Online Machine Learning Modeling and Predictive Control of Nonlinear Systems With Scheduled Mode Transitions

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Abstract

This work develops a model predictive control (MPC) scheme using online learning of recurrent neural network (RNN) models for nonlinear systems switched between multiple operating regions following a prescribed switching schedule. Specifically, an RNN model is initially developed offline to model process dynamics using the historical operational data collected in a small region around a certain steady-state. After the system is switched to another operating region under a Lyapunov-based MPC with suitable constraints to ensure satisfaction of the prescribed switching schedule policy, RNN models are updated using real-time process data to improve closed-loop performance. A generalization error bound is derived for the updated RNN models using the notion of regret, and closed-loop stability results are established for the switched nonlinear system under RNN-based MPC. Finally, a chemical process example with the operation schedule that requires switching between two steady-states is used to demonstrate the effectiveness of the proposed RNN-MPC scheme.

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