

Panel Generation as an Application of Genetic Algorithm

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Abstract : In this paper, a method which can generate academic project review panels by providing the Time Table (TT) of the faculties and a batch of students. The faculties and students in a college are allocated with a TT at the beginning of the academic year. The faculty TT contains the list of hours for which they have to engage a batch of students. The other hours are considered as their non-engaging hours. Likewise, in every final year student's TT there are fixed time slots for their projects. The area of concentration in this paper is to generate a review panel such that the non-engaged slots from the faculty's timetable are matching with the project hours of the batch so that, a review panel can be generated and allocated. The number of members in each project review panel is determined by the project coordinator. When the algorithm is used, the time, the effort, and the accuracy for generation of the review panel are far better than the one generated manually.

Keywords : Optimal, optimized, timetable, faculty, student, schedule, groups, review, project

1. INTRODUCTION

In a University every year, hundreds of projects are handled. All the final year students of a University have a slot for Projects in the Time Table (TT). Deciding the right project is one of the most difficult challenges faced by the students in their academic life. The faculty-in-charge of the project co-ordination need to assign the students into various project groups. During different phases of the project, marks are awarded to the students through reviews decided by a panel of faculties. The manual grouping and scheduling is a time consuming work done on the basis of trial and error methods.

The primary task of a Project Coordinator is the allocation of student groups for the project. Once a project group decides the project and starts working on it, a review panel needs to be identified. The panel then tracks the progress of the group and award marks. At the University, post graduate and under graduate level projects is coordinated. Thus, to generate the review schedule for the various project groups is a time consuming task for the Project Coordinator.

Panel Generation can be categorized as a timetabling and scheduling problem that need to be optimized based on the constraints. There are various algorithms that can be used to solve these kinds of problems. In our paper, we propose Genetic algorithm for Panel Generation. The working of this algorithm is entirely dependent on chromosomes, which is a set of parameters which characterize a proposed answer for the issue that we address to resolve, and the smallest unit of chromosome is a gene which is the smallest unit of information. The concept of gene property of the Genetic Algorithm [1] is used to formulate the problem. In this method the timetable is represented as multi-dimensional arrays. The representation of the arrays used is much similar to the gene representation in Genetic Algorithm.

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2. BACKGROUND STUDY

Timetabling

Timetabling is a resource allocation problem which reduces the conflicts in allocation of courses and staffs based on certain defined constraints. There are mainly two kinds of constraints – hard and soft constraints. Hard constraints are the mandatory conditions which has to be satisfied. Soft constraints are the conditions that are desirable for the solution.

In this problem, the hard constraints are as follows :

- To include a faculty in a review panel, the faculty should be free.
- A review panel can only be reused to a maximum threshold set by the coordinator.
- A Faculty cannot be part of two panels at a time.

To manually fix a solution for timetabling problems, takes many days of work. The following different approaches are done theoretically in timetabling and real data testing is performed.

- **Sequential methods :** In this method timetables are represented graphically with vertexes as events and edges as conflicts between the edges. To resolve this graph coloring problem is modeled which makes it a conflict free timetable to an extent.
- **Cluster methods :** Event sets are grouped on the basis of hard constraint, and are given a time period to satisfy the soft constraints. In this approach the event clusters are generated at the beginning of algorithm, over to low-ent time table.
- **Constraint-based approach :** In this method, the events is set of Variable to which value is referred to satisfy varies constraints.
- **Meta-heuristic methods :** In this method, given a problem and optimal solution is obtained by taking the time as a single or whole set. The main idea of a genetic algorithm is to explore the neighborhood of the solutions obtained by genetic algorithm and to navigate the search towards the local optima before passing back to the genetic algorithm containing the process.

Two main algorithms that was used for this problem are Genetic Algorithm [1] and Memetic Algorithm [2].

In Genetic algorithms (GA) initially the solutions are structured in chromosome concept, here gene is the smallest unit which is represented using six digits. With the timetable in-hand the gene concept is applied as dimensions of an array. The Faculty ID, Faculty Name, Day Number, Day, Hour number (slot), Hour (engaged or not) are represented by using each dimension in the multi-dimensional array (Fig. 1). When a complete chromosome is filled then it represents the timetabling and scheduling solution of the problem.

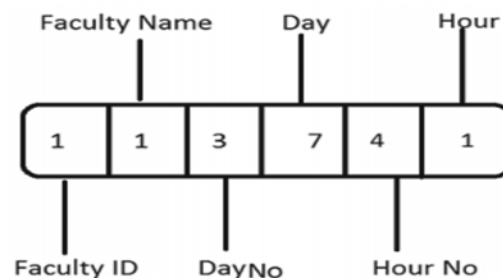


Fig. 1. Gene Representation

In Memetic Algorithm (MA), Meme is the smallest unit in MA which imitate information copy. The main concept behind this algorithm is to analyze regions of the result attained by genetic algorithm. In most of the MAs a search strategy which populates the desired agents cooperates and competes. MAs are an important optimization approach which focuses on technical and formal features without losing any research and practical aspects[3]. A meme is the simplest form of information that can be transmitted between individuals. Unlike a gene here the information can be processed and enhanced by the communication of entities.

3. METHODOLOGY

Creation of the project groups from the student list is usually a time consuming manual work for a Project Coordinator. This system tries in automating the process, thus by reducing the work load of the project coordinator. As an input, an excel file with the details of student such as name, roll no, gender, CGPA (Cumulative Grade Point Average) are provided to the tool as shown in Table 1. The imported excel file is extracted to a two-dimensional array which is an exact mapping of the input file using the Apache POI package. Poor Obfuscation Implementation [5] (POI) is an API that access Microsoft Office formats, developed by Apache Software Foundation. The file is then extracted on the basis of gender and stored into 2 two-dimensional string arrays. Then these arrays are further sorted on the basis of the student's CGPA.

A. Group generation

The Group generation steps are as follows:

1. Read Student list
2. Read number(N) of students in each group
3. Extract student details to an array
4. Sort array on the basis of gender
5. Sort array on the basis of CGPA
6. Compute students with high and low CGPA to form a group.
7. If Total no of students (S) is not a factor of N
 Group remaining students to one group
 End If
8. While 'G' in Groups
 Create Login for G
 Hash password MD5
 Write entry to database
 If (Group – G) not empty
 G ← nextElement(Group)
 else
 Break
 End If
 End While
9. Print Group details.

Each group is assigned with a unique group number, which is a combination of group number, batch, semester and year. Example: "Group3_mca_s5_2015". If the total number of students, S, is not a factor of the number of N, then the remaining students are clubbed into a single group. Each group is created in such a way that the group contain students with high and low CGPA. Next a login table is created for this batch and all these details are written to the table. The initial password for each group is the group name itself and is asked to replace on first login, the passwords to the accounts are protected using the MD5 hashing algorithm. The advantage of using MD5 algorithm is that the passwords stored in the database are hash codes of the original password. Hence even if someone gets access to the database and gain the passwords, they get only the hash codes. If they try to login with the hash code, it hashed again and the login will fail.

B. Review Panel Generation

When Genetic Algorithm is applied to this timetabling problem, the following steps are adopted.

Table 1. Student Database

<i>Name</i>	<i>Roll No</i>	<i>Gender</i>	<i>CGPA</i>
Student 1	Roll_no.1	F	9.83
Student 2	Roll_no.2	M	9.33
Student 3	Roll_no.3	M	6.29
Student 4	Roll_no.4	F	7..5
Student 5	Roll_no.5	F	6.96
Student 6	Roll_no.6	F	7.58
Student 7	Roll_no.6	M	7..11

Table 1 contains the name, Roll No, Gender and CGPA of the students.

1. Read Student's Timetable
2. Extract timetable to a 2D array with Y- axis represents each day in a week, and the Z-axis represents the different hours in a day
3. Read Timetable of all faculties
4. Extract timetable to a multidimensional array in which the X- axis represents each faculty's details, Y- axis represents each day in a week, and the Z-axis represents the different hours in a day
5. Read number of days(D) for which review needs to be scheduled.
6. Read number of members in a panel(P)
7. Read no of time a panel can be reused.
8. Extract a sub array from the main array which contains the details of a particular faculty and students for day 'D'.
9. Compare the two subarrays to find the non-engaging hours of the faculty and the project hours of the class.


```

      If (Faculty TT [location] = False and Student TT [location] = True)
      New Gene[location] ← True
      Else
      New Gene [location] ← False
      End If
      
```
10. /* The result of the above is a new chromosome that contains the details of all the faculties whose non-engaging hours is a match with the project hour of the batch. */


```

      Identify and group faculty with common non-engaging hours to create panels with 'P' number of faculties.
      
```
11. Assign each panel with unique panel ID
12. Initialize weight of each panel to default value.
13. Print Panel Details.
14. Assign each panel to the groups generated /* Working of the panel assigning shown in the Fig 3 */
15. Print Review Schedule.
 - **Initialization :** Initially the class timetable and faculty timetable are chosen, which is already in a prescribed format as shown in Table 2 and Table 3 respectively. The faculties timetable is extracted and stored in a two dimensional array called Faculty's TT. Here the entire details in the excel file are extracted to the Boolean array. So in the excel file, whichever cells like the name of the faculty, day of the week, subject

codes, which has a value that is mapped with a value. We further refine and store the information into a three dimensional array called Faculty, in which the X- axis represents each faculties details, Y- axis represents each day in a week, and the Z-axis represents the different hours in a day.

Table 2. Class Timetable

<i>Batch_Sem_</i>	<i>8.30-9.30</i>	<i>9.30-10.30</i>	<i>10.40-11.40</i>	<i>11.40-12.40</i>	<i>12.40-1.40</i>	<i>1.40-2.40</i>	<i>2.40-3.40</i>	<i>3.50-4.40</i>
<i>Year</i>	1	2	3	4		5	6	7
Mon	CA403	PT033	HU485	CA573		CA401	CA700	CA700
Tue	CA401	CA700	CA700	CA700		HU485	PT033	PT033
Wed	CA573	CA401	CA403	PT033		CA700	CA700	CA700
Thu	HU485	CA700	CA700	CA700		CA403	PT033	PT033
Fri	CA573	CA700	CA700	CA700		CG001	CA403	CA401

- **Evaluation :** The Project coordinator sets the number of times a panel can be used and the number of members in a panel. Based on these constraints the TT's are Evaluated.
- **Selection :** We extract a sub array from the main array which contain the details of a particular faculty in a particular day. We can consider this sub-array as a gene (a piece of information).

Table 3 : Faculty Timetable

<i>Teacher's</i>	<i>8.30-9.30</i>	<i>9.30-10.30</i>	<i>10.40-11.40</i>	<i>11.40-12.40</i>	<i>12.40-1.40</i>	<i>1.40-2.40</i>	<i>2.40-3.40</i>	<i>3.50-4.40</i>
<i>TT</i>	1	2	3	4		5	6	7
Mon	CA301	CA301				EC706	EC706	
Tue		CS237			CA301			
Wed	CS237					CA301		
Thu	CS237	CS237				CS237		
Fri		CA201				DP001		

- **Mutation :** This gene mutates to create a new set of information which contains only the engaged hours of a faculty for a particular day. With the help of this mutation, we are able to fill the values to the 3 dimensional boolean array. This is done based on some processing with another gene. So if we consider the gene for a single day for a particular faculty it could contain the details as shown below (assuming 8 hours in a day including the lunch hour), the non-engaging hours of the faculty is marked as false and the engaged hours of the faculty is marked as true.

True, True, False, False, False, False, True, True

Similarly, we have the timetable of a particular batch of students for whom the review panel is generated. The provided TT is extracted and mapped to a two dimension boolean array. Here the Boolean table is marked with True if that hour is the project hour of the student else, its marked with a false. Now let us assume the class hours of that batch for a day as below.

False, False, False, False, True, True, True, False.

- **Crossover :** The Two Genes (gene 1 from Faculties's TT and gene 2 from Class TT) combine to produce an offspring and is stored to another three dimensional array. The data currently present in the three dimensional boolean array reflects the non-engaging hours of the faculty which are an exact match to the project hours of the batch. So the offspring contains the details as mentioned below

Gene 1- True, True, False, False, False, False, True, True

Gene 2- False, False, False, False, True, True, True, False

Resulting offspring : True, True, True, True, True, False, True, True.

The cells marked with false are the non-engaging slots of the faculty that are an exact match to the project hours of the batch for which the review panel is generated.

- **Solution :** From the generated list it is easy to find the faculties that have common non-engaging hours. Faculties could have single or multiple non-engaging hours together or in a split that align with the project hours of the batch. From this list panels are generated in such a way that each member in a panel has non-engaging hours at the same time. The duration of each review, the number of members, and the number of times a panel can be reused (threshold value) are provided by the project coordinator. A panel could be available at different time slots depending on the members in the panel. While generating the review panel the hard constraints were taken into account (Fig.2).

After the generation of the panel, each panel gives an identification number. A multi-dimensional array is then generated with Panel number's in X-Axis, list of the faculty's in Y-Axis, free slots and initial weight, separated by a comma is stored into the Z-Axis. An internal logic is used to extract the comma separated weight from the Z-Axis. Depending on the weight we can decide how many times a panel can be reused.

Each time a panel needs to be allocated; the panel with the lowest weight is selected and checked with the threshold value. If the weight of the panel is less than the threshold value, the weight of the panel is incremented by one, and that particular panel is used. Else if the weight is greater than the threshold value, the particular panel cannot be used and no further review can be scheduled for the batch. Now a check is conducted to make sure that the number of panels generated is enough to conduct review for the batch if not, then the tool suggests adding

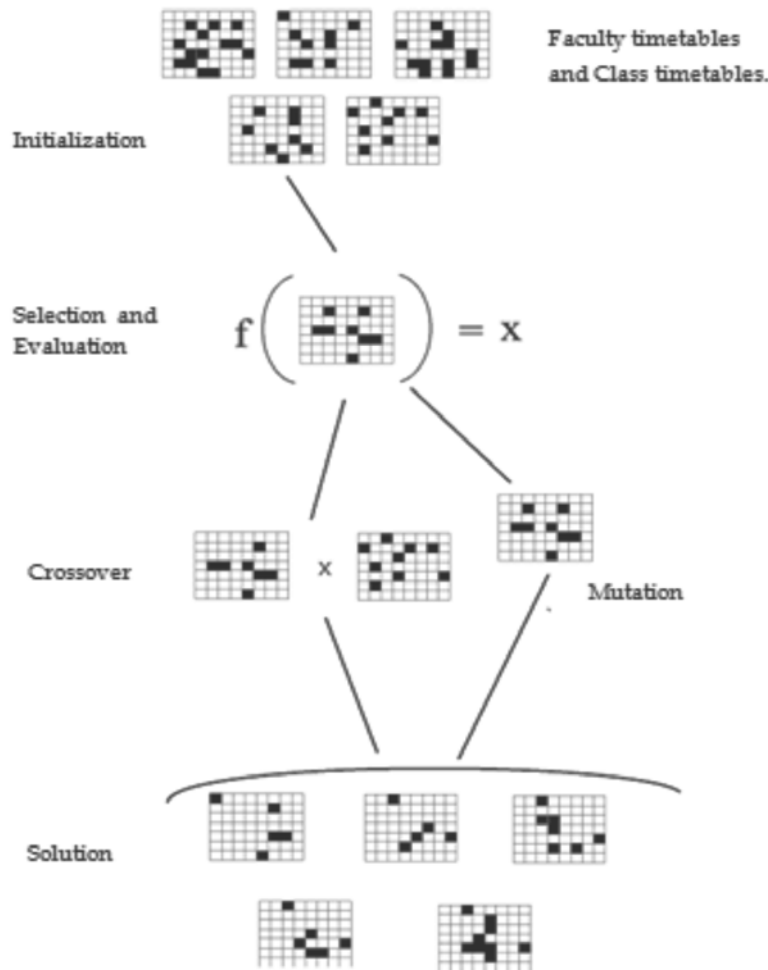


Fig. 2. Review panel logic.

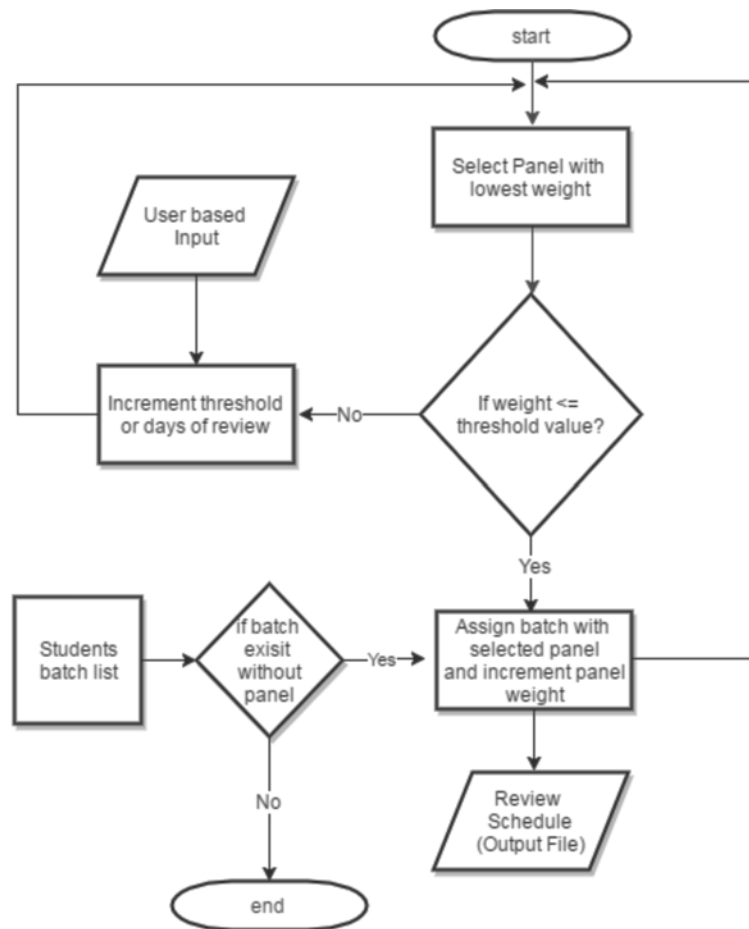


Fig. 3. Flowchart for Panel Generation.

one more day or increasing the threshold value on the panel. If the generated number of panels is able to conduct the review, then the panels are allocated to the project groups.

The tool lets the project coordinator to control the number of concurrent panels and lets the coordinator know if a possible solution can be generated. And the same procedure is again repeated till all the batches are assigned with a review panel(Fig.3).

4. RESULTS AND ANALYSIS

A. Result

With the help of the system, the work of project coordinator becomes easier as the project group and review panel generation can be done in a few seconds. The project coordinator provides the system with the TT of the students, the faculties, the days for review, the number of times a panel can be used, and the members in each panel and group. The tool generates an excel file which contains the details of group members and their initial log-in credentials as shown in Table-4. The file is created with the help of Apache POI package. The generated file contains details like Group number, enrollment number of the students and their names. HSSF Cell Style property of the Apache POI package is used to add styles to the generated excel files like setting the border, font size, type etc. This file containing the group details is published by the Project Coordinator to the students. The initial login password for all the account is the username itself.

During the review panel creation, the tool generates two excel files, one containing the details of the panel as show in Table 5, and the review schedule as shown in Table 6. The project coordinator publishes the file containing the details of the panel to the other facilities in the department. The details of table 6 is published by the coordinator to the students, this table contains the allocation of panels to the project groups.

Table 4. Generated Groups

<i>Group No</i>	<i>Roll No</i>	<i>Name</i>
Group1_mca_s5_2015	Roll_no.1	Student 1
Group1_mca_s5_2016	Roll_no.3	Student 3
Group2_mca_s5_2016	Roll_no.2	Student 2
Group2_mca_s5_2016	Roll_no.5	Student 5
Group3_mca_s5_2016	Roll_no.3	Student 4
Group3_mca_s5_2016	Roll_no.6	Student 6

Table 4 shows the project group generated for a particular batch. It contains the Group name and the members in it.

B. Analysis of the result

- **Automated Group generation :** The tool is provided with an excel file containing the details of the batch for which the review is to be scheduled along with the number of students in a batch and the course and semester of the batch. When conducted an experiment to find the amount of time saved with the help of the system the below results were obtained. The results are rounded to the nearest whole numbers. Table 7 contains the details of the amount of time taken by the system versus the amount of time taken manually in generating a project group for different batches of students.

Table 5. List of Panels

<i>Panel No</i>	<i>Members</i>	<i>Free slots</i>
Panel 001	Faculty 3 Faculty 6	6
Panel 002	Faculty 4 Faculty 5	6
Panel 003	Faculty 5 Faculty 1	5
Panel 004	Faculty 2 Faculty 3	7

Table 5 contains the details of the panels, the faculty's in each panel and the time slots in which each of these panels are available.

Table 6. List of Group and Panels

<i>Group No</i>	<i>Panel No</i>	<i>Slot</i>
Group1_mca_s5_2015	Panel 001	6
Group1_mca_s5_2015	Panel 003	5
Group1_mca_s5_2015	Panel 004	7
Group1_mca_s5_2015	Panel 002	6

Table 6 contains the details of the Project groups and the Panel which is assigned to the group and the time slot the review is scheduled.

Table 7. Analysis of automatic group generation

<i>No. of students in a batch</i>	<i>Manual/Using system</i>	<i>Time taken</i>
60 Students	Manual (With the help of MS Excel)	40 mins
	Using system	2 seconds
100 Students	Manual (With the help of MS Excel)	52 mins
	Using system	2 seconds

Table 7 contains the analysis of group generation based on the comparison of time taken manually (collected as a survey from previous project coordinators) and the time taken by the system.

From the data obtained as in TABLE 7 through an experiment on a large batch of students the amount of time taken by the tool in generating a project group is significantly much less than when done manually.

- **Review panel generation :** For the review panel generation the Project coordinator provides the TTs of both the class and the faculty to the system. The tool provides two outputs excel files. One containing the details of the panel and the other containing the details of the review schedule. Conducting experiments on the TT of different batches the results as shown in table 8 were obtained.

Table 8. Analysis of Review panel generation

<i>Batch ID</i>	<i>Manual/Using system</i>	<i>Time taken</i>	<i>No of corrections required</i>
S5 MCA	Manual	2 hours	8 corrections
	Using system	10 seconds	0 corrections
S7 EC	Manual	1 hour 50 mins	6 corrections
	Using system	8 seconds	0 corrections

From the data obtained above through an experiment on a different batch timetable the amount of time taken by the tool in generating a possible solution is exponentially much better than the one generated manually. We can say that the result is more optimized than the one created manually as there was no corrections required in the review panel generated by the tool.

5. CONCLUSION

In this work, we address the problem of review panel generation. Due to the number of projects, scheduling review is a tedious task that was done on a trial and error basis. The proposed solution takes help of the genetic algorithm for scheduling an optimized review panel for the project groups. The best review panel is generated by this method and it is significantly a better fit than the others generated manually. Moreover, the algorithm also reduces the required time for the panel generation. The manual generation of review panel would take exponential time when compared to the solution by the tool. The manual generated schedule would not be optimal and would have to be rescheduled multiple times for getting a solution. On the other hand, the tool would generate the solution which would take less than couple of minutes.

With the help of the solution, the time and effort required for review panel generation is reduced considerably.

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