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A Study on the Legal Firing Sequence Problem of Petri Nets

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A system in which events occur discrete and asynchronously is called a discrete event systems(DES). Typical applications exist in computer networks, operating systems, communication systems, database systems, sequence controls and so on. From the requirement for the effective control of such applications, there have been many researches on DESs from various viewpoints. Especially, the most of them concentrated the modeling and analysis to these systems. Petri net which is one of logic models is widely used for modeling and the simulation of a discrete event system, and has many applications, such as an assembly line, the operation process of a plant, operating systems, a communication protocol, and an asynchronous circuit.

Petri net is a directed bipartite graph which consists of two kinds of nodes called place and transition. A non-negative number of tokens are assigned to each place, and its distribution situation (marking) changes with fire of transition. Which is the dynamic character of Petri net. If this ability of dynamic expression is used well, it may become a powerful modeling tool at action analysis.

Legal Firing Sequence Problem of Petri nets(**LFS** for short) is defined as follows :"given a Petri net PN, an initial marking M and a firing count vector X, with each component $X(t)$ denoting the prescribed total firing number of a transition t, find a firing sequence δ which is legal on M with respect to X, where δ is a sequence of transitions and is called legal on M with respect to X if and only if the first transition of δ is firable on M, the rest can be fired one by one subsequently and each transition t appears exactly $X(t)$ times inδ. " This is an important problem in case the dynamic character of a system is analyzed.

LFS is very fundamental in the sense that it appears as a subproblem or a simpler form of various basic problems in Petri net theory, such as the well-known marking reachability problem, the minimum initial resource allocation problem, the liveness problem, the scheduling problem and so on. However, in general solving LFS is not easy: it proved NP-hard even for the Petri net with very simple structures by T.Watanabe, Y.Mizobata, K.Onaga. Therefore, heuristics which can solve LFS or optimum LFS with a practical use scale in realistic time has been proposed. For a persistent Petri net, an efficient algorithm which solves LFS is known.

In this paper, the efficient method of LFS is proposed. In this method, using the idea of persistent set, an explosion of the number of states by interleaving of the excution series which is an obstacle in search is suppressed.

The paper is organized as follows. In Chapter 2, definitions of Petri net and LFS are given. In Chapter 3, the NP-hardness of LFS used when T.Watanabe, Y.Mizobata, K.Onaga proved is described. In Chapter 4, examples of LFS of persistent net is described. In Chapter 5, referring to the previous algorithm of LFS, we proposed the method of solving LFS using the persistent set. Finally, it experiments and the obtained result is considered in Chapter 6.