1. Introduction

Our case is an instance of the university timetable program. There are 29 courses which have activities: Lectures, tutorials and practical sessions. For the lectures all students are in the same group, but tutorials and practical sessions have limited capacity. This leads to a total of 129 activities.

These activities need to be spread over time-room slots. There are 7 rooms available (with different capacity) and four time-slots a day. In addition, the largest room has a fifth timeslot. This leads to a total of 145 timeslots.

State Space

Rooms are allowed to be rostered in the same time-room slot, which leaves us with 145^{129} (≈ 6.55E+278) possible solutions. That is a rather large state space However, if we only allow valid rosters the state space dramatically decreases (since the order doesn't matter, it becomes 145 chooses 129, or $\frac{145!}{(129!*16!)}$ (≈7.73E+20).

However, there are also 609 students that need to be spread over the tutorials and practical sessions of their courses. In order to approximate the number potential solutions for this problem I decided to set the group size on the average of all group sizes. For instance, the course 'Autonomous Agents' has 22 students and the tutorials have a maximum amount of 10 students. This leads to 3 tutorials groups with, on average, 7.33 students. Therefore, the possibilities are approximately $\frac{22!}{(7.33!*14.67)} * \frac{14.67!}{(7.33*7.33)} * \frac{7.33}{7.33}$. Of course, the tutorial don't have the size of 7.33 and, more importantly they are allow to have various sizes as long as it is below the maximum amount of 10. Nonetheless, this method offers us a possibility to get a small insight in the state space of student allocation. For all activities combined this method resulted in approximately 5.28E+676. This needs to be multiplied with the state space of the activities to get a an idea of the total amount of rosters.

Soft Constraints

With this amount of possible solutions, the questioning rises what makes a solution 'good' or better than another solution. There are 5 soft constraints:

1. 1000 points when all the activities have unique time-room slots
2. 20 bonus points if a course is spread well over the week, this means:
    a. For a course of two activities: monday-thursday or tuesday-friday
    b. For a course of three activities: monday-wednesday-friday
    c. For a course of four activities: monday-tuesday-thursday-friday

3. 10 malus points for every course of χ activities that are rostered on χ-1 days, 20 malus points for χ-2 days and 30 for χ-3 days
4. 1 malus point for every student that exceeds the room capacity in which the activity, that they are assigned to, takes place
5. 1 malus point for every time a student has more than one activity in a timeslot

Since 22 of the 29 courses have more than one activity, the perfect score would be 1440 (1000 for validity and 22*20=440 for spreading of course and no malus points). Whether this score can be reached is doubtful. In addition, due to the size of state space we need methods to approximate the optimal solution.

2. Methods

2.1 Hillclimber

2.2 Simulated Annealing

2.2.1 Optimalization

2.3 Genetic Algorithm

2.3.1 Variants

2.3.2 Combinations

3. Results

4. Conclusions

5. References

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