

Package ‘Immigrate’

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Title Iterative Max-Min Entropy Margin-Maximization with Interaction Terms for Feature Selection

Version 0.2.1

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Description Based on large margin principle, this package performs feature selection methods: ``IM4E"(Iterative Margin-Maximization under Max-Min Entropy Algorithm); ``Immigrate"(Iterative Max-Min Entropy Margin-Maximization with Interaction Terms Algorithm); ``BIM"(Boosted version of IMMIGRATE algorithm); ``Simba"(Iterative Search Margin Based Algorithm); ``LFE"(Local Feature Extraction Algorithm). This package also performs prediction for the above feature selection methods.

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Depends R (>= 3.0.0)

License GPL (>= 2)

URL <https://cran.r-project.org/package=Immigrate>,
<https://arxiv.org/abs/1810.02658>,
<https://github.com/RuzhangZhao/Immigrate/>

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BIM	<i>BIM</i>
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Description

This function performs BIM algorithm (Boosted version of IMMIGRATE).

Usage

```
BIM(  
  xx,  
  yy,  
  nBoost = 3,  
  max_iter = 5,  
  removesmall = FALSE,  
  sigstart = 0.02,  
  sigend = 4  
)
```

Arguments

xx	model matrix of explanatory variables
yy	label vector
nBoost	number of classifiers in BIM, default to be 3
max_iter	maximum number of iteration for IMMIRGATE classifier, default to be 5
removesmall	whether remove features with small weights, default to be FALSE
sigstart	start of sigma used in algorithm, default to be 0.02
sigend	end of sigma used in algorithm, default to be 4

Value

matrix	list of weight matrices
weights	coefficient vectors for classifiers
sample_wt	sample weights, refer to cost function in link below for more details

References

Zhao, Ruzhang, Pengyu Hong, and Jun S. Liu. "IMMIGRATE: A Margin-based Feature Selection Method with Interaction Terms." *Entropy* 22.3 (2020): 291.

See Also

Please refer to <https://www.mdpi.com/1099-4300/22/3/291/htm> for more details.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
re<-BIM(xx,yy)
```

IM4E	<i>IM4E</i>
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Description

This function performs IM4E(Iterative Margin-Maximization under Max-Min Entropy) algorithm.

Usage

```
IM4E(
  xx,
  yy,
  epsilon = 0.01,
  sig = 1,
  lambda = 1,
  max_iter = 10,
  removesmall = FALSE
)
```

Arguments

xx	model matrix of explanatory variables
yy	label vector
epsilon	criterion for stopping iteration, default to be 0.01
sig	sigma used in algorithm, default to be 1
lambda	lambda used in algorithm, default to be 1
max_iter	maximum number of iteration
removesmall	whether remove features with small weights, default to be FALSE

Value

w	weight vector obtained by IM4E algorithm
iter_num	number of iteration for convergence
final_c	final cost value. Refer to the cost function in reference below for more details

References

Bei Y, Hong P. Maximizing margin quality and quantity[C]//Machine Learning for Signal Processing (MLSP), 2015 IEEE 25th International Workshop on. IEEE, 2015: 1-6.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
re<-IM4E(xx,yy)
print(re)
```

Immigrate

Immigrate

Description

This function performs IMMIGRATE(Iterative Max-Min Entropy Margin-Maximization with Interaction Terms) algorithm. IMMIGRATE is a hypothesis-margin based feature selection method with interaction terms. Its weight matrix reflects the relative importance of features and their interactions, which can be used for feature selection.

Usage

```
Immigrate(
  xx,
  yy,
  w0,
  epsilon = 0.01,
  sig = 1,
  max_iter = 10,
  removesmall = FALSE,
  randomw0 = FALSE
)
```

Arguments

xx	model matrix of explanatory variables
yy	label vector
w0	initial weight matrix, default to be diagonal matrix when missing

epsilon	criterion for stopping iteration
sig	sigma used in algorithm, default to be 1. Refer to the cost function in the link below for more details
max_iter	maximum number of iteration
removesmall	whether to remove features with small weights, default to be FALSE
randomw0	whether to use randomly initial weights, default to be FALSE

Value

w	weight matrix obtained by IMMIGRATE algorithm
iter_num	number of iteration for convergence
final_c	final cost value. Refer to the cost function in link below for more details

References

Zhao, Ruzhang, Pengyu Hong, and Jun S. Liu. "IMMIGRATE: A Margin-based Feature Selection Method with Interaction Terms." *Entropy* 22.3 (2020): 291.

See Also

Please refer to <https://www.mdpi.com/1099-4300/22/3/291/htm> for more details.

Please refer to <https://github.com/RuzhangZhao/Immigrate/> for implementation demo.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
re<-Immigrate(xx,yy)
print(re)
```

LFE

LFE

Description

This function performs LFE(Local Feature Extraction) algorithm.

Usage

```
LFE(xx, yy, T = 5)
```

Arguments

xx	model matrix of explanatory variables
yy	label vector
T	number of instance used to update weights, default to be 5

Value

w new weight matrix after LFE algorithm

References

Sun Y, Wu D. A relief based feature extraction algorithm[C]//Proceedings of the 2008 SIAM International Conference on Data Mining. Society for Industrial and Applied Mathematics, 2008: 188-195.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
re<-LFE(xx,yy)
print(re)
```

one.IM4E	<i>one.IM4E</i>
----------	-----------------

Description

This function performs (IM4E)Iterative Margin-Maximization under Max-Min Entropy algorithm for one loop.

Usage

```
one.IM4E(train_xx, train_yy, w, sig = 1, lambda = 1)
```

Arguments

train_xx	model matrix of explanatory variables
train_yy	label vector
w	initial weight
sig	sigma used in algorithm, default to be 1
lambda	lambda used in algorithm, default to be 1

Value

w	new weight vector after one loop
C	cost after one loop

one.Immigrate	<i>one.Immigrate</i>
---------------	----------------------

Description

This function performs Immigrate(Iterative Max-Min Entropy Margin-Maximization with Interaction Terms) algorithm for one loop.

Usage

```
one.Immigrate(train_xx, train_yy, W, sig = 1)
```

Arguments

train_xx	model matrix of explanatory variables
train_yy	label vector
W	initial weight matrix
sig	sigma used in algorithm, default to be 1

Value

W	new weight matrix after one loop
C	cost after one loop

See Also

Please refer to <https://github.com/RuzhangZhao/Immigrate/> for implementation demo.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
W0 <- diag(rep(1,ncol(xx)),ncol(xx))/sqrt(ncol(xx))
re<-one.Immigrate(xx,yy,W0)
print(re$w)
```

park	<i>Parkinsons Dataset</i>
Description	
Parkinsons Dataset	
Usage	
data(park)	
Format	
An object of class	
Source	
parkinsons	
References	
Frank, A. and A. Asuncion. UCI Machine Learning Repository. 2010.	
Examples	
data(park) xx <- park\$xx yy <- park\$yy	
pred.values	<i>pred.values</i>

Description

This function performs some statistical value prediction

Usage

pred.values(y_train, y_test, pred_train, pred_test)

Arguments

- y_train label vector for training data
- y_test label vector for test data
- pred_train predicted probabilities for training data
- pred_test predicted probabilities for test data

Value

AUC_train	AUC for training data
AUC_test	AUC for test data
accuracy_test	accuracy for test data
precision_test	precision for test data
recall_test	recall for test data
F1_test	F1 score for test data
thre	threshold to separate two labels, obtained from training data

Examples

```

y_train<-c(0,1,0,1,0,1)
y_test<-c(0,1,0,1)
pred_train<-c(0.77,0.89,0.32,0.96,0.10,0.67)
pred_test<-c(0.68,0.75,0.50,0.81)
re<-pred.values(y_train,y_test,pred_train,pred_test)
print(re)

```

predict.BIM

*predict.BIM***Description**

This function performs the prediction for BIM algorithm (Boosted version of IMMIGRATE).

Usage

```

## S3 method for class 'BIM'
predict(object, xx, yy, newx, type = "both", ...)

```

Arguments

object	result of BIM algorithm
xx	model matrix of explanatory variables
yy	label vector
newx	new model matrix to be predicted
type	the form of final output
...	further arguments passed to or from other methods

Value

response	predicted probabilities for for new data (newx)
class	predicted class for for new data (newx)

References

Zhao, Ruzhang, Pengyu Hong, and Jun S. Liu. "IMMIGRATE: A Margin-based Feature Selection Method with Interaction Terms." *Entropy* 22.3 (2020): 291.

See Also

Please refer to <https://www.mdpi.com/1099-4300/22/3/291/htm> for more details.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
index<-c(1:floor(nrow(xx)*0.3))
train_xx<-xx[-index,]
test_xx<-xx[index,]
train_yy<-yy[-index]
test_yy<-yy[index]
re<-BIM(train_xx,train_yy)
res<-predict(re,train_xx,train_yy,test_xx,type="class")
print(res)
```

predict.IM4E

predict.IM4E

Description

This function performs the prediction for IM4E(Iterative Margin-Maximization under Max-Min Entropy) algorithm.

Usage

```
## S3 method for class 'IM4E'
predict(object, xx, yy, newx, sig = 1, type = "both", ...)
```

Arguments

object	weight or result of IM4E algorithm
xx	model matrix of explanatory variables
yy	label vector
newx	new model matrix to be predicted
sig	sigma used in algorithm, default to be 1
type	the form of final output, default to be "both". One can also choose "response"(predicted probabilities) or "class"(predicted labels).
...	further arguments passed to or from other methods

Value

response	predicted probabilities for new data (newx)
class	predicted class labels for new data (newx)

References

Bei Y, Hong P. Maximizing margin quality and quantity[C]//Machine Learning for Signal Processing (MLSP), 2015 IEEE 25th International Workshop on. IEEE, 2015: 1-6.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
index<-c(1:floor(nrow(xx)*0.3))
train_xx<-xx[-index,]
test_xx<-xx[index,]
train_yy<-yy[-index]
test_yy<-yy[index]
re<-IM4E(train_xx,train_yy)
res<-predict(re,train_xx,train_yy,test_xx,type="class")
print(res)
```

predict.Immigrate	<i>predict.Immigrate</i>
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Description

This function performs the prediction for Immigrate(Iterative Max-Min Entropy Margin-Maximization with Interaction Terms) algorithm.

Usage

```
## S3 method for class 'Immigrate'
predict(object, xx, yy, newx, sig = 1, type = "both", ...)
```

Arguments

object	result of Immigrate algorithm
xx	model matrix of explanatory variables
yy	label vector
newx	new model matrix to be predicted
sig	sigma used in prediction function, default to be 1. Refer to the prediction function in the link below for more details
type	the form of final output, default to be "both". One can also choose "response"(predicted probabilities) or "class"(predicted labels).
...	further arguments passed to or from other methods

Value

response	predicted probabilities for new data (newx)
class	predicted class labels for new data (newx)

References

Zhao, Ruzhang, Pengyu Hong, and Jun S. Liu. "IMMIGRATE: A Margin-based Feature Selection Method with Interaction Terms." Entropy 22.3 (2020): 291.

See Also

Please refer to <https://www.mdpi.com/1099-4300/22/3/291/htm> for more details.
Please refer to <https://github.com/RuzhangZhao/Immigrate/> for implementation demo.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
index<-c(1:floor(nrow(xx)*0.3))
train_xx<-xx[-index,]
test_xx<-xx[index,]
train_yy<-yy[-index]
test_yy<-yy[index]
re<-Immigrate(train_xx,train_yy)
res<-predict(re,train_xx,train_yy,test_xx,type="class")
print(res)
```

predict.LFE	<i>predict.LFE</i>
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Description

This function performs predition for LFE(Local Feature Extraction) algorithm.

Usage

```
## S3 method for class 'LFE'
predict(object, xx, yy, newx, ...)
```

Arguments

object	weights obtained from LFE
xx	model matrix of explanatory variables
yy	label vector
newx	new model matrix to be predicted
...	further arguments passed to or from other methods

Value

predicted labels for new data (newx)

References

Sun Y, Wu D. A relief based feature extraction algorithm[C]//Proceedings of the 2008 SIAM International Conference on Data Mining. Society for Industrial and Applied Mathematics, 2008: 188-195.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
w<-LFE(xx,yy)
pred<-predict(w,xx,yy,xx)
print(pred)
```

Simba	<i>Simba</i>
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Description

This function performs Simba(Iterative Search Margin Based Algorithm).

Usage

```
Simba(xx, yy, T = 5)
```

Arguments

- xx model matrix of explanatory variables
- yy label vector
- T number of instance used to update weights, default to be 5

Value

- w new weight after Simba algorithm

References

Gilad-Bachrach R, Navot A, Tishby N. Margin based feature selection-theory and algorithms[C]//Proceedings of the twenty-first international conference on Machine learning. ACM, 2004: 43.

Examples

```
data(park)
xx<-park$xx
yy<-park$yy
re<-Simba(xx,yy)
print(re)
```

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