

# Package ‘raincin’

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**Title** Ranking with Incomplete Information

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**Description** Various statistical and mathematical ranking and rating methods with incomplete information are included. This package is initially designed for the scoring system in a high school project showcase to rank student research projects, where each judge can only evaluate a set of projects in a limited time period. See Langville, A. N. and Meyer, C. D. (2012), Who is Number 1: The Science of Rating and Ranking, Princeton University Press <doi:10.1515/9781400841677>, and Gou, J. and Wu, S. (2020), A Judging System for Project Showcase: Rating and Ranking with Incomplete Information, Technical Report.

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colley	<i>Colley's Method for Rating and Ranking</i>
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### Description

Calculate ratings and provide rankings using Colley's method

### Usage

```
colley(jpMat, method = "colley", ties.method = "average")
```

### Arguments

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Colley's method, including "colley", "colleym", "colleynt" and "colleymnt"
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

### Details

1. colley: Colley's method
2. colleym: Colleyized Massey method
3. colleynt: Colley's method, no ties
4. colleymnt: Colleyized Massey method, no ties

### Value

A list of two vectors: a rating vector and a ranking vector

### Author(s)

Jiangtao Gou

## References

- Colley, W. N. (2001). Colley's bias free college football ranking method: the Colley matrix explained.
- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Langville, A. N. and Meyer, C. D. (2012). Who's Number 1?: The Science of Rating and Ranking. Princeton University Press.

## Examples

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- colley(jpMat, method='colley')
print(result)
```

---

```
convertJudgePresenterMatrix
      Judge-Presenter Matrix Converter
```

---

## Description

Convert a judge-presenter matrix to a data frame with three variables/columns

## Usage

```
convertJudgePresenterMatrix(jpMat)
```

## Arguments

jpMat                    a Judge-Presenter matrix, or a User-Movie matrix

## Details

1. score: nonzero and non-NA scores
2. row: array indices
3. col: array indices

## Value

A data frame as a long table, where each row is an observation, including the score, the row number and the column number in the jpMat matrix

## Author(s)

Jiangtao Gou  
Fengqing Zhang

**Examples**

```

jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- convertJudgePresenterMatrix(jpMat)
print(result)

```

elo

*Elo's Method for Rating and Ranking***Description**

Calculate ratings and provide rankings using Elo's system

**Usage**

```

elo(
  jpMat,
  method = "elow",
  Kfactor = 32,
  xiparameter = 400,
  initScore = 2000,
  round = 100,
  ties.method = "average"
)

```

**Arguments**

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Elo's method, including "elo", "elow", "elos"
Kfactor	a parameter to properly balance the deviation between actual and expected scores against prior ratings
xiparameter	a parameter affects the spread of the ratings in the logistic function
initScore	a parameter describe the average rating
round	a parameter indicates the number of iterations
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

**Details**

1. elo: Elo's system, using win-tie-loss, equivalent to elow
2. elow: Elo's system, using win-tie-loss
3. elos: Elo's system, using game scores (each pair has one pair of scores)

**Author(s)**

Jiangtao Gou

**References**

Elo, A. E. (1978). *The Rating of Chessplayers, Past and Present*. Arco Publishing Company, New York.

Gou, J. and Wu, S. (2020). *A Judging System for Project Showcase: Rating and Ranking with Incomplete Information*. Technical Report.

Langville, A. N. and Meyer, C. D. (2012). *Who's Number 1?: The Science of Rating and Ranking*. Princeton University Press.

**Examples**

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- elo(jpMat,
  method='elow',
  Kfactor=32,
  xiparameter=400,
  initScore=2000,
  round=10,
  ties.method='average')
print(result)
```

---

keener

*Keener's method for Rating and Ranking*

---

**Description**

Calculate ratings and provide rankings using Keener's method, without using Laplace's Rule of Succession, and using Laplace's Rule of Succession

**Usage**

```
keener(
  jpMat,
  method = "keener",
  irreducibility = 0.01,
  ties.method = "average"
)
```

**Arguments**

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Keener's method without applying a nonlinear skweing function, including "keener", "keenerwolrs"
irreducibility	a non-negative parameter, which is the ratio of the value of each element in the pertubation matrix to the average value in the normalized proportaion matrix.
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

**Details**

1. keener: Keener's method with Laplace's Rule of Succession
  2. keenerwolrs: Keener's method without Laplace's Rule of Succession
- 
1. hitsjp: HITS, using judge-presenter matrix, equivalent to offdfsc
  2. offdefnt: Offense-Defense rating method, using judge-presenter matrix

**Author(s)**

Jiangtao Gou

**References**

- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Keener, J. P. (1993). The Perron-Frobenius theorem and the ranking of football teams. SIAM Review 35, 80-93.
- Langville, A. N. and Meyer, C. D. (2012). Who's Number 1?: The Science of Rating and Ranking. Princeton University Press.

**Examples**

```
library(popdemo)
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- keener(jpMat,
  method = 'keener',
  irreducibility = 0)
print(result)
```

---

keenersk	<i>Keener's method applying a nonlinear skweing function for Rating and Ranking</i>
----------	---

---

### Description

Calculate ratings and provide rankings using Keener's method applying a nonlinear skweing function, without using Laplace's Rule of Succession, and using Laplace's Rule of Succession

### Usage

```
keenersk(
  jpMat,
  method = "keenersk",
  irreducibility = 0.01,
  ties.method = "average"
)
```

### Arguments

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Keener's method applying a nonlinear skweing function, including "keenersk", "keenerskwolrs"
irreducibility	a non-negative parameter, which is the ratio of the value of each element in the pertubation matrix to the average value in the normalized proportaion matrix.
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

### Details

1. keenersk: Keener's method with Laplace's Rule of Succession, applying a nonlinear skweing function
2. keenerskwolrs: Keener's method without Laplace's Rule of Succession, applying a nonlinear skweing function

### Author(s)

Jiangtao Gou

### References

- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Keener, J. P. (1993). The Perron-Frobenius theorem and the ranking of football teams. SIAM Review 35, 80-93.
- Langville, A. N. and Meyer, C. D. (2012). Who's Number 1?: The Science of Rating and Ranking. Princeton University Press.

**Examples**

```
library(popdemo)
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- keenersk(jpMat,
  method = 'keenersk',
  irreducibility = 0)
print(result)
```

---

 markov

*Google's PageRank algorithm for Rating and Ranking*


---

**Description**

Calculate ratings and provide rankings using Google's PageRank algorithm

**Usage**

```
markov(
  jpMat,
  method = "markovv1",
  dampingFactor = 0.85,
  ties.method = "average"
)
```

**Arguments**

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Markov's method, including "markov", "markovv1", "markovlvpd", "markovwlv".
dampingFactor	the PageRank theory holds that an imaginary surfer who is randomly clicking on links will eventually stop clicking. The probability, at any step, that the person will continue is a damping factor. Web 0.85, NFL 0.60, NCAA basketball 0.50
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

**Details**

1. markov: Markov's method, voting with losses, equivalent to markovv1
2. markovv1: Markov's method, voting with losses
3. markovlvpd: Markov's method, losers vote with point differentials
4. markovwlv: Markov's method, winners and losers vote with points

**Author(s)**

Jiangtao Gou

## References

- Brin, S. and Page, L. (1998). The anatomy of a large-scale hypertextual web search engine. *Computer Networks and ISDN Systems* 30, 107-117. Proceedings of the Seventh International World Wide Web Conference.
- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Langville, A. N. and Meyer, C. D. (2012). *Who's Number 1?: The Science of Rating and Ranking*. Princeton University Press.

## Examples

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- markov(jpMat,
  method='markovv1',
  dampingFactor=0.85,
  ties.method='average')
print(result)
```

---

massey

*Massey's method for Rating and Ranking*

---

## Description

Calculate ratings and provide rankings using Massey's method, Masseyized Colley method, Massey's method–no ties, Masseyized Colley method–no ties

## Usage

```
massey(jpMat, method = "massey", ties.method = "average")
```

## Arguments

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying Massey's method, including "massey", "masseyc", "masseynt" and "masseycnt"
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

## Details

1. massey: Massey's method
2. masseyc: Masseyized Colley method
3. masseynt: Massey's method, no ties
4. masseycnt: Masseyized Colley method, no ties

**Author(s)**

Jiangtao Gou

**References**

Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.

Langville, A. N. and Meyer, C. D. (2012). Who's Number 1?: The Science of Rating and Ranking. Princeton University Press.

Massey, K. (1997). Statistical models applied to the rating of sports teams. Bachelor's Thesis, Blue eld College.

**Examples**

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
nrow=6,
byrow=TRUE)
result <- massey(jpMat, method='massey')
print(result)
```

---

matchMeanSD

*Transform Data to Desired Mean and Standard Deviation*

---

**Description**

Transform Data to Desired Mean and Standard Deviation

**Usage**

```
matchMeanSD(data, mean = 0, sd = 1)
```

**Arguments**

data	a vector includeing data to be transformed
mean	a value of desired mean
sd	a value of desirred SD

**Value**

a vector of transformed vector

**Author(s)**

Jiangtao Gou

Fengqing Zhang

**Examples**

```
orig_data <- c(1,3,5,10)
trans_data <- matchMeanSD(data=orig_data, mean=100, sd=15)
print(trans_data)
```

---

mixedeff

*Mixed Effects Models for Rating and Ranking*

---

**Description**

Calculate ratings and provide rankings using Mixed Effects Modeling

**Usage**

```
mixedeff(jpMat, REML = FALSE, ties.method = "average")
```

**Arguments**

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
REML	a logical value for lme4::lmer
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

**Author(s)**

Jiangtao Gou  
Fengqing Zhang

**References**

Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.

**Examples**

```
jpMat <- c(1,3,5,2,6,4,3,8,7)
attr(jpMat, "dim") <- c(3,3)
mixedeff(jpMat)
```

---

naive

*Simple Linear Models for Rating and Ranking*

---

## Description

Calculate ratings and provide rankings using Simple Linear regression

## Usage

```
naive(jpMat, stats = FALSE, ties.method = "average")
```

## Arguments

<code>jpMat</code>	a Judge-Presenter matrix, or a User-Movie matrix
<code>stats</code>	a logical value to indicate whether a linear model should be fitted and the test statistics should be reported
<code>ties.method</code>	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from <code>base::rank</code>

## Author(s)

Jiangtao Gou

Shuyi Wu

## References

Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.

## Examples

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
  nrow=6,
  byrow=TRUE)
result <- naive(jpMat)
print(result)
```

---

offdefnt	<i>Kleinberg's HITS algorithm for Rating and Ranking with Rectangular Matrix</i>
----------	--

---

### Description

Calculate ratings and provide rankings using Kleinberg's HITS algorithm, using a rectangular matrix for score matrix (judge-presenter)

### Usage

```
offdefnt(  
  jpMat,  
  method = "hitsjp",  
  totalsupporteps = 0,  
  numiter = 100,  
  ties.method = "average"  
)
```

### Arguments

jpMat	a Judge-Presenter matrix, or a User-Movie matrix
method	a character string specifying the HITS algorithm, including "hitsjp".
totalsupporteps	a small number to guarantee the total support property
numiter	a number of iterations
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

### Details

movie  $i$  is good and deserves a high rating  $m_i$  if it gets high ratings from good (discriminating) users. Similarly, user  $j$  is good and serves a high rating  $h_j$  when his or her ratings match the true ratings of the movies.

1. hitsjp: HITS, using judge-presenter matrix, equivalent to offdefsc
2. offdefnt: Offense-Defense rating method, using judge-presenter matrix

### Author(s)

Jiangtao Gou

## References

- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Kleinberg, J. M. (1999). Authoritative sources in a hyperlinked environment. *Journal of the ACM* 46, 604-632.
- Langville, A. N. and Meyer, C. D. (2012). *Who's Number 1?: The Science of Rating and Ranking*. Princeton University Press.

## Examples

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),nrow=6,byrow=TRUE)
method <- 'hitsjp'
totalsupporteps <- 0.01
numiter <- 10
ties.method <- 'average'
result <- offdefnt(jpMat, method, totalsupporteps, numiter, ties.method)
print(result)
```

---

offdefsc

*Kleinberg's HITS algorithm for Rating and Ranking with Square Matrix*

---

## Description

Calculate ratings and provide rankings using Kleinberg's HITS algorithm, using a square matrix for score matrix (presenter-presenter)

## Usage

```
offdefsc(
  jpMat,
  method = "hitspp",
  totalsupporteps = 0,
  totalsupporttype = 1,
  numiter = 100,
  ties.method = "average"
)
```

## Arguments

`jpMat` a Judge-Presenter matrix, or a User-Movie matrix

`method` a character string specifying the HITS algorithm, including "hitspp".

`totalsupporteps` a small number to guarantee the total support property

`totalsupporttype` an indicator: 1 stands for matrix  $ee^T$  and 2 stands for matrix  $ee^T - I$

numiter	a number of iterations
ties.method	a character string specifying how ties are treated, including "average", "first", "last", "random", "max", "min", from base::rank

### Details

Large offense score means strong offense, and large defense score means weak defense

1. hitspp: HITS, using presenter-presenter matrix, equivalent to offdefsc
2. offdefsc: Offense-Defense rating method, using presenter-presenter matrix

### Author(s)

Jiangtao Gou

### References

- Gou, J. and Wu, S. (2020). A Judging System for Project Showcase: Rating and Ranking with Incomplete Information. Technical Report.
- Kleinberg, J. M. (1999). Authoritative sources in a hyperlinked environment. *Journal of the ACM* 46, 604-632.
- Langville, A. N. and Meyer, C. D. (2012). *Who's Number 1?: The Science of Rating and Ranking*. Princeton University Press.

### Examples

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),nrow=6,byrow=TRUE)
method <- 'hitspp'
totalsupporteps <- 0.01
totalsupporttype <- 1
numiter <- 10
ties.method <- 'average'
result <- offdefsc(jpMat, method, totalsupporteps, totalsupporttype, numiter, ties.method)
print(result)
```

---

readJudgePresenterMatrix

*Transform a Judge-Presenter Matrix Converter*

---

### Description

Convert a judge-presenter matrix to a set of square matrices

### Usage

```
readJudgePresenterMatrix(jpMat)
```

**Arguments**

`jpMat` a Judge-Presenter matrix, or a User-Movie matrix

**Value**

A list, including `numGame`

1. `numGame`: Number of times teams *i* and *j* faced each other
2. `numWin`: Number of wins teams *i* plays against *j*
3. `numTie`: Number of ties teams *i* plays against *j*
4. `numLoss`: Number of losses teams *i* plays against *j*
5. `numPt`: Number of points teams *i* accumulates against *j*

**Author(s)**

Jiangtao Gou

Shuyi Wu

**Examples**

```
jpMat <- matrix(data=c(5,4,3,0, 5,5,3,1, 0,0,0,5, 0,0,2,0, 4,0,0,3, 1,0,0,4),
nrow=6,byrow=TRUE)
result <- readJudgePresenterMatrix(jpMat)
print(result)
```

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