Package ‘prim’

February 20, 2015

Version 1.0.15
Date 2014/11/04
Title Patient Rule Induction Method (PRIM)
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Depends R (>= 2.10.0)
Imports rgl (>= 0.66), misc3d (>= 0.4-0)
Suggests MASS
Description PRIM for bump hunting in high-dimensional data
License GPL-2 | GPL-3
URL http://www.mvstat.net/tduong
NeedsCompilation no
Repository CRAN
Date/Publication 2014-11-04 22:02:48

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Patent Rule Induction Method (PRIM)

Description

PRIM for bump-hunting for high-dimensional regression-type data.

Details

The data are \((X_1, Y_1), \ldots, (X_n, Y_n)\) where \(X_i\) is d-dimensional and \(Y_i\) is a scalar response. We wish to find the modal (and/or anti-modal) regions in the conditional expectation \(m(x) = E(Y|x)\).

PRIM is a bump-hunting technique introduced by Friedman & Fisher (1999), taken from data mining. PRIM estimates are a sequence of nested hyper-rectangles (boxes).

For an overview of this package, see vignette("prim") for PRIM estimation for 2- and 5-dimensional data.

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References


PRIM plot for multivariate data

Description

PRIM plot for multivariate data.

Usage

```r
## S3 method for class 'prim'
plot(x, splom=TRUE, ...)
```

Arguments

- `x` object of class prim
- `splom` flag for plotting 3-d data as scatter plot matrix. Default is TRUE.
- `...` other graphics parameters
Details

The function headers are

```r
## bivariate
plot(x, col, xlim, ylim, xlab, ylab, add=FALSE, add.legend=FALSE,
     cex.legend=1, pos.legend, lwd=1, ...)

## trivariate
plot(x, color, xlim, ylim, zlim, xlab, ylab, zlab, add.axis=TRUE, ...)

## d-variate
plot(x, col, xmin, xmax, xlab, ylab, ...)
```

The arguments are

- `add.legend` flag for adding legend (2-d plot)
- `pos.legend` (x,y) co-ordinates for legend (2-d plot)
- `cex.legend` cex graphics parameter for legend (2-d plot)
- `col` vector of plotting colours, one for each box
- `xlab`, `ylab`, `zlab`, `xlim`, `ylim`, `zlim`, `add`, `lwd` usual graphics parameters
- `xmin`, `xmax` vector of minimum and maximum axis plotting values for scatter plot matrix
- `color` vector of colours, one for each box (3-d plot)
- `add.axis` flag for plotting axes (3-d plot)

Default colours are `topo.colors()`, with one colour per box in the PRIM box sequence.

Value

Plot of 2-dim PRIM is a set of nested rectangles. Plot of 3-dim PRIM is a scatter point cloud. Plot of d-dim PRIM is a scatter plot matrix. The scatter plots indicate which points belong to which box.

See Also

- `prim.box`
- `predict.prim`

Examples

```r
## see ?predict.prim for bivariate example
## trivariate example
data(quasiflow)
qf <- quasiflow[1:1000,1:3]
qf.label <- quasiflow[1:1000,4]
thr <- c(0.25, -0.3)
qf.prim <- prim.box(x=qf, y=qf.label, threshold=thr, threshold.type=0)
plot(qf.prim)
```
### Description

S3 methods PRIM for multivariate data.

### Usage

```r
# S3 method for class 'prim'
predict(object, newdata, y.fun.flag=FALSE, ...)  
# S3 method for class 'prim'
summary(object, ..., print.box=FALSE)
```

### Arguments

- **object**: object of class prim
- **newdata**: data matrix
- **y.fun.flag**: flag to return y value of PRIM box rather than box label. Default is FALSE.
- **print.box**: flag to print out limits of all PRIM boxes. Default is FALSE.
- **...**: other parameters

### Details

- The `predict` method returns the value of PRIM box number in which `newdata` are located.
- The `summary` method displays a table with three columns: `box-fun` is the y value, `box-mass` is the mass of the box, `threshold.type` is the threshold direction indicator: 1 = ">= threshold", -1 = "<= threshold". Each box corresponds to a row. The second last row marked with an asterisk is the box which collates the remaining data points not belonging to a specific PRIM box. The final row is an overall summary, i.e. `box-fun` is the overall mean of y and `box-mass` is 1.

### Examples

```r
data(quasiflow)  
qf <- quasiflow[1:1000,1:2]  
qf.label <- quasiflow[1:1000,3]+quasiflow[1:1000,4]  
qf.prim <- prim.box(x=qf, y=qf.label, threshold=c(0.3, -0.1), threshold.type=0, verbose=TRUE)  
## verbose=TRUE prints out extra information about peeling and pasting  
summary(qf.prim)  
predict(qf.prim, newdata=c(0.6,0.2))  
## using median instead of mean for the response y  
qf.prim2 <- prim.box(x=qf, y=qf.label, threshold=c(0.5, -0.2),
```

PRIM for multivariate data

Description

PRIM for multivariate data.

Usage

prim.box(x, y, box.init=NULL, peel.alpha=0.05, paste.alpha=0.01,
          mass.min=0.05, threshold, pasting=TRUE, verbose=FALSE,
          threshold.type=0, y.fun=mean)

prim.hdr(prim, threshold, threshold.type, y.fun=mean)

prim.combine(prim1, prim2, y.fun=mean)

Arguments

x matrix of data values
y vector of response values
y.fun function applied to response y. Default is mean.
box.init initial covering box
peel.alpha peeling quantile tuning parameter
paste.alpha pasting quantile tuning parameter
mass.min minimum mass tuning parameter
threshold threshold tuning parameter(s)
threshold.type threshold direction indicator: 1 = ">= threshold", -1 = "<= threshold", 0 = ">=
 threshold[1] & <= threshold[2]"
pasting flag for pasting
verbose flag for printing output during execution
prim,prim1,prim2 objects of type prim
Details

The data are \((X_1, Y_1), \ldots, (X_n, Y_n)\) where \(X_i\) is d-dimensional and \(Y_i\) is a scalar response. PRIM finds modal (and/or anti-modal) regions in the conditional expectation \(m(x) = E(Y|x)\).

In general, \(Y_i\) can be real-valued. See vignette("prim"). Here, we focus on the special case for binary \(Y_i\). Let \(Y_i = 1\) when \(X_i \sim F^+\); and \(Y_i = -1\) when \(X_i \sim F^-\) where \(F^+\) and \(F^-\) are different distribution functions. In this set-up, PRIM finds the regions where \(F^+\) and \(F^-\) are most different.

The tuning parameters peel.alpha and paste.alpha control the 'patience' of PRIM. Smaller values involve more patience. The peeling steps remove data from a box till either the box mean is smaller than threshold or the box mass is less than mass.min. Pasting is optional, and is used to correct any possible over-peeling. The default values for peel.alpha, paste.alpha and mass.min are taken from Friedman & Fisher (1999).

The type of PRIM estimate is controlled threshold and threshold.type:

- threshold.type=1, search for \({m(x) \geq \text{threshold}}\).
- threshold.type=-1, search for \({m(x) \leq \text{threshold}}\).
- threshold.type=0, search for both \({m(x) \geq \text{threshold}[1]}\) and \({m(x) \leq \text{threshold}[2]}\).

There are two ways of using PRIM. One is prim.box with pre-specified threshold(s). This is appropriate when the threshold(s) are known to produce good estimates.

On the other hand, if the user doesn’t provide threshold values then prim.box computes box sequences which cover the data range. These can then be pruned at a later stage. prim.hd allows the user to specify many different threshold values in an efficient manner, without having to recomputing the entire PRIM box sequence. prim.combine can be used to join the regions computed from prim.hd. See the examples below.

Value

- prim.box produces a PRIM estimate, an object of type prim, which is a list with 8 fields:
  
  x  
  
  y  
  
  y.mean  
  
  box  
  
  mass  
  
  num.class  
  
  num.hd.class  
  
  ind

The above lists have num.class fields, one for each box.

- prim.hd takes a prim object and prunes it using different threshold values. Returns another prim object. This is much faster for experimenting with different threshold values than calling prim.box each time.

- prim.combine combines two prim objects into a single prim object. Usually used in conjunction with prim.hd. See examples below.
Examples

data(quasiflow)
qf <- quasiflow[1:1000,1:2]
qf.label <- quasiflow[1:1000,4]

## using only one command
thr <- c(0.25, -0.3)
qf.prim1 <- prim.box(x=qf, y=qf.label, threshold=thr, threshold.type=0)

## alternative - requires more commands but allows more control
## in intermediate stages
qf.primp <- prim.box(x=qf, y=qf.label, threshold.type=1)
## default threshold too low, try higher one
qf.primp.hdr <- prim.hdr(x=qf.primp, threshold=0.25, threshold.type=1)
qf.primm <- prim.box(x=qf, y=qf.label, threshold=-0.3, threshold.type=-1)
qf.prim2 <- prim.combine(qf.primp.hdr, qf.primm)

plot(qf.prim1)  ## orange x1>xR, blue xR<x1
points(qf[qf.label==1,], cex=0.5)
points(qf[qf.label==-1,], cex=0.5, col=2)

quasiflow

Quasi flow cytometry data

Description

This data set is simulated data from two normal mixture distributions, mimicking a flow cytometry data set. It contains 10000 observations from an HIV+ patient and 10000 observations an HIV- patient.

Usage

data(quasiflow)

Format

quasiflow is a matrix with 6 columns and 20000 rows. Each row corresponds to measurements for one cell. The first 5 columns are flow cytometric measurements and the sixth column is a binary indicator, with 1 = HIV+ and -1 = HIV-.

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