



## AN INTELLIGENT SYSTEM FOR COURSE SCHEDULING IN HIGHER EDUCATIONS

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### ABSTRACT

*In this paper, we focused on the implementation of genetic algorithm for course scheduling. Course scheduling is how to plan the organization of lecture time in accordance with some constraints. Preparation of a planned schedule can help the academic and administration to manage the resources needed for lectures. Course scheduling has several variables, courses, lecturers, students, lecture rooms and time slots. Bogor Agricultural University (IPB) is one of the major state universities in Indonesia. IPB has a Major Minor curriculum. This curriculum allows students to take a course package or several courses across faculties in the form of course packages or multiple courses according to their interest. The possibility of the students in taking courses outside the faculty is high. Therefore, it may lead to the complexity of course scheduling. Genetic algorithm is used to automatically reschedule. The genetic algorithm is used to optimize the preparation of class schedules. The test result obtained 99 conflicting classes from 635 existing classes. The average non-conflict scheduling accuracy of the system is 84.4%.*

**Keywords:** *Course Scheduling, Genetic Algorithm (GA), Major Minor Curriculum, Optimization*

### INTRODUCTION

Course scheduling is still a complex problem. Course scheduling involves several elements. Those elements are lecturers, courses, classrooms, and time slots. Each department has different curriculums. The course scheduling is change every semester. The technique used to make course scheduling in IPB is still conventional. This technique needs more time in finding the solution to make the course scheduling especially in large data. This method has not been able to minimize the clashing schedules problem. This resulted in changing schedule. Two types of scheduling in university are course and exam scheduling. Course scheduling should pay attention to the problem of Hard and Soft Constraint. Hard Constraint is a restriction that can not be violated in scheduling. Soft Constraint is desired range but it is not too essential [1]. In Hard Constraint, there must be no clash between lecturers, students, classrooms, or time slots. Besides, there is no

lecturing on Friday at 11.00-13.00 in IPB. In the same way, there is no lecturing at break time, at 12.00-13.00, in Soft Constraint.

Genetic algorithm is a searching technique and optimization that mimics the process of evolution and the change in the genetic structure of living things [2]. Genetic Algorithm was used to predict scheduling at the Department of Computer Science and Engineering of Guru Nanak Institute of Technology (GNIT). The study focused on scheduling course classes [3]. This genetic algorithm was used to solve lectures scheduling at Technological Institute of Serres, Greece [4]. This algorithm was also used in preparing the schedule of lectures at the Faculty of Administrative Sciences and Informatics [5]. A new approach of scheduling using Genetic Algorithm was performed by physical and binary weighting method [6]. Genetic algorithm was used to create a schedule of lectures at the Faculty of Mathematics and Natural Sciences (MIPA) of Bogor Agricultural University (IPB) [7], although it was only

the schedule for the course degree program [8]. This algorithm was also used for developing the scheduling application at the Faculty of Technical and Vocational Education University of Ganesha [9]. Course Scheduling problem is a constrained, multi-objective optimization problem, and has proven to be a NP complete problem by OuYang and Chen in 2011 [10]. Aisharafat and Aisharafat in 2010 said that the genetic algorithm can be used for scheduling university exams [11]. Genetic Algorithm combined with Heuristic Search for solving timetable problem [12]. Genetic Algorithm is used as a strategy for university course timetabling [13]. Genetic Algorithm is also used to find optimal values of hidden Markov parameters [14]. Abdulbaki in 2014 used Genetic Algorithm for 2D hand gesture image segmentation and detection [15].

**MATERIALS AND METHODS**

The method used in this study was started by analyzing the problems, followed by formulating the problem with genetic algorithm. Diagram of this research can be seen in Figure 1.

**1. Problem Analysis**

IPB is a university in Indonesia that implements the Major-Minor System for undergraduate students. Every student has their own major (the courses at their department). Each student can also choose course package from other department as student’s additional expertise. This is called minor. In addition to major-minor lecturing, IPB students can also take Supporting Course (SC). SC system allows students to take courses from other departments that have been provided [16]. The major system makes scheduling becomes more complex due to the possibility of taking a cross-faculty courses. In 2012, IPB had 40 Departments and 14105 students. It has 299 classrooms.

Problem that often occurred in the scheduling is the clash of courses caused by taking courses across faculties. This clash was discovered by students when the schedule was running. The courses scheduling in IPB has several constraints including hard and soft constraints. The constraints can be seen in Table 1.

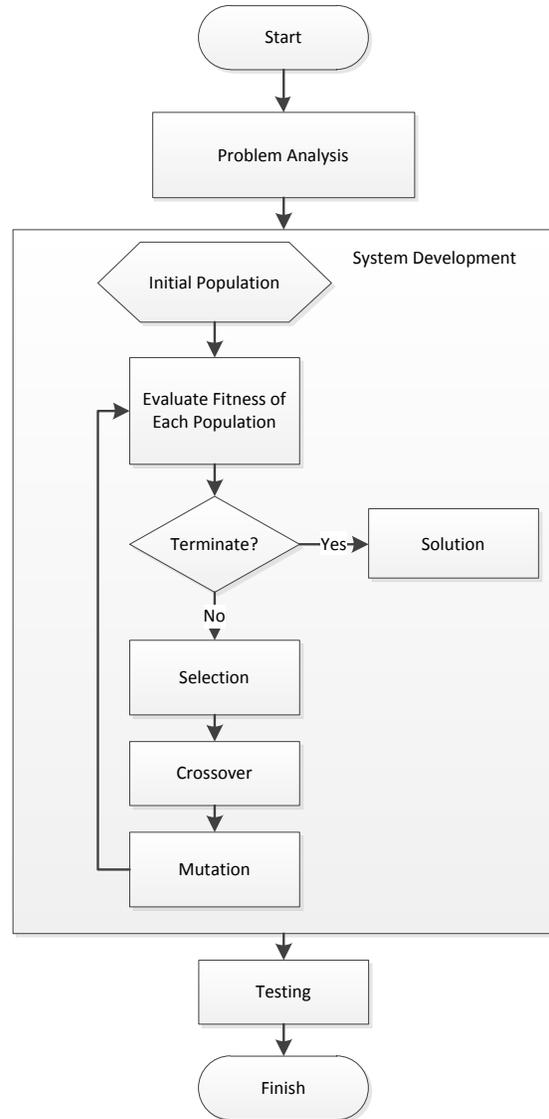


Figure 1: The research methodology

Table 1: Course Scheduling Constraints

Hard Constraint	Soft Constraint
1. Only one lecture in one room,	1. Every student has maximum three lectures in one day,
2. Each room has different capacity, facility and location,	2. The location for the relay schedule is not too far,
3. Every lecturer	3. The distance of time



<p>only teach one lecture at one time,</p> <p>4. Each student only has one lecture at one time,</p> <p>5. No lectures at Friday prayer time at 12.00-13.00</p>	<p>between lectures in a day is not too tight,</p> <p>4. No lectures at break time.</p>
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The components of course scheduling [8] are as follows:

- Groups of students
- Groups of lecturers
- Groups of courses
- Groups of rooms
- Groups of time slots

Lecturing is a combination of lecturers, students and the courses groups. Actual problem encountered in this case was the placement of some activities in the dimensions of classroom and time slot that have been determined in order to obtain the most optimal solution. The most optimal solution can be obtained when a violation of the given requirements is minimum or none at all [8].

## 2. System Development

Genetic algorithm is applied to develop a course scheduling system. C# programming language is used in the making of the program with MySQL as DBMS. Genetic Algorithm is a numerical optimization algorithm which is inspired by natural selection and genetics. This algorithm was developed by John Holland [17]. There are some important definitions of genetic algorithm [18]:

- 1) Genotype (Gen), a value that states the basic unit that makes up a particular meaning in a single gene called chromosome. In the genetic algorithm, this gene could be binary, float, integer, character, or combinatorial.
- 2) Allele, is the value of the gene.
- 3) The individual or chromosome, a combination of genes that make up a particular value and it is one of the possible solutions for the problem.
- 4) Population, is a collection of individuals that will be processed together in the evaluation process cycle.
- 5) Generation, states one cycle of the evolution process or one iteration in the genetic algorithm.

Genetic algorithm has several stages as follows [19]:

- 1) Initialize the population
- 2) Evaluate the population
- 3) Choosing the best member of the population to form a new population. This is called selection process
- 4) Establish a new chromosome by recombination and mutation
- 5) Evaluate the new chromosome and put it into the population
- 6) If the termination criterion is fulfilled, the process stops and returns the best chromosome. Go back to step two if it is not yet fulfilled.

Population initialization is done in the first step of genetic algorithm. The population in course scheduling is number of solutions that randomly searched. Individuals will be randomly generated through this stage in accordance with the prescribed procedure.

The next process is the evaluation and selection of the population formed. The selection process is done by utilizing a predetermined fitness function. Individuals who exceed the specified fitness value will survive and define the next generation. Individuals who have high fitness values will be likely the chosen ones. The selection process can be done in two ways, Roulette Wheel and tournaments. Roulette wheel method is commonly used. This method will select a new population with probability distribution, based on fitness value. Stages of Roulette wheel are as follows [20]:

- 1) Calculate the fitness value of each individual:  $eval(v_i)$ , where  $(i = 1, \dots, population\_size)$ .
- 2) Calculate the fitness total value for population:  $F = \sum_{i=1}^{pop\_size} eval(v_i)$ .
- 3) Calculate the selection probability  $p_i$  of each individual  $v_i$ :  $p_i = \frac{eval(v_i)}{F}$ .
- 4) Calculate the cumulative probability  $q_i$  of each individual:  $q_i = \sum_{j=1}^i p_j$ .
- 5) The selection process begins with a twisted Roulette wheel as much as population size. In every round, an individual is selected to form a new population in the following ways:
  - a. Generate a random value  $r$  in the interval  $[0, 1]$ .
  - b. If  $r < q_1$  then choose the first individual ( $v_1$ ); otherwise select individuals to- $i$  ( $2 \leq i \leq population\_size$ ) so that  $q_{i-1} < r < q_i$ .







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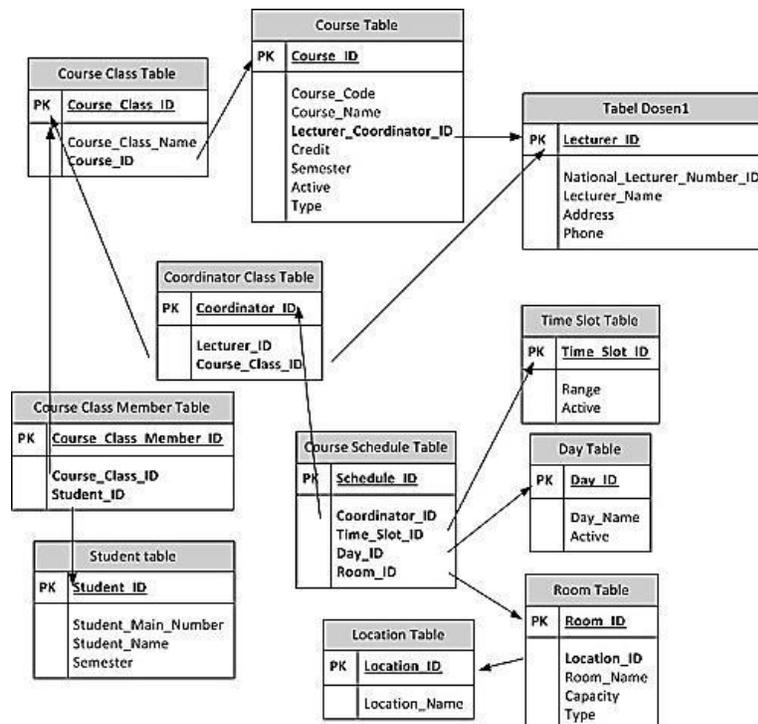


Figure 7: The Database Design