Package 'lavaanExtra'

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Title Convenience Functions for Package 'lavaan'

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Description Affords an alternative, vector-based syntax to 'lavaan', as well as other convenience functions such as naming paths and defining indirect links automatically, in addition to convenience formatting optimized for a publication and script sharing workflow.

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URL https://lavaanExtra.remi-theriault.com

BugReports https://github.com/rempsyc/lavaanExtra/issues

Depends R (>= 3.5)

Imports lavaan, insight

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Contents

`cfa_fit_plot` *Fit and plot CFA simultaneously*

Description

Prints and saves CFA fit, as well as plots CFA factor loadings, simultaneously.

Usage

```
cfa_fit_plot(
  model,
  data,
  covs = FALSE,
  estimator = "MLR",
  remove.items = "",
  print = TRUE,
  save.as.pdf = FALSE,
  file.name,
  ...
)
```

Arguments

`model`	CFA model to fit.
`data`	Data set on which to fit the CFA model.
`covs`	Logical, whether to include covariances on the lavaan plot.
`estimator`	What estimator to use for the CFA.
`remove.items`	Optional, if one wants to remove items from the CFA model without having to redefine it completely again.
`print`	Logical, whether to print model summary to console.

save.as.pdf	Logical, whether to save as PDF for a high-resolution, scalable vector graphic quality plot. Defaults to saving to the "/model" subfolder of the working directory. If it doesn't exist, it creates it. Then automatically open the created PDF in the default browser. Defaults to false.
file.name	Optional (when save.as.pdf is set to TRUE), if one wants something different than the default file name. It saves to pdf per default, so the .pdf extension should not be specified as it will add it automatically.
...	Arguments to be passed to function lavaan::cfa.

Value

The function returns a lavaan fit object. However, it also: prints a summary of the lavaan fit object to the console, and; prints a lavaanPlot of the lavaan fit object.

Illustrations

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

HS.model <- write_lavaan(latent = latent)
cat(HS.model)

library(lavaan)
fit <- cfa_fit_plot(HS.model, HolzingerSwineford1939)
```

---

lavaan_cov *Extract relevant covariance/correlation indices from lavaan model*

Description

Extract relevant covariance/correlation indices from lavaan lavaan::parameterEstimates and lavaan::standardizedsolution.

Usage

```
lavaan_cov(fit, nice_table = FALSE, ...)

lavaan_cor(fit, nice_table = FALSE, ...)
```

Arguments

`fit`	lavaan fit object to extract covariance indices from
`nice_table`	Logical, whether to print the table as a rempsyc::nice_table as well as print the reference values at the bottom of the table.
`...`	Arguments to be passed to rempsyc::nice_table

Value

A dataframe of covariances/correlation, including the covaried variables, the covariance/correlation, and corresponding p-value.

Functions

- `lavaan_cor()`: Shortcut for `lavaan_cov(fit, estimate = "r")`

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(regression <- list(
  ageyr = c("visual", "textual", "speed"),
  grade = c("visual", "textual", "speed")
))

(covariance <- list(speed = "textual", ageyr = "grade"))

HS.model <- write_lavaan(
  regression = regression, covariance = covariance,
  latent = latent, label = TRUE
)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
lavaan_cov(fit)
```

`lavaan_defined` *Extract relevant user-defined parameter (e.g., indirect or total effects) indices from lavaan model*

Description

Extract relevant user-defined parameters (e.g., indirect or total effects) indices from lavaan model through lavaan::parameterEstimates and lavaan::standardizedsolution.

Usage

```
lavaan_defined(
  fit,
  underscores_to_symbol = "→",
  lhs_name = "User-Defined Parameter",
  rhs_name = "Paths",
  nice_table = FALSE,
  ...
)
```

Arguments

fit	lavaan fit object to extract fit indices from
underscores_to_symbol	Character to convert underscores to arrows in the first column, like for indirect effects. Default to the right arrow symbol, but can be set to NULL or "_", or to any other desired symbol. It is also possible to provide a vector of replacements if they they are not all the same.
lhs_name	Name of first column, referring to the left-hand side expression (lhs).
rhs_name	Name of first column, referring to the right-hand side expression (rhs).
nice_table	Logical, whether to print the table as a rempsyc::nice_table as well as print the reference values at the bottom of the table.
...	Arguments to be passed to rempsyc::nice_table

Value

A dataframe, including the indirect effect ("lhs"), corresponding paths ("rhs"), standardized regression coefficient ("std.all"), corresponding p-value, as well as the unstandardized regression coefficient ("est") and its confidence interval ("ci.lower", "ci.upper").

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(mediation <- list(
  speed = "visual",
  textual = "visual",
  visual = c("ageyr", "grade")
```

```
))

(indirect <- list(
  IV = c("ageyr", "grade"),
  M = "visual",
  DV = c("speed", "textual")
))

HS.model <- write_lavaan(mediation,
  indirect = indirect,
  latent = latent, label = TRUE
)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
lavaan_defined(fit, lhs_name = "Indirect Effect")
```

`lavaan_extract` *Extract relevant indices from lavaan model based on specified operator*

Description

Extract relevant indices from lavaan model through lavaan::parameterEstimates and lavaan::standardizedsolution.

Usage

```
lavaan_extract(
  fit,
  operator = NULL,
  lhs_name = "Left-Hand Side",
  rhs_name = "Right-Hand Side",
  underscores_to_symbol = "→",
  diag = NULL,
  nice_table = FALSE,
  ...
)
```

Arguments

`fit`	lavaan fit object to extract fit indices from
`operator`	Which operator to subselect with.
`lhs_name`	Name of first column, referring to the left-hand side expression (lhs).
`rhs_name`	Name of first column, referring to the right-hand side expression (rhs).

underscores_to_symbol
: Character to convert underscores to arrows in the first column, like for indirect effects. Default to the right arrow symbol, but can be set to NULL or "_", or to any other desired symbol. It is also possible to provide a vector of replacements if they they are not all the same.

diag
: When extracting covariances (~~), whether to include or exclude diagonal values (one of "exclude" or "include").

nice_table
: Logical, whether to print the table as a rempsyc::nice_table as well as print the reference values at the bottom of the table.

...
: Arguments to be passed to rempsyc::nice_table

Value

A dataframe, including the indirect effect ("lhs"), corresponding paths ("rhs"), standardized regression coefficient ("std.all"), corresponding p-value, as well as the unstandardized regression coefficient ("est") and its confidence interval ("ci.lower", "ci.upper").

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(mediation <- list(
  speed = "visual",
  textual = "visual",
  visual = c("ageyr", "grade")
))

(indirect <- list(
  IV = c("ageyr", "grade"),
  M = "visual",
  DV = c("speed", "textual")
))

HS.model <- write_lavaan(mediation,
  indirect = indirect,
  latent = latent, label = TRUE
)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
lavaan_extract(fit, lhs_name = "Indirect Effect", operator = ":=")
```

lavaan_reg *Extract relevant regression indices from lavaan model*

Description

Extract relevant regression indices from lavaan model through lavaan::parameterEstimates and lavaan::standardizedsolution.

Usage

```
lavaan_reg(fit, nice_table = FALSE, ...)
```

Arguments

fit	lavaan fit object to extract fit indices from
nice_table	Logical, whether to print the table as a rempsyc::nice_table as well as print the reference values at the bottom of the table.
...	Arguments to be passed to rempsyc::nice_table

Value

A dataframe, including the outcome ("lhs"), predictor ("rhs"), standardized regression coefficient ("std.all"), corresponding p-value, as well as the unstandardized regression coefficient ("est") and its confidence interval ("ci.lower", "ci.upper").

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(regression <- list(
  ageyr = c("visual", "textual", "speed"),
  grade = c("visual", "textual", "speed")
))

HS.model <- write_lavaan(latent = latent, regression = regression)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
lavaan_reg(fit)
```

lavaan_var *Extract relevant variance indices from lavaan model*

Description

Extract relevant variance indices from lavaan model through lavaan::parameterEstimates (when estimate = "sigma", `est` column)) or lavaan::standardizedsolution (when estimate = "r2", `est.std` column). R2 values are then calculated as `1 - est.std`, and the new *p* values for the R2, with the following formula: `stats::pnorm((1 - est) / se)`.

Usage

```
lavaan_var(fit, estimate = "r2", nice_table = FALSE, ...)
```

Arguments

`fit`	lavaan fit object to extract covariance indices from
`estimate`	What estimate to use, either the standardized estimate ("r2", default), or unstandardized estimate ("sigma2").
`nice_table`	Logical, whether to print the table as a rempsyc::nice_table as well as print the reference values at the bottom of the table.
`...`	Arguments to be passed to rempsyc::nice_table

Value

A dataframe of covariances/correlation, including the covaried variables, the covariance/correlation, and corresponding p-value.

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(regression <- list(
  ageyr = c("visual", "textual", "speed"),
  grade = c("visual", "textual", "speed")
))

(covariance <- list(speed = "textual", ageyr = "grade"))

HS.model <- write_lavaan(
  regression = regression, covariance = covariance,
  latent = latent, label = TRUE
)
```

```
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
lavaan_var(fit)
```

`nice_fit` *Extract relevant fit indices from lavaan model*

Description

Compares fit from one or several lavaan models. Also optionally includes references values. The reference fit values are based on Schreiber (2017), Table 3.

Usage

```
nice_fit(
  model,
  model.labels,
  nice_table = FALSE,
  guidelines = TRUE,
  stars = FALSE,
  verbose = TRUE
)
```

Arguments

`model`	lavaan model object(s) to extract fit indices from
`model.labels`	Model labels to use. If a named list is provided for `model`, default to the names of the list. Otherwise, if the list is unnamed, defaults to generic numbering.
`nice_table`	Logical, whether to print the table as a rempsyc::nice_table.
`guidelines`	Logical, if `nice_table = TRUE`, whether to display include reference values based on Schreiber (2017), Table 3, at the bottom of the table.
`stars`	Logical, if `nice_table = TRUE`, whether to display significance stars (defaults to `FALSE`).
`verbose`	Logical, whether to display messages and warnings.

Details

Note that `nice_fit` reports the unbiased SRMR through `lavaan::lavResiduals()` because the standard SRMR is upwardly biased (doi:10.1007/s1133601695527) in a noticeable way for smaller samples (thanks to James Uanhoro for this change).

If using `guidelines = TRUE`, please carefully consider the following 2023 quote from Terrence D. Jorgensen:

I do not recommend including cutoffs in the table, as doing so would perpetuate their misuse. Fit indices are not test statistics, and their suggested cutoffs are not critical values associated with known Type I error rates. Numerous simulation studies have shown how poorly cutoffs perform in model selection (e.g., , Jorgensen et al. (2018). Instead of test statistics, fit indices were designed to be measures of effect size (practical significance), which complement the chi-squared test of statistical significance. The range of RMSEA interpretations above is more reminiscent of the range of small/medium/large effect sizes proposed by Cohen for use in power analyses, which are as arbitrary as alpha levels, but at least they better respect the idea that (mis)fit is a matter of magnitude, not nearly so simple as "perfect or imperfect."

Value

A dataframe, representing select fit indices (chi2, df, chi2/df, p-value of the chi2 test, CFI, TLI, RMSEA and its 90% CI, unbiased SRMR, AIC, and BIC).

References

Schreiber, J. B. (2017). Update to core reporting practices in structural equation modeling. *Research in social and administrative pharmacy*, *13*(3), 634-643. doi:10.1016/j.sapharm.2016.06.006

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(regression <- list(
  ageyr = c("visual", "textual", "speed"),
  grade = c("visual", "textual", "speed")
))

HS.model <- write_lavaan(latent = latent, regression = regression)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
nice_fit(fit)
```

`nice_lavaanPlot` *Make a quick* `lavaanPlot`

Description

Make a quick and decent-looking `lavaanPlot`.

Usage

```
nice_lavaanPlot(
  model,
  node_options = list(shape = "box", fontname = "Helvetica"),
  edge_options = c(color = "black"),
  coefs = TRUE,
  stand = TRUE,
  covs = FALSE,
  stars = c("regress", "latent", "covs"),
  sig = 0.05,
  graph_options = c(rankdir = "LR"),
  ...
)
```

Arguments

model	SEM or CFA model to plot.
node_options	Shape and font name.
edge_options	Colour of edges.
coefs	Logical, whether to plot coefficients. Defaults to TRUE.
stand	Logical, whether to use standardized coefficients. Defaults to TRUE.
covs	Logical, whether to plot covariances. Defaults to FALSE.
stars	Which links to plot significance stars for. One of c("regress", "latent", "covs").
sig	Which significance threshold to use to plot coefficients (defaults to .05). To plot all coefficients, set sig to 1.
graph_options	Read from left to right, rather than from top to bottom.
...	Arguments to be passed to function lavaanPlot::lavaanPlot.

Value

A lavaanPlot, of classes c("grViz", "htmlwidget"), representing the specified lavaan model.

Illustrations

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

HS.model <- write_lavaan(latent = latent)
```

```
cat(HS.model)

library(lavaan)
fit <- cfa(HS.model, HolzingerSwineford1939)
nice_lavaanPlot(fit)
```

`nice_modindices` *Extract relevant modification indices along item labels*

Description

Extract relevant modification indices along item labels, with a similarity score provided to help guide decision-making for removing redundant items with high covariance.

Usage

```
nice_modindices(fit, labels = NULL, method = "lcs", sort = TRUE, ...)
```

Arguments

`fit`	lavaan fit object to extract modification indices from
`labels`	Dataframe of labels. If the original data frame is provided, and that it contains labelled variables, will automatically attempt to extract the correct labels from the dataframe.
`method`	Method for distance calculation from stringdist::stringsim. Defaults to `"lcs"`.
`sort`	Logical. If TRUE, sort the output using the values of the modification index values. Higher values appear first. Defaults to `TRUE`.
`...`	Arguments to be passed to lavaan::modindices

Value

A dataframe, including the outcome ("lhs"), predictor ("rhs"), standardized regression coefficient ("std.all"), corresponding p-value, as well as the unstandardized regression coefficient ("est") and its confidence interval ("ci.lower", "ci.upper").

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

(regression <- list(
  ageyr = c("visual", "textual", "speed"),
  grade = c("visual", "textual", "speed")
```

```
))

HS.model <- write_lavaan(latent = latent, regression = regression)
cat(HS.model)

library(lavaan)
fit <- sem(HS.model, data = HolzingerSwineford1939)
nice_modindices(fit, maximum.number = 5)
data_labels <- data.frame(
  x1 = "I have good visual perception",
  x2 = "I have good cube perception",
  x3 = "I have good at lozenge perception",
  x4 = "I have paragraph comprehension",
  x5 = "I am good at sentence completion",
  x6 = "I excel at finding the meaning of words",
  x7 = "I am quick at doing mental additions",
  x8 = "I am quick at counting dots",
  x9 = "I am quick at discriminating straight and curved capitals"
)
nice_modindices(fit, maximum.number = 10, labels = data_labels, op = "~~")

x <- HolzingerSwineford1939
x <- sjlabelled::set_label(x, label = c(rep("", 6), data_labels))
fit <- sem(HS.model, data = x)
nice_modindices(fit, maximum.number = 10, op = "~~")
```

`nice_tidySEM` *Make a quick* `tidySEM` *plot*

Description

Make a quick and decent-looking `tidySEM` plot.

Usage

```
nice_tidySEM(
  fit,
  layout = NULL,
  hide_nonsig_edges = FALSE,
  hide_var = TRUE,
  hide_cov = FALSE,
  hide_mean = TRUE,
  est_std = TRUE,
  label,
  label_location = NULL,
  reduce_items = NULL,
  plot = TRUE,
  ...
)
```

Arguments

fit	SEM or CFA model fit to plot.
layout	A matrix (or data.frame) that describes the structure; see tidySEM::get_layout. If a named list is provided, with names "IV" (independent variables), "M" (mediator), and "DV" (dependent variables), nice_tidySEM attempts to write the layout matrix automatically.
hide_nonsig_edges	Logical, hides non-significant edges. Defaults to FALSE.
hide_var	Logical, hides variances. Defaults to TRUE.
hide_cov	Logical, hides co-variances. Defaults to FALSE.
hide_mean	Logical, hides means/node labels. Defaults to TRUE.
est_std	Logical, whether to use the standardized coefficients. Defaults to TRUE.
label	Labels to be used on the plot. As elsewhere in lavaanExtra, it is provided as a named list with format (colname = "label").
label_location	Location of label along the path, as a percentage (defaults to middle, 0.5).
reduce_items	A numeric vector of length 1 (x) or 2 (x & y) defining how much space to trim from the nodes (boxes) of the items defining the latent variables. Can be provided either as reduce_items = 0.4 (will only affect horizontal space, x), or reduce_items = c(x = 0.4, y = 0.2) (will affect both horizontal x and vertical y).
plot	Logical, whether to plot the result (default). If FALSE, returns the tidy_sem object, which can be further edited as needed.
...	Arguments to be passed to tidySEM::prepare_graph.

Value

A tidySEM plot, of class ggplot, representing the specified lavaan model.

Illustrations

Examples

```
# Calculate scale averages
library(lavaan)
data <- HolzingerSwineford1939
data$visual <- rowMeans(data[paste0("x", 1:3)])
data$textual <- rowMeans(data[paste0("x", 4:6)])
data$speed <- rowMeans(data[paste0("x", 7:9)])

# Define our variables
IV <- c("sex", "ageyr", "agemo", "school")
M <- c("visual", "grade")
DV <- c("speed", "textual")
```

```
# Define our lavaan lists
mediation <- list(speed = M, textual = M, visual = IV, grade = IV)

# Define indirect object
structure <- list(IV = IV, M = M, DV = DV)

# Write the model, and check it
model <- write_lavaan(mediation, indirect = structure, label = TRUE)
cat(model)

# Fit model
fit <- sem(model, data)

# Plot model

nice_tidySEM(fit, layout = structure)
```

`write_lavaan` *Vector-based lavaan syntax interpreter*

Description

Vector-based lavaan syntax interpreter.

Usage

```
write_lavaan(
  mediation = NULL,
  regression = NULL,
  covariance = NULL,
  indirect = NULL,
  latent = NULL,
  intercept = NULL,
  threshold = NULL,
  constraint.equal = NULL,
  constraint.smaller = NULL,
  constraint.larger = NULL,
  custom = NULL,
  label = FALSE,
  use.letters = FALSE
)
```

Arguments

`mediation`	Mediation indicators (~ symbol: "is regressed on"). Differs from argument `regression` because path names can be optionally specified automatically with argument `label`.

`regression`	Regression indicators (~ symbol: "is regressed on").
`covariance`	(Residual) (co)variance indicators (~~ symbol: "is correlated with").
`indirect`	Indirect effect indicators (:= symbol: "indirect effect defined as"). If a named list is provided, with names "IV" (independent variables), "M" (mediator), and "DV" (dependent variables), `write_lavaan` attempts to write indirect effects automatically. In this case, the `mediation` argument must be specified too.
`latent`	Latent variable indicators (=~ symbol: "is measured by").
`intercept`	Intercept indicators (~ 1 symbol: "intercept").
`threshold`	Threshold indicators (| symbol: "threshold").
`constraint.equal`	Equality indicators (== symbol).
`constraint.smaller`	Smaller than indicators (< symbol).
`constraint.larger`	Greater than indicators (> symbol).
`custom`	Custom specifications. Takes a *single* string just like regular `lavaan` syntax would. Always added at the end of the model.
`label`	Logical, whether to display path names for the mediation argument.
`use.letters`	Logical, for the labels, whether to use letters instead of the variable names.

Value

A character string, representing the specified `lavaan` model.

See Also

The corresponding vignette: https://lavaanextra.remi-theriault.com/articles/write_lavaan.html

Examples

```
x <- paste0("x", 1:9)
(latent <- list(
  visual = x[1:3],
  textual = x[4:6],
  speed = x[7:9]
))

HS.model <- write_lavaan(latent = latent)
cat(HS.model)

library(lavaan)
fit <- lavaan(HS.model,
  data = HolzingerSwineford1939,
  auto.var = TRUE, auto.fix.first = TRUE,
  auto.cov.lv.x = TRUE
)
summary(fit, fit.measures = TRUE)
```

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