Timetable Generation using Value Encoding and Different Selection Methodsin Genetic Algorithm

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Abstract: This paper describes techniques that can be applied on timetable problems. Timetable is explained as, essentially, a schedule with constraints. Timetable is the used to organize the schedule in timely manner or in organized list form. Timetable generation is the Constraint Satisfaction Problem. In this paper, we explain the approach to design and implement Genetic Algorithm to create the institute course based timetables. Institute course timetabling is the NP-hard problem; timetables are usually designed manually, taking several days or week of iterative repair to meet several constraints. Using Evolutionary technique like Genetic Algorithm, it's been seen that the Genetic Algorithm could be improved by further incorporation of repair strategies, and is readily scalable to the complete timetabling problem. In this paper, we generate the timetable with the help of the encoding techniques used in Genetic Algorithm and apply the various selection methods.

Keywords: Constraint Satisfaction Problem, Genetic Algorithm, Evolutionary approach, NP-hard problem.

I. INTRODUCTION

A Genetic Algorithm is a programming technique that mimics biological evolution as a problem solving strategy. This paper describes an implementation of the time table problem by using the Genetic Algorithm. Time table is the very complex part of the scheduling. The time table problem is the common to all the educational institution. Genetic Algorithm is the search technique inspired by evolutionary biology. Genetic Algorithm (GA) is a specialization of the evolutionary programs based on the principals of the normal selection and the random transformation from Darwnistic biological evolution. They were formalized in 1975 by John Holland at the University of Michigan and have been growing in popularity since, particularly for solving problems with a large irregular search space of possible solutions [1]. Genetic Algorithm works on two types of spaces like Coding space and the Solution space or in other words Coding space defines the Genotype space and Solution space defines the Phenotype space. Evolutionary algorithm is the part of the evolutionary computation. Evolutionary approaches are simply defines the idea:

1. Generate a population of possible solution to the problem
2. Choose the best individuals from the population (using the methods inspired by the Survival of the Fittest)

3. Produce a new generation by combining these individuals best one
4. Stop when the best individual of the population is finding

Institute time table problem is the NP-hard problem as well as the Constraint Satisfaction Problem. NP-hard problem in the Non Deterministic Polynomial Time problem hard, it defines at least as hard as the hardest problems in NP. A problem is NP-hard if an algorithm for solving it can be translated into one for solving any problem.
Pi is NP-hard if, for every Pj ∈ NP,

NP-hard problems are regularly tackled with rules based languages. Constraint Satisfaction Problem (CSP) is defined by a set of variables X_1, X_2,...., Xn, and a set of Constraints, C_1, C_2,…, Cm. Each variable Xi has a non empty domain D_i of possible values. Each Constraints C_i involves some subset of variables and specifies the allowable combinations of values for that subset. A state of the problem is defined by an assignment of values to some or all of the variables, $\{X_i=v_i, X_j=vj,\ldots\}$. An assignment that does not violate any constraints is called a consistent or legal assignment. A complete assignment is one in which every variable is mentioned and a solution to a CSP is a complete assignment that satisfies all constraints [2]. In this paper describes the time table problem which shows from the constraints.

Section II describes the problem description, section III describes the constraints occurred during the time table management, section IV describes the previous work, section V describes the overview of the Genetic Algorithm, section VI describes the implementation of the Genetic Algorithm in the Time Table Scenario and section VII describes the conclusions and future scope.

2. PROBLEM DESCRIPTION

Time tables to be treated in this paper are constructed for 4 years courses like B.Tech, BHMCT, B.Arch, B.E., etc. for any Engineering Institute. Course is divided into semesters. In one year 2 semesters. There are 7 time periods within a day and each time period consists of a 1 hour. In every semester the courses contains 6 theoretical subjects, 4 of which contain laboratory work also. Each subject should be allocated 4 time periods in a week along with, 4 time periods for laboratory work in a week. There is also one hour lunch period with in a day. The scheduling problems are basically the problems that deal with helpful allocation of resources. During the scheduling process many constraints have to be considered. Resources are typically limited and no two tasks should engage one particular resource at the same time.

Institute time table scheduling problem presents a set task (classes) and a set of resources (rooms, instructors, students, and time). Every job requests some resources for its realization and has the exact length. The set of timetables when a class can be planned is also determined.

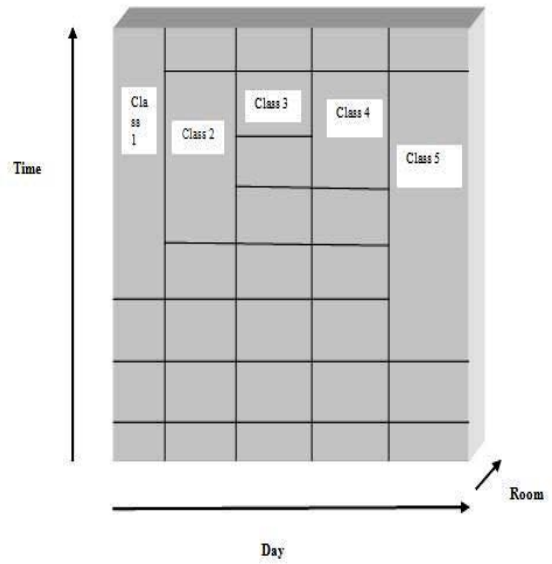

Figure 1: 3D Structure of Timetable Problem

Scheduling a time table could also be represented in the 3D cutting problems. Figure 1 [3] shows the 3D structure of timetable problem. The dimensions of 3D timetables are: days (x-axis), timeslots (y-axis) and rooms (z-axis).

3. CONSTRAINTS

In the time table management we define mainly two constraints: Hard Constraints and Soft Constraints. Hard Constraints for time table management are:

- No participants can be in more than two rooms at similar point.
- No room should be dual booked.
- No faculty should be doubled booked.
- Number of classes each subject should be fulfilled.
- All classes must be scheduled a room and time.
- Room capacities not exceeded.
- Correct room types used (lectures in lecture room, labs in laboratories).

Soft Constraints for time table management are:

- Second time for each subject should not be in same day.
- No subject should be allocated to a time period that heads of department don't demand because of other work.
- Subject should not be allocated to a time period inconvenient for a lecturer.
- No lecture should be booked for repeated time slots.
- Classes should be scheduled within preferred hours.
- Distances between classes minimized.

- Hour for lunch is allowed between the hours of 12 noon and 2 pm.

These constraints are shown in the time table management problem.

4. PREVIOUS WORK

Genetic Algorithms were invented by John Holland and developed by him and his students and colleagues. This lead to Holland's book "Adaption in Natural and Artificial Systems" published in 1975. College courses arranging to solve the problem, the actual efficiency of the Timetable Course Scheduling algorithm using genetic algorithm optimization have been greatly improved. Therefore the optimal solution to the use of genetic algorithms to achieve a similar course timetabling problem is a relatively simple and practical way, the convergence speed quickly, the distribution of the time period is relatively uniform. Course timetabling problem is a combination of a multi-objective optimization problem, too many uncertainties, using genetic algorithm to its optimized technology means continued development. Timetable Problem intractable problems of an interdisciplinary the Timetable Problem in the basis of this article, there are many: First, effective organization in the course timetabling problem constraints, to further improve the Course Scheduling algorithms versatility. Second, the determination of various control parameters of the genetic algorithm is how to set the respective control parameters in the algorithm, to study the influence of each parameter variation on solving algorithm, and to the design parameters of the dynamic changes in the evolution of the iterative process. Third, the course timetabling problem as a starting point, to continue to study the problem of this related fields [4].

5. OVERVIEW OF GENETIC ALGORITHM

Figure 2 [4] shows the flow of Genetic Algorithm. All the GAs works on a set of populations or we can say collection of the several alternating solutions to the given problem. Each individual in population is called the chromosome. The individual characters of the chromosome are known as the Genes. The population size is also play a important role in the GA for getting the amount of the information is stored by the GA. Fitness function is also called the evaluation function. This is used to determine the fitness for each candidate solution. The fitness is the opposite of what is generally known as cost. The fitness function is usually defined by the users as well as the problem specific. If the fitness functions we count then we check the termination condition. Individuals are selected form population for the reproduction with the selection biased. Selection is one of the key operators on GA.

Crossover is the main operator used for the reproduction of the population. This is used to combines of the 2 parents to create 2 new individuals, called the offspring. Mutation is an incremental change made to each member of the population. Then we increase the individuals by increment. Then we calculate the fitness function for the new population. If there is any termination condition is founds then it will generate the final output of that problem, and then stops the whole work and finally getting the result of that problem.

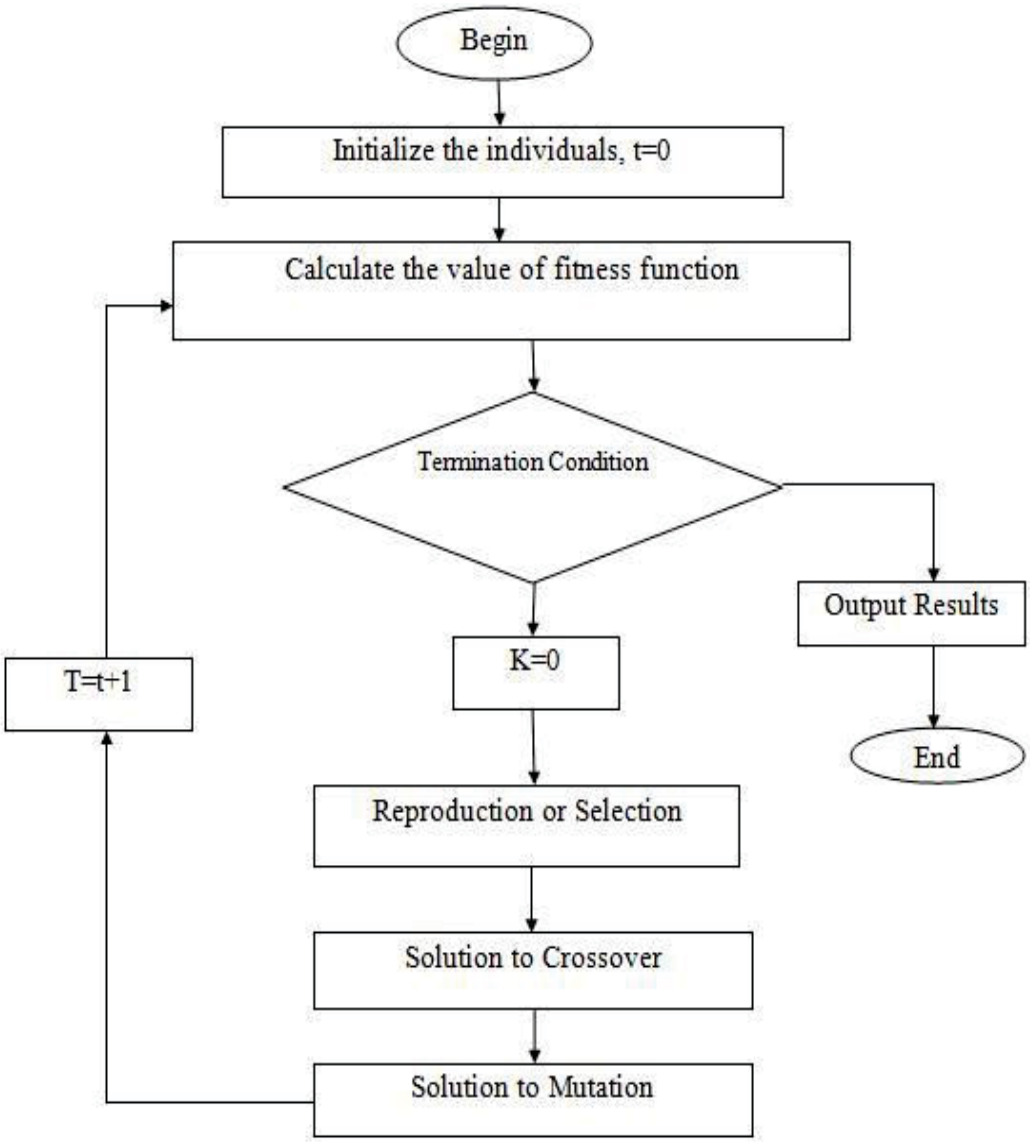

Figure 2: Flowchart of Genetic Algorithm

6. IMPLEMENTATION OF GENETIC ALGORITHM IN TIME-TABLE SCENARIO

Time table is also the resource allocation problem. In this the resources are class rooms, number of students and faculty staff. All these resources are the mutually exclusive, such that if faculty taken any class in the one semester students then there is no possibility to taken the other class in

other semester in the same time.

A. Individual Design

Since in this paper I am taken an institute time table, in this considering the 4 semesters are running in parallel at any point of time. Time table will be for 6 working days. So each semester will have 6 days function. Each day has 8 periods or lectures. And finally each lecture will have a subject being allotted, teacher being allotted and a class room to be used.

So the structure of the individual should have field for every semester, each day, each lecture, each subject, class room and faculty. Figure 3 shows the individual design of the institute time table for above mentioned resources.

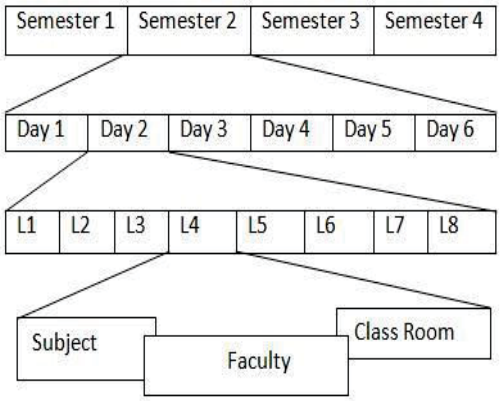

Figure 3: Individual Design of Time Table

B. Value Encoding

In value encoding, every chromosome is a sequence of some values. The values can be anything connected to the problem, such as: real numbers, characters or objects.

a) Time slot/Period/Lecture/Session

The smallest unit object in the time table is the time slot. It has main 3 attributes: Subject, Faculty and Class Room.

b) Day

8 Time slots compose a Day. The Time slots are to be successive for any semester.

c) Semester

6 working days composes a Semester. Each of these 6 days is defined by the time slots. So, now

every day is a time table in itself.

d) Institute Time Table

Since I am making time table for any institute, should also consider the resources of institutes shared by all the semesters, thus mutual exclusion shall be achieved among them.

C. Initialization

For initialization purpose, the domain of every field is to be known so that the relevant value can

be assigned on a random basis to corresponding fields in the individuals.

Table 1: Resources in an Institute

Resource	Quantity
Class Room	20
Faculty	60
Semester per Courses	2
Sections	12
Subjects per Semester	6
Departments	5

Table 1 shows the resources in an institute, it includes the class room, faculty, semester, sections in one class room, subjects and the departments.

Table 2: Resources in the Department

Resource	Quantity
Class Room	6
Faculty	16
Labs	4
Courses	4

In the table 2, define the resources in the department like Class room, faculty, labs and the courses.

D. Fitness Function

This fitness function is to be designed to calculate the fitness of every individual in the generation. For designing the fitness function the constraint are to be known beforehand. This is done by checking the values of each and every field of the individual and then testing that the value is valid for the solution and is not violating the any type of constraint, if it's not violating then the next constraint is checked.

Individual Id	Fitness Count
A1	14
A2	12
A3	9
A4	8
•	
•	
•	
•	
A99	10
A100	6

Figure 4: Fitness Table for any generation

Generation	Average Fitness	Number of individuals	Best Fitness	Worst Fitness
N1	14.5	100	12	22
N2	13.5	100	10	23
N3	12	100	8	20
•				
•				
•				
N1098	10	100	1	0

Figure 5: Record of Execution

E. Selection of Parents and Reproduce

Selection means extract a subset of genes from an existing population according to any definition of quality. Genetic Algorithm supports variety of approaches for the selection of parents. Most popular is Tournament Method.

Common Methods of Selection are:

1) Roulette Wheel Method

2) Tournament Selection
3) Ranking Selection
4) Stochastic Remainder Selection

For the Time Table management problem define these methods:

In the Roulette wheel selection method, firstly calculate the cumulative fitness of the whole population through the sum of the fitness of all the individuals. Roulette wheel selection is the Proportionate Selection methods. After calculating the fitness of all the individuals, calculate the probability of selection for each individual [5].

In the Tournament selection method, the Time Table management solution is occurred:

Tournament of Parents

The new generation is shaped by crossing of individuals selected from the unique generation by the tournament method. In other words, the two parents are selected for the new individual by the tournament method.

Tournament of Parents + Children

The temporary set of individuals is shaped. Parents of each individual are arbitrarily selected from original generation. To the next generation, individuals are selected by tournament form set of both parents and their children.

In the ranking selection method, population is sorted from best to worst according to their fitness values. Each individual in population is assigned a numerical rank based on fitness and selection is based on ranking rather than its fitness.

In the Stochastic Remainder sampling has identical concepts used in the deterministic sampling [5].

F. Crossover

For the recombination purpose, define the crossover technique. The selected individuals are crossed-over several times in different ways to form new individuals.

Some common types of Crossover:

1) One site crossover
2) Two site crossover
3) Uniform crossover

One site crossover operator randomly selects one crossover point and then copying everything before this point from the first parent and then everything after the crossover point copy from the second parent. Two site crossover operators randomly select two crossover points within a chromosome then interchange the two parent chromosome between these points to produce two new offspring. Uniform crossover operator decides which parent will contribute how the gene value in offspring chromosomes.

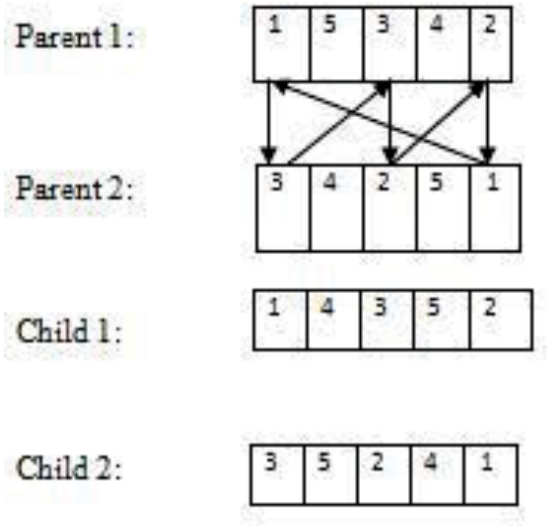

Figure 6: Cycle Crossover

G. Mutation

Mutation used to help preserve diversity in the population by finding new points in the search space to evaluate. When a chromosome is chosen for mutation, a random change is made to the values of some location in the chromosome.

H. Influence Parameters for GA Run

The main aim of measurement was to know what constraint influents the leaning to probing and the time of processing. The swiftness of solving was evaluated by the number of generations desired to creating a "good" timetable. The results of testing fetch the conclusion that it suits to use the bigger value of probability of mutation.

In the tests, mutation probability was changed from 0.0 through 0.5 to 1.0. The best results were reached for the value of mutation probability equal to 1.

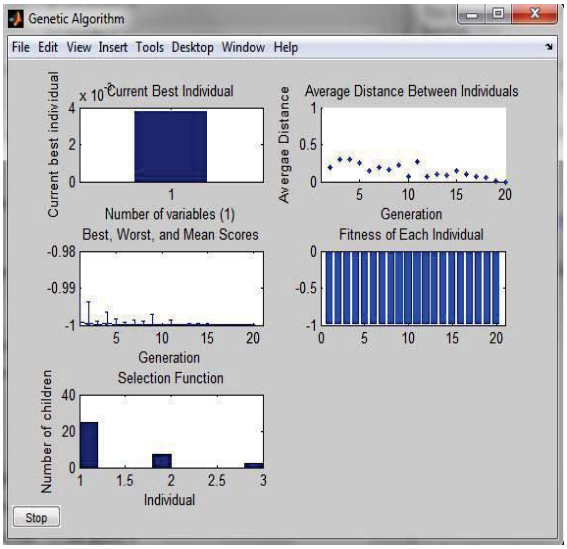

Figure 7: Truncate Selection

The range of is taken from (0, 1) for getting the results. In the figure 7, the unction value is -0.999999963734354. In this figure 8, I have just taken the values with the help of the local and global basis. In the figure 6, show the graphs with the help of the remainder selection

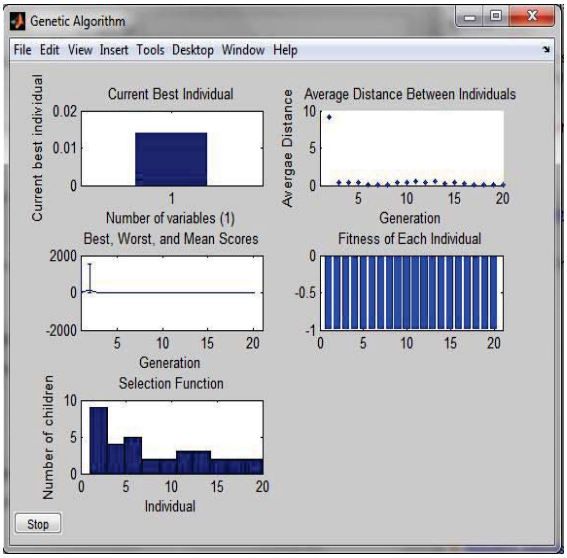

Figure 8: Remainder Selection

For remainder selection the function value is -0.9999999849553026. In the figure 9, I show the graphs for the roulette wheel selection. For this the function value is - 0.9999995137339727. In the figure 10, I simply show the graphs by using the stochastic selection technique. For this technique the function value is - 0.9999998986988838. The probability of mutation is 0.8.

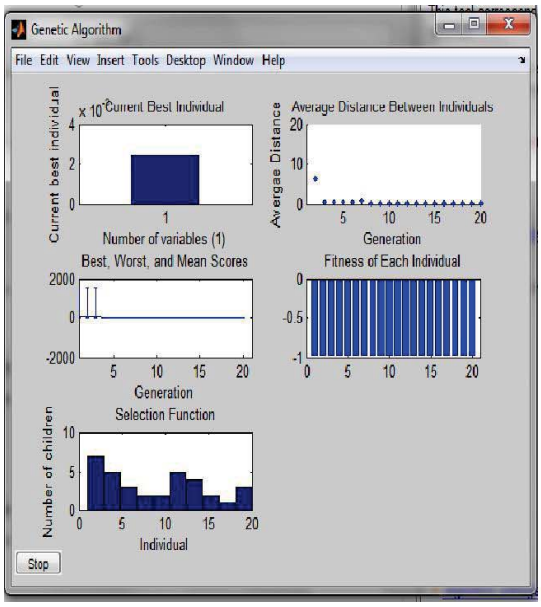

Figure 9: Roulette Wheel Selection

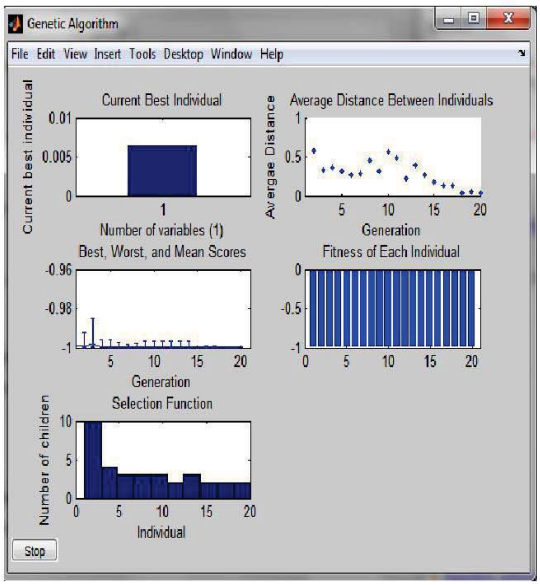

Figure 10: Stochastic Selection

7. CONCLUSIONS AND FUTURE SCOPE

Genetic Algorithm approach is very effective and useful on the lecture time tabling problems. In constraint to generally used GA it was used different implementation of mutation. The mutation is implemented in context of solving problem. In summary, GA in timetabling framework, involving a good solution to correct and optimization the errors and give the reports about lectures, classes and rooms. Future work is under way to more thoroughly test the performance of the technique on a wider variety of timetabling problems.

Further work is wanted to perform comparisons in terms of speed and quality between the individuals. Considering details of the GA in timetabling framework itself, the reason why not is that so far GA mainly to resolve important stated constraints. In the future time table problem is easily solved by the different selection methods. Time table problem is very time taken problem in which solution is found with the help of the different selection techniques and the crossover and the mutation. In the crossover, simply combines the individuals and make the new offspring of those individuals.

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