Package 'TSVC'

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Type Package

Title Tree-Structured Modelling of Varying Coefficients

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Author Moritz Berger

Depends plotrix, mgcv

Suggests AER

Maintainer Moritz Berger <moritz.berger@imbie.uni-bonn.de>

Description
Fitting tree-structured varying coefficient models (Berger et al. (2019), <doi:10.1007/s11222-018-9804-8>). Simultaneous detection of covariates with varying coefficients and effect modifiers that induce varying coefficients if they are present.

License GPL-2

LazyLoad yes

RoxygenNote 7.1.2

NeedsCompilation no

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R topics documented:

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plot.TSVC   *Plotting of Varying Coefficient Trees*

Description

Visualization of trees of effects of covariates that vary with the values of one or several effect modifiers.

Usage

```
## S3 method for class 'TSVC'
plot(
  x,
  variable,
  cex.lines = 2,
  cex.branches = 1,
  cex.coefs = 1,
  cex.main = 1,
  title = NULL,
  ...
)
```

Arguments

x	object of class TSVC.
variable	name of the variable, for which the tree shall be plotted.
cex.lines	width of branches of the tree.
cex.branches	size of the labels of the tree.
cex.coefs	size of the coefficients in the terminal nodes of the tree.
cex.main	size of the title of the tree.
title	optional title, which is addded to the tree; if title=NULL the title is the name of the variable in the data.
...	further arguments passed to or from other methods.

Author(s)

Moritz Berger <Moritz.Berger@imbie.uni-bonn.de>
https://www.imbie.uni-bonn.de/people/dr-moritz-berger/

References

Berger, M., G. Tutz and M. Schmid (2019). Tree-Structured Modelling of Varying Coefficients. Statistics and Computing 29, 217-229, https://doi.org/10.1007/s11222-018-9804-8.

See Also

TSVC, predict.TSVC, summary.TSVC

Examples

```
# Swiss Labour Market
library(AER)
data("SwissLabor")

# recode factors
sl <- SwissLabor
sl$participation <- as.numeric(sl$participation)-1
sl$foreign       <- as.numeric(sl$foreign)-1

## Not run:
fit1 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
             nperm=1000, trace=TRUE)
plot(fit1, "income")

## End(Not run)
```

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predict.TSVC   *Prediction from Varying Coefficient Trees*

Description

Obtains predictions from a fitted TSVC object.

Usage

```
## S3 method for class 'TSVC'
predict(object, X_new = NULL, ...)
```

Arguments

object	a fitted object of class TSVC.
X_new	optionally, data frame of class data.frame which contains the variables with which to predict. If NULL, the fitted linear predictors are use.
...	further arguments passed to predict.glm.

Details

predict.TSVC is a wrapper function of predict.glm, which obtains predictions for objects of class glm. Further arguments can be passed to predict.glm via the '...'-argument.

Author(s)

Moritz Berger <moritz.berger@imbie.uni-bonn.de>
https://www.imbie.uni-bonn.de/people/dr-moritz-berger/

References

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Statistics and Computing 29, 217-229, https://doi.org/10.1007/s11222-018-9804-8.

See Also

TSVC, plot.TSVC, summary.TSVC

Examples

```
# Swiss Labour Market
library(AER)
data("SwissLabor")

# recode factors
sl <- SwissLabor
sl$participation <- as.numeric(sl$participation)-1
sl$foreign       <- as.numeric(sl$foreign)-1

X_new <- data.frame("income"=c(10,12), "age"=c(4.5,5.8))

## Not run:
fit1 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
             nperm=1000, trace=TRUE)
predict(fit1, X_new, type="response")

## End(Not run)
```

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summary.TSVC   *Summary of Tree-Structured Varying Coefficient Models*

Description

Summary for an object of class TSVC, with an overview of all executed splits during the fitting
process.

Usage

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

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

Arguments

object	object of class TSVC.
...	further arguments passed to or from other methods.
x	object of class summary.TSVC.

Value

object of class ″summary.TSVC″. An object of class ″summary.TSVC″ is a list containing the following components:

stats	overview of detected varying coefficients, responsible effect modifiers and executed splits.
nosplits	total number of executed splits during the fitting process.

Author(s)

Moritz Berger <Moritz.Berger@imbie.uni-bonn.de>
https://www.imbie.uni-bonn.de/people/dr-moritz-berger/

References

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See Also

TSVC, plot.TSVC, predict.TSVC

Examples

```
# Swiss Labour Market
library(AER)
data("SwissLabor")

# recode factors
sl <- SwissLabor
sl$participation <- as.numeric(sl$participation)-1
sl$foreign       <- as.numeric(sl$foreign)-1

## Not run:
fit1 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
             nperm=1000, trace=TRUE)
summary(fit1)

## End(Not run)
```

TSVC   *Tree-Structured Modelling of Varying Coefficients*

Description

A function to fit tree-structured varying coefficient (TSVC) models. By recursive splitting the method allows to simultaneously detect covariates with varying coefficients and the effect modifiers that induce varying coefficients if they are present. The basic method is described in Berger, Tutz and Schmid (2018).

Usage

```
TSVC(
  formula,
  data,
  family = gaussian,
  alpha = 0.05,
  nperm = 1000,
  nodesize_min = 5,
  bucket_min = 1,
  depth_max = NULL,
  splits_max = NULL,
  perm_test = TRUE,
  test_linear = TRUE,
  effmod = NULL,
  notmod = NULL,
  only_effmod = NULL,
  smooth = NULL,
  split_intercept = FALSE,
  sb_slope = NULL,
  trace = FALSE,
  ...
)

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

Arguments

formula	object of class formula: a symbolic description of the (linear) model to be fit. See also details.
data	data frame of class data.frame containing the variables in the model.
family	a description of the error distribution and link function to be used in the model (as for [glm](glm)). This can be a character string naming a family function, a family function or the result of a call to a family function. See family for details of family functions.

alpha	significance level $alpha$ for the permutation tests.
nperm	number of permutations used for the permutation tests.
nodesize_min	minimum number of observations that must exist in a node in order for a split to be attempted.
bucket_min	the minimum number of observations in any terminal node.
depth_max	maximum depth of any node in each tree, with the root node counted as depth 0. If NULL (default), the size of the trees is not restricted.
splits_max	maximum number of splits performed. If NULL (default), the number of splits is not restricted.
perm_test	if FALSE, no permutation tests are performed, but each tree is grown until the minimum node size constraint is reached.
test_linear	should linear effects that were not modified during iteration tested for significance?
effmod	optional vector of covariates that serve as effect modifier. If NULL (default), all covariates are considered as potential effect modifiers.
notmod	optional list of class [list](#) containing pairs of covariate/effect modifier that are not considered as candidates for splitting during iteration. If NULL (default), all combinations of covariates and potential effect modifiers are considered for splitting.
only_effmod	optional vector of covariates that serve as effect modifier, only. If NULL (default), all effect modifiers are included in the predictor of the model and are allowed to be modified.
smooth	optional vector of covariates with a smooth effect on the response. The (smooth) effects fo these variables are not allowed to be modified.
split_intercept	
	if TRUE, the intercept is allowed to be modified by the covariates. If FALSE (default), the intercept is set constant.
sb_slope	optional vector of covariates that are allowed to be modified by itself. Such an effect corresponds to a structural break in the slope.
trace	if TRUE, information about the estimation progress is printed.
...	further arguments passed to or from other methods.
x	object of class TSVC.

Details

A typical [formula](#) has the form response ~ covariates, where response is the name of the response variable and covariates is a series of variables that are incorporated in the model.

With p covariates, TSVC expects a formula of the form y $x_1 + ... + x_p$. If no further specifications are made (effmod=NULL, notmod=NULL, only_effmod=NULL) it is assumed that each covariate $x_j, j = 1, ..., p$ can be modified by all the other variables $x_m, m = 1, ..., p$ j.

Remark: Significance of each split is verified by permutation tests. The result of the permutation tests can strongly depend on the number of permutations nperm.

Note: The algorithm currently does not support splitting of/by factor variables. If a factor variable is included in the [formula](#) of the model, the variable will not serve as effect modifier and its effect will not be modified.

Value

Object of class "TSVC". An object of class "TSVC" is a list containing the following components:

splits	matrix with detailed information about all executed splits during the fitting process.
coefficients	list of estimated coefficients for covariates with and without varying coefficients (including a non-varying intercept).
pvalues	p-values of each permuation test during the fitting process.
pvalues_linear	p-values of the permutation tests on the linear effects in the last step of the algorithm.
devs	maximal value statistics T_m of the selected effect modifier in each iteration during the fitting process.
crit	critical values of each permutation test during the fitting process.
y	response vector.
X	matrix of all the variables (covariates and effect modifiers) for model fitting.
sb	variables for which a structural break in the slope was allowed.
model	internally fitted model in the last iteration of class [glm] or [gam].
all_models	list of internally fitted models of class [glm] or [gam].

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References

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Hastie, T. and R. Tibshirani (1993). Varying-coefficient models. Journal of the Royal Statistical Society B 55, 757-796.

Hothorn T., K. Hornik and A. Zeileis (2006). Unbiased recursive partitioning: A conditional inference framework. Journal of Computational and Graphical Statistics 15(3), 651-674.

See Also

[plot.TSVC], [predict.TSVC], [summary.TSVC]

Examples

```
# Swiss Labour Market
library(AER)
data("SwissLabor")

# recode factors
sl <- SwissLabor
sl$participation <- as.numeric(sl$participation)-1
```

```
sl$foreign        <- as.numeric(sl$foreign)-1

## Not run:
fit1 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
             nperm=300, trace=TRUE)
print(fit1)
class(fit$model) # glm

# In fit2, variable 'foreign' does not serve as effect modifier
# and the effect of 'foreign' is not modified by the other variables.
# That means 'foreign' is assumed to only have simple linear effect on the response.
fit2 <- TSVC(participation~income+age+foreign, data=sl, family=binomial(link="logit"),
             nperm=300, trace=TRUE, effmod=c("income","age"),
             notmod=list(c("foreign","income"),c("foreign","age")))
print(fit2)

# In fit3, variable 'age' does only serve as effect modifier. That means the effect of 'age'
# is not included in the predictor of the model.
fit3 <- TSVC(participation~income+age+foreign, data=sl, family=binomial(link="logit"),
             nperm=300, trace=TRUE, only_effmod="age")
print(fit3)

# In fit4, the intercept is allowed to be modified by 'age' and 'income'.
# The two covariates, however, are not allowed to modify each other.
fit4 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
             nperm=300, trace=TRUE, split_intercept=TRUE,
             notmod=list(c("income","age"), c("age", "income")))
print(fit4)


# In fit5, variable 'age' has a smooth effect on the response.
# Hence, the (smooth) effect of 'age' will not be modified by the other variables.
fit5 <- TSVC(participation~income+age+foreign, data=sl, family=binomial(link="logit"),
             nperm=300, trace=TRUE, smooth="age")
print(fit5)
class(fit5$model) # gam

# In fit6, the intercept is allowed to be modified by 'age' and 'income', but the two variables are
# not included in the predictor of the model. Here, no permutation tests are performed, but the
# tree is pruned by a minimum node size constraint.
fit6 <- TSVC(participation~income+age, data=sl, family=binomial(link="logit"),
        perm_test=FALSE, nodesize_min=100, bucket_min=100, trace=TRUE, split_intercept=TRUE,
             effmod=c("income","age"), only_effmod = c("income", "age"))
print(fit6)


## End(Not run)
```

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