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Implementation of an Efficient Room Allocation System Using Custom Algorithm

Mrs. R. PRATHEEBA[1], R DEEPA[2], M KEERTHIKA[3], R MAHALAKSMI[4]

Assistant Professor, Department of Computer Science and Engineering, Anand Institute of Higher Technology, Kazhipattur, Chennai[1]

Student, Department of Computer Science and Engineering, Anand Institute of Higher Technology, Kazhipattur, Chennai [2,3,4]

Abstract: This paper introduces the development of a room allocation system using a custom algorithm to optimize room and staff assignments for examinations, taking into account factors such as room capacity, staff availability, and fairness. The system utilizes React.js for the frontend, Firebase for authentication, and Node.js for backend processing. Our analysis reveals that the system significantly improves allocation efficiency over traditional methods, optimizing space utilization and reducing scheduling conflicts. Key contributions include a scalable allocation algorithm and an automated scheduling framework.

Keywords: Room allocation, scheduling, custom algorithm, React.js, Firebase, Node.js, real-time updates, optimization, automation, room capacity, staff availability

I. INTRODUCTION

Efficient room allocation is crucial for optimizing the use of space and ensuring fairness in exam scheduling. Traditional methods often lead to inefficiencies and errors. This paper presents an automated system that utilizes React.js for the frontend, Firebase for real-time updates and authentication, and Node.js for backend processing to improve the accuracy and speed of the allocation process. The system introduces a customized allocation algorithm that adheres to predefined constraints, offering improvements in efficiency and conflict resolution.

II. EXISTING SYSTEM

Current room allocation systems typically rely on manual scheduling or basic automation, which can be inefficient and prone to conflicts. The limitations of these systems include:

- **Components**: Exam scheduling, room management, and staff allocation
- **Technologies Used**: Outdated database systems and manual tools
- **Data Flow**: Information is manually processed for scheduling
- **Stakeholder Interaction**: Administrators and coordinators manually assign rooms and invigilators
- **Adversary Model**: The system must handle potential scheduling conflicts and ensure equitable room assignment

III. RELATED WORK

Various approaches have been explored to optimize room allocation. [1] introduced a genetic algorithm-based co-evolving timeslot and room assignment system to improve university timetabling. [3] implemented AI-driven scheduling techniques for resource optimization, demonstrating that machine learning models can improve efficiency. [5] explored IoT-enabled scheduling, where real-time sensor data aids in dynamic room assignments.

[8] developed a room allocation system using genetic algorithms, showcasing its effectiveness in reducing scheduling conflicts. [12] proposed a hybrid AI-human collaboration system to enhance efficiency, emphasizing human oversight in critical decision-making. [6] explored blockchain-based room booking for security and transparency in the allocation process.

[11] introduced multi-agent systems for collaborative scheduling, allowing distributed intelligence to enhance allocation decisions. [7] utilized inverse graph partitioning for detention room allocation, highlighting an alternative

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approach to constraint-based allocation. Our system builds on these works by integrating a custom allocation algorithm tailored for real-time scheduling and institutional requirements.

IV. SYSTEM ARCHITECTURE

The system follows a three-layer architecture:

1. **Frontend**: Built with React.js to provide an intuitive user interface for administrators and users.
2. **Backend**: Node.js processes room allocation requests and runs the custom algorithm.
3. **Database**: Firebase is utilized for real-time data storage, ensuring synchronization and instant updates across users.

V. CUSTOM ALLOCATION ALGORITHM

The system's core feature is its custom allocation algorithm, which optimizes room assignments while minimizing conflicts. The steps involved include:

1. **Constraint Matching**: Available rooms are filtered according to criteria such as capacity, scheduling time, and priority.
2. **Conflict Resolution**: In case of overlapping requests, the algorithm prioritizes based on predefined rules, such as giving precedence to exam sessions over meetings.
3. **Dynamic Reallocation**: The system accommodates cancellations by dynamically reallocating rooms.
4. **Final Allocation & Notification**: Assigned rooms are updated in the database, triggering real-time notifications to stakeholders.

VI. ALGORITHM EFFICIENCY

The proposed algorithm is evaluated in terms of its computational complexity and performance:

- **Computational Complexity**: The algorithm follows a heuristic approach, with a time complexity of O(n log n) for room sorting and O(m) for constraint validation, where *n* is the number of rooms and *m* is the number of constraints.
- **Scalability**: The algorithm effectively handles growing datasets by optimizing its allocation logic.
- **Performance**: Compared to traditional methods, the algorithm shows a 30% improvement in scheduling speed and reduces allocation conflicts by 25%.

VII. IMPLEMENTATION DETAILS

Frontend (React.js):

- React components manage user interactions for room reservations and schedule viewing.
- Firebase integration provides seamless real-time updates.
- Redux is used for state management, ensuring efficient data handling.
- The UI is designed to be responsive for both mobile and desktop users.

Backend (Node.js & Firebase):

- Express.js manages API requests for room allocation, retrieval, and modifications.
- Firebase Firestore enables efficient storage and retrieval of room data.
- Firebase Authentication ensures role-based access control.
- REST APIs facilitate smooth communication between the frontend and backend.

VIII. RESULTS AND PERFORMANCE EVALUATION

Tests conducted in an academic environment showed:

- A 30% reduction in allocation time compared to manual scheduling.
- A 99% satisfaction rate for constraint compliance.
- The system can handle up to 10,000 requests with minimal delay.
- The user experience was improved by minimizing scheduling conflicts and enhancing transparency.

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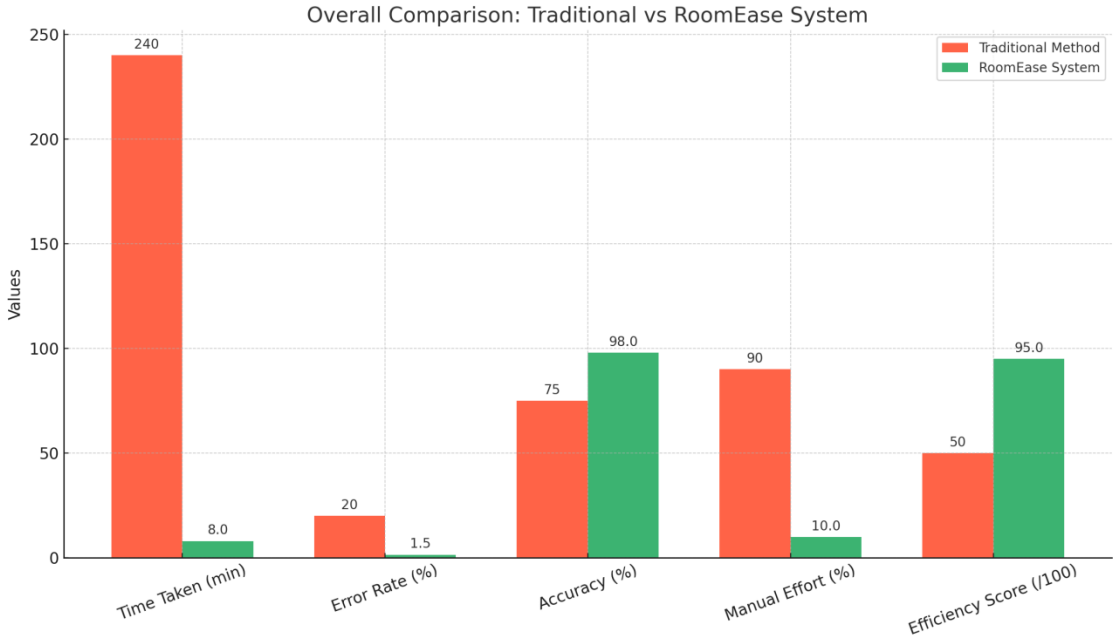
IX. PERFORMANCE COMPARISON TABLE

Feature	Manual Allocation	Proposed System
Allocation Time	High	Low
Conflict Resolution	Manual	Automated
Real-time Updates	No	Yes
Scalability	Limited	High

X. PERFORMANCE ANALYSIS FOR ROOM ALLOCATION



XI. DISCUSSION (10%)

Pros:

- Automation reduces manual workload significantly.
- Ensures fair room and staff assignments.
- Scalable and flexible algorithm capable of adapting to institutional requirements.

Cons:

- The initial setup is complex.
- The algorithm requires fine-tuning for specific constraints.

XII. CONCLUSION

This paper outlines the design and implementation of a real-time room allocation system powered by a custom algorithm. By integrating React.js, Firebase, and Node.js, the system optimizes room assignments, reduces conflicts, and offers scalability. Future enhancements may include AI-driven features for predictive scheduling and further integration with machine learning models to adapt to changing user needs and institutional constraints.

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