Package 'GRRGI'

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Depends nlme, lme4, arm, car

Description Generates confidence intervals for the variance components for Gauge R and R data using ANOVA with the Satterthwaite approximation as well as the method of Generalized Inference.

License GPL-2

LazyLoad yes

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GRRGI-package *Components of Variance and their Confidence Intervals for Gauge R and R Studies*

Description

Calculates components of Variance estimates for Gauge R and R Studies using ANOVA and Restricted Maximum Likelihood. Also generates the confidence intervals using the Satterthwaite approximation with the ANOVA estimates, and using the method of Generalized Inference with the maximum likelihood estimates. Also generates line plots to compare the Satterthwaite and Generalized Inference confidence limits.

Details

Package:	GRRGI
Type:	Package
Version:	1.1
Date:	2009-05-17
License:	GPL-2
LazyLoad:	yes

Gauge R and R input data need to be in a matrix with columns named 'resp', 'part' and 'operator'. Example of data sets are provided in 'HWstudy1' and 'HWstudy2'.

'anovasat' calculates the components of variance using ANOVA and the the confidence intervals for repeatability, reproducibility and total gauge using the Satterthwaite approximation.

'MLGI' calculates the components of variance using restricted maximum likelihood and the the confidence intervals using the method of generalized inference.

Version 1.1

1 Fix the labels on ratiograph. 2 Use the same random variables for both numerator and denominator of ratios (Generalized Inference). 3 Test for and stop the functions anovasat and MLGI if data is unbalanced. 4 change ML label to REML.

Author(s)

Walter Resch <walt55128@msn.com>

References

Package is based on Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

MLGI, anovasat, intsignif, RRgraph, ratiograph

Examples

```
data(HWstudy1)
sat<-anovasat(HWstudy1,0.95)
ML<-MLGI(HWstudy1,0.95,1000)
intsignif(HWstudy1)
RRgraph(sat,ML)
ratiograph(sat,ML)
```

---

anovasat *ANOVA Estimates of Variance and Satterthwaite Confidence Limits for Gauge R and R Data*

Description

Returns a matrix of the ANOVA Estimates of Variance for gauge R and R studies. Also provides the confidence intervals for repeatability, reproducibility and total gauge using the Satterthwaite approximation as shown on page 244 of Hamada and Weerandi.

Usage

```
anovasat(data, prob)
```

Arguments

data	Gauge R and R data, a matrix with columns named 'resp', 'part' and 'operator' in any order
prob	desired confidence level such as 0.95 - a constant between 0 and 1

Details

Returns a matrix with 17 rows and three columns with the estimates: SD:Part, SD:Operator, SD:PartOp, SD:Repeat, SD:Reproduce, SD:Gauge, SD:Total (standard deviations), then Var:Part, Var:Operator, Var:PartOp, Var:Repeat, Var:Reproduce, Var:Gauge, Var:Total (variances), then Gauge/Total, Gauge/Parts, Repeat/Gauge (ratios.)

The columns are 'ANOVA est' (the ANOVA based variance estimate,) 'Lower STH', 'Upper STH'. The 'Lower STH' and 'Upper STH' are the Satterthwaite based confidence limits. They are calculated for repeatability, reproducibility and total gauge. 'anovasat' will eliminate the 'part operator' interaction factor if its P value is greater than 0.25.

Value

A matrix with 17 rows and three columns with the estimates.

Note

The 'data' argument needs to be a matrix with columns named 'resp', 'part' and 'operator'.

Author(s)

Walter Resch <walt55128@msn.com>

References

Package is based on Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

MLGI, RRgraph, ratiograph

Examples

```
data(HWstudy1)
anovasat(HWstudy1,0.95)
```

GI1 *MLGI Output From Study 1*

Description

Output from function MLGI, a matrix of the variance estimates from study 1 of Hamada and Weerandi

Usage

```
data(GI1)
```

Format

A matrix with 17 rows on the following 4 variables.

`ML` a numeric vector of maximum likelihood estimates

`Lower GI` a numeric vector of Generalized Inference 95 percent Lower confidence limits

`Mid GI` a numeric vector of Generalized Inference midpoint values

`Upper GI` a numeric vector of Generalized Inference 95 percent Upper confidence limits

Details

GI1 is the output from function MLGI using study 1 data of Hamada and Weerandi. It gives the restricted maximum likelihood estimates of variance and the confidence intervals using the method of generalized inference as discussed in Hamada and Weerandi. This object can be used to demonstrate the graphing functions.

Source

Study 1 data is from Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(GI1)
data(sat1)
ratiograph(sat1,GI1)
RRgraph(sat1,GI1)
```

GI2 *MLGI Output From Study 2*

Description

Output from function MLGI, a matrix of the variance estimates from study 2 of Hamada and Weerandi

Usage

```
data(GI2)
```

Format

A matrix with 17 rows on the following 4 variables.

`ML` a numeric vector of Maximum Likelihood estimates

`Lower GI` a numeric vector of Generalized Inference 95 percent Lower confidence limits

`Mid GI` a numeric vector of Generalized Inference midpoint values

`Upper GI` a numeric vector of Generalized Inference 95 percent Upper confidence limits

Details

GI2 is the output from function MLGI using study 2 data of Hamada and Weerandi. It gives the restricted maximum likelihood estimates of variance and the confidence intervals using the method of generalized inference as discussed in Hamada and Weerandi. This object can be used to demonstrate the graphing functions.

Source

Study 2 data is from Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(GI2)
data(sat2)
ratiograph(sat2,GI2)
RRgraph(sat2,GI2)
```

HWstudy1 *Gauge R and R: Study 1*

Description

Gauge R and R study 1 data of Hamada and Weerandi

Usage

```
data(HWstudy1)
```

Format

A data frame with 120 observations on the following 3 variables.

`part` a numeric vector of part numbers

`operator` a numeric vector of operator numbers

`resp` a numeric vector of response data

Details

Gauge R and R data, a matrix of 3 columns and 120 rows. As required for the functions anovasat and MLGI, the columns are named: resp, part and operator. There are 20 parts, 3 operators and each has two repeats.

Source

Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(HWstudy1)
anovasat(HWstudy1,0.95)
MLGI(HWstudy1,0.95,1000)
intsignif(HWstudy1)
```

HWstudy2 *Gauge R and R: Study 2*

Description

Gauge R and R study 2 data of Hamada and Weerandi

Usage

```
data(HWstudy2)
```

Format

A data frame with 40 observations on the following 3 variables.

`part` a numeric vector of part numbers

`operator` a numeric vector of operator numbers

`resp` a numeric vector of response data

Details

Gauge R and R data, a matrix of 3 columns and 40 rows. As required for the functions anovasat and MLGI, the columns are named: resp, part and operator. There are 10 parts, 2 operators and each has two repeats.

Source

Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(HWstudy2)
anovasat(HWstudy2,0.95)
MLGI(HWstudy2,0.95,1000)
intsignif(HWstudy2)
```

intsignif *P Value of Interaction for Gauge R and R Data*

Description

Displays the P value of the 'part operator' interaction for a gauge R and R data set.

Usage

```
intsignif(data)
```

Arguments

data	Gauge R and R data set, a matrix with columns named 'resp', 'part' and 'operator'

Details

From a Gauge R and R data set with columns named resp, part and operator, 'intsignif' displays the P value of the 'part operator' interaction. The function creates the interaction factor.

It dsplays two P values. One is the P value of the interaction factor in an ANOVA analysis. And the other is the likelihood ratio done by doing two lmer models (linear mixed effects), one nested in the other.

Value

A vector of the two P values

Note

The argument needs to be a matrix with columns named 'resp', 'part' and 'operator'.

Author(s)

Walter Resch <walt55128@msn.com>

References

Package is based on Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

anovasat, MLGI, HWstudy1, HWstudy2

Examples

```
data(HWstudy1)
intsignif(HWstudy1)
```

MLGI *Restricted Maximum Likelihood Estimates of Variance and Generalized Inference Confidence Limits for Gauge R and R Data*

Description

Returns a matrix of the Restricted Maximum Likelihood Estimates of Variance for gauge R and R studies. Also provides the confidence intervals using Gerneralized Inference as developed by Hamada and Weerandi.

Usage

```
MLGI(data, prob, N)
```

Arguments

data	Gauge R and R data, a matrix with columns named 'resp', 'part' and 'operator' in any order
prob	desired confidence level such as 0.95 - a constant between 0 and 1
N	desired number of simulations for Gerneralized Inference

Details

Returns a matrix with 17 rows and four columns with the estimates: SD:Part, SD:Operator, SD:PartOp, SD:Repeat, SD:Reproduce, SD:Gauge, SD:Total (standard deviations.) Then Var:Part, Var:Operator, Var:PartOp, Var:Repeat, Var:Reproduce, Var:Gauge, Var:Total (variances.) Then Gauge/Total, Gauge/Parts, Repeat/Gauge (ratios.)

The columns are 'REML est' (restricted maximum likelihood estimate,) 'Lower GI', 'Mid GI', 'Upper GI'. The Lower and Upper GI are the Generalized Inference confidence limits. 'MLGI' will eliminate the 'part operator' interaction factor if the P value of the likelihood ratio test is greater than 0.25.

Value

A matrix with 17 rows and four columns with the estimates.

Note

The 'data' argument needs to be a matrix with columns named 'resp', 'part' and 'operator'.

Author(s)

Walter Resch <walt55128@msn.com>

References

Package is based on Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

anovasat, RRgraph, ratiograph

Examples

```
data(HWstudy1)
MLGI(HWstudy1,0.95,1000)
```

`ratiograph` *Line Plot of Generalized Inference Confidence Limits for Gauge R and R Ratios*

Description

ratiograph generates a line plot of confidence intervals for gauge R and R ratios from 'MLGI' (generalized inference). It also displays the ANOVA estimate of the ratio from 'anovasat'.

Usage

```
ratiograph(sat1,GI1)
```

Arguments

`sat1`	output from 'anovasat'
`GI1`	output from 'MLGI'

Details

ratiograph generates a line plot of confidence intervals for gauge R and R ratios from 'MLGI' (generalized inference). It also displays the ANOVA estimate of the ratio from 'anovasat'. The data are contained in two matrices that were generated from the functions anovasat and MLGI.

Value

Line Plot

Note

The arguments need to be the specific outputs from anovasat and MLGI that were run on the same data and at the same percent confidence limits.

Author(s)

Walter Resch <walt55128@msn.com>

References

Based on paper by Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

anovasat, MLGI, sat1, GI1, RRgraph

Examples

```
data(sat1)
data(GI1)
ratiograph(sat1,GI1)
```

RRgraph *Comparison Plot of Satterthwaite and Generalized Inference Confidence Limits*

Description

RRgraph generates a line plot comparing the gauge, reproducibility and repeatability confidence intervals from 'anovasat' (Satterthwaite) to the confidence intervals from 'MLGI' (generalized inference).

Usage

```
RRgraph(sat1,GI1)
```

Arguments

sat1	output from 'anovasat'
GI1	output from 'MLGI'

Details

RRgraph generates a line plot comparing the gauge, reproducibility and repeatability confidence intervals from 'anovasat' (Satterthwaite) to the confidence intervals from 'MLGI' (generalized inference). The confidence intervals are contained in two matrices that were generated from the functions anovasat and MLGI.

Value

Line plot

Note

The arguments need to be the specific outputs from anovasat and MLGI that were run on the same data and at the same confidence level.

Author(s)

Walter Resch <walt55128@msn.com>

References

Based on paper by Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

See Also

anovasat, MLGI, sat1, GI1, ratiograph

Examples

```
data(sat1)
data(GI1)
RRgraph(sat1,GI1)
```

---

sat1 *anovasat Output From Study 1*

Description

Output from function anovasat, a matrix of the estimates from study 1 of Hamada and Weerandi

Usage

```
data(sat1)
```

Format

A matrix with 17 rows on the following 3 variables.

`ANOVA est` a numeric vector of ANOVA estimates

`Lower STH` a numeric vector of Satterthwaite 95 percent Lower confidence limits

`Upper STH` a numeric vector of Satterthwaite 95 percent Upper confidence limits

Details

sat1 is the output from function anovasat using study 1 data of Hamada and Weerandi. It gives the ANOVA estimates of variance and the confidence intervals for repeat, reproducibility and gauge using the Satterthwaite approximation as presented in Hamada and Weerandi. This object can be used to demonstrate the graphing functions.

Source

Study 1 data is from Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(sat1)
data(GI1)
ratiograph(sat1,GI1)
RRgraph(sat1,GI1)
```

---

sat2 *anovasat Output From Study 2*

Description

Output from function anovasat, a matrix of the estimates from study 2 of Hamada and Weerandi

Usage

```
data(sat2)
```

Format

A matrix with 17 rows on the following 3 variables.

`ANOVA est` a numeric vector of ANOVA estimates

`Lower STH` a numeric vector of Satterthwaite 95 percent Lower confidence limits

`Upper STH` a numeric vector of Satterthwaite 95 percent Upper confidence limits

Details

sat2 is the output from function anovasat using study 2 data of Hamada and Weerandi. It gives the ANOVA estimates of variance and the confidence intervals for repeat, reproducibility and gauge using the Satterthwaite approximation as presented in Hamada and Weerandi. This object can be used to demonstrate the graphing functions.

Source

Study 1 data is from Michael Hamada and Sam Weerandi (July 2000) Measurement System Assessment Via Generalized Inference, Journal of Quality Technology 32, 241-253

Examples

```
data(sat2)
data(GI2)
ratiograph(sat2,GI2)
RRgraph(sat2,GI2)
```

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