**DTSC 560**

**Data Science for Business**

**Module 4 Assignment: Time Series Analysis**

For this assignment, you will conduct several different time series analyses. **You will not be turning in any code or output; rather you’ll do the analyses and use the output to answer questions for the associated assignment quiz on Brightspace.**

**Please read these instructions carefully to be able to align your answers with the associated Module 4 assignment quiz in Brightspace.**

**Part 1**

**Data:** airfare.csv (download from Module 4 on Brightspace)

Every quarter, the Bureau of Transportation Statistics (BTS) takes a survey to track domestic airfares. This time series shows average airfares calculated from BTS (inflation adjusted to 2018 dollars) for U.S. domestic flights from 2004 to 2018.

**Background:** For this part of the assignment, you work for a large airline (in 2018) and you would like to forecast 2019 average annual airfare in order to inform your airline’s pricing strategy. Your business question is: “What is a reasonable forecast of 2019 average U.S. domestic airfare given the patterns in past data?”

**Assignment Steps:**

Carry out the steps for Part 1 below to complete the assignment, then answer the questions in the Module 4 Assignment Quiz, Part 1, on Brightspace. The quiz questions are included here, with their numbers, if you prefer to answer them as you are doing the assignment and enter them in the Brightspace quiz all at once (multiple choice questions are labeled “MC”).

1. **Create a time series plot of the average airfare data.**

Quiz question #1: Please upload the time series plot you created showing the average airfare from 2004 to 2018.

Quiz question #2: What patterns do you notice in the time series plot of average annual airfare? (MC)

1. **Use a simple moving average with n = 3 (3 years) to calculate a forecast for the average airfare in 2019.**

Quiz question #3: What is the 2019 forecast for average airfare using the simple moving average technique?

1. **Based on the predicted values up to 2018, calculate accuracy measures (MAE, MSE, RMSE, and MAPE) for the simple moving average method.**

Quiz question #4: What is the MAE for the simple moving average method?

1. **Use a simple exponential smoothing with a smoothing constant of 0.2 to calculate a forecast for the average airfare in 2019.**

Quiz question #5: What is the 2019 forecast for average airfare using simple exponential smoothing with a smoothing constant of 0.2?

1. **Based on the predicted values up to 2018, calculate accuracy measures (MAE, MSE, RMSE, and MAPE) for the simple moving average method.**

Quiz question #6: What is the MAE for the simple exponential smoothing method with a smoothing constant of 0.2?

1. **Use a simple exponential smoothing with a smoothing constant of 0.8 to calculate a forecast for the average airfare in 2019.**

Quiz question #7: What is the 2019 forecast for average airfare using simple exponential smoothing with a smoothing constant of 0.8?

1. **Based on the predicted values up to 2018, calculate accuracy measures (MAE, MSE, RMSE, and MAPE) for the simple moving average method.**

Quiz question #8: What is the MAE for the simple exponential smoothing method with a smoothing constant of 0.8?

Quiz question #9: Reviewing the accuracy measure values for each of these forecasting attempts, which would you trust most to provide the most accurate forecast of 2019 average airfare?

**Part 2**

**Data:** warner\_music.csv (download from Module 4 on Brightspace)

We are using a time series of Warner Music Group's revenue from 4th fiscal quarter 2015 to 4th fiscal quarter 2021 (in million U.S. dollars). The original dataset is accessible through [Statista](https://www-statista-com.eu1.proxy.openathens.net/) using access through Eastern’s library system.

**Background:** For this part of the assignment, you work for Warner Music Group and you would like to forecast 2022 quarterly revenue from past revenue data. Your business question is: “What is a reasonable forecast for 2022 Q1, Q2, Q3, and Q4 revenue given the patterns in past data?”

**Assignment Steps:**

Carry out the steps for Part 2 below to complete the assignment, then answer the questions in the Module 4 Assignment Quiz, Part 2, on Brightspace.

1. **Create a time series plot of the Warner Music Group data.**

Quiz question #10: Please upload the time series plot you created showing Warner Music Group's quarterly revenue.

Quiz question #11: What patterns do you notice in the time series plot? (MC)

1. **Use linear regression to model ONLY the trend in the time series.**

Quiz question #12: After conducting a linear regression to model the trend ONLY, what is the slope coefficient for the trend variable?

1. **Calculate accuracy measures for predicted values based on the regression in (2).**

Quiz question #13: What is the RMSE based on the results of the linear regression you just conducted?

1. **Use linear regression to model both the trend and the seasonality in the time series. Choose as a reference variable the quarter tending to show the highest revenues each year.**

Quiz question #14: After conducting a linear regression to model both trend and seasonality, how should the regression coefficient for Quarter 2 be interpreted? (MC)

1. **Calculate accuracy measures for predicted values based on the regression in (4).**

Quiz question #15: What is the RMSE based on the results of the second linear regression you just conducted?

Quiz question #16: What conclusion can you draw from comparing the accuracy measure values from the first regression to those from the second regression? (MC)

1. **Forecast Q1, Q2, Q3, and Q4 revenues for Warner Music Group for 2022 using the results of the second regression analysis modeling both trend and seasonality.**

Quiz question #17: Based on the second regression analysis modeling both trend and seasonality, what is the forecasted revenue for Warner Music Group for Quarter 4 of 2022?

**Part 3**

**Data:** amazon\_web\_services.csv (download from Module 4 on Brightspace)

We are using a time series of the quarterly revenue of Amazon Web Services from 1st quarter 2014 to 4th quarter 2021 (in million U.S. dollars). Amazon Web Services is the cloud computing and hosting branch of Amazon.com. The original dataset is accessible through [Statista](https://www-statista-com.eu1.proxy.openathens.net/) using access through Eastern’s library system.

**Background:** For this part of the assignment, you work for Amazon Web Services and you would like to forecast 2022 quarterly revenue from past revenue data. Your business question is: “What is a reasonable forecast for 2022 Q1, Q2, Q3, and Q4 revenue given the patterns in past data?”

**Assignment Steps:**

Carry out the steps for Part 3 below to complete the assignment, then answer the questions in the Module 4 Assignment Quiz, Part 3 on Brightspace.

1. **Create a time series plot of the Amazon Web Services revenue data.**

Quiz question #18: Please upload the time series plot you created showing Amazon Web Services’ revenue.

1. **Use linear regression first to model the trend in the time series.**

Quiz question #19: After conducting a linear regression to model the trend in the time series, what is the slope coefficient for the trend variable?

1. **Calculate accuracy measures for predicted values based on the regression in (2).**

Quiz question #20: What is the MAPE based on the results of the linear regression you just conducted?

1. **Based on the pattern in the time series data, choose a regression approach to use to model the trend, and conduct that regression analysis.**

Quiz question #21: Based on the pattern in this time series data, what type of regression discussed in this module would be most appropriate to calculate forecasts based on this time series?

1. **Calculate accuracy measures for predicted values based on the regression in (4).**

Quiz question #22: What is the MAPE based on the results of the regression you just conducted?

1. **Forecast Q1, Q2, Q3, and Q4 revenues for Amazon Web Services for 2022 using the results of the second regression analysis**

Quiz question #23: Based on results from the second regression analysis, what is the forecasted revenue for Amazon Web Services for Quarter 3 of 2022?