# Time Series Exercise: Bitcoin Price

Bitcoin is a form of digital currency, created and held electronically. No one controls it. Bitcoins aren’t printed, like dollars or euros – they’re produced by lots of people running computers all around the world, using software that solves mathematical problems. It’s the first example of a growing category of money known as cryptocurrency (<https://bitcoin.org>).

Bitcoin daily price data was collected from 7/18/2010 to 3/9/2015 (<http://www.coindesk.com/price/>) and aggregate it into a monthly average Bitcoin price data “MonthlyBiPrice.csv”. The first column of the data is the month variable from July-2010 to March-2015, and the second column is monthly average price of Bitcoin. Please follow the instructions and answer the questions.

1. Import the monthly average Bitcoin price data into R. Check the summary of variable Monthly.Average.Price. What is the minimum average price of Bitcoin? What is the maximum average price of Bitcoin?
2. Install the package "forecast" and create a time series object tprice. Select and only include the values from variable Monthly.Average.Price to construct this object. Set start month as c(2010, 7) and frequency = 12.
3. Check the object tprice and see if you have the correct prices and corresponding months. Plot the object tprice. At which year does the price of Bitcoin have a peak? What is the start and end month/year of tprice? What is the frequency of tprice?
4. Create a subset of object tprice. Set the start month as July-2013 and end month as Feb-2015. Plot this subset. Hint: Use window method
5. Try smoothing and plotting and data using function ma( ). Try k=5, 10 and 15 respectively, do you see a smoother plotted curve with increasing k value?
6. Next try seasonal decomposition using stl().What trend do you see in the data?
7. Visualize the seasonal decomposition by using seasonplot functions on the object tprice. What are the price trends of Bitcoin in year 2013 and 2014? Do these two years share the same trend?
8. Build a simple exponential smoothing forecasting model using time series object tprice with model = “ANN”. What is the value of alpha parameter, ie smoothing parameter for the level?
9. Use the forecast() function to predict the time series one step into the future. What is the average predicted Bitcoin price for April-2015? What is the 95% confidence interval for this prediction value? Plot this prediction with “Month” as x label and “Price” as y label.
10. Check the accuracy of this simple model for time series forecasts. What do RMSE, MAE and MAPE stand for? What value of mean absolute percentage error does this model generate?
11. Log transform the data and save it as ltprice. Build an exponential smoothing model with Level, Slope, and Seasonal components with ltprice and model="ZZZ". Check the model. What are the values of smoothing parameters for the level, trend, and seasonal components?
12. Use forecast() function to forecast the Bitcoin price for the next 5 months. Plot the prediction with “Month” as x label and “Price” as y label. Transform the mean, lower and upper prices of the prediction using exponential function to the actual predictions. What is the average predicted Bitcoin price for April-2015? What is the 95% confidence interval of the price?
13. Check the accuracy of this model for time series forecasts. What value is this model’s mean absolute percentage error?
14. Import library tseries. Decide the best d value for object ltprice using ndiffs( ). What is the best d value for our time series object? Then do the differencing of the time series object using diff( ). Plot the time series object after differencing. Does it look like there is trend in time series after differencing?
15. Evaluate the assumption of stationarity using Augmented Dickey-Fuller (ADF) test. Do we have a stationarity time series object based on the test results?
16. Fit an ARIMA model with p = 2, d=1 and q=1. What is the AIC value of this model? Then check the accuracy of the model. What is the value of MAPE?
17. Evaluate the model fitness by check the residuals using qqnorm and qqline functions. Does the residuals fall along the line? What can we learn if the residuals fall along the line? Use box.test() function to check whether autocorrelations are all zero. What can you interpret from the box.test() results?
18. Forecast three months Bitcoin prices with this ARIMA model. What is the predicted average Bitcoin price for April-2015?
19. Use an automated ARIMA forecasting model for the object ltprice. What are the values for p, d and q? Compare this model and the one from Q16 based on AIC. Which of the two models is better base on AIC values?