Package ‘genpathmox’

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Title Generalized Pathmox Approach Segmentation Tree Analysis

Version 0.7

Description It provides an interesting solution for handling a high number of segmentation variables in partial least squares structural equation modeling. The package implements the ``Pathmox'' algorithm (Lamberti, Sanchez, and Aluja,(2016)<doi:10.1002/asmb.2168>) including the F-coefficient test (Lamberti, Sanchez, and Aluja,(2017)<doi:10.1002/asmb.2270>) to detect the path coefficients responsible for the identified differences), the hybrid multi-group approach (Lamberti (2021) <doi:10.1007/s11135-021-01096-9>).

Depends R (>= 3.1.2), stats, graphics, grDevices, utils, diagram, methods, quantreg

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R topics documented:

csibank 2
fibtelereg 4
info.pls-class 5
info.reg_class 5
node-class 5
node.reg_class 5
plot.xtree.pls 6
pls.pathmox 7
pls.treemodel 12

reg.pathmox 14
summarize.mox 16
summarize.reg 17
tree-class 19
treenode.pls 19

Index **22**

`csibank` *CSIbank*

Description

CSIbank

Usage

```
csibank
```

Format

A data frame with 1707 observations on the following 32 variables. The first five variables are segmentation variables. The rest of the variables refer to seven latent concepts: 1) `IMAG`=Image, 2) `EXPE`=Expectations, 3) `QUAL`=Quality, 4) `VAL`=Value, 5) `SAT`=Satisfaction, and 6) `LOY`=Loyalty. Variables description

- `IMAG`: Includes variables such as reputation, trustworthiness, seriousness, solidness, and caring about customer's needs.
- `EXPE`: Includes variables such as products and services provided, customer service, providing solutions, and expectations for the overall quality.
- `QUAL`: Includes variables such as reliable products and services, range of products and services, personal advice, and overall perceived quality.
- `VAL`: Includes variables such as beneficial services and products, valuable investments, quality relative to price, and price relative to quality.
- `SAT`: Includes variables such as overall rating of satisfaction, fulfillment of expectations, satisfaction relative to other banks, and performance relative to customer's ideal bank.
- `LOY`: Includes variables such as propensity to choose the same bank again, propensity to switch to other bank, intention to recommend the bank to friends, and sense of loyalty.

Manifest variables description

- `imag1`First MV of the block Image

- `imag2`Second MV of the block Image
- `imag3`Third MV of the block Image
- `imag4`Fourth MV of the block Image
- `imag5`Fifth MV of the block Image
- `imag6`Sixth MV of the block Image
- `expe1`First MV of the block Expectations
- `expe2`Second MV of the block Expectations
- `expe3`Third MV of the block Expectations
- `expe4`Fourth MV of the block Expectations
- `qual1`First MV of the block Quality
- `qual2`Second MV of the block Quality
- `qual3`Third MV of the block Quality
- `qual4`Fourth MV of the block Quality
- `qual5`Fifth MV of the block Quality
- `qual6`Sixth MV of the block Quality
- `qual7`Seventh MV of the block Quality
- `val1`First MV of the block Value
- `val2`Second MV of the block Value
- `val3`Third MV of the block Value
- `val4`Fourth MV of the block Value
- `sat1`First MV of the block Satisfaction
- `sat2`Second MV of the block Satisfaction
- `sat3`Third MV of the block Satisfaction
- `loy1`First MV of the block Loyalty
- `loy2`Second MV of the block Loyalty
- `loy3`Third MV of the block Loyalty

Segmentation Variables description

- `Gender`a factor with levels `Female` `Male`
- `Age`a factor with levels `<=25` `>=66` `26-35` `36-45` `46-55` `56-65`
- `Education`a factor with levels `Elementary` `Graduated` `Highschool` `Undergrad` `Unfinished`
- `Occupation`a factor with levels `Manager` `MediumEmplo` `Notemploy` `OwnFreelan` `Retired`
- `Region`a factor with levels `Center` `East` `North`

Source

Laboratory of Information Analysis and Modeling (LIAM). Facultat de Informatica de Barcelona, Universitat Politecnica de Catalunya.

References

Lamberti, G. (2014) *Modeling with Heterogeneity.* PhD Dissertation.

`fibtelereg` *Fibtelereg*

Description

Fibtelereg dataset

Usage

```
fibtelereg
```

Format

A data frame with 147 observations on the following 18 variables. The first ten variables are segmentation variables. The rest of the variables refer to five variables 1) `Image` = Image, 2) `Exp.spec` = Specific Expectation, 3) `Exp.gen` = Generic Expectation, 4)`Qual.spec` = Specific Quality, 5) `Qual.gen` = Generic Quality, 6) `Value` = Value, 7) `Satis` = Satisfaction. Variables description

- `Image`: Generic students perception of ICT schools: (internationally recognized, ranges of courses, leader in research).
- `Exp.spec`: Specific Expectation on specific skills (technic or applied skills).
- `Exp.gen`: Generic Expectation on generic skills (abilities in problem solving, communication skills).
- `Qual.spec`: Perception about the achieved quality on the specific skills in the school.
- `Qual.gen`: Perception about achieved quality on the generic skills in the school (abilities in solving problem, communication skills).
- `Value`: The advantage or profit that the alumni may draw from the school degree (well paid job, motivated job, prospectives in improvement and promotion).
- `Satis`: Degree of alumni satisfaction about the formation in school respect to their actual work conditions.

Segmentation Variables description

- `Career`a factor with levels `EI` `ETS` `TEL`
- `Gender`a factor with levels `female` `male`
- `Age`a factor with levels `25-26years` `27-28years` `29-30years` `31years+`
- `Studying`a factor with levels `no.stud` `yes.stud`
- `Contract` a factor with levels `fix.cont` `other.cont` `temp.cont`
- `Salary`a factor with levels `18k` `>45k` `25k` `35k` `45k`
- `Firmtype`a factor with levels `priva` `publi`
- `Accgrade`a factor with levels `7-8accnote` `accnote<7` `accnote>8`
- `Grade`a factor with levels `<6.5note` `>7.5note` `6.5-7note` `7-7.5note`
- `Startwork`a factor with levels `after.grad` `befor.grad`

Source

Laboratory of Information Analysis and Modeling (LIAM). Facultat de Informatica de Barcelona, Universitat Politecnica de Catalunya.

References

Lamberti, G. (2014) *Modeling with Heterogeneity.* PhD Dissertation.

`info.pls-class` *info.pls class*

Description

info.pls is an S4 class that contains info on the variable and his levels that provides the best binary split and the the the Fischers statitistcs: F-global, F-#' block, F-coefficientes

---

`info.reg_class` *info.reg class*

Description

info.pls is a S4 class that contains info on the variable and his levels that provides the best binary split and the the the Fischers statitistcs: F-global, F-coefficientes

---

`node-class` *node class*

Description

node is an S4 class that contains info on each node of the binary segmentation tree

---

`node.reg_class` *node.reg class*

Description

info.pls is a S4 class that contains element of the node class plot.xtree.pls *Plot function for the Pathmox Segmentation Trees: PLS-PM*

Description

The function plot.xtree.pls allows to drow PATHMOX tree for PLS-SEM

Usage

```
## S3 method for class 'xtree.pls'
plot(
  xtree,
  root.col = "grey",
  node.col = "orange",
  leaf.col = "green2",
  shadow.size = 0.003,
  node.shadow = "red",
  leaf.shadow = "darkgreen",
  cex = 0.7,
  seg.col = "blue3",
  lwd = 1,
  show.pval = TRUE,
  pval.col = "blue",
  main = NULL,
  cex.main = 1,
  ...
)
```

Arguments

xtree	An object of class "xtree.pls" returned by pls.pathmox
root.col	Fill color of root node.
node.col	Fill color of child nodes.
leaf.col	Fill color of leaf.
shadow.size	Relative size of shadows.
node.shadow	Color of shadow of child nodes.
leaf.shadow	Color of shadow of leaf nodes.
cex	A numerical value indicating the magnification to be used for plotting text.
seg.col	The color to be used for the labels of the segmentation variables.
lwd	The line width, a positive number, defaulting to 1
show.pval	Logical value indicating whether the p-values should be plotted.
pval.col	The color to be used for the labels of the p-values.
main	A main title for the plot.
cex.main	The magnification to be used for the main title.
...	Further arguments passed on to plot.xtree.pls.

Examples

```
## Not run:
 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)


# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                         deep=2,size=0.2,n.node=20)
plot(bank.pathmox)


## End(Not run)
```

`pls.pathmox` *PATHMOX-PLS: Extended Segmentation Trees in Partial Least Squares Structutal Equation Modeling (PLS-SEM)*

Description

The function `pathmox.pls` calculates a binary segmentation tree in the context PLS-SEM following the PATHMOX algorithm. It allows heterogeneity to be detected in PLS-SEM models when the segmentation variables (categorical variables), external to the model, are available and when the objective of the research is exploratory. Pathmox adapts the principles of binary segmentation processes to produce a tree with different models in each of the obtained nodes. Unlike classic decision trees, pathmox does not aim to predict predefined classes, but to detect different models present in the data. To this end, it identifies the splits (based on the segmentation variables) that maximally discriminate between models. Each binary split defines a pair of nodes, each of which will have an associated structural model, i.e., an associated set of path coefficients. A global comparison test on the identity of the two models is then run. To avoid overfitting, pathmox adopts a pre-pruning process (i.e., stopping rules) based on maximum depth, minimum size of nodes and non-significance of the F-statistic.

Usage

```
pls.pathmox(
  x,
  inner,
  outer,
  mode,
  scheme = "path",
  scaling = NULL,
  scaled = TRUE,
  SVAR,
  signif = 0.05,
  deep,
  method = "lm",
  size,
  tree = TRUE,
  n.node = 30,
  ...
)
```

Arguments

`x` matrix or data frame containing the manifest variables.

`inner` A square (lower triangular) boolean matrix representing the inner model (i.e. the path relationships between latent variables).

`outer` list of vectors with column indices or column names from `x` indicating the sets of manifest variables forming each block (i.e. which manifest variables correspond to each block).

`mode` character vector indicating the type of measurement for each block. Possible values are: `"A"`, `"B"`, `"newA"`, `"PLScore"`, `"PLScow"`. The length of `mode` must be equal to the length of `outer`.

`scheme` string indicating the type of inner weighting scheme. Possible values are `"centroid"`, `"factorial"`, or `"path"`.

`scaling` optional argument for runing the non-metric approach; it is a list of string vectors indicating the type of measurement scale for each manifest variable specified in `outer`. `scaling` must be specified when working with non-metric variables. Possible values: `"num"` (linear transformation, suitable for numerical variables), "raw" (no transformation), "nom" (non-monotonic transformation, suitable for nominal variables), and "ord" (monotonic transformation, suitable for ordinal variables).

scaled	whether manifest variables should be standardized. Only used when scaling = NULL. By the default (TRUE, data is scaled to standardized values (mean=0 and variance=1).
SVAR	A data frame of factors contaning the segmentation variables.
signif	A numeric value indicating the significance threshold of the F-statistic. Must be a decimal number between 0 and 1.
deep	An integer indicating the depth level of the tree. Must be an integer greater than 1.
method	A string indicating the criterion used to calculate the the test can be equal to "lm" or "lad".
size	A numeric value indicating the minimum size of elements inside a node.
tree	A string indicating if the tree plot must be showed. By default is equal to TRUE
n.node	It is the minimum number of individuals to consider a candidate partition (30 by default).
...	Further arguments passed on to pls.pathmox.

Details

The argument x must be a data frame containing the manifest variables of the PLS-SEM model.

The argument inner is a matrix of zeros and ones that indicates the structural relationships between latent variables. inner must be a lower triangular matrix; it contains a 1 when column j affects row i, 0 otherwise.

The argument SVAR must be a data frame containing segmentation variables as factors. The number of rows in SVAR must be the same as the number of rows in the data used in x.

The argument signif represent the p-value level takes as reference to stop the tree partitions. Defaults value is 0.05.

The argument deep represent the depth level of the tree takes as reference to stop the tree partitions.

The argument method is a string contaning the criterion used to calculate the tests; if method="lm" the classic least square approach is used to perform the tests; if method="lad" a LAD (least absolute deviation regression) aproximation of the test is used.

The argument size is defined as a decimal value (i.e. proportion of elements inside a node).

The argument n.node is the minimum number of individuals to consider a candidate partition. If the candidate split produces a partition where the number of individuals is less then n.node, the partition is not considered.

Value

An object of class "xtree.pls". Basically a list with the following results:

MOX	Data frame with the results of the segmentation tree
root	List of elements contained in the root node

`terminal`	List of elements contanined in terminal nodes
`nodes`	List of elements contanined in all nodes: terminal and intermediate
`candidates`	List of data frames containing the candidate splits of each node partition
`Fg.r`	Data frame containing the results of the F-global test for each node partition
`Fc.r`	A list of data frames containing the results of the F-coefficients test for each node partition
`model`	Informations about the internal paramenters
`hybrid`	orginal dataset plus the hybird categorical factor defined according to the final segments idenfied by pathmox. Dataset is ordered by the hybird variable

Author(s)

Giuseppe Lamberti

References

Lamberti, G. (2021) *Hybrid multigroup partial least squares structural equation modelling: an application to bank employee satisfaction and loyalty*. Quality and Quantity; doi: 10.1007/s11135-021-01096-9;

Lamberti, G. et al. (2017) *The Pathmox approach for PLS path modeling: Discovering which constructs differentiate segments.*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2270;

Lamberti, G. et al. (2016) *The Pathmox approach for PLS path modeling segmentation*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2168;

Lamberti, G. (2015) *Modeling with Heterogeneity.* PhD Dissertation.

Examples

```
## Not run:
 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
```

```
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)


# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                         deep=2,size=0.2,n.node=20)


## End(Not run)

 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)


# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                         deep=2,size=0.2,n.node=20)
```

`pls.treemodel` *PLS-SEM results of terminal nodes from the Pathmox Segmentation Trees*

Description

Calculates basic PLS-SEM results for the terminal nodes of PATHMOX trees

Usage

```
pls.treemodel(
  xtree,
  terminal = TRUE,
  scaled = FALSE,
  label = FALSE,
  label.nodes = NULL,
  ...
)
```

Arguments

`xtree`	An object of class "`xtree.pls`" returned by `pls.pathmox`.
`terminal`	is string, if equal to `TRUE`, just the terminal nodes are considered for the output reults. when it is equal to `FALSE`,the PLS-PM results are generated for all nodes of the tree
`scaled`	to standardize the latent variables or not
`label`	is a string. It is false for defect. If it is `TRUE`, label.nodes has to be fix.
`label.nodes`	is a vector with the name of the nodes. It is null for defect.
`...`	Further arguments passed on to `pls.treemodel`.

Details

The argument `xtree` is an object of class "`xtree.pls`" returned by `pls.pathmox`.

Value

An object of class "`treemodel.pls`". Basically a list with the following results:

`weights`	Matrix of outer weights for each terminal node
`loadings`	Matrix of loadings for each terminal node
`path_coef`	Matrix of path coefficients for each terminal node
`path_sgnificance`	Matrix of path coefficients the significance (p-value) for each terminal node
`predictive_power_R2`	Matrix of r-squared coefficients for each terminal node
`total_effects`	list of matrix with the terminal effects for each terminal node

Author(s)

Giuseppe Lamberti

References

Lamberti, G. (2021) *Hybrid multigroup partial least squares structural equation modelling: an application to bank employee satisfaction and loyalty*. Quality and Quantity; doi: 10.1007/s11135-021-01096-9;

Lamberti, G. et al. (2017) *The Pathmox approach for PLS path modeling: Discovering which constructs differentiate segments.*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2270;

Lamberti, G. et al. (2016) *The Pathmox approach for PLS path modeling segmentation*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2168;

Lamberti, G. (2015) *Modeling with Heterogeneity.* PhD Dissertation.

See Also

pls.pathmox

Examples

```
## Not run:
 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)
```

```
# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                          deep=2,size=0.2,n.node=20)

nodes.models=pls.treemodel(bank.pathmox)


## End(Not run)
```

---

reg.pathmox *PATHMOX-REG: Segmentation Trees in linaer and LAD regression model*

Description

The function `reg.pathmox` calculates a binary segmentation tree in the context of linear regression following the PATHMOX algorithm. This function also generalizes the Pathmox algorithm introduced by Sanchez in 2009 to the context of linear and LAD regression.

Usage

```
reg.pathmox(formula, SVAR, signif, deep, method, size, data = NULL, ...)
```

Arguments

`formula`	An object of class "`formula`".
`SVAR`	A data frame of factors contaning the segmentation variables.
`signif`	A numeric value indicating the significance threshold of the F-statistic. Must be a decimal number between 0 and 1.
`deep`	An integer indicating the depth level of the tree. Must be an integer greater than 1.
`method`	A string indicating the criterion used to calculate the the test can be equal to "`lm`" or "`lad`" node.
`size`	A numeric value indicating the minimum size of elements inside a node.
`data`	an optional data frame.
`...`	Further arguments passed on to `reg.pathmox`.

Details

The argument `formula` is an object of class "`formula`" (or one that can be coerced to that class): a symbolic description of the model to be fitted.

The argument `SVAR` must be a data frame containing segmentation variables as factors. The number of rows in `SVAR` must be the same as the number of rows in the data

The argument `signif` represent the p-value level takes as reference to stop the tree partitions.

The argument deep represent the p-value level takes as reference to stop the tree partitions.

The argument method is a string contaning the criterion used to calculate the the test; if method="lm" the classic least square approach is used to perform the test; if method="lad" the lad (least absolute deviation) is used.

The argument size has defined as a decimal value (i.e. proportion of elements inside a node).

Value

An object of class "xtree.reg". Basically a list with the following results:

MOX	Data frame with the results of the segmentation tree
root	element of contaning in the root node
terminal	element of contaning in the terminal nodes
nodes	element of contaning in all nodes terminal and intermediate
candidates	List of data frames containing the candidate splits of each node partition
Fg.r	Data frame containing the results of the F-global test for each node partition
Fc.r	A list of Data frames containing the results of the F-coefficients test for each node partition
model	Information about the internal paramenters

Author(s)

Giuseppe Lamberti

References

Aluja, T. Lamberti, G. Sanchez, G. (2013). Modeling with heterogeneity. Meetings of Italian Statistical Society, Advances in Latent Variables - Methods, Models and Applications. Brescia.

Lamberti, G. (2014) *Modeling with Heterogeneity.* PhD Dissertation.

Sanchez, G. (2009) *PATHMOX Approach: Segmentation Trees in Partial Least Squares Path Modeling.* PhD Dissertation.

Examples

```
 ## Not run:
##example of LM in alumni satisfaction

data(fibtelereg)

#identify the segmentation variables
segvar = fibtelereg[,2:11]

#select the variables
data.fib = fibtelereg[,12:18]

#re-ordering those segmentation variables with ordinal scale
```

```
segvar$Age     = factor(segvar$Age, ordered=T)
segvar$Salary   = factor(segvar$Salary,
levels=c("<18k","25k","35k","45k",">45k"), ordered=T)
segvar$Accgrade = factor(segvar$Accgrade,
levels=c("accnote<7","7-8accnote","accnote>8"), ordered=T)
segvar$Grade  = factor(segvar$Grade,
levels=c("<6.5note","6.5-7note","7-7.5note",">7.5note"), ordered=T)

#regression PATHMOX
fib.reg.pathmox = reg.pathmox(Satisfact~.,data=data.fib,segvar,
signif=0.05,deep=2,method="lm",size=0.15)


## End(Not run)
```

`summarize.mox` *Summary function for the Pathmox Segmentation Trees: PLS-PM*

Description

The function `summarize.mox` returns the most important results obtained by the function `pls.pathmox`. In order, it provides the parameters algorithm (threshold significance, node size limit", tree depth level, and the method used for the split partition), the essential characteristics of the tree (deep and number of terminals nodes), the basic characteristics of the nodes and the F-global and the F-coefficient results. For the test results, the significance level is also indicated.

Usage

```
summarize.mox(x, ...)
```

Arguments

`x`	An object of class `"xtree.pls"`.
`...`	Further arguments are ignored.

Author(s)

Giuseppe Lamberti

References

Lamberti, G. (2021) *Hybrid multigroup partial least squares structural equation modelling: an application to bank employee satisfaction and loyalty*. Quality and Quantity; doi: 10.1007/s11135-021-01096-9;

Lamberti, G. et al. (2017) *The Pathmox approach for PLS path modeling: Discovering which constructs differentiate segments.*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2270;

Lamberti, G. et al. (2016) *The Pathmox approach for PLS path modeling segmentation*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2168;

Lamberti, G. (2015) *Modeling with Heterogeneity.* PhD Dissertation.

pls.pathmox

Examples

```
## Not run:
 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)


# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                         deep=2,size=0.2,n.node=20)
summarize.mox(bank.pathmox)


## End(Not run)
```

---

summarize.reg	*Summary function for the Pathmox Segmentation Trees: linaer regression and LAD*

Description

The function `summarize.reg` returns the most important results obtained by the function `reg.pathmox`. In order, it provides the parameters algorithm (threshold significance,node size limit,tree depth level and the method used for the split partition), the basic characteristics of the tree (deep and number of terminal nodes), the basic characteristics of the nodes and the F-global and F-coefficients results. For the test results the significance level is indicated.

Usage

```
summarize.reg(object, ...)
```

Arguments

`object`	An object of class "`xtree.reg`".
`...`	Further arguments are ignored.

Author(s)

Giuseppe Lamberti

References

Aluja, T. Lamberti, G. Sanchez, G. (2013). Modeling with heterogeneity. Meetings of Italian Statistical Society, Advances in Latent Variables - Methods, Models and Applications. Brescia.

Lamberti, G. (2014) *Modeling with Heterogeneity.* PhD Dissertation.

Sanchez, G. (2009) *PATHMOX Approach: Segmentation Trees in Partial Least Squares Path Modeling.* PhD Dissertation.

`reg.pathmox`.

Examples

```
 ## Not run:
##example of LM in alumni satisfaction

data(fibtelereg)

#identify the segmentation variables
segvar = fibtelereg[,2:11]

#select the variables
data.fib = fibtelereg[,12:18]

#re-ordering those segmentation variables with ordinal scale
segvar$Age     = factor(segvar$Age, ordered=T)
segvar$Salary  = factor(segvar$Salary,
levels=c("<18k","25k","35k","45k",">45k"), ordered=T)
segvar$Accgrade = factor(segvar$Accgrade,
levels=c("accnote<7","7-8accnote","accnote>8"), ordered=T)
```

```
segvar$Grade  = factor(segvar$Grade,
levels=c("<6.5note","6.5-7note","7-7.5note",">7.5note"), ordered=T)

#regression PATHMOX
fib.reg.pathmox = reg.pathmox(Satisfact~.,data=data.fib,segvar,
signif=0.05,deep=2,method="lm",size=0.15)

 summarize.reg(fib.reg.pathmox)


## End(Not run)
```

`tree-class` *tree class*

Description

tree is an S4 class that contains info on the binary segmentation tree

---

`treenode.pls` *PLS-SEM results of a specific terminal node from the Pathmox Segmentation Trees*

Description

Calculates basic PLS-SEM results for a specific terminal node of PATHMOX trees

Usage

```
treenode.pls(xtree, node, boot.val = TRUE, br = 500)
```

Arguments

`xtree`	An object of class "`xtree.pls`" returned by `pls.pathmox`.
`node`	is numeric value indicating the node that we want to aanalyze
`boot.val`	is string, if equal to `TRUE`, calculates the bootstrap intervals. By default is equal to `TRUE`.
`br`	is the numebr of boostrap resempling. By default is equal to 500.

Details

The argument `xtree` is an object of class "`xtree.pls`" returned by `pls.pathmox`.

Value

An object of class "treemodel.pls". Basically a list with the following results:

`Reliability_indexes_and_unidimensionality`
: Classical reliabilitiy indices for PLS-SEM

`Internal_consistency_and_R2`
: AVE and R2 for PLS-SEM

`loadings`
: Outer model loadings

`weights`
: Outer model weights

`discriminant_validity`
: Discriminant validity - Fornell & Larcker criterion

`path_coef`
: Coefficients of the inner model

`total_effects`
: Total effects of the inner model

Author(s)

Giuseppe Lamberti

References

Lamberti, G. (2021) *Hybrid multigroup partial least squares structural equation modelling: an application to bank employee satisfaction and loyalty*. Quality and Quantity; doi: 10.1007/s11135-021-01096-9;

Lamberti, G. et al. (2017) *The Pathmox approach for PLS path modeling: Discovering which constructs differentiate segments.*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2270;

Lamberti, G. et al. (2016) *The Pathmox approach for PLS path modeling segmentation*. Applied Stochastic Models in Business and Industry; doi: 10.1002/asmb.2168;

Lamberti, G. (2015) *Modeling with Heterogeneity.* PhD Dissertation.

See Also

pls.pathmox

Examples

```
## Not run:
 ## example of PLS-PM in bank customer satisfaction

data(csibank)

# select manifest variables
data.bank <-csibank[,6:32]

# define inner model matrix
Image    = rep(0,6)
Expectation   = c(1,0,0,0,0,0)
Quality     = c(0,1,0,0,0,0)
Value     = c(0,1,1,0,0,0)
```

```
Satis     = c(1,1,1,1,0,0)
Loyalty       = c(1,0,0,0,1,0)
inner.bank = rbind(Image,Expectation, Quality, Value, Satis,Loyalty)
colnames(inner.bank) = rownames(inner.bank)

# blocks of indicators (outer model)
outer.bank  = list(1:6,7:10,11:17,18:21,22:24,25:27)
modes.bank = rep("A", 6)


# re-ordering those segmentation variables with ordinal scale
seg.bank= csibank[,1:5]

seg.bank$Age = factor(seg.bank$Age, ordered=TRUE)
seg.bank$Education = factor(seg.bank$Education, ordered=TRUE)


# Pathmox Analysis
bank.pathmox=pls.pathmox(data.bank, inner.bank, outer.bank, modes.bank,SVAR=seg.bank,signif=0.05,
                         deep=2,size=0.2,n.node=20)

treenode=treenode.pls(bank.pathmox,node=2,br=100)


## End(Not run)
```

Index

∗ **datasets**
    csibank, 2
    fibtelereg, 4

csibank, 2

fibtelereg, 4

info.pls-class, 5
info.reg_class, 5

node-class, 5
node.reg_class, 5

plot.xtree.pls, *6*, 6
pls.pathmox, *6*, 7, *9*, *12*, *13*, *17*, *19*, *20*
pls.treemodel, *12*, 12

reg.pathmox, *14*, 14, *18*

summarize.mox, 16
summarize.reg, 17

tree-class, 19
treenode.pls, 19