------	--

Description

Constructs a graph of the probability distribution of two proportions

Usage

```
draw_two_p(prob_matrix, ...)
```

Arguments

prob_matrix	matrix of probabilities of two proportions with the rows and columns labeled by the values
...	other arguments such as the title of the plot

Value

graphical display of the joint probability distribution

Author(s)

Jim Albert

Examples

```
Prob <- testing_prior()
draw_two_p(Prob, title="Testing Prior")
```

dsampling	<i>Hypergeometric sampling density</i>
-----------	--

Description

Hypergeometric sampling density

Usage

```
dsampling(sample_b, pop_N, pop_B, sample_n)
```

Arguments

sample_b	number of black balls in sample
pop_N	number of balls in population
pop_B	number of black balls in population
sample_n	number of balls in sample

Value

Value of hypergeometric sampling probability

Author(s)

Jim Albert

Examples

```
pop_N <- 10
pop_B <- 4
sample_n <- 3
sample_b <- 2
dsampling(sample_b, pop_N, pop_B, sample_n)
```

dspinner

Computes likelihoods for spinner outcomes

Description

Computes likelihoods for spinner outcomes

Usage

```
dspinner(x, Prob)
```

Arguments

x vector of spinner observations
Prob matrix of spinner probabilities where each row corresponds to a different spinner

Value

column vector consisting of the likelihoods for the different spinners

Author(s)

Jim Albert

Examples

```
Prob <- matrix(c(.25, .25, .25, .25,
                .50, .125, .125, .5,
                .25, .5, .25, 0), 3, 4, byrow=TRUE)
obs <- c(1, 2, 1, 3, 4)
dspinner(obs, Prob)
```

many_normal_plots *Graph of several normal curves*

Description

Graph of several normal curves

Usage

```
many_normal_plots(list_normal_par)
```

Arguments

list_normal_par
list of vectors, where each vector is a mean and standard deviation for a normal distribution

Value

Displays the normal curves on a single panel with labels

Author(s)

Jim Albert

Examples

```
normal_parameters <- list(c(100, 15),  
  c(110, 15), c(120, 15))  
many_normal_plots(normal_parameters)
```

many_spinner_plots *Graphs a collection of spinners*

Description

Graphs a collection of spinners

Usage

```
many_spinner_plots(list_regions)
```

Arguments

list_regions list of vectors of integer areas for the spins 1, 2, ...

Value

A ggplot2 object containing the spinner displays

Author(s)

Jim Albert

Examples

```
regions1 <- c(1, 1, 1)
regions2 <- c(2, 1, 2, 1)
many_spinner_plots(list(regions1, regions2))
```

normal_area

Displays Area Under a Normal Curve

Description

Computes and Displays Area Under a Normal Curve

Usage

```
normal_area(lo, hi, normal_pars)
```

Arguments

lo	lower bound of interval
hi	upper bound of interval
normal_pars	vector of mean and standard deviation of the normal curve

Value

Probability that normal random variable falls between two values

Author(s)

Jim Albert

Examples

```
lo <- 10
hi <- 20
parameters <- c(25, 10)
normal_area(lo, hi, parameters)
```

normal_draw	<i>Draws a Normal Curve</i>
-------------	-----------------------------

Description

Draws a Normal Curve

Usage

```
normal_draw(normal_pars)
```

Arguments

normal_pars vector of mean and standard deviation of the normal curve

Value

Displays the normal curve

Author(s)

Jim Albert

Examples

```
parameters <- c(2, 1)
normal_draw(parameters)
```

normal_interval	<i>Probability Interval for a Normal Curve</i>
-----------------	--

Description

Computes "equal-tails" probability interval for a normal curve

Usage

```
normal_interval(prob, normal_pars)
```

Arguments

prob value of coverage probability
normal_pars vector of mean and standard deviation of the normal curve

Value

Computes and displays the interval that contains the normal curve with the specified probability

Author(s)

Jim Albert

Examples

```
parameters <- c(2, 0.5)
prob_content <- 0.5
normal_interval(prob_content, parameters)
```

normal_quantile *Displays a Quantile of a Normal Curve*

Description

Displays a Quantile of a Normal Curve

Usage

```
normal_quantile(prob, normal_pars)
```

Arguments

prob probability value of interest
normal_pars vector of mean and standard deviation of the normal curve

Value

Displays the quantile of a normal curve corresponding to a specific probability value

Author(s)

Jim Albert

Examples

```
parameters <- c(100, 10)
prob_value <- 0.7
normal_quantile(prob_value, parameters)
```

normal_update	<i>Updates a Normal Prior with Normal Data</i>
---------------	--

Description

Finds the parameters of the normal posterior with normal data and a normal prior

Usage

```
normal_update(prior, data, teach=FALSE)
```

Arguments

prior	vector with components mean and sd of the normal prior
data	vector with components the sample mean and the standard error of the estimate
teach	logical variable indicating the form of the output

Value

If `teach = TRUE`, returns data frame that displays the mean, precision, and standard deviation for the prior, data, and posterior. If `teach = FALSE`, returns a vector with mean and standard deviation of the posterior.

Author(s)

Jim Albert

Examples

```
prior <- c(100, 10)
data <- c(110, 15)
normal_update(prior, data)
normal_update(prior, data, teach=TRUE)
```

prior_post_plot	<i>Graphs prior and posterior probabilities</i>
-----------------	---

Description

Graphs prior and posterior probabilities from a discrete Bayesian model

Usage

```
prior_post_plot(d, ...)
```

Arguments

d data frame where the first column are the model values, and columns named Prior and Posterior
... gives an alternative label for the x axis

Value

Constructs a comparative plot of the prior and posterior distributions using separate panels.

Author(s)

Jim Albert

Examples

```
df <- data.frame(p=c(.1, .3, .5, .7, .9),
                 Prior=rep(1/5, 5))
y <- 5
n <- 10
df$Likelihood <- dbinom(y, prob=df$p, size=n)
df <- bayesian_crank(df)
prior_post_plot(df, "Proportion")
```

prob_plot	<i>Constructs a graph of a probability distribution</i>
-----------	---

Description

Constructs a graph of a discrete probability distribution

Usage

```
prob_plot(d)
```

Arguments

d data frame where the first two columns are the variable and associated probabilities

Value

A ggplot2 object containing the plot display

Author(s)

Jim Albert

Examples

```
probability_df <- data.frame(x=1:5,  
  Probability=c(.1, .2, .3, .3, .1))  
prob_plot(probability_df)
```

spinner_data	<i>Simulate random data from a spinner</i>
--------------	--

Description

Simulate random data from a spinner

Usage

```
spinner_data(regions, nsim=1000)
```

Arguments

regions	vector of integer values for the spins 1, 2, ...
nsim	number of spins

Value

A vector of random spins from the spinner

Author(s)

Jim Albert

Examples

```
sp <- c(2, 1, 1, 2)  
spinner_data(sp, nsim=20)
```

spinner_likelihoods	<i>Computes likelihood matrix for many spinners</i>
---------------------	---

Description

Computes likelihood matrix for many spinners

Usage

```
spinner_likelihoods(regions)
```


Arguments

regions list of vectors of integer areas for the spins 1, 2, ...

Value

A matrix where each row corresponds to the outcome probabilities for one spinner.

Author(s)

Jim Albert

Examples

```
sp1 <- c(2, 1, 1)
sp2 <- c(1, 1, 1, 1)
spinner_likelihooods(list(sp1, sp2))
```

spinner_plot	<i>Constructs a spinner</i>
--------------	-----------------------------

Description

Constructs a spinner with different regions

Usage

```
spinner_plot(probs, ...)
```

Arguments

probs vector of probabilities for the spins 1, 2, ...
... optional vector of values and title

Value

A ggplot2 object containing the spinner display

Author(s)

Jim Albert

Examples

```
probs <- rep(.2, 5)
spinner_plot(probs,
             values=c("A", "B", "C", "D", "E"),
             title="My Spinner")
# probs does not need to be normalized
spinner_plot(c(1, 2, 1, 2))
```

spinner_probs	<i>Display probability distribution for a spinner</i>
---------------	---

Description

Display probability distribution for a spinner

Usage

```
spinner_probs(regions)
```

Arguments

regions vector of positive values for the spins 1, 2, ...

Value

Data frame with variables Region and Prob

Author(s)

Jim Albert

Examples

```
sp <- c(2, 1, 1, 2)
spinner_probs(sp)
```

testing_prior	<i>Testing prior for two proportions</i>
---------------	--

Description

Constructs a discrete distribution for two proportions under a testing or uniform hypotheses

Usage

```
testing_prior(lo=.1, hi=.9, n_values=9,
              pequal=0.5, uniform=FALSE)
```

Arguments

lo	minimum value of each proportion
hi	maximum value of each proportion
n_values	number of values of each proportion
pequal	probability of the equality of the two proportions
uniform	indicates if a uniform prior is desired

Value

matrix of probabilities where the rows and columns are labeled by the values of the proportions

Author(s)

Jim Albert

Examples

```
# testing prior where each proportion is
# .1, .3, .5, .7, .9
Prob <- testing_prior(.1, .9, 5)
# uniform prior over same proportion values
Prob <- testing_prior(.1, .9, 5, uniform=TRUE)
```

two_p_summarize

Summaries of a probability matrix

Description

Computes posterior of difference $P2 - P1$ of a probability matrix of two proportions

Usage

```
two_p_summarize(prob_matrix)
```

Arguments

`prob_matrix` probability matrix where the rows and columns are labeled with the values of the proportions

Value

data frame with variables `diff21` and `Prob` where $\text{diff21} = P2 - P1$

Author(s)

Jim Albert

Examples

```
# use uniform prior over values .2, .3, .4
prior <- testing_prior(.2, .4, 3, uniform=TRUE)
two_p_summarize(prior)
```

two_p_update	<i>Posterior updating of two proportions</i>
--------------	--

Description

Computes posterior distribution of two proportions with a discrete prior

Usage

```
two_p_update(prior, s1f1, s2f2)
```

Arguments

prior	prior probability matrix where the rows and columns are labeled with the values of the proportions
s1f1	number of successes and number of failures from first sample
s2f2	number of successes and number of failures from second sample

Value

posterior probability matrix

Author(s)

Jim Albert

Examples

```
prior <- testing_prior()
first_sample <- c(3, 10)
second_sample <- c(8, 20)
two_p_update(prior, first_sample, second_sample)
```

Index

bar_plot, 2
bayesian_crank, 3
beta_area, 3
beta_data, 4
beta_draw, 5
beta_interval, 5
beta_prior_post, 6
beta_quantile, 7

ChooseBeta, 7

draw_two_p, 8
dsampling, 8
dspinner, 9

many_normal_plots, 10
many_spinner_plots, 10

normal_area, 11
normal_draw, 12
normal_interval, 12
normal_quantile, 13
normal_update, 14

prior_post_plot, 14
prob_plot, 15

spinner_data, 16
spinner_likelihoods, 16
spinner_plot, 17
spinner_probs, 18

testing_prior, 18
two_p_summarize, 19
two_p_update, 20