Chapter VI

Information Feedback Approach for the Simulation of Service Quality in the Inter-Object Communications

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Abstract

Simulation of a system with limited data is challenging. It calls for a certain degree of intelligence built into the system. This chapter provides a new model-based simulation methodology that may be customized and used in the simulation of a wide variety of problems involving multiple source-destination flows with intermediate agents. It explains the model based on a new class of neural networks called differentially fed artificial neural networks and the system level performance of the same. Next, as an example, the impact of system level differential feedback on multiple flows and the application of the concept are presented, followed by the simulation results. The author hopes that a variety of real life problems that involve multiple flows may be mapped onto this simulation model and optimal performance may be obtained. The model serves as a reference design that may be fine-tuned based on the application.
Introduction

System simulation in the presence of limited data is challenging, especially when the real time outputs are to be generated. A system working with a limited data set is required to have built-in intelligence to take decisions and extrapolate the results. If there is a feedback from the output to input of the system, the characteristics of the system improve. When the feedback contains historical data or a set of previous outputs, it starts exhibiting interesting properties, such as self-similarity, abstraction, entropy maximization, and so forth, as explained in a future section.

In this chapter, a converse mapping is suggested to model the systems, that is, any system or a process where the indicated properties are observed, it may be simulated with a differential feedback model. It is meaningful since it is the differential feedback that imparts the indicated properties into the system. With this mapping, the other properties of the differentially fed system are explored. It provides better understanding of the system. For example, when the self-similarity of the nucleic acid sequences in a gene is modeled with a differentially fed system, it implies the maximization of entropy in the sequence. It finally leads to the fact that the nature maximizes the randomness of the genes for the better survivability.

In this chapter, the modeling and simulation example of a data network is discussed in depth. The network exhibits self-similarity. It is an ideal candidate to be modeled with a differentially fed system. Further analysis shows that the self-similarity originates as a result of usage of historical information in the network. One striking difference with this simulation model is that it can be made as a part of the real system generating the requisite signals to control the behavior of the system.

It has been shown that the entropy gets minimized with the differential feedback. The resource contention for communication is addressed and the solution is modeled.

The shifted feedback information may be used to achieve some additional quality of service deadlines, such as the absolute delay guarantee, fraction of the services lost, and so forth. The same would be agreed upon with the different communicating units well in advance.

Analysis shows that a system exhibits self-similarity to maximize the entropy (Manjunath, 2005). It is proved that, to maximize entropy, the system makes use of differential feedback of different degrees. They form various levels of abstraction and by and large carry redundant information (Manjunath, 2005). The self-similar property has been exploited here to maintain the quality of service constraints.

Because of abstraction and redundancy, even if a portion of the information is lost or if it is required to predict the future uncertainties with minimum available information, it can be repaired or re-synthesized using the available information. The self-similar property of the component induces interesting properties into the system. This property may be used as lead-lag components in controlling the information transfer over the network. Closed loop feedback is utilized to control the signals transferred over the network. Intermediate self-similar structures or switches may modulate feedback signals and control the system behavior.

The simulation techniques outlined here may be used for constraint bound communication between any pair of objects, be it the defense supply chain or the chemical reaction chamber.
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