Stable Earliest Starting Schedules for Periodic Job Shops: A Linear System Approach

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Abstract

We consider a discrete event dynamic system called periodic job shop, where an identical mixture of items called minimal part set(MPS) is repetitively produced in the same processing order and the primary performance measure is the cycle time. The precedence relationships among events(starts of operations) are represented by a directed graph with rocurront otructure. When each operation starts as soon as all Its preceding operations complete(called earliest starting), the occurrences of events are modeled in a linear system using a special algebra called minimax algebra. By investigating the eigenvalues and the eigenvectors, we develop conditions on the directed graph for which a stable steady state or a finite eigenvector exists. We demonstrate that each finite eigenvector, characterized as a finite linear combination of a class of eigenvectors, defines an earliest starting schedule such that the cycle time, the same as the eigenvalue, is the minimum among all the feasible schedules and an identical schedule pattern repeats every MPS. We develop an efficient algorithm to find a schedule among such schedules that minimizes a secondary performance measure related to work-in-process inventory. As a by-product of the linear system approach, we also propose a way of characterizing stable steady states of a class of discrete event dynamic systems.