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Digital Scheduling and Management System of Lectures in Educational Institutions

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Abstract

The old traditional way of keeping records needs heavy paperwork and maintaining the same. Creating a timetable on paper and managing it according to the availability of the mentors is difficult. The use of an algorithm for generating the schedule automatically can be beneficial. This paper proposes a general solution to the timetabling problem. This solution, however, works in a way where mentor availability for a given time slot is prioritized first. A timetable has defined period lengths. It additionally has specific subjects for each period. Hence, it allows admins to distribute sufficient resources to most curriculum parts. Organizing a good timetable is such that important subjects must be at the best times. While all the hard limitations (e.g., availability of mentors) are solved thoroughly, the primary aim of the solution presented in this paper is to solve the issue of clashes of periods and subjects, applicable to mentors.

Keywords: *Lecture Timetable, Schedule Management, Hand operated Timetable Generation, Digital Timetable Generation, Genetic Algorithm.*

1. Introduction

The lecture scheduling system is a system of scheduling and also managing lecture time and available resources to maximize the effective utilization of such resources [1],[2]. It is one of the most important, yet time-consuming, energy-sapping tasks done periodically in every academic institution of learning, which often leads to general apathy and waste of resources [3]. Therefore, the schedule must be carefully assigned into appropriate timeslot considering the important subjects for students, availability of lecturers, lecture halls along with other constraints. The planning schedule for every session or term examination is among the most complex and error-prone tasks carried out in every educational institution. Thus, the need to adopt a digital means over the traditional hand-operated one cannot be over-emphasized.

Schedule management involves the development, maintenance, and communication of schedules for time and resources. The three schedule types are - the Capacity schedule, the Resource schedules, and the Service schedule. The Capacity schedule is used when students and mentors sign up for classes. The Resource schedule is used when a teacher books a room or is allotted a room to conduct a lecture. The Service schedule is used for combining and linking several schedules and preparing a good timetable (schedule) for teachers and students [4].

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While setting a timetable, it is made sure that the resources such as the hall, the lecturer, etc. are utilized effectively. This task becomes very tedious and every academic institution needs to go through it at least once a year. Most of the institutes deal with the problem manually, i.e., they use a trial & error methodology for setting a timetable [5].

A. Problem statement

The timetabling problem is a scheduling algorithm. It has great implications in the fields of artificial intelligence and operational research. Almost all the solutions for the problem are heuristic in nature, because of the size of the real problem, and they do not guarantee optimality. Scheduling (timetabling) can be represented as a constraint satisfaction problem. The difficulty faced here is loose parameters with many constraints. These constraints can be replicated (reproduced) in a format that can be managed in a structured manner by the scheduling algorithm.

The three main phases involved in timetable creation are: 1) Data Collection from departments, where each department will supply the various courses which will include the course title, course code, contact hour (lectures & practical), course unit, and the mentor to take them. 2) Data Analysis; the data supplied by the departments with the available space (hall sizes) is analyzed. 3) Lecture Scheduling is based on time constraints. Based on the analysis, the lecture timetable is produced with three outputs: Hall timetable, Departmental Input, and Lecturers timetable [6].

2. Literature review

A. Hand-operated time-tabling generation

Timetable scheduling is an NP-hard problem, i.e., there is no known systematic way to come up with a flawless solution. NP-hard is the abbreviation for Non-Polynomial Hard and here it means that as the constraints for setting a timetable vary from institute to institute, there is no dedicated algorithm that can be used for creating timetables and can be used by all the institutions. The hand-operated (manual) lecture timetabling requires an ample amount of time and effort along with a lot of paperwork for keeping records of all the resources with concern to the constraints [7].

In a general academic timetabling problem, a set of events (e.g., course sessions and examinations, etc.) are assigned into a definite number of timeslots (periods) taking into consideration a set of constraints. This often makes the problem exceedingly difficult to solve in real-world circumstances [10]. Large-scale timetables (e.g., university courses and examination timetables) may require a lot of effort and many hours of work spent by a qualified team to produce high-quality timetables that satisfy constraints and at the same time optimizes the objectives of a timetable [11].

The constraints in the lecture schedule are of two types – 1) Hard constraints and 2) Soft constraints. While setting a timetable, it made sure that no hard constraint is violated. For example, a lecturer must be available to be scheduled for any timeslot. A solution for timetabling can be considered ideal only when not a single hard constraint is violated. The soft constraints on the other side are confronted with the solution as much as possible. For example, though importance is given to a mentor's scheduling i.e., availability of mentor for a particular timeslot, the focus is on setting a valid and good timetable. This approach can sometimes lead to a mentor going free for a time slot. Thus, while addressing the timetabling problem, attention must be given to hard constraints; at the same time effort must be made to satisfy as many soft constraints as possible [5].

In lecture timetable scheduling, the hard constraints that must be taken into consideration are 1) No student can attend more than one session (lecture) at a time, 2) No

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mentor can take more than one course (subject) at a time, and 3) A hall cannot be assigned to more than one particular course at a time.

Soft constraints to be considered are: 1) The lectures should not be allotted to time slots which come under the lecturer's forbidden time zones, 2) The hours of taking lectures for a mentor should be limited within the maximum allowed hours, 3) A break between or after the lectures for snacks/lunch must be allotted to the mentors.

B. Digital time-tabling generation

With the increase of student population, new programs being launched, an automated timetabling system is required to cater to this increase. As no systematized or resolved algorithm exists, most of the lecture time-tabling problems fall under the category of NP- hard problems. A timetable is the detailed schedule of specific lectures attended by a group of students in an institution and the mentor at a specific time, which also requires specific resources such as lecture halls and so on [12].

Digital (automated) methods used to solve timetabling are Tabu Search, Simulated Annealing, Evolutionary Algorithms, and Artificial Intelligence. Several papers deal specifically with Genetic Algorithm (Evolutionary) methods of automated timetabling. Studies say that only on particularly complex or resource-starved; timetabling problems do Evolutionary Algorithms including GAs-Genetic Algorithms begin to outperform methods like hill-climbing [12].

Previous professional software systems available for Automated Scheduling (Timetable Generation) lack the generality required by different institutions [12]. This means that system used needs adjustment or lengthy and advanced training along with installation programs before it can be implemented at an institution for which it was not intentionally created.

3. Proposed system

The methods of Timetable generation followed by previous systems included a tedious, time-consuming process of assigning each subject to the faculty manually and scheduling the timetable in such a way that no clashes of courses or halls occur, and also involved a lot of paperwork which is cost-ineffective. Thus, for this approach, we need to use technology and computing skills to generate Timetable. It is done using the Digital Automated Timetable generator. It involves Evolutionary Algorithms (EAs) of which the one used is the Genetic Algorithm [9].

The Genetic Algorithm involves the procedure of Chromosome Representation (biological method) and genetic programming to solve the problem and to generate a good timetable. This technique can get an appropriate solution to search problems when the search space is large and at the same time overly complex [6]. Genetic Algorithm, as it often succeeds in getting the best optimal solution as opposed to other common optimization techniques, has become the most preferred optimization technique. The advantage is that it can explore solution space, multiple directions at once.

The solution gives a block model (refer to Figure 1.) of the following processes: The administrator will enter the data like the number of subjects, classrooms, students. The admin will assign each subject to their respective mentors and assign them corresponding classrooms and the batch of students whom they will teach. He/she will do a verification check so that all the constraints are satisfied, and no anomalies are missed out. The Admin has the option to edit and then regenerate the timetable if any misconception, omission, or clash that had been gone unnoticed earlier, is encountered [9].

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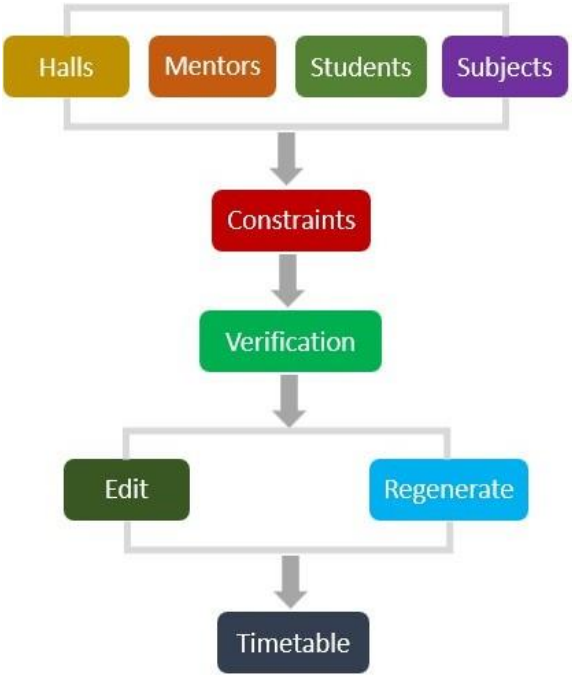

Figure 1. Proposed Approach

The Scheduler app is a user-friendly android app. The objective of the Schedule Management Application is that the application gives a schedule for both students and teachers. This Application is easy to handle and use. It saves the user's time.

The student's and teacher's details will be stored in the Firebase Cloud Firestore. The schedule for both students and teachers will be saved in Firebase Cloud Firestore. The notes of the notepad will be stored in the SQLite database. The data can be accessed easily. This application is made for educational purposes and it makes work easy.

The initial step in the development process was to gather the required information from the committee (team) involved in hand-operated (manual) timetable preparation. Data obtained include the count of lectures halls, number of lecturers, subjects (courses) along with the hours of lectures involved. The Algorithm-Flowchart was created to analyze and represent the manual process, which helped in understanding the flow of operation during the development phase of the project. The next step in the process was system analysis. The user interface was developed to be very friendly. Different interactive elements and pages required for user interaction were developed and designed. The system is the minimum operating system required. A model was created that represents the structure of the database, as well as the interaction of the application with the database, was implemented. After the design and implementation phase, proper documentation of the application was carried out.

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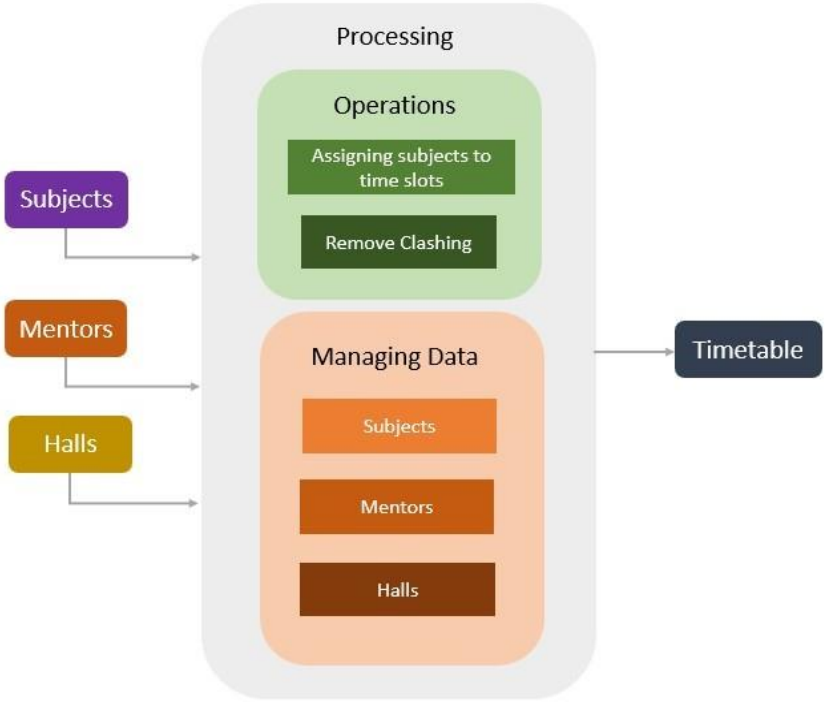

Figure 2. System Model

According to the above system model (refer Figure 2.) process of Timetable Generation involves two main phases. One is Processing Data, and the other is Managing Data, and together they form a block (refer Fig.2) where input will be given by the admin and optimal output (a valid Timetable) will be generated, which then will be shared to mentors and students accordingly [9].

The inputs entered by the admin to the blocks go through the processing phase first. The operations in the processing phase include assigning subjects to time slots and their respective mentors and removing any clashes of time or halls. The calculations of fitting each data in the system will be done with the help of the scheduling algorithm in the Automated Timetable generator. Then follows the Managing Data phase, in which the data of each subject, class, and staff is stored, managed, and then taken to generate the Timetable, without any redundancies. The Admin will take care of entering the inputs and only he/she can control the application and make changes to the timetable.

The system can be used to show both student and teacher's timetable. The application is easy to use and has a user-friendly interface. A special feature of the notepad is available. The application can prove greatly beneficial to the classes. It can be implemented in schools and colleges. It reduces the paperwork for maintaining the notes and schedules, improves time management, and enhances efficiency. The application allows the privatization of tasks.

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4. Implementation

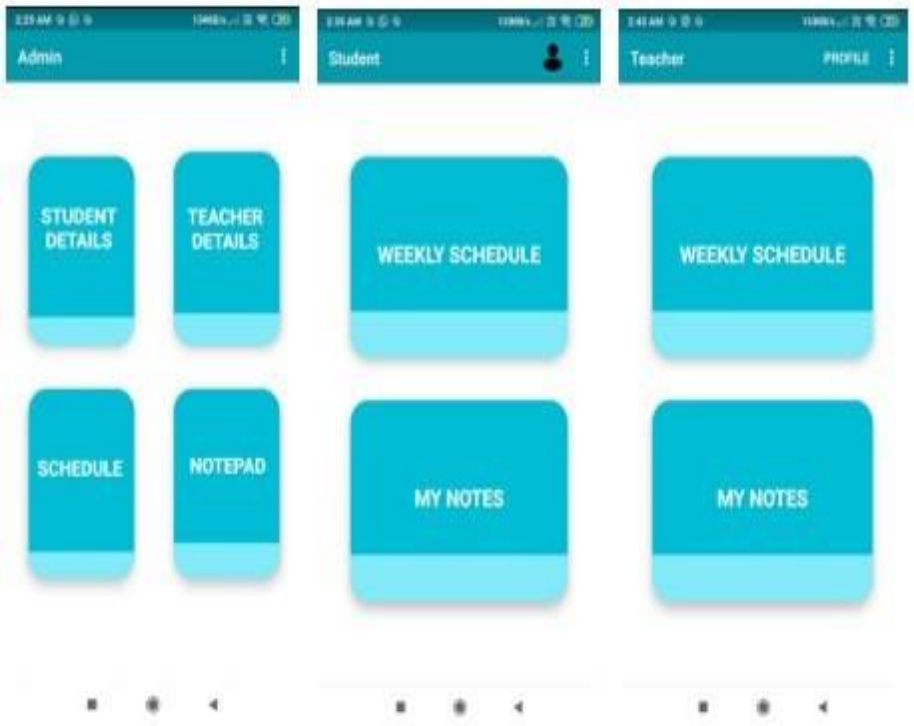

Figure 3. System Output

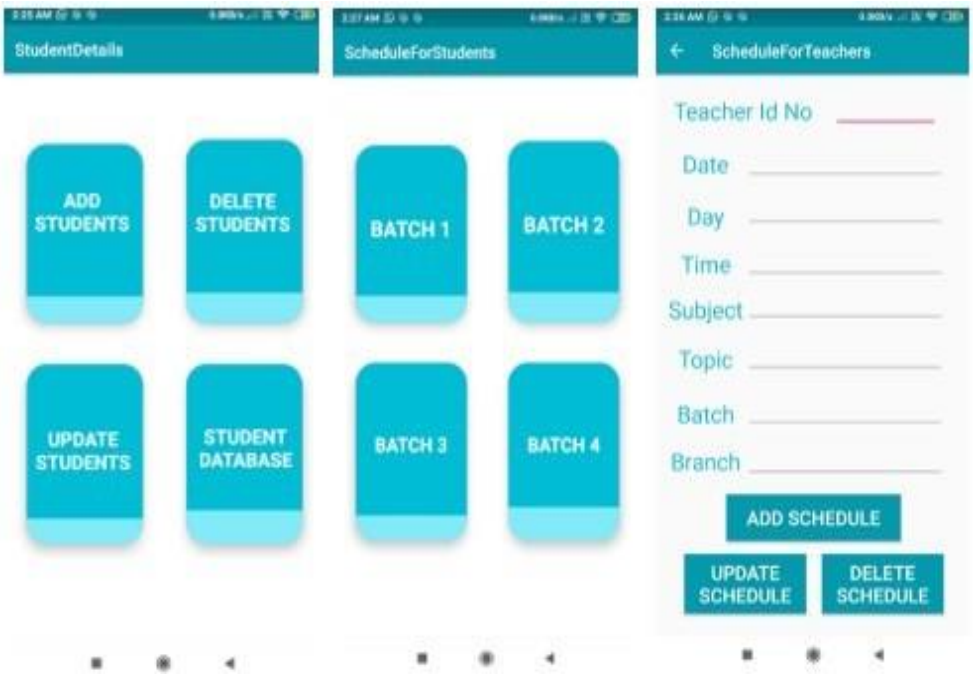

Figure 4. System Output

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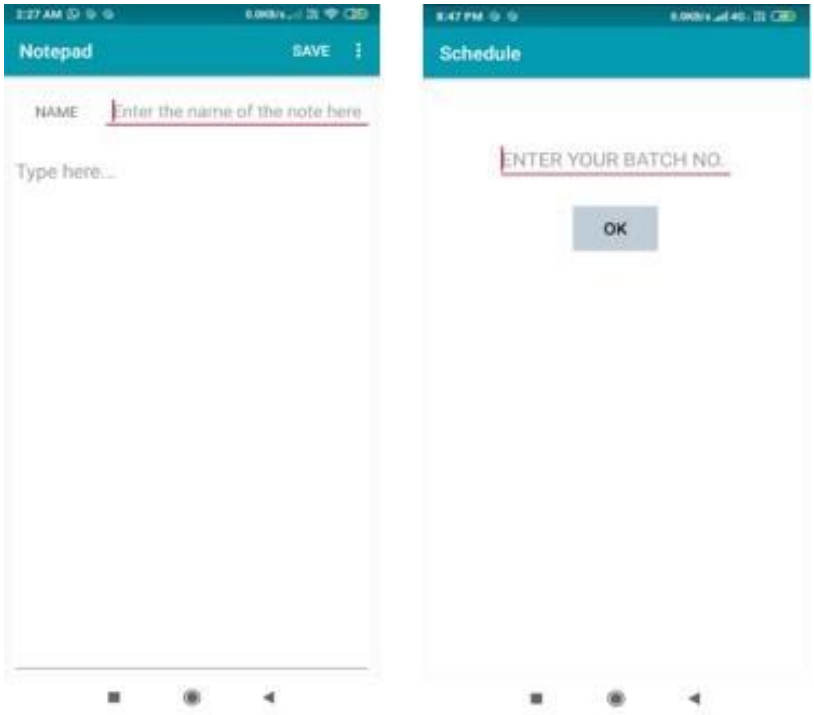

Figure 5. System Output

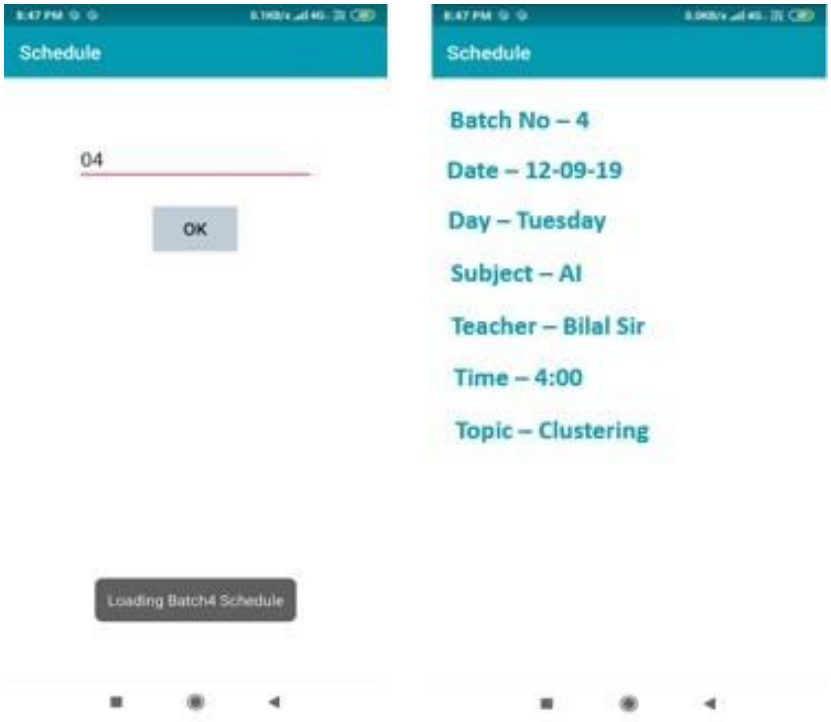

Figure 6. System Output

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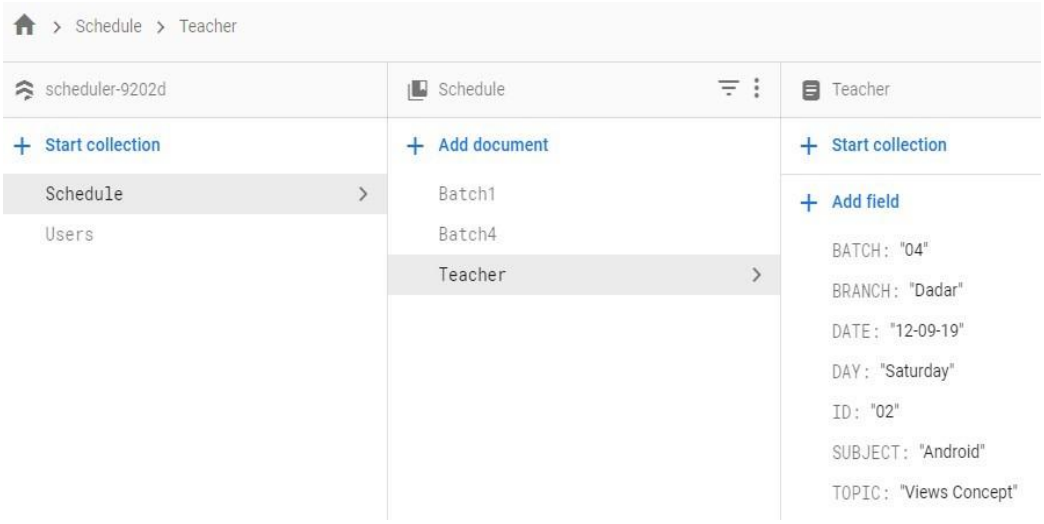

Figure 7. Database

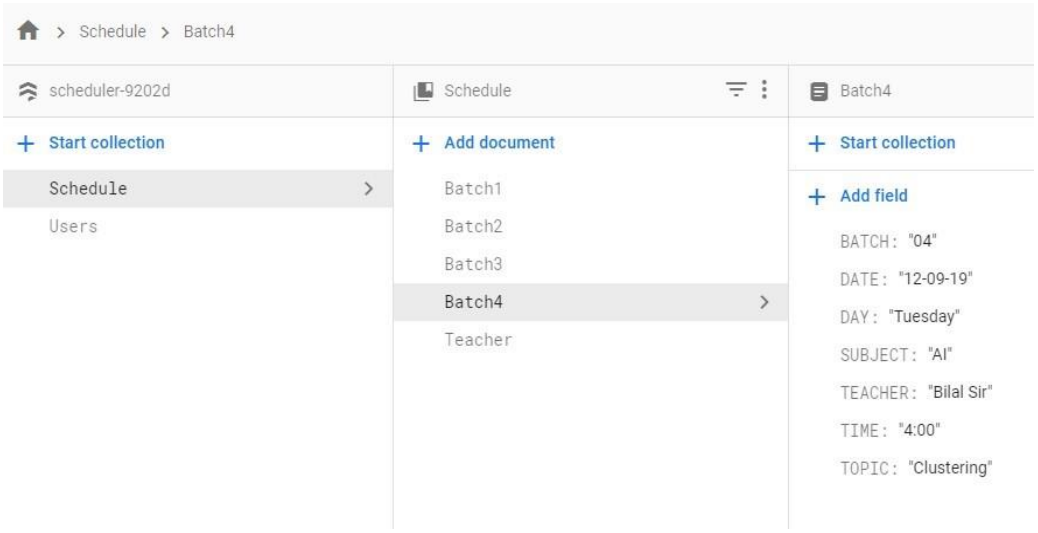

Figure 8. Database

5. Conclusion

This paper addresses the Lecture Scheduling (Timetabling) and its Management Problem, and also covers a broad range of real problems faced continually in almost all the educational institutions. The Scheduler application will simplify the generation of timetable smoothly which can otherwise get to be done using spreadsheets manually possibly resulting in constraints problems that are difficult to determine when the timetable is generated manually [9].

The algorithm used helps to provide an optimal solution. At the end of the software development, a digital lecture scheduling (timetabling) android application was generated to overcome the shortcoming of the hand-operated (manual) timetabling system [6]. The application will simplify the process of scheduling lectures. It will ensure that resources are allocated ideally and will also diminish misconceptions and the probability of omission of courses as well as clashes of halls and lecturers.

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Some of the long-term enhancements which can be done to the present system are:

- Reminder set for an event.
- The very friendly design will lead the user to every module very smoothly with no difficulty.
- The application will show the results.
- The attendance system will be there.
- The application will include the admission procedure for next year.

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