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Analysis of the impact of Initialization and Local Search in the Performance of the Firefly Algorithm in Solving the Flexible Job-shop Scheduling Problem

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Keywords: Flexible job-shop scheduling, hybrid firefly algorithm, local search.

1 Introduction

In the Flexible Job-shop Scheduling Problem (FJSP) a set of jobs must be performed, and each job consist in a set of operations subjected to precedence constraints that can be processed in any machine out of a set of compatible machines. The aim of the FJSP is to find a sequence of the assigned operations that optimises certain objectives e.g. minimize the completion time, the machines´ workload, etc.

Due to the complexity of the problem (Applegate & Cook, 1991), exact methods may require an impractical amount of time for its resolution, and that is the reason why approximate algorithms (i.e. metaheuristics) are the best alternative for industrial applications, since the can provide near-optima solutions in a reduced amount of time (Blum & Roli, 2003).

2 Objectives and methodology

In this work, we implemented three different versions of a metaheuristic called the Firefly Algorithm (FA) for the resolution of the FJSP. The FA is a swarm intelligence algorithm motivated by the social behaviour of the fireflies and how they attract others using their flashing lights with predation or mating purposes (Yang, 2008).

The key aspect of the FA is the association of the objective function with the fireflies´ light intensity, and the main challenges of its discretization are the movements of the fireflies, the measurement of the distance between them and the codification of the solution.

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The aim of this work was to study how differently the discrete FA performs in solving the FJSP when it is enhanced with an initialization phase and several local search strategies.

3 Results

Three different versions of the FA were implemented: a standard discrete FA, another version integrated with the initialization module and one more version with both the initialization and local search modules. For the comparative study, the three different FA versions were tested in solving six well known FJSP benchmark instances: Mk01 and Mk02 from Brandimarte (1993), MFJS2 and MFJS3 from Fattahi et al. (2007) and the two "middle size" instance from Kacem et al. (2002).

The results of the comparative study show how the most complete FA version, the one enhanced with both the initialization and the local search modules, consistently obtains the best results, reaching in many cases the best-known results of the instances, almost in the same computational time.

5 Conclusion

This paper demonstrates how proper strategies to generate the initial population and local search procedures can enhance the performance of the Firefly Algorithm. We explained and then compared three versions of the algorithm in solving some known FJSP instances. Computational results confirm that the version with initialization and local search modules notably outperforms the other two, reaching in most of the cases the best-known results. Future work will be focussed on expanding this comparative study to more instances and studying further techniques to speed-up the algorithm.

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