# OPTIMIZATION TECHNIQUES FOR SOLVING A PROJECT LEADER ASSIGNMENT PROBLEM INVOLVING A HIERARCHICAL EXPERTISE REQUIREMENT STRUCTURE AND FIXED TIME CONSTRAINTS

Jim Chen, Norfolk State University, Norfolk, Virginia, U.S.A.
V. Reddy Dondeti, Norfolk State University, Norfolk, Virginia, U.S.A.
Bidhu B. Mohanty, Norfolk State University, Norfolk, Virginia, U.S.A.

dx.doi.org/10.18374/JABE-23-3.7

## ABSTRACT

*In this paper we consider a project leader assignment problem involving many projects that need to be executed during fixed intervals of time. Further, each project requires a manager or project leader with a specified minimum level of expertise. This implies that a project leader with a higher level of expertise may be assigned to a project that requires a lower level of expertise, but not vice versa. Obviously, the objective is to determine an optimal staffing strategy that would help us complete all the projects on time. This problem is very similar to some of the well-known resource allocation or scheduling problems in which a resource with a higher capacity or size is assigned to a task that requires a resource with a smaller capacity or size, but not vice versa. In the literature, problems with this type of structure are often called Hierarchical Class Scheduling Problems (HCSP). We exploit the similarity between our staffing problem and the HCSP, and transform it into a multi-commodity network flow problem and impose an additional constraint that the values of the variables be either zero or one. This additional constraint forces us to treat the original multi-commodity network flow problem or the corresponding linear programming problem as an integer programming problem. It is well-established, on the basis of its combinatorial structure and computational complexity, that the integer programming problem belongs to the class of NP-hard problems and there are no efficient (polynomial-time) algorithms to solve it. Here we describe optimization techniques that are derived from a combination of integer programming and heuristic methods to obtain near-optimal solutions to our staffing problem and the related HCSP.*

***Keywords:*** *Hierarchical Class Scheduling, NP-hard Problems, Integer Programming, Heuristic Methods*

## 1. INTRODUCTION

When we solve linear programming problems, the values of the variables in the optimal solution may generally have fractional values in the large majority of the applications. However, optimal solutions of the problems with a special structure such as the transportation problem or the assignment problem yield integer values for the variables, when formulated and solved as linear programming problems (Bazaraa, et al. 2009). Similarly, problems with a special structure such as single-commodity network flow problems are most often formulated and solved as linear programming problems and their solutions also yield integer values for the variables (Bazaraa, et al. 2009). In contrast, the solution of multi-commodity network flow problems almost always leads to fractional values for the variables representing the flows of the commodities (Barnhart, et al. 2000, and Wang, 2018). At first glance it may appear that multi-commodity network flow problems and job scheduling problems have nothing in common and the algorithms developed to solve one class of problems will be of no help in solving the other. But, in job scheduling problems when a processor finishes a job, it is assigned to the next job and then to the next job in a sequential fashion. If we look upon the jobs as the arcs of a network and the start and finish times of the jobs as the nodes of the network, and of course, the processors as the commodities, it is apparent that we have a multi-commodity network flow problem on our hands. The significant difference between the two classes of problems is that in case of multi-commodity network flow problems, fractional values for the variables may sometimes be acceptable, whereas in the case of job scheduling problems, the values of the variables representing the optimal number of the different types of processors must always be integers. Since our focus in this paper is on the project leader assignment problem, why should we be concerned with a job scheduling problem or a multi-commodity network flow problem?