EC 513 Problem Set 3

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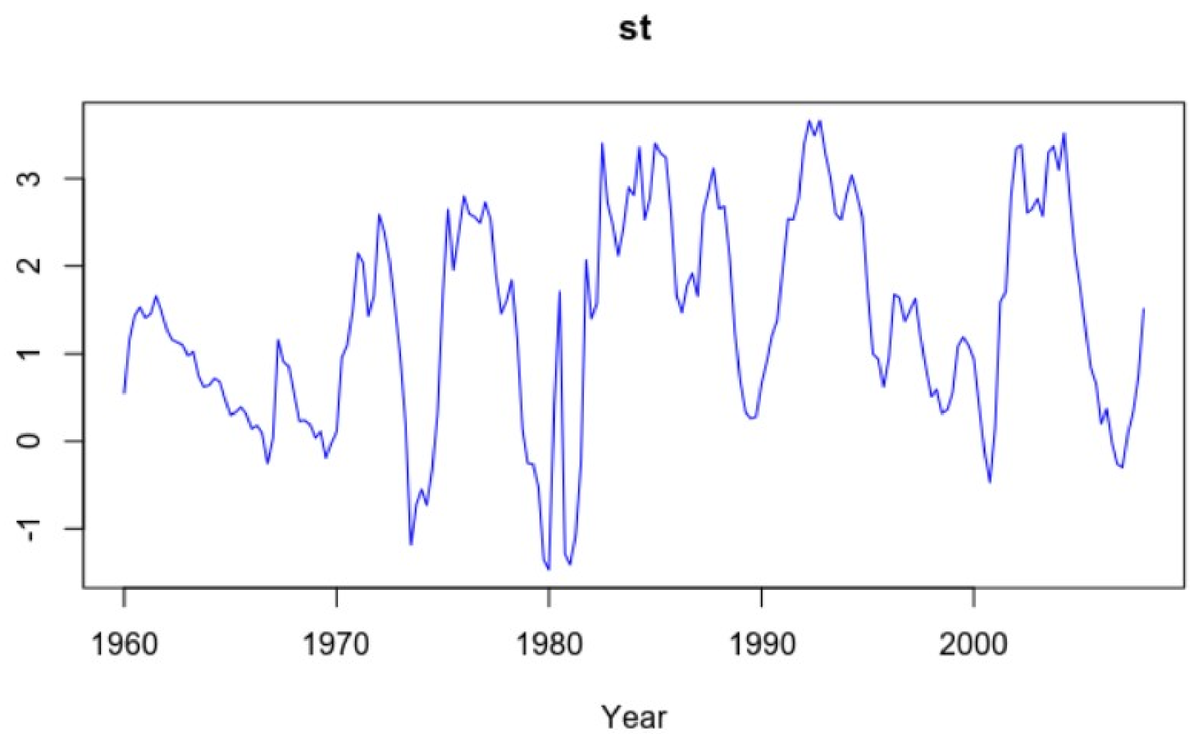
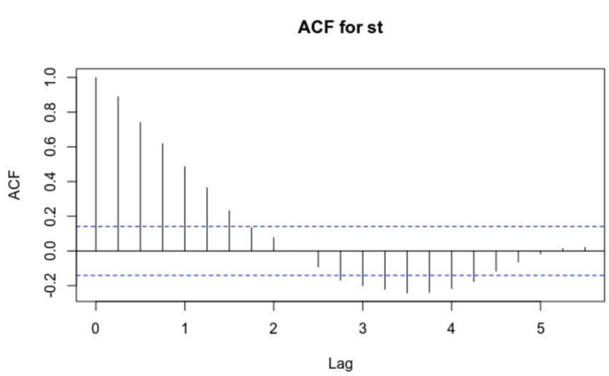
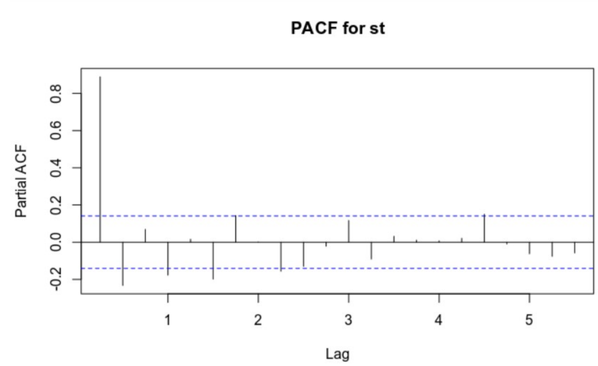
1a. The mean and variance appear relatively constant, so it does seem to be a stationary time series.



b. The decay of the ACF indicates an AR(p) model. Many possibly significant spikes in the PACF means we might have to test multiple models to find the one with the best fit.



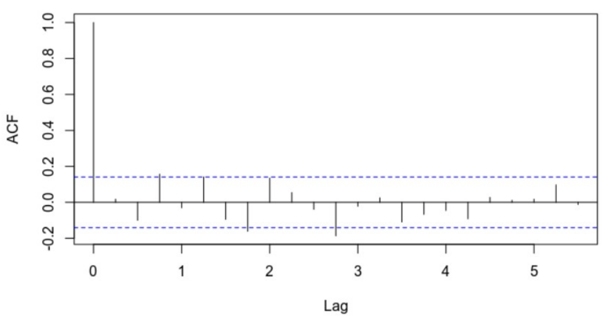


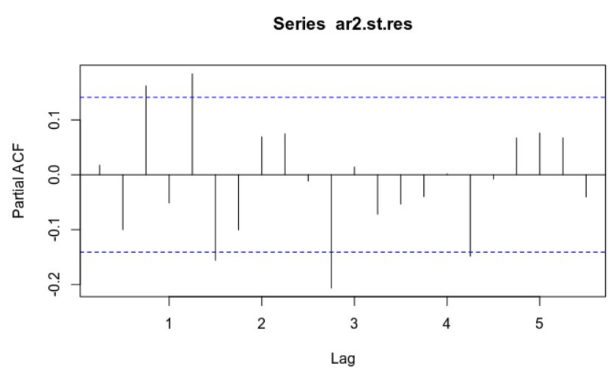
c.

```
> ar2.st
Series: st.ts
ARIMA(2,0,0) with non-zero mean

Coefficients:
         ar1      ar2    mean
      1.1055  -0.2446  1.3589
s.e.  0.0700   0.0700  0.2692

sigma^2 estimated as 0.2874:  log likelihood=-152.87
AIC=313.74   AICc=313.95   BIC=326.79
```

d. With this Q-statistic it is probable that we will have to reject the null; there may be a better model.

```
Box-Ljung test
data:  ar2.st.res
X-squared = 0.059467, df = 1, p-value = 0.8073
```



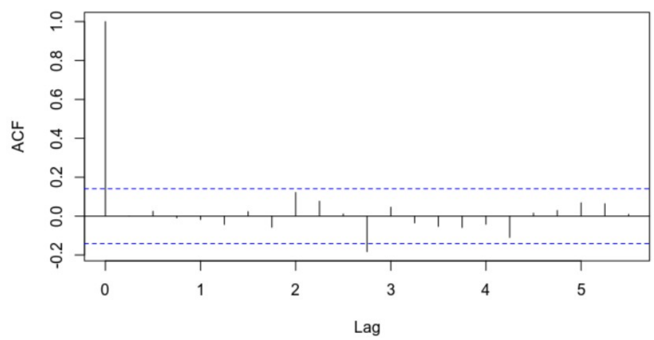


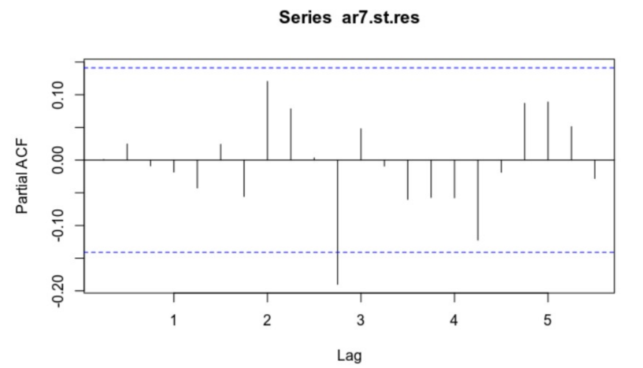
e.

```
> ar7.st
Series: st.ts
ARIMA(7,0,0) with non-zero mean

Coefficients:
         ar1      ar2     ar3      ar4     ar5      ar6     ar7    mean
      1.1759  -0.4691  0.3864  -0.3373  0.3175  -0.3748  0.1483  1.3686
s.e.  0.0713   0.1076  0.1103   0.1106  0.1094   0.1063  0.0707  0.2338

sigma^2 estimated as 0.2649:  log likelihood=-142.71
AIC=303.42   AICc=304.4   BIC=332.78
```

f. With this Q-statistic, we do not have to reject the null.

```
Box-Ljung test
data:  ar7.st.res
X-squared = 0.00016799, df = 1, p-value = 0.9897
```





g. Given the Q-statistic on the residuals, the AIC and the BIC, the AR(7) is superior model.

h. Here, e.hat is the AR(2) error and e.hat2 is the AR(7) error. These were found by differencing the predicted y value from the actual value, as seen in the highlighted portion of the code below.

```
> e.hat
[1] -1.340398
> e.hat2
      ar1
-1.108458
```

i. This time, I created a list of residual values for the next 10 steps ahead, then averaged the residuals squared. Using previously predicted values for future predictions (rather than the actual values), we get a much higher mean error.

```
> mean(e.hat2^2)
[1] 42.92409
> mean(e.hat^2)
[1] 37.58308
```

```
## PS 3

 ## clear memory
 rm(list=ls())

data.df <- read.csv("~/Downloads/1607.csv",header=TRUE, sep=",")
tb3mo.ts <- ts(data=data.df[c("Tbill")], frequency=4, start=c(1960,1), end=c(2008,1))
r10.ts <- ts(data=data.df[c("r10")], frequency=4, start=c(1960,1), end=c(2008,1))
st.ts <- r10.ts-tb3mo.ts;
#a
```

```
plot(st.ts, col="blue", ylab="r10-Tbill", main="st", xlab="Year")
#b
acf(st.ts, main="ACF for st")
pacf(st.ts, main="PACF for st")
#c
ar2.st <- Arima(st.ts, order=c(2,0,0), method = "ML")
ar2.st
#d
ar2.st.res <- st.ts - fitted(ar2.st)
acf(ar2.st.res)
pacf(ar2.st.res)
Box.test(ar2.st.res,type="Ljung")
#e
ar7.st <- Arima(st.ts, order=c(7,0,0), method = "CSS-ML")
ar7.st
#f
ar7.st.res <- st.ts - fitted(ar7.st)
acf(ar7.st.res)
pacf(ar7.st.res)
#g
Box.test(ar7.st.res,type="Ljung")

#Part h
tb3mo.ts2 <- ts(data=data.df[c("Tbill")], frequency=4, start=c(1960,1), end=c(2005,3))
r10.ts2 <- ts(data=data.df[c("r10")], frequency=4, start=c(1960,1), end=c(2005,3))
st.ts2 <- r10.ts2-tb3mo.ts2;
ar2.st2 <- Arima(st.ts2, order=c(2,0,0), method = "CSS-ML")
yt.hat <- 1.3867 + ar2.st2$coef[1]*st.ts2[183] + ar2.st2$coef[2]*st.ts2[182]
e.hat <- st.ts[184]-yt.hat
ar7.st2 <- Arima(st.ts2, order=c(7,0,0), method = "CSS-ML")
ar7.st2
yt.hat2 <- ar7.st2$coef[1]*st.ts2[183] + ar7.st2$coef[2]*st.ts2[182] + ar7.st2$coef[3]*st.ts2[181] +
ar7.st2$coef[4]*st.ts2[180] + ar7.st2$coef[5]*st.ts2[179] + ar7.st2$coef[6]*st.ts2[178]  +
ar7.st2$coef[7]*st.ts2[177] + ar7.st2$coef[8]
e.hat2 <- st.ts[184]-yt.hat2
e.hat
e.hat2
#Part i
list <- as.numeric(st.ts2)
for (h in 1:10){
  yt.hat2[h] <- 0
  yt.hat2[h] <- 1.1789*list[183+h-1] - 0.471*list[182+h-1] + 0.392*list[181+h-1] - 0.345*list[180+h-1]
+0.324*list[179+h-1] - 0.383*list[178+h-1]  + 0.152*list[177+h-1] + 1.389
#  yt.hat2[i] <- ar7.st2$coef[1]*list[183+i-1] + ar7.st2$coef[2]*list[182+i-1] +
ar7.st2$coef[3]*list[181+i-1] + ar7.st2$coef[4]*list[180+i-1] + ar7.st2$coef[5]*list[179+i-1] +
ar7.st2$coef[6]*list[178+i-1]  + ar7.st2$coef[7]*list[177+i-1] + ar7.st2$coef[8]
  e.hat2[h] <- st.ts[183+h]-yt.hat2[h]
  list[183+h] <- yt.hat2[h]
}
```

```
yt.hat2
e.hat2

list <- as.numeric(st.ts2)
for (h in 1:10){
  yt.hat[h] <- 0
  yt.hat[h] <- 1.3867 + 1.0964*list[183+h-1] - 0.245*list[182+h-1]
  e.hat[h] <- st.ts[183+h]-yt.hat[h]
  list[183+h] <- yt.hat[h]
}
yt.hat
e.hat

mean(e.hat^2)
mean(e.hat2^2)
```