Package ‘siRSM’

February 20, 2015

Type Package
Title Single-Index Response Surface Models
Version 1.1
Date 2014-07-15
Author Huan Cheng, Mu Zhu
Maintainer Mu Zhu <m3zhu@uwaterloo.ca>
Description This package fits single-index (quadratic) response surface models.
License GPL-2
Imports rsm, MASS, foreach, doSNOW, parallel
NeedsCompilation no
Repository CRAN
Date/Publication 2014-07-18 07:09:29

R topics documented:

siRSM-package ......................................................... 2
ci.index .............................................................. 3
ci.surface ............................................................. 4
draw.full.quadratic .................................................... 5
EdwardsMBA ............................................................ 5
multi.run .............................................................. 6
single.run ............................................................. 7
siRSM ................................................................. 8
surface.stats .......................................................... 9
surface.test ......................................................... 10

Index 11
Description

This package provides tools for fitting what we call "single-index response surface models", that is, models of the form \( y = f(u,v) + e \), where \( f(u,v) \sim 1 + u + v + u^2 + uv + v^2, u = t(w) \% \% U \), and \( v = t(w) \% \% V \).

Details

Package: siRSM
Type: Package
Version: 1.1
Date: 2014-07-15
License: GPL-2

Author(s)

Huan Cheng, Mu Zhu
Maintainer: Mu Zhu <m3zhu@uwaterloo.ca>

References


See Also

siRSM, surface.test, surface.stats, ci.index, ci.surface

Examples

```r
# Not run:
# load illustrative data set provided within the package
data(EdwardsMBA)

# parse the variables
y = EdwardsMBA[, c('AVGSAT4')]
U = EdwardsMBA[, c('PCPRE', 'DMPRE', 'EIPRE', 'MRPRE')]
V = EdwardsMBA[, c('PCACT', 'DMACT', 'EIACT', 'MRACT')]

# fit the model
m1 = siRSM(y, U, V)
```
# look at the model
m1
plot(m1)

# F-test of surface curvature
surface.test(m1)

# inference on the index (using just 10 bootstrap samples here)
ci.index(y, U, V, B=10)

# obtain statistics of the response surface (conditional on the estimated index)
surface.stats(m1)

# inference for these surface statistics (again, conditional on the estimated index)
 ci.surface(m1)

# fit an interaction-only model
m2=sirsm(y, U, V, interaction.only=TRUE)
plot(m2)

## End(Not run)

---

### ci.index

Confidence Intervals for Single Index

#### Description

Computes 95\% bootstrap confidence intervals for the single index.

#### Usage

```r
ci.index(y, U, V, B=100, use.parallel=TRUE, ...)
```

#### Arguments

- `y` : vector, response
- `U` : matrix, whose columns are covariates for factor one
- `V` : matrix, whose columns are covariates for factor two
- `B` : number of bootstrap samples to take
- `use.parallel` : if TRUE, exploits multiple cores by using `foreach`, `doSNOW`, etc
- `...` : other arguments for `sirsm`, e.g., `interaction.only=TRUE`, `trial=10`

#### Value

A data.frame specifying the lower 2.5\% and upper 97.5\% confidence limits, the mean, and the standard error for each coordinate of the index.
ci.surface

Author(s)

Mu Zhu

Description

Computes 95% bootstrap confidence intervals for various features of the quadratic response surface, CONDITIONAL on the single index.

Usage

ci.surface(obj, B=500, use.parallel=TRUE)

Arguments

obj an object of class sirsm, typically result from sirsm
B number of bootstrap samples
use.parallel if TRUE, exploits multiple cores by using foreach, doSNOW, etc

Value

In all components below, the lower 2.5% and upper 97.5% confidence limits, the mean, and the standard error are given:

stationary.point stationary point, (u0, v0)
prin.ax.1 1st principal axis, intercept (p10) and slope (p11)
prin.ax.2 2nd principal axis, intercept (p20) and slope (p21)
beta coefficients defining the quadratic response surface, b0, b1, ..., b5
line.congr slope (ax) and curvature (ax2) along the congruence line, u-v=0
line.incongr slope (ax) and curvature (ax2) along the congruence line, u+v=0

Author(s)

Huan Cheng, Mu Zhu
### draw.full.quadratic

*Functions for plotting various siRSMs*

**Description**

Internal function called by `plot.siRSM`. Do NOT use.

**Usage**

```r
draw.interaction.only(x, xname=NULL, yname=NULL, zname=NULL)
draw.full.quadratic(x, xname=NULL, yname=NULL, zname=NULL, center='zero', debug=FALSE)
```

**Arguments**

- `x` an object of class `siRSM`
- `xname` character string, name for first (composite) factor
- `yname` character string, name for second (composite) factor
- `zname` character string, name for response
- `center` if 'zero', centers the surface plot at (0, 0)
- `debug` can be turned on for debugging purposes

**Author(s)**

Huan Cheng, Mu Zhu

---

### EdwardsMBA

*MBA Data Set from Edwards (1994)*

**Description**

A real data set to illustrate single-index response surface models. Among a group of MBA students, job satisfaction is highest when preference for various kinds of work matches the extent to which they actually engage in those kinds of work.

**Usage**

```r
data(EdwardsMBA)
```
Format

A matrix containing 172 rows (observations) and 9 columns (variables):

- **PCPRE** preferences (PRE) for 'planning and coordinating' (PC) kind of work
- **DMPRE** preferences (PRE) for 'decision making' (DM) kind of work
- **EIPRE** preferences (PRE) for 'exchanging information' (EI) kind of work
- **MRPRE** preferences (PRE) for 'motivating and rewarding others' (MR) kind of work
- **PCACT** actual engagement (ACT) in 'planning and coordinating' (PC) kind of work
- **DMACT** actual engagement (ACT) in 'decision making' (DM) kind of work
- **EIACT** actual engagement (ACT) in 'exchanging information' (EI) kind of work
- **MRACT** actual engagement (ACT) in 'motivating and rewarding others' (MR) kind of work
- **AVGSAT** a measure of job satisfaction

References


---

multi.run

*Fit siRSM by Trying Multiple Initial Values*

Description

Internal function called by siRSM. Do NOT use.

Usage

```r
multi.run(y, X, Z, rep, interaction.only=FALSE, use.parallel=TRUE)
```

Arguments

- **y** vector, response
- **X** matrix, whose columns are covariates for factor one
- **Z** matrix, whose columns are covariates for factor two, must be of same size as X
- **rep** number of different initial values to try — if unspecified, the default is twice the dimension of the index
- **interaction.only** fit an interaction-only model
- **use.parallel** if TRUE, exploits multiple cores by using `foreach`, `doSNOW`, etc

Note

In these more rudimentary functions (not to be called by user), U is referred to as X, and V as Z, due to "historical reasons". Currently, multiple RANDOM initial values are used. In the future, we'd like to switch to using a space-filling design.
**single.run**

**Author(s)**

Huan Cheng, Mu Zhu

---

**single.run**  
*Fit siRSM Once Based on One Initial Value*

**Description**

Internal function called by siRSM. Do NOT use.

**Usage**

```r
single.run(data, w0, int.only=FALSE, eps=0.005, precision=1e-6, max.iter=10000, debug=FALSE, trace=TRUE)
```

**Arguments**

- **data**  
  y, X, Z together
- **w0**  
  initial guess
- **int.only**  
  fit an interaction-only model
- **eps**  
  step size for gradient descent
- **precision**  
  convergence criterion
- **max.iter**  
  maximum number of iterations
- **debug**  
  can be turned on for debugging
- **trace**  
  if TRUE, reports progress as function runs

**Note**

In these more rudimentary functions (not to be called by user), u is referred to as X, and v as Z, due to "historical reasons".

**Author(s)**

Huan Cheng, Mu Zhu
siRSM  

*Single-index Response Surface Model*

Description

This is the main function for users to call.

Usage

```r
## Default S3 method:
siRSM(y, U, V, trial, interaction.only=FALSE, use.parallel=TRUE)

## S3 method for class 'siRSM'
print(x, ...)

## S3 method for class 'siRSM'
plot(x, ...)
```

Arguments

- `y` response vector
- `U` matrix, whose columns are covariates for first factor
- `V` matrix, whose columns are covariates for second factor, must have same dimension as `U`
- `trial` number of different initial values to try — if missing, defaults to 2*K, where K = ncol(U) = ncol(V)
- `interaction.only` fit an interaction-only (rather than a full-quadratic) model
- `use.parallel` if TRUE, tells underlying utility function multi.run to exploit multiple cores by using `foreach, doSNOW, etc`
- `x` an object of class `siRSM`, often result of `siRSM`
- `...` arguments for `plot` include: `xname=character string, name for first (composite) factor; yname=character string, name for second (composite) factor; zname=character string, name for response; center='zero', centers the surface plot at (0,0)`

Value

An object of class `siRSM`. For most users, the most useful elements are:

- `w` the estimated single index vector
- `coef` the coefficients of the corresponding response surface

Author(s)

Huan Cheng, Mu Zhu
Statistics of Quadratic Response Surface

Description

Computes stationary point, 1st and 2nd principal axes of the quadratic response surface, shapes and curvatures along the congruence and incongruence lines, as well as various parameters useful for plot.sirsm.

Usage

surface.stats(obj)
surface.stats.main(b, xlim, ylim)

Arguments

obj an object of class sirsm, often the result of sirsm
b coefficients of the response surface, e.g., obj$coef where obj is an object of class sirsm
xlim x-boundaries in 3D (x,y,z)-perspective plot — used when surface.stats.main is called internally by plot.sirsm
ylim y-boundaries in 3D (x,y,z)-perspective plot — used when surface.stats.main is called internally by plot.sirsm

Value

u0 x-coordinates of surface’s stationary point
v0 y-coordinates of surface’s stationary point
p10 intercept in xy-plane of surface’s 1st principal axis
p11 slope in xy-plane of surface’s 1st principal axis
p20 intercept in xy-plane of surface’s 2nd principal axis
p21 slope in xy-plane of surface’s 2nd principal axis
ax.congr slope of surface along the congruence line, u-v=0
ax2.congr curvature of surface along the congruence line, u-v=0
ax.incongr slope of surface along the incongruence line, u+v=0
ax2.incongr curvature of surface along the incongruence line, u+v=0
pl intersection of 1st axis at lower border, to be used by plot.sirsm
ph intersection of 1st axis at upper border, to be used by plot.sirsm
sl intersection of 2nd axis at lower border, to be used by plot.sirsm
sh intersection of 2nd axis at upper border, to be used by plot.sirsm
Author(s)
Huan Cheng, Mu Zhu

References

```
surface.test          F-test of Curvature for the Response Surface
```

Description
A standard nested F-test of linear \( f(u,v)^{u+v} \), interaction-only \( f(u,v)^{u+v+I(u*v)} \), and full-quadratic \( f(u,v)^{u+v+I(u^2)+I(u*v)+I(v^2)} \) models.

Usage
```
surface.test(object)
```

Arguments
```
object          an object of class 'siRSM', often result from siRSM
```

Author(s)
Huan Cheng, Mu Zhu
Index

*Topic **bootstrap**
  ci.index, 3
  ci.surface, 4
*Topic **datasets**
  EdwardsMBA, 5
*Topic **foreach**
  ci.index, 3
  ci.surface, 4
  multi.run, 6
*Topic **parallel computing**
  ci.index, 3
  ci.surface, 4
  multi.run, 6
  sirSM, 8
  sirSM-package, 2
*Topic **response surface models**
  sirSM, 8
  sirSM-package, 2
*Topic **single index models**
  sirSM, 8
  sirSM-package, 2

  ci.index, 2, 3
  ci.surface, 2, 4

draw.full.quadratic, 5
draw.interaction.only
  (draw.full.quadratic), 5

EdwardsMBA, 5

multi.run, 6

plot.sirSM(sirSM), 8
print.sirSM(sirSM), 8

single.run, 7
sirSM, 2, 8
sirSM-package, 2
surface.stats, 2, 9
surface.test, 2, 10