Texas Tech University
Department of Chemical Engineering
Seminar Schedule

Qiugang Lu
Postdoctoral Researcher
University of Wisconsin-Madison

Data-Driven Fault Detection and Diagnosis with Machine Learning

Abstract
Early detection of process faults is critical to prevent disastrous consequence of large-scale chemical plants when equipment failures occur. The availability of massive operation data in modern chemical process and the advancement of machine learning and data analytics tools provide extensive resources to better monitor the process faults and gain insights into complex systems. This talk will present our work on using machine learning techniques to facilitate the two main tasks in process monitoring: fault detection and fault diagnosis.

For data-driven fault detection, a major challenge is the high dimensions of the system and the resultant strong auto- and cross-correlations among process variables. We have proposed a novel technique, known as sparse canonical variate analysis (SCVA), to reduce the dimensions by reserving main patterns in the data and removing noise. This approach can significantly improve the fault detection performance than other dimensionality reduction methods. Moreover, the sparsity in the projection vectors (aka loadings) can indicate major components/variables in the systems, thus providing valuable insights into the structures of the complex process.

The second part is on using machine learning techniques to promote fault diagnosis. The objective of fault diagnosis is to classify a given (faulty) dataset to the corresponding fault class with high accuracy. We proposed to use deep convolutional neural networks (CNN) with a softmax classifier to enhance the classification performance. We provide methods to treat traditional multivariable signals from chemical processes as one-channel gray images and thus 2D kernel filters can be applicable. The convolution operations can capture local (both spatial and temporal) correlations in the data and thus our method shows advantageous performance in fault classification. This also provides new opportunities to further combine CNN-based techniques with the fault diagnosis.

Bio
Qiugang Lu is a postdoctoral research associate in the Department of Chemical and Biological Engineering at the University of Wisconsin-Madison. Prior to that he worked at General Motors of Canada Company from 2018 to 2019 as a prognostic engineer for fault detection of autonomous vehicles. He obtained his PhD degree from University of British Columbia, Canada, in 2018. His research interests include process data analytics, system identification, machine learning and data-driven control, with applications to pulp & paper manufacturing, chemical processes and autonomous vehicles.

Friday, Jan 17th
Livermore 101
3:00 pm