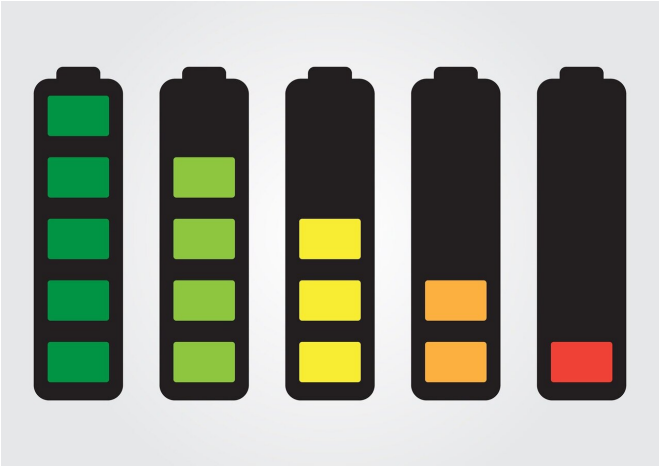
Data-driven machine learning is the best approach for advanced battery modelling

3 March 2020



Credit: CC0 Public Domain

Demand for electrification of transport has emerged in recent years due to increasing concerns about global warming. The widespread adoption of electric vehicles will result in reduced harmful emissions and cleaner air, among other social and economic benefits. The battery industry is in need of software solutions for battery manufacturers to reduce fabrication and development costs while improving key batteries metrics.

AI is unlocking battery technology that will power the future of clean transport, causing a shift in the automotive industry. However, charging capability, energy density and costs will need to improve dramatically. AI has the potential to impact battery development and understand the relationship between data and battery parameters.

The performance, cost, and safety of batteries determine the successful development of electric vehicles (EVs) and currently, Lithium-ion (Li-ion) batteries are the preferred choice for EVs due to their cycle life and reasonable energy density.

However, further research of Li-ion batteries will result in more complicated battery dynamics, where safety and efficiency will become a concern.

Therefore, an advanced battery management system that can optimize and monitor safety is crucial for the electrification of vehicles.

A collaboration between Dr. Gareth Conduit (Cavendish Laboratory, University of Cambridge and co-founder of Intellegens), the Institute of Materials Research and Engineering at A*STAR, and Nanyang Technological University assessed various machine learning (ML) approaches for fast and accurate battery state prediction. The review article was published in *Nature Machine Intelligence*.

Data-Driven Machine learning for EV battery optimization

Machine learning algorithms have been implemented to predict state of health, state of charge, and remaining useful life.

Data-driven models have drawn attention in recent years, and combined with machine learning techniques, these models appear to be more powerful and able to predict without a priori knowledge of the system and have the potential to achieve high accuracy with low computational cost.

Batteries have several key parameters, including voltage, temperature, and state of change. Battery malfunctions are associated with abnormal fluctuations in these parameters, therefore accurately predicting them is crucial to ensure that electric vehicles operate reliably and safely over time.

Once in place, predictive models can be used to standardize processes, allowing all stakeholders access to the same knowledge and tools, and reduce costs both in terms of the number of

experiments that need to be performed and optimizing experiments to minimize the need for expensive components or processes.

This results in reduced environmental impact by designing experiments and products that are less dependent on toxic elements or processes.

What does the future of the battery industry look like?

With the reduced costs of data storage devices and advancement of computational technologies, data-driven machine learning seems to be the most promising approach for advanced battery modeling in the future.

This approach has been used to solve many high-value problems and the key variables for its successful implementation are both data availability and data quality. Nevertheless, there has been a recent surge in applying machine learning methods to help optimize different aspects of the battery industry.

In both cases, the usage of data from multiple domains, including data from experiments that have failed, play a crucial role in accelerating and optimizing battery design, chemistry and management systems.

Dr. Gareth Conduit (Royal Society University Research Fellow at the University of Cambridge and CTO at Intellegens) commented

"Our machine learning technology, Alchemite, can see correlations between all available parameters, both inputs and outputs, in sparse and noisy datasets. The result is accurate models that can predict missing values, find errors and optimize target properties. Capable of working with data that is as little as 0.05% complete, Alchemite can unravel data problems that are not accessible to traditional machine learning approaches."

Alchemite is delivering ground breaking solutions in drug discovery, advanced materials, patient analytics, predictive maintenance and batteries—enabling organizations to break through data analysis bottlenecks, reduce the amount of time and money spent on research, and support better, faster decision-making.

The insights in this review article could have a transformative effect on the battery industry. Highlighting how machine learning can accurately predict and improve the health and life of a battery will enable manufacturers to embed this software straight into their battery devices and improve their in-life service for the consumer.

More information: Man-Fai Ng et al. Predicting the state of charge and health of batteries using data-driven machine learning, *Nature Machine Intelligence* (2020). DOI: 10.1038/s42256-020-0156-7

Provided by University of Cambridge