Chapter 4
New Direction to the Scheduling Problem:
A Pre-Processing Integer Formulation Approach

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ABSTRACT

This chapter presents a new direction to the scheduling problem by exploring the Moore-Hodgson algorithm. This algorithm is used within the context of integer programming to come up with complementarity conditions, more biding constraints, and a strong lower bound for the scheduling problem. With Moore-Hodgson Algorithm, the alternate optimal solutions cannot be easily generated from one optimal solution; however, with integer formulation, this is not a problem. Unfortunately, integer formulations are sometimes very difficult to handle as the number jobs increases. Therefore, the integer formulation presented in this chapter uses infeasibility to verify optimality with branch and bound related algorithms. Thus, the lower bound was obtained using pre-processing and shown to be highly accurate and on its own can be used in those situations where quick scheduling decisions are required.

INTRODUCTION

The Moore-Hodgson algorithm was proposed by Moore (1968) and the algorithm was attributed to Thom Hodgson. It is for this reason that in literature this algorithm is often referred as the "Moore-Hodgson Algorithm". The scheduling problem assumes that all jobs are processed on a single machine, the processing times of the machine are known with certainty and that the release time for each job is

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zero. The Moore-Hodgson was developed to improve the earliest due date (EDD) sequence by minimizing tardiness. Here, this algorithm is use within the context of integer programming to come up with complementarity conditions, extra more biding constraints and a strong lower bound for the scheduling problem. The complementarity conditions, extra more binding constraints together with the lower bound can significantly reduce the complexity of the scheduling problem. Alternate optimal solution are readily available with integer formulation while with the Moore-Algorithm algorithm the problem size does not increase at every iteration. The lower bound proposed in this approach is highly accurate and can be used in those circumstances where very quick scheduling decisions are required. Even though heuristics such as Genetic Local Search (Kim et al., 2018) can quickly find a near optimal solution for the scheduling, but the difference between a near optimal solution and an exact solution may be in millions of dollars as exact solutions are necessary for the scheduling problem. TORA software (Taha, 2011a; 2011b) is used in determining the number of branch and bound sub-problems (Land and Doig, 1960) in this paper.

STATEMENT OF THE PROBLEM

Problem: Using EDD, how can the jobs 1,2,3,…,*n* be sequenced so that tardiness is minimized? Suppose the scheduling problem is given as Table 1.

Table 1. Scheduling problem based on n jobs

Job (J_i)	1	2	3	…	N
Processing time (P_i)	p_1	p_2	p_3	…	p_n
Due Date (D_i)	d_1	d_2	d_3	…	d_n

Assumptions: All jobs are processed on a single machine, processing times are known with certainty and that the release time of each job is 0.

Suppose;

(i) (i) EDD is used i.e.

$$d_1 \le d_2 \le d_3 \le \ldots \le d_n. \tag{1}$$

(ii) L_i is lateness, C_i is the cumulative processing time and T_i is tardiness.

Then the complete table is obtained as shown on Table 2.

We do not have tardiness or lateness in the j^{th} job if

$$p_1 + p_2 + p_3 + \ldots + p_j - d_j \le 0. \tag{2}$$