



**CLASSGRID: TIMETABLING SYSTEM USING  
GENETIC ALGORITHM**

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# **CLASSGRID: TIMETABLING SYSTEM USING GENETIC ALGORITHM**

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## ABSTRACT

This project aims to overcome the problem of manual scheduling among the education organization such as school. The project was carried out by developing timetabling system named ClassGrid which has several features that can be used to generate timetable according to users details. ClassGrid is developed using Laravel framework that consist of Hypertext Preprocessor (PHP) programming language, bootstrap for the design and being tested to 10 school teacher using System Usability Scale (SUS) to evaluate to end user. The results of the study found that the developed system is effective in decrease the overlap of the time slot and subject in timetable. The use of this ClassGrid timetabling system also found that it is a good way to standardised scheduling in every school and ensure all school to have fair opportunity in education. But even though it is good in generating timetabling, it also have their limitation.





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## CHAPTER 1

### INTRODUCTION



#### 6.5 Introduction

Timetabling refers to the practise of producing schedules or timetables for a group of activities, events, or tasks within a specific timeframe. It involves deciding on the best use of resources, such as time, space, employees, or equipment, to make sure that all activities are completed successfully and effectively. Finding a scheduling solution that satisfies specific requests while taking multiple constraints and objectives with it is the main goal of timetabling. These limits may include resource availability, activity dependencies, time frames, capacity limits, and preferences or priorities of persons or groups involved.

Moreover, when it comes to transportation, timetabling is crucial for public transit systems like buses, trains, and aeroplanes. It includes developing timetables that improve vehicle usage, reduce passenger wait times, and coordinate arrivals and departures. In healthcare, timetabling is essential in healthcare facilities for managing appointments,





operations, and other medical procedures. Scheduling patient consultations, arranging operating rooms, organising medical staff, and optimising resource utilisation are all part of the job. Education is also one of the most common application for timetabling. It frequently used in educational institutions to construct timetables for courses, lessons, examinations, and other academic events. While taking into factors such as availability, the subject needs, and avoiding conflicts, the university course timetabling problem (UCTP) involves assigning courses taken by a group of students, taught by a specified lecturer, to a limited number of timeslots into appropriate classroom (Mohd Zaulir et al., 2022).

Timetabling problems are known to be (Nondeterministic Polynomial) NP-complete since the search space for possible solutions grows exponentially with the number of events (Lemos et al., 2019). Timetabling may be a complex and difficult procedure, especially when working with big systems and many constraints. As a result, there are several methods, optimisation approaches, and software tools available to aid in the efficient generation of high quality schedules. Overall, timetabling is a critical procedure for efficiently managing and organising operations within a specified period, and it plays an important role in increasing productivity, the allocation of resources, and user satisfaction across a wide range of sectors.

## 1.2 Background Study

Timetabling is the process of producing schedules or timetables, to effectively control and manage multiple tasks inside a system or organisation. It involves allocating certain time slots or periods to various tasks, events, or resources in order to ensure effective utilisation and coordination. Timetabling is a difficult process that entails arranging and organising activities or occasions within a specific schedule. It is essential in many areas, including education, transportation, healthcare, and event planning. Currently timetable scheduling system in School of Computing (SC), Universiti Teknologi Malaysia (UTM) is done manually which





consumes time and human effort (Kutty Mammi & Ying Ying, 2021). It shows that there are still several educational institutions that struggle to organise their timetables by manually.

Manual timetable preparation may be time-consuming, prone to mistakes, and difficult, especially when dealing with lots of constraints and objectives. Next, difficulty managing the constraints. There are several constraints and needs in educational timetabling, such as teacher availability, course demands, student needs, and classroom capabilities. Managing all of these limitations manually can be difficult, leading to inefficient strategies, scheduling conflicts, or unfulfilling timetables for students as well as teachers. Then, there is the lack of flexibility and adjustment. Manual timetabling frequently is not flexible enough to allow for alterations or unexpected situation. When changes or adjustments are needed, such as adding or eliminating courses, accommodating special events, or coping with unplanned faculty or student availability changes, the manual method becomes hard and time-consuming. As a result, the development of automatic timetabling systems has received a lot of attention in the last few years. These systems use computational methods and optimisation approaches to build efficient schedules while taking consideration of a variety of limitations and goals.

The purpose of this research is to create an automated scheduling system able to producing the ideal timetables for a certain category, such as schools, transportation systems, or healthcare facilities. The system's goal is to improve resource utilisation, reduce conflicts, and achieve stated goals while adapting to restrictions such as availability, capacity limitations, and preferences. Many studies on timetabling systems have been performed, focusing on various areas and optimisation methodologies. In order to handle the difficulty of the issue and produce high-quality solutions, many optimisation strategies such as genetic algorithms, simulated annealing, and constraint programming have been used. The strategies are then categorised into OR based techniques, meta-heuristics (single-solution and population-based





approaches), hyper-heuristic approaches, multi criteria and hybrid approaches (Chen et al., 2021).

The first category is operational research (OR) based techniques (graph colouring heuristics, integer programming, mixed integer linear programming and constraint logic programming). The second category is single solution-based meta-heuristics (tabu search, variable neighbourhood search and simulated annealing). The third category is population-based meta-heuristics (genetic algorithms, ant colony optimisation and particle swarm optimisation). The fourth, fifth and sixth categories are hyper-heuristic, multi criteria and hybrid approaches (Chen et al., 2021).

In this paper, we only focus on genetic algorithm approach. A genetic algorithm (GA) is a type of computing technology inspired by natural selection and evolution. It is often used to find solutions to optimisation and search issues. The algorithm mimics the mechanics of natural selection, in which the fittest individuals have a better probability of survival and reproduction, passing on their beneficial traits to the next generation. In order to implement a genetic algorithm in a timetable system, the problem must be defined in terms of individuals, genes, fitness evaluation, crossover, mutation, and the overall algorithm flow.

The study suggested will make an enhancement to the field of timetabling systems by creating an automated solution focused on to one particular field. To develop effective schedules, manage resource allocation, and minimise conflicts, the system will use optimisation techniques. The solution will increase productivity, operational efficiency, resource management, and user satisfaction within the objective domain by automating the timetabling process.





### 1.3 Problem Statement

A timetable is important in schools because it allows the organization for allocating resources, scheduling activities, and lessons, all within specific time frames. School management will face the problem in assign teacher to respective classroom according to time slot, subject and student group without having clash in timetable. Doing this manually will cost a lot of time and effort to make a perfect timetable to school, especially in big institutions with many classes, subjects, and teachers. Manually coordinating and scheduling each class and teacher takes quite a bit of time. Mistakes in allocating classes, subjects, or teachers might result in conflicts, overlaps, or incomplete schedules.

Furthermore, manual scheduling may be too rigid to accommodate modifications or unexpected situations. Making changes or adjusting the timeline becomes a complicated and time-consuming task. Manually updating the plan when unexpected changes occur, such as teacher absences or timetable changes, can be tedious and error-prone. Coordination of the adjustments and consistency across the timeline becomes difficult.

Even though there already have the existing system, it is not free and expensive to subscribe. User may have bad experience while using the existing system because it hard to understand based on their interface. The purpose of any product development is to create tools that enable users to carry out their jobs accurately and easily, and should be fun to interact with (Jitnupong & Jirachiefpattana, 2018). So, the user-friendly interface needs to be developed for user to have better experience.

In order to create an efficient timetabling system, it must be able to overcome the constrains that have been defined. This is particularly crucial for hard constraints, because all hard requirements must be adhered correctly. If the system fails to fulfil all of the strict criteria, the resulting timetable will never be suited to that school. Soft constraints are not as rigid as





hard limits that must be followed by the system. However, by satisfying the needs of soft constraints, it may provide a solid timetable to assist school management.

The following are hard constraints and soft constraints that needs to overcome. For hard constrain are, the availability of time slot in timetable, availability of teacher during time slot and no double subject or teacher in one time slot. For soft constrain is the continuous teaching hour for teachers.

#### 1.4 Objectives

The main objective of this project is to develop a simple and efficient timetable system to ease the process of generation and distribution of timetable according to terms and condition. In order to achieve the above mentioned aim, below is the objectives of this project:

1. To identify requirements to develop timetabling system for primary school.
2. To design and develop prototype of timetable system using genetic algorithm based on problem discover in Objective 1.
3. To test the usability of timetabling system prototype developed in Objective 2.

#### 1.5 Research Questions

In this research study, there are several research questions that have been formulated to answer the research objective that has been set.

1. What are the requirements to develop the timetabling system?
2. What is the technique used to develop the timetabling system?
3. What is the effectiveness of the developed prototype?





## 1.6 Significant of Study

One of the most popular programmes used by school and university management is timetable scheduling software. It has a significant global effect. The majority of schools and universities use scheduling software to create their timetables. Discussion of the implications for the target user is one technique to highlight the importance of the study.

The first reason for the need of a timetabling system in school management is for curriculum management. Effective curriculum management is established with a well-designed timetable system. It enables schools to allocate proper time slots for different subject areas, ensuring that all relevant subjects and topics are effectively addressed. It also allows schools to arrange for special programmes, extracurricular activities, and events without interfering with the regular academic calendar. A timetabling system is essential in school administration because it smoothly organises and optimises the use of both resources and time.



The second benefits are for the teacher to organize resource and material preparation. Teachers might use a timetabling system to prepare ahead and designate time for gathering items to use for their classes. They can guarantee that they have access to textbooks, extra materials, multimedia resources, and any other instructional tools that are necessary to improve the learning experience. This minimises last minute rushing and enables for greater use of instructional resources. This system may support the in scheduling proper time for various activities and ensuring a smooth flow of education throughout the day.

Lastly, the benefits to Kementerian Pendidikan Malaysia (KPM) to standardised scheduling. A timetabling system provides for standard scheduling all over schools. This makes sure that kids from various schools have an equal learning experience and are given equal opportunity. It supports fairness and equality in the educational system by preventing inconsistencies in scheduling practises.





In essence, a timetabling system is important for enabling organisational efficiency, academic achievement, and an enjoyable learning environment for students as well as teachers. It helps to a productive and peaceful learning environment in schools by managing resources, preventing conflicts, and improving communication.

### 1.7 Scopes

The software will be in web-based software and may be used on any desktop you like. Basically, to use the software you just simply open it on any browser that available in your desktop. The main function on this system is to generate timetable according to constrains that user insert. The software will analyse the constrains to generate timetable and notify user to change the constrain if necessary.

User need to insert hard and soft constrains before generate the timetable. They also can delete and update the constrain if there are any changers. The target users for this system is school management. For the geographical area for this study, it is a primary school that located in Pekan Air Panas, Johor.





## 1.8 Summary

The uses and meaning of a timetable and a schedule differ from one another. A timetable often refers to a planned time frame of dates and times for events, activities, or travel, frequently displayed in the correct sequence. It suggests an outline of events that are expected to take place at particular times. The term “schedule,” on the other hand, typically refers to a more detailed strategy that includes not only precise timings but also the allocation of resources, tasks, and durations for different activities. It often requires deeper planning and may contain more details like locations, responsible those involved, and dependencies. When referring to a system that manages or creates timetables, the terms “timetable system” or “timetabling system” can be used similarly. However, the phrase “timetable scheduling system” combines both ideas to underline the integration of scheduling elements inside the system.

