Assignment 1

Eisha Asim

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Assignment 1

Answer the question using the data file. It is an artificial time series from 1950 to 2020. For the exercise, we assume that it is a series of consumption expenditure in thousands of dollars. For each chart that you create, add a main title and axis titles. When the chart contains more than one line, use a different color and shape for each line and add a legend.

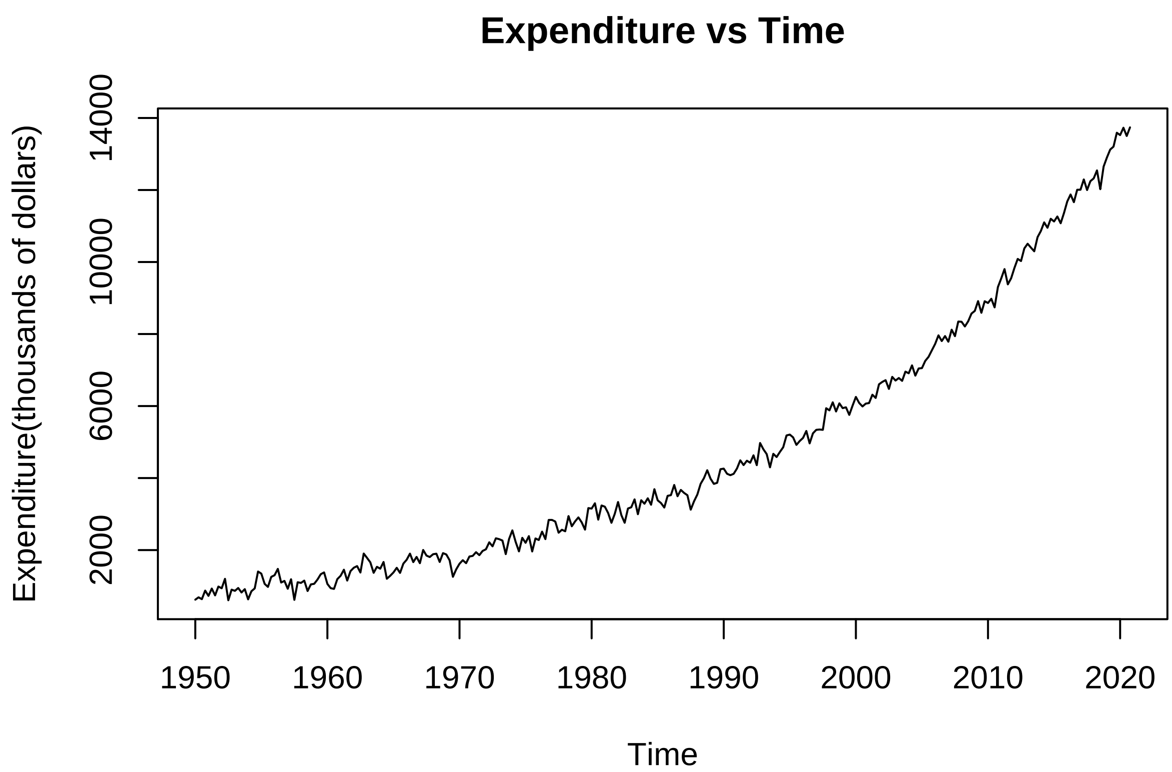
Import Data and Convert to Time series data

```
# Import data
imported_data <- read.csv("assignment_data/dat138.csv")
dat138 <- imported_data[,3]
dat138_ts <- ts(dat138, frequency=4, start=1950) # convert to time series object

dat138_t <- time(dat138_ts) # Decimal dates
```

Part A: Visualization

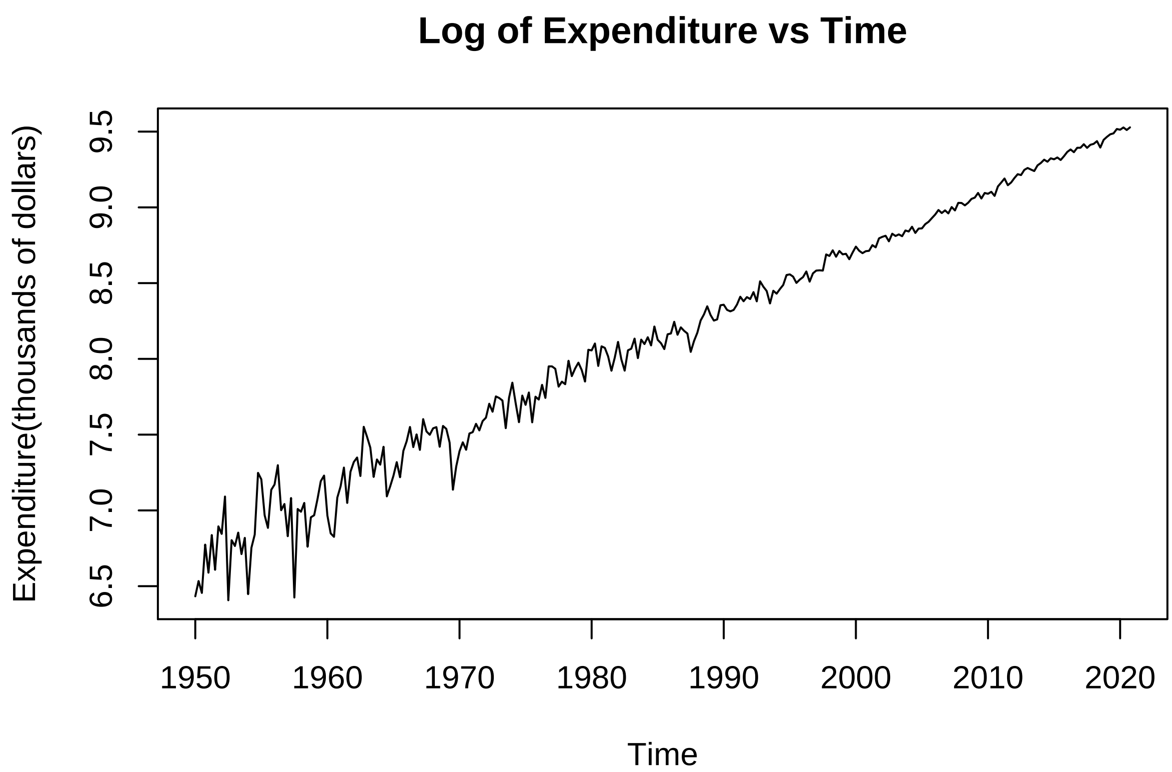
1. Plot the series using a line chart. Briefly describe what you see: Is it a positive or negative trend? Is the trend increasing? What kind of short term fluctuations do you observe?

```
# Plot the series using a line chart
plot(dat138_ts,
     ylab="Expenditure(thousands of dollars)", # y axis title
     xlab = "Time", # x axis title
     main="Expenditure vs Time" # main chart title
     )
```



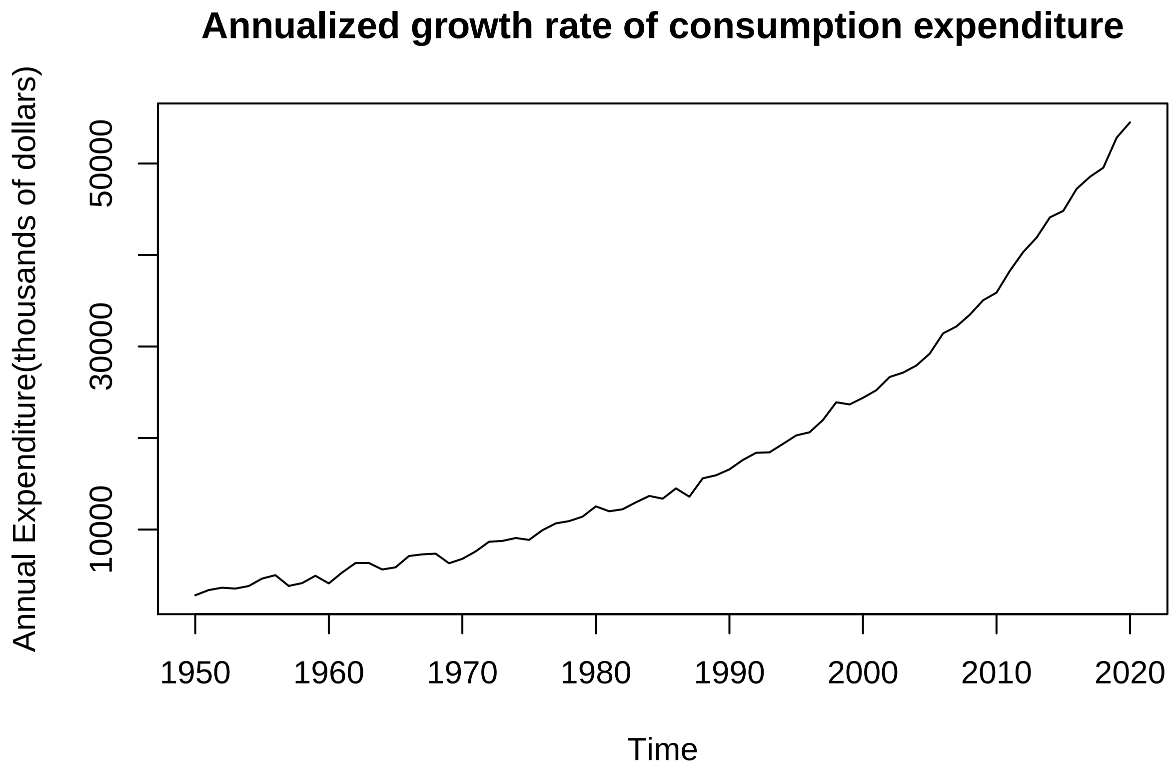
2. Answer the previous question using the log-scale. Can you tell if the growth rate is increasing or decreasing on average over the period?

```
# Plot the series using a line chart
plot(log(dat138_ts),
     ylab="Expenditure(thousands of dollars)", # y axis title
     xlab = "Time", # x axis title
     main="Log of Expenditure vs Time" # main chart title
     )
```



3. To better see how the growth rate evolves through time, plot the annualized growth rate of consumption expenditure. Describe what you see. Is it constant on average?

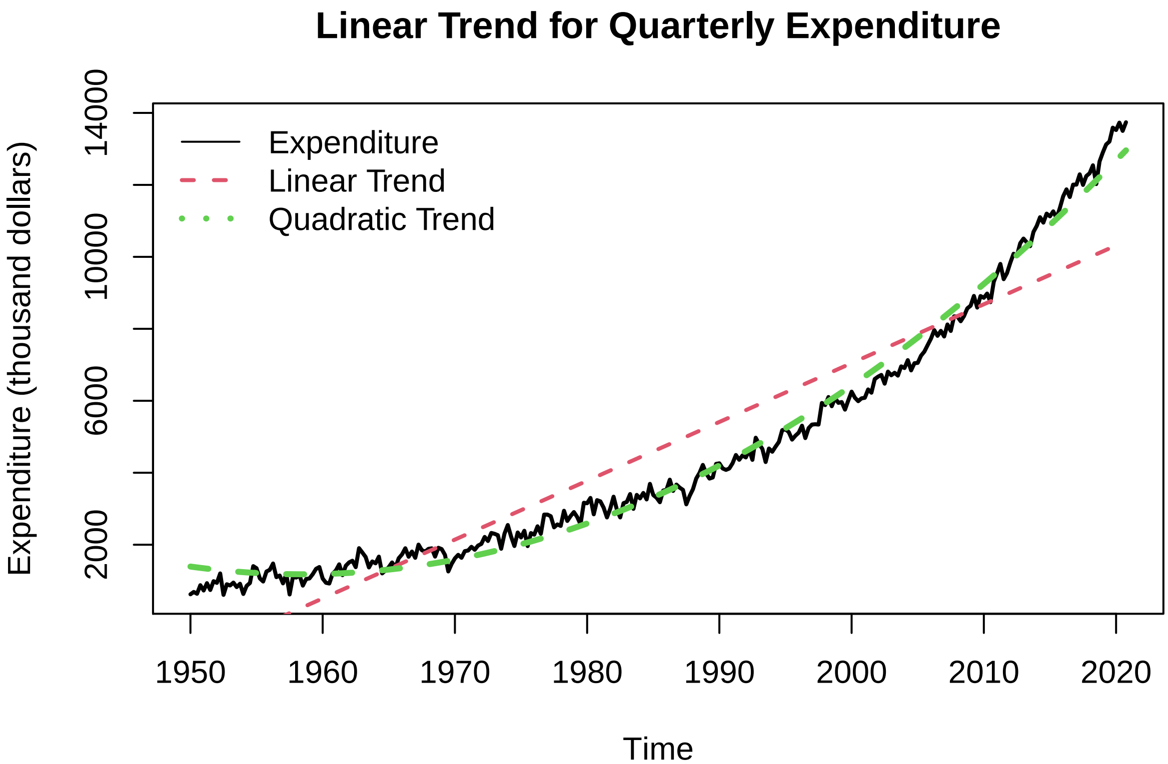
```
# create annualized data
dat138Y <- aggregate(dat138_ts, nfrequency = 1, FUN = sum)

# Plot the series using a line chart
plot(dat138Y,
     ylab="Annual Expenditure(thousands of dollars)", # y axis title
     xlab = "Time", # x axis title
     main="Annualized growth rate of consumption expenditure" # main chart title
     )
```



Part B: Time Series Decomposition

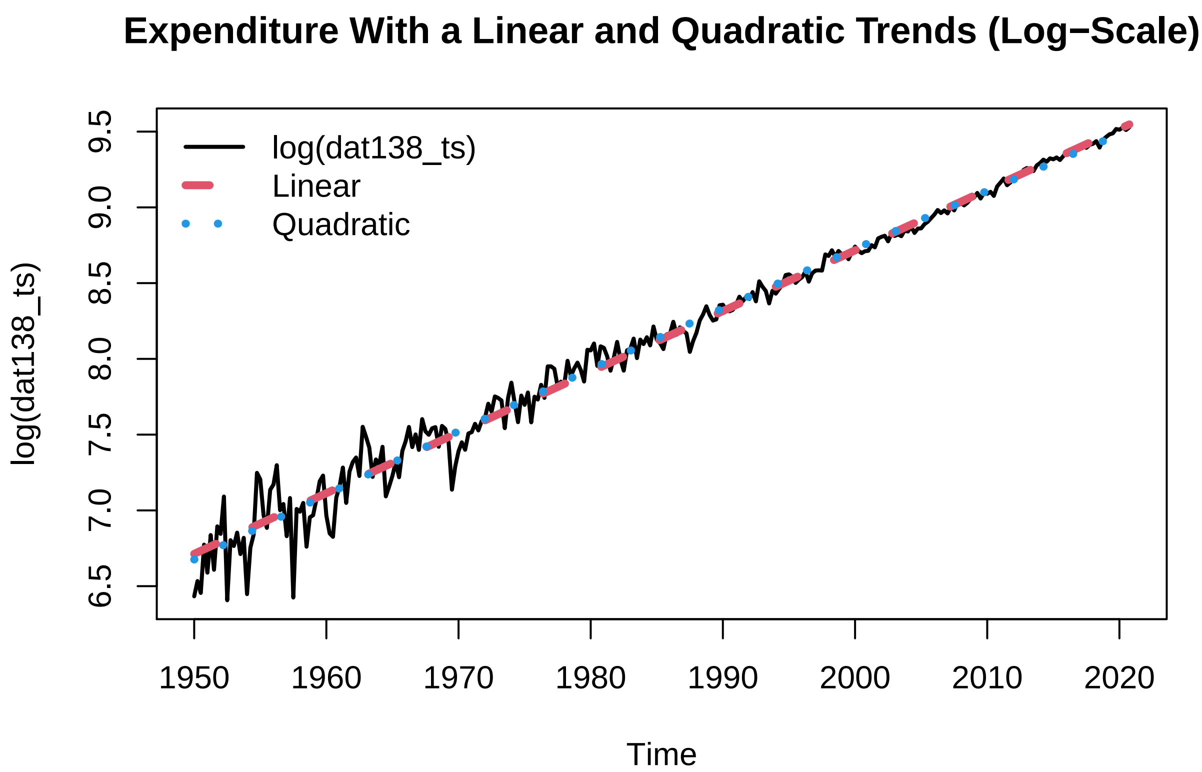
1. Fit a linear and quadratic trends to your series. Then, create a line chart with your original series and the two trends. Which trend seems to best fit the series? Explain.

```
dat138coefT <- coef(lm(dat138_ts~dat138_t))
trend <- dat138coefT[1] + dat138coefT[2]*dat138_t

dat138_t2 <- dat138_t^2
dat138coefT2 <- coef(lm(dat138_ts~dat138_t+dat138_t2))
trend2 <- dat138coefT2[1] + dat138coefT2[2]*dat138_t + dat138coefT2[3]*dat138_t2

plot(dat138_ts,
     ylab="Expenditure (thousand dollars)",
     main="Linear Trend for Quarterly Expenditure",
     lwd=2)
lines(trend, col=2, lty=2, lwd=2)
lines(trend2, col=3, lty=2, lwd=3)
legend("topleft", c("Expenditure","Linear Trend","Quadratic Trend"), col=1:3,
       lty=1:3, lwd=1:3, bty='n')
```



2. Fit a linear and quadratic trends to the log of your series. Then, create a line chart with the log of your series and the two trends. Which trend seems to best fit the series? Do you see a difference between the best trend in this question and in the previous one? Explain.

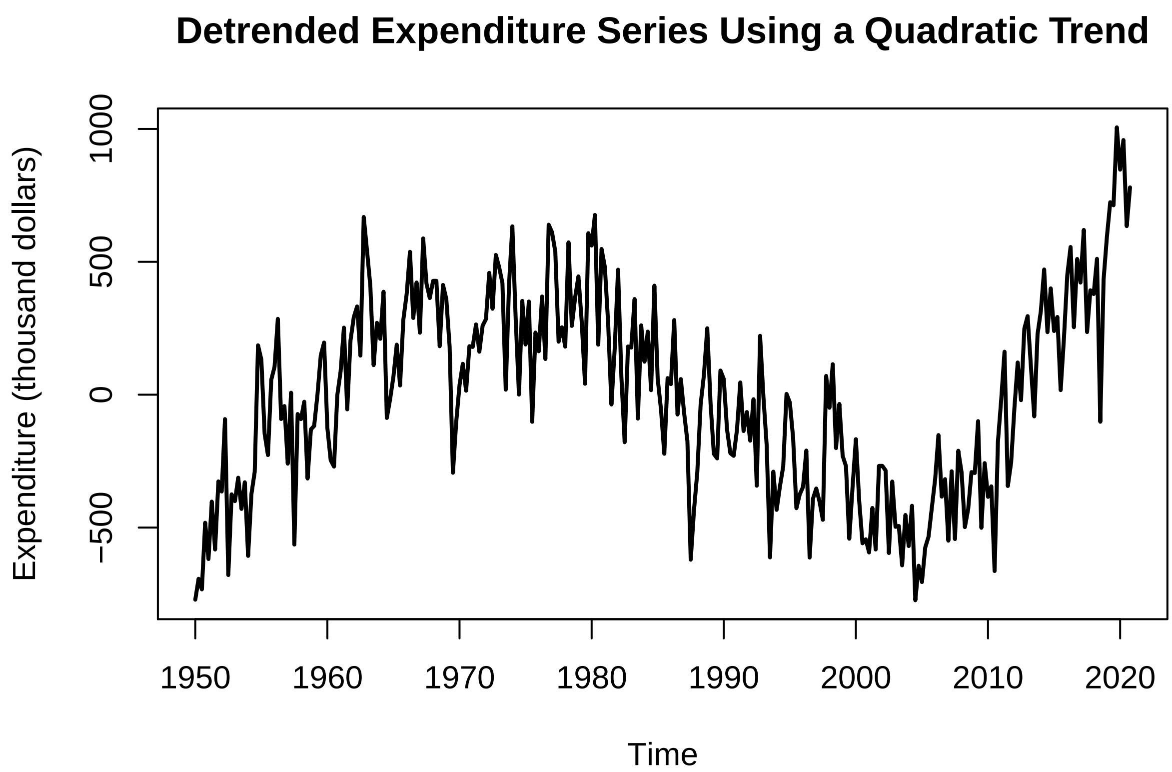
```
ldat183 <- log(dat138_ts)

lcoefT <- coef(lm(ldat183~dat138_t)) ## linear coefficients
lcoefT2 <- coef(lm(ldat183~dat138_t+dat138_t2)) ## quadratic coefficients
ltrend <- lcoefT[1] + lcoefT[2]*dat138_t ## linear trend
ltrend2 <- lcoefT2[1] + lcoefT2[2]*dat138_t + lcoefT2[3]*dat138_t2 ## quadratic trend
plot(ldat183, lwd=2, main="Expenditure With a Linear and Quadratic Trends (Log-Scale)",
     ylab="log(dat138_ts)")
lines(ltrend, col=2, lty=2, lwd=4)
lines(ltrend2, col=4, lty=3, lwd=4)
legend("topleft", c("log(dat138_ts)", "Linear","Quadratic"), col=c(1,2,4), lty=1:3,
       lwd=c(2,4,4), bty='n')
```



Answer the following questions using the log of your series and the trends computed in question 2.

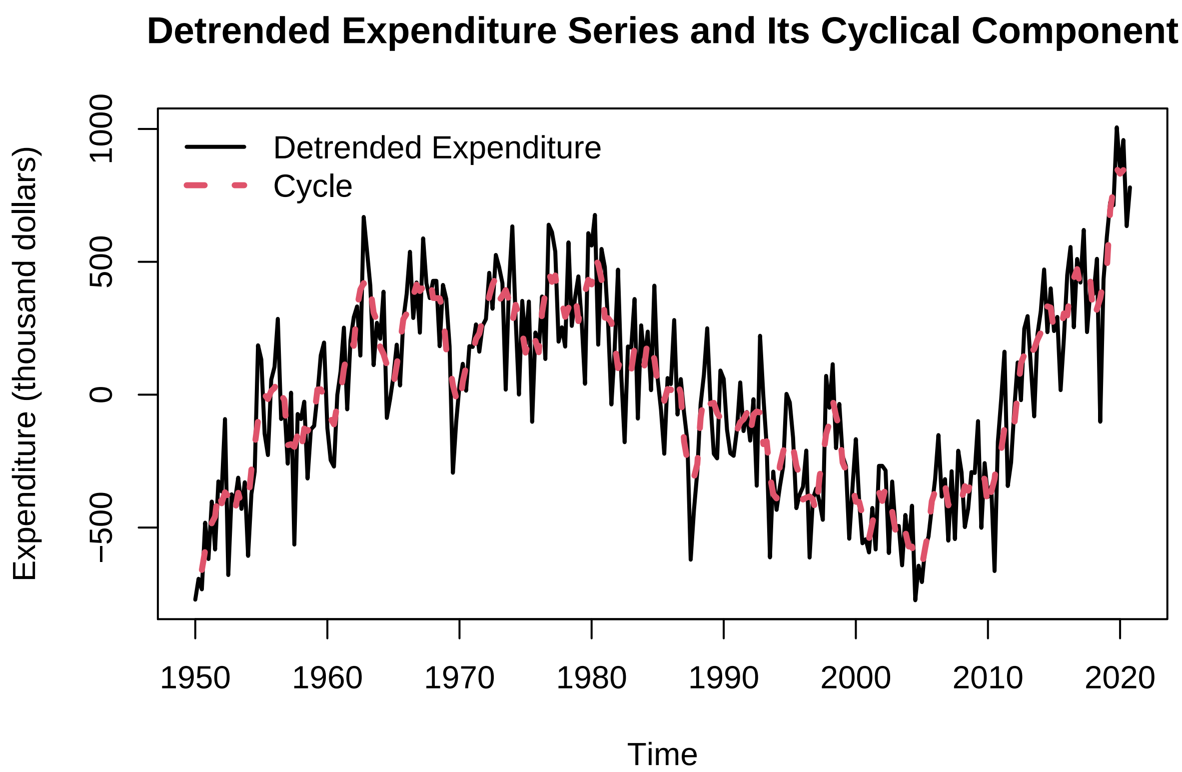
3. Plot the detrended series using the trend that best fit the series. Briefly describe what you see: Do you better detect short term fluctuations?

```
#plot(dat138_ts-trend, lwd=2,main="Detrended Expenditure Series Using a Linear Trend", #ylab="Expenditu


plot(dat138_ts-trend2, lwd=2,
     main="Detrended Expenditure Series Using a Quadratic Trend",
     ylab="Expenditure (thousand dollars)")
```



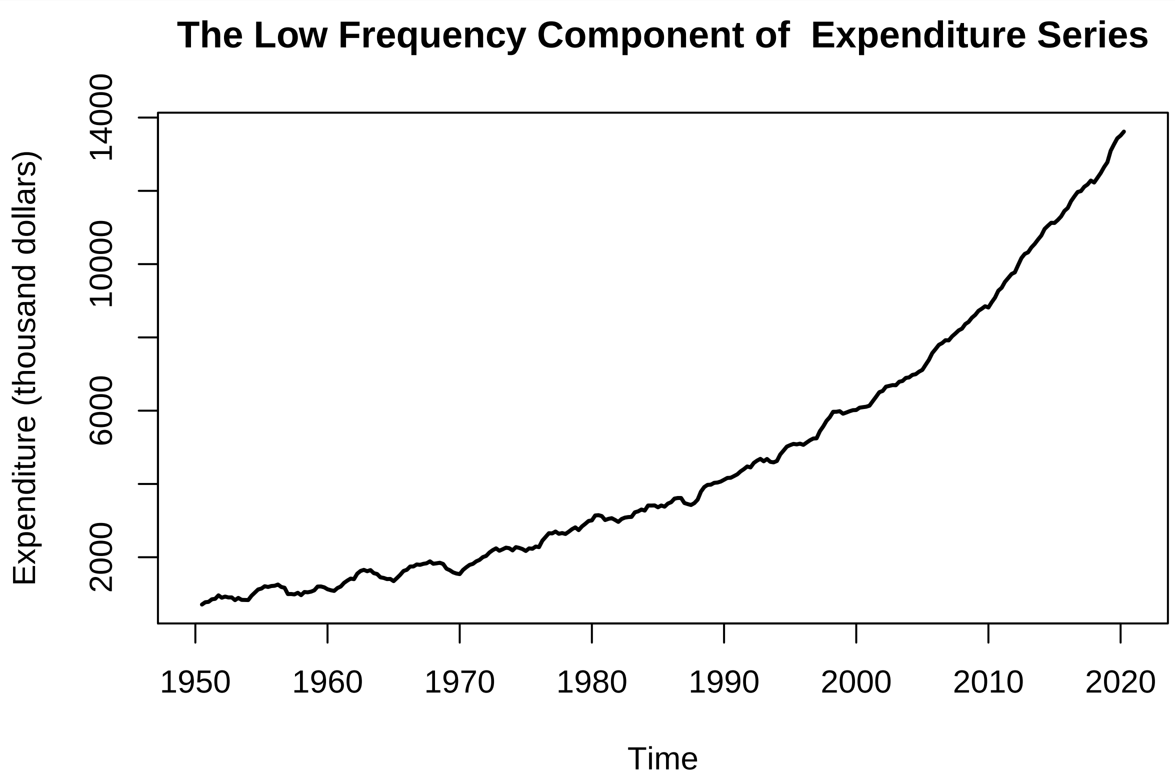
4. Using a moving average of order 5, compute the cyclical component of your series. Then, plot the cycle and briefly describe what you see: interpret the values of some peaks and troughs.

```
CSI <- dat138_ts-trend2
C <- filter(CSI, filter=rep(1/5,5))

plot(CSI, lwd=2,
     main="Detrended Expenditure Series and Its Cyclical Component",
     ylab="Expenditure (thousand dollars)")
lines(C, col=2, lwd=3, lty=2)
legend("topleft", c("Detrended Expenditure", "Cycle"), col=1:2, lty=1:2,
       lwd=2:3, bty='n')
```



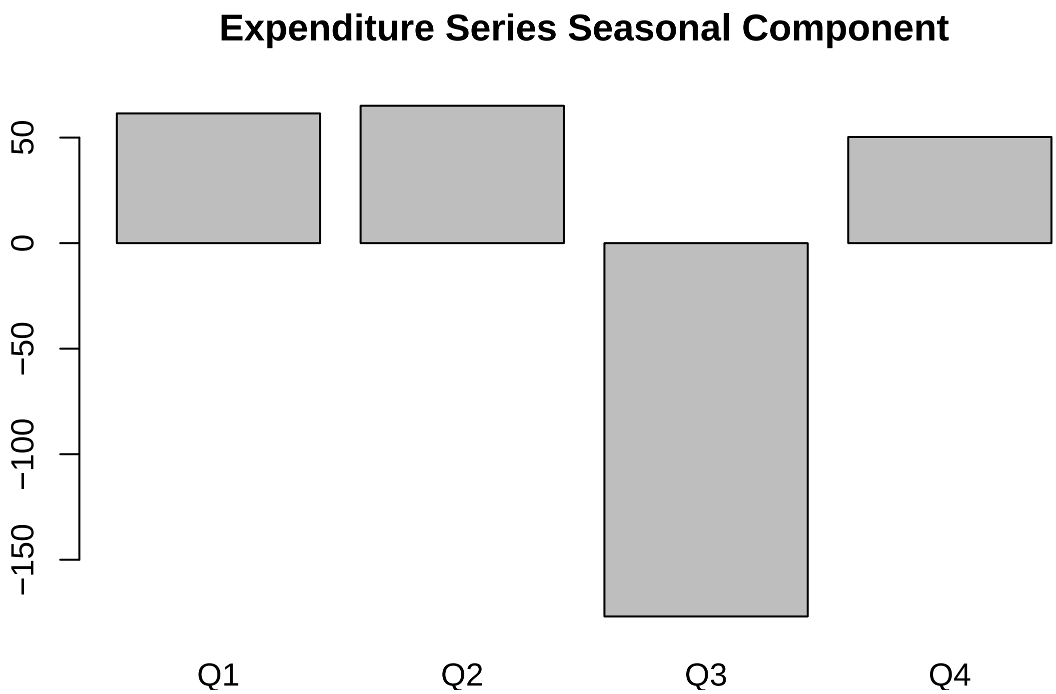
5. Plot the low frequency of your series and briefly describe what you see.

```
CT <- trend2+C
plot(CT, lwd=2,
     main="The Low Frequency Component of  Expenditure Series",
     ylab="Expenditure (thousand dollars)")
```



6. Compute the seasonal component and represent it on a bar chart (only the 4 quarters). Interpret the four seasonal values.

```
Dec <- decompose(CSI, filter=rep(1/5,5))

S <- Dec$figure
barplot(S, main="Expenditure Series Seasonal Component",
        names.arg=c("Q1","Q2","Q3","Q4"))
```

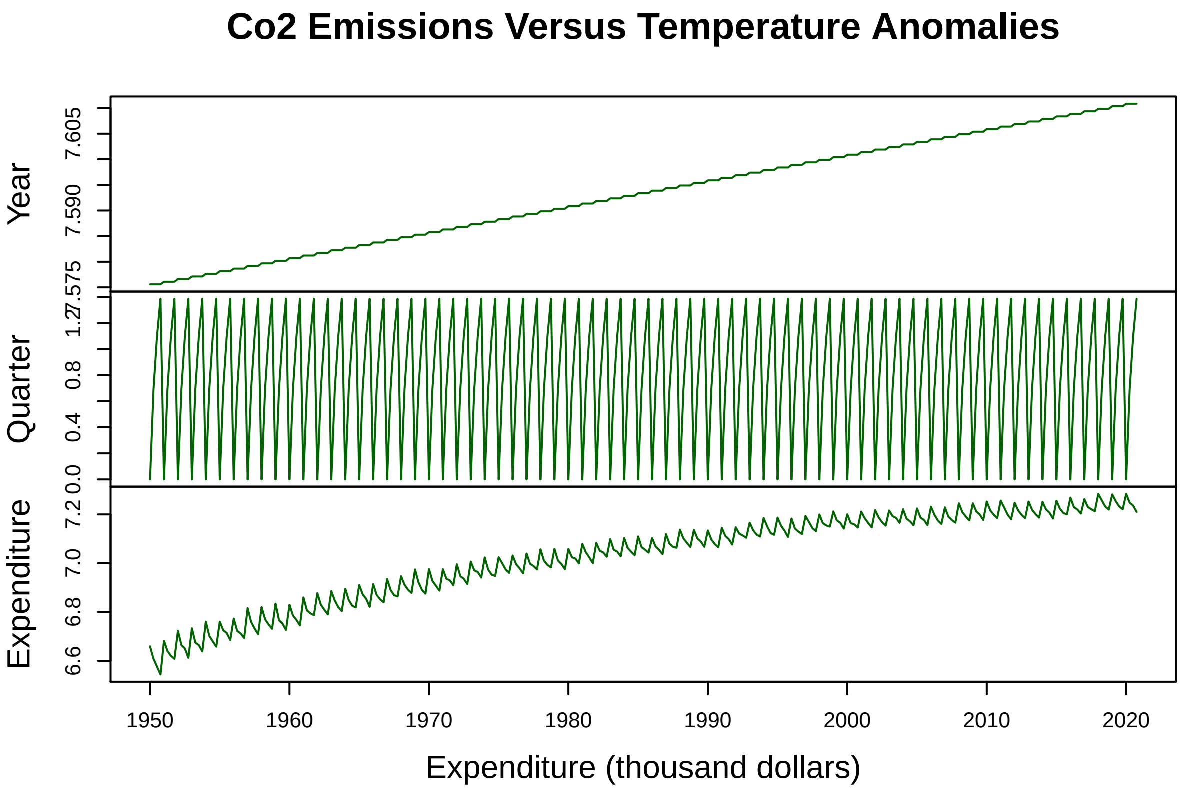


Part C: Comovement

For this part, select any other series in the file assignment1.zip and answer the following questions:

- Create a scatter plot of your series expressed in logs against the selected series also expressed in logs.
- Using the log of the selected series, compute its cyclical component. Then create a scatter plot of this cycle with the cycle of your series computed in Part B.
- Looking at the two scatter plots, what can you say about the type of comovement between the two series?

```
dat1 <- read.csv("assignment_data/dat1.csv")

dat1_ts <- ts(dat1, frequency=4, start=1950)
dat1 <- dat1[,3]
ldat1 <- log(dat1_ts)

plot(ldat1, pch="*", col="darkgreen",
     xlab="Expenditure (thousand dollars)",
     ylab="Temperature (0.1 degree Celsius)",
     main="Co2 Emissions Versus Temperature Anomalies")
```




```
plot(ldat1,
     xy.labels=FALSE, xy.lines=FALSE,
     xlab="Precipitation (mm)",
     ylab="Temperature (degree Celsius)",
     main="Maximum Temperature Versus Total Precipitation")
```

Maximum Temperature Versus Total Precipitation