Robust Scheduling Method Based on Workflow Simulation Model and Biological Immune Principle

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ABSTRACT
A robust scheduling method is proposed to solve uncertain scheduling problems. A set of workflow simulation models is used to model the uncertain scheduling environment, and a robust scheduling scheme is obtained by an immune algorithm to make it has good performances for each model in the model set.

Categories and Subject Descriptors
F.2.2 [**Analysis of Algorithms and Problem Complexity**]: Nonnumerical Algorithms and Problems - *Sequencing and scheduling*

General Terms
Algorithms, Design, Experimentation, Theory.

Keywords
Production scheduling, immune algorithm, workflow model, optimization computation.

1. INTRODUCTION
In recent years, many scheduling methods are proposed, and most of them are used to solve definitive scheduling problems [1]. But in actual production scheduling, there are a lot of uncertainties such as the uncertainty of process time and the failure of machines, which would lead the primary scheduling scheme become worst or even not feasible. Dynamic scheduling methods can generate feasible scheduling schemes, but for some trades such as civil aviation, frequent rescheduling is not a good idea. When an accidental event occurs, we hope that the event would not influence the whole scheduled flight. Frequent rescheduling is not convenience for clients, and a robust flight scheduling is welcome that can still maintain good performances as the scheduling environment changes. In this paper, we borrow ideas from robust control to develop a robust scheduling method. A set of workflow simulation models is used to model an uncertain scheduling problem. By using the set, a variable neighborhood immune algorithm [2] is applied to finding an robust scheduling scheme that has satisfactory performances for each model in the set.

2. MODEL OF SCHEDULING PROBLEMS
For an uncertain scheduling problem, we call the scheduling environment without dynamic events as nominal scheduling environment. The nominal scheduling environment can be modeled by a workflow model. Then workflow simulation can be executed by using the workflow model. During the simulation, dynamic events can be mimicked, so that a series of changed workflow scheduling models and their performance indexes can be obtained. The uncertain scheduling problem can be described by these changed models. The performances of a robust scheduling scheme are evaluated by the performance indexes of these changed models.

3. OPTIMIZING SCHEDULEING SCHEME
Finding an optimal robust scheduling scheme is a complex optimization problem. So a global optimization algorithm is needed to solve this problem. In paper [2], a variable neighborhood immune algorithm (VNIA) is proposed that shows good performances when solving complex optimization problems. In the VNIA, a variable neighborhood strategy is used to balance the conflict of local and global searches, and a two-level immune network is suggested to maintain large diversity of population during optimization process. In this paper, the VNIA is used to search an optimal robust scheduling scheme.

4. EXPERIMENTAL RESULTS
In order to verify the effectiveness of the robust scheduling method, it is used to solve an uncertain job shop problem with 6 jobs and 6 machines. The dynamic event considered in the experiment is the process time uncertainty. Each job of the scheduling problem has a random operation whose processing time is uncertain. Experimental results show that the robust scheduling scheme has better robustness than the definitive scheduling scheme. When the uncertain degree becomes large, the advantage of the robust scheduling scheme appears more and more obviously.

5. REFERENCES
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