Proceedings of the 2013 Winter Simulation Conference
R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, and M. E. Kuhl, eds

USING A FREQUENCY DOMAIN APPROACH ON MODEL COMPARISON

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ABSTRACT

In the area of simulation for production systems the creation of online decision support systems is getting more and more popular. With the application of new simulation methodologies, there is a need for additional approaches on how to handle verification and validation. Model comparison is a common approach for verifications and validation of models. We see it as an approach which can benefit automated system validation in the future. However we need improved methods to automatically compare system behavior. In this paper we introduce ideas based on frequency domain experimentation to approach system comparison.

1 INTRODUCTION

In today's simulation of complex production systems, the use of automatically amended and generated models becomes more and more common, especially considering the rising use and importance of online simulation systems. Developing and deploying these systems is very time consuming and accordingly they are intended as long term solutions. After initial verification and validation these systems need to be monitored, verified and validated during their productive time to guarantee their continued usefulness as a decision making tool. Apart from basic model checks and sanity checks on the included data, it is often hard to determine whether the model generated from the factory database is actually a valid model, or whether there are some underlying data or structural issues which were not yet detected. Automatically generated models therefore need an automated way to be validated which should pay some respect to important model features. We see the possibility to improve these tests by being able to compare two system models automatically. The opportunity of automated model comparisons might be able to help determine whether a model can still be considered valid or if the newly generated model needs manual adjustments. In frequency domain experimentation we see promising an approach to tackle this challenge.

2 RELATED WORK

Identifying the internal workings of a system is a long researched topic which is still open for improvements. There has been a lot of work in factor screening and analyzing the influences of input parameter on output values. Traditional factorial designs have an enormous amount of necessary design points and needed simulation runs to generate a full set of data. Fractional designs, reduce these up to a certain point nevertheless analyzing a system with many factors is very time consuming. These methods are well known and can be found in common books on experimental design, e.g. Montgomery (2009). We base our current work on an approach introduced in by Schruben and Cogliano (1981), they presented a method to simultaneously analyze a systems responses and interactions by inducing oscillations in the factors and measure the response. The responses are transformed to the frequency domain. Factors which

978-1-4799-2076-1/13/$31.00 ©2013 IEEE

influence system responses will transfer their driving frequency, thereby enabling the researcher to assert the influence of factors and factor interactions on responses. A good introduction to this approach, and an extensive overview on relevant literature is given in (Sanchez et al. 2006). Our research focusses on extending these ideas towards the model comparison domain.

3 THE GENERAL IDEA

Comparing systems based on their response characteristics in the frequency domain to certain stimuli is the basic concept of our approach. Using it we expect a decrease in necessary design points to compare systems. We would like to assert the influence of a system on the transformation from input parameters to output values and additionally gather structural information from the “noise” which is currently discarded in the frequency domain approach. There are a lot of features in a model which have a significant influence on key performance indicators as well as general model behavior. These features will have an effect on how and if factors influence output values, for example batching works as a filter for higher frequencies. Some features like rework loops even have the potential to introduce new frequencies. Therefore the noise of a system contains everything about a system which is not directly described by our input factors, i.e., structural information, the effect of dispatching rules and random influences.

We see two major approaches to screen a system for characteristics, first there is the approach which directly follows from the ideas introduced by Schruben and Cogliano (1981). Where different input values are generated with specific frequencies to be able to register/monitor their influence and interactions on certain system properties.

The alternative is to search for frequencies which cause a system to resonate.

3.1 Static observations

As static observations we want to refer to experiments following the guidelines given by (Sanchez et. al. 2006). Test for sensitivity analysis of certain factors can be carried out by selecting reasonable driving integers to generate frequency sets which generate easily distinguishable output curves. The impact of each input factor can be evaluated and compared for different models, serving as an indicator of likeness.

3.2 Frequency band observations

Running multiple simulations and scanning trough a whole bandwidth of frequencies a system can resonate when it is stimulated in a frequency which matches frequencies inherent to some of its components. As these inherent frequencies show significant influence on a systems behavior these can be considered important factors for model comparison. Furthermore we consider this approach to enable a deeper understanding of interactions within a system which might only occur in certain working areas but can built up hard to explain behavior

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