ITERATIVE OPTIMIZATION-BASED SIMULATION (IOS) WITH DETERMINISTIC AND STOCHASTIC TRIGGER EVENTS IN SIMULATED TIME

Mohammad Dehghanimohammadabadi
Thomas K. Keyser

Department of Industrial Engineering and
Engineering Management
Western New England University
Springfield, MA, USA

ABSTRACT

A novel simulation-optimization model called Trigger-based Iterative Optimization-based Simulation (TIOS) framework is designed, developed and examined. This framework includes a threefold contribution of simulation, optimization and database manager. These system managers operate in harmony to achieve the goal of selecting the best system configurations (e.g. scheduling, resource allocation, etc.) for different states of the system. Considering the major activates that cause changes system's status, this frameworks is designed in such a way that updates the system configuration whenever needed. The proposed IOS approach is used to simulate a two-stage non-deterministic flow shop problem. The results prove a positive impact of the TIOS approach on the system's performance measures, although it takes longer to execute compared to the heuristic dispatching rules approaches.

1 INTRODUCTION

Due to their successful application in different disciplines, Simulation Optimization (SO) models gained popularity very fast. Simulation optimization provides a structured approach to optimize parameter values, where optimization is performed by function of the output variables (steady state or transient) associated with a simulation model (Swisher et al., 2004). According to (Figueira and Almada-Lobo, 2014) there are two main classification of the SO models including: Simulation Evaluation (SE) models and Solution Generation (SG) models. In former SO models which have been extensively explored in the literature, an optimization method is used to evaluate a set of solutions in solution space to find the best/set of the best solution. In latter models which are less explored by the research community, comparing the advantage of the solutions is not point of interest; but simply some simulation variables and its characteristics are computed as part of the whole solution generation. Iterative Optimization-based Simulation is one of the GE models which utilizes an optimizer frequently at the model's operational level in order to optimize the combination of the system's state variables during the simulation run.

2 RESEARCH MOTIATION

Unlike the existing IOS models developed for scheduling problems that run optimization at the end each job completion, the proposed Trigger-based IOS (TIOS) model reacts upon major changes of the system status, which are called trigger events. Two different type of trigger events including planned and unplanned are defined which occurrence of each, pauses the simulation momentarily and signals optimization manager to provide an optimal solution. Simulation model continues its run when new system configuration is achieved by optimization manager. Therefor this research aims to:

- develop a generic TIOS framework to cope with complexity and uncertainty in a variety of complex systems, e.g. manufacturing, supply chain, etc.;
- include the ability to call optimizer by occurrence of either planned or unplanned trigger events;

- add new capability to simulation environment to use multiple optimizers as needed with different mathematical programming problem for different simulation circumstances;

3 POSSIBLE TRIGGER EVENTS IN SIMULATION ENVIRONMENT

As previously mentioned, trigger events in this study are classified as planned and unplanned events. Planned events are those which are desired to happen at a specified time and require a new system configuration. For example, in a manufacturing system, an optimization module provides a fresh scheduling at the beginning of every shift routinely. Unplanned event are categorized into two subclasses as event-driven based and control chart based. Event-driven triggers react to any predefined noticeable events in the system which in return causes simulation requests an update. For instance, in manufacturing systems, a server failure yields low system throughput and needs rescheduling actions. In control chart based events a control chart continuously monitors the system performance and invokes the optimization manager to deal with out-of-control system. As an example in manufacturing systems, a control chart monitors the average tardiness of the most recent finished jobs and if it's out of the control, optimizer is triggered.

4 FRAMEWORK STRUCTURE

SIMIO is one of the powerful simulation software packages, which is designed around the basic object oriented principles. With its *"Application Programmers Interface"* (API) capability, users can program their own desired algorithm and embed them into the simulation environment. By leveraging this capability, a new user-defined SIMIO step instance is programed and implemented which integrates MATLAB as an optimization manager to SIMIO. Using MATLAB, enables simulation model to solve variety of optimization problems which require different algorithms or solvers. The MySQL database is integrated to the model which stores number of possible attributes, simulation variables and optimization solution. In fact, database plays a "key role" for transferring the data between simulation and optimization

5 TIOS EVALUATION

The proposed TIOS framework is utilized to model a two-stage manufacturing system with a few number of machines in each stage. Several simulation experimental are designed to compare the performance of the proposed model with heuristics dispatching rules such as SPT and EDD. The initial results indicates that although TIOS takes longer to execute, but it outperformers the regular scheduling rules in terms of Cmax or maximum completion of the jobs, WIP (Work in process) and overall jobs' tardiness.

6 CONCLUSION

A novel simulation optimization framework called TIOS is designed, developed and implemented by integrating SIMIO as simulation manager, Matlab as optimization manager and MySQL as Database Manager. This advancement to the simulation environment could tackle variety of optimization problems within a simulation run for several times. The proposed TIOS framework calls optimizer upon occurrence of the predefined planned and unplanned trigger events to update the simulation configuration during its run. Although TIOS application is illustrated for a manufacturing system, however, it applies to any discipline where simulation applies.

REFERENCES

Figueira, G., Almada-Lobo, B., 2014. Hybrid simulation–optimization methods: A taxonomy and discussion. Simulation Modelling Practice and Theory.

Swisher, J.R., Hyden, P.D., Jacobson, S.H., Schruben, L.W., 2004. A survey of recent advances in discrete input parameter discrete-event simulation optimization. IIE Transactions 36, 591–600.