Package 'echoice2'

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Type Package

Title Choice Models with Economic Foundation

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Description Implements choice models based on economic theory, including estimation using Markov chain Monte Carlo (MCMC), prediction, and more. Its usability is inspired by ideas from 'tidyverse'. Models include versions of the Hierarchical Multinomial Logit and Multiple Discrete-Continous (Volumetric) models with and without screening. The foundations of these models are described in Allenby, Hardt and Rossi (2019) <doi:10.1016/bs.hem.2019.04.002>. Models with conjunctive screening are described in Kim, Hardt, Kim and Allenby (2022) <doi:10.1016/j.ijresmar.2022.04.001>. Models with set-size variation are described in Hardt and Kurz (2020) <doi:10.2139/ssrn.3418383>.

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BugReports https://github.com/ninohardt/echoice2/issues

URL https://github.com/ninohardt/echoice2, http://ninohardt.de/echoice2/

Imports Rcpp, parallel, magrittr, stats, graphics, stringr, purrr, tibble, tidyselect, tidyr, rlang, forcats

Depends R (>= 3.5), dplyr, ggplot2

Suggests knitr, rmarkdown, testthat, bayesm

LinkingTo Rcpp, RcppArmadillo

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R topics documented:

`dd_dem` *Discrete Choice Predictions (HMNL)*

Description

Discrete Choice Predictions (HMNL)

Usage

```
dd_dem(dd, est, prob = FALSE, cores = NULL)
```

Arguments

`dd`	tibble with long-format choice data
`est`	estimation object
`prob`	logical, report probabilities instead of demand
`cores`	cores

Value

Draws of expected choice

See Also

`dd_est_hmnl()` to generate demand predictions based on this model

Examples

```
data(icecream_discrete)
icecream_est <- icecream_discrete %>% filter(id<10) %>% dd_est_hmnl(R=4, cores=2)
#demand prediction
icecream_dempred <- icecream_discrete %>% filter(id<10) %>%
  dd_dem(icecream_est, cores=2)
```

`dd_dem_sr` *Discrete Choice Predictions (HMNL with attribute-based screening)*

Description

Discrete Choice Predictions (HMNL with attribute-based screening)

Usage

```
dd_dem_sr(dd, est, prob = FALSE, cores = NULL)
```

Arguments

`dd`	data
`est`	est
`prob`	logical, report probabilities instead of demand
`cores`	cores

Value

Draws of expected choice

See Also

`dd_est_hmnl_screen()` to generate demand predictions based on this model

Examples

```
data(icecream_discrete)
icecream_est <- icecream_discrete %>% filter(id<20) %>% dd_est_hmnl_screen(R=10, cores=2)
#demand prediction
icecream_dempred <- icecream_discrete %>% filter(id<20) %>%
 dd_dem_sr(icecream_est, cores=2)
```

`dd_est_hmnl` *Estimate discrete choice model (HMNL)*

Description

Estimate discrete choice model (HMNL)

Usage

```
dd_est_hmnl(
  dd,
  R = 1e+05,
  keep = 10,
  cores = NULL,
  control = list(include_data = TRUE)
)
```

Arguments

`dd`	discrete choice data (long format)
`R`	draws
`keep`	thinning
`cores`	no of CPU cores to use (default: auto-detect)
`control`	list containing additional settings

Value

est ec-draw object (List)

See Also

`dd_dem()` to generate demand predictions based on this model

Examples

```
data(icecream_discrete)
icecream_est <- icecream_discrete %>% dd_est_hmnl(R=20, cores=2)
```

`dd_est_hmnl_screen` *Estimate discrete choice model (HMNL, attribute-based screening (not including price))*

Description

Estimate discrete choice model (HMNL, attribute-based screening (not including price))

Usage

```
dd_est_hmnl_screen(
  dd,
  price_screen = TRUE,
  R = 1e+05,
  keep = 10,
  cores = NULL,
  control = list(include_data = TRUE)
)
```

Arguments

`dd`	discrete choice data (long format)
`price_screen`	A logical, indicating whether price tag screening should be estimated
`R`	draws
`keep`	thinning
`cores`	no of CPU cores to use (default: auto-detect)
`control`	list containing additional settings

Value

est ec-draw object (List)

See Also

`dd_dem_sr()` to generate demand predictions based on this model

Examples

```
data(icecream_discrete)
icecream_est <- icecream_discrete %>% dplyr::filter(id<20) %>%
  dd_est_hmnl_screen(R=20, cores=2)
```

dd_LL *Log-Likelihood for compensatory hmnl model*

Description

Log-Likelihood for compensatory hmnl model

Usage

```
dd_LL(draw, dd, fromdraw = 1)
```

Arguments

draw	A list, 'echoice2' draws object
dd	A tibble, tidy choice data (before dummy-coding)
fromdraw	An integer, from which draw onwards to compute LL (i.e., excl. burnin)

Value

N x Draws Matrix of log-Likelihood values

Examples

```
data(icecream_discrete)
#fit model
icecream_est <- icecream_discrete %>% dd_est_hmnl(R=10, keep=1, cores=2)
#compute likelihood for each subject in each draw
loglls<-dd_LL(icecream_est, icecream_discrete, fromdraw = 2)
```

dd_LL_sr *Log-Likelihood for screening hmnl model*

Description

Log-Likelihood for screening hmnl model

Usage

```
dd_LL_sr(draw, dd, fromdraw = 1)
```

Arguments

draw	A list, 'echoice2' draws object
dd	A tibble, tidy choice data (before dummy-coding)
fromdraw	An integer, from which draw onwards to compute LL (i.e., excl. burnin)

Value

N x Draws Matrix of log-Likelihood values

Examples

```
data(icecream_discrete)
#fit model
icecream_est <- icecream_discrete %>% dd_est_hmnl_screen(R=10, keep=1, cores=2)
#compute likelihood for each subject in each draw
loglls<-dd_LL_sr(icecream_est, icecream_discrete, fromdraw = 2)
```

---

dummify *Create dummy variables within a tibble*

Description

Create dummy variables within a tibble

Usage

```
dummify(dat, sel)
```

Arguments

dat	A tibble with the data.
sel	A character vector with the name(s) of the variables to be dummied.

Value

tibble with dummy variables

Examples

```
mytest=data.frame(A=factor(c('a','a','b','c','c')), B=1:5)
dummify(mytest,"A")
```

dummyvar *Dummy-code a categorical variable*

Description

Dummy-code a categorical variable

Usage

```
dummyvar(data)
```

Arguments

data	one column of categorical data to be dummy-coded

Value

tibble with dummy variables

Examples

```
mytest=data.frame(attribute=factor(c('a','a','b','c','c')))
dummyvar(mytest)
```

ec_boxplot_MU *Generate MU_theta boxplot*

Description

Generate MU_theta boxplot

Usage

```
ec_boxplot_MU(draws, burnin = 100)
```

Arguments

draws	A list, 'echoice2' draws object
burnin	burn-in to remove

Value

A ggplot2 plot containing traceplots of draws

See Also

ec_trace_MU() to obtain traceplot

Examples

```
## Not run:
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use
icecream_est <- icecream %>% dplyr::filter(id<100) %>% vd_est_vdm(R=20, cores=2)
ec_boxplot_MU(icecream_est, burnin=1)

## End(Not run)
```

`ec_boxplot_screen` *Generate Screening probability boxplot*

Description

Generate Screening probability boxplot

Usage

```
ec_boxplot_screen(draws, burnin = 100)
```

Arguments

`draws`	A list, 'echoice2' draws object, from a model with attribute-based screening
`burnin`	burn-in to remove

Value

A ggplot2 plot containing traceplots of draws

See Also

`ec_draws_MU()` to obtain MU_theta draws, `ec_trace_screen()` to generate traceplot

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use
icecream_scr_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm_screen(R=20, cores=2)
ec_boxplot_screen(icecream_scr_est, burnin = 1)
```

ec_demcurve *Create demand curves*

Description

This helper function creates demand curves

Usage

```
ec_demcurve(
  ec_long,
  focal_product,
  rel_pricerange,
  dem_fun,
  draws,
  epsilon_not = NULL
)
```

Arguments

ec_long	choice scenario (discrete or volumetric)
focal_product	Logical vector picking the focal product for which to create a demand curve
rel_pricerange	Price range, relative to base case price; this is used to create demand curve
dem_fun	demand function (e.g., dd_prob for HMNL or vd_dem_vdm for volumetric demand). For discrete choice, use choice probabilities instead of choice predictions.
draws	ec-draws object (e.g., output from dd_est_hmnl or vd_est_vd)
epsilon_not	(optional) error realisatins (this helps make curves look smother for voumetric models)

Value

List containing aggregate demand quantities for each scenario defined by rel_pricerange

See Also

ec_gen_err_normal() to generate error realization from Normal distribution, ec_gen_err_ev1() to generate error realization from EV1 distribution

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<100) %>%
vd_est_vdm(R=20, keep=1, cores=2)
#demand at different price points
```

```
dem_scenarios<-
ec_demcurve(icecream%>% dplyr::filter(id<100),
 icecream%>% dplyr::filter(id<100) %>% pull('Brand')=="Store",
 c(.75,1,1.25),vd_dem_vdm,icecream_est)
#optional plot
# dem_scenarios %>%
#   do.call('rbind',.) %>%
#   ggplot(aes(x=scenario,y=`E(demand)`,color=Flavor)) + geom_line()
```

`ec_demcurve_cond_dem` *Create demand-incidence curves*

Description

This helper function creates demand curves

Usage

```
ec_demcurve_cond_dem(
  ec_long,
  focal_product,
  rel_pricerange,
  dem_fun,
  draws,
  epsilon_not = NULL
)
```

Arguments

`ec_long`	choice scenario (discrete or volumetric)
`focal_product`	Logical vector picking the focal product for which to create a demand curve
`rel_pricerange`	Price range, relative to base case price; this is used to create demand curve
`dem_fun`	demand function (e.g., `dd_prob` for HMNL or `vd_dem_vdm` for volumetric demand). For discrete choice, use choice probabilities instead of choice predictions.
`draws`	ec-draws object (e.g., output from `dd_est_hmnl` or `vd_est_vd`)
`epsilon_not`	(optional) error realisatins (this helps make curves look smother for voumetric models)

Value

List containing aggregate demand quantities for each scenario defined by `rel_pricerange`

See Also

ec_gen_err_normal() to generate error realization from Normal distribution, ec_gen_err_ev1() to generate error realization from EV1 distribution

Examples

```
data(icecream)
#run MCMC sampler (use way more draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<20) %>%
vd_est_vdm(R=2, keep=1, cores=2)
#demand at different price points
conddem_scenarios<-
ec_demcurve_cond_dem(icecream%>% dplyr::filter(id<20),
 icecream%>% dplyr::filter(id<20) %>% pull('Brand')=="Store",
 c(.75,1),vd_dem_vdm,icecream_est)
```

---

ec_demcurve_inci *Create demand-incidence curves*

Description

This helper function creates demand curves

Usage

```
ec_demcurve_inci(
  ec_long,
  focal_product,
  rel_pricerange,
  dem_fun,
  draws,
  epsilon_not = NULL
)
```

Arguments

ec_long	choice scenario (discrete or volumetric)
focal_product	Logical vector picking the focal product for which to create a demand curve
rel_pricerange	Price range, relative to base case price; this is used to create demand curve
dem_fun	demand function (e.g., dd_prob for HMNL or vd_dem_vdm for volumetric demand). For discrete choice, use choice probabilities instead of choice predictions.
draws	ec-draws object (e.g., output from dd_est_hmnl or vd_est_vd)
epsilon_not	(optional) error realisatins (this helps make curves look smother for voumetric models)

Value

List containing aggregate demand quantities for each scenario defined by `rel_pricerange`

See Also

`ec_gen_err_normal()` to generate error realization from Normal distribution, `ec_gen_err_ev1()` to generate error realization from EV1 distribution

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<50) %>%
vd_est_vdm(R=20, keep=1, cores=2)
#demand at different price points
inci_scenarios<-
ec_demcurve_inci(icecream%>% dplyr::filter(id<50),
 icecream%>% dplyr::filter(id<50) %>% pull('Brand')=="Store",
 c(.75,1,1.25),vd_dem_vdm,icecream_est)
```

---

ec_dem_aggregate *Aggregate posterior draws of demand*

Description

Aggregate demand draws, e.g. from individual-choice occasion-alternative level to individual level. (using the new demand draw format)

Usage

```
ec_dem_aggregate(de,groupby)
```

Arguments

de	demand draws
groupby	groupby grouping variables (as (vector of) string(s))

Value

Aggregated demand predictions

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm(R=4, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<10) %>%
   vd_dem_vdm(icecream_est)
#aggregate
brand_lvl_pred_demand <-
 icecream_predicted_demand %>% ec_dem_aggregate("Brand")
```

`ec_dem_eval` *Evaluate (hold-out) demand predictions*

Description

This function obtains proper posterior fit statistics. It computes the difference between true demand and each draw from the demand posterior. Then, fit statistics are obtained.

Usage

```
ec_dem_eval(de)
```

Arguments

`de`	demand draws (output from vd_dem_x function)

Value

Predictive fit statistics (MAE, MSE, RAE, bias, hit-probability)

data(icecream) #run MCMC sampler (use way more than 50 draws for actual use) icecream_est <- icecream %>% dplyr::filter(id<100) %>% vd_est_vdm(R=20, keep=1, cores=2) #Generate demand predictions icecream_predicted_demand= icecream %>% dplyr::filter(id<100) %>% vd_dem_vdm(icecream_est) #evaluate in-sample fit (note: too few draws for good results) ec_dem_eval(icecream_predicted_demand)

`ec_dem_summarise` *Summarize posterior draws of demand*

Description

Adds summaries of posterior draws of demand to tibble. (using the new demand draw format)

Usage

```
ec_dem_summarise(de,quantiles)

ec_dem_summarize(de, quantiles = c(0.05, 0.95))
```

Arguments

`de`	demand draws
`quantiles`	Quantiles for Credibility Intervals (default: 90% interval)

Value

Summary of demand predictions

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm(R=10, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<10) %>%
   vd_dem_vdm(icecream_est)
#aggregate
brand_lvl_pred_demand <-
 icecream_predicted_demand %>% ec_dem_aggregate("Brand")
#summarise
brand_lvl_pred_demand %>% ec_dem_summarise()
```

ec_draws_MU *Obtain MU_theta draws*

Description

Obtain MU_theta draws

Usage

```
ec_draws_MU(draws)
```

Arguments

draws	A list, 'echoice2' draws object

Value

A tibble, long format, draws of MU

See Also

ec_draws_screen() to obtain screening parameter draws (where applicable), ec_trace_MU() to generate a traceplot of MU_theta draws

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use
icecream_est <- icecream %>% dplyr::filter(id<50) %>% vd_est_vdm(R=20, cores=2)
ec_draws_MU(icecream_est)
```

ec_draws_screen *Obtain Screening probability draws*

Description

Obtain Screening probability draws

Usage

```
ec_draws_screen(draws)
```

Arguments

draws	A list, 'echoice2' draws object

Value

A tibble, long format, draws of MU

See Also

`ec_draws_MU()` to obtain MU_theta draws, `ec_trace_screen()` to generate a traceplot of screening draws

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use
icecream_scr_est <- icecream %>% dplyr::filter(id<50) %>% vd_est_vdm_screen(R=20, cores=2)
ec_draws_screen(icecream_scr_est)
```

---

ec_estimates_MU *Obtain upper level model estimates*

Description

Obtain upper level model estimates

Usage

```
ec_estimates_MU(est, quantiles = c(0.05, 0.95))
```

Arguments

`est`	is an 'echoice2' draw object (list)
`quantiles`	quantile for CI

Value

tibble with MU (upper level) summaries

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm(R=20, cores=2)
#Upper-level summary
icecream_est %>% ec_estimates_MU
```

ec_estimates_screen *Summarize attribute-based screening parameters*

Description

Summarize attribute-based screening parameters from an attribute-based screening model in 'echoice2'

Usage

```
ec_estimates_screen(est, quantiles = c(0.05, 0.95))
```

Arguments

est	is an 'echoice2' draw object (list) from a model with attribute-based screening
quantiles	quantile for CI

Value

tibble with screening summaries

Examples

```
#run MCMC sampler (use way more than 20 draws for actual use)
data(icecream)
est_scr_icecream <- vd_est_vdm_screen(icecream%>%dplyr::filter(id<30), R=20, cores=2)
#summarise draws of screening probabilities
ec_estimates_screen(est_scr_icecream)
#Note: There is no variance in this illustrative example - more draws are needed
```

ec_estimates_SIGMA *Obtain posterior mean estimates of upper level covariance*

Description

Obtain posterior mean estimates of upper level covariance

Usage

```
ec_estimates_SIGMA(est)
```

Arguments

est	is an 'echoice2' draw object (list)

Value

estimates of upper level covariance

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<50) %>% vd_est_vdm(R=20, cores=2)
icecream_est %>% ec_estimates_SIGMA %>% round(2)
```

---

ec_estimates_SIGMA_corr

Obtain posterior mean estimates of upper level correlations

Description

Obtain posterior mean estimates of upper level correlations

Usage

```
ec_estimates_SIGMA_corr(est)
```

Arguments

est	is an 'echoice2' draw object (list)

Value

estimates of upper level correlations

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm(R=20, cores=2)
icecream_est %>% ec_estimates_SIGMA_corr %>% round(2)
```

ec_gen_err_ev1 *Simulate error realization from EV1 distribution*

Description

Simulate error realization from EV1 distribution

Usage

```
ec_gen_err_ev1(ec_dem, draws, seed = NULL)
```

Arguments

ec_dem	discrete or volumetric choice data, with or without x
draws	draws from volumetric demand model
seed	seed for reproducible error realisations; seet is automatically reset of running this function

Value

error realizations

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<100) %>%
vd_est_vdm(R=100, keep=1, cores=2)
#generate error realizations
errs<- ec_gen_err_ev1(icecream %>% dplyr::filter(id<100), icecream_est, seed=123)
```

ec_gen_err_normal *Simulate error realization from Normal distribution*

Description

Simulate error realization from Normal distribution

Usage

```
ec_gen_err_normal(ec_dem, draws, seed = NULL)
```

Arguments

ec_dem	discrete or volumetric choice data, with or without x
draws	draws from volumetric demand model
seed	seed for reproducible error realisations; seet is automatically reset of running this function

Value

error realizations

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>%
vd_est_vdm(R=10, keep=1, error_dist = "Normal", cores=2)
#generate error realizations
errs<- ec_gen_err_normal(icecream %>% dplyr::filter(id<10), icecream_est, seed=123)
```

---

ec_lmd_NR *Obtain Log Marginal Density from draw objects*

Description

This is a helper function to quickly obtain log marginal density from a draw object

Usage

```
ec_lmd_NR(est)
```

Arguments

est	'echoice2' draw object

Details

Draws are split in 4 equal parts from start to finish, and LMD is computed for each part. This helps to double-check convergence.

Value

tibble with LMDs (first 25% of draws, next 25% of draws, ...)

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<100) %>% vd_est_vdm(R=20, cores=2)
#obtain LMD by quartile of draws
ec_lmd_NR(icecream_est)
```

`ec_lol_tidy1` *Convert "list of lists" format to long "tidy" format*

Description

Convert "list of lists" format to long "tidy" format

Usage

```
ec_lol_tidy1(data_lol, X = "X", y = "y")
```

Arguments

`data_lol`	A list of data frames containing design matrices and response vectors
`X`	The column name of the design matrix, default: "X"
`y`	The column name of the response vector, default: "y"

Value

A tidy data frame with columns for each design matrix column, the response vector, and an id column indicating which data frame the row came from

Examples

```
loldata<-list()
loldata[[1]]=list()
loldata[[1]]$y = c(1,2)
loldata[[1]]$X= data.frame(brand1=c(1,0, 1,0),brand2=c(0,1, 0,1),price=c(1,2))
loldata[[2]]=list()
loldata[[2]]$y = c(1,1)
loldata[[2]]$X= data.frame(brand1=c(1,0, 1,0),brand2=c(0,1, 0,1),price=c(1,2))
ec_lol_tidy1(loldata)
```

ec_screenprob_sr *Screening probabilities of choice alternatives*

Description

Obtain draws of screening probabilities of choiec alternatives

Usage

```
ec_screenprob_sr(xd, est, cores=NULL)
```

Arguments

xd	data
est	ec-model draws
cores	(optional) cores

Value

Draws of screening probabilities of choice alternatives

Examples

```
data(icecream)
icecream_est <- icecream %>% filter(id<10) %>% vd_est_vdm_screen(R=10, price_screen=TRUE, cores=2)
ec_screenprob_sr(icecream %>% filter(id<10), icecream_est, cores=2)
```

ec_screen_summarise *Summarize posterior draws of screening*

Description

Adds summaries of posterior draws of demand to tibble. (using the new demand draw format)

Usage

```
ec_screen_summarise(sc, quantiles = c(0.05, 0.95))

ec_screen_summarize(sc, quantiles = c(0.05, 0.95))
```

Arguments

sc	tibble containing screening draws in .screendraws
quantiles	Quantiles for Credibility Intervals (default: 90% interval)

Value

Summary of screening probabilities

Examples

```
data(icecream)
icecream_est <- icecream %>% vd_est_vdm_screen(R=20,  price_screen=TRUE, cores=2)
#consideration set by respondent
cons_ss <-
ec_screenprob_sr(icecream, icecream_est, cores=2) %>%
group_by(id, task)  %>%
  summarise(.screendraws=list(purrr::reduce(.screendraws ,`+`))) %>%
  ec_screen_summarise() %>%
  group_by(id) %>%
  summarise(n_screen=mean(`E(screening)`))
```

---

ec_summarize_attrlvls *Summarize attributes and levels*

Description

Summarize attributes and levels in tidy choice data containing categorical attributes (before dummy-coding)

Usage

```
ec_summarize_attrlvls(data_in)

ec_summarise_attrlvls(data_in)
```

Arguments

data_in	A tibble, containing long-format choice data

Details

This functions looks for categorical attributes and summaries their levels This is helpful when evaluating a new choice data file.

Value

A tibble with one row per attribute, and a list of the levels

Examples

```
data(icecream)
ec_summarize_attrlvls(icecream)
```

ec_trace_MU *Generate MU_theta traceplot*

Description

Generate MU_theta traceplot

Usage

```
ec_trace_MU(draws, burnin = 100)
```

Arguments

draws	A list, 'echoice2' draws object
burnin	burn-in to remove

Value

A ggplot2 plot containing traceplots of draws

See Also

ec_boxplot_MU() to obtain boxplot

Examples

```
## Not run:
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm(R=10, cores=2)
ec_trace_MU(icecream_est)

## End(Not run)
```

ec_trace_screen *Generate Screening probability traceplots*

Description

Generate Screening probability traceplots

Usage

```
ec_trace_screen(draws, burnin = 100)
```

Arguments

draws	A list, 'echoice2' draws object, from a model with attribute-based screening
burnin	burn-in to remove

Value

A ggplot2 plot containing traceplots of draws

See Also

ec_draws_MU() to obtain MU_theta draws, ec_boxplot_screen() to generate boxplot

Examples

```
## Not run:
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use
icecream_scr_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm_screen(R=20, cores=2)
ec_trace_screen(icecream_scr_est, burnin=1)

## End(Not run)
```

---

ec_undummy *Converts a set of dummy variables into a single categorical variable*

Description

Given a set of dummy variables, this function converts them into a single categorical variable. The categorical variable is created by determining which variables are active (i.e. have a value of 1) for each observation and assigning a category based on the set of active variables. If necessary, a reference level can be specified to ensure that all possible categories are represented. Often, all brands of a brand attribute are added as brand intercepts, while other categorical attributes are coded with respect to a reference level.

Usage

```
ec_undummy(data_in, set_members, attribute_name, ref_level = NULL)
```

Arguments

data_in	a data frame containing the dummy variables
set_members	a character vector of the names of the dummy variables
attribute_name	a character string representing the name of the new categorical variable
ref_level	a character string representing the name of the reference level. If specified, a new dummy variable will be created for this level, and it will be used as the reference category for the categorical variable. Defaults to NULL.

Value

a data frame with the same columns as `data_in`, except for the dummy variables in `set_members`, which are replaced with the new categorical variable `attribute_name`

Examples

```
minidata=structure(list(id = c("1", "1", "1", "1", "2", "2", "2", "2"),
task = c(1L, 1L, 2L, 2L, 3L, 3L, 4L, 4L),
alt = c(1L, 2L, 1L, 2L, 1L, 2L, 1L, 2L),
brand1 = c(1, 0, 1, 0, 1, 0, 1, 0),
brand2 = c(0, 1, 0, 1, 0, 1, 0, 1),
price = c(1, 2, 1, 2, 1, 2, 1, 2),
x = c(1, 0, 0, 1, 1, 0, 1, 0)),
class = c("tbl_df", "tbl", "data.frame"), row.names = c(NA, -8L))

minidata %>% ec_undummy(c('brand1','brand2'),"brand")
```

`ec_undummy_lowhigh` *Convert dummy-coded variables to low/high factor*

Description

Convert dummy-coded variables to low/high factor

Usage

```
ec_undummy_lowhigh(vec_in)
```

Arguments

`vec_in`	A vector of dummy-coded variables (0/1)

Value

A factor vector with levels "low" and "high"

Examples

```
ec_undummy_lowhigh(c(0,1,0,1,1))
```

ec_undummy_lowmediumhigh *Convert dummy-coded variables to low/medium/high factor*

Description

Convert dummy-coded variables to low/medium/high factor

Usage

```
ec_undummy_lowmediumhigh(vec_in)
```

Arguments

vec_in	A vector of dummy-coded variables (0/1/2)

Value

A factor vector with levels "low", "medium" and "high"

Examples

```
ec_undummy_lowmediumhigh(c(0,1,2,1,0,2))
```

ec_undummy_yesno *Convert dummy-coded variables to yes/no factor*

Description

Convert dummy-coded variables to yes/no factor

Usage

```
ec_undummy_yesno(vec_in)
```

Arguments

vec_in	A vector of dummy-coded variables (0/1)

Value

A factor vector with levels "no" and "yes"

Examples

```
ec_undummy_yesno(c(0,1,0,1,1))
```

`ec_util_choice_to_long` *Convert a vector of choices to long format*

Description

Converts a vector of choices into a long format data frame, where each row represents a single choice and contains the choice status for each alternative.

Usage

```
ec_util_choice_to_long(myvec, all_index)
```

Arguments

`myvec`	A vector of choices, where each element represents the index of the chosen alternative.
`all_index`	A vector of all the possible alternative indices.

Value

A tibble with columns 'x', 'task', and 'alt', where 'x' is a binary indicator of whether the alternative was chosen or not, 'task' is the task index, and 'alt' is the alternative index.

Examples

```
#There are 3 alternatives in this task.
#Since there are 3 observations in myvec, there are 3 tasks total.
ec_util_choice_to_long(c(1, 2, 1), c(1, 2, 3))
```

`ec_util_dummy_mutualeclusive` *Find mutually exclusive columns*

Description

This function finds pairs of columns in a data frame that are mutually exclusive, i.e., that never have positive values at the same time.

Usage

```
ec_util_dummy_mutualeclusive(data_in, filtered = TRUE)
```

Arguments

`data_in`	A data frame containing the data.
`filtered`	A logical value indicating whether to return only the mutually exclusive pairs (TRUE) or all pairs (FALSE). Default is TRUE.

Value

A tibble containing all pairs of mutually exclusive columns in the data frame.

Examples

```
minidata=structure(list(id = c("1", "1", "1", "1", "2", "2", "2", "2"),
task = c(1L, 1L, 2L, 2L, 3L, 3L, 4L, 4L),
alt = c(1L, 2L, 1L, 2L, 1L, 2L, 1L, 2L),
brand1 = c(1, 0, 1, 0, 1, 0, 1, 0),
brand2 = c(0, 1, 0, 1, 0, 1, 0, 1),
price = c(1, 2, 1, 2, 1, 2, 1, 2),
x = c(1, 0, 0, 1, 1, 0, 1, 0)),
class = c("tbl_df", "tbl", "data.frame"), row.names = c(NA, -8L))
ec_util_dummy_mutualeclusive(minidata)
```

`get_attr_lvl` *Obtain attributes and levels from tidy choice data with dummies*

Description

Obtain attributes and levels from tidy choice data with dummies

Usage

```
get_attr_lvl(tdc)
```

Arguments

tdc	A tibble with choice data

Value

tibble

Examples

```
mytest=data.frame(A=factor(c('a','a','b','c','c')), B=1:5)
dummied_data = dummify(mytest,"A")
get_attr_lvl(dummied_data)
```

---

icecream *icecream*

Description

Volumetric Conjoint data, ice cream category

Details

Data from volumetric conjoint analysis in the ice cream category. 300 respondents total. Volumetric demand in units of 4 ounces each. Attributes include brand name, flavor, and container size.

---

icecream_discrete *icecream_discrete*

Description

Discrete-Choice Conjoint data, ice cream category

Details

Data from discrete choice conjoint analysis in the ice cream category. 300 respondents total. Attributes include brand name, flavor, and container size.

logMargDenNRu *Log Marginal Density (Newton-Raftery)*

Description

This function uses the quick-and-dirty Newton-Raftery approximation for log-marginal-density.

Usage

```
logMargDenNRu(ll)
```

Arguments

ll	A vector of log-likelihood values (i.e., draws)

Details

Approximation of LMD based on Newton-Raftery. It is not the most accurate, but a very fast method.

Value

A single numeric value representing the log marginal density

Examples

```
logll_values <- c(-4000, -4001, -4002)
logMargDenNRu(logll_values)
```

pizza *pizza*

Description

Volumetric Conjoint data, pizza category

Details

Data from volumetric conjoint analysis in the frozen pizza category.

prep_newprediction *Match factor levels between two datasets*

Description

Makes sure the factor levels in `data_new` are aligned with `data_old` This is helpful for demand simulations.

Usage

```
prep_newprediction(data_new, data_old)
```

Arguments

`data_new`	New long-format choice data
`data_old`	Old long-format choice data

Value

long-format choice data

Examples

```
data(icecream)
prep_newprediction(icecream, icecream)
```

vd_add_prodid *Add product id to demand draws*

Description

This adds a unique product identifier to demand draw objects.

Usage

```
vd_add_prodid(de)
```

Arguments

`de`	demand draws

Value

est

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm(R=4, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<10) %>%
   vd_dem_vdm(icecream_est)
#add prodid
icecream_predicted_demand_w_id<-icecream_predicted_demand %>% vd_add_prodid
```

---

vd_dem_summarise *Summarize posterior draws of demand (volumetric models only)*

Description

Adds summaries of posterior draws of demand to tibble. (using the new demand draw format)

Usage

```
vd_dem_summarise(de, quantiles = c(0.05, 0.95))

vd_dem_summarize(de, quantiles = c(0.05, 0.95))
```

Arguments

de	demand draws
quantiles	Quantiles for Credibility Intervals (default: 90% interval)

Value

Summary of demand predictions

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm(R=10, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<10) %>%
   vd_dem_vdm(icecream_est)
#aggregate
brand_lvl_pred_demand <-
 icecream_predicted_demand %>% ec_dem_aggregate("Brand")
```

```
#summarise
brand_lvl_pred_demand %>% vd_dem_summarise()
```

---

vd_dem_vdm *Demand Prediction (Volumetric Demand Model)*

Description

Generating demand predictions for volumetric demand model. Reminder: there is no closed-form solution for demand, thus we need to integrate not only over the posterior distribution of parameters and the error distribution. The function outputs a tibble containing id, task, alt, p, attributes, draws from the posterior of demand. Error realizations can be pre-supplied to the `epsilon_not`. This helps create smooth demand curves or conduct optimization.

Usage

```
vd_dem_vdm(
  vd,
  est,
  epsilon_not = NULL,
  error_dist = NULL,
  tidy = TRUE,
  cores = NULL
)
```

Arguments

`vd`	data
`est`	ec-model draws
`epsilon_not`	(optional) error realizations
`error_dist`	(optional) A string defining the error term distribution (default: 'EV1')
`tidy`	(optional) apply 'echoice2' tidier (default: TRUE)
`cores`	(optional) cores (default: auto-detect)

Value

Draws of expected demand

See Also

`prep_newprediction()` to match vd's factor levels, `ec_gen_err_ev1()` for pre-generating error realizations and `vd_est_vdm()` for estimating the corresponding model

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm(R=10, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<20) %>%
   vd_dem_vdm(icecream_est, cores=2)
#column .demdraws contains draws from posterior of predicted demand
```

---

vd_dem_vdm_screen *Demand Prediction (Volumetric demand, attribute-based screening)*

Description

Generating demand predictions for volumetric demand model with attribute-based screening. Reminder: there is no closed-form solution for demand, thus we need to integrate not only over the posterior distribution of parameters and the error distribution. The function outputs a tibble containing id, task, alt, p, attributes, draws from the posterior of demand. Eerror realisations can be pre-supplied to the `epsilon_not`. This helps create smooth demand curves or conduct optimization.

Usage

```
vd_dem_vdm_screen(vd, est, epsilon_not = NULL, error_dist = NULL, cores = NULL)
```

Arguments

`vd`	data
`est`	ec-model draws
`epsilon_not`	(optional) error realizations
`error_dist`	(optional) A string defining the error term distribution (default: 'EV1')
`cores`	(optional) cores

Value

Draws of expected demand

See Also

`prep_newprediction()` to match vd's factor levels, `ec_gen_err_normal()` for pre-generating error realizations and `vd_est_vdm_screen()` for estimating the corresponding model

Examples

```
data(icecream)
#run MCMC sampler (use way more than 20 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<20) %>% vd_est_vdm_screen(R=20, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<20) %>%
   vd_dem_vdm_screen(icecream_est, cores=2)
#column .demdraws contains draws from posterior of predicted demand
```

`vd_dem_vdm_ss` *Demand Prediction (Volumetric demand, accounting for set-size variation, EV1 errors)*

Description

Generating demand predictions for volumetric demand model with set-size adjustment. Reminder: there is no closed-form solution for demand, thus we need to integrate not only over the posterior distribution of parameters and the error distribution. The function outputs a tibble containing id, task, alt, p, attributes, draws from the posterior of demand. Eerror realizations can be pre-supplied to the `epsilon_not`. This helps create smooth demand curves or conduct optimization.

Usage

```
vd_dem_vdm_ss(vd, est, epsilon_not = NULL, cores = NULL)
```

Arguments

`vd`	data
`est`	ec-model draws
`epsilon_not`	(optional) error realizations
`cores`	(optional) cores

Value

Draws of expected demand

See Also

`prep_newprediction()` to match vd's factor levels, `ec_gen_err_ev1()` for pre-generating error realizations and `vd_est_vdm_ss()` for estimating the corresponding model

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<10) %>% vd_est_vdm_ss(R=10, keep=1, cores=2)
#Generate demand predictions
icecream_predicted_demand=
 icecream %>% dplyr::filter(id<10) %>%
   vd_dem_vdm_ss(icecream_est, cores=2)
#column .demdraws contains draws from posterior of predicted demand
```

---

vd_est_vdm *Estimate volumetric demand model*

Description

Estimate volumetric demand model

Usage

```
vd_est_vdm(
  vd,
  tidy = TRUE,
  R = 1e+05,
  keep = 10,
  cores = NULL,
  error_dist = "EV1",
  control = list(include_data = TRUE)
)
```

Arguments

vd	A tibble, containing volumetric demand data (long format)
tidy	A logical, whether to apply 'echoice2' tidier function (default: TRUE)
R	A numeric, no of draws
keep	A numeric, thinning factor
cores	An integer, no of CPU cores to use (default: auto-detect)
error_dist	A string defining the error term distribution, 'EV1' or 'Normal'
control	A list containing additional settings

Value

An 'echoice2' draw object, in the form of a list

See Also

vd_dem_vdm() to generate demand predictions based on this model

vd_est_vdm_screen() to estimate a volumetric demand model with screening

Examples

```
data(icecream)
#run MCMC sampler (use way more than 10 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<50) %>% vd_est_vdm(R=10, cores=2)
```

---

vd_est_vdm_screen *Estimate volumetric demand model with attribute-based conjunctive screening*

Description

Estimate volumetric demand model with attribute-based conjunctive screening

Usage

```
vd_est_vdm_screen(
  vd,
  R = 1e+05,
  keep = 10,
  cores = NULL,
  error_dist = "EV1",
  price_screen = TRUE,
  control = list(include_data = TRUE)
)
```

Arguments

vd	volumetric demand data (long format)
R	draws
keep	thinning
cores	no of CPU cores to use (default: auto-detect)
error_dist	A string defining the error term distribution, 'EV1' or 'Normal' (default: 'EV1')
price_screen	A logical, indicating whether price tag screening should be estimated (default: TRUE)
control	list containing additional settings

Value

est ec-draw object (List)

Examples

```
data(icecream)
icecream_est <- icecream %>% vd_est_vdm_screen(R=10, cores=2)
```

`vd_est_vdm_ss` *Estimate volumetric demand model accounting for set size variation (1st order)*

Description

This model REQUIRES variation in choice-set size

Usage

```
vd_est_vdm_ss(
  vd,
  order = 1,
  R = 1e+05,
  keep = 10,
  cores = NULL,
  control = list(include_data = TRUE)
)
```

Arguments

`vd`	volumetric demand data (long format) with set size variation
`order`	integer, either 1 or 2 (for now), indicating linear or quadratic set-size effect
`R`	draws
`keep`	thinning
`cores`	no of CPU cores to use (default: auto-detect)
`control`	list containing additional settings

Value

est ec-draw object (List)

Examples

```
data(icecream)
#note that for this example dataset, the model is not identified
#because the data lacks variation in set size
icecream_est <- icecream %>% vd_est_vdm_ss(R=10, cores=2)
```

vd_LL_vdm *Log-Likelihood for compensatory volumetric demand model*

Description

Log-Likelihood for compensatory volumetric demand model

Usage

```
vd_LL_vdm(draw, vd, fromdraw = 1)
```

Arguments

draw	A list, 'echoice2' draws object
vd	A tibble, tidy choice data (before dummy-coding)
fromdraw	An integer, from which draw onwards to compute LL (i.e., excl. burnin)

Value

N x Draws Matrix of log-Likelihood values

Examples

```
data(icecream)
#fit model
icecream_est <- icecream %>% vd_est_vdm(R=10, keep=1, cores=2)
#compute likelihood for each subject in each draw
loglls<-vd_LL_vdm(icecream_est, icecream, fromdraw = 2)
dim(loglls)
```

vd_LL_vdmss *Log-Likelihood for volumetric demand model with set-size variation*

Description

Log-Likelihood for volumetric demand model with set-size variation

Usage

```
vd_LL_vdmss(draw, vd, fromdraw = 1)
```

Arguments

draw	A list, 'echoice2' draws object
vd	A tibble, tidy choice data (before dummy-coding)
fromdraw	An integer, from which draw onwards to compute LL (i.e., excl. burnin)

Value

N x Draws Matrix of log-Likelihood values

Examples

```
data(icecream)
#fit model
#note: this is just for demo purposes
#on this demo dataset, the model is not identified
#due to a lack of set size variation
icecream_est <- icecream %>% vd_est_vdm_ss(R=10, keep=1, cores=2)
#compute likelihood for each subject in each draw
loglls<-vd_LL_vdmss(icecream_est, icecream, fromdraw = 2)
#300 respondents, 10 draws
dim(loglls)
```

---

vd_LL_vdm_screen *Log-Likelihood for conjunctive-screening volumetric demand model*

Description

Log-Likelihood for conjunctive-screening volumetric demand model

Usage

```
vd_LL_vdm_screen(draw, vd, fromdraw = 1)
```

Arguments

draw	A list, 'echoice2' draws object
vd	A tibble, tidy choice data (before dummy-coding)
fromdraw	An integer, from which draw onwards to compute LL (i.e., excl. burnin)

Value

N x Draws Matrix of log-Likelihood values

Examples

```
data(icecream)
#fit model
icecream_est <- icecream %>% filter(id<20) %>% vd_est_vdm_screen(R=10, keep=1, cores=2)
#compute likelihood for each subject in each draw
loglls<-vd_LL_vdm_screen(icecream_est, icecream%>% filter(id<20), fromdraw = 2)
dim(loglls)
```

vd_long_tidy *Generate tidy choice data with dummies from long-format choice data*

Description

Generate tidy choice data with dummies from long-format choice data

Usage

```
vd_long_tidy(longdata)
```

Arguments

longdata	tibble

Value

tibble

Examples

```
data(icecream)
vd_long_tidy(icecream)
```

vd_prepare *Prepare choice data for analysis*

Description

This utility function prepares tidy choice data for fast MCMC samplers.

Usage

```
vd_prepare(dt, Af = NULL)
```

Arguments

dt	tidy choice data (columns: id, task, alt, x, p, attributes)
Af	(optional) contains a full design matrix (for attribute-based screening), or, more generally, a design matrix used for attribute-based screening

Details

Note: This function is only exported because it makes it easier to tinker with this package. This function re-arranges choice data for fast access in highly-optimized MCMC samplers. It Pre-computes task-wise total expenditures sumpsx and generates indices xfr,xto,lfr,lto for fast data access.

Value

list containing information for estimation functions

Examples

```
#minimal data example
dt <- structure(list(id = c(1L, 1L, 1L, 1L, 1L, 1L, 2L, 2L, 2L, 2L,
                            2L, 2L),
                     task = c(1L, 1L, 1L, 2L, 2L, 2L, 1L, 1L, 1L, 2L, 2L, 2L),
                     alt = c(1L, 2L, 3L, 1L, 2L, 3L, 1L, 2L, 3L, 1L, 2L, 3L),
                     x = c(1, 0, 2, 1, 0, 1, 2, 3, 1, 1, 0, 1),
                     p = c(0, 1, 1, 1, 2, 0, 2, 2, 1, 2, 1, 1),
                     attr2 = c(1, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0),
                     attr1 = c(0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 1)),
                class = c("tbl_df", "tbl", "data.frame"), row.names = c(NA,-12L))
#run prep function
test <- dt %>% vd_prepare
```

---

vd_prepare_nox *Prepare choice data for analysis (without x being present)*

Description

This utility function prepares tidy choice data (without x) for fast data access.

Usage

```
vd_prepare_nox(dt, Af = NULL)
```

Arguments

dt	tidy choice data (columns: id, task, alt, p, attributes)
Af	(optional) contains a full design matrix (for attribute-based screening), or, more generally, a design matrix used for attribute-based screening

Details

Note: This function is only exported because it makes it easier to tinker with this package. This function re-arranges choice data for fast access, mainly for demand prediction.

Value

list containing information for prediction functions

Examples

```
#Minimal example:
#One attribute with 3 levels, 2 subjects, 3 alternatives, 2 tasks
dt <- structure(list(id = c(1L, 1L, 1L, 1L, 1L, 1L, 2L, 2L, 2L, 2L,
                            2L, 2L),
                     task = c(1L, 1L, 1L, 2L, 2L, 2L, 1L, 1L, 1L, 2L, 2L, 2L),
                     alt = c(1L, 2L, 3L, 1L, 2L, 3L, 1L, 2L, 3L, 1L, 2L, 3L),
                     x = c(1, 0, 2, 1, 0, 1, 2, 3, 1, 1, 0, 1),
                     p = c(0, 1, 1, 1, 2, 0, 2, 2, 1, 2, 1, 1),
                     attr2 = c(1, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0),
                     attr1 = c(0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 1)),
                class = c("tbl_df", "tbl", "data.frame"), row.names = c(NA,-12L))
test <- dt %>% dplyr::select(-all_of("x")) %>% vd_prepare_nox()
```

---

vd_thin_draw *Thin 'echoice2'-vd draw objects*

Description

Thin 'echoice2'-vd draw objects

Usage

```
vd_thin_draw(est, burnin_perc = 0.5, total_draws = NULL)
```

Arguments

est	is an 'echoice2' draw object (list)
burnin_perc	how much burn-in to remove
total_draws	how many draws to keep after thinning

Value

thinned 'echoice2' draw object (list)

Examples

```
data(icecream)
#run MCMC sampler (use way more than 50 draws for actual use)
icecream_est <- icecream %>% dplyr::filter(id<100) %>% vd_est_vdm(R=10, keep = 1, cores=2)
#without thinning, yields R=50 draWs
dim(icecream_est$MUDraw)
icecream_est_thinned <- vd_thin_draw(icecream_est,.5)
#26 draws left after thinning about half
dim(icecream_est_thinned$MUDraw)
```

`%.%` *Get the attribute of an object*

Description

Get the attribute of an object

Usage

```
obj %.% attrname
```

Arguments

`obj`	The object to get the attribute from.
`attrname`	The name of the attribute to get.

Value

The attribute of the object.

Examples

```
obj <- list(a = 1, b = 2)
attributes(obj)$test="hello"
`%.%`(obj, "test")
```

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