Spring, 2020: 90-760 Management Science II:

Homework #1. Due Wednesday March 25th at noon

Submission instructions will be forthcoming. It will be online of course.

Problems #1 - #4 concern ten years of (fictitious) quarterly time series data. I have provided you with an Excel template you can use to answer these questions, but make sure you really understand the Excel formulas, both the parts I provided and what you’re typing in. I have not figured out all the details of how we’ll do exams, but since the exams are going to be online anyhow, I may well ask you to work problems in Excel as part of the exam.

I use as the measure of goodness of fit the RMSE or “Root Mean Squared Error”. That very similar to the SSE used in the videos, but take the square root and divide by the number of data points.

**Problem #1:**

The data series has both trend and seasonality, but this problem asks you to apply three stationary methods anyhow. That’s just to keep things simple and use only one data series, but it will also give you a sense of the limitations when mismatched methods are used.

1. Fill in the formulas for exponential smoothing in Column E, remembering that for the very first entry (Cell E9) you just copy over the first data point (from Cell D9). Then use Solver to optimize the alpha parameter (Cell E4) to minimize the RMSE for years 2011 - 2019 (Cell E6).   
   Report:   
   (1) The optimized alpha: **0.128**  
   (2) The resulting RMSE: **75.4**  
   (3) The forecast for Winter 2020 (Cell E49): **280.9**  
   Note: We’ll use RMSE for 2011 – 2019 (not 2010) so that all three methods in this problem can be compared in terms of fit over the same range of time.
2. Fill in the formulas for a simple (i.e., unweighted) 3-period moving average in cells F12:F49.   
   Report   
   the RMSE for years 2011 – 2019 :  **74.2**  
   and the forecast for Winter 2020: **271.0**
3. Fill in the formulas for a weighted 4-period moving average in cells G13:G49. Use Solver to optimize the four weights (in Cells G1:G4) to minimize the RMSE for years 2011-2019.   
   Report:   
   (1) The optimized weights: **w4= 0.447 , w3=0.187, w2=0.048, w1=0.340**  
   (2) the resulting RMSE: **77.2**  
   (3) The forecast for Winter 2020: **358.1**
4. [Ungraded] Look at the plot of actual data, exponential smoothing, and WMA. You should see that exponential smoothing does what its name implies; it just passes a smooth curve through the points, helping one see the trend over time that is not as easy to see with the actual data because those points jump around from seasonality. The 4-WMA manages not to do as well as exponential smoothing despite its greater number of parameters. That won’t always be the case, but here the 4-WMA is overfitting since it (and all simple stationary methods) are fundamentally mismatched to these data.

**Problem #2:**

This problem will ask you to add an (additive) seasonal indices adjustment to the exponential smoothing forecast. This still won’t address the (fairly shallow) trend in the data, but it will help with the seasonality.

1. [Ungraded] Fill in the exponential smoothing forecast in Column E, either by repeating the steps from Problem #1 or just copying those values over from the preceding sheet.
2. Fill column F with the actual (Column D) minus the trend/forecast (Column E) and use the =AVERAGEIF() formulas in Cells F2:F5) to find the (additive) seasonal index adjustments. Report those four adjustments.   
   **Winter = 22.6, Spring = -35.2, Summer = 24.8, Fall = -39.2**
3. Fill in column G with the seasonally adjusted exponential trend forecast. Report (1) the RMSE over all ten years (2010-2019, hence divide by 40 not 36 data points) for plain exponential smoothing (Column E), (2) report the corresponding RMSE when adding seasonal indices, and (3) The seasonal index forecast for Winter 2020.

**Problem #3:**

Repeat Problem #2 but with the (unseasonal) forecast in Column E coming from a simple linear regression implemented with Excel’s =TREND() function and now extending the forecast (including what you report) to all four quarters of 2020.

**Problem #4:**

Run a seasonal regression on these data, and forecast all four quarters of 2020.

1. [Ungraded] Fill in the appropriate dummy variable values in Columns D-F.
2. Apply the =TREND() function using all four columns C-F as “X values” (predictor variables) to create a seasonal regression forecast in Column H. Report the RMSE over all 10 years and the forecast for the four quarters of 2020.
3. That is all one needs to do to create the seasonal regression forecast, but this step lets you see that once one has done that, there is no reason to also use seasonal indices. In column I, compute the actual minus the forecast (Column H – Column G). Then use the =AVERAGEIF() function to create the average error, season by season, in Cells I2:I5, as you did in the previous two problems. Report those four average errors.
4. How different was the RMSE with the regression + seasonal indices approach from Problem #3 as opposed to the RMSE with the seasonal regression approach done here in Problem #4?

**Problem #5**

Find an article (newspaper, magazine, or journal article) that describes an application of forecasting that informs a specific decision or type of decision. Describe the context or situation, including the decision being informed and organization making the decision, and the method and/or data. Usually it will make sense to provide some evaluative statements or suggestions (e.g., “I think they could have produced better forecasts if they had done …”) (Answers should be 1-3 paragraphs.)

Submit also a copy of the article or (if it is long) the relevant passages.