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Variable neighborhood descent search based algorithms for course timetabling problem: Application to a Tunisian University

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Abstract

University course timetabling problem refers to schedule a set of lectures, tutorials and practical works to a limited number of teachers, classrooms and time slots over a planning horizon while satisfying a set of hard and soft constraints. In this paper, we investigate Variable Neighborhood Descent approach to tackle a specific course timetabling problem related to the case of the Faculty of Economics and Management Sciences of Sfax in Tunisia. The objective is to minimize the total number of holes and the number of isolated lessons for all student groups. We have developed eleven specific neighborhood structures: six of these are designed for correcting the holes, while the other five are designed for adjusting the isolated lessons. Computations are made on real instances and numerical results show that our approach outperforms the existing solution with the elimination of 52.47 % of holes and isolated sessions on average.

Keywords: Course timetabling, VND, neighborhood structure, isolated lesson

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1 Introduction

Course Timetabling Problem is considered as one of the hardest problems faced by academic institutions throughout the world. In the II International Timetabling Competition (ITC2007), this problem is decomposed into two sub-categories problems: Post Enrolment-based Course Timetabling and Curriculum-based Course Timetabling. The latter is the one considered in this paper. It involves scheduling a set of courses into a weekly timetable, where each course must be assigned to a teacher, a classroom and a time slot, subject to a set of hard and soft constraints. A variety of timetables problem exists since several specific constraints vary from one institution to another. A variety of solving approaches exist too and have been grouped into three classes: the class of exact methods, the class of approximate methods, and the pseudo class of hybrid methods. Among exact solution strategies, we cite for example the Integer Programming [4], [12], and the Vertex Coloring [3]. For the second class, we cite for example Tabu Search algorithm [9], Genetic Algorithm [11], and Memetic Algorithm [10]. For hybrid techniques, we cite for example the combination of Genetic Algorithm with Tabu Search algorithm [1], Variable Neighborhood Search with Simulated Annealing [2], and Mathematical Programming with Lagrangian Relaxation and Simulated Annealing [7].

In course timetabling domain and according to the ITCs Competitions, local search methods outperform the state-of-art heuristic solvers [6]. As presented by [8], the Variable Neighborhood Search (VNS) is versatile and successful compared to other local search techniques thanks to the strategy to consider different neighborhood structures providing a very effective way for escaping local optima.

In this paper, we investigate the variable neighborhood descent algorithm for course timetabling problems to outperform the manually generated solutions in the Faculty of Economics and Management of Sfax in Tunisia (FEMSS). The remainder of this paper is organized as follows. Section 2 describes the problem considered in this paper. Section 3 presents our solution approach. Section 4 contains the numerical results. Section 5 presents the conclusions and future directions.

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