Package ‘BinSegBstrap’

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Title  Piecewise Smooth Regression by Bootstrapped Binary Segmentation
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Description  Provides methods for piecewise smooth regression. A piecewise smooth signal is estimated by applying a bootstrapped test recursively (binary segmentation approach). Each bootstrapped test decides whether the underlying signal is smooth on the currently considered subsegment or contains at least one further change-point.

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BinSegBstrap-package  Piecewise smooth regression by bootstrapped binary segmentation

Description

Provides methods for piecewise smooth regression. The main function BinSegBstrap estimates a piecewise smooth signal by applying a bootstrapped test recursively (binary segmentation approach). A single bootstrapped test for the hypothesis that the underlying signal is smooth versus the alternative that the underlying signal contains at least one change-point can be performed by the function BstrapTest. A single change-point is estimated by the function estimateSingleCp. More details can be found in the vignette. Parts of this work were inspired by Gijbels and Goderniaux (2004).

Acknowledgement

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References


See Also

BinSegBstrap, BstrapTest, estimateSingleCp

Examples

```r
n <- 200
signal <- sin(2 * pi * 1:n / n)
signal[51:100] <- signal[51:100] + 5

y <- rnorm(n) + signal

est <- BinSegBstrap(y = y)

plot(y)
lines(signal)
lines(est$est, col = "red")

n <- 100
signal <- sin(2 * pi * 1:n / n)
signal[51:100] <- signal[51:100] + 5
```
y <- rnorm(n) + signal
test <- BstrapTest(y = y)
est <- estimateSingleCp(y = y)
plot(y)
lines(signal)
lines(est$est, col = "red")

BinSegBstrap Estimates a piecewise smooth signal

Description
A piecewise smooth signal is estimated by applying BstrapTest recursively (binary segmentation approach). The final estimator is estimated by kernel smoothing on each segment separately; a joint bandwidth is selected by crossvalidation. More details can be found in the vignette.

Usage
BinSegBstrap(y, bandwidth, nb bandwidth = 30L, B = 500L, alpha = 0.05, kernel = c("epanechnikov", "gaussian", "rectangular", "triangular", "biweight", "silverman"))

Arguments
y a numeric vector containing the data points
bandwidth the bandwidth, i.e. a numeric with values between 1 / length(y) and 0.5. If missing exp(seq(log(10 / length(y)), log(0.25), length.out = nb bandwidth)) will be used. Crossvalidation will be performed if it is not a single numeric. Note that the test has almost no power when the bandwidth for the kernel smoother is too small, since then a change-point can be approximated well by a quickly changing smooth function.

nb bandwidth a single integer giving the number of bandwidths (see above) if bandwidth is missing
B a single integer giving the number of bootstrap samples
alpha a probability, i.e. a single numeric between 0 and 1, giving the significance level of the test
kernel the kernel function, i.e. either a string or a function that takes a single numeric vector and returns the values of the kernel at those locations

Value
a list with the following components:
- est: the estimated signal
- cps: the estimated change-point locations
- bandwidth: the selected bandwidth
Examples

```r
n <- 200
signal <- sin(2 * pi * 1:n / n)
signal[51:100] <- signal[51:100] + 5

y <- rnorm(n) + signal

# default bandwidth and kernel
est <- BinSegBstrap(y = y)

plot(y)
lines(signal)
lines(est$est, col = "red")

# fixed bandwidth
est <- BinSegBstrap(y = y, bandwidth = 0.1)

# user specified kernel
kernel <- function(x) 1 - abs(x) # triangular kernel
est <- BinSegBstrap(y = y, kernel = kernel)
```

BstrapTest  

**Bootstrap test for a single change-point**

Description

Tests whether the underlying signal is smooth or contains at least one change-point. The smooth alternative is estimated by a (crossvalidated) kernel smoother. The single change-point alternative is estimated by `estimateSingleCp`. Its estimated jump size is used as a test statistic and the critical value is obtained by bootstrapping. More details can be found in the vignette.

Usage

```r
BstrapTest(y, bandwidth, nbandwidth = 30L, B = 500L, alpha = 0.05,
          kernel = c("epanechnikov", "gaussian", "rectangular",
                      "triangular", "biweight", "silverman"))
```

Arguments

- `y`  
a numeric vector containing the data points
- `bandwidth`  
the bandwidth, i.e. a numeric with values between 1 / length(y) and 0.5. If missing `exp(seq(log(10/length(y)), log(0.25), length.out = nbandwidth))` will be used. Crossvalidation will be performed if it is not a single numeric. Note that the test has almost no power when the bandwidth for the kernel smoother is too small, since then a change-point can be approximated well by a quickly changing smooth function.
BstrapTest

- \texttt{nbbandwidth}: a single integer giving the number of bandwidths (see above) if \texttt{bandwidth} is missing.
- \texttt{B}: a single integer giving the number of bootstrap samples.
- \texttt{alpha}: a probability, i.e. a single numeric between 0 and 1, giving the significance level of the test.
- \texttt{kernel}: the kernel function, i.e. either a string or a function that takes a single numeric vector and returns the values of the kernel at those locations.

\textbf{Value}

A list with the following components:
- \texttt{piecewiseSignal}: the estimated signal with a single change-point.
- \texttt{cp}: the estimated change-point location.
- \texttt{size}: the estimated jump size.
- \texttt{bandwidth}: the selected bandwidth for the piecewise signal.
- \texttt{bandwidthSmooth}: the selected bandwidth for the smooth signal.
- \texttt{smoothSignal}: the estimated smooth signal.
- \texttt{critVal}: the by bootstrapping obtained critical value.
- \texttt{pValue}: the p-Value of the test.
- \texttt{outcome}: a boolean saying whether the test rejects the hypothesis of a smooth signal.

\textbf{Examples}

```r
n <- 100
signal <- sin(2 * pi * 1:n / n)
signal[51:100] <- signal[51:100] + 5
y <- rnorm(n) + signal
# default bandwidth and kernel
test <- BstrapTest(y = y)
if (test$outcome) {
  # null hypothesis of a smooth signal is rejected
  estimatedSignal <- test$piecewiseSignal
} else {
  # null hypothesis of a smooth signal is accepted
  estimatedSignal <- test$smoothSignal
}
plot(y)
lines(signal)
lines(estimatedSignal, col = "red")
# fixed bandwidth
test <- BstrapTest(y = y, bandwidth = 0.1)
# user specified kernel
kernel <- function(x) 1 - abs(x) # triangular kernel
test <- BstrapTest(y = y, kernel = kernel)
```
Estimation of a single change-point

**Description**

Estimates a single change-point in an otherwise smooth function. The change-point location is estimated as the maximum of the differences of left and right sided running means. The estimate left and right of the change-point are obtained by kernel smoothers. Windows of the running mean and kernel bandwidth are chosen by crossvalidation. More details can be found in the vignette.

**Usage**

```r
estimateSingleCp(y, bandwidth, nbandwidth = 30L,  
                  kernel = c("epanechnikov", "gaussian", "rectangular",  
                                "triangular", "biweight", "silverman"))
```

**Arguments**

- `y`: a numeric vector containing the data points
- `bandwidth`: the bandwidth, i.e. a numeric with values between 1 / length(y) and 0.5. If missing `exp(seq(log(2 / length(y)),log(0.25),length.out = nbandwidth))` will be used. Crossvalidation will be performed if it is not a single numeric
- `nbandwidth`: a single integer giving the number of bandwidths (see above) if `bandwidth` is missing
- `kernel`: the kernel function, i.e. either a string or a function that takes a single numeric vector and returns the values of the kernel at those locations

**Value**

A list with the following components:
- `est`: the estimated function with a single change-point
- `cp`: the estimated change-point location
- `size`: the estimated jump size
- `bandwidth`: the selected bandwidth

**Examples**

```r
n <- 100  
signal <- sin(2 * pi * 1:n / n)  
signal[51:100] <- signal[51:100] + 5

y <- rnorm(n) + signal

# default bandwidth and kernel
est <- estimateSingleCp(y = y)

plot(y)
```
estimateSingleCp

```r
lines(signal)
lines(est$est, col = "red")

# fixed bandwidth
est <- estimateSingleCp(y = y, bandwidth = 0.1)

# user specified kernel
kernel <- function(x) 1 - abs(x) # triangular kernel
est <- estimateSingleCp(y = y, kernel = kernel)
```
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