Package 'mixl'

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Type Package

Title Simulated Maximum Likelihood Estimation of Mixed Logit Models for Large Datasets

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Description Specification and estimation of multinomial logit models. Large datasets and complex models are supported, with an intuitive syntax. Multinomial Logit Models, Mixed models, random coefficients and Hybrid Choice are all supported. For more information, see Molloy et al. (2019) <doi:10.3929/ethz-b-000334289>.

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Imports maxLik, numDeriv, randtoolbox, Rcpp (>= 0.12.19), readr, sandwich, stats, stringr (>= 1.3.1)

Suggests knitr, mlogit, rmarkdown, testthat, texreg, xtable

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`mixl-package` *Estimate mixed multinomial logit models*

Description

Estimate mixed multinomial logit models using (simulated) maximum likelihood estimation. The package supports standard mnl, mixed-logit and hybrid choice. Using compilation to C++, model estimation is significantly faster than in native R code.

Details

This section should provide a more detailed overview of how to use the package, including the most important functions.

Author(s)

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References

This optional section can contain literature or other references for background information.

See Also

Optional links to other man pages

Examples

```
data("Train", package="mlogit")
head(Train, 3)
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
```

```
mnl_test <- "
  ASC_B_RND  = @ASC_B  + draw_2 * @SIGMA_B;

 U_A =         @B_price * $price_A / 1000 + @B_time * $time_A / 60 + @B_change * $change_A;
  U_B = ASC_B_RND + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train)

#only take starting values that are needed
est <- stats::setNames(c(0,0,0,0,0,0), c("B_price", "B_time", "B_timeB",
"B_change", "ASC_B", "SIGMA_B"))

availabilities <- mixl::generate_default_availabilities(Train, model_spec$num_utility_functions)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities, nDraws = 20)

summary(model)
```

`av_matrix` *Extract the availabilites matrix from the dataset, using column indicies*

Description

Extract the availabilites matrix from the dataset, using column indicies

Usage

```
av_matrix(data, av_cols)
```

Arguments

`data`	The dataset used in the model
`av_cols`	A vector of the the column indicies of the availabilities for each alternative

Value

Matrix of availabilities for alternatives and the number of choice observations

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
Train$avail_A <- sample(2, replace=TRUE, size=nrow(Train))-1
Train$avail_B <- sample(2, replace=TRUE, size=nrow(Train))-1
av_matrix(Train, c('avail_A', 'avail_B'))
```

check_draw_inputs *Check the inputs to the draw function*

Description

Check the inputs to the draw function

Usage

```
check_draw_inputs(draws, nDraws, draw_dimensions, Nindividuals)
```

Arguments

draws	The specified Model
nDraws	Named vector of proposed start values for the model
draw_dimensions	the dataset on which to estimate
Nindividuals	The availabilities for the alternatives in the model specification

Value

A list consisting of the checked draws and Ndraws, both computed if required)

check_inputs *Check the inputs to the estimate function*

Description

This function checks the start_vlaues, data, availabilities, draws and fixedparams for validity. If this function runs without error, then the inputs are valid for the maxLikelihood function. These checks are important, because an error in the internal C++ code will cause the Rstudio session to crash. Incidentally, if there is concern of this happening, it is recommended to run the script from the command line, using Rscript.

Usage

```
check_inputs(
  model_spec,
  start_values,
  data,
  availabilities,
  draws,
  fixedparam,
  weights
)
```

Arguments

model_spec	The specified Model
start_values	Named vector of proposed start values for the model
data	the dataset on which to estimate
availabilities	The availabilities for the alternatives in the model specification
draws	The matrix of random draws
fixedparam	Named vector of parameters to be fixed
weights	The weights vector

Value

Nothing

---

compileUtilityFunction

compileUtilityFunction Deprecated, please see specify_model()

Description

compileUtilityFunction Deprecated, please see specify_model()

Usage

```
compileUtilityFunction(...)
```

Arguments

...	Parameters to specify_model

---

create_halton_draws

Create a standard set of Halton draws to use in estimation

Description

Create a standard set of Halton draws to use in estimation

Usage

```
create_halton_draws(Nindividuals, nDraws, draw_dimensions)
```

Arguments

Nindividuals	The number individuals in the dataset
nDraws	The number of draws needed
draw_dimensions	the number of draw dimensions needed

Value

Matrix of availabilities for alternatives and the number of choice observations

Examples

```
create_halton_draws(100, 10, 5)
create_halton_draws(100, 100, 20)
```

---

estimate *Runs a maximum likelihood estimation on a mixl choice model*

Description

This function performs a maximum likelihood estimation for choice models speficied using this package.

Usage

```
estimate(
  model_spec,
  start_values,
  data,
  availabilities,
  draws,
  nDraws,
  fixedparam = c(),
  num_threads = 1,
  weights = NULL,
  ...
)
```

Arguments

model_spec	The object that contains the loglikelihood function and other variables that help return better error messages. This function is best generated using the specify_model() function.
start_values	A named vector of start values for the estimation. A warning and error will be given respectively if to many values are included or some are missing.

data	A dataframe of the observations. It must include The columns CHOICE and ID, as well as columns for the variables specified in the utility function. The CHOICE variable must be from 1..k, where k is the number of utility functions
availabilities	A 1/0 matrix of availabilities. The dimensions must be nrows(data) * k, where there are k utility functions.
draws	A numeric matrix of draws for calculating mixed effects. If there no mixed effects, this should be left null. If the model specification included mixed effects, either this or nDraws need to be specified.
nDraws	The number of draws to use in estimating a mixed model. Only needed if draws is left null. Then a matrix of normal halton draws will be generated.
fixedparam	(optional) Coefficients which should be fixed to their starting values during estimation.
num_threads	The maximum number of parallel cores to use in estimation. The default is 1. This should only be speficied on machines with an openMP compiler (linux and some OSXs).
weights	(optional) A vector of weights (vector length must equal the number of observations).
...	futher arguments. such as control are passed to the maximisaiton routine in maxLik. See maxLik::maxLik() for more details

Details

It is a wrapper for the maxLik function in the maxLik package. And additional arguments can be passed through to this function if required.

Value

a mixl object that contains the results of the estimation

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)

#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
```

```
print(model)
```

`extract_av_cols` *Extract the availabilites matrix from the dataset using a column name prefix*

Description

Extract the availabilites matrix from the dataset using a column name prefix

Usage

```
extract_av_cols(data, prefix)
```

Arguments

`data`	The dataset used in the model
`prefix`	The prefix of the availability columns, i.e. avail_

Value

Matrix of availabilities for alternatives and the number of choice observations

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
Train$avail_A <- sample(2, replace=TRUE, size=nrow(Train))-1
Train$avail_B <- sample(2, replace=TRUE, size=nrow(Train))-1
extract_av_cols(Train, 'avail_')
```

`extract_indiv_data` *Extract the individual level data from the dataset for use in posterior analysis*

Description

Extract the individual level data from the dataset for use in posterior analysis

Usage

```
extract_indiv_data(data, data_cols = NULL)
```

Arguments

data	The dataset
data_cols	The individual level columns of attributes - Can be null to take aggregate for each column

Value

dataframe of all individual level data for each ID

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
#in this case not actually individual data columns
#an ID column is required here
extract_indiv_data(Train, c('comfort_A', 'comfort_B'))
```

---

generate_default_availabilities

Generate a ones-matrix of availabilities

Description

Generate a ones-matrix of availabilities

Usage

```
generate_default_availabilities(data, num_utility_functions)
```

Arguments

data	The dataset used in the model
num_utility_functions	the number of alternatives in the model

Value

Ones-matrix of availabilities for alternatives and the number of choice observations

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
generate_default_availabilities(Train, 5)
```

posteriors *Calculate the posteriors for a specified and estimated model*

Description

Calculate the posteriors for a specified and estimated model

Usage

```
posteriors(model, indiv_data, code_output_file = NULL)
```

Arguments

model	The estimated Model
indiv_data	Alternative individual data to use insteaf of that in the dataset
code_output_file	An (optional) location where the compiled code should be saved (useful for debugging

Value

Dataframe of individual-level posteriors

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)
mnl_test <- "
      ASC_A_RND = @ASC_A + draw_1 * @SIGMA_A1 + draw_7 * @SIGMA_A2;
      ASC_B_RND = @ASC_B + draw_2 * @SIGMA_B;

      U_A = ASC_A_RND + @B_price * $price_A / 1000
       + @B_time * $time_A / 60 + @B_change * $change_A;
      U_B = ASC_B_RND + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
    "

#only take starting values that are needed
est <- stats::setNames(c(-1059.69729,  -181.27796,  -251.78909,
 -241.18878,   -86.77386, -173.09451,
  291.02618,   142.71793,   332.60909)
    , c("B_price", "B_time", "B_timeB", "B_change",
     "ASC_A", "ASC_B", "SIGMA_A1", "SIGMA_A2", "SIGMA_B"))

availabilities <- generate_default_availabilities(Train, 2)

model_specification <- specify_model(mnl_test, Train, disable_multicore=T)
model <- estimate(model_specification, est, Train,
```

```
availabilities = availabilities, nDraws = 1)

posteriors(model)
```

---

print.mixl *Prints the output of a model*

Description

print() is an S3 method for the mixl class. It creates a model summary and then prints the result

Usage

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

Arguments

x	The model to print
...	Options to pass to print

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)

#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions
)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
summary(model)
```

`print.summary.mixl` *Print a model summary*

Description

`print()` is an S3 method for the summary.mixl class, the output of a model plus goodness of fit metrics

Usage

```
## S3 method for class 'summary.mixl'
print(x, ...)
```

Arguments

x	The summary to print.
...	Options to pass to print.

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)

#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions
)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
summary(model)
```

probabilities *Calculate the probabilities for a specified and estimated model. Note that if new data or draws are provided, the model will not be re-estimated*

Description

Calculate the probabilities for a specified and estimated model. Note that if new data or draws are provided, the model will not be re-estimated

Usage

```
probabilities(
  model,
  data = NULL,
  availabilities = NULL,
  draws = NULL,
  nDraws = NULL,
  num_threads = 1
)
```

Arguments

model	The estimated Model
data	(Optional) New data to use instead of that in the dataset
availabilities	(Optional) New availabilites to use
draws	(Optional) Optional new set of random draws to use
nDraws	(Optional) Optional new number of random draws to use
num_threads	Enable parallel computing where available using this many cores

Value

Dataframe of individual-level posteriors

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)
```

```
#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions
)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
probabilities(model)

#hypothetical scenario where the travel time of option A doubles
Train$time_A = Train$time_A * 2
probabilities(model, Train)
```

`specify_model` *Validate the utility functions against the dataset and generate the optimised logliklihood function*

Description

This function takes a utility function description, and generates a optimised C++ version of the utility function which can be called from R. If the data_names are provided, then the variables in the function are checked against those provided. If an `output_file` is provided, the C++ code is saved there. See the user guide vignette for how to write valid utility scripts. There is some minimal specific syntax required.

Usage

```
specify_model(
  utility_script,
  dataset = NULL,
  output_file = NULL,
  compile = TRUE,
  model_name = "mixl_model",
  disable_multicore = T,
  ...
)
```

Arguments

`utility_script`	The utility script to be compiled
`dataset`	An (optional) dataframe to check if the all the variables are present
`output_file`	An (optional) location where the compiled code should be saved (useful for debugging
`compile`	If compile is false, then the code will not be compiled, but just validated and saved if an `output_file` is specified. Default is true.

`model_name` A name for the model, which will be used for saving. Defaults to *mixl_model*

`disable_multicore`
Depreciated and not used. Mutlicore is now autodetected

`...` Further parameters to pass to sourceCpp

Value

An `object` which contains the loglikelihood function, and information from the compile process

See Also

browseVignettes("mixl")

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)

#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
print(model)
```

`summary.mixl` *Create a model summary*

Description

summary() is an S3 method for the class mixl, which adds metrics of goodness of fit

Usage

```
## S3 method for class 'mixl'
summary(object, ...)
```

Arguments

object	The mixl output to summarize.
...	Options to pass to summarize (currently).

Value

A summary object for a mixl model

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

mnl_test <- "
U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60;
U_B = @asc + @B_price * $price_B / 1000 + @B_timeB * $time_B / 60;
"

model_spec <- mixl::specify_model(mnl_test, Train, disable_multicore=T)

#only take starting values that are needed
est <- stats::setNames(c(1, 1,1,1), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(
Train, model_spec$num_utility_functions
)

model <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
summary(model)
```

---

summary_tex *Return tex formatted output of a model summary. If an output_file parameter is provided, save the object to that location*

Description

Return tex formatted output of a model summary. If an output_file parameter is provided, save the object to that location

Usage

```
summary_tex(model_summary, output_file)
```

Arguments

model_summary	A summary of an estimated Model
output_file	Where to save the tex representation

Value

Formatted texreg object containing the latex table suitable for a research paper. See createTexreg

---

`utilities` *Return the the utilities for a set of coefficients*

Description

Return the the utilities for a set of coefficients

Usage

```
utilities(model_spec, beta, data, availabilities, draws, nDraws)
```

Arguments

`model_spec`	The generated model_spec.
`beta`	The coefficients to use in the model when estimating the utilities.
`data`	The dataframe of observations.
`availabilities`	The availabilities of each alternative.
`draws`	For mixed models, a matrix of draws. If none is provided, one is created.
`nDraws`	The number of draws to use or generated.

Value

Dataframe of utilties for each observation

Examples

```
data("Train", package="mlogit")
Train$ID <- Train$id
Train$CHOICE <- as.numeric(Train$choice)

est <- stats::setNames(c(1,1,1,1), c("B_price", "B_time", "B_timeB", "B_change"))

availabilities <- mixl::generate_default_availabilities(Train, 2)

Nindividuals <- length(unique(Train$ID))

utility_script <- "
    U_A = @B_price * $price_A / 1000 + @B_time * $time_A / 60 + @B_change * $change_A;
    U_B = @B_price * $price_B / 1000 + @B_timeB * $time_B / 60 ;
    "

model_spec <- mixl::specify_model(utility_script, Train)
```

```
utilities_matrix = mixl::utilities(model_spec, est, Train, availabilities, NULL)

utilities_matrix
```

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