Package 'FinNet'

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Type Package

Title Quickly Build and Manipulate Financial Networks

Version 0.2.1

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Description Providing classes, methods, and functions to deal with financial networks.
Users can easily store information about both physical and legal persons by using pre-made classes that are studied for integration with scraping packages such as 'rvest' and 'RSelenium'.
Moreover, the package assists in creating various types of financial networks depending on the type of relation between its units depending on the relation under scrutiny (ownership, board interlocks, etc.), the desired tie type (valued or binary), and renders them in the most common formats (adjacency matrix, incidence matrix, edge list, 'igraph', 'network').
There are also ad-hoc functions for the Fiedler value, global network efficiency, and cascade-failure analysis.

License GPL (>= 3)

URL https://fatelarico.github.io/FinNet.html

BugReports https://github.com/FATelarico/FinNet/issues

Encoding UTF-8

RoxygenNote 7.3.2

Depends R (>= 2.10)

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Imports Matrix, grDevices, methods, Rcpp

Suggests knitr, igraph, network, markdown, SPB, yahoofinancer

LazyData no

VignetteBuilder knitr

LinkingTo Rcpp

NeedsCompilation yes

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Contents

`as.firm` *Coerce into (a list of)* `firm` *object(s)*

Description

Generic function to coerce other other classes into the S4 class `firm` representing a firm (legal person)

Usage

```
as.firm(x, ...)
```

Arguments

`x`	The object to coerce
`...`	Arguments passed to class-specific methods

Value

An object of class `firm` or a (usually named) list of them, depending on the available method for the object being coerced.

Author(s)

Telarico, Fabio Ashtar

`as.firm,financial_matrix-method`
Coerce a `financial_matrix` *object into a list of* `firm` *objects*

Description

'as.firm' method for an object of class `financial_matrix`

Usage

```
## S4 method for signature 'financial_matrix'
as.firm(x, ...)
```

Arguments

`x`	The `financial_matrix` object to coerce
`...`	Optional arguments

Value

A (usually named) list of `firm` objects the length of which equals the number of rows and columns of the provided `financial_matrix`

Author(s)

Telarico, Fabio Ashtar

`cfa` *Perform cascade failure analysis*

Description

Cascade failure analysis (CFA) involves understanding how failures in one part of the network might cascade to other parts. Networks capable of isolating such failures or minimizing their effects demonstrate higher robustness.

Usage

```
cfa(
  ...,
  ordering = "tot",
  custom.order = NULL,
  decreasing = TRUE,
  Rcpp = ifelse(requireNamespace("Rcpp", quietly = TRUE), yes = TRUE, no = FALSE)
)
```

Arguments

`...`	Firm-Firm network in one of the following classes: • `financial_matrix` produced by `FF` and family; • `network_financial` or `network` if the relevant package is installed; • `igraph_financial` or `igraph` if the relevant package is installed.
`ordering`	In what order to remove the firms, the completing ordering is always returned as part of the result. Take the following values: • `random` - Random order, corresponds to percolation theory • `out` - By out-degree • `in` - By in-degree • `tot` - By sum of in- and out-degre (default) • `custom` - Customised ordering via `custom.order`
`custom.order`	Order in which to remove the firms. If `ordering` is not 'custom', it is ignored. Defaults to `NULL`.
`decreasing`	Logical, defaults to `TRUE`. Only evaluated if `ordering` is neither 'custom' nor 'random'.

- if TRUE - the ordering is by decreasing degree and higher in-/out-/total-degree firms are removed first
- if FALSE - the ordering is by increasing degree and higher in-/out-/total-degree firms are removed last

Rcpp — Whether to use the C++ or native-R version of the search algorithm. Defaults to TRUE if the package Rcpp is installed.

Value

A data.frame with one row for the result of the CFA after each node is removed. The columns report:

- l_scc - Size of the largest strongly connected component
- rem_id - ID of the firm removed
- rem_pos - Position of the firm removed (row/column number)
- n_scc - Number of strongly connected components
- n_rem - Number of firms removed
- n_left - Number of firms left

Author(s)

Telarico, Fabio Ashtar

References

Elliott, Matthew, Benjamin Golub, and Matthew O. Jackson. 'Financial Networks and Contagion'. American Economic Review 104, no. 10 (1 October 2014): 3115–53. doi:10.1257/aer.104.10.3115.

Examples

```
# Create a matrix
mat <- matrix(c(
    0, 1, 0, 1, 0, 1, 0, 0,
    0, 0, 1, 0, 0, 0, 0, 0,
    1, 0, 0, 0, 0, 0, 0, 0,
    0, 1, 1, 0, 1, 0, 0, 0,
    0, 0, 0, 1, 0, 1, 0, 0,
    0, 0, 1, 0, 0, 0, 1, 0,
   0, 0, 0, 0, 0, 1, 0, 0,
    0, 0, 0, 0, 1, 0, 1, 1
  ),ncol = 8, byrow = TRUE)
# Add rownames
rownames(mat) <- paste0("Firm", LETTERS[1:ncol(mat)])

# Create a FF matrix
mat <- methods::new('financial_matrix',
                    M = mat,
                    relation = c('own'),
                    legal_form = c('JSC'),
```

```
                    sector = c('A.01'),
                    revenues = c(NA),
                    capitalisation = c(NA),
                    currency = c('USD'))

# Notice the differnce between:
# a. CFA with ordering by in-degree (decreasing)
# b. CFA with ordering by in-degree (increasing)
cfa(mat, ordering = 'in', decreasing = FALSE)
# But ordering by increasing (decreasing) in-degree is the
# same as ordering by decreasing (increasing) out-degree and
# vice versa!
cfa(mat, ordering = 'out', decreasing = FALSE) # By out-degree (increasing)
```

FF *Create any firm-firm (FF) matrix*

Description

General function to create a firm-firm (FF) matrix

Usage

```
FF(..., who, ties, id_as_firm_name = NULL, Matrix = NULL, self_ties = FALSE)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`who`	Whether to take into account: (`ownership`) co-ownership ; (`management`) board interlocks, or `both` (recognises minimum unambiguous strings).
`ties`	Type of ties to create. Possible values: `binary`; `naive`; `share` (see Details).
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
`self_ties`	Whether to allow self-ties (a 'loop' in graph theory). Defaults to `FALSE`.

Details

See more specific functions for a detailed overview:

for board interlocks (`who == 'management'`):

- `FF.binary.management`, if `ties = 'binary'`;
- `FF.binary.management`, if `ties = 'naive'`;

- FF.norm.management, if ties = 'share'.

for co-ownership (who == 'ownership'):

- FF.binary.ownership, if ties = 'binary';
- FF.naive.ownership, if ties = 'naive';
- FF.norm.ownership, if ties = 'share'.

for both co-ownership and board interlocks (who == 'both'):

- FF.binary.both, if ties = 'binary';
- FF.naive.both, if ties = 'naive';
- FF.norm.both, if ties = 'share'.

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF.binary.both(), FF.binary.management(), FF.binary.ownership(), FF.naive.both(), FF.naive.management(), FF.naive.ownership(), FF.norm.both(), FF.norm.management(), FF.norm.ownership()

Examples

```
# Create the normalised FF matrix of Berkshire Hathaway's holdings by boards interlocks
data('firms_BKB')
FF <- FF(firms_BKB, who = 'man', ties = 'share')
```

FF-basic-methods *Basic methods for objects of class* financial_matrix

---

Description

Basic methods for objects of class financial_matrix

Usage

```
## S4 method for signature 'financial_matrix'
rownames(x, do.NULL = TRUE, prefix = "row")

## S4 method for signature 'financial_matrix'
colnames(x, do.NULL = TRUE, prefix = "row")
```

Arguments

x	The financial_matrix object to operate on
do.NULL	Whether to use NULL names. Defaults to FALSE
prefix	Prefix for created names (if do.NULL is FALSE and names are NULL)

Details

Mind that usually the rows and columns are named after the firm's tickers.

Value

A character vector of length equal to the number of rows (or columns) in the financial_matrix corresponding to the names of the rows (or columns)

Author(s)

Telarico, Fabio Ashtar

FF-comparison-methods *Basic method to check to compare values in a* financial_matrix *object*

Description

Basic method to check to compare values in a financial_matrix object

Usage

```
## S4 method for signature 'financial_matrix,logical'
duplicated(x, incomparables = FALSE, ...)

## S4 method for signature 'financial_matrix,logical'
unique(x, incomparables = FALSE, ...)
```

Arguments

x	The financial_matrix object to operate on
incomparables	Either: • a vector of values that cannot be compared • or FALSE, in which case all values can be compared
...	Arguments passed to the relevant matrix method

Value

- duplicated: A logical array with the same dimensions and dimnames of the financial_matrix's matrix component.
- unique: The matrix component is coerced into a vector and then returned, but with only one copy of each duplicated element.

Author(s)

Telarico, Fabio Ashtar

FF-math-methods *Mathematical methods for* financial_matrix *objects*

Description

isSymmetric checks only the matrix-like part summary operates on all numeric attributes and the matrix-like part

Usage

```
## S4 method for signature 'financial_matrix'
isSymmetric(object, ...)

## S4 method for signature 'financial_matrix'
summary(object, ...)
```

Arguments

object	The financial_matrix object to operate on
...	Arguments passed to the relevant matrix method

Details

Mathematical methods for financial_matrix objects

Value

- isSymmetric: a boolean, TRUE if the matrix is symmetric, FALSE otherwise;
- summary: a list of length equal to the number of numeric attributes possed by the financial_matrix (maximum three, the matrix itself, revenues, and capitalisation) assumed as measured on the same scale and denominated in the same currency). Each element of the list of class c('summaryDefault', 'table') which has specialized format and print methods

Author(s)

Telarico, Fabio Ashtar

FF-nrow-ncol *Number of rows/columns in a* financial_matrix *object*

Description

Unlike most other methods (i.e., duplicated, isSymmetric, summary, rownames, and colnames), these methods act on both the matrix-like and the other components of a financial_matrix object.

Usage

```
## S4 method for signature 'financial_matrix'
ncol(x)

## S4 method for signature 'financial_matrix'
nrow(x)
```

Arguments

x	The financial_matrix object to operate on

Details

Checks if the length of the names matches that of the other attributes that are not NA or structurally of unitary length (i.e., the slots M and relation).

Value

A single numeric, the number of rows (columns) in the matrix. It also prints a message to the console if any of the object's other attributes (e.g., capitalisation) is not conformed to the matrix's dimensions

Author(s)

Telarico, Fabio Ashtar

FF-subset-method *Method to subset a* financial_matrix

Description

Subsets all components of a financial_matrix object

Usage

```
## S4 method for signature 'financial_matrix'
subset(x, ...)
```

Arguments

x	The financial_matrix object to operate on
...	Arguments passed to the relevant matrix method

Value

A financial_matrix object, subsetted to the desired firms

Author(s)

Telarico, Fabio Ashtar

FF.binary.both *Create a complete binary firm-firm (FF) matrix*

Description

Function to create a binary firm-firm (FF) matrix based on both common ownership and board interlocks

Usage

```
FF.binary.both(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE,
  combining = "sum"
)
```

Arguments

...	Either multiple objects of class firm or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to TRUE if all firms' id is neither NULL nor NA.
Matrix	Whether to use the Matrix package. Defaults to TRUE when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to FALSE.
combining	How to combine the FF matrix for managers and that for owners. Possible values: • sum; • mean or average; • min; • max;

Details

The ties' value will be: 1 if there is at least one common manager or owner, 0 otherwise.

Value

A matrix object of class `financial_matrix`(possibly using the `Matrix` package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: `FF()`, `FF.binary.management()`, `FF.binary.ownership()`, `FF.naive.both()`, `FF.naive.management()`, `FF.naive.ownership()`, `FF.norm.both()`, `FF.norm.management()`, `FF.norm.ownership()`

Examples

```
# Create the complete binary firm-firm matrix for the companies held by Berkshire Hathaway
data('firms_BKB')
FF <- FF.binary.both(firms_BKB)
```

`FF.binary.management` *Create a binary firm-firm (FF) matrix for board interlocks*

Description

Function to create a binary firm-firm (FF) matrix based on board interlocks

Usage

```
FF.binary.management(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.

Matrix	Whether to use the Matrix package. Defaults to TRUE when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to FALSE.

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.ownership(), FF.naive.both(), FF.naive.management(), FF.naive.ownership(), FF.norm.both(), FF.norm.management(), FF.norm.ownership()

Examples

```
# Create the binary FF matrix of Berkshire Hathaway's holdings by boards interlock
data('firms_BKB')
FF <- FF.binary.management(firms_BKB)
```

FF.binary.ownership *Create a binary firm-firm (FF) matrix for common ownership*

Description

Function to create a binary firm-firm (FF) matrix based on common ownership

Usage

```
FF.binary.ownership(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

...	Either multiple objects of class firm or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to TRUE if all firms' id is neither NULL nor NA.
Matrix	Whether to use the Matrix package. Defaults to TRUE when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to FALSE.

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.management(), FF.naive.both(), FF.naive.management(), FF.naive.ownership(), FF.norm.both(), FF.norm.management(), FF.norm.ownership()

Examples

```
# Create the binary FF matrix of Berkshire Hathaway's holdings by common ownership
data('firms_BKB')
FF <- FF.binary.ownership(firms_BKB)
```

FF.graph *Easily represent a firm-firm (FF) network using the package* igraph

---

Description

Create an object of class igraph from the package igraph using a FF matrix of class financial_matrix using all the default aesthetic options

Usage

```
FF.graph(x, aesthetic = c("simple", "nice"))
```

Arguments

x	A matrix-like object produced by FF and related functions.
aesthetic	Choose a pre-set for the graph's look. Either 'simple' or 'nice' (see Details).

Details

This function does not allow for any of the additional arguments that can be passed to `FF.graph.custom`.

Value

A network in the desired format

Loops and values

Loops will be allowed if at least one of the matrix's diagonal entries is not zero. The igraph will be valued if at least one entry of the matrix is neither zero nor one.

Instead, if `aesthetic` is set to `'simple'`:

- The width of the ties is `1`;
- The colour of the ties is `#b4b4b4` (Philippine Silver);
- The size of the nodes is `5`;
- The colour of the nodes is `#081677` (Gentian blue).

Otherwise, if `aesthetic` is set to `'nice'`:

- The width of the ties is `1`;
- The colour of the ties is a grey scale reflecting tie strength if the graph is valued, otherwise it is `#b4b4b4` (Philippine Silver);
- The size of the nodes reflects their `capitalisation` if all firms have data on it and ranges between `1` and `5`, otherwise it is `5` for all nodes;
- The colour of the nodes reflects their `sector` if all firms have data on it is taken from a built-in palette, otherwise it is `#081677` (Gentian blue).

Author(s)

Telarico, Fabio Ashtar

See Also

FF.net FF.net.custom FF.graph.custom

Examples

```
# Create a nice graph representation of the binary FF of
# Berkshire Hataway's holdings based on common ownership
data("firms_BKB")
x <- FF.naive.ownership(firms_BKB)
FF.graph(x = x, aesthetic = 'nice')
```

FF.graph.custom *Represent a firm-firm (FF) network using the package* igraph

Description

Create an object of class graph from the package igraph using a FF matrix of class financial_matrix

Usage

```
FF.graph.custom(
  x,
  vertex.size = NULL,
  vertex.colour = NULL,
  edge.width = NULL,
  edge.greyscale = NULL,
  directed = TRUE,
  loops = FALSE,
  weighted = any(x@M %in% c(0, 1)),
  ...
)
```

Arguments

x	A matrix-like object produced by FF and related functions
vertex.size	Which piece of information on the firms should be used to represent the nodes' size (see Details).
vertex.colour	Which piece of information on the firms should be used to represent the nodes' colours (see Details).
edge.width	Whether to use the edges' width to represent tie strength. Defaults to FALSE.
edge.greyscale	Whether to use the edges' colour to represent tie strength through a grey scale. Defaults to TRUE if the matrix is valued.
directed	Whether the network should be directed. Defaults to TRUE
loops	Whether the network should have loops. Defaults to FALSE
weighted	Whether the ties/edges should be weighted. Defaults to TRUE if any element of the matrix equals neither 0 nor 1
...	Aliases to the other parameters and additional settings (see Details).

Details

This function allows for a number of additional arguments.

Value

A network in the desired format

What can be passed to `vertex.colour` **and** `vertex.size`

The pieces of information that is possible to pass to `vertex.size` and `vertex.colour` are:

- `capitalisation`, will be arranged into steps (see `capitalisation.bins` below)
- `revenue`, will be arranged into steps (see `revenues.bins` below)
- `legal_form`
- `sector`
- `currency`

What can be passed to `edge.width` **and** `edge.greyscale`

The pieces of information that is possible to pass to `edge.width` and `edge.greyscale` are:

- `capitalisation`
- `revenue`

Additional parameters related to `vertex.size`

The effect of the additional parameters that modify the behaviour of `vertex.size` are:

`vertex.size.max` (defaults to 5) :

- if `vertex.size` or one of its aliases is specified, this is the size of the biggest vertex;
- if neither `vertex.size` nor any of its aliases is given, this is the size of ALL vertices.

`vertex.size.min` (defaults to 1):

- if `vertex.size` or one of its aliases is specified, this is the size of the smallest vertex;
- if neither `vertex.size` nor any of its aliases is given, it is ignored.

Additional parameters related to `vertex.colour`

The only additional parameter related to `vertex.colour` is `vertex.colour.palette`. It supports a vector of RGB or named colours (see `colours` for all named colours in `R`). It also accepts complete calls to functions that return a such a vector like `RColorBrewer::brewer.pal(n, name)` or `viridisLite::viridis(n, option)`. If the palette is too short, it will be extended automatically using `colorRampPalette`. If the palette is not declared, but this arguemnt is `TRUE`, it will defaulr to the following vector of colours:

- `#00204D`, Oxford Blue
- `#31446B`, Police Blue
- `#666970`, Dim Grey
- `#958F78`, Artichoke
- `#CBBA69`, Dark Khaki
- `#FFEA46`, Gargoyle Gas

If the argument is `FALSE`, `NULL` or `NA`, the vertex will be coloured of `#081677` (Gentian blue).

Additional parameters related to `edge.width`

`edge.width.max` (defaults to 5) :

- if `edge.width` or one of its aliases is specified, this is the thickness of the thickest edge;
- if neither `edge.width` nor any of its aliases is given, this is the thickness of ALL edges

`edge.width.min` (defaults to 1):

- if `edge.width` or one of its aliases is specified, this is the thickness of the slimmest edge;
- if neither `edge.width` nor any of its aliases is given, it is ignored.

Additional parameters related to `edge.greyscale`

`edge.greyscale.darkest` (defaults to 5) :

- if `edge.greyscale` or one of its aliases is specified, this is the thickness of the thickest edge;
- if neither `edge.greyscale` nor any of its aliases is given, this is the thickness of ALL edges

`edge.greyscale.fairest` (defaults to 1):

- if `edge.greyscale` or one of its aliases is specified, this is the thickness of the slimmest edge;
- if neither `edge.greyscale` nor any of its aliases is given, it is ignored.

Several aliases are accepted for all arguments, except `M`:

- for `vertex.size`: `node.size`
- for `vertex.colour`: `vertex.color`, `node.colour`, and `node.color`;
- for `edge.width`: `tie.width`
- for `edge.greyscale`: `tie.grayscale`, `tie.greyscale`, and `edge.grayscale`

Author(s)

Telarico, Fabio Ashtar

See Also

FF.net FF.net.custom FF.graph

Examples

```
# Create the graph representation of the binary FF of
# Berkshire Hataway's holdings based on common ownership
data("firms_BKB")
x <- FF.naive.ownership(firms_BKB)
FF.graph.custom(x = x, node.size = 3)
```

`FF.naive.both` *Create a complete naive-valued firm-firm (FF) matrix*

Description

Function to create a naive-valued firm-firm (FF) matrix based on both common ownership and board interlocks

Usage

```
FF.naive.both(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE,
  combining = "sum"
)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
`self_ties`	Whether to allow self-ties (a 'loop' in graph theory). Defaults to `FALSE`.
`combining`	How to combine the FF matrix for managers and that for owners. Possible values: • `sum`; • `mean` or `average`; • `min`; • `max`;

Details

The ties' value will reflect the count of common owners and membership depending on `combining`:

- `sum`: sum of the counts;
- `mean` or `average`: average of the counts;
- `min`: minimum of the counts;
- `max`: maximum of the counts.

Value

A matrix object of class `financial_matrix`(possibly using the `Matrix` package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: `FF()`, `FF.binary.both()`, `FF.binary.management()`, `FF.binary.ownership()`, `FF.naive.management()`, `FF.naive.ownership()`, `FF.norm.both()`, `FF.norm.management()`, `FF.norm.ownership()`

Examples

```
# Create the complete naive firm-firm matrix for the companies held by Berkshire Hathaway
data('firms_BKB')
FF <- FF.naive.both(firms_BKB)
```

`FF.naive.management` *Create a naive-valued firm-firm (FF) matrix for boards interlocks*

Description

Function to create a naive-valued firm-firm (FF) matrix based on boards interlocks

Usage

```
FF.naive.management(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
`self_ties`	Whether to allow self-ties (a 'loop' in graph theory). Defaults to `FALSE`.

Details

Naive-valued means simply counting the number of common managers.

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.management(), FF.binary.ownership(), FF.naive.both(), FF.naive.ownership(), FF.norm.both(), FF.norm.management(), FF.norm.ownership()

Examples

```
# Create the naive FF matrix of Berkshire Hathaway's holdings by boards interlocks
data('firms_BKB')
FF <- FF.naive.management(firms_BKB)
```

FF.naive.ownership *Create a naive-valued firm-firm (FF) matrix for common ownership*

Description

Function to create a naive-valued firm-firm (FF) matrix based on common ownership

Usage

```
FF.naive.ownership(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

...	Either multiple objects of class firm or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to TRUE if all firms' id is neither NULL nor NA.
Matrix	Whether to use the Matrix package. Defaults to TRUE when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to FALSE.

Details

Naive-valued means simply counting the number of common owners

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.management(), FF.binary.ownership(), FF.naive.both(), FF.naive.management(), FF.norm.both(), FF.norm.management(), FF.norm.ownership()

Examples

```
# Create the naive FF matrix of Berkshire Hathaway's holdings by common ownership
data('firms_BKB')
FF <- FF.naive.ownership(firms_BKB)
```

FF.net *Easily represent a firm-firm (FF) network using the package* network

---

Description

Create an object of class network from the package network using a FF matrix of class financial_matrix using all the default aesthetic options

Usage

```
FF.net(x, aesthetic = c("simple", "nice"))
```

Arguments

x	A matrix-like object produced by FF and related functions.
aesthetic	Choose a pre-set for the network's look. Either 'simple' or 'nice' (see Details).

Details

This function does not allow for any of the additional arguments that can be passed to FF.net.custom.

Value

A network in the desired format

Loops and values

Loops will be allowed if at least one of the matrix's diagonal entries is not zero. The network will be valued if at least one entry of the matrix is neither zero nor one.

Instead, if `aesthetic` is set to `'simple'`:

- The width of the ties is `1`;
- The colour of the ties is `#b4b4b4` (Philippine Silver);
- The size of the nodes is `5`;
- The colour of the nodes is `#081677` (Gentian blue).

Otherwise, if `aesthetic` is set to `'nice'`:

- The width of the ties is `1`;
- The colour of the ties is a grey scale reflecting tie strength if the network is valued, otherwise it is `#b4b4b4` (Philippine Silver);
- The size of the nodes reflects their `capitalisation` if all firms have data on it and ranges between `1` and `5`, otherwise it is `5` for all nodes;
- The colour of the nodes reflects their `sector` if all firms have data on it is taken from a built-in palette, otherwise it is `#081677` (Gentian blue).

Author(s)

Telarico, Fabio Ashtar

See Also

FF.net.custom FF.graph FF.graph.custom

Examples

```
# Create a nice network representation of the binary FF of
# Berkshire Hataway's holdings based on common ownership
data("firms_BKB")
x <- FF.naive.ownership(firms_BKB)
FF.net(x = x, aesthetic = 'nice')
```

FF.net.custom *Represent a firm-firm (FF) network using the package* `network`

Description

Create an object of class `network` from the package `network` using a FF matrix of class `financial_matrix`

Usage

```
FF.net.custom(
  x,
  vertex.size = NULL,
  vertex.colour = NULL,
  edge.width = NULL,
  edge.greyscale = NULL,
  directed = TRUE,
  loops = FALSE,
  weighted = any(x@M %in% c(0, 1)),
  ...
)
```

Arguments

x	A matrix-like object produced by FF and related functions
vertex.size	Which piece of information on the firms should be used to represent the nodes' size (see Details).
vertex.colour	Which piece of information on the firms should be used to represent the nodes' colours (see Details).
edge.width	Whether to use the edges' width to represent tie strength. Defaults to FALSE.
edge.greyscale	Whether to use the edges' colour to represent tie strength through a grey scale. Defaults to TRUE if the matrix is valued.
directed	Whether the network should be directed. Defaults to TRUE
loops	Whether the network should have loops. Defaults to FALSE
weighted	Whether the ties/edges should be weighted. Defaults to TRUE if any element of the matrix equals neither 0 nor 1
...	Aliases to the other parameters and additional settings (see Details).

Details

This function allows for a number of additional arguments.

Value

A network in the desired format

What can be passed to vertex.colour and vertex.size

The pieces of information that is possible to pass to vertex.size and vertex.colour are:

- capitalisation, will be arranged into steps (see capitalisation.bins below)
- revenue, will be arranged into steps (see revenues.bins below)
- legal_form
- sector
- currency

What can be passed to `edge.width` **and** `edge.greyscale`

The pieces of information that is possible to pass to `edge.width` and `edge.greyscale` are:

- `capitalisation`
- `revenue`

Additional parameters related to `vertex.size`

The effect of the additional parameters that modify the behaviour of `vertex.size` are:

`vertex.size.max` (defaults to 5):

- if `vertex.size` or one of its aliases is specified, this is the size of the biggest vertex;
- if neither `vertex.size` nor any of its aliases is given, this is the size of ALL vertices.

`vertex.size.min` (defaults to 1):

- if `vertex.size` or one of its aliases is specified, this is the size of the smallest vertex;
- if neither `vertex.size` nor any of its aliases is given, it is ignored.

Additional parameters related to `vertex.colour`

The only additional parameter related to `vertex.colour` is `vertex.colour.palette`. It supports a vector of RGB or named colours (see `colours` for all named colours in `R`). It also accepts complete calls to functions that return a such a vector like `RColorBrewer::brewer.pal(n, name)` or `viridisLite::viridis(n, option)`. If the palette is too short, it will be extended automatically using `colorRampPalette`. If the palette is not declared, but this arguemnt is `TRUE`, it will defaulr to the following vector of colours:

- `#00204D`, Oxford Blue
- `#31446B`, Police Blue
- `#666970`, Dim Gray
- `#958F78`, Artichoke
- `#CBBA69`, Dark Khaki
- `#FFEA46`, Gargoyle Gas

If the argument is `FALSE`, `NULL` or `NA`, the vertex will be coloured of `#081677` (Gentian blue).

Additional parameters related to `edge.width`

`edge.width.max` (defaults to 5):

- if `edge.width` or one of its aliases is specified, this is the thickness of the thickest edge;
- if neither `edge.width` nor any of its aliases is given, this is the thickness of ALL edges

`edge.width.min` (defaults to 1):

- if `edge.width` or one of its aliases is specified, this is the thickness of the slimmest edge;
- if neither `edge.width` nor any of its aliases is given, it is ignored.

Additional parameters related to `edge.greyscale`

`edge.greyscale.darkest` (defaults to 5) :

- if `edge.greyscale` or one of its aliases is specified, this is the thickness of the thickest edge;
- if neither `edge.greyscale` nor any of its aliases is given, this is the thickness of ALL edges

`edge.greyscale.fairest` (defaults to 1):

- if `edge.greyscale` or one of its aliases is specified, this is the thickness of the slimmest edge;
- if neither `edge.greyscale` nor any of its aliases is given, it is ignored.

Several aliases are accepted for all arguments, except `M`:

- for `vertex.size`: `node.size`
- for `vertex.colour`: `vertex.color`, `node.colour`, and `node.color`;
- for `edge.width`: `tie.width`
- for `edge.greyscale`: `tie.grayscale`, `tie.greyscale`, and `edge.grayscale`

Author(s)

Telarico, Fabio Ashtar

See Also

FF.net FF.graph FF.graph.custom

Examples

```
# Create the network representation of the binary FF of
# Berkshire Hataway's holdings based on common ownership
data("firms_BKB")
x <- FF.naive.ownership(firms_BKB)
FF.net.custom(x = x, node.size = 3)
```

`FF.norm.both` *Create a complete normalised-valued firm-firm (FF) matrix*

Description

Function to create a normalised-valued firm-firm (FF) matrix based on both common ownership and board interlocks

Usage

```
FF.norm.both(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE,
  combining = "sum"
)
```

Arguments

...	Either multiple objects of class `firm` or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
Matrix	Whether to use the `Matrix` package. Defaults to `TRUE` when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to `FALSE`.
combining	How to combine the FF matrix for managers and that for owners. Possible values: • `sum`; • `mean` or `average`; • `min`; • `max`;

Details

The ties' value will reflect the count of common owners and membership depending on `combining`: `-sum`: sum of the shares (normalised on 2); `-mean` or `average`: average of the shares (normalised on 1); `-min`: minimum of the shares (normalised on 1); `-max`: maximum of the shares (normalised on 1).

Value

A matrix object of class `financial_matrix`(possibly using the `Matrix` package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: `FF()`, `FF.binary.both()`, `FF.binary.management()`, `FF.binary.ownership()`, `FF.naive.both()`, `FF.naive.management()`, `FF.naive.ownership()`, `FF.norm.management()`, `FF.norm.ownership()`

Examples

```
# Create the complete normalised firm-firm matrix for the companies held by Berkshire Hathaway
data('firms_BKB')
FF <- FF.norm.both(firms_BKB)
```

`FF.norm.management` *Create a normalised-valued firm-firm (FF) matrix for boards interlocks*

Description

Function to create a normalised-valued firm-firm (FF) matrix based on boards interlocks

Usage

```
FF.norm.management(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
`self_ties`	Whether to allow self-ties (a 'loop' in graph theory). Defaults to `FALSE`.

Details

Normalised-valued means that weights represent the share of common managers.

Value

A matrix object of class `financial_matrix`(possibly using the `Matrix` package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.management(), FF.binary.ownership(), FF.naive.both(), FF.naive.management(), FF.naive.ownership(), FF.norm.both(), FF.norm.ownership()

Examples

```
# Create the normalised FF matrix of Berkshire Hathaway's holdings by boards interlocks
data('firms_BKB')
FF <- FF.norm.management(firms_BKB)
```

FF.norm.ownership *Create a normalised-valued firm-firm (FF) matrix for common ownership*

Description

Function to create a normalised-valued firm-firm (FF) matrix based on common ownership

Usage

```
FF.norm.ownership(
  ...,
  id_as_firm_name = NULL,
  Matrix = NULL,
  self_ties = FALSE
)
```

Arguments

...	Either multiple objects of class firm or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to TRUE if all firms' id is neither NULL nor NA.
Matrix	Whether to use the Matrix package. Defaults to TRUE when any matrix in the pipeline contains more than 10,000 cells and the package is installed.
self_ties	Whether to allow self-ties (a 'loop' in graph theory). Defaults to FALSE.

Details

Normalised-valued means that weights represent the share of common managers.

Value

A matrix object of class financial_matrix(possibly using the Matrix package)

Author(s)

Telarico, Fabio Ashtar

See Also

Other Financial_matrix builders: FF(), FF.binary.both(), FF.binary.management(), FF.binary.ownership(), FF.naive.both(), FF.naive.management(), FF.naive.ownership(), FF.norm.both(), FF.norm.management()

Examples

```
# Create the normalised FF matrix of Berkshire Hathaway's holdings by common ownership
data('firms_BKB')
FF <- FF.norm.ownership(firms_BKB)
```

---

fiedler *Calculate the Fiedler value (algebraic connectivity)*

Description

This function expresses the algebraic connectivity of a Firm-Firm network as its Fiedler value. The Fiedler value, named after Miroslav Fiedler, who explored its significance, summarises the connectivity and robustness of a network. Mathematically, it is the second smallest eigenvalue of the network's Laplacian matrix

Usage

```
fiedler(..., ignore.weights = FALSE, generalise = NULL)
```

Arguments

...	Firm-Firm network in one of the following classes: • financial_matrix produced by FF and family; • network_financial or network if the relevant package is installed; • igraph_financial or igraph if the relevant package is installed.
ignore.weights	Optional parameter, defaults to FALSE. If TRUE, ignore ties weights in the computation.
generalise	See Details for more information. Defaults to NULL.

Details

The Fiedler value is specifically defined for undirected graphs. For directed or asymmetrical networks like the Firm-Firm ones, the Laplacian is not necessarily symmetric, and its eigenvalues can be complex. In practical applications, this is more likely to happen in naively valued networks, due to the presence of large off-diagonal values. But it can happen also under other circumstances.

There are three main workarounds:

1. Symmetrisation - Simply considers the underlying undirected graph. This involves ignoring the direction of edges and calculating the Laplacian matrix and its eigenvalues as if the graph were undirected.

2. The generalised Laplacian calculated as the sum of the diagonal matrices for in-degree and out-degree $\left([D]_{in} + [D]_{out}\right)/2$

3. The Hermitian part of the Laplacian - Uses the Hermitian part of the Laplacian matrix of the directed network $\left([M] + [M]^{C^\top})\right)/2$, where the second addendum is the conjugate transpose of the adjacency matrix.

Practically, the third method is excessive here, as the values of the ties cannot be complex numbers. Indeed, the Hermitian is actually the Laplacian of the underlying symmetric network with the value of the ties being split equally in both directions because the conjugate of a real number is that number. Moreover, symmetrising before calculating the Laplacian or generalising the matrix $[L]$ returns the same result. So, the parameter `generalise` is logical and takes the following values:

1. `TRUE` for the generalised Laplacian;
2. `FALSE` for the possibly complex (and uninterpretable) eigenvalue of the as-is Laplacian.
3. `NULL` will take the generalised Laplacian only if necessary.

Value

A numeric, the Fiedler value.

Author(s)

Telarico, Fabio Ashtar

References

Fiedler, Miroslav. 'Laplacian of Graphs and Algebraic Connectivity'. Banach Center Publications 25, no. 1 (1989): 57–70. https://eudml.org/doc/267812.

Guo, Krystal, and Bojan Mohar. 'Hermitian Adjacency Matrix of Digraphs and Mixed Graphs'. Journal of Graph Theory 85, no. 1 (May 2017): 217–48. doi:10.1002/jgt.22057.

Examples

```
# Load some data
data('firms_BKB')
# Create a FF matrix
mat <- FF(firms_BKB, who = 'b', ties =  'n')
fiedler(mat)

# Create a FF network
if(!require('network')){
  net <- FF.net(mat, 'simple')
  fiedler(net)==fiedler(mat)
}

# Create a FF graph
if(!require('igraph')){
```

```
  g <- FF.graph(mat, 'simple')
  fiedler(g)==fiedler(mat)
}
```

`find.firm` *Function to create a* `firm` *(legal person) using data from 'Yahoo! Finance'*

Description

Tickers can be retrieved from [Yahoo! Finance](https://finance.yahoo.com/lookup/). This function requires the package `yahoofinancer` to be installed. It is available from the CRAN by running `install.packages('yahoofinancer')`.

Usage

```
find.firm(
  ticker,
  name = NULL,
  ticker_is_id = TRUE,
  legal_form = NULL,
  sector_granularity = 1,
  managers_remove_salutation_title = TRUE,
  managers_only_surname = FALSE
)
```

Arguments

`ticker`	Firm's ticker.
`name`	Provide the firm's name. If not provided, `NA`, or `NULL`, will default to the string provided as `ticker`.
`ticker_is_id`	Should the ticker be used as the firm's id?
`legal_form`	The firm's legal form of the firm. Possible values: - a string (e.g., 'LLC', 'Private', 'GmbH', etc.); - `NULL` (default), in which case the function will set `legal_form` to 'JSC'; or - `NA` to specify no legal form.
`sector_granularity`	Sector in which the firm operates. Possible values: - `0`, `NULL`, or `NA` to omit the sector; - `1` or `'generic'` (default) for a generic description (e.g., 'Consumer Technology', 'Consumer Cyclical', 'Consumer Defensive'); - `2` or `'specifc'` for a more granular description (e.g., 'Technology', 'Auto Manufacturers', 'Tobacco').
`managers_remove_salutation_title`	Yahoo! Finance provide salutation titles before the names of the managers. If this is `TRUE` (default), they will be omitted.
`managers_only_surname`	Yahoo! Finance provide first, middle, and last name of the managers. If this is `TRUE` (not recommended for large data sets), only the surname is returned.

Value

An object of the S4 class `firm` containing several fields, only the first one of which is mandatory:

`name`	Name of the firm (or ticker if no name was provided)
`id`	Firm' ticker (if ticker_is_id was 'TRUE') or nothing (otherwise)
`legal_form`	Legal form of the firm (may be null)
`sector`	Sector in which the firm operates (may be null)
`revenues`	Yearly revenues
`capitalisation`	Capitalisation
`management`	Members of the board
`ownership`	Owner(s)
`shares`	Share owned by (each of) the owner(s)
`currency`	Currency

Author(s)

Telarico, Fabio Ashtar

See Also

register.firm find.firms

Examples

```
# Registering Apple automatically
#| Results are subject to the correct functioning of the package `yahoofinancer`
#| and of the Yahoo! Finance API
```

`find.firms` *Function to create mutiple* `firms` *(legal persons) using data from 'Yahoo! Finance'*

Description

If `legal_form` is a vector containing: - one or more `NULL` elements, the corresponding `firm`'s legal form will be `JSC`; - one or more `NA`s, the corresponding `firm`'s legal form will be `NA`.

Usage

```
find.firms(
  tickers,
  name = NULL,
  ticker_is_id = TRUE,
  legal_form = NULL,
  sector_granularity = 1,
  managers_remove_salutation_title = TRUE,
  managers_only_surname = FALSE
)
```

Arguments

tickers	The firms' ticker.
name	Provide the firms' names as a vector of the same length as tickers. If not provided, NA, or NULL, will default to the firm's ticker.
ticker_is_id	Should the ticker be used as the firm's id?
legal_form	The firm's legal form of the firm. Possible values: - a vector of strings (e.g., 'LLC', 'Private', 'GmbH', etc.) of the same length as tickers (see 'Details' for the interpretation of NAs and NULLs); - NULL (default), in which case the function will set legal_form to 'JSC' for all firms; or - NA to specify no legal form.
sector_granularity	Sector in which the firm operates. Possible values: - 0, NULL, or NA to omit the sector; - 1 or 'generic' (default) for a generic description (e.g., 'Consumer Technology', 'Consumer Cyclical', 'Consumer Defensive'); - 2 or 'specifc' for a more granular description (e.g., 'Technology', 'Auto Manufacturers', 'Tobacco').
managers_remove_salutation_title	Yahoo! Finance provide salutation titles before the names of the managers. If this is TRUE (default), they will be omitted.
managers_only_surname	Yahoo! Finance provide first, middle, and last name of the managers. If this is TRUE (not recommended for large data sets), only the surname is returned.

Details

To ensure consistency, ticker_is_id, sector_granularity, managers_remove_salutation_title, and managers_only_surname cannot be vectors.

Tickers can be retrieved from [Yahoo! Finance](https://finance.yahoo.com/lookup/). This function requires the package yahoofinancer to be installed. It is available from the CRAN by running install.packages('yahoofinancer').

Value

An object of the S4 class firm containing several fields, only the first one of which is mandatory:

name	Name of the firm (or ticker if no name was provided)
id	Firm' ticker (if ticker_is_id was 'TRUE') or nothing (otherwise)
legal_form	Legal form of the firm (may be null)
sector	Sector in which the firm operates (may be null)
revenues	Yearly revenues
capitalisation	Capitalisation
management	Members of the board
ownership	Owner(s)
shares	Share owned by (each of) the owner(s)
currency	Currency

Author(s)

Telarico, Fabio Ashtar

See Also

find.firm

Examples

```
# Registering Apple, General Motors, and British American Tobacco automatically
#| Results are subject to the correct functioning of the package `yahoofinancer`
#| and of the Yahoo! Finance API
```

`find.people` *Extract all the unique people associated to at least one of the provided* `firm` *objects*

Description

Extract all the unique people associated to at least one of the provided `firm` objects

Usage

```
find.people(..., who = c("managers", "owners", "both", "all"), sorting = TRUE)
```

Arguments

...	Either multiple objects of class `firm` or a list of such objects
who	Whether to extract the 'managers' or the 'owners' (minimum unambiguous string)
sorting	Whether to sort the people by alphabetical order. Defaults to `TRUE`

Value

A vector containing the names of the individuals looked up. If

Author(s)

Telarico, Fabio Ashtar

Examples

```
# Find all the shareholders in companies that Berkshire Hathaway holds
data('firms_BKB')
shareholders <- find.people(firms_BKB, who = 'own')

# Find all those managing the companies that Berkshire Hathaway holds
data('firms_BKB')
managers <- find.people(firms_BKB, who = 'man')
```

---

firms_BKB *Complete Berkshire Hathaway Portfolio*

Description

Data on Apple (AAPL), General Motors (GM), and British American Tobacco (BTI) extracted from Yahoo! Finance (on May 20, 2023) and formatted a `firm` objects.

Usage

```
data('firms_BKB')
```

Format

Three objects of class `firm`.

Source

- Divine, John. "The Complete Berkshire Hathaway Portfolio." FInancial data. U.S. News & World Report, May 17, 2023. <https://money.usnews.com/investing/stock-market-news/articles/the-complete-berkshire-hathaway-portfolio>. - ICE Data Services. "Nasdaq Stock Exchange & Dow Jones Indexes." Financial data, May 21, 2023, <https://finance.yahoo.com/lookup/>.

firms_US *Three US firms*

Description

Data on Apple (AAPL), General Motors (GM), and British American Tobacco (BTI) extracted from Yahoo! Finance (on May 20, 2023) and formatted a `firm` objects.

Usage

```
data('firms_US')
```

Format

Three objects of class `firm`.

Source

ICE Data Services. "Nasdaq Stock Exchange & Dow Jones Indexes." Financial data, May 21, 2023, <https://finance.yahoo.com/lookup/>

FM *Function to create a (necessarily binary) firm-manager (FM) matrix*

Description

Function to create a (necessarily binary) firm-manager (FM) matrix

Usage

```
FM(..., id_as_firm_name = NULL, Matrix = NULL)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when there are more than 10,000 combinations and the package is installed.

Value

A matrix object of class `financial_matrix` (possibly using the `Matrix` package) in which:

the rows Represent firms;

the columns Represent managers (usually physical persons).

Author(s)

Telarico, Fabio Ashtar

See Also

FO.binary FO.naive FO.norm

Examples

```
# Create the FM matrix of Berkshire Hathaway's holdings

data('firms_BKB')
  FM <- FM(firms_BKB)
```

FO.binary *Function to create a binary firm-owner (FO) matrix*

Description

Function to create a binary firm-owner (FO) matrix

Usage

```
FO.binary(..., id_as_firm_name = NULL, Matrix = NULL)
```

Arguments

...	Either multiple objects of class `firm` or a list of such objects
id_as_firm_name	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
Matrix	Whether to use the `Matrix` package. Defaults to `TRUE` when there are more than 10,000 combinations and the package is installed.

Value

A matrix object of class `financial_matrix` (possibly using the `Matrix` package) in which:

the rows Represent firms;

the columns Represent owners (physical and legal persons).

Author(s)

Telarico, Fabio Ashtar

See Also

FM FO.naive FO.norm

Examples

```
# Create the binary FO matrix of Berkshire Hathaway's holdings

data('firms_BKB')
FO <- FO.binary(firms_BKB)
```

`FO.naive` *Function to create a naive-valued firm-owner (FO) matrix*

Description

The values are simply the value of the owner j's stake in firm i.

Usage

```
FO.naive(..., id_as_firm_name = NULL, Matrix = NULL)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when there are more than 10,000 combinations and the package is installed.

Value

A matrix object of class `financial_matrix` (possibly using the `Matrix` package) in which:

the rows Represent firms;

the columns Represent owners (physical and legal persons).

Author(s)

Telarico, Fabio Ashtar

See Also

FM FO.binary FO.norm

Examples

```
# Create the naive FO matrix of Berkshire Hathaway's holdings

data('firms_BKB')
FO <- FO.naive(firms_BKB)
```

`FO.norm` *Function to create a naive-valued firm-owner (FO) matrix*

Description

The values represent the share of firm i's capital owned by j.

Usage

```
FO.norm(..., id_as_firm_name = NULL, Matrix = NULL)
```

Arguments

`...`	Either multiple objects of class `firm` or a list of such objects
`id_as_firm_name`	Whether to use the ticker as the firm's name. Defaults to `TRUE` if all firms' id is neither `NULL` nor `NA`.
`Matrix`	Whether to use the `Matrix` package. Defaults to `TRUE` when there are more than 10,000 combinations and the package is installed.

Value

A matrix object of class `financial_matrix` (possibly using the `Matrix` package) in which:

the rows Represent firms;

the columns Represent owners (physical and legal persons).

Author(s)

Telarico, Fabio Ashtar

See Also

FM FO.binary FO.naive

Examples

```
# Create the normalised FO matrix of Berkshire Hathaway's holdings

data('firms_BKB')
FO <- FO.norm(firms_BKB)
```

---

graph_methods *Extending* igraph *functions to* igraph_financial *objects*

Description

The following functions are implemented:

- V to retrieve the vertexes (igraph::V);
- vcount to count the vertexes (igraph::vcount);
- gorder as an alias to vcount_fin (igraph::gorder);
- E to retrieve the edges (igraph::E);
- gsize to count the edges (igraph::gsize);
- ecount as an alias to gsize_fin (igraph::ecount)
- plot_igraph to plot graphs (igraph::plot.igraph))

Usage

```
V(x)

vcount(x)

gorder(x)

E(x, ...)

ecount(x, ...)

gsize(x, ...)

plot_igraph(x, ...)
```

Arguments

x	The igraph_financial object
...	Other parameters passed to the corresponding igraph functions (see Details).

Details

Implementing most basic iterators from the package igraph for objects of class igraph_financial

Value

The same result for both igraph and igraph_financial objects

- V: A vertex sequence containing all vertices, in the order of their numeric vertex ids.
- vcount and gorder: Number of vertices, numeric scalar.
- E: An edge sequence of the graph
- ecount and gsize: Number of edges, numeric scalar.
- plot_igraph: Returns NULL, invisibly. Called to print the graph to any R device. (see method and igraph::plot.igraph)

Author(s)

Telarico, Fabio Ashtar

---

igraph_E_iterators *igraph edge iterators for* igraph_financial *objects*

Description

Methods to extend igraph edge iterators and functions to igraph_financial objects

Usage

```
## S4 method for signature 'igraph_financial'
E(x, ...)

## S4 method for signature 'igraph'
E(x, ...)

## S4 method for signature 'igraph_financial'
ecount(x, ...)

## S4 method for signature 'igraph'
ecount(x, ...)

## S4 method for signature 'igraph_financial'
gsize(x, ...)

## S4 method for signature 'igraph'
gsize(x, ...)
```

Arguments

x	The igraph_financial object
...	Other parameters passed to the corresponding method and/or igraph functions (see Details).

Value

The same result for both igraph and igraph_financial objects

- E: An edge sequence of the graph
- ecount and gsize: Number of edges, numeric scalar

Author(s)

Telarico, Fabio Ashtar

---

igraph_financial *An S4 class for relational data extending the package* R*hrefhttps://igraph.org/igraph*

Description

An S4 class for the network objects produced by the FF.graph and FF.graph.custom to represent the relations between firms (legal person)

Slots

data The representation of the network as a igraph object

---

igraph_v_iterators *igraph vertex iterators for* igraph_financial *objects*

Description

Methods to extend igraph vertex iterators and functions to igraph_financial objects

Usage

```
## S4 method for signature 'igraph_financial'
V(x)

## S4 method for signature 'igraph'
V(x)

## S4 method for signature 'igraph_financial'
vcount(x)

## S4 method for signature 'igraph'
vcount(x)

## S4 method for signature 'igraph_financial'
gorder(x)

## S4 method for signature 'igraph'
gorder(x)
```

Arguments

x	The igraph_financial object

Value

The same result for both igraph and igraph_financial objects

- V: A vertex sequence containing all vertices, in the order of their numeric vertex ids
- vcount and gorder: Number of vertices, numeric scalar

Author(s)

Telarico, Fabio Ashtar

---

network.efficiency *Calculate network efficiency*

Description

Network efficiency quantifies how efficiently information (management relations) and/or money capital (ownership relations) flow through a network. It is essential in systemic-risk identification, resilience assessment, and crisis-propagation analysis.

Usage

```
network.efficiency(
  ...,
  ignore.weights = FALSE,
  use.igraph = isTRUE(requireNamespace("igraph", quietly = TRUE))
)
```

Arguments

...	Firm-Firm network in one of the following classes: • financial_matrix produced by FF and family; • network_financial or network if the relevant package is installed; • igraph_financial or igraph if the relevant package is installed.
ignore.weights	Optional parameter, defaults to FALSE. If TRUE, ignore ties weights in the computation.
use.igraph	Whether to use igraph to speed-up the computation. See 'Details'.

Details

The function is implemented both for igraph users and in base R using the Floyd-Warshall algorithm. However, the latter runs in $O(n^3)$, which may not be efficient for very large networks.

The distances enter into play in the formal definition of efficiency:

$$E = \frac{1}{N(N-1)} \sum_{i \neq j \in \mathcal{N}} \frac{1}{d_{i,\,j}}$$

where:

- $\mathcal{N}$ is the set of all nodes;
- N is the number of nodes (i.e., the number of elements in $\mathcal{N}$;
- $d_{i,\,j}$ is the shortest (weighted and directed) path distance between the nodes i and j.

Value

A numeric, the global efficiency value.

Author(s)

Telarico, Fabio Ashtar

References

Latora, Vito, and Masimo Marchiori. 'Economic Small-World Behavior in Weighted Networks'. The European Physical Journal B - Condensed Matter and Complex Systems 32, no. 2 (1 March 2003): 249–63. doi:10.1140/epjb/e2003000955.

Floyd, Robert W. 'Algorithm 97: Shortest path'. Communications of the ACM, 5, no. 6 (1962): 345.

Examples

```
# Load some data
data('firms_BKB')

# Create a FF matrix
mat <- FF(firms_BKB, who = 'b', ties =  'n')
# Use the built-in Floyd-Warshall algorithm
network.efficiency(mat, use.igraph = FALSE)

#' # Create a FF graph
if(!require('igraph')){
  g <- FF.graph(mat, 'simple')
  # Use igraph's implementation, which gives the same result
  # as the built-in Floyd-Warshall algorithm, but is faster
  network.efficiency(g, use.igraph = TRUE)==network.efficiency(mat, use.igraph = FALSE)
}
```

---

network_financial *An S4 class for relational data extending the package* R*hrefhttps://statnet.org/network*

Description

An S4 class for the network objects produced by the `FF.net` and `FF.net.custom` functions to represent the relations between firms (legal person)

Slots

`data` The representation of the network as a network object

---

network_methods *Extending* newtwork *functions to* newtwork_financial *objects*

Description

The following functions are implemented:

- `edgecount` to count the number of eges (`network::network.edgecount`);
- `vertex.names` to retrieve the vertices' names (`network::network.vertex.names`);
- `network.size` to count the edges (`network::network::network.size`);
- `plot_network` to plot networks (`network::plot.network`))

Usage

```
edgecount(x, ...)

network.size(x, ...)

vertex.names(x, ...)

plot_network(x, ...)
```

Arguments

x	The newtwork_financial object
...	Other parameters passed to the corresponding newtwork functions (see Details).

Details

Implementing most basic iterators from the package newtwork for objects of class newtwork_financial

Value

The same result for both newtwork and newtwork_financial objects

- edgecount: Number of edges, numeric scalar
- vertex.names: Names/Labels of the vertices, character vector
- network.size: Number of vertices, numeric scalar
- plot_network: Returns a two-column matrix containing the vertex positions as (x,y) coordinates, invisibly. Called to print the graph to any R device.)

Author(s)

Telarico, Fabio Ashtar

---

network_operators *Operators for* network_financial *objects*

Description

Methods to extend operators from the package network to network_financial objects

Usage

```
## S4 method for signature 'network_financial'
edgecount(x, ...)

## S4 method for signature 'network'
edgecount(x, ...)

## S4 method for signature 'network_financial'
vertex.names(x, ...)

## S4 method for signature 'network'
vertex.names(x, ...)

## S4 method for signature 'network_financial'
network.size(x, ...)

## S4 method for signature 'network'
network.size(x, ...)
```

Arguments

x	The network_financial object
...	Other parameters passed to the corresponding method and/or network functions (see Details).

Value

The same result for both network and network_financial objects

- network.edgecount: Number of edges, numeric scalar
- network.vertex.names: Names/Labels of the vertices, character vector
- network::network.size: Number of vertices, numeric scalar

Author(s)

Telarico, Fabio Ashtar

---

plot_igraph-methods *igraph plotting for* igraph_financial *objects*

Description

Methods to extend igraph's plotting functions to igraph_financial objects

Usage

```
## S4 method for signature 'igraph_financial'
plot_igraph(x, ...)

## S4 method for signature 'igraph'
plot_igraph(x, ...)
```

Arguments

x	The igraph_financial object
...	Other parameters passed to the corresponding method and/or igraph functions (see Details).

Value

For both igraph and igraph_financial objects, returns NULL invisibly. It is called to print the graph to any R device. (see method and igraph::plot.igraph)

Author(s)

Telarico, Fabio Ashtar

---

plot_network-methods *network plotting for* igraph_financial *objects*

Description

Methods to extend network's plotting functions to network_financial objects

Usage

```
## S4 method for signature 'network_financial'
plot_network(x, ...)

## S4 method for signature 'network'
plot_network(x, ...)
```

Arguments

x	The network_financial object
...	Other parameters passed to the corresponding method and/or network functions (see Details).

Value

For both igraph and igraph_financial objects, returns NULL invisibly. It is called to print the graph to any R device. (see method and igraph::plot.igraph)

Author(s)

Telarico, Fabio Ashtar

`print,firm-method` *Print information on a class* `firm` *object*

Description

Print method for the S4 class representing a firm (legal person)

Usage

```
## S4 method for signature 'firm'
print(x)
```

Arguments

`x`	The `firm` object to show

Value

No return value, called to print to the console *detail* information about the `firm` object including:

- in the first paragraph:
  - legal form (if any),
  - revenues (if known),
  - capitalisation (if known).
- in the second paragraph, the names of the board members/managers;
- in the third paragraph, a data frame with two columns:
  - First, the names of the owners
  - The, their respective share of the firm's capital (normalised to 1)

Author(s)

Telarico, Fabio Ashtar

query.firm *Function to extract information from a* firm *object (legal person)*

Description

Function to extract information from a firm object (legal person)

Usage

```
query.firm(firm, which, naming = TRUE)
```

Arguments

firm	Firm which to extract information from
which	Information to extract, minimum unambiguous substring. Possible values (one or more): - name Name of the firm - id ID of the firm, usually the ticker (if provided or otherwise known) - legal_form Legal form of the firm - sector Sector in which the firm operates - revenues Yearly revenues - capitalisation Capitalisation - management Members of the board - ownership Owner(s) - shares Share owned by (each of) the owner(s) - currency Currency in which revenues and capitalisation are denominated
naming	Whether to name the result after the querie information (defaults to TRUE)

Value

Depends on the information queried. One (or, if length(which)>=2, a list of two or more) of the following:

name	A string representing the name of the firm
id	A string representing the ID of the firm (usually its ticker)
legal_form	A string representing the firm's legal form
sector	A string indicating the sector in which the firm operates (possibly a NACE rev. 2 code)
revenues	A numeric (double) quantifying yearly revenues
capitalisation	A numeric (double) quantifying capitalisation
management	A vector of strings representing the members of the board
ownership	A vector of strings representing the owner(s)
shares	A numeric (double) vector indicating the shares controlled by (each of) the owner(s)
currency	A string indicating the currency in which revenues and capitalisation are denominated

Author(s)

Telarico, Fabio Ashtar

See Also

query.firms query.firms.dataframe

Examples

```
# Query Apple's capitalisation
data('firms_US')
list2env(firms_US, parent.frame())
query.firm(AAPL, which = 'capitalisation')

# Query British-American Tobacco's capitalisation using the common abbreviation 'cap'
data('firms_US')
list2env(firms_US, parent.frame())
query.firm(BTI, 'cap')

# Query General Motors's owners and their shares, but return an unnamed \code{\link{list}}
data('firms_US')
list2env(firms_US, parent.frame())
query.firm(GM, c('own', 'sha'), naming = FALSE)
```

---

query.firms *Function to extract information from multiple* firm *object (legal person)*

Description

This function can be fed either: - a (possibly named) list of objects of class firm (see examples 1 and 2); or - multiple objects of class firm(see example 3)

Usage

```
query.firms(..., which, naming = TRUE)
```

Arguments

...	Object/s which to extract information from (see 'Details')
which	Information to extract, minimum unambiguous sub-string. Possible values (one or more): - name Name of the firm - id ID of the firm, usually the ticker (if provided or otherwise known) - legal_form Legal form of the firm - sector Sector in which the firm operates - revenues Yearly revenues - capitalisation Capitalisation - management Members of the board - ownership Owner(s) - shares Share owned by (each of) the owner(s) - currency Currency in which revenues and capitalisation are denominated
naming	Whether to name the result after the querie information (defaults to TRUE)

Value

Depends on the information queried. An object of class `list` (that, if `length(which)>=2`, contain multiple sub-lists) of the following:

`name`	A string representing the name of the firm
`id`	A string representing the ID of the firm (usually its ticker)
`legal_form`	A string representing the firm's legal form
`sector`	A string indicating the sector in which the firm operates (possibly a NACE rev. 2 code)
`revenues`	A numeric (double) quantifying yearly revenues
`capitalisation`	A numeric (double) quantifying capitalisation
`management`	A vector of strings representing the members of the board
`ownership`	A vector of strings representing the owner(s)
`shares`	A numeric (double) vector indicating the shares controlled by (each of) the owner(s)
`currency`	A string indicating the currency in which revenues and capitalisation are denominated

Author(s)

Telarico, Fabio Ashtar

See Also

query.firm query.firms.dataframe

Examples

```
# Query Apple's, GM's, and BTI's market cap and revenues
data('firms_US')
query.firms(firms_US, which = c('cap', 'rev'))

# Query GM's and BTI's management
data('firms_US')
query.firms(firms_US, which = 'man')

# Query Appple's and GM's revenues and currency
data('firms_US')
list2env(firms_US, envir = parent.frame())
query.firms(AAPL, GM, which = c('rev', 'curr'))
```

query.firms.dataframe *Function to extract information from multiple* firm *object (legal person) as a data frame*

Description

This function can be fed either: - a (possibly named) list of objects of class firm (see example 1); or

Usage

```
query.firms.dataframe(..., which, naming = TRUE, transposing = TRUE)
```

Arguments

...	Object/s which to extract information from (see 'Details')
which	Information to extract, minimum unambiguous sub-string. Possible values (one or more): - name Name of the firm - id ID of the firm, usually the ticker (if provided or otherwise known) - legal_form Legal form of the firm - sector Sector in which the firm operates - revenues Yearly revenues - capitalisation Capitalisation - management Members of the board - ownership Owner(s) - shares Share owned by (each of) the owner(s) - currency Currency in which revenues and capitalisation are denominated
naming	Whether to name the result after the queried information (defaults to TRUE)
transposing	If TRUE (default) each row will correspond to a firm and each column to a variable.

Details

It is not recommended to use this function with management, ownership, or shares unless transposing == FALSE.

Value

A data frame in structured as follows (or vice versa if transposing == TRUE):

a row for each queried information; and

a column for each number of firm.

Author(s)

Telarico, Fabio Ashtar

See Also

query.firm query.firms

Examples

```
# Query Apple's, GM's, and BTI's market cap and revenues
data('firms_US')
query.firms.dataframe(firms_US, which = c('cap', 'rev'))

# Query GM's and BTI's market cap and revenues
data('firms_US')
list2env(firms_US, envir = parent.frame())
query.firms.dataframe(GM, BTI, which = c('cap', 'rev'))
```

`register.firm` *Function to create a* `firm` *(legal person)*

Description

Function to create a `firm` (legal person)

Usage

```
register.firm(
  name,
  id = NA,
  legal_form = NA,
  sector = NA,
  sector_classif = NULL,
  revenues = NA,
  capitalisation = NA,
  management = NA,
  ownership = NA,
  shares = NA,
  currency = NA
)
```

Arguments

`name`	Name of the firm
`id`	Provide an ID code for the firm. Defaults to `NA`
`legal_form`	Legal form of the firm (e.g., LLP, Inc, GmbH, Private, etc.)
`sector`	Sector in which the firm operates (its values depend on the value of `sector_classif`)
`sector_classif`	Which standard sector classification (if any) to be used. Possible values are - `NACE` for the Statistical Classification of Economic Activities in the European Community or 'Nomenclature statistique des Activités économiques dans la Communauté Européenne', revision 2; - `NA` for a custom classification (default if anything is provided); - `NULL` for no classification (default if nothing is provided).

revenues	Yearly revenues
capitalisation	Firm's capitalisation
management	Names of the members of the board
ownership	Names of the owner(s)
shares	Share owned by (each of) the owner(s)
currency	Currency in which the capitalisation and revenues are expressed (defaults to 'USD')

Value

An object of the S4 class `firm` containing several fields, only the first one of which is mandatory:

name	Name of the firm
id	ID of the firm, usually the ticker
legal_form	Legal form of the firm
sector	Sector in which the firm operates
revenues	Yearly revenues
capitalisation	Capitalisation
management	Members of the board
ownership	Owner(s)
shares	Share owned by (each of) the owner(s)
currency	Currency

Author(s)

Telarico, Fabio Ashtar

See Also

find.firm

Examples

```
# Registering Apple manually
AAPL <- register.firm(name = 'Apple', id = 'AAPL', legal_form = 'GmbH',
                      revenues = 81665400000, capitalisation = 2755039000000,
                      management = my_vector <- c("Timothy D. Cook",
                                                  "Luca Maestri",
                                                  "Jeffrey E. Williams",
                                                  "Katherine L. Adams",
                                                  "Deirdre O'Brien",
                                                  "Chris Kondo",
                                                  "James Wilson",
                                                  "Mary Demby",
                                                  "Nancy Paxton",
                                                  "Greg Joswiak"),
                      ownership = c('Vanguard Total Stock Market Index Fund',
```

```
                        'Vanguard 500 Index Fund',
                        'Fidelity 500 Index Fund',
                        'SPDR S&P 500 ETF Trust',
                        'iShares Core S&P 500 ETF',
                        'Invesco ETF Tr-Invesco QQQ Tr, Series 1 ETF',
                        'Vanguard Growth Index Fund',
                        'Vanguard Institutional Index Fund-Institutional Index Fund',
                        'Vanguard Information Technology Index Fund',
                        'Select Sector SPDR Fund-Technology'),
                        shares = c(0.0290, 0.0218, 0.0104, 0.0102, 0.0084,
                                   0.0082, 0.0081, 0.0066, 0.0043, 0.0039),
                        currency = 'USD')

# Registering a coal-mining company indicating the sector using `NACE` codes, without ID
set.seed(123456789)
firm_coalmining <- register.firm(
  name = 'A coal-mining firm',
  legal_form = 'Private',
  sector = 'B.05',
  sector_classif = 'NACE'
)

# Getting creative: Register a firm with coded owners and managers
set.seed(123456789)
firm_coded <- register.firm(
  name = 'Coded firm',
  revenues = sample(seq(1:100)/10, 1)*10^sample(1:5, 1),
  capitalisation = sample(seq(1:100)/10, 1)*10^sample(2:7, 1),
  management = c('Board Member', 'CEO', 'CTO', 'Activist investor'),
  ownership = c('State', 'Foreign investors'),
  shares = c(51, 49),
  currency = 'EUR'
)
```

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