# Package ‘ftnonpar’

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**Description** The package contains R-functions to perform the methods in nonparametric regression and density estimation, described in Davies, P. L. and Kovac, A. (2001) Local Extremes, Runs, Strings and Multiresolution (with discussion) Annals of Statistics. 29. p1-65 Davies, P. L. and Kovac, A. (2004) Densities, Spectral Densities and Modality Annals of Statistics. Annals of Statistics. 32. p1093-1136 Kovac, A. (2006) Smooth functions and local extreme values. Computational Statistics and Data Analysis (to appear) D\{}"umbgen, L. and Kovac, A. (2006) Extensions of smoothing via taut strings Davies, P. L. (1995) Data features. Statistica Neerlandica 49,185-245.

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`balloon` *Data from a weather balloon*

---

### Description

The data consist of 4984 observations taken from a balloon about 30 kilometres above the surface of the earth. The outliers are caused by the fact that the balloon slowly rotates, causing the ropes from which the measuring instrument is suspended to cut off the direct radiation from the sun.

### Usage

```
data(djdata)
```

### Format

A one-dimensional data set of size 4984

### Source

Davies, L. and Gather, U. (1993), The Identification of Multiple Outliers. *JASA* **88**, 782–801.

### Examples

```
data(balloon)
plot(balloon)
```

## dclaw — *The Claw Distribution*

### Description

Generates a sample from the claw distribution.

### Usage

```
dclaw(x)
```

### Arguments

| | |
|---|---|
| x | Vector of points where the claw density is evaluated. |

### Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

### References

Marron, J. S. and Wand, M. P. (1992) Exact mean integrated squared error

### See Also

rclaw

### Examples

```
plot(dclaw(seq(-3,3,len=1000)),ty="l")
```

## djdata — *Donoho-Johnstone test signals*

### Description

Four samples, each of size 2048 from Donoho and Johnstone's famous signals commonly used as test beds for smoothing methods.

### Usage

```
data(djdata)
```

### Format

Four one-dimensional data sets, each of size 2048

## Source

Donoho, D. L. et al (1995) Wavelet Shrinkage: Asymptopia? *Journal of the Royal Statistical Society* series B, **57**, 301–337.

## Examples

```
data(djdata)
par(mfrow=c(2,2))
plot(djdoppler)
plot(djheavisine)
plot(djblocks)
plot(djbumps)
```

---

`frun` *Runs and local extremes*

---

## Description

Calculation of bounds for functions such that the residuals satisfy a run criterion

## Usage

```
frun(y, ..., alpha = 0.5, r = 0, mr = 0)
```

## Arguments

| | |
|---|---|
| `y` | the data |
| `...` | an optional argument which specifies the approximate positions of the local extreme values. These should be consisten with the run length otherwise the result will be nonsensical. Should you wish to use this option then you should first run the macro without it. The item xb of the output list gives the acceptable limits of the local extreme values. You can then specify the positions within these limits. |
| `alpha` | Quantile determining the acceptable run length. |
| `r` | Acceptable run length: Overrides alpha if not 0 |
| `mr` | mr=0 minimizes the run length consistent with the number of local extreme values found for the specified run length. mr=1 disables the option. |

## Value

| | |
|---|---|
| `l1` | lower bounds |
| `u1` | upper bounds |
| `l2` | lower bound with specified extremes: the default choices for the positions of the local extreme values are the mid-points of the intervals specified by xb above. |
| `u2` | upper bound with specified extremes |
| `f` | function between l2 and u2 satisfying run condition |

| | |
|---|---|
| xb | bounds for location of extremes: the position of the ith extreme value lies between xb[2*i-1] and xb[2*i] |
| nx | number of extremes |
| r | run length: may differ from specified if mr=1 |

## Note

IN GENERAL THE MEAN OF THE BOUNDS l2 AND u2 (l2+u2)/2 GIVES A BETTER REGRESSION FUNCTION THAN f. HOWEVER THIS FUNCTION IS INFINITE AT THE TWO ENDPOINTS AND AT LOCAL EXTREME VALUES. IN THESE INTERVALS IT CAN BE REPLACED BY ANY VALUES WHICH DO NOT ALTER THE NUMBER OF LOCAL EXTREME VALUES. THE MEDIAN OF THE y-VALUES IN THESE INTERVALS IS A REASONABLE CHOICE.

## Author(s)

Laurie Davies <Laurie.Davies@uni-essen.de>

## References

Davies, P. L. (1995) Data features. Statistica Neerlandica 49,185-245.

Davies, P. L. and Kovac, A. (2001) Local Extremes, Runs, Strings and Multiresolution (with discussion) Annals of Statistics. 29. p1-65

## See Also

mintvmon,pmreg,l1pmreg

---

genpmreg — *Piecewise monotone regression with generalised taut strings*

---

## Description

Applies the generalised taut string method to one-dimensional data.

## Usage

```
genpmreg(y, beta = 0.5, squeezing.factor = 0.5, verbose = FALSE, localsqueezing = TRUE, DYADIC = TRUE,
```

## Arguments

| | |
|---|---|
| y | observed values (ordered by value of independent variable) |
| beta | If method=1 specifies the quantile |
| squeezing.factor | The amount of decrement applied to the bandwidthes |
| verbose | logical, if T progress (for each iteration) is illustrated grahically |

| | |
|---|---|
| localsqueezing | logical, if T (default) the bandwidth is changed locally. |
| DYADIC | If T checks the multiresolution criterion only on dyadic intervals, otherwise all intervals are checked |
| thr.const | smoothing parameter for the multiresolution criterion (should be approximately 2.5) |
| extrema.nr | if set to a positive integer an approximation with the specified number of local extreme values is calculated |
| bandwidth | if set to a positive value the specified bandwidth is used instead of the multiresolution criterion. |
| SETTOMEAN | logical, if T (default) the value of the taut string approximation at local extreme values is set to the mean or median of the observations on the interval where the extremum is taken. |
| method | The method used which can be 1 (quantile regression), 2 (usual taut string), 3 (logistic regression) and 4 (Poisson regression) |
| ... | Passed to the plot command if verbose=T |

## Value

A list with components

| | |
|---|---|
| y | The approximation of the given data |
| lambda | Values for lambda used |
| nmax | Number of local extreme values |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

D\"umbgen, L. and Kovac, A. (2006) Extensions of smoothing via taut strings

## See Also

pmreg

## Examples

```
data(djdata)
par(mfrow=c(2,2))
plot(djblocks,col="grey")
lines(genpmreg(djblocks,verbose=FALSE,method=2,thr.const=2.5)$y,col="red")
title("Usual taut string method")
ind <- sample(1:length(djblocks),300)
djblocks[ind] <- djblocks[ind]+rnorm(length(ind),0,100)
plot(djblocks,col="grey")
lines(genpmreg(djblocks,verbose=FALSE,method=2)$y,col="red")
title("Usual taut string method with outliers")
```

```
plot(djblocks,col="grey")
lines(genpmreg(djblocks,verbose=FALSE,method=1)$y,col="red")
title("Robust taut string method with outliers")
plot(djblocks,col="grey",ylim=c(-10,10))
lines(genpmreg(djblocks,verbose=FALSE,method=1)$y,col="red")
title("Again robust taut string method, different scaling of y-axis")
```

---

kkuip *Generalized Kuiper Metrics*

---

## Description

Calculates the generalized k-th Kuiper metric

## Usage

```
kkuip(x, k=1)
```

## Arguments

| | |
|---|---|
| x | Data vector |
| k | Number of intervals to be used for the generalized Kuiper metric. The usual Kuiper metric is obtained by the default value 1. |

## Value

| | |
|---|---|
| metric | Value of the metric |
| a | The left borders of the intervals where the maximum is obtained. |
| b | The right borders of the intervals where the maximum is obtained. |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

Davies, P. L. and Kovac, A. (2001) Densities, Spectral Densities and Modality

## See Also

pmden

## Examples

```
aaa <- rclaw(500)
kkuip(aaa,9)
```

l1pmreg *Piecewise monotone nonparameric quantile regression*

## Description

Applies the generalized taut string method to quantile regression.

## Usage

```
quantpmreg(y, beta = 0.5, squeezing.factor = 0.5, verbose = FALSE, localsqueezing = TRUE, DYADIC = TRU
l1pmreg(y, beta=0.5, squeezing.factor = 0.5, verbose = FALSE, localsqueezing = TRUE, DYADIC = TRUE, th
```

## Arguments

| | |
|---|---|
| `y` | observed values (ordered by value of independent variable) |
| `beta` | quantile. The default is 0.5 which corresponds to the robust taut string. |
| `squeezing.factor` | The amount of decrement applied to the bandwidthes |
| `verbose` | logical, if T progress (for each iteration) is illustrated grahically |
| `localsqueezing` | logical, if T (default) the bandwidth is changed locally. |
| `DYADIC` | logical, if T (default) the multiresolution criterion is only verified on intervals with dyadic endpoints. |
| `thr.const` | smoothing parameter for the multiresoultion criterion (should be approximately 2) |
| `extrema.nr` | if set to a positive integer an approximation with the specified number of local extreme values is calculated |
| `bandwidth` | if set to a positive value the specified bandwidth is used instead of the multiresolution criterion. |
| `SETTOMEAN` | logical, if T (default) the value of the taut string approximation at local extreme values is set to the mean or median of the observations on the interval where the extremum is taken. |
| `method` | The method used which can be 1 (quantile regression), 2 (usual taut string), 3 (logistic regression) and 4 (Poisson regression) |
| `...` | Passed to the plot command if verbose=T |

## Value

A list with components

| | |
|---|---|
| `y` | The approximation of the given data |
| `lambda` | The final values of lambda |
| `nmax` | Number of local extreme values |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

D\"umbgen, L. and Kovac, A. (2003) Extensions of smoothing via taut strings

## See Also

pmreg,frun

---

mintvmon *Minimization of total variation*

---

## Description

Finds a function vector which minimizes the total variation of the function or a derivative under multiresolution constraints and monotonicity and convexity constraints.

## Usage

```
mintvmon(y, sigma = -1, DYADIC = TRUE, thresh = -1, method = 2, MONCONST = TRUE, CONVCONST = FALSE)
```

## Arguments

| | |
|---|---|
| `y` | observed values (ordered by value of independent variable). |
| `sigma` | if set to a positive value the standard deviation is set to sigma and not estimated from the data |
| `DYADIC` | logical, if T (default) the multiresolution constraints are only verifeid on intervals with dyadic endpoints |
| `thresh` | if set to a positive value other thresholds for the multiresolution criterion than the default sqrt(2*log(n))*sigma can be used. |
| `method` | Number of derivative the total variation of which is minimzed. Possible values are 0,1,2. Higher values lead to numerical inconsistencies. |
| `MONCONST` | logical, if T (default) additional monotonicty constraints are gathered from minimzing the total variation of f. Makes only sense, if method is 1 or 2. |
| `CONVCONST` | logical, if T (default) additional convexity constraints are gathered from minimzing the total variation of f'. Makes only sense, if method is 2. |

## Value

A list with components

| | |
|---|---|
| `y` | The approximation of the given data |
| `derivsign` | Vector of 1 and -1, monotonicty constraints used if MONCONST was true |
| `secsign` | Vector of 1 and -1, convexity constraints used if CONVCONST was true |
| `jact` | Left endpoints of active multiresolution constraints for the final approximation |
| `kact` | Right endpoints of active multiresolution constraints for the final approximation |
| `signact` | Vector of 1 and -1, gives for each active multiresolution constraints, if the residuals on that interval attain upper or lower bound |
| `pl` | Left endpoint of piecewise constant intervals of the derivative of f being minimized |
| `pr` | Right endpoint of piecewise constant intervals of the derivative of f being minimized |

## Author(s)

Arne Kovac

## References

Kovac, A. (2003) Minimizing Total Variation under Multiresolution Conditions

## See Also

pmreg

## Examples

```
data(djdata)
djdoppler.tv0 <- mintvmon(djdoppler,method=0)
djdoppler.tv1 <- mintvmon(djdoppler,method=1)
djdoppler.tv2 <- mintvmon(djdoppler)
par(mfrow=c(2,2))
plot(djdoppler,col="lightgrey")
plot(djdoppler,col="lightgrey")
lines(djdoppler.tv0$y,col="blue")
plot(djdoppler,col="lightgrey")
lines(djdoppler.tv1$y,col="green")
plot(djdoppler,col="lightgrey")
lines(djdoppler.tv2$y,col="red")
```

pmden *Piecewise monotone density estimation with taut strings*

## Description

Applies the taut string method to one-dimensional data.

## Usage

```
pmden(x, DISCR=FALSE,verbose = FALSE, bandwidth=-1, extrema.nr = -1, accuracy = mad(x)/1000,  extrema.
```

## Arguments

| | |
|---|---|
| x | observed values |
| DISCR | logical, if T a discrete density is fitted |
| verbose | logical, if T progress (for each iteration) is illustrated grahically |
| bandwidth | if set to a positive value the specified bandwidth is used instead of the automatic criterion based on generalized Kuiper metrics. |
| extrema.nr | if set to a positive integer an approximation with the specified number of local extreme values is calculated |
| accuracy | Precision of the data. Handling of identical observations depends on this parameter. |
| extrema.mean | logical, if T the value at the local extrema is changed to the mean frequency of observations on that interval |
| maxkuipnr | The order of the highest generalized Kuiper metric used for the automatic choice of the bandwidth |
| asympbounds | If set to T asymptotic bounds derived from a Brwonian Bridge are used for the Kuiper criterion. Otherwise simulated bounds for various sample sizes are interpolated for the size of the data x |
| tolerance | Accuracy used for the determination of the bandwidth when extrema.nr is greater than 0. |
| localsq | If set to TRUE (default) performs, if necessary, additional local squeezing after the Kuiper metrics are small enough |
| locsq.factor | The amount of decrement applied to the bandwidthes if local squeezing is carried out. |

## Value

| | |
|---|---|
| y | values of the density approximation between the observations |
| widthes | bandwidth used for the taut string approximation |
| nmax | number of local extreme values |
| ind | indices of knots points of the taut string |
| trans | taut string at the observations, should look like uniform noise |

### Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

### References

Davies, P. L. and Kovac, A. (2003) Densities, Spectral Densities and Modality

### See Also

pmreg,l1pmreg,pmspec

### Examples

```
aaa <- rclaw(500)
pmden(aaa,verb=TRUE)$n
```

---

## pmlogreg *Piecewise monotone logistic regression with taut strings*

---

### Description

Applies the taut string method to binary data.

### Usage

```
pmlogreg(y, thr.const=2.5, verbose=FALSE, extrema.nr=-1, bandwidth=-1,
localsqueezing=TRUE, squeezing.factor=0.5, tolerance=0.001,extrema.mean=TRUE)
```

### Arguments

| | |
|---|---|
| `y` | observed values (ordered by value of independent variable) |
| `thr.const` | smoothing parameter for the multiresolution criterion (should be approximately 2.5) |
| `verbose` | logical, if T progress (for each iteration) is illustrated grahically |
| `extrema.nr` | if set to a positive integer an approximation with the specified number of local extreme values is calculated |
| `bandwidth` | if set to a positive value the specified bandwidth is used instead of the multiresolution criterion. |
| `localsqueezing` | logical, if T (default) the bandwidth is changed locally. |
| `squeezing.factor` | The amount of decrement applied to the bandwidthes |
| `tolerance` | Accuracy used for the determination of the bandwidth when extrema.nr is greater than 0. |
| `extrema.mean` | logical, if T (default) the value of the taut string approximation at local extreme values is set to the mean of the observations on the interval where the extremum is taken. |

## Value

A list with components

| | |
|---|---|
| y | The approximation of the given data |
| widthes | Bandwidth used |
| nmax | Number of local extreme values |
| knotsind | Indices of knot points |
| knotsy | y-koordinates of knots of the taut string |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## See Also

l1pmreg,pmden,pmspec

## Examples

```
aaa<-rbinom(1024,1,0.5+0.5*sin(seq(0,10*pi,len=1024)))
pmlogreg(aaa,verbose=TRUE)$n
```

---

pmreg *Piecewise monotone regression with taut strings*

---

## Description

Applies the taut string method to one-dimensional data.

## Usage

```
pmreg(y, thr.const=2.3, verbose=FALSE, extrema.nr=-1, bandwidth=-1,
sigma=-1, localsqueezing=TRUE, squeezing.factor=0.5, tolerance=1e-08,
extrema.mean=TRUE,DYADIC=TRUE,dyad.factor=1.1,POSTISO=TRUE)
```

## Arguments

| | |
|---|---|
| y | observed values (ordered by value of independent variable) |
| thr.const | smoothing parameter for the multiresolution criterion (should be approximately 2.3) |
| verbose | logical, if T progress (for each iteration) is illustrated grahically |
| extrema.nr | if set to a positive integer an approximation with the specified number of local extreme values is calculated |
| bandwidth | if set to a positive value the specified bandwidth is used instead of the multiresolution criterion. |

| | |
|---|---|
| sigma | if set to a positive value sigma the standard deviation is set to sigma and not estimated from the data |
| localsqueezing | logical, if TRUE (default) the bandwidth is changed locally. |
| squeezing.factor | The amount of decrement applied to the bandwidthes |
| tolerance | Accuracy used for the determination of the bandwidth when extrema.nr is greater than 0. |
| extrema.mean | logical, if TRUE (default) the value of the taut string approximation at local extreme values is set to the mean of the observations on the interval where the extremum is taken. |
| DYADIC | If TRUE the multiresolution constraints are only checked on dyadic intervals. |
| dyad.factor | If the multiresolution constraints are checked on dyadic intervals, dyad.factor determines the ratio between the lengths of two subsequent level (default is 1.1). |
| POSTISO | If TRUE (default) any bias caused by local squeezing is removed by applying isotonic and isotonic regression between each two local extreme values. |

## Value

A list with components

| | |
|---|---|
| y | The approximation of the given data |
| sigma | Standard deviation used |
| widthes | Bandwidth used |
| nmax | Number of local extreme values |
| knotsind | Indices of knot points |
| knotsy | y-koordinates of knots of the taut string |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

Davies, P. L. and Kovac, A. (2001) Local Extremes, Runs, Strings and Multiresolution (with discussion) Annals of Statistics. 29. p1-65

## See Also

mintvmon,l1pmreg,pmden,pmspec

## Examples

```
data(djdata)
pmreg(djdoppler,verbose=TRUE)$n
```

pmspec *Piecewise monotone spectral density approximation with taut strings*

### Description

Applies the taut string method to spectral densities.

### Usage

```
pmspec(x, pks=0, alpha=0.9, sqzf=0.9, mult=0, lcl=0, ln=0, fig = 0, pow=10^-2)
```

### Arguments

| | |
|---|---|
| `x` | data |
| `pks` | if pks=0 then the number of peaks is determined automatically. If pks = k >0 then a density with n paeks is returned `pks` |
| `alpha` | If pks=0 then on Gaussian test beds the number of peaks of the true density is at least the returned value with an asymptotic probability of at least alpha. If pks > 0 then the parameter is not operational `alpha` |
| `sqzf` | Squeeze factor for the taut string `sqzf` |
| `mult` | If mult = T then rescaled empirical density is compared with the exponential distribution only on intervals forming a multiresolution scheme. If T = F then all intervals are used. If the sample size of the data is less than 512 then T = F is default `mult` |
| `lcl` | If lcl = T then string is calculated using local squeezing. If lcl = F then global squeezing is used.`lcl` |
| `fig` | If fig = T then the data are automticall plotted `fig` |
| `ln` | If fig = T and ln = T then the densities are plotted on a log scale. If ln = F then no transformation is performed `ln` |
| `pow` | Peaks with a power less than pow * total power will be ignored |

### Value

| | |
|---|---|
| `edf` | Emprical spectral density |
| `df` | String density |
| `pks` | Number of peaks |
| `ll` | Lower boundary for string |
| `uu` | Upper boundary for string |
| `str` | String |

### Author(s)

Laurie Davies <Laurie.Davies@uni-essen.de>

## References

Davies, P.L. snd Kovac, A. (2001) Local extremes, runs, strings and multiresolution, Annals of Statistics 29 (1) 1-65. Davies, P. L. and Kovac, A. (2002) Densities, Spectral Densities and Modality

## See Also

pmreg,l1pmreg,pmden

---

rclaw *The Claw Distribution*

---

## Description

Generates a sample from the claw distribution.

## Usage

```
rclaw(n)
```

## Arguments

| | |
|---|---|
| n | Sample size |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

Marron, J. S. and Wand, M. P. (1992) Exact mean integrated squared error

## See Also

dclaw

## Examples

```
aaa <- rclaw(500)
kkuip(aaa,9)
```

`rtennormal` *Mixture of ten normal distributions*

### Description

Generates a sample from a mixture of ten normal distributions.

### Usage

```
rtennormal(n)
```

### Arguments

| | |
|---|---|
| n | Sample size |

### Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

### See Also

rclaw

### Examples

```
aaa <- rtennormal(500)
kkuip(aaa,9)
```

`smdenreg` *Piecewise monotone density estimation with smooth taut strings*

### Description

Applies the smooth taut string method to one-dimensional data.

### Usage

```
smdenreg(x, verbose = FALSE, bandwidth=-1, maxkuipnr=19,asympbounds=FALSE,
squeezing.factor=0.9, firstlambda=10,smqeps=1/length(x),fsign=double(0),
gensign=TRUE,...)
```

### Arguments

| | |
|---|---|
| `x` | observed values |
| `verbose` | logical, if T progress (for each iteration) is illustrated grahically |
| `bandwidth` | if set to a positive value the specified bandwidth is used instead of the automatic criterion based on generalized Kuiper metrics. |
| `maxkuipnr` | The order of the highest generalized Kuiper metric used for the automatic choice of the bandwidth |
| `asympbounds` | If set to T asymptotic bounds derived from a Brownian Bridge are used for the Kuiper criterion. Otherwise simulated bounds for various sample sizes are interpolated for the size of the data x |
| `squeezing.factor` | The amount of decrement applied to the bandwidthes |
| `firstlambda` | Initial value of lambda's for global squeezing. |
| `smqeps` | Distance between the (equally-spaced) time points. |
| `fsign` | Monotonicity constraints, vector of size n-1 of -1,0 and 1's. If fsign[i]==1, then fhat[i+1]>= fhat[i]. If fsign[i]==-1, then fhat[i+1]<=f[i]. Otherwise no constraint at this position. |
| `gensign` | If TRUE the taut string method is used to automatically produce suitable monotonicity constraints. |
| `...` | Passed to the plot command if verbose=T. |

### Value

| | |
|---|---|
| `x` | The sorted data |
| `y` | values of the density approximation between the observations |
| `nmax` | Number of local extreme values |
| `trans` | taut string at the observations, should look like uniform noise |

### Author(s)

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### References

Kovac, A. (2006) Smooth functions and local extreme values. Technical Report

### See Also

pmreg,l1pmreg,pmspec

### Examples

```
y <- rclaw(500)
hist(y,col="lightgrey",40,freq=FALSE)
lines(smdenreg(y),col="red")
```

smqreg *Smooth piecewise monotone regression with taut strings*

## Description

Applies the smooth taut string method to one-dimensional data.

## Usage

```
smqreg(y, thr.const=2.5, verbose=FALSE, bandwidth=-1,
sigma=-1, localsqueezing=TRUE, squeezing.factor=0.5, DYADIC=TRUE,
firstlambda=100,smqeps=1/length(y),fsign=double(0),gensign=TRUE,
tolerance = 1e-12,...)
```

## Arguments

| | |
|---|---|
| `y` | observed values (ordered by value of independent variable) |
| `thr.const` | smoothing parameter for the multiresolution criterion (should be approximately 2.5) |
| `verbose` | logical, if T progress (for each iteration) is illustrated grahically |
| `bandwidth` | if set to a positive value the specified bandwidth is used instead of the multiresolution criterion. |
| `sigma` | if set to a positive value sigma the standard deviation is set to sigma and not estimated from the data |
| `localsqueezing` | logical, if T (default) the bandwidth is changed locally. |
| `squeezing.factor` | The amount of decrement applied to the bandwidthes |
| `DYADIC` | If TRUE the multiresolution constraints are only checked on dyadic intervals. |
| `firstlambda` | Initial value of lambda's for local or global squeezing. |
| `smqeps` | Distance between the (equally-spaced) time points. |
| `fsign` | Monotonicity constraints, vector of size n-1 of -1,0 and 1's. If fsign[i]==1, then fhat[i+1]>= fhat[i]. If fsign[i]==-1, then fhat[i+1]<=f[i]. Otherwise no constraint at this position. |
| `gensign` | If TRUE the taut string method is used to automatically produce suitable monotonicity constraints. |
| `tolerance` | Precision for the nested intervals for solving the minimisation problem. |
| `...` | Passed to the plot command if verbose=T. |

## Value

A list with components

| | |
|---|---|
| `y` | The approximation of the given data |
| `nmax` | Number of local extreme values |
| `sigma` | Standard deviation used |

## Author(s)

Arne Kovac <A.Kovac@bristol.ac.uk>

## References

Kovac, A. (2006) Smooth functions and local extreme values. Technical Report

## See Also

pmreg, mintvmon, l1pmreg, pmden, pmspec

## Examples

```
data(djdata)
par(mfrow=c(2,2))
plot(djblocks,col="grey")
lines(smqreg(djblocks)$y,col="red")
plot(djbumps,col="grey")
lines(smqreg(djbumps)$y,col="red")
plot(djheavisine,col="grey")
lines(smqreg(djheavisine)$y,col="red")
plot(djdoppler,col="grey")
lines(smqreg(djdoppler)$y,col="red")
```

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