HOMEWORK ASSIGNMENT 1

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PROBLEM 1: Unemployment in Maine

Unemployment rates are one of the main economic indicators used by politicians and other decision makers. They can influence policies for regional development and welfare provision. The monthly unemployment rate for the US state of Maine from January 1996 until August 2006 is given in the file `Maine.dat`.

(a) Use the `read.table()` function to read in the data from `Maine.dat` and assign it to the variable `Maine.month`. Determine its data class. Don't forget to run `attach()` on your variable after reading it in.

```r
## Read in the data
Maine.month <- read.table("Maine.dat",header = T)
attach(Maine.month)

## Determine class of 'Maine.month'
class(Maine.month)
```

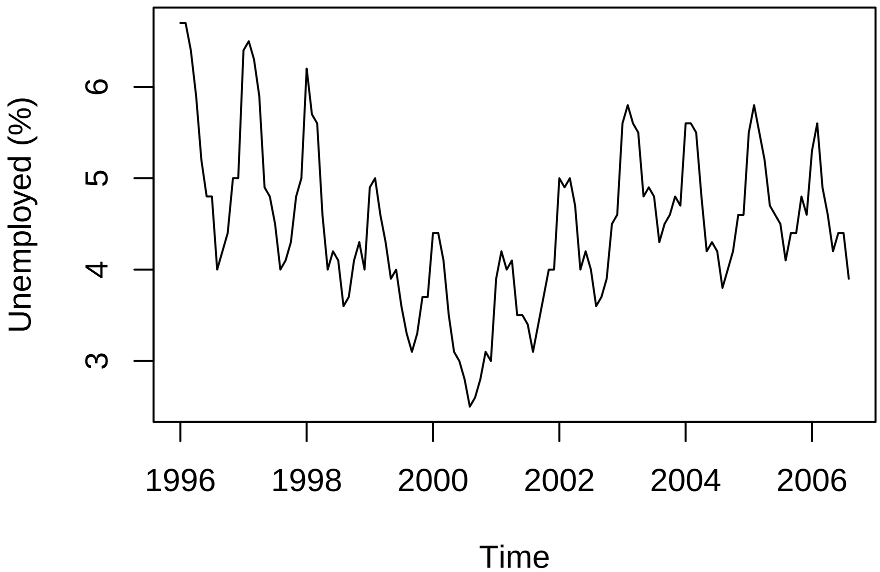
```
## [1] "data.frame"
```

(b) Convert the data frame to a time series using the `ts()` function. Then create a new time series, where the data are aggregated over month.

```r
## Create time series
## freq = 12 to aggregate by month
Maine.month.ts <- ts(unemploy, start = c(1996, 1), freq = 12)
```

(c) Plot the monthly time series What do you observe?

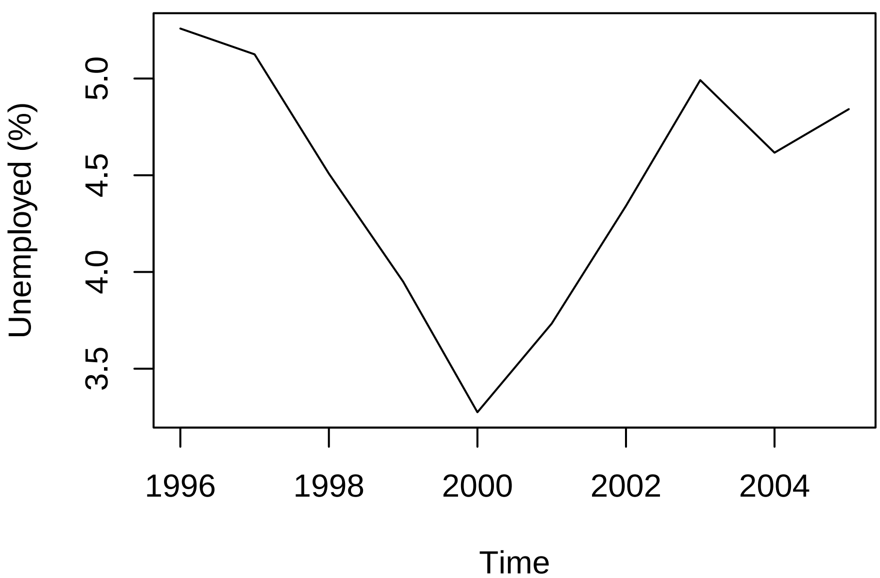
```
plot(Maine.month.ts, ylab = "Unemployed (%)")
```



In the monthly time series, we see that from the start date in 1996, the secular trend roughly decreased until sometime after 2000, to slightly increase again until it appears to have reached a steady rate from the years 2003 to 2006.

(d) Plot the annual time series. Does this confirm your answer in part (c)?

```
## Create new time series
## Since 'Maine.month.ts' is aggregated by month, divide by 12 for year
Maine.annual.ts <- aggregate(Maine.month.ts)/12

plot(Maine.annual.ts, ylab = "Unemployed (%)")
```



The annual time series confirms what we saw in the monthly trends in part (c). From the start date, the unemployment rate decreases until around 2000, only to increase to roughly return to its start point in 1996.

(e) Use the `window()` function to sample the original time series for the months of Jan and Jul (separately).

```
## January Sample
Maine.Jan <- window(Maine.month.ts, start = c(1996, 1), freq = T)
Jan.ratio <- mean(Maine.Jan) / mean(Maine.month.ts)

## July Sample
Maine.Jul <- window(Maine.month.ts, start = c(1996, 7), freq = T)
Jul.ratio <- mean(Maine.Jul) / mean(Maine.month.ts)
```

(f) On average, how much higher than average is the unemployment rate in Jan? How much lower than average is the unemployment rate in Jul?

```
Jan.ratio
```

```
## [1] 1.208314
```

On average, the unemployment rate in January was 20.83% higher than the aggregated monthly average.

```
Jul.ratio
```

```
## [1] 0.9158813
```

On average, the unemployment rate in July was 8.42% lower than the aggregated monthly average.

PROBLEM 2: Global temperature series

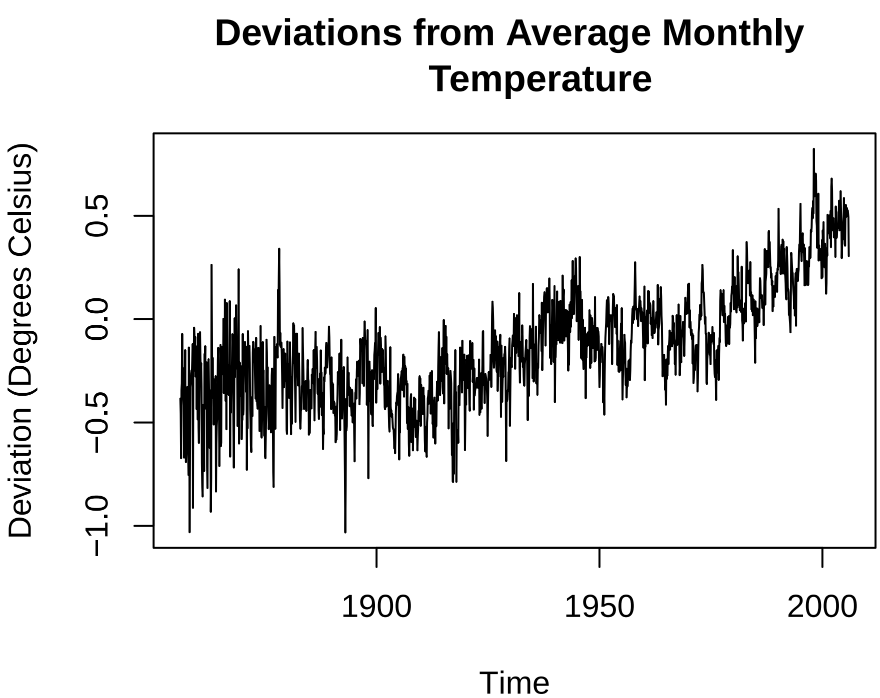
A change in the world's climate will have a major impact on the lives of many people, as global warming is likely to lead to an increase in ocean levels and natural hazards such as floods and droughts. It is likely that the world economy will be severely affected as governments from around the globe try to enforce a reduction in fossil fuel use and measures are taken to deal with any increase in natural disasters.

In climate change studies, the following global temperature series, expressed as anomalies from the monthly means over the period 1856-2005, are given in `global.dat`.

(a) Use the `scan()` function to read in the data from `global.dat` and assign it to the variable `Global`. Then convert it into a time series, naming it appropriately, and plot it.

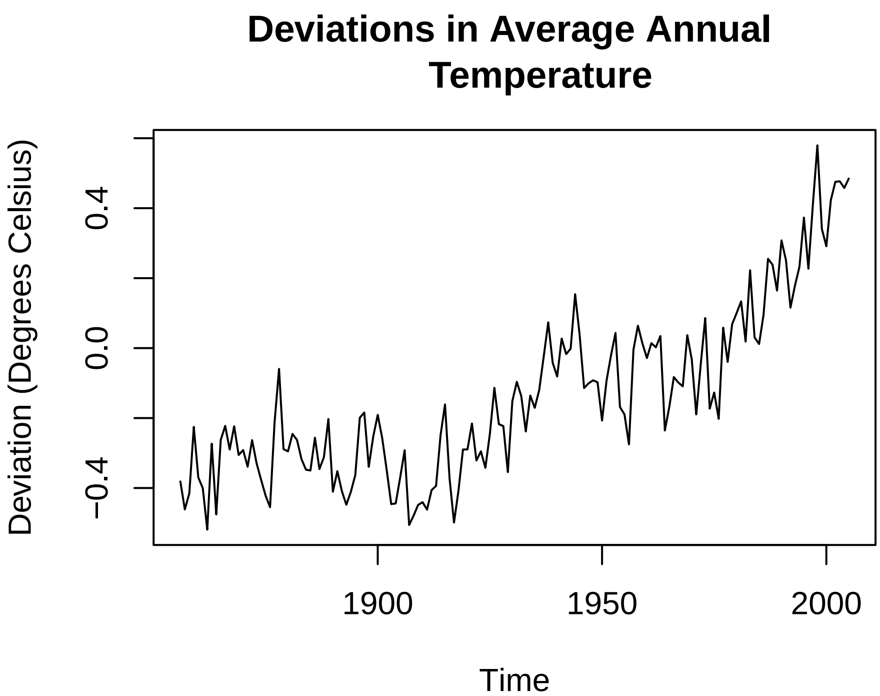
Note that `scan()` is used instead of `read.table()` because `global.dat` does not have a header.

```
Global <- scan("global.dat")
Global.month.ts <- ts(Global, start = c(1856, 1),
                      end = c(2005, 12), freq = 12)

plot(Global.month.ts, main = "Deviations from Average Monthly
     Temperature", ylab = "Deviation (Degrees Celsius)")
```



(b) Use the `aggregate()` function to remove any seasonal effects within each year and produce an annual series of mean temperatures for the period 1856 to 2005. Then plot the annual series.

```
Global.annual.ts <- aggregate(Global.month.ts, FUN = mean)

plot(Global.annual.ts, main = "Deviations in Average Annual
     Temperature", ylab = "Deviation (Degrees Celsius)")
```

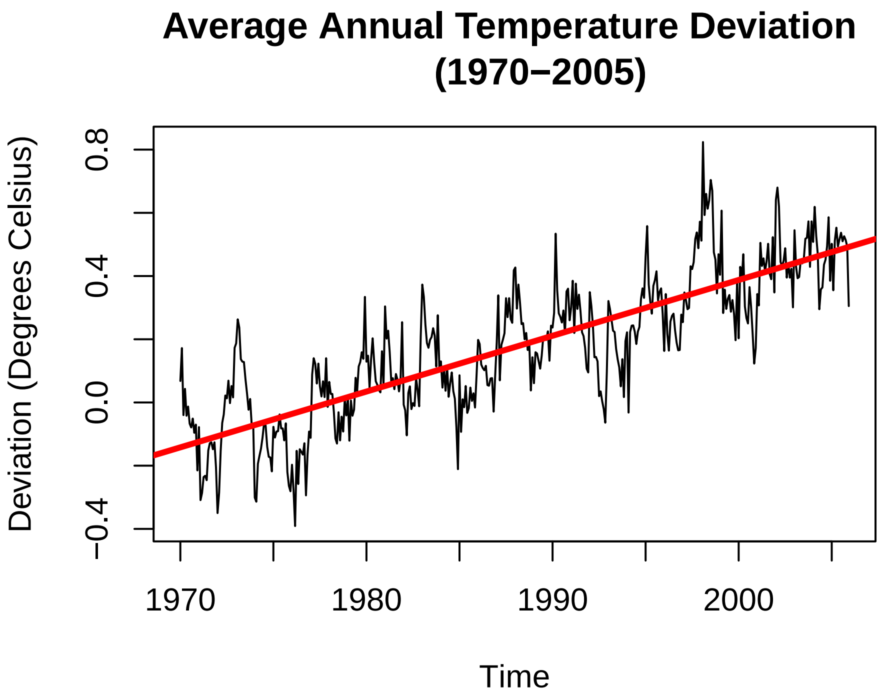


(c) At approximately which points on the graph of the annual series do you see a change in the series?

A noticeable change in the series occurs at around the year 1910 (about $t = 50$) and again at around the year 1960 ($t = 100$). Both of these changes result in drastic increases in the deviation of average annual temperature, suggesting global warming is a real phenomenon.

(d) Create a new series for the time period 1970-2005 using the `window()` function. Then extract the corresponding monthly time intervals corresponding to the 36-year period 1970-2005 using the `time()` function. Then plot the new series and a superimposed regression line using a regression of temperature on the new time index. What do you observe?

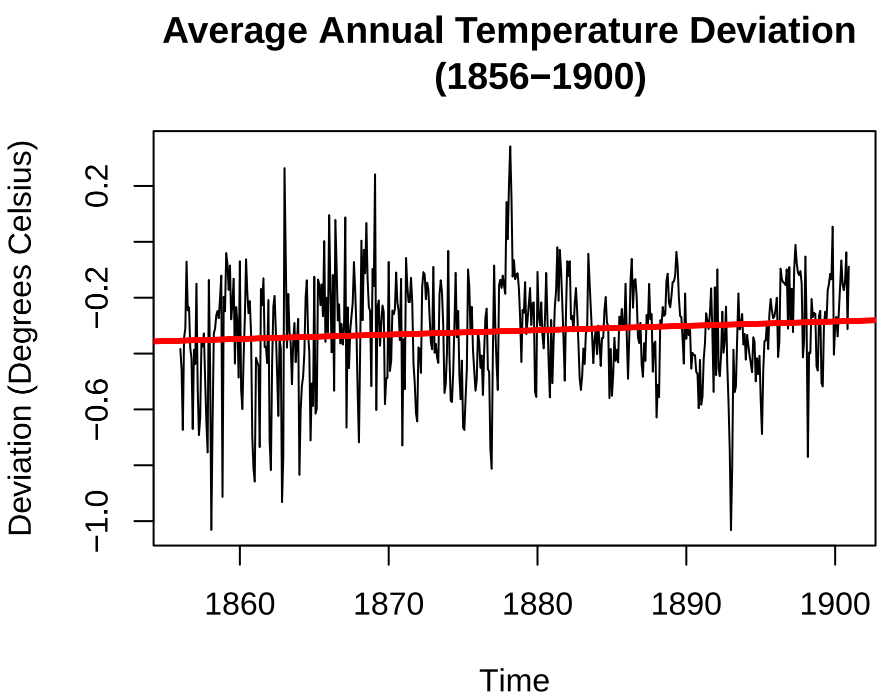
```
## Time Series 1970-2005
last36yrs <- window(Global.month.ts, start = c(1970, 1),
                    end = c(2005, 12))

## Extract months for regression line
last36yrs.time <- time(last36yrs)

## Plot
plot(last36yrs, main = "Average Annual Temperature Deviation
     (1970-2005)", ylab = "Deviation (Degrees Celsius)")

## Superimpose Regression onto plot
abline(reg = lm(last36yrs~last36yrs.time),
       col = "red", lwd = 3)
```



From the fitted regression line, I observe a strong positive correlation, implying a strong positive secular trend, between Time and Deviation, with most of the values for the Deviation being positive. This implies that the average temperature is increasing, suggesting that global warming is real.

(e) Create a new series for the time period 1856-1900 using the `window()` function. Then extract the corresponding monthly time intervals corresponding to that same period using the `time()` function. Then plot the new series and a superimposed regression line using a regression of temperature on the new time index. Do you observe the same behavior in temperature difference here that you did for the time period 1970-2005?

```
## Time Series 1856 -- 1900
first45yrs <- window(Global.month.ts, start = c(1856, 1),
                     end = c(1900, 12))

## Extract months for regression line
first45yrs.time <- time(first45yrs)

##Plot
plot(first45yrs, main = "Average Annual Temperature Deviation
     (1856-1900)", ylab = "Deviation (Degrees Celsius)")

## Superimpose Regression onto plot
abline(reg = lm(first45yrs~first45yrs.time),
                col = "red", lwd = 3)
```



I do not observe the same behavior. This suggests that temperatures were not rising on above like from 1970 to 2005. Also, although the super-imposed regression line's slope is still positive, it is significantly less than that for the years 1970 - 2005. This suggests that there was very little correlation between average temperature deviation and time for these years, implying that the overall change in deviation was smaller from 1856-1900 than from 1970-2005.