

## Weakly Supervised Battery SOH Estimation with Imprecise Intervals

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The data-driven approach has demonstrated exceptional predictive efficacy in the estimation of state of health (SOH) for batteries. However, its applicability is currently constrained to experimental data, rendering it unsuitable for real-world operational conditions due to specific prerequisites such as high-fidelity measurement data, adaptability to diverse harsh conditions, and adherence to physical constraints governing battery degradation. In response to these challenges, this study introduces a novel weakly supervised SOH estimation method incorporating imprecise intervals. This method comprehensively accounts for potential error sources, rigorously evaluates the alignment of labels within imprecise intervals with predicted and real values, guided by an empirical battery aging model. It encompasses imprecise interval computation techniques tailored to address low measurement precision and sampling rates, incomplete charging and discharging cycles, and the complexities of on-board electric vehicle (EV) operational conditions. Moreover, a weighted loss function is formulated, assigning weights to labels within the interval based on their conformity with the empirical model. Additionally, rationality correction mechanisms are devised to confine predictions within sensible boundaries. The case study verifies the effectiveness of the proposed weakly supervised battery SOH estimation method, demonstrating high predictive accuracy across diverse imprecise intervals, even when operating within the working condition environment of EVs.