Extraction of Decision Alternatives in Project Management: Application of Hybrid PSO-SFLA

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Abstract: Resource-constrained project-scheduling problem (RCPSP) management is a process of scheduling activities based on time and resources to determine an appropriate decision alternative that minimizes the time duration of a project by considering resource limitations and precedence of activities. The critical path method (CPM) is a management tool for project scheduling that considers the longest path through the activity network of an entire project. By using the CPM tool in RCPSPs, the complex and discrete nature of the solution domain for such problems causes failing of traditional and gradient-based methods in determining an optimal or even feasible solution in some problems. Thus, evolutionary algorithms are extensively employed and adapted to extract decision alternatives in the RCPSP. Hybrid algorithms focus on a more efficient search in the decision space. This paper proposes a hybrid algorithm based on particle swarm optimization (PSO) and shuffled frog leaping algorithm (SFLA) to solve simple and complex RCPSPs. Convergence speed and number of critical paths are two factors that show the capabilities of the PSO-SFLA algorithm in solving RCPSPs. Results show that the hybrid algorithm is more capable to determine an optimal solution in all problems, even with fewer number of iterations, as well as more feasible and optimal solutions compared with the individual application of PSO and SFLA. Moreover, the hybrid PSO-SFLA showed an improvement compared with other algorithms employed to determine more paths, especially in a simple network. **DOI: 10.1061/(ASCE)ME.1943-5479.0000186.**

Author keywords: Project management; Resource-constrained project-scheduling problem (RCPSP); Hybrid particle swarm optimization shuffled frog leaping algorithm (PSO-SFLA).

Introduction

A project is a temporary endeavor with a defined beginning and end, undertaken to meet goals and objectives, typically to bring about beneficial change or added value. Project management is a discipline of planning, organizing, securing, and managing time and/or resources to achieve specific goals. Resource-constrained project-scheduling problem (RCPSP) is a type of project management defined by Davis (1973) as a method for scheduling activities within a fixed amount of resources available during each time period to minimize an increase in project duration. The critical path method (CPM) is widely used to manage different activities of a project considering limitation of resources. This method addresses the scheduling of a set of project activities that calculates the longest path of planned activities to the end of the project, and the earliest and latest that each activity can begin and end without making the project longer. Determination of a critical path in the RCPSP is a nondeterministic polynomial (NP)—hard problem in which various computational tools have been used to overcome its complexity.

In recent decades, various approaches based on evolutionary algorithms have been proposed to solve the scheduling problem (Bozorg Haddad et al. 2008, 2009, 2010a). These algorithms were used to achieve more appropriate solutions or decision alternatives with fewer function evaluations and more critical paths (Bozorg Haddad et al. 2011; Bozorg Haddad and Mariño 2011; Ghajarnia et al. 2011; Rasoulzadeh-Gharibdousti et al. 2011; Sabbaghpour et al. 2012). Thus, an algorithm that improves all of these options at the same time is a good candidate to determine the best decision alternative from a decision space. Hybrid algorithms exploit the good properties of various methods to increase the efficiency of solution methodologies. The hybrid algorithm of particle swarm optimization (PSO) and shuffled frog leaping algorithm (SFLA) is a typical swarm-based optimization method in which the search algorithm is inspired by the behavior of particles and frogs in a swarm (Fallah-Mehdipour et al. 2011; Seifollahi-Aghmiuni et al. 2011, 2013; Noory et al. 2012).

This paper proposes a hybrid PSO-SFLA methodology to achieve the shortest path for construction problems with an improvement in the performance of the CPM in the RCPSP. Case studies consider three RCPSPs, ranging from a simple problem with a single source and a low number of activities to a complex problem with multiple sources and a high number of activities. A comparison of results of the hybrid PSO-SFLA with results

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