BattDeg

Prediction Lithium-ion Battery Degradation Using Machine Learning

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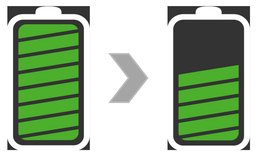
Introduction

Motivation

When we use our cell phones, computers and other electronic device, we may notice that after a period of time, the batteries seem not durable as before, that's because of the battery degradation. Usually, the lithium-ion battery we use in our device will face obvious degradation when the amount of cycle goes to 300, so if we can know how the degradation goes on, we will be able to deal with the degradation and know when to change the battery.



In our project, we are using the battery data from three type of batteries: CS2, CX2 and PL Samples. The data contains the test time, charge capacity, discharge capacity, current, voltage, and etc.

Use Case

Predict the battery capacity degradation using charge – discharge cycle data.

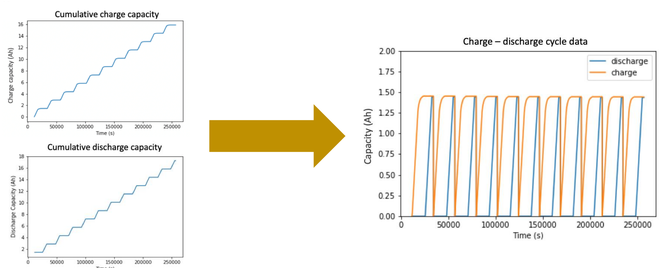
Goals

1. Data cleaning and manipulation
2. Developing a long short term memory (LSTM) model
3. Training the model
4. Predicting the discharge capacity values to determine the degradation in battery capacity over multiple cycles.

Procedure

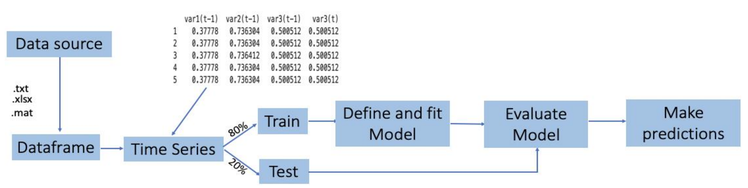
Data Cleaning

1. The time series data obtained was cleaned, manipulated and converted to a supervised learning data to make it suitable for the LSTM model.
2. The important step in the data cleaning was to convert the available cumulative charge and discharge capacity data to cyclic data.



Creating and training the model

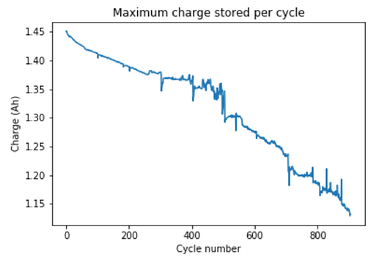
1. The keras long short term memory (LSTM) model was implemented to develop a sequence to sequence model.
2. The available datasets were converted to the appropriate form and used to train and test the model.
3. The values of current, voltage and discharge capacity at a prior time (t-1) were used as the features to forecast the values of discharge capacity at the next time step (t).

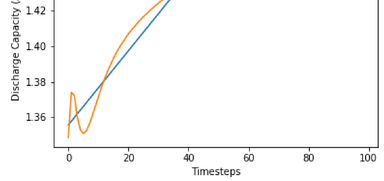


Results

Data Cleaning

The data cleaning resulted in charge – discharge cycle data which can be easily understood and used for various purposes. The figure on the right shows a plot of maximum charge stored per cycle versus number of charge – discharge cycles and clearly shows the degradation.





Model Prediction

The figure on the left shows a plot of experimental values and LSTM prediction values. It can be seen that the predicted values are quite accurate and follow the trend of experimental values.

Future Work

1. Improve the model such that it can predict the battery capacity value at multiple time steps.
2. Gain a better understanding of the hyper parameters involved in developing a sequence to sequence model and improve the accuracy of the model.
3. Deploy the solution as a web-service and create a web-UI.

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Acknowledgement

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- Only open source packages were used in this work.