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

Version 0.3.0

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Description R Codes and Datasets for Stroup, W. W. (2012). Generalized Linear Mixed Models Modern Concepts, Methods and Applications, CRC Press.

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, lattice, lmerTest, magrittr, MASS, mutoss, nlme, parameters, phia, scatterplot3d, splines, stats, survey

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NeedsCompilation no

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Contents

`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 *Data for Example 3.1 and Example 3.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

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 isndependent 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 desgin
- trt treatments representing incomplete block desgin
- 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)
```

DataSet8.1 *Data for Example 8.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet8.1 is used for Nested factorial structure

Usage

```
data(DataSet8.1)
```

Format

A `data.frame` with 30 rows and 4 variables.

Details

- block 10 blocks
- trt 6 treatments nested within sets
- set 2 sets
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam8.1

Examples

```
data(DataSet8.1)
```

DataSet8.2 *Data for Example 8.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet8.2 is used for Incomplete strip-plot (3 cross 3 factorial).

Usage

```
data(DataSet8.2)
```

Format

A data.frame with 36 rows and 6 variables.

Details

- block 9 blocks each consisting of 2 rows and 2 coloumns
- a is a factor with 3 levels assigned at random to rows
- b is a factor with 3 levels assigned at random to columns
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam8.2

Examples

```
data(DataSet8.2)
```

DataSet8.3 *Data for Example 8.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet8.3 is used for Response surface design with incomplete blocking

Usage

```
data(DataSet8.3)
```

Format

A data.frame with 28 rows and 4 variables.

Details

- block with 7 blocks
- a is a factor with 3 levels 0,-1 and 1
- b is a factor with 3 levels 0,-1 and 1
- c is a factor with 3 levels 0,-1 and 1
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam8.3

Examples

```
data(DataSet8.3)
```

DataSet8.4 *Data for Example 8.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet8.4 is used for Multifactor treatment and Multilevel design structures

Usage

```
data(DataSet8.4)
```

Format

A `data.frame` with 36 rows and 6 variables.

Details

- block 9 blocks each consisting of 2 rows and 2 coloumns
- a is a factor with 3 levels assigned at random to rows
- b is a factor with 3 levels assigned at random to columns
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam8.4

Examples

```
data(DataSet8.4)
```

DataSet9.1 *Data for Example 9.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet9.1 is used for One-way random effects only model

Usage

```
data(DataSet9.1)
```

Format

A `data.frame` with 24 rows and 2 variables.

Details

- a is a factor with 12 levels
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam9.1

Examples

```
data(DataSet9.1)
```

DataSet9.2 *Data for Example 9.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet9.2 is used for Two way random effects nested model

Usage

```
data(DataSet9.2)
```

Format

A `data.frame` with 28 rows and 3 variables with levels of b nested within levels of.

Details

- a is a factor with 7 levels
- b is a factor with 2 levels
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam9.2

Examples

```
data(DataSet9.2)
```

DataSet9.4 *Data for Example 9.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup*

Description

DataSet9.4 is used for Relationship between BLUP and Fixed Effect Estimators

Usage

```
data(DataSet9.4)
```

Format

A `data.frame` with 32 rows and 3 variables

Details

- a is a factor with 2 levels
- b is a factor with 8 levels
- y is a Gaussian response variable

Author(s)

Muhammad Yaseen (<myaseen208@gmail.com>) 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

Exam9.4

Examples

```
data(DataSet9.4)
```

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 fmaily = 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 fmaily=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)))
```

`Exam3.5` *Example 3.5 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup(p-85)*

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   <-
  glmmPQL(
      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"
           )
           )
```

Exam7.7 *Example 7.7 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-235)*

Description

Exam7.7 is an explaination of segmented regression

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

DataSet7.7

Examples

```
library(splines)
library(ggplot2)

DataSet7.7$a  <- factor(x = DataSet7.7$a)
knots <- c(0, 0, 0, 0, 10, 10, 20, 30, 40, 40, 40, 45, 45, 45, 50, 50, 50)

bx <- splineDesign(knots = knots, x = DataSet7.7$x, outer.ok = TRUE)

Exam7.7fm <- lm(formula = y ~ a*bx, data  = DataSet7.7)
anova(Exam7.7fm)

Data  <- data.frame(DataSet7.7, fit = Exam7.7fm$fit)
##---Estimated response surface by using segmented regression
Plot <-
     ggplot(data = Data , mapping = aes(x = x, y = y, colour = a)) +
     geom_point() +
     geom_line(linewidth = 1) +
     ggtitle("Response surface by using segmented regression")

print(Plot)
```

Exam8.1 *Example 8.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-250)*

Description

Exam8.1 Nested factorial structure

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

DataSet8.1

Examples

```
data(DataSet8.1)
DataSet8.1$block <- factor(x = DataSet8.1$block)
DataSet8.1$set <- factor(x = DataSet8.1$set)
DataSet8.1$trt <- factor(x = DataSet8.1$trt)

library(lmerTest)
Exam8.1Lmer <- lmer(y ~ set + trt %in% set + (1|set/block), DataSet8.1)
summary(Exam8.1Lmer)
anova(Exam8.1Lmer)

library(emmeans)
emmeans(object  = Exam8.1Lmer, specs = ~trt|set)
contrast(emmeans(object  = Exam8.1Lmer, specs = ~trt|set), method = "pairwise", by = "set")
```

`Exam8.2` *Example 8.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-252)*

Description

Exam8.2 Incomplete strip-plot

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

DataSet8.2

Examples

```
data(DataSet8.2)
DataSet8.2$block <- factor(x = DataSet8.2$block)
DataSet8.2$a <- factor(x = DataSet8.2$a)
DataSet8.2$b <- factor(x = DataSet8.2$b)

library(lmerTest)

Exam8.2lmer <-
          lmer(
```

```
                  formula = y ~ a*b + (1|block) + (1|block:a) + (1|block:b)
                , data    = DataSet8.2
                )
anova(Exam8.2lmer,ddf="Kenward-Roger")

library(emmeans)
emmeans(object  = Exam8.2lmer, specs = ~a|b)
emmip(
       object  = emmeans(object  = Exam8.2lmer, specs = ~a|b)
     , formula = a~b
     , ylab    = "y Lsmeans"
     , main    = "Lsmeans for a*b"
      )

##---Simple effect comparisons of a*b Least Squares Means by a ( page # 254)
emmeans(Exam8.2lmer, pairwise ~ b|a)
```

Exam8.3 *Example 8.3 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-255)*

Description

Exam8.3 explains Response surface design with incomplete blocking

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

DataSet8.3

Examples

```
## Response Surface Design with incomplete blocking (page 255)
data(DataSet8.3)
DataSet8.3$block <- factor(x = DataSet8.3$block)
DataSet8.3$aa <- factor(x = DataSet8.3$a)
DataSet8.3$bb <- factor(x = DataSet8.3$b)
DataSet8.3$cc <- factor(x = DataSet8.3$c)
```

```
library(lmerTest)
library(lattice)

Exam8.3.fm1 <-
         lmer(
             y ~ aa:bb:cc + a + b + c +
                 I(a^2) + I(b^2) + I(c^2) +
                 a*b + a*c + b*c + (1|block)
           , data = DataSet8.3
           )

##--- page 256
anova(Exam8.3.fm1, ddf = "Kenward-Roger", type = 1)


Exam8.3.fm2 <-
           lmer(
                y ~ a + b + c +
                    I(a^2) + I(b^2) + I(c^2) +
                    a*b + a*c + b*c + (1|block)
              , data = DataSet8.3
              )
##--- page 257
anova(Exam8.3.fm2, ddf = "Kenward-Roger", type = 1)

##--- page 257
Exam8.3.fm3 <-
        lmer(
             y ~ a + b + c +
                 I(a^2) + I(b^2) +
                 a*c + b*c + (1|block)
          , DataSet8.3
          )
anova(Exam8.3.fm3, ddf = "Kenward-Roger", type = 1)

##--- scatter plot with regression plane by using Hoerl function ( page#233)
a <- seq(from = -1, to = 1, by = 1)
b <- seq(from = -1, to = 1, by = 1)
c <- seq(from = -1, to = 1, by = 1)
abc <- expand.grid(a = a, b = b, c = c)

Yhat <- NULL
for(i in 1:nrow(abc)) {
Yhat[i] <- 50.08500 + 1.6*abc$a[i] + 1.69375*abc$b[i] +  0.51875*abc$c[i]-
           3.30250*I((abc$a[i])^2)-3.51500*I((abc$b)^2)[i] -
           0.52500*(abc$a)[i]*(abc$c)[i]-1.16250*(abc$b)[i]*(abc$c)[i]
}

Newdata <- data.frame(abc, Yhat)
Plot1 <-
  wireframe(Yhat ~ b*a, data = subset(Newdata,c==-1),
  xlab = "b", ylab = "a",
```

```
  main = "Predicte response surface at C=-1",  colorkey = FALSE,
  drape = TRUE, scales = list(arrows = FALSE),xlim=c(max(b),(min(b))),
  screen = list(z = -50, x =-70)
)

Plot2 <-
  wireframe(Yhat ~ b*a, data = subset(Newdata,c==0),
  xlab = "b", ylab = "a",
  main = "Predicte response surface at C=0",  colorkey = FALSE ,
  drape = TRUE, scales = list(arrows = FALSE),xlim=c(max(b),(min(b))),
  screen = list(z = -50, x =-70)
)

Plot3 <-
 wireframe(Yhat ~ b*a, data = subset(Newdata,c==1),
  xlab = "b", ylab = "a",
  main = "Predicte response surface at C=1",  colorkey = FALSE,
  drape = TRUE, scales = list(arrows = FALSE),xlim=c(max(b),(min(b))),
  screen = list(z = -50, x =-70)
)

print(Plot1)
print(Plot2)
print(Plot3)
```

`Exam8.4` *Example 8.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-259)*

Description

Exam8.4 Multifactor treatment and Multilevel design structures

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

DataSet8.4

Examples

```
data(DataSet8.4)
DataSet8.4$block <- factor(x = DataSet8.4$block)
DataSet8.4$a <- factor(x = DataSet8.4$a)
DataSet8.4$b <- factor(x = DataSet8.4$b)

library(lmerTest)
Exam8.4lmer   <-
           lmer(
                y ~ a + b %in% a +
                    (1|block) + (1|block:a) + (1|block:b)
              , data = DataSet8.4
              )
anova(Exam8.4lmer, ddf = "Kenward-Roger")

library(emmeans)
emmeans(object = Exam8.4lmer, specs = ~a|b)
```

`Exam9.1` *Example 9.1 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-273)*

Description

Exam9.1 One-way random effects only model

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

DataSet9.1

Examples

```
data(DataSet9.1)
DataSet9.1$a <- factor(x = DataSet9.1$a)

##---Random effects model
library(lmerTest)
Exam9.1lmer <- lmer( y ~ 1 + (1|a), data = DataSet9.1)
summary(Exam9.1lmer)
```

```
##---fixed effects model
Exam9.1lmer2 <- lm(y ~ a, data = DataSet9.1)
summary(Exam9.1lmer2)

 #-------------------------------------------------
 ## Over all mean narrow( page # 274)
 #-------------------------------------------------
library(emmeans)
library(phia)
list9.1 <- list(a = c( "1" = 1/12,"2" = 1/12
                      , "3" = 1/12,"4" = 1/12
                      , "5" = 1/12,"6" = 1/12
                      , "7" = 1/12,"8" = 1/12
                      , "9" = 1/12,"10" = 1/12
                      , "11" = 1/12,"12" = 1/12
                      ))
phia::testFactors(model = Exam9.1lmer2, levels = list9.1)


#---BLUP Estimates (Table 9.1)
coef <- unlist(ranef(Exam9.1lmer))
BLUPa <- NULL
for( i in 1:length(coef)) {
  BLUPa[i] <- (mean(DataSet9.1$y)+coef[i])
  }
print(BLUPa)
```

`Exam9.2` *Example 9.2 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-276)*

Description

Exam9.2 Two way random effects nested model

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

DataSet9.2

Examples

```
data(DataSet9.2)
DataSet9.2$a <- factor(x = DataSet9.2$a)
DataSet9.2$b <- factor(x = DataSet9.2$b)

library(lmerTest)
Exam9.2lmer <- lmer(y ~ (1|b/a), data = DataSet9.2)
summary(Exam9.2lmer)

Exam9.2lmer2 <- lm(y ~ a + b %in% a, data = DataSet9.2)
summary(Exam9.2lmer2)

##--- Over all mean
library(phia)
list9.2 <- list(a = c("1" = 1/7,"2" = 1/7
                    , "3" = 1/7,"4" = 1/7
                    , "5" = 1/7,"6" = 1/7
                    , "7" = 1/7
                     ))
phia::testFactors(model = Exam9.2lmer2, levels = list9.2)

#---BLUP Estimates
coef <- unlist(ranef(Exam9.2lmer)$a)
BLUPa <- NULL
for(i in 1:length(coef)){
  BLUPa[i] <- (mean(DataSet9.2$y) + coef[i])
  }
print(BLUPa)

#---BLUP Estimates Narrow
BLUPaNar <- NULL
for( i in 1:length(coef)) {
  BLUPaNar[i] <- (mean(DataSet9.2$y) + coef[i])
}

BLUPaNar
```

`Exam9.4` *Example 9.4 from Generalized Linear Mixed Models: Modern Concepts, Methods and Applications by Walter W. Stroup (p-288)*

Description

Exam9.4 Relationship between BLUP and Fixed Effect Estimators

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

DataSet9.4

Examples

```
data(DataSet9.4)
DataSet9.4$a <- factor(x = DataSet9.4$a)
DataSet9.4$b <- factor(x = DataSet9.4$b)

library(lmerTest)
Exam9.4lmer <- lmer(y ~ a + (1|b) + (1|a/b), data = DataSet9.4)
summary(Exam9.4lmer)
library(emmeans)
emmeans(Exam9.4lmer, spec = ~a)
```

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

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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