Chapter 12

A New Formalism for Diagnosis and Safe Development of Information Systems

Calin Ciufudean
Stefan cel Mare University, Romania

ABSTRACT

Failure diagnosis in large and complex information systems (LCIS) is a critical task due to respect the safe development of these systems. A discrete event system (DES) approach to the problem of failure diagnosis of LCIS is presented in this chapter. A classic solution to solve DES’s diagnosis is a stochastic Petri nets. Unfortunately, the solution of a stochastic Petri net is severely restricted by the size of its underlying Markov chain. On the other hand, it has been shown that foraging behavior of ant colonies can give rise to the shortest path, which will reduce the state explosion of stochastic Petri net. Therefore, a new model of stochastic Petri net, based on foraging behavior of real ant colonies is introduced in this paper. This model can contribute to the diagnosis, the performance analysis and design of information systems.

INTRODUCTION

As modern world evolves, so does the technique, economy, the life style, and unfortunately, the information avalanche many times deformed by the sources, often deformed and delayed by transmission channels and media. Therefore, nowadays mainly due to stress, low infrastructure facilities and rush life style we confront with a new problem: the diagnosis of multiple informational news and data releases of mutant informational transmission infrastructure. Failure diagnosis in large and complex information systems (LCIS) is a critical task due to respect the safe development of these systems. A discrete event system (DES) approach to the problem of failure diagnosis of LCIS is presented in this chapter. A classic solution to solve DES’s diagnosis is a stochastic Petri nets. Unfortunately, the solution of a stochastic Petri net is severely restricted by the size of its underlying Markov chain. On the other hand, it has been shown that foraging behavior of ant colonies can give rise to the shortest path, which will reduce the state explosion of stochastic Petri net.
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The property of diagnosis is introduced in the context of the availability problem of the DES. We propose a systematic procedure for diagnosis implemented with a new class of stochastic Petri nets, i.e. Ant Colony Decision Petri Nets (ADPN), and related models (e.g., stochastic reward nets stochastic activity networks) are gaining increased acceptance as tools for analyzing complex systems. The acceptance of such high-level formalism is due to their ability to represent LCIS in a compact and convenient way, while still describing an underlying discrete-time Markov chain (DTMC), (Campos, s.a., 1991). Our approach proposes non-expanded dimension of DTMC so we afford to model LCIS and take advantage on a finite horizon of their behavior, due to DTMC properties. The prediction and the optimization of the performance of information systems represent a must for the modern socio-economic systems. We consider an information system as coupled processing elements working co-operatively and concurrently on a set of related tasks. We notice that a information system consists of discrete and continuous parts, and according to the chart level, these parts may have different significations; for example a discrete part seen from a macro-level looks like a continuous one, and a continuous part of the system seen from a macro-level may be analyzed as a discrete one. Various algorithms have been used to perform this task. In general, there are two approaches for the diagnosis of complex systems (Bacelli & Zin, 1992): deterministic models and probabilistic models. In deterministic models, it is usually assumed that the task arrival times, the task execution times, and the synchronization involved are known in advance to the analysis. This approach is very useful for the performance evaluation of real-time control systems with hard deadline requirements. In probabilistic models, the task arrival rates and the task service time are usually specified by probabilistic distribution functions. Probabilistic models usually give a gross prediction on the performance of a system and are usually used for the early stages of system design when the system characteristics are not well understood. Various algorithms like evolutionary computations (Michalewicz, Z & Michalewicz, M, 1997), genetic algorithms, adaptive cultural models etc. have been used to perform this task. Swarm intelligence (Kennedy & Eberhart, 1995) links artificial intelligence to the concept of fish shoaling or swarming theory. It is based on the social behavior of flocks of birds/shoals of fish and the success of the group is due to the communication established between them. Ant colony optimization algorithm proposed by Marco Dorigo in 1992 in his PhD thesis (Dorigo, 1992) is based on this simple concept and the paradigms can be easily implemented. It is relatively a new concept and is used for target tracing by autonomous communicating bodies. This paper presents the application the ant colony optimization (ACO) for searching targets in a given scheduling problem using a number of tasks referred to as agents in the rest of the chapter.

This chapter has three main parts according to the formalisms used to optimize the diagnosis of a hybrid system:

1. Ant colony optimization (ACO) for scheduling the tasks of complex systems,
2. Petri nets model for modeling the tasks synchronization, and
3. Henstock-Kurzweil integral introduced in a new technique for determining the reliability of information systems in the presence of perturbations with parameters described by highly oscillating functions.