

# A MLP-Mixer and Mixture of Expert Model for Remaining Useful Life Prediction of Lithium-ion Batteries

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# Problems & Ideas

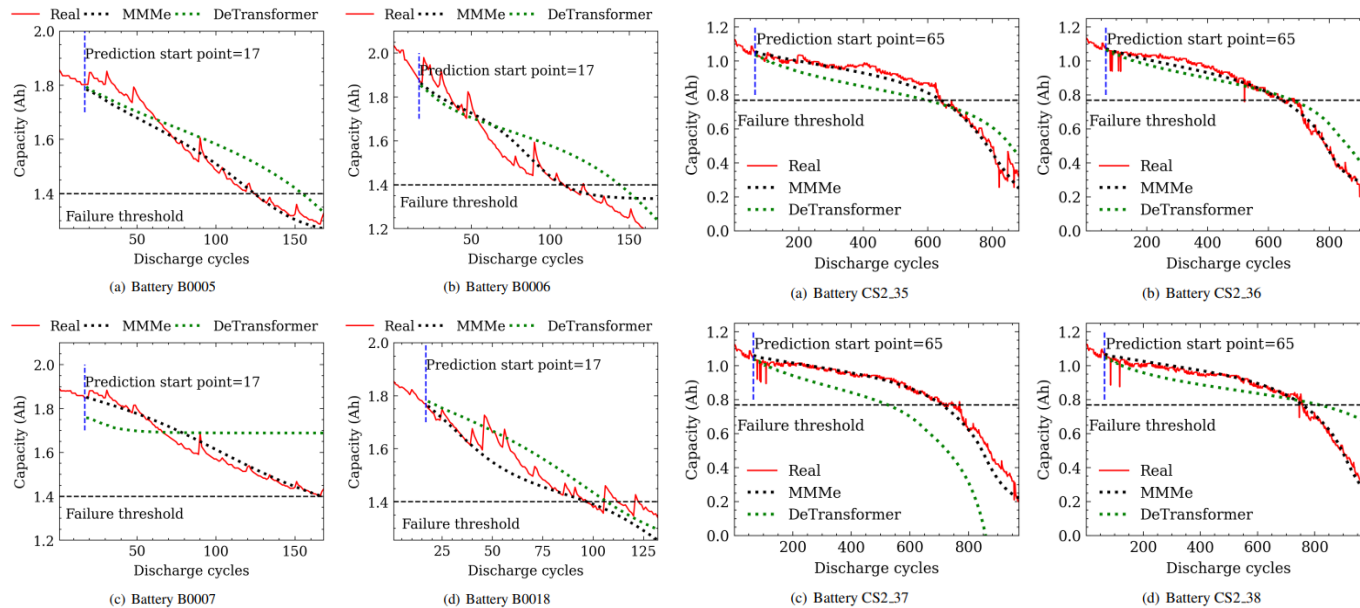
- Problem of predicting the remaining useful life of lithium-ion batteries:
  - Characterization learning of features such as long sequence dependence and mutation in capacity time series helps RUL prediction.
  - Existing approaches to deep learning use the same weights to process data with different levels of contribution, limiting feature extraction capabilities.
- Ideas: Explore models that can effectively handle the different contributions of different time steps in RUL estimation.

Methods	NASA			CALCE		
	RE	MAE	RMSE	RE	MAE	RMSE
MLP	0.3851	0.1379	0.1541	0.4018	0.1557	0.2038
RNN	0.2851	0.0749	0.0848	0.1614	0.0938	0.1099
LSTM	0.2648	0.0829	0.0905	0.0902	0.0582	0.0736
GRU	0.3044	0.0806	0.0921	0.1319	0.0671	0.0946
Dual-LSTM	0.2557	0.0815	0.0879	0.0885	0.0636	0.0874
DeTransformer	0.2252	0.0713	0.0802	0.0764	0.0613	0.0705
MMMe	<b>0.005</b>	<b>0.04</b>	<b>0.0515</b>	<b>0.0019</b>	<b>0.0229</b>	<b>0.0306</b>

Plot of experimental results for the public dataset. Left: For the NASA dataset, MMMe achieves RE, MAE, and RMSE of 0.005, 0.04, and 0.0515; Right: For the CALCE dataset, the proposed method reduces RE, MAE, and RMSE scores by at least 97.5%, 60.6%, and 56.6% compared to the second-best method.

# Main Contributions

- Contributions:
  - a novel approach called MMMe for the accurate prediction of the RUL of lithium-ion batteries , providing more reliable and precise RUL predictions;
  - A Bi-directional Gated Recurrent Unit with a Multi-Head Attention mechanism for capturing input sequence information;
  - An MLP-Mixer Module Allows Communication with Learned Features in Time and Channel Direction;
  - An ensemble predictor based on the Mixture of Expert architecture is devised to determine the RUL value.



Plot of experimental results for the public dataset. Left: the NASA dataset ;Right: the CALCE dataset.