Combination of Graph Heuristic with Hill Climbing Search for Solving Capacitated Examination Timetabling Problem

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***Abstract*-Examination timetabling problem is a nontrivial task due to its NP-hard nature as well as the involvement of numerous constraints. Moreover, solving capacitated examination timetabling is more challenging compared to un-capacitated one. This paper implements graph heuristic with hill climbing search to solve the capacitated examination timetabling considering partial examination assignment concepts. The algorithm starts with ordering all the exams according to graph heuristic approach and then partial exams are considered for construction. Afterwards, the qualities of these exams are improved using hill climbing search. The entire process continues until scheduling all the exams. The effects of different graph heuristic orderings and *exam assignment values* on the quality of the solutions are studied. We test the proposed approach on ITC2007 benchmark exam datasets which contains highly constraint capacitated datasets. Experimental results reveal that the approach is able to produce quality solutions for all datasets and competitive results with competition results.**

Keywords- timetabling; optimzation, graph heuristics; hill climbing.

I. INTRODUCTION

The examination timetabling problem has received much attention in the last 40 years due to its highly constraint nature. Examination timetable problem can be defined as assigning a set of exams to a set of timeslots and rooms aiming to satisfy a set of constraints. These constraints are categorized into hard constraints and soft constraints. Hard constraints are those constraints that must be satisfied for the examination timetable to be accepted (referred to as feasible solution), while soft constraints need to be satisfied as much as possible. The soft constraints are usually defined by an objective function or penalty function, which is used to determine the quality of the timetable.

The examination timetabling problem can be categorized as capacitated and un-capacitated. In un-capacitated problem, room capacity is not considered, while in capacitated variant, room capacity is considered as hard constraint. It is observed in the literature that most of the researchers concentrate more on un-capacitated datasets (i.e. Toronto dataset) compared to capacitated datasets. Recently, the second International Timetabling Competition (ITC2007) datasets has received considerable attention due to the fact that it is a capacitated dataset and closely resembles a real world problem with lots of constraints.

Various meta-heuristic approaches have been used to solve the timetabling problems. This includes graph heuristic [1], tabu search [2], simulated annealing [3], great deluge [4], late acceptance hill climbing [5], evolutionary algorithms [6][7][8], constraint programming [9], case-based reasoning [10], fuzzy methodologies [11] and many other approaches.

In this work, we present partial exam assignment with graph heuristic and hill climbing approach to solve the ITC2007 examination timetabling problem. The remainder of this paper is structured as follows: Section II describes in details about the ITC2007 examination datasets and section III represents related works on that datasets. Our proposed approach and the experimental setup are described in section IV and section V respectively. The experimental results and discussions on the obtained results are presented in section VI. Finally, conclusions are discussed and future works are highlighted in section VII.

II. ITC2007 EXAM TRACK

The ITC2007 examination datasets has been established to facilitate researchers to carry out exploration on real world examination timetabling problem to minimize the gap between theory and practice. The ITC2007 examination dataset contains eight instances (see Table I) and also contains numerous complex hard and soft constrains.

TABLE I. ITC2007 EXAMINATION DATASETS

Data Sets	A1	A2	A3	A4	A5	A6	A7
Exam_1	7,833	607	54	7	12	0	5.05%
Exam_2	12,484	870	40	49	12	2	1.17%
Exam_3	16,365	934	36	48	170	15	2.62%
Exam_4	4,421	273	21	1	40	0	15.0%
Exam_5	8,719	1,018	42	3	27	0	0.87%
Exam_6	7,909	242	16	8	23	0	6.16%
Exam_7	13,795	1,096	80	15	28	0	1.93%
Exam_8	7,718	598	80	8	20	1	4.55%

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