Package ‘clustAnalytics’

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<td>Average degree (weighted degree, if the graph is weighted) of a graph’s communities.</td>
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Usage

average_degree(g, com)

Arguments

g Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
com community membership integer vector. Each element corresponds to a vertex.

Value

Numeric vector with the average degree of each community.
average_odf

See Also

Other cluster scoring functions: FOMD(), average_odf(), conductance(), coverage(), cut_ratio(), density_ratio(), edges_inside(), expansion(), internal_density(), max_odf(), normalized_cut(), weighted_clustering_coefficient(), weighted_transitivity()

Examples

data(karate, package="igraphdata")
average_degree(karate, membership(cluster_louvain(karate)))

<table>
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<th>Average Out Degree Fraction</th>
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Description

Computes the Average Out Degree Fraction (Average ODF) of a graph (which can be weighted) and its communities.

Usage

average_odf(g, com)

Arguments

g Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights (otherwise, all edges are assumed to be 1).
com Community membership integer vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.

Value

Numeric vector with the Average ODF of each community.

See Also

Other cluster scoring functions: FOMD(), average_degree(), conductance(), coverage(), cut_ratio(), density_ratio(), edges_inside(), expansion(), internal_density(), max_odf(), normalized_cut(), weighted_clustering_coefficient(), weighted_transitivity()

Examples

data(karate, package="igraphdata")
average_odf(karate, membership(cluster_louvain(karate)))
Generates a Barabási-Albert graph with community structure

**Description**

Generates a Barabási-Albert graph with community structure

**Usage**

```r
barabasi_albert_blocks(
  m,
  p,
  B,
  t_max,
  G0 = NULL,
  t0 = NULL,
  G0_labels = NULL,
  sample_with_replacement = FALSE,
  type = "Hajek"
)
```

**Arguments**

- `m`: number of edges added at each step.
- `p`: vector of label probabilities. If they don’t sum 1, they will be scaled accordingly.
- `B`: matrix indicating the affinity of vertices of each label.
- `t_max`: maximum value of t (which corresponds to graph order).
- `G0`: initial graph
- `t0`: t value at which new vertex start to be attached. If G0 is provided, this argument is ignored and assumed to be gorder(G0)+1. If it isn’t, a G0 graph will be generated with order t0-1.
- `G0_labels`: labels of the initial graph. If NULL, they will all be set to 1.
- `sample_with_replacement`: If TRUE, allows parallel edges.
- `type`: Either "Hajek" or "block_first".

**Value**

The resulting graph, as an igraph object. The vertices have a "label" attribute.

**Examples**

```r
B <- matrix(c(1, 0.2, 0.2, 1), ncol=2)
G <- barabasi_albert_blocks(m=4, p=c(0.5, 0.5), B=B, t_max=100, type="Hajek",
                           sample_with_replacement = FALSE)
```
boot_alg_list

**Description**

Performs nonparametric bootstrap on a graph’s by resampling its vertices and clustering the results using a list of clustering algorithms.

**Usage**

```r
boot_alg_list(
  alg_list = list(Louvain = cluster_louvain, `label prop` = cluster_label_prop, walktrap = cluster_walktrap),
  g,
  R = 999,
  return_data = FALSE,
  type = "global"
)
```

**Arguments**

- `alg_list` List of igraph clustering algorithms
- `g` igraph graph object
- `R` Number of bootstrap replicates.
- `return_data` Logical. If TRUE, returns a list of "boot" objects with the full results. Otherwise, returns a table with the mean results.
- `type` Can be "global" (Variation of Information, Reduced Mutual Information, and adjusted Rand Index) or "cluster-wise" (Jaccard distance)

**Value**

If `return_data` is set to TRUE, returns a list of objects of class "boot" (see `boot`). Otherwise, returns a table with the mean distances from the clusters in the original graph to the resampled ones, for each of the algorithms.

---

clustAnalytics

**Description**

This package evaluates the stability and significance of clusters in igraph graphs. Supports weighted and unweighted graphs.
Details

Extensions to weighted graphs of multiple functions present in igraph are provided, such as scoring functions or edge rewiring methods.

Author(s)

Martí Renedo Mirambell

conductance

Description

Conductance of a graph’s communities, which is given by

$$\frac{c_s}{2m_s + c_s}$$

where $c_s$ is the weight of the edges connecting the community $s$ to the rest of the graph, and $m_s$ is the internal weight of the community.

Usage

`conductance(g, com)`

Arguments

- `g`: Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- `com`: community membership integer vector. Each element corresponds to a vertex.

Value

Numeric vector with the conductance of each community.

See Also

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`

Examples

```r
data(karate, package="igraphdata")
conductance(karate, membership(cluster_louvain(karate)))
```
coverage

Description
Computes the coverage (fraction of internal edges with respect to the total number of edges) of a graph and its communities.

Usage
coverage(g, com)

Arguments
- g: Graph to be analyzed (as an igraph object).
- com: Community membership integer vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.

Value
Numeric value of the coverage of g and com.

See Also
Other cluster scoring functions: FOMD(), average_degree(), average_odf(), conductance(), cut_ratio(), density_ratio(), edges_inside(), expansion(), internal_density(), max_odf(), normalized_cut(), weighted_clustering_coefficient(), weighted_transitivity()

Examples
data(karate, package="igraphdata")
coverage(karate, membership(cluster_louvain(karate)))

cut_ratio

Description
The cut ratio of a graph’s community is the total edge weight connecting the community to the rest of the graph divided by number of unordered pairs of vertices such that one belongs to the community and the other does not.

Usage
cut_ratio(g, com)
**density_ratio**

**Arguments**

- `g` Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- `com` community membership integer vector. Each element corresponds to a vertex.

**Value**

Numeric vector with the cut ratio of each community.

**See Also**

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`

**Examples**

```r
data(karate, package="igraphdata")
cut_ratio(karate, membership(cluster_louvain(karate)))
```

---

**density_ratio**

**Density Ratio**

**Description**

Density ratio of a graph’s communities.

**Usage**

```r
density_ratio(g, com, type = "local")
```

**Arguments**

- `g` Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- `com` community membership integer vector. Each element corresponds to a vertex.
- `type` can either be "local" or "global"

**Value**

Numeric vector with the internal density of each community.

**See Also**

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`
edges_inside

Examples

```r
data(karate, package="igraphdata")
density_ratio(karate, membership(cluster_louvain(karate)))
```

### Description

Number of edges inside a graph’s communities, or their accumulated weight if the graph’s edges are weighted.

### Usage

```r
edges_inside(g, com)
```

### Arguments

- `g`: Graph to be analyzed (as an `igraph` object). If the edges have a "weight" attribute, those will be used as weights.
- `com`: Community membership integer vector. Each element corresponds to a vertex.

### Value

Numeric vector with the internal edge weight of each community

### See Also

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`

### Examples

```r
data(karate, package="igraphdata")
density_ratio(karate, membership(cluster_louvain(karate)))
```
evaluate_significance  Evaluates significance of cluster algorithm results on a graph

Description

Given a graph and a list of clustering algorithms, computes several scoring functions on the clusters found by each of the algorithms.

Usage

evaluate_significance(
  g,
  alg_list = list(Louvain = cluster_louvain, 'label prop' = cluster_label_prop,
                  walktrap = cluster_walktrap),
  no_clustering_coef = TRUE,
  ground_truth = FALSE,
  gt_clustering = NULL,
  w_max = NULL
)

Arguments

- **g**: Graph to be analyzed (as an igraph object)
- **alg_list**: List of clustering algorithms, which take an igraph graph as input and return an object of the communities class.
- **no_clustering_coef**: Logical. If TRUE, skips the computation of the clustering coefficient, which is the most computationally costly of the scoring functions.
- **ground_truth**: Logical. If set to TRUE, computes the scoring functions for a ground truth clustering, which has to be provided as gt_clustering
- **gt_clustering**: Vector of integers that correspond to labels of the ground truth clustering. Only used if ground_truth is set to TRUE.
- **w_max**: Numeric. Upper bound for edge weights. Should be generally left as default (NULL).

Value

A data frame with the values of scoring functions (see scoring_functions) of the clusters obtained by applying the clustering algorithms to the graph.

Examples

data(karate, package="igraphdata")
evaluate_significance(karate)
evaluate_significance_r

Evaluates the significance of a graph’s clusters

Description

Computes community scoring functions to the communities obtained by applying the given clustering algorithms to a graph. These are compared to the same scores for randomized versions of the graph obtained by a switching algorithm that rewire edges.

Usage

```r
evaluate_significance_r(
  g,
  alg_list = list(Louvain = cluster_louvain,
                  `label prop` = cluster_label_prop,
                  walktrap = cluster_walktrap),
  no_clustering_coef = FALSE,
  ground_truth = FALSE,
  gt_clustering = NULL,
  table_style = "default",
  ignore_degenerate_cl = TRUE,
  Q = 100,
  lower_bound = 0,
  weight_sel = "const_var",
  n_reps = 5,
  w_max = NULL
)
```

Arguments

- **g**
  - Graph to be analyzed (as an igraph object)

- **alg_list**
  - List of clustering algorithms, which take an igraph graph as input and return an object of the communities class.

- **no_clustering_coef**
  - Logical. If TRUE, skips the computation of the clustering coefficient, which is the most computationally costly of the scoring functions.

- **ground_truth**
  - Logical. If set to TRUE, computes the scoring functions for a ground truth clustering, which has to be provided as `gt_clustering`

- **gt_clustering**
  - Vector of integers that correspond to labels of the ground truth clustering. Only used if `ground_truth` is set to TRUE.

- **table_style**
  - By default returns a table with three columns per algorithm: the original one, the mean of the corresponding rewired scores (suffix "_r") and it’s percentile rank within the distribution of rewired scores (suffix "_percentile"). If `table_style == "string"`, instead returns a table with a column per algorithm where each element is of the form "originalrewired(percentile)"
ignore_degenerate_cl
Logical. If TRUE, when computing the means of the scoring functions, samples with only one cluster will be ignored. See rewireCpp.

Q  Numeric. Parameter that controls the number of iterations of the switching algorithm, which will be Q times the order of the graph.

lower_bound  Numeric. Lower bound to the edge weights. The randomization process will avoid steps that would make edge weights fall outside this bound. It should generally be left as 0 to avoid negative weights.

weight_sel  Can be either const_var or max_weight.

n_reps  Number of samples of the rewired graph.

w_max  Numeric. Upper bound for edge weights. The randomization algorithm will avoid steps that would make edge weights fall outside this bound. Should be generally left as default (NULL), unless the network has by nature or by construction a known upper bound.

Value

A matrix with the results of each scoring function and algorithm. See table_style for details.

<table>
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<tr>
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<th>Expansion</th>
</tr>
</thead>
</table>

Description

Given a graph (possibly weighted) split into communities, the expansion of a community is the sum of all edge weights connecting it to the rest of the graph divided by the number of vertices in the community.

Usage

expansion(g, com)

Arguments

g  Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.

com  community membership integer vector. Each element corresponds to a vertex.

Value

Numeric vector with the expansion of each community.

See Also

Other cluster scoring functions: FOMD(), average_degree(), average_odf(), conductance(), coverage(), cut_ratio(), density_ratio(), edges_inside(), internal_density(), max_odf(), normalized_cut(), weighted_clustering_coefficient(), weighted_transitivity()
Examples

```r
data(karate, package="igraphdata")
expansion(karate, membership(cluster_louvain(karate)))
```

---

**FOMD (Fraction Over Median Degree)**

**Description**

Given a weighted graph and a partition into communities, returns the fraction of nodes of each community whose internal degree (i.e. the degree accounting only intra-community edges) is greater than the median degree of the whole graph.

**Usage**

```r
FOMD(g, com, edgelist = NULL)
```

**Arguments**

- `g`: Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- `com`: Community membership integer vector. Each element corresponds to a vertex.
- `edgelist`: alternatively, the edgelist of the graph, as a matrix where the first two columns to the vertices and the third is the weight of each edge.

**Value**

Numeric vector with the FOMD of each community.

**See Also**

Other cluster scoring functions: `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`

**Examples**

```r
data(karate, package="igraphdata")
FOMD(karate, membership(cluster_louvain(karate)))
```
**internal_density**

---

**g_forex**  
*Forex correlation network*

**Description**

Network built from correlations between time series of exchange rate returns. It was built from the 13 most traded currencies and with data of January 2009. It is a complete graph of 78 vertices (corresponding to pairs of currencies) and has edge weights bounded between 0 and 1.

**Usage**

```r
g_forex
```

**Format**

An igraph object with 78 vertices and 3003 weighted edges

---

**internal_density**  
*Internal Density*

**Description**

Internal density of a graph’s communities. That is, the sum of weights of their edges divided by the number of unordered pairs of vertices (which is the number of potential edges).

**Usage**

```r
internal_density(g, com)
```

**Arguments**

- `g`: Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- `com`: Community membership integer vector. Each element corresponds to a vertex.

**Value**

Numeric vector with the internal density of each community.

**See Also**

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`
**max_odf**

**Examples**
```r
data(karate, package="igraphdata")
internal_density(karate, membership(cluster_louvain(karate)))
```

---

**Description**

Computes the Maximum Out Degree Fraction (Max ODF) of a graph (which can be weighted) and its communities.

Computes the Flake Out Degree Fraction (Max ODF) of a graph (which can be weighted) and its communities.

**Usage**

```r
max_odf(g, com)
```

**Arguments**

- `g` Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights (otherwise, all edges are assumed to be 1).
- `com` Community membership integer vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.

**Value**

Numeric vector with the Max ODF of each community.

**See Also**

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `normalized_cut()`, `weighted_clustering_coefficient()`, `weighted_transitivity()`

**Examples**

```r
data(karate, package="igraphdata")
max_odf(karate, membership(cluster_louvain(karate)))
data(karate, package="igraphdata")
max_odf(karate, membership(cluster_louvain(karate)))
```
Normalized cut of a graph’s communities, which is given by

\[
\frac{c_s}{2m_s + c_s} + \frac{c_s}{2(m - m_s) + c_s}
\]

, where \(c_s\) is the weight of the edges connecting the community s to the rest of the graph, \(m_s\) is the internal weight of the community, and \(m\) is the total weight of the network.

Usage

\[\text{normalized_cut}(g, \text{com})\]

Arguments

- \(g\) : Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights.
- \(\text{com}\) : Community membership integer vector. Each element corresponds to a vertex.

Value

Numeric vector with the normalized cut of each community.

See Also

Other cluster scoring functions: \(\text{FOMD()}\), \(\text{average_degree()}\), \(\text{average_odf()}\), \(\text{conductance()}\), \(\text{coverage()}\), \(\text{cut_ratio()}\), \(\text{density_ratio()}\), \(\text{edges_inside()}\), \(\text{expansion()}\), \(\text{internal_density()}\), \(\text{max_odf()}\), \(\text{weighted_clustering_coefficient()}\), \(\text{weighted_transitivity()}\)

Examples

\[\text{data(karate, package="igraphdata")}\]
\[\text{normalized_cut(karate, membership(cluster_louvain(karate)))}\]
out_degree_fractions

Maximum, Average, and Flake Out Degree Fractions of a Graph Partition

Description

Given a weighted graph and a partition into communities, returns the maximum, average and flake out degree fractions of each community.

Usage

out_degree_fractions(g, com, edgelist)

Arguments

- **g**: Graph to be analyzed (as an igraph object)
- **com**: Community membership vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.
- **edgelist**: alternatively, the edgelist of the graph

Value

A numeric matrix where each row corresponds to a community, and the columns contain the max, average and flake ODFs respectively.

reduced_mutual_information

Reduced Mutual Information

Description

Computes the Newman’s Reduced Mutual Information (RMI) as defined in (Newman et al. 2020).

Usage

reduced_mutual_information(
    c1,
    c2,
    base = exp(1),
    normalized = FALSE,
    method = "approximation2",
    warning = TRUE
)
Arguments

- **c1, c2**: membership vectors
- **base**: base of the logarithms used in the calculations. Changing it only scales the final value. By default set to e=exp(1).
- **normalized**: If true, computes the normalized version of the corrected mutual information.
- **method**: Can be "approximation1" (appropriate for partitions into many very small clusters), or "approximation2" (for partitions into few larger clusters).
- **warning**: set to false to ignore the warning.

Details

The implementation is based on equations 23 (25 for the normalized case) and 29 in (Newman et al. 2020). The evaluations of the $\Gamma$ functions can get too large and cause overflow issues in the intermediate steps, so the following term of equation 29:

$$\frac{1}{2} \log \frac{\Gamma(\mu R)\Gamma(\nu S)}{(\Gamma(\nu)\Gamma(R))^S(\Gamma(\mu)\Gamma(S))^R}$$

is rewritten as

$$\frac{1}{2} (\log \Gamma(\mu R) + \log \Gamma(\nu S) - S \log(\Gamma(\nu) - S \log(\Gamma(R) - R \log \Gamma(\mu) - R \log \Gamma(R))$$

, and then the function `lgamma` is used instead of `gamma`.

Value

The value of Newman’s RMI (a scalar).

References


relabel

Relabels membership vector

Description

Takes a vector of vertex ids indicating community membership, and relabels the communities to have consecutive values from 1 to the number of communities.

Usage

relabel(c)
Arguments

c numeric vector of vertex ids, not necessarily consecutive

Value

A numeric vector of consecutive vertex ids starting from one

Description

Converts the graph to a weighted edge list in NumericMatrix, which is compatible with Rcpp. The Rcpp function "randomize" is called, and then the resulting edge list is converted back into an igraph object.

Usage

rewireCpp(
  g,
  Q = 100,
  weight_sel = "max_weight",
  lower_bound = 0,
  upper_bound = NULL
)

Arguments

  g igraph graph, which can be weighted.
  Q Numeric. Parameter that controls the number of iterations, which will be Q times the order of the graph.
  weight_sel can be either "const_var" or "max_weight".
  lower_bound, upper_bound Bounds to the edge weights. The randomization process will avoid steps that would make edge weights fall outside these bounds. Set to NULL for no bound. By default, 0 and NULL respectively.

Value

The rewired graph.
scoring_functions  Scoring Functions of a Graph Partition

Description
Computes the scoring functions of a graph and its clusters.

Usage
```
scoring_functions(
  g,  
  com, 
  no_clustering_coef = TRUE, 
  type = "local", 
  weighted = TRUE, 
  w_max = NULL
)
```

Arguments
- **g** : Graph to be analyzed (as an igraph object). If the edges have a "weight" attribute, those will be used as weights (otherwise, all edges are assumed to be 1).
- **com** : Community membership integer vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.
- **no_clustering_coef** : Logical. If TRUE, skips the computation of the clustering coefficient (which can be slow on large graphs).
- **type** : can be "local" for a cluster by cluster analysis, or "global" for a global analysis of the whole graph partition.
- **weighted** : Is the graph weighted? If it is, doesn’t compute TPR score.
- **w_max** : Numeric. Upper bound for edge weights. Should be generally left as default (NULL). Only affects the computation of the clustering coefficient.

Value
If type="local", returns a dataframe with a row for each community, and a column for each score. If type="global", returns a single row with the weighted average scores.

Examples
```
data(karate, package="igraphdata")
scoring_functions(karate, membership(cluster_louvain(karate)))
```
Description
Computes the triangle participation ratio (proportion of vertices that belong to a triangle). The computation is done to the subgraphs induced by each of the communities in the given partition.

Usage
triangle_participation_ratio_communities(g, com)

Arguments
- **g**: The input graph (as an igraph object). Edge weights and directions are ignored.
- **com**: Community membership vector. Each element corresponds to a vertex of the graph, and contains the index of the community it belongs to.

Value
A vector containing the triangle participation ratio of each community.

---------------------------------------------------------------------

weighted_clustering_coefficient

Weighted clustering coefficient of a weighted graph.

Description
Weighted clustering Computed using the definition given by McAssey, M. P. and Bijma, F. in "A clustering coefficient for complete weighted networks" (2015).

Usage
weighted_clustering_coefficient(g, upper_bound = NULL)

Arguments
- **g**: igraph graph
- **upper_bound**: upper bound to the edge weights used to compute the integral

Value
The weighted clustering coefficient of the graph (a scalar).
See Also

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_transitivity()`

Examples

```r
data(karate, package="igraphdata")
weighted_clustering_coefficient(karate)
```

---

**weighted_transitivity**

**Weighed transitivity of a weighted graph.**

**Description**

Computed using the definition given by McAssey, M. P. and Bijma, F. in "A clustering coefficient for complete weighted networks" (2015).

**Usage**

```r
weighted_transitivity(g, upper_bound = NULL)
```

**Arguments**

- `g` igraph graph
- `upper_bound` upper bound to the edge weights used to compute the integral

**Value**

The weighted transitivity of the graph (a scalar).

**See Also**

Other cluster scoring functions: `FOMD()`, `average_degree()`, `average_odf()`, `conductance()`, `coverage()`, `cut_ratio()`, `density_ratio()`, `edges_inside()`, `expansion()`, `internal_density()`, `max_odf()`, `normalized_cut()`, `weighted_clustering_coefficient()`

**Examples**

```r
data(karate, package="igraphdata")
weighted_transitivity(karate)
```
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