

Package ‘weco’

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Title Western Electric Company Rules (WECO) for Shewhart Control Chart

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Description Western Electric Company Rules (WECO) have been widely used for Shewhart control charts in order to increase the sensitivity of detecting assignable causes of process change. This package implements eight commonly used WECO rules and allow to apply the combination of these individual rules for detecting the deviation from a stable process. The package also provides a web-based graphical user interface to help users conduct the analysis.

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License GPL (>= 3)

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weco-package	<i>Western Electric Company Rules (WECO) for Shewhart Control Chart</i>
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Description

Western Electric Company Rules (WECO) for Shewhart Control Chart

Introduction

WECO rules got the name from the quality control hand book published by the Western Electric Company in 1956. These rules detect the deviation from a stable process by continuously testing data against predefined abnormal patterns and have been accompanied with Shewhart control chart in statistical process control.

There are eight commonly adopted abnormal patterns, namely, eight WECO rules. It is of great interest to combine different WECO rules to increase the power to detect deviation from a stable process. This package implements the combination of multiple WECO rules.

Note that it is necessary to minimize the probability for making false alarms when the process is in control. Running length is the first time at which a process experiences out-of-control signals. The average running length (ARL) is frequently used as a measure in statistical process control for evaluating and comparing the performances of different methods.

Rules

This package considers the following eight WECO rules:

Rule 1 1 data point is greater than 3 standard deviation from the center line. (This rule is to identify single data point that is out of the acceptable range.)

Rule 2 9 data points in a row on the same side of the center line. (The ideal stable process is assumed to be up and down around the center line. A large block of data points on the same side of the center line indicates a process mean is shifted.)

Rule 3 6 data points in a row, all increasing or decreasing. (This rule is also an indicator of possible mean shift.)

Rule 4 16 data points in a row, alternating up and down. (When data points are routinely alternating up and down, it shows a high negative correlation between neighboring observations, which is abnormal for a stable process. For an in-control-process, it is not expected to observe correlation between neighboring data points.)

Rule 5 2 out of 3 data points on the same side are greater than 2 standard deviations from the center line. (For a normally distributed in-control-process, about 95 deviation. The chance to violate this rule is 0.00306. This rule is used to detect increase in process variation.)

Rule 6 4 out of 5 data points on the same side are greater than 1 standard deviation from the center line. (For a normally distributed in-control-process, about 62 deviation. This chance to violate this rule is 0.00553. This rule is also used to detect increase in process variation.)

Rule 7 15 data points in a row within 1 standard deviation of the center line. (Too many data points are within 1 standard deviation indicates the decrease in process variation.)

Rule 8 8 data points in a row are greater than 1 standard deviation of the center line. (This is another rule to detect increase in process variance.)

Graphical user interface (GUI)

This package provides a web-based Shiny GUI. See [run.weco](#) for details.

References

Introduction to Statistical Quality Control. Montgomery D.C. Third Edition. Wiley, New York. 1996

plot.weco

Plot WECO results

Description

Generate plot with the observed data with abnormalities identified

Usage

```
## S3 method for class 'weco'
plot(x, ...)
```

Arguments

x	A class weco vector returned from weco.rule or weco.combine
...	The function takes the following arguments
start	First point for plotting
end	Last point for plotting
selected	Index of data points that will be highlighted
runin	Number of running points that will be colored differently
ref	Boolean. If true, reference lines will be given at 1, 2 and 3 times standard deviation
ylim	Range of Y-axis
cols	Color of each data point

See Also

[weco.rule](#), [weco.combine](#)

Examples

```
x          <- rnorm(1000);
rst.comb <- weco.combine(x, lst.rules=list(list(1), list(2, k=9)));
plot(rst.comb, start=10, end=80, selected = c(60,70));
```

run.weco	<i>Run Web-Based weco application</i>
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Description

Call Shiny to run weco as a web-based application. A web browser will be brought up.

Usage

```
run.weco()
```

Examples

```
## Not run:
run.weco()
## End(Not run)
```

summary.weco	<i>Summary of WECO outcome</i>
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Description

Print summary of a class weco object

Usage

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

Arguments

object	A class weco object returned from weco.rule or weco.combine
...	Other arguments for summary

Examples

```
x          <- rnorm(1000);
rst.comb <- weco.combine(x, lst.rules=list(list(1), list(2, k=9)));
summary(rst.comb);
```

weco.combine	<i>Combination of WECO Rules</i>
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Description

Apply a combination of multiple WECO rules to continuously observed data from some process to detect abnormal signals

Usage

```
weco.combine(x, sd = sd(x), mux = mean(x), lst.rules)
```

Arguments

x	A vector of continuously observed data from some process
sd	Standard deviation of the observed data
mux	Mean of the observed data
lst.rules	List of rules with parameters. The first element in the list is the rule number

Value

A vector with the same length as x that contains the out of boundary status of each point

Examples

```
x          <- rnorm(1000);
rst.comb  <- weco.combine(x, lst.rules=list(list(1), list(2, k=9)));
rst.comb2 <- weco.combine(x, lst.rules=list(list(3), list(4, k=16)));
```

weco.info

Describe WECO rules

Description

Get the description of a WECO rule

Usage

```
weco.info(rule, ..., prt = TRUE)
```

Arguments

rule	WECO rule number from 1 to 8
...	Specifications for individual rule
k	Number of "abnormal" data points
l	Number of standard deviations
n	Number of data points prior to the current point (including the current point) to be evaluated
prt	Whether to print the detailed information

Value

A list that contains a text description of the rule and a vector of parameters with their default values

Examples

```
info.1 <- weco.info(rule=1);
print(info.1$description);
info.1 <- weco.info(rule=1, l=2);
print(info.1$description);
```

weco.rl

Get running lengths

Description

Get running lengths

Usage

```
weco.rl(weco.rst)
```

Arguments

weco.rst A class weco vector returned from [weco.rule](#) or [weco.combine](#)

Value

A vector of running lengths detected from the observed continuously observed data

See Also

[weco.rule](#), [weco.combine](#)

Examples

```
x            <- rnorm(1000);
rst.comb <- weco.combine(x, lst.rules=list(list(1), list(2, k=9)));
weco.rl(rst.comb);
```

weco.rule

Individual WECO Rule

Description

Apply individual WECO rules 1-8 to continuously observed data from some process to detect abnormal signals. See [weco-package](#) for the details of the eight WECO rules.

Usage

```
weco.rule(rule, x, sdx = sd(x), mux = mean(x), ...)
```

Arguments

rule	WECO rule number from 1 to 8
x	A vector of continuously observed data from some process
sdx	Standard deviation of the observed data
mux	Mean of the observed data
...	Specifications for individual rule
	k Number of "abnormal" data points
	l Number of standard deviations
	n Number of data points prior to the current point (including the current point) to be evaluated

Value

A class weco list contains the original data x , the mean, standard deviation, the rules, and a vector with the same length as x that contains the out of boundary status of each point

See Also

[weco-package](#)

Examples

```
x <- rnorm(1000);

## use empirical mean and standard deviation of x
rst.1 <- weco.rule(1, x, l=3);
rst.2 <- weco.rule(2, x, k=9);
rst.3 <- weco.rule(3, x, k=6);
rst.4 <- weco.rule(4, x, k=16);
rst.5 <- weco.rule(5, x, k=2, n=3, l=2);
rst.6 <- weco.rule(6, x, k=4, n=5, l=1);
rst.7 <- weco.rule(7, x, k=15, l=1);
rst.8 <- weco.rule(8, x, k=8, l=1);

## use given mean and standard deviation
rst.1 <- weco.rule(1, x, l=3, mux=0, sdx=1);
```


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