MMCS assignment 2

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An ideal timetable is a combined table which contains four columns with each column's name is course name, room, day and period.

To solve the problem, we introduce sets of courses, rooms, days, periods, curricula, and teachers.

Courses CS ={c0001,c0002…, cs}, day D={0,1,2,…,d},room R={A,B,…,r},period P={0,1,2…p}, Teacher T={t000,t001,t002,…,t}, curriculas CR (binary) ={(q000,c0001),(q000,c0002),…,(cr,cs)}.

To simplify the invocation and calculation, we can rewrite the data in a new .dat document, some data relation is in it. Rewrite some matrixes and arrays to show the relationships. Take 'course_teacher' as an example, column means courses, row means teachers, if the course corresponds to the teacher, the number in this position is 1. For this type of binary inputs, we have 'course_teacher', 'curriculas', 'unavailability'. And we decompose 'Course' into 'course_teacher', 'course_lecture' (lecture_num), 'course_minday' (minimum_day), 'course_studentnum' (student_num) respectively.

Introduce a binary variable $timetable_{(cs,r,d,p)}$ for every position with the meaning that it is one if one course is scheduled in it.

We obtain the following constraints:

Firstly, we model that the allocation of every course should meet the number of classes per week:

$$\sum_{r\in R,d\in D,p\in P} timetable_{(cs,r,d,p)} = lecture\_num_{(cs)}$$

for all cs∈CS

Note that the lecture_num here is the number of lectures for a certain course per week.

Then, we model the teacher should only attend in one course in the same period.

We need to rewrite the data in a new matrix for course as column and teacher as row, each position in this new matrix is binary to show the relationship.

$$\sum\nolimits_{r\in R,cs\in CS} timetable_{(cs,r,d,p)} \times course\_teacher_{(cs,t)} \le 1$$

for all d∈D, p∈P, t∈T

Same as the teacher, each room should be occupied only by one class in the same period

$$\sum_{cs\in CS} timetable_{(cs,r,d,p)} \le 1$$

for all d∈D, p∈P, r∈R

For the curricula, the course with student under same group of course plan (curricula) should not take at the same time

Also, we need to rewrite the data in a new matrix for curriculas as column and courses as row, each position in this new matrix is binary to show the relationship.

$$\sum_{cs\in CS} timetable_{(cs,r,d,p)} \times course\_curriculas_{(cs,cr)} \le 1$$

for all d∈D, p∈P, r∈R, cr∈CR

For the unavailability constraints, we have some time periods for some certain courses cannot be allocated in, so firstly we need to decide whether the unavailability relationship exits.

If the relationship exists, the digit in timetable should be

$$timetable_{(cs,r,d,p)} = 0$$

for all d∈D, p∈P, r∈R, cs∈CS

Also, we need to consider about the penalties.

1. If the expected number of students more than the capacity of room, lost 1 point for one student.

$$penalty1 = \sum_{cs\in CS, d\in D} timetable_{(cs,r,d,p)} \times max(0, student\_num - room\_num)$$

for all p∈P, r∈R

we need to explain here that the student_num is the expected number of students in a certain course, day, period, and room, room_num is the capacity of a specific room.

And let penalty1 to represent the number of students over the capacity.

2. If the spread of class of a course less than the "minimum number of days", lost 5 points for one day.

$$penalty2 = \sum timetable_{(cs,r,d,p)} \times max(0, minimum\_day - spread)$$

$$spread = \sum_{d\in D} \max_{\forall r\in R, p\in P} timetable_{(cs,r,d,p)}$$

Let penalty2 to represent the number of days exceed the minimum stipulation.

We need to claim that the penalty should be as low as possible, which is the objective function for this timetable problem:

$$penalty = \min(1 \times penalty1 + 5 \times penalty2)$$