Hyndman and Athanasopoulos – Answers to chapter 8

1. – ACF for random numbers.
   1. All three figures suggest that the data is white noise. Their pattern suggests that there is no autocorrelation between values of the series.
   2. Because the critical values are a function of the length of the series. The critical values are equal to 1.96/√T. That is why the critical values have different distances from zero. The autocorrelations are different because we are dealing with random numbers, so the existence of autocorrelations is a product of change and not of any characteristic in the data.
2. IBM closing price analysis.
   1. The ACF pattern suggests that that the data is non-stationary due to the fact that it decreases slowly, showing that more recent values depend heavily on past values. The plot also makes it clear that there is a possible negative trend. The PACF also contains a unique significant spike at lag 1, which suggests that the data is basically a random walk (which is non-stationary). After differencing the ACF does not show the decreasing pattern anymore. The high correlation at lag-1 on the PACF also disappears.
3. Appropriate Box-Cox and differencing.
   1. Box-cox
      1. usnetelec = 0.517
      2. usgdp = 0.366
      3. mcopper = 0.192
      4. enplanements = -0.227
      5. visitors = 0.278
   2. Differencing
      1. Usnetelec = 1
      2. Usgdp = 2
      3. mcopper = 1
      4. enplanements = 1
      5. Visitors = 1
4. Done in notebook
5. Seasonal differencing is not necessary, while we need only one regular differencing.
6. ARIMA simulation.
   1. Done in R.
   2. The variance increases and the resulting series becomes smoother.
   3. Same as above.
   4. The variance increases and the resulting series becomes smoother.
   5. Done in R
   6. Done in R
   7. The AR (2,0) model is much less smooth than the ARMA (1,1) model.
7. Women Murdered in the US series
   1. After twice- differencing the series to make it stationary, an analysis of the ACF suggests an MA (2) process and an AR (2) process.
   2. A non-zero constant and a twice differenced series will cause long-term forecasts to follow a quadratic trend, which seems to be unwarranted given the data at hand.
   3. Done in notebook
   4. The residuals pass the test. The Ljung-box test fails to reject the null hypothesis. The residuals also seem to not deviate from normality.
   5. They check
   6. Done in R. Notice how the forecasts follow a straight line
   7. Auto-arima chose a different model: ARIMA (0,2,3). Notice that double-differencing remains.
8. USGDP quarterly analysis
   1. Box-Cox with lambda equals to 0.36
   2. Exhaustive search found an ARIMA (0,1,2) model with a drift parameter.
   3. Done in R
   4. Using time-series cross-validation, the auto-arima model is better than the fitted model.
   5. The residuals seem to follow a white-noise process.
   6. They seem reasonable.
   7. The ETS fits a model with no seasonality, but with an additive trend and additive errors. The ARIMA model forecasts slightly lower future levels of GDP. The ETS (A,A,N) show an upward trend into the future as we would expect from a model without a damping parameter.