Abstract

In the field of operations research, the set of scheduling problems of activities is considered as one of the most relevant ones due to its great applicability and complexity. Within the broad variety of problems in this set, it is remarkable the Resource-Constrained Project Scheduling Problem (RCPSP), since it is regarded as the most important-base problem in this area and it has been the object of study in countless research projects. Basically, this problem consists of a project split into sets of activities that are related to each other by means of precedence-constraints, and require an amount of each limited resource, to be performed. The objective, then, is to allocate in the most efficient way those resources to the activities in order to optimize a scoring function such as the makespan. Similar in importance is the multimodal-version of the RCPSP, called MRCPSP, in which for each activity there exists multiple execution modes that involve a different combination of limited resources, giving rise to a different execution time. In the literature, it has been addressed widely these two problems with both exact methods and approximation methods, being these latter the most successful.

These research works have focused mainly on obtaining economic advantages such as costs and project time minimization. However, with the accelerating globalization and the fast countries' growing economies, the race for power resources have increased sharply. In fact, the importance of taking into account the energy consumption on modeling has become so important that it is now considered as important as other performance measures such as productivity and costs. Hence, the main goal of this Ph.D. dissertation is to develop a new RCPSP and MRCPSP approach based on the energetic efficiency, which is aimed at searching for sustainable solutions in terms of time and energy consumption.

To this end, it has been proposed an extension of the RCPSP, named MRCPSP-ENERGY, which considers besides the traditional resources of the RCPSP, a variable energetic consumption that generates different execution modes for the activities. This proposal includes a new optimization criterion based on the energetic efficiency of a project, which considers simultaneously the minimization of both the total duration and the energy consumption of such project. Moreover, in order to assess the solution methods for the MRCPSP-ENERGY, the standard library mostly used for this purpose has been extended and a new one has been proposed, called PSPLIB-ENERGY.

In order to solve the proposed problem, firstly, the most successful metaheuristics methods, which address the RCPSP, were analyzed. Secondly, it was shown that these methods lead to redundant solutions, hindering the search. Therefore, an evolutive method was proposed, whose main contribution is the development of a new mutation operator that reduces the number of redundant solutions. Similarly, in the multimodal case, it was determined that the most widespread searching methods are also focused on the activity list representation and therefore they yield redundant solutions. As a solution alternative for the MRCPSP-ENERGY, it was shown that such search can be carried out by focusing on the mode list representation, as different mode lists also reach diverse solutions, giving rise to a less number of redundant solutions. Keeping in mind this finds, it was proposed a new evolutive method for solving the MRCPSP-ENERGY, which unifies both searching methods such that the search is conducted with two optimization phases. Based on the obtained results given by the PSPLIB-ENERGY library, the proposed method proved to be able to reach highly efficient solutions.