

Thesis title:

Probabilistic Modeling of Process Systems with Application to Risk Assessment and Fault Detection

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Abstract

Three new methods of joint probability estimation (modeling), a maximum-likelihood maximum-entropy method, a constrained maximum-entropy method, and a copula-based method called the rolling pin (RP) method, were developed. Compared to many existing probabilistic modeling methods such as Bayesian networks and copulas, the developed methods yield models that have better performance in terms of flexibility, interpretability and computational tractability. These methods can be used readily to model process systems and perform risk analysis and fault detection at steady state conditions, and can be coupled with appropriate mathematical tools to develop dynamic probabilistic models. Also, a method of performing probabilistic inference using RP-estimated joint probability distributions was introduced; this method is superior to Bayesian networks in several aspects. The RP method was also applied successfully to identify regression models that have high level of flexibility and are appealing in terms of computational costs.