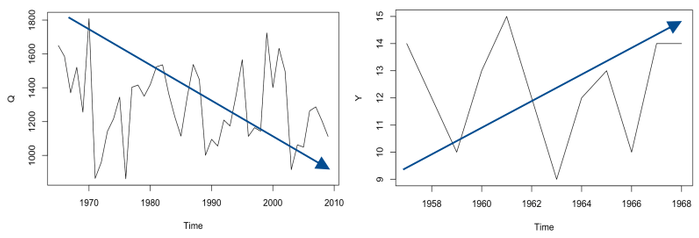
Trends analysis with trends: : **CHEAT SHEET**

Monotonic Trends

Analyse time series data for monotonic trends (consistently increasing or decreasing trends) and whether the trends are statistically significant



Installation

library(trends)

Trend Detection

MANN-KENDALL TEST (Detect monotonic trends in series)
mk.test(x, alternative = c("two.sided", "greater", "less"), continuity = TRUE)

SEASONAL MANN-KENDALL TEST (Detect monotonic trend in monthly data and compute scores for each month)
smk.test(x, alternative = c("two.sided", "greater", "less"), continuity = TRUE) %>%
summary()

CORRELATED SEASONAL MANN-KENDALL TEST (Perform a Seasonal Mann-Kendall test in the presence of correlated seasons or data are corelated with e.g. the preceding months)
csmk.test(x, alternative = c("two.sided", "greater", "less"))

MULTIVARIATE MANN-KENDALL TEST (Detect global trend between data collected at multiple sites)
mult.mk.test(x, alternative = c("two.sided", "greater", "less"))

PARTIAL MANN-KENDALL TEST (Test can be conducted in the presence of co-variates)

I. cor.test(x, y, alternative = c("two.sided", "less", "greater"), method = c("pearson", "kendall", "spearman"), exact = NULL, conf.level = 0.95, continuity = FALSE, ...) First test to see if variables x and y are correlated ($p < 0.05$)

II. partial.mk.test(x, y, alternative = c("two.sided", "greater", "less")) If x and y are correlated, detect trends in x when the covariate (y) is partialled out

PARTIAL CORRELATION TREND TEST (Magnitude of linear trend in x while covariate (y) is partialled out)
partial.cor.trend.test(x, z, method = c("pearson", "spearman"))

Magnitude of Trend

Calculate the average change in x with time

SEN'S SLOPE
sens.slope(x, conf.level = 0.95)

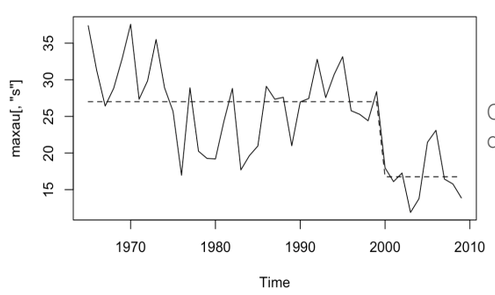
SEASONAL SEN'S SLOPE
sea.sens.slope(x)

Change Point Detection

Analyse data for homogeneity and identify points/times where there are changes in the statistical properties of the time series

PETTITT'S TEST (non-parametric method)

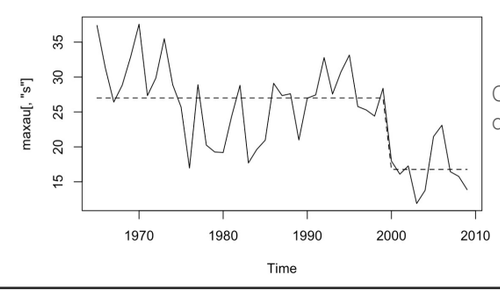
```
data(maxau) ; plot(maxau[,"s"])
s.res <- pettitt.test(maxau[,"s"])
n <- s.res$nobs
i <- s.res$estimate
s.1 <- mean(maxau[1:i,"s"])
s.2 <- mean(maxau[(i+1):n,"s"])
s <- ts(c(rep(s.1,i), rep(s.2,(n-i))))
tsp(s) <- tsp(maxau[,"s"])
lines(s, lty=2)
```



Change point at K = 35 (2000) and change in mean values from 27 to 16

LAZANTE'S TEST (non-parametric method)

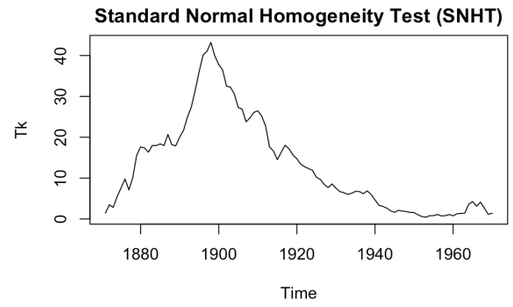
```
data(maxau) ; plot(maxau[,"s"])
s.res <- lanzante.test(maxau[,"s"])
n <- s.res$nobs
i <- s.res$estimate
s.1 <- mean(maxau[1:i,"s"])
s.2 <- mean(maxau[(i+1):n,"s"])
s <- ts(c(rep(s.1,i), rep(s.2,(n-i))))
tsp(s) <- tsp(maxau[,"s"])
lines(s, lty=2)
```



Change point at K = 35 (2000) and change in mean values from 27 to 16

STANDARD NORMAL HOMOGENIETY TEST (assuming data is normally distributed)

```
data(Nile)
(out <- snh.test(Nile))
plot(out)
```

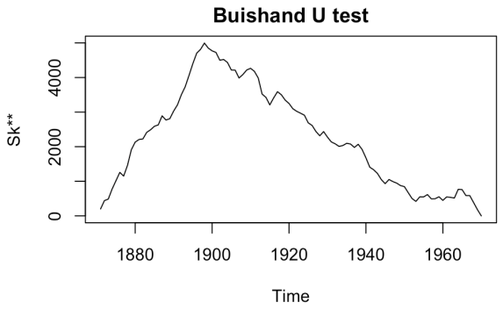


Change point at K = 28 (1899)

BUISHAND RANGE TEST (assuming data is normally distributed)

```
data(Nile)
(out <- bu.test(Nile))

plot(out)
```



Change point at K = 28 (1899)

Randomness

Test series for any recognizable patterns or regularities

WALLIS AND MOORE PHASE FREQUENCY TEST
wm.test(x) test for randomness

BARTEL'S TEST FOR RANDOMNESS
bartels.test(xs) test for randomness

WALD-WOLFOWITZ TEST FOR STATIONARITY AND INDEPENDENCE
ww.test(x) test for independence and stationarity

Wayne Ndlovu • wndlovu@usapglobal.org • https://github.com/wndlovu