Solving the resource-constrained project scheduling problem using filter-and-fan approach

Mohammad Ranjbar

Department of Industrial Engineering, Faculty of Engineering, Ferdowsi University of Mashad, Mashad, Iran

Abstract

The resource-constrained project scheduling problem is a notoriously difficult problem in combinatorial optimization for which extensive investigation has been devoted to the development of efficient algorithms to find optimal or near-optimal solutions. This paper proposes a new heuristic algorithm for this problem based on filter-and-fan method incorporated with a local search, exploring in the defined neighborhood space. In the algorithm, the local search is used to generate a starting solution as well as to re-optimize the best schedules produced by the filter-and-fan method. The filter-and-fan is itself a local search procedure that generates compound moves in a tree search fashion. Computational results applied on a standard set of 2040 benchmark problems from the literature demonstrate the effectiveness of the approach.

Keywords: Project scheduling; Neighborhood search; Heuristic; Filter-and-fan

1. Introduction

The Resource-constrained project scheduling problem (RCPSP), denoted as \( m, 1|\text{cpm}|C_{\text{max}} \) [1], is one of the most intractable optimization problems in operations research. The RCPSP can be stated as follows: A single project consisting of a set \( N \) of activities, including \( n \) real activities and two dummy activities as the start and finish of the project, numbered from 0 to \( n+1 \), has to be scheduled on a set \( R \) of constrained renewable resource types subject to finish–start-type precedence constraints with time lag of zero. While being processed, activity \( i \) requires \( r_{ik} \in \mathbb{N} \) units of resource-type \( k \in R \) in every time unit of its deterministic and non-preemptive duration \( d_i \in \mathbb{N} \). Capacity of resource \( k \) is constant throughout the project horizon and limited to \( R_k \). The dummy start and finish activities have zero duration and resource usage, while the real activities have positive duration and non-negative resource usage subject to \( r_{ik} \leq R_k, i \in N, k \in R \). The objective of RCPSP is to find a precedence and resource-feasible schedule \( S \), defined by a starting times vector \( s = (s_0, \ldots, s_{n+1}) \), such that the project makespan \( T = s_{n+1} \) is minimized.

E-mail address: ranjbar@ferdowsi.um.ac.ir

0069-3003/$ - see front matter © 2007 Elsevier Inc. All rights reserved.