Replications of Brandsma 2016

JBvR

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Intro

Replicate findings from Brandsma - De Bilt, 2016, Technical report; TR-356 - the homogenization of Dutch temperature records. The comments will be brief. The main purpoe is to have insight in and aa replication of the methods. We will not exactly replicate tables and figures.

Sources

On the KNMI site we found the unhomogenized and homogenized data from stations

1. Den Helder/De Kooy,
2. De Bilt,
3. Groningen/Eelde,
4. Vlissingen, and
5. Maastricht/Beek.

(235, 260, 280, 310 and 380). We did not yet find th parallel data so we cannot yet replicate the parallel part of the report.

Percentiles phase

When we have a sample without any knowledge of the distribution of the population, the only available tools come from the area of non-parametric statistics. That means we will start with the so-called empirical cumulative distribution function (e-cdf) for the observations $x_i, i = 1, ..., N$

$$F(x) := |x_i <= x|)/(N + 1)$$

where $|v|$ is the length of the vector v..

$F(x)$ is a stepfunction, so neither differentiable nor invertable.We have to approximate them, f.i. using interpolation. The *quantile* function in R does just that. Given all observations, it fixes $F(min(x)) := 0$ and $F(max(x)) := 1$ interpolates all other values.

The R quantile function has 9 different methods availble. The first 3 relate to count data, the other 6 to continuous data. The classical commercial statistical packages such as SAS, SPSS, Stata and S-(plus) all had slightly different algorithms, so R, the Open Source succesor to S-(plus) has all these methods and more implemented. The default is the same as S.

Which one is the best? In the theory of non-parametric statistics they are equally valid because they have the same asymtotic behaviour. But otherwise it is completely undecidable. Simulation is not applicable, because we do not know how to daw a random sample from any unknown distribution. Hyndman, the author of the above R-function has added his owen favorite ("type 8") which according to him has some advantges.

Reading and processing data

```
inv_F <- function(s) quantile(s, seq(0.05, 0.95, by=0.05))

pretty_inv_F <- function(aa, ...) {
  pretty_plot(data.frame(seq(0.05, 0.95, by=0.05), inv_F(aa)), ...)
  }

get_etm <- function(fname){
    a<- readLines(fname)
    b<- read.csv(text=a, skip=49,
                 header=FALSE, stringsAsFactors = FALSE)
    names(b)<-  gsub("\\s", "", strsplit(a[48], ",")[[1]])
    return(b)
}

ref_etm<- function(etm){
  # need yy mm dd TN, TX, TG
  etm$yy <- as.integer(substring(etm$YYYYMMDD,1,4))
  etm$mm <- as.integer(substring(etm$YYYYMMDD,5,6))
  etm$dd <- as.integer(substring(etm$YYYYMMDD,7,8))

  return(etm[, c("yy", "mm", "dd", "TX", "TN", "TG")])
}


get_pre <- function(fname){
    a<- readLines(fname)
    b<- read.csv(text=a, skip=13,
                 header=TRUE, stringsAsFactors = FALSE)
    return(b[, -ncol(b)])
}

ref_pre<- function(etm){
  # need yy mm dd TN, TX, TG
  etm$yy <- as.integer(substring(etm$YYYYMMDD,1,4))
  etm$mm <- as.integer(substring(etm$YYYYMMDD,5,6))
  etm$dd <- as.integer(substring(etm$YYYYMMDD,7,8))

  return(etm[, c("yy", "mm", "dd", "TX", "TN", "TG")])
}


DeBilt_h <- ref_etm(get_etm("./input/etmgeg_260.txt"))
DeBilt_u <- ref_pre(get_pre("./input/temp_260.txt"))
DeBilt_u <- rbind(DeBilt_u, DeBilt_h[-(1:24350),])
```

Do monthly change point(s) analysis, first de-season it.

```
b<- complete.cases(DeBilt_u)
m<- aggregate(DeBilt_u[b, c("TN", "TG", "TX")], by=list(DeBilt_u$mm[b]), FUN=mean)

DeBilt_u_des <- DeBilt_u
DeBilt_u_des$TN <- DeBilt_u_des$TN -
  rep(m$TN, 150*365)[1: nrow(DeBilt_u)]
DeBilt_u_des$TG <- DeBilt_u_des$TG -
```

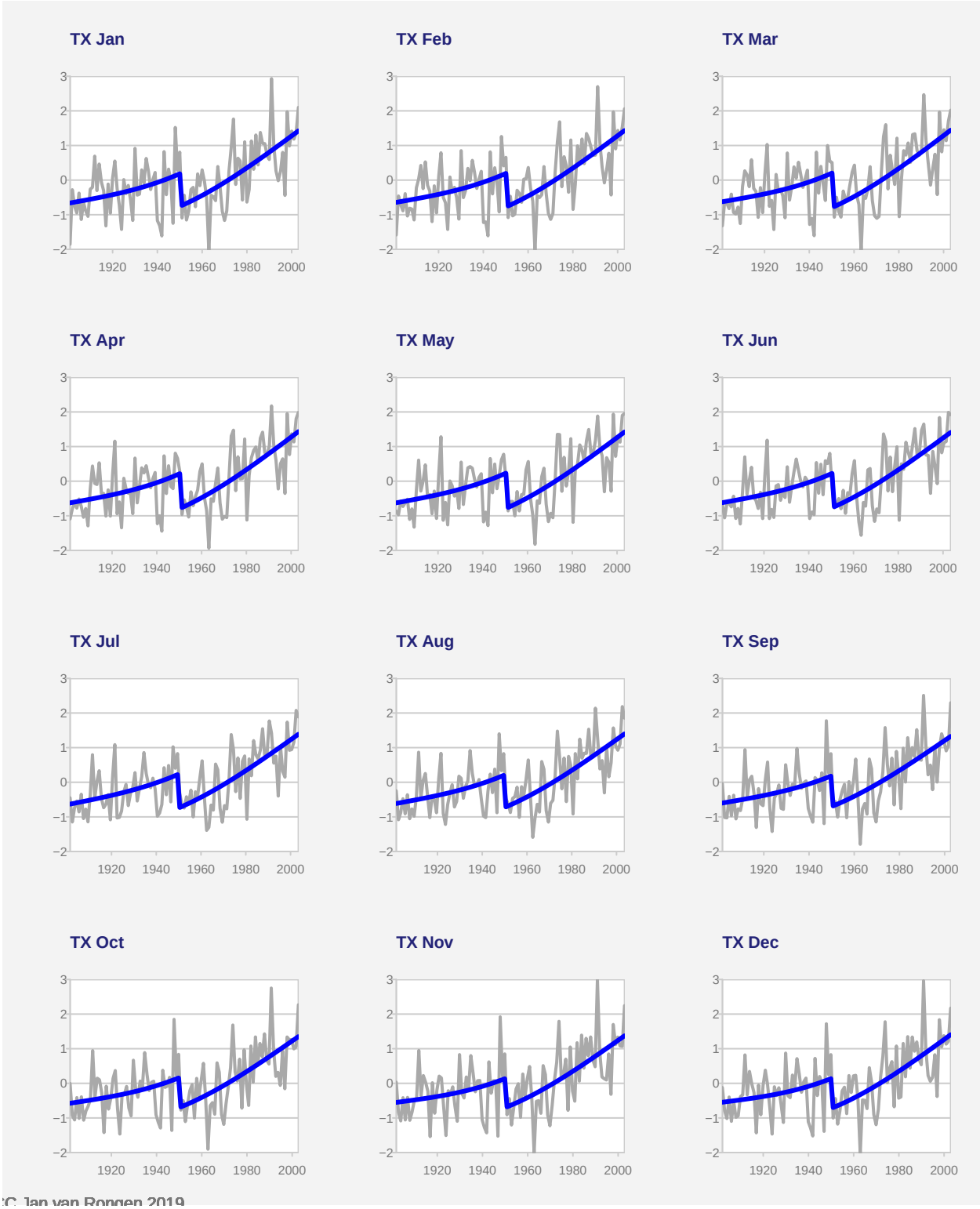
```
  rep(m$TG, 150*365)[1: nrow(DeBilt_u)]
DeBilt_u_des$TX <- DeBilt_u_des$TX -
  rep(m$TX, 150*365)[1: nrow(DeBilt_u)]

monthly_DeBilt_u_des <- aggregate(DeBilt_u_des[, c( "TX", "TN", "TG")],
  by = list(DeBilt_u_des$yy, DeBilt_u_des$mm ),
                              FUN=mean)
names(monthly_DeBilt_u_des) <- c("yy", "mm", "TX", "TN", "TG")


monthly_DeBilt_u_des <- monthly_DeBilt_u_des[
  order(monthly_DeBilt_u_des$yy, monthly_DeBilt_u_des$mm),]
```

Analyse those TSeries

```
one_month <- function(this_month, Tvalue, ns_points= 2)
{
    work1<- ts(monthly_DeBilt_u_des[, Tvalue],
               start=1901, freq=12)/10

    b<- stl(work1, s.window= "periodic")


    work1 <- window(b$time.series[,2],
                    start=c(1901, this_month), freq=1)
    range <- 0:length(work1)
    require(splines)
    result<- sapply(range, function(N)
                {cpt <- c(rep(0, N),
                          rep(1,length(work1)-N))
                t<- time(work1)
                l<- lm(work1 ~ ns(t, ns_points)+ cpt)
                return(AIC(l))
    })

    dd<- range[which(result== min(result))][1]
    titl = sprintf("%s %s", Tvalue, month.abb[this_month])
    pretty_plot(work1, kleur=4, lwd=2,
                main=titl, ccloc=0, ylim=c(-2,3))

    l<- lm(work1 ~ time(work1))
    N = dd
    cpt <- c(rep(0, N), rep(1,length(work1)-N))

    t<- time(work1)
    l<-lm(work1 ~ ns(t, ns_points)+ cpt )

    pretty_plot(add=TRUE, work1-l$res, kleur=2, lwd=3)
    return(list(value= l$fit[1+dd]- l$fit[dd],
                match= summary(l)))
}

results<-rep(0,12)
op <- par(mfrow=c(4,3))
```

```
for(mm in 1:12) results[mm] <- one_month(mm, "TX", ns_point=2)$value
```

```
## Loading required package: splines
```



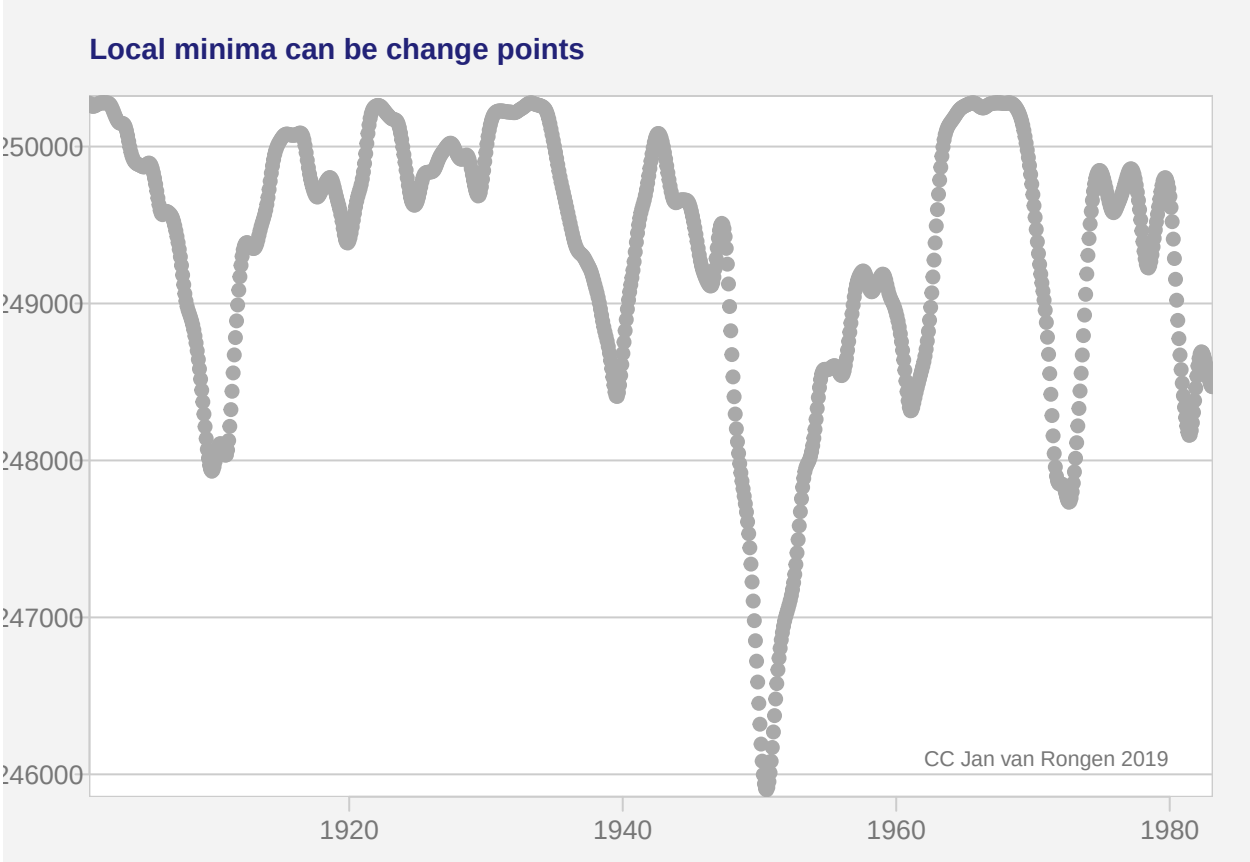
```
par(op)
```

On a monthly basis we still find a CP around 1950 for TX but not for the others. However if we do not run it per month, this rather unsophisticated analysis of monthly means finds a change point in 1951 for TX, TG and TN - independent of each other. The size of the downward step is 0.96 for TX, 0.46 for TG and 0.25 for TN. It is very remarkable that the method actually show that the change points are very likely located in sept. 1951

```
b<- stl(ts(DeBilt_u$TX, start=1901, freq=365.25) , s.window = "periodic")

# pretty_plot(b$time.series[,2])

work1 <- b$time.series[,2]
ns_points= 2
range <- (0:1000)*30
require(splines)
result<- sapply(range, function(N)
                {cpt <- c(rep(0, N),
                          rep(1,length(work1)-N))
                t<- time(work1)
                l<- lm(work1 ~ ns(t, ns_points)+ cpt)
                return(AIC(l))
})

dd<- range[which(result== min(result))]
zoo::as.yearmon(time(work1))[dd]
```

```
## [1] "jul 1950"
```

```
pretty_plot(ts(result, start=1901, freq=365.25/30), type="p", kleur=4,
            cex=0.9, main="Local minima can be change points")
```


Local minima can be change points
250000
249000
248000
247000
246000
1920
1940
1960
1980
CC Jan van Rongen 2019