CSC425 – Time series analysis and forecasting

Homework 3
Due on Saturday October 10th, 2015 before 11:59pm
Total points: 25

Reading assignment

- Chapter 2 sections 2.4 and 2.5, 2.6 on AR(p), MA(q) and ARMA(p,q) models
- Chapter 3: section 3.1, and 3.3 (case studies)
- Review course documents posted under week 4.

For R users

- Review notes on R posted under R resources in the Documents page on the course website.
- Useful resources are at http://www.statmethods.net/ and http://www.ats.ucla.edu/stat/R/

PROBLEMS

Problem 0 (not to be graded…just for fun!)
Suppose that the time series follows a MA(1) model: $X_t = a_t + 0.2\, a_{t-1}$, with $\sigma_a = 0.025$. Assume that $a_{100} = 0.01$.

a) Compute the 1-step ahead and the 2-step ahead forecasts of the return at the forecast origin t=100.
b) Also compute the lag-1 and lag-2 autocorrelations of the Ma(1) time series.

Problem 1 [3 pts]
Describe the different behaviors of the ACF functions for an MA(q) model and an AR(p) model, and highlights the main differences.

Problem 2 [20 points]

The Industrial Production Index (INDPRO) is an economic indicator that measures real output for all facilities located in the United States manufacturing, mining, and electric, and gas utilities. Since 1997, the Industrial Production Index has been determined from 312 individual series. The index is compiled on a monthly basis to bring attention to short- term changes in industrial production. Growth in the production index from month to month is an indicator of growth in the industry. Monthly values of the INDPRO index from February 1970 to June 2015 were obtained from the St Louis Federal Reserve Bank. The dataset contains two variables: date, growth. The following problem focuses on building a TS model for the **index growth** series.

a) Import the data in R and create a time object for the growth variable using the ts() function (where the starting date is second month of 1970, and frequency is set equal to 12)
b) Create the time plot of the index growth rate X_t and analyze trends displayed by the plot?
c) Analyze the distribution of growt. Can you assume that growth is normally distributed?
d) Analyze the first 15 lags of ACF for growth and discuss if time series can be considered stationary.

e) Analyze the ACF and the PACF functions and determine which model seems more appropriate to describe the time series. Does the process show clear AR behavior or MA behavior, or neither? Explain your answer.

f) Use the BIC criterion to identify orders p and q of an initial model in the ARMA(p,q) family. What is the selected model? (*in R, use the auto.arima(var, ic="bic") in the forecast package with the option* ***ic="bic".*** *The default setting for the function is to use the AIC criterion.)*

g) *MODEL M1*: Fit the model selected by the BIC criterion and apply the diagnostic methods to evaluate goodness of fit of the model: examine if model coefficients are significant, and perform residual analysis. Discuss if this model provides a good fit for the data.

h) *MODEL M2*: Identify a possible order **p** for an AR(p) model and fit an AR(p) model for index growth (growth) time series. Examine the significance of the model coefficients and analyze the residuals to check adequacy of the model. Finding an appropriate model is an iterative process. If you are not satisfied with your initial model, modify it and find a more adequate model.

i) *MODEL M3*: Fit an MA(4) model for the index growth (growth) time series. Examine the significance of the model coefficients and analyze the residuals to check adequacy of the model. Discuss if this model provides a good fit for the data.

j) Compute up to 5-step ahead forecasts for each of the three models, and compare them. Are they close in value?

k) Now write down the expressions for the three models M1, M2 and M3

"Reflection" Problem [2 pts]

Post a message on the discussion board reflecting on the topics in week 4. Indicate the assignment in this module you found to be the easiest, the one you found to be the hardest, and why.

Submission instructions

Submit the homework at the Course Web page http:d2l.depaul.edu in the Dropbox page. Keep a copy of all your submissions!

1. Submit your answers in a word or pdf document. Make sure to explain in detail your analyses, and include relevant output and graphs. You should attach code to your submission or past code in your word document.
2. If you have questions about the homework, email me BEFORE the deadline.
3. The assignment will lose 10% of the points per day, after the due date.
4. Assignments submitted five days after the deadline will not be accepted.