DATA DRIVEN DEMAND FORECASTING AND INVENTORY OPTIMIZATION

RESEARCH ISSUES

Spare Parts (SP) demand forecasting and inventory optimization comes with the difficulty of improving the accuracy when the time series data is of an intermittent or lumpy nature. In other words, the data might have many zero demand in most time intervals recorded. Most previous research have focused on the statistical methods such as Croston's method to forecast data of such nature. Now with more powerful computers, sophisticated deep learning models can be trained to improve the accuracy of the forecasts. In this project, we build models using Recurrent Neural Networks (RNN) such as the Long Short-Term Memory (LSTM) and its cousin, the Gated Recurrent Unit (GRU) to improve the forecast of such spare parts.

METHODOLOGY

First, we investigated our data set and found that the data had mostly intermittent and lumpy data which makes forecasting very challenging as shown in our literature reviews. We also took the opportunity to use unsupervised learning algorithms like density-based clustering and hierarchical clustering to uncover any hidden relationships within the SPs data.

Second, as much of the data is intermittent and lumpy, we applied a study that fuses some aspects of signal processing into our RNN, which is the LSTM cell. This method was called EEMD-LSTM. Where EEMD stands for Ensemble Empirical Mode Decomposition and LSTM stands for Long Short-Term Memory. Model was trained on 70-30 split, where 70% of earlier time steps were used for training.

Lastly, to improve (decrease) the Mean Squared Error (MSE) of the EEMD-LSTM model, we experimented on different hyperparameters and even replaced the LSTM unit with its cousin, the Gated Recurrent Unit (GRU).

ACHIEVEMENTS

We have built three slightly different models to compare how the (1) window size (6 vs 10) for prediction or (2) change in RNN unit (LSTM vs GRU) may have effect on the $\log(MSE + 1)$ of our forecast (refer to bottom-most violin plot). The first 3 plots are results for a particular SP.

LSTM UNIT WITH WINDOW SIZE 6

LSTM UNIT WITH WINDOW SIZE 10

GRU UNIT WITH WINDOW SIZE 6
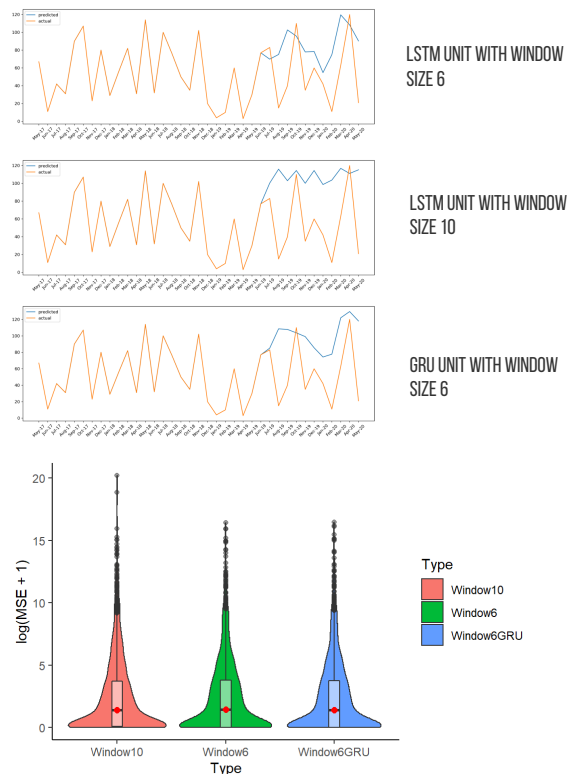
INDUSTRY RELEVANCE

The application of demand forecasting in all aspects of our lives will enable businesses and individuals to make data-driven decisions. The relevance of demand forecasting is beyond just SPs in our project. It can be applied to healthcare, tourism, electricity load monitoring and even other smart city initiatives like crowd monitoring when paired with computer vision.

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