Package 'mulSEM'

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Type Package

Title Some Multivariate Analyses using Structural Equation Modeling

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Depends R (>= 4.3.0), OpenMx

Imports stats

Encoding UTF-8

Description A set of functions for some multivariate analyses utilizing a
structural equation modeling (SEM) approach through the 'OpenMx' package.
These analyses include canonical correlation analysis (CANCORR),
redundancy analysis (RDA), and multivariate principal component regression (MPCR).
It implements procedures discussed in Gu and Cheung (2023) <doi:10.1111/bmsp.12301>,
Gu, Yung, and Cheung (2019) <doi:10.1080/00273171.2018.1512847>, and
Gu et al. (2023) <doi:10.1080/00273171.2022.2141675>.

License GPL (>= 2)

LazyLoad yes

LazyData yes

ByteCompile yes

URL https://github.com/mikewlcheung/mulsem

BugReports https://github.com/mikewlcheung/mulsem/issues

Suggests roxygen2

RoxygenNote 7.3.3

NeedsCompilation no

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Contents

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cancorr   *Canonical correlation analysis*

Description

This function conducts canonical correlation analysis using the OpenMx package. Missing data are handled with the full information maximum likelihood method when raw data are available. It provides standard errors for the estimates.

Usage

```
cancorr(
  X_vars,
  Y_vars,
  data = NULL,
  Cov = NULL,
  numObs = NULL,
  model = c("CORR-W", "CORR-L", "COV-W", "COV-L"),
  extraTries = 50,
  ...
)
```

Arguments

X_vars	A vector of characters of the X variables.
Y_vars	A vector of characters of the Y variables.
data	A data frame containing raw data. If NULL, Cov and numObs must be provided.
Cov	A covariance or correlation matrix. Required when data is NULL.
numObs	A sample size. Required when data is NULL.

model	Four models defined in Gu, Yung, and Cheung (2019). CORR and COV refer to analyses of correlation structures and covariance structures, respectively.
extraTries	This function calls `OpenMx::mxTryHard()` to obtain parameter estimates and their standard errors. `extraTries` is the number of extra runs. If `extraTries=0`, `OpenMx::mxRun()` is called.
...	Additional arguments passed to either `OpenMx::mxTryHard()` or `OpenMx::mxRun()`.

Value

A list with class `CanCorr`. It stores the model in OpenMx objects. The fitted object is stored in `mx.fit`.

Note

cancorr expects the number of variables in `Y_vars` to be equal to or greater than that in `X_vars`. If there are fewer in `Y_vars`, you may swap between `X_vars` and `Y_vars`.

Author(s)

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References

Gu, F., Yung, Y.-F., & Cheung, M. W.-L. (2019). Four covariance structure models for canonical correlation analysis: A COSAN modeling approach. *Multivariate Behavioral Research*, **54(2)**, 192-223. doi:10.1080/00273171.2018.1512847

See Also

Thorndike00, sas_ex1

Examples

```
## Canonical Correlation Analysis
cancorr(X_vars=c("Weight", "Waist", "Pulse"),
        Y_vars=c("Chins", "Situps", "Jumps"),
        data=sas_ex1)
```

Chittum19	*Correlation matrix of a model of motivation*

Description

This dataset includes a correlation matrix of 12 variables (n=533) of a model of motivation reported by Chittum, Jones, and Carter (2019).

Usage

```
Chittum19
```

Format

A list with the following components:

data A 12x12 correlation matrix.

n A sample size (533).

Source

Chittum, J. R., Jones, B. D., & Carter, D. M. (2019). A person-centered investigation of patterns in college students' perceptions of motivation in a course. *Learning and Individual Differences*, **69**, 94-107. doi:10.1016/j.lindif.2018.11.007

References

Gu, F., Yung, Y.-F., Cheung, M. W.-L., Joo, B.-K., & Nimon, K. (2023). Statistical inference in redundancy analysis: A direct covariance structure modeling approach. *Multivariate Behavioral Research*, **58(5)**, 877-893. doi:10.1080/00273171.2022.2141675

Examples

```
data(Chittum19)

## Redundancy Analysis
rda(X_vars=c("Empowerment", "Usefulness", "Success", "Interest", "Caring"),
    Y_vars=c("Final_Exam", "Learning", "Course_Rating", "Instr_Rating",
             "Effort", "Cog_Engage", "Cost"),
    Cov=Chittum19$data, numObs=Chittum19$n)
```

Lambert88 *Correlation matrix of artificial data*

Description

This dataset includes a correlation matrix of nine artificial variables used in Table 1 of Lambert, Wildt, and Durand (1988).

Usage

```
Lambert88
```

Format

A 9x9 correlation matrix.

Source

Lambert, Z. V., Wildt, A. R., & Durand, R. M. (1988). Redundancy analysis: An alternative to canonical correlation and multivariate multiple regression in exploring interset associations. *Psychological Bulletin*, **104(2)**, 282-289. doi:10.1037/00332909.104.2.282

References

Gu, F., Yung, Y.-F., Cheung, M. W.-L., Joo, B.-K., & Nimon, K. (2023). Statistical inference in redundancy analysis: A direct covariance structure modeling approach. *Multivariate Behavioral Research*, **58(5)**, 877-893. doi:10.1080/00273171.2022.2141675

Examples

```
data(Lambert88)


## Redundancy Analysis
rda(X_vars=paste0("x", 1:5), Y_vars=paste0("y", 1:4), Cov=Lambert88, numObs=100)
```

---

mpcr   *Multivariate Principal Component Regression (MPCR)*

Description

Conduct multivariate principal component regression

Usage

```
mpcr(
  X_vars,
  Y_vars,
  data = NULL,
  Cov = NULL,
  Means = NULL,
  numObs = NULL,
  pca = c("COV", "COR"),
  pc_select = NULL,
  extraTries = 50,
  ...
)
```

Arguments

X_vars	A vector of characters of the X variables.
Y_vars	A vector of characters of the Y variables.
data	A data frame containing raw data. If NULL, Cov and numObs must be provided.

Cov	A covariance or correlation matrix. Required when `data` is NULL.
Means	An optional mean vector. Can be provided when `data` is NULL.
numObs	A sample size. Required when `data` is NULL.
pca	Whether principal component analysis is based on unstandardized (`COV`) or standardized (`COR`) variables.
pc_select	PCs selected in the regression analysis. For example, `pc_select=c(1,2)` to use the first two PCs in the multiple regression analysis.
extraTries	This function calls `OpenMx::mxTryHard()` to obtain parameter estimates and their standard errors. `extraTries` is the number of extra runs. If `extraTries=0`, `OpenMx::mxRun()` is called.
...	Additional arguments passed to either `OpenMx::mxTryHard()` or `OpenMx::mxRun()`.

Details

This function conducts multivariate principal component regression using the OpenMx package. Missing data are handled with the full information maximum likelihood method when raw data are available. It provides standard errors for the estimates.

Value

A list with class MPCR. It stores the model in OpenMx objects. The fitted object is stored in `mx.fit`.

Author(s)

Mike W.-L. Cheung mikewlcheung@nus.edu.sg

References

Gu, F., & Cheung, M. W.-L. (2023). A model-based approach to multivariate principal component regression: Selection of principal components and standard error estimates for unstandardized regression coefficients. *British Journal of Mathematical and Statistical Psychology*, **76(3)**, 605-622. doi:10.1111/bmsp.12301

See Also

Nimon21

Examples

```
## Multivariate Principal Component Regression
mpcr(X_vars=c("AU", "CC", "CL", "CO", "DF", "FB", "GR", "MW"),
     Y_vars=c("IDE", "IEE", "IOCB", "IPR", "ITS"),
     pca="COR", pc_select=1,
     data=Nimon21)
```

Nimon21   *Raw data used in Nimon, Joo, and Bontrager (2021)*

Description

This dataset includes the raw data of 13 variables reported by Nimon, Joo, and Bontrager (2021).

Usage

```
Nimon21
```

Format

A data frame with 13 variables.

Source

Nimon, K., Joo, B.-K. (Brian), & Bontrager, M. (2021). Work cognitions and work intentions: A canonical correlation study. *Human Resource Development International*, **24(1)**, 65-91. doi:10.1080/13678868.2020.1775038

References

Gu, F., & Cheung, M. W.-L. (2023). A Model-based approach to multivariate principal component regression: Selection of principal components and standard error estimates for unstandardized regression coefficients. *British Journal of Mathematical and Statistical Psychology*, **76(3)**, 605-622. doi:10.1111/bmsp.12301

Gu, F., Yung, Y.-F., Cheung, M. W.-L., Joo, B.-K., & Nimon, K. (2023). Statistical inference in redundancy analysis: A direct covariance structure modeling approach. *Multivariate Behavioral Research*, **58(5)**, 877-893. doi:10.1080/00273171.2022.2141675

Examples

```
data(Nimon21)

## Redundancy Analysis
rda(X_vars=c("AU", "CC", "CL", "CO", "DF", "FB", "GR", "MW"),
    Y_vars=c("IDE", "IEE", "IOCB", "IPR", "ITS"),
    data=Nimon21)

## Multivariate Principal Component Regression
mpcr(X_vars=c("AU", "CC", "CL", "CO", "DF", "FB", "GR", "MW"),
     Y_vars=c("IDE", "IEE", "IOCB", "IPR", "ITS"),
     pca="COR", pc_select=1,
     data=Nimon21)
```

---

print.CanCorr   *Print Method for CanCorr Objects*

Description

Print method for CanCorr objects.

Usage

```
## S3 method for class 'CanCorr'
print(x, digits = 4, ...)
```

Arguments

x	An object returned from the class of CanCorr.
digits	Number of digits in printing the matrices. The default is 4.
...	Unused.

Value

No return value, called for side effects

Author(s)

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---

print.MPCR   *Print Method for MPCR Objects*

Description

Print method for MPCR objects.

Usage

```
## S3 method for class 'MPCR'
print(x, digits = 4, ...)
```

Arguments

x	An object returned from the class of MPCR.
digits	Number of digits in printing the matrices. The default is 4.
...	Unused.

Value

No return value, called for side effects

Author(s)

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---

print.RDA	*Print Method for RDA Objects*

Description

Print method for RDA objects.

Usage

```
## S3 method for class 'RDA'
print(x, digits = 4, ...)
```

Arguments

x	An object returned from the class of RDA.
digits	Number of digits in printing the matrices. The default is 4.
...	Unused.

Value

No return value, called for side effects

Author(s)

Mike W.-L. Cheung mikewlcheung@nus.edu.sg

---

rda   *Redundancy analysis*

Description

This function conducts redundancy analysis using the OpenMx package. Missing data are handled with the full information maximum likelihood method when raw data are available. It provides standard errors for the standardized estimates.

Usage

```
rda(
  X_vars,
  Y_vars,
  data = NULL,
  Cov = NULL,
  numObs = NULL,
  extraTries = 50,
  ...
)
```

Arguments

X_vars	A vector of characters of the X variables.
Y_vars	A vector of characters of the Y variables.
data	A data frame containing raw data. If NULL, Cov and numObs must be provided.
Cov	A covariance or correlation matrix. Required when data is NULL.
numObs	A sample size. Required when data is NULL.
extraTries	This function calls OpenMx::mxTryHard() to obtain parameter estimates and their standard errors. extraTries is the number of extra runs. If extraTries=0, OpenMx::mxRun() is called.
...	Additional arguments passed to either OpenMx::mxTryHard() or OpenMx::mxRun().

Value

A list with class RDA. It stores the model in OpenMx objects. The fitted object is stored in mx.fit.

Author(s)

Mike W.-L. Cheung mikewlcheung@nus.edu.sg

References

Gu, F., Yung, Y.-F., Cheung, M. W.-L., Joo, B.-K., & Nimon, K. (2023). Statistical inference in redundancy analysis: A direct covariance structure modeling approach. *Multivariate Behavioral Research*, **58(5)**, 877-893. doi:10.1080/00273171.2022.2141675

See Also

[Chittum19](), [sas_ex2]()

Examples

```
## Redundancy Analysis
rda(X_vars=c("x1", "x2", "x3", "x4"),
    Y_vars=c("y1", "y2", "y3"),
    data=sas_ex2)
```

---

sas_ex1 *Sample data for canonical correlation analysis from the SAS manual*

Description

This dataset includes six variables of fitness club data from the SAS manual.

Usage

```
sas_ex1
```

Format

A data frame with 20 rows and 6 variables:

Weight Weight measurement

Waist Waist measurement

Pulse Pulse measurement

Chins Number of chin-ups

Situps Number of sit-ups

Jumps Number of jumps

Source

https://documentation.sas.com/doc/en/statcdc/14.2/statug/statug_cancorr_example01.htm

Examples

```
data(sas_ex1)


## Canonical Correlation Analysis
cancorr(X_vars=c("Weight", "Waist", "Pulse"),
        Y_vars=c("Chins", "Situps", "Jumps"),
        data=sas_ex1)
```

---

sas_ex2   *Sample data for redundancy analysis from the SAS manual*

Description

This dataset includes seven variables from the SAS manual.

Usage

```
sas_ex2
```

Format

A matrix with 10 rows and 7 columns:

y1, y2, y3 Y variables

x1, x2, x3, x4 X variables

Source

https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.3/statug/statug_transreg_details23.htm

Examples

```
data(sas_ex2)


## Redundancy Analysis
rda(X_vars=c("x1", "x2", "x3", "x4"),
    Y_vars=c("y1", "y2", "y3"),
    data=sas_ex2)
```

Thorndike00   *Correlation matrix of a model of disgust*

Description

This dataset includes a correlation matrix of 13 variables (n=679) between five subscales (y1 to y5) of the Disgust Emotion Scale and eight subscales (x1 to x8) of the Disgust Scale reported by Thorndike (2000, p. 238).

Usage

```
Thorndike00
```

Format

A list with the following components:

data A 13x13 correlation matrix.

n A sample size (679).

Source

Thorndike, R. M. (2000). Canonical correlation analysis. In H. E. A. Tinsley & S. D. Brown (Eds.), *Handbook of applied multivariate statistics and mathematical modeling* (pp. 237-263). San Diego, CA: Academic Press.

References

Gu, F., Yung, Y.-F., & Cheung, M. W.-L. (2019). Four covariance structure models for canonical correlation analysis: A COSAN modeling approach. *Multivariate Behavioral Research*, **54(2)**, 192-223. doi:10.1080/00273171.2018.1512847

Examples

```
data(Thorndike00)

## Canonical Correlation Analysis
## Note. We swap the X_vars and Y_vars because cancorr() expects that
## X_vars cannot have more variables than Y_vars.

cancorr(X_vars=c("y1", "y2", "y3", "y4", "y5"),
        Y_vars=c("x1", "x2", "x3", "x4", "x5", "x6", "x7", "x8"),
        Cov=Thorndike00$data, numObs=Thorndike00$n)
```

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