Package 'seminr'

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Type Package

Title Building and Estimating Structural Equation Models

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Description A powerful, easy to use syntax for specifying and estimating complex Structural Equation Models. Models can be estimated using Partial Least Squares Path Modeling or Covariance-Based Structural Equation Modeling or covariance based Confirmatory Factor Analysis (Ray, Danks, and Valdez 2021 <doi:10.2139/ssrn.3900621>).

Imports parallel, lavaan, glue, DiagrammeR (>= 1.0.6), DiagrammeRsvg (>= 0.1), stats

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License GPL-3

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Author Soumya Ray [aut, ths],
Nicholas Patrick Danks [aut, cre],
André Calero Valdez [aut],
Juan Manuel Velasquez Estrada [ctb],
James Uanhoro [ctb],
Johannes Nakayama [ctb],
Lilian Koyan [ctb],
Laura Burbach [ctb],

Arturo Heynar Cano Bejar [ctb],
Susanne Adler [ctb]

Maintainer Nicholas Patrick Danks <seminrgroup@gmail.com>

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`all_composites` *Get all composite constructs in a model*

Description

Returns the names of constructs estimated as composites (i.e., not reflective common factors) in an estimated seminr model.

Usage

```
all_composites(seminr_model)
```

Arguments

`seminr_model`	An estimated seminr model.

Value

A character vector of construct names.

all_factors *Get all common-factor (reflective) constructs in a model*

Description

Returns the names of constructs estimated as common factors (reflective measurement) in an estimated seminr model.

Usage

```
all_factors(seminr_model)
```

Arguments

seminr_model	An estimated seminr model.

Value

A character vector of construct names.

all_non_interactions *Select non-interaction constructs from a measurement model*

Description

Filters out interaction constructs from a measurement model list, returning only the constructs specified via ‘composite()‘, ‘reflective()‘, or higher-order construct constructors.

Usage

```
all_non_interactions(measurement_model)
```

Arguments

measurement_model	A ‘measurement_model‘ list (e.g., the output of ‘constructs()‘).

Value

A filtered list of construct specifications with all interaction constructs removed.

`as.reflective` *Converts all contructs of a measurement model, or just a single construct into reflective factors.*

Description

Converts all contructs of a measurement model, or just a single construct into reflective factors.

Usage

```
as.reflective(x, ...)
```

Arguments

`x`	A measurement model defined by `constructs` or a single composite construct defined by `composite`
`...`	Any further parameters for the specific construct.

Value

A list of reflective constructs.

See Also

`as.reflective.measurement_model`, `as.reflective.construct`

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2))
)

new_mm <- as.reflective(mobi_mm)
```

`as.reflective.construct` *Converts a contruct of a measurement model into a reflective factor.*

Description

Converts a contruct of a measurement model into a reflective factor.

Usage

```
## S3 method for class 'construct'
as.reflective(x, ...)
```

Arguments

x	A measurement model defined by constructs or a single composite construct defined by composite
...	Any further parameters for the specific construct.

Value

A list of reflective constructs.

See Also

as.reflective.measurement_model

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2))
)

new_mm <- as.reflective(mobi_mm)
```

---

as.reflective.interaction

Converts interaction of a measurement model into a reflective factors.

Description

Converts interaction of a measurement model into a reflective factors.

Usage

```
## S3 method for class 'interaction'
as.reflective(x, ...)
```

Arguments

x	A measurement model defined by constructs or a single composite construct defined by composite
...	Any further parameters for the specific construct.

Value

A list of reflective constructs.

See Also

as.reflective.measurement_model

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2))
)

new_mm <- as.reflective(mobi_mm)
```

---

as.reflective.measurement_model

Converts all contructs of a measurement model, or just a single construct into reflective factors.

Description

Converts all contructs of a measurement model, or just a single construct into reflective factors.

Usage

```
## S3 method for class 'measurement_model'
as.reflective(x, ...)
```

Arguments

x	A measurement model defined by constructs or a single composite construct defined by composite
...	Any further parameters for the specific construct.

Value

A list of reflective constructs.

See Also

as.reflective.construct

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2))
)

new_mm <- as.reflective(mobi_mm)
```

`associations` *Specifies inter-item covariances that should be supplied to CBSEM estimation (`estimate_cbsem`) or CFA estimation (`estimate_cfa`)*

Description

Specifies inter-item covariances that should be supplied to CBSEM estimation (`estimate_cbsem`) or CFA estimation (`estimate_cfa`)

Usage

```
associations(...)
```

Arguments

`...`	One or more associations defined by `item_errors`

Value

A matrix of items that covary.

Examples

```
covaries <- associations(
  item_errors(c("a1", "a2"), c("b1", "b2")),
  item_errors("a3", "c3")
)
```

bootstrap_model *seminr bootstrap_model Function*

Description

The seminr package provides a natural syntax for researchers to describe PLS structural equation models. bootstrap_model provides the verb for bootstrapping a pls model from the model parameters and data.

Usage

```
bootstrap_model(seminr_model, nboot = 500, cores = NULL, seed = NULL, ...)
```

Arguments

seminr_model	A fully estimated model with associated data, measurement model and structural model
nboot	A parameter specifying the number of bootstrap iterations to perform, default value is 500. If 0 then no bootstrapping is performed.
cores	A parameter specifying the maximum number of cores to use in the parallelization. The default, NULL, uses all available cores (parallel::detectCores()), or at most two during R CMD check with CRAN's core limit set. Results do not depend on the number of cores.
seed	A parameter to specify the seed for reproducibility of results. Default is NULL. Resample i uses set.seed(seed + i), so two seeds that differ by less than nboot share most of their resamples; to check how much results vary between runs, use seeds that differ by more than nboot.
...	A list of parameters passed on to the estimation method.

Value

A list of the estimated parameters for the bootstrapped model including:

boot_paths	An array of the 'nboot' estimated bootstrap sample path coefficient matrices.
boot_loadings	An array of the 'nboot' estimated bootstrap sample item loadings matrices.
boot_weights	An array of the 'nboot' estimated bootstrap sample item weights matrices.
boot_HTMT	An array of the 'nboot' estimated bootstrap sample model HTMT matrices.
boot_total_paths	An array of the 'nboot' estimated bootstrap sample model total paths matrices.
paths_descriptives	A matrix of the bootstrap path coefficients and standard deviations.
loadings_descriptives	A matrix of the bootstrap item loadings and standard deviations.
weights_descriptives	A matrix of the bootstrap item weights and standard deviations.

`HTMT_descriptives`
: A matrix of the bootstrap model HTMT and standard deviations.

`total_paths_descriptives`
: A matrix of the bootstrap model total paths and standard deviations.

References

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), 2nd Ed., Sage: Thousand Oaks.

See Also

`relationships` `constructs` `paths` `interaction_term`

Examples

```
data(mobi)
# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  interaction_term(iv = "Image", moderator = "Expectation", method = orthogonal),
  interaction_term(iv = "Image", moderator = "Value", method = orthogonal)
)

# structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation", "Image*Value"))
)

seminr_model <- estimate_pls(data = mobi,
                             measurement_model = mobi_mm,
                             structural_model = mobi_sm)

# Load data, assemble model, and bootstrap
boot_seminr_model <- bootstrap_model(seminr_model = seminr_model,
                                     nboot = 50, cores = 2, seed = NULL)

summary(boot_seminr_model)
```

`boot_paths_df` *Return all path bootstraps as a long dataframe. Columns of the dataframes are specified paths and rows are the estimated coefficients for the paths at each bootstrap iteration.*

Description

Return all path bootstraps as a long dataframe. Columns of the dataframes are specified paths and rows are the estimated coefficients for the paths at each bootstrap iteration.

Usage

```
boot_paths_df(pls_boot)
```

Arguments

pls_boot	bootstrapped PLS model

Examples

```
data(mobi)

mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Satisfaction", multi_items("CUSA", 1:3))
)

mobi_sm <- relationships(
  paths(from = c("Image", "Expectation"), to = "Satisfaction")
)

pls_model <- estimate_pls(data = mobi,
                          measurement_model = mobi_mm,
                          structural_model = mobi_sm)

pls_boot <- bootstrap_model(seminr_model = pls_model,
                            nboot = 50, cores = 2, seed = NULL)

boot_paths_df(pls_boot)
```

---

browse_plot *Open Edotor graphViz Website with the preloaded in the Browser*

Description

Open Edotor graphViz Website with the preloaded in the Browser

Usage

```
browse_plot(model, theme = seminr_theme_get())
```

Arguments

model	A SEMinR Model
theme	An optional SEMinR theme

Examples

```
## Not run:
browse_plot(model)

## End(Not run)
```

---

composite *Composite construct measurement model specification*

Description

composite creates the composite measurement model matrix for a specific construct, specifying the relevant items of the construct and assigning the relationship of either correlation weights (Mode A) or regression weights (Mode B).

Usage

```
composite(construct_name, item_names,weights = correlation_weights)
```

Arguments

construct_name	of construct
item_names	returned by the multi_items or single_item functions
weights	is the relationship between the construct and its items. This can be specified as correlation_weights or mode_A for correlation weights (Mode A) or as regression_weights or mode_B for regression weights (Mode B). Default is correlation weights.

Details

This function conveniently maps composite defined measurement items to a construct and is estimated using PLS.

Value

A vector of the indicators for a composite.

See Also

See constructs, reflective

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5), weights = correlation_weights),
  composite("Expectation",  multi_items("CUEX", 1:3), weights = mode_A),
  composite("Quality",      multi_items("PERQ", 1:7), weights = regression_weights),
  composite("Value",        multi_items("PERV", 1:2), weights = mode_B)
)
```

`compute_itcriteria_weights` *Function to calculate Akaike weights for IT Criteria*

Description

Function to calculate Akaike weights for IT Criteria

Usage

```
compute_itcriteria_weights(vector_of_itcriteria)
```

Arguments

`vector_of_itcriteria`
: This argument is a vector consisting of the IT criterion estimated value for each model.

`constructs` *Measurement functions*

Description

`constructs` creates the constructs from measurement items by assigning the relevant items to each construct and specifying reflective or formative (composite/causal) measurement models

Usage

```
constructs(...)
```

Arguments

`...`
: Comma separated list of the construct variable measurement specifications, as generated by the `reflective()`, or `composite()` methods.

Details

This function conveniently maps measurement items to constructs using root name, numbers, and affixes with explicit definition of formative or reflective relationships

Value

A list of constructs, their indicators and estimation technique (SEMinR measurement model).

See Also

See composite, reflective

Examples

```
mobi_mm <- constructs(
  reflective("Image",        multi_items("IMAG", 1:5)),
  reflective("Expectation",  multi_items("CUEX", 1:3)),
  reflective("Quality",      multi_items("PERQ", 1:7)),
  reflective("Value",        multi_items("PERV", 1:2)),
  reflective("Satisfaction", multi_items("CUSA", 1:3)),
  reflective("Complaints",   single_item("CUSCO")),
  reflective("Loyalty",      multi_items("CUSL", 1:3))
)
```

---

construct_items *Get indicator item names for a construct*

Description

S3 generic that returns the indicator (measurement) item names for a construct from any object that carries measurement-model information. Methods dispatch on the class of ‘x‘: ‘seminr_model‘, ‘measurement_model‘, ‘mmMatrix‘, ‘matrix‘, ‘construct‘, or ‘list‘.

Usage

```
construct_items(x, ...)
```

Arguments

x	A ‘seminr_model‘, ‘measurement_model‘, ‘mmMatrix‘, plain matrix, single ‘construct‘, or list of constructs.
...	Additional arguments passed to methods. Matrix-like methods typically take a ‘construct_name‘ argument.

Value

A character vector of indicator item names.

construct_mode *Get the measurement mode of a construct*

Description

Returns the measurement mode (e.g., '"A"', '"B"', or reflective) for a given construct in the measurement-model matrix.

Usage

```
construct_mode(mmMatrix, construct)
```

Arguments

mmMatrix	A measurement model matrix as found on an estimated seminr model ('model$mmMatrix').
construct	The construct name.

Value

A character string identifying the measurement mode.

construct_name *Get the name of a single construct specification*

Description

Returns the construct's name from a 'construct' vector (the user-side specification produced by 'reflective()', 'composite()', etc.).

Usage

```
construct_name(construct)
```

Arguments

construct	A 'construct' vector.

Value

A character string with the construct name.

construct_names *Get construct names from a model or model component*

Description

S3 generic that returns the construct names found in a model, measurement model, structural model, or related object. Methods dispatch on the class of ‘x‘.

Usage

```
construct_names(x, ...)
```

Arguments

x	A ‘seminr_model‘, ‘measurement_model‘, ‘structural_model‘, ‘mmMatrix‘, or related object.
...	Additional arguments passed to methods.

Value

A character vector of construct names.

construct_type *Get the user-facing measurement type of a construct*

Description

Returns the measurement type string (e.g., ‘"composite"‘, ‘"reflective"‘, ‘"interaction"‘) for a construct in an estimated model.

Usage

```
construct_type(model, construct)
```

Arguments

model	An estimated seminr model.
construct	The construct name (or construct specification, for interaction constructs).

Value

A character string identifying the construct type.

corp_rep_data *Measurement Instrument for the Corporate Reputation Model*

Description

The data set is used as measurement instrument for corporate reputation.

Usage

```
corp_rep_data
```

Format

A data frame with 344 rows and 41 variables:

serviceprovider A categorical variable for the service provider: 1, 2, 3, or 4.

servicetype A categorical variable for the service type: 1=Prepaid plan (n=125); 2=Contract plan (n=219).

csor_1 The company behaves in a socially conscious way.

csor_2 The company is forthright in giving information to the public.

csor_3 The company has a fair attitude toward competitors.

csor_4 The company is concerned about the preservation of the environment.

csor_5 The company is not only concerned about the profits.

csor_global Please assess the extent to which the company acts in socially conscious ways 0 (not at all) to 7 (definitely).

attr_1 The company is succesful in attracting high-quality employees.

attr_2 I could see myself working at the company.

attr_3 I like the physical appearance of the company/buildings/shops, etc.

attr_global Please assess the company's overall attractiveness; 0=very low; 7=very high.

perf_1 The company is a very well managed company.

perf_2 The company is an economically stable company.

perf_3 The business risk for the company is modest compared to its competitors.

perf_4 The company has growth potential.

perf_5 The company has a clear vision about the future of the company.

perf_global Please assess the company's overall performance; 0=very low; 7=very high.

qual_1 The products/services offered by the company are of high quality.

qual_2 The company is an innovator, rather than an imitator with respect to industry.

qual_3 The company's services/products offer good quality for money.

qual_4 The services the company offered are good.

qual_5 Customer concerns are held in high regard at the company.

qual_6 The company is a reliable partner for customers.

qual_7 The company is a trustworthy company.

qual_8 I have a lot of respect for the company.

qual_global Please assess the overall quality of the company's activities; 0=very low; 7=very high.

like_1 The company is a copany that I can better identify with than other companies.

like_2 The company is a company that I would regret more not having if it no longer existed than other companies.

like_3 I regard the company as a likeable company.

comp_1 The company is a top competitor in its market.

comp_2 As far as I know, the company is recognized worldwide.

comp_3 I believe that the company performs at a premium level.

cusl_1 I would recommend the company to friends and relatives.

cusl_2 If I had to choose again, I would choose the company as my mobile phone services provider.

cusl_3 I will remain a customer of the company in the future.

cusa I am satisfied with company.

switch_1 It takes me a great deal of time to switch to another company.

switch_2 It costs me too much to switch to another company.

switch_3 It takes a lot of effort to get used to a new company with its specific "rules" and practices.

switch_4 In general, it would be a hassle switching to another company.

Details

The data frame mobi contains the observed data for the model specified by Corporate Reputation.

References

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (2nd ed.). Thousand Oakes, CA: Sage.

Examples

```
data("corp_rep_data")
```

`corp_rep_data2` *A Second Measurement Instrument for the Corporate Reputation Model*

Description

The data set is used as measurement instrument for corporate reputation.

Usage

```
corp_rep_data2
```

Format

A data frame with 347 rows and 41 variables:

servicetype A categorical variable for the service type: 1=Postpaid plan; 2=Prepaid plan.

serviceprovider A categorical variable for the service provider: 1, 2, 3, or 4.

cusa If you consider your experiences with "company", how satisfied are you with "company"?

cusl_1 I would recommend "the company" to friends and relatives.

cusl_2 If I had to choose again, I would choose "the company" as my mobile phone services provider.

cusl_3 I will remain a customer of "the company" in the future.

qual_1 The products/services offered by "the company" are of high quality.

qual_2 "The company" is an innovator, rather than an imitator with respect to the mobile phone service industry.

qual_3 "The company's" services/products offer good quality for money.

qual_4 The services "the company" offers are good.

qual_5 Customer concerns are held in high regard at "the company".

qual_6 "The company" is a reliable partner for customers.

qual_7 "The company" is a trustworthy company.

qual_8 I have a lot of respect for "the company".

perf_1 "The company" is a very well managed company.

perf_2 "The company" is an economically stable company.

perf_3 The business risk of "the company" is reasonable compared to its competitors.

perf_4 The growth of "the company" is promising.

perf_5 "The company" has a clear vision about the future of the company.

csor_1 "The company" behaves in a socially conscious way.

csor_2 "The company" is honest in giving information to the public.

csor_3 "The company" competes fairly in the indsutry.

csor_4 "The company" cares for the preservation of the environment.

csor_5 "The company" is doing more than just making profits.

attr_1 "The company" is succesful in attracting high-quality employees.

attr_2 I could see myself working at "the company".

attr_3 I like the physical appearance of "the company" (company/buildings/shops, etc.).

comp_1 "The company" is a top competitor in its market.

comp_2 As far as I know, "the company" is recognized worldwide.

comp_3 I believe that "the company" performs at a premium level.

like_1 "The company" is a company that I can better identify with than other companies.

like_2 When comparing with other companies, "The company" is the company I would regret more if it no longer existed.

like_3 I regard "the company" as a likeable company.

qual_global Please assess the general quality of "the company".

perf_global Please assess the general performance of "the company".

csor_global Please assess the extent to which "the company" acts in socially conscious ways.

attr_global Please assess the attractiveness of "the company".

switch_1 It takes me a great deal of time to switch to another mobile phone services provider.

switch_2 It costs me too much to switch to another mobile phone services provider.

switch_3 It takes a lot of effort to get used to a new mobile phone services provider with its specific "rules" and practices.

switch_4 In general, it would be a hassle switching to another mobile phone services provider.

Details

The data frame mobi contains the observed data for the model specified by Corporate Reputation.

References

Sarstedt, M., Hair Jr, J. F., Cheah, J. H., Becker, J. M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. Australasian Marketing Journal (AMJ), 27(3), 197-211.

Examples

```
data("corp_rep_data2")
```

`cor_rsq` *Returns R-sq of a dv given correlation matrix of ivs, dv cors <- cbsem_summary$descriptives$correlations$constructs cor_rsq(cors, dv_name = "Value", iv_names = c("Image", "Quality"))*

Description

Returns R-sq of a dv given correlation matrix of ivs, dv cors <- cbsem_summary$descriptives$correlations$constructs cor_rsq(cors, dv_name = "Value", iv_names = c("Image", "Quality"))

Usage

```
cor_rsq(cor_matrix, dv_name, iv_names)
```

Arguments

`cor_matrix`	A correlation matrix that includes ivs and dv
`dv_name`	Character string of dependent variable
`iv_names`	Vector of character strings for independent variables

`csem2seminr` *seminr csem2seminr() function*

Description

Converts lavaan syntax for composite models used by `cSEM` package to `SEMinR` model specifications

Usage

```
csem2seminr(lav_syntax)
```

Arguments

`lav_syntax`	A `string` specifying the composite model measurement and structure using lavaan syntax

Value

A SEMinR model.

See Also

`estimate_pls`

Examples

```
lav_syntax <- '
# Composite model
 Image <~ IMAG1 + IMAG2 + IMAG3 + IMAG4 + IMAG5
 Expectation <~ CUEX1 + CUEX2 + CUEX3
 Value  <~ PERV1  + PERV2
 Satisfaction <~ CUSA1 + CUSA2 + CUSA3

 # Structural model
 Satisfaction ~ Image + Expectation + Value '

csem_model <- estimate_pls(mobi, model = csem2seminr(lav_syntax))
```

---

df_xtab_matrix *Cross-tabulates columns of a dataframe into a matrix with NAs for unspecified pairs*

Description

Cross-tabulates columns of a dataframe into a matrix with NAs for unspecified pairs

Usage

```
df_xtab_matrix(model, df, rows, columns)
```

Arguments

model	A formula indicating relevant columns from data frame
df	A data.frame of columns to cross-tabulate
rows	A vector of row names for the matrix to sort by
columns	A vector of column names for the matrix to sort by

Value

A cross-tabulated matrix matrix with NAs for unspecified pairs.

dot_component_mm *Generates the dot code for the measurement model*

Description

Generates the dot code for the measurement model

Usage

```
dot_component_mm(model, theme)
```

Arguments

model	the model to use
theme	the theme to use

dot_graph *Generate a dot graph from various SEMinR models*

Description

With the help of the DiagrammeR package this dot graph can then be plotted in various in RMarkdown, shiny, and other contexts. Depending on the type of model, different parameters can be used.

For a full description of parameters for lavaan models see semPaths method in the semPlot package.

Usage

```
dot_graph(model, title = "", theme = NULL, ...)

## S3 method for class 'cfa_model'
dot_graph(
  model,
  title = "",
  theme = NULL,
  what = "std",
  whatLabels = "std",
  alpha = NULL,
  ...
)

## S3 method for class 'cbsem_model'
dot_graph(
  model,
  title = "",
```

```
  theme = NULL,
  what = "std",
  whatLabels = "std",
  alpha = NULL,
  ...
)

## S3 method for class 'measurement_model'
dot_graph(model, title = "", theme = NULL, alpha = NULL, ...)

## S3 method for class 'structural_model'
dot_graph(model, title = "", theme = NULL, alpha = NULL, ...)

## S3 method for class 'specified_model'
dot_graph(
  model,
  title = "",
  theme = NULL,
  measurement_only = FALSE,
  structure_only = FALSE,
  alpha = NULL,
  ...
)

## S3 method for class 'boot_seminr_model'
dot_graph(
  model,
  title = "",
  theme = NULL,
  measurement_only = FALSE,
  structure_only = FALSE,
  alpha = 0.05,
  ...
)

## S3 method for class 'pls_model'
dot_graph(
  model,
  title = "",
  theme = NULL,
  measurement_only = FALSE,
  structure_only = FALSE,
  alpha = 0.05,
  ...
)
```

Arguments

model	Model created with seminr.

title	An optional title for the plot
theme	Theme created with seminr_theme_create.
...	Unused
what	The metric to use for edges ("path", "est", "std", "eq", "col")
whatLabels	The metric to use for edge labels
alpha	The significance level for the confidence interval. Default is 0.05. Only meaningful for bootstrapped models.
measurement_only	Plot only measurement part
structure_only	Plot only structure part

Details

Current limitations: - Only plots PLS Models - no higher order constructs

Value

The path model as a formatted string in dot language.

Examples

```
mobi <- mobi

#seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)

# adapt nboot for better results
mobi_boot <- bootstrap_model(mobi_pls, nboot = 20, cores = 1)
# generate dot-Notation
```

```
res <- dot_graph(mobi_pls, title = "PLS-Model plot")

## Not run:
DiagrammeR::grViz(res)
## End(Not run)

# generate dot-Notation
res <- dot_graph(mobi_boot, title = "Bootstrapped PLS-Model plot", alpha = 0.01)

## Not run:
DiagrammeR::grViz(res)
## End(Not run)

# - - - - - - - - - - - - - - - - -
# Example for plotting a measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
dot_graph(mobi_mm, title = "Preview measurement model")
# - - - - - - - - - - - - - - - - -
# Example for plotting a structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)
res <- dot_graph(mobi_sm, title = "Preview structural model")

## Not run:
DiagrammeR::grViz(res)

## End(Not run)
```

---

dot_graph_htmt *Creates a dot string with a network graph of constructs based on HTMT measures*

Description

Using a bootstrapped model this functions shows which constructs show insufficient discriminant validity.

Usage

```
dot_graph_htmt(
  model,
  title = "HTMT Plot",
  theme = seminr::seminr_theme_get(),
  htmt_threshold = 1,
  omit_threshold_edges = TRUE,
  use_ci = FALSE
)
```

Arguments

model	A bootsrapped PLS-Model
title	Optional title over the plot.
theme	Optional theme to use for plotting
htmt_threshold	The threshold to use under which constructs are highlighted (default = 1.0)
omit_threshold_edges	Whether or not to omit constructs that have low HTMT values (default = TRUE)
use_ci	Whether or not to rely on the upper threshold of the CI instead of the bootstrapped mean (default = FALSE)

Value

Returs a dot string of the plot

---

dot_subcomponent_mm *generates the dot code for a subgraph (per construct)*

Description

generates the dot code for a subgraph (per construct)

Usage

```
dot_subcomponent_mm(index, model, theme)
```

Arguments

index	the index of the construct
model	the model to use
theme	the theme to use

edge_template_default *The default template for labeling bootstrapped edges*

Description

The default template for labeling bootstrapped edges

Usage

```
edge_template_default()
```

Value

The template string

edge_template_minimal *A minimal template for labeling bootstrapped edges that only shows the bootstrapped mean value*

Description

A minimal template for labeling bootstrapped edges that only shows the bootstrapped mean value

Usage

```
edge_template_minimal()
```

Value

The template string

esc_node *Wrap a text in single quotes*

Description

Wrap a text in single quotes

Usage

```
esc_node(x)
```

Arguments

x	a character string

estimate_cbsem *seminr estimate_cbsem() function*

Description

The seminr package provides a natural syntax for researchers to describe structural equation models.

Usage

```
estimate_cbsem(data, measurement_model = NULL,
               structural_model = NULL, item_associations = NULL,
               model = NULL, lavaan_model = NULL, estimator = "MLR", ...)
```

Arguments

data	A dataframe containing the indicator measurement data. The entire CBSEM model can be specified in one of three ways: The pair of measurement and structural models, along associated items, can optionally be specified as separate model components
measurement_model	An optional measurement_model object representing the outer/measurement model, as generated by constructs. Note that only reflective constructs are supported for CBSEM models, though a composite measurement model can be converted into a reflective one using as.reflective.
structural_model	An optional smMatrix object representing the inner/structural model, as generated by relationships.
item_associations	An item-to-item matrix representing error covariances that are freed for estimation. This matrix is created by associations(), or defaults to NULL (no inter-item associations). The combination of measurement and structural models and inter-item associations can also be specified as a single specified_model object Note that any given model components (measurement_model, structural_model, item_associations) will override components in the fully specified model
model	An optional specified_model object containing both the the outer/measurement and inner/structural models, along with any inter-item associations, as generated by specify_model. The entire model can also be specified in Lavaan syntax (this overrides any other specifications)
lavaan_model	Optionally, a single character string containing the relevant model specification in lavaan syntax. Any further optional parameters to alter the estimation method:

estimator	A character string indicating which estimation method to use in Lavaan. It defaults to "MLR" for robust estimation. See the Lavaan documentation for other supported estimators.
...	Any other parameters to pass to lavaan::sem during estimation.

Value

A list of the estimated parameters for the CB-SEM model including:

data	A matrix of the data upon which the model was estimated.
measurement_model	The SEMinR measurement model specification.
factor_loadings	The matrix of estimated factor loadings.
associations	A matrix of model variable associations.
mmMatrix	A Matrix of the measurement model relations.
smMatrix	A Matrix of the structural model relations.
constructs	A vector of the construct names.
construct scores	A matrix of the estimated construct scores for the CB-SEM model.
item_weights	A matrix of the estimated CFA item weights.
lavaan_model	The lavaan model syntax equivalent of the SEMinR model.
lavaan_output	The raw lavaan output generated after model estimation.

References

Joreskog, K. G. (1973). A general method for estimating a linear structural equation system In: Goldberger AS, Duncan OD, editors. Structural Equation Models in the Social Sciences. New York: Seminar Press.

See Also

as.reflective relationships constructs paths associations item_errors

Examples

```
mobi <- mobi

#seminr syntax for creating measurement model
mobi_mm <- constructs(
  reflective("Image",        multi_items("IMAG", 1:5)),
  reflective("Quality",      multi_items("PERQ", 1:7)),
  reflective("Value",        multi_items("PERV", 1:2)),
  reflective("Satisfaction", multi_items("CUSA", 1:3)),
  reflective("Complaints",   single_item("CUSCO")),
  reflective("Loyalty",      multi_items("CUSL", 1:3))
)
```

```
#seminr syntax for freeing up item-item covariances
mobi_am <- associations(
  item_errors(c("PERQ1", "PERQ2"), "IMAG1")
)

#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = c("Image", "Quality"), to = c("Value", "Satisfaction")),
  paths(from = c("Value", "Satisfaction"), to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

# Estimate model and get results
mobi_cbsem <- estimate_cbsem(mobi, mobi_mm, mobi_sm, mobi_am)

# Use or capture the summary object for more results and metrics
summary(mobi_cbsem)

cbsem_summary <- summary(mobi_cbsem)
cbsem_summary$descriptives$correlations$constructs
```

`estimate_cfa` *seminr estimate_cfa() function*

Description

Estimates a Confirmatory Factor Analysis (CFA) model

Usage

```
estimate_cfa(data, measurement_model = NULL, item_associations=NULL,
             model = NULL, lavaan_model = NULL, estimator="MLR", ...)
```

Arguments

`data`	A `dataframe` containing the indicator measurement data. The entire CBSEM model can be specified in one of three ways: The pair of measurement and structural models, along associated items, can optionally be specified as separate model components
`measurement_model`	An optional `measurement_model` object representing the outer/measurement model, as generated by `constructs`. Note that only reflective constructs are supported for CBSEM models, though a composite measurement model can be converted into a reflective one using `as.reflective`.
`item_associations`	An item-to-item matrix representing error covariances that are freed for estimation. This matrix is created by `associations()`, or defaults to NULL (no inter-item associations).

	The combination of measurement and structural models and inter-item associations can also be specified as a single `specified_model` object Note that any given model components (measurement_model, structural_model, item_associations) will override components in the fully specified model
`model`	An optional `specified_model` object containing both the the outer/measurement and inner/structural models, along with any inter-item associations, as generated by `specify_model`. The entire model can also be specified in Lavaan syntax (this overrides any other specifications)
`lavaan_model`	Optionally, a single character string containing the relevant model specification in `lavaan` syntax. Any further optional parameters to alter the estimation method:
`estimator`	A character string indicating which estimation method to use in Lavaan. It defaults to "MLR" for robust estimation. See the Lavaan documentation for other supported estimators.
`...`	Any other parameters to pass to `lavaan::sem` during estimation.

Value

A list of the estimated parameters for the CFA model including:

`data`	A matrix of the data upon which the model was estimated.
`measurement_model`	The SEMinR measurement model specification.
`construct scores`	A matrix of the estimated construct scores for the CB-SEM model.
`item_weights`	A matrix of the estimated CFA item weights.
`lavaan_model`	The lavaan model syntax equivalent of the SEMinR model.
`lavaan_output`	The raw lavaan output generated after model estimation.

References

Jöreskog, K.G. (1969) A general approach to confirmatory maximum likelihood factor analysis. Psychometrika, 34, 183-202.

See Also

`constructs` `reflective` `associations` `item_errors` `as.reflective`

#' @examples mobi <- mobi

#seminr syntax for creating measurement model mobi_mm <- constructs(reflective("Image", multi_items("IMAG", 1:5)), reflective("Expectation", multi_items("CUEX", 1:3)), reflective("Quality", multi_items("PERQ", 1:7)))

#seminr syntax for freeing up item-item covariances mobi_am <- associations(item_errors(c("PERQ1", "PERQ2"), "CUEX3"), item_errors("IMAG1", "CUEX2"))

mobi_cfa <- estimate_cfa(mobi, mobi_mm, mobi_am)

`estimate_lavaan_ten_berge` *seminr estimate_lavaan_ten_berge() function*

Description

Estimates factor scores using ten Berge method for a fitted Lavaan model

Usage

```
estimate_lavaan_ten_berge(fit)
```

Arguments

`fit`	A fitted `lavaan` object – can be extracted from cbesem estimation or from using Lavaan directly.

Value

A list with two elements: ten berge scores; weights for calculating scores

Examples

```
#' #seminr syntax for creating measurement model
mobi_mm <- constructs(
  reflective("Image",        multi_items("IMAG", 1:5)),
  reflective("Quality",      multi_items("PERQ", 1:7)),
  reflective("Value",        multi_items("PERV", 1:2)),
  reflective("Satisfaction", multi_items("CUSA", 1:3)),
  reflective("Complaints",   single_item("CUSCO")),
  reflective("Loyalty",      multi_items("CUSL", 1:3))
)

#seminr syntax for freeing up item-item covariances
mobi_am <- associations(
  item_errors(c("PERQ1", "PERQ2"), "IMAG1")
)

#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = c("Image", "Quality"), to = c("Value", "Satisfaction")),
  paths(from = c("Value", "Satisfaction"), to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

# Estimate model and get results
cbsem <- estimate_cbsem(mobi, mobi_mm, mobi_sm, mobi_am)
tb <- estimate_lavaan_ten_berge(cbsem$lavaan_output)
tb$scores
tb$weights
```

estimate_pls *seminr estimate_pls() function*

Description

Estimates a pair of measurement and structural models using PLS-SEM, with optional estimation methods

Usage

```
estimate_pls(data,
             measurement_model = NULL, structural_model = NULL, model = NULL,
             inner_weights = path_weighting,
             missing = mean_replacement,
             missing_value = NA,
             maxIt = 300,
             stopCriterion = 7,
             assess_syntax = FALSE)
```

Arguments

data	A dataframe containing the manifest measurement items in named columns.
measurement_model	The pair of measurement and structural models can optionally be specified as separate model objects An optional measurement_model object representing the outer/measurement model, as generated by constructs.
structural_model	An optional smMatrix object representing the inner/structural model, as generated by relationships. The pair of measurement and structural models can also be specified as a single specified_model object
model	An optional specified_model object containing both the the outer/measurement and inner/structural models, as generated by specify_model.
inner_weights	Function that implements inner weighting scheme: path_weighting (default) or path_factorial can be used.
missing	Function that replaces missing values. mean_replacement is default. na.omit removes incomplete cases.
missing_value	Value in dataset that indicates missing values. NA is used by default.
maxIt	A parameter that specifies that maximum number of iterations when estimating the PLS model. Default value is 300.
stopCriterion	A parameter specifying the stop criterion for estimating the PLS model. Default value is 7.
assess_syntax	A parameter that specifies whether the measurement and structural model should be assessed for errors. Default value is FALSE.

Value

A list of the estimated parameters for the SEMinR model including:

meanData	A vector of the indicator means.
sdData	A vector of the indicator standard deviations
mmMatrix	A Matrix of the measurement model relations.
smMatrix	A Matrix of the structural model relations.
constructs	A vector of the construct names.
mmVariables	A vector of the indicator names.
outer_loadings	The matrix of estimated indicator loadings.
outer_weights	The matrix of estimated indicator weights.
path_coef	The matrix of estimated structural model relationships.
iterations	A numeric indicating the number of iterations required before the algorithm converged.
weightDiff	A numeric indicating the minimum weight difference between iterations of the algorithm.
construct_scores	A matrix of the estimated construct scores for the PLS model.
rSquared	A matrix of the estimated R Squared for each construct.
inner_weights	The inner weight estimation function.
data	A matrix of the data upon which the model was estimated (INcluding interactions.
rawdata	A matrix of the data upon which the model was estimated (EXcluding interactions.
measurement_model	The SEMinR measurement model specification.

See Also

specify_model relationships constructs paths interaction_term bootstrap_model

Examples

```
mobi <- mobi

#seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
```

```
#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm,
                         missing = mean_replacement,
                         missing_value = NA)

summary(mobi_pls)
plot_scores(mobi_pls)
```

`estimate_pls_mga` *Performs PLS-MGA to report significance of path differences between two subgroups of data*

Description

Performs PLS-MGA to report significance of path differences between two subgroups of data

Usage

```
estimate_pls_mga(pls_model, condition, nboot = 2000, ...)
```

Arguments

`pls_model`	SEMinR PLS model estimated on the full sample
`condition`	logical vector of TRUE/FALSE indicating which rows of sample data are in group 1
`nboot`	number of bootstrap resamples to use in PLS-MGA
`...`	any further parameters for bootstrapping (e.g., cores)

References

Henseler, J., Ringle, C. M. & Sinkovics, R. R. New Challenges to International Marketing. Adv Int Marketing 277–319 (2009) doi:10.1108/s1474-7979(2009)0000020014

Examples

```
mobi <- mobi

#seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Quality",      multi_items("PERQ", 1:7)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  composite("Complaints",   single_item("CUSCO")),
  composite("Loyalty",      multi_items("CUSL", 1:3))
)

#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm,
                         missing = mean_replacement,
                         missing_value = NA)

# Should usually use nboot ~2000 and don't specify cores for full parallel processing

mobi_mga <- estimate_pls_mga(mobi_pls, mobi$CUEX1 < 8, nboot=50, cores = 2)
```

---

extract_bootstrapped_values

extract bootstrapped statistics from an edge using a row_index

---

Description

extract bootstrapped statistics from an edge using a row_index

Usage

```
extract_bootstrapped_values(ltbl, row_index, model, theme)
```

Arguments

ltbl	a table of bootstrapped values (weights, loadings, path coefficients)
row_index	the index for the specific edge to extract
model	the model to use
theme	the theme to use

---

extract_htmt_nodes *Helper function that applies formatting to each construct*

Description

Helper function that applies formatting to each construct

Usage

```
extract_htmt_nodes(model, theme)
```

Arguments

model	the model to use
theme	the theme to use

Value

Returns a string of the structural model in dot notation.

---

extract_mm_coding *extracts the constructs and their types from the model*

Description

extracts the constructs and their types from the model

Usage

```
extract_mm_coding(model)
```

Arguments

model	the model to use

`extract_mm_edges` *extract mm edges from model for a given index of all constructs*

Description

extract mm edges from model for a given index of all constructs

Usage

```
extract_mm_edges(index, model, theme, weights = 1000)
```

Arguments

`index`	the index of the construct
`model`	the model to use
`theme`	the theme to use
`weights`	a default weight for measurment models (high values suggested)

`extract_mm_edge_value` *gets the mm_edge value (loading, weight) for bootstrapped and regular models*

Description

gets the mm_edge value (loading, weight) for bootstrapped and regular models

Usage

```
extract_mm_edge_value(model, theme, indicator, construct)
```

Arguments

`model`	the model to use
`theme`	the theme to use
`indicator`	the indicator to use
`construct`	the construct to use

extract_mm_nodes *gets the individual nodes and applies formatting*

Description

gets the individual nodes and applies formatting

Usage

```
extract_mm_nodes(index, model, theme)
```

Arguments

index	the index of the construct
model	the model to use
theme	the theme to use

extract_sm_nodes *Helper function that applies formatting to each construct*

Description

Helper function that applies formatting to each construct

Usage

```
extract_sm_nodes(model, theme, structure_only = FALSE)
```

Arguments

model	the model to use
theme	the theme to use
structure_only	is this called in a structure_only model

Value

Returns a string of the structural model in dot notation.

format_endo_node_label *Helps to render a node label for endogenous variables*

Description

Helps to render a node label for endogenous variables

Usage

```
format_endo_node_label(theme, name, rstring)
```

Arguments

theme	the theme to use
name	the content of the name placeholder
rstring	the content of the rstring placeholder

Value

Returns the formatted string

format_exo_node_label *Helps to render a node label for exogenous variables*

Description

Helps to render a node label for exogenous variables

Usage

```
format_exo_node_label(theme, name)
```

Arguments

theme	the theme to use
name	the content of the name placeholder

Value

Returns the formatted string

`fSquared` *seminr fSquared Function*

Description

The `fSquared` function calculates f^2 effect size for a given IV and DV

Usage

```
fSquared(seminr_model, iv, dv)
```

Arguments

`seminr_model`	A `seminr_model` containing the estimated seminr model.
`iv`	An independent variable in the model.
`dv`	A dependent variable in the model.

Value

A matrix of the estimated F Square metric for each construct.

References

Cohen, J. (2013). Statistical power analysis for the behavioral sciences. Routledge.

Examples

```
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )

mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)
```

```
fSquared(mobi_pls, "Image", "Satisfaction")
```

`get_construct_element_size` *Gets the optimal size for construct elements in the plot*

Description

Currently orients on reflective theme settings

Usage

```
get_construct_element_size(model, theme)
```

Arguments

`model`	the model to use
`theme`	the theme to use

Value

Returns a two-element vector with c(width, height)

`get_manifest_element_size` *Gets the optimal size for manifest elements in the plot*

Description

Currently orients on reflective theme settings

Usage

```
get_manifest_element_size(model, theme)
```

Arguments

`model`	the model to use
`theme`	the theme to use

Value

Returns a two-element vector with c(width, height)

get_mm_edge_style *individual styles for measurement model edges*

Description

individual styles for measurement model edges

Usage

```
get_mm_edge_style(theme, construct_type, flip = FALSE)
```

Arguments

theme	the theme to use
construct_type	Forward direction?
flip	invert the arrow direction because of sink?

get_mm_node_shape *Get a string to insert into a node specification using the themed shape*

Description

Get a string to insert into a node specification using the themed shape

Usage

```
get_mm_node_shape(model, construct, theme)
```

Arguments

model	the model to use
construct	the construct to use
theme	the theme to use

Value

Returns a string that determines the shape of a node

get_mm_node_style *get global measurement model node style*

Description

get global measurement model node style

Usage

```
get_mm_node_style(theme)
```

Arguments

theme	the theme to use

get_sm_node_shape *Get a string to insert into a node specification using the themed shape*

Description

Get a string to insert into a node specification using the themed shape

Usage

```
get_sm_node_shape(model, construct, theme)
```

Arguments

model	the model to use
construct	the construct to use
theme	the theme to use

Value

Returns a string that determines the shape of a node

`get_value_dependent_mm_edge_style` *Formats the style of the structural model edges*

Description

Formats the style of the structural model edges

Usage

```
get_value_dependent_mm_edge_style(value, theme)
```

Arguments

`value`	value to compare for negativity
`theme`	the theme to use

Value

Returns the style for the edge (both style and color)

`get_value_dependent_sm_edge_style` *Formats the style of the structural model edges*

Description

Formats the style of the structural model edges

Usage

```
get_value_dependent_sm_edge_style(value, theme)
```

Arguments

`value`	value to compare for negativity
`theme`	the theme to use

Value

Returns the style for the edge (both style and color)

higher_composite *higher_composite*

Description

higher_composite creates a higher order construct from first-order constructs using the two-stage method (Becker et al., 2012).

Usage

```
higher_composite(construct_name, dimensions, method, weights)
```

Arguments

construct_name	of second-order construct
dimensions	the first-order constructs
method	is the estimation method, default is two_stage
weights	is the relationship between the second-order construct and first-order constructs. This can be specified as correlation_weights or mode_A for correlation weights (Mode A) or as regression_weights or mode_B for regression weights (Mode B). Default is correlation weights.

Details

This function conveniently maps first-order constructs onto second-order constructs using construct names.

Value

A vector of the indicators for a higher-order-composite.

See Also

See constructs, reflective

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5), weights = correlation_weights),
  composite("Expectation",  multi_items("CUEX", 1:3), weights = mode_A),
  higher_composite("Quality",  c("Image","Expectation"), method = two_stage),
  composite("Value",        multi_items("PERV", 1:2), weights = mode_B)
)
```

higher_reflective *higher_reflective*

Description

higher_reflective creates a higher-order reflective construct

Usage

```
higher_reflective(construct_name, dimensions)
```

Arguments

construct_name	of second-order construct
dimensions	the first-order constructs

Details

This function maps first-order constructs onto second-order reflective constructs using construct names. It is currently only suitable for CB-SEM and not PLS

Value

A vector of the indicators for a higher-order-factor.

See Also

See constructs, reflective

Examples

```
mobi_mm <- constructs(
  reflective("Image",           multi_items("IMAG", 1:5)),
  reflective("Expectation",     multi_items("CUEX", 1:3)),
  higher_reflective("Quality",  c("Image", "Expectation"))
)
```

`influencer_data` *Measurement Instrument for the Influencer Model*

Description

The data set is used as measurement instrument for the Influencer Model which is used in Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R - A Workbook (2021) Hair, J.F. (Jr), Hult, T.M., Ringle, C.M., Sarstedt, M., Danks, N.P., and Ray, S.

Usage

```
influencer_data
```

Format

A data frame with 250 rows and 24 variables:

sic_1 The influencer reflects who I am.

sic_2 I can identify with the influencer.

sic_3 I feel a personal connection to the influencer.

sic_4 I (can) use the influencer to communicate who I am to other people.

sic_5 I think the influencer (could) help(s) me become the type of person I want to be.

sic_6 I consider the influencer to be "me".

sic_7 The influencer suits me well.

sic_global My personality and the personality of the influencer relate accordingly to one another.

pq_1 The product has excellent quality.

pq_2 The product looks to be reliable and durable.

pq_3 The product will have fewer problems.

pq_4 The product has excellent quality features.

pl_1 I dislike the product (reverse coded).

pl_2 The product is appealing to me.

pl_3 The presented product raises a positive feeling in me.

pl_4 The product is interesting to me.

pi_1 It is very likely that I will purchase this product.

pi_2 I will purchase this product the next time I need it.

pi_3 I would definitely try the product out.

pi_4 I would recommend this product to my friends.

pi_5 I am willing to purchase this product.

pic_1 The influencer is qualified.

pic_2 The influencer is competent.

pic_3 The influencer is an expert.

pic_4 The influencer is experienced.

pic_5 The influencer is knowledgeable.

wtp Please state your willingness to pay (in Euro) for the presented product.

influencer_group A binary variable indicating which group the influencer belongs to.

Details

The data frame influencer_data contains the observed data for the model specified in the Influencer Model.

Examples

```
data("influencer_data")
```

`interaction_term` *Interaction function*

Description

`interaction_term` creates interaction measurement items by applying product indicator, two stage, or orthogonal approaches to creating new interaction constructs.

Usage

```
interaction_term(iv, moderator, method, weights)
```

Arguments

`iv`	The independent variable that is subject to moderation.
`moderator`	The moderator variable.
`method`	The method to generate the estimated interaction term with a default of 'two_stage'.
`weights`	The weighting mode for interaction items in a PLS model (only) with default of 'modeA'.

Details

This function automatically generates interaction measurement items for a PLS or a CBSEM model.

Value

An un-evaluated function (promise) for generating a vector of interaction terms.

Interaction Combinations as generated by the `interaction` or `interaction_term` methods.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  interaction_term(iv = "Image", moderator = "Expectation", method = orthogonal),
  interaction_term(iv = "Image", moderator = "Value", method = product_indicator)
)

#  structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation", "Image*Value"))
)

mobi_pls <- estimate_pls(mobi, mobi_mm, mobi_sm)
summary(mobi_pls)
```

---

is_only_endogenous *Tests whether the i_th construct is endogenous or not*

Description

Tests whether the i_th construct is endogenous or not

Usage

```
is_only_endogenous(model, index)
```

Arguments

model	the model object
index	the index of the construct to test

Value

whether the construct is endogenous or not

`item_errors` *Specifies pair of items, or sets of items, that should covary. Used to specify error covariances for* `associations`.

Description

Specifies pair of items, or sets of items, that should covary. Used to specify error covariances for `associations`.

Usage

```
item_errors(items_a, items_b)
```

Arguments

`items_a`	One or more items that should covary
`items_b`	One or more items that should covary

Value

A vector of items that covary.

Examples

```
item_errors(c("a1", "a2"), c("b1", "b2"))
```

`mean_replacement` *Function to clean data of omitted values by mean replacement*

Description

The `seminr` package provides a natural syntax for researchers to describe PLS structural equation models.

Usage

```
mean_replacement(data)
```

Arguments

`data`	A dataset to be used for estimating a SEMinR model

Details

`mean_replacement` provides the verb for replacing all omitted values (NA only) in the dataset with the mean of the variable. It gives a warning if more than 5

Value

A dataset with all missing values replaced with column means

References

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), 2nd Ed., Sage: Thousand Oaks.

---

mobi *Measurement Instrument for the Mobile Phone Industry*

Description

The data set is used as measurement instrument for the european customer satisfaction index (ECSI) adapted to the mobile phone market, see Tenenhaus et al. (2005).

Usage

```
mobi
```

Format

A data frame with 250 rows and 24 variables:

CUEX1 Expectations for the overall quality of "your mobile phone provider" at the moment you became customer of this provider

CUEX2 Expectations for "your mobile phone provider" to provide products and services to meet your personal need

CUEX3 How often did you expect that things could go wrong at "your mobile phone provider

CUSA1 Overall satisfaction

CUSA2 Fulfillment of expectations

CUSA3 How well do you think "your mobile phone provider" compares with your ideal mobile phone provider?

CUSCO You complained about "your mobile phone provider" last year. How well, or poorly, was your most recent complaint handled or You did not complain about "your mobile phone provider" last year. Imagine you have to complain to "your mobile phone rovider" because of a bad quality of service or product. To what extent do you think that "your mobile phone provider" will care about your complaint?

CUSL1 If you would need to choose a new mobile phone provider how likely is it that you would choose "your provider" again?

CUSL2 Let us now suppose that other mobile phone providers decide to lower their fees and prices, but "your mobile phone provider" stays at the same level as today. At which level of difference (in percentage) would you choose another mobile phone provider?

CUSL3 If a friend or colleague asks you for advice, how likely is it that you would recommend "your mobile phone provider"?

IMAG1 It can be trusted what it says and does

IMAG2 It is stable and firmly established

IMAG3 It has a social contribution to society

IMAG4 It is concerned with customers

IMAG5 It is innovative and forward looking

PERQ1 Overall perceived quality

PERQ2 Technical quality of the network

PERQ3 Customer service and personal advice offered

PERQ4 Quality of the services you use

PERQ5 Range of services and products offered

PERQ6 Reliability and accuracy of the products and services provided

PERQ7 Clarity and transparency of information provided

PERV1 Given the quality of the products and services offered by "your mobile phone provider" how would you rate the fees and prices that you pay for them?

PERV2 Given the fees and prices that you pay for "your mobile phone provider" how would you rate the quality of the products and services offered by "your mobile phone provider"?

Details

The data frame mobi contains the observed data for the model specified by ECSImobi.

References

Tenenhaus, M., V. E. Vinzi, Y.-M. Chatelin, and C. Lauro (2005) PLS path modeling. Computational Statistics & Data Analysis 48, 159-205.

Examples

```
data("mobi")
```

`mode_A` *Outer weighting scheme functions to estimate construct weighting.*

Description

`mode_A`, `correlation_weights` and `mode_B`, `regression_weights` specify the outer weighting scheme to be used in the estimation of the construct weights and score.

Usage

```
mode_A(mmMatrix, i, normData, construct_scores)
```

Arguments

mmMatrix	is the measurement_model - a source-to-target matrix representing the measurement model, generated by constructs.
i	is the name of the construct to be estimated.
normData	is the dataframe of the normalized item data.
construct_scores	is the matrix of construct scores generated by estimate_model.

Value

A matrix of estimated measurement model relations.

---

mode_B *Outer weighting scheme functions to estimate construct weighting.*

Description

mode_A, correlation_weights and mode_B, regression_weights specify the outer weighting scheme to be used in the estimation of the construct weights and score.

Usage

```
mode_B(mmMatrix, i, normData, construct_scores)
```

Arguments

mmMatrix	is the measurement_model - a source-to-target matrix representing the measurement model, generated by constructs.
i	is the name of the construct to be estimated.
normData	is the dataframe of the normalized item data.
construct_scores	is the matrix of construct scores generated by estimate_model.

Value

A matrix of estimated measurement model relations.

mode_plsc *Outer weighting scheme functions to estimate construct weighting.*

Description

mode_plsc specifies outer weighting as mode A and then applies PLSc disattenuation to mimic common-factor model estimates.

Usage

```
mode_plsc(mmMatrix, j, normData, construct_scores)
```

Arguments

mmMatrix	is the measurement_model - a source-to-target matrix representing the measurement model, generated by constructs.
j	is the name of the construct to be estimated.
normData	is the dataframe of the normalized item data.
construct_scores	is the matrix of construct scores generated by estimate_model.

Value

A matrix of estimated measurement model relations.

multi_items *Multi-items measurement model specification*

Description

multi_items creates a vector of measurment names given the item prefix and number range.

Usage

```
multi_items(item_name, item_numbers, ...)
```

Arguments

item_name	Prefix name of items
item_numbers	The range of number suffixews for the items
...	Additional Item names and nubers

Value

A vector of numbered indicators.

See Also

See single_item

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5), weights = correlation_weights),
  composite("Expectation",  multi_items("CUEX", 1:3), weights = mode_A),
  composite("Quality",      multi_items("PERQ", 1:7), weights = regression_weights),
  composite("Value",        multi_items("PERV", 1:2), weights = mode_B)
)
```

---

node_endo_template_default

The default template for labeling endogenous construct nodes

Description

The default template for labeling endogenous construct nodes

Usage

```
node_endo_template_default()
```

Value

The template string

---

node_exo_template_default

The default template for labeling exogenous construct nodes

Description

The default template for labeling exogenous construct nodes

Usage

```
node_exo_template_default()
```

Value

The template string

orthogonal *orthogonal creates interaction measurement items by using the orthogonalized approach wherein*

Description

This function automatically generates interaction measurement items for a PLS SEM using the orthogonalized approach..

Usage

```
# orthogonalization approach as per Henseler & Chin (2010):
 orthogonal(iv, moderator, weights)
```

Arguments

iv	The independent variable that is subject to moderation.
moderator	The moderator variable.
weights	is the relationship between the items and the interaction terms. This can be specified as correlation_weights or mode_A for correlation weights (Mode A) or as regression_weights or mode_B for regression weights (Mode B). Default is correlation weights.

Value

An un-evaluated function (promise) for estimating an orthogonal interaction effect.

References

Henseler & Chin (2010), A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling. Structural Equation Modeling, 17(1),82-109.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  interaction_term(iv = "Image", moderator = "Expectation", method = orthogonal),
  interaction_term(iv = "Image", moderator = "Value", method = orthogonal)
)

#  structural model: note that name of the interactions construct should be
```

```
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation", "Image*Value"))
)

mobi_pls <- estimate_pls(mobi, mobi_mm, mobi_sm)
summary(mobi_pls)
```

`path_factorial` *Inner weighting scheme functions to estimate inner paths matrix*

Description

`path_factorial` and `path_weighting` specify the inner weighting scheme to be used in the estimation of the inner paths matrix

Usage

```
path_factorial(smMatrix,construct_scores, dependant, paths_matrix)
```

Arguments

`smMatrix`	is the `structural_model` - a source-to-target matrix representing the inner/structural model, generated by `relationships`.
`construct_scores`	is the matrix of construct scores generated by `estimate_model`.
`dependant`	is the vector of dependant constructs in the model.
`paths_matrix`	is the matrix of estimated path coefficients estimated by `estimate_model`.

Value

A matrix of estimated structural relations.

References

Lohmoller, J.-B. (1989). Latent variables path modeling with partial least squares. Heidelberg, Germany: Physica Verlag.

path_weighting *Inner weighting scheme functions to estimate inner paths matrix*

Description

path_factorial and path_weighting specify the inner weighting scheme to be used in the estimation of the inner paths matrix

Usage

```
path_weighting(smMatrix,construct_scores, dependant, paths_matrix)
```

Arguments

smMatrix	is the structural_model - a source-to-target matrix representing the inner/structural model, generated by relationships.
construct_scores	is the matrix of construct scores generated by estimate_model.
dependant	is the vector of dependant constructs in the model.
paths_matrix	is the matrix of estimated path coefficients estimated by estimate_model.

Value

A matrix of estimated structural relations.

References

Lohmoller, J.B. (1989). Latent variables path modeling with partial least squares. Heidelberg, Germany: Physica-Verlag.

plot.reliability_table *Function for plotting the measurement model reliability metrics of a PLS model*

Description

plot.reliability_table generates an easy to read visualization of the rhoA, Cronbachs alpha, and Composite Reliability for all constructs. The plot visualizes the metrics in such a way as to draw meaning from not only the absolute values, but their relative values too.

Usage

```
## S3 method for class 'reliability_table'
plot(x, threshold = 0.7, ...)
```

Arguments

x	A reliability_table object from a SEMinR PLS model. This can be accessed as the reliability element of the PLS model summary object.
threshold	The reference line drawn across the plot, defaulting to 0.70. This is the conventional minimum for internal consistency reliability (Hair et al., 2019). Note that it is not the same as the 0.708 threshold applied to indicator loadings, which derives from the criterion that an indicator explain at least 50% of its own variance (0.708^2 approximately 0.50). The metrics shown here – Cronbach's alpha, rhoA and rhoC – are construct-level reliabilities, to which the loading threshold does not apply.
...	All other arguments inherited from plot.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
 composite("Image",        multi_items("IMAG", 1:5)),
 composite("Expectation",  multi_items("CUEX", 1:3)),
 composite("Value",        multi_items("PERV", 1:2)),
 composite("Satisfaction", multi_items("CUSA", 1:3))
)

#  structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
 paths(to = "Satisfaction",
       from = c("Image", "Expectation", "Value"))
)

mobi_pls <- estimate_pls(mobi, measurement_model = mobi_mm, structural_model = mobi_sm)
plot(summary(mobi_pls)$reliability)
```

---

plot.seminr_model *Plot various SEMinR models*

Description

With the help of the DiagrammeR package this dot graph can then be plotted in various in RMarkdown, shiny, and other contexts. Depending on the type of model, different parameters can be used. Please check the dot_graph function for additional parameters.

Usage

```
## S3 method for class 'seminr_model'
plot(x, title = "", theme = NULL, alpha = 0.05, ...)
```

Arguments

x	The model description
title	An optional title for the plot
theme	Theme created with seminr_theme_create.
alpha	The significance level for the confidence interval. Default is 0.05. Only meaningful for bootstrapped models.
...	Please check the dot_graph for the additional parameters

Value

Returns the plot.

---

plot_htmt *Plots a network graph of constructs based on HTMT measures*

Description

Using a bootstrapped model this functions shows which constructs show insufficient discriminant validity.

Usage

```
plot_htmt(
  model,
  title = "HTMT Plot",
  theme = seminr::seminr_theme_get(),
  htmt_threshold = 1,
  omit_threshold_edges = TRUE,
  use_ci = FALSE
)
```

Arguments

model	A bootsrapped PLS-Model
title	Optional title over the plot.
theme	Optional theme to use for plotting
htmt_threshold	The threshold to use under which constructs are highlighted (default = 1.0)
omit_threshold_edges	Whether or not to omit constructs that have low HTMT values (default = TRUE)
use_ci	Whether or not to rely on the upper threshold of the CI instead of the bootstrapped mean (default = FALSE)

Value

Returs a dot string of the plot

plot_interaction *Function for plotting interaction plot for moderated PLS or CBSEM model*

Description

plot_interaction generates an interaction plot for the effect of an antecedent on an outcome given a mediator variable.

Usage

```
plot_interaction(moderated_model, intxn, dv, legend)
```

Arguments

moderated_model	SEMinR model that contains an interaction.
intxn	Name (character) of the interaction term in the structural model. Must look like a product of independent variabel and moderator (e.g., "ABC*XYZ")
dv	Name (character) of the dependant consutruct affected by the moderator.
legend	Location (character) of the legend on the plot; must be a combination of bottomltop and leftlright (e.g., "bottomright").

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
composite("Image",        multi_items("IMAG", 1:5)),
composite("Expectation",  multi_items("CUEX", 1:3)),
composite("Value",        multi_items("PERV", 1:2)),
composite("Satisfaction", multi_items("CUSA", 1:3)),
interaction_term(iv = "Image", moderator = c("Expectation"), method = orthogonal))

# Structural model
#  note: interactions should be the names of its main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation")))

# Load data, assemble model, and estimate
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)

plot_interaction(mobi_pls, "Image*Expectation", "Satisfaction", "bottomright")
```

PLSc *seminr PLSc Function*

Description

The PLSc function calculates the consistent PLS path coefficients and loadings for a common-factor model. It returns a seminr_model containing the adjusted and consistent path coefficients and loadings for common-factor models and composite models. Only common-factor (reflective()) constructs are corrected for measurement error; composites of any mode are treated as fully reliable (rho_A = 1), as in Dijkstra and Henseler (2015). A higher-order composite of common factors is corrected with the reliability of its stage-2 proxy, a weighted sum of error-laden lower-order construct scores (van Riel et al., 2017).

Usage

```
PLSc(seminr_model)
```

Arguments

seminr_model	A seminr_model containing the estimated seminr model.

Value

A SEMinR model object which has been adjusted according to PLSc.

References

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. *MIS Quarterly*, 39(2), 297–316.

van Riel, A. C. R., Henseler, J., Kemény, I., & Sasovova, Z. (2017). Estimating hierarchical constructs using consistent partial least squares: The case of second-order composites of common factors. *Industrial Management & Data Systems*, 117(3), 459–477.

See Also

relationships constructs paths interaction_term bootstrap_model

Examples

```
mobi <- mobi

#seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
```

```
            reflective("Complaints",   single_item("CUSCO")),
            reflective("Loyalty",      multi_items("CUSL", 1:3))
          )
#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

seminr_model <- estimate_pls(data = mobi,
                             measurement_model = mobi_mm,
                             structural_model = mobi_sm)

PLSc(seminr_model)
```

`predict.cbsem_model` *Predict method for SEMinR CB-SEM models*

Description

Generates out-of-sample predictions for a model estimated by `estimate_cbsem()`, using the model-implied conditional expectation of de Rooij et al. (2023): the items of each endogenous construct are predicted from the predictor items through the covariance matrix implied by the fitted model. This is the rule implemented by `lavaan::lavPredictY()`; the prediction technique chooses the predictor items.

Usage

```
## S3 method for class 'cbsem_model'
predict(
  object,
  testData,
  technique = predict_DA,
  na.print = ".",
  digits = 3,
  ...
)
```

Arguments

`object`	An estimated `cbsem_model` from `estimate_cbsem()`.
`testData`	A data.frame of held-out test data containing all indicator columns.
`technique`	The prediction technique: `predict_DA` (Direct Antecedents, default) or `predict_EA` (Earliest Antecedents).

na.print	Character string for printing NA values.
digits	Number of digits for printing.
...	Additional arguments (currently unused).

Details

- predict_DA: each endogenous construct's items are predicted from the items of its direct antecedents.
- predict_EA: all endogenous items are predicted from the items of the exogenous constructs.

Items of exogenous constructs are returned as observed. Prediction stops for models with interaction terms (a latent product is not normally distributed, so the linear rule does not apply; see https://github.com/sem-in-r/seminr/issues/427), higher-order constructs, ordinal indicators, multiple groups, and non-converged or inadmissible fits (for example a negative residual variance).

Value

A predicted_seminr_model object containing:

testData	The test data (indicator columns).
predicted_items	Predicted indicator scores on the raw scale.
item_residuals	Residuals (actual - predicted) for each indicator.
predicted_construct_scores	Conditional expectations of the latent variables given the predictor items (for exogenous constructs, given their own items).

References

de Rooij, M., Karch, J. D., Fokkema, M., Bakk, Z., Pratiwi, B. C., & Kelderman, H. (2023). SEM-based out-of-sample predictions. *Structural Equation Modeling*, 30(1), 132–148.

Examples

```
mobi_mm <- constructs(
  reflective("Image",        multi_items("IMAG", 1:5)),
  reflective("Expectation",  multi_items("CUEX", 1:3)),
  reflective("Satisfaction", multi_items("CUSA", 1:3))
)
mobi_sm <- relationships(
  paths(from = "Image", to = c("Expectation", "Satisfaction")),
  paths(from = "Expectation", to = "Satisfaction")
)
model <- estimate_cbsem(mobi[1:200, ], mobi_mm, mobi_sm)
predictions <- predict(model, testData = mobi[201:250, ], technique = predict_DA)
head(predictions$predicted_items)
```

`predict.seminr_model` *Predict method for SEMinR PLS models*

Description

Generates out-of-sample predictions for a PLS model estimated by `estimate_pls()`. Supports models with and without interaction terms. For interaction models, the prediction method is automatically detected from the measurement model specification:

Usage

```
## S3 method for class 'seminr_model'
predict(
  object,
  testData,
  technique = predict_DA,
  na.print = ".",
  digits = 3,
  ...
)
```

Arguments

`object`	An estimated `seminr_model` from `estimate_pls()`.
`testData`	A data.frame of held-out test data containing all indicator columns. Must not include interaction columns (these are recreated internally).
`technique`	The prediction technique: `predict_DA` (Direct Antecedents, default) or `predict_EA` (Earliest Antecedents).
`na.print`	Character string for printing NA values.
`digits`	Number of digits for printing.
`...`	Additional arguments (currently unused).

Details

- `two_stage`: Recreates interaction from construct-score products
- `product_indicator`: Recreates scaled item-level products from test data
- `orthogonal`: Recreates scaled products and applies stored orthogonalization coefficients from estimation

For models with `reflective()` constructs, which `estimate_pls()` estimates as consistent PLS (PLSc), items are predicted with the model-implied conditional expectation of de Rooij et al. (2023) instead of the PLSpredict construct-score chain: the PLSc path coefficients and loadings describe the common factors, not the weighted composites, so applying them to composite scores overdisperses the predictions. The indicator correlation matrix implied by the PLSc estimates is used to predict each endogenous construct's items from the items of its direct antecedents (`predict_DA`)

or of the exogenous constructs (`predict_EA`). Prediction stops with the reason if the PLSc solution is inadmissible, which is checked as: a rho_A outside (0, 1]; a standardized loading above one; a disattenuated construct correlation of 1 or more in absolute value; a non-positive-definite construct correlation matrix implied by the structural model; or a non-positive-definite implied correlation matrix of the predictor items. The full matrix of disattenuated construct correlations is not itself required to be positive definite: only its exogenous block enters the implied matrix (cSEM's `verify()` checks the full matrix, so it can flag a solution that seminr predicts from). PLSc models with interaction terms are not supported. Models saved by seminr < 2.6.0 that mix reflective constructs with Mode A or unit-weighted composites give a warning to re-estimate them, because their PLSc estimates changed in 2.6.0.

Higher-order construct (HOC) models are not currently supported for prediction. Models with mixed interaction methods (e.g., one `two_stage` and one `product_indicator`) will produce an error.

Value

A `predicted_seminr_model` object containing:

`testData` The test data (non-interaction items only).

`predicted_items`
: Predicted indicator scores.

`item_residuals` Residuals (actual - predicted) for each indicator.

`predicted_composite_scores`
: Predicted construct scores.

`composite_residuals`
: Residuals for construct scores.

`actual_star` Reference construct scores from re-estimation on combined data.

References

de Rooij, M., Karch, J. D., Fokkema, M., Bakk, Z., Pratiwi, B. C., & Kelderman, H. (2023). SEM-based out-of-sample predictions. *Structural Equation Modeling*, 30(1), 132–148.

Examples

```
data(mobi)

mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  interaction_term(iv = "Image", moderator = "Expectation",
                   method = product_indicator)
)
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Image*Expectation"))
)
model <- estimate_pls(mobi, mobi_mm, mobi_sm)
```

```
predictions <- predict(model, testData = mobi[1:20, ])
```

`predict_DA` *Predictive Scheme*

Description

`predict_EA` and `predict_DA` specify the predictive scheme to be used in the generation of the predictions. EA refers to Earliest Antecedents nad DA to Direct Antecedents.

Usage

```
predict_DA(smMatrix, path_coef, construct_scores)
```

Arguments

`smMatrix`	is the `structural_model` - a source-to-target matrix representing the inner/structural model, generated by `relationships` generated by SEMinR.
`path_coef`	is the Path Coefficients matrix from a SEMinR model.
`construct_scores`	is the matrix of construct scores generated by SEMinR.

`predict_EA` *Predictive Scheme*

Description

`predict_EA` and `predict_DA` specify the predictive scheme to be used in the generation of the predictions. EA refers to Earliest Antecedents nad DA to Direct Antecedents.

Usage

```
predict_EA(smMatrix, path_coef, construct_scores)
```

Arguments

`smMatrix`	is the `structural_model` - a source-to-target matrix representing the inner/structural model, generated by `relationships` generated by SEMinR.
`path_coef`	is the Path Coefficients matrix from a SEMinR model.
`construct_scores`	is the matrix of construct scores generated by SEMinR.

predict_pls *Predict_pls performs either k-fold or LOOCV on a SEMinR PLS model and generates predictions*

Description

predict_pls uses cross-validation to generate in-sample and out-sample predictions for PLS models generated by SEMinR.

Usage

```
predict_pls(model, technique, noFolds, reps, cores)
```

Arguments

model	A SEMinR model that has been estimated on the FULL dataset.
technique	The predictive technique to be employed, Earliest Antecedents (EA) predict_EA or Direct Antecedents (DA) predict_DA
noFolds	The required number of folds to use in k-fold cross validation. If NULL, then parallel LOOCV will be executed. Default is NULL.
reps	The number of times the cross-validation will be repeated, each time with new random folds. The predictions are averaged over the repetitions. Default is NULL (a single run, the same as reps = 1).
cores	The number of cores to use for parallel processing. If NULL (default), cross-validation runs sequentially. Specify an integer to enable parallel execution — useful for LOOCV or high-k folds (e.g., noFolds = 50) where each fold requires re-estimation. Note: parallel workers load the *installed* version of seminr via library(seminr), so run devtools::install() if testing development code.

Details

This function generates cross-validated in-sample and out-sample predictions for PLS models generated by SEMinR. The cross validation technique can be k-fold if a number of folds are specified, or leave-one-out-cross-validation (LOOCV) if no folds arew specified. LOOCV is recommended for small datasets.

Models with reflective() constructs (PLSc) are predicted with the model-implied conditional expectation rather than the construct-score chain; see predict.seminr_model. A PLSc solution can be inadmissible in a training fold even when the full-sample solution is admissible, especially with few folds. Such folds are skipped with a warning: their test rows are NA for both PLS and the LM benchmark, and the prediction metrics use the remaining rows. If every fold is inadmissible, predict_pls() stops.

Value

A list of the estimated PLS and LM prediction results:

`PLS_out_of_sample`
: A matrix of the out-of-sample indicator predictions generated by the SEMinR model.

`PLS_in_sample`
: A matrix of the in-sample indicator predictions generated by the SEMinR model.

`lm_out_of_sample`
: A matrix of the out-of-sample indicator predictions generated by a linear regression model.

`lm_in_sample`
: A matrix of the in-sample indicator predictions generated by a linear regression model.

`item_actuals`
: A matrix of the actual indicator scores.

`PLS_out_of_sample_residuals`
: A matrix of the out-of-sample indicator PLS prediction residuals.

`PLS_in_sample_residuals`
: A matrix of the in-sample indicator PLS prediction residuals.

`lm_out_of_sample_residuals`
: A matrix of the out-of-sample LM indicator prediction residuals.

`lm_in_sample_residuals`
: A matrix of the in-sample LM indicator prediction residuals.

`mmMatrix`
: A Matrix of the measurement model relations.

`smMatrix`
: A Matrix of the structural model relations.

`constructs`
: A vector of the construct names.

`mmVariables`
: A vector of the indicator names.

`outer_loadings`
: The matrix of estimated indicator loadings.

`outer_weights`
: The matrix of estimated indicator weights.

`path_coef`
: The matrix of estimated structural model relationships.

`iterations`
: A numeric indicating the number of iterations required before the algorithm converged.

`weightDiff`
: A numeric indicating the minimum weight difference between iterations of the algorithm.

`construct_scores`
: A matrix of the estimated construct scores for the PLS model.

`rSquared`
: A matrix of the estimated R Squared for each construct.

`inner_weights`
: The inner weight estimation function.

`data`
: A matrix of the data upon which the model was estimated (INcluding interactions.

`rawdata`
: A matrix of the data upon which the model was estimated (EXcluding interactions.

`measurement_model`
: The SEMinR measurement model specification.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3))
)

mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value"))
)

mobi_pls <- estimate_pls(mobi, mobi_mm, mobi_sm)
cross_validated_predictions <- predict_pls(model = mobi_pls,
                                           technique = predict_DA,
                                           noFolds = 10,
                                           cores = NULL)
```

---

print.seminr_pls_mga *Summary function for PLS-MGA*

Description

Summary function for PLS-MGA

Usage

```
## S3 method for class 'seminr_pls_mga'
print(x, digits = 3, ...)
```

Arguments

x	estimated seminr_pls_mga object
digits	number of digits to print
...	any further parameters for printing

product_indicator `product_indicator` *creates interaction measurement items by scaled product indicator approach.*

Description

This function automatically generates interaction measurement items for a PLS SEM using scaled product indicator approach.

Usage

```
# standardized product indicator approach as per Henseler & Chin (2010):
 product_indicator(iv, moderator, weights)
```

Arguments

`iv`	The independent variable that is subject to moderation.
`moderator`	The moderator variable.
`weights`	is the relationship between the items and the interaction terms. This can be specified as `correlation_weights` or `mode_A` for correlation weights (Mode A) or as `regression_weights` or `mode_B` for regression weights (Mode B). Default is correlation weights.

Value

An un-evaluated function (promise) for estimating a product-indicator interaction effect.

References

Henseler & Chin (2010), A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling. Structural Equation Modeling, 17(1),82-109.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
 composite("Image",        multi_items("IMAG", 1:5),weights = mode_A),
 composite("Expectation",  multi_items("CUEX", 1:3),weights = mode_A),
 composite("Value",        multi_items("PERV", 1:2),weights = mode_A),
 composite("Satisfaction", multi_items("CUSA", 1:3),weights = mode_A),
 interaction_term(iv = "Image",
                  moderator = "Expectation",
                  method = product_indicator,
                  weights = mode_A),
 interaction_term(iv = "Image",
```

```
                  moderator = "Value",
                  method = product_indicator,
                  weights = mode_A)
)

# structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation", "Image*Value"))
)

# Load data, assemble model, and estimate using semPLS
mobi <- mobi
seminr_model <- estimate_pls(mobi, mobi_mm, mobi_sm, inner_weights = path_factorial)
```

`quadratic_term` *Quadratic term function*

Description

`quadratic_term` is a convenience wrapper around `interaction_term` for creating a quadratic effect of a single construct (i.e., X squared). It is equivalent to calling `interaction_term(iv = construct, moderator = construct, ...)`.

Usage

```
quadratic_term(iv, method, weights)
```

Arguments

`iv`	The construct to square.
`method`	The method to generate the quadratic term with a default of `two_stage`.
`weights`	The weighting mode for quadratic items in a PLS model (only) with default of `mode_A`.

Details

The resulting construct in the structural model is named `"X*X"` where `X` is the construct name. Reference it accordingly in `paths()`.

Value

An un-evaluated function (promise) for generating a quadratic term, identical to what `interaction_term(iv, iv, method, weights)` returns.

Examples

```
data(mobi)

mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  quadratic_term(iv = "Image", method = two_stage)
)

mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Image*Image"))
)

mobi_pls <- estimate_pls(mobi, mobi_mm, mobi_sm)
summary(mobi_pls)
```

---

reflective *Reflective construct measurement model specification*

Description

`reflective` creates the reflective measurement model matrix for a specific common-factor, specifying the relevant items of the construct and assigning the relationship of reflective. By definition this construct will be estimated by PLS consistent.

Usage

```
reflective(construct_name, item_names)
```

Arguments

`construct_name`	of construct
`item_names`	returned by the `multi_items` or `single_item` functions

Details

This function conveniently maps reflectively defined measurement items to a construct and is estimated using PLS consistent.

Value

A vector of the indicators for a reflective construct.

See Also

See `composite`, `constructs`

Examples

```
mobi_mm <- constructs(
  reflective("Image",        multi_items("IMAG", 1:5)),
  reflective("Expectation",  multi_items("CUEX", 1:3)),
  reflective("Quality",      multi_items("PERQ", 1:7)),
  reflective("Value",        multi_items("PERV", 1:2)),
  reflective("Satisfaction", multi_items("CUSA", 1:3)),
  reflective("Complaints",   single_item("CUSCO")),
  reflective("Loyalty",      multi_items("CUSL", 1:3))
)
```

`relationships` *Structural specification functions for seminr package*

Description

`paths` creates the structural paths of a PLS SEM model and `relationships` generates the matrix of paths.

Usage

```
relationships(...)

paths(from,to)
```

Arguments

`...`	A comma separated list of all the structural relationships in the the model. These paths take the form (from = c(construct_name), to = c(construct_name)).
`to`	The destination construct of a structural path
`from`	The source construct of a structural path
`paths`	The function `paths` that specifies the source and destination constructs for each of the model's structural paths.

Value

A vector of construct names and structural relationships.

Examples

```
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)
```

report_missing — *Function to report how missing data was handled and how much was missing.*

Description

Function to report how missing data was handled and how much was missing.

Usage

```
report_missing(seminr_model)
```

Arguments

seminr_model	An estimated seminr PLS model.

report_paths — *Functions for reporting the Path Coefficients and R2 of endogenous constructs and for generating a scatterplot matrix of construct scores.*

Description

report_paths generates an easy to read table reporting path coefficients and R2 values for endogenous constructs.plot_scores generates a scatterplot matrix of each construct's scores against every other construct's scores.

Usage

```
report_paths(seminr_model, digits=3)

plot_scores(seminr_model, constructs=NULL)
```

Arguments

seminr_model	The PLS model estimated by seminr. The estimated model returned by the estimate_pls or bootstrap_model methods.
digits	A numeric minimum number of significant digits. If not specified, default is "2".
constructs	a list indicating which constructs to report. If not specified, all constructs are graphed and returned.

Details

These functions generate an easy to read table reporting path coefficients and R2 values for endogenous constructs or a scatterplot matrix of construct scores.

Value

A matrix of structural paths.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3))
)

#  structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value"))
)

mobi_pls <- estimate_pls(mobi, measurement_model = mobi_mm, structural_model = mobi_sm)
report_paths(mobi_pls)
plot_scores(mobi_pls)
```

---

rerun *Reruns a previously specified seminr model/analysis*

Description

Reruns a previously specified seminr model/analysis

Usage

```
rerun(x, ...)
```

Arguments

x	An estimated seminr_model object - refer to specific rerun methods
...	Any parameters to change during the rerun.

Value

A re-estimated model of the same class

See Also

rerun.pls_model

`rerun.pls_model` *Reruns a previously specified seminr PLS model*

Description

Reruns a previously specified seminr PLS model

Usage

```
## S3 method for class 'pls_model'
rerun(x, ...)
```

Arguments

`x`	An estimated pls_model object produced by `estimate_pls`
`...`	Any parameters to change during the re-estimation (e.g., data, measurement_model, etc.)

Value

A re-estimated pls_model object

Examples

```
mobi <- mobi

mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Loyalty",      multi_items("CUSL", 1:3))
)

mobi_sm <- relationships(
  paths(from = "Image",        to = c("Loyalty"))
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm,
                         missing = mean_replacement,
                         missing_value = NA)

# Re-estimate model faithfully
mobi_pls2 <- rerun(mobi_pls)

# Re-estimated model with altered measurement model
mobi_pls3 <- rerun(mobi_pls, measurement_model=as.reflective(mobi_mm))
```

rhoC_AVE *seminr rhoC_AVE() function*

Description

Get rhoC and AVE for a CFA model estimated with `estimate_pls`, `estimate_cbsem` or `estimate_cfa`. Dillon-Goldstein's Rho as per: Dillon, W. R, and M. Goldstein. 1987. Multivariate Analysis: Methods and Applications. Biometrical Journal 29 (6). Average Variance Extracted as per: Fornell, C. and D. F. Larcker (February 1981). Evaluating structural equation models with unobservable variables and measurement error, Journal of Marketing Research, 18, pp. 39-5

Usage

```
rhoC_AVE(x, constructs = NULL)
```

Arguments

`x`	Estimated `seminr_model` object.
`constructs`	Vector containing the names of the constructs to calculate rhoC and AVE for; if NULL, all constructs are used.

Value

A matrix containing the rhoC and AVE metrics for each construct.

rho_A *seminr rho_A Function*

Description

The `rho_A` function calculates the rho_A reliability indices for each construct. For formative constructs, the index is set to 1.

Usage

```
rho_A(seminr_model, constructs)
```

Arguments

`seminr_model`	A `seminr_model` containing the estimated seminr model.
`constructs`	A vector containing the names of the constructs to calculate rhoA for.

Value

A matrix containing the rhoA metric for each construct.

References

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. MIS quarterly, 39(2).

See Also

relationships constructs paths interaction_term bootstrap_model

Examples

```
#seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)

rho_A(mobi_pls, mobi_pls$constructs)
```

---

save_plot *Saves a SEMinR model plot to file*

Description

Saves a SEMinR model plot to a graphical file. Default output is RPlots.pdf.

Usage

```
save_plot(
  filename = "RPlot.pdf",
  plot = last_seminr_plot(),
  width = NULL,
```

```
  height = NULL
)
```

Arguments

filename	The name of the file output (can be png, pdf, webp, ps, or svg.)
plot	A plot that is created from the plot function. By default it uses the last plot created.
width	An optional parameter for width in pixels.
height	An optional parameter for height in pixels.

Value

Does not return a value

Examples

```
mobi <- mobi

# seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
# seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

# estimate the model
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)
## Not run:
# generate the plot
plot(mobi_pls)
# save to file
save_plot("myplot.pdf")

## End(Not run)
```

seminr_theme_academic *A theme function for a basic b/w theme*

Description

A theme function for a basic b/w theme

Usage

```
seminr_theme_academic(
  plot.title.fontsize = 24,
  mm.node.label.fontsize = 8,
  sm.node.label.fontsize = 12,
  mm.edge.label.fontsize = 7,
  sm.edge.label.fontsize = 9
)
```

Arguments

`plot.title.fontsize`
: Title font size

`mm.node.label.fontsize`
: Font size for measurement variables

`sm.node.label.fontsize`
: Font size for constructs

`mm.edge.label.fontsize`
: Font size for measurement model edges

`sm.edge.label.fontsize`
: Font size for path edges

Value

a theme object

seminr_theme_create *Create a theme for a seminr graph visualization*

Description

All customizable options are parameters of this function. See the details all the way down for more information.

Usage

```
seminr_theme_create(
  plot.title.fontsize = 24,
  plot.title.fontcolor = "black",
  plot.fontname = "helvetica",
  plot.splines = TRUE,
  plot.rounding = 3,
  plot.adj = FALSE,
  plot.specialcharacters = TRUE,
  plot.randomizedweights = FALSE,
  plot.bgcolor = "transparent",
  mm.node.color = "dimgrey",
  mm.node.fill = "white",
  mm.node.label.fontsize = 8,
  mm.node.label.fontcolor = "black",
  mm.edge.positive.color = "dimgrey",
  mm.edge.negative.color = "dimgrey",
  mm.edge.positive.style = "solid",
  mm.edge.negative.style = "dashed",
  mm.edge.label.fontsize = 7,
  mm.edge.label.fontcolor = "black",
  mm.edge.label.show = TRUE,
  mm.edge.minlen = 1,
  mm.edge.width_multiplier = 3,
  mm.edge.width_offset = 0.5,
  mm.edge.use_outer_weights = TRUE,
  mm.edge.boot.show_t_value = FALSE,
  mm.edge.boot.show_p_value = FALSE,
  mm.edge.boot.show_p_stars = TRUE,
  mm.edge.boot.show_ci = FALSE,
  mm.edge.boot.template = edge_template_minimal(),
  sm.node.color = "black",
  sm.node.fill = "white",
  sm.node.label.fontsize = 12,
  sm.node.label.fontcolor = "black",
  sm.node.endo.template = node_endo_template_default(),
  sm.node.exo.template = node_exo_template_default(),
  sm.edge.boot.show_t_value = FALSE,
  sm.edge.boot.show_p_value = FALSE,
  sm.edge.boot.show_p_stars = TRUE,
  sm.edge.boot.show_ci = TRUE,
  sm.edge.boot.template = edge_template_default(),
  sm.edge.positive.color = "black",
  sm.edge.negative.color = "black",
  sm.edge.positive.style = "solid",
  sm.edge.negative.style = "dashed",
  sm.edge.label.fontsize = 9,
  sm.edge.label.fontcolor = "black",
```

```
  sm.edge.label.show = TRUE,
  sm.edge.label.all_betas = TRUE,
  sm.edge.minlen = NA_integer_,
  sm.edge.width_offset = 0.5,
  sm.edge.width_multiplier = 5,
  construct.reflective.shape = "ellipse",
  construct.reflective.arrow = "backward",
  construct.reflective.use_weights = FALSE,
  construct.compositeA.shape = "hexagon",
  construct.compositeA.arrow = "backward",
  construct.compositeA.use_weights = FALSE,
  construct.compositeB.shape = "hexagon",
  construct.compositeB.arrow = "forward",
  construct.compositeB.use_weights = TRUE,
  manifest.reflective.shape = "box",
  manifest.compositeA.shape = "box",
  manifest.compositeB.shape = "box",
  ...
)
```

Arguments

plot.title.fontsize	Font size of the title.
plot.title.fontcolor	Fontcolor of the title of the plot.
plot.fontname	Font to be used throughout the plot.
plot.splines	Whether or not to use splines as edges (default = TRUE).
plot.rounding	The amount of decimals to keep for rounding (default = 3).
plot.adj	TRUE or FALSE (default). Whether or not to use adjusted r^2 in constructs.
plot.specialcharacters	Whether or not to use greek UTF-8 symbols in plots.
plot.randomizedweights	TRUE or FALSE (default), decides whether to add. minimal random weights to the measurement model. Can help with determinism in plot outcomes.
plot.bgcolor	The background color of the plot (default = "transparent").
mm.node.color	Color of the measurement model nodes.
mm.node.fill	Fill of the measurement model nodes.
mm.node.label.fontsize	Font size of the measurement model node labels.
mm.node.label.fontcolor	Color of the measurement model node labels.
mm.edge.positive.color	Color of the measurement model edges, when values are positive.
mm.edge.negative.color	Color of the measurement model edges, when values are negative.

`mm.edge.positive.style`
: Style of the measurement model edges, when values are positive.

`mm.edge.negative.style`
: Style of the measurement model edges, when values are negative.

`mm.edge.label.fontsize`
: Font size of the measurement model edge labels.

`mm.edge.label.fontcolor`
: Font color of the measurement model edge labels.

`mm.edge.label.show`
: Whether or not to show measurement model edge labels.

`mm.edge.minlen` Minimum length of the measurement model edges.

`mm.edge.width_multiplier`
: The multiplier for measurement model edge penwidth (default = 3).

`mm.edge.width_offset`
: The minimal width of an edge of the measurement model (default = 0.5).

`mm.edge.use_outer_weights`
: Whether or not to use outer weights as edge labels in the measurement model.

`mm.edge.boot.show_t_value`
: Should boot-strapped loadings/weights show a t-value

`mm.edge.boot.show_p_value`
: Should boot-strapped loadings/weights show a p-value

`mm.edge.boot.show_p_stars`
: Should boot-strapped loadings/weights show significance stars

`mm.edge.boot.show_ci`
: Should boot-strapped loadings/weights show a 95 percent confidence interval

`mm.edge.boot.template`
: A template string for HTML formatting of edges for loadings/weights

`sm.node.color` Color of the structural model nodes.

`sm.node.fill` Fill of the structural model nodes.

`sm.node.label.fontsize`
: Font size of the structural model node labels.

`sm.node.label.fontcolor`
: Font color of the structural model node labels.

`sm.node.endo.template`
: A template string for the nodes of endogenous constructs

`sm.node.exo.template`
: A template string for the nodes of exogenous constructs

`sm.edge.boot.show_t_value`
: Should boot-strapped path coefficients show a t-value

`sm.edge.boot.show_p_value`
: Should boot-strapped path coefficients show a p-value

`sm.edge.boot.show_p_stars`
: Should boot-strapped path coefficients show significance stars

`sm.edge.boot.show_ci`
: Should boot-strapped path coefficients show a 95 percent confidence interval

`sm.edge.boot.template`
: A template string for HTML formatting of edges

`sm.edge.positive.color`
: Color of the structural model edges, when values are positive.

`sm.edge.negative.color`
: Color of the structural model edges, when values are negative.

`sm.edge.positive.style`
: Style of the structural model edges, when values are positive.

`sm.edge.negative.style`
: Style of the structural model edges, when values are negative.

`sm.edge.label.fontsize`
: Font size of the structural model edge labels.

`sm.edge.label.fontcolor`
: Font color of the structural model edge labels.

`sm.edge.label.show`
: Whether or not to show edge labels on structural model edges.

`sm.edge.label.all_betas`
: Whether to label both endogenous and exogenous paths with a beta (default = TRUE).

`sm.edge.minlen` Minimum length of the structural model edges.

`sm.edge.width_offset`
: The minimal width of an edge of the structural model (default = 0.5).

`sm.edge.width_multiplier`
: The multiplier for structural model edges (default = 5).

`construct.reflective.shape`
: Dot shape of reflective constructs

`construct.reflective.arrow`
: Direction of the arrow for reflective constructs. Can be forward, backward (default), or none.

`construct.reflective.use_weights`
: Should measurements from reflective constructs show weights (TRUE) or loadings (FALSE: default).

`construct.compositeA.shape`
: Dot shape of composite constructs using correlation weights

`construct.compositeA.arrow`
: Direction of the arrow for constructs using correlation weight (default: backward)

`construct.compositeA.use_weights`
: Should measurements from constructs using correlation weights show weights (TRUE) or loadings (FALSE: default).

`construct.compositeB.shape`
: Dot shape of composite constructs using regression weights

`construct.compositeB.arrow`
: Direction of the arrow for constructs using regression weights (default: forward)

`construct.compositeB.use_weights`
: Should measurements from constructs using regression weights show weights (TRUE: default) or loadings (FALSE).

`manifest.reflective.shape`
: Dot shape of manifest variables of reflective constructs

`manifest.compositeA.shape`
: Dot shape of manifest variables of composite constructs using correlation weights

`manifest.compositeB.shape`
: Dot shape of manifest variables of composite constructs using regression weights

`...`
: additional parameters (unused)

Details

You can use the auto-complete feature of your editor to help you find the right parameter.

General settings start with plot.*

Measurement model settings start with mm.*

Structural model settings start with sm.*

Setting the shape of manifest or construct variables depending on their estimation type can be found under manifest.* and construct.*

Value

A `seminr.theme` object that can be supplied to `dot_graph`

---

seminr_theme_dark *The theme function for an inverted theme on black background.*

Description

The theme function for an inverted theme on black background.

Usage

```
seminr_theme_dark(
  plot.title.fontsize = 24,
  mm.node.label.fontsize = 8,
  sm.node.label.fontsize = 12,
  mm.edge.label.fontsize = 7,
  sm.edge.label.fontsize = 9
)
```

Arguments

`plot.title.fontsize`
: Title font size

`mm.node.label.fontsize`
: Font size for measurement variables

`sm.node.label.fontsize`
: Font size for constructs

`mm.edge.label.fontsize`
: Font size for measurement model edges

`sm.edge.label.fontsize`
: Font size for path edges

Value

a theme object

`seminr_theme_get` *Get and set the active theme*

Description

The current/active theme (see [seminr_theme()]) is automatically applied to every graph you draw. Use ‘seminr_theme_get()‘ to get the current theme, and ‘seminr_theme_set()‘ to completely override it.

Usage

```
seminr_theme_get()

seminr_theme_set(new)
```

Arguments

`new`	new theme (a list of theme elements)

`seminr_theme_smart` *A colored theme*

Description

A colored theme

A theme function for a modern approach of visualizing PLS models in b/w

Usage

```
seminr_theme_smart(
  plot.title.fontsize = 24,
  mm.node.label.fontsize = 8,
  sm.node.label.fontsize = 12,
  mm.edge.label.fontsize = 7,
  sm.edge.label.fontsize = 9
)

seminr_theme_default(
  plot.title.fontsize = 24,
  mm.node.label.fontsize = 8,
  sm.node.label.fontsize = 12,
  mm.edge.label.fontsize = 7,
  sm.edge.label.fontsize = 9,
  construct.reflective.shape = "ellipse",
  construct.compositeA.shape = "hexagon",
  construct.compositeB.shape = "hexagon",
  construct.reflective.arrow = "backward",
  construct.compositeA.arrow = "backward",
  construct.compositeB.arrow = "forward",
  ...
)
```

Arguments

`plot.title.fontsize`
: Title font size

`mm.node.label.fontsize`
: Font size for measurement variables

`sm.node.label.fontsize`
: Font size for constructs

`mm.edge.label.fontsize`
: Font size for measurement model edges

`sm.edge.label.fontsize`
: Font size for path edges

`construct.reflective.shape`
: Shape of reflective constructs

`construct.compositeA.shape`
: Shape of composite constructs mode A

`construct.compositeB.shape`
: Shape of composite constructs mode B

`construct.reflective.arrow`
: Direction of arrows of reflective constructs

`construct.compositeA.arrow`
: Direction of arrows of composite constructs mode A

`construct.compositeB.arrow`
: Direction of arrows of composite constructs mode B

`...`
: Other parameters for the seminr_theme_create function

Value

a theme object

`simplePLS` *seminr simplePLS Function*

Description

The `seminr` package provides a natural syntax for researchers to describe PLS structural equation models. `seminr` is compatible with simplePLS. `simplePLS` provides the verb for estimating a pls model.

Usage

```
simplePLS(obsData,smMatrix, mmMatrix,inner_weights = path_weighting,
          maxIt=300, stopCriterion=7,measurement_mode_scheme)
```

Arguments

`obsData`
: A `dataframe` containing the indicator measurement data.

`smMatrix`
: A source-to-target matrix representing the inner/structural model, generated by `relationships`.

`mmMatrix`
: A source-to-target matrix representing the outer/measurement model, generated by `constructs`.

`inner_weights`
: A parameter declaring which inner weighting scheme should be used path_weighting is default, alternately path_factorial can be used.

`maxIt`
: The maximum number of iterations to run (default is 300).

`stopCriterion`
: The criterion to stop iterating (default is 7).

`measurement_mode_scheme`
: A named list of constructs and measurement scheme functions

Value

A list of the estimated parameters for the SimplePLS model including:

meanData	A vector of the indicator means.
sdData	A vector of the indicator standard deviations
mmMatrix	A Matrix of the measurement model relations.
smMatrix	A Matrix of the structural model relations.
constructs	A vector of the construct names.
mmVariables	A vector of the indicator names.
outer_loadings	The matrix of estimated indicator loadings.
outer_weights	The matrix of estimated indicator weights.
path_coef	The matrix of estimated structural model relationships.
iterations	A numeric indicating the number of iterations required before the algorithm converged.
weightDiff	A numeric indicating the minimum weight difference between iterations of the algorithm.
construct_scores	A matrix of the estimated construct scores for the PLS model.
rSquared	A matrix of the estimated R Squared for each construct.
inner_weights	The inner weight estimation function.

See Also

relationships constructs paths interaction_term estimate_pls bootstrap_model

Examples

```
#seminr syntax for creating measurement model
mobi_mm <- constructs(
             reflective("Image",        multi_items("IMAG", 1:5)),
             reflective("Expectation",  multi_items("CUEX", 1:3)),
             reflective("Quality",      multi_items("PERQ", 1:7)),
             reflective("Value",        multi_items("PERV", 1:2)),
             reflective("Satisfaction", multi_items("CUSA", 1:3)),
             reflective("Complaints",   single_item("CUSCO")),
             reflective("Loyalty",      multi_items("CUSL", 1:3))
           )
#seminr syntax for creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)
```

```
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)
```

`single_item` *Single-item measurement model specification*

Description

`single_item` specifies a single item name to be assigned to a construct.

Usage

```
single_item(item)
```

Arguments

`item`	Name of item

Value

A vector of a single indicator for a composite.

See Also

See `multi_items`

Examples

```
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5), weights = correlation_weights),
  composite("Expectation",  multi_items("CUEX", 1:3), weights = mode_A),
  composite("Quality",      multi_items("PERQ", 1:7), weights = regression_weights),
  composite("Value",        single_item("PERV1"))
)
```

slope_analysis *Function for plotting a slope analysis for an interaction in a PLS model*

Description

slope_analysis generates an interaction plot for the effect of an antecedent on an outcome given a mediator variable.

Usage

```
slope_analysis(moderated_model, dv, moderator, iv,  leg_place)
```

Arguments

moderated_model	A SEMinR model that contains an interaction.
dv	The name of the dependant consutruct affected by the moderator (interaction term).
moderator	The name of the moderator construct.
iv	The name of the independant construct affected by the moderator.
leg_place	The location of the legend, in order to make sure the legend does not obscure the plot lines.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
composite("Image",        multi_items("IMAG", 1:5)),
composite("Expectation",  multi_items("CUEX", 1:3)),
composite("Value",        multi_items("PERV", 1:2)),
composite("Satisfaction", multi_items("CUSA", 1:3)),
interaction_term(iv = "Image", moderator = c("Expectation"), method = orthogonal))

# Structural model
#  note: interactions should be the names of its main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation")))

# Load data, assemble model, and estimate
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)
```

```
slope_analysis(mobi_pls, "Satisfaction", "Expectation", "Image", "bottomright")
```

`specific_effect_significance` *seminr specific effect significance function*

Description

The `seminr` package provides a natural syntax for researchers to describe PLS structural equation models. `specific_effect_significance` provides the verb for calculating the bootstrap mean, standard deviation, T value, and confidence intervals for direct or mediated path in a bootstrapped SEMinR model.

Usage

```
specific_effect_significance(boot_seminr_model, from, to, through, alpha)
```

Arguments

`boot_seminr_model`	A bootstrapped model returned by the `bootstrap_model` function.
`from`	A parameter specifying the antecedent composite for the path.
`to`	A parameter specifying the outcome composite for the path.
`through`	A parameter to specify a vector of mediators for the path. Default is NULL.
`alpha`	A parameter for specifying the alpha for the confidence interval. Default is 0.05.

Value

A vector of lower and upper confidence intervals for a path.

References

Zhao, X., Lynch Jr, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. Journal of consumer research, 37(2), 197-206.

See Also

`bootstrap_model`

Examples

```
mobi_mm <- constructs(
composite("Image",        multi_items("IMAG", 1:5)),
composite("Expectation",  multi_items("CUEX", 1:3)),
composite("Quality",      multi_items("PERQ", 1:7)),
composite("Value",        multi_items("PERV", 1:2)),
composite("Satisfaction", multi_items("CUSA", 1:3)),
composite("Complaints",   single_item("CUSCO")),
composite("Loyalty",      multi_items("CUSL", 1:3))
)

# Creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

# Estimating the model
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)

# Load data, assemble model, and bootstrap
boot_seminr_model <- bootstrap_model(seminr_model = mobi_pls,
                                     nboot = 50, cores = 2, seed = NULL)

specific_effect_significance(boot_seminr_model = boot_seminr_model,
                             from = "Image",
                             through = c("Expectation", "Satisfaction","Complaints"),
                             to = "Loyalty",
                             alpha = 0.05)
```

`specify_model` *seminr specify_model() function*

Description

Combines model components together into a single `specified_model` object for estimation functions

Usage

```
specify_model(
  measurement_model,
  structural_model = NULL,
```

```
  item_associations = NULL
)
```

Arguments

measurement_model
: An optional measurement_model object representing the outer/measurement model, as generated by constructs.

structural_model
: An optional smMatrix object representing the inner/structural model, as generated by relationships.

item_associations
: An item-to-item matrix representing error covariances that are freed for estimation. This matrix is created by associations(), or defaults to NULL (no inter-item associations).

Value

A list containing a SEMinR measurement model, structural model, and item associations.

See Also

estimate_pls estimate_cbsem estimate_cfa

---

standardize_safely *Standardize (scale) a matrix/df and report interpretable errors*

Description

Standardize (scale) a matrix/df and report interpretable errors

Usage

```
standardize_safely(x)
```

Arguments

x
: vector, data.frame, or matrix

Value

scaled object as returned by scale function

`total_indirect_ci` *seminr total indirect confidence intervals function*

Description

`total_indirect_ci` provides the verb for calculating the total indirect confidence intervals of a direct or mediated path in a bootstrapped SEMinR model.

Usage

```
total_indirect_ci(boot_seminr_model, from, to, alpha)
```

Arguments

`boot_seminr_model`	A bootstrapped model returned by the `bootstrap_model` function.
`from`	A parameter specifying the antecedent composite for the path.
`to`	A parameter specifying the outcome composite for the path.
`alpha`	A parameter for specifying the alpha for the confidence interval. Default is 0.05.

Value

A vector of lower and upper confidence intervals for a path.

References

Zhao, X., Lynch Jr, J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. Journal of consumer research, 37(2), 197-206.

See Also

`bootstrap_model`

Examples

```
mobi_mm <- constructs(
composite("Image",        multi_items("IMAG", 1:5)),
composite("Expectation",  multi_items("CUEX", 1:3)),
composite("Quality",      multi_items("PERQ", 1:7)),
composite("Value",        multi_items("PERV", 1:2)),
composite("Satisfaction", multi_items("CUSA", 1:3)),
composite("Complaints",   single_item("CUSCO")),
composite("Loyalty",      multi_items("CUSL", 1:3))
)

# Creating structural model
mobi_sm <- relationships(
  paths(from = "Image",        to = c("Expectation", "Satisfaction", "Loyalty")),
```

```
  paths(from = "Expectation",  to = c("Quality", "Value", "Satisfaction")),
  paths(from = "Quality",      to = c("Value", "Satisfaction")),
  paths(from = "Value",        to = c("Satisfaction")),
  paths(from = "Satisfaction", to = c("Complaints", "Loyalty")),
  paths(from = "Complaints",   to = "Loyalty")
)

# Estimating the model
mobi_pls <- estimate_pls(data = mobi,
                         measurement_model = mobi_mm,
                         structural_model = mobi_sm)

# Load data, assemble model, and bootstrap
boot_seminr_model <- bootstrap_model(seminr_model = mobi_pls,
                                     nboot = 50, cores = 2, seed = NULL)

total_indirect_ci(boot_seminr_model = boot_seminr_model,
                  from = "Image",
                  to = "Loyalty",
                  alpha = 0.05)
```

`two_stage` *Creates an interaction measurement item using a two-stage approach. The two-stage procedure for both PLS and CBSEM models estimates construct scores in the first stage, and uses them to produce a single-item product item for the interaction term in the second stage. For a PLS model, the first stage uses PLS to compute construct scores. For a CBSEM model, the first stage uses a CFA to produce ten Berge construct scores.*

Description

Creates an interaction measurement item using a two-stage approach. The two-stage procedure for both PLS and CBSEM models estimates construct scores in the first stage, and uses them to produce a single-item product item for the interaction term in the second stage. For a PLS model, the first stage uses PLS to compute construct scores. For a CBSEM model, the first stage uses a CFA to produce ten Berge construct scores.

Usage

```
# two stage approach as per Henseler & Chin (2010):
 two_stage(iv, moderator, weights)
```

Arguments

`iv`	The independent variable that is subject to moderation.
`moderator`	The moderator variable.

weights — is the relationship between the items and the interaction terms. This can be specified as `correlation_weights` or `mode_A` for correlation weights (Mode A) or as `regression_weights` or `mode_B` for regression weights (Mode B). Default is correlation weights.

Value

An un-evaluated function (promise) for estimating a two-stage interaction effect.

References

Henseler & Chin (2010), A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling. Structural Equation Modeling, 17(1),82-109.

Examples

```
data(mobi)

# seminr syntax for creating measurement model
mobi_mm <- constructs(
  composite("Image",        multi_items("IMAG", 1:5)),
  composite("Expectation",  multi_items("CUEX", 1:3)),
  composite("Value",        multi_items("PERV", 1:2)),
  composite("Satisfaction", multi_items("CUSA", 1:3)),
  interaction_term(iv = "Image", moderator = "Expectation", method = two_stage)
)

#  structural model: note that name of the interactions construct should be
#  the names of its two main constructs joined by a '*' in between.
mobi_sm <- relationships(
  paths(to = "Satisfaction",
        from = c("Image", "Expectation", "Value",
                 "Image*Expectation"))
)

# PLS example:
mobi_pls <- estimate_pls(mobi, mobi_mm, mobi_sm)
summary(mobi_pls)

# CBSEM example:
mobi_cbsem <- estimate_cbsem(mobi, as.reflective(mobi_mm), mobi_sm)
summary(mobi_cbsem)
```

---

unit_weights *Outer weighting scheme functions to estimate construct weighting.*

Description

mode_A, correlation_weights and mode_B, regression_weights and unit_weights specify the outer weighting scheme to be used in the estimation of the construct weights and score.

Usage

```
unit_weights(mmMatrix, i, normData, construct_scores)
```

Arguments

mmMatrix	is the measurement_model - a source-to-target matrix representing the measurement model, generated by constructs.
i	is the name of the construct to be estimated.
normData	is the dataframe of the normalized item data.
construct_scores	is the matrix of construct scores generated by estimate_model.

Value

A matrix of estimated measurement model relations.

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