INNOVATIVE EVOLUTIONARY ALGORITHM APPROACH FOR CLASS-TEACHER TIMETABLING PROBLEM

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ABSTRACT
This paper presents the application of genetic algorithms (GAs) as a means of inducing solutions to the Class-Teacher Timetabling Problem (CTTP). Timetabling problem in almost all research focus on solving the hard constraints. This is an attempt to satisfy as many soft constraints as possible, as soft constraints are varying in nature. Initially the population is created depending on the number of rooms and distribution of subjects with no clashes of a particular professor. The application of genetic algorithm to this domain is divided into 3-phases, which provide timetables that meet the hard constraints during the first phase. In the next phase different sets, which represent population satisfying single soft constraints from group of soft constraints is created and in the last phase we obtain the desired timetable by applying different soft constraints in the form of Set Operations. This provides flexibility in adding or removing soft constraints easily.

CCS Concepts
•CCS → computing methodologies → Machine learning → Machine learning approaches → Bio-inspired approaches → Genetic algorithms

Keywords
Genetic Algorithm, Timetabling, Set Operations, Time Slot, Hard Constraints, Soft Constraints

1. INTRODUCTION
Timetabling problems are optimization problems and can be thought of as a subset of scheduling problems. However, it is far more complicated than general scheduling as it involves teachers, students, classrooms, and courses. From a broader perspective, course arrangement includes many interrelated issues, such as exams, meetings, administrative allocation. Conventionally, course timetabling has been conducted manually. Due to the large variety of constraints, resource limitations and complicated human factors involved, course timetabling often takes a lot of time and manpower. Using computers to perform course timetabling, however, can not only consolidate the preferences of the people concerned but can also enable achievement of high satisfaction in spite of the many constraints. Obviously, this results in saving a lot of time and thus manpower. Genetic algorithms are among those that can be used to find approximate solutions of timetabling problems. Genetic algorithm is a general and optimization algorithms inspired by the processes of natural selection. It can be used as techniques for solving complex problems and for searching of large problem spaces. Unlike many heuristic schemes, which have only one optimal solution at any time, Genetic algorithms maintain many individual solutions in the form of population. Individuals (parents) are chosen from the population and are then mated to form a new individual (child). The child is further mutated to introduce diversity into the population. Rather than starting from a single point within the search space, GA is initialized to the population of guesses. These are usually random and will be spread throughout the search space. A typical algorithm then uses three operators, selection, crossover and mutation, to direct the population toward convergence at global optimum.

2. LITERATURE REVIEW
Few research papers and articles published in prestigious journals, on Genetic Algorithms and Resource-Constrained Scheduling were surveyed and analyzed, Lin-Yu Tseng and Shih-Chieh Chen [5] presented a paper on two-phase genetic local search algorithm for the multimode resource-constrained project scheduling problem, in which authors studied, the resource-constrained project scheduling problem with multiple execution modes for each activity. This paper aims to find a schedule of activities such that the make span of the schedule is minimized subject to the precedence and resource constraints. A two phase genetic local search algorithm that combines the genetic algorithm and the local search method to solve this problem is used. The first phase aims to search globally for promising areas, and the second phase aims to search more thoroughly in these promising areas. A set of elite solutions is collected during the first phase, and this set, which acts as the indication of promising areas, is utilized to construct the initial population of the second phase. By suitable applications of the mutation with a large mutation rate, the restart of the genetic local search algorithm, and the collection of good solutions in the elite set, the strength of intensification and diversification can be properly adapted and the search ability retained in a long term. Jorge Magalhaes and Mendes [6] presented a paper on a comparative study of crossover operators for genetic algorithms to solve the job shop scheduling problem. To standardized the results of experiments, GA is applied to the job shop scheduling problem (JSSP) which is based on a decision support system (DSS).In job shop scheduling problem There are a set of jobs $j = 1,\ldots, n$, a set of machines $M=1,\ldots, m$, and a set of operations $O = o_0, o_1,\ldots o_{ij},\ldots o_{nm}, o_{nm+1}$ Set O contains all the operations of each job. Each job has m operations. Each machine can

process at most one operation at time. The JSSP is to find a schedule which minimizes the make span (Cmax), that is, the finish time of the last operation completed in the schedule, taking into account the precedence constraints. Equal opportunity is given to all the operators to compare the abilities of different crossover operators. The genetic crossover operators are tested on a set of standard instances taken from the literature. The make span is the measure used to evaluate the genetic crossover operators. In the sense of Jorge Magalhaes and Mendes authors the main conclusion is that there is a crossover operator having the best average performance on a specific set of solved instances.Umut Besikcia, Umit Bilgea, Gunduz Ulusoyb[7] presented a paper on multi-mode resource constrained multi-project scheduling and resource portfolio problem, in this work authors introduced a multi-project problem environment which involves multiple projects with assigned due dates; activities that have alternative resource usage modes; a resource dedication policy that does not allow sharing of resources among projects throughout the planning horizon; and a total budget. The dedication of resources reduces the scheduling of the projects' activities to a multi-mode resource constrained project scheduling problem (MRCPSP) for each individual project. In this paper, this multi-project environment is modeled in an integrated fashion and designated as the Resource Portfolio Problem. A two-phase and a monolithic genetic algorithm are proposed as two solution approaches, each of which employs a new improvement move designated as the combinatorial auction for resource portfolio and the combinatorial auction for resource dedication.

3. METHODOLOGY

The Class-Teacher Timetabling Problem (CTTP) concerns scheduling teachers and classes over a set of periods, typically covering five or six week days depending upon the institutional policy [8]. The basic constraints that must be satisfied are i)professors can only be in one class at any given time ii) classrooms need to be big enough to host the class iii) Classrooms can only host one class at any given time. This classical version of the CTTP was shown to be NP-Complete [9]. The manual construction of timetables in educational institutions is often a very time-taking task. Besides the basic constraints, a good timetable should consider many other requirements, such as institutional, pedagogical and personal (staff related) needs [8].In fact, quality of timetable generated depends upon the specific educational system. However some common assumptions are made in most works like there should be gap of at least one period after two consecutive periods. The solution space definition, specified by the hard constraints, usually does not include many other constraints besides the above mentioned basic constraints. Another very common type of soft constraint is the number of lectures required by the professor that basically depends upon type of subject taught by the professor. Heuristic methods are effective in practice for solving timetabling problem as exact methods require large amount of processing time on most timetabling variants. These methods include meta heuristics such as Simulated Annealing [1], Evolutionary Algorithms [2], Tabu Search [2,3,4,5] and some of their hybrids. The approach taken in this study differs from previous studies applying genetic algorithms to this domain as follows:

- A three-phased approach is taken to the problem. In the first phase a genetic algorithm is employed to produce timetables that do not violate any hard constraints to generate it we will remove the fittest population representing timetable from the population and move it to the selected list. Now we apply cross-over and mutation operator on remaining population and we continue this process till user defined number of times and in the second phase different sets representing particular soft constraint from the group of soft constraints is created and in third and final phase different Set Operations are used to generate the final timetable.
- The genetic algorithm implemented in all the three phases uses domain specific knowledge, in the form of heuristics, to guide the evolutionary process.

4. CONCLUSION

The timetabling problem has become a current area of research as it becomes difficult to manage the uniformity of subjects taught and clash management of rooms and professors. A proper and well organized scheduling approach for solving Timetabling problem is necessary. Adding or removing soft constraints much more flexible and we can generate different instances of time table with less computational time. Crossover and Mutation policies can be enhanced in future work, thus generating a precise and accurate time table generation equalizing to the intelligence of human brain.

5. ACKNOWLEDGMENTS

This work was supported by Research and Development Laboratory, Department of Computer Science and Engineering at Bhilai Institute of Technology, Durg, Chhattisgarh, India, awaiting sponsorship from suitable funding agencies.

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