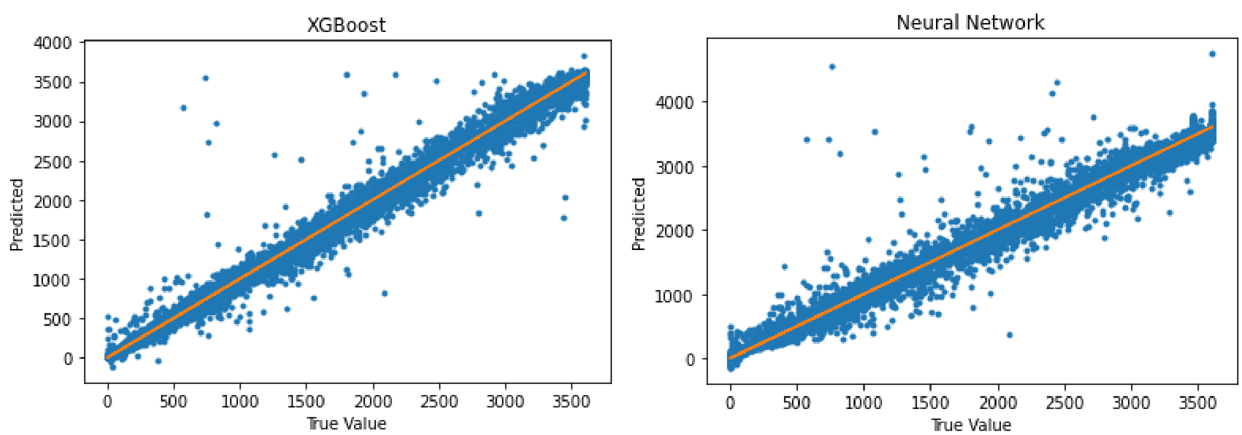
Introduction:

For this project, I was asked to develop a prediction of the wind power from wind speed, wind direction, and prior wind power using the following three regression methods: XGBoost, Neural Network (Deep Learning), and Recurrent Neural Network (LSTM). To accomplish this, I first visualized, explored, and cleansed the data set. I then determined what factors were the most important and split the data into train and test sets. This allowed me to successfully teach my regression models to predict the wind power from wind speed, direction, and previous power.

Results and Discussion:

Since the provided data only included wind direction, wind speed, and wind power, I added a column labeled 'Previous Power' which read the power from the previous time stamp. I then began visualizing the data. Using a heat map, I noticed that wind speed and the previous wind power seemed to be the best features for determining current wind power. However, it was noted that there are time periods within the data where no power is produced due to scheduled maintenance. Thus, I removed all data in which power was less than or equal to 0 (there were some points with negative power values). With the data cleansed, I used SelectKBest to confirm which features were the most important. I found that the most important feature was prior power. Wind speed was the second most important and wind direction was the least important feature.

Next, the data was separated into training and test sets. The first two regression methods were then trained and tested. Both the XGBoost regression method and Neural Network (Deep Learning) method were successfully able to predict the wind power based on a single row of measurements. Below are plots comparing the true test value to the predicted test value for both the XGBoost and neural network regression methods. In addition, the mean absolute error (MAE) of the test data is shown below the graph for each regression method. A y = x line has been added to each graph for visual aid.

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MAE = 72.42302699618786
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MAE = 107.62417081464207
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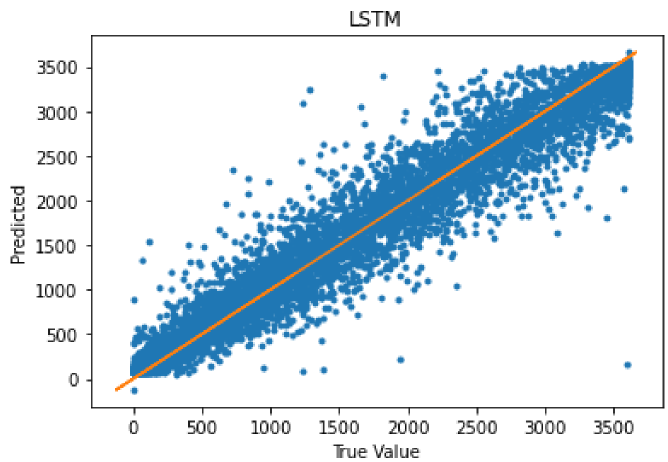
Figure 1 - Plot comparing regression method to test values. Left – XGBoost. Right – Neural Network

As seen in figure 1, the MAE for XGBoost regression is slightly lower than the MAE for the Neural Network method. This indicates that the XGBoost technique is a better regression tool in this case. The MAE for the training sets were 58.4 and 112.3 for XGBoost and Neural Network respectively. Regardless, both are very capable of predicting the wind power from wind speed, wind direction, and prior wind power.

After training and testing these two regression methods, I began to implement the Recurrent Neural Network (LSTM). Since we were asked to use a window of 60 minutes of prior data to predict the wind power with this model, creating the model was more difficult. Regardless, I was successfully able to train this model to accurately predict the wind power accordingly. Below is a graph comparing the test values to the predicted values using the LSTM model.



MAE = 177.48646221823532

Figure 2 - Plot comparing test values to LSTM predicted values

As shown, the MAE for the training set is about twice as large as both the Deep Learning neural network and XGBoost methods. The MAE for the training set is 169.0. Since the MAE is larger than both the previous methods, I would not recommend using this method as a regression tool for predicting the wind power of this wind turbine.

Conclusion:

After complete analysis of this data set, I would recommend using the XGBoost regression method to predict the wind power of this turbine. This regression method had the lowest MAE values for both the training and test sets. Although all three methods can predict the wind power, the XGBoost method is the most accurate. In addition, the previous wind power is the best feature in determining the wind power and the wind speed is the next most useful feature. The wind direction is the least useful feature and shows almost no correlation in determining the wind power.