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Joint Training Offer Selection and Course Timetabling Problems: Models and Algorithms

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Abstract : In this article, we deal with a variant of the classical course timetabling problem that has a practical application in many areas of education. In particular, in this paper we are interested in high schools remedial courses. The purpose of such courses is to provide under-prepared students with the skills necessary to succeed in their studies. In particular, a student might be under prepared in an entire course, or only in a part of it. The limited availability of funds, as well as the limited amount of time and teachers at disposal, often requires schools to choose which courses and/or which teaching units to activate. Thus, schools need to model the training offer and the related timetabling, with the goal of ensuring the highest possible teaching quality, by meeting the above-mentioned financial, time and resources constraints. Moreover, there are some prerequisites between the teaching units that must be satisfied. We first present a Mixed-Integer Programming (MIP) model to solve this problem to optimality. However, the presence of many peculiar constraints contributes inevitably in increasing the complexity of the mathematical model. Thus, solving it through a general purpose solver may be performed for small instances only, while solving real-life-sized instances of such model requires specific techniques or heuristic approaches. For this purpose, we also propose a heuristic approach, in which we make use of a fast constructive procedure to obtain a feasible solution. To assess our exact and heuristic approaches we perform extensive computational results on both real-life instances (obtained from a high school in Lecce, Italy) and randomly generated instances. Our tests show that the MIP model is never solved to optimality, with an average optimality gap of 57%. On the other hand, the heuristic algorithm is much faster (in about the 50% of the considered instances it converges in approximately half of the time limit) and in many cases allows achieving an improvement on the objective function value obtained by the MIP model. Such an improvement ranges between 18% and 66%.

Keywords : heuristic, MIP model, remedial course, school, timetabling
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