Package ‘GeneNetworkBuilder’

February 23, 2024

Type Package
Version 1.44.0
Title GeneNetworkBuilder: a bioconductor package for building regulatory network using ChIP-chip/ChIP-seq data and Gene Expression Data
Author Jianhong Ou, Haibo Liu, Heidi A Tissenbaum and Lihua Julie Zhu
Maintainer Jianhong Ou <jianhong.ou@duke.edu>
Imports plyr, graph, htmlwidgets, Rgraphviz, rjson, XML, methods, grDevices, stats, graphics
Depends R (>= 2.15.1), Rcpp (>= 0.9.13)
Suggests RUnit, BiocGenerics, RBGL, knitr, simpIntLists, shiny, STRINGdb, BiocStyle, magick, rmarkdown, org.Hs.eg.db
LinkingTo Rcpp
Description Application for discovering direct or indirect targets of transcription factors using ChIP-chip or ChIP-seq, and microarray or RNA-seq gene expression data. Inputting a list of genes of potential targets of one TF from ChIP-chip or ChIP-seq, and the gene expression results, GeneNetworkBuilder generates a regulatory network of the TF.
License GPL (>= 2)
Lazyload yes
LazyData true
biocViews Sequencing, Microarray, GraphAndNetwork
VignetteBuilder knitr
RoxygenNote 7.2.1
Encoding UTF-8
git_url https://git.bioconductor.org/packages/GeneNetworkBuilder
git_branch RELEASE_3_18
git_last_commit e57b568
git_last_commit_date 2023-10-24
Description

Application for discovering direct or indirect targets of transcription factors using ChIP-chip or ChIP-seq, and microarray or RNA-seq gene expression data. Inputting a list of genes of potential targets of one TF from ChIP-chip or ChIP-seq, and the gene expression results, GeneNetworkBuilder generates a regulatory network of the TF.

Author(s)

Maintainer: Jianhong Ou Developer <jianhong.ou@duke.edu>

Authors:

- Lihua Julie Zhu Developer <Julie.Zhu@umassmed.edu>
browseNetwork

---

**Description**

plot network generated by `polishNetwork`

**Usage**

```r
browseNetwork(
  gR = graphNEL(),
  layoutType = c("fdp", "dot", "neato", "twopi", "circo"),
  width = NULL,
  height = NULL,
  maxNodes = 500,
  ...
)
```

**Arguments**

- `gR` an object of `graphNEL`
- `layoutType` layout type. see `GraphvizLayouts`
- `width` width of the figure
- `height` height of the figure
- `maxNodes` max nodes number to plot. Because if there are two many nodes, the running time will be too long.
- `...` parameters used by `GraphvizLayouts`

**Value**

An object of class htmlwidget that will intelligently print itself into HTML in a variety of contexts including the R console, within R Markdown documents, and within Shiny output bindings.

**Examples**

```r
data("ce.miRNA.map")
data("example.data")
data("ce.interactionmap")
data("ce.IDsMap")
sifNetwork<-buildNetwork(example.data$ce.bind, ce.interactionmap, level=2)
cifNetwork<-filterNetwork(rootgene=ce.IDsMap["DAF-16"], sifNetwork=sifNetwork,
  exprsData=uniqueExprsData(example.data$ce.exprData, "Max", condenseName='logFC'),
  mergeBy='symbols',
  miRNAlist=as.character(ce.miRNA.map[,1]), tolerance=1)
gR<-polishNetwork(cifNetwork)
browseNetwork(gR)
```
## browseNetwork-shiny

### Shiny bindings for browseNetwork

**Description**

Output and render functions for using browseNetwork within Shiny applications and interactive Rmd documents.

**Usage**

```r
browseNetworkOutput(outputId, width = "100\%", height = "400px")
```

```r
renderBrowseNetwork(expr, env = parent.frame(), quoted = FALSE)
```

**Arguments**

- **outputId**: output variable to read from
- **width, height**: Must be a valid CSS unit (like '100%', '400px', 'auto') or a number, which will be coerced to a string and have 'px' appended.
- **expr**: An expression that generates a browseNetwork
- **env**: The environment in which to evaluate expr.
- **quoted**: Is expr a quoted expression (with `quote()`)? This is useful if you want to save an expression in a variable.

## buildNetwork

### construct the regulatory network

**Description**

Get all the connections of interesting genes from regulatory map.

**Usage**

```r
buildNetwork(TFbindingTable, interactionmap, level = 3)
```

**Arguments**

- **TFbindingTable**: a matrix or data.frame with interesting genes. Column names must be 'from', 'to'
- **interactionmap**: Transcription regulatory map. Column names of interactionmap must be 'from', 'to'
- **level**: Depth of node path

**Value**

a dataframe or matrix of all the connections of interesting genes
### ce.IDsMap

**Examples**

```r
data("ce.interactionmap")
data("example.data")
xx<-buildNetwork(example.data$ce.bind, ce.interactionmap, level=2)
```

---

**Description**

Map file for converting gene name or sequence name of *Caenorhabditis elegans* to wormbase identifier.

**Usage**

```r
ce.IDsMap
```

**Format**

Character vector.

**Details**

Character vector with gene name or sequence name as names and wormbase identifier as values.

**Source**


---

### ce.interactionmap

**Examples**

```r
data(ce.IDsMap)
head(ce.IDsMap)
```

---

**Description**

Transcript regulatory map of *Caenorhabditis elegans*.

**Usage**

```r
ce.interactionmap
```
ce.mapIDs

Format

dataframe

Details

transcript regulatory map of *Caenorhabditis elegans* is generated using databases edgedb and microCosm Targets.

Source


Examples

data(ce.interactionmap)
head(ce.interactionmap)

---

ce.mapIDs  

map file for converting from wormbase identifier to *Caenorhabditis elegans* gene name

Description

map file for converting from wormbase identifier to *Caenorhabditis elegans* gene name

Usage

ce.mapIDs

Format

ccharacter vector

Details

ccharacter vector with wormbase identifier as names and gene name as values.

Source

http://www.wormbase.org/

Examples

data(ce.mapIDs)
head(ce.mapIDs)
**ce.miRNA.map**

**Description**

micro RNA of *Caenorhabditis elegans*

**Usage**

```r
ce.miRNA.map
```

**Format**

dataframe

**Details**

The first column is wormbase identifier. And the second column is miRNA names.

**Source**


**Examples**

```r
data(ce.miRNA.map)
head(ce.miRNA.map)
```

---

**convertID**

**convert gene IDs by id map**

**Description**

For same gene, there are multiple gene alias. In order to eliminate the possibility of missing any connections, convert the gene symbols to unique gene ids is important. This function can convert the gene symbols to unique ids and convert it back according a giving map.

**Usage**

```r
convertID(x, IDsMap, ByName = c("from", "to"))
```

**Arguments**

- `x`: a matrix or dataframe contain the columns to be converted.
- `IDsMap`: a character vector of the identifier map
- `ByName`: the column names to be converted
Value

a matrix or dataframe with converted gene IDs

Examples

data("ce.IDsMap")
bind<-cbind(from="daf-16", to=c("fkh-7", "h1h-13", "mxl-3", "nhr-3", "lfi-1"))
convertID(toupper(bind), ce.IDsMap, ByName=c("from", "to"))

descriptor example.data example datasets for documentation

Description

example.data is a data list of example datasets. There is a dataset example.microarrayData, which is
the example of gene expression data of a gene-chip result of C.elegans. Dataset example.data$ce.bind
is a TF binding matrix of ChIP-chip experiment of C.elegans. Dataset example.data$ce.exprData
is expression data of a gene-chip result of C.elegans. Dataset example.data$hs.bind is a TF binding
matrix of ChIP-chip experiment of H.sapiens. Dataset example.data$hs.exprData is expression data
of a combination of a gene-chip result and a RNA-SEQ result of H.sapiens.

Usage

example.data

Format

dataframe

Details

The dataset example.microarrayData contains columns: ID, logFC, AveExpr, t, P.Value, adj.P.Val,
B, genes and symbols. The columns of ID, logFC and symbols are required by GeneNetwork-
Builder. The dataset example.data$ce.exprData contains columns: ID, symbols, logFC and P.Value. The
dataset example.data$hs.exprData contains columns: from and to.

Examples

data(example.data)
names(example.data)
head(example.data$example.microarrayData)
head(example.data$ce.bind)
head(example.data$ce.exprData)
head(example.data$hs.bind)
head(example.data$hs.exprData)
exportNetwork

Save network in various formats

Description

Save graph into HTML, json or xgmml format.

Usage

exportNetwork(network, file, format = c("HTML", "json", "XGMML"), ...)

Arguments

network  output of browseNetwork
file  Name of the file to save to.
format  type in which graph shall be saved. Could be one of HTML, json or XGMML.
...  Parameter could be used by saveWidget for HTML or writeLines for json or saveXML for XGMML.

Examples

data("ce.miRNA.map")
data("example.data")
data("ce.interactionmap")
data("ce.IDsMap")
sifNetwork<-buildNetwork(example.data$ce.bind, ce.interactionmap, level=2)
cifNetwork<-filterNetwork(rootgene=ce.IDsMap["DAF-16"], sifNetwork=sifNetwork,
  exprsData=uniqueExprsData(example.data$ce.exprData, "Max", condenseName='logFC'),
  mergeBy="symbols",
  miRNAlist=as.character(ce.miRNA.map[, 1]), tolerance=1)
gR<-polishNetwork(cifNetwork)
network <- browseNetwork(gR)
extportNetwork(network, "sample.html")

filterNetwork

filter the regulatory network table by expression profile

Description

verify every nodes in the regulatory network by expression profile
Usage

```r
filterNetwork(
  rootgene,
  sifNetwork,
  exprsData,
  mergeBy = "symbols",
  miRNAlist,
  remove_miRNA = FALSE,
  tolerance = 0,
  cutoffPVal = 0.01,
  cutoffLFC = 0.5,
  minify = TRUE,
  miRNAtol = FALSE
)
```

Arguments

- **rootgene**  
  name of root gene. It must be the ID used in xx regulatory network

- **sifNetwork** 
  Transcription regulatory network table. Column names of xx must be 'from','to'

- **exprsData** 
  dataset of expression comparison data, which should contain column logFC and column given by exprsDataByName

- **mergeBy** 
  The column name contains ID information used to merge with 'to' column of sifNetwork in exprsData

- **miRNAlist** 
  vector of microRNA ids.

- **remove_miRNA** 
  remove miRNA from the network or not. Bool value, TRUE or FALSE

- **tolerance** 
  maximum number of unverified nodes in each path

- **cutoffPVal** 
  cutoff p value of valid differential expressed gene/miRNA

- **cutoffLFC** 
  cutoff log fold change value of a valid differential expressed gene/miRNA

- **minify** 
  Only keep the best path if multiple paths exists for single node? Bool value, TRUE or FALSE

- **miRNAtol** 
  take miRNA expression into account for tolerance calculation. Bool value, TRUE or FALSE

Value

a dataframe of filtered regulatory network by expression profile

Examples

```r
data("ce.miRNA.map")
data("example.data")
data("ce.interactionmap")
data("ce.IDsMap")
sifNetwork<-buildNetwork(example.data$ce.bind, ce.interactionmap, level=2)
cifNetwork<-filterNetwork(rootgene=ce.IDsMap["DAF-16"], sifNetwork=sifNetwork, 
  exprsData=uniqueExprsData(example.data$ce.exprData, "Max", condenseName='logFC'),
```
hs.IDsMap

```r
mergeBy="symbols",
miRNAlist=as.character(ce.miRNA.map[, 1]), tolerance=1)
```

---

**hs.IDsMap**  
*map file for converting gene name or sequence name of* Homo sapiens  
to Entrez identifier

---

**Description**  
map file for converting gene name or sequence name of *Homo sapiens* to Entrez identifier

**Usage**

`hs.IDsMap`

**Format**

character vector

**Details**

character vector with gene name as names and Entrez identifier as values.

**Examples**

```r
data(hs.IDsMap)
head(hs.IDsMap)
```

---

**hs.interactionmap**  
*transcript regulation map of* Homo sapiens

---

**Description**  
*transcript regulation map of* Homo sapiens

**Usage**

`hs.interactionmap`

**Format**

dataframe

**Details**

transcript regulatory map of *Homo sapiens* is generated using databases FANTOM, mirGen and microCosm Targets.
**Source**


**Examples**

```r
data(hs.interactionmap)
head(hs.interactionmap)
```

---

<table>
<thead>
<tr>
<th>hs.mapIDs</th>
<th>map file for converting from Entrez identifier to Homo sapiens gene name</th>
</tr>
</thead>
</table>

**Description**

map file for converting from Entrez identifier to *Homo sapiens* gene name

**Usage**

hs.mapIDs

**Format**

character vector

**Details**

character vector with Entrez identifier as names and gene name as values.

**Examples**

```r
data(hs.mapIDs)
head(hs.mapIDs)
```
hs.miRNA.map

---

**Description**

micro RNA of *Homo sapiens*

**Usage**

hs.miRNA.map

**Format**

dataframe

**Details**

The first column is entrez identifier. And the second column is miRNA names.

**Source**

http://www.mirbase.org/

**Examples**

data(hs.miRNA.map)
head(hs.miRNA.map)

---

**networkFromGenes**

*Build network by a list of given genes*

---

**Description**

By providing a list of given genes, build a network for input of filterNetwork.

**Usage**

networkFromGenes(genes, interactionmap, level = 3, unrooted = FALSE)

**Arguments**

- **genes**: A vector of character for interested genes.
- **interactionmap**: Transcription regulatory map. Column names of interactionmap must be 'from','to'
- **level**: Depth of node path
- **unrooted**: Return unrooted regulatory network table or not.
polishNetwork

Value

a list with elements: rootgene: The nodes with maximal connections. sifNetwork: Transcription regulatory network table.

Examples

data("ce.interactionmap")
data("example.data")
genes <- as.character(example.data$ce.bind$from)
xx<-networkFromGenes(example.data$ce.bind, ce.interactionmap, level=2)

---

polishNetwork generate an object of grahpNEL to represent the regulation network

Description

generate an object of grahpNEL to represent the regulation network. Each node will has three attributes: size, borderColor and fill.

Usage

polishNetwork(
    cifNetwork,
    nodesDefaultSize = 48,
    useLogFCAsWeight = FALSE,
    nodecolor = colorRampPalette(c("green", "yellow", "red"))(5),
    nodeBg = "white",
    nodeBorderColor = list(gene = "darkgreen", miRNA = "darkblue"),
    edgelwd = 0.25,
    ...
)

Arguments

cifNetwork dataframe used to draw network graph. column names of cifNetwork must contain 'from', 'to', 'logFC' and 'miRNA'
nodesDefaultSize nodes default size
useLogFCAsWeight how to determine the weights for each nodes. If TURE, use logFC value as weight. If FALSE, use constant 1 as weight.
nodecolor a character vector of color set. The node color will be mapped to color set by log fold change. Or the column names for the colors.
nodeBg background of node
nodeBorderColor a list of broder node color set. nodeBorderColor's element must be gene and miRNA
**saveXGMML**

saveXGMML  
*Save network as xgmml*

**Description**

Save graph into xgmml format.

**Usage**

saveXGMML(network, file, ...)

**Arguments**

- **network**: output of `browseNetwork`  
- **file**: Name of the file to save to.  
- **...**: Parameter could be used by `saveXML`
subsetNetwork  Subset a polished network

Description
Subset the output of polishNetwork by a list of nodes name

Usage
subsetNetwork(graph, genes)

Arguments
  graph  A graphNEL object. The output of polishNetwork.
  genes  A list of nodes names

Value
An object of graph.

Examples
library(graph)
set.seed(123)
g1 <- randomEGraph(LETTERS[seq.int(15)], edges=100)
g1 <- subsetNetwork(g1, LETTERS[seq.int(5)])
plot(g1)

uniqueExprsData  unique the microarray data

Description
get unique the microarray data for each gene id.

Usage
uniqueExprsData(exprsData, method = "Max", condenseName = "logFC")

Arguments
  exprsData  dataset of expression comparison data
  method     method must be Max, Median or Min
  condenseName  column names to be condensed
**uniqueExprsData**

**Value**

a dataframe of expression data without duplicates

**Examples**

```r
data("example.data")
example.microarrayData<-uniqueExprsData(example.data$example.microarrayData,
method="Max", condenseName='logFC')```
Index

* IO
  exportNetwork, 9
  saveXGMML, 15

* convert
  convertID, 7

* data
  ce.IDsMap, 5
  ce.interactionmap, 5
  ce.mapIDs, 6
  ce.miRNA.map, 7
  example.data, 8
  hs.IDsMap, 11
  hs.interactionmap, 11
  hs.mapIDs, 12
  hs.miRNA.map, 13

* network
  buildNetwork, 4
  filterNetwork, 9
  networkFromGenes, 13
  polishNetwork, 14
  uniqueExprsData, 16

* plot
  browseNetwork, 3
  browseNetwork, 3, 9, 15
  browseNetwork-shiny, 4
  browseNetworkOutput
    (browseNetwork-shiny), 4
  buildNetwork, 4

  ce.IDsMap, 5
  ce.interactionmap, 5
  ce.mapIDs, 6
  ce.miRNA.map, 7
  convertID, 7

  example.data, 8
  exportNetwork, 9
  filterNetwork, 9

GeneNetworkBuilder
  (GeneNetworkBuilder-package), 2
GeneNetworkBuilder-package, 2
graph.par, 15
graphNEL, 3
GraphvizLayouts, 3

hs.IDsMap, 11
hs.interactionmap, 11
hs.mapIDs, 12
hs.miRNA.map, 13

networkFromGenes, 13
polishNetwork, 3, 14

renderBrowseNetwork
  (browseNetwork-shiny), 4

saveWidget, 9
saveXGMML, 15
saveXML, 9
subsetNetwork, 16

uniqueExprsData, 16