Classifying Battery Health Stages

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July 28, 2025

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Context

Context

- Lithium ion batteries degrade over time — some internal parameters can led us to verify the safety operation.
- Instead of predicting *SOH - State of Health*, I tried to classify batteries into categories: **Critical**, **Warning**, and **Healthy**.
- Orange allows building this workflow visually using unsupervised learning (K-means).

Main Objective

Classify battery units into health stages by clustering based on *Remaining Useful Life* and degradation features.

Dataset

NASA: Li-ion Battery Aging

filename	ambient_temp	battery_id	Capacity	Re	Rct
00001.csv	4	47	0.983689	0.054543	0.18313
00002.csv	24	47	0.983689	0.054543	0.18313
00003.csv	4	47	0.983689	0.054543	0.18313
00004.csv	24	47	0.983689	0.0518254	0.152493

Table: Battery dataset sample with electrical characteristics.

Feature Engineering

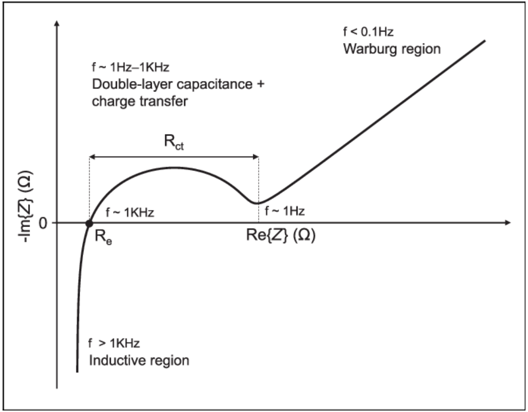

Figure: *Electrochemical Impedance Spectroscopy* (EIS) characterization.

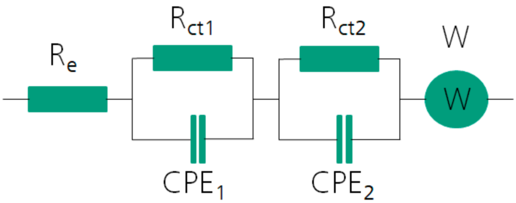

Figure: Complete *Eletrical Circuit Model* (ECM) of battery cell.

Feature Engineering

RUL calculation:

$$RUL = \frac{1000}{1 + R_e * R_{ct}} \tag{1}$$

Where:

- $1000 =$ rated average total cycles;
- $R_e =$ Electrolyte resistance (internal ohmic);
- $R_{ct} =$ Charge transfer resistance (dynamic).

Methods

Orange Workflow

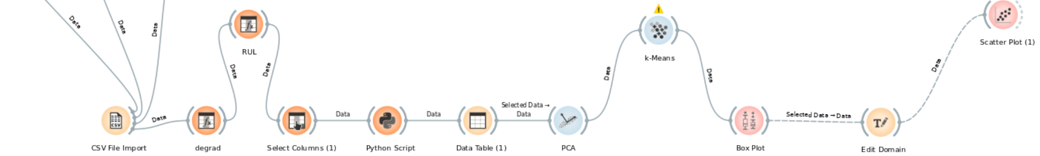

Figure: Project workflow.

Results

Clustering identification

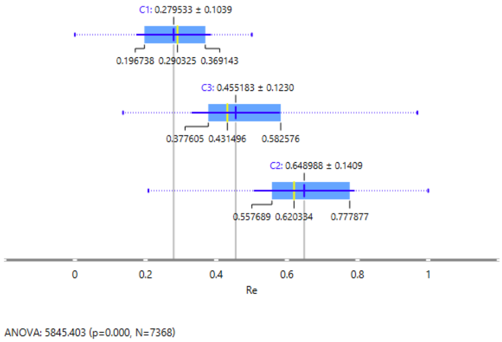

Figure: Normalized R_e boxplot.

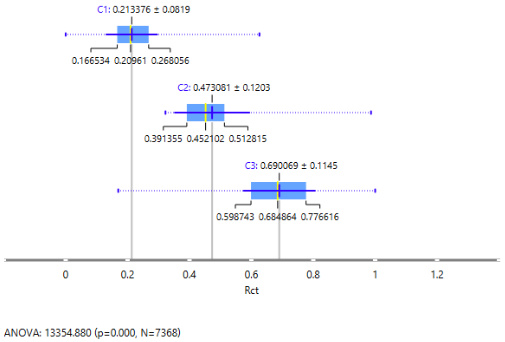

Figure: Normalized R_{ct} boxplot.

Clustering identification

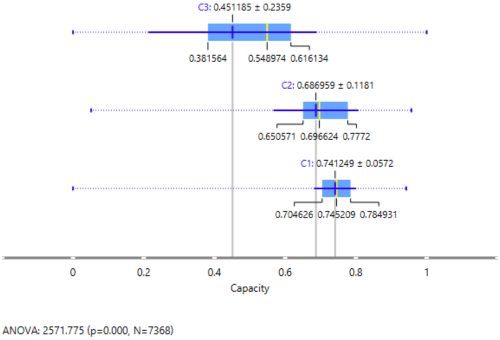

Figure: Normalized capacity boxplot.

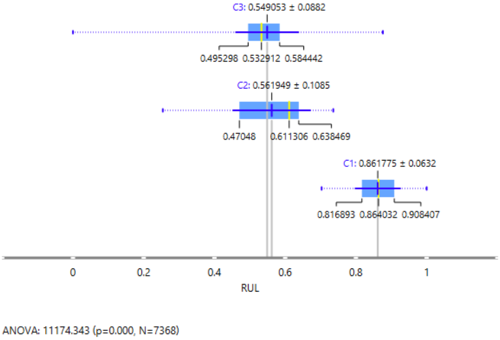

Figure: Normalized RUL boxplot.

Clustering identification

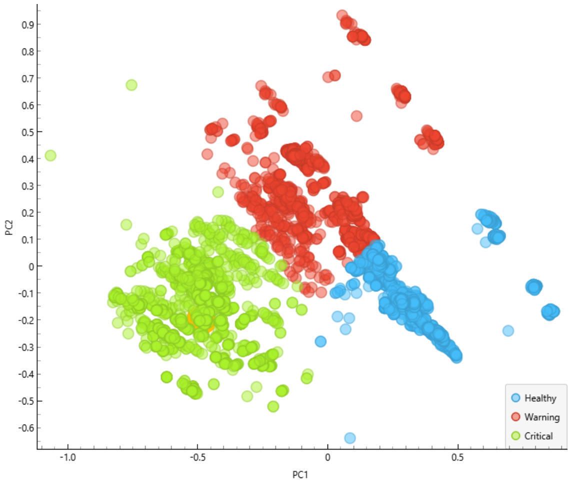

Figure: K-means analysis.