

# Deep Learning with MBD – State-of-charge estimator for batteries

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**Theme:** Artificial Intelligence

**Sum up:**

AI-based state-of-charge estimator for batteries using Model-Based Design:

- Designing and training deep learning components with Deep Learning Toolbox
- Importing trained TensorFlow models into MATLAB
- Integrating deep learning models into Simulink for system-level simulation

**Key words:** Deep Learning, Model-Based Design, TensorFlow, Simulink

## 1. Introduction

The role of the battery management system (BMS) is to monitor battery state and ensure safe operation. For example, the BMS helps avoid overcharging and over discharging, it manages the temperature of the battery and so on, and it does so by collecting information from sensors on the battery for current, voltage, temperature etc. So, this is a closed-loop system by design.

One of the things that cannot be directly measured but is required for many of these operations is the battery state of charge. So, this quantity needs to be estimated somehow. One way to solve this problem is using recursive estimation based on a Kalman filter. But, the Kalman filter requires a dynamical model of the battery – which may or may not be accurate – and is very time-consuming.

## **2. Methodology**

We will explore, in detail, the workflow involved in developing, testing, and deploying an AI-based state-of-charge estimator for batteries using Model-Based Design.

- Show where deep learning is being applied in engineering and science, and how its driving MATLAB's development.
- Demonstrate a workflow for how you can research, develop, and deploy your own deep learning application with Model-Based Design
- Outline what MathWorks engineers can do to help support you achieve success with deep learning

## **3. Perspective / originality**

Models need to be incorporated into an entire system design workflow to deliver a product or a service to the market. The bridge between engineering and science workflows is one of the most important brick of such an application.

Mix and link Model-Based-Design to Artificial Intelligence will enrich the model and make collaboration between teams robust and more automated.

The next step is to generate optimized C code and perform PIL tests.