Project report for ME504-2020

Predictive Maintenance using LSTM

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Objective:

This project aims to predict aircraft engine failure within the given number of cycles based on sensor values using LSTM. It shows the application of deep learning in the predictive maintenance domain uses a simple scenario using only one data source(sensor reading) to make predictions.

Results and Conclusion:

Results of binary classification

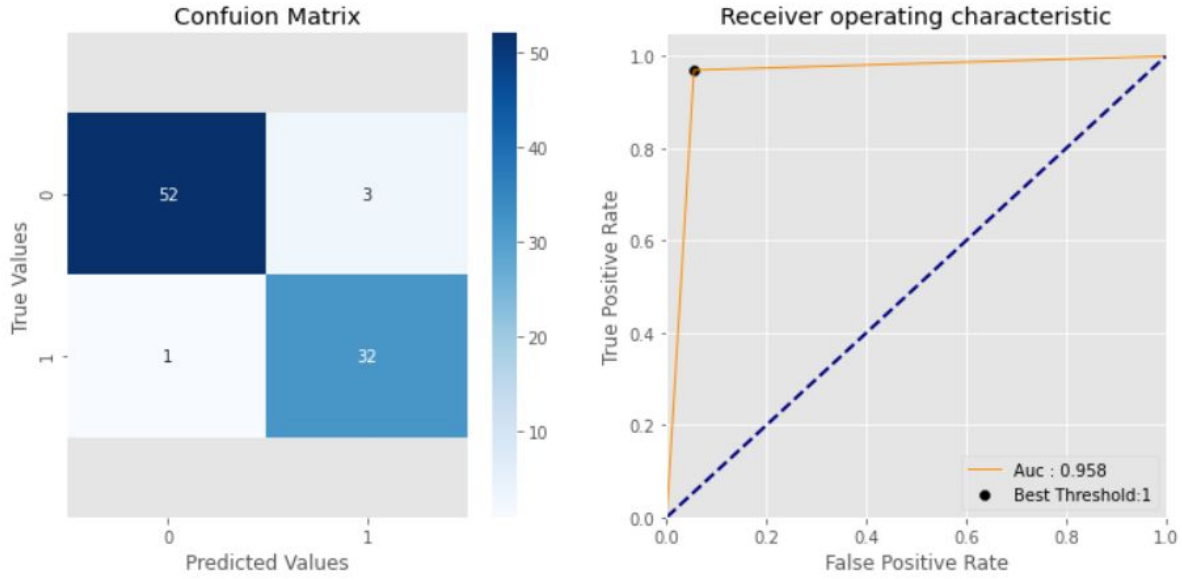

Fig: Confusion matrix and roc curve

Evaluation metrics

Recall: 0.96

Precision : 0.91

F1 score: 0.94

Area under curve: 0.958

Accuracy: 0.95

The trained LSTM model can detect whether an aircraft engine will fail within 50 cycles with an accuracy of 95.45%. The above figure shows the confusion matrix and the roc curve for the test data set.

Results of Regression model

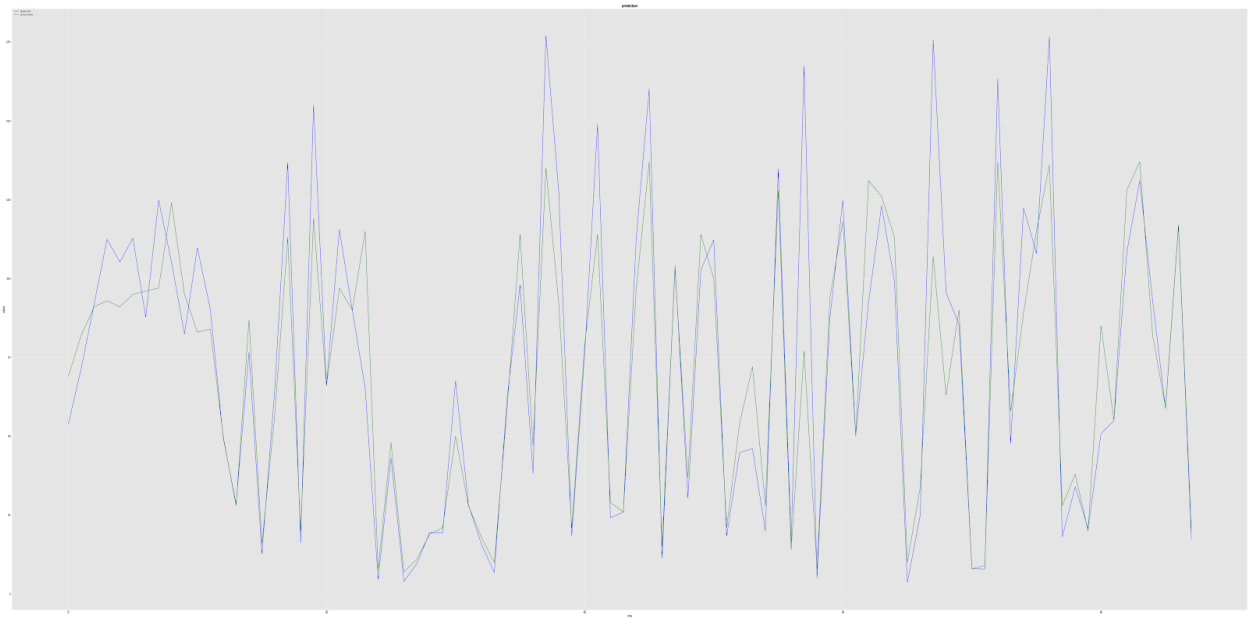

Fig: Predicted(blue) and actual(green) RUL values

Mean Absolute Error: 12.96

The above figure shows the predicted(in blue) and actual(in green) RUL cycles. Thus, our LSTM model is able to predict the RUL of aircraft engines accurately.

Therefore, we have applied deep learning techniques in the predictive maintenance domain.

Novelty:

- We have observed that the LSTM network outperforms other deep learning techniques(ex: Random Forests, SVM, ANN, etc.) in the predictive maintenance domain since they are very good at learning from sequences.
- Our model can also solve the multi-class classification problem using both label1 and label2 as the labels for the dataset, which determines if a failure will occur in different time windows, for example, fails in the window(1,w0) or (w0+1,w1) cycles.
- Feature selection and dimensionality reduction techniques should also be utilized to enhance model performance and speed.

References:

1. Understanding LSTM Networks
   http://colah.github.io/posts/2015-08-Understanding-LSTMs/
2. Predictive Maintenance: Step 2A of 3, train and evaluate regression models
   https://gallery.cortanaintelligence.com/Experiment/Predictive-Maintenance-Step-2A-of-3-train-and-evaluate-regression-models-2
3. http://azuremlsamples.azureml.net/templatedata/PM_train.txt
4. http://azuremlsamples.azureml.net/templatedata/PM_test.txt
5. http://azuremlsamples.azureml.net/templatedata/PM_truth.txt
6. https://gallery.azure.ai/Collection/Predictive-Maintenance-Template-3