STAT 443 – Winter 2015 – Assignment 4

due Thursday March 26 at the beginning of class

You may work in pairs if you choose; both names and ID numbers should appear on it, and both will receive the same mark. (No extra credit will be given for working alone.)

For any parts involving R, you should hand in the R code and output, as well as your interpretations of the output. You will NOT receive marks for uncommented R code or output.

1. You have the following three data points from a time series: $X_1 = 0.5$, $X_2 = 0.3$, $X_3 = -0.3$. For each of the following proposed $ARMA(p, q)$ models for the process, predict (by hand) the next three values in the series, $\widehat{X_4}$, $\widehat{X_5}$, and $\widehat{X_6}$.

   (a) $AR(1)$ with $\phi = -0.4$

   (b) $MA(1)$ with $\theta = -0.4$

   (c) $AR(2)$ with $\phi_1 = 0.7$ and $\phi_2 = -0.2$

   (d) $MA(2)$ with $\theta_1 = 0.7$ and $\theta_2 = -0.2$

   (e) $ARMA(1, 1)$ with $\phi = 0.4$ and $\theta = 0.5$. When you use innovations, let $U_0 = U_1 = 0$

2. The data in quarterly.txt contains 96 quarterly observations from a seasonal time series for which we propose the simple causal model $Y_t = \beta_0 + \sum_{j=1}^{3} \beta_j X_{t,j} + \epsilon_t$, where $X_{t,1}$, $X_{t,2}$, and $X_{t,3}$ are indicator variables corresponding to the first three quarters. Use the following code to input the data into R and turn it into a time series object.

```
quarterly <- read.table("quarterly.txt")
quarterly <- ts(quarterly[,1], frequency=4)
```

   (a) Plot the data and comment on the apparent appropriateness of the proposed model.

   (b) Fit the regression model above and provide the parameter estimates.

   (c) Perform a complete residual analysis.

   (d) Using the SACF and SPACF of the residuals, propose an $ARMA(p, q)$ model for the residuals. Fit it and check the new residuals.

   (e) Fit the regression model with your chosen model for the residuals to the original data. Comment on the differences in the parameter estimates and the residuals.

   (f) Predict the next two years (8 quarterly observations) under both models and compare them. Which ones should we trust and why?

3. For this question you will need to install the "tseries" package and import some daily stock price data in R. Use the following code to do so:

```
install.packages("tseries")
library("tseries")
rim<-get.hist.quote(instrument="rim",quote="Close")
```

   (a) Plot the entire history of the RIM stock price over time and comment.

   (b) We will focus only on the last 5 years (March 17, 2010 to March 16, 2015). To get a specific time period, add start="2010-03-17", end="2015-03-16" inside the get.hist.quote function. Take the daily RIM stock prices from the last 5 years and create a new time series of the log stock returns. (That is, if Y_t is the price on day t, create the time series $X_t = log(Y_t/Y_{t-1}) = log(Y_t) - log(Y_{t-1})$.)

(c) Plot your time series of log returns and comment on the plot.

(d) Plot the ACF of your time series as well as the ACF of the squares and absolute values of your time series. Does the information in these plots suggest an ARCH/GARCH model would be appropriate? You may have to convert the data to a numerical series rather than a time series to get the ACF function to work, since the original series has missing data on weekends/holidays. To convert, use the as.numeric() command.

(e) Fit an ARCH(1) model to the log returns and comment on the model.

(f) Fit a GARCH(1,1) model to the log returns and comment on the model.

(g) You notice the ACF of the log returns themselves have a negative spike at lag 1. Fit an MA(1) model to the log returns, and then a GARCH(1,1) model to the residuals from the ARIMA model. Comment on the model.