Package ‘feature’

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Description

Package for feature significance for multivariate kernel density estimation.

Details

The feature package contains functions to display and compute kernel density estimates, significant gradient and significant curvature regions. Significant gradient and/or curvature regions often correspond to significant features (e.g. local modes).

There are two main functions in this package. featureSignifGUI is the interactive function where the user can select bandwidths from a pre-defined range. This mode is useful for initial exploratory data analysis. featureSignif is the non-interactive function. This is useful when the user has a more definite idea of suitable values for the bandwidths. For a more detailed example for 1-, 2- and 3-d data, see vignette("feature").

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See Also

ks, sm, KernSmooth

earthquake

Mt St Helens earthquake data

Description

This data set is a reduced version of the full data set in Scott (1992). It contains the first three variables.

Usage

data(earthquake)

Format

A matrix with 3 columns and 510 rows. Each row corresponds to the measurements of an earthquake beneath the Mt St Helens volcano. The first column is the longitude (in degrees, where a negative number indicates west of the International Date Line), the second column is the latitude (in degrees, where a positive number indicates north of the Equator) and the third column is the depth (in km, where a negative number indicates below the Earth’s surface).
featureSignif

Source

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featureSignif  Feature significance for kernel density estimation

Description
Identify significant features of kernel density estimates of 1- to 4-dimensional data.

Usage
```
featureSignif(x, bw, gridsize, scaleData=FALSE, addSignifGrad=TRUE,
             addSignifCurv=TRUE, signifLevel=0.05)
```

Arguments
- **x**: data matrix
- **bw**: vector of bandwidth(s)
- **gridsize**: vector of estimation grid sizes
- **scaleData**: flag for scaling the data i.e. transforming to unit variance for each dimension.
- **addSignifGrad**: flag for computing significant gradient regions
- **addSignifCurv**: flag for computing significant curvature regions
- **signifLevel**: significance level

Details
Feature significance is based on significance testing of the gradient (first derivative) and curvature (second derivative) of a kernel density estimate. This was developed for 1-d data by Chaudhuri & Marron (1995), for 2-d data by Godtliebsen, Marron & Chaudhuri (1999), and for 3-d and 4-d data by Duong, Cowling, Koch & Wand (2007).

The test statistic for gradient testing is at a point $x$ is

$$ W(x) = \| \widehat{\nabla} f(x; H) \|^2 $$

where $\widehat{\nabla} f(x; H)$ is kernel estimate of the gradient of $f(x)$ with bandwidth $H$, and $\| \cdot \|$ is the Euclidean norm. $W(x)$ is approximately chi-squared distributed with $d$ degrees of freedom where $d$ is the dimension of the data.

The analogous test statistic for the curvature is

$$ W^{(2)}(x) = \| \text{vech} \widehat{\nabla}^{(2)} f(x; H) \|^2 $$

where $\widehat{\nabla}^{(2)} f(x; H)$ is the kernel estimate of the curvature of $f(x)$, and vech is the vector-half operator. $W^{(2)}(x)$ is approximately chi-squared distributed with $d(d+1)/2$ degrees of freedom.

Since this is a situation with many dependent hypothesis tests, we use the Hochberg multiple comparison testing procedure to control the overall level of significance. See Hochberg (1988) and Duong, Cowling, Koch & Wand (2007).
**Value**

Returns an object of class `fs` which is a list with the following fields:

- `x` data matrix
- `names` name labels used for plotting
- `bw` vector of bandwidths
- `fhat` kernel density estimate on a grid
- `grad` logical grid for significant gradient
- `curv` logical grid for significant curvature
- `gradData` logical vector for significant gradient data points
- `gradDataPoints` significant gradient data points
- `curvData` logical vector for significant curvature data points
- `curvDataPoints` significant curvature data points

**References**


**See Also**

`featureSignifGUI`, `plot.fs`

**Examples**

```r
## Univariate example
data(earthquake)
eq3 <- -log10(-earthquake[,3])
fs <- featureSignif(eq3, bw=0.1)
plot(fs, addSignifGradRegion=TRUE)

## Bivariate example
library(MASS)
data(geyser)
fs <- featureSignif(geyser)
plot(fs, addKDE=FALSE, addData=TRUE) ## data only
plot(fs, addKDE=TRUE) ## KDE plot only
plot(fs, addSignifGradRegion=TRUE)
plot(fs, addKDE=FALSE, addSignifCurvRegion=TRUE)
plot(fs, addSignifCurvData=TRUE, curvCol="cyan")
```
Description

GUI for feature significance for kernel density estimation.

Usage

featureSignifGUI(x, scaleData=FALSE)

Arguments

x data matrix
scaleData flag for scaling the data to the unit interval in each dimension

Details

In the first column are the sliders for selecting the bandwidths (one for each dimension). Move the slider buttons to change the value of the bandwidths. The text field is for the grid size which specifies the number of points in each dimension of the kernel estimation binning grid. Press the Compute significant features button to begin the computation. This creates a plot of the kernel density estimate (KDE) from the data with the specified bandwidths by calling featureSignif. Once this complete, a pop-up window will appear.

In the second column are the axis limits and labels. The last text field is for the (maximum) number of data points used in the display. Press the Reset plot (except KDE) button to clear the plot of all added features except for the KDE itself.

In the third column are 5 buttons which can be used to add to the KDE plot such as the data points, significant gradient points/regions and significant curvature points/regions. For 1-d data, the button in the third column is Compute SiZer map. Press this button to compute a gradient SiZer plot using the SiZer function. Once this complete, a pop-up window will appear. For 2- and 3-d data, the button in the third column is Reset plot. This will clear the plot of all features as well as the KDE. This is useful for showing only the significant features when the KDE may interfere with their display.

For 3-d data, there is an extra fourth column of options: these are sliders for the transparency values for the features. Move the slider button along to the desired value (between 0 and 1) and then press the Add ... button to the left. Repeatedly pressing the Add ... button will cause the transparency of the features to decrease. In this case, press the one of the Reset plot buttons to clear the plot window, and replot the significant feature with the desired transparency.

Examples

if (interactive()){ library(MASS) data(geyser) duration <- geyser$duration
Feature significance plot for 1- to 3-dimensional data

Description

Feature significance plot for 1- to 3-dimensional data.

Usage

```r
## S3 method for class 'fs'
plot(x, xlab, ylab, zlab, xlim, ylim, zlim, add=FALSE, addData=FALSE,
     scaleData=FALSE, addDataNum=1000, addKDE=TRUE, jitterRug=TRUE,
     addSignifGradRegion=FALSE, addSignifGradData=FALSE,
     addSignifCurvRegion=FALSE, addSignifCurvData=FALSE, addAxes3d=TRUE,
     densCol, dataCol="black", gradCol="#33A02C", curvCol="#1F78B4",
     axisCol="black", bgCol="white", dataAlpha=0.1, gradDataAlpha=0.3,
     gradRegionAlpha=0.2, curvDataAlpha=0.3, curvRegionAlpha=0.3, rgl=FALSE, ...)
```

Arguments

- `x`: object of class `fs` (output from `featureSignif` function)
- `xlim`, `ylim`, `zlim`: x-, y-, z-axis limits
- `xlab`, `ylab`, `zlab`: x-, y-, z-axis labels
- `scaleData`: flag for scaling the data i.e. transforming to unit variance for each dimension
- `add`: flag for adding to an existing plot
- `addData`: flag for display of the data
- `addDataNum`: maximum number of data points plotted in displays
- `addKDE`: flag for display of kernel density estimates
- `jitterRug`: flag for jittering of rug-plot for univariate data display
- `addSignifGradRegion`, `addSignifGradData`: flag for display of significant gradient regions/data points
- `addSignifCurvRegion`, `addSignifCurvData`: flag for display of significant curvature regions/data points
- `addAxes3d`: flag for displaying axes in 3-d displays
- `densCol`: colour of density estimate curve
- `dataCol`: colour of data points
gradCol   colour of significant gradient regions/data points
curvCol   colour of significant curvature regions/data points
axisCol   colour of axes
bgCol     colour of background
dataAlpha  transparency of data points
gradRegionAlpha,gradDataAlpha
            transparency of significant gradient regions/data points
curvRegionAlpha,curvDataAlpha
            transparency of significant curvature regions/data points
rgl       flag to send 3D graphics to RGL window. Default is FALSE (usual graphics window).
...       other graphics parameters

Value
Plot of 1-d and 2-d kernel density estimates are sent to graphics window. Plot for 3-d is sent to RGL/graphics window.

See Also
featureSignif

Examples
## See ? featureSignif for uni- and bivariate examples
## Trivariate example
data(earthquake)
earthquake[,3] <- -log10(-earthquake[,3])
fs <- featureSignif(earthquake, scaleData=TRUE, bw=c(0.06, 0.06, 0.05))
plot(fs, addKDE=TRUE, addSignifCurvData=TRUE)
plot(fs, addKDE=FALSE, addSignifCurvRegion=TRUE)
if (interactive()) plot(fs, addKDE=FALSE, addSignifCurvRegion=TRUE, rgl=TRUE)

SiZer,SiCon

SiZer and SiCon plots for 1-dimensional data

Description
SiZer (Significant Zero crossings) and SiCon (Significant Convexity) plots for 1-dimensional data.

Usage
SiZer(x, bw, gridsize, scaleData=FALSE, signifLevel=0.05, plotSiZer=TRUE,
       logbw=TRUE, xlim, xlab, addLegend=TRUE, posLegend="bottomright")

SiCon(x, bw, gridsize, scaleData=FALSE, signifLevel=0.05, plotSiCon=TRUE,
       logbw=TRUE, xlim, xlab, addLegend=TRUE, posLegend="bottomright")
Arguments

- **x**: data vector
- **bw**: vector of range of bandwidths
- **gridsize**: number of x- and y-axis grid points
- **scaleData**: flag for scaling the data i.e. transforming to unit variance for each dimension.
- **signifLevel**: significance level
- **plotSiZer,plotSiCon**: flag for displaying SiZer/SiCon map
- **logbw**: flag for displaying log bandwidths on y-axis
- **xlim**: x-axis limits
- **xlab**: x-axis label
- **addLegend**: flag for legend display
- **posLegend**: legend position

Details

The gradient SiZer and curvature SiCon maps of Chaudhuri & Marron (1999) are implemented. The horizontal axis is the data axis, the vertical axis are the bandwidths. The colour scheme for the SiZer map is red: negative gradient, blue: positive gradient, purple: zero gradient and grey: sparse regions. For the SiCon map, orange: negative curvature (concave), blue: positive curvature (convex), green: zero curvature and grey: sparse regions.

Value

SiZer/SiCon plot sent to graphics window.

References


See Also

featureSignif

Examples

data(earthquake)
eq3 <- -log10(-earthquake[,3])
SiZer(eq3)
SiCon(eq3)
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