HW4

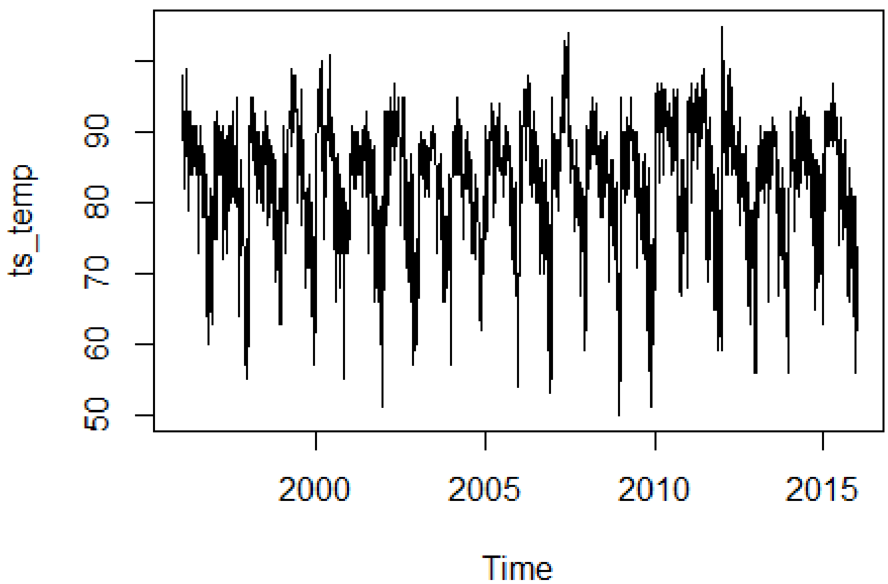
2021-09-22

Question 7.1:

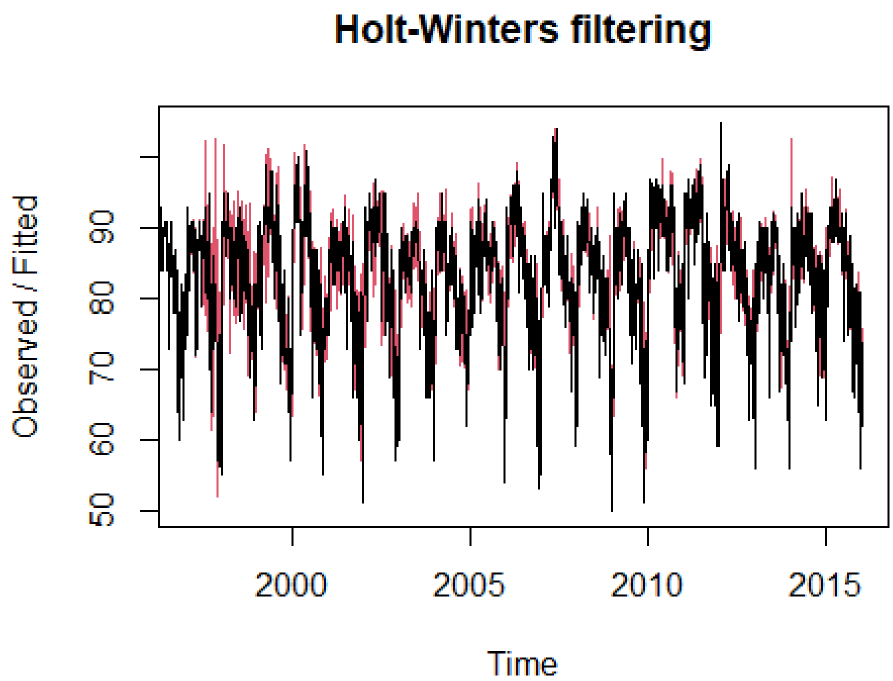
We could use smoothing model in forecasting tourism in developing countries where there isn't a clear trend to use moving average method, I would choose alpha depending on the country and historical data, most likely α will be closer to 1. Unless the country has come out of political turmoil and instability then α will likely be smaller.

Question 7.2 is in R script below:

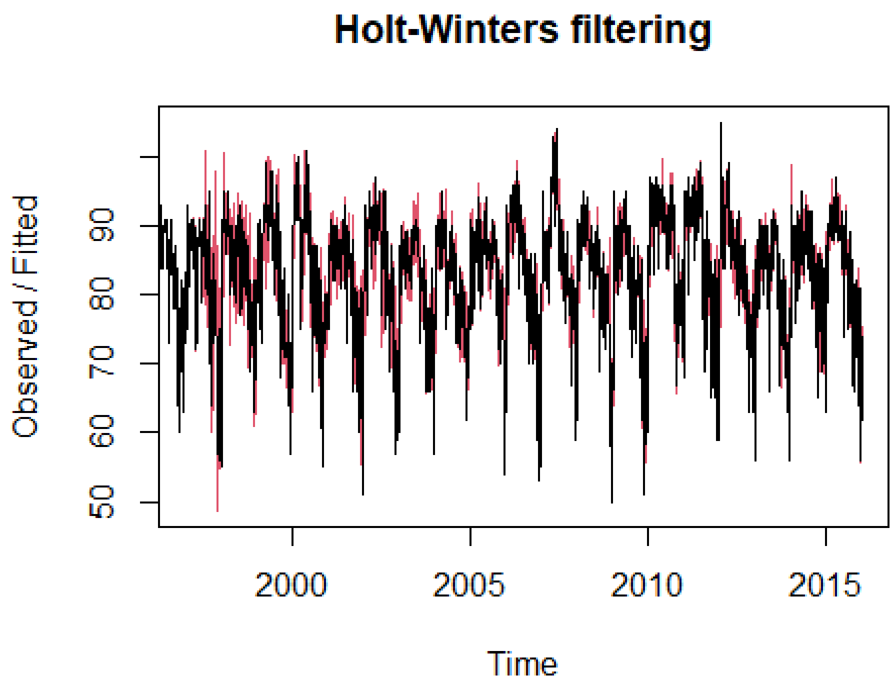
```
library(tidyverse)

#Q7.2
set.seed(1)

temp_data<- read.table("temps.txt", header = TRUE)
names(temp_data) = gsub(pattern = "X", replacement = "", x = names(temp_data)
)
temp_data <- data.frame(unlist(temp_data[,2:21]))
ts_temp= ts(temp_data, frequency = 123, start=1996)
summary(ts_temp)

##  unlist.temp_data...2.21..
##  Min.   : 50.00
##  1st Qu.: 79.00
##  Median : 85.00
##  Mean   : 83.34
##  3rd Qu.: 90.00
##  Max.   :105.00

ts.plot(ts_temp)
```



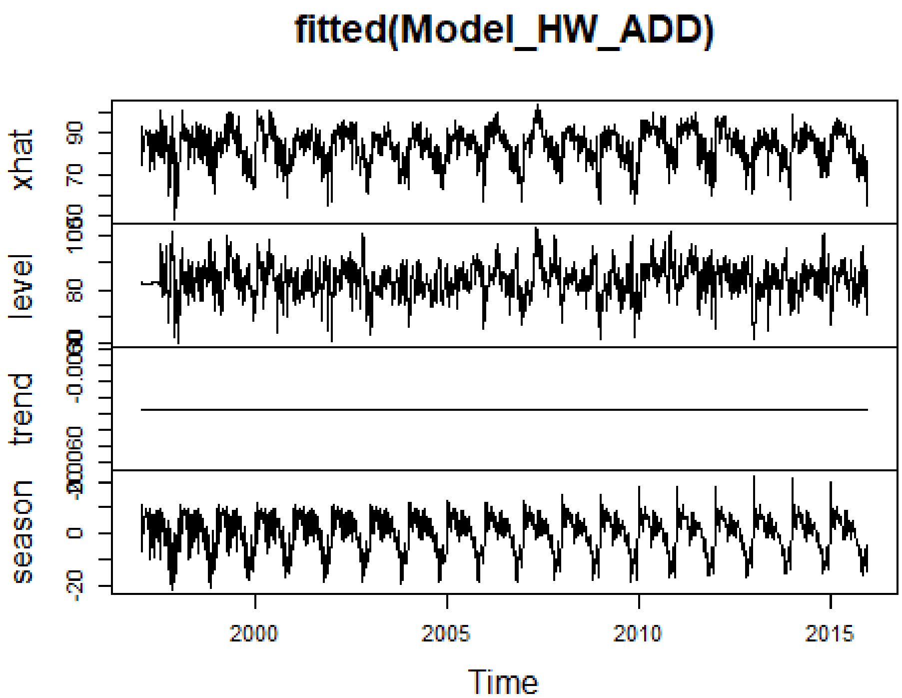

```
Model_HW_Mult<-HoltWinters(ts_temp, seasonal="multiplicative")
summary(Model_HW_Mult)

##              Length Class  Mode
## fitted       9348   mts    numeric
## x            2460   ts     numeric
## alpha           1   -none- numeric
## beta            1   -none- numeric
## gamma           1   -none- numeric
## coefficients  125   -none- numeric
## seasonal        1   -none- character
## SSE             1   -none- numeric
## call            3   -none- call

plot(Model_HW_Mult)
```




```
Model_HW_ADD<-HoltWinters(ts_temp, seasonal="additive")
summary(Model_HW_ADD)

##              Length Class  Mode
## fitted       9348   mts    numeric
## x            2460   ts     numeric
## alpha           1   -none- numeric
## beta            1   -none- numeric
## gamma           1   -none- numeric
## coefficients  125   -none- numeric
## seasonal        1   -none- character
## SSE             1   -none- numeric
## call            3   -none- call

plot(Model_HW_ADD)
```




```
cat("Sum of squared Errors in Multiplicative model",Model_HW_Mult$SSE,"\n")

## Sum of squared Errors in Multiplicative model 68904.57

cat("Sum of squared Errors in Addititve model",Model_HW_ADD$SSE,"\n")

## Sum of squared Errors in Addititve model 66244.25

#Additive model has smaller SSE hence I am choosing additive seasonality, bet
ter way to do it would be using cross-validation but for now I am choosing se
asonality as additive
#Lets visualize the trend to understand if the temperature is increasing
plot(fitted(Model_HW_ADD))
```




```
# We can observe that there is no visible change in trend over time in the te
mperature
# I think one of the reason why it's hard to see the change over time in temp
erature is because the temperature is increasing very slowly
# and the changes would be very minute, additional our data is too small to c
apture that since there are random fluctuation in yearly temperature as well
such as heatwaves etc.

#Let us further use cusum to determine if there is change is seasonality over
the years

Seasonality_data<- matrix(Model_HW_ADD$fitted[,4],nrow = 123)

temp_data1<- read.table("temps.txt", header = TRUE)
names(temp_data1) = gsub(pattern = "X", replacement = "", x = names(temp_data
1))

dim(Seasonality_data)

## [1] 123  19

dim(temp_data1)

## [1] 123  21

colnames(Seasonality_data)<-c(1997:2015)
days <- temp_data1[,1]
```

```
rownames(Seasonality_data)<-days

cumsum_data <- data.frame(matrix(0, nrow=123, ncol=19))
rownames(cumsum_data) <-days
colnames(cumsum_data)<-c(1997:2015)

mean_year1= mean(Seasonality_data[,1])
var=sd(Seasonality_data[,1])
day_counter=1
threshold= var*3 #(Using threshold for change as 3 times SD, as I want to giv
e some room for variation)


for(i in 1:ncol(cumsum_data)){
  date_change=NULL
  for (j in 1:nrow(cumsum_data)){
    val=Seasonality_data[j,i]
    cumsum_data[j,i] <- max(0, cumsum_data[j-1,i] + (mean_year1 - val- var*0.
5))

    if (cumsum_data[j,i]>=threshold){

      cat("Year",colnames(cumsum_data[i]),"Day winter started is:",
          rownames(cumsum_data)[j],"Day","\n")
      break
    }


  }

}

## Year 1997 Day winter started is: 30-Sep Day
## Year 1998 Day winter started is: 1-Oct Day
## Year 1999 Day winter started is: 1-Oct Day
## Year 2000 Day winter started is: 1-Oct Day
## Year 2001 Day winter started is: 2-Oct Day
## Year 2002 Day winter started is: 2-Oct Day
## Year 2003 Day winter started is: 4-Oct Day
## Year 2004 Day winter started is: 3-Oct Day
## Year 2005 Day winter started is: 4-Oct Day
## Year 2006 Day winter started is: 5-Oct Day
## Year 2007 Day winter started is: 6-Oct Day
## Year 2008 Day winter started is: 6-Oct Day
## Year 2009 Day winter started is: 6-Oct Day
## Year 2010 Day winter started is: 5-Oct Day
## Year 2011 Day winter started is: 5-Oct Day
## Year 2012 Day winter started is: 5-Oct Day
## Year 2013 Day winter started is: 5-Oct Day
```

```
## Year 2014 Day winter started is: 6-Oct Day
## Year 2015 Day winter started is: 6-Oct Day

#According to my CUSUM model with C of 0.5 SD and threshold of 3 times SD, on
seasonality measure from our Holt Winters model, it appears that summer end i
s delayed slowly over the years,it ends with 30th September in 1997
#but for 2015 it ends in 6th October
#Note that we can't say if summer is longer or shorter because we don't have
data to know if summer started earlier or delayed
#but according to our model it is gradually delayed
```