Package 'QCCTS'

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Type Package

Title Quality Control Charts for Time Series

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Description Applying Shewhart quality control principles for time series data. The package performers following tasks including: subgrouping for various time intervals; obtaining subgroup summaries (e.g. mean, standard deviation, skewness, kurtosis); partitioning data into common and special cause using Shewhat S chart; estimate mean and standard deviation using stepwise Shewhart robust chart procedures; other robust estimators for standard deviation}; calculating the first four moments in total, common and special cause partitions; Difference charts (mean and standard deviation) and plotting charts.

Imports zoo,xts,IQCC,moments

License GPL-3

LazyData TRUE

RoxygenNote 6.0.1

Suggests knitr, rmarkdown

VignetteBuilder knitr

R topics documented:

AAPL *Price series of Apple Inc. stock*

Description

The price series of Apple stock is obtained from Yahoo finance. This data set is used to demonstrate several functions in the package such as subgrouping, obtaining a summary of the subgroups, common and special cause partitioning and calculating the σ in total, common and special cause data .

Usage

```
data(AAPL)
```

Format

An object of class zoo with 3395 rows and 6 columns:

open Opening price

High Daily high price

Low Daily low price

Close Closing price

AdjClose Adjusted closing price for dividends and splits

Volume Trading volume

Source

YAHOO Finace

Examples

```
data(AAPL)
head(AAPL)
ClosePrice=AAPL[,"Close"]
```

MeltIndex *Melt index of a polyethylene compound*

Description

Data set was used to demonstrate the stepwise approach for setting up a robust Shewhart location and dispersion control charts.

Usage

```
data(MeltIndex)
```

Format

An object of class xts (inherits from zoo) with 80 rows and 1 columns.

Source

Wadsworth, Harrison M., Kenneth S. Stephens, and A. Blanton Godfrey. "Modern methods for quality control and improvement". John Wiley & Sons, 2002.

References

Nazir, Hafiz Z., Marit Schoonhoven, Muhammad Riaz, and Ronald JMM Does. "Quality Quandaries: A Stepwise Approach for Setting Up a Robust Shewhart Location Control Chart." Quality Engineering 26, no. 2 (2014): 246-252.

Nazir, Hafiz Z., Marit Schoonhoven, Muhammad Riaz, and Ronald JMM Does. "Quality Quandaries: How to Set Up a Robust Shewhart Control Chart for Dispersion?." Quality Engineering 26, no. 1 (2014): 130-136.

Examples

```
data(MeltIndex)
```

`MomentsInPartitions` *The first four moments (mean, standard deviation, skewness, kurtosis) in total, common and special cause periods.*

Description

This function gives the first four moments in total, common and special cause periods. Partitioning of common and special cause periods is based on the Shewhart S chart.

Usage

```
MomentsInPartitions(PartitonedData, Subgroups)
```

Arguments

`PartitonedData`	common and special cause partitions
`Subgroups`	a list of subgroups used for partitioning

Value

Mean, standard deviation, skewness and kurtosis in total, common and special caused periods

Author(s)

Nadeeka Premarathna

References

Nadeeka Premarathna, A. Jonathan R. Godfrey and K. Govindaraju. "Decomposition of stock market trade-offs using Shewhart methodology." International Journal of Quality & Reliability Management 33, no. 9 (2016): 1311-1331.

Examples

```
# subgroup size
SubgroupCriteria="weeks"
# data loading
data(AAPL)
#subgrouping
require(zoo)
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2014-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
# obtain subgroup summary
DataSum=SubgroupSummary(Subgroups,MaxSgpSize=5)
# partitioning data into common and special cause periods
PartitonedData=PartitioningSgps(DataSum,ChartType="S")
# calculate the first four moments
MomentsInPartitions(PartitonedData$SgpSummary,Subgroups)
```

`MuStepwiseRobustPhaseI` *Unbiased robust estimator for μ based on a stepwise robust chart procedure*

Description

Estimation procedure combines the use of individual observations and subgroup screening. An initial estimate for μ is based on the trimmed means of the tri means and screen the subgroups. Then, the resulting estimator for μ from the remaining subgroups is sued to screen the individual outliers in the remaining subgroups.

Usage

```
MuStepwiseRobustPhaseI(Subgroups, sigma)
```

Arguments

`Subgroups`	subgroups of the data series, function handles the unequal subgroup sizes.
`sigma`	estimate for σ

Value

estimates of μ from Phase I data

Author(s)

Nadeeka Premarathna

References

Nazir, Hafiz Z., Marit Schoonhoven, Muhammad Riaz, and Ronald JMM Does. "Quality Quandaries: A Stepwise Approach for Setting Up a Robust Shewhart Location Control Chart." Quality Engineering 26, no. 2 (2014): 246-252.

Examples

```
data(MeltIndex)
require(xts)
Subgroups=split(MeltIndex, f="weeks")
Subgroups[20]=NULL
sigma=SigmaStepwiseRobustPhaseI(Subgroups)
Subgroups=split(MeltIndex, f="weeks")
Subgroups[20]=NULL
MuStepwiseRobustPhaseI(Subgroups,sigma)
```

`PartitioningSgps` *Subgroup partition into common and special causes based on the Shewhart S chart rules*

Description

' Function separates subgroups into common and special cause periods.

Usage

```
PartitioningSgps(Data, ChartType = c("Xbar", "R", "S"))
```

Arguments

`Data`	subgroup summary (object type "SgpSummary")
`ChartType`	Chart type for partitioning rule: if "Xbar"- Shewhart X-bar chart (mean), "R"- Shewhart control chart for range, "S"- Shewhart S chart

Value

Subgroups in common and special caused periods

Author(s)

Nadeeka Premarathna

References

Nadeeka Premarathna, A. Jonathan R. Godfrey and K. Govindaraju. "Decomposition of stock market trade-offs using Shewhart methodology." International Journal of Quality & Reliability Management 33, no. 9 (2016): 1311-1331.

See Also

`Subgrouping`, `SubgroupSummary`

Examples

```
SubgroupCriteria="weeks"
data(AAPL)
require(zoo)
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2013-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
DataSum=SubgroupSummary(Subgroups,MaxSgpSize=5)
B=PartitioningSgps(DataSum,ChartType="S")
```

ShewhartSgpCharts *Plotting the Shewhart charts for Phase I and Phase II data*

Description

The function plots the Shewhart charts for subgroups, in Phase I and Phase II.

Usage

```
ShewhartSgpCharts(Data, PhaseIIData, ChartType, plot = TRUE)
```

Arguments

Data	Phase I partitioned subgroup summary (object type "Partition.SgpSummary")
PhaseIIData	Phase II subgroup summary (object type "SgpSummary")
ChartType	Chart type "Xbar"- Shewhart X-bar chart, "R"- Shewhart control chart for range, "S"- Shewhart S chart
plot	logical. If TRUE the corresponding Shewhart chart is plotted.

Value

plot Shewhart charts

Author(s)

Nadeeka Premarathna

References

Nadeeka Premarathna, A. Jonathan R. Godfrey and K. Govindaraju. "Decomposition of stock market trade-offs using Shewhart methodology." International Journal of Quality & Reliability Management 33, no. 9 (2016): 1311-1331.

Examples

```
require(zoo)
SubgroupCriteria="weeks"
# data loading
data(AAPL)
#subgrouping Phase I data
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2013-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
# obtain subgroup summary of Phase I data
```

```
DataSum=SubgroupSummary(Subgroups,MaxSgpSize=5)
# partitioning data into common and special cause periods (Phase I data)
PartitonedData=PartitioningSgps(DataSum,ChartType="S")

# Phase II data
StockPrice=window(AAPL[,"Close"],start=as.Date("2014-01-06"),end=as.Date("2014-05-30"))
SubgroupsPhaseII=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
PhaseIIData=SubgroupSummary(SubgroupsPhaseII,MaxSgpSize=5)
B=ShewhartSgpCharts(PartitonedData, PhaseIIData,ChartType="S",plot=TRUE)
```

`SigmaStepwiseRobustPhaseI` *Estimating σ using a stepwise robust chart procedure*

Description

Estimation procedure performs individual observations and subgroup screening. An initial estimate for σ is obtained from trimmed means of interquartile ranges. Subgroups are first screened. Then, the resulting σ from the remaining subgroups is used to eliminate individual outliers in the remaining subgroups.

Usage

```
SigmaStepwiseRobustPhaseI(Subgroups)
```

Arguments

`Subgroups`	a list subgroups, function handles the unequal subgroup sizes.

Value

estimates of σ from Phase I data

Author(s)

Nadeeka Premarathna

References

Nazir, Hafiz Z., Marit Schoonhoven, Muhammad Riaz, and Ronald JMM Does. "Quality Quandaries: How to Set Up a Robust Shewhart Control Chart for Dispersion?." Quality Engineering 26, no. 1 (2014): 130-136.

Examples

```
data(MeltIndex)
require(xts)
Subgroups=split(MeltIndex, f="weeks")
Subgroups[20]=NULL
sigma=SigmaStepwiseRobustPhaseI(Subgroups)
```

Subgrouping *Divide into subgroups*

Description

Function divides the data series into subgroups according to the given criteria.

Usage

```
Subgrouping(Data, SubgroupCriteria, CountSgps)
```

Arguments

Data	a series of time series data (data type: zoo or xts)
SubgroupCriteria	length of the subgroups based on time, eg. "weeks", "months", if using daliy data
CountSgps	subgroups sizes further increase using CountSgps=2,3,4 eg. SubgroupCriteria="weeks", CountSgps=2 gives subgroups size of two weeks

Value

Subgropus

Author(s)

Nadeeka Premarathna

See Also

PartitioningSgps

Examples

```
SubgroupCriteria="weeks"
data(AAPL)
require(zoo)
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2014-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
```

SubgroupSummary *Subgroup summary*

Description

Function gives subgroup size, mean, standard deviation, adjusted standard deviation, skewness, kurtosis and a table of control chart constants for subgroups in the given series.

Usage

```
SubgroupSummary(Subgroups, MaxSgpSize)
```

Arguments

Subgroups	a series of subgroups
MaxSgpSize	possible maximum size of a subgroup

Value

SgpSummary

Author(s)

Nadeeka Premarathna

See Also

Subgrouping

Subgrouping

Examples

```
# Subgroup size
SubgroupCriteria="weeks"
#  load data
data(AAPL)
# divide into subgroups
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2014-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
# obtain the subgroup summary
SubgroupSummary(Subgroups,MaxSgpSize=5)
```

TotalandCommonCauseSigma *Standard deviation in total and common cause periods*

Description

Function calculates the standard deviation in total and common cause periods

Usage

```
TotalandCommonCauseSigma(Data)
```

Arguments

Data	subgroup summary (object type "SgpHist")

Value

Standard deviation in total and common cause periods

Author(s)

Nadeeka Premarathna

References

K. Govindaraju and A. Jonathan R. Godfrey. " Analysis of stock market volatility using Shewhart methodology." Total Quality Managment & Business Excellence 22 no. 4 (2011): 425-432.

Examples

```
SubgroupCriteria="weeks"
data(AAPL)
require(zoo)
StockPrice=window(AAPL[,"Close"],start=as.Date("2012-01-02"),end=as.Date("2014-12-31"))
Subgroups=Subgrouping(StockPrice,SubgroupCriteria,CountSgps=1)
DataSum=SubgroupSummary(Subgroups,MaxSgpSize=5)
# partitioning data into common and special cause periods
PartitonedData=PartitioningSgps(DataSum,ChartType="S")
TCCSigmaVal=TotalandCommonCauseSigma(PartitonedData)
```

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