INTRODUCTION

A gas turbine is a combustion engine that can convert natural gas or other liquid fuels to mechanical energy. It has multitude of applications in different industries. Our focus is on Marine applications predominantly on naval propulsion plants. The mechanical energy generated for the combustion chamber then drives a generator that produces electrical energy. Gas Turbines are valued for their high power – to weight ratio and their ships resulting acceleration and the ability to get underway quickly.
Increasing use of Gas turbine application demands high reliability, economic sustainability which in turn increases the maintenance cost. Depending on the strategy adopted by the application the costs can vary, in order to cut the costs effectively and prevent the components from breakdown condition based maintenance approach is being used.
The main idea here is to propose Machine learning models to get a good prediction accuracy of compressor deterioration, and most influential factors that effect this. For this analysis the data used is generated from a sophisticated simulator of a gas turbine, mounted on a Frigate characterized by a Combined Diesel Electric and Gas propulsion plant type.
The results will show the most important factors that are used to predict the deterioration and effectiveness of the models approached to use in marine applications.

OBSERVATIONS

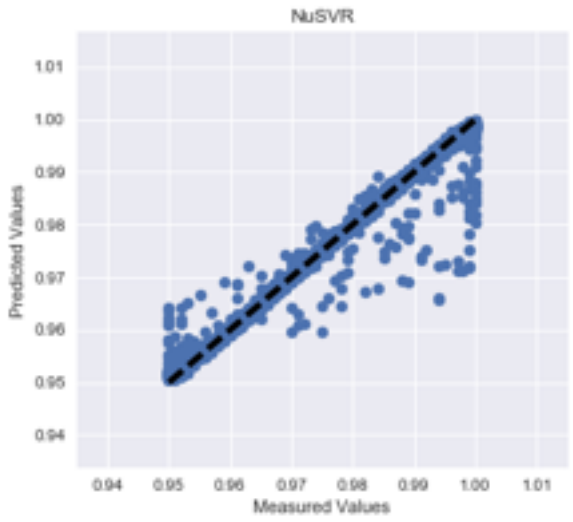
Initial Findings – The data is highly correlated as one would expect with mechanical dynamics of the Gas Turbine.

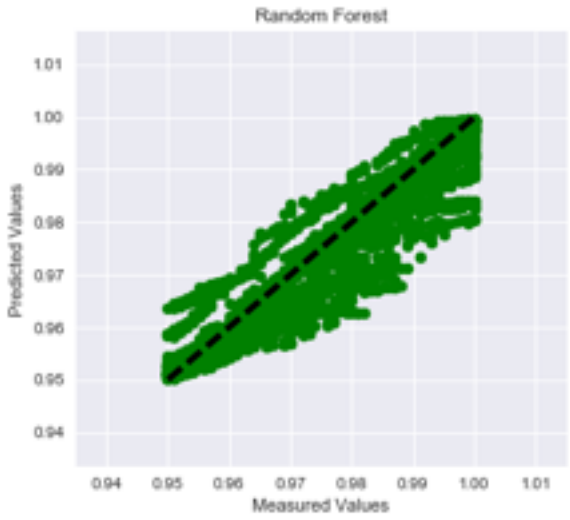
Inferential Statistics – With high correlation, we expect multicollinearity problems with the ordinary least square regression. To reduce this problem lasso regression or l1 regularization method is used inorder to get the most significant features for the predictions.

Lasso plot or feature importances

Predictive Analytics - The primary purpose of our regression analysis is to predict a new response y, so we don't have to worry much about multicollinearity. We built Linear regression,SVM and Random Forest models and compare which model gives a better performance in predicting the degradation coefficient. Comparing the RandomForest and SVR in the below plots and R-sqaured value.

Plotting Cross Validated Predictions





R-Squared— 97.3%

R-Squared- 99.7%

cross val score

The above plots clearly shows that Random Forest is a better model for our application with more R-Squared and less variance between the estimated and predicted values.

CONCLUSION

Compressor degradation is the major cause of output and efficiency loss in a gas turbine. “Degradation reduces the air mass flow and pressure ratio, thus reducing power output”.

The effectiveness of the condition-based maintenance rely on the quality of the predictive methods, but more than that, the understanding each variable for the failure and its relationship can permit a higher efficacy to intervene in advance, reducing costs of unplanned shutdowns.This analysis shows the most important features affecting the Gas Turbine Compressor degradation –

1.The regularization methods reduces the coefficients of magnitude to give most import features in the prediction.

2.From the Predictive Analytics we compare Random Forest and SVR models and see that RandomForest model has good prediction R-Squared and cross validation prediction plots also show that RandomForest has less variance and would be a better model for prediction in this application.

3.With software strategy adopted by the application if there is a diagnostic raised when ever the features meet the threshold and then investigating before the actual failure would prevent the unplanned shutdowns and reduce the maintenance costs.