

Package ‘autoMrP’

January 21, 2021

Type Package

Title Improving MrP with Ensemble Learning

Version 0.98

Description A tool that improves the prediction performance of multilevel regression with post-stratification (MrP) by combining a number of machine learning methods. For information on the method, please refer to Broniecki, Wüest, Leemann (2020) "Improving Multilevel Regression with Post-Stratification Through Machine Learning (autoMrP)" forthcoming in 'Journal of Politics'. Final pre-print version:
<<https://lucasleemann.files.wordpress.com/2020/07/automrp-r2pa.pdf>>.

URL <https://github.com/retowuest/autoMrP>

BugReports <https://github.com/retowuest/autoMrP/issues>

Depends R (>= 3.6)

Imports rlang (>= 0.4.5), dplyr (>= 1.0.2), lme4 (>= 1.1), gbm (>= 2.1.5), e1071 (>= 1.7-3), tibble (>= 3.0.1), glmmLasso (>= 1.5.1), EBMAforecast (>= 1.0.0), foreach (>= 1.5.0), doParallel (>= 1.0.15), doRNG (>= 1.8.2), ggplot2 (>= 3.3.2), knitr (>= 1.29), tidyr (>= 1.1.2), purrr (>= 0.3.4)

Suggests rmarkdown, R.rsp

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

VignetteBuilder R.rsp

NeedsCompilation no

Author Reto Wüest [aut] (<<https://orcid.org/0000-0002-7502-6489>>),
Lucas Leemann [aut] (<<https://orcid.org/0000-0001-5201-869X>>),
Philipp Broniecki [aut, cre] (<<https://orcid.org/0000-0001-9214-4404>>),
Hadley Wickham [ctb]

Maintainer Philipp Broniecki <philippbroniecki@gmail.com>

Repository CRAN

Date/Publication 2021-01-21 11:00:09 UTC

R topics documented:

absentee_census	3
absentee_voting	4
auto_MrP	5
best_subset_classifier	11
binary_cross_entropy	12
boot_auto_mrp	13
census	18
cv_folding	19
ebma	19
ebma_folding	21
ebma_mc_draws	21
ebma_mc_tol	23
error_checks	25
f1_score	29
gb_classifier	29
gb_classifier_update	30
lasso_classifier	31
log_spaced	32
loss_function	32
loss_score_ranking	33
mean_absolute_error	34
mean_squared_error	34
mean_squared_false_error	35
model_list	35
model_list_pca	36
multicore	37
output_table	37
plot.autoMrP	38
post_stratification	38
predict_glmLasso	40
quiet	41
run_best_subset	42
run_best_subset_mc	43
run_gb	44
run_gb_mc	47
run_lasso	48
run_lasso_mc_lambda	50
run_pca	51
run_svm	52
run_svm_mc	54
summary.autoMrP	56
survey_item	56
svm_classifier	57
taxes_census	59
taxes_survey	60

absentee_census *Quasi census data.*

Description

The census file is generated from the full 2008 Cooperative Congressional Election Studies item cc419_1 by disaggregating the 64 ideal type combinations of the individual level variables L1x1, L2x2 and L1x3. A row is an ideal type in a given state.

Usage

```
data(absentee_census)
```

Format

A data frame with 2934 rows and 13 variables:

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L1x1 Age group (four categories)

L1x2 Education level (four categories)

L1x3 Gender-race combination (six categories)

proportion State-level proportion of respondents of that ideal type in the population

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

absentee_voting

A sample of the absentee voting item from the CCES 2008

Description

The Cooperative Congressional Election Studies (CCES) item (cc419_1) asked: "States have tried many new ways to run elections in recent years. Do you support or oppose any of the following ways of voting or conducting elections in your state? Election Reform - Allow absentee voting over the Internet?" The original 2008 CCES item contains 26,934 respondents. This sample mimics a typical national survey. It contains at least 5 respondents from each state but is otherwise a random sample.

Usage

```
data(absentee_voting)
```

Format

A data frame with 1500 rows and 13 variables:

YES 1 if individual supports use of troops; 0 otherwise

L1x1 Age group (four categories: 1 = 18-29; 2 = 30-44; 3 = 45-64; 4 = 65+)

L1x2 Education level (four categories: 1 = < high school; 2 = high school graduate; 3 = some college; 4 = college graduate)

L1x3 Gender-race combination (six categories: 1 = white male; 2 = black male; 3 = hispanic male; 4 = white female; 5 = black female; 6 = hispanic female)

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. It is a random sample with at least 5 respondents per state. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

`auto_MrP`*Improve MrP through ensemble learning.*

Description

This package improves the prediction performance of multilevel regression with post-stratification (MrP) by combining a number of machine learning methods through ensemble Bayesian model averaging (EBMA).

Usage

```
auto_MrP(  
  y,  
  L1.x,  
  L2.x,  
  L2.unit,  
  L2.reg = NULL,  
  L2.x.scale = TRUE,  
  pcs = NULL,  
  folds = NULL,  
  bin.proportion = NULL,  
  bin.size = NULL,  
  survey,  
  census,  
  ebma.size = 1/3,  
  cores = 1,  
  k.folds = 5,  
  cv.sampling = "L2 units",  
  loss.unit = c("individuals", "L2 units"),  
  loss.fun = c("msfe", "cross-entropy", "f1", "MSE"),  
  best.subset = TRUE,  
  lasso = TRUE,  
  pca = TRUE,  
  gb = TRUE,  
  svm = TRUE,  
  mrp = FALSE,  
  oversampling = FALSE,  
  forward.select = FALSE,  
  best.subset.L2.x = NULL,  
  lasso.L2.x = NULL,  
  pca.L2.x = NULL,  
  gb.L2.x = NULL,  
  svm.L2.x = NULL,  
  mrp.L2.x = NULL,  
  gb.L2.unit = TRUE,  
  gb.L2.reg = FALSE,  
  svm.L2.unit = TRUE,
```

```

svm.L2.reg = FALSE,
lasso.lambda = NULL,
lasso.n.iter = 100,
gb.interaction.depth = c(1, 2, 3),
gb.shrinkage = c(0.04, 0.01, 0.008, 0.005, 0.001),
gb.n.trees.init = 50,
gb.n.trees.increase = 50,
gb.n.trees.max = 1000,
gb.n.minobsinnode = 20,
svm.kernel = c("radial"),
svm.gamma = NULL,
svm.cost = NULL,
ebma.n.draws = 100,
ebma.tol = c(0.01, 0.005, 0.001, 5e-04, 1e-04, 5e-05, 1e-05),
seed = NULL,
verbose = FALSE,
uncertainty = FALSE,
boot.iter = NULL
)

```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>L2.x.scale</code>	Scale context-level covariates. A logical argument indicating whether the context-level covariates should be normalized. Default is <code>TRUE</code> . Note that if set to <code>FALSE</code> , then the context-level covariates should be normalized prior to calling <code>auto_MrP()</code> .
<code>pcs</code>	Principal components. A character vector containing the column names of the principal components of the context-level variables in survey and census. Default is <code>NULL</code> .
<code>folds</code>	EBMA and cross-validation folds. A character scalar containing the column name of the variable in survey that specifies the fold to which an observation is allocated. The variable should contain integers running from 1 to $k + 1$, where k is the number of cross-validation folds. Value $k + 1$ refers to the EBMA

	fold. Default is NULL. <i>Note:</i> if <code>fold</code> s is NULL, then <code>ebma.size</code> , <code>k.fold</code> s, and <code>cv.sampling</code> must be specified.
<code>bin.proportion</code>	Proportion of ideal types. A character scalar containing the column name of the variable in census that indicates the proportion of individuals by ideal type and geographic unit. Default is NULL. <i>Note:</i> if <code>bin.proportion</code> is NULL, then <code>bin.size</code> must be specified.
<code>bin.size</code>	Bin size of ideal types. A character scalar containing the column name of the variable in census that indicates the bin size of ideal types by geographic unit. Default is NULL. <i>Note:</i> ignored if <code>bin.proportion</code> is provided, but must be specified otherwise.
<code>survey</code>	Survey data. A <code>data.frame</code> whose column names include <code>y</code> , <code>L1.x</code> , <code>L2.x</code> , <code>L2.unit</code> , and, if specified, <code>L2.reg</code> , <code>pcs</code> , and <code>fold</code> s.
<code>census</code>	Census data. A <code>data.frame</code> whose column names include <code>L1.x</code> , <code>L2.x</code> , <code>L2.unit</code> , if specified, <code>L2.reg</code> and <code>pcs</code> , and either <code>bin.proportion</code> or <code>bin.size</code> .
<code>ebma.size</code>	EBMA fold size. A number in the open unit interval indicating the proportion of respondents to be allocated to the EBMA fold. Default is $1/3$. <i>Note:</i> ignored if <code>fold</code> s is provided, but must be specified otherwise.
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.
<code>k.fold</code> s	Number of cross-validation folds. An integer-valued scalar indicating the number of folds to be used in cross-validation. Default is 5. <i>Note:</i> ignored if <code>fold</code> s is provided, but must be specified otherwise.
<code>cv.sampling</code>	Cross-validation sampling method. A character-valued scalar indicating whether cross-validation folds should be created by sampling individual respondents (individuals) or geographic units (L2 units). Default is L2 units. <i>Note:</i> ignored if <code>fold</code> s is provided, but must be specified otherwise.
<code>loss.unit</code>	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is <code>c("individuals", "L2 units")</code> . With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is <code>c("MSE", "cross-entropy", "msfe", "f1")</code> . With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>best.subset</code>	Best subset classifier. A logical argument indicating whether the best subset classifier should be used for predicting outcome <code>y</code> . Default is TRUE.
<code>lasso</code>	Lasso classifier. A logical argument indicating whether the lasso classifier should be used for predicting outcome <code>y</code> . Default is TRUE.
<code>pca</code>	PCA classifier. A logical argument indicating whether the PCA classifier should be used for predicting outcome <code>y</code> . Default is TRUE.

gb	GB classifier. A logical argument indicating whether the GB classifier should be used for predicting outcome y . Default is TRUE.
svm	SVM classifier. A logical argument indicating whether the SVM classifier should be used for predicting outcome y . Default is TRUE.
mrp	MRP classifier. A logical argument indicating whether the standard MRP classifier should be used for predicting outcome y . Default is FALSE.
oversampling	Over sample to create balance on the dependent variable. A logical argument. Default is FALSE.
forward.select	Forward selection classifier. A logical argument indicating whether to use forward selection rather than best subset selection. Default is FALSE. <i>Note:</i> forward selection is recommended if there are more than 8 context-level variables. <i>Note:</i> forward selection is not implemented yet.
best.subset.L2.x	Best subset context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the best subset classifier. If NULL and best.subset is set to TRUE, then best subset uses the variables specified in L2.x. Default is NULL.
lasso.L2.x	Lasso context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the lasso classifier. If NULL and lasso is set to TRUE, then lasso uses the variables specified in L2.x. Default is NULL.
pca.L2.x	PCA context-level covariates. A character vector containing the column names of the context-level variables in survey and census whose principal components are to be used by the PCA classifier. If NULL and pca is set to TRUE, then PCA uses the principal components of the variables specified in L2.x. Default is NULL.
gb.L2.x	GB context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the GB classifier. If NULL and gb is set to TRUE, then GB uses the variables specified in L2.x. Default is NULL.
svm.L2.x	SVM context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the SVM classifier. If NULL and svm is set to TRUE, then SVM uses the variables specified in L2.x. Default is NULL.
mrp.L2.x	MRP context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the MRP classifier. The character vector <i>empty</i> if no context-level variables should be used by the MRP classifier. If NULL and mrp is set to TRUE, then MRP uses the variables specified in L2.x. Default is NULL.
gb.L2.unit	GB L2.unit. A logical argument indicating whether L2.unit should be included in the GB classifier. Default is FALSE.
gb.L2.reg	GB L2.reg. A logical argument indicating whether L2.reg should be included in the GB classifier. Default is FALSE.
svm.L2.unit	SVM L2.unit. A logical argument indicating whether L2.unit should be included in the SVM classifier. Default is FALSE.

svm.L2.reg	SVM L2.reg. A logical argument indicating whether L2.reg should be included in the SVM classifier. Default is FALSE.
lasso.lambda	Lasso penalty parameter. A numeric vector of non-negative values. The penalty parameter controls the shrinkage of the context-level variables in the lasso model. Default is a sequence with minimum 0.1 and maximum 250 that is equally spaced on the log-scale. The number of values is controlled by the lasso.n.iter parameter.
lasso.n.iter	Lasso number of lambda values. An integer-valued scalar specifying the number of lambda values to search over. Default is 100. <i>Note:</i> Is ignored if a vector of lasso.lambda values is provided.
gb.interaction.depth	GB interaction depth. An integer-valued vector whose values specify the interaction depth of GB. The interaction depth defines the maximum depth of each tree grown (i.e., the maximum level of variable interactions). Default is c(1, 2, 3).
gb.shrinkage	GB learning rate. A numeric vector whose values specify the learning rate or step-size reduction of GB. Values between 0.001 and 0.1 usually work, but a smaller learning rate typically requires more trees. Default is c(0.04, 0.01, 0.008, 0.005, 0.001).
gb.n.trees.init	GB initial total number of trees. An integer-valued scalar specifying the initial number of total trees to fit by GB. Default is 50.
gb.n.trees.increase	GB increase in total number of trees. An integer-valued scalar specifying by how many trees the total number of trees to fit should be increased (until gb.n.trees.max is reached). Default is 50.
gb.n.trees.max	GB maximum number of trees. An integer-valued scalar specifying the maximum number of trees to fit by GB. Default is 1000.
gb.n.minobsinnode	GB minimum number of observations in the terminal nodes. An integer-valued scalar specifying the minimum number of observations that each terminal node of the trees must contain. Default is 20.
svm.kernel	SVM kernel. A character-valued scalar specifying the kernel to be used by SVM. The possible values are linear, polynomial, radial, and sigmoid. Default is radial.
svm.gamma	SVM kernel parameter. A numeric vector whose values specify the gamma parameter in the SVM kernel. This parameter is needed for all kernel types except linear. Default is a sequence with minimum = 1e-5, maximum = 1e-1, and length = 20 that is equally spaced on the log-scale.
svm.cost	SVM cost parameter. A numeric vector whose values specify the cost of constraints violation in SVM. Default is a sequence with minimum = 0.5, maximum = 10, and length = 5 that is equally spaced on the log-scale.
ebma.n.draws	EBMA number of samples. An integer-valued scalar specifying the number of bootstrapped samples to be drawn from the EBMA fold and used for tuning EBMA. Default is 100.

ebma.tol	EBMA tolerance. A numeric vector containing the tolerance values for improvements in the log-likelihood before the EM algorithm stops optimization. Values should range at least from 0.01 to 0.001. Default is $c(0.01, 0.005, 0.001, 0.0005, 0.0001, 0.00005, 0.00001)$.
seed	Seed. Either NULL or an integer-valued scalar controlling random number generation. If NULL, then the seed is set to 546213978. Default is NULL.
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is FALSE.
uncertainty	Uncertainty estimates. A logical argument indicating whether uncertainty estimates should be computed. Default is FALSE.
boot.iter	Number of bootstrap iterations. An integer argument indicating the number of bootstrap iterations to be computed. Will be ignored unless <code>uncertainty = TRUE</code> . Default is 200 if <code>uncertainty = TRUE</code> and NULL if <code>uncertainty = FALSE</code> .

Value

The context-level predictions. A list with two elements. The first element, EBMA, contains the post-stratified ensemble bayesian model averaging (EBMA) predictions. The second element, classifiers, contains the post-stratified predictions from all estimated classifiers.

Examples

```
# Minimal example without machine learning
m <- auto_MrP(
  y = "YES",
  L1.x = c("L1.x1"),
  L2.x = c("L2.x1", "L2.x2"),
  L2.unit = "state",
  bin.proportion = "proportion",
  survey = taxes_survey,
  census = taxes_census,
  ebma.size = 0,
  cores = max_cores,
  best.subset = FALSE,
  lasso = FALSE,
  pca = FALSE,
  gb = FALSE,
  svm = FALSE,
  mrp = TRUE
)

# summarize and plot results
summary(m)
plot(m)

# MrP model only:
mrp_out <- auto_MrP(
  y = "YES",
  L1.x = c("L1.x1", "L1.x2", "L1.x3"),
  L2.x = c("L2.x1", "L2.x2", "L2.x3", "L2.x4", "L2.x5", "L2.x6"),
```

```
L2.unit = "state",
L2.reg = "region",
bin.proportion = "proportion",
survey = taxes_survey,
census = taxes_census,
ebma.size = 0,
best.subset = FALSE,
lasso = FALSE,
pca = FALSE,
gb = FALSE,
svm = FALSE,
mrp = TRUE
)

# Predictions through machine learning

# detect number of available cores
max_cores <- parallel::detectCores()

# autoMrP with machine learning
ml_out <- auto_MrP(
  y = "YES",
  L1.x = c("L1x1", "L1x2", "L1x3"),
  L2.x = c("L2.x1", "L2.x2", "L2.x3", "L2.x4", "L2.x5", "L2.x6"),
  L2.unit = "state",
  L2.reg = "region",
  bin.proportion = "proportion",
  survey = taxes_survey,
  census = taxes_census,
  gb.L2.reg = TRUE,
  svm.L2.reg = TRUE,
  cores = max_cores
)
```

best_subset_classifier

Best subset classifier

Description

best_subset_classifier applies best subset classification to a data set.

Usage

```
best_subset_classifier(
  model,
  data.train,
  model.family,
  model.optimizer,
```

```

  n.iter,
  verbose = c(TRUE, FALSE)
)
```

Arguments

model	Multilevel model. A model formula describing the multilevel model to be estimated on the basis of the provided training data.
data.train	Training data. A data.frame containing the training data used to train the model.
model.family	Model family. A variable indicating the model family to be used by glmer. Defaults to binomial(link = "probit").
model.optimizer	Optimization method. A character-valued scalar describing the optimization method to be used by glmer. Defaults to "bobyqa".
n.iter	Iterations. A integer-valued scalar specifying the maximum number of function evaluations tried by the optimization method.
verbose	Verbose output. A logical vector indicating whether or not verbose output should be printed.

Value

The multilevel model. An `glmer` object.

binary_cross_entropy *Estimates the inverse binary cross-entropy, i.e. 0 is the best score and 1 the worst.*

Description

binary_cross_entropy() estimates the inverse binary cross-entropy on the individual and state-level.

Usage

```

binary_cross_entropy(
  pred,
  data.valid,
  loss.unit = c("individuals", "L2 units"),
  y,
  L2.unit
)
```

Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (<code>individuals</code>) or geographic units (<code>L2 units</code>). Default is <code>individuals</code> .
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble containing two binary cross-entropy prediction errors. The first is measured at the level of individuals and the second is measured at the context level. The tibble dimensions are 2x3 with variables: `measure`, `value` and `level`.

boot_auto_mrp	<i>Bootstrapping wrapper for auto_mrp</i>
---------------	---

Description

`boot_auto_mrp` estimates uncertainty for `auto_mrp` via bootstrapping.

Usage

```
boot_auto_mrp(
  y,
  L1.x,
  L2.x,
  mrp.L2.x,
  L2.unit,
  L2.reg,
  L2.x.scale,
  pcs,
  folds,
  bin.proportion,
  bin.size,
  survey,
  census,
  ebma.size,
  k.folds,
  cv.sampling,
  loss.unit,
  loss.fun,
```

```

best.subset,
lasso,
pca,
gb,
svm,
mrp,
forward.select,
best.subset.L2.x,
lasso.L2.x,
pca.L2.x,
gb.L2.x,
svm.L2.x,
gb.L2.unit,
gb.L2.reg,
lasso.lambda,
lasso.n.iter,
gb.interaction.depth,
gb.shrinkage,
gb.n.trees.init,
gb.n.trees.increase,
gb.n.trees.max,
gb.n.minobsinnode,
svm.kernel,
svm.gamma,
svm.cost,
ebma.tol,
seed,
boot.iter,
cores
)

```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>mrp.L2.x</code>	MRP context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the MRP classifier. The character vector <i>empty</i> if no context-level variables should be used by the MRP classifier. If NULL and <code>mrp</code> is set to TRUE, then MRP uses the variables specified in <code>L2.x</code> . Default is NULL.
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.
L2.x.scale	Scale context-level covariates. A logical argument indicating whether the context-level covariates should be normalized. Default is TRUE. Note that if set to FALSE, then the context-level covariates should be normalized prior to calling auto_MrP().
pcs	Principal components. A character vector containing the column names of the principal components of the context-level variables in survey and census. Default is NULL.
fold	EBMA and cross-validation folds. A character scalar containing the column name of the variable in survey that specifies the fold to which an observation is allocated. The variable should contain integers running from 1 to $k + 1$, where k is the number of cross-validation folds. Value $k + 1$ refers to the EBMA fold. Default is NULL. <i>Note:</i> if fold is NULL, then ebma.size, k.fold, and cv.sampling must be specified.
bin.proportion	Proportion of ideal types. A character scalar containing the column name of the variable in census that indicates the proportion of individuals by ideal type and geographic unit. Default is NULL. <i>Note:</i> if bin.proportion is NULL, then bin.size must be specified.
bin.size	Bin size of ideal types. A character scalar containing the column name of the variable in census that indicates the bin size of ideal types by geographic unit. Default is NULL. <i>Note:</i> ignored if bin.proportion is provided, but must be specified otherwise.
survey	Survey data. A data.frame whose column names include y, L1.x, L2.x, L2.unit, and, if specified, L2.reg, pcs, and fold.
census	Census data. A data.frame whose column names include L1.x, L2.x, L2.unit, if specified, L2.reg and pcs, and either bin.proportion or bin.size.
ebma.size	EBMA fold size. A number in the open unit interval indicating the proportion of respondents to be allocated to the EBMA fold. Default is 1/3. <i>Note:</i> ignored if fold is provided, but must be specified otherwise.
k.fold	Number of cross-validation folds. An integer-valued scalar indicating the number of folds to be used in cross-validation. Default is 5. <i>Note:</i> ignored if fold is provided, but must be specified otherwise.
cv.sampling	Cross-validation sampling method. A character-valued scalar indicating whether cross-validation folds should be created by sampling individual respondents (individuals) or geographic units (L2 units). Default is L2 units. <i>Note:</i> ignored if fold is provided, but must be specified otherwise.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.

loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is c("MSE", "cross-entropy", "msfe", "f1"). With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
best.subset	Best subset classifier. A logical argument indicating whether the best subset classifier should be used for predicting outcome y. Default is TRUE.
lasso	Lasso classifier. A logical argument indicating whether the lasso classifier should be used for predicting outcome y. Default is TRUE.
pca	PCA classifier. A logical argument indicating whether the PCA classifier should be used for predicting outcome y. Default is TRUE.
gb	GB classifier. A logical argument indicating whether the GB classifier should be used for predicting outcome y. Default is TRUE.
svm	SVM classifier. A logical argument indicating whether the SVM classifier should be used for predicting outcome y. Default is TRUE.
mrp	MRP classifier. A logical argument indicating whether the standard MRP classifier should be used for predicting outcome y. Default is FALSE.
forward.select	Forward selection classifier. A logical argument indicating whether to use forward selection rather than best subset selection. Default is FALSE. <i>Note:</i> forward selection is recommended if there are more than 8 context-level variables. <i>Note:</i> forward selection is not implemented yet.
best.subset.L2.x	Best subset context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the best subset classifier. If NULL and best.subset is set to TRUE, then best subset uses the variables specified in L2.x. Default is NULL.
lasso.L2.x	Lasso context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the lasso classifier. If NULL and lasso is set to TRUE, then lasso uses the variables specified in L2.x. Default is NULL.
pca.L2.x	PCA context-level covariates. A character vector containing the column names of the context-level variables in survey and census whose principal components are to be used by the PCA classifier. If NULL and pca is set to TRUE, then PCA uses the principal components of the variables specified in L2.x. Default is NULL.
gb.L2.x	GB context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the GB classifier. If NULL and gb is set to TRUE, then GB uses the variables specified in L2.x. Default is NULL.
svm.L2.x	SVM context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the SVM classifier. If NULL and svm is set to TRUE, then SVM uses the variables specified in L2.x. Default is NULL.

gb.L2.unit	GB L2.unit. A logical argument indicating whether L2.unit should be included in the GB classifier. Default is FALSE.
gb.L2.reg	GB L2.reg. A logical argument indicating whether L2.reg should be included in the GB classifier. Default is FALSE.
lasso.lambda	Lasso penalty parameter. A numeric vector of non-negative values. The penalty parameter controls the shrinkage of the context-level variables in the lasso model. Default is a sequence with minimum 0.1 and maximum 250 that is equally spaced on the log-scale. The number of values is controlled by the lasso.n.iter parameter.
lasso.n.iter	Lasso number of lambda values. An integer-valued scalar specifying the number of lambda values to search over. Default is 100. <i>Note:</i> Is ignored if a vector of lasso.lambda values is provided.
gb.interaction.depth	GB interaction depth. An integer-valued vector whose values specify the interaction depth of GB. The interaction depth defines the maximum depth of each tree grown (i.e., the maximum level of variable interactions). Default is c(1, 2, 3).
gb.shrinkage	GB learning rate. A numeric vector whose values specify the learning rate or step-size reduction of GB. Values between 0.001 and 0.1 usually work, but a smaller learning rate typically requires more trees. Default is c(0.04, 0.01, 0.008, 0.005, 0.001).
gb.n.trees.init	GB initial total number of trees. An integer-valued scalar specifying the initial number of total trees to fit by GB. Default is 50.
gb.n.trees.increase	GB increase in total number of trees. An integer-valued scalar specifying by how many trees the total number of trees to fit should be increased (until gb.n.trees.max is reached). Default is 50.
gb.n.trees.max	GB maximum number of trees. An integer-valued scalar specifying the maximum number of trees to fit by GB. Default is 1000.
gb.n.minobsinnode	GB minimum number of observations in the terminal nodes. An integer-valued scalar specifying the minimum number of observations that each terminal node of the trees must contain. Default is 20.
svm.kernel	SVM kernel. A character-valued scalar specifying the kernel to be used by SVM. The possible values are linear, polynomial, radial, and sigmoid. Default is radial.
svm.gamma	SVM kernel parameter. A numeric vector whose values specify the gamma parameter in the SVM kernel. This parameter is needed for all kernel types except linear. Default is a sequence with minimum = 1e-5, maximum = 1e-1, and length = 20 that is equally spaced on the log-scale.
svm.cost	SVM cost parameter. A numeric vector whose values specify the cost of constraints violation in SVM. Default is a sequence with minimum = 0.5, maximum = 10, and length = 5 that is equally spaced on the log-scale.
ebma.tol	EBMA tolerance. A numeric vector containing the tolerance values for improvements in the log-likelihood before the EM algorithm stops optimization. Values should range at least from 0.01 to 0.001. Default is c(0.01, 0.005, 0.001, 0.0005, 0.0001, 0.00005, 0.00001).

seed	Seed. Either NULL or an integer-valued scalar controlling random number generation. If NULL, then the seed is set to 546213978. Default is NULL.
boot.iter	Number of bootstrap iterations. An integer argument indicating the number of bootstrap iterations to be computed. Will be ignored unless uncertainty = TRUE. Default is 200 if uncertainty = TRUE and NULL if uncertainty = FALSE.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

census	<i>Quasi census data.</i>
--------	---------------------------

Description

The census file is generated from the full 2008 Cooperative Congressional Election Studies item cc418_1 by disaggregating the 64 ideal type combinations of the individual level variables L1x1, L2x2 and L1x3. A row is an ideal type in a given state.

Usage

```
census
```

Format

A data frame with 2934 rows and 13 variables:

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L1x1 Age group (four categories)

L1x2 Education level (four categories)

L1x3 Gender-race combination (six categories)

proportion State-level proportion of respondents of that ideal type in the population

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

cv_folding	<i>Generates folds for cross-validation</i>
------------	---

Description

cv_folding creates folds used in classifier training within the survey data.

Usage

```
cv_folding(data, L2.unit, k.folds, cv.sampling = c("individuals", "L2 units"))
```

Arguments

data	The survey data; must be a tibble.
L2.unit	The column name of the factor variable identifying the context-level unit
k.folds	An integer value indicating the number of folds to be generated.
cv.sampling	Cross-validation sampling method. A character-valued scalar indicating whether cross-validation folds should be created by sampling individual respondents (individuals) or geographic units (L2 units). Default is L2 units. <i>Note:</i> ignored if folds is provided, but must be specified otherwise.

Value

Returns a list with length specified by k.folds argument. Each element is a tibble with a fold used in k-fold cross-validation.

ebma	<i>Bayesian Ensemble Model Averaging EBMA</i>
------	---

Description

ebma tunes EBMA and generates weights for classifier averaging.

Usage

```
ebma(  
  ebma.fold,  
  y,  
  L1.x,  
  L2.x,  
  L2.unit,  
  L2.reg,  
  pc.names,  
  post.strat,  
  n.draws,
```

```

    tol,
    best.subset.opt,
    pca.opt,
    lasso.opt,
    gb.opt,
    svm.opt,
    verbose,
    cores
  )

```

Arguments

<code>ebma.fold</code>	New data for EBMA tuning. A list containing the the data that must not have been used in classifier training.
<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>pc.names</code>	Principal Component Variable names. A character vector containing the names of the context-level principal components variables.
<code>post.strat</code>	Post-stratification results. A list containing the best models for each of the tuned classifiers, the individual level predictions on the data classifier trainig data and the post-stratified context-level predictions.
<code>n.draws</code>	EBMA number of samples. An integer-valued scalar specifying the number of bootstrapped samples to be drawn from the EBMA fold and used for tuning EBMA. Default is 100. Passed on from <code>ebma.n.draws</code> .
<code>tol</code>	EBMA tolerance. A numeric vector containing the tolerance values for improvements in the log-likelihood before the EM algorithm stops optimization. Values should range at least from 0.01 to 0.001. Default is <code>c(0.01, 0.005, 0.001, 0.0005, 0.0001, 0.00005, 0.00001)</code> . Passed on from <code>ebma.tol</code> .
<code>best.subset.opt</code>	Tuned best subset parameters. A list returned from <code>run_best_subset()</code> .
<code>pca.opt</code>	Tuned best subset with principal components parameters. A list returned from <code>run_pca()</code> .
<code>lasso.opt</code>	Tuned lasso parameters. A list returned from <code>run_lasso()</code> .
<code>gb.opt</code>	Tuned gradient tree boosting parameters. A list returned from <code>run_gb()</code> .

svm.opt	Tuned support vector machine parameters. A list returned from run_svm().
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is FALSE.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

ebma_folding *Generates data fold to be used for EBMA tuning*

Description

#' ebma_folding() generates a data fold that will not be used in classifier tuning. It is data that is needed to determine the optimal tolerance for EBMA.

Usage

```
ebma_folding(data, L2.unit, ebma.size)
```

Arguments

data	The full survey data. A tibble.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
ebma.size	EBMA fold size. A number in the open unit interval indicating the proportion of respondents to be allocated to the EBMA fold. Default is 1/3.

Value

Returns a list with two elements which are both tibble. List element one is named ebma_fold and contains the tibble used in Ensemble Bayesian Model Averaging Tuning. List element two is named cv_data and contains the tibble used for classifier tuning.

ebma_mc_draws *EBMA multicore tuning - parallelises over draws.*

Description

ebma_mc_draws is called from within ebma. It tunes using multiple cores.

Usage

```

ebma_mc_draws(
  train.preds,
  train.y,
  ebma.fold,
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  pc.names,
  model.bs,
  model.pca,
  model.lasso,
  model.gb,
  model.svm,
  model.mrp,
  tol,
  n.draws,
  cores
)

```

Arguments

<code>train.preds</code>	Predictions of classifiers on the classifier training data. A tibble.
<code>train.y</code>	Outcome variable of the classifier training data. A numeric vector.
<code>ebma.fold</code>	New data for EBMA tuning. A list containing the the data that must not have been used in classifier training.
<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>pc.names</code>	Principal Component Variable names. A character vector containing the names of the context-level principal components variables.
<code>model.bs</code>	The tuned model from the multilevel regression with best subset selection classifier. An <code>glmer</code> object.

model.pca	The tuned model from the multilevel regression with principal components as context-level predictors classifier. An <code>glmer</code> object.
model.lasso	The tuned model from the multilevel regression with L1 regularization classifier. A <code>glmLasso</code> object.
model.gb	The tuned model from the gradient boosting classifier. A <code>gbm</code> object.
model.svm	The tuned model from the support vector machine classifier. An <code>svm</code> object.
model.mrp	The standard MrP model. An <code>glmer</code> object
tol	EBMA tolerance. A numeric vector containing the tolerance values for improvements in the log-likelihood before the EM algorithm stops optimization. Values should range at least from 0.01 to 0.001. Default is <code>c(0.01, 0.005, 0.001, 0.0005, 0.0001, 0.00005, 0.00001)</code> . Passed on from <code>ebma.tol</code> .
n.draws	EBMA number of samples. An integer-valued scalar specifying the number of bootstrapped samples to be drawn from the EBMA fold and used for tuning EBMA. Default is 100. Passed on from <code>ebma.n.draws</code> .
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

The classifier weights. A numeric vector.

ebma_mc_tol *EBMA multicore tuning - parallelises over tolerance values.*

Description

ebma_mc_tol is called from within ebma. It tunes using multiple cores.

Usage

```
ebma_mc_tol(
  train.preds,
  train.y,
  ebma.fold,
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  pc.names,
  model.bs,
  model.pca,
  model.lasso,
  model.gb,
  model.svm,
```

```

  model.mrp,
  tol,
  n.draws,
  cores
)

```

Arguments

<code>train.preds</code>	Predictions of classifiers on the classifier training data. A tibble.
<code>train.y</code>	Outcome variable of the classifier training data. A numeric vector.
<code>ebma.fold</code>	The data used for EBMA tuning. A tibble.
<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>pc.names</code>	Principal Component Variable names. A character vector containing the names of the context-level principal components variables.
<code>model.bs</code>	The tuned model from the multilevel regression with best subset selection classifier. An <code>glmer</code> object.
<code>model.pca</code>	The tuned model from the multilevel regression with principal components as context-level predictors classifier. An <code>glmer</code> object.
<code>model.lasso</code>	The tuned model from the multilevel regression with L1 regularization classifier. A <code>glmLasso</code> object.
<code>model.gb</code>	The tuned model from the gradient boosting classifier. A <code>gbm</code> object.
<code>model.svm</code>	The tuned model from the support vector machine classifier. An <code>svm</code> object.
<code>model.mrp</code>	The standard MrP model. An <code>glmer</code> object
<code>tol</code>	The tolerance values used for EBMA. A numeric vector.
<code>n.draws</code>	EBMA number of samples. An integer-valued scalar specifying the number of bootstrapped samples to be drawn from the EBMA fold and used for tuning EBMA. Default is 100. Passed on from <code>ebma.n.draws</code> .
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

The classifier weights. A numeric vector.

Examples

```
## Not run:  
# not yet  
  
## End(Not run)
```

error_checks

Catches user input errors

Description

error_checks() checks for incorrect data entry in autoMrP() call.

Usage

```
error_checks(  
  y,  
  L1.x,  
  L2.x,  
  L2.unit,  
  L2.reg,  
  L2.x.scale,  
  pcs,  
  folds,  
  bin.proportion,  
  bin.size,  
  survey,  
  census,  
  ebma.size,  
  k.folds,  
  cv.sampling,  
  loss.unit,  
  loss.fun,  
  best.subset,  
  lasso,  
  pca,  
  gb,  
  svm,  
  mrp,  
  forward.select,  
  best.subset.L2.x,  
  lasso.L2.x,  
  gb.L2.x,  
  svm.L2.x,  
  mrp.L2.x,  
  gb.L2.unit,  
  gb.L2.reg,
```

```

    lasso.lambda,
    lasso.n.iter,
    uncertainty,
    boot.iter,
    seed
  )

```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>L2.x.scale</code>	Scale context-level covariates. A logical argument indicating whether the context-level covariates should be normalized. Default is <code>TRUE</code> . Note that if set to <code>FALSE</code> , then the context-level covariates should be normalized prior to calling <code>auto_MrP()</code> .
<code>pcs</code>	Principal components. A character vector containing the column names of the principal components of the context-level variables in survey and census. Default is <code>NULL</code> .
<code>folds</code>	EBMA and cross-validation folds. A character scalar containing the column name of the variable in survey that specifies the fold to which an observation is allocated. The variable should contain integers running from 1 to $k + 1$, where k is the number of cross-validation folds. Value $k + 1$ refers to the EBMA fold. Default is <code>NULL</code> . <i>Note:</i> if <code>folds</code> is <code>NULL</code> , then <code>ebma.size</code> , <code>k.folds</code> , and <code>cv.sampling</code> must be specified.
<code>bin.proportion</code>	Proportion of ideal types. A character scalar containing the column name of the variable in census that indicates the proportion of individuals by ideal type and geographic unit. Default is <code>NULL</code> . <i>Note:</i> if <code>bin.proportion</code> is <code>NULL</code> , then <code>bin.size</code> must be specified.
<code>bin.size</code>	Bin size of ideal types. A character scalar containing the column name of the variable in census that indicates the bin size of ideal types by geographic unit. Default is <code>NULL</code> . <i>Note:</i> ignored if <code>bin.proportion</code> is provided, but must be specified otherwise.
<code>survey</code>	Survey data. A data frame whose column names include <code>y</code> , <code>L1.x</code> , <code>L2.x</code> , <code>L2.unit</code> , and, if specified, <code>L2.reg</code> , <code>pcs</code> , and <code>folds</code> .

census	Census data. A data.frame whose column names include L1.x, L2.x, L2.unit, if specified, L2.reg and pcs, and either bin.proportion or bin.size.
ebma.size	EBMA fold size. A number in the open unit interval indicating the proportion of respondents to be allocated to the EBMA fold. Default is 1/3. <i>Note:</i> ignored if folds is provided, but must be specified otherwise.
k.folds	Number of cross-validation folds. An integer-valued scalar indicating the number of folds to be used in cross-validation. Default is 5. <i>Note:</i> ignored if folds is provided, but must be specified otherwise.
cv.sampling	Cross-validation sampling method. A character-valued scalar indicating whether cross-validation folds should be created by sampling individual respondents (individuals) or geographic units (L2 units). Default is L2 units. <i>Note:</i> ignored if folds is provided, but must be specified otherwise.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is c("MSE", "cross-entropy", "msfe", "f1"). With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
best.subset	Best subset classifier. A logical argument indicating whether the best subset classifier should be used for predicting outcome y. Default is TRUE.
lasso	Lasso classifier. A logical argument indicating whether the lasso classifier should be used for predicting outcome y. Default is TRUE.
pca	PCA classifier. A logical argument indicating whether the PCA classifier should be used for predicting outcome y. Default is TRUE.
gb	GB classifier. A logical argument indicating whether the GB classifier should be used for predicting outcome y. Default is TRUE.
svm	SVM classifier. A logical argument indicating whether the SVM classifier should be used for predicting outcome y. Default is TRUE.
mrp	MRP classifier. A logical argument indicating whether the standard MRP classifier should be used for predicting outcome y. Default is FALSE.
forward.select	Forward selection classifier. A logical argument indicating whether to use forward selection rather than best subset selection. Default is FALSE. <i>Note:</i> forward selection is recommended if there are more than 8 context-level variables. <i>Note:</i> forward selection is not implemented yet.
best.subset.L2.x	Best subset context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the best subset classifier. If NULL and best.subset is set to TRUE, then best subset uses the variables specified in L2.x. Default is NULL.

<code>lasso.L2.x</code>	Lasso context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the lasso classifier. If NULL and <code>lasso</code> is set to TRUE, then lasso uses the variables specified in <code>L2.x</code> . Default is NULL.
<code>gb.L2.x</code>	GB context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the GB classifier. If NULL and <code>gb</code> is set to TRUE, then GB uses the variables specified in <code>L2.x</code> . Default is NULL.
<code>svm.L2.x</code>	SVM context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the SVM classifier. If NULL and <code>svm</code> is set to TRUE, then SVM uses the variables specified in <code>L2.x</code> . Default is NULL.
<code>mrp.L2.x</code>	MRP context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the MRP classifier. The character vector <i>empty</i> if no context-level variables should be used by the MRP classifier. If NULL and <code>mrp</code> is set to TRUE, then MRP uses the variables specified in <code>L2.x</code> . Default is NULL.
<code>gb.L2.unit</code>	GB <code>L2.unit</code> . A logical argument indicating whether <code>L2.unit</code> should be included in the GB classifier. Default is FALSE.
<code>gb.L2.reg</code>	GB <code>L2.reg</code> . A logical argument indicating whether <code>L2.reg</code> should be included in the GB classifier. Default is FALSE.
<code>lasso.lambda</code>	Lasso penalty parameter. A numeric vector of non-negative values. The penalty parameter controls the shrinkage of the context-level variables in the lasso model. Default is a sequence with minimum 0.1 and maximum 250 that is equally spaced on the log-scale. The number of values is controlled by the <code>lasso.n.iter</code> parameter.
<code>lasso.n.iter</code>	Lasso number of lambda values. An integer-valued scalar specifying the number of lambda values to search over. Default is 100. <i>Note:</i> Is ignored if a vector of <code>lasso.lambda</code> values is provided.
<code>uncertainty</code>	Uncertainty estimates. A logical argument indicating whether uncertainty estimates should be computed. Default is FALSE.
<code>boot.iter</code>	Number of bootstrap iterations. An integer argument indicating the number of bootstrap iterations to be computed. Will be ignored unless <code>uncertainty = TRUE</code> . Default is 200 if <code>uncertainty = TRUE</code> and NULL if <code>uncertainty = FALSE</code> .
<code>seed</code>	Seed. Either NULL or an integer-valued scalar controlling random number generation. If NULL, then the seed is set to 546213978. Default is NULL.

Value

No return value, called for detection of errors in `autoMrP()` call.

f1_score	<i>Estimates the inverse f1 score, i.e. 0 is the best score and 1 the worst.</i>
----------	--

Description

f1_score() estimates the inverse f1 scores on the individual and state levels.

Usage

```
f1_score(pred, data.valid, y, L2.unit)
```

Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble containing two f1 prediction errors. The first is measured at the level of individuals and the second is measured at the context level. The tibble dimensions are 2x3 with variables: measure, value and level.

gb_classifier	<i>GB classifier</i>
---------------	----------------------

Description

gb_classifier applies gradient boosting classification to a data set.

Usage

```
gb_classifier(
  form,
  distribution,
  data.train,
  n.trees,
  interaction.depth,
  n.minobsinnode,
  shrinkage,
  verbose = c(TRUE, FALSE)
)
```

Arguments

form	Model formula. A two-sided linear formula describing the model to be fit, with the outcome on the LHS and the covariates separated by + operators on the RHS.
distribution	Model distribution. A character string specifying the name of the distribution to be used.
data.train	Training data. A data.frame containing the training data used to train the model.
n.trees	Total number of trees. An integer-valued scalar specifying the total number of trees to be fit.
interaction.depth	Interaction depth. An integer-valued scalar specifying the maximum depth of each tree.
n.minobsinnode	Minimum number of observations in terminal nodes. An integer-valued scalar specifying the minimum number of observations in the terminal nodes of the trees.
shrinkage	Learning rate. A numeric scalar specifying the shrinkage or learning rate applied to each tree in the expansion.
verbose	Verbose output. A logical vector indicating whether or not verbose output should be printed.

Value

A gradient tree boosting model. A [gbm](#) object.

gb_classifier_update *GB classifier update*

Description

gb_classifier_update() grows additional trees in gradient tree boosting ensemble.

Usage

```
gb_classifier_update(object, n.new.trees, verbose = c(TRUE, FALSE))
```

Arguments

object	Gradient tree boosting output. A gbm object.
n.new.trees	Number of additional trees to grow. A numeric scalar.
verbose	Verbose output. A logical vector indicating whether or not verbose output should be printed.

Value

An updated gradient tree boosting model. A [gbm.more](#) object.

lasso_classifier	<i>Lasso classifier</i>
------------------	-------------------------

Description

`lasso_classifier` applies lasso classification to a data set.

Usage

```
lasso_classifier(  
  L2.fix,  
  L1.re,  
  data.train,  
  lambda,  
  model.family,  
  verbose = c(TRUE, FALSE)  
)
```

Arguments

<code>L2.fix</code>	Fixed effects. A two-sided linear formula describing the fixed effects part of the model, with the outcome on the LHS and the fixed effects separated by + operators on the RHS.
<code>L1.re</code>	Random effects. A named list object, with the random effects providing the names of the list elements and ~ 1 being the list elements.
<code>data.train</code>	Training data. A data.frame containing the training data used to train the model.
<code>lambda</code>	Tuning parameter. Lambda is the penalty parameter that controls the shrinkage of fixed effects.
<code>model.family</code>	Model family. A variable indicating the model family to be used by <code>glmmLasso</code> . Defaults to <code>binomial(link = "probit")</code> .
<code>verbose</code>	Verbose output. A logical vector indicating whether or not verbose output should be printed.

Value

A multilevel lasso model. An `glmmLasso` object.

log_spaced	<i>A sequence of values with equal spacing on the log-scale.</i>
------------	--

Description

A sequence of values with equal spacing on the log-scale.

Usage

```
log_spaced(min, max, n)
```

Arguments

min	The minimum value of the sequence. A positive numeric scalar (min > 0).
max	The maximum value of the sequence. a positive numeric scalar (max > 0).
n	The length of the sequence. An integer valued scalar.

Value

Returns a numeric vector with length specified in argument n. The vector elements are equally spaced on the log-scale.

loss_function	<i>Estimates loss value.</i>
---------------	------------------------------

Description

loss_function() estimates the loss based on a loss function.

Usage

```
loss_function(
  pred,
  data.valid,
  loss.unit = c("individuals", "L2 units"),
  loss.fun = c("MSE", "MAE", "cross-entropy"),
  y,
  L2.unit
)
```


Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals) or geographic units (L2 units). Default is individuals.
loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE) or the mean absolute error (MAE). Default is MSE.
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble with number of rows equal to the number of loss functions tested (defaults to 4 for cross-entropy, f1, MSE, and msfe). The number of columns is 2 where the first is called measure and contains the names of the loss-functions and the second is called value and contains the loss-function scores.

loss_score_ranking	<i>Ranks tuning parameters according to loss functions</i>
--------------------	--

Description

loss_score_ranking() ranks tuning parameters according to the scores received in multiple loss functions.

Usage

```
loss_score_ranking(score, loss.fun)
```

Arguments

score	A data set containing loss function names, the loss function values, and the tuning parameter values.
loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE) or the mean absolute error (MAE). Default is MSE.

Value

Returns a tibble containing the parameter grid as well as a rank column that corresponds to the cross-validation rank of a parameter combination across all loss function scores.

mean_absolute_error *Estimates the mean absolute prediction error.*

Description

mean_absolute_error() estimates the mean absolute error for the desired loss unit.

Usage

```
mean_absolute_error(pred, data.valid, y, L2.unit)
```

Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble containing two mean absolute prediction errors. The first is measured at the level of individuals and the second is measured at the context level. The tibble dimensions are 2x3 with variables: measure, value and level.

mean_squared_error *Estimates the mean squared prediction error.*

Description

mean_squared_error() estimates the mean squared error for the desired loss unit.

Usage

```
mean_squared_error(pred, data.valid, y, L2.unit)
```

Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble containing two mean squared prediction errors. The first is measured at the level of individuals and the second is measured at the context level. The tibble dimensions are 2x3 with variables: measure, value and level.

mean_squared_false_error

Estimates the mean squared false error.

Description

msfe() estimates the inverse f1 scores on the individual and state levels.

Usage

```
mean_squared_false_error(pred, data.valid, y, L2.unit)
```

Arguments

pred	Predictions of outcome. A numeric vector of outcome predictions.
data.valid	Test data set. A tibble of data that was not used for prediction.
y	Outcome variable. A character vector containing the column names of the outcome variable.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.

Value

Returns a tibble containing two mean squared false prediction errors. The first is measured at the level of individuals and the second is measured at the context level. The tibble dimensions are 2x3 with variables: measure, value and level.

model_list

A list of models for the best subset selection.

Description

model_list() generates an exhaustive list of lme4 model formulas from the individual level and context level variables as well as geographic unit variables to be iterated over in best subset selection.

Usage

```
model_list(y, L1.x, L2.x, L2.unit, L2.reg = NULL)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .

Value

Returns a list with the number of elements equal to 2^k where k is the number context-level variables. Each element is of class `formula`.

<code>model_list_pca</code>	<i>A list of models for the best subset selection with PCA.</i>
-----------------------------	---

Description

`model_list_pca()` generates an exhaustive list of `lme4` model formulas from the individual level and context level principal components as well as geographic unit variables to be iterated over in best subset selection with principal components.

Usage

```
model_list_pca(y, L1.x, L2.x, L2.unit, L2.reg = NULL)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .

Value

Returns a list with the number of elements $k+1$ where k is the number of context-level variables. Each element is of class formula. The first element is a model with context-level variables and the following models iteratively add the principal components as context-level variables.

multicore	<i>Register cores for multicore computing</i>
-----------	---

Description

multicore() registers cores for parallel processing.

Usage

```
multicore(cores = 1, type, cl = NULL)
```

Arguments

cores	Number of cores to be used. An integer. Default is 1.
type	Whether to start or end parallel processing. A character string. The possible values are open, close.
cl	The registered cluster. Default is NULL

Value

No return value, called to register or un-register clusters for parallel processing.

output_table	<i>A table for the summary function</i>
--------------	---

Description

output_table() ...

Usage

```
output_table(object, col.names, format, digits)
```

Arguments

object	An autoMrP() object for which a summary is desired.
col.names	The column names of the table. A
format	The table format. A character string passed to kable . Default is simple.
digits	The number of digits to be displayed. An integer scalar. Default is 4.

Value

No return value, prints a table to the console.

plot.autoMrP	<i>A plot method for autoMrP objects. Plots unit-level preference estimates.</i>
--------------	--

Description

plot.autoMrP() plots unit-level preference estimates and error bars.

Usage

```
## S3 method for class 'autoMrP'
plot(x, algorithm = "ebma", ci.lvl = 0.95, ...)
```

Arguments

x	An autoMrP() object.
algorithm	The algorithm/classifier for which preference estimates are desired. A character-valued scalar indicating either ebma or the classifier to be used. Allowed choices are: "ebma", "best_subset", "lasso", "pca", "gb", "svm", and "mrp". Default is ebma.
ci.lvl	The level of the confidence intervals. A proportion. Default is 0.95. Confidence intervals are based on bootstrapped estimates and will not be printed if bootstrapping was not carried out.
...	Additional arguments affecting the summary produced.

post_stratification	<i>Apply post-stratification to classifiers.</i>
---------------------	--

Description

Apply post-stratification to classifiers.

Usage

```
post_stratification(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  best_subset.opt,
```

```

    lasso.opt,
    lasso.L2.x,
    pca.opt,
    gb.opt,
    svm.opt,
    svm.L2.reg,
    svm.L2.unit,
    svm.L2.x,
    mrp.include,
    n.minobsinnode,
    L2.unit.include,
    L2.reg.include,
    kernel,
    mrp.L2.x,
    data,
    ebma.fold,
    census,
    verbose
)

```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>best.subset.opt</code>	Optimal tuning parameters from best subset selection classifier. A list returned by <code>run_best_subset()</code> .
<code>lasso.opt</code>	Optimal tuning parameters from lasso classifier A list returned by <code>run_lasso()</code> .
<code>lasso.L2.x</code>	Lasso context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the lasso classifier. If <code>NULL</code> and <code>lasso</code> is set to <code>TRUE</code> , then lasso uses the variables specified in <code>L2.x</code> . Default is <code>NULL</code> .
<code>pca.opt</code>	Optimal tuning parameters from best subset selection with principal components classifier A list returned by <code>run_pca()</code> .
<code>gb.opt</code>	Optimal tuning parameters from gradient tree boosting classifier A list returned by <code>run_gb()</code> .

svm.opt	Optimal tuning parameters from support vector machine classifier A list returned by run_svm().
svm.L2.reg	SVM L2.reg. A logical argument indicating whether L2.reg should be included in the SVM classifier. Default is FALSE.
svm.L2.unit	SVM L2.unit. A logical argument indicating whether L2.unit should be included in the SVM classifier. Default is FALSE.
svm.L2.x	SVM context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the SVM classifier. If NULL and svm is set to TRUE, then SVM uses the variables specified in L2.x. Default is NULL.
mrp.include	Whether to run MRP classifier. A logical argument indicating whether the standard MRP classifier should be used for predicting outcome y. Passed from autoMrP() argument mrp.
n.minobsinnode	GB minimum number of observations in the terminal nodes. An integer-valued scalar specifying the minimum number of observations that each terminal node of the trees must contain. Passed from autoMrP() argument gb.n.minobsinnode.
L2.unit.include	GB L2.unit. A logical argument indicating whether L2.unit should be included in the GB classifier. Passed from autoMrP() argument gb.L2.unit.
L2.reg.include	A logical argument indicating whether L2.reg should be included in the GB classifier. Passed from autoMrP() argument GB L2.reg.
kernel	SVM kernel. A character-valued scalar specifying the kernel to be used by SVM. The possible values are linear, polynomial, radial, and sigmoid. Passed from autoMrP() argument svm.kernel.
mrp.L2.x	MRP context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the MRP classifier. The character vector <i>empty</i> if no context-level variables should be used by the MRP classifier. If NULL and mrp is set to TRUE, then MRP uses the variables specified in L2.x. Default is NULL.
data	A data.frame containing the survey data used in classifier training.
ebma.fold	A data.frame containing the data not used in classifier training.
census	Census data. A data.frame whose column names include L1.x, L2.x, L2.unit, if specified, L2.reg and pcs, and either bin.proportion or bin.size.
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is FALSE.

predict_glmLasso *Predicts on newdata from glmLasso objects*

Description

glmLasso() predicts on newdata objects from a glmLasso object.

Usage

```
predict_glmLasso(census, m, L1.x, lasso.L2.x, L2.unit, L2.reg)
```

Arguments

census	Census data. A data.frame whose column names include L1.x, L2.x, L2.unit, if specified, L2.reg and pcs, and either bin.proportion or bin.size.
m	A glmLasso() object.
L1.x	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome y. Note that geographic unit is specified in argument L2.unit.
lasso.L2.x	Lasso context-level covariates. A character vector containing the column names of the context-level variables in survey and census to be used by the lasso classifier. If NULL and lasso is set to TRUE, then lasso uses the variables specified in L2.x. Default is NULL.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.

Value

Returns a numeric vector of predictions from a glmLasso() object.

quiet	<i>Suppress cat in external package</i>
-------	---

Description

quiet() suppresses cat output.

Usage

```
quiet(x)
```

Arguments

x	Input. It can be any kind.
---	----------------------------

Value

No return value, called to suppress cat output to the console.

run_best_subset	<i>Apply best subset classifier to MrP.</i>
-----------------	---

Description

run_best_subset is a wrapper function that applies the best subset classifier to a list of models provided by the user, evaluates the models' prediction performance, and chooses the best-performing model.

Usage

```
run_best_subset(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  loss.unit,
  loss.fun,
  data,
  verbose,
  cores
)
```

Arguments

y	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
L1.x	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome y. Note that geographic unit is specified in argument L2.unit.
L2.x	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome y.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.

loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is c("MSE", "cross-entropy", "msfe", "f1"). With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
data	Data for cross-validation. A list of k data.frames, one for each fold to be used in k -fold cross-validation.
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is FALSE.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

A model formula of the winning best subset classifier model.

run_best_subset_mc *Best subset multicore tuning.*

Description

run_best_subset_mc is called from within run_best_subset. It tunes using multiple cores.

Usage

```
run_best_subset_mc(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  loss.unit,
  loss.fun,
  data,
  cores,
  models,
  verbose
)
```

Arguments

y Outcome variable. A character scalar containing the column name of the outcome variable in survey.

L1.x	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome y . Note that geographic unit is specified in argument L2.unit.
L2.x	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome y .
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals) or geographic units (L2 units). Default is individuals.
loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE) or the mean absolute error (MAE). Default is MSE.
data	Data for cross-validation. A list of k data.frames, one for each fold to be used in k -fold cross-validation.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.
models	The models to perform best subset selection on. A list of model formulas.
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is TRUE.

Value

The cross-validation errors for all models. A list.

Examples

```
## Not run:
# not yet

## End(Not run)
```

run_gb

Apply gradient boosting classifier to MrP.

Description

run_gb is a wrapper function that applies the gradient boosting classifier to data provided by the user, evaluates prediction performance, and chooses the best-performing model.

Usage

```
run_gb(
  y,
  L1.x,
  L2.x,
  L2.eval.unit,
  L2.unit,
  L2.reg,
  loss.unit,
  loss.fun,
  interaction.depth,
  shrinkage,
  n.trees.init,
  n.trees.increase,
  n.trees.max,
  cores = cores,
  n.minobsinnode,
  data,
  verbose
)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.eval.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>loss.unit</code>	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (<code>individuals</code>), geographic units (<code>L2 units</code>) or at both levels. Default is <code>c("individuals", "L2 units")</code> . With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error

(MAE), binary cross-entropy (`cross-entropy`), mean squared false error (`msfe`), the f1 score (`f1`), or a combination thereof. Default is `c("MSE", "cross-entropy", "msfe", "f1")`. With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.

<code>interaction.depth</code>	GB interaction depth. An integer-valued vector whose values specify the interaction depth of GB. The interaction depth defines the maximum depth of each tree grown (i.e., the maximum level of variable interactions). Default is <code>c(1, 2, 3)</code> .
<code>shrinkage</code>	GB learning rate. A numeric vector whose values specify the learning rate or step-size reduction of GB. Values between 0.001 and 0.1 usually work, but a smaller learning rate typically requires more trees. Default is <code>c(0.04, 0.01, 0.008, 0.005, 0.001)</code> .
<code>n.trees.init</code>	GB initial total number of trees. An integer-valued scalar specifying the initial number of total trees to fit by GB. Default is 50.
<code>n.trees.increase</code>	GB increase in total number of trees. An integer-valued scalar specifying by how many trees the total number of trees to fit should be increased (until <code>n.trees.max</code> is reached) or an integer-valued vector of length <code>length(shrinkage)</code> with each of its values being associated with a learning rate in <code>shrinkage</code> . Default is 50.
<code>n.trees.max</code>	GB maximum number of trees. An integer-valued scalar specifying the maximum number of trees to fit by GB or an integer-valued vector of length <code>length(shrinkage)</code> with each of its values being associated with a learning rate and an increase in the total number of trees. Default is 1000.
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.
<code>n.minobsinnode</code>	GB minimum number of observations in the terminal nodes. An integer-valued scalar specifying the minimum number of observations that each terminal node of the trees must contain. Default is 5.
<code>data</code>	Data for cross-validation. A list of k <code>data.frames</code> , one for each fold to be used in k -fold cross-validation.
<code>verbose</code>	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is <code>TRUE</code> .

Value

The tuned gradient boosting parameters. A list with three elements: `interaction_depth` contains the interaction depth parameter, `shrinkage` contains the learning rate, `n_trees` the number of trees to be grown.

run_gb_mc	<i>GB multicore tuning.</i>
-----------	-----------------------------

Description

run_gb_mc is called from within run_gb. It tunes using multiple cores.

Usage

```
run_gb_mc(
  y,
  L1.x,
  L2.eval.unit,
  L2.unit,
  L2.reg,
  form,
  gb_grid,
  n.minobsinnode,
  loss.unit,
  loss.fun,
  data,
  cores
)
```

Arguments

y	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
L1.x	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome y. Note that geographic unit is specified in argument L2.unit.
L2.eval.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.
form	Model formula. A two-sided linear formula describing the model to be fit, with the outcome on the LHS and the covariates separated by + operators on the RHS.
gb_grid	Search grid. A data.frame object where columns are parameters and rows are search iterations.
n.minobsinnode	GB minimum number of observations in the terminal nodes. An integer-valued scalar specifying the minimum number of observations that each terminal node of the trees must contain. Default is 5.

loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is c("MSE", "cross-entropy", "msfe", "f1"). With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
data	Data for cross-validation. A list of k data.frames, one for each fold to be used in k -fold cross-validation.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

The tuning parameter combinations and there associated loss function scores. A list.

run_lasso	<i>Apply lasso classifier to MrP.</i>
-----------	---------------------------------------

Description

run_lasso is a wrapper function that applies the lasso classifier to data provided by the user, evaluates prediction performance, and chooses the best-performing model.

Usage

```
run_lasso(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  n.iter,
  loss.unit,
  loss.fun,
  lambda,
  data,
  verbose,
  cores
)
```


Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>n.iter</code>	Lasso number of lambda values. An integer-valued scalar specifying the number of lambda values to search over. Default is 100. <i>Note:</i> Is ignored if a vector of <code>lasso.lambda</code> values is provided.
<code>loss.unit</code>	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (<code>L2.units</code>) or at both levels. Default is <code>c("individuals", "L2.units")</code> . With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (<code>msfe</code>), the f1 score (<code>f1</code>), or a combination thereof. Default is <code>c("MSE", "cross-entropy", "msfe", "f1")</code> . With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>lambda</code>	Lasso penalty parameter. A numeric vector of non-negative values. The penalty parameter controls the shrinkage of the context-level variables in the lasso model. Default is a sequence with minimum 0.1 and maximum 250 that is equally spaced on the log-scale. The number of values is controlled by the <code>lasso.n.iter</code> parameter.
<code>data</code>	Data for cross-validation. A list of k <code>data.frames</code> , one for each fold to be used in k -fold cross-validation.
<code>verbose</code>	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is <code>FALSE</code> .
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

The tuned lambda value. A numeric scalar.

run_lasso_mc_lambda *Lasso multicore tuning.*

Description

run_lasso_mc_lambda is called from within run_lasso. It tunes using multiple cores.

Usage

```
run_lasso_mc_lambda(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  loss.unit,
  loss.fun,
  data,
  cores,
  L2.fe.form,
  L1.re,
  lambda
)
```

Arguments

y	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
L1.x	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome y. Note that geographic unit is specified in argument L2.unit.
L2.x	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome y.
L2.unit	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
L2.reg	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (L2.unit must be nested within L2.reg). Default is NULL.
loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.

loss.fun	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (cross-entropy), mean squared false error (msfe), the f1 score (f1), or a combination thereof. Default is c("MSE", "cross-entropy", "msfe", "f1"). With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
data	Data for cross-validation. A list of k data.frames, one for each fold to be used in k -fold cross-validation.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.
L2.fe.form	The fixed effects part of the Lasso classifier formula. The formula is inherited from run_lasso.
L1.re	A list of random effects for the Lasso classifier formula. The formula is inherited from run_lasso.
lambda	Lasso penalty parameter. A numeric vector of non-negative values. The penalty parameter controls the shrinkage of the context-level variables in the lasso model. Default is a sequence with minimum 0.1 and maximum 250 that is equally spaced on the log-scale. The number of values is controlled by the lasso.n.iter parameter.

Value

The cross-validation errors for all models. A list.

run_pca

Apply PCA classifier to MrP.

Description

run_pca is a wrapper function that applies the PCA classifier to data provided by the user, evaluates prediction performance, and chooses the best-performing model.

Usage

```
run_pca(
  y,
  L1.x,
  L2.x,
  L2.unit,
  L2.reg,
  loss.unit,
  loss.fun,
  data,
  cores,
  verbose
)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>loss.unit</code>	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (<code>individuals</code>), geographic units (<code>L2 units</code>) or at both levels. Default is <code>c("individuals", "L2 units")</code> . With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (<code>cross-entropy</code>), mean squared false error (<code>msfe</code>), the f1 score (<code>f1</code>), or a combination thereof. Default is <code>c("MSE", "cross-entropy", "msfe", "f1")</code> . With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>data</code>	Data for cross-validation. A list of k <code>data.frames</code> , one for each fold to be used in k -fold cross-validation.
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.
<code>verbose</code>	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is <code>FALSE</code> .

Value

A model formula of the winning best subset classifier model.

`run_svm`

Apply support vector machine classifier to MrP.

Description

`run_svm` is a wrapper function that applies the support vector machine classifier to data provided by the user, evaluates prediction performance, and chooses the best-performing model.

Usage

```
run_svm(
  y,
  L1.x,
  L2.x,
  L2.eval.unit,
  L2.unit,
  L2.reg,
  kernel = "radial",
  loss.fun,
  loss.unit,
  gamma,
  cost,
  data,
  verbose,
  cores
)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.eval.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>kernel</code>	SVM kernel. A character-valued scalar specifying the kernel to be used by SVM. The possible values are <code>linear</code> , <code>polynomial</code> , <code>radial</code> , and <code>sigmoid</code> . Default is <code>radial</code> .
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (MSE), the mean absolute error (MAE), binary cross-entropy (<code>cross-entropy</code>), mean squared false error (<code>msfe</code>), the f1 score (<code>f1</code>), or a combination thereof. Default is <code>c("MSE", "cross-entropy", "msfe", "f1")</code> . With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.

loss.unit	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (individuals), geographic units (L2 units) or at both levels. Default is c("individuals", "L2 units"). With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
gamma	SVM kernel parameter. A numeric vector whose values specify the gamma parameter in the SVM kernel. This parameter is needed for all kernel types except linear. Default is a sequence with minimum = 1e-5, maximum = 1e-1, and length = 20 that is equally spaced on the log-scale.
cost	SVM cost parameter. A numeric vector whose values specify the cost of constraints violation in SVM. Default is a sequence with minimum = 0.5, maximum = 10, and length = 5 that is equally spaced on the log-scale.
data	Data for cross-validation. A list of k data.frames, one for each fold to be used in k -fold cross-validation.
verbose	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is FALSE.
cores	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is 1.

Value

The support vector machine tuned parameters. A list.

run_svm_mc	<i>SVM multicore tuning.</i>
------------	------------------------------

Description

run_svm_mc is called from within run_svm. It tunes using multiple cores.

Usage

```
run_svm_mc(
  y,
  L1.x,
  L2.x,
  L2.eval.unit,
  L2.unit,
  L2.reg,
  form,
  loss.unit,
  loss.fun,
  data,
  cores,
  svm.grid,
  verbose
)
```

Arguments

<code>y</code>	Outcome variable. A character vector containing the column names of the outcome variable. A character scalar containing the column name of the outcome variable in survey.
<code>L1.x</code>	Individual-level covariates. A character vector containing the column names of the individual-level variables in survey and census used to predict outcome <code>y</code> . Note that geographic unit is specified in argument <code>L2.unit</code> .
<code>L2.x</code>	Context-level covariates. A character vector containing the column names of the context-level variables in survey and census used to predict outcome <code>y</code> .
<code>L2.eval.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.unit</code>	Geographic unit. A character scalar containing the column name of the geographic unit in survey and census at which outcomes should be aggregated.
<code>L2.reg</code>	Geographic region. A character scalar containing the column name of the geographic region in survey and census by which geographic units are grouped (<code>L2.unit</code> must be nested within <code>L2.reg</code>). Default is <code>NULL</code> .
<code>form</code>	The SVM model formula.
<code>loss.unit</code>	Loss function unit. A character-valued scalar indicating whether performance loss should be evaluated at the level of individual respondents (<code>individuals</code>), geographic units (<code>L2 units</code>) or at both levels. Default is <code>c("individuals", "L2 units")</code> . With multiple loss units, parameters are ranked for each loss unit and the loss unit with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>loss.fun</code>	Loss function. A character-valued scalar indicating whether prediction loss should be measured by the mean squared error (<code>MSE</code>), the mean absolute error (<code>MAE</code>), binary cross-entropy (<code>cross-entropy</code>), mean squared false error (<code>msfe</code>), the f1 score (<code>f1</code>), or a combination thereof. Default is <code>c("MSE", "cross-entropy", "msfe", "f1")</code> . With multiple loss functions, parameters are ranked for each loss function and the parameter combination with the lowest rank sum is chosen. Ties are broken according to the order in the search grid.
<code>data</code>	Data for cross-validation. A list of k <code>data.frames</code> , one for each fold to be used in k -fold cross-validation.
<code>cores</code>	The number of cores to be used. An integer indicating the number of processor cores used for parallel computing. Default is <code>1</code> .
<code>svm.grid</code>	Search grid. A <code>data.frame</code> object where columns are parameters and rows are search iterations.
<code>verbose</code>	Verbose output. A logical argument indicating whether or not verbose output should be printed. Default is <code>FALSE</code> .

Value

The cross-validation errors for all models. A list.

summary.autoMrP	<i>A summary method for autoMrP objects.</i>
-----------------	--

Description

summary.autoMrP() ...

Usage

```
## S3 method for class 'autoMrP'
summary(
  object,
  ci.lvl = 0.95,
  digits = 4,
  format = "simple",
  classifiers = NULL,
  n = 10,
  ...
)
```

Arguments

object	An autoMrP() object for which a summary is desired.
ci.lvl	The level of the confidence intervals. A proportion. Default is 0.95. Confidence intervals are based on bootstrapped estimates and will not be printed if bootstrapping was not carried out.
digits	The number of digits to be displayed. An integer scalar. Default is 4.
format	The table format. A character string passed to kable . Default is simple.
classifiers	Summarize a single classifier. A character string. Must be one of best_subset, lasso, pca, gb, svm, or mrp. Default is NULL.
n	Number of rows to be printed. An integer scalar. Default is 10.
...	Additional arguments affecting the summary produced.

survey_item	<i>A sample of a survey item from the CCES 2008</i>
-------------	---

Description

The Cooperative Congressional Election Studies (CCES) item (cc418_1) asked: "Would you approve of the use of U.S. military troops in order to ensure the supply of oil?" The original 2008 CCES item contains 36,832 respondents. This sample mimics a typical national survey. It contains at least 5 respondents from each state but is otherwise a random sample.

Usage

survey_item

Format

A data frame with 1500 rows and 13 variables:

YES 1 if individual supports use of troops; 0 otherwise

L1x1 Age group (four categories: 1 = 18-29; 2 = 30-44; 3 = 45-64; 4 = 65+)

L1x2 Education level (four categories: 1 = < high school; 2 = high school graduate; 3 = some college; 4 = college graduate)

L1x3 Gender-race combination (six categories: 1 = white male; 2 = black male; 3 = hispanic male; 4 = white female; 5 = black female; 6 = hispanic female)

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L2.x1 Normalized state-level share of votes for the Republican candidate in the previous presidential election

L2.x2 Normalized state-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 Normalized state-level percentage of the population living in urban areas

L2.x4 Normalized state-level unemployment rate

L2.x5 Normalized state-level share of Hispanics

L2.x6 Normalized state-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. It is a random sample with at least 5 respondents per state. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

svm_classifier

SVM classifier

Description

svm_classifier applies support vector machine classification to a data set.

Usage

```
svm_classifier(
  form,
  data,
  kernel,
  type,
  probability,
  svm.gamma,
  svm.cost,
  verbose = c(TRUE, FALSE)
)
```

Arguments

form	Model formula. A two-sided linear formula describing the model to be fit, with the outcome on the LHS and the covariates separated by + operators on the RHS.
data	Data. A data.frame containing the cross-validation data used to train and evaluate the model.
kernel	Kernel for SVM. A character string specifying the kernel to be used for SVM. The possible types are linear, polynomial, radial, and sigmoid. Default is radial.
type	svm can be used as a classification machine, as a regression machine, or for novelty detection. Depending of whether y is a factor or not, the default setting for type is C-classification or eps-regression, respectively, but may be overwritten by setting an explicit value. Valid options are: # <ol style="list-style-type: none"> 1. C-classification 2. nu-classification 3. one-classification (for novelty detection) 4. eps-regression 5. nu-regression
probability	Probability predictions. A logical argument indicating whether the model should allow for probability predictions
svm.gamma	Gamma parameter for SVM. This parameter is needed for all kernels except linear.
svm.cost	Cost parameter for SVM. This parameter specifies the cost of constraints violation.
verbose	Verbose output. A logical vector indicating whether or not verbose output should be printed.

Value

The support vector machine model. An [svm](#) object.

taxes_census
Quasi census data.

Description

The census file is generated from the full 2008 National Annenberg Election Studies item CBb01 by disaggregating the 64 ideal type combinations of the individual level variables L1x1, L2x2 and L1x3. A row is an ideal type in a given state.

Usage

```
data(taxes_census)
```

Format

A data frame with 2934 rows and 13 variables:

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L1x1 Age group (four categories)

L1x2 Education level (four categories)

L1x3 Gender-race combination (six categories)

freq State-level frequency of ideal type

proportion State-level proportion of respondents of that ideal type in the population

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

 taxes_survey

Sample on raising taxes from the 2008 National Annenberg Election Studies.

Description

The 2008 National Annenberg Election Studies (NAES) item (CBb01) asked: "I'm going to read you some options about federal income taxes. Please tell me which one comes closest to your view on what we should be doing about federal income taxes: (1) Cut taxes; (2) Keep taxes as they are; (3) Raise taxes if necessary; (4) None of these; (998) Don't know; (999) No answer. Category (3) was turned into a 'raise taxes response,' categories (1) and (2) were combined into a 'do not raise taxes' response. The original item from the phone and online surveys contains 50,483 respondents. This sample mimics a typical national survey. It contains at least 5 respondents from each state but is otherwise a random sample.

The 2008 National Annenberg Election Studies (NAES) item (CBb01) asked: "I'm going to read you some options about federal income taxes. Please tell me which one comes closest to your view on what we should be doing about federal income taxes: (1) Cut taxes; (2) Keep taxes as they are; (3) Raise taxes if necessary; (4) None of these; (998) Don't know; (999) No answer. Category (3) was turned into a 'raise taxes response,' categories (1) and (2) were combined into a 'do not raise taxes' response. The original item from the phone and online surveys contains 50,483 respondents. This sample mimics a typical national survey. It contains at least 5 respondents from each state but is otherwise a random sample.

Usage

```
data(taxes_survey)
```

```
data(taxes_survey)
```

Format

A data frame with 1500 rows and 13 variables:

YES 1 if individual supports raising taxes; 0 otherwise

L1x1 Age group (four categories: 1 = 18-29; 2 = 30-44; 3 = 45-64; 4 = 65+)

L1x2 Education level (four categories: 1 = < high school; 2 = high school graduate; 3 = some college; 4 = college graduate)

L1x3 Gender-race combination (six categories: 1 = white male; 2 = black male; 3 = hispanic male; 4 = white female; 5 = black female; 6 = hispanic female)

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

A data frame with 1500 rows and 13 variables:

YES 1 if individual supports raising taxes; 0 otherwise

L1x1 Age group (four categories: 1 = 18-29; 2 = 30-44; 3 = 45-64; 4 = 65+)

L1x2 Education level (four categories: 1 = < high school; 2 = high school graduate; 3 = some college; 4 = college graduate)

L1x3 Gender-race combination (six categories: 1 = white male; 2 = black male; 3 = hispanic male; 4 = white female; 5 = black female; 6 = hispanic female)

state U.S. state

L2.unit U.S. state id

region U.S. region (four categories: 1 = Northeast; 2 = Midwest; 3 = South; 4 = West)

L2.x1 State-level share of votes for the Republican candidate in the previous presidential election

L2.x2 State-level percentage of Evangelical Protestant or Mormon respondents

L2.x3 State-level percentage of the population living in urban areas

L2.x4 State-level unemployment rate

L2.x5 State-level share of Hispanics

L2.x6 State-level share of Whites

Source

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. It is a random sample with at least 5 respondents per state. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

The data set (excluding L2.x3, L2.x4, L2.x5, L2.x6) is taken from the article: Buttice, Matthew K, and Benjamin Highton. 2013. "How does multilevel regression and poststrat-stratification perform with conventional national surveys?" *Political Analysis* 21(4): 449-467. It is a random sample with at least 5 respondents per state. L2.x3, L2.x3, L2.x4, L2.x5 and L2.x6 are available at <https://www.census.gov>.

Index

- * **EBMA**
 - auto_MrP, 5
 - * **MRP**
 - auto_MrP, 5
 - * **averaging**
 - auto_MrP, 5
 - * **bayesian**
 - auto_MrP, 5
 - * **datasets**
 - absentee_census, 3
 - absentee_voting, 4
 - census, 18
 - survey_item, 56
 - taxes_census, 59
 - taxes_survey, 60
 - * **ensemble**
 - auto_MrP, 5
 - * **learning**
 - auto_MrP, 5
 - * **machine**
 - auto_MrP, 5
 - * **model**
 - auto_MrP, 5
 - * **multilevel**
 - auto_MrP, 5
 - * **post-stratification**
 - auto_MrP, 5
 - * **regression**
 - auto_MrP, 5
- absentee_census, 3
absentee_voting, 4
auto_MrP, 5
- best_subset_classifier, 11
binary_cross_entropy, 12
boot_auto_mrp, 13
- census, 18
cv_folding, 19
- ebma, 19
ebma_folding, 21
ebma_mc_draws, 21
ebma_mc_tol, 23
error_checks, 25
- f1_score, 29
- gb_classifier, 29
gb_classifier_update, 30
gbm, 23, 24, 30
gbm.more, 30
glmer, 12, 22–24
glmLasso, 23, 24, 31
- kable, 37, 56
- lasso_classifier, 31
log_spaced, 32
loss_function, 32
loss_score_ranking, 33
- mean_absolute_error, 34
mean_squared_error, 34
mean_squared_false_error, 35
model_list, 35
model_list_pca, 36
multicore, 37
- output_table, 37
- plot.autoMrP, 38
post_stratification, 38
predict_glmLasso, 40
- quiet, 41
- run_best_subset, 42
run_best_subset_mc, 43
run_gb, 44
run_gb_mc, 47

run_lasso, [48](#)
run_lasso_mc_lambda, [50](#)
run_pca, [51](#)
run_svm, [52](#)
run_svm_mc, [54](#)

summary.autoMrP, [56](#)
survey_item, [56](#)
svm, [23](#), [24](#), [58](#)
svm_classifier, [57](#)

taxes_census, [59](#)
taxes_survey, [60](#)