Package 'rbcc'

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Type Package

Title Risk-Based Control Charts

Version 0.2.0

Description Implements univariate and multivariate risk-based control charts for statistical process control in the presence of measurement uncertainty. Available charts include Shewhart X-bar, R, and S charts, moving-average charts, exponentially weighted moving-average charts, cumulative-sum charts, and Hotelling T-squared charts. Chart parameters can be optimized by minimizing the total cost of the four decision outcomes. The methodology is described by Kosztyan and Katona (2016) <doi:10.1016/j.eswa.2016.06.019>, Kosztyan and Katona (2018) <doi:10.1016/j.cie.2018.04.052>, Katona et al. (2023) <doi:10.1109/ACCESS.2023.3312226>, Saghir et al. (2025) <doi:10.1016/j.rineng.2025.107278>, and Saghir et al. (2026) <doi:10.1016/j.rico.2026.100661>.

License GPL (>= 2)

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Imports ggplot2 (>= 3.4.0), parallel, PearsonDS, qcc, stats, utils

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URL https://github.com/kzst/rbcc

BugReports https://github.com/kzst/rbcc/issues

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Contents

rbcc-package . . . 2
data_gen . . . 3
plot-rbcc . . . 4
print-rbcc . . . 4
rbcc . . . 5
rbcc_control . . . 6
rbcc_opt . . . 6
rbcusumcc . . . 8
rbcusumcc_opt . . . 8
rbewmacc . . . 9
rbewmacc_opt . . . 10
rbmacc . . . 11
rbmacc_opt . . . 12
rbmcc . . . 13
rbmcc_opt . . . 14
summary-rbcc . . . 15
t2uc . . . 15

Index **17**

`rbcc-package` *Risk-Based Control Charts*

Description

Tools for risk-based statistical process control in the presence of measurement uncertainty. The package evaluates four decision outcomes and optimizes chart parameters by minimizing total decision cost.

Details

Available charts include X-bar, R, S, moving-average, EWMA, CUSUM, and multivariate T-squared charts. See `citation("rbcc")` for references.

Author(s)

Aamir Saghir, Attila Imre Katona, and Zsolt Tibor Kosztyan.

data_gen *Generate Data from the Pearson Distribution System*

Description

Generate Data from the Pearson Distribution System

Usage

```
data_gen(
  obs,
  mu,
  va,
  sk,
  ku,
  seed = NULL,
  engine = c("auto", "pearson"),
  validate = TRUE
)
```

Arguments

obs	Positive number of observations per variable.
mu	Numeric vector of means.
va	Numeric vector of variances.
sk	Numeric vector of skewness coefficients.
ku	Numeric vector of kurtosis coefficients.
seed	Optional integer seed. The caller's random-number state is restored after generation.
engine	Either "auto" or "pearson".
validate	Logical; validate inputs.

Value

A numeric matrix with one column per variable.

plot-rbcc *Plot Risk-Based Control Charts*

Description

Plot Risk-Based Control Charts

Usage

```
## S3 method for class 'rbcc'
plot(x, title = NULL, xlab = "Group", ylab = "Chart statistic", ...)

## S3 method for class 'rbcusumcc'
plot(x, title = NULL, xlab = "Group", ylab = "Cumulative sum", ...)

## S3 method for class 'rbmcc'
plot(x, title = NULL, xlab = "Group", ylab = "T-squared statistic", ...)
```

Arguments

x	A fitted risk-based chart object.
title	Optional title.
xlab, ylab	Axis labels.
...	Reserved for future use.

Value

A visible ggplot object.

print-rbcc *Print Risk-Based Control-Chart Objects*

Description

Print Risk-Based Control-Chart Objects

Usage

```
## S3 method for class 'rbcc'
print(x, digits = getOption("digits"), ...)

## S3 method for class 'rbcusumcc'
print(x, digits = getOption("digits"), ...)

## S3 method for class 'rbmcc'
```

```
print(x, digits = getOption("digits"), ...)

## S3 method for class 'summary.rbcc'
print(x, digits = getOption("digits"), ...)

## S3 method for class 'summary.rbcusumcc'
print(x, digits = getOption("digits"), ...)

## S3 method for class 'summary.rbmcc'
print(x, digits = getOption("digits"), ...)
```

Arguments

x	A fitted or summarized chart object.
digits	Number of significant digits.
...	Additional print arguments.

Value

The input object, invisibly.

---

rbcc *Risk-Based Shewhart Control Chart*

Description

Risk-Based Shewhart Control Chart

Usage

```
rbcc(
  X,
  UC,
  C,
  n,
  type = c("xbar", "R", "S"),
  confidence_level = 0.9973,
  K = 3,
  validate = TRUE
)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.

n	Subgroup size. Defaults to one when omitted.
type	Chart type: "xbar", "R", or "S".
confidence_level	Traditional-chart confidence level.
K	Nonnegative risk-based limit coefficient.
validate	Logical; validate inputs.

Value

An object of class rbcc.

---

rbcc_control *Construct Optimization Controls*

Description

Construct Optimization Controls

Usage

```
rbcc_control(grid_size = 201L, tol = .Machine$double.eps^0.25)
```

Arguments

grid_size	Number of points used by the grid optimizer.
tol	Positive numerical tolerance.

Value

A list suitable for the control argument.

---

rbcc_opt *Optimize a Risk-Based Shewhart Control Chart*

Description

Optimize a Risk-Based Shewhart Control Chart

Usage

```
rbcc_opt(
  X,
  UC,
  C,
  n,
  type = c("xbar", "R", "S"),
  confidence_level = 0.9973,
  K_init = 0,
  LKL = 0,
  UKL = 5,
  optimizer = c("exact", "optimize", "grid"),
  parallel = FALSE,
  workers = NULL,
  control = list(),
  validate = TRUE
)
```

Arguments

`X`	Numeric process observations.
`UC`	Numeric additive measurement errors.
`C`	Four decision costs ordered as `c11`, `c10`, `c01`, `c00`.
`n`	Subgroup size. Defaults to one when omitted.
`type`	Chart type: `"xbar"`, `"R"`, or `"S"`.
`confidence_level`	Traditional-chart confidence level.
`K_init`	Initial or tie-breaking coefficient.
`LKL`, `UKL`	Lower and upper search bounds.
`optimizer`	One of `"exact"`, `"optimize"`, or `"grid"`.
`parallel`	Logical; parallelize the grid optimizer.
`workers`	Optional worker count.
`control`	A list created by `rbcc_control()`.
`validate`	Logical; validate inputs.

Value

An optimized `rbcc` object.

rbcusumcc *Risk-Based CUSUM Control Chart*

Description

Risk-Based CUSUM Control Chart

Usage

```
rbcusumcc(X, UC, C, n = 1, T = 5, se.shift = 1, K = 5, validate = TRUE)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size. Defaults to one when omitted.
T	Positive traditional decision-interval coefficient.
se.shift	Positive standardized reference shift.
K	Nonnegative risk-based limit coefficient.
validate	Logical; validate inputs.

rbcusumcc_opt *Optimize a Risk-Based CUSUM Control Chart*

Description

Optimize a Risk-Based CUSUM Control Chart

Usage

```
rbcusumcc_opt(
  X,
  UC,
  C,
  n = 1,
  T = 5,
  se.shift = 1,
  K_init = 0,
  LKL = 0,
  UKL = 6,
  optimizer = c("exact", "optimize", "grid"),
  parallel = FALSE,
```

```
  workers = NULL,
  control = list(),
  validate = TRUE
)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size. Defaults to one when omitted.
T	Positive traditional decision-interval coefficient.
se.shift	Positive standardized reference shift.
K_init	Initial or tie-breaking coefficient.
LKL, UKL	Lower and upper search bounds.
optimizer	One of "exact", "optimize", or "grid".
parallel	Logical; parallelize the grid optimizer.
workers	Optional worker count.
control	A list created by rbcc_control().
validate	Logical; validate inputs.

---

rbewmacc *Risk-Based EWMA Control Chart*

Description

Risk-Based EWMA Control Chart

Usage

```
rbewmacc(
  X,
  UC,
  C,
  n = 1,
  lambada = 0.2,
  nsigmas = 3,
  K = 3,
  lambda = NULL,
  validate = TRUE
)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size. Defaults to one when omitted.
lambada	EWMA smoothing parameter; retained for compatibility.
nsigmas	Traditional EWMA limit coefficient.
K	Nonnegative risk-based limit coefficient.
lambda	Correctly spelled alias for lambada.
validate	Logical; validate inputs.

---

rbewmacc_opt *Optimize a Risk-Based EWMA Control Chart*

Description

Optimize a Risk-Based EWMA Control Chart

Usage

```
rbewmacc_opt(
  X,
  UC,
  C,
  n = 1,
  lambada = 0.2,
  nsigmas = 3,
  K_init = 0,
  LKL = 0,
  UKL = 5,
  lambda = NULL,
  optimizer = c("exact", "optimize", "grid"),
  parallel = FALSE,
  workers = NULL,
  control = list(),
  validate = TRUE
)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.

n	Subgroup size. Defaults to one when omitted.
lambada	EWMA smoothing parameter; retained for compatibility.
nsigmas	Traditional EWMA limit coefficient.
K_init	Initial or tie-breaking coefficient.
LKL, UKL	Lower and upper search bounds.
lambda	Correctly spelled alias for lambada.
optimizer	One of "exact", "optimize", or "grid".
parallel	Logical; parallelize the grid optimizer.
workers	Optional worker count.
control	A list created by rbcc_control().
validate	Logical; validate inputs.

---

rbmacc *Risk-Based Moving-Average Control Chart*

Description

Risk-Based Moving-Average Control Chart

Usage

```
rbmacc(X, UC, C, n = 1, w = 2, K = 3, validate = TRUE)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size. Defaults to one when omitted.
w	Positive moving-average span.
K	Nonnegative risk-based limit coefficient.
validate	Logical; validate inputs.

rbmacc_opt *Optimize a Risk-Based Moving-Average Control Chart*

Description

Optimize a Risk-Based Moving-Average Control Chart

Usage

```
rbmacc_opt(
  X,
  UC,
  C,
  n = 1,
  w = 2,
  K_init = 0,
  LKL = 0,
  UKL = 5,
  optimizer = c("exact", "optimize", "grid"),
  parallel = FALSE,
  workers = NULL,
  control = list(),
  validate = TRUE
)
```

Arguments

X	Numeric process observations.
UC	Numeric additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size. Defaults to one when omitted.
w	Positive moving-average span.
K_init	Initial or tie-breaking coefficient.
LKL, UKL	Lower and upper search bounds.
optimizer	One of "exact", "optimize", or "grid".
parallel	Logical; parallelize the grid optimizer.
workers	Optional worker count.
control	A list created by rbcc_control().
validate	Logical; validate inputs.

`rbmcc` *Risk-Based Multivariate T-Squared Control Chart*

Description

Constructs a risk-based Hotelling T-squared control chart in the presence of additive measurement uncertainty.

Usage

```
rbmcc(
  X,
  UC,
  C,
  n = 1,
  confidence_level = 0.99,
  K = 0,
  validate = TRUE
)
```

Arguments

`X`	Numeric matrix of true process characteristics.
`UC`	Numeric matrix of additive measurement errors.
`C`	Four decision costs ordered as `c11`, `c10`, `c01`, `c00`.
`n`	Subgroup size.
`confidence_level`	Traditional-chart confidence level.
`K`	Correction subtracted from the traditional upper control limit.
`validate`	Logical; validate inputs.

Value

An object of class `rbmcc`.

References

Kosztyan, Z. T. and Katona, A. I. (2016). Risk-Based Multivariate Control Chart. *Expert Systems with Applications*, 62, 250–262. doi: 10.1016/j.eswa.2016.06.019

Examples

```
data("t2uc")
X <- as.matrix(t2uc[, 1:2])
UC <- as.matrix(t2uc[, 5:6])
C <- c(1, 20, 160, 5)
fit <- rbmcc(X, UC, C)
fit$cost0
```

rbmcc_opt *Optimize a Risk-Based Multivariate T-Squared Control Chart*

Description

Optimize a Risk-Based Multivariate T-Squared Control Chart

Usage

```
rbmcc_opt(
  X,
  UC,
  C,
  n = 1,
  confidence_level = 0.99,
  K_init = 0,
  LKL = -5,
  UKL = 5,
  optimizer = c("exact", "optimize", "grid"),
  parallel = FALSE,
  workers = NULL,
  control = list(),
  validate = TRUE
)
```

Arguments

X	Numeric matrix of true process characteristics.
UC	Numeric matrix of additive measurement errors.
C	Four decision costs ordered as c11, c10, c01, c00.
n	Subgroup size.
confidence_level	Traditional-chart confidence level.
K_init	Initial or tie-breaking correction.
LKL, UKL	Lower and upper correction bounds.
optimizer	One of "exact", "optimize", or "grid".
parallel	Logical; parallelize the grid optimizer.
workers	Optional worker count.
control	A list created by rbcc_control().
validate	Logical; validate inputs.

Value

An optimized rbmcc object.

summary-rbcc *Summarize Risk-Based Control-Chart Objects*

Description

Summarize Risk-Based Control-Chart Objects

Usage

```
## S3 method for class 'rbcc'
summary(object, ...)

## S3 method for class 'rbcusumcc'
summary(object, ...)

## S3 method for class 'rbmcc'
summary(object, ...)
```

Arguments

object	A fitted risk-based chart object.
...	Reserved for future use.

Value

A structured summary object retaining all original components.

t2uc *Brake-Cylinder Measurement Data*

Description

Measurements of two brake-cylinder characteristics obtained with a high-precision optical system and production measurement devices. Measurement errors are the differences between production and optical measurements.

Usage

```
data("t2uc")
```

Format

A data frame with 50 observations and six numeric variables:

length_optical Optical cutting-length measurement in millimeters.

diameter_optical Optical main-diameter measurement in millimeters.

length_manual Manual cutting-length measurement in millimeters.

diameter_manual Manual main-diameter measurement in millimeters.

length_error Manual minus optical cutting-length measurement.

diameter_error Manual minus optical main-diameter measurement.

Source

Automotive-industry measurement study.

References

Katona, A. I. (2021). Validation of Risk-Based Quality Control Techniques: A Case Study from the Automotive Industry. *Journal of Applied Statistics*.

Examples

```
data("t2uc")
X <- as.matrix(t2uc[, 1:2])
UC <- as.matrix(t2uc[, 5:6])
fit <- rbmcc_opt(X, UC, c(1, 20, 160, 5))
fit$cost0
```

Index

∗ **datasets**
t2uc, 15
∗ **multivariate**
rbmcc, 13
∗ **package**
rbcc-package, 2
∗ **quality**
rbmcc, 13

data_gen, 3

plot-rbcc, 4
plot.rbcc *(*plot-rbcc*)*, 4
plot.rbcusumcc *(*plot-rbcc*)*, 4
plot.rbmcc *(*plot-rbcc*)*, 4
print-rbcc, 4
print.rbcc *(*print-rbcc*)*, 4
print.rbcusumcc *(*print-rbcc*)*, 4
print.rbmcc *(*print-rbcc*)*, 4
print.summary.rbcc *(*print-rbcc*)*, 4
print.summary.rbcusumcc *(*print-rbcc*)*, 4
print.summary.rbmcc *(*print-rbcc*)*, 4

rbcc, 5
rbcc-package, 2
rbcc_control, 6
rbcc_opt, 6
rbcusumcc, 8
rbcusumcc_opt, 8
rbewmacc, 9
rbewmacc_opt, 10
rbmacc, 11
rbmacc_opt, 12
rbmcc, 13
rbmcc_opt, 14

summary-rbcc, 15
summary.rbcc *(*summary-rbcc*)*, 15
summary.rbcusumcc *(*summary-rbcc*)*, 15
summary.rbmcc *(*summary-rbcc*)*, 15
t2uc, 15