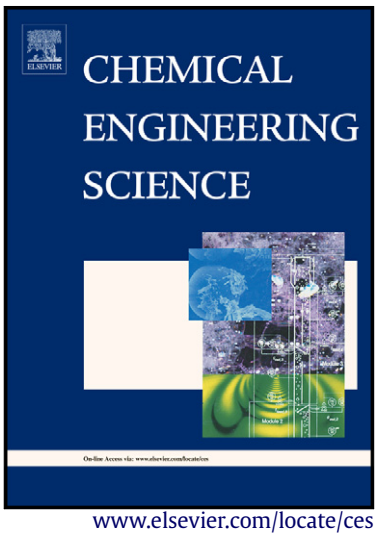

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Amanda Rogers, Marianthi Ierapetritou

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Title: Feasibility and flexibility analysis of black-box processes Part 1: Surrogate-based feasibility analysis

Authors : Amanda Rogers, Marianthi Ierapetritou*

Department of Chemical and Biochemical Engineering,Rutgers, The State University of New Jersey, 98 Brett Road, Piscataway, NJ 08901

**corresponding author: marianth@soemail.rutgers.edu*

Abstract

Feasibility analysis is a useful technique for evaluating the operability and ultimately the flexibility of chemical processes. However, it is difficult to solve the feasibility test problem for process models involving black-box constraints. This issue can be addressed through the use of surrogate-based methods for feasibility analysis. These techniques rely on the creation of a reduced-order model that approximates the feasibility function for a process. The feasible region for the process can then be evaluated based on the surrogate model. In this work, a novel method for surrogate-based feasibility analysis based on kriging metamodels will be presented. This algorithm differs from previously published approaches in the way that the expected improvement function is evaluated. In addition, the proposed method explicitly considers surrogate model prediction uncertainty. The algorithm is also extended to problems of dynamic feasibility analysis, where the shape and size of the feasible region may change with time. A series of test problems will be used to demonstrate the surrogate-based feasibility algorithm, including those with nonconvex and disjoint feasible regions. Finally, the algorithm will be used to evaluate the feasible region for a dynamic roller compaction process.

1. Introduction

Feasibility describes the ability of a process to satisfy all relevant operating, quality and production constraints in the presence of uncertainty (I. E. Grossmann et al., 2014). Uncertainty can arise from a variety of sources, including variability in raw materials, demand uncertainty,