Optimization Algorithm of Class Schedule

February 2022

1 The Data

1.1 Table a

Table a includes the course ID, start time, end time, frequency, and maximum enrollment for each class.
Sample a table:

Class Nbr	Start	End	Frequency	Max Enrollment
12967	11:15:00AM	12:05:00PM	2	18
5960	9:05:00AM	9:55:00AM	2	479

1.2 Table b

Table b includes the classroom ID and capacity for each classroom.
Sample b table:

Classroom Nbr	Capacity
ADW201	120
BTBG10	25

1.3 Table c

Table c is a compatibility table that denotes whether or not two classes can be scheduled in the same room on a given day.

$$c_{ij} = \begin{cases} 1, & \text{if } a_j['\text{start}'] \geq a_i['\text{end}'] + 15, \text{ OR } a_i['\text{start}'] \geq a_j['\text{end}'] + 15, \text{ OR } i = j \\ 0, & \text{otherwise} \end{cases}$$

Sample c table:

1.4 Table d

Table d is another compatibility table that denotes whether or not a class can be assigned to a classroom given the enrollment and capacity.
Sample d table:

	5960	5971	5972	5290	6091	6108	6109	14491	15335	3052
5960	1	1	1	1	1	0	1	1	1	1
5971	1	1	1	1	1	1	0	1	0	1
5972	1	1	1	1	1	1	1	1	1	1
5290	1	1	1	1	1	1	1	1	1	1
6091	1	1	1	1	1	1	1	0	1	1
6108	0	1	1	1	1	1	1	1	1	1
6109	1	0	1	1	1	1	1	1	0	1
14491	1	1	1	1	0	1	1	1	1	1
15335	1	0	1	1	1	1	0	1	1	1
3052	1	1	1	1	1	1	1	1	1	1

	BLY101	STL185	OLH155	WRNB25	KLRKG70	KND116	RCK201
5960	1	1	0	0	0	1	0
5971	1	1	1	1	1	1	1
5972	1	1	1	1	1	1	1
5290	1	1	1	1	1	1	1

2   Define Variables

We define our variables as

$$X_{ijk} = \begin{cases} 1, & \text{if class } i \text{ meets in classroom } j \text{ on day } k \text{ (M,W,F)} \\ 0, & \text{otherwise} \end{cases}$$

$$y_j = \begin{cases} 1, & \text{if a classroom is used } (\sum_i \sum_k X_{ijk} > 0) \\ 0, & \text{otherwise } (\sum_i \sum_k X_{ijk} = 0) \end{cases}$$

3   Objective

Our goal is to minimize the number of classrooms used:

$$min \sum_j y_j$$

4   Constraints

1. Linking y_j and X_{ijk}:
$$y_j \geq X_{ijk} \quad \forall i, j, k$$

2. Each course i must meet the appropriate number of times per week:
$$\sum_j \sum_k X_{ijk} = a_i[\text{'frequency'}], \quad \forall i$$

3. There are no overlapping schedules for one classroom:
$$X_{ijk} + X_{i'jk} - 1 \leq c_{ii'}, \quad \forall (i, i'|c_{ii'} = 0), j, k$$

4. The enrollment for a course must be at most the capacity of its assigned classroom:
$$X_{ijk} \leq d_{ij} \quad \forall i, j, k$$

5. Each course meets at most once per day:
$$\sum_j X_{ijk} \leq 1 \quad \forall i, k$$