Classroom Scheduling Problem using Propositional Logic

1 Introduction

We have encoded the problem using 7 sets of propositions.

- A[i][j] represents i^{th} professor teaching j^{th} course.
- B[i][j] represents j^{th} course is scheduled in i^{th} room.
- C[i][j] represents i^{th} room occupied in j^{th} timeslot.
- D[i][j] represents i^{th} course in j^{th} timeslot.
- E[i][j] represents i^{th} batch studies j^{th} course.
- F[i][j] represents i^{th} professor teaches in j^{th} timeslot.
- G[i][j] represents i^{th} batch has a class in j^{th} timeslot.

So, the following statement

$$A[p][c] \wedge B[c][r] \wedge C[r][t] \wedge E[b][c] \tag{1}$$

means that Professor P is teaching course C in room r at time t to batch B

Our timeslot is defined by ["Day"]["start time:end time"]
Eg: Monday 8:30-9:30

2 Input

We have made the following assumptions about the input:

- Institute Time is input as [(start time),(endtime)] i.e. ["HH:MM","HH:MM"]
  Note: HH and MM should be colon seperated
- No two professors have the same name
- All lectures of a given course will be of equal duration (There isn't much issue in encoding variable durations as well but we made this assumption to simplify implementation)

3 Implementation

For implementation purpose, we included the following constraints:

3.1 at same time 1 prof can’t teach 2 courses

$$A[p][c1] \land D[c1][t] \implies \neg A[p][c2] \land D[c2][t] \tag{2}$$

This has been done for all courses c2 for a given course c1 and prof p i.e.

For all c1, P,t (And over all c2 (A[p][c1] $\land D[c1][t] \implies \neg A[p][c2] \land D[c2][t]$))

3.2 at same time 1 batch can’t be taught 2 courses

$$E[b][c1] \land D[c1][t] \implies \neg E[b][c2] \land D[c2][t] \tag{3}$$

This has been done for all courses c2 for a given course c1 and batch b i.e.

For all c1, b,t (And over all c2 (E[b][c1] $\land D[c1][t] \implies \neg E[b][c2] \land D[c2][t]$))

3.3 at same time 2 courses can’t be taught in same room

$$B[r][c1] \land D[c1][t] \implies \neg B[r][c2] \land D[c2][t] \tag{4}$$

This has been done for all courses c2 for a given course c1 and room r i.e.

For all c1, r,t (And over all c2 (B[r][c1] $\land D[c1][t] \implies \neg B[r][c2] \land D[c2][t]$))

3.4 One course one professor

$$A[p1][c] \implies \neg A[p2][c] \tag{5}$$

For all c, p1 (And over all p2 (A[p1][c] $\implies \neg A[p2][c]$))

3.5 All lectures of one course to be taken by same professor

We treated two lectures of same course CS 228 as CS 228-1 and CS 228-2. This constraint ensures that both are being taught by same professor.

3.6 each course should be assigned one room

So that Z3 doesn’t set all course-room propositions to false(because of the implication coding), we put a condition that each course should get at least one room(combined with other constraints, it ensures only one room)

For all r (B[r][c]) i.e.

B[r1][c] $\lor B[r2][c] \lor \ldots.$

3.7 each lecture of a course should be assigned exactly one time.

$$A[p1][c] \implies \neg A[p2][c] \tag{6}$$

3.8 Each room, professor and batch can't be assigned overlapping time slots.

We made seperate propositions for each time slot i.e. there will be propositions D-CS228-Monday-8:30-9:30, D-CS228-Monday-9:00-10:00, and so on for all possible(valid) one hour durations.
To encode this constraint, we extracted the start and end times of the propositions. Then we put the constraint that if one course starts before other, then the second course(if in the same room, or same batch or same professor) can't start before the first ends

4 Result

The final time-table has been displayed in a CSV file. We have printed the Professor assigned to each course seperately.