INTERPRETABILITY ANALYSIS OF BATTERY CAPACITY MODEL

Quanxi Guo, Tong Sun, Xin Li

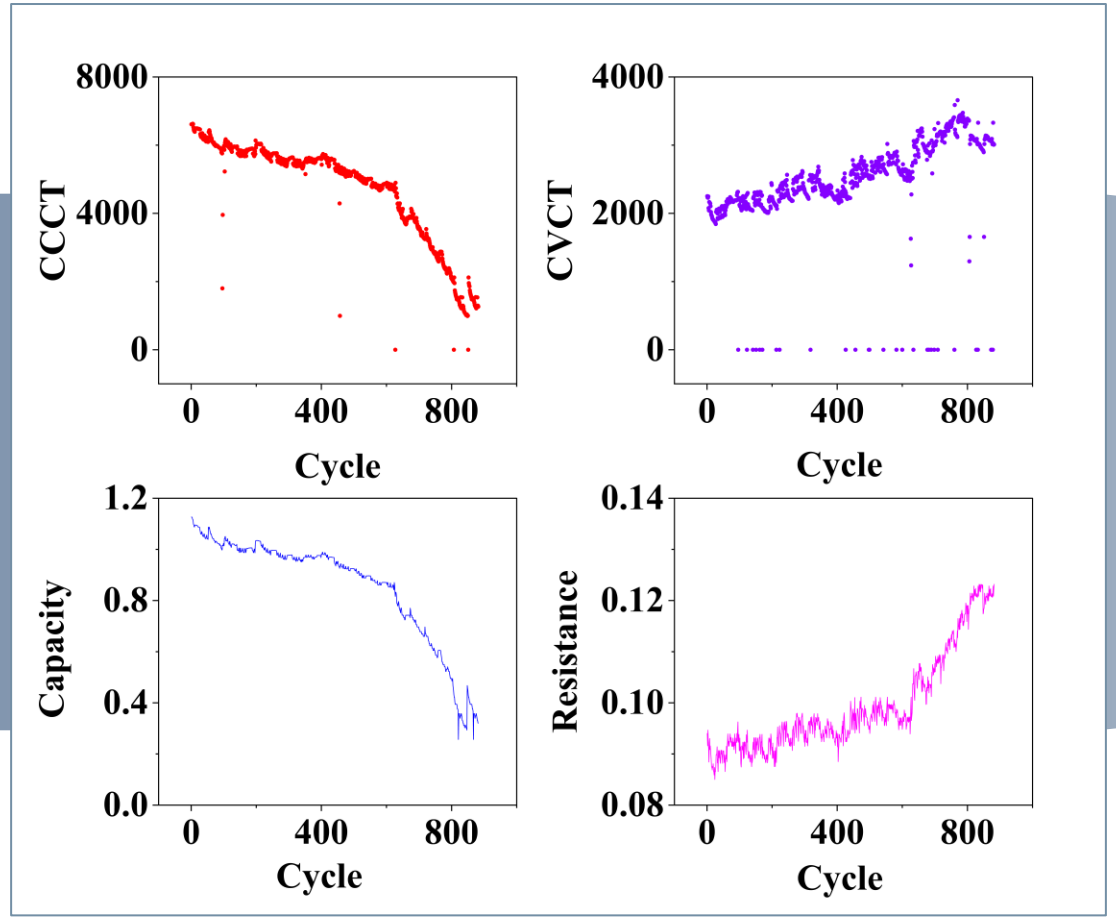
Dataset

Dataset

University of Maryland CACLE Battery Dataset

Dataset Contents

Constant current charging time (CCCT)
Constant voltage charging time (CVCT)
Resistance (R) and Capacity



Research Objectives

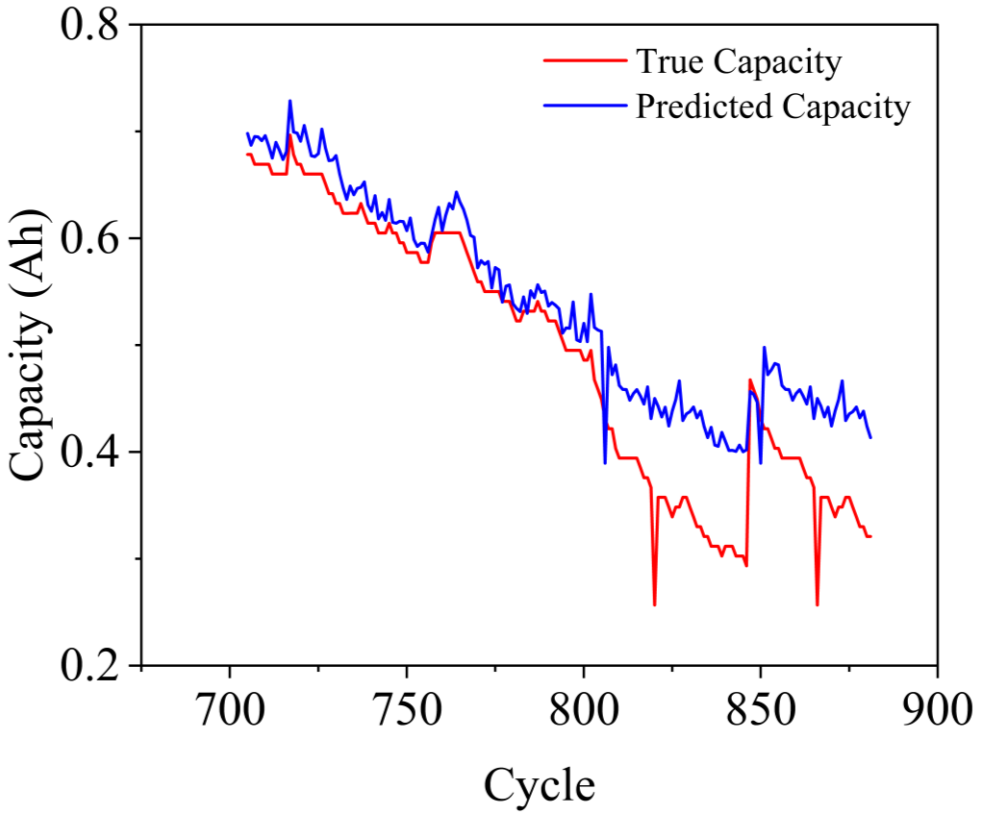
Ridge Regression

- Modeling using Python's ridge regression package
- Input: CCCT, CVCT and R
- Output: Capacity
- Objective: Build an interpretable capacity model

SHAP (LSTM-based)

- Modeling using Python's SHAP package, LSTM is built based on Pytorch library
- Input: CCCT, CVCT and R
- Output: Capacity
- Objective: Using SHAP to analyze the contribution of LSTM inputs

Ridge Regression



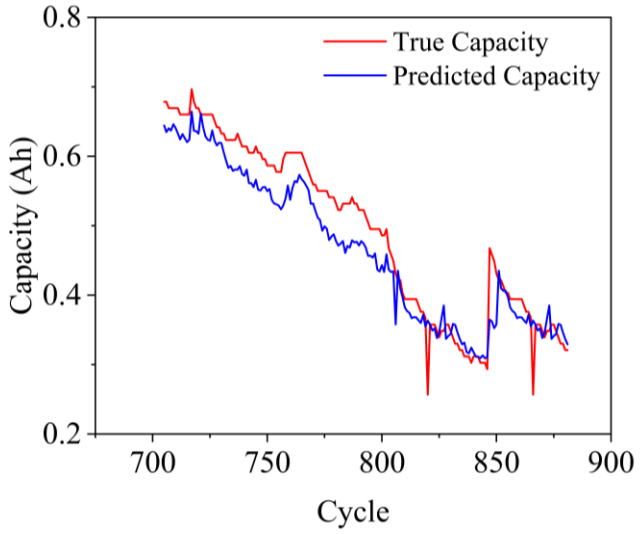
Compare the true capacity with the model predicted capacity to verify the model accuracy

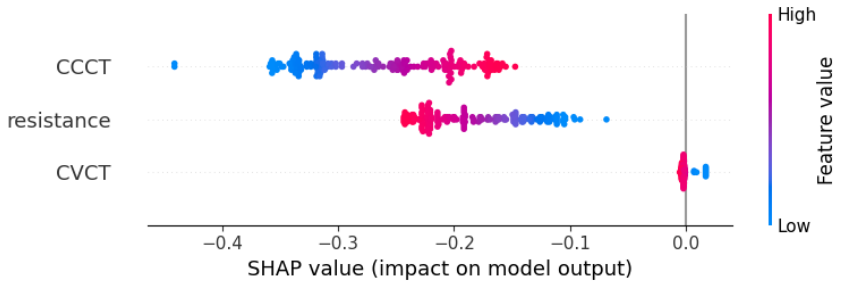
Final Model

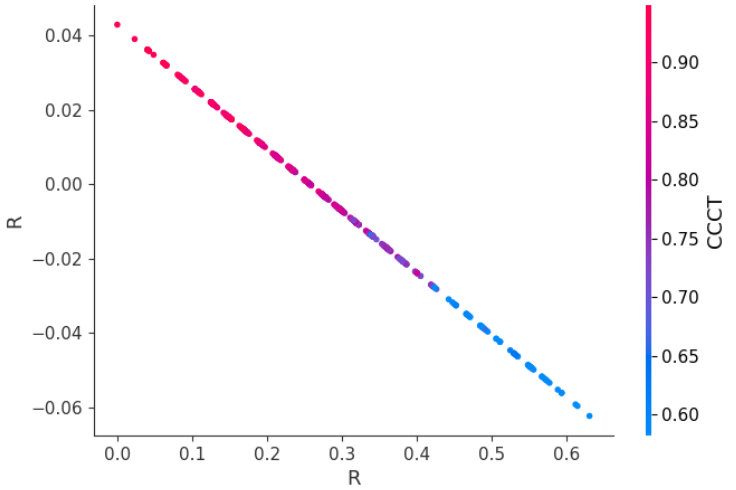
$$Capacity = 0.404CCCT - 0.013CVCT - 0.242R$$

Advantages:
Rapidly model capacity
The model is Explainable

SHAP (LSTM-based)







Fitting results

LSTM has a higher prediction accuracy for capacity than ridge regression, which also proves the effectiveness of the LSMT model.

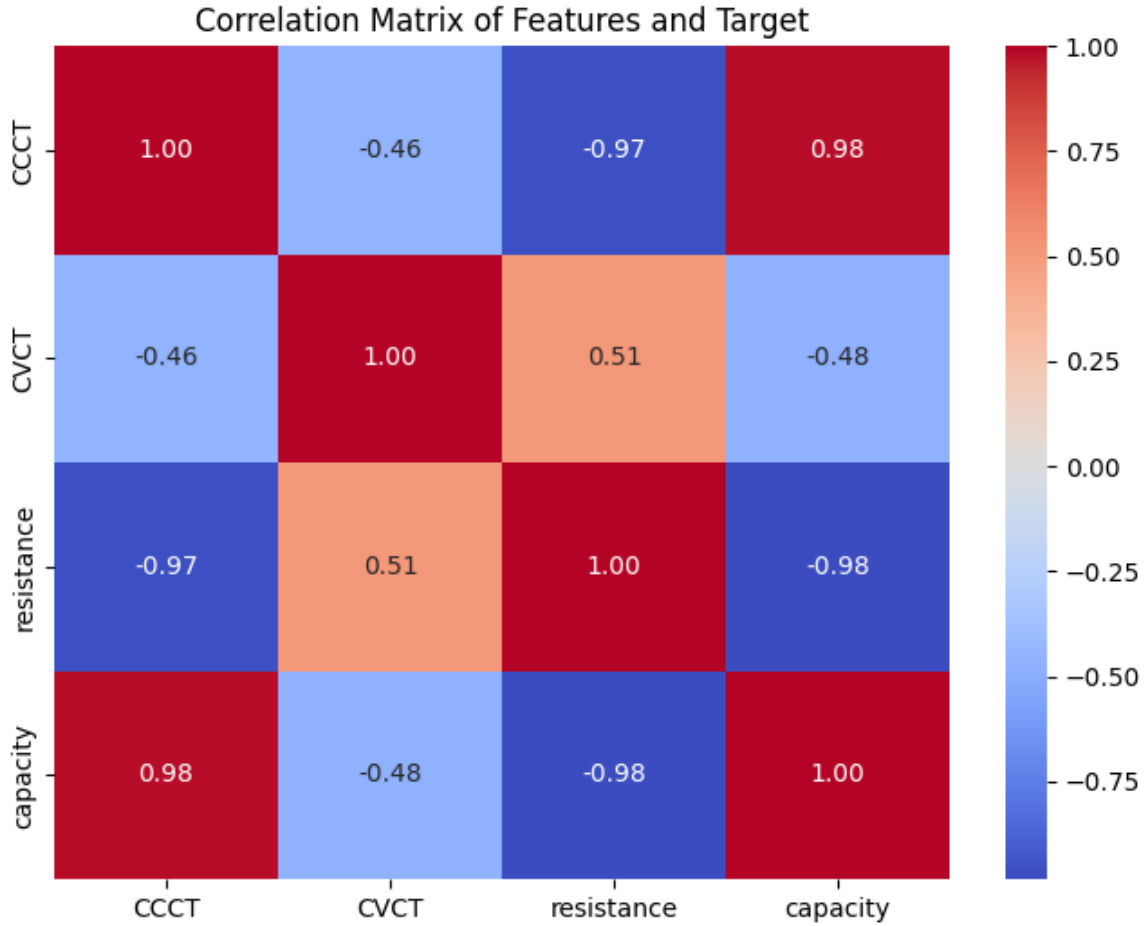
SHAP Value

The contribution of CCCT to capacity analyzed by SHAP is opposite to that of ridge regression. There should be collinear features among the three input features

Collinearity analysis

R and CCCT are collinear, and the contribution of CCCT was largely replaced by R, resulting in CCCT being negatively correlated with capacity like R in the SHAP analysis.

Pearson correlation analysis



CCCT is strongly positively correlated with R

R is strongly negatively correlated with capacity

The contribution of CCCT may be affected by R

Conclusion

Ridge regression itself does not have the ability to identify collinearity between input variables.

In scenarios where features are highly correlated, Ridge regression coefficient may be affected.

In contrast, SHAP value analysis can make a more detailed assessment of the contribution of each input variable, especially in the presence of severe collinear feature combinations.

THANKS

Quanxi Guo, Tong Sun, Xin Li