

The academic project described below is my diploma thesis project. It concerns a variation of the Job Shop Scheduling, an NP-hard optimization problem. In this problem, a set of Machines is given, as well as a set of Jobs to be completed. Each Job consists of a chain of Operations to be performed by Machines in a specific order. In the specific variation (called Flexible Job Shop Scheduling) of the problem in question, each Operation can be performed by a subset of all the Machines. The goal was to minimize the time in which all the Jobs have been completed.

The problem presents an enormous number of different possible machine time schedules for completing the jobs. Thus, brute-force testing all possible combinations is not a viable approach. I decided to approach the problem using the Firefly Algorithm, an evolutionary algorithm primarily used for solving continuous variable problems, adjusting it so that it can be used for optimization problems with discrete variables.

This algorithm explores the solution space in a random but systematic way. Starting from a set of random schedules, it searches for improved ones, assuming that the best solution is more likely to be similar to the best solutions found so far. In each iteration, solutions are modified by borrowing aspects from other solutions, with an emphasis on solutions that are similar to each other, as well as in a random way.

In continuous variable problems, e.g. maximizing/minimizing a 2 variable function, similarity between two sets of inputs can be defined simply as the reciprocal of the distance between the two sets on the Euclidian space. Smaller distance implicates greater similarity between the sets.

However, in a discrete variable problem, quantifying the distance between solutions (machine schedules) poses a much greater challenge. Similarity between two schedules was defined using a function that takes into consideration how many of the operations are assigned to the same machine in both solutions, with extra similarity points for consecutive identical assignments. The similarity ratings were inserted into a matrix. To measure the convergence of solutions, the norm of this matrix was used. The convergence of solutions is an important measure for the firefly algorithm, as solutions are expected to create swarms, moving closer together over iterations of the algorithm.

Another hurdle I encountered was becoming familiar with object oriented programming (C#) principles and practices, as my previous programming experience was limited to FORTRAN and MATLAB. It took significant amounts of study and practice to adjust but it opened up a lot of potential for achieving results in larger scale applications.

The algorithm was used on test cases of the problem, achieving optimal or near optimal results depending on the size of the problem. My thesis was presented in the 4th International Symposium & 26th National Conference on Operational Research in Chania, Greece.