Proposal for Open Invited Track on

Machine learning and big data applied to energy storage system modeling and control

at IFAC World Congress 2023

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Abstract

The rapid growth in the vehicle electrification and grid storage market has given rise to the need for intelligent and efficient modeling and control of energy storage systems. Despite the popularity of physics-based models in energy-related research, their applications have been greatly hindered by computational burden and parameterization complexity. Machine learning and big data, proven successful in many other disciplines, have sparked tremendous research interests in the field of energy storage. This open invited track provides an opportunity for like-minded researchers to explore, advertise and exchange works at a time frame where the trend of integrating machine learning and big data in control strategies has become eminent. The discussions that follow are expected to make an immediate impact on the participating researchers and initiate collaborations between research groups around the globe.

Evaluating IFAC Technical Committee

The organizers recommend the proposal to be evaluated by the following Technical Committee:

- IFAC TC 3.2. Computational Intelligence in Control

Additional recommended Technical Committees are:

- IFAC TC 6.3. Power and Energy Systems
- IFAC TC 1.2. Adaptive and Learning Systems
- IFAC TC 1.1. Modeling, Identification and Signal Processing

Description

The intermittent and stochastic nature of renewable energy production has created high demand for energy storage systems. Particularly, energy storage devices have become the workhorse for driving the zero-carbon energy transition, including rechargeable batteries, fuel cells, thermal and hydrogen energy storage systems. To push these systems to operate at their (potentially time-varying) boundary for optimal performance while guaranteeing safety and reliability, sophisticated control strategies developed from physics-based models may have limited applications, particularly where the computational speed is critical. Data-driven approaches, enabled by machine learning algorithms and big data, open a window to balance prediction accuracy and computational efficiency, therefore facilitating real-time optimal control of energy storage devices. This emerging

area of research has attracted attention from the intersection between energy and artificial intelligence with applications ranging from fault detection, safety diagnosis, and lifetime prognosis to learning-based control.

This open invited track thus focuses on modeling and control strategies using machine learning and big data featured in recent progress and breakthrough of energy storage systems. The topics of this track include but are not limited to:

1. Surrogate modeling, digital twining, or big data analytics of energy storage devices
2. Machine learning-based algorithms for health prognostics and diagnostics
3. Physics-informed or physics-embedded neural networks for energy storage systems
4. Data-driven techniques for model parameterization and adaptive modeling
5. Reinforcement learning for optimizing energy efficiency, dynamic performance, and lifetime
6. Reinforcement learning or learning-based control of energy storage systems
7. Machine learning methods to enable the integration of energy storage systems into e-mobility, smart homes, buildings, and power grids

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