Package ‘RobMixReg’

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Title Robust Mixture Regression
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Description Finite mixture models are a popular technique for modelling unobserved heterogeneity or to approximate general distribution functions in a semi-parametric way. They are used in a lot of different areas such as astronomy, biology, economics, marketing or medicine.

This package is the implementation of popular robust mixture regression methods based on different algorithms including: flexmix, finite mixture models and latent class regression; CTLERob, component-wise adaptive trimming likelihood estimation; mixbi, bi-square estimation; mixL, Laplacian distribution; mixt, t-distribution; TLE, trimmed likelihood estimation.

The implemented algorithms includes: CTLERob stands for Component-wise adaptive Trimming Likelihood Estimation based mixture regression; mixbi stands for mixture regression based on bi-square estimation; mixL stands for mixture regression based on Laplacian distribution; TLE stands for Trimmed Likelihood Estimation based mixture regression. For more detail of the algorithms, please refer to below references.


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**biscalew**

Tukey’s bisquare family of functions.

**Usage**

\[
biscalew(t)
\]

**Arguments**

- **t**: Numerical input, usually residuals.

**Value**

A bisquare weight for scale.

---

**bisquare**

Tukey’s bisquare family of functions.

**Usage**

\[
bisquare(t, k = 4.685)
\]

**Arguments**

- **t**: Numerical input, usually residuals.
- **k**: A constant tuning parameter, default is 4.685.

**Value**

A bi-square weight for mean.
blockMap

Plot the coefficient matrix.

Description

Plot the coefficient matrix.

Usage

blockMap(rrr)

Arguments

rrr The result from CSMR function

CCLE_data

RobMixReg package built-in CCLE data.

Description

The list which contain all the information to generate variables used in the real application.

Usage

CCLE_data

Format

A list whose length is 2:

X Gene expression dataset.

Y AUCC score.
**colon_data**

*RobMixReg* package built-in Colon cancer data.

---

### Description

The list which contain all the information to generate variables used in the real application.

### Usage

```r
colon_data
```

### Format

A list whose length is 3:

- **rnames** A string contains the name of binding protein and epigenetic regulator.
- **x3** The gene expression profile of CREB3L1.
- **y3** The methylation profile of cg16012690 on 299 colon adenocarcinoma patients.
- **x2**
- **y2**
- **x1**
- **y1**

---

**compPlot**

*The plot wrapper function.*

---

### Description

The plot wrapper function.

### Usage

```r
compPlot(type = "rlr", x, y, nc, inds_in, res)
```

### Arguments

- **type**: The character to choose which type of plot to generate.
- **x**: The independent variables
- **y**: The external variable
- **nc**: The number of components
- **inds_in**: A vector indicate the outlier samples.
- **res**: The result object returned by MLM function.
Compute_Rbase_SVD  
Compute the row space using SVD.

Description
Compute the row space using SVD.

Usage
Compute_Rbase_SVD(bulk_data, tg_R1_lists_selected)

Arguments
- bulk_data: The bulk data.
- tg_R1_lists_selected: A list of the marker genes for several cell types.

Value
A matrix which each row span the row space using cell type specific marker genes.

CSMR
The main function of the RBSL algorithm.

Description
The main function of the RBSL algorithm.

Usage
CSMR(x, y, nit, nc, max_iter)

Arguments
- x: The matrix
- y: The external supervised variable.
- nit: xxx?
- nc: The component number in the mixture model.
- max_iter: The maximum iteration number.

Value
A list object consist of coefficient, clustering membership, data x, external variable y, predicted y based on regression model.
CSMR_one

Perform the RBSL algorithm one times.

Description
Perform the RBSL algorithm one times.

Usage
CSMR_one(x, y, nit = 1, nc, max_iter)

Arguments
- **x**
  - The matrix
- **y**
  - The external supervised variable.
- **nit**
  - xxx?
- **nc**
  - The component number in the mixture model.
- **max_iter**
  - The maximum iteration number.

Value
A list object consist of coefficient, clustering membership, data x, external variable y, predicted y based on regression model.

CSMR_predict
The predict function of the CSMR algorithm.

Description
The predict function of the CSMR algorithm.

Usage
CSMR_predict(CSMR_coffs, CSMR.model, xnew, ynew, singleMode = F)

Arguments
- **CSMR_coffs**
  - The coefficient matrix.
- **CSMR.model**
  - The trained model.
- **xnew**
  - x variable.
- **ynew**
  - y variable.
- **singleMode**
  - A parameter to set the component to one.
CTLERob

Value
A list object consist of coefficient, clustering membership, data x, external variable y, predicted y based on regression model.

CSMR_train
The train function of the CSMR algorithm.

Description
The train function of the CSMR algorithm.

Usage
CSMR_train(x, y, nit, nc, max_iter)

Arguments
- `x`: The matrix
- `y`: The external supervised variable.
- `nit`: xxx
- `nc`: The component number in the mixture model.
- `max_iter`: The maximum iteration number.

Value
A list object consist of coefficient, clustering membership, data x, external variable y, predicted y based on regression model.

CTLERob
CTLERob: Robust mixture regression based on component-wise adaptive trimming likelihood estimation.

Description
CTLERob performes robust linear regression with high breakdown point and high efficiency in each mixing components and adaptively remove the outlier samples.

Usage
CTLERob(formula, data, nit = 20, nc = 2, rlr_method = "ltsReg")

## S4 method for signature 'formula,ANY,ANY,numeric'
CTLERob(formula, data, nit = 20,
        nc = 2, rlr_method = "ltsReg")
**denLp**

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>formula</td>
<td>A symbolic description of the model to be fit.</td>
</tr>
<tr>
<td>data</td>
<td>A data frame containing the predictor and response variables, where the last column is the response variable.</td>
</tr>
<tr>
<td>nit</td>
<td>Number of iterations.</td>
</tr>
<tr>
<td>nc</td>
<td>Number of mixture components.</td>
</tr>
<tr>
<td>rlr_method</td>
<td>The regression methods, default is 'ltsReg'.</td>
</tr>
</tbody>
</table>

---

**Description**

Laplace distribution.

**Usage**

denLp(rr, sig)

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rr</td>
<td>Shift from the location parameter</td>
</tr>
<tr>
<td>sig</td>
<td>Scale parameter.</td>
</tr>
</tbody>
</table>

**Value**

Laplace density.

---

**DeOut**

**DeOut : Detect outlier observations.**

**Description**

Detect outlier observations from a vector.

**Usage**

DeOut(daData, method)

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>daData</td>
<td>A numerical vector.</td>
</tr>
<tr>
<td>method</td>
<td>Choose from '3sigma','hampel' and 'boxplot'.</td>
</tr>
</tbody>
</table>

**Value**

indices of outlier observations.
Description

Mixture regression based on MLE could be unstable when assuming unequal variance. Multiple runs of flexmix is performed to stabilize the results.

Usage

`flexmix_2(formula, data1, k, mprior)`

Arguments

- `formula`: A symbolic description of the model to be fit.
- `data1`: A data frame containing the predictor and response variables, where the last column is the response variable.
- `k`: Number of mixture components.
- `mprior`: A numeric number in (0,1) that specifies the minimum proportion of samples in each mixing components.

Value

A S4 object of flexmix class.

gaussData

Description

A dataset generated from gaussian distribution in RobMixReg package.

Usage

`gaussData`

Format

A data frame with 100 rows and 3 variables:

- `x`: x variable
- `y`: y variable
- `c`: cluster information
**lars.lsa**

**lars variant for LSA.**

**Description**

lars variant for LSA.

**Usage**

```r
lars.lsa(Sigma0, b0, intercept, n, type = c("lasso", "lar"),
    eps = .Machine$double.eps, max.steps)
```

**Arguments**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sigma0</td>
<td>The parameter.</td>
</tr>
<tr>
<td>b0</td>
<td>The intercept of the regression line.</td>
</tr>
<tr>
<td>intercept</td>
<td>The bool variable of whether consider the intercept situation</td>
</tr>
<tr>
<td>n</td>
<td>The number of data point.</td>
</tr>
<tr>
<td>type</td>
<td>Regression options, choose form &quot;lasso&quot; or &quot;lar&quot;.</td>
</tr>
<tr>
<td>eps</td>
<td>The converge threshold defined by the machine.</td>
</tr>
<tr>
<td>max.steps</td>
<td>The maximum iteration times to stop.</td>
</tr>
</tbody>
</table>

**Value**

object.

**Author(s)**


---

**logLik_mixtureReg**

**Obtain Log-likelihood from a mixtureReg Object**

**Description**

S3 method for class `mixtureReg`. However, it doesn’t return a `logLik` object. For simplicity, it returns a ‘numeric’ value.

**Usage**

```r
logLik_mixtureReg(mixtureModel)
```

**Arguments**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mixtureModel</td>
<td>mixtureReg object, typically result from <code>mixtureReg()</code>.</td>
</tr>
</tbody>
</table>
**ls**

*Least square approximation. This version Oct 19, 2006.*

**Description**

Least square approximation. This version Oct 19, 2006.

**Usage**

```r
lsa(obj)
```

**Arguments**

- `obj`  
  lm/glm/coxph or other object.

**Value**

- `beta.ols` the MLE estimate  
- `beta.bic` the LSA-BIC estimate  
- `beta.aic` the LSA-AIC estimate.

**Author(s)**


**mixlinrb_bi**

*`mixlinrb_bi`: `mixlinrb_bione` estimates the mixture regression parameters robustly using bisquare function based on multiply initial value.*

**Description**

An EM-type of parameter estimation by replacing the least square estimation in the M-step with a robust criterion.

**Usage**

```r
mixlinrb_bi(formula, data, nc = 2, nit = 200)
```

```r
## S4 method for signature 'formula,ANY,numeric,numeric'
mixlinrb_bi(formula, data,
            nc = 2, nit = 20)
```
mixlinrb_bione estimates the mixture regression parameters robustly using bisquare function based on one initial value.

**Arguments**

- **formula**: A symbolic description of the model to be fit.
- **data**: A data frame containing the predictor and response variables, where the last column is the response variable.
- **nc**: Number of mixture components.
- **nit**: Number of iterations for biSauqre method.

**Value**

Estimated coefficients of all components.

**Description**

An EM-type of parameter estimation by replacing the least square estimation in the M-step with a robust criterion.

**Usage**

mixlinrb_bione(formula, data, nc = 2)

**Arguments**

- **formula**: A symbolic description of the model to be fit.
- **data**: A data frame containing the predictor and response variables, where the last column is the response variable.
- **nc**: Number of mixture components.

**Value**

Estimated coefficients of all components.
mixLp

mixLp: mixLp_one estimates the mixture regression parameters robustly using Laplace distribution based on multiply initial value.

Description

mixLp estimates the mixture regression parameters robustly using bisquare function based on multiple initial values. The solution is found by the modal solution.

Usage

mixLp(formula, data, nc=2, nit=200)

## S4 method for signature 'formula,ANY,numeric,numeric'
mixLp(formula, data, nc = 2,
      nit = 20)

Arguments

formula A symbolic description of the model to be fit.

data A data frame containing the predictor and response variables, where the last column is the response variable.

nc Number of mixture components.

nit Number of iterations

Value

Estimated coefficients of all components.

Examples

library("RobMixReg")
formula01=as.formula("y~x")
x=(gaussData$x);y=as.numeric(gaussData$y);
example_data01=data.frame(x,y)
res = mixLp(formula01, example_data01, nc=2, nit=20)
mixLp_one

mixLp_one estimates the mixture regression parameters robustly using Laplace distribution based on one initial value.

Description

Robust mixture regression assuming that the error terms follow a Laplace distribution.

Usage

mixLp_one(formula, data, nc = 2)

Arguments

formula A symbolic description of the model to be fit.
data A data frame containing the predictor and response variables, where the last column is the response variable.
nc Number of mixture components.

Value

Estimated coefficients of all components.

mixtureReg

Function to Fit Mixture of Regressions

Description

The main function in this package.

Usage

mixtureReg(regData, formulaList, xName = NULL, yName = NULL,
mixingProb = c("Constant", "loess"), initialWList = NULL,
epsilon = 1e-08, max_iter = 10000, max_restart = 15,
min_lambda = 0.01, min_sigmaRatio = 0.1, silently = TRUE)

Arguments

regData data frame used in fitting model.
formulaList a list of the regression components that need to be estimated.
xName character; Name used to pick x variable from data.
yName character; Name used to pick y variable from data.
mixingProb character; Specify how the mixing probabilities are estimated in the M step. "Constant" specifies a constant mixing probabilities; "loess" specifies predictor dependent mixing probabilities obtained by loess smoothing.

initialWList a list of weights guesses (provided by user). Typically this is not used, unless the user has a good initial guess.

epsilon a small value that the function consider as zero. The value is used in determine matrix singularity and in determine convergence.

max_iter the maximum number of iterations.

max_restart the maximum number of restart before giving up.

min_lambda a value used to ensure estimated mixing probabilities (lambda’s) are not too close to zero.

min_sigmaRatio a value used to prevent estimated variances of any regression component from collapsing to zero.

silently a switch to turn off the screen printout.

Value
A class ’mixtureReg’ object.

Author(s)
The mixtureReg package is developed by Tianxia Zhou on github. All right reserved by Tianxia Zhou.
formula: The linear relationship between two variables.
nit: Number of iterations for CTLE, mixbi, mixLp.
nc: Number of mixture components.
x: The matrix x of the high dimension situation.
y: The external outcome variable.
max_iter: Maximum iteration for TLE method.
tRatio: The ratio of the outliers in the TLE robust mixture regression method.

Value
Main result object.

---

**MLM_bic**

*Model selection function for low dimension data.*

**Description**
Model selection function for low dimension data.

**Usage**

```r
MLM_bic(ml.method = "rlr", x, y, nc = 1, formulaList = NULL, K = 2)
```

**Arguments**

- `ml.method`: The parameter to choose the fitted model for calculating the BIC
- `x`: x variable.
- `y`: y variable.
- `nc`: The component number for low dimensional feature
- `formulaList`: The list of target formula
- `K`: The component number for high dimensional feature

**Value**
BIC value.
MLM_cv

Cross validation (fold-5) function for high dimension data.

Description

Cross validation (fold-5) function for high dimension data.

Usage

MLM_cv(x = NULL, y = NULL, nit = 1, nc = 2, max_iter = 50)

Arguments

x  
x variable.
y  
y variable.
nit  
Iteration number.
nc  
The number of component.
max_iter  
Maximum iteration.

Value

The correlation between y and y_hat based on five fold cross validation.

orderedLines

Sort by X Coordinates and Add Line to a Plot

Description

Rearrange X and Y coordinates before calling "lines()" function.

Usage

orderedLines(x, y, ...)

Arguments

x  
X coordinate vectors of points to join.
y  
Y coordinate vectors of points to join.
...  
Further graphical parameters.
**plot_CTLE**

*plot_CTLE: Plot the mixture/single regression line(s) in a simply function.*

---

**Description**

CTLERob performs robust linear regression with high breakdown point and high efficiency in each mixing components and adaptively remove the outlier samples.

**Usage**

```r
plot_CTLE(formula, data, nc = 2, inds_in)
```

## S4 method for signature 'formula,ANY,numeric'

```r
plot_CTLE(formula, data, nc = 2, inds_in)
```

**Arguments**

- **formula**: A symbolic description of the model to be fit.
- **data**: A data frame containing the predictor and response variables, where the last column is the response variable.
- **nc**: Number of mixture components.
- **inds_in**: The index of the point which belongs to the current regression line.

---

**plot_mixtureReg**

*Plot Fit and Mixing Probability of a mixtureReg Object*

---

**Description**

S3 plot method for class 'mixtureReg'.

**Usage**

```r
plot_mixtureReg(mixtureModel, which = 1:2, xName = NULL, yName = NULL, xlab = NULL, ylab = NULL, ...)
```

**Arguments**

- **mixtureModel**: mixtureReg object, typically result from 'mixtureReg()'.
- **which**: numeric; choose which plot to display. '1' gives a plot of fit; '2' gives a plot of mixing probability.
- **xName**: character; Name used to pick x variable from data.
- **yName**: character; Name used to pick y variable from data.
- **xlab**: character; label that should be put on the x axis.
- **ylab**: character; label that should be put on the y axis.
- **...**: Further graphical parameters.
**plot_mixtureRegList**  
*Plot a List of mixtureReg Objects*

**Description**
Feed in a list of mixtureReg models and get an overlayed plot.

**Usage**
```r
plot_mixtureRegList(mixtureRegList, xName = NULL, yName = NULL, ...)
```

**Arguments**
- `mixtureRegList`: a list of multiple mixtureReg objects.
- `xName`: character; Name used to pick x variable from data.
- `yName`: character; Name used to pick y variable from data.
- `...`: Further graphical parameters.

---

**Rec_Lm**  
*Adaptive lasso.*

**Description**
Adaptive lasso.

**Usage**
```r
Rec_Lm(XX, yy)
```

**Arguments**
- `XX`: The independent variable.
- `yy`: The dependent variable.

**Value**
A list object consist of index of selected variable and coefficient for all variables.
rmm

The main function of Robust Mixture Regression using five methods.

Description

The main function of Robust Mixture Regression using five methods.

Usage

rmm(lr.method = "flexmix", formula = NULL, data = NULL, nc = 2,
    nit = 20, tRatio = 0.05, MaxIt = 200)

Arguments

lr.method  A robust mixture regression method to be used. Should be one of "flexmix", "TLE", "CTLERob", "mixbi", "mixLp".
formula  A symbolic description of the model to be fit.
data  A data frame containing the predictor and response variables, where the last column is the response variable.
nc  Number of mixture components.
nit  Number of iterations for CTLE, mixbi, mixLp.
tRatio  trimming proportion for TLE method.
MaxIt  Maximum iteration for TLE method.

Value

An S4 object about the regression result.

Examples

library(RobMixReg)
library(robust)
library(flexmix)
library(robustbase)
library(MASS)
library(gtools)
# gaussData
x=(gaussData$x);y=as.numeric(gaussData$y);
formula01=as.formula("y~x")
example_data01=data.frame(x,y)
res_rmm = rmm(lr.method='flexmix', formula=formula01, data=example_data01)
res_rmm = rmm(lr.method='CTLERob', formula=formula01, data=example_data01)
RobMixReg-class

Class RobMixReg.

Description

Class RobMixReg defines a robust mixture regression class as a S4 object.

Slots

- `inds_in` The indices of observations used in the parameter estimation.
- `indout` The indices of outlier samples, not used in the parameter estimation.
- `ctleclusters` The cluster membership of each observation.
- `compc` Regression coefficients for each component.
- `comppval` Component p values.
- `compww` The posterior of the clustering.
- `call` Call function.

simuData

RobMixReg package built-in simulated example data.

Description

A simulation dataset from RobMixReg package. This simulation dataset is in dimension 2 and ground truth (include outliers label) of the cluster information also generated.

Usage

simuData

Format

A data frame with 500 rows and 5 variables:

- `X1` X1 variable
- `X2` X2 variable
- `y` y variable
- `c` cluster information
- `outlier` outlier indicator
**simu_data_sparse**

*Simulate high dimension data for RBSL algorithm validation.*

**Description**

Simulate high dimension data for RBSL algorithm validation.

**Usage**

`simu_data_sparse(n, bet, pr, sigma)`

**Arguments**

- **n**: Patient number.
- **bet**: The coefficient matrix.
- **pr**: A vector of probability threshold which simulate the sampling based on uniform distribution.
- **sigma**: A vector of noise level. The length should be equal to the component number.

**Value**

A list object consist of x, y, true cluster label.

---

**simu_func**

*The simulation function for low/high dimensional space.*

**Description**

The simulation function for low/high dimensional space.

**Usage**

`simu_func(beta, sigma, alpha = NULL, n = 400)`

**Arguments**

- **beta**: The slope vector for low dimensional space or matrix for high dimensional space.
- **sigma**: A vector whose k-th element is the standard deviation for the k-th regression component.
- **alpha**: The parameter to control the number of outliers for low dimensional space.
- **n**: The sample number for high dimensional data.

**Value**

A list object.
simu_low

*The simulation function for low dimensional space.*

**Description**

The simulation function for low dimensional space.

**Usage**

```r
simu_low(beta, inter, alpha = NULL)
```

**Arguments**

- `beta`: The slope vector.
- `inter`: The intercept vector.
- `alpha`: The parameter to control the number of outliers.

**Value**

A list object consists of the x variable in low dimensional space and the external y variable.

---

TLE

*TLE: robust mixture regression based on trimmed likelihood estimation.*

**Description**

The algorithm fits a mixture regression model after trimming a proportion of the observations, given by `tRatio`.

**Usage**

```r
TLE(formula, data, nc = 2, tRatio, MaxIt = 200)
```

```r
# S4 method for signature 'formula,ANY,numeric,numeric,numeric'
TLE(formula, data, nc = 2, tRatio, MaxIt = 200)
```

**Arguments**

- `formula`: A symbolic description of the model to be fit.
- `data`: A data frame containing the predictor and response variables, where the last column is the response variable.
- `nc`: Number of mixture components.
- `tRatio`: Trimming proportion.
- `MaxIt`: Maximum iteration.
**Value**

A S4 object of RobMixReg class.

**Examples**

```r
library("RobMixReg")
formula01=as.formula("y~x")
x=(gaussData$x);y=as.numeric(gaussData$y);
exa
```
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