13-Identification of Breakpoints in Time Series

2023-11-08

1 Text needs to be written

The example is adapted from the help pages of R package “strucchange”, see Zeileis, A. et al. (2002), Journal of Statistical Software, 7(2), https://www.jstatsoft.org/v07/i02/

```
library(strucchange)
```

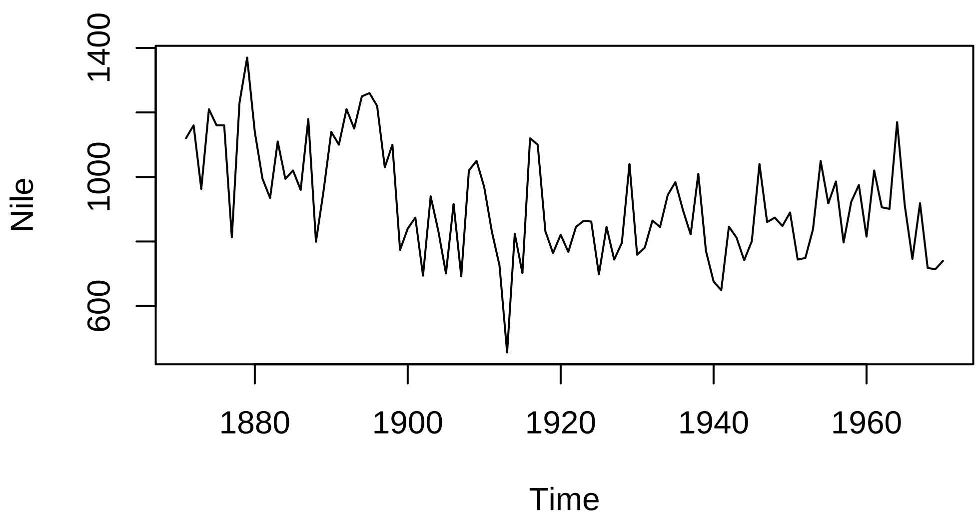
```
Lade nötiges Paket: zoo
```

```
Attache Paket: 'zoo'
```

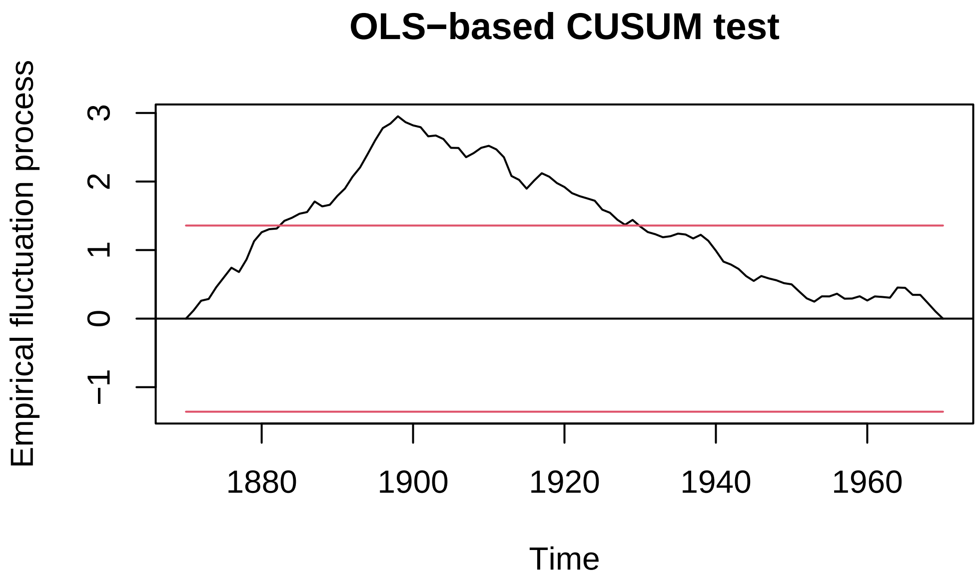
```
Die folgenden Objekte sind maskiert von 'package:base':

    as.Date, as.Date.numeric
```

```
Lade nötiges Paket: sandwich
```

```
data("Nile")
plot(Nile)
```



```r
## OLS-CUMSUM test for structural breaks in the time series
## are there periods with different discharge?
ocus <- efp(Nile ~ 1, type = "OLS-CUSUM")
plot(ocus)
```




```r
sctest(ocus)
```

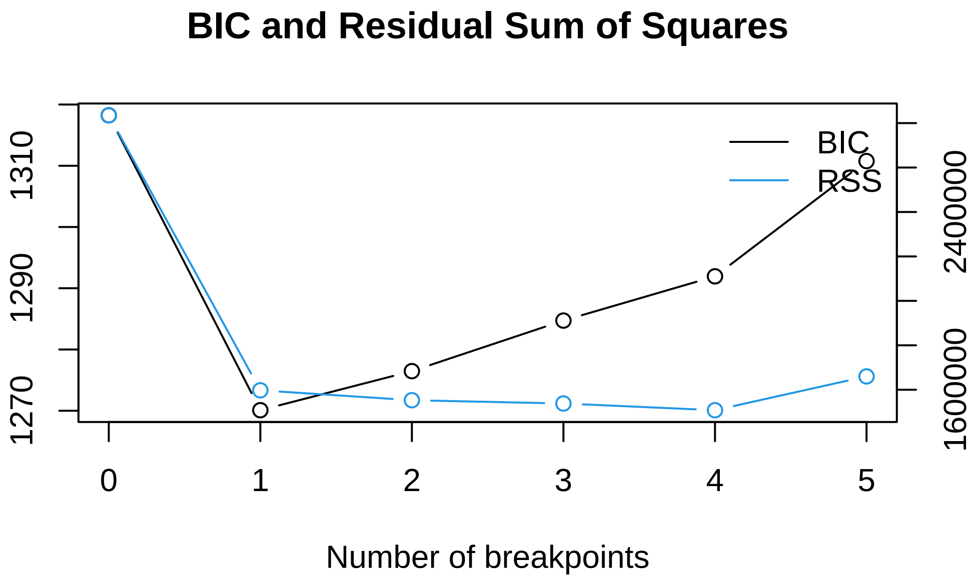
```
    OLS-based CUSUM test

data:  ocus
S0 = 2.9518, p-value = 5.409e-08
```

```r
## identify time of structural break (with respect to mean value)
bp.nile <- breakpoints(Nile ~ 1)
summary(bp.nile)
```

```
     Optimal (m+1)-segment partition:

Call:
breakpoints.formula(formula = Nile ~ 1)

Breakpoints at observation number:

m = 1       28
m = 2       28       83
m = 3       28    68 83
m = 4       28 45 68 83
m = 5    15 30 45 68 83

Corresponding to breakdates:

m = 1         1898
```

```
m = 2         1898            1953
m = 3         1898       1938 1953
m = 4         1898 1915 1938 1953
m = 5    1885 1900 1915 1938 1953

Fit:

m   0       1       2       3       4       5
RSS 2835157 1597457 1552924 1538097 1507888 1659994
BIC    1318    1270    1276    1285    1292    1311
```

```
## the BIC also chooses one breakpoint
plot(bp.nile)
```

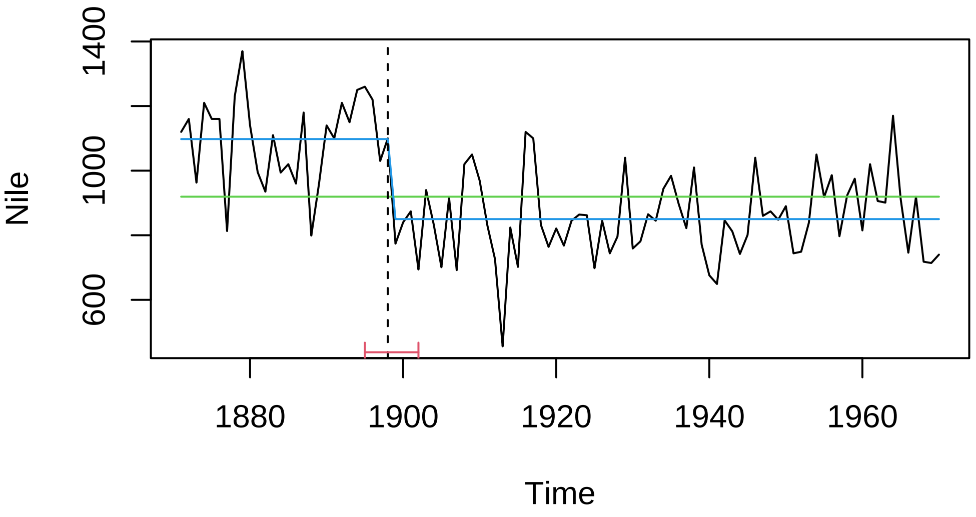



```
## fit null hypothesis model and model with 1 breakpoint
fm0 <- lm(Nile ~ 1)
fm1 <- lm(Nile ~ breakfactor(bp.nile,  breaks = 1))
plot(Nile)
lines(ts(fitted(fm0),  start = 1871),  col = 3)
lines(ts(fitted(fm1),  start = 1871),  col = 4)
lines(bp.nile)

## confidence interval
ci.nile <- confint(bp.nile)
ci.nile
```

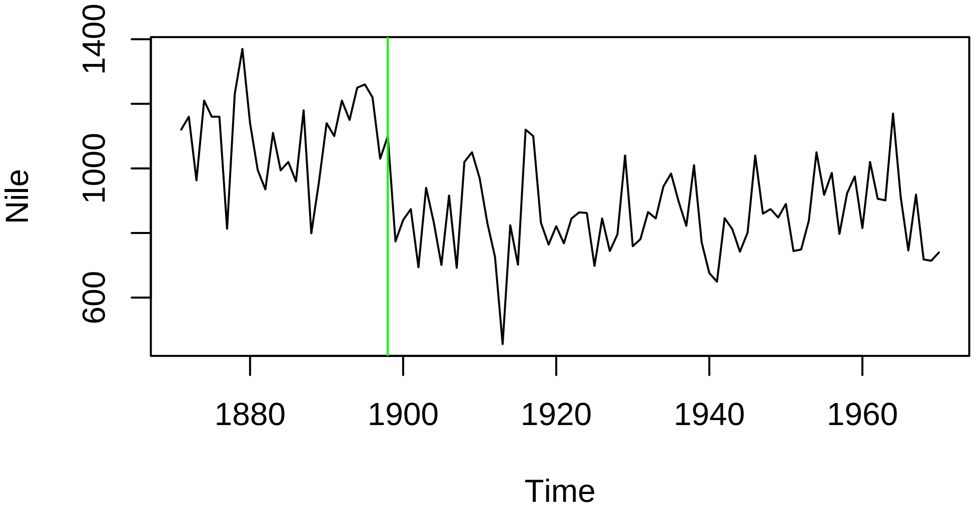
```
     Confidence intervals for breakpoints
     of optimal 2-segment partition:

Call:
confint.breakpointsfull(object = bp.nile)

Breakpoints at observation number:
  2.5 % breakpoints 97.5 %
```

```
1    25           28     32

Corresponding to breakdates:
  2.5 % breakpoints 97.5 %
1  1895         1898   1902
```

```r
lines(ci.nile)
```




```r
## mark breakoint using a simpler (and less fancy) method
plot(Nile)
dat <- data.frame(time = time(Nile), Q = as.vector(Nile))
abline(v=dat$time[bp.nile$breakpoints],  col="green")
```




```r
## ANOVA test whether the two models are significantly different
anova(fm0, fm1)
```

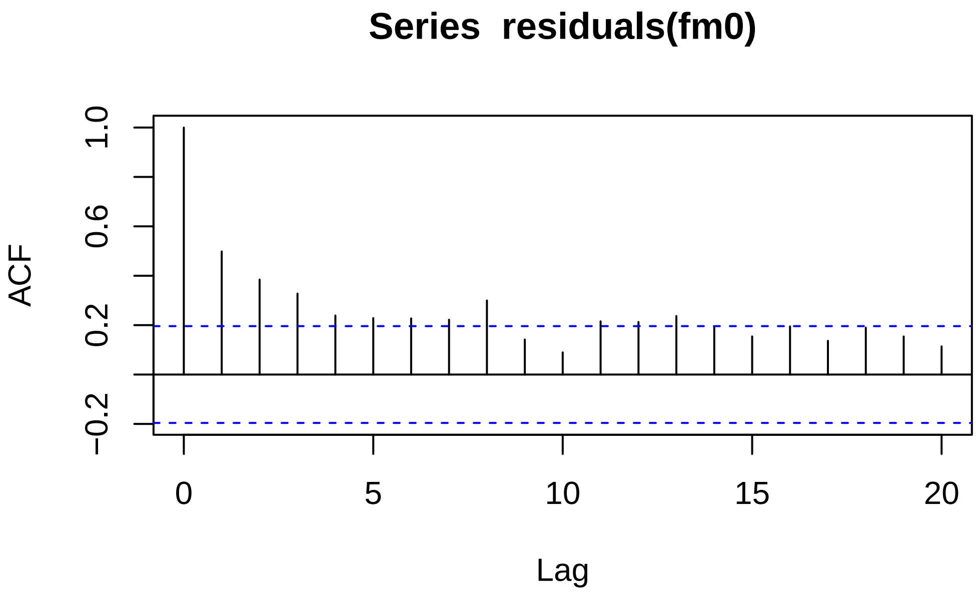
```
Analysis of Variance Table

Model 1: Nile ~ 1
Model 2: Nile ~ breakfactor(bp.nile, breaks = 1)
  Res.Df     RSS Df Sum of Sq     F    Pr(>F)
```

```
1      99 2835157
2      98 1597457  1   1237700 75.93 7.439e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

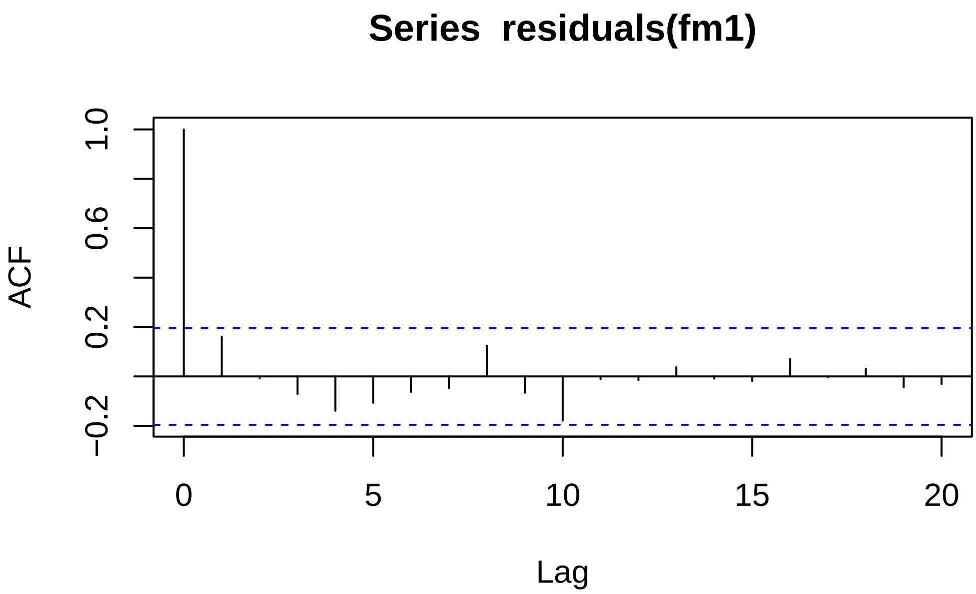
```
## alternative: AIC-based model comparison.
## The model with lower AIC is better
AIC(fm0,fm1)
```

```
    df      AIC
fm0  2 1313.031
fm1  3 1257.663
```

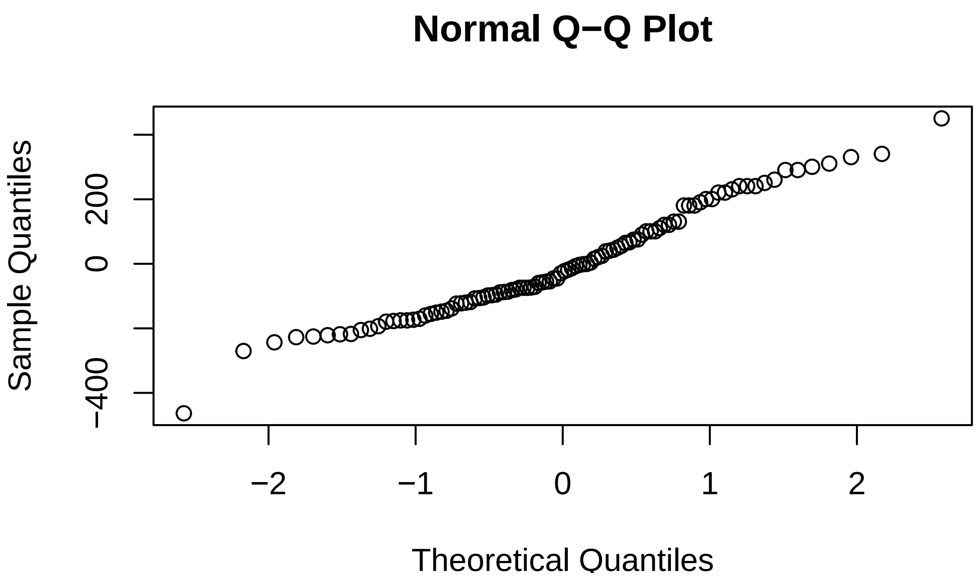
```
## some tests for quality and assumptions of the fitted model
acf(residuals(fm0))
```




```
acf(residuals(fm1))
```



```
qqnorm(residuals(fm0))
```




```
qqnorm(residuals(fm1))
```