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Line-up Sensei: The Smart Timetable Management System

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Abstract: *This project presents "Line-up Sensei," a system based on AI that will transform timetable planning for schools. It applies CSP to generate schedules automatically conflict-free with all the constraints: availability of faculty, capacity of rooms, and enrollments of students [1]. It has a strong backend by the Node.js using Express framework and MySQL database for real-time updates as well as cross-platform accessible web applications [5][6]. Through overcoming the inefficiencies of the conventional methods, "Line-up Sensei" enhances the efficiency of operations, lessens mistakes, and largely lessens the scheduling time [4]. The system demonstrates how AI is able to change academic operations [3]..*

Keywords: AI, Timetable Management, Constraint Satisfaction Problems, Automation, Real-Time Scheduling, Node.js using Express Framework

I. INTRODUCTION

Timetable management is one of the basic but challenging operations in educational institutions, where classrooms, faculty, and students are assigned to time slots without any clash [4]. Although conventional manual techniques are widely used, they are laborious, prone to errors, and not scalable [3][4]. Due to the growing needs from the institutions, these methods are unable to satisfy the needs for flexibility, efficiency, and real-time responsiveness [9]. "Line-up Sensei: The Smart Timetable Planning System" addresses this issue by applying AI to timetable generation [8]. This system relies on CSPs and dynamically manages scheduling constraints to generate an optimized and conflict-free timetable [1][3]. It is implemented with the most up-to-date technologies, boasting a Node.js-powered backend and MySQL database for effective data management and cross-platform access via intuitive web interfaces [5][6]. The project seeks to minimize the administrative workloads pertaining to academic scheduling and maximize user satisfaction [9][10].

II. RELATED WORKS

The literature emphasizes some of the systems that have been created to manage scheduling:

Manual and Rule-Based Scheduling Systems:

Manual scheduling is judgmental in nature but extremely labour-intensive and error-prone. Meeting different constraints, including room booking and availability of faculty members, becomes increasingly more difficult as the number of students and courses increases [4].

Rule-based systems can manage most straightforward tasks, i.e., eliminating duplicate classes, but rule-based systems' strict rule set renders them inefficient in addressing dynamic and changing circumstances. Rule-based systems do not possess any flexibility in addressing unexpected alterations such as last-minute cancellation or faculty absence [9].

Illustrative Study:

Sharma and Gupta (2017) explained the inefficiencies of manual scheduling and the inability of rule-based systems to address complex scheduling constraints effectively [4].

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AI-Based Scheduling:

AI techniques, like CSP and GA, are used in scheduling to manage multiple constraints. CSP is particularly useful when the goal is to allocate values to variables (e.g., timeslots, rooms) such that no constraint is broken [1][3]. Example Research: Lopez and Garcia, 2019, demonstrate how CSP algorithms were utilized in academic scheduling to maximize resource allocation on rooms, times, faculties, and minimize scheduling conflicts [3].

Real-Time Adaptability:

Real-time adaptability in the scheduling system allows the schedule to change immediately in the event of change, which may be due to, say, an employee being absent or a particular room being double-booked [9].

Example Research: Kumar and Desai (2020) determined that real-time scheduling systems, where the system is able to dynamically consider unforeseen changes, maximize efficiency and user satisfaction [9].

Although the systems currently available have made significant improvements in using AI to schedule, they still lag in terms of scalability, user interface design, and real-time responsiveness [3][9]. Line-up Sensei overcomes all these problems through its provision of dynamic CSP method, real-time responsiveness, and cross-platform user interface. Carried out to mark each object individually [8].

III. METHODOLOGY

It was rather step-by-step development of Line-up Sensei beginning from gathering the requirements by drawing feeds from the administrators, faculty, and students regarding the main limiting factors of scheduling that include faculty availability, rooms, and course conflicts [4]. The system was thus developed for Constraint Satisfaction Problems (CSP), where variables (rooms and time slots) as well as the constraints (e.g., no conflicting classes, faculty unavailability) were specified [1]. Using the CSP algorithm, this dynamic assignment of values will never break any constraint and thus will provide a conflict-free schedule [3].

The system backend used the Node js using Express Framework due to its lightweight and asynchronous server design, on the basis of Node js, in handling requests and for real-time communication among the database and the interfaces [5]. MySQL database managed information about courses, faculty members, rooms, and registered students [6]. The user interface was handled for the frontend through a web interface for accessing and communicating with users' schedules in a seamless [7].

In implementation, APIs were designed to enable real-time flexibility, permitting the schedules to dynamically respond to changes such as room reassignments or faculty unavailability [9]. Thorough testing was conducted to verify system reliability: functional testing confirmed primary features like timetable generation, performance testing verified scalability with large inputs of up to 10,000 students and 500 courses, and user acceptance testing captured feedback to enhance usability and interface design [10]. This approach verified Line-up Sensei adhered to efficiency, scalability, and user satisfaction parameters [9].

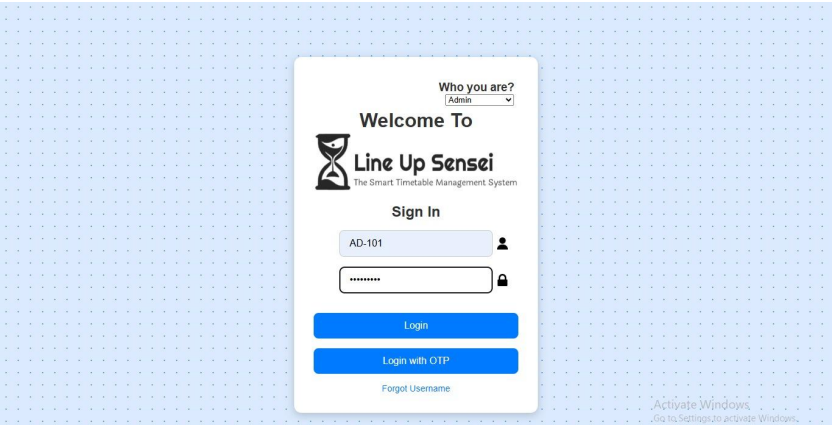

Fig 1. Login Page

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Line-up Sensei offers three login options. Users can choose their role, Enter username and password and click "Login." Users may also click "Login with OTP" for an OTP. There is a "Forgot Username" link for getting the forgotten usernames using OTP authentication.

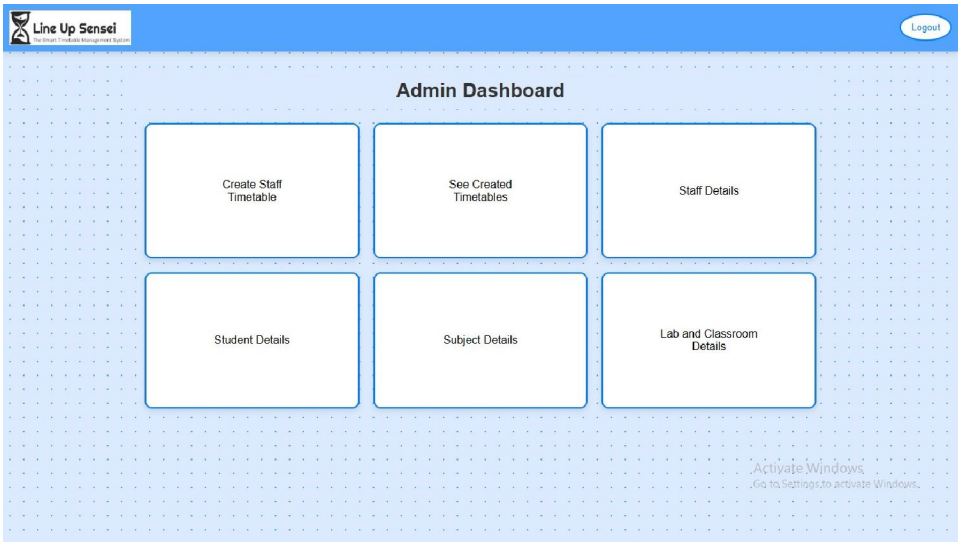

Fig 2. Admin Dashboard

Upon logging into the system under the administrator account, AD-101 would check the dashboard for the module labelled "Create Staff Timetable". In that Windowthe admin will able to create a timetable for staff members.

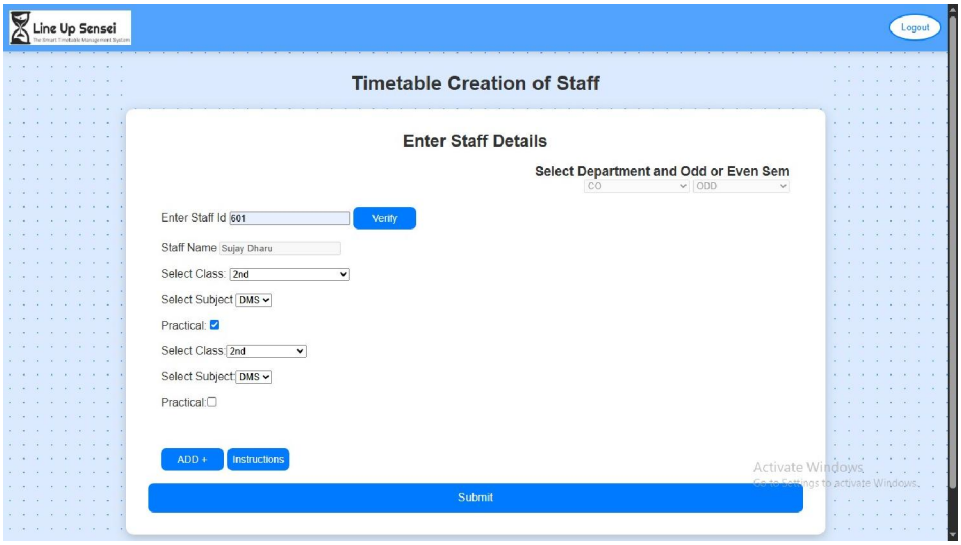

Fig 3. Timetable Creation

This is an important part of the "Staff Timetable Creation" module within Line-up Sensei. Administrators such as Sandip_3 carefully enter all the information required for each member of staff. This includes listing names, department assigned, classes they cover (e.g., "2nd"), and subject they teach (e.g., "DMS"), along with a note if a subject incorporates practical sessions. By correctly inputting this information, the system may then produce an overall and exact staff timetable in accordance with teaching duties of each individual.

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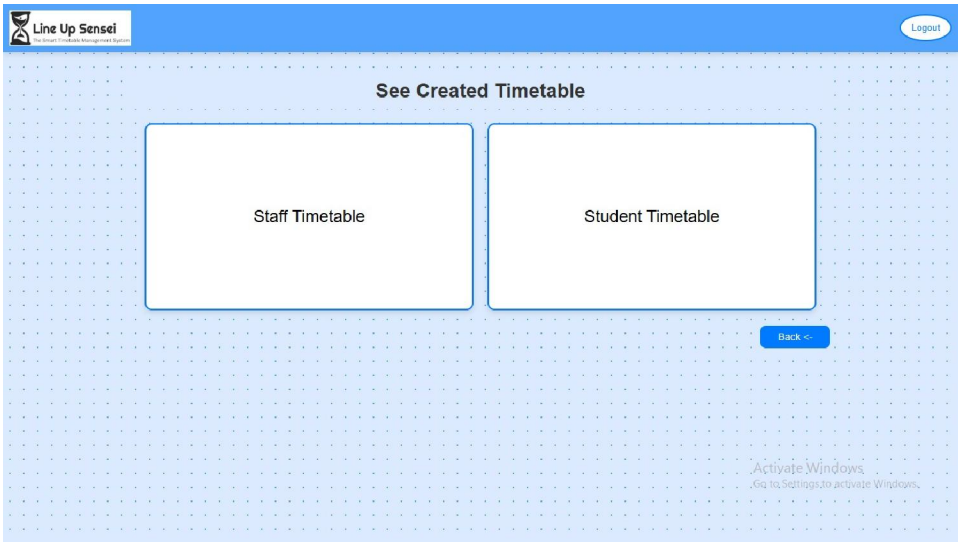
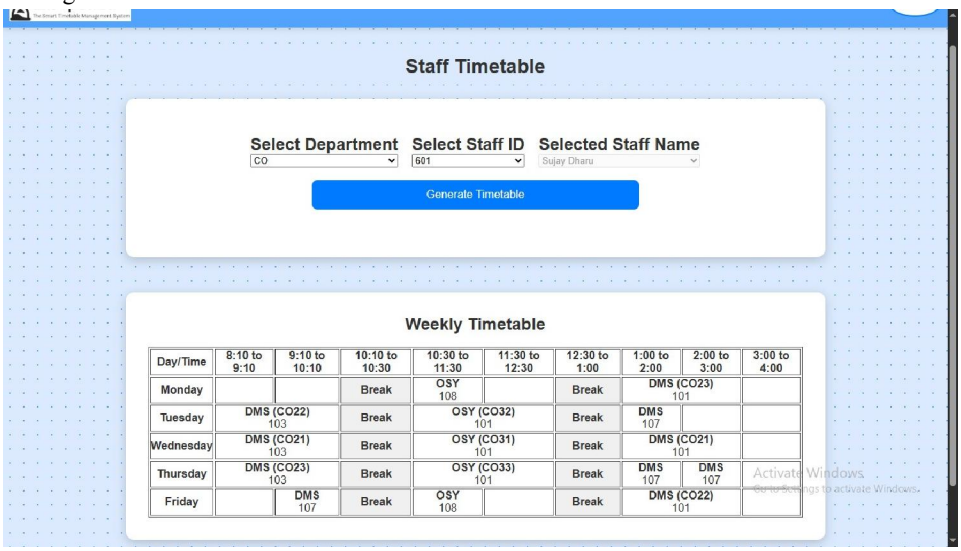


Fig. 4 See Created Timetables

The See Created Timetable tab consist of two sub-tabs which are Staff Timetable and Student Timetable, in which the admin can see the generated timetables of staff and students.



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			Break	OSY 108		Break	DMS (CO23) 101		
Tuesday	DMS (CO22) 103		Break	OSY (CO32) 101		Break	DMS 107		
Wednesday	DMS (CO21) 103		Break	OSY (CO31) 101		Break	DMS (CO21) 101		
Thursday	DMS (CO23) 103		Break	OSY (CO33) 101		Break	DMS 107	DMS 107	
Friday		DMS 107	Break	OSY 108		Break	DMS (CO22) 101		

Fig. 5 Generated Staff Timetable

This Fig. 5 presents the "Weekly Timetable" of a staff with the class schedule across days and time intervals. Each cell presents the subject (e.g., DMS, DTE) and room number (e.g., 103, 107, 101, 102) of the corresponding class and labs for that period or practical, with the "Break" slots also highlighted.

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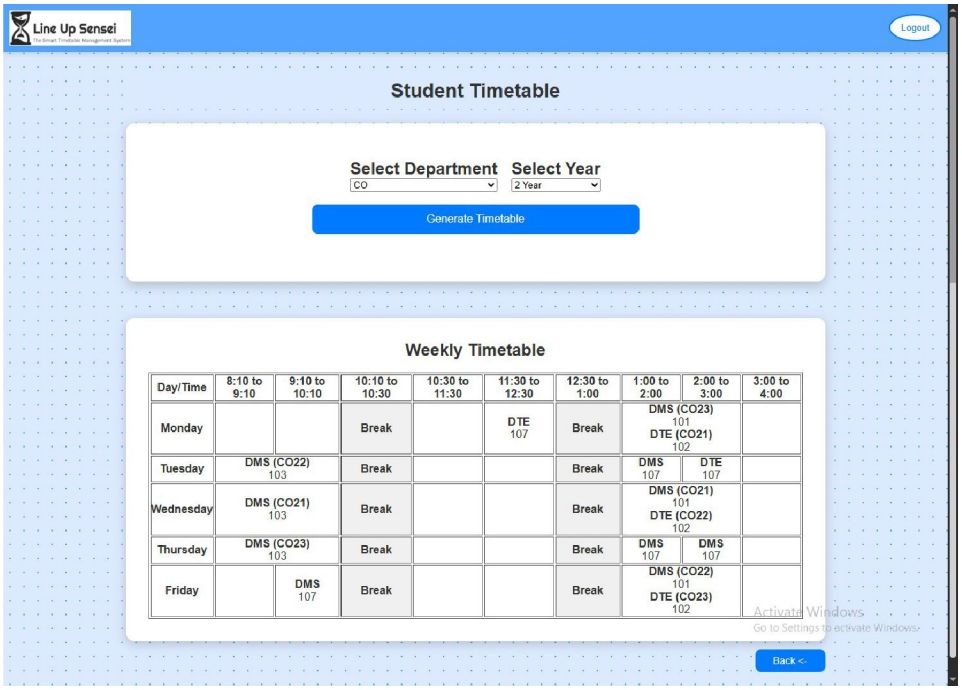

Day/Time	8:10 to 9:10	9:10 to 10:10	10:10 to 10:30	10:30 to 11:30	11:30 to 12:30	12:30 to 1:00	1:00 to 2:00	2:00 to 3:00	3:00 to 4:00
Monday			Break		DTE 107	Break	DMS (CO23) 101 DTE (CO21) 102		
Tuesday	DMS (CO22) 103		Break			Break	DMS 107	DTE 107	
Wednesday	DMS (CO21) 103		Break			Break	DMS (CO21) 101 DTE (CO22) 102		
Thursday	DMS (CO23) 103		Break			Break	DMS 107	DMS 107	
Friday		DMS 107	Break			Break	DMS (CO22) 101 DTE (CO23) 102		

Fig. 6 Student Timetable

This Fig. 6 presents the "Weekly Timetable" of a student with the class schedule across days and time intervals. Each cell presents the subject (e.g., DMS, DTE) and room number (e.g., 103, 107, 101, 102) of the corresponding class and labs for that period or practical, with the "Break" slots also highlighted.

IV. 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 uses CSP methods to manage various scheduling rules. These rules cover aspects like the times when teachers are available and the limits on how many people each room can accommodate [3][4].By integrating a Node js-based backend and a MySQL database, 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].

V. ACKNOWLEDGMENT

Most importantly, we thank Ms. S. D. Chavan, Associate Professor, Department of Artificial Intelligence and Machine Learning, AISSMS Polytechnic College, Pune, for her timely guidance, inspiration, and advice that guided us in developing our project from ideation to realization.

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This project is the result of collaborative effort, ongoing learning, and a common passion for enhancing academic timetabling using intelligent systems.

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