Package 'AMIAS'

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Title Alternating Minimization Induced Active Set Algorithms

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Description

An implementation of alternating minimization induced active set (AMIAS) method for solving the L0 regularized learning problems. It includes a piecewise smooth estimator by minimizing the least squares function with constraints on the number of kink points in the discrete derivatives. It also includes generalized structural sparsity via composite L0 penalty. Both time series and image segmentation can be handled by this package.

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AMIAS *Alternating Minimization Induced Active Set Algorithms(1d)*

Description

Extremely Efficient Procedures for Composite L0 Penalized Estimation(1d).

Usage

```
AMIAS(y, D_type="fused.1d", composite=FALSE, W_type="identity", k1=NULL,
k2=1, D=NULL, W=NULL, T1=NULL, T2=min(10,nmw[1]-1), rho1=n^2, rho2=n^2, h=5,
tao=1, outer_itermax=20, select_max=min(20,nm[1]-1), eps=0.1, iter_max=10,
smooth=TRUE, ...)
```

Arguments

y	Observe sequence, with length n.
D_type	Specifcation of D, either one of "fused.1d" or "fused.tfk". when D is set, it would be "user".
composite	Whether to use composite L0 penalty.
W_type	Specifcation of W, either one of "identity", "fused.1d" or "fused.tfk". when W is set, it would be "user".
k1	Integer: used to generate D for polynomial trend filtering of order k(see genDtf1d for Details).
k2	Integer: used to generate W for polynomial trend filtering of order k(see genDtf1d for Details).
D	Matrix in the penalty item(see Details).
W	Matrix in the penalty item for composite L0 panalty(see Details).
T1	The number of change point to detect in $D\beta$ penalty,default is NULL and it would be selected adatively.
T2	The number of change point to detect in $W\beta$ penalty,default is 10.
rho1	The lagrange operator of the argumented lagrange form for split item in $D\beta$.
rho2	The lagrange operator of the argumented lagrange form for split item in $W\beta$.
h	Arguments for my.rollmean.
tao	Number: increment of the T1 sequence in adative function algorithm.
outer_itermax	The maximum iterations to select T1 adatively.
select_max	The maximum number of change point to detect.
eps	The threshold to stop the adative AMIAS algorithm, when MSE is smaller than eps.
iter_max	The maximum iterations to setect change point for given T1.
smooth	Whether to smooth the data, if TRUE, it smooth the input data.
...	Other arguments.

Details

The Parameter of models implied by T1 and T2 is fit by primal dual active set and this is the number of change point to detect in AMIAS. Note that the model to fit is

$$\beta_i + \sigma_i,$$

and the objective function is

$$1/2 * RSS + \lambda_1 * penalty_1 + \lambda_2 * penalty_2(\lambda_2 = 0 for non - compositetype),$$

where

$$panalty_1 = |D\beta|_0, panalty_2 = |W\beta|_0.$$

If the parameter T1 is not set, a sequence of T1 would be fitted by increment tao adatively. For details, see the AMIAS paper.

Value

A list with class attribute 'AMIAS.1d' and named components:

call	The call that produced this object.
y	Observe sequence, if smooth, the smooth y would be return.
beta	The fitting coefficients in the noparameter model.
composite	Whether to use composite L0 penalty.
k1	Integer: used to generate D for polynomial trend filtering of order k(see Details).
k2	Integer: used to generate W for polynomial trend filtering of order k(see Details).
alpha	The split variable of the argumented lagrange form in $D\beta$
u	The lagrange operator of the argumented lagrange form in $D\beta$ for linear item.
gamma	The split variable of the argumented lagrange form in $W\beta$
v	The lagrange operator of the argumented lagrange form in $W\beta$ for linear item.
df	Degree of freedom of the seleted model.
T2	The number of change point to detect in $W\beta$ penalty.
D_type	Specifcation of D, default is "fused.1d". when D is set, it would be "user".
W_type	Specifcation of D, default is "identity". when W is set, it would be "user".
rho1	The lagrange operator of the argumented lagrange form in $D\beta$ for split item.
rho2	The lagrange operator of the argumented lagrange form in $W\beta$ for split item.
tao	Number: increment of the T1 sequence in adative function algorithm.
eps	The threshold to stop the adative AMIAS algorithm, when MSE is smaller than eps.
iter	The iterations to setect change point for given T1
iter_max	The maximum iterations to setect change point for given T1
smooth	Whether to smooth the data.
outer_itermax	The maximum iterations to select T1 adatively.
select_max	The maximum number of change point to detect.

References

Wen, C., Zhu, J., Wang, X., and Zhang, A. (2017) *L0 trend filtering for piecewise smooth modeling*, technique report.

See Also

genDtf1d my.rollmean.

Examples

```
library(AMIAS)

set.seed(12580)
n <- 100
sigma <- 0.3
y0 <- rep(0,n)
y0[10:15] <- 2
y0[40:60] <- -1
y0[80:82] <- 4
y <- y0 + sigma*rnorm(n)
y[80:82] <- y0[80:82] + sigma*rnorm(3)
AMIAS(y, h=1, outer_itermax=5)
```

AMIAS2d *Alternating Minimization Induced Active Set Algorithms(2d)*

Description

Extremely Efficient Procedures for Composite L0 Penalized Estimation(2d).

Usage

```
AMIAS2d(Mat, D_type="fused.2d", composite=FALSE, W_type="identity",
k1=NULL, k2=1, D=NULL, W=NULL, T1=NULL, T2=min(10,nmw[1]-1), rho1=(dim1*dim2)^6,
rho2=(dim1*dim2)^6, h=5, tao=1, outer_itermax=20, select_max=min(20,nm[1]-1),
eps=0.1, iter_max=10, ...)
```

Arguments

Mat	a grapha matrix.
D_type	Specifcation of D, either one of "fused.2d" or "fused.tfk". when D is set, it would be "user".
composite	Whether to use composite L0 penalty.
W_type	Specifcation of W, either one of "identity", "fused.1d" or "fused.tfk". when W is set, it would be "user".
k1	Integer: used to generate D for polynomial trend filtering of order k(see genDtf1d for Details).

k2	Integer: used to generate W for polynomial trend filtering of order k(see genDtf1d for Details).
D	Matrix in the penalty item(see Details).
W	Matrix in the penalty item for composite L0 panalty(see Details).
T1	The number of change point to detect in $D\beta$ penalty,default is NULL and it would be selected adatively.
T2	The number of change point to detect in $W\beta$ penalty,default is 10.
rho1	The lagrange operator of the argumented lagrange form for split item in $D\beta$.
rho2	The lagrange operator of the argumented lagrange form for split item in $W\beta$.
h	Arguments for my.rollmean.
tao	Number: increment of the T1 sequence in adative function algorithm.
outer_itermax	The maximum iterations to select T1 adatively.
select_max	The maximum number of change point to detect.
eps	The threshold to stop the adative AMIAS algorithm, when MSE is smaller than eps.
iter_max	The maximum iterations to setect change point for given T1.
...	Other arguments.

Details

The Parameter of models implied by T1 and T2 is fit by primal dual active set and this is the number of change point to detect in AMIAS. Note that the model to fit is

$$\beta_i + \sigma_i,$$

and the objective function is

$$1/2 * RSS + \lambda_1 * penalty_1 + \lambda_2 * penalty_2(\lambda_2 = 0 for non - compositetype),$$

where

$$panalty_1 = |D\beta|_0, panalty_2 = |W\beta|_0.$$

If the parameter T1 is not set, a sequence of T1 would be fitted by increment tao adatively. For details, see the AMIAS paper.

Value

A list with class attribute 'AMIAS' and named components:

call	The call that produced this object.
Mat	Observe grapha matrix.
Mathat	The fitting coefficients in the noparameter model.
composite	Whether to use composite L0 penalty.
k1	Integer: used to generate D for polynomial trend filtering of order k(see Details).

k2	Integer: used to generate W for polynomial trend filtering of order k(see Details).
alpha	The split variable of the argumented lagrange form in $D\beta$
u	The lagrange operator of the argumented lagrange form in $D\beta$ for linear item.
gamma	The split variable of the argumented lagrange form in $W\beta$
v	The lagrange operator of the argumented lagrange form in $W\beta$ for linear item.
df	Degree of freedom of the seleted model.
T2	The number of change point to detect in $W\beta$ penalty.
D_type	Specifcation of D, default is "fused.1d". when D is set, it would be "user".
W_type	Specifcation of D, default is "identity". when W is set, it would be "user".
rho1	The lagrange operator of the argumented lagrange form in $D\beta$ for split item.
rho2	The lagrange operator of the argumented lagrange form in $W\beta$ for split item.
tao	Number: increment of the T1 sequence in adative function algorithm.
eps	The threshold to stop the adative AMIAS algorithm, when MSE is smaller than eps.
iter	The iterations to setect change point for given T1
iter_max	The maximum iterations to setect change point for given T1
outer_itermax	The maximum iterations to select T1 adatively.
select_max	The maximum number of change point to detect.

References

Wen, C., Zhu, J., Wang, X., and Zhang, A. (2017) *L0 trend filtering for piecewise smooth modeling*, technique report.

See Also

genDtf2d genD2d my.rollmean.

Examples

```
library(AMIAS)

set.seed(12580)
n <- 100
sigma <- 0.3
y0 <- rep(0,n)
y0[10:15] <- 2
y0[40:60] <- -1
y0[80:82] <- 4
y <- y0 + sigma*rnorm(n)
y[80:82] <- y0[80:82] + sigma*rnorm(3)
y <- matrix(y,10,10)

AMIAS2d(y, D_type = "fused.2d")
```

genDXX *Generate D Matrix*

Description

Generate D matrix which is used to do polynomial trend filtering of order k

Usage

```
genDtf1d(k,n=NULL,full=FALSE)
genDtf2d(k,dim1=NULL,dim2=NULL,full=FALSE)
genD2d(dim1=NULL,dim2=NULL,full=FALSE)
```

Arguments

k	The order of polynomial trend filtering.
n	Length of observe sequence y for genDtf1d, only be used in the full mode.
dim1	The number of rows for genDtf2d, only be used in the full mode.
dim2	The number of columns for genDtf2d, only be used in the full mode.
full	Whether to return the full matrix, if TRUE, it gennerate a full matrix.

Details

In 1d case, D is used to do polynomial trend filtering of order k, and generated by

$$D_{tf,k} = D1d * D_{tf,k-1} fork >= 2,$$

where the nozero elements in each row is (1,-2,1) in D_tf,1 and (-1,1) in D_1d. This is usually not necessary to call directly, as AMIAS internally gennerate D, but inspection of the matrix can sometimes be useful.

Value

vecctor	Vector: return when full is FALSE, nozero elements in first row(equal to any other row) of D.
matrix	Matrix: return when full is TRUE, whole sparse D.

Examples

```
library(AMIAS)

genDtf1d(k=2)
genDtf1d(k=1,n=10,full=TRUE)
```

my.rollmean *Specil Rolling Means*

Description

Generic functions for computing rolling means of ordered observations.

Usage

```
my.rollmean(y,h=5,...)
```

Arguments

y	Observe sequence, with length n.
h	integer width of the rolling window, rollmean would be used with k = h*2+1.
...	Other arguments, see rollmean for details.

Value

vector	Vector: smooth observe sequence, with length n.

Examples

```
library(AMIAS)

set.seed(12580)
n <- 100
sigma <- 0.3
y0 <- rep(0,n)
y0[10:15] <- 2
y0[40:60] <- -1
y0[80:82] <- 4
y <- y0 + sigma*rnorm(n)
y[80:82] <- y0[80:82] + sigma*rnorm(3)
my.rollmean(y,1)
```

plot.AMIAS.1d *plot observe data with fitted value for AMIAS model*

Description

Similar to other plot methods, this functions plot fitted lines with the given sequence from a fitted "AMIAS.1d" object.

Usage

```
  ## S3 method for class 'AMIAS.1d'
plot(x, s=length(x$df), betatype="l", betacolor="blue", betalwd=2, ...)
```

Arguments

x	A list with class attribute 'AMIAS.1d'.
s	If the AMIAS object contain a T sequence to select adatively, the s-th model would be plot, default is the selected model.
betatype	Character indicating the type of plotting; actually any of the types as in plot.default.
betacolor	Color of the fitted line.
betalwd	Wide of the fitted line.
...	Other arguments,see plot.default for details.

See Also

AMIAS plot.default lines.default.

Examples

```
library(AMIAS)

set.seed(12580)
n <- 100
sigma <- 0.3
y0 <- rep(0,n)
y0[10:15] <- 2
y0[40:60] <- -1
y0[80:82] <- 4
y <- y0 + sigma*rnorm(n)
y[80:82] <- y0[80:82] + sigma*rnorm(3)
object <- AMIAS(y, h=1, outer_itermax=5)
plot(object)
```

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