Package 'MSQC'

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Description This package is a toolkit for multivariate process monitoring. It contains the main alternatives of multivariate control chart such as: Hotelling, Chi squared, MEWMA, MCUSUM and Generelized Variance control chart. Also, it includes some tools for assessing multivariate normality like: Mardia, Roysston and Henze Zirkler test and the univariate D'Agostino test. Moreover, it possess ten didactic datasets.

License GPL (>= 2)

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`MSQC-package` *Multivariate Statistical Quality Control*

Description

It computates some of the Multivariate Statistical Quality Control tools. It contains the main alternatives of multivariate control chart such as: Hotelling, Chi squared, MEWMA, MCUSUM and Generelized Variance control chart. Also, it includes some tools for assessing multivariate normality like: Mardia, Royston and Henze Zirkler test and the univariate D'Agostino test. Moreover, it contains ten didactic datasets.

Details

Package:	MSQC
Type:	Package
Version:	1.0.1
Date:	2014-04-13
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Author(s)

Edgar Santos-Fernandez

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References

Bodden, K.M., Rigdon, S.E.: A Program for Approximating the In Control ARL for the MEWMA Chart. Journal of Quality Technology 31,(1999)

Borror, C.M., Montgomery, D.C., Runger, G.C.: Robustness of the EWMA control chart to non normality. Journal of Quality Technology 31(3), (1999)

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Mason, R.L., Tracy, N.D., Young, J.C.: Decomposition of T square for multivariate control chart interpretation. Journal of Quality Technology 27, (1995)

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Montgomery, D.C.: Introduction to Statistical Quality Control, 5 ed. John Wiley & Sons, (2005)

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Prabhu, S.S., Runger, G.C.: Designing a multivariate EWMA control chart. Journal of Quality Technology 29, (1997)

Runger, G.C., Alt, F.B., Montgomery, D.C.: Contributors to a multivariate SPC chart signal. Communications in Statistics: Theory and Methods 25, (1996)

Santos-Fernandez, E.: Multivariate Statistical Quality Control Using R. Springer, 14, (2013)

Sullivan, J.H., Woodall, W.H.: A Comparison of Multivariate Quality Control Charts for Individual Observations. Journal of Quality Technology 28(4) (1996)

Tracy, N., Young, Mason, R.: Multivariate Control Charts for Individual Observations. Journal of Quality Technology 24 (1992)

Woodall, W.H., Ncube, M.M.: Multivariate CUSUM Quality Control Procedures. Technometrics 3(3), (1985)

See Also

#mpci

Examples

```
data(dowel1)
mult.chart(dowel1, type = "chi", alpha = 0.05)

#Phase I
data(carbon1)
mult.chart(type = "t2", carbon1)

#Phase II
Xmv <- mult.chart(carbon1, type = "t2") $Xmv
S <- mult.chart(carbon1, type = "t2") $covariance
colm <- nrow(carbon1)

data(carbon2)
mult.chart(carbon2, type = "t2", Xmv = Xmv, S = S, colm = colm)

# (MEWMA) in Phase II
Xmv <- mult.chart(carbon1, type = "t2") $Xmv
S <- mult.chart(carbon1, type = "t2") $covariance
mult.chart(type = "mewma", carbon2, Xmv = Xmv, S = S)


#Multivariate Cumulative Sum (MCUSUM) in Phase I
mult.chart(type = "mcusum", carbon2)
mult.chart(type = "mcusum2", carbon2)
```

---

archery1 *Target archery dataset in the ranking round (used as Phase I)*

Description

It consists in an stage in which the archer shoots 72 arrows in 12 ends of six arrows. The information is given in x and y coordinates.

Usage

```
data(archery1)
```

Format

An array of (24 x 2 x 3).

`"x-coordinate"` x coordinate

`"y-coordinate"` y coordinate

Examples

```
data(archery1)
## maybe str(archery1) ; plot(archery1) ...
```

---

archery2 *Target archery dataset in the elimination stage (used as Phase II)*

Description

It consists in an stage in which the archer shoots 52 arrows in 12 ends of six arrows. The information is given in x and y coordinates.

Usage

```
data(archery1)
```

Format

An array of (18 x 2 x 3).

`"x-coordinate"` x coordinate

`"y-coordinate"` y coordinate

Examples

```
data(archery1)
## maybe str(archery1) ; plot(archery1) ...
```

bimetal1 *Bimetal dataset in Phase I*

Description

Bimetal thermostat has innumerable practical uses. This type of thermostat holds a bimetallic strip composed by two strips of different metals that convert the changing of temperature in mechanical displacement due to the difference in thermal expansion. Certain type of strip composed of brass and steel is analyzed on a quality laboratory by testing the deflection, the curvature, the resistivity and hardness in low and high expansion sides.

Usage

```
data(bimetal1)
```

Format

A matrix of (28 x 5)

`"deflection"` the deflection level in 10^-6 1/K

`"curvature"` the curvature level in 10^-6 1/K

`"resistivity "` the resistivity level in 10 ^-1ohm x mm^2 / m

`"hardness low expansion side"` the hardness of the low expansion side in 10 N/mm^2

`"hardness high expansion side"` the hardness of the high expansion side in 10 N/mm^3

Examples

```
data(bimetal1)
## maybe str(bimetal1) ; plot(bimetal1) ...
```

bimetal2 *Bimetal dataset in Phase II*

Description

Bimetal thermostat has innumerable practical uses. This type of thermostat holds a bimetallic strip composed by two strips of different metals that convert the changing of temperature in mechanical displacement due to the difference in thermal expansion. Certain type of strip composed of brass and steel is analyzed on a quality laboratory by testing the deflection, the curvature, the resistivity and hardness in low and high expansion sides.

Usage

```
data(bimetal2)
```

Format

A matrix of (28 x 5)

`"deflection"` the deflection level in 10^-6 1/K

`"curvature"` the curvature level in 10^-6 1/K

`"resistivity "` the resistivity level in 10 ^-1ohm x mm^2 / m

`"hardness low expansion side"` the hardness of the low expansion side in 10 N/mm^2

`"hardness high expansion side"` the hardness of the high expansion side in 10 N/mm^3

Examples

```
data(bimetal2)
## maybe str(bimetal2) ; plot(bimetal2) ...
```

---

carbon1 *Carbon fiber tubing in Phase I*

Description

The manufacturing process of a specific carbon fiber tubing three correlated quality characteristics are measured: inner diameter, thickness and length of the tubes in inches. This dataset contains the information of a trivariate (p = 3) process in wich 30 samples of size 8 were collected

Usage

```
data(carbon1)
```

Format

An array of (30 x 3 x 8).

`"inner diameter"` is the inner diameter of the tubings

`"thickness"` is the thickness of the tubings

`"length"` is the length of the tubings

Examples

```
data(carbon1)
## maybe str(carbon1) ; plot(carbon1) ...
```

carbon2 *Carbon fiber tubing in Phase II*

Description

The manufacturing process of a specific carbon fiber tubing three correlated quality characteristics are measured: inner diameter, thickness and length of the tubes in inches. This dataset contains the information of a trivariate (p = 3) process in wich 25 samples of size 8 were collected.

Usage

```
data(carbon2)
```

Format

An array of (30 x 3 x 8).

`"inner diameter"` is the inner diameter of the tubings

`"thickness"` is the thickness of the tubings

`"length"` is the length of the tubings

Examples

```
data(carbon2)
## maybe str(carbon2) ; plot(carbon2) ...
```

covariance *Sample covariance*

Description

It allows to compute the sample covariance in presence of rational subgroups or for individuals according to (Sullivan,Woodall 1996) and (Holmes,Mergen 1993)

Usage

```
covariance(x, stat, method, ...)
```

Arguments

`x`	matrix or array of the quality characteristics.
`stat`	is the statistics
`method`	is the method used in individual observation case.
`...`	other parameters

Note

In individuals observation case (n = 1) use for default the (Sullivan,Woodall 1996) proposal

Author(s)

Edgar Santos-Fernandez

References

Holmes, D.S., Mergen, A.E.: Improving the performance of T-square control chart. Quality Engineering 5(4), 619-625 (1993)

Sullivan, J.H., Woodall, W.H.: A Comparison of Multivariate Quality Control Charts for Individual Observations. Journal of Quality Technology 28(4) (1996)

Examples

```
# individual case
data(bimetal1)
covariance(bimetal1,method="sw")
covariance(bimetal1,method="hm")

# rational subgroup case
data(carbon1)
covariance(carbon1)
```

DAGOSTINO *DAgostino test*

Description

It computes the DAgostino test for assessing univariate normality

Usage

```
DAGOSTINO(data)
```

Arguments

```
data
```

Author(s)

This test is a modification of the original written in Spanish by Peter Mandeville

References

DAgostino, R., Pearson, E.S.: Tests for Departure from Normality. Empirical Results for the Distributions of b2 and v b1. Biometrika 60(3),(1973)

DAgostino, R.B.: Transformation to normality of the null distribution of g1. Biometrika 57(3), (1970)

DAgostino, R.B., Belanger, A., Jr, R.B.D.A.: A suggestion for using powerful and informative tests of normality. The American Statistician 44(4),(1990)

See Also

Chi squared, Anderson Darling, Kolmorov Smirnov, Jarque Bera and Shapiro Wilks tests

Examples

```
data(bimetal1)
for (i in 1 : 5){
DAGOSTINO(bimetal1[,i])
}
```

---

dowel1 *Dowel pin dataset in Phase I*

Description

Diameter and length of a manufacturing process of a dowel pin

Usage

```
data(dowel1)
```

Format

A data frame with 40 observations on the following 2 variables.

`diameter` a numeric vector

`length` a numeric vector

Examples

```
data(dowel1)
## maybe str(dowel1) ; plot(dowel1) ...
```

dowel2 *Dowel pin dataset in Phase II*

Description

Diameter and length of a manufacturing process of a dowel pin

Usage

```
data(dowel2)
```

Format

A data frame with 40 observations on the following 2 variables.

`diameter` a numeric vector

`length` a numeric vector

Examples

```
data(dowel2)
## maybe str(dowel2) ; plot(dowel2) ...
```

ellip *confidence ellipse*

Description

It returns the contour to construct a confidence ellipse according to the knowledge or not of the parameters of the distribution (mu and sigma).

Usage

```
ellip(type = c("chi", "t2"), x, Xmv, S, phase=1, alpha=0.01, method="sw", colm,...)
```

Arguments

`type`	is the type of ellipsoid to constructs (chi or t2)
`x`	matrix of the quality characteristics.
`Xmv`	is the mean vector
`S`	is the sample covariance matrix
`phase`	is the Phase to use. Allows to select the type of UCL to use. Only values of phase = 1 or 2 are allowed.
`alpha`	is the the significance level (0.01 for default)

method	is the method to compute S. The methods sw and hm by (Sullivan,Woodall 1996) and (Holmes,Mergen 1993) are allowed
colm	is the number of samples (m) and it is only used in Hotelling control chart for Phase II
...	other parameters

Author(s)

Edgar Santos-Fernandez

Examples

```
data(dowel1)
ellip(type = "chi", dowel1, alpha = 0.01)
```

---

gen.var *Generalized Variance Control Chart*

Description

It computes the Generalized Variance Control Chart

Usage

```
gen.var(x, ...)
```

Arguments

x	array of the quality characteristics
...	

Details

Notice that it is a chart for rational subgroups only and n must be higher than p

Author(s)

Edgar Santos-Fernandez

References

Montgomery, D.C.: Introduction to Statistical Quality Control, 5 ed. John Wiley & Sons, (2004)

Examples

```
data("carbon1")
gen.var(carbon1)
```

glass1 *Glass manufacturing in Phase I*

Description

It contains three variables measured with the aim to establish a multivariate monitoring program in a manufacturing process

Usage

```
data(glass1)
```

Format

An array of (32 x 3 x 5).

`"Var1"` a numeric vector

`"Var2"` a numeric vector

`"Var3"` a numeric vector

Examples

```
data(glass1)
## maybe str(glass1) ; plot(glass1) ...
```

glass2 *Glass manufacturing in Phase II*

Description

It contains three variables measured with the aim to establish a multivariate monitoring program in a manufacturing process

Usage

```
data(glass2)
```

Format

An array of (32 x 3 x 5).

`"Var1"` a numeric vector

`"Var2"` a numeric vector

`"Var3"` a numeric vector

Examples

```
data(glass2)
## maybe str(glass2) ; plot(glass2) ...
```

HZ.test *Henze-Zirkler test*

Description

It computes the Henze-Zirkler test for assessing multivariate normality

Usage

```
HZ.test(data)
```

Arguments

```
data
```

Author(s)

Patrick Farrell, Matias Salibian-Barrera, Kat Naczk

References

Henze, N., Zirkler, B.: A Class of Invariant Consistent Tests for Multivariate Normality. Communications in Statistics - Theory and Methods 19(10), 3595-3617 (1990)

See Also

Royston.test MardiaTest

Examples

```
data(bimetal1)
HZ.test(bimetal1)
```

indust1 *Industrial dataset collected in Phase I*

Description

A bivariate industrial process

Usage

```
data(indust1)
```

Format

A data frame with 28 observations on the following 2 variables.

`Var1` a numeric vector

`Var2` a numeric vector

Examples

```
data(indust1)
## maybe str(indust1) ; plot(indust1) ...
```

indust2 *Industrial dataset collected in Phase II*

Description

A bivariate industrial process

Usage

```
data(indust2)
```

Format

A data frame with 35 observations on the following 2 variables.

`Var1` a numeric vector

`Var2` a numeric vector

Examples

```
data(indust2)
## maybe str(indust2) ; plot(indust2) ...
```

kulpa *Coordinates of the pitches called "strike" by Ron Kulpa*

Description

The dataset was selected from games against Tampa Bay on July 10, 2011

Usage

```
data(kulpa)
```

Format

A data frame with 113 observations on the following 2 variables.

`px` the x-axis is the horizontally oriented

`pz` the z-axis is the vertically oriented

Examples

```
data(kulpa)
```

larg.ellip *Largest ellipsoid*

Description

It builds the largest ellipsoid centered at the Target. It uses the g

Usage

```
larg.ellip(LSL,USL,n=25,box=FALSE,add=TRUE,xlim=xlim,ylim=ylim,zlim=zlim,
xlab="xlab",ylab="ylab",zlab="zlab",col=2,alpha=0.2,...)
```

Arguments

`LSL`	is the lower specification limit
`USL`	is the upper specification limit
`n`	
`box`	
`add`	
`xlim`	
`ylim`	
`zlim`	

xlab
ylab
zlab
col
alpha
...

Author(s)

This fucntion is a little modification of a function of the rgl package by Duncan Murdoch

Examples

```
#
```

MardiaTest *Mardia test*

Description

It computes the Mardia test for assessing multivariate normality

Usage

```
MardiaTest(data)
```

Arguments

data

Author(s)

Scott Ulman

References

Mardia, K.V.: Measures of multivariate skewness and kurtosis. Biometrika 57,(1970) Mardia, K.V.: Applications of some measures of multivariate skewness and kurtosis for testing normality and robustness studies. Sankhya 36,(1974)

See Also

HZ.test Royston.test

Examples

```
data(bimetal1)
MardiaTest(bimetal1)
```

mech1 *A mechanical process in Phase I*

Description

Seven variables collected from a mechanical process

Usage

```
data(mech1)
```

Format

The format is: An array of (45 x 7). num [1:45, 1:7] 9.55 9.95 10.5 8.75 9.98 ... - attr(*, "dimnames")=List of 2 ..$: NULL ..$: chr [1:7] "var1" "var2" "var3" "var4" ...

Examples

```
data(mech1)
## maybe str(mech1) ; plot(mech1) ...
```

mech2 *A mechanical process in Phase II*

Description

Seven variables collected from a mechanical process

Usage

```
data(mech2)
```

Format

The format is: An array of (50 x 7). num [1:50, 1:7] 9.95 10.08 9.19 10.51 9.39 ... - attr(*, "dimnames")=List of 2 ..$: NULL ..$: chr [1:7] "var1" "var2" "var3" "var4" ...

Examples

```
data(mech2)
## maybe str(mech2) ; plot(mech2) ...
```

`mult.chart` *Multivariate Control Chart*

Description

This function computes the most widely used multivariate control chart such as: Hotelling, Chi-squared, MEWMA, MCUSUM and Generelized Variance control chart.

Usage

```
mult.chart(type = c("chi", "t2", "mewma", "mcusum", "mcusum2"), x, Xmv,
 S, colm, alpha = 0.01, lambda = 0.1, k = 0.5, h = 5.5, phase = 1,
 method = "sw", ...)
```

Arguments

`type`	is the name of the type of chart to use. For instance: type="chi", type="t2", type="mewma"or type="mcusum"
`x`	matrix or array of the quality characteristics.
`Xmv`	is the mean vector. It is only specified for Phase II or when the parameters of the distribution are known.
`S`	is the sample covariance matrix. It is only used for Phase II or when the parameters of the distribution are known.
`colm`	is the number of samples (m) and it is only used in Hotelling control chart for Phase II
`alpha`	it is the the significance level (0.01 for default)
`lambda`	is the smoothing constant. Only values of 0.1, 0.2,...,0.9 are allowed.
`k`	is a constant used in MCUSUM chart. Frequently k = 0.5
`h`	is a constant used in MCUSUM chart. Usually h = 5.5
`phase`	Allows to select the type of UCL to use. Only values of phase = 1 or 2 are allowed.
`method`	Is the method employed to compute the covatiance matrix in individual observation case. Two methods are used "sw" for compute according to (Sullivan,Woodall 1996a) and "hm" by (Holmes,Mergen 1993)
`...`	other parameters

Author(s)

Edgar Santos-Fernandez

References

Bodden, K.M., Rigdon, S.E.: A Program for Approximating the In Control ARL for the MEWMA Chart. Journal of Quality Technology 31,(1999)

Borror, C.M., Montgomery, D.C., Runger, G.C.: Robustness of the EWMA control chart to non normality. Journal of Quality Technology 31(3), (1999)

Camil Fuchs, R.K.: Multivariate Quality Control: theory and applications. Chapman and Hall/CRC, (1998)

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Hotelling, H.: Multivariate Quality Control. McGraw Hill, (1947)

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Jackson, J.E.: Quality Control Methods for Several Related Variables. Technometrics 1 (1959)

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Mason, R.L., Tracy, N.D., Young, J.C.: Decomposition of T square for multivariate control chart interpretation. Journal of Quality Technology 27, (1995)

Mason, R.L., Young, J.C.: Multivariate Statistical Process Control with Industrial Application, 1 ed. Society for Industrial and Applied Mathematics, (2001)

Montgomery, D.C.: Introduction to Statistical Quality Control, 5 ed. John Wiley & Sons, (2005)

Pignatiello, J., Runger, G.: Comparisons of Multivariate CUSUM Charts. Journal of Quality Technology 22(3), (1990)

Prabhu, S.S., Runger, G.C.: Designing a multivariate EWMA control chart. Journal of Quality Technology 29, (1997)

Runger, G.C., Alt, F.B., Montgomery, D.C.: Contributors to a multivariate SPC chart signal. Communications in Statistics: Theory and Methods 25, (1996)

Sullivan, J.H., Woodall, W.H.: A Comparison of Multivariate Quality Control Charts for Individual Observations. Journal of Quality Technology 28(4) (1996)

Tracy, N., Young, Mason, R.: Multivariate Control Charts for Individual Observations. Journal of Quality Technology 24 (1992)

Woodall, W.H., Ncube, M.M.: Multivariate CUSUM Quality Control Procedures. Technometrics 3(3), (1985)

Examples

```
data(dowel1)
mult.chart(dowel1, type = "chi", alpha = 0.05)

#Phase I
data(carbon1)
mult.chart(type = "t2", carbon1)

#Phase II
Xmv <- mult.chart(carbon1, type = "t2") $Xmv
S <- mult.chart(carbon1, type = "t2") $covariance
colm<-nrow(carbon1)

data(carbon2)
mult.chart(carbon2, type = "t2", Xmv = Xmv, S = S, colm = colm)

# (MEWMA) in Phase II
Xmv <- mult.chart(carbon1, type = "t2") $Xmv
S <- mult.chart(carbon1, type = "t2") $covariance
mult.chart(type = "mewma", carbon2, Xmv = Xmv, S = S)


#Multivariate Cumulative Sum (MCUSUM) in Phase I
mult.chart(type = "mcusum", carbon2)
mult.chart(type = "mcusum2", carbon2)
```

`prism` *Make a prism*

Description

This fucntion draws a prism

Usage

```
prism(LSL = LSL, USL = USL, add = TRUE, xlim = xlim, ylim = ylim, zlim = zlim, ...)
```

Arguments

`LSL`	is the lower specification limit
`USL`	is the upper specification limit
`add`	
`xlim`	xlim
`ylim`	ylim
`zlim`	zlim
`...`	additional parameters

Author(s)

Edgar Santos Fernandez

Examples

```
require(rgl)
LSL <- c( 0.60, 0.30, 49.00)
USL <- c(1.40, 1.70, 51.00)
prism(LSL, USL, add = TRUE, col = "#D55E00" )
```

---

proc.reg *Process region*

Description

It computes the process region

Usage

```
proc.reg(x, alpha = 0.0027, ...)
```

Arguments

x	a matrix of quality characteristics
alpha	it is the the significance level (0.0027 for default)
...	other parameters

Author(s)

Edgar Santos-Fernandez

Examples

```
data(dowel1)
proc.reg(dowel1, alpha = 0.01)
```

`Royston.test` *Royston test*

Description

It computes the (Royston 1992) Test for assessing multivariate normality

Usage

```
Royston.test(data)
```

Arguments

`data`

Author(s)

Patrick Farrell, Matias Salibian-Barrera, Kat Naczk

References

Royston, J.P.: An Extension of Shapiro and Wilk' s W Test for Normality to Large Samples. Applied Statistics 31(2),(1982)

Royston, J.P.: Some Techniques for Assessing Multivarate Normality Based on the Shapiro Wilk W. Journal of the Royal Statistical Society. Series C (Applied Statistics) 32(2), (1983)

Royston, J.P.: Approximating the Shapiro Wilk W Test for non normality. Statistics and Computing 2(3), (1992)

Royston, J.P.: Remark AS R94: A remark on Algorithm AS 181: The W test for normality. Journal of the Royal Statistical Society. Series C (Applied Statistics) 44(4), (1995)

See Also

MardiaTest HZ.test

Examples

```
data(bimetal1)
Royston.test(bimetal1)
```

rskewed *Right skewed dataset*

Description

It is a bivariate dataset with a presence of right skewness

Usage

```
data(rskewed)
```

Format

The format is: num [1:30, 1:2] 0.763 0.546 0.787 0.535 0.519 ... - attr(*, "dimnames")=List of 2 ..$: NULL ..$: chr [1:2] "var1" "var2"

Examples

```
data(rskewed)
## maybe str(rskewed) ; plot(rskewed) ...
```

sabathia.ind *Individual observations of C.C. Sabathia on July 10, 2011.*

Description

The dataset was selected from games against Tampa Bay on July 10, 2011. It is composed by the individual observations.

Usage

```
data(sabathia.ind)
```

Format

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

`px` the x-axis is the horizontally oriented

`pz` the z-axis is the vertically oriented

Examples

```
data(sabathia.ind)
```

sabathia1 *A pitching log of C.C. Sabathia on July 10, 2011.*

Description

The dataset was selected from games against Tampa Bay on July 10, 2011. It is composed by the mean of the rational subgroup.

Usage

```
data(sabathia1)
```

Format

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

`px` the x-axis is the horizontally oriented

`pz` the z-axis is the vertically oriented

`start speed` is the start speed of the fastball

Examples

```
data(sabathia1)
```

sabathia2 *A pitching log of C.C. Sabathia on August 12, 2011*

Description

The dataset was selected from games against Tampa Bay on August 12, 2011

Usage

```
data(sabathia2)
```

Format

A data frame with 26 observations on the following 3 variables.

`px` the x-axis is the horizontally oriented

`pz` the z-axis is the vertically oriented

`start speed` is the start speed of the fastball

Examples

```
data(sabathia2)
## maybe str(sabathia2) ; plot(sabathia2) ...
```

water1 *A water quality test in Phase I*

Description

It consists on five variables (pH, phosphates (mg/L), nitrates (mg/L), dissolved oxygen and total solids (mg/L)) measured in a water quality test

Usage

```
data(water1)
```

Format

The format is: is a matrix (30 x 5)

Examples

```
data(water1)
## maybe str(water1) ; plot(water1) ...
```

water2 *A water quality test in Phase II*

Description

It consists on five variables (pH, phosphates (mg/L), nitrates (mg/L), dissolved oxygen and total solids (mg/L)) measured in a water quality test

Usage

```
data(water2)
```

Format

The format is: is a matrix (25 x 5)

Examples

```
data(water2)
## maybe str(water2) ; plot(water2) ...
```

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