

# Package ‘TDARACNE’

October 12, 2016

**Type** Package

**Title** Network reverse engineering from time course data.

**Version** 1.22.0

**Date** 2009-11-11

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**Depends** GenKern, Rgraphviz, Biobase

**biocViews** Microarray, TimeCourse

## Description

To infer gene networks from time-series measurements is a current challenge into bioinformatics research area. In order to detect dependencies between genes at different time delays, we propose an approach to infer gene regulatory networks from time-series measurements starting from a well known algorithm based on information theory. The proposed algorithm is expected to be useful in reconstruction of small biological directed networks from time course data.

**License** GPL-2

**collate** IcEfx.R PercentileC.R RangeRank2.R CalcMI\_time2.R bootstrap.R  
saveTime.R MItimeIcE2.R MItimeThreshperm2.R DPI\_TDAracne.R  
DPI2\_TDAracne.R ToTheGraph\_timeShiftmax2.R TDARACNE.R  
TDARACNEdataPublished.R plotRgraphviz.R

**LazyLoad** yes

**NeedsCompilation** no

## R topics documented:

bootstrap	2
CalcMI_time2	2
dataIRMAoff	3
dataIRMAon	4
dataSOSmean	5
dataYeast	6
DPI2_TDAracne	7
DPI_TDAracne	7

IcEfx . . . . .	8
MItimeIcE2 . . . . .	8
MItimeThreshperm2 . . . . .	9
PercentileC . . . . .	9
plotRgraphviz . . . . .	10
RangeRank2 . . . . .	10
saveTime . . . . .	10
TDARACNE . . . . .	11
TDARACNEdataPublished . . . . .	12
threshIRMAon . . . . .	13
threshSOSmean . . . . .	13
threshYeast . . . . .	13
ToTheGraph_timeShiftmax2 . . . . .	14

## Index 15

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bootstrap	<i>bootstrap</i>
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### Description

make a block bootstrap. See the reference paper

### Usage

bootstrap(TS)

### Arguments

TS	TS is the time series that have to be bootstrapped
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CalcMI_time2	<i>CalcMI_time2</i>
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### Description

Compute the d-delayed Mutual information

### Usage

CalcMI\_time2(l, t, delta)

### Arguments

l	one gene profile
t	another gene profile
delta	maximum delay

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 dataIRMAoff

*dataIRMAoff*


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**Description**

data used to infer the IRMAoff network

**Usage**

```
data(dataIRMAoff)
```

**Format**

The format is: Formal class 'ExpressionSet' [package "Biobase"] with 7 slots ..@ assayData :<environment: 0x115feb540> ..@ phenoData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 21 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ featureData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 5 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "featureNames" "featureColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ experimentData :Formal class 'MIAME' [package "Biobase"] with 13 slots .. .. ..@ name : chr "" .. .. ..@ lab : chr "" .. .. ..@ contact : chr "" .. .. ..@ title : chr "" .. .. ..@ abstract : chr "" .. .. ..@ url : chr "" .. .. ..@ pubMedIds : chr "" .. .. ..@ samples : list() .. .. ..@ hybridizations : list() .. .. ..@ normControls : list() .. .. ..@ preprocessing : list() .. .. ..@ other : list() .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 0 0 ..@ annotation : chr(0) ..@ protocolData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 21 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 4 .. .. .. ..\$ : int [1:3] 2 11 0 .. .. .. ..\$ : int [1:3] 2 8 0 .. .. .. ..\$ : int [1:3] 1 3 0 .. .. .. ..\$ : int [1:3] 1 0 0

**Details**

gene on the rows and time points on the columns

dataIRMAon

*dataIRMAon***Description**

data used to infer the IRMA network

**Usage**

```
data(dataIRMAon)
```

**Format**

The format is: Formal class 'ExpressionSet' [package "Biobase"] with 7 slots ..@ assayData :<environment: 0x1159767c8> ..@ phenoData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 16 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ featureData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 5 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "featureNames" "featureColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ experimentData :Formal class 'MIAME' [package "Biobase"] with 13 slots .. ..@ name : chr "" .. ..@ lab : chr "" .. ..@ contact : chr "" .. ..@ title : chr "" .. ..@ abstract : chr "" .. ..@ url : chr "" .. ..@ pubMedIds : chr "" .. ..@ samples : list() .. ..@ hybridizations : list() .. ..@ normControls : list() .. ..@ preprocessing : list() .. ..@ other : list() .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 0 0 ..@ annotation : chr(0) ..@ protocolData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 16 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 4 .. .. .\$ : int [1:3] 2 11 0 .. .. .\$ : int [1:3] 2 8 0 .. .. .\$ : int [1:3] 1 3 0 .. .. .\$ : int [1:3] 1 0 0

**Details**

gene on the rows and time points on the columns

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 dataSOSmean

*dataSOSmean*


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## Description

data used to infer the E.coli SOS network

## Usage

```
data(dataSOSmean)
```

## Format

The format is: Formal class 'ExpressionSet' [package "Biobase"] with 7 slots ..@ assayData :<environment: 0x1159ba7f0> ..@ phenoData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 14 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ featureData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 8 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "featureNames" "featureColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ experimentData :Formal class 'MIAME' [package "Biobase"] with 13 slots .. .. ..@ name : chr "" .. .. ..@ lab : chr "" .. .. ..@ contact : chr "" .. .. ..@ title : chr "" .. .. ..@ abstract : chr "" .. .. ..@ url : chr "" .. .. ..@ pubMedIds : chr "" .. .. ..@ samples : list() .. .. ..@ hybridizations : list() .. .. ..@ normControls : list() .. .. ..@ preprocessing : list() .. .. ..@ other : list() .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 0 0 ..@ annotation : chr(0) ..@ protocolData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. ..\$ labelDescription: chr(0) .. .. ..@ data :'data.frame': 14 obs. of 0 variables .. .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 1 .. .. .. ..\$ : int [1:3] 1 1 0 ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. .. ..@ .Data:List of 4 .. .. .. ..\$ : int [1:3] 2 11 0 .. .. .. ..\$ : int [1:3] 2 8 0 .. .. .. ..\$ : int [1:3] 1 3 0 .. .. ..\$ : int [1:3] 1 0 0

## Details

gene on the rows and time points on the columns

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 dataYeast

*dataYeast*


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## Description

data used to infer a partial Yeast G1/M cell cycle network

## Usage

```
data(dataYeast)
```

## Format

The format is: Formal class 'ExpressionSet' [package "Biobase"] with 7 slots ..@ assayData :<environment: 0x100e32508> ..@ phenoData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 16 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ featureData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 11 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "featureNames" "featureColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ experimentData :Formal class 'MIAME' [package "Biobase"] with 13 slots .. ..@ name : chr "" .. ..@ lab : chr "" .. ..@ contact : chr "" .. ..@ title : chr "" .. ..@ abstract : chr "" .. ..@ url : chr "" .. ..@ pubMedIds : chr "" .. ..@ samples : list() .. ..@ hybridizations : list() .. ..@ normControls : list() .. ..@ preprocessing : list() .. ..@ other : list() .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 0 0 ..@ annotation : chr(0) ..@ protocolData :Formal class 'AnnotatedDataFrame' [package "Biobase"] with 4 slots .. ..@ varMetadata :'data.frame': 0 obs. of 1 variable: .. .. .\$ labelDescription: chr(0) .. ..@ data :'data.frame': 16 obs. of 0 variables .. ..@ dimLabels : chr [1:2] "sampleNames" "sampleColumns" .. ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 1 .. .. .\$ : int [1:3] 1 1 0 ..@ \_\_classVersion\_\_:Formal class 'Versions' [package "Biobase"] with 1 slots .. ..@ .Data:List of 4 .. .. .\$ : int [1:3] 2 11 0 .. .. .\$ : int [1:3] 2 8 0 .. .. .\$ : int [1:3] 1 3 0 .. .. .\$ : int [1:3] 1 0 0

## Details

gene on the rows and time points on the columns

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DPI2_TDAracne	<i>DPI2_TDAracne</i>
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**Description**

MAke the second DPI

**Usage**

DPI2\_TDAracne(MItab, tolerance)

**Arguments**

MItab	MItab is the adjacency matrix before the second DPI
tolerance	tolerance is the DPI tolerance.

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DPI_TDAracne	<i>DPI_TDAracne</i>
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**Description**

MAake the first DPI

**Usage**

DPI\_TDAracne(MItab, delta, tolerance)

**Arguments**

MItab	MItab is the adjacency matrix before DPI
delta	delta is the maximum time delay allowed to infer connections.
tolerance	tolerance is the DPI tolerance.

IcEfx

*IcEfx***Description**

Select the point of Initial change Expression of the genes

**Usage**

```
IcEfx(z, likelihood, logarit)
```

**Arguments**

z	z is the data matrix
likelihood	likelihood is the fold change used as threshold to state the initial change expression
logarit	if z is log put logarithm == 0;

MitimeIcE2

*MitimeIcE2***Description**

Compute the d-delayed Mutual information all over the whole set of genes

**Usage**

```
MitimeIcE2(z, N, delta, norm, threshold, ksd, IcE)
```

**Arguments**

z	z is the data matrix
N	N is respectively the number of bins in percentile normalization or in rank normalization
delta	delta is the maximum time delay allowed to infer connections
norm	if you want column percentile normalization put norm == 1; if you want Rank normalization put norm == 2;
threshold	the Influence threshold. if you have a threshold and a SD put them here in this format: c(thresh,SD) if you don't have threshold put 0 in thresh;
ksd	ksd is the standard deviation multiplier;
IcE	the IcE value



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MTimeThreshperm2	<i>MTimeThreshperm2</i>
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**Description**

Compute the threshold of the d-delayed Mutual information

**Usage**

MTimeThreshperm2(z, N, delta, norm)

**Arguments**

z	z is the data matrix
N	N is respectively the number of bins in percentile normalization or in rank normalization
delta	delta is the maximum time delay allowed to infer connections
norm	if you want column percentile normalization put norm == 1; if you want Rank normalization put norm == 2;

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PercentileC	<i>PercentileC</i>
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**Description**

Percentile row normalization, each column goes from 0 to 1

**Usage**

PercentileC(z, N)

**Arguments**

z	z is the data matrix
N	N is respectively the number of bins in percentile normalization or in rank normalization

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plotRgraphviz	<i>plotRgraphviz</i>
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**Description**

use Rgraphviz to plot the adj; bonus help function

**Usage**

```
plotRgraphviz(Influence)
```

**Arguments**

Influence	the adj matrix
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RangeRank2	<i>RangeRank2</i>
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---

**Description**

Column Rank discretization and normalization, each row goes from 0 to 1

**Usage**

```
RangeRank2(z, N)
```

**Arguments**

z	the data matrix
N	number of bins

---

saveTime	<i>saveTime</i>
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**Description**

make some useful check on the data

**Usage**

```
saveTime(newz, delta)
```

**Arguments**

newz	newz is the data matrix
delta	delta is the maximum time delay allowed to infer connections

---

 TDARACNE

*TDARACNE*


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### Description

Main function, see P. Zoppoli, S. Morganella, M. Ceccarelli. TimeDelay-ARACNE: Reverse engineering of gene networks from time-course data by an information theoretic approach. BMC Bioinformatics 2010, 11:154.

### Usage

```
TDARACNE(eSet,N,delta=3,likelihood=1.2,norm=2,logarithm=1,thresh=0,ksd=1,tolerance=0.15,plot=FALSE,dot=FALSE,name="example",adj=FALSE)
```

### Arguments

eSet	eSet is the ExpressionSet object
N	N is respectively the number of bins in percentile normalization or in rank normalization
delta	delta is the maximum time delay allowed to infer connections
likelihood	likelihood is the fold change used as threshold to state the initial change expression (IcE)
norm	if you want column percentile normalization put norm == 1; if you want Rank normalization put norm == 2;
logarithm	if z is log put logarithm == 0;
thresh	the Influence threshold. if you have a threshold and a SD put them here in this format: c(thresh,SD) if you don't have threshold put 0 in thresh;
ksd	ksd is the standard deviation multiplier;
tolerance	tolerance is the DPI tolerance; 0 means no tolerance 1 means no DPI 0.15 is the default ARACNE tolerance as it is for TDARACNE
plot	plot must be TRUE to obtain automatically the graph
dot	dot must be TRUE to obtain a .dot file
name	name must be written with quotation marks(like this:'example') and is the name of the .dot file produced;
adj	adj must be TRUE to obtain an adjacent matrix

### Examples

```
## take paper data
library(TDARACNE)
data(dataIRMAon)
data(threshIRMAon)
## main function; in output gives to you and adj matrix and a .dot file
# eSet is the ExpressionSet object
# N is respectively the number of bins in percentile normalization or in rank normalization
```

```

# delta is the maximum time delay allowed to infer connections
# likelihood is the fold change used as threshold to state the initial change expression (IcE)
# if you want column percentile normalization put norm == 1;
# if you want Rank normalization put norm == 2;
# if z is log put logarithm == 0;
# if you don't have threshold put 0 in thresh;
# ksd is the standard deviation multiplier;
# tolerance is the DPI tolerance;
# plot must be TRUE to obtain automatically the graph
# dot must be TRUE to obtain a .dot file
# name must be written with quotation marks(like this:'examplename') and is the name of the .dot file produced;
# adj must be TRUE to obtain an adjacent matrix

TDARACNE(dataIRMAon,11,"netIRMAon",delta=3,likelihood=1.2,norm=2,logarithm=1,thresh=threshIRMAon,ksd=0,tolerance

```

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TDARACNEdataPublished *TDARACNEdataPublished*

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## Description

main function with reference paper data. This reproduce the paper results. Simply run the function with no arguments to obtain the paper results.

## Usage

```
TDARACNEdataPublished()
```

## Examples

```

## take the paper data
library(TDARACNE)
data(dataYeast)
data(dataSOSmean)
data(dataIRMAon)
data(threshIRMAon)
data(threshSOSmean)
data(threshYeast)
## paper results
  TDARACNEdataPublished()
## see in your working directory for .dot files

```

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threshIRMAon	<i>threshIRMAon</i>
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**Description**

IRMAon thresh

**Usage**

data(threshIRMAon)

**Format**

The format is: num [1:2] 0.593 0.309

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threshSOSmean	<i>threshSOSmean</i>
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**Description**

SOS thresh

**Usage**

data(threshSOSmean)

**Format**

The format is: num [1:2] 0.428 0.311

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threshYeast	<i>threshYeast</i>
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**Description**

Yeast threshold

**Usage**

data(threshYeast)

**Format**

The format is: num [1:2] 0.216 0.156

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ToTheGraph\_timeShiftmax2

*ToTheGraph\_timeShiftmax2*

---

**Description**

make a .dot file of the adj

**Usage**

ToTheGraph\_timeShiftmax2(network, name)

**Arguments**

network            the adj matrix

name                name for the .dot file

# Index

[bootstrap](#), [2](#)

[CalcMI\\_time2](#), [2](#)

[dataIRMAoff](#), [3](#)

[dataIRMAon](#), [4](#)

[dataSOSmean](#), [5](#)

[dataYeast](#), [6](#)

[DPI2\\_TDAracne](#), [7](#)

[DPI\\_TDAracne](#), [7](#)

[IcEfx](#), [8](#)

[MItimeIcE2](#), [8](#)

[MItimeThreshperm2](#), [9](#)

[PercentileC](#), [9](#)

[plotRgraphviz](#), [10](#)

[RangeRank2](#), [10](#)

[saveTime](#), [10](#)

[TDARACNE](#), [11](#)

[TDARACNEdataPublished](#), [12](#)

[threshIRMAon](#), [13](#)

[threshSOSmean](#), [13](#)

[threshYeast](#), [13](#)

[ToTheGraph\\_timeShiftmax2](#), [14](#)