

# Package ‘easyanova’

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**Type** Package

**Title** Analysis of Variance and Other Important Complementary Analyses

**Version** 11.0

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**Maintainer** Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**Description** Perform analysis of variance and other important complementary analyses. The functions are easy to use. Performs analysis in various designs, with balanced and unbalanced data.

**Depends** R (>= 3.0.0)

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**License** GPL-2

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easynova-package      *Analysis of Variance and Other Important Complementary Analyzes*

---

## Description

Perform analysis of variance and other important complementary analyzes. The functions are easy to use. Performs analysis in various designs, with balanced and unbalanced data.

## Details

Package: easynova  
 Type: Package  
 Version: 11.0  
 Date: 2024-09-14  
 License: GPL-2

## Author(s)

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

## References

- CRUZ, C.D. and CARNEIRO, P.C.S. Modelos biometricos aplicados ao melhoramento genetico. 2nd Edition. Vicosa, UFV, v.2, 2006. 585p.
- KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.
- SAMPAIO, I. B. M. Estatistica aplicada a experimentacao animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundacao de Ensino e Pesquisa em Medicina Veterinaria e Zootecnia, 2010. 264p.
- SANDERS W.L. and GAYNOR, P.J. Analysis of switchback data using Statistical Analysis System, Inc. Software. Journal of Dairy Science, 70.2186-2191. 1987.
- PIMENTEL-GOMES, F. and GARCIA C.H. Estatistica aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.
- RAMALHO, M. A. P.; FERREIRA, D. F. and OLIVEIRA, A. C. Experimentacao em Genetica e Melhoramento de Plantas. Editora UFLA, 2005, 322p.

## See Also

ea1, ea2, ec

## Examples

```
# Kaps and Lamberson(2009)
data(data1)
data(data2)
data(data3)
data(data4)

# analysis in completely randomized design
r1<-ea1(data1, design=1)

names(r1)

r1

# analysis in randomized block design
r2<-ea1(data2, design=2)

# analysis in latin square design
r3<-ea1(data3, design=3)

# analysis in several latin squares design
r4<-ea1(data4, design=4)

r1[1]
r2[1]
r3[1]
r4[1]
```

```

# analysis in unbalanced randomized block design
response<-ifelse(data2$Gain>850, NA, data2$Gain)
ndata<-data.frame(data2[-3],response)
ndata

r5<-ea1(ndata, design=2 )

r5

# multivariable response (list argument = TRUE)
t<-c('a','a','a','b','b','b','c','c','c')
r1<-c(10,12,12.8,4,6,8,14,15,16)
r2<-c(102,105,106,125,123,124,99,95,96)
r3<-c(560,589,590,658,678,629,369,389,378)

d<-data.frame(t,r1,r2,r3)

results=ea1(d, design=1, list=TRUE)
names(results)
results

results[1][[1]]

names(results[1][[1]])

```

---

box.plot

*Box plot*

---

## Description

Plot quartis

## Usage

```

box.plot(data,test=1, xlab=NULL, ylab=NULL,legend=TRUE,
letters=TRUE, family="Times", bg="white", cex.axis=0.7,...)

```

## Arguments

data	data.frame with data (see examples)
test	type of test 1 = Kruskal-Wallis 2 = Friedman
xlab	name of x-axis
ylab	name of y-axis
legend	TRUE = plot p-value of test FALSE = not plot p-value
letters	TRUE = plot letters FALSE = not plot letters

family	font of plot
bg	background color
cex.axis	font size in the axis
...	more plot parameters

**Value**

Returns box plots and test of Kruskal-Wallis and Friedman

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2, means.plot

**Examples**

```
#data3: Kaps and Lamberson (2009)
#Description:
##The experiment compared three diets for pigs in a completely randomized design
data(data1)

# Kruskal-Wallis test
box.plot(data1, test=1)

#Description
#Complete randomized block design to determine the average daily gain of steers
data(data2)
box.plot(data2, test=2)

#More plot parameters
box.plot(data2, test=2, col=c(2,7,3), col.axis="red",las=1,
legend=FALSE, bg="cornsilk", sub="Treatments", cex=1.2);grid(10, lwd=1.5)
```

---

data1

*data1: Kaps and Lamberson(2009): page 252*

---

### Description

The experiment compared three diets for pigs in a completely randomized design

### Usage

```
data(data1)
```

### Format

A data frame with 15 observations on the following 2 variables.

Diet a factor with levels d1 d2 d3

Gain a numeric vector

### References

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

### Examples

```
data(data1)  
summary(data1)
```

---

data10

*data10: Kaps and Lamberson (2009): page 395*

---

### Description

Completely randomized design with a covariate. The effect of three diets on daily gain of steers was investigated. The design was a completely randomized design. Weight at the beginning of the experiment (initial weight) was recorded, but not used in the assignment of animals to diet.

### Usage

```
data(data10)
```

**Format**

A data frame with 15 observations on the following 4 variables.

Diets a factor with levels A B C

Initial\_weight a numeric vector

Repetitions a numeric vector

Gain a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data10)
summary(data10)
```

---

data11

*data11: Pimentel Gomes and Garcia (2002): page 199*

---

**Description**

Incomplete block design

**Usage**

```
data(data11)
```

**Format**

A data frame with 56 observations on the following 4 variables.

treatments a numeric vector

rep a numeric vector

blocks a numeric vector

yield a numeric vector

**References**

PIMENTEL-GOMES, F. and GARCIA C.H. Estatística aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

**Examples**

```
data(data11)
summary(data11)
```

---

data12

*data12: Pimentel Gomes and Garcia (2002): page 202*

---

**Description**

Incomplete block design

**Usage**

```
data(data12)
```

**Format**

A data frame with 42 observations on the following 4 variables.

treatments a numeric vector

rep a numeric vector

blocks a numeric vector

yield a numeric vector

**References**

PIMENTEL-GOMES, F. and GARCIA C.H. Estatística aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

**Examples**

```
data(data12)  
summary(data12)
```

---

data13

*data13: Cruz and Carneiro (2006): page 575*

---

**Description**

Incomplete block design

**Usage**

```
data(data13)
```

**Format**

A data frame with 23 observations on the following 3 variables.

genotypes a factor with levels f1 f10 f11 f12 f13 f14 f2 f3 f4 f5 f6 f7 f8 f9 test1 test2 test3

blocks a factor with levels b1 b2 b3

yield a numeric vector

**References**

CRUZ, C.D. and CARNEIRO, P.C.S. Modelos biometricos aplicados ao melhoramento genetico. 2nd Edition. Vicosa, UFV, v.2, 2006. 585p.

**Examples**

```
data(data13)
summary(data13)
```

---

data14

*data14: Sampaio (2009): page173*

---

**Description**

Incomplete block design in animals

**Usage**

```
data(data14)
```

**Format**

A data frame with 28 observations on the following 4 variables.

treatment a factor with levels A B C D E F G

animal a factor with levels A1 A2 A3 A4 A5 A6 A7

period a factor with levels P1 P2 P3 P4

response a numeric vector

**References**

SAMPAIO, I. B. M. Estatística aplicada a experimentação animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundação de Ensino e Pesquisa em Medicina Veterinária e Zootecnia, 2010. 264p.

**Examples**

```
data(data14)
summary(data14)
```

---

data15

*data15: Pimentel Gomes and Garcia (2002): page 211*

---

**Description**

Lattice design

**Usage**

```
data(data15)
```

**Format**

A data frame with 48 observations on the following 4 variables.

treatments a numeric vector

rep a numeric vector

blocks a numeric vector

yield a numeric vector

**References**

PIMENTEL-GOMES, F. and GARCIA C.H. Estatística aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

**Examples**

```
data(data15)  
summary(data15)
```

---

data16

*data16: Sampaio (2010): page164*

---

**Description**

Switchback design

**Usage**

```
data(data16)
```

**Format**

A data frame with 36 observations on the following 4 variables.

treatment a factor with levels A B C

period a numeric vector

animal a numeric vector

gain a numeric vector

**References**

SAMPAIO, I. B. M. Estatística aplicada a experimentação animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundação de Ensino e Pesquisa em Medicina Veterinária e Zootecnia, 2010. 264p.

**Examples**

```
data(data16)
summary(data16)
```

---

data17	<i>data17: Sanders and Gaynor (1987)</i>
--------	--

---

**Description**

Switchback design

**Usage**

```
data(data17)
```

**Format**

A data frame with 36 observations on the following 5 variables.

treatments a numeric vector

blocks a factor with levels b1 b2 b3

period a numeric vector

animal a numeric vector

gain a numeric vector

**References**

SANDERS W.L. and GAYNOR, P.J. Analysis of switchback data using Statistical Analysis System, Inc. Software. Journal of Dairy Science, 70.2186-2191. 1987.

**Examples**

```
data(data17)
summary(data17)
```

---

data18

*data18: Ramalho et al. (2005): page 115*

---

**Description**

Repetition of experiments in block design

**Usage**

```
data(data18)
```

**Format**

A data frame with 60 observations on the following 4 variables.

treatments a numeric vector

experiments a numeric vector

blocks a numeric vector

response a numeric vector

**References**

RAMALHO, M. A. P.; FERREIRA, D. F. and OLIVEIRA, A. C. Experimentacao em Genetica e Melhoramento de Plantas. Editora UFLA, 2005, 322p.

**Examples**

```
data(data18)  
summary(data18)
```

---

data19

*data19: Sampaio (2010): page 155*

---

**Description**

Repetition of latin square design

**Usage**

```
data(data19)
```

**Format**

A data frame with 32 observations on the following 5 variables.

treatments a factor with levels A B C D

squares a factor with levels 1 2

rows a factor with levels 1 2 3 4

columns a factor with levels 1 2 3 4

response a numeric vector

**References**

SAMPAIO, I. B. M. Estatística aplicada a experimentação animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundação de Ensino e Pesquisa em Medicina Veterinária e Zootecnia, 2010. 264p.

**Examples**

```
data(data19)
summary(data19)
```

---

data2	<i>data2: Kaps and Lamberson (2009): page 313: randomized block design</i>
-------	--

---

**Description**

Complete randomized block design to determine the average daily gain of steers

**Usage**

```
data(data2)
```

**Format**

A data frame with 12 observations on the following 3 variables.

Treatments a factor with levels t1 t2 t3

Blocks a factor with levels b1 b2 b3 b4

Gain a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data2)
summary(data2)
```

---

data3

*data3: Kaps and Lamberson (2009): page 347*

---

### Description

Latin square design for test four different treatments on hay intake of fattening steers

### Usage

```
data(data3)
```

### Format

A data frame with 16 observations on the following 4 variables.

```
treatment a factor with levels A B C D
period a factor with levels p1 p2 p3 p4
steer a factor with levels a1 a2 a3 a4
response a numeric vector
```

### References

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

### Examples

```
data(data3)
summary(data3)
```

---

data4

*data4: Kaps and Lamberson (2009): page 349*

---

### Description

Two latin squares design for test four different treatments on hay intake of fattening steers

### Usage

```
data(data4)
```

**Format**

A data frame with 32 observations on the following 5 variables.

diet a factor with levels A B C D

square a numeric vector

steer a numeric vector

period a numeric vector

response a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data4)
summary(data4)
```

---

data5

*data5: Kaps and Lamberson (2009): page 361*

---

**Description**

Factorial in randomized design for testing two vitamins in feed of pigs

**Usage**

```
data(data5)
```

**Format**

A data frame with 20 observations on the following 3 variables.

Vitamin\_1 a numeric vector

Vitamin\_2 a numeric vector

Gains a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data5)
summary(data5)
```

---

data6

*data6: Pimentel Gomes and Garcia (2002): page 127*

---

**Description**

Factorial in randomized block design

**Usage**

```
data(data6)
```

**Format**

A data frame with 16 observations on the following 4 variables.

factor1 a numeric vector

factor2 a numeric vector

block a numeric vector

yield a numeric vector

**References**

PIMENTEL-GOMES, F. and GARCIA C.H. Estatística aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

**Examples**

```
data(data6)
summary(data6)
```

---

data7

*data7: Kaps and Lamberson (2009): page 409*

---

**Description**

The aim of this experiment was to test the difference between two treatments on gain of kids. A sample of 18 kids was chosen, nine for each treatment. One kid in treatment 1 was removed from the experiment due to illness. The experiment began at the age of 8 weeks. Weekly gain was measured at ages 9, 10, 11 and 12 weeks.

**Usage**

```
data(data7)
```

**Format**

A data frame with 68 observations on the following 4 variables.

treatment a character vector

rep a numeric vector

week a character vector

gain a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data7)
summary(data7)
```

---

data8

*data8: Kaps and Lamberson (2009): page 386*

---

**Description**

Split-plot Design. Main Plots in Randomized Blocks. An experiment was conducted in order to investigate four different treatments of pasture and two mineral supplements on milk yield. The total number of cows available was 24. The experiment was designed as a split-plot, with pasture treatments (factor A) assigned to the main plots and mineral supplements (factor B) assigned to split-plots. The experiment was replicated in three blocks.

**Usage**

```
data(data8)
```

**Format**

A data frame with 24 observations on the following 4 variables.

pasture a factor with levels p1 p2 p3 p4

block a numeric vector

mineral a factor with levels m1 m2

milk a numeric vector

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**Examples**

```
data(data8)
summary(data8)
```

---

data9

*data9: Sampaio (2010): page 67*

---

**Description**

Factorial design to evaluate egg quality according to the lineage of chicken, packaging and storage time.

**Usage**

```
data(data9)
```

**Format**

A data frame with 120 observations on the following 5 variables.

lineage a factor with levels A B

packing a factor with levels Ce Co S

time a numeric vector

repetitions a numeric vector

response a numeric vector

**References**

SAMPAIO, I. B. M. Estatística aplicada a experimentação animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundação de Ensino e Pesquisa em Medicina Veterinária e Zootecnia, 2010. 264p.

**Examples**

```
data(data9)
summary(data9)
```

---

 ea1

*Analysis of variance in simple designs*


---

### Description

Perform analysis of variance and other important complementary analyzes. The function are easy to use. Performs analysis in various simples designs, with balanced and unbalanced data. Too performs analysis the kruskal-Wallis and Friedman (designs 14 and 15).

### Usage

```
ea1(data, design = 1, alpha = 0.05, list = FALSE, p.adjust=1, plot=2)
```

### Arguments

data	data is a data.frame see how the input data in the examples
design	1 = completely randomized design 2 = randomized block design 3 = latin square design 4 = several latin squares 5 = analysis with a covariate (completely randomized design) 6 = analysis with a covariate (randomized block design) 7 = incomplete blocks type I and II 8 = incomplete blocks type III or augmented blocks 9 = incomplete blocks type III in animal experiments 10 = lattice (intra-block analysis) 11 = lattice (inter-block analysis) 12 = switchback design 13 = switchback design in blocks 14 = Kruskal-Wallis rank sum test 15 = Friedman rank sum test
alpha	significance level for multiple comparisons
list	FALSE = a single response variable TRUE = multivariable response
p.adjust	1="none"; 2="holm"; 3="hochberg"; 4="hommel"; 5="bonferroni"; 6="BH", 7="BY"; 8="fdr"; for more details see function "p.adjust"
plot	1 = box plot for residuals; 2 = standardized residuals vs sequence data; 3 = standardized residuals vs theoretical quantiles

### Details

The response variable must be numeric. Other variables can be numeric or factors.

**Value**

Returns analysis of variance, means (adjusted means), multiple comparison test (tukey, snk, duncan, t and scott knott) and residual analysis. Too returns analysis the kruskal-Wallis and Friedman (designs 14 and 15).

**Author(s)**

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**References**

CRUZ, C.D. and CARNEIRO, P.C.S. Modelos biometricos aplicados ao melhoramento genetico. 2nd Edition. Vicosa, UFV, v.2, 2006. 585p.

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

SAMPAIO, I. B. M. Estatistica aplicada a experimentacao animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundacao de Ensino e Pesquisa em Medicina Veterinaria e Zootecnia, 2010. 264p.

SANDERS W.L. and GAYNOR, P.J. Analysis of switchback data using Statistical Analysis System, Inc. Software. Journal of Dairy Science, 70.2186-2191. 1987.

PIMENTEL-GOMES, F. and GARCIA C.H. Estatistica aplicada a experimentos agronomicos e florestais: exposicao com exemplos e orientacoes para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

**See Also**

ea2, ec

**Examples**

```
# Kaps and Lamberson(2009)
data(data1)
data(data2)
data(data3)
data(data4)

# analysis in completely randomized design
r1<-ea1(data1, design=1)

names(r1)

r1

# analysis in randomized block design
r2<-ea1(data2, design=2)

# analysis in latin square design
r3<-ea1(data3, design=3)
```

```
# analysis in several latin squares design
r4<-ea1(data4, design=4)

r1[1]
r2[1]
r3[1]
r4[1]

# analysis in unbalanced randomized block design
response<-ifelse(data2$Gain>850, NA, data2$Gain)
ndata<-data.frame(data2[-3],response)
ndata

r5<-ea1(ndata, design=2 )

r5

# multivariable response (list argument = TRUE)
t<-c('a','a','a','b','b','b','c','c','c')
r1<-c(10,12,12.8,4,6,8,14,15,16)
r2<-c(102,105,106,125,123,124,99,95,96)
r3<-c(560,589,590,658,678,629,369,389,378)

d<-data.frame(t,r1,r2,r3)

results=ea1(d, design=1, list=TRUE)
names(results)
results

results[1][[1]]

names(results[1][[1]])

# analysis with a covariate
# Kaps and Lamberson (2009)
data(data10)

# analysis in completely randomized design
r6<-ea1(data10[-3], design=5)

r6

# incomplete blocks type I and II
# Pimentel Gomes and Garcia (2002)
data(data11)
data(data12)

r7<-ea1(data11,design=7)
r8<-ea1(data12,design=7)

r7;r8
```

```
# incomplete blocks type III or augmented blocks
# Cruz and Carneiro (2006)
data(data13)

r9<-ea1(data13, design=8)
r9

# incomplete blocks type III in animal experiments
# Sampaio (2010)
data(data14)

r10<-ea1(data14, design=9)
r10

# lattice
# Pimentel Gomes and Garcia (2002)
data(data15)

r11<-ea1(data15, design=10) # intra-block analysis
r12<-ea1(data15, design=11) # inter-block analysis

r11
r12

# switchback design
# Sampaio (2010)
data(data16)
r13<-ea1(data16, design=12)
r13

# switchback design in blocks
# Sanders and Gaynor (1987)
data(data17)
r14<-ea1(data17, design=13)
r14

#Kruskal-Wallis Rank Sum Test
r15<-ea1(data1, design=14)
r15

#Friedman Rank Sum Test
r16<-ea1(data2, design=15)
r16

# Graeco-Latin Square
#latin letters
treatment=c("A","B","C","D","E","B","C","D","E","A","C",
"D","E","A","B","D","E","A","B","C","E","A","B","C","D")
```

```

##blocked factors
#greek letters
block=c(1,2,3,4,5,3,4,5,1,2,5,1,2,3,4,2,3,4,5,1,4,5,1,2,3)
# rows
rows=rep(1:5,5)
#coluns
columns=rep(1:5, each=5)
#variable
response=c(-1,-8,-7,1,-3,-5,-1,13,6,5,-6,5,1,1,-5,-1,2,2,-2,4,-1,11,-4,-3,6)
# table
data=data.frame(treatment, block, rows, columns, response)
r16=ea1(data, design=16)
r16

### Repetitions of Graeco-Latin Square
#latin letters
treatment=c("A","B","C","D","E","B","C","D","E",
"A","C","D","E","A","B","D","E","A","B","C","E","A","B","C","D",
"A","B","C","D","E","B","C","D","E","A","C","D",
"E","A","B","D","E","A","B","C","E","A","B","C","D")
#squares
squares=rep(1:2,25)
##blocked factors
#greek letters
block=c(1,2,3,4,5,3,4,5,1,2,5,1,2,3,4,2,3,4,5,1,4,5,1,2,3,
1,2,3,4,5,3,4,5,1,2,5,1,2,3,4,2,3,4,5,1,4,5,1,2,3)
# rows
rows=c(rep(1:5,5),rep(1:5,5))
#coluns
columns=c(rep(1:5, each=5),rep(1:5, each=5))
#variable
response=c(-1,-8,-7,1,-3,-5,-1,13,6,5,-6,5,1,1,-5,-1,2,2,-2,4,-1,11,-4,-3,6,
-2,-9,-8,1,-2,-5,-1,9,6,5,-5,2,3,1,-7,-1,2,4,-1,2,-2,15,-5,-1,7)

# table
data=data.frame(treatment, squares, block, rows, columns, response)
r17=ea1(data, design=17)
r17

```

**Description**

Perform analysis of variance and other important complementary analyzes in factorial and split plot scheme, with balanced and unbalanced data.

**Usage**

```
ea2(data, design = 1, alpha = 0.05, cov = 4, list = FALSE, p.adjust=1, plot=2)
```

**Arguments**

<code>data</code>	data is a data.frame see how the input data in the examples
<code>design</code>	1 = double factorial in completely randomized design 2 = double factorial in randomized block design 3 = double factorial in latin square design 4 = split plot in completely randomized design 5 = split plot in randomized block design 6 = split plot in latin square design 7 = triple factorial in completely randomized design 8 = triple factorial in randomized block design 9 = double factorial in split plot (completely randomized) 10 = double factorial in split plot (randomized in block) 11 = joint analysis of experiments with hierarchical blocks 12 = joint analysis of repetitions of latin squares (hierarchical rows) 13 = joint analysis of repetitions of latin squares (hierarchical rows and columns)
<code>alpha</code>	significance level for multiple comparisons
<code>cov</code>	for split plot designs 1 = Autoregressive 2 = Heterogenous Autoregressive 3 = Continuous Autoregressive Process 4 = Compound Symmetry 5 = Unstructured
<code>list</code>	FALSE = a single response variable TRUE = multivariable response
<code>p.adjust</code>	1="none"; 2="holm"; 3="hochberg"; 4="hommel"; 5="bonferroni"; 6="BH", 7="BY"; 8="fdr"; for more details see function "p.adjust"
<code>plot</code>	1 = box plot for residuals; 2 = standardized residuals vs sequence data; 3 = standardized residuals vs theoretical quantiles

**Details**

The response variable must be numeric. Other variables can be numeric or factors.

**Value**

Returns analysis of variance, means (adjusted means), multiple comparison test (tukey, snk, duncan, t and scott knott) and residual analysis.

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

SAMPAIO, I. B. M. Estatística aplicada a experimentação animal. 3rd Edition. Belo Horizonte: Editora FEPMVZ, Fundação de Ensino e Pesquisa em Medicina Veterinária e Zootecnia, 2010. 264p.

PIMENTEL-GOMES, F. and GARCIA C.H. Estatística aplicada a experimentos agrônomicos e florestais: exposição com exemplos e orientações para uso de aplicativos. Editora Fealq, v.11, 2002. 309p.

RAMALHO, M. A. P.; FERREIRA, D. F. and OLIVEIRA, A. C. Experimentação em Genética e Melhoramento de Plantas. Editora UFLA, 2005, 322p.

**See Also**

ea1, ec

**Examples**

```
# double factorial

# completely randomized design
data(data5)
r1=ea2(data5, design=1)
r1

# randomized block design
# data(data6)
# r2=ea2(data6, design=2)
# r2

# names(r1)

# names(r2)

# triple factorial

# completely randomized design
# data(data9)
# r3=ea2(data9[,-4], design=7)
# r3[1]

# split plot

# completely randomized design
# data(data7)
```

```
# r4=ea2(data7, design=4)
# r4

# randomized block design
# data(data8)
# r5=ea2(data8, design=5)
# r5

# hierarchical blocks
# Ramalho et al. (2005)
# data(data18)
# data18
# r6=ea2(data18, design=11)
# r6

# hierarchical latin squares
# Sampaio (2010)
# data(data19)
# data19
# r7=ea2(data19, design=12)
# r8=ea2(data19, design=13)

# hierarchical rows
# r7

# hierarchical rows and columns
# r8

#split.plot in latin square
#data(data3)
#d=rbind(data3,data3)
#d=data3[,-4];d=data.frame(d,time=rep(1:2,each=16),response=rnorm(32,45,4))
# r9=ea2(d,design=6)
# r9
```

---

ec

*Easy contrast*

---

## Description

Performs contrasts of means

## Usage

```
ec(mg1, mg2, sdg1, sdg2, df)
```

## Arguments

mg1	Means of the group 1
mg2	Means of the group 2

sdg1	Standard error of the group 1
sdg2	Standard error of the group 2
df	Degree of freedom from error

**Value**

Returns t test for contrast

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2

**Examples**

```
# Kaps and Lamberson(2009, pg 254)

data(data1)

r<-ea1(data1, design=1)
r[2]

# first contrast
mg1=312;mg2=c(278,280); sdg1=7.7028;sdg2=c(7.7028,7.7028); df=12
ec(mg1,mg2,sdg1,sdg2,df)

# second contrast
mg1=280;mg2=278; sdg1=7.7028;sdg2=7.7028; df=12
ec(mg1,mg2,sdg1,sdg2,df)
```

---

ic *Confidence intervals of contrasts*

---

**Description**

Estimate of confidence intervals of the contrasts

**Usage**

```
ic(data, test=1, df=10, alpha=0.05)
```

**Arguments**

data	output object of ea1 or ea2 function (see examples)
test	Letters of the post-hoc test 1=Tukey 2=SNK 3=Duncan 4=t 5=Scott-Knott
df	degree of freedom of residuals in anova
alpha	significance level

**Value**

Returns confidence intervals of the contrasts

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2, box.plot, means.plot, means.plotfat, ic.plot, p.plot

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
#means
means=r[[2]]
means
ic(means, test=1, df=6) # tukey

# alpha = 0.10
ic(r[[2]], test=1, df=6, alpha=0.10)

# split plot
data('data7')
r<-ea2(data7,4)

#plot
ic(r[2], df=15)
```

```
#split.plot  
ic(r[4], df=45)
```

---

ic.plot

*Plot confidence intervals of contrasts*

---

### Description

Plot confidence intervals of contrasts

### Usage

```
ic.plot(data,col="dark green", cex=0.5, xlab="constrats",  
pch=19,family="Times", bg="white",...)
```

### Arguments

data	output object of ic (see examples)
col	colours of lines
cex	size of points
xlab	title of x-axis
pch	type of points
family	font of plot
bg	background color
...	more plot parameters

### Value

Plot confidence intervals of contrasts

### Author(s)

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

### References

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

### See Also

ea1,ea2, box.plot, means.plot, means.plotfat, ic.plot, p.plot

**Examples**

```

#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
#means
means=r[[2]]
means
ic(means, test=1, df=6) # tukey

#intervals
conf=ic(means, test=1, df=6)

#plot intervals
ic.plot(conf)

#more plot parameters
ic.plot(conf, las=2, bg="cornsilk");grid(10)

```

---

m.plot

*Plot Means*


---

**Description**

Plot contrasts of means

**Usage**

```
m.plot(data, s="sd", test="tukey", family="Times", bg="white", cex.text=0.7,
cex=0.5, bar.order=2, decreasing=TRUE, xlab="treatments", ylab="", pch=19, ...)
```

**Arguments**

data	output object of ea1 or ea2 function (see examples)
s	s="sd" (default) plot standard deviation s="sem" plot standard error of mean
test	Letters of the post-hoc test test="tukey" (default) test="snk" test="duncan" test="t" test="scott_knott"
family	font of plot

bg	background color
cex.text	font size in letters and means
cex	font size in points
bar.order	order of bar or means 1 = order of treatments names 2 = order of the means (default)
decreasing	decreasing bar order (TRUE or FALSE)
xlab	title of x-axis
ylab	title of y-axis
pch	type of points
...	more plot parameters

**Value**

Returns plots of means

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2, box.plot, means.plot, means.plotfat, ic, ic.plot, p.plot

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
#means
means=r[[2]]
means
m.plot(means, col=gray.colors(4))

#direct
m.plot(r[[2]], col=gray.colors(4))

# more graphical parameters
```

```

m.plot(means, col=c(2,7,3,5), bg="white", las=1, cex.text=1,main="Tukey (0.05)",
family="sans", bar.order=2, decreasing=FALSE);grid(10)

data('data7')
r<-ea2(data7,4)
m.plot(r[[4]], col=c(2,7,3,5), las=1, bg="cornsilk");grid(10)

par(mfrow=c(1,2))
m.plot(r[[8]][1], test="scott_knott",xlab="treatment 1",col=c(2,7,3,5),
las=2, bg="cornsilk",bar.order=2, decreasing=FALSE);grid(10)
m.plot(r[[8]][2], test="scott_knott",xlab="treatment 2", col=c(2,7,3,5),
las=2, bg="cornsilk", bar.order=2, decreasing=FALSE);grid(10)

```

means.plot

*Plot Means***Description**

Plot contrasts of means

**Usage**

```

means.plot(data, plot=1, s=1, test=1, legend=TRUE, letters=TRUE,
family="Times", bg="white", cex.names=0.8, cex.text=0.7, cex.legend=1,
bar.order=2, decreasing=TRUE, alpha=0.05, cex=0.5, pch=19, ...)

```

**Arguments**

data	output object of ea1 function (see examples)
plot	type of plot 1 = bar plot (default) 2 = means plot 3 = confidence interval of the contrasts
s	s=1 (defalt) plot standard deviation s=2 plot standard error of mean
test	Letters of the post-hoc test 1=Tukey 2=SNK 3=Duncan 4=t 5=Scott-Knott
legend	TRUE = plot p-value of F test FALSE = not plot p-value
letters	TRUE = plot letters FALSE = not plot letters
family	font of plot
bg	background color
cex.names	font size in names of treatments (x-axis)
cex.text	font size in letters and means
cex.legend	font size in legend
bar.order	order of bar or means 1 = order of treatments names 2 = order of the means (default)
decreasing	decreasing bar order (TRUE or FALSE)
alpha	0.05 (default) is the alpha of confidence intervals
cex	size of points
pch	type of points
...	more plot parameters

**Value**

Returns plots and confidence intervals

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
means.plot(r, col=gray.colors(4))

# more graphical parameters
means.plot(r, col=c(2,7,3,5), bg="cornsilk", las=1, cex.names=2,
sub="treatments", family="sans");grid(10)

# plot = 2
means.plot(r, plot=2, col="dark green", bg="gray", las=1, cex.names=2,
sub="Treatments", family="Times", ylab="Hay intake")

# plot = 2 decreasing =FALSE
means.plot(r, plot=2, las=1, cex.names=2, col="red",lty=2,pch=20,cex=1.1,
sub="Treatments", family="Times", ylab="Hay intake", decreasing=FALSE, legend=FALSE);grid(10)

# plot=3
means.plot(r, plot=3, las=1, cex.names=2,
sub="Contrasts (Tukey 0.05)", family="Times", ylab="")

# plot=3 alpha=0.10
means.plot(ea1(data3, design=3), plot=3, las=2, cex.names=2,
sub="Contrasts (Tukey 0.10)", family="Times", ylab="", alpha=0.10, bg="cornsilk");grid(10)
```

---

means.plotfat                      *Plot Means (interactions)*

---

### Description

Plot contrasts of means

### Usage

```
means.plotfat(data, plot=1, s=1, test=1, legend=TRUE, letters=TRUE,
family="Times", bg="white", cex.names=0.8, cex.text=0.7,
cex.legend=1, bar.order=1, decreasing=TRUE, ...)
```

### Arguments

data	output object of ea2 function (see examples)
plot	type of plot 1 = bar plot factor 1 (default) 2 = bar plot factor 2 3 = bar plot interactions (option 1) 4 = bar plot interactions (option 2) 5 = bar plot interactions (option 3) 6 = bar plot interactions (option 4)
s	s=1 (defalt) plot standard deviation s=2 plot standard error of mean
test	Letters of the post-hoc test 1=Tukey 2=SNK 3=Duncan 4=t 5=Scott-Knott
legend	TRUE = plot p-value of F test FALSE = not plot p-value
letters	TRUE = plot letters FALSE = not plot letters
family	font of plot
bg	background color
cex.names	font size in names of treatments (x-axis)
cex.text	font size in letters and means
cex.legend	font size in legend
bar.order	order of bar or means 1 = order of treatments names 2 = order of the means (default)
decreasing	decreasing bar order (TRUE or FALSE)
...	more plot parameters

### Value

Returns bar plots

### Author(s)

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

### References

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

ea1,ea2, means.plot, box.plot

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
means.plot(r, col=gray.colors(4))

# more graphical parameters
means.plot(r, col=c(2,7,3,5), bg="cornsilk", las=1, cex.names=2,
sub="treatments", family="sans");grid(10)

# plot = 2
means.plot(r, plot=2, col="dark green", bg="gray", las=1, cex.names=2,
sub="Treatments", family="Times", ylab="Hay intake")

# plot = 2 decreasing =FALSE
means.plot(r, plot=2, las=1, cex.names=2, col="red",lty=2,pch=20,cex=1.1,
sub="Treatments", family="Times", ylab="Hay intake", decreasing=FALSE, legend=FALSE);grid(10)

# plot=3
means.plot(r, plot=3, las=1, cex.names=2,
sub="Contrasts (Tukey 0.05)", family="Times", ylab="")

# plot=3 alpha=0.10
means.plot(ea1(data3, design=3), plot=3, las=2, cex.names=2,
sub="Contrasts (Tukey 0.10)", family="Times", ylab="", alpha=0.10, bg="cornsilk");grid(10)
```

---

p.plot

*Plot p values of the contrasts*

---

**Description**

Plot p values of the contrasts

**Usage**

```
p.plot(data, ylab="", xlab="", col.lines="red", cex.axis=0.7,
cex=0.9 , col.text="dark green",family="Times", bg="white",...)
```

**Arguments**

<code>data</code>	output object of <code>ea1</code> or <code>ea2</code> function (see examples)
<code>ylab</code>	title of y-axis
<code>xlab</code>	title of x-axis
<code>col.lines</code>	colours of the lines
<code>cex.axis</code>	font size in axis
<code>cex</code>	size of points
<code>col.text</code>	colours in letters and means
<code>family</code>	font of plot
<code>bg</code>	background color
<code>...</code>	more plot parameters

**Value**

Plot p values of the contrasts

**Author(s)**

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

**References**

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

**See Also**

`ea1`, `ea2`, `box.plot`, `means.plot`, `means.plotfat`, `ic`, `ic.plot`, `m.plot`

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

#plot
contrasts=r[[3]]
contrasts
p.plot(contrasts)

#direct
p.plot(r[3])
```

```
# more graphical parameters
p.plot(contrasts, bg="cornsilk", cex=1.5,cex.axis=1.5,
main="P-values of the tukey contrasts",family="sans");grid(10)

data('data7')
r<-ea2(data7,4)
p.plot(r[[5]], bg="cornsilk");grid(10)

par(mfrow=c(1,2))
p.plot(r[[9]][1], xlab="treatment 1", cex=0.5, bg="cornsilk");grid(10)
p.plot(r[[9]][2], xlab="treatment 2", cex=0.5, bg="cornsilk");grid(10)
```

---

tab

---

*Table of results in the ea1 function*


---

### Description

Summary of results in ea1 function

### Usage

```
tab(data, test=1)
```

### Arguments

data	output object of ea1 function (see examples)
test	Letters of the post-hoc test 1=Tukey 2=SNK 3=Duncan 4=t 5=Scott-Knott

### Value

Summary of results in ea1 function

### Author(s)

Emmanuel Arnhold <emmanuelarnhold@yahoo.com.br>

### References

KAPS, M. and LAMBERSON, W. R. Biostatistics for Animal Science: an introductory text. 2nd Edition. CABI Publishing, Wallingford, Oxfordshire, UK, 2009. 504p.

### See Also

ea1,ea2, box.plot, means.plot, means.plotfat, ic.plot, p.plot

**Examples**

```
#data3: Kaps and Lamberson (2009): page 347
#Description:
##Latin square design for test four different treatments on hay intake of fattening steers

data(data3)

r<-ea1(data3, design=3)

tab(r)

### multiple variables

t<-c('a','a','a','b','b','b','c','c','c')
r1<-c(10,12,12.8,4,6,8,14,15,16)
r2<-c(102,105,106,125,123,124,99,95,96)
r3<-c(560,589,590,658,678,629,369,389,378)

d<-data.frame(t,r1,r2,r3)

results=ea1(d, design=1, list=TRUE)

# scottknott test
tab(results,test=5)
```

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