

# Package ‘SteinerNet’

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**Type** Package

**Version** 3.0

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**Title** Steiner Tree Approach for Graph Analysis

**Description** A set of functions for finding and analysing Steiner trees. It has applications in biological pathway network analysis. Sadeghi 2013 <doi:10.1186/1471-2105-14-144>.

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**URL** <https://github.com/krashkov/SteinerNet>

**BugReports** <https://github.com/krashkov/SteinerNet/issues>

**Depends** R (>= 3.1.0)

**Suggests** knitr,  
rmarkdown

**Imports** igraph,  
grDevices,  
stats,  
utils,  
graphics

**VignetteBuilder** knitr

**License** GPL-3

**Repository** CRAN

**NeedsCompilation** no

**Encoding** UTF-8

**RoxygenNote** 6.0.1

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generate_st_samples	<i>Select terminals</i>
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### Description

Provides random walk procedure. Starting from the randomly selected node, choose a neighbour node uniformly randomly, until given number of terminals won't be found.

### Usage

```
generate_st_samples(graph, ter_number, prob)
```

### Arguments

graph	an igraph graph; should be undirected, otherwise it is converted to undirected.
ter_number	a numeric vector; each element indicates the number of terminals to be selected and length of vector indicates the number of terminal sets to be picked.
prob	a numeric vector of the same length as ter_number; prob[i] defines a propability with which each next node accepted or rejected while selecting ter_number[i] terminals.

### Value

A list of the same length as ter\_number. Each element of list contains a vector of ids of selected vertices.

### References

1. Afshin Sadeghi and Holger Froehlich, "Steiner tree methods for optimal sub-network identification: an empirical study", BMC Bioinformatics 2013 14:144

### Examples

```
library(igraph)

generate_st_samples(graph = graph("Zachary"),
  ter_number = c(3, 4),
  prob = c(0.1, 0.2))
```

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steinertree	<i>Find Steiner Tree</i>
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### Description

A set of functions for finding Steiner Tree. Includes both exact and heuristic approaches.

### Usage

```
steinertree(type, repeattimes = 70, optimize = TRUE, terminals,
  graph, color = TRUE, merge = FALSE)
```

## Arguments

type	a character scalar, which indicates type of algorithms to perform. Can be "EXA", "SP", "KB", "RSP", "SPM" or "ASP".
repeattimes	a numeric scalar to specify "RSP" algorithm; number of times the optimization procedure is repeated.
optimize	a logical scalar to specify all algorithms except "EXA"; if TRUE, an optimization of the resultant steiner tree is performed, otherwise nothing is done.
terminals	a numeric or character vector with ids of terminals or a character vector with names of vertices (only if vertices have name attribute).
graph	an igraph graph; should be undirected, otherwise it is converted to undirected.
color	a logical scalar; whether to return an original graph with terminals colored in red and steiner nodes colored in green. Note, if several trees will be found, steiner nodes from all trees are colored in green.
merge	a logical scalar to specify "EXA" and "SPM" algorithms; if several trees will be found, whether to return a list with trees or merge them

## Details

Firstly, if input graph doesn't have name attribute, one is created, otherwise realname attribute is created and names is stored in it. In its turn name attribute will contain character ids of vertices. Further, if the terminals variable has character type and it can not be converted to numeric type, the terminals are searched among realnames. If the terminals variable has numeric type or it can be converted to numeric type, it is considered, ids of vertices is passed.

Note, that before algorithm is running all vertices will be colored in yellow and terminals will be colored in red.

## Value

(color = FALSE) Returns a list first element of which is a steiner tree (or a graph of merged trees). If several steiner trees are found, return a list, each element of which is a steiner tree.

(color = TRUE) Returns a list, first element of which is a colored original graph and second element is a steiner tree (or a graph of merged trees) or list of steiner trees.

## References

1. Path heuristic and Original path heuristic ,Section 4.1.3 of the book "The Steiner tree Problem", Petter,L,Hammer
2. "An approximate solution for the Steiner problem in graphs", H Takahashi, A Matsuyama
3. F K. Hwang, D S. Richards and P Winter, "The steiner tree Problem", Kruskal-Based Heuristic Section 4.1.4, ISBN: 978-0-444-89098-6
4. Afshin Sadeghi and Holger Froehlich, "Steiner tree methods for optimal sub-network identification: an empirical study", BMC Bioinformatics 2013 14:144
5. F K. Hwang, D S. Richards and P Winter, "The steiner tree Problem", Kruskal-Based Heuristic Section 4.1.4, The Optimal solution for stiner trees on networks, ISBN: 978-0-444-89098-6.

## See Also

[generate\\_st\\_samples](#)

**Examples**

```
library(igraph)

steinertree(type = "RSP", optimize = FALSE,
            terminals = c(1, 3),
            graph = graph("Cubical"),
            color = TRUE, merge = FALSE)
```

---

```
steiner_comparison_plots
```

```
Plot simulated data
```

---

**Description**

This function plots the comparison results of simulated data and stores it in PDF file.

**Usage**

```
steiner_comparison_plots(type, method, data, outputname)
```

**Arguments**

type	a character vector, which indicates types of algorithms to perform. Can be "EXA", "SP", "KB", "RSP", "SPM" or "ASP".
method	a character vector; specifies a calculated parameter based on which comparison is performed. Can be "runtime" (for time of execution), "log10runtime", "edge" (for number of edges in resultant steiner tree), "log10edge", "ter_freq" (for terminal frequency in resultant steiner tree) or "edge_dens" (for edge density in resultant steiner tree).
data	should have structure as output of steiner_simulation function.
outputname	a character scalar; name of file in which the result is stored

**Value**

For each method a plot with comparison of algorithms (pointed in type variable) is created. An additional information about the number of experiments and number of terminals for each type of algorithm is added. If the number of terminals is the same for each type, then their number is printed, otherwise the range is printed.

**References**

1. Afshin Sadeghi and Holger Froehlich, "Steiner tree methods for optimal sub-network identification: an empirical study", BMC Bioinformatics 2013 14:144

**See Also**

[generate\\_st\\_samples](#), [steiner\\_simulation](#), [steinertree](#)

**Examples**

```
library(igraph)

g <- graph("Cubical")

data <- steiner_simulation(type = c("SP", "KB", "SPM"),
                          graph = g,
                          ter_list = generate_st_samples(graph = g,
                                                         ter_number = c(2, 3),
                                                         prob = c(0.1, 0.2)))

steiner_comparison_plots(type = c("SP", "KB"),
                        method = c("runtime", "ter_freq"),
                        data = data,
                        outputname = "plot1.pdf")
```

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```
steiner_comparison_wilcox
```

*Perform wilcox test*

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**Description**

Perform pairwise wilcoxon rank sum tests

**Usage**

```
steiner_comparison_wilcox(type, method, data)
```

**Arguments**

type	a character vector, which indicates type of algorithms to perform. Can be "EXA", "SP", "KB", "RSP", "SPM" or "ASP".
method	a character scalar; specifies a calculated parameter based on which comparison is performed. Can be "runtime" (for time of execution), "log10runtime" "edge" (for number of edges in resultant steiner tree), "log10edge", "ter_freq" (for terminal frequency in resultant steiner tree) or "edge_dens" (for edge density in resultant steiner tree).
data	should have structure as output of steiner_simulation function.

**Details**

"holm" method for adjusting p-values is used.

**Value**

Object of class "pairwise.htest"

**References**

1. Afshin Sadeghi and Holger Froehlich, "Steiner tree methods for optimal sub-network identification: an empirical study", BMC Bioinformatics 2013 14:144

**See Also**

[generate\\_st\\_samples](#), [steiner\\_simulation](#), [steinertree](#), [pairwise.wilcox.test](#)

**Examples**

```
library(igraph)

g <- graph("Cubical")

data <- steiner_simulation(type = c("SP", "KB", "SPM"),
                          graph = g,
                          ter_list = generate_st_samples(graph = g,
                                                         ter_number = c(2, 3),
                                                         prob = c(0.1, 0.2)))

steiner_comparison_wilcox(type = c("SP", "KB"),
                          method = "ter_freq",
                          data = data)
```

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steiner_simulation	<i>Execute Steiner Algorithms and calculate parameters of output trees</i>
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**Description**

This function executes given Steiner Algorithms and calculates such parameters as runtime of each algorithm, number of edges, number of vertices, terminal frequency, edge density of resultant Steiner tree and number of trees in case of "EXA" or "SPM" algorithm. Wraps steinertree function.

**Usage**

```
steiner_simulation(type, re peattimes = 70, optimize = TRUE, graph, ter_list)
```

**Arguments**

type	a character vector, which indicates types of algorithms to perform. Can be "EXA", "SP", "KB", "RSP", "SPM" or "ASP".
re peattimes	a numeric scalar to specify "RSP" algorithm; number of times the optimization procedure is repeated.
optimize	a logical scalar to specify all algorithms in type variable (ignored for "EXA"); if TRUE, an optimization of the resultant steiner tree is performed, otherwise nothing is done.
graph	an igraph graph; should be undirected, otherwise it is converted to undirected.
ter_list	a list each element of which contains a numeric or character vector with ids of terminals or a character vector with names of vertices (only if vertices have name attribute). Therefore, length of ter_list declares a number of experiments to perform with different terminal sets for each type of algorithm.

**Details**

As a ter\_list, a vector can be passed. In this case it is converted to a list containing only one element.

**Value**

List, each element of which corresponds to specific algorithms type. Each element of a list also is a list and contains a named vector of evaluated parameters of steiner tree (runtime, edges\_num, vert\_num, trees\_num, term\_freq, edge\_den). Number of sublist corresponds to number of terminal set in ter\_list.

**References**

1. Afshin Sadeghi and Holger Froehlich, "Steiner tree methods for optimal sub-network identification: an empirical study", BMC Bioinformatics 2013 14:144

**See Also**

[generate\\_st\\_samples](#), [steinertree](#)

**Examples**

```
library(igraph)

g <- graph("Cubical")

steiner_simulation(type = c("SP", "KB", "SPM"),
                  graph = g,
                  ter_list = generate_st_samples(graph = g,
                                                ter_number = c(2, 3),
                                                prob = c(0.1, 0.2)))

steiner_simulation(type = c("EXA", "RSP"),
                  graph = g,
                  ter_list = c(1, 3, 8))
```

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