

Package ‘MPV’

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Title Data Sets from Montgomery, Peck and Vining

Version 1.64

Description Most of this package consists of data sets from the textbook Introduction to Linear Regression Analysis, by Montgomery, Peck and Vining. All data sets from the 3rd edition are included and many from the 6th edition are also included. The package also contains some additional data sets and functions.

LazyLoad true

LazyData true

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Author W.J. Braun [aut, cre],
S. MacQueen [aut]

Maintainer W.J. Braun <john.braun@ubc.ca>

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BCCIPlot	<i>Confidence Intervals for Bias Corrected Local Regression</i>
----------	---

Description

Graphs of confidence interval estimates for bias and standard deviation of in bias-corrected local polynomial regression curve estimates.

Usage

```
BCCIPlot(data, k1=1, k2=2, h, h2, output, g, layout, incl.biasplot, plotdata)
```

Arguments

data	A data frame, whose first column must be the explanatory variable and whose second column must be the response variable.
k1	degree of local polynomial used in curve estimator.
k2	degree of local polynomial used in bias estimator.
h	bandwidth for regression estimator.
h2	bandwidth for bias estimator.
output	if TRUE, numeric output is printed to the console window.
g	the target function, if known (for use in simulations).

layout	if TRUE, a 2x1 layout of plots is sent to the graphics device.
incl.biasplot	if TRUE, the confidence intervals for the bias of the uncorrected estimate are plotted.
plotdata	if TRUE, the data points are plotted as a scatter plot.

Value

A list containing the confidence interval limits, pointwise estimates of bias, standard deviation of bias, curve estimate, standard deviation of curve estimate, and approximate confidence limits for curve estimates. Graphs of the curve estimate confidence limits and the bias confidence limits.

Author(s)

W. John Braun and Wenkai Ma

BCLPBias

Bias for Bias-Corrected Local Polynomial Regression

Description

Confidence interval estimates for bias in local polynomial regression.

Usage

```
BCLPBias(xy,k1,k2,h,h2,numgrid=401,alpha=.95)
```

Arguments

xy	A data frame, whose first column must be the explanatory variable and whose second column must be the response variable.
k1	degree of local polynomial used in curve estimator.
k2	degree of local polynomial used in bias estimator.
h	bandwidth for regression estimator.
h2	bandwidth for bias estimator.
numgrid	number of gridpoints used in the curve estimator.
alpha	nominal confidence level.

Value

A list containing the confidence interval limits, pointwise estimates of bias, standard deviation of bias, curve estimate, standard deviation of curve estimate, and approximate confidence limits for curve estimates and corresponding bias-corrected estimates.

Author(s)

W. John Braun and Wenkai Ma

BiasVarPlot

Local Polynomial Bias and Variability

Description

Graphs of confidence interval estimates for bias and standard deviation of in local polynomial regression curve estimates.

Usage

```
BiasVarPlot(data, k1=1, k2=2, h, h2, output=FALSE, g, layout=TRUE)
```

Arguments

data	A data frame, whose first column must be the explanatory variable and whose second column must be the response variable.
k1	degree of local polynomial used in curve estimator.
k2	degree of local polynomial used in bias estimator.
h	bandwidth for regression estimator.
h2	bandwidth for bias estimator.
output	if true, numeric output is printed to the console window.
g	the target function, if known (for use in simulations).
layout	if true, a 2x1 layout of plots is sent to the graphics device.

Value

A list containing the confidence interval limits, pointwise estimates of bias, standard deviation of bias, curve estimate, standard deviation of curve estimate, and approximate confidence limits for curve estimates. Graphs of the curve estimate confidence limits and the bias confidence limits.

Author(s)

W. John Braun and Wenkai Ma

BioOxyDemand	<i>Biochemical Oxygen Demand</i>
--------------	----------------------------------

Description

The BioOxyDemand data frame has 14 rows and 2 columns.

Usage

```
data(BioOxyDemand)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

Source

Devore, J. L. (2000) *Probability and Statistics for Engineering and the Sciences (5th ed)*, Duxbury

Examples

```
plot(BioOxyDemand)
summary(lm(y ~ x, data = BioOxyDemand))
```

bp	<i>Blood Pressure Measurements on a Single Adult Male</i>
----	---

Description

Systolic and diastolic blood pressure measurement readings were taken on a 56-year-old male over a 39 day period, sometimes in the mornings (AM) and sometimes in the evening (PM). Varying number of replicate measurements were taken at each time point.

Usage

```
bp
```

Format

A data frame with 121 observations on the following 4 variables.

TimeofDay factor with levels AM and PM

Date numeric

Systolic numeric

Diastolic numeric

Examples

```

require(lattice)
xyplot(Date ~ Diastolic|TimeofDay, groups=cut(Systolic, c(0, 130, 140,
  200)), data = bp, col=c(3, 1, 2), pch=16)
matplot(bp[, c(3, 4)], type="l", lwd=2, ylab="Pressure")
n <- nrow(bp)
abline(v=(1:n)[bp[,1]=="PM"]-.5, col="grey")
abline(v=(1:n)[bp[,1]=="PM"], col="grey")
abline(v=(1:n)[bp[,1]=="PM"]+.5, col="grey")
bp.stk <- stack(bp, c("Systolic", "Diastolic"))
bp.tmp <- rbind(bp[,1:2], bp[,1:2])
bp.stk <- cbind(bp.tmp, bp.stk)
names(bp.stk) <- c("TimeofDay", "Date", "Pressure", "Type")
reps <- NULL
for (j in rle(paste(bp.stk$Date, bp.stk$TimeofDay))$lengths) reps <- c(reps, (1:j))
bp.stk$Rep <- reps
xyplot(Pressure ~ I(Date+Rep/24)|TimeofDay, groups=Type, data = bp.stk, xlab="Date", pch=16)

```

 cement

Table B21 - Cement Data

Description

The cement data frame has 13 rows and 5 columns.

Usage

```
data(cement)
```

Format

This data frame contains the following columns:

y a numeric vector
x1 a numeric vector
x2 a numeric vector
x3 a numeric vector
x4 a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```

data(cement)
pairs(cement)

```

cigbutts	<i>Cigarette Butts</i>
----------	------------------------

Description

On a university campus there are a number of areas designated for smoking. Outside of those areas, smoking is not permitted. One of the smoking areas is towards the north end of the campus near some parking lots and a large walkway towards one of the residences. Along the walkway, cigarette butts are visible in the nearby grass. Numbers of cigarette butts were counted at various distances from the smoking area in 200x80 square-cm quadrats located just west of the walkway.

Usage

```
data("cigbutts")
```

Format

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

distance distance from gazebo

count observed number of butts

earthquake	<i>Earthquakes Data</i>
------------	-------------------------

Description

The earthquake data frame contains measurements of latitude, longitude, focal depth and magnitude for all earthquakes having magnitude greater than 5.8 between 1964 and 1985.

Usage

```
earthquake
```

Format

This data frame contains 2178 observations on the following columns:

depth numeric vector of focal depths.

latitude latitudinal coordinate.

longitude longitudinal coordinate.

magnitude numeric vector of magnitudes.

Source

Jeffrey S. Simonoff (1996), *Smoothing Methods in Statistics*, Springer-Verlag, New York.

Examples

```
summary(earthquake)
```

```
fires
```

```
Micro-fires recorded in a lab setting
```

Description

Rate of spread measurements (inches/s) in each direction: East, West, North and South for each of 31 experimental runs at given slopes, measured over the given time period of each (measured in seconds).

Usage

```
fires
```

Format

A data frame with 31 observations on the following 7 variables.

Run numeric

Slope numeric: vertical rise divided by horizontal run, inclined from East to West

ROS_E numeric: rate of spread measured in easterly direction

ROS_W numeric: rate of spread measured in westerly direction

ROS_S numeric: rate of spread measured in southerly direction

ROS_N numeric: rate of spread measured in northerly direction

Time numeric

Source

Braun, W.J. and Woolford, D.G. (2013) Assessing a stochastic fire spread simulator. *Journal of Environmental Informatics*. 22:1-12.

GANOVA

Graphical ANOVA Plot

Description

Graphical analysis of one-way ANOVA data. It allows visualization of the usual F-test.

Usage

`GANOVA(dataset, var.equal=TRUE, type="QQ", center=TRUE, shift=0)`

Arguments

<code>dataset</code>	A data frame, whose first column must be the factor variable and whose second column must be the response variable.
<code>var.equal</code>	Logical: if TRUE, within-sample variances are assumed to be equal
<code>type</code>	"QQ" or "hist"
<code>center</code>	if TRUE, center and scale the means to match the scale of the errors
<code>shift</code>	on the histogram, lift the points representing the means above the horizontal axis by this amount.

Value

A QQ-plot or a histogram and rugplot

Author(s)

W. John Braun and Sarah MacQueen

Source

Braun, W.J. 2013. Naive Analysis of Variance. Journal of Statistics Education.

gasdata

Natural Gas Consumption in a Single-Family Residence

Description

This data frame contains the average monthly volume of natural gas used in the furnace of a 1600 square foot house located in London, Ontario, for each month from 2006 until 2011. It also contains the average temperature for each month, and a measure of degree days. Insulation was added to the roof on one occasions, the walls were insulated on a second occasion, and the mid-efficiency furnace was replaced with a high-efficiency furnace on a third occasion.

Usage

```
data("gasdata")
```

Format

A data frame with 70 observations on the following 9 variables.

month numeric 1=January, 12=December

degreedays numeric, Celsius

cubicmetres total volume of gas used in a month

dailyusage average amount of gas used per day

temp average temperature in Celsius

year numeric

I1 indicator that roof insulation is present

I2 indicator that wall insulation is present

I3 indicator that high efficiency furnace is present

GFplot

Graphical F Plot for Significance in Regression

Description

This function analyzes regression data graphically. It allows visualization of the usual F-test for significance of regression.

Usage

```
GFplot(X, y, plotIt=TRUE, sortTrt=FALSE, type="hist", includeIntercept=TRUE, labels=FALSE)
```

Arguments

X	The design matrix.
y	A numeric vector containing the response.
plotIt	Logical: if TRUE, a graph is drawn.
sortTrt	Logical: if TRUE, an attempt is made at sorting the predictor effects in descending order.
type	"QQ" or "hist"
includeIntercept	Logical: if TRUE, the intercept effect is plotted; otherwise, it is omitted from the plot.
labels	logical: if TRUE, names of predictor variables are used as labels; otherwise, the design matrix column numbers are used as labels

Value

A QQ-plot or a histogram and rugplot, or a list if plotIt=FALSE

Author(s)

W. John Braun

Source

Braun, W.J. 2013. Regression Analysis and the QR Decomposition. Preprint.

Examples

```
# Example 1
X <- p4.18[,-4]
y <- p4.18[,4]
GFplot(X, y, type="hist", includeIntercept=FALSE)
title("Evidence of Regression in the Jojoba Oil Data")
# Example 2
set.seed(4571)
Z <- matrix(rnorm(400), ncol=10)
A <- matrix(rnorm(81), ncol=9)
simdata <- data.frame(Z[,1], crossprod(t(Z[,-1]),A))
names(simdata) <- c("y", paste("x", 1:9, sep=""))
GFplot(simdata[,-1], simdata[,1], type="hist", includeIntercept=FALSE)
title("Evidence of Regression in Simulated Data Set")
# Example 3
GFplot(table.b1[,-1], table.b1[,1], type="hist", includeIntercept=FALSE)
title("Evidence of Regression in NFL Data Set")
# An example where stepwise AIC selects the complement
# of the set of variables that are actually in the true model:
X <- pathoeg[,-10]
y <- pathoeg[,10]
par(mfrow=c(2,2))
GFplot(X, y)
GFplot(X, y, sortTrt=TRUE)
GFplot(X, y, type="QQ")
GFplot(X, y, sortTrt=TRUE, type="QQ")
X <- table.b1[,-1] # NFL data
y <- table.b1[,1]
GFplot(X, y)
```

Description

This function analyzes regression data graphically. It allows visualization of the usual F-test for significance of regression.

Usage

```
GRegplot(X, y, sortTrt=FALSE, includeIntercept=TRUE, type="hist")
```

Arguments

X	The design matrix.
y	A numeric vector containing the response.
sortTrt	Logical: if TRUE, an attempt is made at sorting the predictor effects in descending order.
includeIntercept	Logical: if TRUE, the intercept effect is plotted; otherwise, it is omitted from the plot.
type	Character: hist, for histogram; dot, for stripchart

Value

A histogram or dotplot and rugplot

Author(s)

W. John Braun

Source

Braun, W.J. 2014. Visualization of Evidence in Regression Analysis with the QR Decomposition. Preprint.

Examples

```
# Example 1
X <- p4.18[,-4]
y <- p4.18[,4]
GRegplot(X, y, includeIntercept=FALSE)
title("Evidence of Regression in the Jojoba Oil Data")
# Example 2
set.seed(4571)
Z <- matrix(rnorm(400), ncol=10)
A <- matrix(rnorm(81), ncol=9)
simdata <- data.frame(Z[,1], crossprod(t(Z[, -1]), A))
names(simdata) <- c("y", paste("x", 1:9, sep=""))
GRegplot(simdata[, -1], simdata[, 1], includeIntercept=FALSE)
title("Evidence of Regression in Simulated Data Set")
# Example 3
GRegplot(table.b1[, -1], table.b1[, 1], includeIntercept=FALSE)
title("Evidence of Regression in NFL Data Set")
# An example where stepwise AIC selects the complement
# of the set of variables that are actually in the true model:
X <- pathoeg[, -10]
y <- pathoeg[, 10]
par(mfrow=c(2, 1))
```

```
GRegplot(X, y)
GRegplot(X, y, sortTrt=TRUE)
X <- table.b1[, -1] # NFL data
y <- table.b1[, 1]
GRegplot(X, y)
```

Juliet

Juliet

Description

Juliet has 28 rows and 9 columns. The data is of the input and output of the Spirit Still "Juliet" from Endless Summer Distillery. It is suggested to split the data by the Batch factor for ease of use.

Usage

Juliet

Format

The data frame contains the following 9 columns.

Batch a Factor determining how many times the volume has been through the still.

Vo11 Volume in litres, initial

P1 Percent alcohol present, initial

LAA1 Litres Absolute Alcohol initial, $Vo11 * P1$

Vo12 Volume in litres, final

P2 Percent alcohol present, final

LAA2 Litres Absolute Alcohol final, $Vo12 * P2$

Yield Percent yield obtained, $LAA2 / LAA1$

Date Character, Date of run

Details

The purpose of this information is to determine the optimal initial volume and percentage. The information is broken down by Batch. A batch factor 1 means that it is the first time the liquid has gone through the spirit still. The first run through the still should have the most loss due to the "heads" and "tails". Literature states that the first run through a spirit still should yield 70 percent. A batch factor 2 means that it is the second time the liquid has gone through the spirit still. A batch factor 3 means that it is the third time or more that the liquid has gone through the spirit still. Each subsequent distillation should result in a higher yield, never to exceed 95 percent.

Source

Charisse Woods, Endless Summer Distillery, (2015).

Examples

```
summary(Juliet)

#Split apart the Batch factor for easier use.
juliet<-split(Juliet,Juliet$Batch)
juliet1<-juliet$'1'
juliet2<-juliet$'2'
juliet3<-juliet$'3'

plot(LAA1~LAA2,data=Juliet)
plot(LAA1~LAA2,data=juliet1)
```

lengthguesses

Length Guesses Data

Description

The lengthguesses list consists of 2 numeric vectors, one giving the metric-converted length guesses (in feet) of an auditorium whose actual length (in meters) was 13.1m, and the other containing the length guesses of 69 others (in meters).

Usage

```
data(lengthguesses)
```

Format

This list contains the following columns:

imperial a numeric vector of 69 student guesses as to the length of an auditorium using the imperial system, converted to meters.

metric a numeric vector of 44 student guesses as to the length of an auditorium using the metric system.

Source

Hills, M. and the M345 Course Team (1986) M345 Statistical Methods, Unit 1: Data, distributions and uncertainty, Milton Keynes: The Open University. Tables 2.1 and 2.4.

References

Hand, D.J., Daly, F., Lunn, A.D., McConway, K.J. and Ostrowski, E. (1994) A Handbook of Small Data Sets. Boca Raton: Chapman & Hall/CRC.

Examples

```
with(lengthguesses, t.test(imperial, metric))
```

 lesions

Lesions in Rat Colons

Description

Numbers of aberrant crypt foci (ACF) in each of six cross-sectional regions of the colons of 66 rats subjected to varying doses of the carcinogen azoxymethane (AOM), sacrificed at 3 different times.

Usage

```
lesions
```

Format

This data frame contains the following columns:

T Incubation time factor, levels: 6, 12 and 18 weeks

INJ Number of injections

SECT Section of colon, a factor with levels 1 through 6, where 1 denotes the proximal end of the colon and 6 denotes the distal end

RAT Label for animal within a particular T-INJ factor level combination

ACF.Total Total number of ACF lesions in a section of a rat's colon

ACF.total.mult Sum of ACF multiplicities for a section of a rat's colon

id Identifier for each of the 66 rats.

Source

Ranjana P. Bird, University of Northern British Columbia, Prince George, Canada.

References

E.A. McLellan, A. Medline and R.P. Bird. Dose response and proliferative characteristics of aberrant crypt foci: putative preneoplastic lesions in rat colon. *Carcinogenesis*, 12(11): 2093-2098, 1991.

Examples

```
summary(lesions)
ACF.All <- aggregate(ACF.Total ~ id + INJ + T, FUN=sum, data = lesions)
lesions.glm <- glm(ACF.Total ~ INJ * T, data = ACF.All, family=poisson)
summary(lesions.glm)
lesions.qp <- glm(ACF.Total ~ INJ * T, data = ACF.All, family=quasipoisson)
summary(lesions.qp)
lesions.noInt <- glm(ACF.Total ~ INJ + T, data = ACF.All, family=quasipoisson)
summary(lesions.noInt)
```

 LPBias

Local Polynomial Bias

Description

Confidence interval estimates for bias in local polynomial regression.

Usage

```
LPBias(xy,k1,k2,h,h2,numgrid=401,alpha=.95)
```

Arguments

xy	A data frame, whose first column must be the explanatory variable and whose second column must be the response variable.
k1	degree of local polynomial used in curve estimator.
k2	degree of local polynomial used in bias estimator.
h	bandwidth for regression estimator.
h2	bandwidth for bias estimator.
numgrid	number of gridpoints used in the curve estimator.
alpha	nominal confidence level.

Value

A list containing the confidence interval limits, pointwise estimates of bias, standard deviation of bias, curve estimate, standard deviation of curve estimate, and approximate confidence limits for curve estimates.

Author(s)

W. John Braun and Wenkai Ma

 motor

Motor Vibration Data

Description

Noise measurements for 5 samples of motors, each sample based on a different brand of bearing.

Usage

```
data("motor")
```

Format

A data frame with 5 columns.

Brand 1 A numeric vector length 6

Brand 2 A numeric vector length 6

Brand 3 A numeric vector length 6

Brand 4 A numeric vector length 6

Brand 5 A numeric vector length 6

Source

Devore, J. and N. Farnum (2005) Applied Statistics for Engineers and Scientists. Thomson.

noisyimage

noisy image

Description

The noisyimage is a list. The third component is noisy version of the third component of [tarimage](#).

Usage

```
data(noisyimage)
```

Format

This list contains the following elements:

x a numeric vector having 101 elements.

y a numeric vector having 101 elements.

xy a numeric matrix having 101 rows and columns

Examples

```
with(noisyimage, image(x, y, xy))
```

oldwash	<i>oldwash</i>
---------	----------------

Description

The oldwash dataframe has 49 rows and 8 columns. The data are from the start up of a wash still considering the amount of time it takes to heat up to a specified temperature and possible influencing factors.

Usage

```
data("oldwash")
```

Format

A data frame with 49 observations on the following 8 variables.

Date character, the date of the run

startT degrees Celsius, numeric, initial temperature

endT degrees Celsius, numeric, final temperature

time in minutes, numeric, amount of time to reach final temperature

Vol in litres, numeric, amount of liquid in the tank (max 2000L)

alc numeric, the percentage of alcohol present in the liquid

who character, relates to the person who ran the still

batch factor with levels 1 = first time through, 2 = second time through

Details

The purpose of the wash still is to increase the percentage of alcohol and strip out unwanted particulate. It can take a long time to heat up and this can lead to problems in meeting production time limits.

Source

Charisse Woods, Endless Summer Distillery (2014)

Examples

```
oldwash.lm<-lm(log(time)~startT+endT+Vol+alc+who+batch,data=oldwash)
summary(oldwash.lm)
par(mfrow=c(2,2))
plot(oldwash.lm)
```

```
data2<-subset(oldwash,batch==2)
hist(data2$time)
data1<-subset(oldwash,batch==1)
hist(data1$time)
```

```
oldwash.lmc<-lm(time~startT+endT+Vol+alc+who+batch,data=data1)
summary(oldwash.lmc)
plot(oldwash.lmc)

oldwash.lmd<-lm(time~startT+endT+Vol+alc+who+batch,data=data2)
summary(oldwash.lmd)
plot(oldwash.lmd)
```

p11.12

Data For Problem 11-12

Description

The p11.12 data frame has 19 observations on satellite cost.

Usage

```
data(p11.12)
```

Format

This data frame contains the following columns:

cost first-unit satellite cost

x weight of the electronics suite

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Simpson and Montgomery (1998)

Examples

```
data(p11.12)
attach(p11.12)
plot(cost~x)
detach(p11.12)
```

p11.15

Data set for Problem 11-15

Description

The p11.15 data frame has 9 rows and 2 columns.

Usage

```
data(p11.15)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Ryan (1997), Stefanski (1991)

Examples

```
data(p11.15)
plot(p11.15)
attach(p11.15)
lines(lowess(x,y))
detach(p11.15)
```

p12.11

Data Set for Problem 12-11

Description

The p12.11 data frame has 44 observations on the fraction of active chlorine in a chemical product as a function of time after manufacturing.

Usage

```
data(p12.11)
```

Format

This data frame contains the following columns:

xi time

yi available chlorine

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p12.11)
plot(p12.11)
lines(lowess(p12.11))
```

p12.12

Data Set for Problem 12-12

Description

The p12.12 data frame has 18 observations on an chemical experiment. A nonlinear model relating concentration to reaction time and temperature with an additive error is proposed to fit these data.

Usage

```
data(p12.12)
```

Format

This data frame contains the following columns:

x1 reaction time (in minutes)

x2 temperature (in degrees Celsius)

y concentration (in grams/liter)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p12.12)
attach(p12.12)
# fitting the linearized model
logy.lm <- lm(I(log(y))~I(log(x1))+I(log(x2)))
summary(logy.lm)
plot(logy.lm, which=1) # checking the residuals
# fitting the nonlinear model
y.nls <- nls(y ~ theta1*I(x1^theta2)*I(x2^theta3), start=list(theta1=.95,
theta2=.76, theta3=.21))
summary(y.nls)
plot(resid(y.nls)~fitted(y.nls)) # checking the residuals
```

p12.16

Data Set for Problem 12-16

Description

The p12.16 data frame has 26 observations on 5 variables.

Usage

```
data(p12.16)
```

Format

This data frame contains the following columns:

Mixture numeric

x1 numeric

x2 numeric

x3 numeric

y numeric

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

Myers, R. Technometrics, vol. 6, no. 4, 343-356, 1964.

p12.8

Data Set for Problem 12-8

Description

The p12.8 data frame has 14 rows and 2 columns.

Usage

```
data(p12.8)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p12.8)
```

p13.1

Data Set for Problem 13-1

Description

The p13.1 data frame has 25 observation on the test-firing results for surface-to-air missiles.

Usage

```
data(p13.1)
```

Format

This data frame contains the following columns:

x target speed (in Knots)

y hit (=1) or miss (=0)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.1)
```

p13.16

Data Set for Problem 13-16

Description

The p13.16 data frame has 16 rows and 5 columns.

Usage

```
data(p13.16)
```

Format

This data frame contains the following columns:

X1 a numeric vector

X2 a numeric vector

X3 a numeric vector

X4 a numeric vector

Y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.16)
```

p13.2

Data Set for Problem 13-2

Description

The p13.2 data frame has 20 observations on home ownership.

Usage

```
data(p13.2)
```

Format

This data frame contains the following columns:

x family income

y home ownership (1 = yes, 0 = no)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.2)
```

p13.20

Data Set for Problem 13-20

Description

The p13.20 data frame has 30 rows and 2 columns.

Usage

```
data(p13.20)
```

Format

This data frame contains the following columns:

yhat a numeric vector

resdev a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.20)
```

p13.3

Data Set for Problem 13-3

Description

The p13.3 data frame has 10 observations on the compressive strength of an alloy fastener used in aircraft construction.

Usage

```
data(p13.3)
```

Format

This data frame contains the following columns:

x load (in psi)

n sample size

r number failing

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.3)
```

p13.4

Data Set for Problem 13-4

Description

The p13.4 data frame has 11 observations on the effectiveness of a price discount coupon on the purchase of a two-litre beverage.

Usage

```
data(p13.4)
```

Format

This data frame contains the following columns:

x discount

n sample size

r number redeemed

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.4)
```

p13.5

Data Set for Problem 13-5

Description

The p13.5 data frame has 20 observations on new automobile purchases.

Usage

```
data(p13.5)
```

Format

This data frame contains the following columns:

x1 income

x2 age of oldest vehicle

y new purchase less than 6 months later (1=yes, 0=no)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.5)
```

p13.6

Data Set for Problem 13-6

Description

The p13.6 data frame has 15 observations on the number of failures of a particular type of valve in a processing unit.

Usage

```
data(p13.6)
```

Format

This data frame contains the following columns:

valve type of valve

numfail number of failures

months months

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p13.6)
```

p13.7

Data Set for Problem 13-7

Description

The p13.7 data frame has 44 observations on the coal mines of the Appalachian region of western Virginia.

Usage

```
data(p13.7)
```

Format

This data frame contains the following columns:

y number of fractures in upper seams of coal mines

x1 inner burden thickness (in feet), shortest distance between seam floor and the lower seam

x2 percent extraction of the lower previously mined seam

x3 lower seam height (in feet)

x4 time that the mine has been in operation (in years)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Myers (1990)

Examples

```
data(p13.7)
```

p14.1

Data Set for Problem 14-1

Description

The p14.1 data frame has 15 rows and 3 columns.

Usage

```
data(p14.1)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

time a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p14.1)
```

p14.2

Data Set for Problem 14-2

Description

The p14.2 data frame has 18 rows and 3 columns.

Usage

```
data(p14.2)
```

Format

This data frame contains the following columns:

t a numeric vector

xt a numeric vector

yt a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p14.2)
```

p15.4

Data Set for Problem 15-4

Description

The p15.4 data frame has 40 rows and 4 columns.

Usage

```
data(p15.4)
```

Format

This data frame contains the following columns:

x1 a numeric vector

x2 a numeric vector

y a numeric vector

set a factor with levels e and p

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p15.4)
```

p2.10

Data Set for Problem 2-10

Description

The p2.10 data frame has 26 observations on weight and systolic blood pressure for randomly selected males in the 25-30 age group.

Usage

```
data(p2.10)
```

Format

This data frame contains the following columns:

weight in pounds

sysbp systolic blood pressure

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p2.10)
attach(p2.10)
cor.test(weight, sysbp, method="pearson") # tests rho=0
                                           # and computes 95% CI for rho
                                           # using Fisher's Z-transform
```

p2.12

Data Set for Problem 2-12

Description

The p2.12 data frame has 12 observations on the number of pounds of steam used per month at a plant and the average monthly ambient temperature.

Usage

```
data(p2.12)
```

Format

This data frame contains the following columns:

temp ambient temperature (in degrees F)

usage usage (in thousands of pounds)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p2.12)
attach(p2.12)
usage.lm <- lm(usage ~ temp)
summary(usage.lm)
predict(usage.lm, newdata=data.frame(temp=58), interval="prediction")
detach(p2.12)
```

p2.13

Data Set for Problem 2-13

Description

The p2.13 data frame has 16 observations on the number of days the ozone levels exceeded 0.2 ppm in the South Coast Air Basin of California for the years 1976 through 1991. It is believed that these levels are related to temperature.

Usage

```
data(p2.13)
```

Format

This data frame contains the following columns:

days number of days ozone levels exceeded 0.2 ppm

index a seasonal meteorological index giving the seasonal average 850 millibar temperature.

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Davidson, A. (1993) Update on Ozone Trends in California's South Coast Air Basin. *Air Waste*, 43, 226-227.

Examples

```
data(p2.13)
attach(p2.13)
plot(days~index, ylim=c(-20,130))
ozone.lm <- lm(days ~ index)
summary(ozone.lm)
# plots of confidence and prediction intervals:
ozone.conf <- predict(ozone.lm, interval="confidence")
lines(sort(index), ozone.conf[order(index),2], col="red")
lines(sort(index), ozone.conf[order(index),3], col="red")
ozone.pred <- predict(ozone.lm, interval="prediction")
lines(sort(index), ozone.pred[order(index),2], col="blue")
lines(sort(index), ozone.pred[order(index),3], col="blue")
detach(p2.13)
```

p2.14

Data Set for Problem 2-14

Description

The p2.14 data frame has 8 observations on the molar ratio of sebacic acid and the intrinsic viscosity of copolyesters. One is interested in predicting viscosity from the sebacic acid ratio.

Usage

```
data(p2.14)
```

Format

This data frame contains the following columns:

ratio molar ratio

visc viscosity

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Hsue, Ma, and Tsai (1995) Separation and Characterizations of Thermotropic Copolyesters of p-Hydroxybenzoic Acid, Sebacic Acid and Hydroquinone. Journal of Applied Polymer Science, 56, 471-476.

Examples

```
data(p2.14)
attach(p2.14)
plot(p2.14, pch=16, ylim=c(0,1))
visc.lm <- lm(visc ~ ratio)
summary(visc.lm)
visc.conf <- predict(visc.lm, interval="confidence")
lines(ratio, visc.conf[,2], col="red")
lines(ratio, visc.conf[,3], col="red")
visc.pred <- predict(visc.lm, interval="prediction")
lines(ratio, visc.pred[,2], col="blue")
lines(ratio, visc.pred[,3], col="blue")
detach(p2.14)
```

p2.15

Data Set for Problem 2-15

Description

The p2.15 data frame has 8 observations on the impact of temperature on the viscosity of toluene-tetralin blends. This particular data set deals with blends with a 0.4 molar fraction of toluene.

Usage

```
data(p2.15)
```

Format

This data frame contains the following columns:

temp temperature (in degrees Celsius)

visc viscosity (mPa s)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Byers and Williams (1987) Viscosities of Binary and Ternary Mixtures of Polynomatic Hydrocarbons. Journal of Chemical and Engineering Data, 32, 349-354.

Examples

```
data(p2.15)
attach(p2.15)
plot(visc ~ temp, pch=16)
visc.lm <- lm(visc ~ temp)
plot(visc.lm, which=1)
detach(p2.15)
```

p2.16

Data Set for Problem 2-16

Description

The p2.16 data frame has 33 observations on the pressure in a tank the volume of liquid.

Usage

```
data(p2.16)
```

Format

This data frame contains the following columns:

volume volume of liquid

pressure pressure in the tank

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Carroll and Spiegelman (1986) The Effects of Ignoring Small Measurement Errors in Precision Instrument Calibration. Journal of Quality Technology, 18, 170-173.

Examples

```
data(p2.16)
attach(p2.16)
plot(pressure ~ volume, pch=16)
pressure.lm <- lm(pressure ~ volume)
plot(pressure.lm, which=1)
summary(pressure.lm)
detach(p2.16)
```

p2.17

Data Set for Problem 2-17

Description

The p2.17 data frame has 17 observations on the boiling point of water (in Fahrenheit degrees) for various barometric pressures (in inches of mercury).

Usage

```
data(p2.17)
```

Format

This data frame contains the following columns:

BoilingPoint numeric vector

BarometricPressure numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

Atkinson, A.C. (1985) Plots, Transformations and Regression, Clarendon Press, Oxford.

Examples

```
data(p2.17)
attach(p2.17)
plot(BoilingPoint ~ BarometricPressure, pch=16)
detach(p2.17)
```

p2.18

Data Set for Problem 2-18

Description

The p2.18 data frame has 21 observations on the advertising expenses (in millions of US dollars) and retain impressions (in millions per week) for various companies.

Usage

```
data(p2.18)
```

Format

This data frame contains the following columns:

Firm character vector

Amount.Spent numeric vector

Returned.Impressions numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
data(p2.18)
attach(p2.18)
plot(Returned.Impressions ~ Amount.Spent, pch=16)
detach(p2.18)
```

p2.7

Data Set for Problem 2-7

Description

The p2.7 data frame has 20 observations on the purity of oxygen produced by a fractionation process. It is thought that oxygen purity is related to the percentage of hydrocarbons in the main condenser of the processing unit.

Usage

```
data(p2.7)
```

Format

This data frame contains the following columns:

purity oxygen purity (percentage)

hydro hydrocarbon (percentage)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p2.7)
attach(p2.7)
purity.lm <- lm(purity ~ hydro)
summary(purity.lm)
# confidence interval for mean purity at 1% hydrocarbon:
predict(purity.lm,newdata=data.frame(hydro = 1.00),interval="confidence")
detach(p2.7)
```

p2.9

Data Set for Problem 2-9

Description

The p2.9 data frame has 25 rows and 2 columns. See help on `softdrink` for details.

Usage

```
data(p2.9)
```

Format

This data frame contains the following columns:

y a numeric vector: time

x a numeric vector: cases stocked

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) *Introduction to Linear Regression Analysis*. 3rd Edition, John Wiley and Sons.

Examples

```
data(p2.9)
```

p4.18

Data Set for Problem 4-18

Description

The p4.18 data frame has 13 observations on an experiment to produce a synthetic analogue to jojoba oil.

Usage

```
data(p4.18)
```

Format

This data frame contains the following columns:

x1 reaction temperature

x2 initial amount of catalyst

x3 pressure

y yield

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Coteron, Sanchez, Matinez, and Aracil (1993) Optimization of the Synthesis of an Analogue of Jojoba Oil Using a Fully Central Composite Design. Canadian Journal of Chemical Engineering.

Examples

```
data(p4.18)
y.lm <- lm(y ~ x1 + x2 + x3, data=p4.18)
summary(y.lm)
y.lm <- lm(y ~ x1, data=p4.18)
```

Description

The p4.19 data frame has 14 observations on a designed experiment studying the relationship between abrasion index for a tire tread compound and three factors.

Usage

```
data(p4.19)
```

Format

This data frame contains the following columns:

x1 hydrated silica level

x2 silane coupling agent level

x3 sulfur level

y abrasion index for a tire tread compound

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Derringer and Suich (1980) Simultaneous Optimization of Several Response Variables. Journal of Quality Technology.

Examples

```
data(p4.19)
attach(p4.19)
y.lm <- lm(y ~ x1 + x2 + x3)
summary(y.lm)
plot(y.lm, which=1)
y.lm <- lm(y ~ x1)
detach(p4.19)
```

p4.20

Data Set for Problem 4-20

Description

The p4.20 data frame has 26 observations on a designed experiment to determine the influence of five factors on the whiteness of rayon.

Usage

```
data(p4.20)
```

Format

This data frame contains the following columns:

acidtemp acid bath temperature

acidconc cascade acid concentration

watertemp water temperature

sulfconc sulfide concentration

amtbl amount of chlorine bleach

y a measure of the whiteness of rayon

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Myers and Montgomery (1995) Response Surface Methodology, pp. 267-268.

Examples

```
data(p4.20)
y.lm <- lm(y ~ acidtemp, data=p4.20)
summary(y.lm)
```

p5.1

Data Set for Problem 5-1

Description

The p5.1 data frame has 8 observations on the impact of temperature on the viscosity of toluene-tetralin blends.

Usage

```
data(p5.1)
```

Format

This data frame contains the following columns:

temp temperature

visc viscosity

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Byers and Williams (1987) Viscosities of Binary and Ternary Mixtures of Polyaromatic Hydrocarbons. Journal of Chemical and Engineering Data, 32, 349-354.

Examples

```
data(p5.1)
plot(p5.1)
```

p5.10

Data Set for Problem 5-10

Description

The p5.10 data frame has 27 observations on the effect of three factors on a printing machine's ability to apply coloring inks on package labels.

Usage

```
data(p5.10)
```

Format

This data frame contains the following columns:

x1 speed
x2 pressure
x3 distance
yi1 response 1
yi2 response 2
yi3 response 3
ybar.i average response
si standard deviation of the 3 responses

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p5.10)
attach(p5.10)
y.lm <- lm(ybar.i ~ x1 + x2 + x3)
plot(y.lm, which=1)
detach(p5.10)
```

p5.11

Data Set for Problem 5-11 of the Third Edition of MPV

Description

The p5.11 data frame has 8 observations on an experiment with a catapult. This data set is used in Exercise 5.13 of the 6th edition of MPV.

Usage

```
data(p5.11)
```

Format

This data frame contains the following columns:

x1 hook
x2 arm length
x3 start angle
x4 stop angle
yi1 response 1
yi2 response 2
yi3 response 3

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

See Also

[p5.13](#)

Examples

```
attach(p5.11)
ybar.i <- apply(p5.11[,5:7], 1, mean)
sd.i <- apply(p5.11[,5:7], 1, sd)
y.lm <- lm(ybar.i ~ x1 + x2 + x3 + x4)
plot(y.lm, which=1)
detach(p5.11)
```

p5.12

Data Set for Problem 5-12

Description

The p5.12 data frame has 27 observations on 3 variables, with responses replicated 3 times. Averages and standard deviations are calculated for each level of the experimental design.

Usage

```
data(p5.12)
```

Format

This data frame contains the following columns:

- i** numeric, experimental run number
- xi** numeric
- x2** numeric
- x3** numeric
- yi1** response 1
- yi2** response 2
- yi3** response 3
- ybari** average of 3 responses at ith level
- si** standard deviation of 3 responses at ith level

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

Vining, G. and Myers, R. (1990) "Combining Taguchi and Response Surface Philosophies: A Dual Response Approach," *Journal of Quality Technology*, 22, 15-22.

Examples

```
y.lm <- lm(ybari ~ xi + x2 + x3, data = p5.12)
plot(y.lm, which=1)
```

p5.13

Data Set for Problem 5-13

Description

The p5.13 data frame has 8 observations on 4 variables, with responses replicated 3 times.

Usage

```
data(p5.13)
```

Format

This data frame contains the following columns:

x1 numeric
x2 numeric
x3 numeric
x4 numeric
y.1 response 1
y.2 response 2
y.3 response 3

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) *Introduction to Linear Regression Analysis*. 6th Edition, John Wiley and Sons.

References

Schubert, K., M. W., Kerber, S. R., Schmidt, and Jones, S.E. (1992) "The catapult problem; enhanced engineering modeling using experimental design," *Quality Engineering*, 4, 463-473.

Examples

```
y.lm <- lm(I((y.1+y.2+y.3)/3) ~ x1 + x2 + x3 + x4, data = p5.13)
plot(y.lm, which=1)
```

p5.2

Data Set for Problem 5-2

Description

The p5.2 data frame has 11 observations on the vapor pressure of water for various temperatures.

Usage

```
data(p5.2)
```

Format

This data frame contains the following columns:

temp temperature (K)

vapor vapor pressure (mm Hg)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p5.2)
plot(p5.2)
```

p5.21

Data Set for Problem 5-21

Description

The p5.21 data frame has 4 observations on 2 variables (replicated 4 times).

Usage

```
data(p5.21)
```

Format

This data frame contains the following columns:

Mix.Rate a numeric vector

y1 a numeric vector

y2 a numeric vector

y3 a numeric vector

y4 a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
cementStrength <- reshape(p5.21, idvar = "Mix.Rate", varying=list(2:5),
  direction="long", v.names=c("TensileStrength"))
rownames(cementStrength) <- NULL
anova(lm(TensileStrength ~ Mix.Rate*time, data = cementStrength))
```

p5.22

Data Set for Problem 5-22

Description

The p5.22 data frame has 18 observations on 2 variables.

Usage

```
data(p5.22)
```

Format

This data frame contains the following columns:

Temp a numeric vector

Density a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
anova(lm(Density ~ Temp, data = p5.22))
```

p5.23

Data Set for Problem 5-23

Description

The p5.23 data frame has 18 observations on 3 variables.

Usage

```
data(p5.23)
```

Format

This data frame contains the following columns:

Batch a character vector

Pressure a numeric vector

Strength a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
anova(lm(Strength ~ Pressure*Batch, data = p5.23))
```

p5.24

Data Set for Problem 5-24

Description

The p5.24 data frame has 13 observations on 7 variables.

Usage

```
data(p5.24)
```

Format

This data frame contains the following columns:

Location a character vector

x1 a numeric vector

x2 a numeric vector

x3 a numeric vector

x4 a numeric vector

x5 a numeric vector

y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

French, R.J. and Schultz, J.E. "Water Use Efficiency of Wheat in a Mediterranean-type Environment, I The Relation between Yield, Water Use, and Climate," Australian Journal of Agricultural Research, 35, 743-764, 1984.

Examples

```
lm(y ~ x1 + x2 + x3 + x4 + x5, data = p5.24)
```

p5.3

Data Set for Problem 5-3

Description

The p5.3 data frame has 12 observations on the number of bacteria surviving in a canned food product and the number of minutes of exposure to 300 degree Fahrenheit heat.

Usage

```
data(p5.3)
```

Format

This data frame contains the following columns:

bact number of surviving bacteria

min number of minutes of exposure

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p5.3)
plot(bact~min, data=p5.3)
```

p5.4

Data Set for Problem 5-4

Description

The p5.4 data frame has 8 observations on 2 variables.

Usage

```
data(p5.4)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p5.4)
plot(y ~ x, data=p5.4)
```

p5.5

Data Set for Problem 5-5

Description

The p5.5 data frame has 14 observations on the average number of defects per 10000 bottles due to stones in the bottle wall and the number of weeks since the last furnace overhaul.

Usage

```
data(p5.5)
```

Format

This data frame contains the following columns:

defects a numeric vector

weeks a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p5.5)
defects.lm <- lm(defects~weeks, data=p5.5)
plot(defects.lm, which=1)
```

p7.1

Data Set for Problem 7-1

Description

The p7.1 data frame has 10 observations on a predictor variable.

Usage

```
data(p7.1)
```

Format

This data frame contains the following columns:

x a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.1)
attach(p7.1)
x2 <- x^2
detach(p7.1)
```

p7.11

Data Set for Problem 7-11

Description

The p7.11 data frame has 11 observations on production cost versus production lot size.

Usage

```
data(p7.11)
```

Format

This data frame contains the following columns:

x production lot size

y average production cost per unit

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.11)
plot(y ~ x, data=p7.11)
```

p7.13

Data Set for Problem 7-13

Description

The p7.13 data frame has 11 observations on production cost versus production lot size. (This data set was for problem 7-11 in the third edition of MPV).

Usage

```
data(p7.13)
```

Format

This data frame contains the following columns:

x production lot size

y average production cost per unit

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
plot(y ~ x, data=p7.13)
```

p7.15

Data Set for Problem 7-15

Description

The p7.15 data frame has 6 observations on vapor pressure of water at various temperatures.

Usage

```
data(p7.15)
```

Format

This data frame contains the following columns:

y vapor pressure (mm Hg)

x temperature (degrees Celsius)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.15)
y.lm <- lm(y ~ x, data=p7.15)
plot(y ~ x, data=p7.15)
abline(coef(y.lm))
plot(y.lm, which=1)
```

p7.16

Data Set for Problem 7-16

Description

The p7.16 data frame has 26 observations on the observed mole fraction solubility of a solute at a constant temperature.

Usage

```
data(p7.16)
```

Format

This data frame contains the following columns:

y negative logarithm of the mole fraction solubility

x1 dispersion partial solubility

x2 dipolar partial solubility

x3 hydrogen bonding Hansen partial solubility

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

(1991) Journal of Pharmaceutical Sciences 80, 971-977.

Examples

```
data(p7.16)
pairs(p7.16)
```

p7.17

Data Set for Problem 7-17

Description

The p7.17 data frame has 6 observations on vapor pressure of water at various temperatures. This data set is the same as p7.15 which was used for exercise 7-15 in the third edition of MPV.

Usage

```
data(p7.17)
```

Format

This data frame contains the following columns:

y vapor pressure (mm Hg)

x temperature (degrees Celsius)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
y.lm <- lm(y ~ x, data=p7.17)
plot(y ~ x, data=p7.17)
abline(coef(y.lm))
plot(y.lm, which=1)
```

p7.18

Data Set for Problem 7-18

Description

The p7.18 data frame has 26 observations on the observed mole fraction solubility of a solute at a constant temperature. This data set is the same as p7.16 which was for problem 7-16 in the third edition of MPV.

Usage

```
data(p7.18)
```

Format

This data frame contains the following columns:

y negative logarithm of the mole fraction solubility

x1 dispersion partial solubility

x2 dipolar partial solubility

x3 hydrogen bonding Hansen partial solubility

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

(1991) Journal of Pharmaceutical Sciences 80, 971-977.

Examples

```
pairs(p7.18)
```

p7.19

Data Set for Problem 7-19

Description

The p7.19 data frame has 10 observations on the concentration of green liquor and paper machine speed from a kraft paper machine.

Usage

```
data(p7.19)
```

Format

This data frame contains the following columns:

y green liquor (g/l)

x paper machine speed (ft/min)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

(1986) Tappi Journal.

Examples

```
data(p7.19)
y.lm <- lm(y ~ x + I(x^2), data=p7.19)
summary(y.lm)
```

p7.2

Data Set for Problem 7-2

Description

The p7.2 data frame has 10 observations on solid-fuel rocket propellant weight loss.

Usage

```
data(p7.2)
```

Format

This data frame contains the following columns:

x months since production

y weight loss (kg)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.2)
y.lm <- lm(y ~ x + I(x^2), data=p7.2)
summary(y.lm)
plot(y ~ x, data=p7.2)
```

p7.20

Data Set for Problem 7-20

Description

The p7.20 data frame has 10 observations on the concentration of green liquor and paper machine speed from a kraft paper machine. This data set is the same as p7.19 which was used in problem 7.19 of the third edition of MPV.

Usage

```
data(p7.20)
```

Format

This data frame contains the following columns:

y green liquor (g/l)

x paper machine speed (ft/min)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

(1986) Tappi Journal.

Examples

```
data(p7.20)
y.lm <- lm(y ~ x + I(x^2), data=p7.20)
summary(y.lm)
```

p7.4

Data Set for Problem 7-4

Description

The p7.4 data frame has 12 observations on two variables.

Usage

```
data(p7.4)
```

Format

This data frame contains the following columns:

x a numeric vector

y a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.4)
y.lm <- lm(y ~ x + I(x^2), data = p7.4)
summary(y.lm)
```

p7.6

Data Set for Problem 7-6

Description

The p7.6 data frame has 12 observations on softdrink carbonation.

Usage

```
data(p7.6)
```

Format

This data frame contains the following columns:

y carbonation

x1 temperature

x2 pressure

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(p7.6)
y.lm <- lm(y ~ x1 + I(x1^2) + x2 + I(x2^2) + I(x1*x2), data=p7.6)
summary(y.lm)
```

p8.11

Data Set for Problem 8-11

Description

The p8.11 data frame has 25 observations on the tensile strength of synthetic fibre used for men's shirts.

Usage

```
data(p8.11)
```

Format

This data frame contains the following columns:

y tensile strength

percent percentage of cotton

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Montgomery (2001)

Examples

```
data(p8.11)
y.lm <- lm(y ~ percent, data=p8.11)
model.matrix(y.lm)
```

p8.16

Data Set for Problem 8-16

Description

The p8.16 data frame has 17 observations on 4 variables.

Usage

```
data(p8.16)
```

Format

This data frame contains the following columns:

Location numeric

INHIBIT numeric

UVB numeric

SURFACE character

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

Smith, R. C. et al., "Ozone depletion: Ultraviolet radiation and phytoplankton biology in Antarctic waters," Science, 255, 952-957, 1992.

p8.3

Data Set for Problem 8-3

Description

The p8.3 data frame has 25 observations on delivery times taken by a vending machine route driver.

Usage

`data(p8.3)`

Format

This data frame contains the following columns:

y delivery time (in minutes)

x1 number of cases of product stocked

x2 distance walked by route driver

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

`data(p8.3)`

`pairs(p8.3)`

p9.10

Data Set for Problem 9-10

Description

The p9.10 data frame has 31 observations on the rut depth of asphalt pavements prepared under different conditions.

Usage

```
data(p9.10)
```

Format

This data frame contains the following columns:

y change in rut depth/million wheel passes (log scale)

x1 viscosity (log scale)

x2 percentage of asphalt in surface course

x3 percentage of asphalt in base course

x4 indicator

x5 percentage of fines in surface course

x6 percentage of voids in surface course

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Gorman and Toman (1966)

Examples

```
data(p9.10)  
pairs(p9.10)
```

pathoeg

Pathological Example

Description

Artificial regression data which causes stepwise regression with AIC to produce a highly non-parsimonious model. The true model used to simulate the data has only one real predictor (x8).

Usage

pathoeg

Format

This data frame contains the following columns:

x1 a numeric vector

x2 a numeric vector

x3 a numeric vector

x4 a numeric vector

x5 a numeric vector

x6 a numeric vector

x7 a numeric vector

x8 a numeric vector

x9 a numeric vector

y a numeric vector

PRESS

PRESS statistic

Description

Computation of Allen's PRESS statistic for an lm object.

Usage

PRESS(x)

Arguments

x An lm object

Value

Allen's PRESS statistic.

Author(s)

W.J. Braun

See Also

lm

Examples

```
data(p4.18)
attach(p4.18)
y.lm <- lm(y ~ x1 + I(x1^2))
PRESS(y.lm)
detach(p4.18)
```

qqANOVA

QQ Plot for Analysis of Variance

Description

This function is used to display the weight of the evidence against null main effects in data coming from a 1 factor design, using a QQ plot. In practice this method is often called via the function GANOVA.

Usage

```
qqANOVA(x, y, plot.it = TRUE, xlab = deparse(substitute(x)),
        ylab = deparse(substitute(y)), ...)
```

Arguments

x	numeric vector of errors
y	numeric vector of scaled responses
plot.it	logical vector indicating whether to plot or not
xlab	character, x-axis label
ylab	character, y-axis label
...	any other arguments for the plot function

Value

A QQ plot is drawn.

Author(s)

W. John Braun

quadline	<i>Quadratic Overlay</i>
----------	--------------------------

Description

Overlays a quadratic curve to a fitted quadratic model.

Usage

```
quadline(lm.obj, ...)
```

Arguments

lm.obj	A lm object (a quadratic fit)
...	Other arguments to the lines function; e.g. col

Value

The function superimposes a quadratic curve onto an existing scatterplot.

Author(s)

W.J. Braun

See Also

lm

Examples

```
data(p4.18)
attach(p4.18)
y.lm <- lm(y ~ x1 + I(x1^2))
plot(x1, y)
quadline(y.lm)
detach(p4.18)
```

Description

This function analyzes regression data graphically. It allows visualization of the usual F-test for significance of regression.

Usage

```
Qyplot(X, y, plotIt=TRUE, sortTrt=FALSE, type="hist", includeIntercept=TRUE, labels=FALSE)
```

Arguments

X	The design matrix.
y	A numeric vector containing the response.
plotIt	Logical: if TRUE, a graph is drawn.
sortTrt	Logical: if TRUE, an attempt is made at sorting the predictor effects in descending order.
type	"QQ" or "hist"
includeIntercept	Logical: if TRUE, the intercept effect is plotted; otherwise, it is omitted from the plot.
labels	logical: if TRUE, names of predictor variables are used as labels; otherwise, the design matrix column numbers are used as labels

Value

A QQ-plot or a histogram and rugplot, or a list if plotIt=FALSE

Author(s)

W. John Braun

Source

Braun, W.J. 2013. Regression Analysis and the QR Decomposition. Preprint.

Examples

```
# Example 1
X <- p4.18[,-4]
y <- p4.18[,4]
Qyplot(X, y, type="hist", includeIntercept=FALSE)
title("Evidence of Regression in the Jojoba Oil Data")
# Example 2
set.seed(4571)
```

```

Z <- matrix(rnorm(400), ncol=10)
A <- matrix(rnorm(81), ncol=9)
simdata <- data.frame(Z[,1], crossprod(t(Z[, -1]), A))
names(simdata) <- c("y", paste("x", 1:9, sep=""))
Qyplot(simdata[, -1], simdata[, 1], type="hist", includeIntercept=FALSE)
title("Evidence of Regression in Simulated Data Set")
# Example 3
Qyplot(table.b1[, -1], table.b1[, 1], type="hist", includeIntercept=FALSE)
title("Evidence of Regression in NFL Data Set")
# An example where stepwise AIC selects the complement
# of the set of variables that are actually in the true model:
X <- pathoeg[, -10]
y <- pathoeg[, 10]
par(mfrow=c(2,2))
Qyplot(X, y)
Qyplot(X, y, sortTrt=TRUE)
Qyplot(X, y, type="QQ")
Qyplot(X, y, sortTrt=TRUE, type="QQ")
X <- table.b1[, -1] # NFL data
y <- table.b1[, 1]
Qyplot(X, y)

```

radon

Radon Release

Description

Percentage of radon from water released in showers with orifices of various diameters. Four replicates were obtained, but it should be noted that the temperatures for the replicates (in degrees Celsius) are 21, 30, 38, and 46, respectively. This information should really be accounted for in any serious analysis of the data.

Usage

```
data("radon")
```

Format

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

```

diameter shower orifice diameter in mm
rep 1 percentage radon released in first run
rep 2 percentage radon released in second run
rep 3 percentage radon released in third run
rep 4 percentage radon released in fourth run

```

Source

Hazin, C.A. and Eichholz, G.G. (1992) Influence of Water Temperature and Shower Head Orifice Size on the Release of Radon During Showering, *Environment International*, 18, 363-369.

rectangles

Length Measurements on Rectangular Objects

Description

Observations of heights, widths and diagonal lengths of several rectangular objects, such as books, photographs, and so on were measured. Only the data in MPV versions 1.62 and later can be trusted; there were errors in the third column in previous versions.

Usage

rectangles

Format

A data frame with 51 observations on the following 4 variables.

h numeric, heights in centimeters

w numeric, widths in centimeters

d numeric, diagonal lengths in centimeters

index numeric, sum of squares of heights and widths

Examples

```
x <- sqrt(rectangles$index)
y <- rectangles$d
y.lp <- locpoly(x, y, bandwidth=dpill(x,y), degree=1)
plot(y ~ x)
lines(y.lp, col=2, lty=2)
abline(0,1) # y = x + measurement error
plot(y.lp$y - y.lp$x, type="l", col=2)
```

`rftest`*Pseudorandom Number Testing via Random Forest*

Description

Given a sequence of pseudorandom numbers, this function constructs a random forest prediction model for successive values, based on previous values up to a given lag. The ability of the random forest model to predict future values is inversely related to the quality of the sequence as an approximation to locally random numbers.

Usage

```
rftest(u, m=5)
```

Arguments

`u` numeric, a vector of pseudorandom numbers to test
`m` numeric, number of lags to test

Value

Side effect is a two way layout of graphs showing effectiveness of prediction on a training and a testing subset of data. Good predictions indicate a poor quality sequence.

Author(s)

W. John Braun

Examples

```
x <- runif(200)
rftest(x, m = 4)
```

`seismictimings`*Seismic Timing Data*

Description

The seismictimings data frame has 504 rows and 3 columns. Thickness of a layer of Alberta substratum as measured by several transects of geophones.

Usage

```
seismictimings
```


Format

This data frame contains the following columns:

x longitudinal coordinate of geophone.

y latitudinal coordinate of geophone.

z time for signal to pass through substratum.

Examples

```
plot(y ~ x, data = seismictimings)
```

softdrink

Softdrink Data

Description

The softdrink data frame has 25 rows and 3 columns.

Usage

```
data(softdrink)
```

Format

This data frame contains the following columns:

y a numeric vector

x1 a numeric vector

x2 a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(softdrink)
```

solar

Solar Data

Description

The solar data frame has 29 rows and 6 columns.

Usage

```
data(solar)
```

Format

This data frame contains the following columns:

total.heat.flux a numeric vector

insolation a numeric vector

focal.pt.east a numeric vector

focal.pt.south a numeric vector

focal.pt.north a numeric vector

time.of.day a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(solar)
```

stain

Stain Removal Data

Description

Data on an experiment to remove ketchup stains from white cotton fabric by soaking the stained fabric in one of five substrates for one hour. Remaining stains were scored visually and subjectively according to a 6-point scale (0 = completely clean, 5 = no change) The stain data frame has 15 rows and 2 columns.

Usage

```
data(stain)
```

Format

This data frame contains the following columns:

treatment a factor

response a numeric vector

Examples

```
data(stain)
```

table.b1

Table B1

Description

The table.b1 data frame has 28 observations on National Football League 1976 Team Performance.

Usage

```
data(table.b1)
```

Format

This data frame contains the following columns:

y Games won in a 14 game season

x1 Rushing yards

x2 Passing yards

x3 Punting average (yards/punt)

x4 Field Goal Percentage (FGs made/FGs attempted)

x5 Turnover differential (turnovers acquired - turnovers lost)

x6 Penalty yards

x7 Percent rushing (rushing plays/total plays)

x8 Opponents' rushing yards

x9 Opponents' passing yards

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b1)
attach(table.b1)
y.lm <- lm(y ~ x2 + x7 + x8)
summary(y.lm)
# over-all F-test:
y.null <- lm(y ~ 1)
anova(y.null, y.lm)
# partial F-test for x7:
y7.lm <- lm(y ~ x2 + x8)
anova(y7.lm, y.lm)
detach(table.b1)
```

table.b10

*Table B10***Description**

The table.b10 data frame has 40 observations on kinematic viscosity of a certain solvent system.

Usage

```
data(table.b10)
```

Format

This data frame contains the following columns:

x1 Ratio of 2-methoxyethanol to 1,2-dimethoxyethane
x2 Temperature (in degrees Celsius)
y Kinematic viscosity (.000001 m²/s)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Viscosimetric Studies on 2-Methoxyethanol + 1, 2-Dimethoxyethane Binary Mixtures from -10 to 80C. Canadian Journal of Chemical Engineering, 75, 494-501.

Examples

```
data(table.b10)
attach(table.b10)
y.lm <- lm(y ~ x1 + x2)
summary(y.lm)
detach(table.b10)
```

table.b11	<i>Table B11</i>
-----------	------------------

Description

The table.b11 data frame has 38 observations on the quality of Pinot Noir wine.

Usage

```
data(table.b11)
```

Format

This data frame contains the following columns:

Clarity a numeric vector

Aroma a numeric vector

Body a numeric vector

Flavor a numeric vector

Oakiness a numeric vector

Quality a numeric vector

Region a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b11)
attach(table.b11)
Quality.lm <- lm(Quality ~ Clarity + Aroma + Body + Flavor + Oakiness +
  factor(Region))
summary(Quality.lm)
detach(table.b11)
```

table.b12	<i>Table B12</i>
-----------	------------------

Description

The table.b12 data frame has 32 rows and 6 columns.

Usage

```
data(table.b12)
```

Format

This data frame contains the following columns:

temp a numeric vector

soaktime a numeric vector

soakpct a numeric vector

difftime a numeric vector

diffpct a numeric vector

pitch a numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b12)
```

table.b13	<i>Table B13</i>
-----------	------------------

Description

The table.b13 data frame has 40 observations on 7 variables concerning jet turbine engine thrust.

Usage

```
data(table.b13)
```

Format

This data frame contains the following columns:

- y** a numeric vector representing thrust
- x1** a numeric vector representing primary speed of rotation
- x2** a numeric vector representing secondary speed of rotation
- x3** a numeric vector representing fuel flow rate
- x4** a numeric vector representing pressure
- x5** a numeric vector representing exhaust temperature
- x6** a numeric vector representing ambient temperature at time of test

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b13)
```

table.b14	<i>Table B14</i>
-----------	------------------

Description

The table.b14 data frame has 25 observations on the transient points of an electronic inverter.

Usage

```
data(table.b14)
```

Format

This data frame contains the following columns:

- x1** width of the NMOS Device
- x2** length of the NMOS Device
- x3** width of the PMOS Device
- x4** length of the PMOS Device
- x5** a numeric vector
- y** transient point of PMOS-NMOS Inverters

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b14)
y.lm <- lm(y ~ x1 + x2 + x3 + x4, data=table.b14)
plot(y.lm, which=1)
```

`table.b15`*Table B15 - Air Pollution and Mortality Data*

Description

The `table.b15` data frame has 60 observations on the mortality, environment, and demographic variables for a sample of American cities.

Usage

```
data(table.b15)
```

Format

This data frame contains the following columns:

City character vector

Mort numeric vector, age-adjusted mortality from all causes per 100000

Precip numeric vector, precipitation in inches

Educ numeric vector, median number of school years completed

Nonwhite numeric vector, percentage of 1960 population that is nonwhite

Nox numeric vector, relative pollution potential of nitrous oxides

SO2 numeric vector, relative pollution potential of sulfur dioxide

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

References

McDonald, G. C. and Ayers, J.A. [1978], "Some applications of Chernoff faces: A technique for graphically representing multivariate data", in Graphical Representation of Multivariate Data, Academic Press, New York.

Examples

```
data(table.b15)
pairs(table.b15[, -1])
```

table.b16	<i>Table B16 Data Set</i>
-----------	---------------------------

Description

The table.b16 data frame has 38 observations on 6 variables.

Usage

```
data(table.b16)
```

Format

This data frame contains the following columns:

Country character

LifeExp numeric

People.per.TV numeric

People.per.Dr numeric

LifeExpMale numeric

LifeExpFemale numeric

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

table.b17	<i>Table B17</i>
-----------	------------------

Description

The table.b17 data frame has 25 observations on 5 variables.

Usage

```
data(table.b17)
```

Format

This data frame contains the following columns:

Satisfaction numeric vector

Age numeric vector

Severity numeric vector

Surgical.Medical numeric vector

Anxiety numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b17)
```

table.b18

<i>Table B18</i>

Description

The table.b18 data frame has 16 observations on 9 variables.

Usage

```
data(table.b18)
```

Format

This data frame contains the following columns:

- y** numeric vector
- x1** numeric vector
- x2** numeric vector
- x3** numeric vector
- x4** numeric vector
- x5** numeric vector
- x6** numeric vector
- x7** numeric vector
- x8** numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b18)
```

table.b19	<i>Table B19</i>
-----------	------------------

Description

The table.b19 data frame has 32 observations on 11 variables.

Usage

```
data(table.b19)
```

Format

This data frame contains the following columns:

y numeric vector

x1 numeric vector

x2 numeric vector

x3 numeric vector

x4 numeric vector

x5 numeric vector

x6 numeric vector

x7 numeric vector

x8 numeric vector

x9 numeric vector

x10 numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b19)
```

table.b2

Table B2

Description

The table.b2 data frame contains 29 observations on 6 variables related to a solar thermal energy test.

Usage

```
data(table.b2)
```

Format

This data frame contains the following columns:

y a numeric vector measuring total heat flux (kwatts)

x1 a numeric vector measuring insulation (watts/m²)

x2 a numeric vector measuring position of focal point in east direction (inches)

x3 a numeric vector measuring position of focal point in south direction (inches)

x4 a numeric vector measuring position of focal point in north direction (inches)

x5 a numeric vector representing time of day

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
data(table.b2)
pairs(table.b2)
```

table.b20

Table B20

Description

The table.b20 data frame has 18 observations on 6 variables.

Usage

```
data(table.b20)
```

Format

This data frame contains the following columns:

x1 numeric vector
x2 numeric vector
x3 numeric vector
x4 numeric vector
x5 numeric vector
y numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b20)
```

table.b22

Table B22 - Baseball Data

Description

The table.b22 data frame has 30 observations on 12 variables.

Usage

```
data(table.b22)
```

Format

This data frame contains the following columns:

Team character vector
Wins numeric vector
Batter.Age numeric vector
Runs numeric vector
HRs numeric vector
SLG numeric vector
Pitcher.Age numeric vector
ERA numeric vector
SO numeric vector
HRA numeric vector
RA.G numeric vector
Errors numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b22[, -1])
```

table.b23

Table B23

Description

The table.b23 data frame has 59 observations on 8 variables.

Usage

```
data(table.b23)
```

Format

This data frame contains the following columns:

Player character vector

Per numeric vector

Lane.Agility.Time..Seconds. numeric vector

Shuttle.Run..Seconds. numeric vector

Three.Quarter.Sprint..Seconds. numeric vector

Standing.Vertical.Leap..Inches. numeric vector

Max.Vertical.Leap..Inches. numeric vector

Position character vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b23[, -c(1, 8)])
```

`table.b24`*Table B24 - Rental Data*

Description

The `table.b24` data frame has 51 observations on 6 variables.

Usage

```
data(table.b24)
```

Format

This data frame contains the following columns:

City character vector

Population numeric vector

X95th.Percentile.Income numeric vector

Median.Sale.Price numeric vector

Median.Price.sqft numeric vector

Rental.Price numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b24[,-1])
```

`table.b25`*Table B25 Golf Data*

Description

The `table.b25` data frame has 50 observations on 6 variables.

Usage

```
data(table.b25)
```

Format

This data frame contains the following columns:

Player character vector
Average.Score numeric vector
SG..Off.the.Tee numeric vector
SG..Approach.to.Green numeric vector
SG..Around.the.Green numeric vector
SG..Putting numeric vector

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2021) Introduction to Linear Regression Analysis. 6th Edition, John Wiley and Sons.

Examples

```
pairs(table.b25[, -1])
```

table.b3	<i>Table B3</i>
----------	-----------------

Description

The table.b3 data frame has observations on gasoline mileage performance for 32 different automobiles.

Usage

```
data(table.b3)
```

Format

This data frame contains the following columns:

y Miles/gallon
x1 Displacement (cubic in)
x2 Horsepower (ft-lb)
x3 Torque (ft-lb)
x4 Compression ratio
x5 Rear axle ratio
x6 Carburetor (barrels)
x7 No. of transmission speeds
x8 Overall length (in)
x9 Width (in)
x10 Weight (lb)
x11 Type of transmission (1=automatic, 0=manual)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Motor Trend, 1975

Examples

```
data(table.b3)
attach(table.b3)
y.lm <- lm(y ~ x1 + x6)
summary(y.lm)
# testing for the significance of the regression:
y.null <- lm(y ~ 1)
anova(y.null, y.lm)
# 95% CI for mean gas mileage:
predict(y.lm, newdata=data.frame(x1=275, x6=2), interval="confidence")
# 95% PI for gas mileage:
predict(y.lm, newdata=data.frame(x1=275, x6=2), interval="prediction")
detach(table.b3)
```

table.b4

Table B4

Description

The table.b4 data frame has 24 observations on property valuation.

Usage

```
data(table.b4)
```

Format

This data frame contains the following columns:

- y** sale price of the house (in thousands of dollars)
- x1** taxes (in thousands of dollars)
- x2** number of baths
- x3** lot size (in thousands of square feet)
- x4** living space (in thousands of square feet)
- x5** number of garage stalls
- x6** number of rooms
- x7** number of bedrooms
- x8** age of the home (in years)
- x9** number of fireplaces

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Narula, S.C. and Wellington (1980) Prediction, Linear Regression and Minimum Sum of Relative Errors. Technometrics, 19, 1977.

Examples

```
data(table.b4)
attach(table.b4)
y.lm <- lm(y ~ x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9)
summary(y.lm)
detach(table.b4)
```

table.b5

Data Set for Table B5

Description

The table.b5 data frame has 27 observations on liquefaction.

Usage

```
data(table.b5)
```

Format

This data frame contains the following columns:

- y** CO2
- x1** Space time (in min)
- x2** Temperature (in degrees Celsius)
- x3** Percent solvation
- x4** Oil yield (g/100g MAF)
- x5** Coal total
- x6** Solvent total
- x7** Hydrogen consumption

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

(1978) Belle Ayr Liquefaction Runs with Solvent. *Industrial Chemical Process Design Development*, 17, 3.

Examples

```
data(table.b5)
attach(table.b5)
y.lm <- lm(y ~ x6 + x7)
summary(y.lm)
detach(table.b5)
```

table.b6

Data Set for Table B6

Description

The table.b6 data frame has 28 observations on a tube-flow reactor.

Usage

```
data(table.b6)
```

Format

This data frame contains the following columns:

y NbOCl₃ concentration (g-mol/l)

x1 COCl₂ concentration (g-mol/l)

x2 Space time (s)

x3 Molar density (g-mol/l)

x4 Mole fraction CO₂

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) *Introduction to Linear Regression Analysis*. 3rd Edition, John Wiley and Sons.

References

(1972) Kinetics of Chlorination of Niobium oxychloride by Phosgene in a Tube-Flow Reactor. *Industrial and Engineering Chemistry, Process Design Development*, 11(2).

Examples

```
data(table.b6)
# Partial Solution to Problem 3.9
attach(table.b6)
y.lm <- lm(y ~ x1 + x4)
summary(y.lm)
detach(table.b6)
```

table.b7

Data Set for Table B7

Description

The table.b7 data frame has 16 observations on oil extraction from peanuts.

Usage

```
data(table.b7)
```

Format

This data frame contains the following columns:

- x1** CO2 pressure (bar)
- x2** CO2 temperature (in degrees Celsius)
- x3** peanut moisture (percent by weight)
- x4** CO2 flow rate (L/min)
- x5** peanut particle size (mm)
- y** total oil yield

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Kilgo, M.B. An Application of Fractional Experimental Designs. Quality Engineering, 1, 19-23.

Examples

```
data(table.b7)
attach(table.b7)
# partial solution to Problem 3.11:
peanuts.lm <- lm(y ~ x1 + x2 + x3 + x4 + x5)
summary(peanuts.lm)
detach(table.b7)
```

table.b8	<i>Table B8</i>
----------	-----------------

Description

The table.b8 data frame has 36 observations on Clathrate formation.

Usage

```
data(table.b8)
```

Format

This data frame contains the following columns:

x1 Amount of surfactant (mass percentage)

x2 Time (min)

y Clathrate formation (mass percentage)

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Tanii, T., Minemoto, M., Nakazawa, K., and Ando, Y. Study on a Cool Storage System Using HCFC-14 lb Clathrate. Canadian Journal of Chemical Engineering, 75, 353-360.

Examples

```
data(table.b8)
attach(table.b8)
clathrate.lm <- lm(y ~ x1 + x2)
summary(clathrate.lm)
detach(table.b8)
```

`table.b9`*Data Set for Table B9*

Description

The `table.b9` data frame has 62 observations on an experimental pressure drop.

Usage

```
data(table.b9)
```

Format

This data frame contains the following columns:

- x1** Superficial fluid velocity of the gas (cm/s)
- x2** Kinematic viscosity
- x3** Mesh opening (cm)
- x4** Dimensionless number relating superficial fluid velocity of the gas to the superficial fluid velocity of the liquid
- y** Dimensionless factor for the pressure drop through a bubble cap

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

References

Liu, C.H., Kan, M., and Chen, B.H. A Correlation of Two-Phase Pressure Drops in Screen-Plate Bubble Column. Canadian Journal of Chemical Engineering, 71, 460-463.

Examples

```
data(table.b9)
attach(table.b9)
# Partial Solution to Problem 3.13:
y.lm <- lm(y ~ x1 + x2 + x3 + x4)
summary(y.lm)
detach(table.b9)
```

table5.2	<i>Table 5.2</i>
----------	------------------

Description

The table5.2 data frame has 53 observations on energy usage (KWH) and corresponding demand (KW) at a sample of residences. This is the Electric Utility Data of Example 5.1.

Usage

```
data(table5.2)
```

Format

This data frame contains the following columns:

Customer a numeric vector of customer IDs
x a numeric vector of energy usage values
y a numeric vector of demand values

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
plot(y ~ x, xlab = "Usage", ylab = "Demand", data = table5.2)  
anova(lm(y ~ x, data = table5.2)) # Note the typo in Table 5.3 for SS Regression
```

table5.5	<i>Table 5.5</i>
----------	------------------

Description

The table5.5 data frame has 25 observations on wind velocity (mph) and corresponding DC output from a windmill turbine. This is the Windmill Data of Example 5.2.

Usage

```
data(table5.5)
```

Format

This data frame contains the following columns:

v numeric vector of velocities
DC numeric vector of DC output values

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
plot(DC ~ v, data = table5.5)
```

table5.9	<i>Table 5.9</i>
----------	------------------

Description

The table5.9 data frame has 30 observations on wind income (dollars) and corresponding advertising expense. This is the Restaurant Food Sales Data of Example 5.5.

Usage

```
data(table5.9)
```

Format

This data frame contains the following columns:

y numeric vector of incomes

x numeric vector of advertising expenses

Source

Montgomery, D.C., Peck, E.A., and Vining, C.G. (2001) Introduction to Linear Regression Analysis. 3rd Edition, John Wiley and Sons.

Examples

```
plot(y ~ x, xlab = "expense", ylab = "income", data = table5.9)
# carrying out the calculations in the example to obtain the regression
# weights:
indices <- rep(1:10, c(3, 2, 1, 5, 5, 1, 6, 2, 1, 4))
xbar <- sapply(split(table5.9$x, indices), mean)
yvarhat <- sapply(split(table5.9$y, indices), var)
xbar <- xbar[!is.na(yvarhat)]
yvarhat <- yvarhat[!is.na(yvarhat)]
eg55.lm <- lm(yvarhat ~ xbar)
wts <- 1/predict(eg55.lm, newdata = data.frame(xbar = table5.9$x))
# the values are different from those of the textbook; there seems
# to be some problem with either the calculations or the recorded values
```

tarimage	<i>target image</i>
----------	---------------------

Description

The tarimage is a list. Most of the values are 0, but there are small regions of 1's.

Usage

```
data(tarimage)
```

Format

This list contains the following elements:

x a numeric vector having 101 elements.

y a numeric vector having 101 elements.

xy a numeric matrix having 101 rows and columns

Examples

```
with(tarimage, image(x, y, xy))
```

tplot	<i>Graphical t Test for Regression</i>
-------	--

Description

This function analyzes regression data graphically. It allows visualization of the usual t-tests for individual regression coefficients.

Usage

```
tplot(X, y, plotIt=TRUE, type="hist", includeIntercept=TRUE)
```

Arguments

X The design matrix.

y A numeric vector containing the response.

plotIt Logical: if TRUE, a graph is drawn.

type "QQ" or "hist"

includeIntercept Logical: if TRUE, the intercept effect is plotted; otherwise, it is omitted from the plot.

Value

A QQ-plot or a histogram and rugplot, or a list if plotIt=FALSE

Author(s)

W. John Braun

Examples

```
# Jojoba oil data set
X <- p4.18[,-4]
y <- p4.18[,4]
tplot(X, y, type="hist", includeIntercept=FALSE)
title("Tests for Individual Coefficients in the Jojoba Oil Regression")
# Simulated data set where none of the predictors are in the true model:
set.seed(4571)
Z <- matrix(rnorm(400), ncol=10)
A <- matrix(rnorm(81), ncol=9)
simdata <- data.frame(Z[,1], crossprod(t(Z[, -1]),A))
names(simdata) <- c("y", paste("x", 1:9, sep=""))
X <- simdata[,-1]
y <- simdata[,1]
tplot(X, y, type="hist", includeIntercept=FALSE)
title("Tests for Individual Coefficients for the Simulated Data Set")
# NFL Data set:
X <- table.b1[,-1]
y <- table.b1[,1]
tplot(X, y, type="hist", includeIntercept=FALSE)
title("Tests for Individual Coefficients for the NFL Data Set")
# Simulated Data set where x8 is the only predictor in the true model:
X <- pathoeg[,-10]
y <- pathoeg[,10]
par(mfrow=c(2,2))
tplot(X, y)
tplot(X, y, type="QQ")
```

tree.sample

Sample of Loblolly Pine Data

Description

A random sample of observations taken from the 'Loblolly' data frame, one per Seed.

Usage

```
data("tree.sample")
```

Format

A data frame with 12 observations on the following 2 variables.

height tree heights (ft)

age tree ages (yr)

Uplot

Plot of Multipliers in Regression ANOVA Plot

Description

This function graphically displays the coefficient multipliers used in the Regression Plot for the given predictor.

Usage

```
Uplot(X.qr, Xcolumn = 1, ...)
```

Arguments

X.qr	The design matrix or the QR decomposition of the design matrix.
Xcolumn	The column(s) of the design matrix under study; this can be either integer valued or a character string.
...	Additional arguments to barchart.

Value

A bar plot is displayed.

Author(s)

W. John Braun

Examples

```
# Jojoba oil data set
X <- p4.18[,-4]
Uplot(X, 1:4)
# NFL data set; see GFplot result first
X <- table.b1[,-1]
Uplot(X, c(2,3,9))
# In this example, x8 is the only predictor in
# the true model:
X <- pathoeg[,-10]
y <- pathoeg[,10]
pathoeg.F <- GFplot(X, y, plotIt=FALSE)
Uplot(X, "x8")
Uplot(X, 9) # same as above
```

```
Uplot(pathoeg.F$QR, 9) # same as above
X <- table.b1[,-1]
Uplot(X, c("x2", "x3", "x9"))
```

widths

Measurements of the Widths of Book Covers

Description

Measurements in centimeters of the widths of a random collection of books.

Usage

```
widths
```

Format

A numeric vector of length 24.

windWin80

Winnipeg Wind Speed

Description

The windWin80 data frame has 366 observations on midnight and noon windspeed at the Winnipeg International Airport for the year 1980.

Usage

```
data(windWin80)
```

Format

This data frame contains the following columns:

h0 a numeric vector containing the wind speeds at midnight.

h12 a numeric vector containing the wind speeds at the following noon.

Examples

```
data(windWin80)
ts.plot(windWin80$h12^2)
```

Wpgtemp

Winnipeg Maximum Temperatures

Description

The Wpgtemp data frame has 7671 observations on daily maximum temperatures at the Winnipeg International Airport for the years 1960 through 1980.

Usage

```
data(Wpgtemp)
```

Format

This data frame contains the following columns:

temperature A numeric vector containing the temperatures in degrees Celsius

day A numeric vector denoting the observation date in numbers of days after December 31, 1959

Source

Environment Canada

Examples

```
summary(Wpgtemp)
```

wxNWO

Weather Observations for Three Stations in Northwestern Ontario

Description

Daily observations taken from 2012 through 2021 on temperature, rain, snow and wind for Fort Frances, Kenora and Dryden, Ontario.

Usage

```
wxNWO
```

Format

A data frame with 10959 observations on the following 31 variables.

Longitude numeric
Latitude numeric
Station.Name character
Climate.ID numeric
Date.Time numeric
Year numeric
Month numeric
Day numeric
Data.Quality numeric
Max.Temp numeric
Max.Temp.Flag numeric
Min.Temp numeric
Min.Temp.Flag numeric
Mean.Temp numeric
Mean.Temp.Flag numeric
Heat.Deg.Days numeric
Heat.Deg.Days.Flag numeric
Cool.Deg.Days numeric
Cool.Deg.Days.Flag numeric
Total.Rain numeric
Total.Rain.Flag numeric
Total.Snow numeric
Total.Snow.Flag numeric
Total.Precip numeric
Total.Precip.Flag numeric
Snow.on.Ground numeric
Snow.on.Ground.Flag numeric
Dir.of.Max.Gust numeric
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Source

Environment Canada

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