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A New Class Scheduling Approach using Genetic Algorithm Methods for Isabela State University

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ABSTRACT

Genetic algorithm methods have been used for solving complex problems in the field of medicines, business, agriculture and academe. In the academe like Isabela State University, one of the challenges every semester is the development of class, faculty, lecture and laboratory schedules. Some of the challenges encountered that greatly affect the start of conducting classes were overlapping of subjects and time conflicts this result shortage in terms of time tor the faculty in delivering the topics as scheduled. In the part of the clienteles-the students there will be shortage in the expected skills and knowledge to be acquired in the subject. The integration of the genetic algorithm methods in the existing scheduling process creates a new scheduling technique named as Isabela State University Class Scheduling Algorithm (ISUCSA), use as basis in forming the program structure and logic flow of class scheduling program. The ISUCSA provides programming concepts for crafting class, faculty, classroom and laboratory schedules in lesser period of time and lessen if not free from overlapping of subjects and time conflicts

Keywords: Class, Scheduling, Genetic Algorithm, Greedy Algorithm, Class Scheduing, New Scheduling Technique.

INTRODUCTION

In the most general terms, scheduling can be described as the constrained allocation, of resources to objects, being placed in space-time in such a way as to minimize the total cost of a set of the resources used. (Wren, 1996). Most of the techniques used in addressing problems of class scheduling are the methods of genetic algorithm. Genetic Algorithm (GA) is population based heuristic method mostly used to solve scheduling problems and also a search method based on principles of natural selection and genetics [3].

In the academic settings, class scheduling is one of the important elements that should be planned and done before the opening of classes every semester. The initial process or steps in assigning and plotting of class schedules depends on the institutions policy, in most of the private and public higher education institutions, the initial steps in creating class schedule is the faculty need analysis. The Registrar's, Dean and Program Chairs are the personnel involve in identifying the number of faculty need to teach the subjects based on the current number of students enrolled and subjects offered in the College. The output of the faculty need analysis would be the basis on the crafting of the faculty, room, laboratory and class schedules for the semester. Furthermore, in this phase usually encounter problems that entails more time in providing solutions to address the overlapping of the scheduled subject; time conflicts on rooms, laboratory and faculty schedules; uneven distribution of faculty workloads and addressing schedule of irregular students. The effects of these problem manifest on the faculty members not meeting their classes as scheduled, deficiency on the topics to be discuss within the semester and tendency of not providing adequate knowledge and skills to the students that greatly affects the quality education that the institutions provide.

The Isabela State University as one of the leading State Universities and Colleges (SUC) in the Philippines follows the mechanisms of plotting and constructing the class schedules as stipulated in the University Manual, University Code and ISO 9001:2015 standards. The crafting of the class schedules is done manually in a week or more with the help of a software (spreadsheet) involving the registrar's and the college secretaries or program chairmen. The abovementioned problems are encountered during the process despite of the thorough planning in crafting the class schedules ahead of time. As the University continuous to uphold the quality of service to its clientele and sought for

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further improvement of these services, considers computerization of these processes and integrating new knowledge of information technology that will help solve if not lessen the existence of the problems.

It is in this light, that the proponents propose the development of the Isabela State University Class Scheduling Algorithm (ISUCSA) it is a new Class Scheduling Approach using Genetic Algorithm Methods for Isabela State University that primarily aims to provides new mechanisms and techniques in designing computer – based class scheduling system. The ISUCSA components uses methods of the genetic algorithm use to construct scheduling templates for class, room, laboratory and faculty schedules in a shorter period of time and lesser or free from time conflicts and overlapping of schedules. The development ISUCSA believe that it would be a big help for the personnel involves in the scheduling specifically to lessen the time spent for constructing class schedules and limit queries and problems arises pertains to time schedules and conflicts.

OBJECTIVES

The main objective of this paper is to develop a clustering approach for efficient creation of class, room, laboratory, student and faculty schedules for Isabela State University through integration of the representation and fitness methods of the genetic algorithm and greedy algorithm. Specifically, it sought for; (1) Identifying the gap of the existing manual-based scheduling of the university, (2) Mapped the manual – based scheduling process, university policies and concepts of the genetic algorithm methods in solving the identified gaps and (3) Creation of the Issabela State University class scheduling algorithm.

METHODS

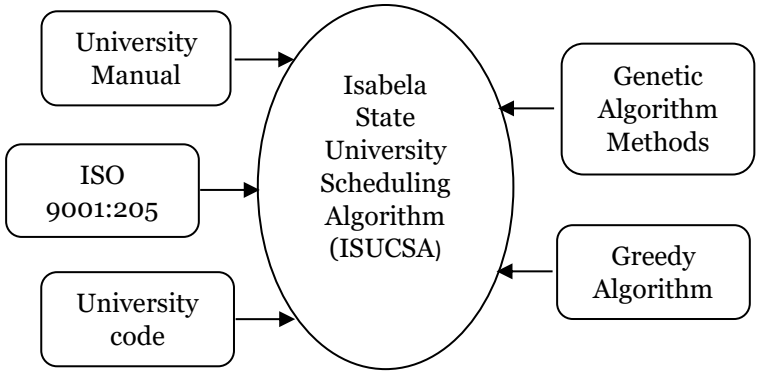

Fig. 1. ISUCSA Conceptual Framework

The development of the Isabela state University Scheduling Algorithm was based on the scheduling procedures stated in the ISO 9001:2015, University Manual and University Code and the integration of the Genetic Algorithm methods and greedy algorithm as presented in figure 1.

University Manual, University Code and ISO 9001:2015

Evenly distribution of teaching assignments is one of the challenges that the University Registrar is facing during the crafting of subject's assignments and development of class schedules for the coming semester. In the standard operational instruction for support services of ISO 9001:2015 where one of its process flowcharts is the Load Analysis or Faculty Loading. The process flowchart of the load analysis or faculty loading aims to provide guidelines for the assignment of workload for fulltime and non – tenured faculty [6].

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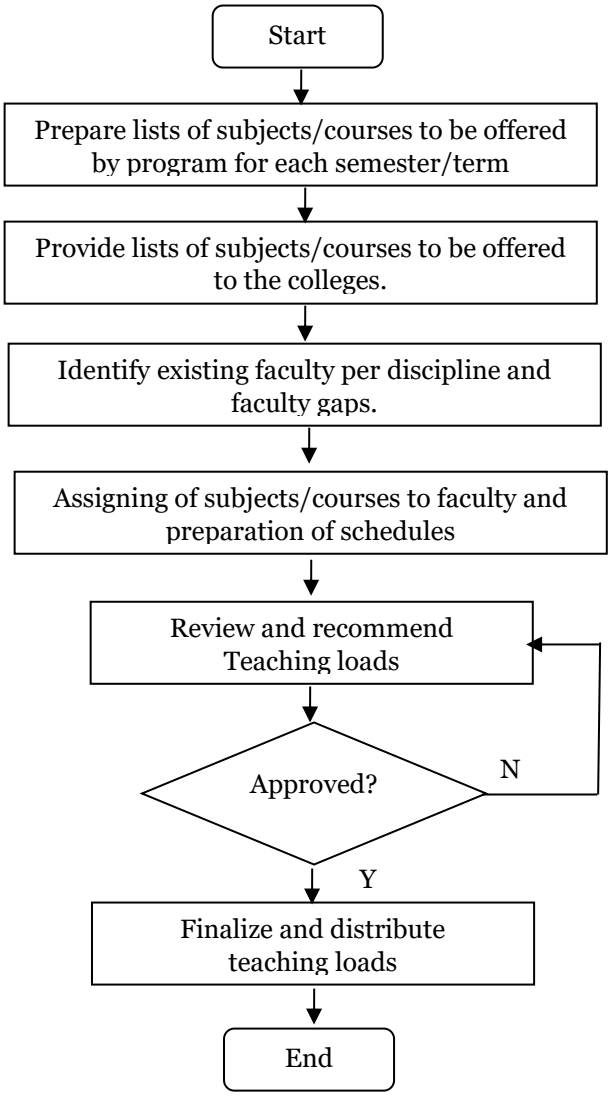

Fig. 2. Existing Class Scheduling Process

Faculty need analysis is the basis for identifying the number of faculty who will be given teaching assignments for the semester/term and absorptive capacity per program offering. The required faculty work load shall be in accordance with the workload policy of the University which is 21 faculty teaching equivalent (FTE) [7].

As presented in figure 2, the process flow of loading analysis/ faculty loading. The first process is the Registrar's Office prepares lists or result of the faculty need analysis and provides the college deans/associate deans and college secretaries two (2) months before enrolment. Second, one week (1) before the preparation of class schedules of faculty the Registrar's distributes list of subjects to different Colleges. Third, the program chairman, dean and registrar representative identify existing faculty per discipline, two (2) weeks after determination of number of faculty needed per discipline; and determine the gaps per discipline two (2) days after the preparation of list of subjects/courses offered. Fourth, scheduling of subjects based on specialization, submits subject's assignments to the registrar and prepares schedule of classes, room assignments and faculty teaching assignments for the semester in one (1) month before the first day of classes. Fifth, the campus workload committee reviews and recommends the faculty workload if it is equitably distributed two (2) weeks before the first day of classes. Lastly, the deans or program chairman or college secretary prepares and issues teaching appointment to concerned faculty and submit to the registrar for any changes in the schedule, one (1) week before the first day of classes [6].

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Genetic Algorithm

Genetic Algorithm is a population based heuristic method for constant optimization problem like class scheduling in the field of academic institution, employees scheduling tasks in business field, predicting health diseases in medicine and the like.

Application of genetic algorithm in solving class scheduling problem has been widely used in most of the academic institutions in the globe. The methods of the genetic algorithm were based on principles and concepts of natural selection and genetics [8].

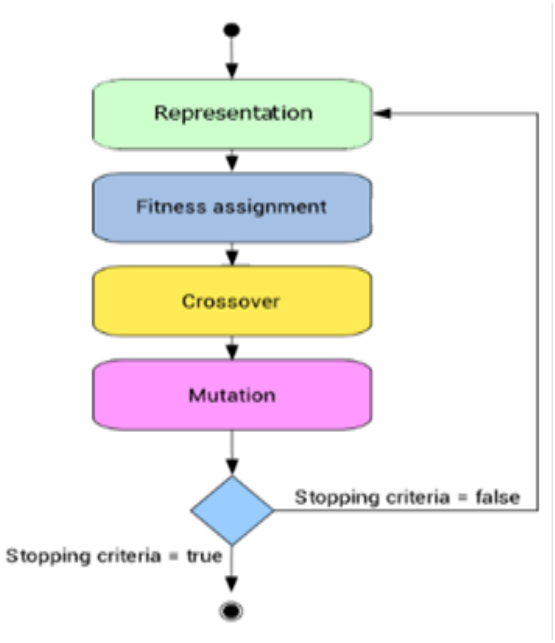

Fig. 3 Genetic Algorithm Process Flowchart

The basic process flowchart of genetic algorithm was presented in figure 3 and based on the human evolution theory of Charles Darwin that compose of four (4) methods namely representation, fitness, crossover and mutation [8]. Among the methods of genetic algorithm, the representation and fitness methods were integrated in the development of the Isabela State University Class Scheduling Algorithm (ISUCSA).

The Representation Method

This method was used to generate the pre – scheduling template of the class, faculty, rooms and laboratory schedules. The initial step of representation method is to initialize the size of time – space - slot (TSS) using equation 1 and computing the time granules use for hashing the time-space-slot. If the assign class will consume 3 hours' duration, then 3 time-space-slot of lecture room or laboratory room will be occupied [2]

$$S = NR * WD * WH \qquad \text{Eq. (1)}$$

Where: S = size of TSS, NR – number of rooms, WD = working days and WH = working hours

The Fitness Method

This method was used to address the overlapping or time conflicts of schedules. The process is that; a class will be scored from zero (0) to five (5) points base from the fitness of a class schedule. In computing the fitness score of each class a rule was applied during the scheduling process. The rule is if the assigned time – space – slot of the class has no conflicts or overlapping the class score is incremented and if the class has conflicts or overlapping of time- space

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– slot then, no increment of class score will happen. The total class score of a class schedule is the sum of points of all classes [9]. The fitness value (FV) and maximum score (MS) of every template are determined using the following formulas;

$$FV = SS / MS \text{ of } n \qquad \text{Eq. (2)}$$

$$MS = NC * 5 \qquad \text{Eq. (3)}$$

Where: FV = fitness value, SS = Schedule Score, MS of n = Maximum Score of every Template and NC – Number of Classes

The fitness value is used for the generation of the pre-scheduling template. The pre-scheduling template is based on the number of time-space-slot of the classroom and the number of templates generated is equal to the number of classrooms. The generation of the pre-scheduling template is one-by-one rules validation every classroom and it is also how the scheduled score is incremented. The fitness value is range 0 to 1 [9]. And if the fitness value is equal to 1 then the template will be generated. Fitness functions are of paramount importance. Chromosomes are an abstract representation of a candidate solution. The fitness function is used in quantifying the desirability of the solution, which is closely correlated with the objective of the Algorithm or optimization process. The fitness level is used in evaluating candidate solution, that is, the values being generated characterize the solutions [10]. The fitness function, on the other hand, is to make a decision as to whether the value is appropriate for the determined solutions [11].

Greedy Algorithm

Greedy Algorithms considers the data of a particular problem, and then set a rule for which elements to add to the solution at each step of the algorithm. The rule was to select the largest number available at each level in the graph and the solution that the algorithm builds is the sum of all of those choice [9]. In a class-scheduling system that will allow collaborative preparation of schedules among several users the greedy algorithm was used for creating and detecting overlapping of time- space – slot and time conflicts. The algorithm mainly executes this sequence of processes; selecting an available time, finding available room, and looking for an appropriate faculty while considering different constraints and preferences set by users [10], [11],[12].

RESULTS AND DISCUSSION

The Isabela State University Class Scheduling Algorithm (ISUCSA)

Through mapping of the genetic algorithm methods in the existing process flow of class scheduling it resulted in the development of the Isabela State University Class Scheduling Algorithm (ISUCSA). The ISUCSA is depicted below.

Initialization Phase

1. Result of the faculty need analysis.
2. Initialize the pre – scheduling template structure: time granules (TG) to 30 minutes per block of time slot, working days (Mondays to Saturdays) and working hours (WH) from 7:00 am to 5:00 pm
3. Initialize fitness value (FV) to zero (0).
4. Initializes the S (Time – space – slot), NR (number of rooms), WD (working days) and WH (working hours) based on the time required by the course, lecture and laboratory rooms per college and University policy on working days and hours.
5. Initialize tables for subjects of each class, class subjects per College/Department, number of lecture and laboratory rooms per College/Department and faculty profiles.

Scheduling Phase (*Genetic Algorithm Methods and Greedy Algorithm*)

6. Foreach (class) {

   Retrieving subjects per class;

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Retrieving class subjects per college/department;

Retrieving lecture and laboratory rooms base from the filtered college/department;

7. Generating the pre-scheduling template;
8. Retrieving plotted schedule in each pre-scheduling template;
9. Apply marking/tagging the block of time – slot per pre – scheduling template;
10. Compiling and sorting blocks of available time – slot of each pre – scheduling template (this serve as schedules);
11. Creating a dynamic dataset (Course Class) compose of the following variables: Class Group, Subject, Faculty, Duration and Class Session Type
12. Passing and processing the **dataset** in the genetic algorithm methods;
13. Foreach (**dataset**) {

    If (rules == 1) ***FV using the formula fitness ()

    {
14. Select the first element of available time – slot in the compiled container of available time – slot;
15. Plot the dataset and selected available time – slot based on the following structure: Class Group, Subject, Faculty, Class Session Type, Room and Schedule (Day, Start, End);

    } ***end of if

    Else {
16. Hold the dataset into an array of dataset for the subject that was not plotted;

    } ***end of else

    } ***end of foreach
17. Validation of output;
18. If (array of dataset of un - plotted subjects find available schedule) {
19. Return the array of dataset of un - plotted subjects as callback output notification to the user;

    } ***end of if

    Else {
20. Return success all dataset is scheduled;

    } ***end of Else

} ***end of foreach (main)

The ISUCSA composes of two (2) phases namely the initialization and scheduling, the processes indicated in each phase were anchored in the existing scheduling process of the University.

The initialization phase initializes the different parameters needed in the scheduling process, these includes tables for subject per class, class subject per college, number of lecture and laboratory rooms per college and profiles of the faculty members as stated in the faculty need analysis conducted by the registrar, deans, program chairs and college secretary. Also, initializes the fitness value that determine the number of overlapping time – slot of schedules this will be the basis in considering the best pre – scheduling template use in plotting the class schedules.

Once the initialization is set the next phase is the scheduling process. Under this phase are the generation of pre –

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scheduling template and plotting of class schedules. For the generation of pre – scheduling template the representation and fitness methods of genetic algorithm comes in and uses the following rules;

1. If a class uses a spare classroom, the schedule score is incremented.
2. If a class requires classroom for both lecture and laboratory, the schedule score is incremented.
3. If a class uses a spare classroom for subject specialization, the schedule score is incremented.
4. If a class uses classroom that accommodate the class size, the schedule score is incremented.
5. If a class uses a classroom with at least one available time – slot from the allotted class duration, the schedule score is incremented.
6. If some student in a class has no overlapping time – slot, the schedule score is incremented.

The pre-scheduling template per class is generated if the computed fitness value using equation 2 is equal to 1. The generated pre-scheduling template will be used for the greedy algorithm for assigning and plotting of class, faculty, lecture and laboratory rooms schedules.

CONCLUSION

This paper presented a new class scheduling algorithm for Isabela State University named as Isabela State University Class Scheduling Algorithm (ISUCSA) using genetic algorithm methods and greedy algorithm. The integration of these algorithms in the existing scheduling processes believed that it addresses the problems on overlapping of subjects, time conflicts of schedule and uneven distribution of workloads. Also, this may result in generating the class, faculty, and lecture and laboratory rooms schedules in a lesser period of time.

Moreover, the proponents strongly recommend the use of the ISUCSA programming techniques in the development of a class scheduling system for the Isabela State Universityfelis bibendum ut tristique et egestas quis.

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