Package ‘PH1XBAR’

September 23, 2021

Type Package

Title Phase I Shewhart X-Bar Chart

Version 0.10.1

Maintainer Yuhui Yao <yyao17@cba.ua.edu>

Description The purpose of 'PH1XBAR' is to build a Phase I Shewhart control chart for the basic Shewhart, the variance components and the ARMA models in R for subgrouped and individual data. More details can be found: Yao and Chakraborti (2020) <doi:10.1002/qre.2793>, and Yao and Chakraborti (2021) <doi:10.1080/089

License GPL-3

Encoding UTF-8

LazyData true

Depends R (>= 3.5.0)

Imports forecast, mvtnorm, pracma

URL https://github.com/bolus123/PH1XBAR

NeedsCompilation no

Author Yuhui Yao [aut, cre],
Subha Chakraborti [ctb],
Tyler Thomas [ctb],
Jason Parton [ctb],
Xin Yang [ctb]

Repository CRAN

Date/Publication 2021-09-23 16:00:18 UTC

R topics documented:

PH1XBAR-package *Phase I Shewhart X-bar Control Chart*

Description

The utility of this package is in building a Shewhart-type control chart based on new methods for subgrouped and individual data. The Phase I chart is based on the multivariate normal/t or ARMA process.

Details

Package:	PH1XBAR
Type:	Package
Date:	2021-09-22
License:	GPL (>= 3)

Function 'PH1XBAR' builds a Phase I Shewhart X-bar/individual control chart with a correct charting constant. Function 'getCC.XBAR' gets a charting constant for the data with a balanced one-way random effects model. Function 'PH1ARMA' builds a Phase I individual control chart with an ARMA model using a correct charting constant. Function 'getCC.ARMA' gets a charting constant for the data with an ARMA model.

Author(s)

Yuhui Yao, Subha Chakraborti, Tyler Thomas, Xin Yang, Jason Parton.

Maintainer: Yuhui Yao <yyao17@crimson.ua.edu>

References

Champ, C.W., and Jones, L.A. (2004) Designing Phase I X-bar charts with small sample sizes. Quality and Reliability Engineering International. 20(5), 497-510 Yao, Y., Hilton, C.W., and Chakraborti, S. (2017) Designing Phase I Shewhart X-bar charts: Extended tables and software. Quality and Reliability Engineering International. 33(8), 2667-2672. Yao, Y., and Chakraborti, S. (2021). Phase I monitoring of individual normal data: Design and implementation. Quality Engineering, 33(3), 443-456. Yao, Y., and Chakraborti, S. (2021). Phase I process monitoring: The case of the balanced one-way random effects model. Quality and Reliability Engineering International, 37(3), 1244-1265.

Examples

```
# Build a Phase I basic Shewhart control chart
data(grinder_data)
PH1XBAR(grinder_data, nsim=10)

# Build a Phase I individual control chart with an ARMA model
data(preston_data)
PH1ARMA(preston_data, nsimProcess=10, nsimCoefs=10)
```

`bore_diameter_data` *Bore Diameter in Manufacturing Automotive Driver Gears (mm)*

Description

Source: Woodall, William H. "Controversies and contradictions in statistical process control." Journal of quality technology 32.4 (2000): 341-350.

A dataset containing the diameter of the bore in manufacturing automotive driver gears. The variables are as follows:

Format

A data frame with 20 rows and 5 variables:

X1 Diameter measurement at Position 1

X2 Diameter measurement at Position 2

X3 Diameter measurement at Position 3

X4 Diameter measurement at Position 4

X5 Diameter measurement at Position 5

Examples

```
data(bore_diameter_data)
```

`getCC.ARMA` *get Phase I corrected charting constant with an ARMA model*

Description

Obtain a corrected charting constant.

Usage

```
getCC.ARMA(
FAP0 = 0.1
   ,interval = c(1, 4)
   ,n = 50
   ,order = c(1, 0, 0)
   ,phiVec = 0.5
   ,thetaVec = NULL
   ,case = 'U'
   ,method = 'Method 3'
   ,nsimCoefs = 100
   ,nsimProcess = 1000
   ,burnIn = 50
   ,simType = 'Matrix'
   ,logliktol = 1e-2
,verbose = FALSE
)
```

Arguments

FAP0	nominal false Alarm Probabilty in Phase 1
interval	searching range of charting constants for the exact method
n	number of observations
order	order for ARMA model
phiVec	given vectors of autoregressive parameters for ARMA models
thetaVec	given vectors of moving-average parameters for ARMA models
case	known or unknown case. When case = 'U', the parameters are estimated
method	estimation method for the control chart. When method = 'Method 3' is maximum likehood estimations plus method of moments. Other options are 'Method 1' which is pure MLE and 'Method 2' which is pure CSS.
nsimCoefs	number of simulation for coeficients. It is functional when double.sim = TRUE.
nsimProcess	number of simulation for ARMA processes
burnIn	number of burn-ins. When burnIn = 0, the ECM gets involved. When burnIn is large enough, the ACM gets involved.
simType	type of simulation. When simType = 'Matrix', the simulation is generated using matrix computation. When simType = 'Recursive', the simulation is based on a recursion.
logliktol	convergence tolerance for the log likelihood
verbose	print diagnostic information about FAP0 and the charting constant during the simulations for the exact method

Value

Object type double. The corrected charting constant.

Examples

```
set.seed(12345)

# Calculate the charting constant using FAP0 of 0.05, and 50 observations
getCC.ARMA(FAP0=0.05, n=50, nsimCoefs=10, nsimProcess=10)
```

---

getCC.XBAR   *get Phase I corrected charting constant*

Description

Obtain a corrected charting constant.

Usage

```
getCC.XBAR(
FAP0
,m
,var.est = c('S', 'MR')
,ubCons = 1
,method = c('exact', 'BA')
,interval = c(1, 5)
,nsim = 10000
,nu = m - 1
,lambda = 1
   ,verbose = FALSE
)

getCC(
FAP0
,m
,var.est = c('S', 'MR')
,ubCons = 1
,method = c('exact', 'BA')
,interval = c(1, 5)
,nsim = 10000
,nu = m - 1
,lambda = 1
   ,verbose = FALSE
)
```

Arguments

FAP0	nominal false Alarm Probabilty in Phase 1
m	number of subgroups

var.est	'S' - use mean-square-based estimator, 'MR' - use moving-range-based estimator
ubCons	unbiasing constant
method	'exact' - calculate results using the exact method, 'BA' - calculate results using the Bonfferoni approximation
interval	searching range of charting constants for the exact method
nsim	number of simulation for the exact method
nu	degrees of freedom for the Bonfferoni approximation
lambda	constant for the Bonfferoni approximation
verbose	print diagnostic information about FAP0 and the charting constant during the simulations for the exact method

Value

Object type double. The corrected charting constant.

Examples

```
set.seed(12345)

# Calculate the charting constant using 10 simulations and mean-square-based estimator
getCC.XBAR(FAP0=0.05, m=20, nsim=10, var.est='S', verbose = TRUE)

# Calculate the charting constant using 10 simulations and moving-range-based estimator
getCC.XBAR(FAP0=0.05, m=20, nsim=10, var.est='MR', verbose = TRUE)
```

---

grinder_data *Thickness measurement of silicon waffer*

Description

A dataset containing the thickness in micrometer at different positions in a grinder. The variables are as follows:

Format

A data frame with 30 rows and 5 variables:

pos1 Thickness measurement at Position 1

pos2 Thickness measurement at Position 2

pos3 Thickness measurement at Position 3

pos4 Thickness measurement at Position 4

pos5 Thickness measurement at Position 5

Examples

```
data(grinder_data)
```

PH1ARMA — *Build Phase I individual control chart with an ARMA model using a corrected charting constant*

Description

Build a Phase I individual control chart for the ARMA models. The charting constant is correted by this approach.

Usage

```
PH1ARMA(
X
,cc = NULL
,FAP0 = 0.1
,order = NULL
,plot.option = TRUE
,interval = c(1, 4)
,case = 'U'
   ,method = 'Method 3'
,nsimCoefs = 100
,nsimProcess = 1000
,burnIn = 50
,simType = 'Matrix'
   ,logliktol = 1e-2
,verbose = FALSE
)
```

Arguments

X	input and it must be a vector
cc	nominal Phase I charting constant. If this is given, the function will not re-compute the charting constant.
FAP0	nominal false Alarm Probabilty in Phase I
order	order for ARMA model
plot.option	TRUE - draw a plot for the process; FALSE - Not draw a plot for the process
interval	searching range of charting constants for the exact method
case	known or unknown case. When case = 'U', the parameters are estimated
method	estimation method for the control chart. When method = 'Method 3' is maximum likehood estimations plus method of moments. Other options are 'Method 1' which is pure MLE and 'Method 2' which is pure CSS.

nsimCoefs number of simulation for coeficients. It is functional when double.sim = TRUE.

nsimProcess number of simulation for ARMA processes

burnIn number of burn-ins. When burnIn = 0, the ECM gets involved. When burnIn is large enough, the ACM gets involved.

simType type of simulation. When simType = 'Matrix', the simulation is generated using matrix computation. When simType = 'Recursive', the simulation is based on a recursion.

logliktol convergence tolerance for the log likelihood

verbose print diagnostic information about FAP0 and the charting constant during the simulations for the exact method

Value

Object of type list. A named list with the following objects:

CL Object type double - central line

gamma Object type double - process variance estimate

cc Object type double - charting constant

order Object type integer - order for ARMA model

phiVec Object type integer - values of autoregressors

thetaVec Object type integer - values of moving averages

LCL Object type double - lower charting limit

UCL Object type double - upper charting limit

CS Object type double - charting statistic

Examples

```
# load the data in the package as an example
data(preston_data)

# set number of simulations
nsimProcess <- 10
nsimCoefs <- 10

# An example using the default setting whose FAP0 = 0.1
PH1ARMA(preston_data, nsimProcess = nsimProcess, nsimCoefs = nsimCoefs)

# When users get an error message about the size of matrix,
# the function needs to use the alternative simulation type as follows
PH1ARMA(preston_data, FAP0 = 0.05,
nsimProcess = nsimProcess, nsimCoefs = nsimCoefs, simType = 'Recursive')
```

PH1XBAR *Build Phase I X-bar control chart with a corrected charting constant*

Description

Build a Phase I Shewhart control chart for the variance components model if the data are subgrouped or for the basic Shewhart model if the data are individual. The charting constant is correted by this approach.

Usage

```
PH1XBAR(
X
,cc = NULL
,FAP0 = 0.1
,var.est = c('S', 'MR')
,ub.option = TRUE
,method = c('exact', 'BA')
,plot.option = TRUE
,interval = c(1, 5)
,nsim = 10000
   ,verbose = FALSE
)
```

Arguments

`X`	input and it must be a matrix
`cc`	nominal Phase I charting constant. If this is given, the function will not recompute the charting constant.
`FAP0`	nominal false Alarm Probabilty in Phase 1
`var.est`	'S' - use mean-square-based estimator, 'MR' - use moving-range-based estimator
`ub.option`	TRUE - the standard deviation estimator corrected by a unbiasing constant. For MS, it is c4 and for MR, it is d2. FALSE - no unbiasing constant
`method`	'exact' - calculate results using the exact method, 'BA' - calculate results using the Bonfferoni approximation
`plot.option`	TRUE - draw a plot for the process; FALSE - Not draw a plot for the process
`interval`	searching range of charting constants for the exact method
`nsim`	number of simulation for the exact method
`verbose`	print diagnostic information about FAP0 and the charting constant during the simulations for the exact method

Value

Object of type list. A named list with the following objects:

CL	Object type double - central line
var.est	Object type double - variance estimate
ubCons	Object type double - unbiasing constant
cc	Object type double - charting constant
m	Object type integer - number of observations
nu	Object type integer - degrees of freedom
lambda	Object type integer - chi-squared unbiasing constant
LCL	Object type double - lower charting limit
UCL	Object type double - upper charting limit
CS	Object type double - charting statistic

Examples

```
set.seed(12345)

# load the data in the package as an example
data(grinder_data)

# An example using a false alarm probability of 0.05, and 10 simulations
PH1XBAR(grinder_data, FAP0 = 0.05, nsim=10, verbose=TRUE)
```

---

preston_data *Prescription fentanyl consumption in Preston county, WV*

Description

A dataset containing prescription fentanyl consumption in Preston county, WV, measured using MME percapita. This is a subset from Rich et al. <doi: 10.21105/joss.02450>

Examples

```
data(preston_data)
```

Index