SOLVING UNIVERSITY COURSE TIMETABLING PROBLEM USING LINEAR PROGRAMMING MODEL

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1. Introduction

The process of allocating time and resources to each operation or activity is known as timetabling. This study focused on the educational timetabling problem and utilized a linear programming method to build feasible timetables for all tutorial classes taken by various student groups. The goal of this study is to maximize allocation preference of classes to timeslot and employ the integer linear programming model for solving a course timetabling problem for a university. Data is taken from the study in a Tunisian University, as described by Dammak et al.(2008).

2. Methodology

Generally, this study focuses on solving a university course timetabling problem by using a linear programming model. The data used in this study is secondary data and consists of tutorial classes, student groups, lecturers and rooms. The problem was to assign 40 tutorials classes to six time slots (including one unavailable timeslot) of 90 minutes. To construct a ILP model of course timetabling which represent the features of the problem, define the following sets of model formulation:

L = Set of lecturers, $l \in L = \{1,2, 3, 4, 5, 6, 7\}$
S = Set of student groups, $s \in S = \{1,2, 3, 4, 5\}$
T = Set of timeslots, $t \in T = \{1,2, 3, 4, 5, 6\}$
M = Set of class meeting, $m \in M = \{1,2, \ldots, 40\}$
R = Set of rooms, $r \in R = \{1,2, 3, 4, 5, 6, 7\}$
M_L = Set of class meeting taught by each lecturer, $m_L \in M_L$
M_S = Set of class meeting that have the same group of students S, $m_S \in M_S$
T_{break} = Set of break timeslot.

Decision variable:

The model is built on a set of decision variables defined below:

$$X_{m,t} = \begin{cases} 1, & if\ the\ class\ meeting\ m\ is\ schedule\ in\ timeslot\ t \\ 0, & otherwise \end{cases}$$

Objective function:

$$Max \sum_{m}^{M}\sum_{t}^{T} P_{m,t}X_{m,t} \quad (1)$$

The value of $P_{m,t}$ reflects the priority of allocating classes to the desired time slots. These soft constraints, or the desirable type of restrictions that may be viewed as less essential, are what these preferences are referred to as. Requirements that are optional, on the other hand, should be empowered. These preferences are determined using integer values ranging from one (less favored) to five (more favored).

Model constraint:

In this study, there are three main concepts that are often employed in UCTP models. Completeness, in which each element of a course or unit must be assigned to a timeslot, the minimization of resource conflict (lectures and students), and reliability are among them. All the basic constraints are listed below:

a) Completeness

$$\sum_{m}\sum_{t} X_{m,t} = 1, \quad \forall m \quad (2)$$

Constraint (2) is to ensure that all the class meetings must be assigned to a timeslot.

b) Break time

$$\sum_{T_{break}} X_{m,t} = 0, \quad \forall m \quad (3)$$

Constraint (3) is to ensure there is no class meeting assigned during the break time.

c) Students and overlap

$$\sum_{m \in M_s}\sum_{t} X_{m,t} \leq 1, \quad \forall t,\ \forall s \in S \quad (4)$$

Constraint (4) proposed when the students are assigned with more than one class meeting, those should not be overlapped.

d) **Lecturers and overlap**

$$\sum_{m \in M_L}\sum_{l} X_{m,t} \leq 1, \quad \forall t,\ \forall l \in L \quad (5)$$

Constraint (5) proposed when the lecturers are assigned with more than one class meeting, those should not be overlapped.

e) Rooms and overlap

$$\sum_{m} X_{m,t} \leq 1, \quad \forall t, \ \forall r \tag{6}$$

Constraint (6) proposed when a room cannot be used for more than one class meeting, those should not be overlapped.

3. Results and Discussion

The objective function of the model is to maximize the time slot preferences for each class meeting. From the data obtained on the preferences of class meetings, all (100%) of the classes were assigned to the most preferred time slots with preference of 5. Thus, the result achieved satisfies the preferences of each lecturer and meets the requirements of the model. Figure 1 shows the results for the class meeting preferences as percentages.

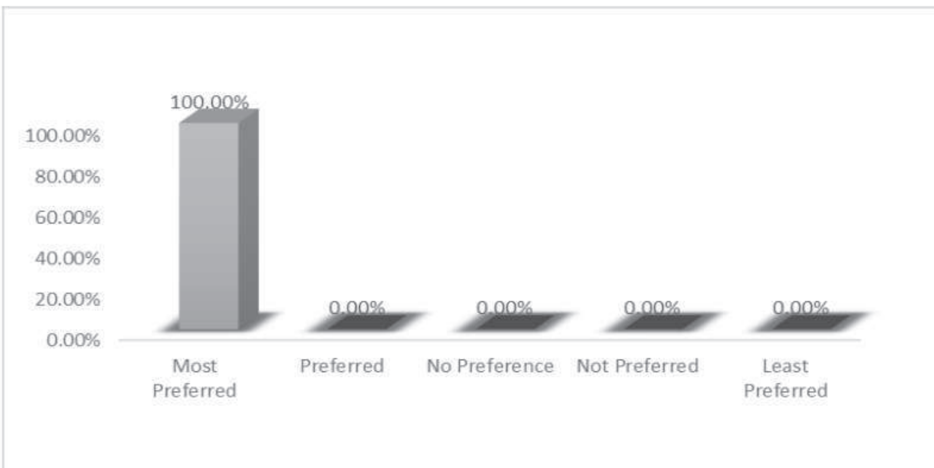

Figure 1. Percentage of Timeslots Matching Class Meeting Preferences for Group SE11

Table 1 shows the whole course timetable, including specific lecturer (L), rooms (R) and timeslots (T). There are no classes scheduled in timeslots T4, which satisfies Constraint (2), that ensure there is no class meeting during the break time. Table 1 shows all tutorial classes were scheduled from timeslots T1 until T6. For example, tutorial classes CM1 and CM2 were scheduled in T2 and T5 respectively. The results demonstrated the ability of the integer linear programming model to solve the university course timetabling problem. From Table 1, it can be seen that there is no conflict between students, lecturers and rooms. Hence, constraint (4) to constraint (6) are satisfied.

Table 1. Timetable for Group SE11.

Timeslot			08:00-09:30	09:45-11:15	11:30-13:00	13:15-14:45	15:00-16:30	16:45-18:15
CM	L	R	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
CM1	L10	R1				-		
CM2	L10	R1				-		
CM3	L10	R1				-		
CM4	L10	R1				-		
CM5	L10	R1				-		
CM6	L2	R2				-		
CM7	L2	R2				-		
CM8	L2	R2				-		
CM9	L2	R2				-		
CM10	L2	R2				-		
CM11	L18	R3				-		
CM12	L18	R3				-		
CM13	L18	R3				-		
CM14	L18	R3				-		
CM15	L18	R3				-		
CM16	L22	R4				-		
CM17	L22	R4				-		
CM18	L22	R4				-		
CM19	L22	R4				-		
CM20	L22	R4				-		
CM21	L22	R4				-		
CM22	L22	R4				-		
CM23	L22	R4				-		
CM24	L22	R4				-		
CM25	L22	R4				-		
CM26	L9	R5				-		
CM27	L9	R5				-		
CM28	L9	R5				-		
CM29	L9	R5				-		
CM30	L9	R5				-		
CM31	L31	R6				-		
CM32	L31	R6				-		
CM33	L31	R6				-		
CM34	L31	R6				-		
CM35	L31	R6				-		
CM36	L35	R7				-		
CM37	L35	R7				-		
CM38	L35	R7				-		
CM39	L35	R7				-		
CM40	L35	R7				-		

4. Conclusion

Dammak et al. (2008) recently established a model that covered all essential constraints of university course timetabling. The requirements of the timetabling community have an impact on the creation of successful timetabling, although they are frequently dismissed. The final output satisfies both the model's desires and its needs. It emphasizes the importance of having a reference model for use at a variety of universities when dealing with timetabling problems.

References

Dammak, A., Elloumi, A., Kamoun, H., & Ferland, J. A. (2008). Course timetabling at a Tunisian University: A case study. Journal of Systems Science and Systems Engineering, 17(3), 334–352.