Chapter 83
Phased Method for Solving Multi-Objective MPM Job Shop Scheduling Problem

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ABSTRACT

The project portfolio scheduling problem has become very popular in recent years since many modern organizations operate in multi-project and multi-objective environment. Current project oriented organizations have to design a plan in order to execute a set of projects sharing common resources such as personnel teams. This problem can be seen as an extension of the job shop scheduling problem; the multi-purpose job shop scheduling problem. In this paper, the authors propose a hybrid approach to deal with a bi-objective optimisation problem; Makespan and Total Weighted Tardiness. The approach consists of three phases; in the first phase they utilise a Genetic Algorithm (GA) to generate a set of initial solutions, which are used as inputs to recurrent neural networks (RNNs) in the second phase. In the third phase the authors apply adaptive learning rate and a Tabu Search like algorithm with the view to improve the solutions returned by the RNNs. The proposed hybrid approach is evaluated on some well-known benchmarks and the experimental results are very promising.

1. INTRODUCTION

The project portfolio scheduling focuses on discrete projects (Tselios et al., 2013b), and it has attracted significant research interest (Browning & Yassine, 2010; Trojet et al., 2010; Schwindt, 2005; Brucker et

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al., 1999) because the modern organisations operate in multi-project and multi-objective environment. The typical approach to this problem usually aims at a single objective. However, recent studies (Tselios et al., 2013b, a) have proposed multi-objective models that are close to the real world projects.

Job shop scheduling problem (JSSP) has been explored by many researchers during the last few decades. Some of these efforts utilised a very promising concept, the recurrent neural network (RNN) (Kechadi et al., 2013). Other researchers (Agarwal et al., 2011) combined two evolutionary approaches i.e. Neural Networks and Genetic Algorithms in order to solve similar problem; the Resource Constraint Project Scheduling problem. According to this approach, the key difference between the two techniques is that GA is suitable for global search while neural network fits well with local search. This distinction is also strong for our problem because the authors need to enhance a RNN method, as it depends on the initial conditions e.g. the initial solution. Hence, the researchers need a method that will feed the RNN with good initial solutions and the GA approach can provide a set of efficient initial solutions.

In this paper, not only the authors propose an approach that combines two well-known techniques; the neural network and the Genetic Algorithm (GA) in order to deal with the multi-purpose machines JSSP (MPM JSSP), but also they propose an auxiliary tabu search like algorithm (TSA) to improve the final solution.

Tabu search is a meta-heuristic technique (Chelouah & Siarry, 2000) which has been heavily applied to various combinatorial optimisation problems for its fast and aggressive search overcoming the limitations of the neighbour search (Cavin et al., 2004). The goal of an optimisation problem is to optimise an objective that consists of more than one function (multi-objective or vector optimisation) by selecting the best from the solution space. Exact techniques for exploring the whole solution space are NP-complete, therefore, heuristic methods could provide a good alternative that can return good solutions within a reasonable execution time. The basic concept of Tabu search aims to continue the search whenever a local optimum is reached by allowing non-improving moves. Tabus prevent the examination of previously visited solutions while the non-tabu list concentrates only on promising searches. Using a combination of RNNs with the Tabu meta-heuristic method seems to be a very promising technique since Tabu search could accelerate the process by not allowing returning back to already visited solutions.

The motivation of the current work is its subject matter. It deals with projects that are implemented by an organisation not just a single isolated project. Secondly, it utilises an MPM JSSP model that fits well in other disciplines such as manufacturing. Another fascinating aspect of this work is the combination of GA, RNN, Tabu and it aims at solving a multi-objective formulation of the problem. The authors have to underline that the presented work is an enriched extension of a recent research effort (Tselios et al., 2015).

The rest of the text is organised as follows: The system model is presented in Section System Model. In Section Benchmarks the authors discuss the adopted and adapted benchmark instances. In Section Proposed Approach they present the proposed approach while in Section Experimental results they present the experimental results and corresponding analysis. Finally, in Section Conclusions the authors conclude and discuss some future research directions.

2. SYSTEM MODEL

A globally accepted notation for theoretical study of scheduling problems was proposed by Graham et al. Graham R. L. et al. (1979). According to this classification $\alpha \mid \beta \mid \gamma$, the generalised version of our problem can be expressed as follows: