

Package: eda4treeR (via r-universe)

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Type Package

Title Experimental Design and Analysis for Tree Improvement

Version 1.1.0

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Description Provides data sets and R Codes for E.R. Williams, C.E. Harwood and A.C. Matheson (2023). Experimental Design and Analysis for Tree Improvement, CSIRO Publishing.

Depends R (>= 4.1.0)

Imports car, dae, dplyr, emmeans, ggplot2, lmerTest, magrittr, predictmeans, stats, supernova

License GPL-3

URL <https://github.com/MYaseen208/eda4treeR>
<https://CRAN.R-project.org/package=eda4treeR>
<https://myaseen208.com/eda4treeR/> <https://myaseen208.com/EDATR/>

BugReports <https://github.com/myaseen208/eda4treeR/issues>

LazyData TRUE

RoxygenNote 7.3.2

Encoding UTF-8

Suggests testthat

Note 1. Asian Development Bank (ADB), Islamabad, Pakistan. 2. Benazir Income Support Programme (BISP), Islamabad, Pakistan. 3. Department of Mathematics and Statistics, University of Agriculture Faisalabad, Pakistan.

Repository <https://myaseen208.r-universe.dev>

RemoteUrl <https://github.com/myaseen208/eda4treer>

RemoteRef HEAD

RemoteSha 6274ccf6496ead10f37ae48241bcfc7068b6f581

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DataExam2.1	<i>Data for Example 2.1 from Experimental Design and Analysis for Tree Improvement</i>
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Description

Exam2.1 is used to compare two seed lots by using single factor ANOVA.

Usage

```
data(DataExam2.1)
```

Format

A data.frame with 16 rows and 2 variables.

seedlot Two Seedlots Seed Orchard (SO) and rutin plantation (P)

dbh Diameter at breast height

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam2.1](#)

Examples

```
data(DataExam2.1)
```

DataExam2.2

Data for Example 2.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam2.2 is used to compare two seed lots by using ANOVA under RCB Design.

Usage

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

Format

A data.frame with 16 rows and 2 variables.

repl repl

block block

Seedlot Two Seedlots Seed Orchard (SO) and routine plantation (P)

dbh Diameter at breast height

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also[Exam2.2](#)**Examples**

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

DataExam3.1

Data for Example 3.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam3.1 is part of data from Australian Centre for Agricultural Research (ACIAR) in Queensland, Australia (Experiment 309).

Usage

```
data(DataExam3.1)
```

Format

A data.frame with 80 rows and 6 variables.

rep1 Replication number of different Seedlots

PlotNo Plot No of differnt Trees

seedlot Seed Lot number

TreeNo Tree number of Seedlots

ht Height in meter

dgl Diameter at ground level

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also[Exam3.1](#)

Examples

```
data(DataExam3.1)
```

DataExam3.1.1	<i>Data for Example 3.1.1 from Experimental Design and Analysis for Tree Improvement</i>
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Description

Exam3.1.1 is part of data from Australian Centre for Agricultural Research (ACIAR) in Queensland, Australia (Experiment 309).

Usage

```
data(DataExam3.1.1)
```

Format

A data.frame with 10 rows and 6 variables.

repl Replication number of different Seedlots

PlotNo Plot No of differnt Trees

seedlot Seed Lot number

TreeNo Tree number of Seedlots

ht Height in meter

Var Var

TreeCount TreeCount

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam3.1.1](#)

Examples

```
data(DataExam3.1.1)
```

DataExam4.3

Data for Example 4.3 from Experimental Design and Analysis for Tree Improvement

Description

Exam4.3 presents the germination count data for 4 Pre-Treatments and 6 Seedlots.

Usage

```
data(DataExam4.3)
```

Format

A data.frame with 72 rows and 8 variables.

rep Replication number of Treatment

row Row number of different Seedlots

column Column number of different Trees

seedlot Seed lot number

treat Treatment types

count Number of germinated seeds out of 25

percent Germination Percentage

contcomp Control or Treated Plot

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam4.3](#)

Examples

```
data(DataExam4.3)
```

DataExam4.3.1	<i>Data for Example 4.3.1 from Experimental Design and Analysis for Tree Improvement</i>
---------------	--

Description

Exam4.3.1 presents the germination count data for 4 Pre-Treatments and 6 Seedlots.

Usage

```
data(DataExam4.3.1)
```

Format

A data.frame with 72 rows and 8 variables.

Row Row number of different Seedlots

Column Column number of different Trees

Replication Replication number of Treatment

Contcomp Control or Trated Plot

Pretreatment Treatment types

SeedLot Seed lot number

GerminationCount Number of germinated seeds out of 25

Percent Germination Percentage

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam4.3.1](#)

Examples

```
data(DataExam4.3.1)
```

DataExam4.4

Data for Example 4.4 from Experimental Design and Analysis for Tree Improvement

Description

Exam4.4 presents the height means for 4 seedlots under factorial arrangement for two levels of Fertilizer and two levels of Irrigation.

Usage

```
data(DataExam4.4)
```

Format

A data.frame with 32 rows and 5 variables.

repl Replication number

irrig Irrigation type

fert Fertilizer type

seedlot Seed Lot number

height Height of the plants

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam4.4](#)

Examples

```
data(DataExam4.4)
```

DataExam5.1

Data for Example 5.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam5.1 presents the height of 27 seedlots from 4 sites.

Usage

```
data(DataExam5.1)
```

Format

A data.frame with 108 rows and 4 variables.

site Sites for the experiment

seedlot Seed lot number

ht Height of the plants

sitemean Mean Height of Each Site

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam5.1](#)

Examples

```
data(DataExam5.1)
```

DataExam5.2

Data for Example 5.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam5.2 presents the height of 37 seedlots from 6 sites.

Usage

```
data(DataExam5.2)
```

Format

A data.frame with 108 rows and 4 variables.

site Sites for the experiment

seedlot Seed lot number

ht Height of the plants

sitemean Mean Height of Each Site

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam5.2](#)

Examples

```
data(DataExam5.2)
```

DataExam6.2

Data for Example 6.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam 6.2 Dbh mean, Dbh variance and number of trees per plot from 3 provinces("PNG", "Sabah", "Queensland") with 4 replications of 48 families.

Usage

```
data(DataExam6.2)
```

Format

A data frame with 192 rows and 7 variables.

Replication Replication number of different Families

Plot.number Plot number of different Trees

Family Family Number

Province Province of family

Dbh.mean Average Diameter at breast height of trees within plot

Dbh.variance Variance of Diameter at breast height of trees within plot

Dbh.count Number of trees within plot

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

Examples

```
data(DataExam6.2)
```

DataExam8.1

Data for Example 8.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam8.1 presents the Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries.

Usage

```
data(DataExam8.1)
```

Format

A data.frame with 236 rows and 8 variables.

repl There are 4 replication for the design

row Experiment is conducted under 6 rows\

col Experiment is conducted under 4 columns

inoc Seedling were inoculated for 2 different time periods half for one week and half for seven weeks

prov provenance

Country Data for different seedlots was collected from 18 countries

Dbh Diameter at breast height

Country.1 Recoded Country lables

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam8.1](#)

Examples

```
data(DataExam8.1)
```

DataExam8.2	<i>Data for Example 8.2 from Experimental Design and Analysis for Tree Improvement</i>
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Description

Exam8.2 presents the Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries.

Usage

```
data(DataExam8.2)
```

Format

A data.frame with 236 rows and 8 variables.

repl There are 4 replication for the design

row Experiment is conducted under 6 rows\

column Experiment is conducted under 4 columns

clonenum Clonenum

contcompf Contcompf

standard Standard

clone Clone

dbh dbhmean

dbhvar dbhvariance

ht htmean

htvar htvariance

count count

contcompv Contcompv

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[Exam8.2](#)

Examples

```
data(DataExam8.2)
```

Exam2.1

Example 2.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam2.1 is used to compare two seed lots by using single factor ANOVA.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam2.1](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam2.1)
# Pg. 22
fmtab2.3 <- lm(formula = dbh ~ seedlot, data = DataExam2.1)
# Pg. 23
anova(fmtab2.3)

# Pg. 23
emmeans(object = fmtab2.3, specs = ~ seedlot)
emmip(object = fmtab2.3, formula = ~ seedlot) +
  theme_classic()
```

Exam2.2	<i>Example 2.2 from Experimental Design and Analysis for Tree Improvement</i>
---------	---

Description

Exam2.2 is used to compare two seed lots by using ANOVA under RCB Design.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam2.2](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam2.2)

# Pg. 24
fmtab2.5 <-
  lm(
    formula = dbh ~ block + seedlot
    , data = DataExam2.2
  )

# Pg. 26
anova(fmtab2.5)

# Pg. 26
emmeans(object = fmtab2.5, specs = ~ seedlot)
emmip(object = fmtab2.5, formula = ~ seedlot) +
  theme_classic()
```

Exam3.1

Data for Example 3.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam3.1 is part of data from Australian Centre for Agricultural Research (ACIAR) in Queensland, Australia (Experiment 309).

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam3.1](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)
library(supernova)

data(DataExam3.1)

# Pg. 28
fmtab3.3 <-
  lm(
    formula = ht ~ repl*seedlot
    , data   = DataExam3.1
  )

fmtab3.3ANOVA1 <-
  anova(fmtab3.3) %>%
  mutate(
    "F value" =
```



```

      c(
        anova(fmtab3.3)[1:2, 3]/anova(fmtab3.3)[3, 3]
      , anova(fmtab3.3)[3, 4]
      , NA
      )
    )

# Pg. 33 (Table 3.3)
fmtab3.3ANOVA1 %>%
  mutate(
    "Pr(>F)" =
      c(
        NA
      , pf(
          q = fmtab3.3ANOVA1[2, 4]
        , df1 = fmtab3.3ANOVA1[2, 1]
        , df2 = fmtab3.3ANOVA1[3, 1], lower.tail = FALSE
        )
      , NA
      , NA
      )
    )

# Pg. 33 (Table 3.3)
emmeans(object = fmtab3.3, specs = ~ seedlot)

# Pg. 34 (Figure 3.2)
ggplot(
  mapping = aes(
    x = fitted.values(fmtab3.3)
  , y = residuals(fmtab3.3)
  )
) +
geom_point(size = 2) +
labs(
  x = "Fitted Values"
, y = "Residual"
) +
theme_classic()

# Pg. 33 (Table 3.4)
DataExam3.1m <- DataExam3.1
DataExam3.1m[c(28, 51, 76), 5] <- NA
DataExam3.1m[c(28, 51, 76), 6] <- NA

fmtab3.4 <-
  lm(
    formula = ht ~ repl*seedlot
  , data = DataExam3.1m
  )

```

```

fmtab3.4ANOVA1 <-
  anova(fmtab3.4) %>%
  mutate(
    "F value" =
      c(
        anova(fmtab3.4)[1:2, 3]/anova(fmtab3.4)[3, 3]
        , anova(fmtab3.4)[3, 4]
        , NA
        )
    )

# Pg. 33 (Table 3.4)
fmtab3.4ANOVA1 %>%
  mutate(
    "Pr(>F)" =
      c(
        NA
        , pf(
            q = fmtab3.4ANOVA1[2, 4]
            , df1 = fmtab3.4ANOVA1[2, 1]
            , df2 = fmtab3.4ANOVA1[3, 1], lower.tail = FALSE
            )
        , NA
        , NA
        )
    )

# Pg. 33 (Table 3.4)
emmeans(object = fmtab3.4, specs = ~ seedlot)

```

Exam3.1.1

Example 3.1.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam3.1.1 is part of data from Australian Centre for Agricultural Research (ACIAR) in Queensland, Australia (Experiment 309).

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also[DataExam3.1.1](#)**Examples**

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam3.1.1)

# Pg. 36
fm3.8 <-
  lm(
    formula = ht ~ repl + seedlot
    , data   = DataExam3.1.1
  )

# Pg. 40
anova(fm3.8)

# Pg. 40
emmeans(object = fm3.8, specs = ~seedlot)
emmip(object = fm3.8, formula = ~seedlot) +
  theme_classic()
```

Exam4.3*Example 4.3 from Experimental Design and Analysis for Tree Improvement*

Description

Exam4.3 presents the germination count data for 4 Pre-Treatments and 6 Seedlots.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also[DataExam4.3](#)**Examples**

```

library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam4.3)

# Pg. 50
fm4.2 <-
  aov(
    formula =
      percent ~ repl + contcomp + seedlot +
        treat/contcomp + contcomp/seedlot +
        treat/contcomp/seedlot
    , data = DataExam4.3
  )

# Pg. 54
anova(fm4.2)

# Pg. 54
model.tables(x = fm4.2, type = "means")

emmeans(object = fm4.2, specs = ~ contcomp)
emmeans(object = fm4.2, specs = ~ seedlot)
emmeans(object = fm4.2, specs = ~ contcomp + treat)
emmeans(object = fm4.2, specs = ~ contcomp + seedlot)
emmeans(object = fm4.2, specs = ~ contcomp + treat + seedlot)

DataExam4.3 %>%
  dplyr::group_by(treat, contcomp, seedlot) %>%
  dplyr::summarize(Mean = mean(percent))
RESFIT <-
  data.frame(
    residualvalue = residuals(fm4.2)
    , fittedvalue = fitted.values(fm4.2)
  )

ggplot(mapping = aes(
  x = fitted.values(fm4.2)
  , y = residuals(fm4.2))) +
  geom_point(size = 2) +
  labs(

```

```

    x = "Fitted Values"
  , y = "Residuals"
) +
theme_classic()

```

Exam4.3.1

Example 4.3.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam4.3.1 presents the germination count data for 4 Pre-Treatments and 6 Seedlots.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam4.3.1](#)

Examples

```

library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam4.3)

# Pg. 57
fm4.4 <-
  aov(
    formula = percent ~ repl + treat*seedlot
    , data   = DataExam4.3 %>%
      filter(treat != "control")
  )

```

```
# Pg. 57
anova(fm4.4)
model.tables(x = fm4.4, type = "means", se = TRUE)

emmeans(object = fm4.4, specs = ~ treat)
emmeans(object = fm4.4, specs = ~ seedlot)
emmeans(object = fm4.4, specs = ~ treat * seedlot)
```

Exam4.4

Example 4.4 from Experimental Design and Analysis for Tree Improvement

Description

Exam4.4 presents the height means for 4 seedlots under factorial arrangement for two levels of Fertilizer and two levels of Irrigation.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam4.4](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam4.4)

# Pg. 58
fm4.6 <-
  aov(
    formula = height ~ repl + irrig*fert*seedlot +
      Error(repl/irrig:fert)
```

```
, data = DataExam4.4
)

# Pg. 61
summary(fm4.6)

# Pg. 61
model.tables(x = fm4.6, type = "means")

# Pg. 61
emmeans(object = fm4.6, specs = ~ irrig)
emmip(object = fm4.6, formula = ~ irrig) +
  theme_classic()
```

Exam5.1

Example 5.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam5.1 presents the height of 27 seedlots from 4 sites.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam5.1](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam5.1)
```

```

# Pg. 68
fm5.4 <-
  lm(
    formula = ht ~ site*seedlot
    , data   = DataExam5.1
  )

# Pg. 73
anova(fm5.4)
# Pg. 73
emmeans(object = fm5.4, specs = ~ site)
emmeans(object = fm5.4, specs = ~ seedlot)

ANOVAfm5.4 <- anova(fm5.4)

ANOVAfm5.4[4, 1:3] <- c(208, 208*1040, 1040)
ANOVAfm5.4[3, 4]   <- ANOVAfm5.4[3, 3]/ANOVAfm5.4[4, 3]
ANOVAfm5.4[3, 5]   <-
  pf(
    q      = ANOVAfm5.4[3, 4]
    , df1  = ANOVAfm5.4[3, 1]
    , df2  = ANOVAfm5.4[4, 1]
    , lower.tail = FALSE
  )

# Pg. 73
ANOVAfm5.4

# Pg. 80
DataExam5.1 %>%
  filter(seedlot %in% c("13653", "13871")) %>%
  ggplot(
    data = .
    , mapping = aes(
      x      = sitemean
      , y      = ht
      , color = seedlot
      , shape = seedlot
    )
  ) +
  geom_point() +
  geom_smooth(
    method = lm
    , se    = FALSE
    , fullrange = TRUE
  ) +
  theme_classic() +
  labs(
    x = "SiteMean"
    , y = "SeedLot Mean"
  )

```



```

Tab5.10 <-
  DataExam5.1 %>%
  summarise(Mean = mean(ht), .by = seedlot) %>%
  left_join(
    DataExam5.1 %>%
    nest_by(seedlot) %>%
    mutate(fm1 = list(lm(ht ~ sitemean, data = data))) %>%
    summarise(Slope = coef(fm1)[2])
  , by = "seedlot"
  )

# Pg. 81
Tab5.10

ggplot(data = Tab5.10, mapping = aes(x = Mean, y = Slope)) +
  geom_point(size = 2) +
  theme_bw() +
  labs(
    x = "SeedLot Mean"
    , y = "Regression Coefficient"
  )

DevSS1 <-
  DataExam5.1 %>%
  nest_by(seedlot) %>%
  mutate(fm1 = list(lm(ht ~ sitemean, data = data))) %>%
  summarise(SSE = anova(fm1)[2, 2]) %>%
  ungroup() %>%
  summarise(Dev = sum(SSE)) %>%
  as.numeric()

ANOVAfm5.4[2, 2]

length(levels(DataExam5.1$SeedLot))

ANOVAfm5.4.1 <-
  rbind(
    ANOVAfm5.4[1:3, ]
  , c(
    ANOVAfm5.4[2, 1]
    , ANOVAfm5.4[3, 2] - DevSS1
    , (ANOVAfm5.4[3, 2] - DevSS1)/ANOVAfm5.4[2, 1]
    , NA
    , NA
  )
  , c(
    ANOVAfm5.4[3, 1]-ANOVAfm5.4[2, 1]
    , DevSS1
    , DevSS1/(ANOVAfm5.4[3, 1]-ANOVAfm5.4[2, 1])
    , DevSS1/(ANOVAfm5.4[3, 1]-ANOVAfm5.4[2, 1])/ANOVAfm5.4[4, 3]
  , pf(
    q = DevSS1/(ANOVAfm5.4[3, 1]-ANOVAfm5.4[2, 1])/ANOVAfm5.4[4, 3]
  )

```

```
      , df1 = ANOVAfm5.4[3, 1]-ANOVAfm5.4[2, 1]
      , df2 = ANOVAfm5.4[4, 1]
      , lower.tail = FALSE
    )
  )
  , ANOVAfm5.4[4, ]
)

rownames(ANOVAfm5.4.1) <-
  c(
    "Site"
    , "seedlot"
    , "site:seedlot"
    , " regressions"
    , " deviations"
    , "Residuals"
  )
# Pg. 82
ANOVAfm5.4.1
```

Exam5.2

Example 5.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam5.2 presents the height of 37 seedlots from 6 sites.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam5.2](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
```

```

library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam5.2)

# Pg. 75
fm5.7 <-
  lm(
    formula = ht ~ site*seedlot
    , data   = DataExam5.2
  )

# Pg. 77
anova(fm5.7)

fm5.9 <-
  lm(
    formula = ht ~ site*seedlot
    , data   = DataExam5.2
  )
# Pg. 77
anova(fm5.9)

ANOVAfm5.9 <- anova(fm5.9)

ANOVAfm5.9[4, 1:3] <- c(384, 384*964, 964)
ANOVAfm5.9[3, 4]   <- ANOVAfm5.9[3, 3]/ANOVAfm5.9[4, 3]
ANOVAfm5.9[3, 5]   <-
  pf(
    q = ANOVAfm5.9[3, 4]
    , df1 = ANOVAfm5.9[3, 1]
    , df2 = ANOVAfm5.9[4, 1]
    , lower.tail = FALSE
  )
# Pg. 77
ANOVAfm5.9

Tab5.14 <-
DataExam5.2 %>%
  summarise(
    Mean = round(mean(ht, na.rm = TRUE), 0)
    , .by = seedlot
  ) %>%
  left_join(
    DataExam5.2 %>%
    nest_by(seedlot) %>%
    mutate(fm2 = list(lm(ht ~ sitemean, data = data))) %>%
    summarise(Slope = round(coef(fm2)[2], 2))
    , by = "seedlot"
  ) %>%

```

```

as.data.frame()

# Pg. 81
Tab5.14

DevSS2 <-
  DataExam5.2 %>%
  nest_by(seedlot) %>%
  mutate(fm2 = list(lm(ht ~ sitemean, data = data))) %>%
  summarise(SSE = anova(fm2)[2, 2]) %>%
  ungroup() %>%
  summarise(Dev = sum(SSE)) %>%
  as.numeric()

ANOVAfm5.9.1 <-
  rbind(
    ANOVAfm5.9[1:3, ]
    , c(
      ANOVAfm5.9[2, 1]
      , ANOVAfm5.9[3, 2] - DevSS2
      , (ANOVAfm5.9[3, 2] - DevSS2)/ANOVAfm5.9[2, 1]
      , NA
      , NA
      )
    , c(
      ANOVAfm5.9[3, 1]-ANOVAfm5.9[2, 1]
      , DevSS2
      , DevSS2/(ANOVAfm5.9[3, 1]-ANOVAfm5.9[2, 1])
      , DevSS2/(ANOVAfm5.9[3, 1]-ANOVAfm5.9[2, 1])/ANOVAfm5.9[4, 3]
      , pf(
          q = DevSS2/(ANOVAfm5.9[3, 1]-ANOVAfm5.9[2, 1])/ANOVAfm5.9[4, 3]
          , df1 = ANOVAfm5.9[3, 1]-ANOVAfm5.9[2, 1]
          , df2 = ANOVAfm5.9[4, 1]
          , lower.tail = FALSE
          )
      )
    , ANOVAfm5.9[4, ]
  )
rownames(ANOVAfm5.9.1) <-
  c(
    "site"
    , "seedlot"
    , "site:seedlot"
    , " regressions"
    , " deviations"
    , "Residuals"
  )

# Pg. 82
ANOVAfm5.9.1

```

```
Code <-
c(
  "a","a","a","a","b","b","b","b"
, "c","d","d","d","d","e","f","g"
, "h","h","i","i","j","k","l","m"
, "n","n","n","o","p","p","q","r"
, "s","t","t","u","v"
)

Tab5.14$Code <- Code

ggplot(
  data = Tab5.14
, mapping = aes(x = Mean, y = Slope)
) +
geom_point(size = 2) +
geom_text(
  mapping = aes(label = Code)
, hjust = -0.5
, vjust = -0.5
) +
theme_bw() +
labs(
  x = "SeedLot Mean"
, y = "Regression Coefficient"
)

```

Exam6.2

Example 6.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam 6.2 Dbh mean, Dbh varince and number of trees per plot from 3 provinces("PNG","Sabah","Queensland") with 4 replications of 48 families.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam6.2](#)

Examples

```

library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam6.2)

DataExam6.2.1 <-
  DataExam6.2 %>%
  filter(Province == "PNG")

# Pg. 94
fm6.3 <-
  lm(
    formula = Dbh.mean ~ Replication + Family
    , data   = DataExam6.2.1
  )

b <- anova(fm6.3)

HM <- function(x){length(x)/sum(1/x)}
w <- HM(DataExam6.2.1$Dbh.count)
S2 <- b[["Mean Sq"]][length(b[["Mean Sq"]])]
Sigma2t <- mean(DataExam6.2.1$Dbh.variance)
sigma2m <- S2-(Sigma2t/w)

fm6.3.1 <-
  lmer(
    formula = Dbh.mean ~ 1 + Replication + (1|Family)
    , data   = DataExam6.2.1
    , REML   = TRUE
  )

# Pg. 104
# summary(fm6.3.1)
varcomp(fm6.3.1)
sigma2f <- 0.2584
h2 <- (sigma2f/(0.3))/(Sigma2t + sigma2m + sigma2f)
cbind(hmean = w, Sigma2t, sigma2m, sigma2f, h2)

fm6.4 <-
  lm(
    formula = Dbh.mean ~ Replication+Family
    , data   = DataExam6.2
  )

```

```

b <- anova(fm6.4)
HM <- function(x){length(x)/sum(1/x)}
w <- HM(DataExam6.2$Dbh.count)
S2 <- b[["Mean Sq"]][length(b[["Mean Sq"]])]
Sigma2t <- mean(DataExam6.2$Dbh.variance)
sigma2m <- S2-(Sigma2t/w)

fm6.4.1 <-
  lmer(
    formula = Dbh.mean ~ 1 + Replication + Province + (1|Family)
    , data = DataExam6.2
    , REML = TRUE
    )

# Pg. 107
varcomp(fm6.4.1)
sigma2f <- 0.3514
h2 <- (sigma2f/(0.3))/(Sigma2t+sigma2m+sigma2f)
cbind(hmean = w, Sigma2t, sigma2m, sigma2f, h2)

fm6.7.1 <-
  lmer(
    formula = Dbh.mean ~ 1+Replication+(1|Family)
    , data = DataExam6.2.1
    , REML = TRUE
    )

# Pg. 116
varcomp(fm6.7.1)
sigma2f[1] <- 0.2584

fm6.7.2<-
  lmer(
    formula = Ht.mean ~ 1 + Replication + (1|Family)
    , data = DataExam6.2.1
    , REML = TRUE
    )

# Pg. 116
varcomp(fm6.7.2)
sigma2f[2] <- 0.2711

fm6.7.3 <-
  lmer(
    formula = Sum.means ~ 1 + Replication + (1|Family)
    , data = DataExam6.2.1
    , REML = TRUE
    , control = lmerControl()
    )

# Pg. 116
varcomp(fm6.7.3)
sigma2f[3] <- 0.873

```

```

sigma2xy <- 0.5*(sigma2f[3]-sigma2f[1]-sigma2f[2])
GenCorr <- sigma2xy/sqrt(sigma2f[1]*sigma2f[2])
cbind(
  S2x = sigma2f[1]
  , S2y = sigma2f[2]
  , S2.x.plus.y = sigma2f[3]
  , GenCorr
)

```

Exam8.1

Example 8.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam8.1 presents the Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam8.1](#)

Examples

```

library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam8.1)

# Pg. 141
fm8.4 <-
  aov(
    formula = dbh ~ inoc + Error(repl/inoc) +

```



```

                                inoc*country*prov
, data    = DataExam8.1
)

# Pg. 150
summary(fm8.4)

# Pg. 150
model.tables(x = fm8.4, type = "means")

RESFit <-
  data.frame(
    fittedvalue = fitted.aovlist(fm8.4)
    , residualvalue = proj(fm8.4)$Within[,"Residuals"]
  )

ggplot(
  data    = RESFit
  , mapping = aes(x = fittedvalue, y = residualvalue)
) +
geom_point(size = 2) +
labs(
  x = "Residuals vs Fitted Values"
  , y = ""
) +
theme_bw()

# Pg. 153
fm8.6 <-
  aov(
    formula = terms(
      dbh ~ inoc + repl + col +
        repl:row + repl:col +
        prov + inoc:prov
      , keep.order = TRUE
    )
    , data    = DataExam8.1
  )
summary(fm8.6)

```

Exam8.1.1

Example 8.1.1 from Experimental Design and Analysis for Tree Improvement

Description

Exam8.1.1 presents the Mixed Effects Analysis of Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries given in Example 8.1.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam8.1](#)

Examples

```

library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam8.1)

# Pg. 155
fm8.8 <-
  lmerTest::lmer(
    formula = dbh ~ 1 + repl + col + prov +
              (1|repl:row) + (1|repl:col)
    , data   = DataExam8.1
    , REML  = TRUE
    )

# Pg. 157
## Not run:
varcomp(fm8.8)

## End(Not run)

anova(fm8.8)
anova(fm8.8, ddf = "Kenward-Roger")

predictmeans(model = fm8.8, modelterm = "repl")
predictmeans(model = fm8.8, modelterm = "col")
predictmeans(model = fm8.8, modelterm = "prov")

# Pg. 161
RCB1 <-
  aov(dbh ~ prov + repl, data = DataExam8.1)

```

```
RCB <-
  emmeans(RCB1, specs = "prov") %>%
  as_tibble()

Mixed <-
  emmeans(fm8.8, specs = "prov") %>%
  as_tibble()

table8.9 <-
  left_join(
    x = RCB
    , y = Mixed
    , by = "prov"
    , suffix = c(".RCBD", ".Mixed")
  )
print(table8.9)
```

Exam8.1.2

Example 8.1.2 from Experimental Design & Analysis for Tree Improvement

Description

Exam8.1.2 presents the Analysis of Nested Seedlot Structure of Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries given in Example 8.1.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam8.1](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
```

```

library(magrittr)
library(predictmeans)

data(DataExam8.1)

# Pg. 167
fm8.11 <-
  aov(
    formula = dbh ~ country + country:prov
    , data   = DataExam8.1
  )

b <- anova(fm8.11)
Res <- length(b[["Sum Sq"]])
df <- 119
MSS <- 0.1951

b[["Df"]][Res] <- df
b[["Sum Sq"]][Res] <- MSS*df
b[["Mean Sq"]][Res] <- b[["Sum Sq"]][Res]/b[["Df"]][Res]

b[["F value"]][1:Res-1] <-
  b[["Mean Sq"]][1:Res-1]/b[["Mean Sq"]][Res]

b[["Pr(>F)"]][Res-1] <-
  df(
    b[["F value"]][Res-1]
    , b[["Df"]][Res-1]
    , b[["Df"]][Res]
  )
b

emmeans(fm8.11, specs = "country")

```

Exam8.2

Example 8.2 from Experimental Design and Analysis for Tree Improvement

Description

Exam8.2 presents the Diameter at breast height (Dbh) of 60 SeedLots under layout of row column design with 6 rows and 10 columns in 18 countries and 59 provinces of 18 selected countries.

Author(s)

1. Muhammad Yaseen (<myaseen208@gmail.com>)
2. Sami Ullah (<samiullahuos@gmail.com>)

References

1. E.R. Williams, C.E. Harwood and A.C. Matheson (2023). *Experimental Design and Analysis for Tree Improvement*. CSIRO Publishing (<https://www.publish.csiro.au/book/3145/>).

See Also

[DataExam8.2](#)

Examples

```
library(car)
library(dae)
library(dplyr)
library(emmeans)
library(ggplot2)
library(lmerTest)
library(magrittr)
library(predictmeans)

data(DataExam8.2)

# Pg.
fm8.2 <-
  lmerTest::lmer(
    formula = dbh ~ repl + column +
              contcompf + contcompf:standard +
              (1|repl:row) + (1|repl:column) +
              (1|contcompv:clone)
    , data = DataExam8.2
  )
## Not run:
varcomp(fm8.2)

## End(Not run)
anova(fm8.2)
Anova(fm8.2, type = "II", test.statistic = "Chisq")

predictmeans(model = fm8.2, modelterm = "repl")
predictmeans(model = fm8.2, modelterm = "column")

emmeans(object = fm8.2, specs = ~contcompf|standard)
```

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