Package 'SixSigma'

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Title Six Sigma Tools for Quality Control and Improvement

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Description Functions and utilities to perform
Statistical Analyses in the Six Sigma way.
Through the DMAIC cycle (Define, Measure, Analyze, Improve, Control),
you can manage several Quality Management studies:
Gage R&R, Capability Analysis, Control Charts, Loss Function Analysis,
etc. Data frames used in the books ``Six Sigma with R'', Cano et al. (2012) [ISBN 978-1-4614-3652-2]
and ``Quality Control with R'', Cano et al. (2015) [ISBN 978-3-319-24046-6],
are also included in the package.

URL http://www.sixsigmawithr.com

License GPL (>= 2)

Depends R (>= 2.14.0)

Imports grDevices, stats, graphics, qcc, lattice, ggplot2, reshape2,
nortest, e1071, scales, testthat, xtable

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LazyData yes

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NeedsCompilation no

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R **topics documented:**

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clim Profiles	*Compute profiles limits*

Description

Function to compute prototype profile and confidence bands for a set of profiles (Phase I)

Usage

```
climProfiles(profiles, x = 1:nrow(profiles), smoothprof = FALSE,
  smoothlim = FALSE, alpha = 0.01)
```

Arguments

profiles	Matrix with profiles in columns
x	Vector for the independent variable
smoothprof	regularize profiles? [FALSE]
smoothlim	regularize confidence bands? [FALSE]
alpha	limit for control limits [0.01]

Value

a matrix with three profiles: prototype and confidence bands

Author(s)

Javier M. Moguerza and Emilio L. Cano

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
wby.phase1 <- ss.data.wby[, 1:35]
wb.limits <- climProfiles(profiles = wby.phase1,
    x = ss.data.wbx,
    smoothprof = FALSE,
    smoothlim = FALSE)
    plotProfiles(profiles = wby.phase1,
                x = ss.data.wbx,
                cLimits = wb.limits)
```

---

outProfiles	*Get out-of-control profiles*

Description

Returns a list with information about the out-of-control profiles given a set of profiles and some control limits

Usage

```
outProfiles(profiles, x = 1:nrow(profiles), cLimits, tol = 0.5)
```

Arguments

profiles	Matrix of profiles
x	Vector with the independent variable
cLimits	Matrix with the prototype and confidence bands profiles
tol	Tolerance (%)

Value

a list with the following elements:

labOut	labels of the out-of-control profiles
idOut	ids of the out-of-control profiles
pOut	proportion of times the profile values are out of the limits

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
wby.phase1 <- ss.data.wby[, 1:35]
wb.limits <- climProfiles(profiles = wby.phase1,
    x = ss.data.wbx,
    smoothprof = TRUE,
    smoothlim = TRUE)
wby.phase2 <- ss.data.wby[, 36:50]
wb.out.phase2 <- outProfiles(profiles = wby.phase2,
    x = ss.data.wbx,
    cLimits = wb.limits,
    tol = 0.8)
wb.out.phase2
plotProfiles(wby.phase2,
    x = ss.data.wbx,
```

```
    cLimits = wb.limits,
    outControl = wb.out.phase2$idOut,
    onlyout = TRUE)
```

---

plotControlProfiles   *Profiles control plot*

Description

Plots the proportion of times that each profile remains out of the confidence bands

Usage

```
plotControlProfiles(pOut, tol = 0.5)
```

Arguments

pOut   identifiers of profiles out of control

tol   tolerance for the proportion of times the value of the profile is out of control

Value

There is only graphical output

Author(s)

Javier M. Moguerza and Emilio L. Cano

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach.* Springer.

Examples

```
wby.phase1 <- ss.data.wby[, 1:35]
wb.limits <- climProfiles(profiles = wby.phase1,
    x = ss.data.wbx,
    smoothprof = TRUE,
    smoothlim = TRUE)
wby.phase2 <- ss.data.wby[, 36:50]
wb.out.phase2 <- outProfiles(profiles = wby.phase2,
    x = ss.data.wbx,
    cLimits = wb.limits,
    tol = 0.8)
plotControlProfiles(wb.out.phase2$pOut, tol = 0.8)
```

---

plotProfiles	*Plot Profiles*

Description

Plot profiles and optionally control limits

Usage

```
plotProfiles(profiles, x = 1:nrow(profiles), cLimits = NULL,
  outControl = NULL, onlyout = FALSE)
```

Arguments

profiles	matrix with profiles in columns
x	vector with the independent variable
cLimits	matrix with three profiles: prototype and confidence bands (limits)
outControl	identifiers of out-of-control profiles
onlyout	plot only out-of-control profiles? [FALSE]

Value

Only graphical output with the profiles

Author(s)

Javier M. Moguerza and Emilio L. Cano

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
plotProfiles(profiles = ss.data.wby,
    x = ss.data.wbx)
```

| SixSigma | *Six Sigma Tools for Quality and Process Improvement* |

Description

Six Sigma Tools for Quality and Process Improvement

Details

This package contains functions and utilities to perform Statistical Analyses in the Six Sigma way. Through the DMAIC cycle (Define, Measure, Analyze, Improve, Control), you can manage several Quality Management studies: Gage R&R, Capability Analysis, Control Charts, Loss Function Analysis, etc. Data frames used in "Six Sigma with R" (Springer, 2012) are also included in the package. Use the package to perform Six Sigma Methodology tasks, throughout its breakthrough strategy: Define, Measure, Analyze, Improve, Control (DMAIC)
Define: Process Map (ss.pMap), Cause and effect Diagram (ss.ceDiag);
Measure: Gage R&R study (ss.rr); Capability Analysis (ss.study.ca); Loss Function Analysis (ss.lfa)
Analyze: Confidence Intervals (ss.ci)
Control: Moving Average Control Chart
Soon: further functions

Note

The current version includes Loss Function Analysis, Gage R&R Study, confidence intervals, Process Map and Cause-and-Effect diagram. We plan to regularly upload updated versions, with new functions and improving those previously deployed. The subsequent versions will cover tools for the whole cycle:

- Define
- Measure
- Analyze
- Improve
- Control

Author(s)

Emilio L. Cano, Javier M. Moguerza, Mariano Prieto Corcoba and Andrés Redchuk;

Maintainer: Emilio L. Cano <emilio.lopez@urjc.es>

References

Allen, T. T. (2010) *Introduction to Engineering Statistics and Lean Six Sigma - Statistical Quality Control and Design of Experiments and Systems* (Second Edition ed.). London: Springer.

Box, G. (1991). Teaching engineers experimental design with a paper helicopter. Report 76, Center for Quality and Productivity Improvement. University of Wisconsin.

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Cano, Emilio L., Moguerza, Javier M. and Prieto Corcoba, Andrés. 2015. *Quality Control with R. An ISO Standards approach*, Use R!, Springer, New York.

Chambers, J. M. (2008) *Software for data analysis. Programming with R* New York: Springer.

Montgomery, DC (2008) *Introduction to Statistical Quality Control* (Sixth Edition). New York: Wiley&Sons

Wikipedia, http://en.wikipedia.org/wiki/Six_Sigma

See Also

ss.pMap, ss.rr, ss.ceDiag, ss.ci, ss.heli, ss.lfa

---

smoothProfiles   *Regularise set of profiles*

Description

This function takes a set of profiles and regularise them by means of a SVM

Usage

```
smoothProfiles(profiles, x = 1:nrow(profiles), svm.c = NULL,
  svm.eps = NULL, svm.gamma = NULL, parsvm.unique = TRUE)
```

Arguments

profiles	Matrix of y values, one column per profile
x	Vector of predictive variable values, common to all profiles
svm.c	SVM parameter (cost)
svm.eps	SVM parameter (epsilon)
svm.gamma	SVM parameter (gamma)
parsvm.unique	Same parameters for all profiles? (logical [TRUE])

Value

Regularized profiles

Note

The package e1071 is needed in order to be able to use this function. SVM Parameters can be vectors of the same lenght as number of profiles, or a single value for all of them

Author(s)

Javier M. Moguerza and Emilio L. Cano

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
wby.smooth <- smoothProfiles(profiles = ss.data.wby,
    x = ss.data.wbx)
plotProfiles(profiles = wby.smooth,
    x = ss.data.wbx)
```

---

ss.ca.yield	*Main calculations regarding The Voice of the Process in SixSigma: Yield, FTY, RTY, DPMO*

Description

Computes the Yield, First Time Yield, Rolled Throughput Yield and Defects per Million Opportunities of a process.

Usage

```
ss.ca.yield(defects = 0, rework = 0, opportunities = 1)
```

Arguments

defects	A vector with the number of defects in each product/batch, ...
rework	A vector with the number of items/parts reworked
opportunities	A numeric value with the size or length of the product/batch

Details

The three arguments must have the same length.

Value

Yield	Number of good stuff / Total items
FTY	(Total - scrap - rework) / Total
RTY	prod(FTY)
DPMO	Defects per Million Opportunities

Author(s)

Emilio L. Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Gygi C, DeCarlo N, Williams B (2005) *Six sigma for dummies*. –For dummies, Wiley Pub.

Examples

```
ss.ca.yield(c(3,5,12),c(1,2,4),1915)
```

---

ss.ca.z   *Capability Indices*

Description

Compute the Capability Indices of a process, Z (Sigma Score), C_p and C_{pk}.

Usage

```
ss.ca.cp(x, LSL = NA, USL = NA, LT = FALSE, f.na.rm = TRUE,
  ci = FALSE, alpha = 0.05)
```

Arguments

x	A vector with the data of the process performance
LSL	Lower Specification Limit
USL	Upper Specification Limit
LT	Long Term data (TRUE/FALSE). Not used for the moment
f.na.rm	Remove NA data (TRUE/FALSE)
ci	If TRUE computes a Confidence Interval
alpha	Type I error (α) for the Confidence Interval

Value

A numeric value for the index, or a vector with the limits of the Confidence Interval

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Montgomery, DC (2008) *Introduction to Statistical Quality Control* (Sixth Edition). New York: Wiley&Sons

See Also

ss.study.ca

Examples

```
ss.ca.cp(ss.data.ca$Volume,740, 760)
ss.ca.cpk(ss.data.ca$Volume,740, 760)
ss.ca.z(ss.data.ca$Volume,740,760)
```

---

ss.cc *Control Charts*

Description

Plot control charts

Usage

```
ss.cc(type, data, cdata, CTQ = names(data)[1], groups, climits, nsigmas = 3)
```

Arguments

type	Type of chart (see details)
data	data.frame with the process data.
cdata	Vector with the controlled process data to compute limits.
CTQ	Name of the column in the data.frame containing the CTQ.
groups	Name of the column in the data.frame containing the groups.
climits	Limits of the controlled process. It should contain three ordered values: lower limit, center line and upper limit.
nsigmas	Number of sigmas to compute the limits from the center line (default is 3)

Details

If control limits are provided, cdata is dismissed and a message is shown. If there are no control limits nor controlled data, the limits are computed using data.
Supported types of control charts:

- mrMoving Range

Value

A plot with the control chart, and a list with the following elements:

LCL	Lower Control Limit
CL	Center Line
UCL	Upper Control Limit
phase	II when cdata or climits are provided. I otherwise.
out	Out of control points

Note

We have created this function since the qAnalyst package has been removed from CRAN, and it was used in the "Six Sigma with R" book to plot moving average control charts.

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.cc.constants

Examples

```
ss.cc("mr", ss.data.pb1, CTQ = "pb.humidity")
testout <- ss.data.pb1
testout[31,] <- list(31,17)
ss.cc("mr", testout, CTQ = "pb.humidity")
```

---

ss.cc.constants   *Functions to find out constants of the relative range distribution.*

Description

These functions compute the constants d2, d3 and c4 to get estimators of the standard deviation to set control limits.

Usage

```
ss.cc.getd2(n = NA)
```

Arguments

n	Sample size

Value

A numeric value for the constant.

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.cc

Examples

```
ss.cc.getd2(20)
ss.cc.getd3(20)
ss.cc.getc4(20)
```

---

ss.ceDiag	*Cause and Effect Diagram*

Description

Represents a Cause and Effect Diagram by cause group.

Usage

```
ss.ceDiag(effect, causes.gr, causes,
  main = "Six Sigma Cause-and-effect Diagram", sub, ss.col = c("#666666",
  "#BBBBBB", "#CCCCCC", "#DDDDDD", "#EEEEEE"))
```

Arguments

effect	A short character string that represents the effect we want to analyse.
causes.gr	A vector of characters that represents the causes groups.
causes	A vector with lists that represents the individual causes for each
main	Main title for the diagram
sub	Subtitle for the diagram (recommended the Six Sigma project name)
ss.col	A vector of colors for a personalized drawing. At least five colors, sorted by descendant intensity

Details

The default value for ss.col is c("#666666", "#BBBBBB", "#CCCCCC", "#DDDDDD", "#EEEEEE"), a grayscale style. You can pass any accepted colour string.

Value

A drawing of the causes and effect with "fish-bone" shape

Note

The cause and effect diagram is also known as "Ishikawa diagram", and has been widely used in Quality Management. It is one of the Seven Basic Tools of Quality.

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Wikipedia, http://en.wikipedia.org/wiki/Ishikawa_diagram

See Also

ss.pMap

Examples

```
effect <- "Flight Time"
causes.gr <- c("Operator", "Environment", "Tools", "Design",
  "Raw.Material", "Measure.Tool")
causes <- vector(mode = "list", length = length(causes.gr))
causes[1] <- list(c("operator #1", "operator #2", "operator #3"))
causes[2] <- list(c("height", "cleaning"))
causes[3] <- list(c("scissors", "tape"))
causes[4] <- list(c("rotor.length", "rotor.width2", "paperclip"))
causes[5] <- list(c("thickness", "marks"))
causes[6] <- list(c("calibrate", "model"))
ss.ceDiag(effect, causes.gr, causes, sub = "Paper Helicopter Project")
```

---

ss.ci   *Confidence Interval for the mean*

Description

Computes a confidence interval for the mean of the variable (parameter or feature of the process), and prints the data, a histogram with a density line, the result of the Shapiro-Wilks normality test and a quantile-quantile plot.

Usage

```
ss.ci(x, sigma2 = NA, alpha = 0.05, data = NA, xname = "x",
  approx.z = FALSE, main = "Confidence Interval for the Mean", digits = 3,
  sub = "", ss.col = c("#666666", "#BBBBBB", "#CCCCCC", "#DDDDDD",
  "#EEEEEE"))
```

Arguments

x	A numeric vector with the variable data
sigma2	The population variance, if known
alpha	The eqn\alpha error used to compute the $100 * (1 - alpha)\%$ confidence interval
data	The data frame containing the vector
xname	The name of the variable to be shown in the graph
approx.z	If TRUE it uses z statistic instead of t when sigma is unknown and sample size is greater than 30. The default is FALSE, change only if you want to compare with results obtained with the old-fashioned method mentioned in some books.
main	The main title for the graph
digits	Significant digits for output
sub	The subtitle for the graph (recommended: six sigma project name)
ss.col	A vector with colors

Details

When the population variance is known, or the size is greater than 30, it uses z statistic. Otherwise, it is uses t statistic.
If the sample size is lower than 30, a warning is displayed so as to verify normality.

Value

The confidence Interval.
A graph with the figures, the Shapiro-Wilks test, and a histogram.

Note

Thanks to the kind comments and suggestions from the anonymous reviewer of a tentative article.

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.data.rr

Examples

```
ss.ci(len, data=ss.data.strings, alpha = 0.05,
  sub = "Guitar Strings Test | String Length",
  xname = "Length")
```

---

ss.data.batteries   *Data for the batteries example*

Description

This is a simulated data set of 18 measurements of the voltage of batteries using different voltmeters.

Usage

```
data(ss.data.batteries)
```

Format

A data frame with 18 observations on the following 4 variables.

voltmeter a factor with levels 1 2

battery a factor with levels 1 2 3

run a factor with levels 1 2 3

voltage a numeric vector

Note

This data set is used in chapter 5 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.rr

Examples

```
data(ss.data.batteries)
summary(ss.data.batteries)
plot(voltage~voltmeter, data = ss.data.batteries)
```

---

ss.data.bills *Errors in bills data set*

Description

This data set contains the number of errors detected in a set of bills and the name of the person in charge of the bill.

Usage

```
data("ss.data.bills")
```

Format

A data frame with 32 observations on the following 3 variables.

nbill a numeric vector identifying a given bill

clerk a character vector for the clerk responsible for the bill

errors a character vector with the number of errors in the bill

Details

This data set illustrates concepts in the book "Quality Control with R".

Source

Table 6.1 in the reference below.

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach.* Springer.

Examples

```
data(ss.data.bills)
str(ss.data.bills)
barplot(table(ss.data.bills$clerk),
    main = "number of invoices")
aggregate(errors ~ clerk, ss.data.bills, sum)
```

---

ss.data.bolts   *Data for the bolts example*

Description

A data frame with 50 observations of the diameter of the bolts manufactured in a production line.

Usage

```
data(ss.data.bolts)
```

Format

A data frame with 50 observations on the following variable.

diameter a numeric vector with the diameter of the bolts

Note

This data set is used in chapter 4 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.lfa

Examples

```
data(ss.data.bolts)
summary(ss.data.bolts)
hist(ss.data.bolts$diameter)
```

---

ss.data.ca   *Data for a filling process in a winery*

Description

The only field of the data is the volume measured in 20 bottles.

Usage

```
data(ss.data.ca)
```

Format

A data frame with 20 observations on the following variable.

Volume a numeric vector (volume in cl

Note

This data set is used in chapter 7 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.study.ca

Examples

```
data(ss.data.ca)
summary(ss.data.ca)
hist(ss.data.ca$Volume)
```

---

ss.data.density   *Pellets density*

Description

This data set contains the density for 24 pellets.

Usage

```
data("ss.data.density")
```

Format

A vector with 24 items for the density of a set of pellets (*gr/cm*^{3}).

Details

This data set illustrates concepts in the book "Quality Control with R". Note that, in the book, the vector named pdensity is directly created and then used in the examples.

Source

Table 1.2 in the reference below.

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
data(ss.data.density)
str(ss.data.density)
library(qcc)
qcc(ss.data.density,
    type = "xbar.one")
```

---

ss.data.doe1 *Pizza dough example data*

Description

Experimental data for the scores given to a set of pizza doughs.

Usage

```
data(ss.data.doe1)
```

Format

A data frame with 16 observations on the following 6 variables.

repl Replication id

flour Level of flour in the recipe (- +)

salt Level of salt in the recipe (- +)

bakPow Level of Baking Powder in the recipe (- +)

score Scored assigned to the recipe

ord Randomized order

Note

This data set is used in chapter 11 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.doe1)
summary(ss.data.doe1)
lattice::bwplot(score ~ flour | salt + bakPow ,
 data = ss.data.doe1,
 xlab = "Flour",
 strip = function(..., style) lattice::strip.default(..., strip.names=c(TRUE,TRUE)))
```

---

ss.data.doe2   *Data for the pizza dough example (robust design)*

Description

Experimental data for the scores given to a set of pizza doughs. Noise factors added for robust design.

Usage

```
data(ss.data.doe2)
```

Format

A data frame with 64 observations on the following 7 variables.

repl Replication id

flour Level of flour in the recipe (- +)

salt Level of salt in the recipe (- +)

bakPow Level of Baking Powder in the recipe (- +)

temp Level of temperature in preparation (- +)

time Level of time in preparation (- +)

score Scored assigned to the recipe

Note

This data set is used in chapter 11 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.doe2)
summary(ss.data.doe2)
lattice::bwplot(score ~ temp | time, data = ss.data.doe2)
```

---

ss.data.pastries   *Pastries data*

Description

A data frame with 18 observations of the amount of the CTQ compound in some pastries from a bakery. There are two runs for each combination of two factors (laboratory and batch).

Usage

```
data(ss.data.pastries)
```

Format

A data frame with 18 observations on the following 4 variables.

lab laboratory: a factor with levels 1 2 3

batch batch: a factor with levels 1 2 3

run identifies the run: a factor with levels 1 2

comp proportion of the compound in the pastry: a numeric vector

Note

This data set is used in chapter 5 exercises of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pastries)
summary(ss.data.pastries)
lattice::xyplot(comp ~ lab | batch, data = ss.data.pastries)
```

---

ss.data.pb1   *Particle Boards Example - Individual Data*

Description

Humidity of 30 raw material used to make particle boards for individual control chart.

Usage

```
data(ss.data.pb1)
```

Format

A data frame with 30 observations on the following 2 variables.

pb.group Group id (distinct for each observation)

pb.humidity Humidity of the particle board

Note

This data set is used in chapter 12 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pb1)
summary(ss.data.pb1)
library(qcc)
pb.groups.one <- with(ss.data.pb1, qcc.groups(pb.humidity, pb.group))
pb.xbar.one <- qcc(pb.groups.one, type="xbar.one")
summary(pb.xbar.one)
plot(pb.xbar.one)
```

---

ss.data.pb2   *Particle Boards Example - by Groups*

Description

Humidity of 20 groups of size 5 of raw materials to make particle boards. For the mean and range control chart.

Usage

```
data(ss.data.pb2)
```

Format

A data frame with 100 observations on the following 2 variables.

pb.group a numeric vector

pb.humidity a numeric vector

Note

This data set is used in chapter 12 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pb2)
summary(ss.data.pb2)
if (require(qcc)){
  pb.groups.xbar <- with(ss.data.pb2, qcc.groups(pb.humidity, pb.group))
  pb.xbar <- qcc(pb.groups.xbar, type="xbar")
  summary(pb.xbar)
} else {
message("qcc package is needed to run this example")
}
```

---

ss.data.pb3   *Particle Boards Example - Attribute data*

Description

Counts of raw materials stockouts during 22 weekdays in a month.

Usage

```
data(ss.data.pb3)
```

Format

A data frame with 22 observations on the following 3 variables.

day Day id

stockouts Number of stockouts

orders Number of orders

Note

This data set is used in chapter 12 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pb3)
summary(ss.data.pb3)
if (require(qcc)){
with(ss.data.pb3,
plot(qcc(stockouts, orders, type ="p"))
)
} else {
message("qcc package is needed to run this example")
}
```

---

ss.data.pb4   *Data for Practicle Boards Example - number of defects*

Description

Number of defects detected in an order of particle boards.

Usage

```
data(ss.data.pb4)
```

Format

A data frame with 80 observations on the following 2 variables.

order Order id

defects Number of defects

Note

This data set is used in chapter 12 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pb4)
summary(ss.data.pb4)
```

---

ss.data.pc   *Data set for the printer cartridge example*

Description

This data set contains data from a simulated process of printer cartridge filling.

Usage

```
data(ss.data.pc)
```

Format

A data frame with 24 observations on the following 6 variables.

`pc.col` a factor with levels `C B` for the colour

`pc.filler` a factor with levels `1 2 3`

`pc.volume` a numeric vector

`pc.density` a numeric vector

`pc.batch` a numeric vector

`pc.op` a factor with levels `A B C D` for the operator

Note

This data set is used in chapter 8 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pc)
summary(ss.data.pc)
```

---

ss.data.pc.big *Larger data set for the printer cartridges example*

Description

This data set contains data from a simulated process of printer cartridges filling with complete replications.

Usage

```
data(ss.data.pc.big)
```

Format

A data frame with 72 observations on the following 5 variables,

`filler` a factor with levels 1 2 3

`batch` a factor with levels 1 2 3 4

`col` a factor with levels B C

`operator` a factor with levels 1 2 3

`volume` a numeric vector

Note

This data set is used in chapter 8 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pc.big)
summary(ss.data.pc.big)
```

---

ss.data.pc.r   *Data set for the printer cartridge example, by region*

Description

This data set contains data from a simulated process of printer cartridge filling. The dataframe contains defects by region of each type of cartridge.

Usage

```
data(ss.data.pc.r)
```

Format

A data frame with 5 observations on the following 4 variables.

pc.regions a factor with levels region.1 region.2 region.3 region.4 region.5

pc.def.a a numeric vector for defects type A

pc.def.b a numeric vector for defects type B

pc.def a numeric vector for total defects

Note

This data set is used in chapter 8 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.pc.r)
summary(ss.data.pc.r)
```

`ss.data.rr` *Gage R&R data*

Description

Example data for Measure phase of the Six Sigma methodology.

Usage

```
data(ss.data.rr)
```

Format

A data frame with 27 observations on the following 5 variables.

`prototype` a factor with levels `prot #1` `prot #2` `prot #3`

`operator` a factor with levels `op #1` `op #2` `op #3`

`run` a factor with levels `run #1` `run #2` `run #3`

`time1` a numeric vector

`time2` a numeric vector

Note

This data set is used in chapter 5 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.rr)
summary(ss.data.rr)
```

ss.data.strings *Data set for the Guitar Strings example*

Description

This data set contains data from a simulated process of guitar strings production.

Usage

```
data(ss.data.strings)
```

Format

A data frame with 120 observations on the following 6 variables.

id a numeric vector

type a factor with levels A5 B2 D4 E1 E6 G3

res a numeric vector for resistance

len a numeric vector for length

sound a numeric vector for

power a numeric vector

Note

This data set is used in chapter 10 of the book "Six Sigma with R" (see References).

Source

See references.

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andrés. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
data(ss.data.strings)
summary(ss.data.strings)
```

`ss.data.thickness`   *Metal Plates Thickness*

Description

This data set contains the thickness and additional data for 24 metal plates.

Usage

```
data("ss.data.thickness")
```

Format

A data frame with 24 observations on the following 5 variables.

thickness a numeric vector with the thickness (*in*)

day a factor with the day (two days)

shift a factor with the shift (two shifts)

dayshift a factor with the day-shift combination

position a factor with the position of the thickness with respect to the nominal value of 0.75 *in*

Details

This data set illustrates concepts in the book "Quality Control with R". Note that, in the book, the data set is named `plates` and it is created sequentially throughout the examples.

Source

Table 5.1 in the reference below.

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
data(ss.data.thickness)
str(ss.data.thickness)
lattice::bwplot(thickness ~ shift | day,
    data = ss.data.thickness)
```

---

ss.data.thickness2   *Metal Plates thickness (extended)*

Description

This data set contains the thickness and additional data for 84 metal plates.

Usage

```
data("ss.data.thickness2")
```

Format

A data frame with 84 observations on the following 5 variables.

day a factor with the day (seven days)

shift a factor with the shift (two shifts)

thickness a numeric vector with the thickness (*in*)

ushift a factor with the day-shift combination

flaws an integer vector with the number of flaws on the surface of sampled plates

Details

This data set illustrates concepts in the book "Quality Control with R".

Source

Examples 8.1 and 9.9 in the reference below.

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Examples

```
data(ss.data.thickness2)
str(ss.data.thickness2)
lattice::dotplot(thickness ~ shift | day,
    data = ss.data.thickness2,
    layout = c(7, 1))
```

---

ss.data.wbx   *Woodboard location for profiles*

Description

This data set contains the 500 locations at which the density of a 0.5*in*-thick engineered woodboard is measured, i.e., 0.001 *in* apart

Usage

```
data("ss.data.wbx")
```

Format

A vector with 500 items for the locations (*in*).

Details

This data set illustrates concepts in the book "Quality Control with R". This data set should be used along with the `ss.data.wby` data set.

Source

Example 10.1 in the reference below. It is a variation of the one introduced by Walker (2002).

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach*. Springer.

Walker, E. amd Wright, W (2002) Comparing curves with additive models. *J. Qual. Technol.* **34**(1), 118–129

See Also

`ss.data.wby`

Examples

```
data(ss.data.wbx)
data(ss.data.wby)
plotProfiles(profiles = ss.data.wby,
    x = ss.data.wbx)
```

ss.data.wby   *Woodboard profiles*

Description

This data set contains 50 profiles corresponding to the density measurements of 50 0.5*in*-thick engineered woodboard, measured in 500 locations.

Usage

```
data("ss.data.wby")
```

Format

A matrix with 500 rows (locations) and 50 columns (woodboard).

Details

This data set illustrates concepts in the book "Quality Control with R". This data set should be used along with the `ss.data.wbx` data set.

Source

Example 10.1 in the reference below. It is a variation of the one introduced by Walker (2002).

References

Cano, E.L. and Moguerza, J.M. and Prieto Corcoba, M. (2015) *Quality Control with R. An ISO Standards Approach.* Springer.

Walker, E. amd Wright, W (2002) Comparing curves with additive models. *J. Qual. Technol.* **34**(1), 118–129

See Also

`ss.data.wbx`

Examples

```
data(ss.data.wbx)
data(ss.data.wby)
plotProfiles(profiles = ss.data.wby,
    x = ss.data.wbx)
```

| ss.heli | *Creates a pdf file with the design of the Paper Helicopter* |

Description

The pdf file contains a template with lines and indications to build the paper helicopter described in many SixSigma publications.

Usage

```
ss.heli()
```

Details

The pdf file must be printed in A4 paper, without adjusting size to paper.

Value

No value is returned. A pdf file is saved in the working directory

Note

See the `vignette("HelicopterInstructions")` to see assembling instructions.

Author(s)

EL Cano

References

George Box. Teaching engineers experimental design with a paper helicopter. *Quality Engineering*, 4(3):453–459, 1992.

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Examples

```
ss.heli()
vignette("HelicopterInstructions")
```

---

ss.lf   *Evaluates the Loss Function for a process.*

Description

The quality loss function is one of the tools of the Six Sigma methodology. The function assigns a cost to an observed value, that is larger as far as it is from the target.

Usage

```
ss.lf(lfa.Y1, lfa.Delta, lfa.Y0, lfa.L0)
```

Arguments

lfa.Y1	The observed value of the CTQ (critical to quality) characteristic that will be evaluated.
lfa.Delta	The tolerance for the CTQ.
lfa.Y0	The target for the CTQ.
lfa.L0	The cost of poor quality when the characteristic is $Y_0 + \Delta$.

Value

ss.lf	A number with the evaluated function at Y_1

Author(s)

EL Cano

References

Taguchi G, Chowdhury S,Wu Y (2005) *Taguchi's quality engineering handbook*. John Wiley

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.lfa

Examples

```
#Example bolts: evaluate LF at 10.5 if Target=10, Tolerance=0.5, L_0=0.001
ss.lf(10.5, 0.5, 10, 0.001)
```

Description

This function performs a Quality Loss Function Analysis, based in the Taguchi Loss Function for "Nominal-the-Best" characteristics.

Usage

```
ss.lfa(lfa.data, lfa.ctq, lfa.Delta, lfa.Y0, lfa.L0, lfa.size = NA,
  lfa.output = "both", lfa.sub = "Six Sigma Project")
```

Arguments

lfa.data	Data frame with the sample to get the average loss.
lfa.ctq	Name of the field in the data frame containing the data.
lfa.Delta	Tolerance of the process.
lfa.Y0	Target of the process (see note).
lfa.L0	Cost of poor quality at tolerance limit.
lfa.size	Size of the production, batch, etc. to calculate the total loss in a group (span, batch, period, ...)
lfa.output	Type of output (see details).
lfa.sub	Subtitle for the graphic output.

Details

`lfa.output` can take the values "text", "plot" or "both".

Value

lfa.k	Constant k for the loss function
lfa,lf	Expression with the loss function
lfa.MSD	Mean Squared Differences from the target
lfa.avLoss	Average Loss per unit of the process
lfa.Loss	Total Loss of the process (if a size is provided)

Note

For smaller-the-better characteristics, the target should be zero (`lfa.Y0 = 0`). For larger-the-better characteristics, the target should be infinity (`lfa.Y0 = Inf`).

Author(s)

EL Cano

References

Taguchi G, Chowdhury S,Wu Y (2005) *Taguchi's quality engineering handbook.* John Wiley

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.lf, ss.data.bolts.

Examples

```
ss.lfa(ss.data.bolts, "diameter", 0.5, 10, 0.001,
lfa.sub = "10 mm. Bolts Project",
lfa.size = 100000, lfa.output = "both")
```

---

ss.pMap   *Process Map*

Description

This function takes information about the process we want to represent and draw the Process Map, with its X's, x's, Y's and y's in each step of the process

Usage

```
ss.pMap(steps, inputs.overall, outputs.overall, input.output, x.parameters,
  y.features, main = "Six Sigma Process Map", sub, ss.col = c("#666666",
  "#BBBBBB", "#CCCCCC", "#DDDDDD", "#EEEEEE"))
```

Arguments

steps	A vector of characters with the name of the 'n' steps
inputs.overall	A vector of characters with the name of the overall inputs
outputs.overall	A vector of characters with the name of the overall outputs
input.output	A vector of lists with the names of the inputs of the $i - th$ step, that will be the outputs of the $(i - 1) - th$ step
x.parameters	A vector of lists with a list of the x parameters of the process. The parameter is a vector with two values: the name and the type (view details)
y.features	A vector of lists with a list of the y features of the step. The feature is a vector with two values: the name and the type (view details)
main	The main title for the Process Map

sub	Subtitle for the diagram (recommended the Six Sigma project name)
ss.col	A vector of colours for a custom drawing. At least five colours, sorted by descendant intensity (see details)

Details

The type of the x parameters and y features can be: C(controllable), N(noise), Cr(Critical), P(Procedure). The default value for ss.col is c("#666666", "#BBBBBB", "#CCCCCC", "#DDDDDD", "#EEEEEE"), a grayscale style. You can pass any accepted color string.

Value

A graphic representation of the Map Process.

Note

The process map is the starting point for a Six Sigma Project, and it is very important to find out who the x's and y'x are.

Author(s)

EL Cano

References

http://en.wikipedia.org/wiki/Business_Process_Mapping

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

See Also

ss.ceDiag

Examples

```
inputs.overall<-c("operators", "tools", "raw material", "facilities")
outputs.overall<-c("helicopter")
steps<-c("INSPECTION", "ASSEMBLY", "TEST", "LABELING")
#Inputs of process "i" are inputs of process "i+1"
input.output<-vector(mode="list",length=length(steps))
input.output[1]<-list(c("sheets", "..."))
input.output[2]<-list(c("sheets"))
input.output[3]<-list(c("helicopter"))
input.output[4]<-list(c("helicopter"))

#Parameters of each process
```

```
x.parameters<-vector(mode="list",length=length(steps))
x.parameters[1]<-list(c(list(c("width", "NC")),list(c("operator", "C")),
list(c("Measure pattern", "P")), list(c("discard", "P"))))
x.parameters[2]<-list(c(list(c("operator", "C")),list(c("cut", "P")),
list(c("fix", "P")), list(c("rotor.width", "C")),list(c("rotor.length",
"C")), list(c("paperclip", "C")), list(c("tape", "C"))))
x.parameters[3]<-list(c(list(c("operator", "C")),list(c("throw", "P")),
list(c("discard", "P")), list(c("environment", "N"))))
x.parameters[4]<-list(c(list(c("operator", "C")),list(c("label", "P"))))
x.parameters

#Features of each process
y.features<-vector(mode="list",length=length(steps))
y.features[1]<-list(c(list(c("ok", "Cr"))))
y.features[2]<-list(c(list(c("weight", "Cr"))))
y.features[3]<-list(c(list(c("time", "Cr"))))
y.features[4]<-list(c(list(c("label", "Cr"))))
y.features

ss.pMap(steps, inputs.overall, outputs.overall,
        input.output, x.parameters, y.features,
        sub="Paper Helicopter Project")
```

---

ss.rr   *Gage R & R (Measurement System Assessment)*

Description

Performs Gage R&R analysis for the assessment of the measurement system of a process. Related to the Measure phase of the DMAIC strategy of Six Sigma.

Usage

```
ss.rr(var, part, appr, lsl = NA, usl = NA, sigma = 6, data,
  main = "Six Sigma Gage R&R Study", sub = "", alphaLim = 0.05,
  errorTerm = "interaction", digits = 4)
```

Arguments

var	Measured variable
part	Factor for parts
appr	Factor for appraisers (operators, machines, ...)
lsl	Numeric value of lower specification limit used with USL to calculate Study Variation as %Tolerance
usl	Numeric value of upper specification limit used with LSL to calculate Study Variation as %Tolerance
sigma	Numeric value for number of std deviations to use in calculating Study Variation

data	Data frame containing the variables
main	Main title for the graphic output
sub	Subtitle for the graphic output (recommended the name of the project)
alphaLim	Limit to take into account interaction
errorTerm	Which term of the model should be used as error term (for the model with interation)
digits	Number of decimal digits for output

Details

Performs an R&R study for the measured variable, taking into account part and appraiser factors. It outputs the sources of Variability, and six graphs: bar chart with the sources of Variability, plots by appraiser, part and interaction and x-bar and R control charts.

Value

Analysis of Variance Table/s. Variance composition and %Study Var. Graphics.

anovaTable	The ANOVA table of the model
anovaRed	The ANOVA table of the reduced model (without interaction, only if interaction not significant)
varComp	A matrix with the contribution of each component to the total variation
studyVar	A matrix with the contribution to the study variation
ncat	Number of distinct categories

Note

The F test for the main effects in the ANOVA table is usually made taken the operator/appraisal interaction as the error term (repeated measures model), thereby computing F as $MS_{factor}/MS_{interaction}$, e.g. in appendix A of AIAG MSA manual, in Montgomery (2009) and by statistical software such as Minitab. However, in the example provided in page 127 of the AIAG MSA Manual, the F test is performed as $MS_{factor}/MS_{equipment}$, i.e., repeatability. Thus, since version 0.9-3 of the SixSigma package, a new argument errorTerm controls which term should be used as error Term, one of "interaction", "repeatability".

Argument alphaLim is used as upper limit to use the full model, i.e., with interaction. Above this value for the interaction effect, the ANOVA table without the interaction effect is also obtained, and the variance components are computed pooling the interaction term with the repeatibility.

Author(s)

EL Cano with contributions by Kevin C Limburg

References

Automotive Industry Action Group. (2010). Measurement Systems Analysis (Fourth Edition). AIAG.

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Montgomery, D. C. (2009). Introduction to Statistical Quality Control (Sixth Edition ed.). New York: Wiley & Sons, Inc.

See Also

ss.data.rr

Examples

```
ss.rr(time1, prototype, operator, data = ss.data.rr,
sub = "Six Sigma Paper Helicopter Project",
alphaLim = 0.05,
errorTerm = "interaction",
lsl = 0.7,
usl = 1.8)
```

---

ss.study.ca	*Graphs and figures for a Capability Study*

Description

Plots a Histogram with density lines about the data of a process. Check normality with qqplot and normality tests. Shows the Specification Limits and the Capability Indices.

Usage

```
ss.study.ca(xST, xLT = NA, LSL = NA, USL = NA, Target = NA,
  alpha = 0.05, f.na.rm = TRUE, f.main = "Six Sigma Capability Analysis Study",
  f.sub = "")
```

Arguments

xST	Short Term process performance data
xLT	Long Term process performance data
LSL	Lower Specification Limit of the process
USL	Upper Specification Limit of the process
Target	Target of the process
alpha	Type I error for the Confidence Interval

`f.na.rm`	If TRUE NA data will be removed
`f.main`	Main Title for the graphic output
`f.sub`	Subtitle for the graphic output

Value

Figures and plot for Capability Analysis

Author(s)

EL Cano

References

Cano, Emilio L., Moguerza, Javier M. and Redchuk, Andres. 2012. *Six Sigma with R. Statistical Engineering for Process Improvement*, Use R!, vol. 36. Springer, New York. http://www.springer.com/statistics/book/978-1-4614-3651-5.

Montgomery, DC (2008) *Introduction to Statistical Quality Control* (Sixth Edition). New York: Wiley&Sons

See Also

ss.ca.cp

Examples

```
ss.study.ca(ss.data.ca$Volume, rnorm(40, 753, 3),
LSL = 740, USL = 760, T = 750, alpha = 0.05,
  f.sub = "Winery Project")
```

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