Research on Online Condition monitoring for Complex System based on Modified Broad Learning Systems

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January 27, 2023

Abstract

Monitoring the condition of complex systems with implemented sensors in an online manner is of great importance to their safety and availability. Broad learning system (BLS), which expands the single-hidden-layer neural network by enriching the number of hidden-layer nodes, can greatly improve the model training efficiency. But, the randomly generated hidden-layer nodes make BLSs performing poorly in some high-dimensional data classification tasks. This paper focuses on providing some ideas to tackle this problem by optimizing the generation of initial nodes to compact the BLS hidden-layer structure. Specifically, logistic regression (LR) and structural causal model (SCM) are considered to obtain rough predictions of system fault state to replace the randomly generated hidden-layer nodes with no practical significance. Thus, the outputs of the initial node groups are more closely related to the system health status. The proposed methods are expected to improve the feature extraction effectiveness, to simplify the network structure, and to reduce the computational burden. Various simulation datasets are considered to prove the universality of the proposed method in complex system fault diagnosis. And, with real data from a high-speed train brake control system, the effectiveness of the proposed online monitoring framework is further verified. It is also shown that the proposed methods are convenient to migrate to new operation environments.

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