Assignment 4

Question 7.1

Describe a situation or problem from your job, everyday life, current events, etc., for which exponential smoothing would be appropriate. What data would you need? Would you expect the value of alpha (the first smoothing parameter) to be closer to 0 or 1, and why?

Answer 7.1

As a production engineer I deal with production data. The data is of high frequency collected every hour. I can use the exponential smoothing method to get a smoother trend without loosing the sanctity of the data. In terms of value of alpha I would expect it to be low telling me that the forecasts are based on both recent and less recent observations (although more weight is placed on recent observations).

Question 7.2

Using the 20 years of daily high temperature data for Atlanta (July through October) from Question 6.2 (file temps.txt), build and use an exponential smoothing model to help make a judgment of whether the unofficial end of summer has gotten later over the 20 years. (Part of the point of this assignment is for you to think about how you might use exponential smoothing to answer this question. Feel free to combine it with other models if you'd like to. There's certainly more than one reasonable approach.)

Answer 7.2

- Approach 1: Using Excel

Refer to Holt's Winter excel file (All formula's are in the excel file)

The original temp data was tweaked to create a table representing data for each year having the average temperature data for the four months. This step makes it ready to apply Holt Winter's method. The data is similar in look to quarterly temp data for each year with the each month can be envisioned as a quarter.

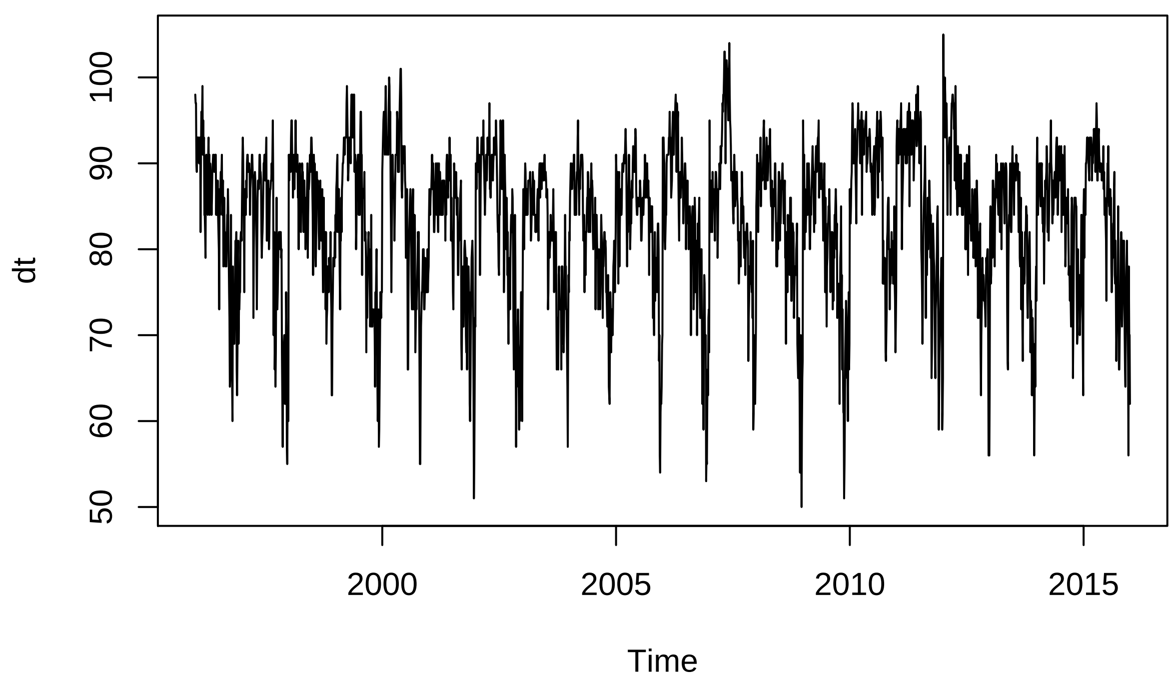
Holt Winters method was applied to the data and a forecast was also generated. Alpha, beta and gamma were found using the solver functionality in excel with the constrain of minimizing the RMSE. The question here is to find if the summer have gotten longer.We have already established this fact in Assignment 3 that the summers starts to end from the second week of September. Now if the summers would have gotten longer, then technically the average September temperature must rise. The data does not show any increasing/decreasing trend.

Thus, no conclusive evidence whether of the summers are getting longer in Atlanta

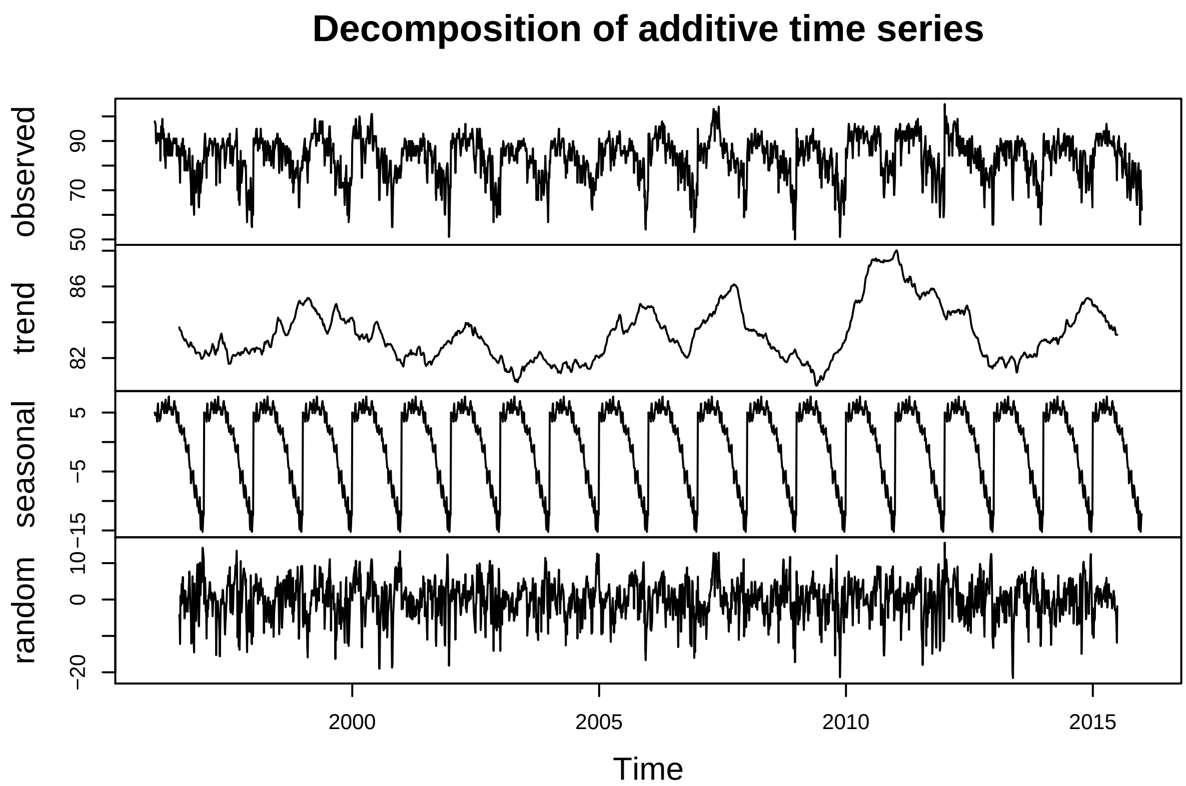
- Approach 2: Using R and excel

```r
library(ggplot2)
library(TTR)
library(forecast)
library(xlsx)
```

```r
#Getting the data
temp<-read.table('temps.txt',sep = "", header = TRUE)

#Converting the data to make it ready for time series analysis. The code below
#puts the data in a long list containing the yearly data with temperatures
#for the four months
con<-as.vector(unlist(temp[,2:21]))

#Time series data
dt<-ts(con, start = 1996, frequency = 123)

#Plotting the time series data
plot.ts(dt)
```



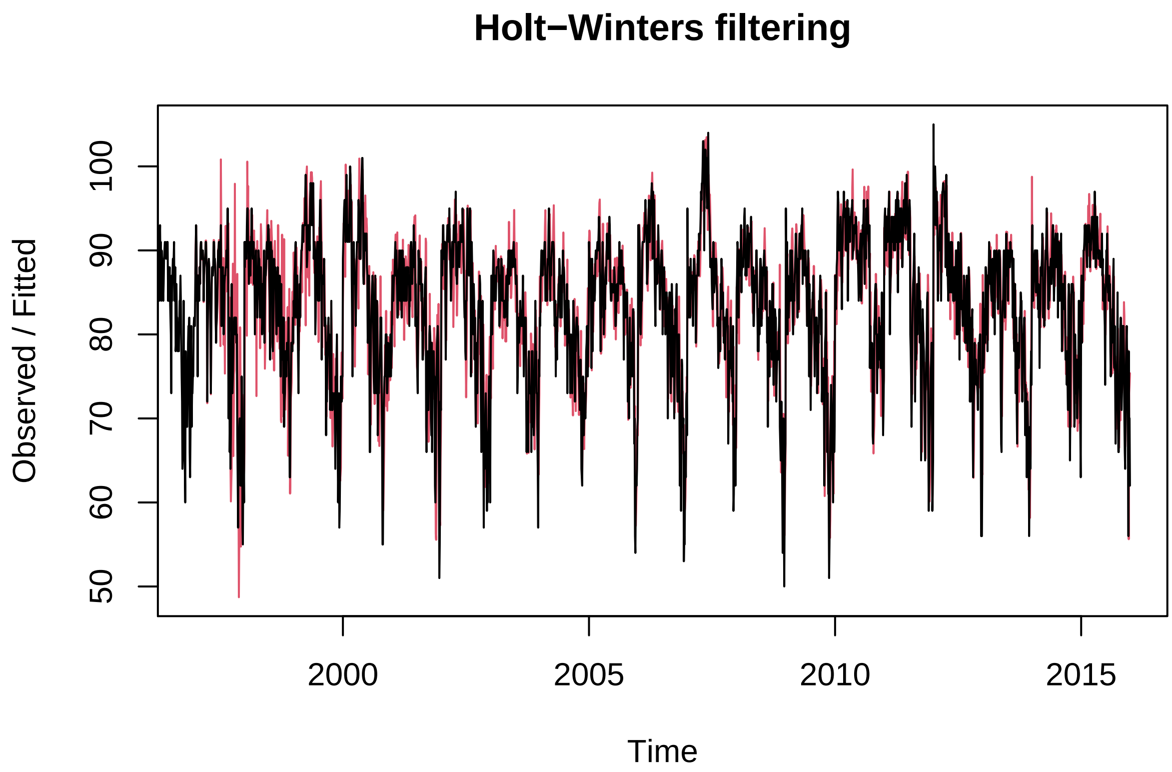

```r
#Decomposing the data to understand its components. This step helps to see how
#to use Holt Winters method.
plot(decompose(dt))
```



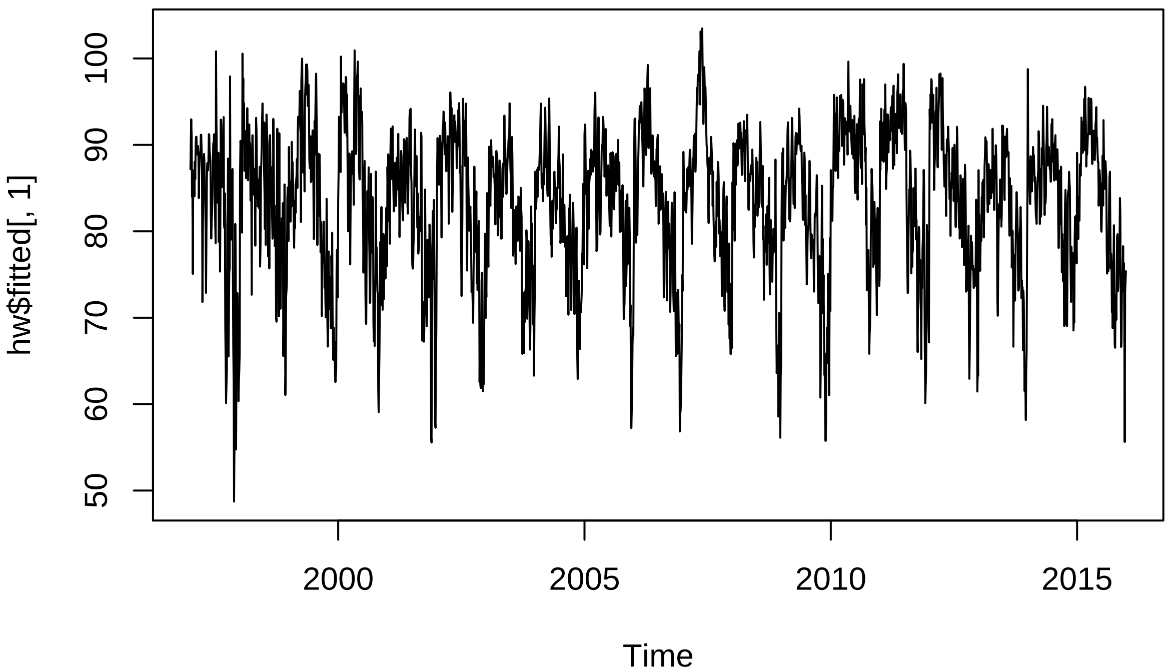

```
#The above plot shows that there is seasonality in the data but there is no
#specific trend in the data (increasing/ decreasing)

#Note
#The additive model is useful when the seasonal variation is relatively constant
#over time.The multiplicative model is useful when the seasonal variation
#increases over time. Thus, we will use the additive model for Holt Winter's
#since seasonal variations are constant.

#Applying Holt Winter's method taking care of level, trend and seasonality

hw<-HoltWinters(dt, alpha =NULL , beta=NULL, gamma = NULL,
                seasonal = 'additive')

#Root Mean Square Error
sqrt(hw$SSE)
```

```
## [1] 257.3796
```

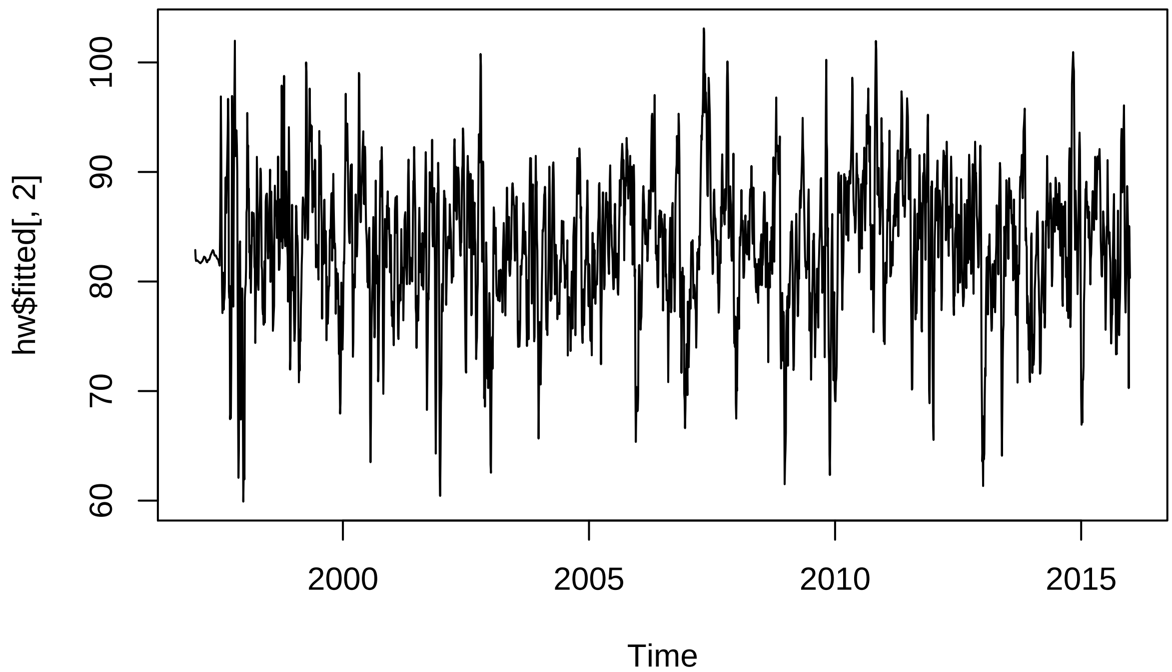
```
#Plotting the results
plot(hw)
```



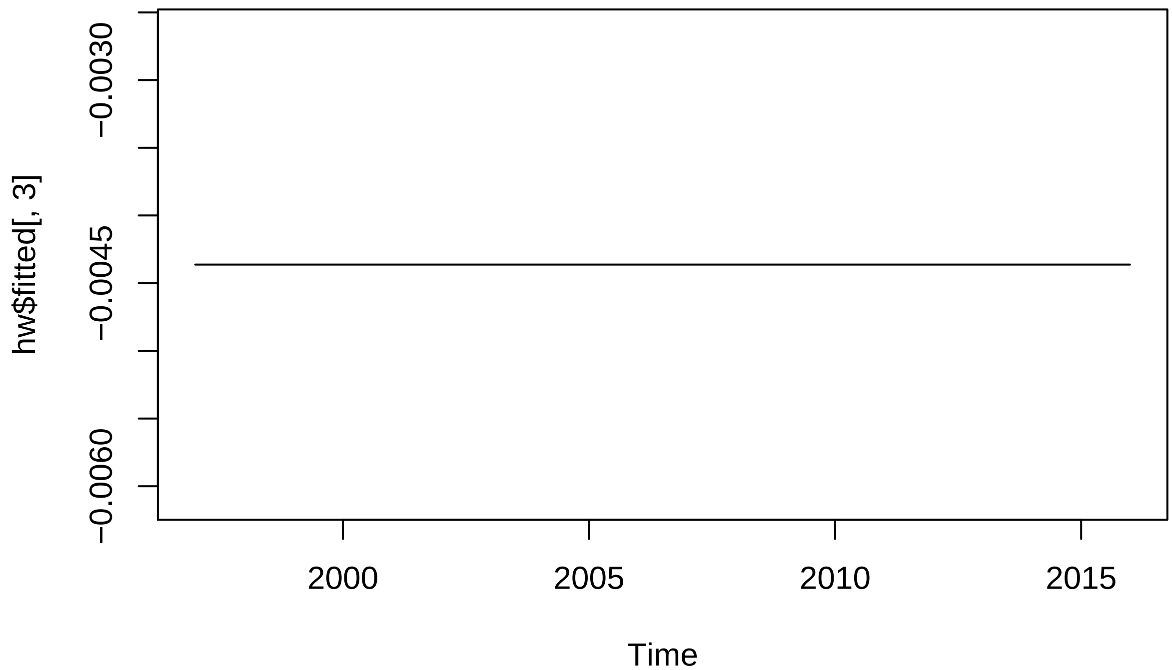

```
plot(hw$fitted[,1]) #Predicted data
```



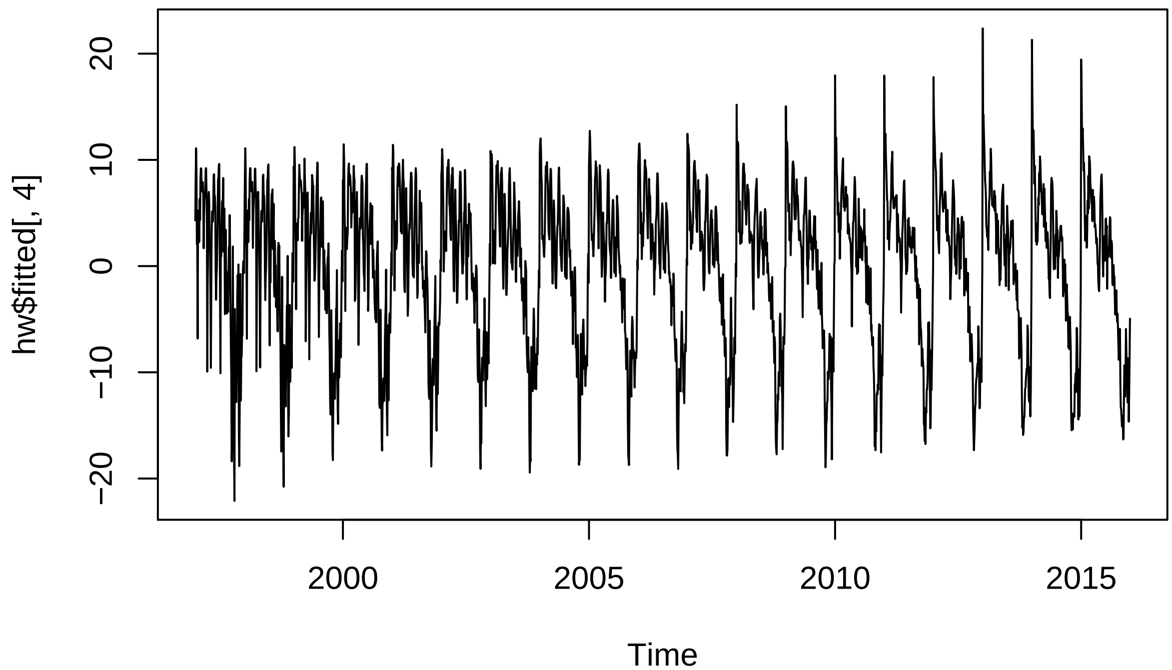

```r
plot(hw$fitted[,2]) #Level
```




```
plot(hw$fitted[,3]) #Trend
```




```r
plot(hw$fitted[,4]) #Seasonality
```




```r
#Looking into the individual components of the fitted data. The trend data is
#flat which is in agreement with our earlier conclusion of decompose data. Now,
#the seasonality data is extracted from the analysis results do CUSUM and see
#if we can detect any changes in the seasonal factors which are equivalent to
#the temperature changes.

#Extracting the seasonality data as a matrix and exporting it into a csv
seas<-matrix(hw$fitted[,4], nrow = 123)
write.xlsx(seas, "C:/Users/cheta/OneDrive/Desktop/seas.xlsx")
```

Conclusion:

Refer to the Seasonality-CUSUM excel file

The seasonality factor data is analyzed using CUSUM. Using the similar approach as in assignment 3, the first step was to calculate the mu and SD using the data for the first five years until September as summers official end in September. Different combinations of C and T was tried but the data did not give any concrete evidence of the summers getting longer in Atlanta. Thus, this analysis again remains inconclusive in proving if the summers have gotten longer in Atlanta.