A HYBRID APPROACH COMBINING SIMULATION AND A QUEUEING MODEL FOR OPTIMIZING A BIOMANUFACTURING SYSTEM

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ABSTRACT

We explore a hybrid approach to designing a biomanufacturing system with low-volume, high variability, and individualized products. Simulating a large number of possible configurations to determine those that meet target production goals is computationally impractical. We create an explainable surrogate model, specifically a queueing network model, that is calibrated to the output of a few computationally expensive simulations. The queueing network model enables a quick exploration of large numbers of mixed integer-continuous configurations, which would be challenging for traditional surrogate-based approaches. The queueing network model is used to quickly identify promising regions where a few configurations can then be evaluated with the simulation. The difference in evaluations at these configurations is used to decide whether the queueing model requires partitioning and/or re-calibration. The use of this hybrid approach with an explainable surrogate enables analysis, such as identifying bottle-necks, and gives insight into robust designs of the biomanufacturing system.

1 INTRODUCTION

Biomanufacturing provides unique challenges for simulation and optimization. These applications tend to have low-volume production of highly variable personalized products. Production often requires timely coordination between operators and machines across multiple production phases. Additionally, the resulting yield is variable, which can cause the need for rework.

In addition to these structural challenges, these biomanufacturing applications can be difficult to model due to a lack of data. Simulation, built from subject matter expert knowledge, can be a powerful tool. These