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A hybrid approach to transfer learning for product quality prediction

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The progress of technology and market demand led chemical process industries to abandon stationary production towards more flexible operation models that are able to respond to rapid changes on market demand (Zhang et al. 2021). Therefore, being able to move production from a source product grade A to a target product grade B with minimal effort and cost is highly desirable. Since the new product grade is frequently lacking information and data, transfer learning methods can use past information from data-driven or mechanistic models to support the tasks to be carried out in the new operation window (Tomba et al. 2012).
This problem was first approached in the chemical engineering field by García-Muñoz et al. (2005) with the development of the Joint-Y Partial Least Squares (JYPLS) which relates similar process conditions through a latent variable model. Several improvements on JYPLS were since then proposed (Chu et al. 2018, Jia et al. 2020). However, these approaches only consider information from historical data, leaving out prior knowledge. The incorporation of the mechanistic knowledge has been shown to improve predicting performance, especially under extrapolation conditions (Sansana et al. 2021).
In this work, we study the integration of various knowledge sources in JYPLS including data generated through simulation of mechanistic models. Simulation conditions are obtained through Sobol experiments within the target process domain. Furthermore, we discuss when transfer learning can be reliably applied, as well as how much information should be transferred from each information block without negative transfer (Pan et al. 2010).

Keywords

Transfer learning; Hybrid modeling; Multimode

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