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Slow Feature Analysis Improvements for Process Control

Unsupervised learning methods are an attractive tool for process monitoring as they require no knowledge of the particular process and a minimal number of parameters to be chosen. Slow feature analysis (SFA) is an unsupervised learning method that extracts the slowest varying latent features from a set of time variant data, which has been used in the past for process monitoring and fault diagnosis. However, the existing SFA suffers from several issues, such as high computation load for voluminous samples, poor performance for nonlinear data and inaccurate fault diagnosis results.

In this presentation, improvements of SFA and SFA based monitoring are proposed to address the aforementioned issues. Firstly, incremental SFA is adapted to process large datasets sequentially with linear feature updating complexity. Further, neural networks are introduced to integrate with SFA for complex nonlinearity handling. Finally, sparsity is introduced into SFA through the use of manifold optimization and proximal gradient methods, which is referred to as sparse SFA, and it is effective to locate the root causes of the faults. All the proposed methods are evaluated using the Tennessee Eastman Process data set which is a common benchmark in process monitoring research.