MATH3205 - Paper Review

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1 Paper Review

1.1 Group Members

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1.2 Chosen Paper

Title: Exact and metaheuristic methods for a real-world examination timetabling problem Journal of Scheduling
`https://link.springer.com/article/10.1007/s10951-023-00778-6`

1.3 Brief description of the problem that was solved

The paper proposes the problem or organising Italian university exams in a given time horizon as well as allocating 0, 1 or multiple rooms for each exam. Courses are composite meaning exams can occur in multiple periods and/or multiple rooms. As the enrollment figures are not known at the time of planning, courses are grouped into curricula which determines which courses conflict and therefore need separation. The time horizon is divided into days with each day equally split into timeslots.

1.4 Brief description of the solution technique used in the paper

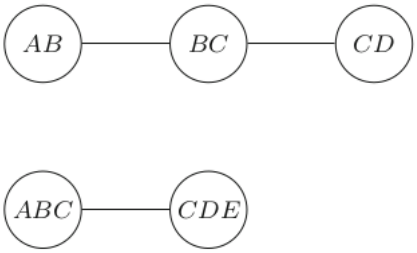
Two MIP formulations were proposed in the paper: a direct formulation and a two-stage problem where exams were first allocated to time periods and then rooms were allocated to exams. The paper found that the two-stage implementation was significantly faster, but it is not guaranteed that a time allocation in the first stage will admit a feasible solution in the second stage.

Moreover, the two-stage model does not guarantee that any solution is feasible with respect to allocating composite rooms in the second stage — the model only considers composite room conflicts for composite rooms with the same number of member rooms. On all of the data instances the model was run against, no solutions were found to be infeasible, but the two-stage decomposition is nonetheless not as robust as the direct integer formulation.

1.5 What ideas, if any, you have for improving the solution technique

One idea is to split the problem using Benders Decomposition, where the master problem would leave out some of the hard/soft constraints of the global problem - i.e. determine the time slot allocation of exams. The sub-problem would then be the room allocation and remaining constraints given the constraints imposed by the master problem.

The paper notices that the capacities for composite rooms is the independence number of the conflict graph. We could construct these graphs in each time period to check (in callback) for composite room member conflicts. An example from the paper is five single small rooms ($\{A, B, C, D, E\}$) can be allocated to three $(2, S)$ ($\{AB, BC, CD\}$) and two $(3, S)$ ($\{ABC, CDE\}$) composite rooms. By inspection of the conflict graph (below), we may see that at most two of the $(2, S)$ or one of the $(3, S)$ can be used at one time, although the two-stage formulation proposed in the paper would not notice this:



1.6 Where you are going to get data

Data is linked in the paper at `https://bitbucket.org/satt/examtimetablinguniuddata`

The Bitbucket has many instances of individual problem sets - some large and some small which we can use to test our model. Additionally, the solutions to each of these problem sets are provided. Both are in JSON format which we can read into Python very easily.

1.7 Preferred day for presenting (Wednesday or Thursday)

We would prefer Wednesday but are all available either day.