

Package ‘aMNLFA’

July 22, 2025

Title Automated Moderated Nonlinear Factor Analysis Using 'M-plus'

Version 1.1.2

Description Automated generation, running, and interpretation of moderated nonlinear factor analysis models for obtaining scores from observed variables, using the method described by Gottfredson and colleagues (2019) <doi:10.1016/j.addbeh.2018.10.031>. This package creates M-plus input files which may be run iteratively to test two different types of covariate effects on items: (1) latent variable impact (both mean and variance); and (2) differential item functioning. After sequentially testing for all effects, it also creates a final model by including all significant effects after adjusting for multiple comparisons. Finally, the package creates a scoring model which uses the final values of parameter estimates to generate latent variable scores. \n\n This package generates TEMPLATES for M-plus inputs, which can and should be inspected, altered, and run by the user. In addition to being presented without warranty of any kind, the package is provided under the assumption that everyone who uses it is reading, interpreting, understanding, and altering every M-plus input and output file. There is no one right way to implement moderated nonlinear factor analysis, and this package exists solely to save users time as they generate M-plus syntax according to their own judgment.

Depends R (>= 3.1.0), utils

Imports grDevices, graphics, stats, ggplot2, MplusAutomation, reshape2, gridExtra, stringr, plyr, devtools, dplyr, stringi

License GPL-2

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

NeedsCompilation no

Author Veronica Cole [aut, cre],
Nisha Gottfredson [aut],
Michael Giordano [aut],
Isabella Stallworthy [aut],
Meriah DeJoseph [aut],
Robin Sifre [aut],
Tim Janssen [ctb]

Maintainer Veronica Cole <colev@wfu.edu>

Repository CRAN
Date/Publication 2022-02-13 18:40:03 UTC

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aMNLFA.DIFplot	<i>aMNLFA plotting function for aMNLFA.prune() results</i>
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Description

This function gives the user a plot corresponding to loading, intercept, or threshold DIF from the aMNLFA.prune() function

Usage

```
aMNLFA.DIFplot(diflist, diftype, log = FALSE)
```

Arguments

diflist	The listing of results from aMNLFA.prune(), which contains the DIF tables (as well as impact tables, which aren't used here)
diftype	The type of DIF the user wants plot for. Options include "loading" (for loading DIF), "intercept" (for intercept DIF when threshold DIF is not tested), "threshold.highest" (which uses only the largest test statistic across all categories when threshold DIF is tested), and "threshold.all" (which uses the test statistic for all categories when threshold DIF is tested)
log	Logical. If TRUE, plot the y axis on a log scale. Defaults to FALSE.

Value

No return value; generates a plot using base R.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
mrdata = xstudy,
indicators = paste0("BIN_", 1:12),
catindicators = paste0("BIN_", 1:12),
meanimpact = c("AGE", "GENDER", "STUDY"),
varimpact = c("AGE", "GENDER", "STUDY"),
measinvar = c("AGE", "GENDER", "STUDY"),
factors = c("GENDER", "STUDY"),
ID = "ID",
thresholds = FALSE)

prune.object <- aMNLFA.prune(ob)
aMNLFA.DIFplot(prune.object, "loading", log = FALSE)

## End(Not run)
```

aMNLFA.final

aMNLFA simultaneous model fitting function

Description

This function generates the simultaneous aMNLFA model from all the initial inputs.

Usage

```
aMNLFA.final(
  input.object,
  mchoice = "actual",
  method = "BH",
  highest.category = TRUE,
  keepmean = FALSE
)
```

Arguments

input.object	The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.
mchoice	String representing the method of determining the number of tests, denoted m. Options include "actual", which uses the number of effects actually tested in the round 2 model as m, and "ibc", which uses the maximum number of all possible tests – i.e., the number of items times the number of covariates. Defaults to "actual".

method	String representing the method of adjusting for multiple comparisons. Options include "bh", which invokes Benjamini-Hochberg correction with m defined using the mchoice parameter, and "bonferroni", which invokes a Bonferroni correction with m defined using the mchoice parameter. Defaults to "bh".
highest.category	Boolean. If threshold DIF is tested, should only the category with the highest value of the test statistic be used when adjusting p. values? Defaults to TRUE, which corresponds to the results from "threshold.highest" in the aMNLFA.prune() step. If FALSE, all threshold effects will be considered, even those below the maximum value for a given item, which corresponds to the "thresholds.all" option in the aMNLFA.prune() step.
keepmean	Boolean. If intercept or loading DIF are present, should the corresponding mean impact effect be retained? Defaults to FALSE.

Value

No return value. Generates a file entitled "round3calibration.inp", to be run in *Mplus*, in the directory specified in the aMNLFA.object.

Examples

```
## Not run:
wd <- tempdir()
first <- paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrdta = xstudy,
  indicators = paste0("BIN_", 1:12),
  catindicators = paste0("BIN_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.simultaneous(ob)

## End(Not run)
```

aMNLFA.initial

aMNLFA initial model fitting function

Description

This function generates the initial itemwise aMNLFA models.

Usage

```
aMNLFA.initial(input.object)
```

Arguments

`input.object` The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/examplefiles")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)
ob <- aMNLFA::aMNLFA.object(dir = wd,
mrdata = xstudy,
indicators = paste0("BIN_", 1:12),
catindicators = paste0("BIN_", 1:12),
meanimpact = c("AGE", "GENDER", "STUDY"),
varimpact = c("AGE", "GENDER", "STUDY"),
measinvar = c("AGE", "GENDER", "STUDY"),
factors = c("GENDER", "STUDY"),
ID = "ID",
thresholds = FALSE)

aMNLFA.initial(ob)

## End(Not run)
```

aMNLFA.itemplots

aMNLFA item plotting function

Description

This function generates plots of item endorsement by time, and by each covariate. This is necessary for determining which covariates to use in the MNLFA.

Usage

```
aMNLFA.itemplots(input.object)
```

Arguments

`input.object` The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/examplefiles")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)
ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrdata = xstudy,
  indicators = paste0("BIN_", 1:12),
  catindicators = paste0("BIN_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.itemplots(ob)

## End(Not run)
```

aMNLFA.object

aMNLFA object function

Description

This function creates an aMNLFA object based on user specifications to pass to aMNLFA functions.

Usage

```
aMNLFA.object(
  dir,
  mrdata,
  indicators = NULL,
  catindicators = NULL,
  countindicators = NULL,
  meanimpact = NULL,
  varimpact = NULL,
  measinvar = NULL,
  factors = NULL,
  time = NULL,
  auxiliary = NULL,
  ID = NULL,
  thresholds = NULL
)
```

Arguments

dir	The directory in which data, inputs, and outputs are to be stored. Must be supplied.
mrdata	The R dataframe containing the multiple-record dataset. Must be supplied.
indicators	The names of all indicators (items, observed variables) in the MNLFA.
catindicators	The list of indicators which are categorical. Defaults to NULL.
countindicators	The list of indicators which are count. Defaults to NULL.
meanimpact	The list of covariates (predictors) which may generate impact on the latent variable mean. Defaults to NULL.
varimpact	The list of covariates (predictors) which may generate impact on the latent variable variance. Defaults to NULL.
measinvar	The list of covariates (predictors) which may generate DIF. Defaults to NULL.
factors	The list of covariates which are categorical. Defaults to NULL.
time	The variable which indexes time (or multiple records within a single case). If left blank, assumes single-record data. Defaults to NULL.
auxiliary	The list of variables to be considered as auxiliary (i.e., retained in the dataset but not used in the analysis). Defaults to NULL.
ID	The variable which identifies cases. Defaults to NULL.
thresholds	A Boolean operator indicating whether to test for threshold DIF.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/examplefiles")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
mrdata = xstudy,
indicators = paste0("BIN_", 1:12),
catindicators = paste0("BIN_", 1:12),
meanimpact = c("AGE", "GENDER", "STUDY"),
varimpact = c("AGE", "GENDER", "STUDY"),
measinvar = c("AGE", "GENDER", "STUDY"),
factors = c("GENDER", "STUDY"),
ID = "ID",
thresholds = FALSE)

## End(Not run)
```

aMNLFA.prune

*aMNLFA simultaneous model fitting function***Description**

This function generates the simultaneous aMNLFA model from all the initial inputs.

Usage

```
aMNLFA.prune(input.object)
```

Arguments

`input.object` The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.

Value

A list (entitled summary) with the following elements:

- `indicators` a list of indicators as specified by the user in the aMNLFA.object()
- `measinvar` a list of measurement invariance variables as specified by the user in the aMNLFA.object()
- `meanimpact` parameter values, standard errors, test statistics, and p. values for all mean impact effects tested in the simultaneous model
- `varimpact` parameter values, standard errors, test statistics, and p. values for all variance impact effects tested in the simultaneous model
- `loadingDIF` parameter values, standard errors, test statistics, and p. values for all loading DIF effects tested in the simultaneous model. Also includes critical values for different corrections according to the number of tests, m : Benjamini-Hochberg or Bonferroni with m defined as the actual number of tests included in the model (BH.actual and bon.actual, respectively); Benjamini-Hochberg or Bonferroni with m defined as the number of items times the number of covariates (BH.ibc and bon.ibc, respectively).
- `interceptDIF` If `thresholds = FALSE` in the corresponding aMNLFA.object: parameter values, standard errors, test statistics, and p. values for all intercept DIF effects tested in the simultaneous model. Also includes critical values for different corrections according to the number of tests, m : Benjamini-Hochberg or Bonferroni with m defined as the actual number of tests included in the model (BH.actual and bon.actual, respectively); Benjamini-Hochberg or Bonferroni with m defined as the number of items times the number of covariates (BH.ibc and bon.ibc, respectively).
- `tDIF_highest` If `thresholds = TRUE` in the corresponding aMNLFA.object: parameter values, standard errors, test statistics, and p. values for all threshold DIF effects tested in the simultaneous model, with tests performed only on the category with the largest test statistic for each item. Also includes critical values for different corrections according to the number of tests, m : Benjamini-Hochberg or Bonferroni with m defined as the actual number of tests included in the model (BH.actual and bon.actual, respectively); Benjamini-Hochberg or Bonferroni with m defined as the number of items times the number of covariates (BH.ibc and bon.ibc, respectively).

- `tDIF_all` If `thresholds = TRUE` in the corresponding `aMNLFA.object`: parameter values, standard errors, test statistics, and p. values for all threshold DIF effects tested in the simultaneous model, with tests performed on all categories for each item. Also includes critical values for different corrections according to the number of tests, m : Benjamini-Hochberg or Bonferroni with m defined as the actual number of tests included in the model (`BH.actual` and `bon.actual`, respectively); Benjamini-Hochberg or Bonferroni with m defined as the number of items times the number of covariates (`BH.ibc` and `bon.ibc`, respectively).

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrdta = xstudy,
  indicators = paste0("BIN_", 1:12),
  catindicators = paste0("BIN_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.prune(ob)

## End(Not run)
```

aMNLFA.sample

aMNLFA sampling function

Description

This function generates a single-record dataset using a random sample of time points from the multiple-record sample.

Usage

```
aMNLFA.sample(input.object)
```

Arguments

`input.object` The `aMNLFA` object (created using the `aMNLFA.object` function) which provides instructions for the function.

Value

No return value. Generates a calibration data file in the directory specified in the aMNLFA.object.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrddata = xstudy,
  indicators = paste0("BIN_", 1:12),
  catindicators = paste0("BIN_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.sample(ob)

## End(Not run)
```

aMNLFA.scores

aMNLFA score generating function

Description

This function creates scores generated using aMNLFA. Can only be run after the final model has been fit – i.e., after the aMNLFA.final function.

Usage

```
aMNLFA.scores(input.object)
```

Arguments

input.object The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.

Value

No return value. Generates an INP file to be run in *Mplus* to generate scores in the directory specified in the aMNLFA.object.

Examples

```
## Not run:
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrdata = xstudy,
  indicators = paste0("BIN_", 1:12),
  catindicators = paste0("BIN_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.scores(ob)

## End(Not run)
```

aMNLFA.simultaneous	<i>aMNLFA simultaneous model fitting function</i>
---------------------	---

Description

This function generates the simultaneous aMNLFA model from all the initial inputs.

Usage

```
aMNLFA.simultaneous(input.object, keepmean = FALSE)
```

Arguments

input.object	The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.
keepmean	Boolean. If intercept or loading DIF are present, should the corresponding mean impact effect be retained? Defaults to FALSE.

Value

No return value. Generates a file entitled "round3calibration.inp", to be run in *Mplus*, in the directory specified in the aMNLFA.object.

Examples

```
## Not run:
wd <- tempdir()
first <- paste0(system.file(package='aMNLFA'),"/extdata")
the.list <- list.files(first,full.names=TRUE)
file.copy(the.list,wd,overwrite=TRUE)

ob <- aMNLFA::aMNLFA.object(dir = wd,
  mrddata = xstudy,
  indicators = paste0("bin_", 1:12),
  catindicators = paste0("bin_", 1:12),
  meanimpact = c("AGE", "GENDER", "STUDY"),
  varimpact = c("AGE", "GENDER", "STUDY"),
  measinvar = c("AGE", "GENDER", "STUDY"),
  factors = c("GENDER", "STUDY"),
  ID = "ID",
  thresholds = FALSE)

aMNLFA.simultaneous(ob)

## End(Not run)
```

fixPath

helper function - removes the final slash at the end of a given string

Description

This function generates the initial itemwise aMNLFA models.

Usage

```
fixPath(somecharacter)
```

Arguments

somecharacter The aMNLFA object (created using the aMNLFA.object function) which provides instructions for the function.

Value

outcharacter - string with slash at the end deleted

Examples

```
wd <- tempdir()
first<-paste0(system.file(package='aMNLFA'),"/examplefiles")
fixPath(first)
```

write.inp.file	<i>helper function for writing out Mplus inputs</i>
----------------	---

Description

This function generates the initial itemwise aMNLFA models.

Usage

```
write.inp.file(df, outfile)
```

Arguments

df	- the Mplus code to be written out, in a data frame
outfile	- a directory to which the Mplus code should be written

Value

outcharacter - string with slash at the end deleted

Examples

```
## Not run:
wd <- tempdir()
somestring <- as.data.frame("This is some text which would be written to an Mplus file.")
write.inp.file(somestring, wd)

## End(Not run)
```

xstudy	<i>Simulated cross-study data</i>
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Description

Data are simulated as part of a larger study (Curran et al., 2016; Curran et al., under review). Meant to simulate a dataset pooled across two studies, with 12 indicators and 3 moderators (age, gender, and study). Impact and DIF exist on the basis of these moderators.

Usage

```
data(xstudy)
```

Format

A data frame with 500 rows and 25 columns. The 25 variables are:

ID Unique identifier

AGE Age in years, centered around age 13

GENDER Effect-coded gender

STUDY Effect-coded study membership

STUDYAGE Interaction between age and study

TRUEETA True score on latent variable for each subject – not used in analysis

STUDYETA Interaction between study and score – not used in analysis

ZETA Deviation score – not used in analysis

W External covariate for original simulation – not used in analysis

Z1 External outcome for original simulation – not used in analysis

Z2 External outcome for original simulation – not used in analysis

Z3 External outcome for original simulation – not used in analysis

Z4 External outcome for original simulation – not used in analysis

BIN_1 Binary item 1

BIN_2 Binary item 2

BIN_3 Binary item 3

BIN_4 Binary item 4

BIN_5 Binary item 5

BIN_6 Binary item 6

BIN_7 Binary item 7

BIN_8 Binary item 8

BIN_9 Binary item 9

BIN_10 Binary item 10

BIN_11 Binary item 11

BIN_12 Binary item 12

Source

Curran et al., 2016 ([PubMed](#))

References

Curran et al., 2016 Structural Equation Modeling 23(6), 827-844. ([PubMed](#))

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