Predicting Battery Degradation Using Linear Regression

This presentation explores a linear regression model for predicting battery degradation, focusing on capacity and voltage loss.

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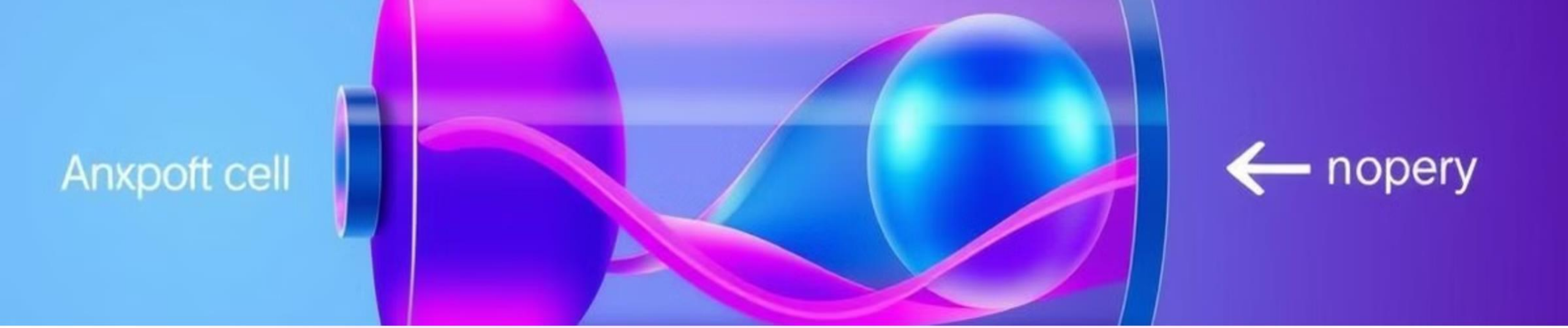
Battery Basics

What is a Battery?

A device that converts chemical energy into electrical energy.

Key Parameters:

- **Capacity (C):** Total energy a battery can store (C = I ⊠ t).
- **Voltage (V):** Electric potential difference.
- **Energy (E):** Total energy delivered (E = V ⊠ Q).
- **Degradation:** Loss in capacity and efficiency over cycles.



Understanding Battery Degradation

1 **Capacity Degradation**

Loss of energy storage capacity over time

2 **Voltage Degradation**

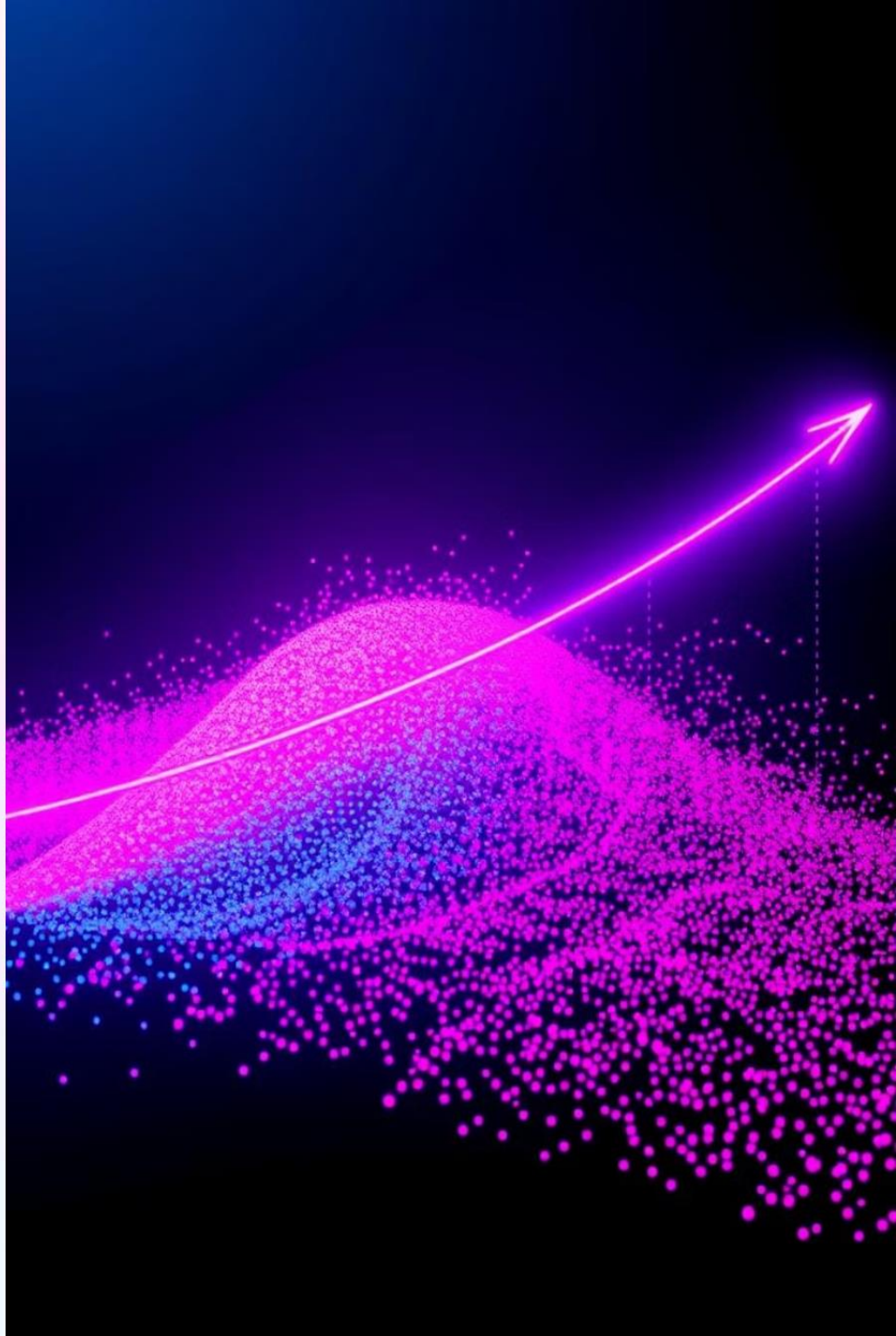
Decrease in voltage output, affecting energy delivery

3 **Causes**

Repeated charge/discharge cycles, high temperatures, aging

Linear Regression: Modeling Battery Health

Linear regression models the relationship between battery performance indicators (capacity, voltage) and factors influencing degradation (cycles, temperature).



Dataset Overview

Data Sources

NASA Ames Prognostics Center of Excellence.

Real-world battery data collected from various Li-ion batteries undergoing multiple charge-discharge cycles

Data Features

Cycle number, capacity, voltage, temperature, discharge data

Modeling Process

1

Data Preprocessing

Cleaning, normalization, feature engineering

2

Model Training

Fitting the linear regression model to the data

3

Prediction

Estimating future battery degradation based on trained model

4

Evaluation

Assessing model performance using metrics like MAE, RMSE, and R^2

Results: Predicting Capacity and Voltage Degradation

1

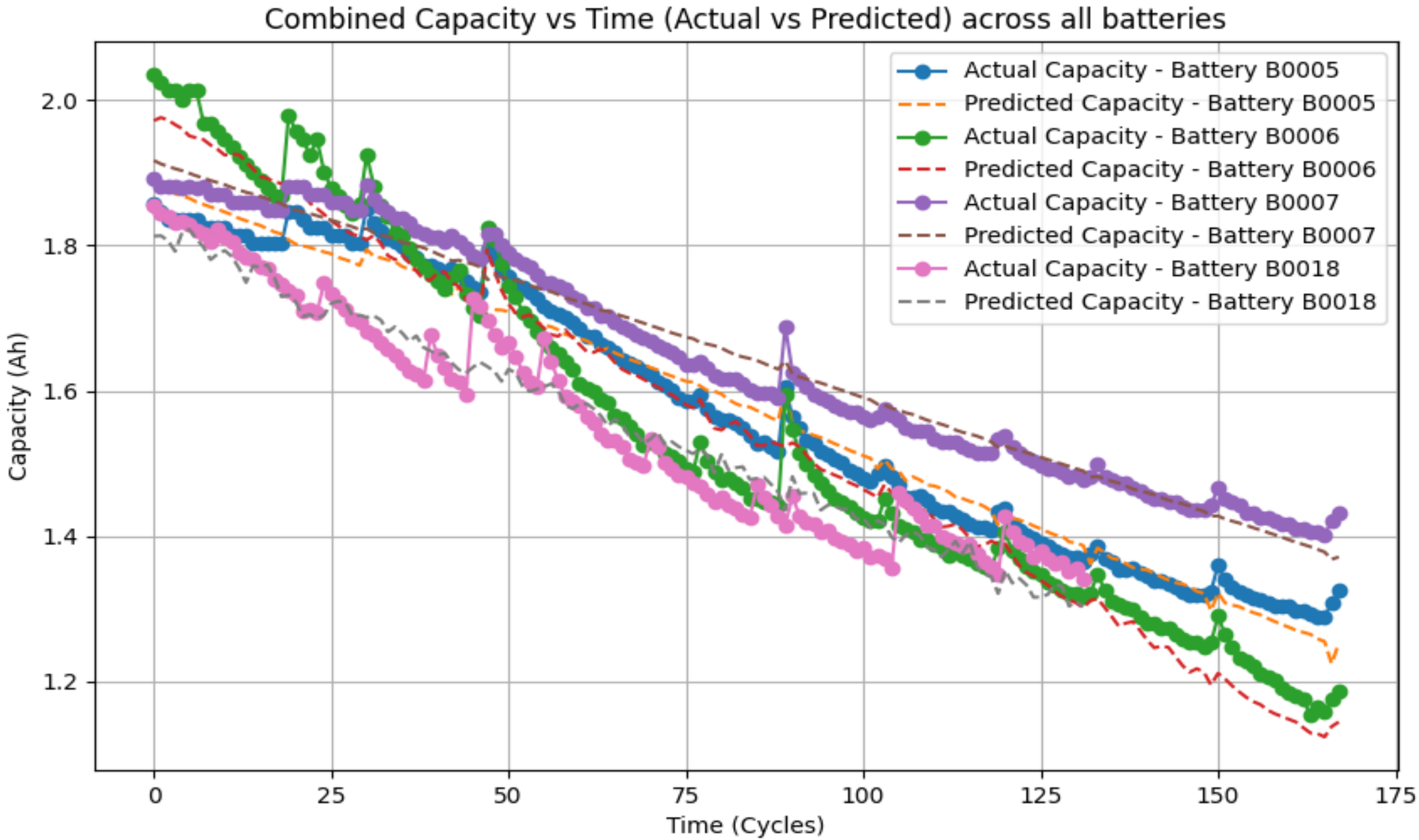
Accurate Predictions

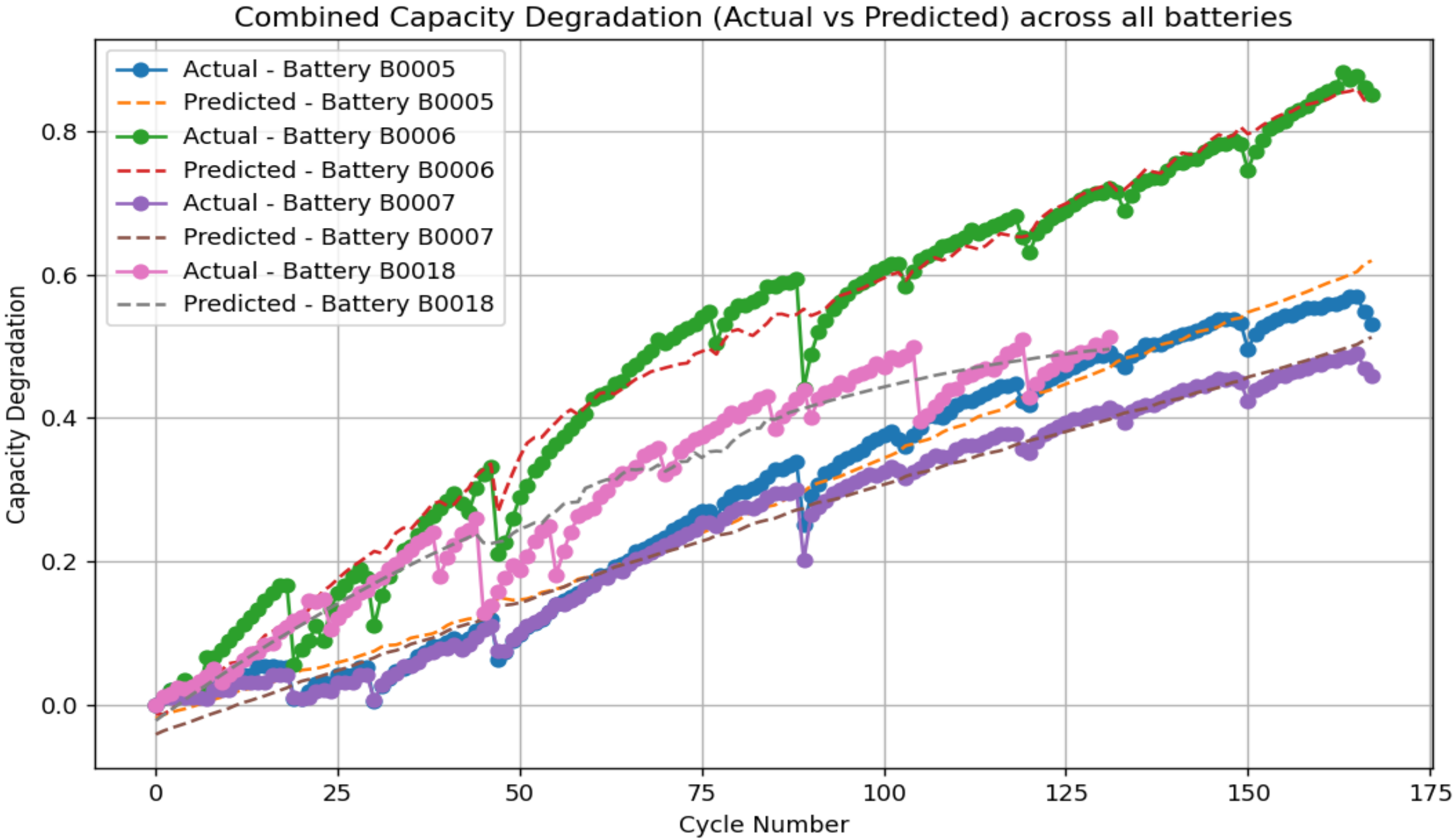
The model demonstrates strong correlation between predicted and actual degradation trends.

2

Insights for Battery Management

Provides a foundation for optimizing battery usage and extending lifespan.


Combined Capacity vs Time (Actual vs Predicted) across all batteries
Actual Capacity - Battery B0005
Predicted Capacity - Battery B0005
Actual Capacity - Battery B0006
Predicted Capacity - Battery B0006
Actual Capacity - Battery B0007
Predicted Capacity - Battery B0007
Actual Capacity - Battery B0018
Predicted Capacity - Battery B0018
Capacity (Ah)
2.0
1.8
1.6
1.4
1.2
0
25
50
75
100
125
150
175
Time (Cycles)


Combined Capacity Degradation (Actual vs Predicted) across all batteries
Actual - Battery B0005
Predicted - Battery B0005
Actual - Battery B0006
Predicted - Battery B0006
Actual - Battery B0007
Predicted - Battery B0007
Actual - Battery B0018
Predicted - Battery B0018
Capacity Degradation
0.0
0.2
0.4
0.6
0.8
0
25
50
75
100
125
150
175
Cycle Number

Next Steps & Future Directions