

Package ‘fastkqr’

July 22, 2025

Type Package

Title A Fast Algorithm for Kernel Quantile Regression

Version 1.0.0

Date 2024-05-07

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Description An efficient algorithm to fit and tune kernel quantile regression models based on the majorization-minimization (MM) method. It can also fit multiple quantile curves simultaneously without crossing.

Depends R (>= 3.5.0), methods

Imports graphics, grDevices, stats, utils, dotCall64, rlang, MASS, Matrix

License GPL-2

NeedsCompilation yes

RoxygenNote 7.2.3

Encoding UTF-8

Suggests knitr, rmarkdown

VignetteBuilder knitr

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Repository CRAN

Date/Publication 2024-05-13 11:13:15 UTC

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coef.kqr	<i>Extract model coefficients from a 'kqr' object.</i>
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Description

Computes the coefficients at the requested value(s) for 'lambda' from a [kqr()] object.

Usage

```
## S3 method for class 'kqr'
coef(object, s = NULL, ...)
```

Arguments

object	Fitted [kqr()] object.
s	Value(s) of the penalty parameter 'lambda' at which coefficients are required. Default is the entire sequence.
...	Not used.

Details

's' is the new vector of 'lambda' values at which predictions are requested. If 's' is not in the lambda sequence used for fitting the model, the 'coef' function will use linear interpolation to make predictions. The new values are interpolated using a fraction of coefficients from both left and right 'lambda' indices.

Value

The coefficients at the requested values for 'lambda'.

See Also

[kqr()] and [predict.kqr()].

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
lambda <- 10^(seq(1, -4, length.out=10))
fit <- kqr(x, y, lambda=lambda, tau=0.1)
coef(fit)
```

coef.nckqr	<i>Extract model coefficients from a 'nckqr' object.</i>
------------	--

Description

Computes the coefficients at the requested value(s) for 'lambda1' for a given 'lambda2' from a [nckqr()] object.

Usage

```
## S3 method for class 'nckqr'
coef(object, s1 = NULL, s2, ...)
```

Arguments

object	A fitted nckqr object.
s1	Value(s) of the penalty parameter 'lambda1' at which coefficients are required. Default is the entire sequence used to create the model.
s2	Value of the penalty parameter 'lambda2' at which coefficients are required.
...	Not used.

Details

's1' is the new vector of 'lambda1' values at which predictions are requested. If 's1' is not in the lambda sequence used for fitting the model, the 'coef' function will use linear interpolation to make predictions. The new values are interpolated using a fraction of coefficients from both left and right 'lambda' indices.

Value

The coefficients for the non-crossing kernel quantile regression model.

See Also

[nckqr()] and [predict.nckqr()].

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
l2 <- 1e-4
ttau <- c(0.1, 0.3, 0.5, 0.7, 0.9)
l1_list <- 10^seq(-8, 2, length.out=10)
fit <- nckqr(x,y, lambda1=l1_list, lambda2=l2, tau=ttau)
coef(fit, s1=l1_list[1:3], s2=1e-4)
```

cv.kqr	<i>cross-validation for selecting the tuning parameter of kernel quantile regression</i>
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Description

Performs k-fold cross-validation for [kqr()]. This function is largely similar [glmnet::cv.glmnet()].

Usage

```
cv.kqr(x, y, tau, lambda = NULL, sigma = NULL, nfolds = 5L, foldid, ...)
```

Arguments

x	A numerical input matrix. The dimension is n rows and p columns.
y	Response variable.
tau	A user-supplied tau value for a quantile level.
lambda	A user-supplied lambda sequence.
sigma	Kernel bandwidth.
nfolds	The number of folds in cross-validation. Default is 5.
foldid	An optional vector which indexed the observations into each cross-validation fold. If supplied, nfolds is overridden.
...	Additional arguments passed into kqr

Details

The function computes the average cross-validation error and reports the standard error.

Value

An object of class [cv.kqr()] is returned, which is a list with the components describing the cross-validation error.

lambda	The lambda candidate values.
cvm	Mean cross-validation error.
cvsd	Estimates of standard error of cross-validation error.
cvup	The upper curve: $cvm + cvsd$.
cvlo	The lower curve: $cvm - cvsd$.
lambda.min	The lambda incurring the minimum cross-validation error.
lambda.1se	The largest lambda whose error is within one standard error of the minimum.
cv.min	The cross-validation error at lambda.min.
cv.1se	The cross-validation error at lambda.1se.

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
lambda <- 10^(seq(1, -4, length.out=10))
cv.fit <- cv.kqr(x, y, lambda=lambda, tau=0.1)
```

cv.nckqr	<i>cross-validation for selecting the tuning parameter 'lambda2' of non-crossing kernel quantile regression</i>
----------	---

Description

Performs k-fold cross-validation for [nckqr()]. This function is largely similar [glmnet::cv.glmnet()].

Usage

```
cv.nckqr(
  x,
  y,
  tau,
  lambda1 = NULL,
  lambda2 = NULL,
  sigma = NULL,
  nfolds = 5L,
  foldid,
  ...
)
```

Arguments

x	A numerical input matrix. The dimension is n rows and p columns.
y	Response variable.
tau	A user-supplied tau sequence.
lambda1	A user-supplied lambda1 value.
lambda2	A user-supplied lambda2 sequence.
sigma	Kernel bandwidth.
nfolds	The number of folds in cross-validation. Default is 5.
foldid	An optional vector which indexed the observations into each cross-validation fold. If supplied, nfolds is overridden.
...	Additional arguments passed into nckqr

Details

The function computes the average cross-validation error and reports the standard error.

Value

An object of class [cv.nckqr()] is returned, which is a list with the components describing the cross-validation error.

lambda2	The lambda2 candidate values.
cvm	Mean cross-validation error.
cvsd	Estimates of standard error of cross-validation error.
cvup	The upper curve: cvm + cvsd.
cvlo	The lower curve: cvm - cvsd.
lambda.min	The lambda2 incurring the minimum cross-validation error.
lambda.1se	The largest lambda whose error is within one standard error of the minimum.
cv.min	The cross-validation error at lambda.min.
cv.1se	The cross-validation error at lambda.1se.

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
ttau <- c(0.1, 0.3, 0.5)
l2_list <- 10^(seq(1, -4, length.out=10))
cvres <- cv.nckqr(x, y, ttau, lambda1 = 10, lambda2 = l2_list)
```

kqr	<i>Solve the kernel quantile regression. The solution path is computed at a grid of values of tuning parameter lambda.</i>
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Description

Solve the kernel quantile regression. The solution path is computed at a grid of values of tuning parameter lambda.

Usage

```
kqr(
  x,
  y,
  lambda,
  tau,
  delta = 0.125,
  eps = 1e-05,
  maxit = 1e+06,
  gam = 1e-07,
  sigma = NULL,
  is_exact = FALSE
)
```

Arguments

<code>x</code>	A numerical input matrix. The dimension is n rows and p columns.
<code>y</code>	Response variable. The length is n .
<code>lambda</code>	A user-supplied lambda sequence.
<code>tau</code>	A user-supplied tau value for a quantile level.
<code>delta</code>	The smoothing index for method='huber'. Default is 0.125.
<code>eps</code>	Stopping criterion.
<code>maxit</code>	Maximum number of iterates.
<code>gam</code>	A small number for numerical stability.
<code>sigma</code>	Kernel bandwidth.
<code>is_exact</code>	Exact or approximated solutions. Default is FALSE.

Details

The function implements an accelerated proximal gradient descent to solve kernel quantile regression.

Value

An object with S3 class `kqr`

<code>alpha</code>	An $n + 1$ by L matrix of coefficients, where n is the number of observations and L is the number of tuning parameters. The first row of <code>alpha</code> contains the intercepts.
<code>lambda</code>	The lambda sequence that was actually used.
<code>delta</code>	The smoothing index.
<code>npass</code>	The total number of iterates used to train the classifier.
<code>jerr</code>	Warnings and errors; 0 if none.
<code>info</code>	A list includes some settings used to fit this object: <code>eps</code> , <code>maxit</code>

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
lambda <- 10^(seq(1, -4, length.out=30))
fit <- kqr(x, y, lambda=lambda, tau=0.1, is_exact=TRUE)
```

nckqr

Solve the non-crossing kernel quantile regression

Description

Trains the kernel quantile regression

Usage

```
nckqr(
  x,
  y,
  lambda1,
  lambda2,
  tau,
  delta = 0.125,
  eps = 1e-08,
  maxit = 5e+06,
  gam = 1e-07,
  sigma = NULL,
  kernel = "rbfdot",
  is_exact = FALSE
)
```

Arguments

<code>x</code>	A numerical input matrix. The dimension is $n + 1$ by $ntau$ by $L1$ by $L2$.
<code>y</code>	Response variable. The length is n .
<code>lambda1</code>	A user-supplied <code>lambda1</code> sequence. The length is $L1$.
<code>lambda2</code>	A user-supplied <code>lambda2</code> sequence. The length is $L2$.
<code>tau</code>	A user-supplied <code>tau</code> sequence for quantile levels. The length is $ntau$.
<code>delta</code>	The smoothing index for <code>method='huber'</code> . Default is 0.125.
<code>eps</code>	Stopping criterion.
<code>maxit</code>	Maximum number of iterates.
<code>gam</code>	A small number for numerical stability.
<code>sigma</code>	Kernel bandwidth.
<code>kernel</code>	Name of kernel function. Default is "Gaussian".
<code>is_exact</code>	Exact or approximated solutions.

Details

The function implements the majorization-minimization method to solve non-crossing kernel quantile regression.

Value

An object with S3 class nckqr

alpha	An $n + 1$ by L matrix of coefficients, where n represents the number of observations, $ntau$ represents the number of quantile levels, and L denotes the number of tuning parameters.
tau	The tau sequence that was actually used.
lambda1	The lambda1 sequence that was actually used.
lambda2	The lambda2 sequence that was actually used.
delta	The smoothing index.
npass	The total number of iterates used to train the classifier.
jerr	Warnings and errors; 0 if none.
info	A list includes some settings used to fit this object: eps, maxit

Examples

```
library(MASS)
lambda2 <- 1e-4
tau <- c(0.1, 0.3, 0.5, 0.7, 0.9)
lambda1 <- 10^seq(-8, 2, length.out=10)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
fit <- nckqr(x ,y, lambda1 = lambda1 , lambda2 = lambda2, tau = tau)
```

predict.kqr

Predict the fitted values for a kqr object.

Description

Predict the fitted values for a kqr object.

Usage

```
## S3 method for class 'kqr'
predict(object, x, newx = NULL, s = NULL, ...)
```

Arguments

object	A fitted kqr object.
x	The predictor matrix, i.e., the x matrix used when fitting the kqr object.
newx	A matrix of new values for x at which predictions are to be made. Note that newx must be of a matrix form, predict function does not accept a vector or other formats of newx.

s	Value(s) of the penalty parameter ‘lambda’ at which predictions are required. Default is the entire sequence used to create the model.
...	Not used.

Details

The result is $\beta_0 + K_i' \alpha$ where β_0 and α are from the kqr object and K_i is the i th row of the kernel matrix.

Value

Returns the fitted values.

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
lambda <- 10^(seq(1, -4, length.out=30))
fit <- kqr(x, y, lambda=lambda, tau=0.1, is_exact=TRUE)
predict(fit, x, tail(x))
```

predict.nckqr

Predict the fitted values for a nckqr object.

Description

Predict the fitted values for a nckqr object.

Usage

```
## S3 method for class 'nckqr'
predict(object, x, newx = NULL, s2, s1 = NULL, ...)
```

Arguments

object	A fitted nckqr object.
x	The predictor matrix, i.e., the x matrix used when fitting the nckqr object.
newx	A matrix of new values for x at which predictions are to be made. Note that newx must be of a matrix form, predict function does not accept a vector or other formats of newx.
s2	Value of the penalty parameter ‘lambda2’ at which predictions are required.
s1	Value(s) of the penalty parameter ‘lambda1’ at which predictions are required. Default is the entire sequence used to create the model.
...	Not used.

Value

Returns the fitted values for the non-crossing kernel quantile regression model.

Examples

```
library(MASS)
data(GAGurine)
x <- as.matrix(GAGurine$Age)
y <- GAGurine$GAG
l2 <- 1e-4
ttau <- c(0.1, 0.3, 0.5, 0.7, 0.9)
l1_list <- 10^seq(-8, 2, length.out=10)
fit <- nckqr(x,y, lambda1=l1_list, lambda2=l2, tau=ttau)
predict(fit, x, tail(x), s1=l1_list[1:3], s2=1e-4)
```

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