Package ‘gpls’

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Title Classification using generalized partial least squares

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Author Beiying Ding

Description Classification using generalized partial least squares for
two-group and multi-group (more than 2 group) classification.

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R topics documented:

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**glpls1a**

*Fit IRWPLS and IRWPLSF model*

**Description**

Fit Iteratively ReWeighted Least Squares (IRWPLS) with an option of Firth’s bias reduction procedure (IRWPLSF) for two-group classification
Usage

```r
glpls1a(X, y, K.prov = NULL, eps = 0.001, lmax = 100, b.ini = NULL, 
denom.eps = 1e-20, family = "binomial", link = NULL, br = TRUE)
```

Arguments

- `X`: n by p design matrix (with no intercept term)
- `y`: response vector 0 or 1
- `K.prov`: number of PLS components, default is the rank of X
- `eps`: tolerance for convergence
- `lmax`: maximum number of iteration allowed
- `b.ini`: initial value of regression coefficients
- `denom.eps`: small quantity to guarantee nonzero denominator in deciding convergence
- `family`: glm family, `binomial` is the only relevant one here
- `link`: link function, `logit` is the only one practically implemented now
- `br`: TRUE if Firth’s bias reduction procedure is used

Value

- `coefficients`: regression coefficients
- `convergence`: whether convergence is achieved
- `niter`: total number of iterations
- `bias.reduction`: whether Firth’s procedure is used
- `loading.matrix`: the matrix of loadings

Author(s)

Beiying Ding, Robert Gentleman

References


See Also

- `glpls1a.mlogit`, `glpls1a.logit.all`, `glpls1a.train.test.error`, `glpls1a.cv.error`, `glpls1a.mlogit.cv.error`

Examples

```r
x <- matrix(rnorm(20),ncol=2)
y <- sample(0:1,10,TRUE)
## no bias reduction
glpls1a(x,y,br=FALSE)

## no bias reduction and 1 PLS component
glpls1a(x,y,K.prov=1,br=FALSE)

## bias reduction
glpls1a(x,y,br=TRUE)
```
**glpls1a.cv.error**  
*Leave-one-out cross-validation error using IRWPLS and IRWPLSF model*

**Description**

Leave-one-out cross-validation training set classification error for fitting IRWPLS or IRWPLSF model for two group classification.

**Usage**

```r
glpls1a.cv.error(train.X, train.y, K.prov = NULL, eps = 1e-3, lmax = 100, family = "binomial", link = "logit", br = NULL)
```

**Arguments**

- `train.X`: n by p design matrix (with no intercept term) for training set.
- `train.y`: response vector (0 or 1) for training set.
- `K.prov`: number of PLS components, default is the rank of `train.X`.
- `eps`: tolerance for convergence.
- `lmax`: maximum number of iteration allowed.
- `family`: glm family, `binomial` is the only relevant one here.
- `link`: link function, `logit` is the only one practically implemented now.
- `br`: TRUE if Firth’s bias reduction procedure is used.

**Value**

- `error`: LOOCV training error.
- `error.obs`: the misclassified error observation indices.

**Author(s)**

Beiying Ding, Robert Gentleman

**References**


**See Also**

- `glpls1a.train.test.error`, `glpls1a.mlogit.cv.error`, `glpls1a`, `glpls1a.mlogit`, `glpls1a.logit.all`

**Examples**

```r
x <- matrix(rnorm(20), ncol=2)
y <- sample(0:1, 10, TRUE)

# no bias reduction
glpls1a.cv.error(x, y, br = FALSE)

# bias reduction and 1 PLS component
glpls1a.cv.error(x, y, K.prov = 1, br = TRUE)
```
**glpls1a.logit.all**  
*Fit MIRWPLS and MIRWPLSF model separately for logits*

**Description**

Apply Iteratively ReWeighted Least Squares (MIRWPLS) with an option of Firth’s bias reduction procedure (MIRWPLSF) for multi-group (say C+1 classes) classification by fitting logit models for all C classes vs baseline class separately.

**Usage**

```r
glpls1a.logit.all(X, y, K.prov = NULL, eps = 0.001, lmax = 100, b.ini = NULL, denom.eps = 1e-20, family = "binomial", link = "logit", br = T)
```

**Arguments**

- `X` n by p design matrix (with no intercept term)
- `y` response vector with class labels 1 to C+1 for C+1 group classification, baseline class should be 1
- `K.prov` number of PLS components
- `eps` tolerance for convergence
- `lmax` maximum number of iteration allowed
- `b.ini` initial value of regression coefficients
- `denom.eps` small quantity to guarantee nonzero denominator in deciding convergence
- `family` glm family, binomial (i.e. multinomial here) is the only relevant one here
- `link` link function, logit is the only one practically implemented now
- `br` TRUE if Firth’s bias reduction procedure is used

**Value**

- `coefficients` regression coefficient matrix

**Author(s)**

Beiying Ding, Robert Gentleman

**References**


**See Also**

`glpls1a.mlogit,glpls1a.glpls1a.mlogit.cv.error,glpls1a.train.test.error,glpls1a.cv.error`
Examples

```r
x <- matrix(rnorm(20), ncol=2)
y <- sample(1:3, 10, TRUE)
## no bias reduction
glplsl1a.logit.all(x, y, br=FALSE)
## bias reduction
glplsl1a.logit.all(x, y, br=TRUE)
```

glplsl1a.mlogit

Fit MIRWPLS and MIRWPLSF model

Description

Fit multi-logit Iteratively ReWeighted Least Squares (MIRWPLS) with an option of Firth’s bias reduction procedure (MIRWPLSF) for multi-group classification

Usage

```r
glplsl1a.mlogit(x, y, K.prov = NULL, eps = 0.001, lmax = 100, b.ini = NULL, denom.eps = 1e-20, family = "binomial", link = "logit", br = T)
```

Arguments

- `x`: n by p design matrix (with intercept term)
- `y`: response vector with class labels 1 to C+1 for C+1 group classification, baseline class should be 1
- `K.prov`: number of PLS components
- `eps`: tolerance for convergence
- `lmax`: maximum number of iteration allowed
- `b.ini`: initial value of regression coefficients
- `denom.eps`: small quantity to guarantee nonzero denominator in deciding convergence
- `family`: glm family, `binomial` (i.e. multinomial here) is the only relevant one here
- `link`: link function, `logit` is the only one practically implemented now
- `br`: TRUE if Firth’s bias reduction procedure is used

Value

- `coefficients`: regression coefficient matrix
- `convergence`: whether convergence is achieved
- `niter`: total number of iterations
- `bias.reduction`: whether Firth’s procedure is used

Author(s)

Beiying Ding, Robert Gentleman
References


See Also

- glplsa.glplsa.mlogit.cv.error
- glplsa.train.test.error
- glplsa.cv.error

Examples

```r
x <- matrix(rnorm(20),ncol=2)
y <- sample(1:3,10,TRUE)
## no bias reduction and 1 PLS component
glplsa.mlogit(cbind(rep(1,10),x),y,K.prov=1,br=FALSE)
## bias reduction
glplsa.mlogit(cbind(rep(1,10),x),y,br=TRUE)
```

**Description**

Leave-one-out cross-validation training set error for fitting MIRWPLS or MIRWPLSF model for multi-group classification

**Usage**

```r
glplsa.mlogit.cv.error(train.X, train.y, K.prov = NULL, eps = 0.001,lmax = 100, mlogit = T, br = T)
```

**Arguments**

- `train.X`: n by p design matrix (with no intercept term) for training set
- `train.y`: response vector with class labels 1 to C+1 for C+1 group classification, baseline class should be 1
- `K.prov`: number of PLS components
- `eps`: tolerance for convergence
- `lmax`: maximum number of iteration allowed
- `mlogit`: if TRUE use the multinomial logit model, otherwise fit all C-1 logistic models (vs baseline class 1) separately
- `br`: TRUE if Firth’s bias reduction procedure is used

**Value**

- `error`: LOOCV training error
- `error.obs`: the misclassified error observation indices

---

**glplsa.mlogit.cv.error**

*Leave-one-out cross-validation error using MIRWPLS and MIRWPLSF model*
Author(s)
Beiying Ding, Robert Gentleman

References

See Also
`glpls1a.cv.error, glpls1a.train.test.error, glpls1a.mlogit, glpls1a.logit.all`

Examples
```r
x <- matrix(rnorm(20), ncol=2)
y <- sample(1:3, 10, TRUE)

## no bias reduction
glpls1a.mlogit.cv.error(x, y, br=FALSE)
glpls1a.mlogit.cv.error(x, y, mlogit=FALSE, br=FALSE)

## bias reduction
glpls1a.mlogit.cv.error(x, y, br=TRUE)
glpls1a.mlogit.cv.error(x, y, mlogit=FALSE, br=TRUE)
```

Description
Out-of-sample test set error using IRWPLS and IRWPLSF model

Usage
```r
?glpls1a.train.test.error
```

Arguments
- `train.X`: n by p design matrix (with no intercept term) for training set
- `train.y`: response vector (0 or 1) for training set
- `test.X`: transpose of the design matrix (with no intercept term) for test set
- `test.y`: response vector (0 or 1) for test set
- `K.prov`: number of PLS components, default is the rank of train.X
- `eps`: tolerance for convergence
- `lmax`: maximum number of iteration allowed
- `family`: glm family, binomial is the only relevant one here
- `link`: link function, logit is the only one practically implemented now
- `br`: TRUE if Firth’s bias reduction procedure is used
gpls

**Value**

- **error**: out-of-sample test error
- **error.obs**: the misclassified error observation indices
- **predict.test**: the predicted probabilities for test set

**Author(s)**

Beiying Ding, Robert Gentleman

**References**


**See Also**

- `glpls1a.cv.error`, `glpls1a.mlogit.cv.error`, `glpls1a.glpls1a.mlogit`, `glpls1a.logit.all`

**Examples**

```r
x <- matrix(rnorm(20),ncol=2)
y <- sample(0:1,10,TRUE)
x1 <- matrix(rnorm(10),ncol=2)
y1 <- sample(0:1,5,TRUE)

## no bias reduction
glpls1a.train.test.error(x,y,x1,y1,br=FALSE)

## bias reduction
glpls1a.train.test.error(x,y,x1,y1,br=TRUE)
```

---

**gpls**

*A function to fit Generalized partial least squares models.*

**Description**

Partial least squares is a commonly used dimension reduction technique. The paradigm can be extended to include generalized linear models in several different ways. The code in this function uses the extension proposed by Ding and Gentleman, 2004.

**Usage**

```r
gpls(x, ...)
```

## Default S3 method:

gpls(x, y, K.prov=NULL, eps=1e-3, lmax=100, b.ini=NULL, denom.eps=1e-20, family="binomial", link=NULL, br=TRUE, ...)

## S3 method for class 'formula'

gpls(formula, data, contrasts=NULL, K.prov=NULL, eps=1e-3, lmax=100, b.ini=NULL, denom.eps=1e-20, family="binomial", link=NULL, br=TRUE, ...)
Arguments

**x**
The matrix of covariates.

**formula**
A formula of the form \( y \sim x_1 + x_2 + ... \), where \( y \) is the response and the other terms are covariates.

**y**
The vector of responses

**data**
A data.frame to resolve the formula, if used

**K.prov**
Number of PLS components, default is the rank of \( X \)

**eps**
Tolerance for convergence

**lmax**
Maximum number of iteration allowed

**b.ini**
Initial value of regression coefficients

**denom.eps**
Small quantity to guarantee nonzero denominator in deciding convergence

**family**
Glm family, binomial is the only relevant one here

**link**
Link function, logit is the only one practically implemented now

**br**
TRUE if Firth’s bias reduction procedure is used

**...**
Additional arguments.

**contrasts**
An optional list. See the contrasts.arg of model.matrix.default.

Details

This is a different interface to the functionality provided by \texttt{glpls1a}. The interface is intended to be simpler to use and more consistent with other machine learning code in R.

The technology is intended to deal with two class problems where there are more predictors than cases. If a response variable (\( y \)) is used that has more than two levels the behavior may be unusual.

Value

An object of class \texttt{gp1s} with the following components:

**coefficients**
The estimated coefficients.

**convergence**
A boolean indicating whether convergence was achieved.

**niter**
The total number of iterations.

**bias.reduction**
A boolean indicating whether Firth’s procedure was used.

**family**
The family argument that was passed in.

**link**
The link argument that was passed in.

**terms**
The constructed terms object.

**call**
The call

**levs**
The factor levels for prediction.

Author(s)

B. Ding and R. Gentleman

References

predict.gpls

See Also
gipls1a

Examples

library(MASS)
m1 = gpls(type~., data=Pima.tr, K=3)

Usage

## S3 method for class 'gpls'
predict(object, newdata, ...)

Arguments

object A gpls object, typically obtained from a call to gpls
newdata New data, for which predictions are desired.
... Other arguments to be passed on

Details

The prediction method is straightforward. The estimated coefficients from object are used, together with the new data to produce predicted values. These are then split, according to whether the predicted values is larger or smaller than 0.5 and predictions returned.

The code is similar to that in gipls1a.train.test.error except that in that function both the test and train matrices are centered and scaled (the covariates) by the same values (those from the test data set).

Value

A list of length two:

class The predicted classes; one for each row of newdata.
predicted The estimated predictors.

Author(s)

B. Ding and R. Gentleman

See Also
gpls
predict.gpls

Examples

```r
example(gpls)
p1 = predict(m1)
```
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