

Package ‘StroupGLMM’

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Type Package

Title R Codes and Datasets for Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

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Maintainer Muhammad Yaseen <myaseen208@gmail.com>

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URL <https://myaseen208.com/StroupGLMM/>
<https://CRAN.R-project.org/package=StroupGLMM>

BugReports <https://github.com/myaseen208/StroupGLMM/issues>

Depends R (>= 3.1)

Imports aod, broom.mixed, car, dplyr, emmeans, ggplot2, lmerTest, magrittr, MASS, mutoss, nlme, parameters, phia, scatterplot3d, stats, survey

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Note 1. School of Mathematical & Statistical Sciences, Clemson University, Clemson, South Carolina, USA 2. Department of Mathematics and Statistics, University of Agriculture Faisalabad, Faisalabad, Pakistan

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Author Muhammad Yaseen [aut, cre, cph]
(<<https://orcid.org/0000-0002-5923-1714>>),
Adeela Munawar [aut, ctb],
Walter W. Stroup [aut, ctb],
Kent M. Eskridge [aut, ctb]

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DataExam2.B.2

Data for Example 2.B.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-54)

Description

Exam2.B.2 is used to visualize the effect of glm model statement with binomial data with logit and probit links.

Usage

```
data(DataExam2.B.2)
```

Format

A data.frame with 11 rows and 3 variables.

Details

- x independent variable
- n bernouli trials (bernouli outcomes on each individual)
- y number of successes on each individual

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam2.B.2](#)

Examples

```
data(DataExam2.B.2)
```

DataExam2.B.3

Data for Example 2.B.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-55)

Description

Exam2.B.3 is used to illustrate one way treatment design with Gaussian observations.

Usage

```
data(DataExam2.B.3)
```

Format

A data.frame with 6 rows and 2 variables.

Details

- trt treatments as factor with number 1 to 3
- y response variable

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam2.B.3](#)

Examples

```
data(DataExam2.B.3)
```

DataExam2.B.4

Data for Example 2.B.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-54)

Description

Exam2.B.4 is used to illustrate one way treatment design with Binomial observations.

Usage

```
data(DataExam2.B.4)
```

Format

A data.frame with 6 rows and 4 variables.

Details

- obs number of observations
- trt three treatments with class factor
- Nij number of bernouli trials on each individual
- y number of successes on each individual

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam2.B.4](#)

Examples

```
data(DataExam2.B.4)
```

DataExam2.B.7

Data for Example 2.B.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-60)

Description

Exam2.B.7 is related to multi batch regression data assuming different forms of linear models with factorial experiment.

Usage

```
data(DataExam2.B.7)
```

Format

A data.frame with 16 rows and 4 variables.

Details

- Rep number of replications
- a factor with two levels 1 and 2
- b factor with two levels 1 and 2
- y response variable

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam2.B.7](#)

Examples

```
data(DataExam2.B.7)
```

DataSet3.1	<i>Data for Example 3.1 and Example 3.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup</i>
------------	---

Description

DataSet3.1 is used for linear and generalized linear models

Usage

```
data(DataSet3.1)
```

Format

A data.frame with 20 rows and 5 variables.

Details

- trt two treatment 0 and 1
- rep unit of observation or observation ID
- Y is continuous & may be assumed Gaussian
- N is the number of obs
- F is the number of "successes"(N and F specify a binomial response)

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam3.2](#)

Examples

```
data(DataSet3.1)
```

DataSet3.2 *DataSt3.2 for Example 3.3, Example 3.4, Example3.6, Example3.8 and Example 3.9 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet3.2 Multi-Location, 4 Treatment Randomized Block

Usage

```
data(DataSet3.2)
```

Format

A data.frame with 32 rows and 10 variables.

Details

- trt two treatment 0 and 1
- loc four locations used as blocks
- Y is Gaussian response variable
- Nbin subjects at each Loc x Trt for binomial response
- S1 and S2 are two binomial response variables
- count1 and count 2 used later
- A and B are factors with level 0 and 1

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam3.3](#) [Exam3.9](#)

Examples

```
data(DataSet3.2)
```

DataSet3.3

Data for Example3.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Exam1.2 is used to see types of model effects by plotting regression data

Usage

```
data(DataSet3.3)
```

Format

A data . frame with 36 rows and 6 variables.

Details

- X Each batch observed at several times:0,3,6,12,24,36,48 months
- Y continuous variable observed at each level of X
- Fav number of successes
- N is independent bernoulli trials
- Batch Batches as 1, 2, 3, 4
- Count binomial response variable

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

Examples

```
data(DataSet3.3)
```

DataSet4.1

Data for Example 4.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

DataSet4.1 comes from Cochran and Cox (1957) Experimental Design

Usage

```
data(DataSet4.1)
```

Format

A data.frame with 60 rows and 3 variables.

Details

- blocks 15 blocks in an incomplete block design
- trt treatments representing incomplete block design
- y is continuous & may be assumed Gaussian

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.
2. Cochran, W. G., & Cox, G. M. (1957). *Experimental designs*.

See Also

[Exam4.1](#)

Examples

```
data(DataSet4.1)
```

DataSet5.1

Data for Example 5.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

DataSet5.1 is used for polynomial multiple regression

Usage

```
data(DataSet5.1)
```

Format

A data.frame with 14 rows and 3 variables.

Details

- X is predictor variable with level 0, 1, 2, 4, 8, 12, 16
- N is the number of independent bernoulli trials for a given observation
- F is the number of "successes"(N and F specify a binomial response)

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam5.1](#)

Examples

```
data(DataSet5.1)
```

DataSet5.2

Data for Example 5.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

DataSet5.2 is used for three factor orthogonal main effects only design with sequential fitting of predictors

Usage

```
data(DataSet5.2)
```

Format

A data.frame with 9 rows and 4 variables.

Details

- a is predictor variable with level 0, 1
- b is predictor variable with level 0, 1
- c is predictor variable with level 0, 1
- y response variable

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam5.2](#)

Examples

```
data(DataSet5.2)
```

DataSet7.1

Data for Example 7.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.1)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam7.1](#)

Examples

```
data(DataSet7.1)
```

DataSet7.2

Data for Example 7.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.2)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam7.2](#)

Examples

```
data(DataSet7.2)
```

DataSet7.3

Data for Example 7.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.3)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam7.3](#)

Examples

```
data(DataSet7.3)
```

DataSet7.4

Data for Example 7.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.4)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

Examples

```
data(DataSet7.4)
```

DataSet7.4rsm

Data for Example 7.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.4rsm)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

Examples

```
data(DataSet7.4rsm)
```

DataSet7.6

Data for Example 7.6 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.6 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.6)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam7.6.2.1](#)

Examples

```
data(DataSet7.6)
```

DataSet7.7

Data for Example 7.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Description

Data for Example 7.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup

Usage

```
data(DataSet7.7)
```

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

Examples

```
data(DataSet7.7)
```

Exam1.1

Example1.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-5)

Description

Exam1.1 is used for inspecting probability distribution and to define a plausible process through linear models and generalized linear models.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also[Table1.1](#)**Examples**

```

#-----
## Linear Model and results discussed in Article 1.2.1 after Table1.1
#-----
data(Table1.1)
Exam1.1.lm1 <- lm(formula = y/Nx ~ x, data = Table1.1)
summary(Exam1.1.lm1 )
library(parameters)
model_parameters(Exam1.1.lm1)

#-----
## GLM fitting with logit link (family=binomial)
#-----
Exam1.1.glm1 <-
  glm(
    formula = y/Nx ~ x
    , family = binomial(link = "logit")
    , data = Table1.1
  )
## this glm() function gives warning message of non-integer success
summary(Exam1.1.glm1)
model_parameters(Exam1.1.glm1)

#-----
## GLM fitting with logit link (family = Quasibinomial)
#-----
Exam1.1.glm2 <-
  glm(
    formula = y/Nx~x
    , family = quasibinomial(link = "logit")
    , data = Table1.1
  )
## problem of "warning message of non-integer success" is overome by using quasibinomial family
summary(Exam1.1.glm2)
model_parameters(Exam1.1.glm2)

#-----
## GLM fitting with survey package(produces same result as using quasi binomial family in glm)
#-----
library(survey)
design <- svydesign(ids = ~1, data = Table1.1)

Exam1.1.svyglm <-
  svyglm(
    formula = y/Nx~x
    , design = design
    , family = quasibinomial(link = "logit")
  )

```

```

summary(Exam1.1.svyglm)
model_parameters(Exam1.1.svyglm)

#-----
## Figure 1.1
#-----
Newdata <-
  data.frame(
    Table1.1
    , LM      = Exam1.1.lm1$fitted.values
    , GLM     = Exam1.1.glm1$fitted.values
    , QB      = Exam1.1.glm2$fitted.values
    , SM      = Exam1.1.svyglm$fitted.values
  )
#-----
## One Method to plot Figure1.1
#-----
library(ggplot2)

Figure1.1 <-
  ggplot(
    data      = Newdata
    , mapping = aes(x = x, y = y/Nx)
  ) +
  geom_point (
    mapping = aes(colour = "black")
  ) +
  geom_point (
    data      = Newdata
    , mapping = aes(x = x, y = LM, colour = "blue"), shape = 2
  ) +
  geom_line(
    data      = Newdata
    , mapping = aes(x = x, y = LM, colour = "blue")
  ) +
  geom_point (
    data      = Newdata
    , mapping = aes(x = x, y = GLM, colour = "red"), shape = 3
  ) +
  geom_smooth (
    data      = Newdata
    , mapping = aes(x = x, y = GLM, colour = "red")
    , stat    = "smooth"
  ) +
  theme_bw() +
  scale_colour_manual (
    values = c("black", "blue", "red"),
    labels = c("observed", "LM", "GLM")
  ) +
  guides (
    colour = guide_legend(title = "Plot")
  ) +
  labs (

```

```

    title    = "Linear Model vs Logistic Model"
  ) +
  labs (
    y        = "p"
  )
print(Figure1.1)

#-----
## Another way to plot Figure 1.1
#-----
newdata  <-
  data.frame(
    P      = c(
      Table1.1$y/Table1.1$Nx
      , Exam1.1.lm1$fitted.values
      , Exam1.1.glm1$fitted.values
    )
    , X    = rep(Table1.1$x, 3)
    , group = rep(c('Obs','LM','GLM'), each = length(Table1.1$x))
  )

Figure1.1 <-
  ggplot(
    data    = newdata
    , mapping = aes(x = X , y = P)
  ) +
  geom_point(
    mapping = aes(x = X , y = P, colour = group , shape=group)
  ) +
  geom_smooth(
    data    = subset(x = newdata, group == "LM")
    , mapping = aes(x=X,y=P)
    , col    = "green"
  ) +
  geom_smooth(
    data    = subset(x = newdata, group=="GLM")
    , mapping = aes(x = X , y = P)
    , col    = "red"
  ) +
  theme_bw() +
  labs(
    title  = "Linear Model vs Logistic Model"
  )
print(Figure1.1)

#-----
## Correlation among p and fitted values using Gaussian link
#-----
(lmCor <- cor(Table1.1$y/Table1.1$Nx, Exam1.1.lm1$fitted.values))

#-----
## Correlation among p and fitted values using quasi binomial link
#-----

```

```
(glmCor <- cor(Table1.1$y/Table1.1$Nx, Exam1.1.glm1$fitted.values))
```

Exam1.2

Example1.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-9)

Description

Exam1.2 is used to see types of model effects by plotting regression data

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[Table1.2](#)

Examples

```
#-----
## Plot of multi-batch regression data discussed in Article 1.3
#-----
data(Table1.1)

Table1.2$Batch <- factor(x = Table1.2$Batch)

library(ggplot2)
Plot <-
  ggplot(data = Table1.2, mapping = aes(y = Y, x = X, colour = Batch, shape = Batch)) +
  geom_point() +
  geom_smooth(method = "lm", fill = NA) +
  labs(title = "Plot of Multi Batch Regression data") +
  theme_bw()
Plot
```

Exam2.B.1

Example 2.B.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-53)

Description

Exam2.B.1 is used to visualize the effect of lm model statement with Gaussian data and their design matrix

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[Table1.1](#)

Examples

```
#-----  
## Linear Model discussed in Example 2.B.1 using simple regression data of Table1.1  
#-----  
  
data(Table1.1)  
  
Exam2.B.1.lm1 <- lm(formula = y~x, data = Table1.1)  
summary(Exam2.B.1.lm1)  
library(parameters)  
model_parameters(Exam2.B.1.lm1)  
  
DesignMatrix.lm1 <- model.matrix (object = Exam2.B.1.lm1)  
DesignMatrix.lm1
```

Exam2.B.2

Example 2.B.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-54)

Description

Exam2.B.2 is used to visualize the effect of glm model statement with binomial data with logit and probit links.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataExam2.B.2](#)

Examples

```
#-----
## probitit Model discussed in Example 2.B.2 using DataExam2.B.2
## Default link is logit
## using family = binomial gives warning message of no-integer successes
#-----
data(DataExam2.B.2)
Exam2.B.2glm <- glm(formula = y/n~x, family = quasibinomial(link = "probit"), data = DataExam2.B.2)
summary(Exam2.B.2glm)
library(parameters)
model_parameters(Exam2.B.2glm)
```

Exam2.B.3

Example 2.B.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-55)

Description

Exam2.B.3 is used to illustrate one way treatment design with Gaussian observations.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataExam2.B.3](#)

Examples

```
#-----
## Means Model  discussed in Example 2.B.3 using DataExam2.B.3
#-----
Exam2.B.3.lm1 <- lm(formula = y ~ trt, data = DataExam2.B.3)
summary(Exam2.B.3.lm1)

#-----
## Effectss Model  discussed in Example 2.B.3 using DataExam2.B.3
#-----
Exam2.B.3.lm2 <- lm(formula = y ~ 0 + trt, data = DataExam2.B.3)
summary(Exam2.B.3.lm2)
library(parameters)
model_parameters(Exam2.B.3.lm2)
```

Exam2.B.4

Example 2.B.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-56)

Description

Exam2.B.4 is used to illustrate one way treatment design with Binomial observations.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also[DataExam2.B.4](#)**Examples**

```

#-----
## logit Model discussed in Example 2.B.2 using DataExam2.B.4
## Default link is logit
## using family=binomial gives warning message of no-integer successes
#-----
data(DataExam2.B.4)
DataExam2.B.4$trt <- factor(x = DataExam2.B.4$trt)
Exam2.B.4glm <-
  glm(
    formula = Yij/Nij ~ trt
    , family = quasibinomial(link = "probit")
    , data = DataExam2.B.4
  )
summary(Exam2.B.4glm)
library(parameters)
model_parameters(Exam2.B.4glm)

```

Exam2.B.5

Example 2.B.5 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-57)

Description

Exam2.B.5 is related to multi batch regression data assuming different forms of linear models.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also[Table1.2](#)

Examples

```

#-----
## Nested Model with no intercept
#-----

data(Table1.2)
Table1.2$Batch <- factor(x = Table1.2$Batch)

Exam2.B.5.lm1 <- lm(formula = Y ~ 0 + Batch + Batch/X, data = Table1.2)
DesignMatrix.lm1 <- model.matrix (object = Exam2.B.5.lm1)
DesignMatrix.lm1

#-----
## Interaction Model with intercept
#-----
Exam2.B.5.lm2 <-lm(formula = Y ~ Batch + X + Batch*X, data = Table1.2)
DesignMatrix.lm2 <- model.matrix (object = Exam2.B.5.lm2)
DesignMatrix.lm2

#-----
## Interaction Model with no intercept
#-----
Exam2.B.5.lm3 <- lm(formula = Y ~ 0 + Batch + Batch*X, data = Table1.2)
DesignMatrix.lm3 <- model.matrix(object = Exam2.B.5.lm3)
DesignMatrix.lm3

#-----
## Interaction Model with intercept but omitting X term as main effect
#-----
Exam2.B.5.lm4 <- lm(formula = Y ~ Batch + Batch*X, data = Table1.2)
DesignMatrix.lm4 <- model.matrix(object = Exam2.B.5.lm4)
DesignMatrix.lm4

```

Exam2.B.6

Example 2.B.6 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-58)

Description

Exam2.B.6 is related to multi batch regression data assuming different forms of linear models keeping batch effect random.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[Table1.2](#)

Examples

```
#-----
## Nested Model with no intercept
#-----

data(Table1.2)
Table1.2$Batch <- factor(x = Table1.2$Batch)
library(nlme)
Exam2.B.6fm1 <- lme(
  fixed      = Y ~ X
  , data     = Table1.2
  , random   = list(Batch = pdDiag(~1), X = pdDiag(~1))
  , method   = c("REML", "ML")[1]
)
Exam2.B.6fm1
library(broom.mixed)
tidy(Exam2.B.6fm1)
```

Exam2.B.7

Example 2.B.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-60)

Description

Exam2.B.7 is related to multi batch regression data assuming different forms of linear models with factorial experiment.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataExam2.B.7](#)

Examples

```

#-----
## Classical main effects and Interaction Model
#-----
data(DataExam2.B.7)
DataExam2.B.7$a <- factor(x = DataExam2.B.7$a)
DataExam2.B.7$b <- factor(x = DataExam2.B.7$b)
Exam2.B.7.lm1 <- lm(formula = y~ a + b + a*b, data = DataExam2.B.7)
#-----
## One way treatment effects model
#-----
DesignMatrix.lm1 <- model.matrix (object = Exam2.B.7.lm1)
DesignMatrix2.B.7.2 <- DesignMatrix.lm1[,!colnames(DesignMatrix.lm1) %in% c("a2", "b")]

lmfit2 <- lm.fit(x = DesignMatrix2.B.7.2, y = DataExam2.B.7$y)
Coefficientslmfit2 <- coef( object = lmfit2)
Coefficientslmfit2

#-----
## One way treatment effects model without intercept
#-----
DesignMatrix2.B.7.3 <-
  as.matrix(DesignMatrix.lm1[,!colnames(DesignMatrix.lm1) %in% c("(Intercept)", "a2", "b")])

lmfit3 <- lm.fit(x = DesignMatrix2.B.7.3, y = DataExam2.B.7$y)
Coefficientslmfit3 <- coef( object = lmfit3)
Coefficientslmfit3

#-----
## Nested Model (both models give the same result)
#-----
Exam2.B.7.lm4 <- lm(formula = y~ a + a/b, data = DataExam2.B.7)
summary(Exam2.B.7.lm4)

Exam2.B.7.lm4 <- lm(formula = y~ a + a*b, data = DataExam2.B.7)
summary(Exam2.B.7.lm4)

```

Exam3.2

Example 3.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-73)

Description

Exam3.2 used binomial data, two treatment samples

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet3.1](#)

Examples

```
#-----
## Linear Model and results discussed in Article 1.2.1 after Table1.1
#-----
data(DataSet3.1)
DataSet3.1$trt <- factor(x = DataSet3.1$trt)
Exam3.2.glm <- glm(formula = F/N~trt, family = quasibinomial(link = "logit"), data = DataSet3.1)
summary(Exam3.2.glm)
library(parameters)
model_parameters(Exam3.2.glm)

#-----
## Individula least squares treatment means
#-----
library(emmeans)
emmeans(object = Exam3.2.glm, specs = "trt")
emmeans(object = Exam3.2.glm, specs = "trt", type = "response")

#-----
## Over all mean
#-----
library(phia)
list3.2 <- list(trt = c("0" = 0.5, "1" = 0.5 ))
testFactors(model = Exam3.2.glm, levels = list3.2 )

#-----
## Repairwise treatment means estimate
#-----
contrast(emmeans(object = Exam3.2.glm, specs = "trt"))
contrast(emmeans(object = Exam3.2.glm, specs = "trt", type = "response"))
```

Exam3.3

Example 3.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-77)

Description

Exam3.3 use RCBD data with fixed location effect and different forms of estimable functions are shown in this example.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet3.2](#)

Examples

```

#-----
## linear model for Gaussian data
#-----
data(DataSet3.2)
DataSet3.2$trt <- factor(x = DataSet3.2$trt, level = c(3,0,1,2))
DataSet3.2$loc <- factor(x = DataSet3.2$loc, level = c(8, 1, 2, 3, 4, 5, 6, 7))

levels(DataSet3.2$trt)
levels(DataSet3.2$loc)

Exam3.3.lm1 <- lm(formula = Y~ trt + loc, data = DataSet3.2)
summary( Exam3.3.lm1 )

#-----
## Individual least squares treatment means
#-----
library(emmeans)
(Lsm3.3 <- emmeans(object = Exam3.3.lm1, specs = ~trt))

#-----
## Pairwise treatment means estimate
#-----
contrast(object = Lsm3.3 , method = "pairwise")

#-----
## Revpairwise treatment means estimate
#-----
contrast(object = Lsm3.3, method = "revpairwise")
#-----
## LSM Trt0 (This term is used in Walter Stroups' book)
#-----
contrast(
  object = emmeans(object = Exam3.3.lm1, specs = ~ trt)
  , list(trt = c(0, 1, 0, 0))
  )

```

```

library(phia)
testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 1)))

#-----
## LSM Trt0 alt(This term is used in Walter Stroups' book)
#-----
# contrast(
#   object = emmeans(object = Exam3.3.lm1, specs = ~ trt + loc)
#   , list(
#     trt = c(0, 1, 0, 0)
#     , loc = c(1, 0, 0, 0, 0, 0, 0, 0)
#   )
# )
#
#
# list3.3.2 <-
# list(
#   trt = c("0" = 1 )
#   , loc = c("1" = 0, "2" = 0, "3" = 0, "4" = 0, "5" = 0, "6" = 0, "7" = 0)
# )
# testFactors(model = Exam3.3.lm1, levels = list3.3.2)

#-----
## Trt0 Vs Trt1
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(0, 1, -1, 0))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 1, "1" = -1)))

#-----
## average Trt0 + Trt1
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(0, 1/2, 1/2, 0))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 0.5 , "1" = 0.5)))

#-----
## average Trt0+2+3
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(1/3, 1/3, 0, 1/3))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 1/3, "2" = 1/3, "3" = 1/3)))

```

```

#-----
## Trt 2 Vs 3 difference
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(-1, 0, 0, 1))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("2" = 1,"3" = -1)))

#-----
## Trt 1 Vs 2 difference
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(0, 0, 1, -1))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("1" = 1,"2" = -1)))

#-----
## Trt 1 Vs 3 difference
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(-1, 0, 1, 0))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("1" = 1,"3" = -1)))

#-----
## Average trt0+1 vs Average Trt2+3
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(-1/2, 1/2, 1/2, -1/2))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 0.5,"1" = 0.5,"2" = -0.5,"3" = -0.5)))

#-----
## Trt1 vs Average Trt0+1+2
#-----
contrast(
  emmeans(object = Exam3.3.lm1, specs = ~trt)
  , list(trt = c(1/3, 1/3, -1, 1/3))
)

testFactors(model = Exam3.3.lm1, levels = list(trt = c("0" = 1/3,"1" = -1,"2" = 1/3,"3" = 1/3)))

```


Description

Exam3.5 fixed location, factorial treatment structure, Gaussian response

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet3.2](#)

Examples

```
data(DataSet3.2)
DataSet3.2$A <- factor(x = DataSet3.2$A)
DataSet3.2$B <- factor(x = DataSet3.2$B)
DataSet3.2$loc <- factor(x = DataSet3.2$loc, level = c(8, 1, 2, 3, 4, 5, 6, 7))

Exam3.5.lm <- lm(formula = Y~ A + B +loc, data = DataSet3.2)
Exam3.5.lm

##---a0 marginal mean
library(emmeans)
contrast(
  object = emmeans(object = Exam3.5.lm, specs = ~ B)
  , list(trt = c(1, 0))
)
library(phia)
testFactors(model = Exam3.5.lm, levels = list(B = c("0" = 1, "1" = 0) ))

##---b0 marginal mean
testFactors(model = Exam3.5.lm, levels=list(B = c("0" = 1, "1" = 0)))

##---Simple effect of A on B0
testInteractions(model = Exam3.5.lm, custom = list(B = c("0" = 1, "1" = 0)), across = "B")

##---Simple effect of B on A0
testInteractions(model = Exam3.5.lm, custom = list(A = c("0" = 1, "1" = 0)), across = "A")

##---Simple Effect of A over B
testInteractions(model = Exam3.5.lm, fixed = "A", across = "B")

##---Simple Effect of B over A
testInteractions(model = Exam3.5.lm, fixed = "B", across = "A")
```

```
#-----
## Individula least squares treatment means
#-----
emmeans(object = Exam3.5.lm, specs = ~A*B)
```

Exam3.9

Example 3.9 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-118)

Description

Exam3.9 used to differentiate conditional and marginal binomial models with and without interaction for S2 variable.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet3.2](#)

Examples

```
#-----
## Binomial conditional GLMM without interaction, logit link
#-----
library(MASS)
DataSet3.2$trt <- factor( x = DataSet3.2$trt )
DataSet3.2$loc <- factor( x = DataSet3.2$loc )

Exam3.9.fm1 <-
  glmnPQL(
    fixed = S2/Nbin~trt
    , random = ~1|loc
    , family = quasibinomial(link = "logit")
    , data = DataSet3.2
    , niter = 10
    , verbose = TRUE
  )
summary(Exam3.9.fm1)
library(parameters)
model_parameters(Exam3.9.fm1)
```

```

#-----
## treatment means
#-----
library(emmeans)
emmeans(object = Exam3.9.fm1, specs = ~trt, type = "response")
emmeans(object = Exam3.9.fm1, specs = ~trt, type = "link")
emmeans(object = Exam3.9.fm1, specs = ~trt, type = "logit")

##--- Normal Approximation
library(nlme)
Exam3.9fm2 <-
  lme(
    fixed      = S2/Nbin~trt
    , data     = DataSet3.2
    , random   = ~1|loc
    , method   = c("REML", "ML")[1]
  )

Exam3.9fm2
model_parameters(Exam3.9fm2)

emmeans(object = Exam3.9fm2, specs = ~trt)

##---Binomial GLMM with interaction
Exam3.9fm3 <-
  glmmPQL(
    fixed      = S2/Nbin~trt
    , random   = ~1|trt/loc
    , family   = quasibinomial(link = "logit")
    , data     = DataSet3.2
    , niter    = 10
    , verbose  = TRUE
  )
summary(Exam3.9fm3)
model_parameters(Exam3.9fm3)
emmeans(object = Exam3.9fm3, specs = ~trt)

##---Binomial Marginal GLMM(assuming compound symmetry)
Exam3.9fm4 <-
  glmmPQL(
    fixed      = S2/Nbin~trt
    , random   = ~1|loc
    , family   = quasibinomial(link = "logit")
    , data     = DataSet3.2
    , correlation = corCompSymm(form = ~1|loc)
    , niter    = 10
    , verbose  = TRUE
  )
summary(Exam3.9fm4)
model_parameters(Exam3.9fm4)

```

```
emmeans(object = Exam3.9fm4, specs = ~trt)
```

Exam4.1

Example 4.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-138)

Description

Exam4.1 REML vs ML criterion is used keeping block effects random

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet4.1](#)

Examples

```
DataSet4.1$trt <- factor(x = DataSet4.1$trt)
DataSet4.1$block <- factor(x = DataSet4.1$block)

#---REML estimates on page 138(article 4.4.3.3)
library(lmerTest)

Exam4.1REML <- lmer(formula = y~ trt +( 1|block ), data = DataSet4.1)
library(parameters)
model_parameters(Exam4.1REML)
print(VarCorr(x = Exam4.1REML), comp = c("Variance"))

##---ML estimates on page 138(article 4.4.3.3)
Exam4.1ML <- lmer(formula = y ~ trt + (1|block), data = DataSet4.1, REML = FALSE)
model_parameters(Exam4.1ML)
print(VarCorr(x = Exam4.1ML), comp = c("Variance"))

Exam4.1.lm <- lm(formula = y~ trt + block, data = DataSet4.1)
anova(object = Exam4.1.lm)
```

Exam5.1

Example 5.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-163)

Description

Exam5.1 is used to show polynomial multiple regression with binomial response

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet5.1](#)

Examples

```
##--Sequential Fit of the logit Model
Exam5.1.glm.1 <-
  glm(
    formula    = F/N~ X
    , family   = quasibinomial(link = "logit")
    , data     = DataSet5.1
  )
summary(Exam5.1.glm.1)
library(parameters)
model_parameters(Exam5.1.glm.1)

## confint.default() produce Wald Confidence interval as SAS produces
##--Likelihood Ratio test for Model 1
anova(object = Exam5.1.glm.1, test = "Chisq")

library(aod)
WaldExam5.1.glm.1 <-
  wald.test(
    Sigma    = vcov(object = Exam5.1.glm.1)
    , b      = coef(object = Exam5.1.glm.1)
    , Terms  = 2
    , L      = NULL
    , H0     = NULL
    , df     = NULL
    , verbose = FALSE
```

```

)

##---Sequential Fit of the logit Model quadratic terms involved
Exam5.1.glm.2 <-
  glm(
    formula = F/N~ X + I(X^2)
    , family = quasibinomial(link = "logit")
    , data = DataSet5.1
  )
summary( Exam5.1.glm.2 )
model_parameters( Exam5.1.glm.2 )

##---Likelihood Ratio test for Model Exam5.1.glm.2
anova(object = Exam5.1.glm.2, test = "Chisq")

WaldExam5.1.glm.2 <-
  wald.test(
    Sigma = vcov(object = Exam5.1.glm.2)
    , b = coef(object = Exam5.1.glm.2)
    , Terms = 3
    , L = NULL
    , H0 = NULL
    , df = NULL
    , verbose = FALSE
  )

##---Sequential Fit of the logit Model 5th power terms involved
Exam5.1.glm.3 <-
  glm(
    formula = F/N~ X + I(X^2) + I(X^3) + I(X^4) + I(X^5)
    , family = quasibinomial(link = "logit")
    , data = DataSet5.1
  )
summary(Exam5.1.glm.3)
model_parameters(Exam5.1.glm.3)

## confint.default() produce Wald Confidence interval as SAS produces
##---Likelihood Ratio test for Model 1
anova(object = Exam5.1.glm.3, test = "Chisq")

WaldExam5.1.glm.3 <-
  wald.test(
    Sigma = vcov(object = Exam5.1.glm.3)
    , b = coef(object = Exam5.1.glm.3)
    , Terms = 6
    , L = NULL
    , H0 = NULL
    , df = NULL
    , verbose = FALSE
  )

```

Exam5.2

Example 5.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-164)

Description

Exam5.2 three factor main effects only design

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet5.2](#)

Examples

```
DataSet5.2$a <- factor( x = DataSet5.2$a)
DataSet5.2$b <- factor( x = DataSet5.2$b)
DataSet5.2$c <- factor(x = DataSet5.2$c)

##---first adding factor a in model
Exam5.2.lm1 <- lm(formula = y~ a, data = DataSet5.2)
summary(Exam5.2.lm1)
library(parameters)
model_parameters(Exam5.2.lm1)

library(emmeans)
##---A first
emmeans(object = Exam5.2.lm1, specs = ~a)
contrast(emmeans(object = Exam5.2.lm1, specs = ~a), method = "pairwise")
anova(object = Exam5.2.lm1)

##---then adding factor b in model
Exam5.2.lm2 <- lm(formula = y~ a + b, data = DataSet5.2)
summary(Exam5.2.lm2)
model_parameters(Exam5.2.lm2)

emmeans(object = Exam5.2.lm2, specs = ~b)
contrast(emmeans(object = Exam5.2.lm2, specs = ~b), method = "pairwise")
anova(object = Exam5.2.lm2)
```

```
##---then adding factor c in model
Exam5.2.lm3 <- lm(formula = y~ a + b + c, data = DataSet5.2)

summary(Exam5.2.lm3)
model_parameters(Exam5.2.lm3)

emmeans(object = Exam5.2.lm3, specs = ~c)
contrast(emmeans(object = Exam5.2.lm3, specs = ~c), method = "pairwise")
anova(object = Exam5.2.lm3)

##---Now Change the order and add b first in model
Exam5.2.lm4 <- lm(formula = y ~ b, data = DataSet5.2)
summary(Exam5.2.lm4)
model_parameters(Exam5.2.lm4)

emmeans(object = Exam5.2.lm4, specs = ~b)
contrast(emmeans(object = Exam5.2.lm4, specs = ~b), method = "pairwise")
anova(object = Exam5.2.lm4)

##---then adding factor a in model
Exam5.2.lm5 <- lm(formula = y ~ b + a, data = DataSet5.2)
summary(Exam5.2.lm5)
model_parameters(Exam5.2.lm5)

emmeans(object = Exam5.2.lm5, specs = ~a)
contrast(emmeans(object = Exam5.2.lm5, specs = ~a), method = "pairwise")
anova(object = Exam5.2.lm5)
```

Exam5.3

Example 5.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-172)

Description

Exam5.3 Inference using empirical standard error with different Bias connection

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

See Also

[DataSet4.1](#)

Examples

```

data(DataSet4.1)
DataSet4.1$trt <- factor(x = DataSet4.1$trt)
DataSet4.1$block <- factor(x = DataSet4.1$block)

##---REML estimates on page 172
library(lmerTest)
Exam5.3REML <- lmerTest::lmer(formula = y ~ trt + (1|block), data = DataSet4.1, REML = TRUE)
Exam5.3REML
library(parameters)
model_parameters(Exam5.3REML)
##---Standard Error Type "Model Based" with no Bias Connection
anova(object = Exam5.3REML)
anova(object = Exam5.3REML, ddf = "Satterthwaite")

##---Standard Error Type "Model Based" with "Kenward-Roger approximation" Bias Connection
anova(object = Exam5.3REML, ddf = "Kenward-Roger")

##---ML estimates on page 172
Exam5.3ML <- lmerTest::lmer(formula = y ~ trt + (1|block), data = DataSet4.1, REML = FALSE)
Exam5.3ML
library(parameters)
model_parameters(Exam5.3ML)

##---Standard Error Type "Model Based" with no Bias Connection
anova(object = Exam5.3ML)
anova(object = Exam5.3ML, ddf = "Satterthwaite")

```

Exam7.1

Example 7.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-213)

Description

Exam7.1 explains multifactor models with all factors qualitative

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

@seealso [DataSet7.1](#)

Examples

```
library(emmeans)
library(car)
data(DataSet7.1)

DataSet7.1$a <- factor(x = DataSet7.1$a)
DataSet7.1$b <- factor(x = DataSet7.1$b)

Exam7.1.lm1 <- lm(formula = y ~ a + b + a*b, data = DataSet7.1)
summary(Exam7.1.lm1)
library(parameters)
model_parameters(Exam7.1.lm1)
anova(Exam7.1.lm1)

##---Result obtained as in SLICE statement in SAS for a0 & a1
library(phia)
testInteractions(
  model = Exam7.1.lm1
  , custom = list(a = c("0" = 1))
  , across = "b"
)

testInteractions(
  model = Exam7.1.lm1
  , custom = list(a = c("1" = 1))
  , across = "b"
)

##---Interaction plot
emmip(
  object = Exam7.1.lm1
  , formula = a~b
  , ylab = "y Lsmeans"
  , main = "Lsmeans for a*b"
)

#-----
## Individula least squares treatment means
#-----
emmeans(object = Exam7.1.lm1, specs = ~a*b)

##---Simpe effects comparison of interaction by a
## (but it doesn't give the same p-value as in article 7.4.2 page#215)
emmeans(object = Exam7.1.lm1, specs = pairwise~b|a)$contrasts
```

```

pairs(emmeans(object = Exam7.1.lm1, specs = ~b|a), simple = "each", combine = TRUE)
pairs(emmeans(object = Exam7.1.lm1, specs = ~b|a), simple = "a")
pairs(emmeans(object = Exam7.1.lm1, specs = ~b|a), simple = "b")
pairs(emmeans(object = Exam7.1.lm1, specs = ~b|a))
contrast(emmeans(object = Exam7.1.lm1, specs = ~b|a))
emmeans(object = Exam7.1.lm1, specs = pairwise~b|a)
emmeans(object = Exam7.1.lm1, specs = pairwise~b|a)$contrasts

##---Alternative method of pairwise comparisons by
## applying contrast
## coefficient (gives the same p-value as in 7.4.2)
contrast(
  emmeans(object = Exam7.1.lm1, specs = ~a*b)
  , list (
    c1 = c(1, 0, -1, 0, 0, 0)
    , c2 = c(1, 0, 0, 0, -1, 0)
    , c3 = c(0, 0, 1, 0, -1, 0)
    , c4 = c(0, 1, 0, -1, 0, 0)
    , c5 = c(0, 1, 0, 0, 0, -1)
    , c6 = c(0, 1, 0, 0, -1, 0)
  )
)

##---Nested Model (page 216)----
Exam7.1.lm2 <- lm(formula = y ~ a + a %in% b, data = DataSet7.1)

summary(Exam7.1.lm2)
model_parameters(Exam7.1.lm2)
anova(Exam7.1.lm2)

car::linearHypothesis(Exam7.1.lm2, c("a0:b1 = a0:b2"))
car::linearHypothesis(Exam7.1.lm2, c("a1:b1 = a1:b2"))

##---Bonferroni's adjusted p-values
emmeans(object = Exam7.1.lm2, specs = pairwise~b|a, adjust = "bonferroni")$contrasts

##--- Alternative method of pairwise comparisons by
## applying contrast coefficient with Bonferroni adjustment
contrast(
  emmeans(object = Exam7.1.lm1, specs = ~a*b)
  , list (
    c1 = c(1, 0, -1, 0, 0, 0)
    , c2 = c(1, 0, 0, 0, -1, 0)
    , c3 = c(0, 0, 1, 0, -1, 0)
    , c4 = c(0, 1, 0, -1, 0, 0)
    , c5 = c(0, 1, 0, 0, 0, -1)
    , c6 = c(0, 1, 0, 0, -1, 0)
  )
  , adjust = "bonferroni"
)

```

Exam7.2

Example 7.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-219)

Description

Exam7.2 explains multifactor models with some factors qualitative and some quantitative (Equal slopes ANCOVA)

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

@seealso [DataSet7.2](#)

Examples

```
library(emmeans)
library(car)
library(ggplot2)

data(DataSet7.2)
DataSet7.2$trt <- factor( x = DataSet7.2$trt )

##---ANCOVA(Equal slope Model)
Exam7.2fm1 <- aov(formula = y ~ trt*x, data = DataSet7.2)
car::Anova(mod = Exam7.2fm1 , type = "III")

##---ANCOVA(without interaction because of non significant slope effect)
Exam7.2fm2 <- aov(formula = y ~ trt + x, data = DataSet7.2)
car::Anova(mod = Exam7.2fm2 , type = "III")

##---Ls means for 2nd model
emmeans(object = Exam7.2fm2, specs = ~trt)

##---Anova without covariate
Exam7.2fm3 <- aov(formula = y ~ trt, data = DataSet7.2)
car::Anova(mod = Exam7.2fm3, type = "III")

##---Ls means for 3rd model
emmeans(object = Exam7.2fm3, specs = ~trt)

##---Box Plot of Covariate by treatment
Plot <-
```

```

ggplot(
  data = DataSet7.2
  , mapping = aes(x = factor(trt), y = x)
) +
geom_boxplot(width = 0.5) +
coord_flip() +
geom_point() +
stat_summary(
  fun = "mean"
  , geom = "point"
  , shape = 23
  , size = 2
  , fill = "red"
) +
theme_bw() +
ggtitle("Covariate by treatment Box Plot") +
xlab("Treatment")
print(Plot)

```

Exam7.3

Example 7.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-223)

Description

Exam7.3 explains multifactor models with some factors qualitative and some quantitative (Unequal slopes ANCOVA)

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

@seealso [DataSet7.3](#)

Examples

```

library(car)
library(ggplot2)
library(emmeans)
data(DataSet7.3)

DataSet7.3$trt <- factor(x = DataSet7.3$trt )

```

```
##----ANCOVA(Unequal slope Model)
Exam7.3fm1 <- aov(formula = y ~ trt*x, data = DataSet7.3)
car::Anova( mod = Exam7.3fm1 , type = "III")

Plot <-
  ggplot(
    data = DataSet7.3
    , mapping = aes(x = factor(trt), y = x)
  )
  +
  geom_boxplot(width = 0.5) +
  coord_flip() +
  geom_point() +
  stat_summary(
    fun = "mean"
    , geom = "point"
    , shape = 23
    , size = 2
    , fill = "red"
  )
  +
  theme_bw() +
  ggtitle("Covariate by treatment Box Plot") +
  xlab("Treatment")
print(Plot)

##----ANCOVA(Unequal slope Model without intercept at page 224)
Exam7.3fm2 <- lm(formula = y ~ 0 + trt/x, data = DataSet7.3)
summary(Exam7.3fm2)
library(parameters)
model_parameters(Exam7.3fm2)

##--Lsmeans treatment at x=7 & 12 at page 225
emmeans(object = Exam7.3fm2, specs = ~trt|x, at = list(x = c(7, 12)))
```

Exam7.6.2.1

Example 7.6.2.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-231)

Description

Exam7.6.2.1 Nonlinear Mean Models (Quantitative by quantitative models)

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*. CRC Press.

@seealso [DataSet7.6](#)

Examples

```
library(scatterplot3d)
data(DataSet7.6)

library(dplyr)
library(magrittr)

DataSet7.6 <-
  DataSet7.6 %>%
  mutate(
    logx1 = ifelse(test = x1 == 0, yes = log(x1 + 0.1), no = log(x1))
    , logx2 = ifelse(test = x2 == 0, yes = log(x2 + 0.1), no = log(x2))
  )
DataSet7.6
Exam7.6.2.1.lm <- lm(formula = response ~ x1*x2 + logx1*logx2 , data = DataSet7.6)
summary(Exam7.6.2.1.lm)
library(parameters)
model_parameters(Exam7.6.2.1.lm)

##---3D Scatter plot ( page#232)
attach(DataSet7.6)
(
  ScatterPlot1 <-
    scatterplot3d(
      x          = x1
      , y        = x2
      , z        = response
      , color    = response
      , main     = " 3D Scatter plot of response")
)

##--- scatter plot with regression plane by using Hoerl function ( page#233)
grid.lines <- 5
x1.pred <- seq(min(x1), max(x1), length.out = grid.lines)
x2.pred <- seq(min(x2), max(x2), length.out = grid.lines)
x1x2    <- expand.grid( x = x1.pred, y = x2.pred)

z.pred <- matrix(data = predict(Exam7.6.2.1.lm, newdata = x1x2),
                 nrow = grid.lines
                 , ncol = grid.lines)
(ScatterPlot2 <-
  scatterplot3d(
    x          = x1
    , y        = x2
    , z        = response
    , pch      = 20
```

```

, phi      = 25
, theta    = 30
, ticktype = "detailed"
, xlab     = "x1"
, ylab     = "x2"
, zlab     = "response"
, add      = FALSE
, surf     = list(x      = x1.pred ,
                  y      = x2.pred ,
                  z      = z.pred  ,
                  facets = NA
                  )
, plot     = TRUE
, main     = "Fitted Response Surface by Hoerl Function"
)
)

```

Table1.1 *Data for Table1.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

Table1.1 is used for inspecting probability distribution and to define a plausible process.

Usage

```
data(Table1.1)
```

Format

A data.frame with 11 rows and 3 variables.

Details

- x independent variable
- Nx bernouli trials (bernouli outcomes on each individual)
- y number of successes on each individual

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). Generalized linear mixed models: modern concepts, methods and applications. CRC press.

Examples

```
library(StroupGLMM)
data(Table1.1)
```

Table1.2	<i>Data for Table1.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-10)</i>
----------	--

Description

Exam1.2 is used to see types of model effects by plotting regression data

Usage

```
data(Table1.2)
```

Format

A data.frame with 36 rows and 5 variables.

Details

- X have 11 levels in varying intervals from 0 to 48 observed for multiple batches
- Y continuous variable observed at each level of X
- Fav number of successes
- N number of bernoulli trials
- Batch Batches as 1, 2, 3, 4

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Adeela Munawar (<adeela.uaf@gmail.com>)

References

1. Stroup, W. W. (2012). *Generalized linear mixed models: modern concepts, methods and applications*. CRC press.

See Also

[Exam1.2](#)

Examples

```
data(Table1.2)
```

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