

# 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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## Contents

BIM . . . . .	2
IM4E . . . . .	3
Immigrate . . . . .	4

LFE . . . . .	5
one.IM4E . . . . .	6
one.Immigrate . . . . .	7
park . . . . .	8
pred.values . . . . .	8
predict.BIM . . . . .	9
predict.IM4E . . . . .	10
predict.Immigrate . . . . .	11
predict.LFE . . . . .	12
Simba . . . . .	13

## Index 15

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BIM

*BIM*

---

### 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

*IM4E*

---

## 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

*one.IM4E*

---

**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>
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---

### 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

*Parkinsons Dataset*

---

### **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

*pred.values*

---

### **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>
-------------------	--------------------------

---

**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

*predict.LFE*

---

**Description**

This function performs prediction 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

*Simba*

---

**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)
```

# Index

- \* **BIM**
    - BIM, 2
    - predict.BIM, 9
  - \* **IM4E**
    - IM4E, 3
    - one.IM4E, 6
    - predict.IM4E, 10
  - \* **Immigrate**
    - Immigrate, 4
    - one.Immigrate, 7
    - predict.Immigrate, 11
  - \* **LFE**
    - LFE, 5
    - predict.LFE, 12
  - \* **Simba**
    - Simba, 13
  - \* **based**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **datasets**
    - park, 8
  - \* **data**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **label**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **new**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **of**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **one**
    - one.Immigrate, 7
  - \* **on**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **predict**
    - pred.values, 8
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
  - \* **the**
    - predict.BIM, 9
    - predict.IM4E, 10
    - predict.Immigrate, 11
    - predict.LFE, 12
- BIM, 2
- IM4E, 3
- Immigrate, 4
- LFE, 5
- one.IM4E, 6
- one.Immigrate, 7
- park, 8
- pred.values, 8
- predict.BIM, 9
- predict.IM4E, 10
- predict.Immigrate, 11
- predict.LFE, 12
- Simba, 13