Package 'qcr'

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Suggests rmarkdown, knitr

Description Univariate and multivariate SQC tools that completes and increases the SQC techniques available in R. Apart from integrating different R packages devoted to SQC ('qcc','MSQC'), provides nonparametric tools that are highly useful when Gaussian assumption is not met.
This package computes standard univariate control charts for individual measurements, 'X-bar', 'S', 'R', 'p', 'np', 'c', 'u', 'EWMA' and 'CUSUM'. In addition, it includes functions to perform multivariate control charts such as 'Hotelling T2', 'MEWMA' and 'MCUSUM'. As representative feature, multivariate nonparametric alternatives based on data depth are implemented in this package: 'r', 'Q' and 'S' control charts. In addition, Phase I and II control charts for functional data are included. This package also allows the estimation of the most complete set of capability indices from first to fourth generation, covering the nonparametric alternatives, and performing the corresponding capability analysis graphical outputs, including the process capability plots. See Flores et al. (2021) <doi:10.32614/RJ-2021-034>.

License GPL (>= 2)

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BugReports https://github.com/mflores72000/qcr/issues

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

Description

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

Format

An array of (24 x 2 x 3).

x-coordinate x-coordinate

y-coordinate y-coordinate

Examples

```
data(archery1)
str(archery1) ; plot(archery1)
```

circuit *Circuit boards data*

Description

Number of nonconformities observed in 26 successive samples of 100 printed circuit boards. Sample 6 and 20 are out of control limits. Sample 6 was examined by a new inspector and he did not recognize several type of nonconformities that could have been present. Furthermore, the unusually large number of nonconformities in sample 20 resulted from a temperature control problem in the wave soldering machine, which was subsequentely repaired. The last 20 samples are further samples collected on inspection units (each formed by 100 boards).

Format

A data frame with 46 observations on the following 4 variables:

x number of defectives in 100 printed circuit boards (inspection unit)

sample sample ID

size sample size

trial trial sample indicator (TRUE/FALSE)

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons, pp. 173–175

Examples

```
data(circuit)
attach(circuit)
summary(circuit)
boxplot(x ~ trial)
plot(x, type="b")
detach(circuit)
```

counters *The performance of the counters data*

Description

A water company from A Corunia wants to control the performance of the counters installed throughout the city. 60 subsamples are taken each one composed by 3 measurements made by the counters of the same antiquity (10 years) and caliber, in a period of 5 years. Taking into account that there are two brands or providers of counters

Format

A data frame with 180 observations on the following 3 variables:

error the measurement error of the counters (Error: (Real Volume - Measured Volume)/Real Volume)

sample sample id

brand brands of providers of counters

Examples

```
data(counters)
attach(counters)
summary(counters)
plot(error, type="b")
detach(counters)
```

`dowel1` *Dowel pin dataset*

Description

Diameter and length of a manufacturing process of a dowel pin

Format

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

diameter a numeric vector

length a numeric vector

Examples

```
data(dowel1)
str(dowel1) ; plot(dowel1)
```

employment *Level of employment data*

Description

A Spaniard-Argentinian hotel company wants to control the level of employment in their establishments. For this it is going to make a continuous control that measures the amount of occupants in terms of percentage. 48 sub samples are taken of six hotels belonging to two countries

Format

A data frame with 288 observations on the following 3 variables:

occupantion the amount of occupants in terms of percentage

sample sample id

hemisphere Hemisphere

Examples

```
data(employment)
attach(employment)
summary(employment)
boxplot(occupantion ~ hemisphere)
plot(occupantion, type="b")
detach(employment)
```

fdqcd *It creates a data object to be used in Functional Data Quality Control*

Description

Create an object of class 'fdqcd' to perform statistical quality control. This object is used to plot Functional Data Control Charts.

Usage

```
fdqcd(x, data.name = NULL, ...)
```

Arguments

x	Matrix of set cases with dimension (n x m), where n is the number of curves and m are the points observed in each curve.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.
...	arguments passed to or from methods.

Examples

```
library(qcr)
m <- 30
tt<-seq(0,1,len=m)
mu<-30 * tt * (1 - tt)^(3/2)
n0 <- 100
set.seed(12345)
mdata<-matrix(NA,ncol=m,nrow=n0)
sigma <- exp(-3*as.matrix(dist(tt))/0.9)
for (i in 1:n0) mdata[i,]<- mu+0.5*mvrnorm(mu = mu,Sigma = sigma )
fdchart <- fdqcd(mdata)
plot(fdchart,type="l",col="gray")
```

---

fdqcs.depth *Function to plot depth functional data (DFD) - chart*

Description

This function is used to compute statistics required by the DFD chart.

Usage

```
fdqcs.depth(x, ...)

## Default S3 method:
fdqcs.depth(
  x,
  data.name = NULL,
  func.depth = depth.mode,
  nb = 200,
  type = c("trim", "pond"),
  ns = 0.01,
  plot = TRUE,
  trim = 0.025,
  smo = 0.05,
  draw.control = NULL,
  ...
)

## S3 method for class 'fdqcd'
fdqcs.depth(
  x,
  func.depth = depth.mode,
  nb = 200,
  type = c("trim", "pond"),
  ns = 0.01,
  plot = TRUE,
```

```
  trim = 0.025,
  smo = 0.05,
  draw.control = NULL,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.
func.depth	Type of depth measure, by default depth.mode.
nb	The number of bootstrap samples.
type	the method used to trim the data (trim or pond).
ns	Quantile to determine the cutoff from the Bootstrap procedure
plot	a logical value indicating that it should be plotted.
trim	The porcentage of the trimming.
smo	The smoothing parameter for the bootstrap samples.
draw.control	ist that it specifies the col, lty and lwd for objects: fdataobj, statistic, IN and OUT.

References

Flores, M.; Naya, S.; Fernández-Casal,R.; Zaragoza, S.; Raña, P.; Tarrío-Saavedra, J. Constructing a Control Chart Using Functional Data. Mathematics 2020, 8, 58.

Examples

```
## Not run:
library(qcr)
m <- 30
tt<-seq(0,1,len=m)
mu<-30 * tt * (1 - tt)^(3/2)
n0 <- 100
set.seed(12345)
mdata<-matrix(NA,ncol=m,nrow=n0)
sigma <- exp(-3*as.matrix(dist(tt))/0.9)
for (i in 1:n0) mdata[i,]<- mu+0.5*mvrnorm(mu = mu,Sigma = sigma )
fdchart <- fdqcd(mdata)
plot.fdqcd(fdchart,type="l",col="gray")
set.seed(1234)
fddep <- fdqcs.depth(fdchart,plot = T)
plot(fddep,title.fdata = "Fdata",title.depth = "Depth")
summary(fddep)

## End(Not run)
```

`fdqcs.rank` *Function to plot rank functional data (DFD) - chart*

Description

This function is used to compute statistics required by the RFD chart.

Usage

```
fdqcs.rank(x, ...)

## S3 method for class 'fdqcd'
fdqcs.rank(
  x,
  y = x,
  func.depth = depth.FM,
  alpha = 0.01,
  plot = TRUE,
  trim = 0.1,
  draw.control = NULL,
  ...
)
```

Arguments

`x`	an R object (used to select the method). See details.
`...`	arguments passed to or from methods.
`y`	The set of new curves to evaluate the depth. fdqcd class object. The set of reference curves respect to which the depth is computed. fdqcd class object.
`func.depth`	Type of depth measure, by default depth.mode.
`alpha`	Quantile to determine the cutoff from the Bootstrap procedure
`plot`	a logical value indicating that it should be plotted.
`trim`	The porcentage of the trimming.
`draw.control`	ist that it specifies the col, lty and lwd for objects: fdataobj, statistic, IN and OUT.

References

Flores, M.; Naya, S.; Fernández-Casal,R.; Zaragoza, S.; Raña, P.; Tarrío-Saavedra, J. Constructing a Control Chart Using Functional Data. Mathematics 2020, 8, 58.

Examples

```
## Not run:
library(qcr)
m <- 30
tt<-seq(0,1,len=m)
mu<-30 * tt * (1 - tt)^(3/2)
n0 <- 100
set.seed(12345)
mdata<-matrix(NA,ncol=m,nrow=n0)
sigma <- exp(-3*as.matrix(dist(tt))/0.9)
for (i in 1:n0) mdata[i,]<- mu+0.5*mvrnorm(mu = mu,Sigma = sigma )
fdchart <- fdqcd(mdata)
summary(fdchart)
plot(fdchart,type="l",col="gray")
out <- fddep$out
## Outliers - State in Control
alpha <- 0.005
trim <- 0.1
while (length(out)>0) {
 mdata <- fddep$fdata$data[-out,]
 fddep <- fdqcs.depth(mdata,ns = alpha, trim=trim, plot=FALSE)
 out <- fddep$out
}
plot(fddep,title.fdata = "FD-State in Control",title.depth = "Depth")
# Ha
mu_a<- 30 * tt^(3/2) * (1 - tt)
n_a <- 50
set.seed(12345)
mdata_a<-matrix(NA,ncol=m,nrow=n_a)
for (i in 1:n_a) mdata_a[i,]<- mu_a+0.5*mvrnorm(mu = mu_a,Sigma = sigma )
fdchart_a <- fdqcd(mdata_a,"Curves Monitoring")
plot(fdchart_a)
plot(fdchart,fdchart_a,main="Phase II")
pashe2.chart <- fdqcs.rank(fdchart,fdchart_a)
plot(pashe2.chart,title.fdata = "FDA",title.rank = "Rank")
summary(pashe2.chart)

## End(Not run)
```

---

mqcd *It creates a data object to be used in Multivariante Quality Control*

Description

Create an object of class 'mqcd' to perform statistical quality control. This object is used to plot Multivariate Control Charts.

Usage

```
mqcd(data, data.name = NULL)
```

Arguments

data	a matrix or data-frame or array where it should contain data.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.

Examples

```
library(qcr)
data(dowel1)
str(dowel1)
data.mqcd <- mqcd(dowel1)
str(data.mqcd)
```

---

mqcs *It computes statistics to be used in Multivariante Quality Control*

Description

Create an object of class 'mqcs' to perform statistical quality control. This function is used to compute statistics required to plot Multivariate Control Charts

Usage

```
mqcs(x, method = "sw", ...)
```

Arguments

x	Object mqcd (Multivariante Quality Control Data)
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)
...	arguments passed to or from methods.

---

mqcs.add *mqcs.add Add a matrix, data.frame or array object with a mqcs object*

Description

This function is used to join two objects of type matrix, data.frame or array and mqcs.

Usage

```
mqcs.add(x, ...)

## Default S3 method:
mqcs.add(x, value, ...)
```

Arguments

x	Object type mqcs
...	arguments to be passed to or from methods.
value	Object type data.frame, matrix or array

`mqcs.mcusum` *Function to plot mcusum chart*

Description

This function is used to compute statistics required by the mcusum chart.

Usage

```
mqcs.mcusum(x, ...)

## Default S3 method:
mqcs.mcusum(
  x,
  data.name = NULL,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  k = 0.5,
  h = 5.5,
  method = "sw",
  plot = FALSE,
  ...
)

## S3 method for class 'mqcd'
mqcs.mcusum(
  x,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  k = 0.5,
  h = 5.5,
  method = "sw",
  plot = FALSE,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.
limits	a two-values vector specifying the control limits.
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.
k	is a constant used in MCUSUM chart. Frequently k = 0.5
h	is a constant used in MCUSUM chart. Usually h = 5.5
method	is the method employed to compute the covatiance matrix in the individual observation case. Two methods are used "sw" for compute according to (Sullivan,Woodall 1996a) and "hm" by (Holmes,Mergen 1993)
plot	a logical value indicating that it should be plotted.

Author(s)

Edgar Santos-Fernandez

Examples

```
##
##  Continuous data
##
library(qcr)
data(dowel1)
str(dowel1)
data.mqcd <- mqcd(dowel1)
res.mqcs <- mqcs.mcusum(data.mqcd)
summary(res.mqcs)
plot(res.mqcs, title =" MCUSUM Control Chart for dowel1")
```

---

mqcs.mewma *Function to plot mewma chart*

Description

This function is used to compute statistics required by the mewma chart.

Usage

```
mqcs.mewma(x, ...)

## Default S3 method:
mqcs.mewma(
  x,
  data.name = NULL,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  method = "sw",
  plot = FALSE,
  ...
)

## S3 method for class 'mqcd'
mqcs.mewma(
  x,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  lambda = 0.1,
  method = "sw",
  plot = FALSE,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.
limits	a two-values vector specifying the control limits.
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.
method	is the method employed to compute the covatiance matrix in the individual observation case. Two methods are used "sw" for compute according to (Sullivan,Woodall 1996a) and "hm" by (Holmes,Mergen 1993)
plot	a logical value indicating that it should be plotted.
lambda	is the smoothing constant. Only values of 0.1, 0.2,...,0.9 are allowed.

Author(s)

Edgar Santos-Fernandez

Examples

```
##
##  Continuous data
##
library(qcr)
data(dowel1)
str(dowel1)
data.mqcd <- mqcd(dowel1)
res.mqcs <- mqcs.mewma(data.mqcd)
summary(res.mqcs)
plot(res.mqcs, title =" MEWMA Control Chart for dowel1")
```

---

mqcs.t2 *Function to plot t2 Hotelling chart*

Description

This function is used to compute statistics required by the t2 chart.

Usage

```
mqcs.t2(x, ...)

## Default S3 method:
mqcs.t2(
  x,
  data.name = NULL,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  colm = NULL,
  alpha = 0.01,
  phase = 1,
  method = "sw",
  plot = FALSE,
  ...
)

## S3 method for class 'mqcd'
mqcs.t2(
  x,
  limits = NULL,
  Xmv = NULL,
  S = NULL,
  colm = NULL,
  alpha = 0.01,
  phase = 1,
```

```
  method = "sw",
  plot = FALSE,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object's data.
limits	a two-values vector specifying the control limits.
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)
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 the individual observation case. Two methods are used "sw" for compute according to (Sullivan,Woodall 1996a) and "hm" by (Holmes,Mergen 1993)
plot	a logical value indicating that it should be plotted.

Author(s)

Edgar Santos-Fernandez

Examples

```
##
##  Continuous data
##
library(qcr)
data(dowel1)
str(dowel1)
data.mqcd <- mqcd(dowel1)
res.mqcs <- mqcs.t2(data.mqcd)
summary(res.mqcs)
plot(res.mqcs, title =" Hotelling Control Chart for dowel1")

data(archery1)
str(archery1)
data.mqcd <- mqcd(archery1)
res.mqcs <- mqcs.t2(data.mqcd)
summary(res.mqcs)
plot(res.mqcs, title =" Hotelling Control Chart for archery1")
```

mstate.control *Multivariate process state*

Description

This function removes observations from the sample which violates the rules of a process under control

Usage

```
mstate.control(x)
```

Arguments

x	Object mqcd (Multivariate Quality Control Statistical)
control	a logical value indicating whether the initial sample comes from a process under control.

Examples

```
##
##  Continuous data
##
library(qcr)
set.seed(356)
x <- matrix(rnorm(66),ncol=3)
x <- rbind(x,matrix(rexp(66,100),ncol=3))
dim(x)
x <-mqcd(x)
str(x)
x <-mqcs.mewma(x)
str(x)
plot(x)
data.mqcs <- mstate.control(x)
x <-mqcs.mewma(data.mqcs)
plot(x)
```

npqcd *It creates a data object for Non Parametric Quality Control*

Description

It creates an object of class 'npqcd' to perform statistical quality control. This object is used to plot Non Parametric Multivariate Control Charts.

Usage

```
npqcd(x, G = NULL, data.name = NULL)
```

Arguments

x	a matrix or data-frame or array which it should contain data. Dimension has to be the same as that of the observations.
G	The x as a matrix, data frame or list. If it is a matrix or data frame, then each row is viewed as one multivariate observation.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object x.

Examples

```
library(qcr)

set.seed(356)
data <- matrix(rnorm(999), nc = 3)
x <-rexp(999,0.5)
x <-matrix(x,ncol=3)
data.npqcd <- npqcd(data,x)
str(data.npqcd)
```

---

npqcs *Statistical Quality Control Object*

Description

Create an object of class 'npqcs' to perform statistical quality control. This function is used to compute statistics required to plot Non Parametric Multivariate Control Charts

Usage

```
npqcs(x, method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"), ...)
```

Arguments

x	Object npqcd (Non Parametric Multivariante Quality Control Data)
method	Character string which determines the depth function used. method can be "Tukey" (the default), "Liu", "Mahalanobis", "RP" Random Project or "LD" Likelihood depth.
...	arguments passed to or from methods.

npqcs.add *npqcs.add Add a matrix, data.frame or array object with a npqcs object*

Description

This function is used to join two objects of type matrix, data.frame or array and npqcs.

Usage

```
npqcs.add(x, ...)

## Default S3 method:
npqcs.add(x, value, ...)
```

Arguments

x	Object type npqcs
...	arguments to be passed to or from methods.
value	Object type data.frame, matrix or array

npqcs.Q *Function to plot the Q chart*

Description

This function is used to compute statistics required by the Q chart.

Usage

```
npqcs.Q(x, ...)

## Default S3 method:
npqcs.Q(
  x,
  G,
  data.name = NULL,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  ...
)

## S3 method for class 'npqcd'
```

```
npqcs.Q(
  x,
  data.name,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  ...
)
```

Arguments

x	An object npqcd (Non parametric Quality Control Data)
...	arguments passed to or from methods.
G	The x as a matrix, data frame or list. If it is a matrix or data frame, then each row is viewed as one multivariate observation.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object x.
limits	a two-value vector specifying the control limits lower and central.
method	Character string which determines the depth function used. method can be "Tukey" (the default), "Liu", "Mahalanobis", "RP" Random Project or "LD" Likelihood depth.
alpha	it is the the significance level (0.01 for default)
plot	a logical value indicating it should be plotted.

References

Regina Liu (1995)

Examples

```
## Not run:
##
##  Continuous data
##
library(qcr)
set.seed(12345)
mu<-c(0,0)
Sigma<- matrix(c(1,0,0,1),nrow = 2,ncol = 2)
u <- c(2,2)
S <- matrix(c(4,0,0,4),nrow = 2,ncol = 2)
G <- rmvnorm(540, mean = mu, sigma = Sigma)
x<- rmvnorm(40,mean=u,sigma = S)
x <- rbind(G[501:540,],x)
n <- 4 # samples
m <- 20  # measurements
k <- 2  # number of variables
x.a <- array(,dim=c(n,k,m))
for (i in 1:m){
```

```
x.a[,,i] <- x[(1+(i-1)*n):(i*n),] }
M <- G[1:500,]
data.npqcd <- npqcd(x.a,M)
str(data.npqcd)
res.npqcs <- npqcs.Q(data.npqcd,method = "Liu", alpha=0.025)
str(res.npqcs)
summary(res.npqcs)
plot(res.npqcs,title =" Q Control Chart")
## End(Not run)
```

`npqcs.r` *Function to plot the r chart*

Description

This function is used to compute statistics required by the r chart.

Usage

```
npqcs.r(x, ...)

## Default S3 method:
npqcs.r(
  x,
  G,
  data.name = NULL,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  ...
)

## S3 method for class 'npqcd'
npqcs.r(
  x,
  data.name,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  ...
)
```

Arguments

`x`	An object npqcd (Non parametric Quality Control Data)
`...`	arguments passed to or from methods.

G	The x as a matrix, data frame or list. If it is a matrix or data frame, then each row is viewed as one multivariate observation.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object x.
limits	a two-value vector specifying the control limits lower and central.
method	Character string which determines the depth function used. method can be "Tukey" (the default), "Liu", "Mahalanobis", "RP" Random Project or "LD" Likelihood depth.
alpha	it is the the significance level (0.01 for default)
plot	a logical value indicating it should be plotted.

References

Regina Liu (1995)

Examples

```
## Not run:
library(qcr)
set.seed(356)
mu<-c(0,0)
Sigma<- matrix(c(1,0,0,1),nrow = 2,ncol = 2)
u <- c(2,2)
S <- matrix(c(4,0,0,4),nrow = 2,ncol = 2)
G <- rmvnorm(540, mean = mu, sigma = Sigma)
x<- rmvnorm(40,mean=u,sigma = S)
x <- rbind(G[501:540,],x)
M <- G[1:500,]
data.npqcd <- npqcd(x,M)
str(data.npqcd)
res.npqcs <- npqcs.r(data.npqcd,method = "Liu", alpha=0.025)
str(res.npqcs)
summary(res.npqcs)
plot(res.npqcs,title =" r Control Chart")
## End(Not run)
```

---

npqcs.S *Function to plot the S chart*

Description

This function is used to compute statistics required by the S chart.

Usage

```
npqcs.S(x, ...)

## Default S3 method:
npqcs.S(
  x,
  G,
  data.name = NULL,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  standardize = FALSE,
  ...
)

## S3 method for class 'npqcd'
npqcs.S(
  x,
  data.name,
  limits = NULL,
  method = c("Tukey", "Liu", "Mahalanobis", "RP", "LD"),
  alpha = 0.01,
  plot = FALSE,
  standardize = F,
  ...
)
```

Arguments

x	An object npqcd (Non parametric Quality Control Data)
...	arguments passed to or from methods.
G	The x as a matrix, data frame or list. If it is a matrix or data frame, then each row is viewed as one multivariate observation.
data.name	a string that specifies the title displayed on the plots. If not provided it is taken from the name of the object x.
limits	a two-value vector specifying the control limits lower and central.
method	Character string which determines the depth function used. method can be "Tukey" (the default), "Liu", "Mahalanobis", "RP" Random Project or "LD" Likelihood depth.
alpha	it is the the significance level (0.01 for default)
plot	a logical value indicating it should be plotted.
standardize	a logical value indicating data should be standardized.

References

Regina Liu (1995)

Examples

```
## Not run:
##
##  Continuous data
##
set.seed(12345)
mu<-c(0,0)
Sigma<- matrix(c(1,0,0,1),nrow = 2,ncol = 2)
u <- c(2,2)
S <- matrix(c(4,0,0,4),nrow = 2,ncol = 2)
G <- rmvnorm(540, mean = mu, sigma = Sigma)
x<- rmvnorm(40,mean=u,sigma = S)
x.a <- rbind(G[501:540,],x)
M <- G[1:500,]
data.npqcd <- npqcd(x.a,M)
res.npqcs <- npqcs.S(data.npqcd,method = "Liu", alpha=0.05)
summary(res.npqcs)
plot(res.npqcs,title =" S Control Chart")
## End(Not run)
```

---

npstate.control *non parametric process state*

Description

This function removes observations from the sample which violates the rules of a process under control

Usage

```
npstate.control(x, control = FALSE)
```

Arguments

x	Object npqcd (Quality Control Statitical Non Parametric)
control	a logical value indicating whether the initial sample comes from a process under control.

Examples

```
## Not run:
##
##  Continuous data
##
library(qcr)
set.seed(356)
mu<-c(0,0)
Sigma<- matrix(c(1,0,0,1),nrow = 2,ncol = 2)
mu <- c(2,2)
```

```
S <- matrix(c(4,0,0,4),nrow = 2,ncol = 2)
G <- rmvnorm(540, mean = mu, sigma = Sigma)
x<- rmvnorm(40,mean=mu,sigma = S)
x <- rbind(G[501:540,],x)
M <- G[1:500,]
data.npqcd <- npqcd(x,M)
str(data.npqcd)
res.npqcs <- npqcs.r(data.npqcd,method = "Liu", alpha=0.025)
str(res.npqcs)
summary(res.npqcs)
plot(res.npqcs)
new.npqcd <- npstate.control(x = res.npqcs)
res.npqcs <- npqcs.r(new.npqcd)
summary(res.npqcs)
plot(res.npqcs)

## End(Not run)
```

`orangejuice` *Orange juice data*

Description

Frozen orange juice concentrate is packed in 6-oz cardboard cans. These cans are formed on a machine by spinning them from cardboard stock and attaching a metal bottom panel. A can is then inspected to determine whether, when filled, the liquid could possible leak either on the side seam or around the bottom joint. If this occurs a can is considered nonconforming. The data were collected as 30 samples of 50 cans each at half-hour intervals over a three-shift period in which the machine was in continuous operation. From sample 15 used, a new bacth of cardboard stock was punt into production. Sample 23 was obtained when an inexperienced operator was temporarily assigned to the machine. After the first 30 samples, a machine adjustment was made. Then further 24 samples were taken from the process.

Format

A data frame with 54 observations on the following 4 variables:

sample sample id

D number of defectives

size sample sizes

trial trial samples (TRUE/FALSE)

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons, pp. 152–155.

Examples

```
data(orangejuice)
orangejuice$d <- orangejuice$D/orangejuice$size
attach(orangejuice)
summary(orangejuice)
boxplot(d ~ trial)
mark <- ifelse(trial, 1, 2)
plot(sample, d, type="b", col=mark, pch=mark)
```

---

oxidation *Oxidation Onset Temperature*

Description

This database contains information about the level of purity of each batch of Picual varities. Then we have the type of oil by measuring the Oxidation Onset Temperature. We have 50 subsamples of oil with their temperature to oxide.

Format

A data frame with 250 observations on the following 2 variables:

OOT That is a quantitative variable that controls the quality of oil.

sample sample id

Examples

```
data(oxidation)
attach(oxidation)
summary(oxidation)
plot(OOT, type="b")
detach(oxidation)
```

---

pcmanufact *Personal computer manufacturer data*

Description

A personal computer manufacturer counts the number of nonconformities per unit on the final assembly line. He collects data on 20 samples of 5 computers each.

Format

A data frame with 10 observations on the following 2 variables.

x number of nonconformities (inspection units)

sample sample ID

size number of computers inspected

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons, pp. 181–182

Examples

```
data(pcmanufact)
summary(pcmanufact)
plot(pcmanufact$x/pcmanufact$size, type="b")
```

`pistonrings` *Piston rings data*

Description

Piston rings for an automotive engine are produced by a forging process. The inside diameter of the rings manufactured by the process is measured on 25 samples, each of size 5, drawn from a process being considered 'in control'.

Format

A data frame with 200 observations on the following 3 variables.

diameter a numeric vector

sample sample ID

trial trial sample indicator (TRUE/FALSE)

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons, pp. 206–213

Examples

```
data(pistonrings)
attach(pistonrings)
summary(pistonrings)
boxplot(diameter ~ sample)
plot(sample, diameter, cex=0.7)
lines(tapply(diameter,sample,mean))
detach(pistonrings)
```

plates *Vickers hardness data*

Description

A known chemical company is developing a patent for a new variant of artificial stone composed mostly of quartz (93wt and polyester resin . This company is launching a pilot plant where it begins to produce plates of this material to industry scale. In order to measure the degree of product homogeneity, 50 samples were taken, performed 5 measurements per plate corresponding to different areas of artificial stone Vickers hardness

Format

A data frame with 250 observations on the following 2 variables:

hardness Vickers hardness corresponding to different areas of artificial stone

sample sample id

Examples

```
data(plates)
attach(plates)
summary(plates)
plot(hardness, type="b")
detach(plates)
```

plot.fdqcd *Plot method for 'fdqcd' objects*

Description

Generic function for plotting Multivarite charts of object of class 'fdqcd' to perform statistical quality control.

Usage

```
## S3 method for class 'fdqcd'
plot(x, y = NULL, title = NULL, xlab = NULL, ylab = NULL, col = NULL, ...)
```

Arguments

x	Object fdqcd (pashe I)
y	Object fdqcd (monitoring)
title	an overall title for the plot
xlab	a title for the x axis
ylab	a title for the y axis
col	The color for curves
...	arguments to be passed to or from methods.

Examples

```
library(qcr)
m <- 30
tt<-seq(0,1,len=m)
mu<-30 * tt * (1 - tt)^(3/2)
n0 <- 100
set.seed(12345)
mdata<-matrix(NA,ncol=m,nrow=n0)
sigma <- exp(-3*as.matrix(dist(tt))/0.9)
for (i in 1:n0) mdata[i,]<- mu+0.5*mvrnorm(mu = mu,Sigma = sigma )
fdchart <- fdqcd(mdata)
plot(fdchart,type="l",col="gray")
```

---

plot.fdqcs.depth *Plot method for 'fdqcs.depth' objects*

Description

Generic function for plotting charts of object of class 'fdqcs.depth' to perform statistical quality control.

Generic function for plotting charts of object of class 'fdqcs.rank' to perform statistical

Usage

```
## S3 method for class 'fdqcs.depth'
plot(
  x,
  title.fdata = NULL,
  title.depth = NULL,
  xlab = NULL,
  ylab = NULL,
  col = NULL,
  draw.control = NULL,
  ...
)
```

```
## S3 method for class 'fdqcs.rank'
plot(
  x,
  title.fdata = NULL,
  title.rank = NULL,
  xlab = NULL,
  ylab = NULL,
  col = NULL,
  draw.control = NULL,
  ...
)
```

Arguments

x	Object fdqcs.depth
title.fdata	an overall title for the fdata plot
title.depth	an overall title for the depth plot
xlab	a title for the x axis
ylab	a title for the y axis
col	The color for curves
draw.control	ist that it specifies the col, lty and lwd for objects: fdataobj, statistic, IN and OUT.
...	arguments to be passed to or from methods.
title.rank	an overall title for the depth plot

---

plot.mqcs *Plot method for 'mqcs' objects*

Description

Generic function for plotting Multivarite charts of object of class 'mqcs' to perform statistical quality control.

Usage

```
## S3 method for class 'mqcs'
plot(x, title, subtitle, xlab, ylab, ylim, ...)

## S3 method for class 'mqcs.t2'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
```

```
  ylab = NULL,
  ylim = NULL,
  ...
)

## S3 method for class 'mqcs.mcusum'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)

## S3 method for class 'mqcs.mewma'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)
```

Arguments

x	Object mqcs (Multivarite Quality Control Statical)
title	an overall title for the plot
subtitle	a sub title for the plot
xlab	a title for the x axis
ylab	a title for the y axis
ylim	the y limits of the plot
...	arguments to be passed to or from methods.

`plot.npqcs` *Plot method for 'npqcs' objects*

Description

Generic function for plotting Multivarite charts of object of class 'npqcs' to perform statistical quality control.

Usage

```
## S3 method for class 'npqcs'
plot(x, title, subtitle, xlab, ylab, ylim, lim = TRUE, ...)

## S3 method for class 'npqcs.r'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)

## S3 method for class 'npqcs.Q'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)

## S3 method for class 'npqcs.S'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)
```

Arguments

x	Object npqcs (Multivarite Quality Control Statical)
title	an overall title for the plot
subtitle	a sub title for the plot
xlab	a title for the x axis
ylab	a title for the y axis
ylim	the y limits of the plot
lim	a logical value indicating that limits should be constant.

... arguments to be passed to or from methods.

---

plot.qcs *function to create a plotting 'qcs' object*

Description

Generic function for plotting Shewhart charts of object of class 'qcs' to perform statistical quality control.

Usage

```
## S3 method for class 'qcs'
plot(
  x,
  title,
  subtitle,
  xlab,
  ylab,
  ylim,
  center.nominal = NULL,
  limits.specification = NULL,
  limits.alert = NULL,
  type.data = c("continuous", "atributte", "dependence"),
  ...
)

## S3 method for class 'qcs.xbar'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.S'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
```

```
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.R'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.one'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.p'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
```

```
)

## S3 method for class 'qcs.np'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.c'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.u'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  conf.nsigma.alert = NULL,
  center.nominal = NULL,
  limits.specification = NULL,
  ...
)

## S3 method for class 'qcs.ewma'
plot(
  x,
  title = NULL,
```

```
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)

## S3 method for class 'qcs.cusum'
plot(
  x,
  title = NULL,
  subtitle = NULL,
  xlab = NULL,
  ylab = NULL,
  ylim = NULL,
  ...
)
```

Arguments

x	Object qcs (Quality Control Statical)
title	an overall title for the plot
subtitle	a sub title for the plot
xlab	a title for the x axis
ylab	a title for the y axis
ylim	the y limits of the plot
center.nominal	a value specifying the center of group statistics or the "target" value of the process
limits.specification	a two-value vector specifying control limits.
limits.alert	a two-value vector specifying control alert limits.
type.data	a string specifying the type of data.
...	arguments to be passed to or from methods.
conf.nsigma.alert	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).

presion *Level of presion data*

Description

A shipyard of recreational boats manufacturing, intended to optimize and control the mechanical properties hull yacht models. This has made a study in which the modulus of elasticity tensile strength of the epoxy resin (polymer) used, after applying different curing pressures measured: 0.1 y 10 MPa. 60 subsamples composed of three measurements taken on the same day are taken.

Format

A data frame with 180 observations on the following 3 variables:

presion presion level

sample sample id

measur pressures measured: 0.1 y 10 MPa

Examples

```
data(presion)
attach(presion)
summary(presion)
plot(presion$presion, type="b")
detach(presion)
```

qcd *Quality Control Data*

Description

Create an object of class 'qcd' to perform statistical quality control. This object may then be used to plot Shewhart charts, Multivariate Control Charts, and more.

Usage

```
qcd(
  data,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  type.data = c("continuous", "atributte", "dependence"),
  sizes = NULL
)
```

Arguments

data	a matrix or data-frame which should contain data, index sample and, optionally, covariate(s).
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
type.data	a string specifying the type of data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.

---

qcr *Quality Control Review*

Description

Quality Control Review Univariate and multivariate SQC tools that completes and increases the SQC techniques available in R. Apart from integrating different R packages devoted to SQC ('qcc','MSQC'), provides nonparametric tools that are highly useful when Gaussian assumption is not met. This package computes standard univariate control charts for individual measurements, X-bar, S, R, p, np, c, u, EWMA and CUSUM. In addition, it includes functions to perform multivariate control charts such as Hotelling T2, MEWMA and MCUSUM. As representative feature, multivariate nonparametric alternatives based on data depth are implemented in this package: r, Q and S control charts. In addition, Phase I and II control charts for functional data are included. This package also allows the estimation of the most complete set of capability indices from first to fourth generation, covering the nonparametric alternatives, and performing the corresponding capability analysis graphical outputs, including the process capability plots.

qcs *Quality Control Statistics*

Description

Create an object of class 'qcs' to perform statistical quality control. This object may then be used to plot Shewhart charts, Multivariate Control Charts, and more.

Usage

```
qcs(
  x,
  sample.index,
  sizes = NULL,
  type = c("xbar", "R", "S", "one", "p", "np", "c", "u", "ewma", "cusum"),
  center = NULL,
  std.dev,
  conf.nsigma = 3,
  limits = NULL,
  type.data = c("continuous", "atributte", "dependence"),
  lambda = 0.2,
  decision.interval = 5,
  se.shift = 1
)

qcs.continuous(
  x,
  sample.index,
  sizes = NULL,
  type = c("xbar", "R", "S", "one"),
  center = NULL,
  std.dev,
  conf.nsigma = 3,
  limits = NULL
)

qcs.atributte(
  x,
  sample.index = NULL,
  sizes = NULL,
  type = c("p", "np", "c", "u"),
  center = NULL,
  conf.nsigma = 3,
  limits = NULL
)

qcs.dependence(
```

```
  x,
  sample.index = NULL,
  sizes = NULL,
  type = c("ewma", "cusum"),
  center = NULL,
  std.dev,
  nsigma = 3,
  lambda = 0.2,
  decision.interval = 5,
  se.shift = 1
)
```

Arguments

x	a vector containing observed data
sample.index	a scalar with the column number corresponding to the index of each group (sample).
sizes	a value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements of the sample.index vector. For "p", "np" and "u" charts the argument sizes is required.
type	a character string specifying the group statistics to compute:

	Statistic charted	Chart description
"xbar"	mean	means of a continuous process variable
"R"	range	ranges of a continuous process variable
"S"	standard deviation	standard deviations of a continuous variable
"one"	mean	one-at-time data of a continuous process variable
"p"	proportion	proportion of nonconforming units
"np"	count	number of nonconforming units
"c"	count	nonconformities per unit
"u"	count	average nonconformities per unit
"g"	count	number of non-events between events

center	a value specifying the center of group statistics or the "target" value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-value vector specifying control limits.
type.data	a string specifying el type de data.
lambda	the smoothing parameter $0 \leq \lambda \leq 1$

`decision.interval`
: A numeric value specifying the number of standard errors of the summary statistics at which the cumulative sum is out of control.

`se.shift`
: The amount of shift to detect in the process, measured in standard errors of the summary statistics.

`nsigma`
: a numeric value used to compute control limits, specifying the number of standard deviations.

Value

Returns an object of class 'qcs'.

References

Montgomery, D.C. (2000) *Introduction to Statistical Quality Control*, 4th ed. New York: John Wiley & Sons.
Wetherill, G.B. and Brown, D.W. (1991) *Statistical Process Control*. New York: Chapman & Hall.

`qcs.add` *qcs.add Add a data.frame object with a qcs object*

Description

This function is used to join two objects of type data.frame and qcs.

Usage

```
qcs.add(x, ...)

## Default S3 method:
qcs.add(
  x,
  value,
  var.index = NULL,
  sample.index = NULL,
  covar.index = NULL,
  ...
)
```

Arguments

`x`
: Object type qcs

`...`
: arguments to be passed to or from methods.

`value`
: Object type data.frame

`var.index`
: a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly it can be a string with the name of the quality variable.

sample.index	a scalar with the column number corresponding the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly can be a character vector with the names of the covariates.

---

qcs.c *Function to plot Shewhart c chart*

Description

This function is used to compute statistics required by the c chart.

Usage

```
qcs.c(x, ...)

## Default S3 method:
qcs.c(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.c(x, center = NULL, conf.nsigma = 3, limits = NULL, plot = FALSE, ...)
```

Arguments

x	an object qcd (Quality Control Data)
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).

covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-value vector specifying control limits.
plot	a logical value indicating that it should be plotted.

Examples

```
library(qcr)
data(circuit)
attach(circuit)
str(circuit)
datos <- circuit
datos$sample <- 1:length(datos$x)
str(datos)
sizes <- datos[,2]

datos.qcd <- qcd(data = datos, var.index = 1,sample.index = 2,
                 sizes = size, type.data = "atributte")
res.qcs <- qcs.c(datos.qcd)
summary(res.qcs)
plot(res.qcs)
```

---

qcs.ca *Capability Analysis*

Description

Calculates the process capability indices cp, cpk, cpL cpU, cpm, cpmk for a qcs object and normal distribution. Also, this function calculates confidence limits for C_p using the method described by Chou et al. (1990). Approximate confidence limits for C_{pl}, C_{pu} and C_{pk} are computed using the

method in Bissell (1990). Confidence limits for C_{pm} are based on the method of Boyles (1991); this method is approximate and it assumes the target is midway between the specification limits. Moreover, calculates the process capability indices cnp, cnpk, cnpm, cnpmk for a qcs object. A histogramm with a density curve is displayed along with the specification limits, a Quantile-Quantile Plot for the specified distribution and contour graph is plotted for estimate the indice cpm.

Usage

```
qcs.ca(
  object,
  limits = c(lsl = -3, usl = 3),
  target = NULL,
  std.dev = NULL,
  nsigmas = 3,
  confidence = 0.9973,
  plot = TRUE,
  main = NULL,
  ...
)
```

Arguments

`object`	qcs object of type `"qcs.xbar"` or `"qcs.one"`.
`limits`	A vector specifying the lower and upper specification limits.
`target`	A value specifying the target of the process. If is `NULL`, the target is set at the middle value bewteen specification limits.
`std.dev`	A value specifying the within-group standard deviation.
`nsigmas`	A numeric value specifying the number of sigmas to use.
`confidence`	A numeric value between 0 and 1 specifying the probabilities for computing the quantiles. This values is used only when object values is provided. The default value is 0.9973.
`plot`	Logical value indicating whether graph should be plotted.
`main`	Title of the plot.
`...`	Arguments to be passed to or from methods.

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons.

Tong, L.I. and Chen, J.P. (1998), *Lower con???dence limits of process capability indices for non-normal process distributions.* International Journal of Quality & Reliability Management, Vol. 15 No. 8/9, pp. 907-19.

Vannman, K (1995) *A Unified Approach to Capability Indices*. Statitica Sinica,5,805-820.

Vannman, K. (2001). *A Graphical Method to Control Process Capability*. Frontiers in Statistical Quality Control, No 6, Editors: H-J Lenz and P-TH Wilrich. Physica-Verlag, Heidelberg, 290-311.

Hubele and Vannman (2004). *The E???ect of Pooled and Un-pooled Variance Estimators on Cpm When Using Subsamples*. Journal Quality Technology, 36, 207-222.

Examples

```
library(qcr)
data(pistonrings)
xbar <- qcs.xbar(pistonrings[1:125,],plot = TRUE)
LSL=73.99; USL=74.01
limits = c(lsl = 73.99, usl = 74.01)
qcs.ca(xbar, limits = limits)
```

---

qcs.cp *Process capability indices (parametric)*

Description

Calculates Cp, Cpm using the formulation described by Kerstin Vannman(1995).

Usage

```
qcs.cp(
  object,
  parameters = c(u = 0, v = 0),
  limits = c(lsl = -3, usl = 3),
  target = NULL,
  mu = 0,
  std.dev = 1,
  nsigmas = 3,
  k = 1,
  contour = TRUE,
  ylim = NULL,
  ...
)
```

Arguments

object	qcs object of type "qcs.xbar" or "qcs.one".
parameters	A vector specifying the u and v parameters values. If parameters = c(u=0, v=0), the cp indice is calculed; If parameters = c(u=1, v=0), the cpk indice is calculed; If parameters = c(u=0, v=1), the cpm indice is calculed; If parameters = c(u=1, v=1), the cpmk indice is calculed.
limits	A vector specifying the lower and upper specification limits.
target	A value specifying the target of the process. If is NULL, the target is set at the middle value bewteen specification limits.
mu	A value specifying the mean of data.
std.dev	A value specifying the within-group standard deviation.
nsigmas	A numeric value specifying the number of sigmas to use.

k	A numeric value. If the capacity index exceeds the k value, then the process is capable.
contour	Logical value indicating whether contour graph should be plotted.
ylim	The y limits of the plot.
...	Arguments to be passed to or from methods.

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons.
Vannman, K (1995) *A Unified Approach to Capability Indices*. Statitica Sinica,5,805-820.

Examples

```
library(qcr)
data(pistonrings)
xbar <- qcs.xbar(pistonrings[1:125,],plot = TRUE)
mu <-xbar$center
std.dev <-xbar$std.dev
LSL=73.99; USL=74.01
qcs.cp(parameters = c(0,0),limits = c(LSL,USL),
      mu = mu,std.dev = std.dev,ylim=c(0,1))
#calculating all the indices
qcs.cp(object = xbar,parameters = c(0,0), limits = c(LSL,USL),ylim=c(0,1))
qcs.cp(object = xbar,parameters = c(1,0), limits = c(LSL,USL),ylim=c(0,1))
qcs.cp(object = xbar,parameters = c(0,1), limits = c(LSL,USL),ylim=c(0,1))
qcs.cp(object = xbar,parameters = c(1,1), limits = c(LSL,USL),ylim=c(0,1))
```

---

qcs.cpn *Process capability indices (Nonparametric)*

Description

Calculates CNp, $CNpm$ using the formulation described by Tong and Chen (1998).

Usage

```
qcs.cpn(
  object,
  parameters = c(u = 0, v = 0),
  limits = c(lsl = -3, usl = 3),
  q = c(lq = -3, uq = 3),
  target = NULL,
  median = 0,
  nsigmas = 3,
  confidence = 0.9973
)
```

Arguments

object	qcs object of type "qcs.xbar" or "qcs.one".
parameters	A vector specifying the u and v parameters values. If parameters = c(u=0, v=0), the cp indice is calculed; If parameters = c(u=1, v=0), the cpk indice is calculed; If parameters = c(u=0, v=1), the cpm indice is calculed; If parameters = c(u=1, v=1), the cpmk indice is calculed.
limits	A vector specifying the lower and upper specification limits.
q	A vector specifying the lower and upper quantiles. These values are necessary, if object value is missing.
target	A value specifying the target of the process. If is NULL, the target is set at the middle value bewteen specification limits.
median	A value specifying the median of data.
nsigmas	A numeric value specifying the number of sigmas to use.
confidence	A numeric value between 0 and 1 specifying the probabilities for computing the quantiles. This values is used only when object values is provided. The default value is 0.9973.

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons.
Tong, L.I. and Chen, J.P. (1998), *Lower confidence limits of process capability indices for nonnormal process distributions.* International Journal of Quality & Reliability Management, Vol. 15 No. 8/9, pp. 907-19.

Examples

```
library(qcr)
##' data(pistonrings)
xbar <- qcs.xbar(pistonrings[1:125,],plot = TRUE)
x<-xbar$statistics[[1]]
LSL=73.99; USL=74.01
median <-median(x)
lq=as.numeric(quantile(x,probs=0.00135))
uq=as.numeric(quantile(x,probs=0.99865))
qcs.cpn(parameters = c(0,0),limits = c(LSL,USL),
       median = median, q=c(lq,uq))
qcs.cpn(object = xbar,parameters = c(0,0), limits = c(LSL,USL))
qcs.cpn(object = xbar,parameters = c(1,0), limits = c(LSL,USL))
qcs.cpn(object = xbar,parameters = c(0,1), limits = c(LSL,USL))
qcs.cpn(object = xbar,parameters = c(1,1), limits = c(LSL,USL))
```

qcs.cusum *Function to plot the cusum chart*

Description

This function is used to compute statistics required by the cusum chart.

Usage

```
qcs.cusum(x, ...)

## Default S3 method:
qcs.cusum(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  std.dev = NULL,
  decision.interval = 5,
  se.shift = 1,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.cusum(
  x,
  center = NULL,
  std.dev = NULL,
  decision.interval = 5,
  se.shift = 1,
  plot = FALSE,
  ...
)
```

Arguments

x	Object qcd (Quality Control Data)
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.

sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	a value or a vector of values specifying the sample sizes associated with each group.
center	a value specifying the center of group statistics or the "target" value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation.
decision.interval	A numeric value specifying the number of standard errors of the summary statistics at which the cumulative sum is out of control.
se.shift	The amount of shift to detect in the process, measured in standard errors of the summary statistics.
plot	a logical value indicating it should be plotted.

Examples

```
library(qcr)
data(pistonrings)
attach(pistonrings)
res.qcd <- qcd(pistonrings, type.data = "dependence")
res.qcs <- qcs.cusum(res.qcd, type = "cusum")
summary(res.qcs)
plot(res.qcs)
```

---

qcs.ewma *Function to plot ewma chart*

Description

This function is used to compute statistics required by the ewma chart.

This function is used to compute statistics required by the ewma chart.

Usage

```
qcs.ewma(x, ...)

## Default S3 method:
qcs.ewma(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  std.dev = NULL,
  nsigma = 3,
  lambda = 0.2,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.ewma(
  x,
  center = NULL,
  std.dev = NULL,
  nsigma = 3,
  lambda = 0.2,
  plot = FALSE,
  ...
)
```

Arguments

x	Object qcd (Quality Control Data)
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.

data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements##' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.
nsigma	a numeric value used to compute control limits, specifying the number of standard deviations.
lambda	the smoothing parameter $0 \leq \lambda \leq 1$
plot	a logical value indicating it should be plotted.

Examples

```
library(qcr)
data(pistonrings)
attach(pistonrings)
res.qcd <- qcd(pistonrings, type.data = "dependence")
res.qcs <- qcs.ewma(res.qcd, type = "ewma")
summary(res.qcs)
plot(res.qcs)
```

---

qcs.hat.cpm *Process capability index (estimate cpm)*

Description

Estimate "cpm" using the method described by Kerstin Vannman(2001).

Usage

```
qcs.hat.cpm(
  object,
  limits = c(lsl = -3, usl = 3),
  target = NULL,
  mu = 0,
  std.dev = 1,
  nsigmas = 3,
  k0 = 1,
  alpha = 0.05,
  n = 50,
  contour = TRUE,
```

```
  ylim = NULL,
  ...
)
```

Arguments

object	qcs object of type "qcs.xbar" or "qcs.one".
limits	A vector specifying the lower and upper specification limits.
target	A value specifying the target of the process. If is NULL, the target is set at the middle value bewteen specification limits.
mu	A value specifying the mean of data.
std.dev	A value specifying the within-group standard deviation.
nsigmas	A numeric value specifying the number of sigmas to use.
k0	A numeric value. If the capacity index exceeds the k value, then the process is capable.
alpha	The significance level (0.05 for default)
n	Size of the sample.
contour	Logical value indicating whether contour graph should be plotted.
ylim	The y limits of the plot.
...	Arguments to be passed to or from methods.

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons.
Vannman, K. (2001). *A Graphical Method to Control Process Capability*. Frontiers in Statistical Quality Control, No 6, Editors: H-J Lenz and P-TH Wilrich. Physica-Verlag, Heidelberg, 290-311.
Hubele and Vannman (2004). *The E???ect of Pooled and Un-pooled Variance Estimators on Cpm When Using Subsamples*. Journal Quality Technology, 36, 207-222.

Examples

```
library(qcr)
data(pistonrings)
xbar <- qcs.xbar(pistonrings[1:125,],plot = TRUE)
mu <-xbar$center
std.dev <-xbar$std.dev
LSL=73.99; USL=74.01
qcs.hat.cpm(limits = c(LSL,USL),
           mu = mu,std.dev = std.dev,ylim=c(0,1))
qcs.hat.cpm(object = xbar, limits = c(LSL,USL),ylim=c(0,1))
```

qcs.np *Function to plot Shewhart np chart*

Description

This function is used to compute statistics required by the np chart.

Usage

```
qcs.np(x, ...)

## Default S3 method:
qcs.np(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.np(x, center = NULL, conf.nsigma = 3, limits = NULL, plot = FALSE, ...)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.

data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements##' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-values vector specifying control limits.
plot	a logical value indicating should be plotted.

Examples

```
library(qcr)
data(orangejuice)
str(orangejuice)
attach(orangejuice)

datos.qcd <- qcd(data = orangejuice, var.index = 1, sample.index = 2,
                 sizes = size, type.data = "atributte")

res.qcs <- qcs.np(datos.qcd)
summary(res.qcs)
plot(res.qcs)

datos.qcs <- qcs.np(orangejuice[trial,c(1,2)], sizes = orangejuice[trial,3])
plot(datos.qcs)
```

---

qcs.one *Function to plot the Shewhart xbar.one chart*

Description

This function is used to compute statistics required by the xbar.one chart.

Usage

```
qcs.one(x, ...)

## Default S3 method:
qcs.one(
  x,
  var.index = 1,
  sample.index = 2,
```

```
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  std.dev = c("MR", "SD"),
  k = 2,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.one(
  x,
  center = NULL,
  std.dev = c("MR", "SD"),
  k = 2,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)
```

Arguments

x	Object qcd (Quality Control Data)
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements of the sample.index vector. For attribute variable the argument sizes is required.

center	a value specifying the center of group statistics or the ”target” value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.
k	number of successive pairs of observations for computing the standard deviation based on moving ranges of k points.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-value vector specifying control limits.
plot	a logical value indicating should be plotted.

Examples

```
##
##  Continuous data
##
library(qcr)
x <- c(33.75, 33.05, 34, 33.81, 33.46, 34.02, 33.68, 33.27, 33.49, 33.20,
      33.62, 33.00, 33.54, 33.12, 33.84)

sample <- 1:length(x)
datos <- data.frame(x,sample)
datos.qcd <- qcd(datos)

res.qcs <- qcs.one(datos.qcd)
class(res.qcs)
summary(res.qcs)
 plot(res.qcs, title = "Control Chart Xbar.one for pistonrings")
```

---

qcs.p *Function to plot Shewhart xbar chart*

Description

This function is used to compute statistics required by the p chart.

Usage

```
qcs.p(x, ...)

## Default S3 method:
qcs.p(
  x,
  var.index = 1,
```

```
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.p(x, center = NULL, conf.nsigma = 3, limits = NULL, plot = FALSE, ...)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-values vector specifying control limits.
plot	a logical value indicating should be plotted.

Examples

```
library(qcr)
data(orangejuice)
str(orangejuice)
attach(orangejuice)

datos.qcd <- qcd(data = orangejuice, var.index = 1, sample.index = 2,
                 sizes = size, type.data = "atributte")

res.qcs <- qcs.p(datos.qcd)
summary(res.qcs)
plot(res.qcs)

datos.qcs <- qcs.p(orangejuice[trial,c(1,2)], sizes = orangejuice[trial,3])
plot(datos.qcs)
```

`qcs.pcr` *Process capability indices for a given dataset and distribution*

Description

Calculates the process capability indices cp, cpk, cpkL and cpkU for a given dataset and distribution. A histogramm with a density curve is displayed along with the specification limits and a Quantile-Quantile Plot for the specified distribution.

Usage

```
qcs.pcr(
  object,
 distribution = c("normal", "beta", "chi-squared", "exponential", "f", "geometric",
    "lognormal", "log-normal", "logistic", "t", "negative binomial", "poisson",
    "weibull", "gamma"),
  limits = c(lsl = -3, usl = 3),
  target = NULL,
  std.dev = NULL,
  boxcox = FALSE,
  lambda = c(-5, 5),
  confidence = 0.9973,
  plot = TRUE,
  main = NULL,
  ...
)
```

Arguments

`object`	qcs object of type `"qcs.xbar"` or `"qcs.one"`.

distribution	character string that representing the probability distribution the data, such as:"normal","beta", "chi-squared", "exponential", "f", "geometric", "lognormal", "log-normal", "logistic","t", "negative binomial", "poisson", "weibull", "gamma".
limits	A vector specifying the lower and upper specification limits.
target	A value specifying the target of the process. If is NULL, the target is set at the middle value bewteen specification limits.
std.dev	A value specifying the within-group standard deviation.
boxcox	Logical value (default is FALSE). If TRUE, perform a Box-Cox transformation.
lambda	A vector specifying or numeric value indicating lambda for the transformation
confidence	A numeric value between 0 and 1 specifying the nivel for computing the specification limits.
plot	Logical value indicating whether graph should be plotted.
main	Title of the plot.
...	Arguments to be passed to or from methods.

References

Montgomery, D.C. (1991) *Introduction to Statistical Quality Control*, 2nd ed, New York, John Wiley & Sons.

Examples

```
library(qcr)
data(pistonrings)
xbar <- qcs.xbar(pistonrings[1:125,],plot = TRUE)
limits = c(lsl = 73.99, usl = 74.01)
qcs.pcr(xbar, "normal", limits = limits)
qcs.pcr(xbar, "weibull", limits = limits)
```

---

qcs.R *Function to plot Shewhart R chart*

Description

This function is used to compute statistics required by the R chart.

Usage

```
qcs.R(x, ...)

## Default S3 method:
qcs.R(
  x,
  var.index = 1,
```

```
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  std.dev = c("UWAVE-R", "MVLUE-R"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.R(
  x,
  center = NULL,
  std.dev = c("UWAVE-R", "MVLUE-R"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.

std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-values vector specifying control limits.
plot	a logical value indicating should be plotted.

Examples

```
##
##  Continuous data
##
library(qcr)
data(pistonrings)
str(pistonrings)
pistonrings.qcd<-qcd(pistonrings)

class(pistonrings.qcd)

res.qcs <- qcs.R(pistonrings.qcd)
class(res.qcs)
plot(res.qcs,title="Control Chart R for pistonrings")
summary(res.qcs)
```

---

qcs.S *Function to plot Shewhart S chart*

Description

This function is used to compute statistics required by the S chart.

Usage

```
qcs.S(x, ...)

## Default S3 method:
qcs.S(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
```

```
  center = NULL,
  std.dev = c("UWAVE-SD", "MVLUE-SD", "RMSDF"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.S(
  x,
  center = NULL,
  std.dev = c("UWAVE-SD", "MVLUE-SD", "RMSDF"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.

conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-values vector specifying control limits.
plot	a logical value indicating should be plotted.

Details

In the default method qcs.S.default parameter x is a matrix or data-frame where it should contain data, index sample and, optionally, covariate(s).

See Also

qcs, qcd

Examples

```
##
##  Continuous data
##
library(qcr)
data(pistonrings)
str(pistonrings)
pistonrings.qcd<-qcd(pistonrings)

class(pistonrings.qcd)

res.qcs <- qcs.S(pistonrings.qcd)
class(res.qcs)
plot(res.qcs,title="Control Chart S for pistonrings")
summary(res.qcs)
```

---

qcs.u *Function to plot Shewhart u chart*

Description

This function is used to compute statistics required by the u chart.

Usage

```
qcs.u(x, ...)

## Default S3 method:
qcs.u(
  x,
  var.index = 1,
```

```
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.u(x, center = NULL, conf.nsigma = 3, limits = NULL, plot = FALSE, ...)
```

Arguments

x	an R object (used to select the method). See details.
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements## ' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-values vector specifying control limits.
plot	a logical value indicating should be plotted.

Examples

```
data(pcmanufact)
attach(pcmanufact)
str(pcmanufact)
datos <- pcmanufact
datos$sample <- 1:length(datos$x)
str(datos)
sizes <- datos[,2]

datos.qcd <- qcd(data = datos, var.index = 1,sample.index = 2,
                 sizes = sizes, type.data = "atributte")

res.qcs <- qcs.u(datos.qcd)
summary(res.qcs)
plot(res.qcs)
```

---

qcs.xbar *Function to plot the Shewhart xbar chart*

Description

This function is used to compute statistics required by the xbar chart.

Usage

```
qcs.xbar(x, ...)

## Default S3 method:
qcs.xbar(
  x,
  var.index = 1,
  sample.index = 2,
  covar.index = NULL,
  covar.names = NULL,
  data.name = NULL,
  sizes = NULL,
  center = NULL,
  std.dev = c("UWAVE-R", "UWAVE-SD", "MVLUE-R", "MVLUE-SD", "RMSDF"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)

## S3 method for class 'qcd'
qcs.xbar(
  x,
```

```
  center = NULL,
  std.dev = c("UWAVE-R", "UWAVE-SD", "MVLUE-R", "MVLUE-SD", "RMSDF"),
  conf.nsigma = 3,
  limits = NULL,
  plot = FALSE,
  ...
)
```

Arguments

x	Object qcd (Quality Control Data)
...	arguments passed to or from methods.
var.index	a scalar with the column number corresponding to the observed data for the variable (the variable quality). Alternativelly can be a string with the name of the quality variable.
sample.index	a scalar with the column number corresponding to the index each group (sample).
covar.index	optional. A scalar or numeric vector with the column number(s) corresponding to the covariate(s). Alternativelly it can be a character vector with the names of the covariates.
covar.names	optional. A string or vector of strings with names for the covariate columns. Only valid if there is more than one column of data. By default, takes the names from the original object.
data.name	a string specifying the name of the variable which appears on the plots. If not provided it is taken from the object given as data.
sizes	optional. A value or a vector of values specifying the sample sizes associated with each group. For continuous data the sample sizes are obtained counting the non-NA elements##' of the sample.index vector. For attribute variable the argument sizes is required.
center	a value specifying the center of group statistics or the "target" value of the process.
std.dev	a value or an available method specifying the within-group standard deviation(s) of the process. Several methods are available for estimating the standard deviation in case of a continuous process variable.
conf.nsigma	a numeric value used to compute control limits, specifying the number of standard deviations (if conf.nsigma > 1) or the confidence level (if 0 < conf.nsigma < 1).
limits	a two-value vector specifying control limits.
plot	a logical value indicating should be plotted.

References

Montgomery, D.C. (2000)

Examples

```
##
##  Continuous data
##
library(qcr)
data(pistonrings)
str(pistonrings)
pistonrings.qcd<-qcd(pistonrings)

class(pistonrings.qcd)

res.qcs <- qcs.xbar(pistonrings.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings I")
summary(res.qcs)

res.qcd <- state.control(res.qcs)
res.qcs <- qcs.xbar(res.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings II")
summary(res.qcs)

res.qcd <- state.control(res.qcs)
res.qcs <- qcs.xbar(res.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings III")
summary(res.qcs)

x <- droplevels(pistonrings[1:125,])
y <- droplevels(pistonrings[126:200,])

res.qcs <- qcs.xbar(x, data.name="Control Chart Xbar for pistonrings")
plot(res.qcs)

res.qcs <- qcs.add(x = res.qcs, value = y[,c(1,2)])
plot(res.qcs)
summary(res.qcs)


res.qcs <- qcs.xbar(pistonrings.qcd, std.dev="UWAVE-SD")
class(res.qcs)
plot(res.qcs,title="Control Chart Xbar for pistonrings (UWAVE-SD)")
summary(res.qcs)
```

`state.control` *Univariante process state*

Description

This function removes observations from the sample which violates the rules of a process under control

Usage

```
state.control(x)
```

Arguments

x	Object qcs (Quality Control Statistical)

Examples

```
##
##  Continuous data
##
library(qcr)
data(pistonrings)
str(pistonrings)
pistonrings.qcd<-qcd(pistonrings)

class(pistonrings.qcd)

res.qcs <- qcs.xbar(pistonrings.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings I")
summary(res.qcs)

res.qcd <- state.control(res.qcs)
res.qcs <- qcs.xbar(res.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings II")
summary(res.qcs)

res.qcd <- state.control(res.qcs)
res.qcs <- qcs.xbar(res.qcd)
plot(res.qcs,title="Control Chart Xbar for pistonrings III")
summary(res.qcs)
```

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