Package ‘mixl’

December 8, 2021

Type Package

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

Version 1.3.3

Date 2021-12-07

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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URL https://github.com/joemolloy/fast-mixed-mnl

BugReports https://github.com/joemolloy/fast-mixed-mnl/issues

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

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

VignetteBuilder knitr

Encoding UTF-8

RoxygenNote 7.1.1

NeedsCompilation yes

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R topics documented:

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mixl-package

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)

Joe Molloy <joseph.molloy@ivt.baug.ethz.ch>.

References

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

See Also

Optional links to other man pages
Examples

```r
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 availabilities matrix from the dataset, using column indicies

**Description**

Extract the availabilities matrix from the dataset, using column indicies

**Usage**

```r
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_values, 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

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>model_spec</td>
<td>The specified Model</td>
</tr>
<tr>
<td>start_values</td>
<td>Named vector of proposed start values for the model</td>
</tr>
<tr>
<td>data</td>
<td>the dataset on which to estimate</td>
</tr>
<tr>
<td>availabilities</td>
<td>The availabilities for the alternatives in the model specification</td>
</tr>
<tr>
<td>draws</td>
<td>The matrix of random draws</td>
</tr>
<tr>
<td>fixedparam</td>
<td>Named vector of parameters to be fixed</td>
</tr>
<tr>
<td>weights</td>
<td>The weights vector</td>
</tr>
</tbody>
</table>

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 specified using this package.

Usage

estimate(
  model_spec,
  start_values,
  data,
  availabilities,
  draws,
  nDraws,
  fixedparam = c(),
)
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 too 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 are 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 specified on machines with an openMP compiler (Linux and some OSXs).

weights  (optional) A vector of weights (vector length must equal the number of observations).

...  Further arguments, such as control, are passed to the maximization 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"))
availables <- mixl::generate_default_availables(Train, model_spec$num_utility_functions)

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

---

**extract_av_cols**

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

**Description**

Extract the availabilities 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**

```r
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**

```r
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)

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 instead 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 + @B_price * $price_A / 1000 + @B_time * $time_A / 60 + @B_change * $change_A;
U_B = ASC_B + @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)
posterior(model)

print.mxl

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;"
```r
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)

model2 <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
print(model2)
```

---

### Description

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

### Usage

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

### Arguments

- **x**
  - The summary to print.

- **...**
  - Options to pass to print.

### Examples

```r
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
)

model2 <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
print(model2)

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 availabilities 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

```r
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 loglikelihood function

---

**Description**

This function takes a utility function description, and generates an 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**

```r
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. Multicore 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), 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), c("asc", "B_price", "B_time", "B_timeB"))
availabilities <- mixl::generate_default_availabilities(Train, model_spec$\text{num\_utility\_functions})

model2 <- mixl::estimate(model_spec, est, Train, availabilities = availabilities)
print(model2)
**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 utilities 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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