

Package ‘rsem’

April 21, 2020

Type Package

Title Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Version 0.5.0

Date 2020-04-21

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Depends R (>= 2.7), MASS, lavaan

Description

A robust procedure is implemented to estimate means and covariance matrix of multiple variables with missing data using Huber weight and then to estimate a structural equation model.

License GPL-2

URL <https://bigdatalab.nd.edu>

ZipData no

LazyLoad yes

NeedsCompilation no

Repository CRAN

Date/Publication 2020-04-21 14:20:02 UTC

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| | |
|--------------|--|
| rsem-package | <i>Robust Structural Equation Modeling with Missing Data and Auxiliary</i> |
|--------------|--|

Description

This package estimates means and covariance matrix of multiple variables with missing data using Huber weight and then estimates a SEM model using either lavaan or EQS.

Details

| | |
|-----------|------------|
| Package: | rsem |
| Type: | Package |
| Version: | 0.4.3 |
| Date: | 2010-12-27 |
| License: | GPL-2 |
| LazyLoad: | yes |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang Maintainer: Zhiyong Zhang <zhiyongzhang@nd.edu>

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

| | |
|------------|-----------------------|
| mardiamv25 | <i>Simulated data</i> |
|------------|-----------------------|

Description

mardiamv25: Original data

mardiamv25_contaminated: Contaminated data with outliers

Usage

```
data(mardiamv25)
data(mardiamv25_contaminated)
```

| | |
|------|--|
| rsem | <i>The main function for robust SEM analysis</i> |
|------|--|

Description

This is the function to carry out all analysis.

Usage

```
rsem(dset, select, EQSmodel, moment=TRUE, varphi=.1, st='i', max.it=1000,
eqsdata='data.txt', eqsweight='weight.txt', EQSpgm="C:/Progra~1/EQS61/WINEQS.EXE",
serial="1234")
```

Arguments

| | |
|-----------|---|
| dset | A data matrix or a data frame |
| select | Variables to be selected for SEM analysis. If omitted, all variables in the data set will be used. |
| moment | With mean structure. For covariance only, set moment=FALSE. |
| EQSmodel | The input file for EQS. If omitted, only the first-stage analysis will be conducted. |
| varphi | Proportion of data to be down-weighted. Default is 0.1. |
| max.it | Maximum number of iterations for EM. Default is 1000 |
| st | Starting values for EM algorithm. The default is 0 for mean and I for covariance. Alternative, the starting values can be estimated according to MCD. |
| eqsdata | Data file name used in EQS |
| eqsweight | File name for weight matrix |
| EQSpgm | The path to the installed EQS program |
| serial | The serial no of EQS |

Details

This function will run the robust analysis and output results.

Value

If EQSmodel is not supplied

| | |
|---------|--|
| sem | Information for SEM analysis including estimated means, covariance matrix and their sandwich type covariance matrix in the order of mean first and then covariance matrix. |
| misinfo | Information related to missing data pattern |
| em | Results from expectation robust algorithm |
| ascov | Covariance matrix |

If EQSmodel is supplied,

| | |
|-----|--|
| sem | Information for SEM analysis including estimated means, covariance matrix and their sandwich type covariance matrix according to the requirement of EQS. |
|-----|--|

In addition, the following model parameters are from EQS

| | |
|----------|-------------------------------------|
| fit.stat | Fit indices and associated p-values |
| para | Parameter estimates |
| eqs | All information from REQS |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

See Also

[rsem.pattern](#), [rsem.emmusig](#), [rsem.Ascov](#)

Examples

```
## Not run:
## an example
## to use eqs, first load the package semdiag
library(semdiag)
data(mardiamv25)
analysis<-rsem(mardiamv25, c(1,2,4,5), 'eqsinput.eqs')

## End(Not run)
```

| | |
|------------|--|
| rsem.Ascov | <i>Sandwich-type covariance matrix</i> |
|------------|--|

Description

Returns the sandwich type covariance matrix. This function is not intended to use separately from the `rsem.emmusig` function.

Usage

```
rsem.Ascov(xpattern, musig, varphi=.1)
```

Arguments

| | |
|----------|--|
| xpattern | Missing data pattern output from <code>rsem.pattern</code> . |
| musig | Robust mean and covariance matrix from <code>rsem.emmusig</code> |
| varphi | Proportion of data to be down-weighted. Default is 0.1. |

Details

Data should be a matrix. To change a data frame to a matrix, using `data.matrix(x)`.

Value

| | |
|-------|---------------------------------|
| Abeta | A matrix |
| Bbeta | B matrix |
| Gamma | Sandwich type covariance matrix |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

See Also

[rsem.emmusig](#)

Examples

```
#dset<-read.table('MardiaMV25.dat.txt', na.string='-99')
#dset<-data.matrix(dset)
#n<-dim(dset)[1]
#p<-dim(dset)[2]
#miss_pattern<-rsem.pattern(n,p,dset)
#misinfo<-miss_pattern$misinfo
#V_forana<-c(1,2,4,5)
#em_results<-rsem.emmusig(dset,misinfo)
#hmu1<-em_results$mu
#hsigma1<-em_results$sigma
#rsem.Ascov(x, hmu1, hsigma1)
```

rsem.DP

Generate a duplication matrix

Description

Generate a duplication matrix

Usage

```
rsem.DP(x)
```

Arguments

x A matrix

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:6, c(2,3))
rsem.DP(x)
```

`rsem.emmusig`*Robust mean and covariance matrix using Huber-type weight*

Description

Robust mean and covariance matrix using Huber-type weight.

Usage

```
rsem.emmusig(xpattern, varphi=.1, max.it=1000, st='i')
```

Arguments

| | |
|-----------------------|---|
| <code>xpattern</code> | Missing data pattern output from <code>rsem.pattern</code> . |
| <code>varphi</code> | Proportion of data to be down-weighted. Default is 0.1. |
| <code>max.it</code> | Maximum number of iterations for EM. Default is 1000 |
| <code>st</code> | Starting values for EM algorithm. The default is 0 for mean and I for covariance. Alternative, the starting values can be estimated according to MCD. |

Details

Estimate mean and covariance matrix using the expectation robust (ER) algorithm.

Value

| | |
|--------------------|--|
| <code>err</code> | Error code. 0: good. 1: maximum iterations are exceeded. |
| <code>mu</code> | Mean vector |
| <code>sigma</code> | Covariance matrix |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

See Also

[rsem.emmusig](#)

Examples

```
#dset<-read.table('MardiaMV25.dat.txt', na.string='-99')
#dset<-data.matrix(dset)
#n<-dim(dset)[1]
#p<-dim(dset)[2]
#miss_pattern<-rsem.pattern(n,p,dset)
#misinfo<-miss_pattern$misinfo
#V_forana<-c(1,2,4,5)
#em_results<-rsem.emmusig(dset,misinfo)
#em_results
```

rsem.fit

Calculate robust test statistics

Description

Calculate robust test statistics

Usage

```
rsem.fit(object, gamma, musig)
```

Arguments

| | |
|--------|---|
| object | Output from lavaan analysis, such as growth, factor, sem functions. |
| gamma | Robust covariance matrix for saturated mean and covariances |
| musig | Robust saturated mean and covariances |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:6, c(2,3))
rsem.vec(x)
```

| | |
|------------|--------------------------|
| rsem.gname | <i>Internal function</i> |
|------------|--------------------------|

Description

Internal function

Usage

```
rsem.gname(name)
```

Arguments

| | |
|------|-----------------|
| name | Variable names. |
|------|-----------------|

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

| | |
|------------|----------------------------|
| rsem.index | <i>rsem.index function</i> |
|------------|----------------------------|

Description

To be added

Usage

```
rsem.index(p, oj)
```

Arguments

| | |
|----|---------------------|
| p | number of variables |
| oj | observed variables |

| | |
|-------------|-----------------------------|
| rsem.indexv | <i>rsem.indexv function</i> |
|-------------|-----------------------------|

Description

Internal function.

Usage

```
rsem.indexv(p, select)
```

Arguments

| | |
|--------|----------------------|
| p | number of variables |
| select | variables to be used |

| | |
|--------------|------------------------------|
| rsem.indexvc | <i>rsem.indexvc function</i> |
|--------------|------------------------------|

Description

Internal function.

Usage

```
rsem.indexvc(p, select)
```

Arguments

| | |
|--------|----------------------|
| p | number of variables |
| select | variables to be used |

`rsem.lavaan`*Conduct robust SEM analysis using lavaan*

Description

Conduct robust SEM analysis using lavaan

Usage

```
rsem.lavaan(dset, model, select, varphi=.1, max.it=1000)
```

Arguments

| | |
|---------------------|--|
| <code>dset</code> | A data matrix or a data frame |
| <code>select</code> | Variables to be selected for SEM analysis. If omitted, all variables in the data set will be used. |
| <code>model</code> | The model using lavaan syntax |
| <code>varphi</code> | Proportion of data to be down-weighted. Default is 0.1. |
| <code>max.it</code> | Maximum number of iterations for EM. Default is 1000 |

Details

This function will run the robust analysis and output results.

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Yuan, K.-H., & Zhang, Z. (2012). Robust Structural Equation Modeling with Missing Data and Auxiliary Variables. *Psychometrika*, 77(4), 803-826.

See Also

[rsem.pattern](#), [rsem.emmusig](#), [rsem.Ascov](#)

Examples

```
data(mardiamv25)
names(mardiamv25)<-paste('V', 1:5, sep='')

fa.model<-'f1 =~ V1 + V2
f2 =~ V4 + V5
f1 ~ 1
f2 ~ 1
```

```
V1 ~0*1
V2 ~0*1
V4 ~0*1
V5 ~0*1'

analysis<-rsem.lavaan(mardiamv25, fa.model, c(1,2,4,5))
```

rsem.pattern

Obtaining missing data patterns

Description

This function obtains the missing data patterns and the number of cases in each patterns. It also tells the number of observed variables and their indices for each pattern.

Usage

```
rsem.pattern(x, print=FALSE)
```

Arguments

| | |
|-------|--|
| x | A matrix as data |
| print | Whether to print the missing data pattern. The default is FALSE. |

Details

The missing data pattern matrix has $2+p$ columns. The first column is the number cases in that pattern. The second column is the number of observed variables. The last p columns are a matrix with 1 denoting observed data and 0 denoting missing data.

Value

| | |
|---------|--|
| x | Data ordered according to missing data pattern |
| misinfo | Missing data pattern matrix |
| mispat | Missing data pattern in better readable form. |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
#dset<-read.table('MardiaMV25.dat.txt', na.string='-99')
#dset<-data.matrix(dset)
#n<-dim(dset)[1]
#p<-dim(dset)[2]
#miss_pattern<-rsem.pattern(n,p,dset)
#miss_pattern
```

rsem.print

Organize the output for Lavaan with robust s.e. and test statistics

Description

Organize the output for Lavaan with robust s.e. and test statistics. Modified from the print function of Lavaan.

Usage

```
rsem.print(object, robust.se, robust.fit, estimates=TRUE, fit.measures=FALSE,
standardized=FALSE, rsquare=FALSE, std.nox=FALSE, modindices=FALSE)
```

Arguments

| | |
|--------------|---|
| object | Output from lavaan analysis, such as growth, factor, sem functions. |
| robust.se | Robust standard error from the function rsem.se |
| robust.fit | Robust fit statistics from the function rsem.fit |
| estimates | Show parameter estimates |
| fit.measures | Show fit statistics of lavaan (no need for it) |
| standardized | standardized coefficients |
| rsquare | R square for dependent variables. |
| std.nox | to add |
| modindices | Modification indices |

Details

This function will run the robust analysis and output results.

Value

If EQSmodel is not supplied

| | |
|---------|--|
| sem | Information for SEM analysis including estimated means, covariance matrix and their sandwich type covariance matrix in the order of mean first and then covariance matrix. |
| misinfo | Information related to missing data pattern |

em Results from expectation robust algorithm
 ascov Covariance matrix

If EQSmodel is supplied,

sem Information for SEM analysis including estimated means, covariance matrix and their sandwich type covariance matrix according to the requirement of EQS.

In addition, the following model parameters are from EQS

fit.stat Fit indices and associated p-values
 para Parameter estimates
 eqs All information from REQS

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

See Also

[rsem.pattern](#), [rsem.emmusig](#), [rsem.Ascov](#)

Examples

```
##\dontrun{
## an example
data(mardiamv25)
names(mardiamv25)<-paste('V', 1:5, sep='')

fa.model<-'f1 =~ V1 + V2
f2 =~ V4 + V5
f1 ~ 1
f2 ~ 1
V1 ~0*1
V2 ~0*1
V4 ~0*1
V5 ~0*1'

pat<-rsem.pattern(mardiamv25)

phi<-0.1
musig<-rsem.emmusig(pat, varphi=phi)

res.lavaan<-sem(fa.model, sample.cov=musig$sigma, sample.mean=musig$mu, sample.nobs=88,mimic='EQS')

ascov<-rsem.Ascov(pat, musig, varphi=phi)
```

```
robust.se<-rsem.se(res.lavaan, ascov$Gamma)
robust.fit <- rsem.fit(res.lavaan, ascov$Gamma, musig)
rsem.print(res.lavaan, robust.se, robust.fit)
## }
```

rsem.se

Calculate robust standard errors

Description

Calculate robust standard errors

Usage

```
rsem.se(object, gamma)
```

Arguments

| | |
|--------|---|
| object | Output from lavaan analysis, such as growth, factor, sem functions. |
| gamma | Robust covariance matrix for saturated mean and covariances |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:6, c(2,3))
rsem.vec(x)
```

rsem.ssq

Calculate the squared sum of a matrix

Description

Calculate the squared sum of a matrix

Usage

```
rsem.ssq(x)
```

Arguments

x A matrix

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:6, c(2,3))  
rsem.ssq(x)
```

rsem.switch

swith function

Description

swith function

Usage

```
rsem.switch(p)
```

Arguments

p number of variables

rsem.switch.gamma *Internal function*

Description

Internal function

Usage

```
rsem.switch.gamma(gamma, ov.names)
```

Arguments

| | |
|----------|---|
| gamma | Robust covariance matrix for saturated mean and covariances |
| ov.names | Observed variable names. |

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

rsem.vec *Stacking a matrix to a vector*

Description

Stacking a matrix to a vector

Usage

```
rsem.vec(x)
```

Arguments

| | |
|---|----------|
| x | A matrix |
|---|----------|

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:6, c(2,3))
rsem.vec(x)
```

rsem.vech

Stacking lower triange of a matrix to a vector

Description

Stacking lower triange of a matrix to a vector

Usage

```
rsem.vech(x)
```

Arguments

x A matrix

Author(s)

Ke-Hai Yuan and Zhiyong Zhang

References

Ke-Hai Yuan and Zhiyong Zhang (2011) Robust Structural Equation Modeling with Missing Data and Auxiliary Variables

Examples

```
x<-array(1:9, c(3,3))
rsem.vec(x)
```

| | |
|-------------|--|
| rsem.weight | <i>Calculate weight for each subject</i> |
|-------------|--|

Description

Calculate weight for each subject in estimating the mean and covariance matrix.

Usage

```
rsem.weight(x, varphi, mu0, sig0)
```

Arguments

| | |
|--------|---------------------------|
| x | Data |
| varphi | Downweight rate. |
| mu0 | Robust mean |
| sig0 | Robust covariance matrix. |

Value

| | |
|----|--|
| w1 | Weight for robust mean estimates |
| w2 | Weight for robust covariance estimates |

Author(s)

Zhiyong Zhang and Ke-Hai Yuan

References

Yuan, K.-H., & Zhang, Z. (2012). Robust Structural Equation Modeling with Missing Data and Auxiliary Variables. *Psychometrika*, 77(4), 803-826.

| | |
|----------------------|---|
| semdiag.combinations | <i>Enumerate the Combinations of the Elements of a Vector</i> |
|----------------------|---|

Description

Enumerate the Combinations of the Elements of a Vector

Usage

```
semdiag.combinations(n, r)
```

Arguments

| | |
|---|----------------------------|
| n | Size of the source vector |
| r | Size of the target vectors |

semdiag.read.eq.s *Import of EQS outputs into R*

Description

This function reads EQS output files (.ets, .CBK and .ETP) into R and stores the results as objects.

Usage

```
semdiag.read.eq.s(file)
```

Arguments

| | |
|------|---|
| file | The name (string) of the .ets file or the full path which the data are to be read from. If it does not contain an absolute path, the file name is relative to the current working directory, 'getwd()'. A .CBK and .ETP file have to be of the same name and in the same directory. |
|------|---|

Details

The value list below provides objects for the full EQS output. If in EQS some objects are not computed, the corresponding values in R are NA.

Value

Returns a list with the following objects:

| | |
|-------------|--|
| model.info | General model information |
| pval | p-values for various test statistics |
| fit.indices | Variuos fit indices |
| model.desc | Descriptive measures |
| Phi | Phi matrix |
| Gamma | Gamma matrix |
| Beta | Beta matrix |
| par.table | Parameter table (with standard errors) |
| sample.cov | Sample covariance matrix |
| sigma.hat | Model covariance matrix |
| inv.infmt | Inverse information matrix |
| rinv.infmt | Robust inverse information matrix |
| cinv.infmt | Corrected inverse information matrix |
| derivatives | First derivatives |
| moment4 | Matrix with 4th moments |
| ssolution | Standardized elements |

| | |
|-----------|--|
| Rsquared | R-squared measures |
| fac.means | Factor means |
| var.desc | Descriptive measures for the variables (univariate statistics) |
| indstd | Independent variable standardization vector |
| depstd | Dependent variable standardization vector |

Author(s)

Patrick Mair, Eric Wu

References

Bentler, P. M. (2008). EQS Program Manual. Encino, CA: Multivariate Software Inc.

See Also

[semdiag.call.eqs](#), [semdiag.run.eqs](#)

| | |
|-----------------|-----------------------|
| semdiag.run.eqs | <i>Run EQS from R</i> |
|-----------------|-----------------------|

Description

Calls an EQS script file from R, executes EQS, and imports the results into R. Basically it is a wrapper function of `call.eqs` and the subsequent `read.eqs`.

Usage

```
semdiag.run.eqs(EQSpgm, EQSmodel, serial, Rmatrix = NA, datname = NA, LEN = 2000000)
semdiag.call.eqs(EQSpgm, EQSmodel, serial, Rmatrix = NA, datname = NA, LEN = 2000000)
```

Arguments

| | |
|----------|--|
| EQSpgm | String containing path where EQS is located (see details) |
| EQSmodel | String containing path where .eqs script file is located (see details) |
| serial | EQS serial number as integer value |
| Rmatrix | Optional matrix argument if data or covariances are stored in R |
| datname | If data is specified, a filename (string) must be provided for saving the data in text format (blank separated; see details) |
| LEN | Integer containing number of working array units. By default, it is 2000000 8 bytes units |

Details

If the path in EQSpgm and EQSmodel contains a blank, single quotes and double quotes are required in argument. See EQSpgm argument in examples. The last statement in the EQSpgm argument refers to the name of the executable program file. Under Windows it is ".../WINEQS" (referring to WINEQS.exe), under Mac ".../MACEQS" and under Linux ".../EQS". When specifying the path, use slash instead of backslash.

The .ETS, .CBK and .ETP files are written in the directory where the .eqs file is located. Note that these 3 files must be in the same directory than the .eqs file.

The argument datname must match with the input data specified in the corresponding .eqs file. This option can be used for simulations: Generate data in R, run.eq() on with the corresponding data argument, pick out the relevant return values.

The value list below provides objects for the full EQS output. If in EQS some objects are not computed, the corresponding values in R are NA.

Value

Returns a list with the following objects:

| | |
|-------------|--|
| success | TRUE if estimation was successful, FALSE otherwise |
| model.info | General model information |
| pval | p-values for various test statistics |
| fit.indices | Variuos fit indices |
| model.desc | Descriptive measures |
| Phi | Phi matrix |
| Gamma | Gamma matrix |
| Beta | Beta matrix |
| par.table | Parameter table (with standard errors) |
| sample.cov | Sample covariance matrix |
| sigma.hat | Model covariance matrix |
| inv.infmat | Inverse information matrix |
| rinv.infmat | Robust inverse information matrix |
| cinv.infmat | Corrected inverse information matrix |
| derivatives | First derivatives |
| moment4 | Matrix with 4th moments |
| ssolution | Standardized elements |
| Rsquared | R-squared measures |
| fac.means | Factor means |
| var.desc | Descriptive measures for the variables (univariate statistics) |
| indstd | Independent variable standardization vector |
| depstd | Dependent variable standardization vector |

Author(s)

Patrick Mair, Eric Wu

References

Bentler, P. M. (1995). EQS Program Manual. Encino, CA: Multivariate Software Inc.

See Also

[semdiag.read.eqs](#), [semdiag.call.eqs](#)

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