Full life cycle management of lithium-ion batteries

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Hefei University of Technology

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Personal profile

Research background

Behavioral characterization

State estimation

Fault diagnosis

Echelon utilization

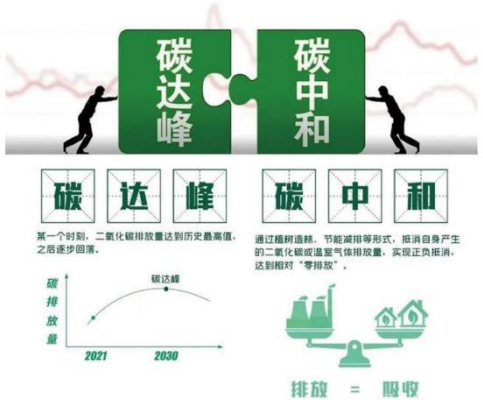
I Personal profile

- 2013.09-2017.06 Hunan University Automation Bachelor's degree
- 2017.09-2022.11 USTC Control science and engineering PhD degree
- 2022.12-Now Hefei University of Technology Lecturer
- Battery management system, complex system modeling, simulation, and control

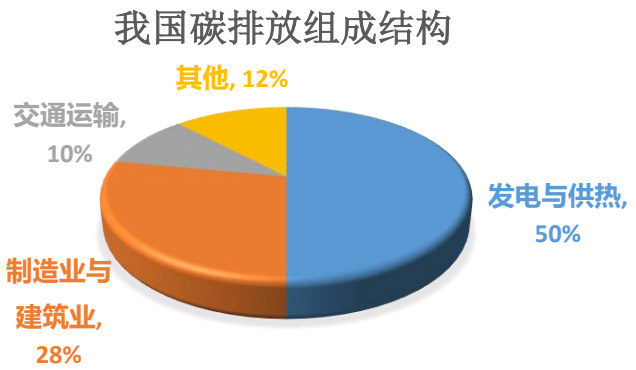
- Chinese Association of Automation member
- System Simulation Professional Committee member
- Young editorial board member of *Batteries*, Topical Advisory Panel Member
- "Advanced Technology of Smart Battery and Energy Management System of Transportation Electrification" Topic Editor
- SEGRE2024, CIEEC2025, SEGRE2025 Sub-forum Chair
- IoT, TTE, JES, Information and Control, Batteries reviewer

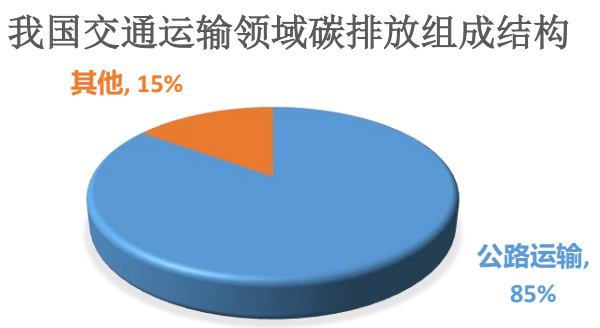
Ⅱ Research background

China has set the “30•60” goal.



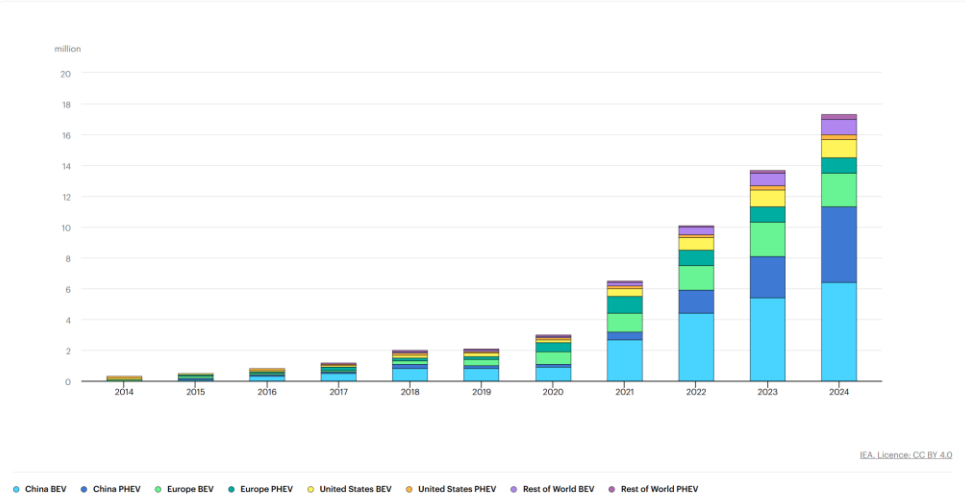
Carbon emissions in transportation field are dominated by road transportation.

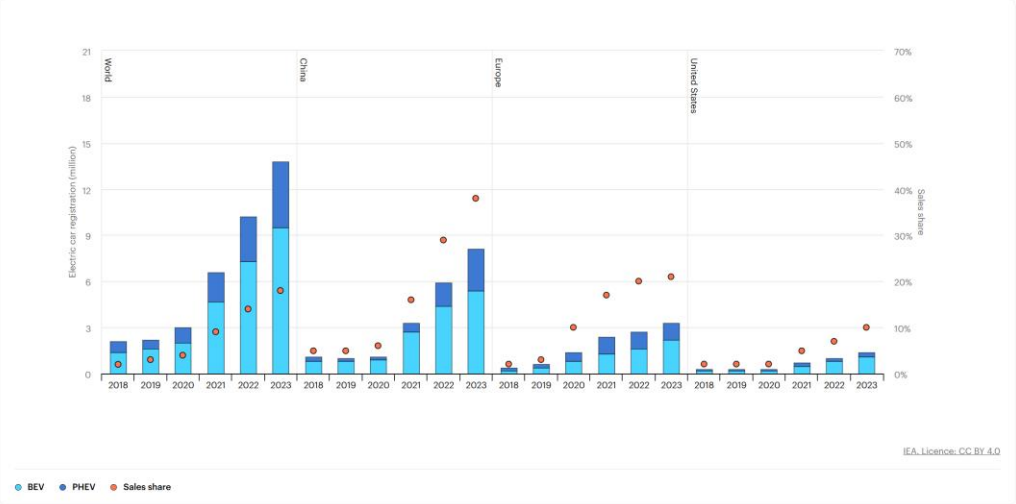




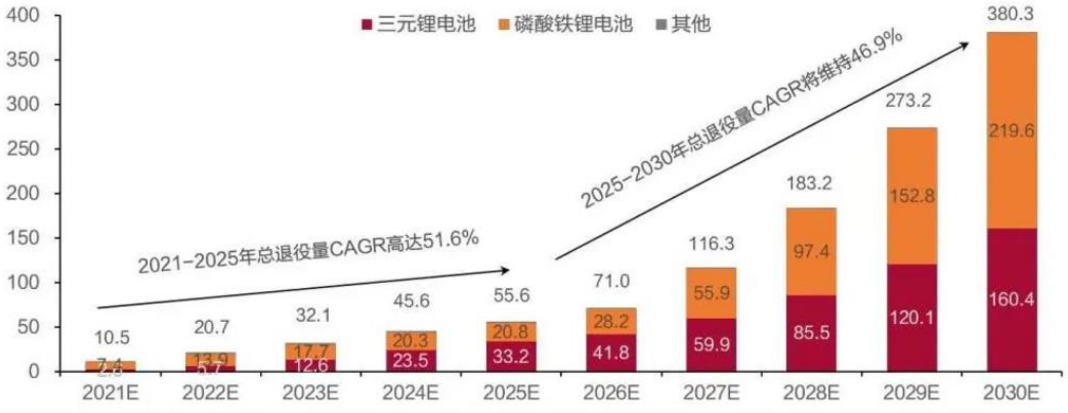
Ⅱ Research background

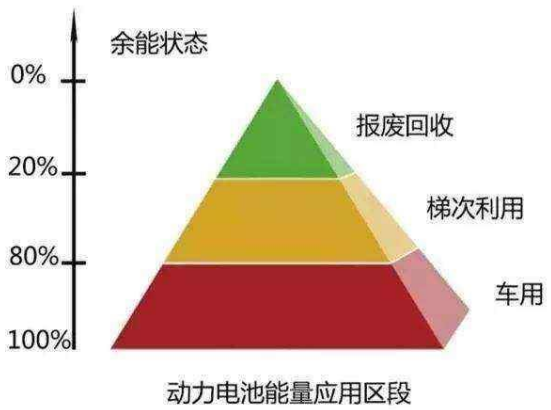
Global electric car sales are increasing rapidly.





Loaded number and retired number of lithium-ion batteries are growing rapidly.

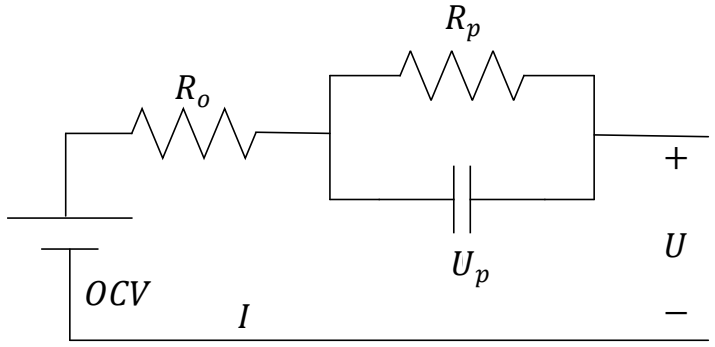


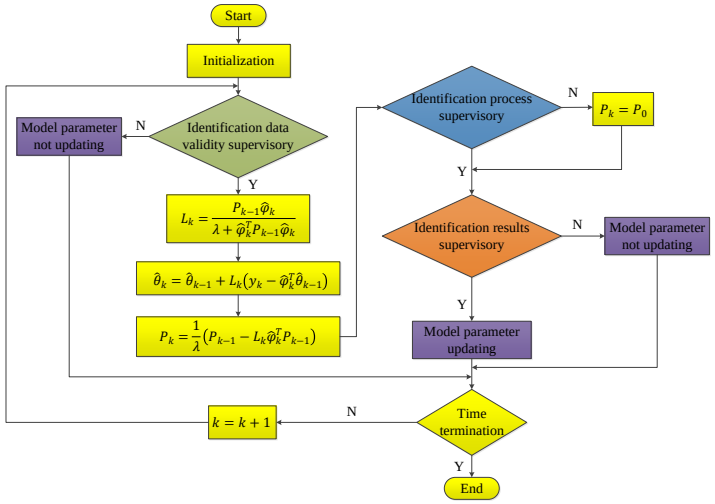


Ⅲ Behavioral characterization

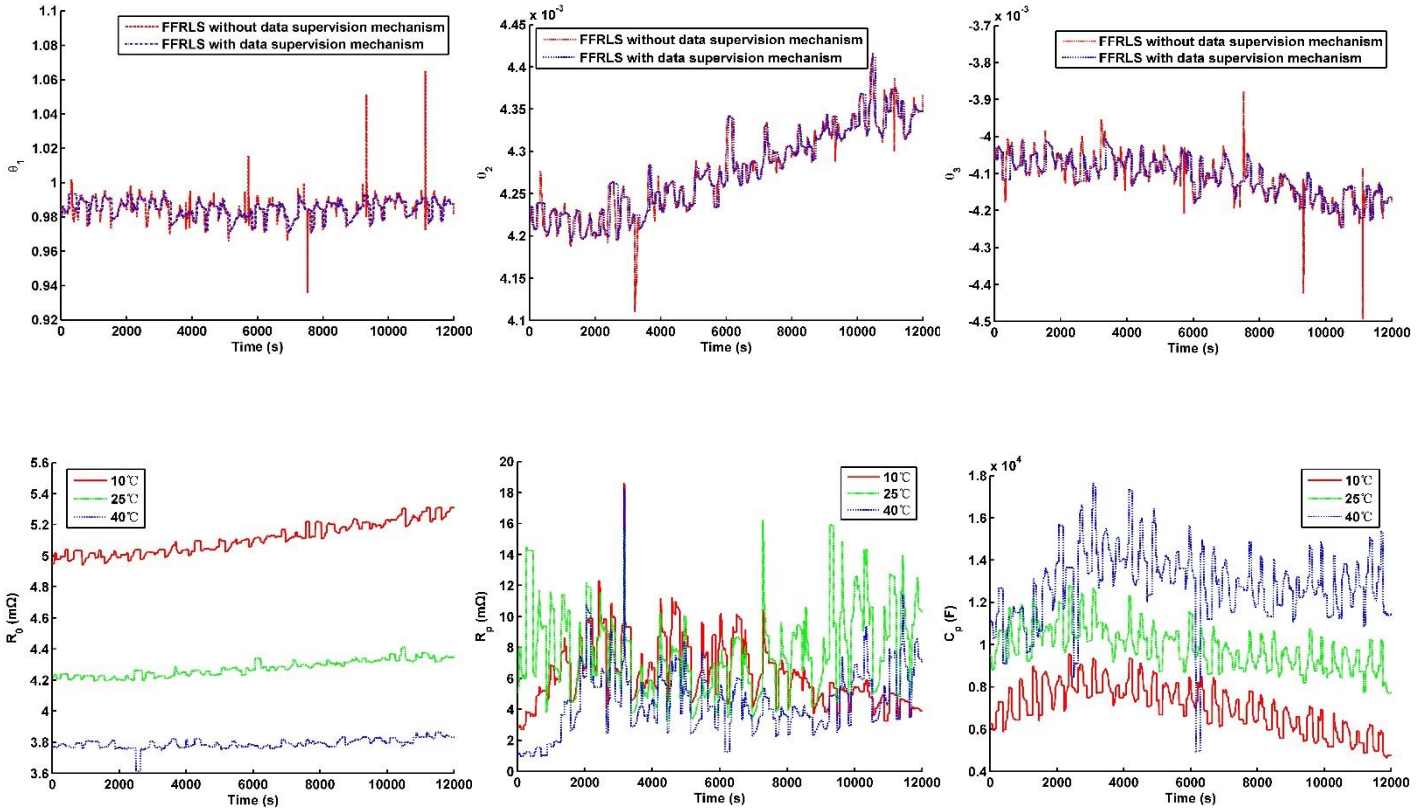
A data supervisory mechanism is designed for online modeling.

Equivalent circuit model





Model parameter identification



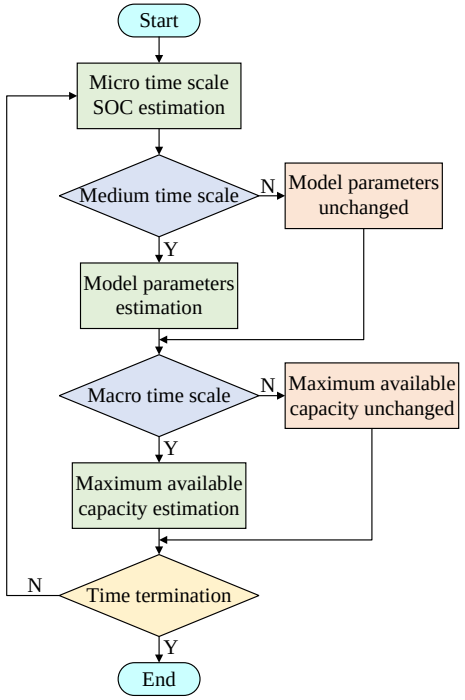
[1] **Muyao Wu,** et al. Online modeling of the LiFePO4 power battery based on the data supervisory mechanism[J], Journal of Energy Storage, 2023, 72: 108359.

IV State estimation

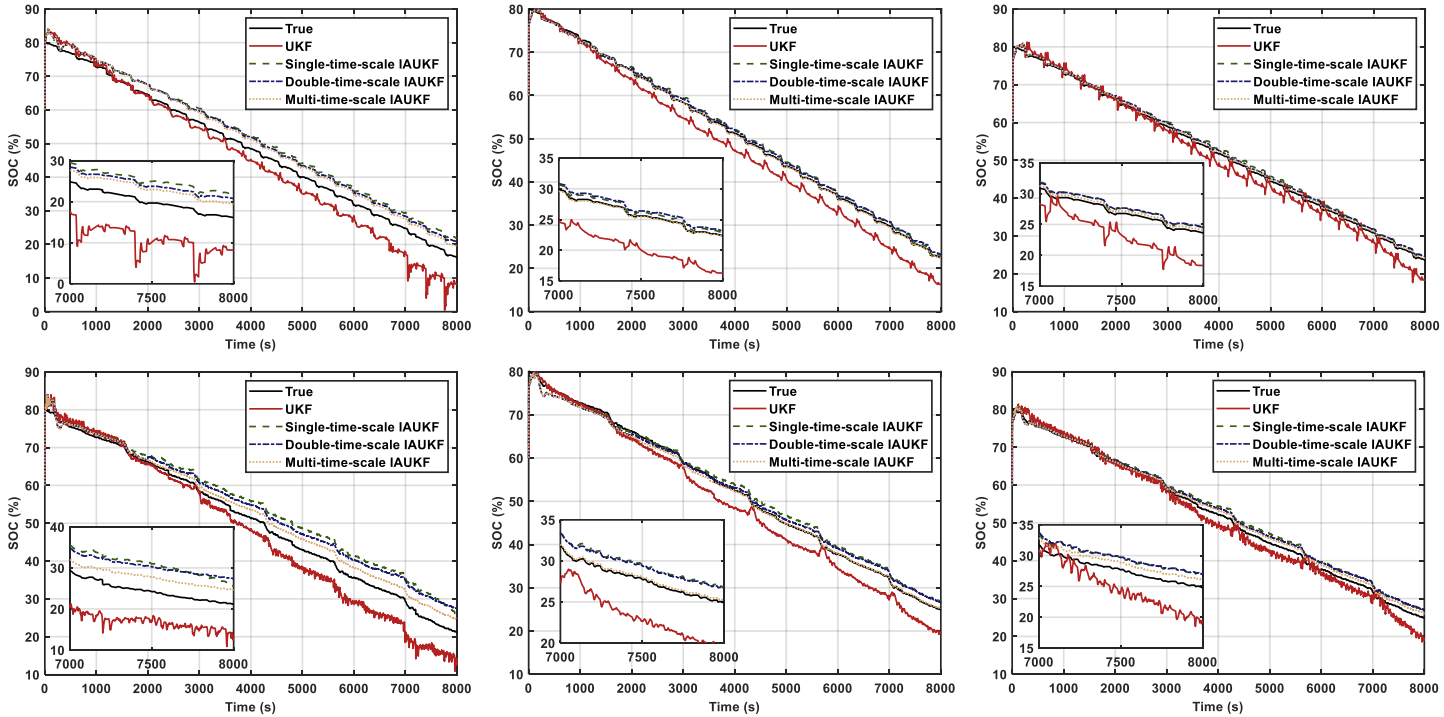
◆1. SOC estimation

■A multi-time-scale improved adaptive unscented Kalman filter (MIAUKF) is introduced.

MIAUKF



SOC estimation results



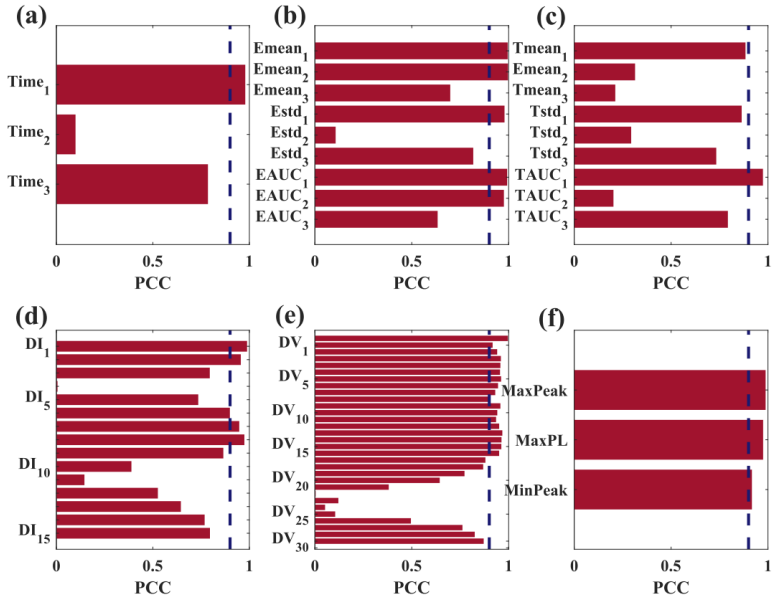
[2] **Muyao Wu,** et al. State of Charge Estimation of the Lithium-ion Power Battery based on a Multi-Time-Scale Improved Adaptive Unscented Kalman Filter[J], IEEE Transactions on Instrumentation and Measurement, 2024, 73: 9003212.

IV State estimation

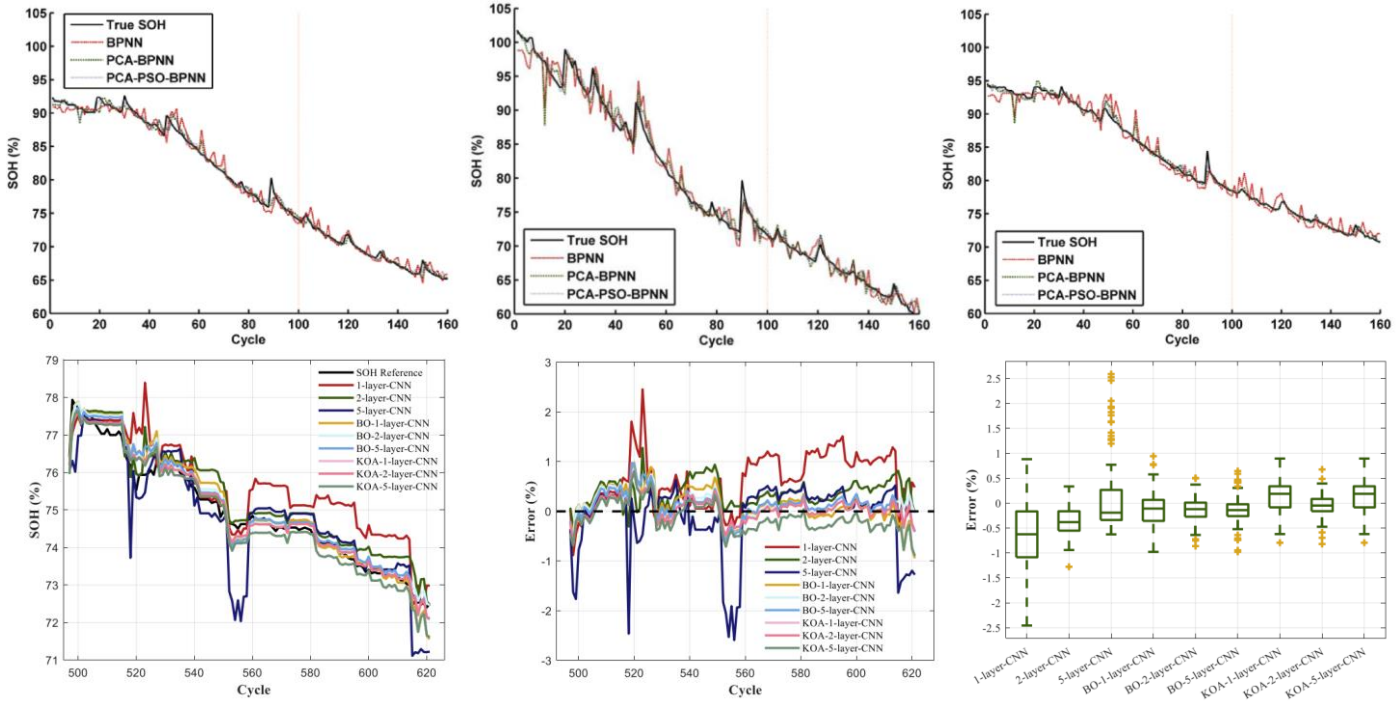
◆2. SOH estimation

■A SOH estimation method based on the charging fragments is proposed.

Cha features（Lab，NCA）



SOH estimation results（Lab，NCA）



[3] **Muyao Wu,** et al. State of health estimation of the lithium-ion power battery based on the principal component analysis-particle swarm optimization-back propagation neural network[J], Energy, 2023, 283: 129061.

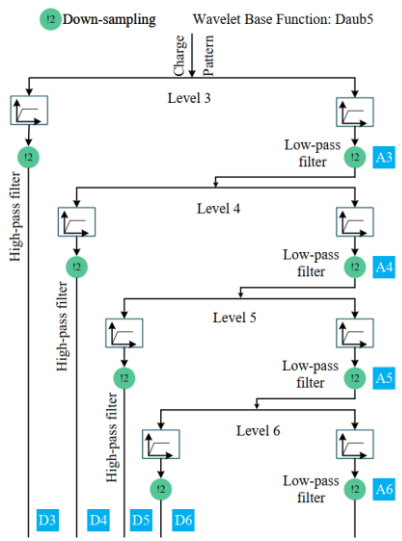
[4] **Muyao Wu,** et al. State of health estimation of lithium-ion batteries based on the Kepler optimization algorithm-multilayer-convolutional neural network[J], Journal of Energy Storage, 2025, 122: 116644.

IV State estimation

◆2. SOH estimation

■A SOH estimation method based on the charging fragments is proposed.

Cha features （Real vehicle）



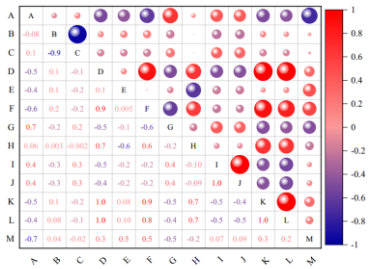
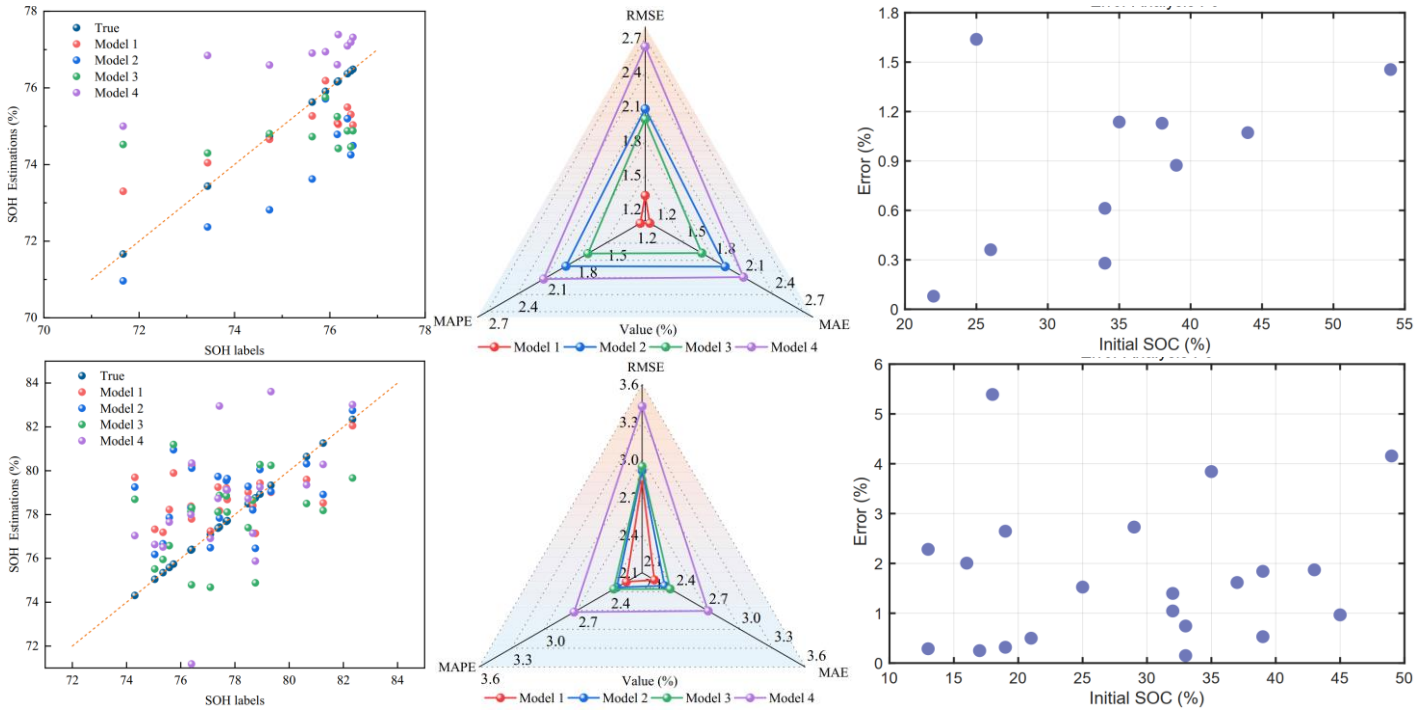


Fig. 3. Pearson correlation analysis results. A to M correspond to Mileage, I_ave, I_var, V_ave, V_var, cell_V_diff, Temp_diff, initial SOC, max_Temp_ave, min_ Temp_ave, max_cell_V_ave, min_cell_V_ave, and SOH.

SOH estimation results （Real vehicle）



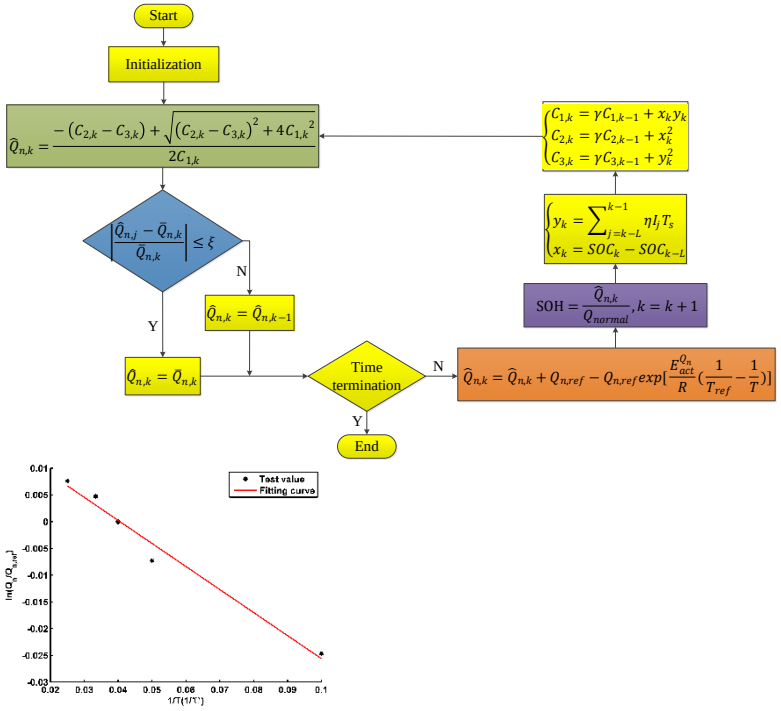
[5] **Muyao Wu,** et al. Hierarchical Feature-Fusion Architecture for State-of-Health Estimation in Vehicle-Deployed Lithium-Ion Batteries[J], IEEE Transactions on Transportation Electrification, 2025, Under review.

IV State estimation

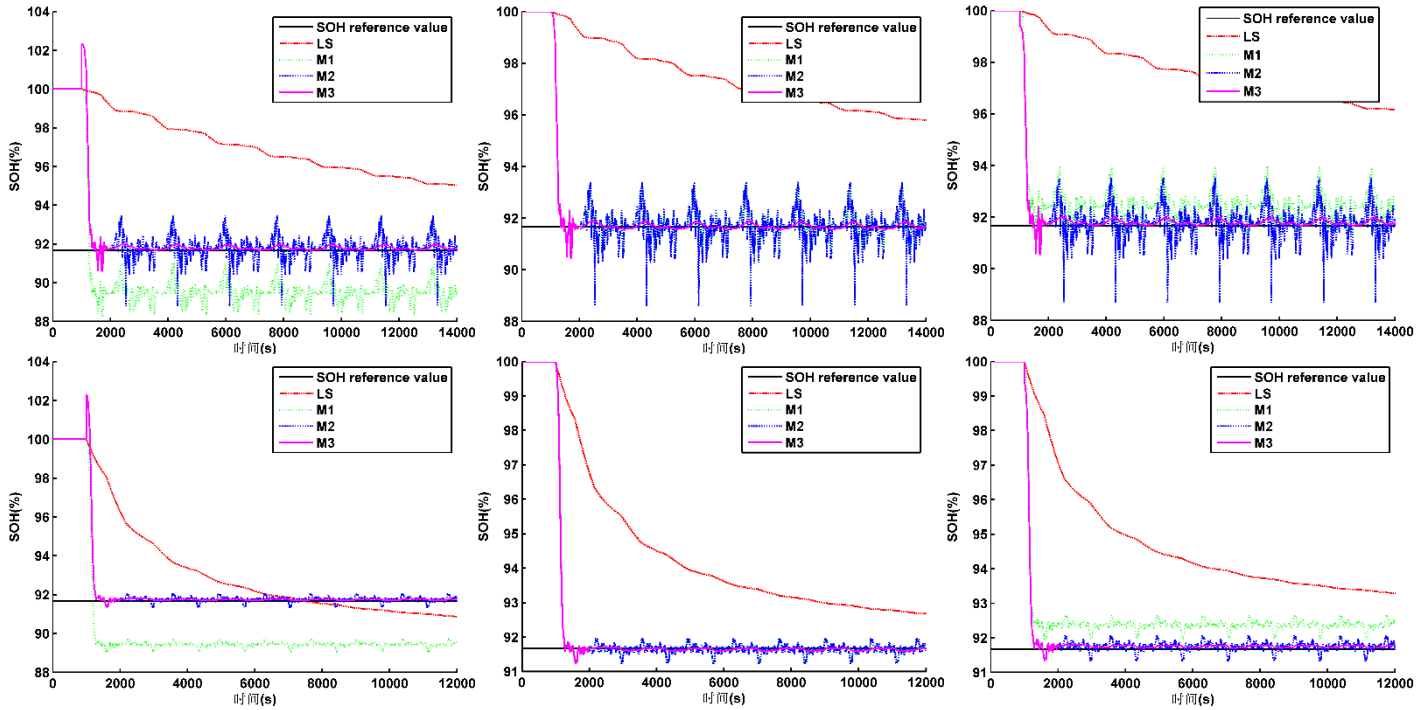
◆2. SOH estimation

■A SOH estimation method based on the discharging fragments is proposed.

Dis fragments



SOH estimation results



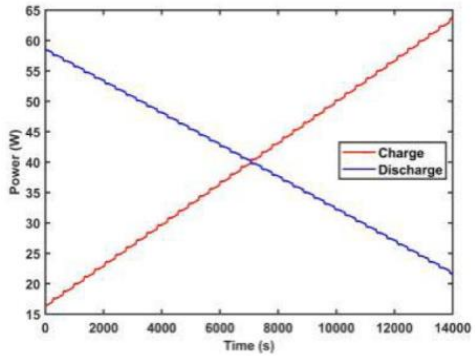
[6] **Muyao Wu,** et al. State of health estimation of the LiFePO4 power battery based on the forgetting factor recursive total least squares and the temperature correction, Energy, 2023, 282: 128437.

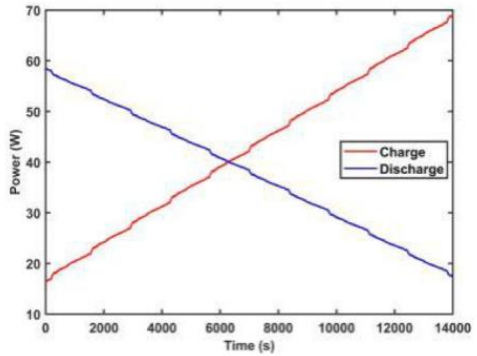
IV State estimation

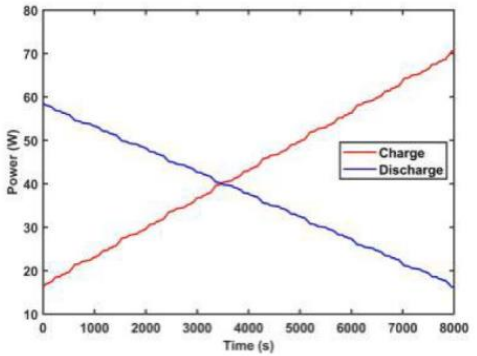
◆3. SOP estimation

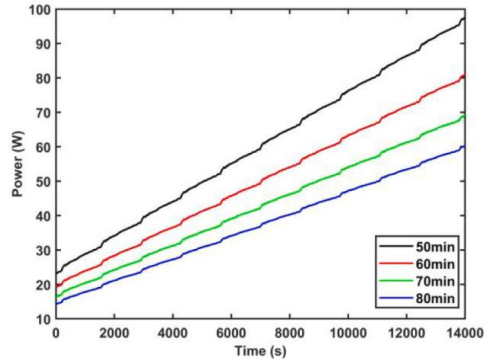
■A SOP estimation method based on multiple constraint conditions is proposed.

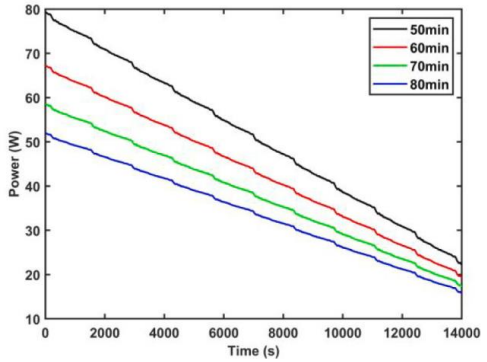
Voltage、SOC、Current constraint







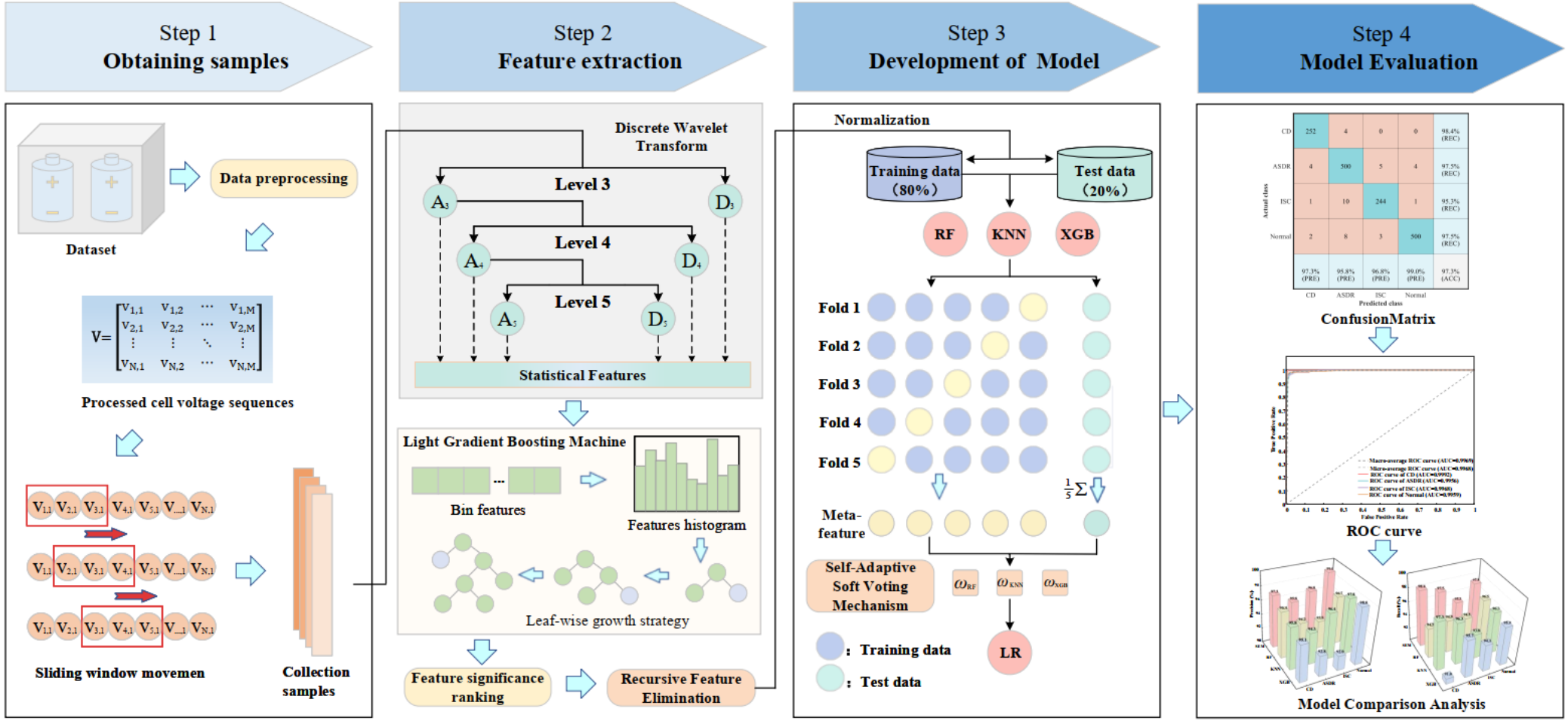




[7] **Muyao Wu,** et al. State of power estimation of power lithium-ion battery based on an equivalent circuit model[J], Journal of Energy Storage, 2022, 51: 104538.

V Fault diagnosis

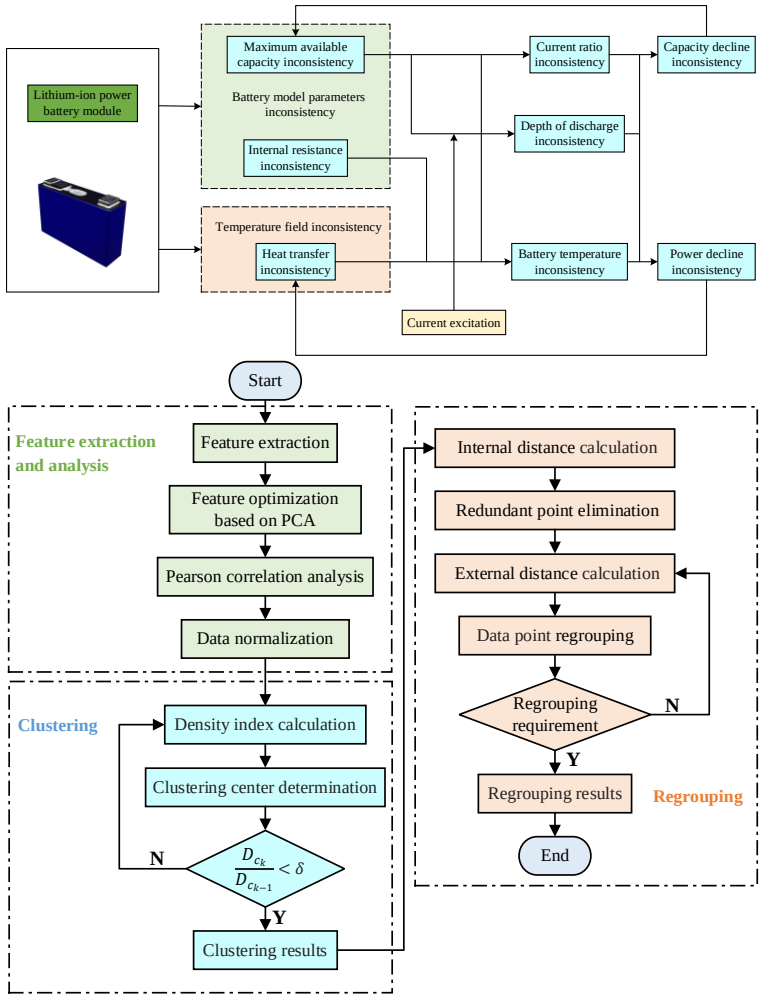
An online multi-fault diagnosis method via Stacking strategy is proposed.

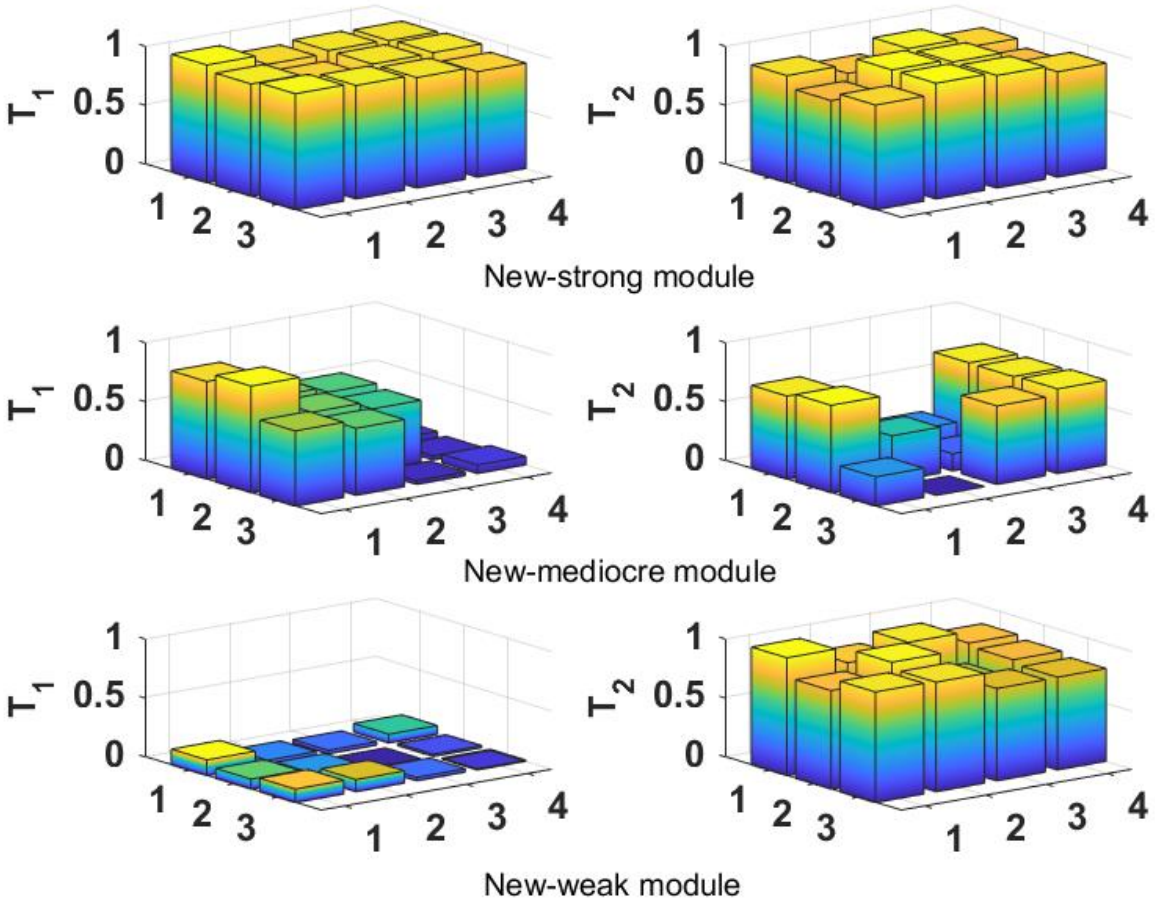


[8] **Muyao Wu,** et al. Online Multi-Fault Diagnosis of Lithium-Ion Batteries via Stacking Strategy with Real-World Vehicle Data[J], IEEE Transactions on Transportation Electrification, 2025, Under review.

VI Echelon utilization

An unsupervised clustering and a stepwise regrouping approach is proposed.





[9] **Muyao Wu,** et al. Screening and Echelon Utilization of Lithium-ion Power Batteries Using Clustering and Stepwise Regrouping Approach[J], IEEE Transactions on Transportation Electrification, 2025, 11 (1): 1939-1948.

Thank you!

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