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Machine learning and statistical methods for characterising and predicting capacity degradation of Li-ion cells

In automotive applications, Li-ion cells are typically considered to have reached their end-of-life when they are down to 80% of their initial capacity. However, the degradation of these cells typically displays a "knee" pattern: the capacity degrades at a slow rate up to a so-called "knee-point", after which it degrades very rapidly until its end-of-life. This knee-point therefore gives a more advanced warning of the cell's degradation than the end-of-life. Nevertheless, the industry does not have a standard definition or identification method for this crucial metric.

In this talk, we present robust statistical methods to identify two different knee-points in capacity degradation data of Li-ion cells. Following this identification step, we show how machine learning algorithms can be employed to successfully predict the occurrence of these knee-points from the first few discharge cycles of a cell's life. We rely on feature engineering to overcome the challenge of working with a very small, yet high-dimensional data set and we quantify the uncertainty of the predictions to build trust in our models.