Package: adass (via r-universe)

October 17, 2024

Type Package

Title Adaptive Smoothing Spline (AdaSS) Estimator for the Function-on-Function Linear Regression

Version 1.0.1

Description Implements the adaptive smoothing spline estimator for the function-on-function linear regression model described in Centofanti et al. (2023) <doi:10.1007/s00180-022-01223-6>.

License GPL (>= 3)

Encoding UTF-8

Imports fda, parallel, matrixcalc, SparseM, mvtnorm, Rfast, plot3D

URL https://github.com/unina-sfere/adass

BugReports https://github.com/unina-sfere/adass

SystemRequirements GNU make

Suggests knitr, rmarkdown, testthat

Roxygen list(markdown = TRUE)

RoxygenNote 7.2.3

Repository https://unina-sfere.r-universe.dev

RemoteUrl https://github.com/unina-sfere/adass

RemoteRef HEAD

RemoteSha 4b4025276bd42bb43443f00fe38843590828645e

Contents

adass-package *Adaptive smoothing spline estimator for the function-on-function linear regression model*

Description

Implements the adaptive smoothing spline estimator for the function-on-function linear regression model described in Centofanti et al. (2023) doi:10.1007/s00180022012236.

Details

Package:	adass
Type:	Package
Version:	1.0.1
Date:	2024-07-16
License:	GPL (>= 3) + file LICENSE

Author(s)

Fabio Centofanti, Antonio Lepore, Alessandra Menafoglio, Biagio Palumbo, Simone Vantini

References

Centofanti, F., Lepore, A., Menafoglio, A., Palumbo, B., Vantini, S. (2023). Adaptive Smoothing Spline Estimator for the Function-on-Function Linear Regression Model. *Computational Statistics 38(1), 191–216*.

See Also

adass.fr, adass.fr_eaass

Examples

```
library(adass)
data<-simulate_data("Scenario HAT",n_obs=100)
X_fd=data$X_fd
Y_fd=data$Y_fd
basis_s <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
basis_t <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
mod_smooth <-adass.fr(Y_fd,X_fd,basis_s = basis_s,basis_t = basis_t,tun_par=c(10^-6,10^-6,0,0,0,0))
grid_s<-seq(0,1,length.out = 10)
grid_t<-seq(0,1,length.out = 10)
beta_der_eval_s<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,sLfdobj = 2)
beta_der_eval_t<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,tLfdobj = 2)
mod_adsm<-adass.fr_eaass(Y_fd,X_fd,basis_s,basis_t,
```

```
                        beta_ders=beta_der_eval_s, beta_dert=beta_der_eval_t,
                    rand_search_par=list(c(-8,4),c(-8,4),c(0,0.1),c(0,4),c(0,0.1),c(0,4)),
                        grid_eval_ders=grid_s, grid_eval_dert=grid_t,
                        popul_size = 2,ncores=1,iter_num=1)

mod_opt <-adass.fr(Y_fd, X_fd, basis_s = basis_s, basis_t = basis_t,
                    tun_par=mod_adsm$tun_par_opt,beta_ders = beta_der_eval_s,
                beta_dert = beta_der_eval_t,grid_eval_ders=grid_s,grid_eval_dert=grid_t )
plot(mod_opt)
```

`adass.fr` *Adaptive smoothing spline estimator for the function-on-function linear regression model*

Description

The adaptive smoothing spline (AdaSS) estimator for the function-on-function linear regression proposed in Centofanti et al., 2020.

Usage

```
adass.fr(
  Y_fd,
  X_fd,
  basis_s,
  basis_t,
  beta_ders = NULL,
  beta_dert = NULL,
  grid_eval_ders = NULL,
  grid_eval_dert = NULL,
  tun_par = c(lambda_s = 10^4, lambda_t = 10^4, delta_s = 0, gamma_s = 1, delta_t = 0,
    delta_t = 1),
  CV = FALSE,
  K = 10,
  X_fd_test = NULL,
  Y_fd_test = NULL
)
```

Arguments

`Y_fd`	An object of class fd corresponding to the response functions.
`X_fd`	An object of class fd corresponding to the covariate functions.
`basis_s`	B-splines basis along the s-direction of class basisfd.
`basis_t`	B-splines basis along the t-direction of class basisfd.

beta_ders	Initial estimate of the partial derivative of the coefficient function along the s-direction. Either a matrix or a class basisfd object. If NULL no adaptive penalty is used along the s-direction.
beta_dert	Initial estimate of the partial derivative of the coefficient function along the t-direction. Either a matrix or a class basisfd object. If NULL no adaptive penalty is used along the t-direction.
grid_eval_ders	Grid of evaluation of the partial derivatives along the s-direction.
grid_eval_dert	Grid of evaluation of the partial derivatives along the t-direction.
tun_par	Vector of tuning parameters.
CV	If TRUE the K-fold cross-validation prediction error is calculated. Default is FALSE. If X_fd_test and Y_fd_test are both provided the prediction error on the test set is calculated in place of the cross-validation prediction error when CV is TRUE.
K	Number of folds. Default is 10.
X_fd_test	Test set covariate functions. Default is NULL.
Y_fd_test	Test set response functions. Default is NULL.

Value

A list containing the following arguments:

- B: The basis coefficients matrix estimate of the coefficient function.
- Beta_hat_fd: The coefficient function estimate of class bifd.
- alpha: The intercept function estimate.
- tun_par: Vector of tuning parameters.
- CV: Estimated prediction error.
- CV_sd: Standard error of the estimated prediction error.
- Y_fd: The response functions.
- X_fd: The covariate functions.

References

Centofanti, F., Lepore, A., Menafoglio, A., Palumbo, B., Vantini, S. (2023). Adaptive Smoothing Spline Estimator for the Function-on-Function Linear Regression Model. *Computational Statistics 38(1), 191–216*.

See Also

adass.fr_eaass

Examples

```
library(adass)
data<-simulate_data("Scenario HAT",n_obs=100)
X_fd=data$X_fd
Y_fd=data$Y_fd
basis_s <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
basis_t <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
mod_smooth <-adass.fr(Y_fd,X_fd,basis_s = basis_s,basis_t = basis_t,tun_par=c(10^-6,10^-6,0,0,0,0))
grid_s<-seq(0,1,length.out = 10)
grid_t<-seq(0,1,length.out = 10)
beta_der_eval_s<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,sLfdobj = 2)
beta_der_eval_t<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,tLfdobj = 2)
mod_adass <-adass.fr(Y_fd, X_fd, basis_s = basis_s, basis_t = basis_t,
                     tun_par=c(10^-6,10^-6,0,1,0,1),beta_ders = beta_der_eval_s,
               beta_dert = beta_der_eval_t,grid_eval_ders=grid_s,grid_eval_dert=grid_t )
```

`adass.fr_eaass` *Evolutionary algorithm for the adaptive smoothing spline estimator (EAASS).*

Description

EAASS algorithm to choose the tuning parameters for the AdaSS estimator (Centofanti et al., 2020).

Usage

```
adass.fr_eaass(
  Y_fd,
  X_fd,
  basis_s,
  basis_t,
  beta_ders = NULL,
  beta_dert = NULL,
  grid_eval_ders = NULL,
  grid_eval_dert = NULL,
 rand_search_par = list(c(-4, 4), c(-4, 4), c(0, 1, 5, 10, 15), c(0, 1, 2, 3, 4), c(0,
    1, 5, 10, 15), c(0, 1, 2, 3, 4)),
  popul_size = 12,
  iter_num = 10,
  r = 0.2,
  pert_vec = c(0.8, 1.2),
  X_fd_test = NULL,
  Y_fd_test = NULL,
  progress = TRUE,
  ncores = 1,
  K = 10
)
```

Arguments

Y_fd	An object of class fd corresponding to the response functions.
X_fd	An object of class fd corresponding to the covariate functions.
basis_s	B-splines basis along the s-direction of class basisfd.
basis_t	B-splines basis along the t-direction of class basisfd.
beta_ders	Initial estimate of the partial derivative of the coefficient function along the s-direction. Either a matrix or a class basisfd object. If NULL no adaptive penalty is used along the s-direction.
beta_dert	Initial estimate of the partial derivative of the coefficient function along the t-direction. Either a matrix or a class basisfd object. If NULL no adaptive penalty is used along the t-direction.
grid_eval_ders	Grid of evaluation of the partial derivatives along the s-direction.
grid_eval_dert	Grid of evaluation of the partial derivatives along the t-direction.
rand_search_par	List containing the initial population ranges for the tuning parameters.
popul_size	Initial population size.
iter_num	Algorithm iterations.
r	Truncation parameter in the exploitation phase.
pert_vec	Perturbation parameters in the exploration phase.
X_fd_test	Test set covariate functions. Default is NULL. If X_fd_test and Y_fd_test are both provided the prediction error on the test set is used as performance metric in place of the cross-validation prediction error.
Y_fd_test	Test set response functions. Default is NULL. If X_fd_test and Y_fd_test are both provided the prediction error on the test set is used as performance metric in place of the cross-validation prediction error.
progress	If TRUE a progress bar is printed. Default is TRUE.
ncores	If ncores>1, then parallel computing is used, with ncores cores. Default is 1.
K	Number of folds. Default is 10.

Value

A list containing the following arguments:

- tun_par_opt: Vector of optimal tuning parameters.
- CV: Estimated prediction errors.
- CV_sd: Standard errors of the estimated prediction errors.
- comb_list: The combinations of tuning parameters explored.
- Y_fd: The response functions.
- X_fd: The covariate functions.

References

Centofanti, F., Lepore, A., Menafoglio, A., Palumbo, B., Vantini, S. (2023). Adaptive Smoothing Spline Estimator for the Function-on-Function Linear Regression Model. *Computational Statistics 38(1), 191–216*.

See Also

adass.fr_eaass

Examples

```
library(adass)
data<-simulate_data("Scenario HAT",n_obs=100)
X_fd=data$X_fd
Y_fd=data$Y_fd
basis_s <- fda::create.bspline.basis(c(0,1),nbasis = 5,norder = 4)
basis_t <- fda::create.bspline.basis(c(0,1),nbasis = 5,norder = 4)
mod_smooth <-adass.fr(Y_fd,X_fd,basis_s = basis_s,basis_t = basis_t,tun_par=c(10^-6,10^-6,0,0,0,0))
grid_s<-seq(0,1,length.out = 5)
grid_t<-seq(0,1,length.out = 5)
beta_der_eval_s<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,sLfdobj = 2)
beta_der_eval_t<-fda::eval.bifd(grid_s,grid_t,mod_smooth$Beta_hat_fd,tLfdobj = 2)
mod_adsm<-adass.fr_eaass(Y_fd,X_fd,basis_s,basis_t,
                         beta_ders=beta_der_eval_s, beta_dert=beta_der_eval_t,
                   rand_search_par=list(c(-8,4),c(-8,4),c(0,0.1),c(0,4),c(0,0.1),c(0,4)),
                         grid_eval_ders=grid_s, grid_eval_dert=grid_t,
                         popul_size = 1,ncores=1,iter_num=1)
```

`plot.adass` *Plot the results of the AdaSS method*

Description

This function provides plots of the AdaSS coefficient function estimate when applied to the output of `adass.fr`.

Usage

```
## S3 method for class 'adass'
plot(x, ...)
```

Arguments

`x`	The output of `adass.fr`.
`...`	No additional parameters, called for side effects.

Value

No return value, called for side effects.

Examples

```
library(adass)
data<-simulate_data("Scenario HAT",n_obs=100)
X_fd=data$X_fd
Y_fd=data$Y_fd
basis_s <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
basis_t <- fda::create.bspline.basis(c(0,1),nbasis = 10,norder = 4)
mod_adass <- adass.fr(Y_fd,X_fd,basis_s = basis_s, basis_t = basis_t,
 tun_par=c(10^-6,10^-6,0,0,0,0))
plot(mod_adass)
```

---

simulate_data *Simulate data through the function-on-function linear regression model*

Description

Generate synthetic data as in the simulation study of Centofanti et al. (2020).

Usage

```
simulate_data(scenario, n_obs = 3000)
```

Arguments

scenario	A character strings indicating the scenario considered. It could be "Scenario HAT", "Scenario DAMP", or "Scenario RCHANGE".
n_obs	Number of observations.

Value

A list containing the following arguments:

X: Covariate matrix, where the rows correspond to argument values and columns to replications.

Y: Response matrix, where the rows correspond to argument values and columns to replications.

X_fd: Coavariate functions.

Y_fd: Response functions.

Beta_vero_fd: The true coefficient function.

References

Centofanti, F., Lepore, A., Menafoglio, A., Palumbo, B., Vantini, S. (2023). Adaptive Smoothing Spline Estimator for the Function-on-Function Linear Regression Model. *Computational Statistics 38(1), 191–216*.

Examples

```
library(adass)
data<-simulate_data("Scenario HAT",n_obs=100)
```

Index