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Line-up Sensei: The Smart Timetable Management System

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ABSTRACT: This project introduces "Line-up Sensei," an AI-driven system designed to revolutionize timetable management for educational institutions. It utilizes CSP for the automatic generation of schedules free from conflicts with all the constraints: faculty availability, room capacity, and student enrollments [1]. It boasts a robust backend powered by the Ktor framework and MySQL database for real-time updates as well as cross-platform accessibility via Android and web applications [5][6]. By addressing the inefficiencies of traditional approaches, "Line-up Sensei" improves operational efficiency, reduces errors, and significantly minimizes scheduling time [4]. This system shows that AI can transform academic operations [3].

KEYWORDS: AI, Timetable Management, Constraint Satisfaction Problems, Automation, Real-Time Scheduling, Ktor Framework.

I. INTRODUCTION

Timetable management is one of the fundamental but difficult operations in academic institutions, as it involves allocation of classrooms, faculty, and students into time slots without any conflicts [4]. While traditional manual methods are in wide use, they are cumbersome, error-prone, and not scalable [3][4]. With the increasing demands from the institutions, these approaches fail to meet the requirements for flexibility, efficiency, and real-time adaptability [9]. "Line-up Sensei: The Intelligent Timetable Management System" solves this problem by using AI in the generation of timetables [8]. The system is based on CSPs and dynamically handles scheduling constraints in order to produce an optimized and conflict-free timetable [1][3]. It is designed with the latest technologies, having a Ktor-based backend and a MySQL database for the efficient management of data and cross-platform accessibility through intuitive Android and web applications [5][6]. The project aims to reduce the number of administrative workloads related to academic scheduling and enhance user satisfaction [9][10].

LITERATURE SURVEY:

The literature shows the growing need for AI-driven solutions in complex scheduling systems [1]. Reference [1] has shown the effectiveness of Constraint Satisfaction Problems (CSP) to resolve conflicts, while Reference [3] validated its efficiency in dynamic environments [3]. Reference [4] underlined the limitation of manual scheduling and argued for automation [4]. Reference [9] further elaborates the need for real-time adaptability for improved user satisfaction [9]. Tools such as Ktor and MySQL form the technical underpinning to ensure strong backend development and database management for scalable implementations [5][6].

II. RELATED WORK

The literature highlights several types of systems developed to handle scheduling:

Manual and Rule-Based Scheduling Systems:

Manual scheduling often relies on human expertise but is extremely labour-intensive and error-prone. The task of balancing different constraints, like room allocation and faculty availability, becomes exponentially difficult as the number of students and courses grows [4].

Rule-based systems can automate most basic tasks, such as the elimination of overlapping classes, but their inflexible rule sets make them poor at adapting to changing and dynamic environments. These systems lack flexibility in dealing with unexpected changes such as last-minute cancellations or faculty absence [9].

Illustrative Study:

Sharma and Gupta (2017) described the inefficiencies of manual scheduling and the failure of rule-based systems in effectively addressing complex scheduling constraints [4].

AI-Based Scheduling:

AI methods, such as CSP and GA, are applied to scheduling to handle multiple constraints. CSP is especially effective when the objective is to assign values to variables (for example, timeslots, rooms) so that no constraints are violated [1][3]. Example Research: Lopez and Garcia, 2019, show how CSP algorithms were used in academic scheduling to optimize resource allocation on rooms, times, faculties, and reduce scheduling conflicts [3].

Real-Time Adaptability:

Real-time adaptability in the scheduling system enables the timetable to adjust immediately in case of changes, which could be due to, for example, a staff member being unavailable or a specific room being double-booked [9].

Example Research: Kumar and Desai (2020) found that real-time scheduling systems, which can dynamically account for unexpected changes, optimize efficiency and user satisfaction [9].

While existing systems had advanced in the use of AI for scheduling, there are still gaps as regards scalability, user interface design, and real-time adaptability [3][9]. Line-up Sensei addresses all these issues by offering dynamic CSP approach, real-time adaptability, and a cross-platform interface. Performed to label each object separately [8].

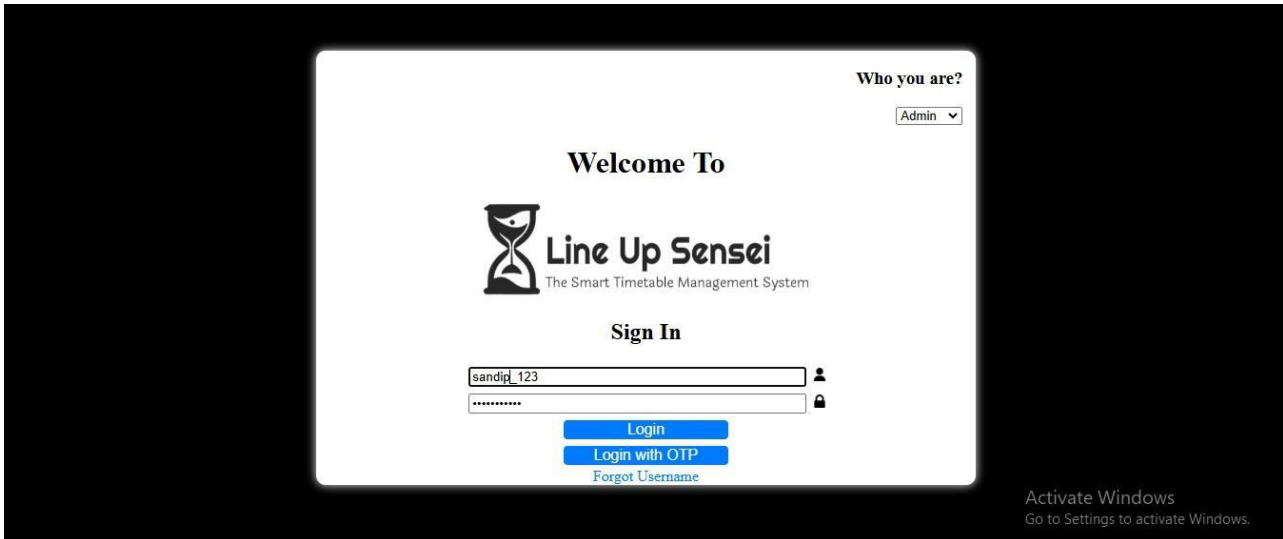
III. METHODOLOGY

The development of Line-up Sensei was quite stepwise, starting from collecting the requirements by feeding from the administrators, faculty members, and students about the significant constraining factors of scheduling that consist of faculty availability, rooms, and course overlaps [4]. So, the system was designed for Constraint Satisfaction Problems (CSP), where variables (rooms and time slots) along with the constraints (for instance no overlapping classes, faculty unavailability) were defined [1]. Implementing the CSP algorithm, this assignment of values dynamically will not violate any constraint, ensuring the conflict-free schedule [3].

The backend of the system utilized the Ktor framework for its lightweight and asynchronous server architecture, based on Kotlin, in processing requests and for real-time communication between the database and the interfaces [5]. The MySQL database handled information regarding courses, faculty members, rooms, and enrolled students [6]. For the frontend, the user interface was implemented both through an Android application and as a web interface for accessing and interacting with users' schedules in a smooth, cross-platform manner [7].

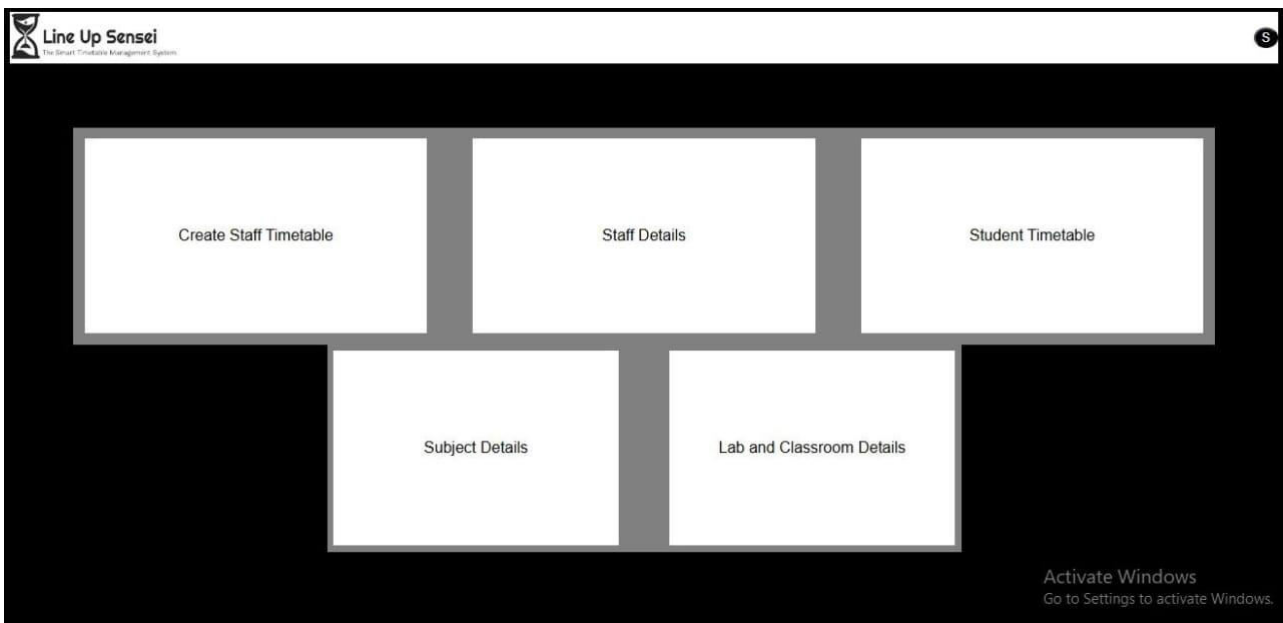
During implementation, APIs were designed to allow real-time adaptability, allowing schedules to adjust dynamically to changes like room reallocations or faculty unavailability [9]. Extensive testing was done to ensure the reliability of the system: functional testing validated core features such as timetable generation, performance testing confirmed scalability with large datasets up to 10,000 students and 500 courses, and user acceptance testing gathered feedback to improve usability and interface design [10]. This methodology ensured Line-up Sensei met the parameters for efficiency, scalability, and user satisfaction [9].

IV. EXPERIMENTAL RESULTS



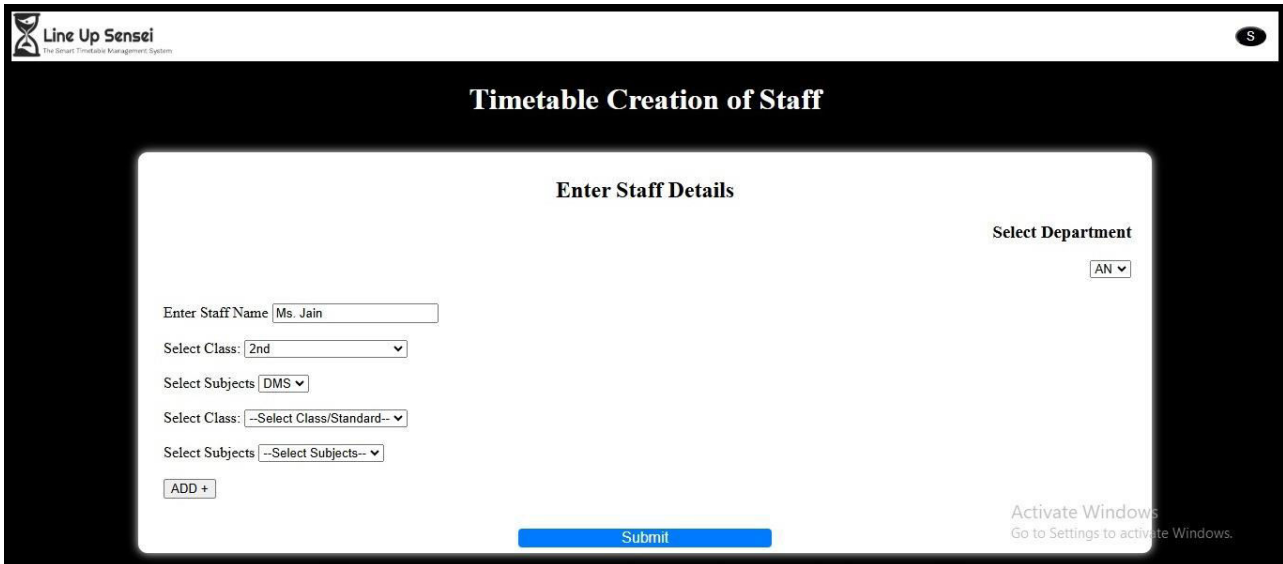
(a). Login Page

To log into the Line-up Sensei timetable management system, a user such as Sandip_3 would first select their role from the dropdown menu as "Admin," then input their designated username, such as "sandip_3," into the appropriate field, and then type in their password in the password field. After inputting all of the above information, the user would click on the "Login" button. This, if the entered username and password are correct, access was granted, and the individual could continue to do things within the Line-up Sensei system



(b) Staff Panel

Upon logging into the system under the administrator account, Sandip_3 would check the dashboard for the module labelled "Create Staff Timetable". In that tab he will be able to create a timetable for staff.



Line Up Sensei
The Smart Timetable Management System

Timetable Creation of Staff

Enter Staff Details

Select Department: AN

Enter Staff Name: Ms. Jain

Select Class: 2nd

Select Subjects: DMS

Select Class: --Select Class/Standard--

Select Subjects: --Select Subjects--

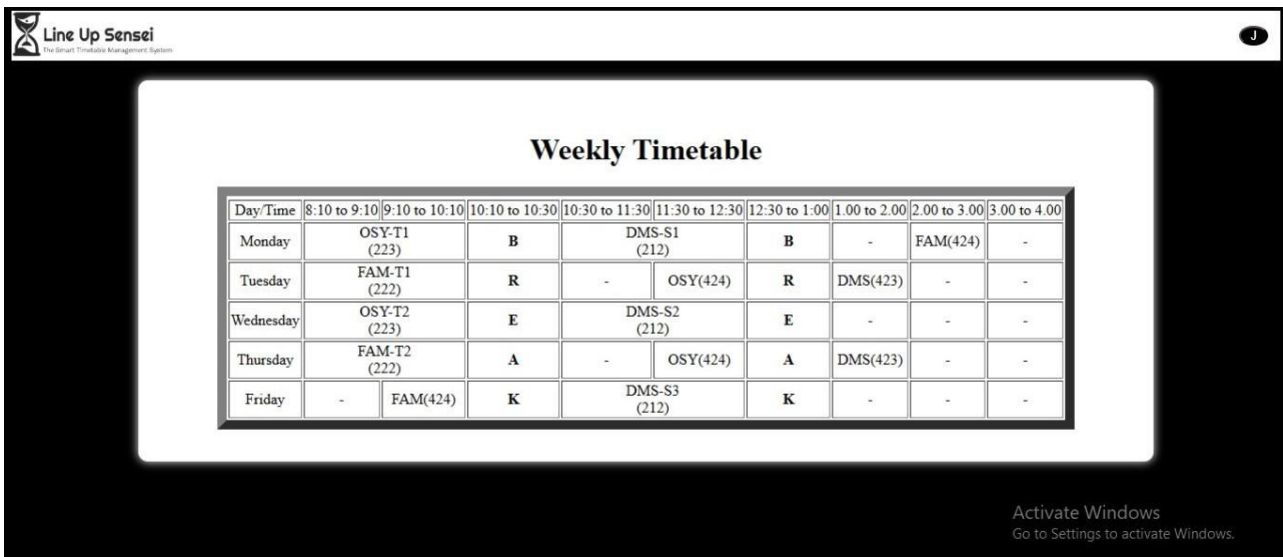
ADD +

Submit

Activate Windows
Go to Settings to activate Windows.

(c) Creating Staff Timetable

This is an important section of the “Staff Timetable Creation” module of Line-up Sensei. Administrators use this screen to input all the information relevant to each staff member into the system. They do this by inputting names, departments, classes they have been assigned, and what they teach. All the information is then used in the system to generate a good staff timetable. By carefully inputting these details, the system ensures that the resulting timetabling reflects teaching tasks and schedules for all of the staff members accurately.



Line Up Sensei
The Smart Timetable Management System

Weekly Timetable

Day/Time	8:10 to 9:10	9:10 to 10:10	10:10 to 10:30	10:30 to 11:30	11:30 to 12:30	12:30 to 1:00	1:00 to 2:00	2:00 to 3:00	3:00 to 4:00
Monday	OSY-T1 (223)	B		DMS-S1 (212)	B	-	FAM(424)	-	
Tuesday	FAM-T1 (222)	R	-	OSY(424)	R	DMS(423)	-	-	
Wednesday	OSY-T2 (223)	E		DMS-S2 (212)	E	-	-	-	
Thursday	FAM-T2 (222)	A	-	OSY(424)	A	DMS(423)	-	-	
Friday	-	FAM(424)	K	DMS-S3 (212)	K	-	-	-	

Activate Windows
Go to Settings to activate Windows.

(d) Generated Timetable

After the administrator had diligently provided information for staff, names, departments, assigned classes, and subjects, this system generated this weekly schedule automatically. This schedule lists a detailed, structured layout of every class with regards to what is taught when throughout the week.

V. CONCLUSION

We have implemented an AI-driven timetable management system, Line-up Sensei, which automates the generation of conflict-free timetables [1][3]. Our system leverages Constraint Satisfaction Problems (CSP) to handle multiple scheduling constraints, such as faculty availability and room capacities [3][4]. By integrating a Ktor-based backend and a MySQL database, along with cross-platform applications, we have created a scalable and efficient solution for academic scheduling [5][6]. The results show that the system effectively reduces scheduling time, enhances resource utilization, and ensures real-time adaptability [9]. Our system demonstrates the potential of AI in optimizing academic operations and is a step toward improving operational efficiency in educational institutions [8][9].

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