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A DIGITAL APPROACH TO TRANSPARENT EXAM SEATING ALLOCATION USING SMART ALGORITHMS

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ABSTRACT

Today in many educational institutes, managing allocation of seats for various examinations is still based on manual process, leading to errors, consumes time, and there are huge chances of unfair seating practices of students. This occurs especially while handling large amounts of students and having multiple rooms for allocation. To address these problems, a smart web-based seating allocation system is designed to ensure that the exams should be transparent, fair and cheating free in institutions. Instead of making machine learning models, this system applies an algorithmic approach along with the MERN stack to do the seating arrangement carefully and efficiently. The proposed system uses effective techniques, Hashing is used for mixing student data randomly, while sorting is used to organize the data properly according to need. The constraint satisfaction approach defines various rules and ensures that all the rules are followed, such that not any student of the same branch and same year can sit together at the same bench. Greedy algorithm is helpful in assigning the best possible seat for an individual and Graph coloring is used to avoid the conflicts between nearby students, Round Robin will distribute students evenly in rooms. This system has an exam cell panel from where the authorized user can access it, the exam cell head will simply upload the data of students and the system will easily generate a seating plan using these algorithms and make the manual process of seating arrangements easy for the user. This approach will make the process easy and reduce the consumption of time and efforts both. The backend architecture of this system is a modular and secure design having authentication system, while the frontend dashboard has a clear and user-friendly interface so that anyone can easily operate it and can generate the seating plan. The proposed system was tested on data of up to 1500 students, the performance was on the mark. The result shows reduction of over 90% in the

time for allocation of seats as compared to the manual approach of seating allocation without any conflicts, the system ensures the utilization of rooms efficiently. Overall the system is fast and easy to use for anyone, it can also handle large numbers of students and works well in real world situations.

KEYWORDS: Examination Seating Allocation, Web-Based Automation, Fairness and Transparency, MERN Stack, Automated Seat Allocation.

1. INTRODUCTION

Exams are the fundamental parts of the academic systems, and arrangements of proper seating play an important role in maintaining discipline and preventing cheating. In most of the institutions, the making of the seating plan is still based on a manual process that takes a lot of time and efforts. The institutions face the challenges in arranging the seats in the examination hall. The traditional approach leads to problems such as uneven seating arrangement of the students, and difficulty in separating students according to year and branch according to the rules. As the number of student increasing the colleges, manual methods are no longer reliable and efficient, there is need of a system which can easily generate the seating plans with just few steps while maintaining the fairness and ensures that it follows the defined rules in the system. This platform enables the exam cell head to upload the students data and after applying the rules and

algorithms including Hashing, Sorting, Constraint Satisfaction Problem, Greedy Algorithm, Round Robin Algorithm, Color Graphing to generate the seating plan for students. The integration of algorithmic approach and web technology, results in an efficient and scalable solution for the seating arrangement in the exam hall.

2. Literature Survey

In Academic systems, examinationseating allocation is an important area of research so that we can address issues regardingseating arrangement. Traditional method based on manual planning, which is a time consuming process and often results in errors. To address all the issues, several approacheshave been proposed in recent years. Existing research has introduced lots of techniques to reduce the lack of manual methods such as enforcing rules and fairness arrangements. Some researchers have focused on using basic algorithms for seat allocation such as sorting and randomization techniques to allocate students across all the rooms available. These approaches improve the speed of the system but they fail to handle complex rules like avoiding the same branch and same year student at a

single bench. Some studies use graph coloring to avoid conflicts between students seated on adjacent seats, the approach reduces the cheating risk effectively but fails on handling large data of students. These methods are effective in minimizing the issue of the adjacent allocation of the student but may face problems when having a large number of students. Modelsbased on the Constraint Satisfaction Problem imposed strong rules and constraints, these approaches provide good accuracy but they are computationally expensive and may be slower for large data of students. The existing web-based systems provide a good user interface and only automate some parts of the process. Most of them based on a single technique, they aren't very efficient and can't be adaptable to the situation where we have larger datasets. The proposed system has a hybrid method that combines multiple algorithms to enhance the performance and fairness in the examinations. In comparison with previous works, the designed system uses a combination of multiple algorithms and each of them has a specific role in the system that contributes to better performance and accuracy. Unlike the earlier systems that either focus on speed or constraint handling, the proposed system can achieve both efficiency and accuracy. The system not only works fast but also properly follows all the rules while handling students up to 1500 easily. The inclusion of a web based exam panel only allows the authorized user to upload student data and generate seating plans easily, making the system suitable for real world academic use.

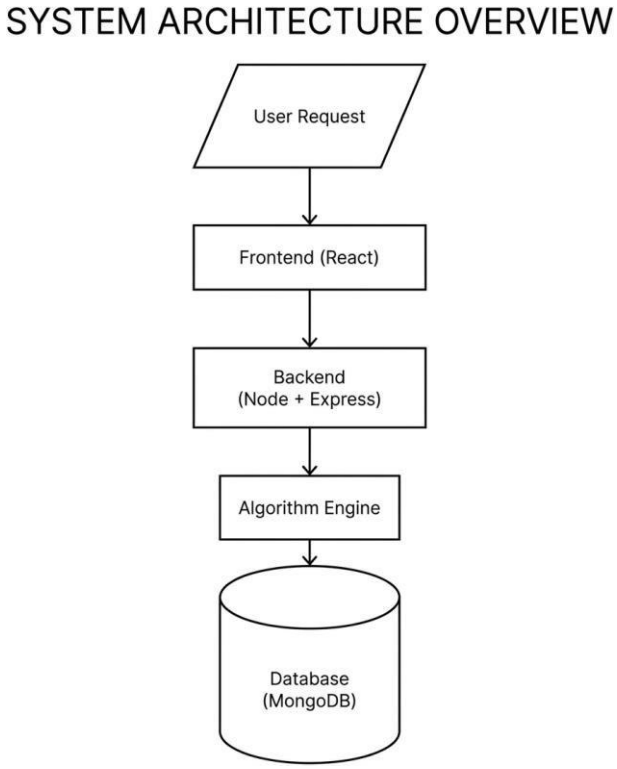
3. PROPOSED METHODOLOGY

The system with multiple algorithms aims to make the examination seating allocation process using a web based approach. It is designed to reduce the manual efforts and time consumption while handling the large amount of student data. It focuses on maintaining a cheating-free environment, avoiding conflicts while allocating seats in examinations. The system follows a well planned structure starting from data collection to actual seating plan generation and each stage is carefully designed to ensure efficiency and real world applicability.

3.1 System Overview

The proposed system is a web based application designed using MERN Stack with multiple algorithms. It ensures the scalability and efficiency of the overall system so that it will give better results. To store the data of the system, MongoDB is used as a database while Node.js and Express.js will handle the backend functionalities with api management. To provide a

user friendly and attractive interface to the user, the frontend of the system built using React. The system the system has a secure authentication system so that only the authorized exam cell head can access it. This ensures data privacy in the system and prevents unauthorized modifications. Overall, the architecture of the system is modular, making it easy to use and maintain, the system is capable of handling large numbers of students easily.



3.2 Data Collection and Preprocessing

All the data of students is uploaded to the system in PDF format, which is then parsed to the parser to extract the useful information like serial number, name, roll number, branch and year. This raw data is cleaned and organized in a specific way for the further processing. Sorting techniques are applied to organize the data of all students based on specific parameters like branch and year. Hashing is used for randomness in data, all these steps are required to eliminate bias and build a cheating free system. The main task of these steps is to prepare the accurate input data for the allocation algorithms.

3.3 Constraint Handling Mechanism

It uses the Constraint Satisfaction Problem (CSP) techniques so that all the rules must be followed strictly by the system while generating seating plans. Constraints include preventing the students of the same year and same branch sitting adjacent to each other. It plays an

important role in maintaining the integrity of the examination process.

3.4 Algorithm-Based Seat Allocation

The system has the combinations of multiple algorithms to achieve the better seat allocation. We have used the greedy algorithm to assign the best seat quickly, reducing overall execution time of the system. Graph coloring is used to ensure that the allocation of the adjacent seats for the students will be free from conflicts. All the algorithms combined together to minimize the limitations of individual algorithms. As a result, the system achieves both high speed and accuracy.

3.5 Output Generation and System Interface When this allocation process is get completed, the system will generate a detailed seating plan and a summary that can be easily viewed by user and downloadable. The system is designed simple and user friendly for the exam cell head to operate it easily. Features like exam creation, seating generation, and plan viewing are integrated into a single dashboard. The output is generated and organized in the room-wise manner, it also has secure access through authentication mechanisms. All the generated plans will be stored and accessed later when needed.

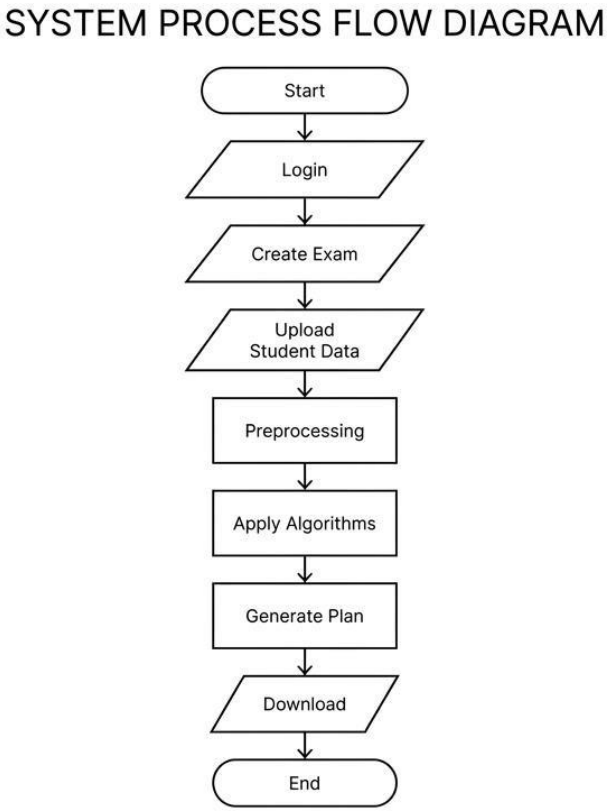
4. Implementation

The implementation of the seating allocation system for the exams is done in several steps and developed using the MERN stack for all the tasks related to the exams. Every module has its own responsibility and it ensures that all the tasks will be completed positively.

4.1 System Architecture Design

The proposed system is built using three layers of architecture consisting of Frontend, Backend and Database. They all collectively support the full architecture of our system of exam seating allocation system. The first part of this architecture is Frontend where all the users will come and interact with the system. From Frontend all the work will be done regarding seating allocation for the exams. First of all, exam cell staff can log in to the system, create exams, upload pdf of student data, and with the help of an easy and simple user-friendly interface generate the seating plan easily by clicking on generate plans. The Backend works well and its responsibility is to process all the requests that come from the authorized user, applying all the seating algorithms that are necessary for generating seating plans and it will manage all the logics of the system. When all these steps will be done then there is a need for storage so that all the data will be stored there, so we will use MongoDB as our database

which will store all the necessary information.



4.2 User Interface Development

The interface where the user interact and make all the request is built using React and designed of the exam cell authority to use it for generating seating plans. The user interface provides simple and different sections such as an authentication system, creating exams and seating plans all at one place. The designed interface is clean, responsive and easy to use for the user who has basic knowledge of operating it. All the features in the panel are organized at the same place in the dashboard so that the user can easily switch between all the tasks and he'll not face any of the confusion and problems. The dashboard acts as our central control system of the system from where all the activities have been done. Overall the system will save user time and provide a clean and smooth experience.

4.3 API Integration

The backend is developed using Node.js and express.js, where all the logic of the system will be handled. It supports all the functionality of the system and makes the data flow smooth between Frontend and the Database. The APIs are created to perform all the task, when an user performs an action in the frontend, the request is sent to the backend and will process quickly. The middlewares are used to validate the incoming requests and prevent the system

from crashing. Overall the system will have smooth communication, fast processing due to the backend.

4.4 Database Implementation

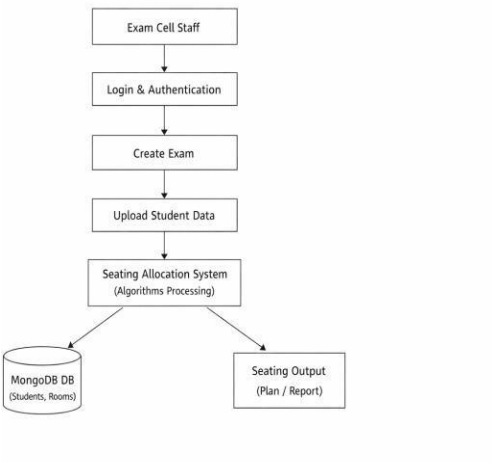
To store all the necessary information and manage all the data we use MongoDB as a database for our system. It stores all the useful information that we performed in our system. All the data is divided into different collections for better management and clarity. The schemas are flexible and allow easy modifications and updates.

4.5 Algorithm Integration and Execution

The algorithms are integrated in the backend of the system collectively. They make the system efficient and fast for seat allocation for students. After receiving the data, the systemfirst preprocess the data and then applies all the algorithms one after another uring seat allocation. All these algorithms work together in A disciplined manner so that it will balance the speed and accuracy. The integration of multiple algorithms with our backend will easily produce fair and conflict free seating plans.

4.6 Result Generation

When the process of seating allocation system will get completed, the system will generate an understandable output. All the seating plans will be displayed clearly and make it simple to view for the exam cell authority. Instead of only viewing it on-screen, we have saved the generated plans in the database so that whenever it is needed then we can easily see it on the system and view it and do further activity. The generated output contains complete details such as room-wise allocation, seat positions, and student information like name and roll number.



4.7 Testing and Deployment

The system is tested on different datasets up to 1500 students to ensure its functionality. After testing, the result shows that seating plans generate in a few seconds while maintaining all the constraints and rules. After successfully testing, the system will be deployed on cloud platforms for real time use. This deployment allows easy access of the interface so that the exam cell authority will easily use it from different places.

5. Future Scopes

Here are some points that will be updated in future to our system:

5.1 Integration with AI and ML

AIML will be integrated for making models so that it can predict the optimal seating plan based on patterns of past data. Due to this, it will increase the decision making capability of our system.

5.2 Advanced Cheating Detection Mechanism We will include feature detection in future to prevent cheating in examinations effectively. Where there will be suspicious placement of the students, an alarm will be generated to remind this. It will support our exam security system and adds an extra layer in the system.

5.3 Biometric Authentication Integration

For more security of the system, we can easily add biometric systems like fingerprints or face detection. This layer ensures that only authorized users can access it, it can also be used for verification of students during exams.

5.4 Integration with College ERP Systems

The proposed system can be integrated with the college ERP system so that the system will easily fetch all the data of students. It will reduce the manual effort for uploading the data of students. It will increase the overall efficiency of the system to perform all the tasks easily.

5.5 Automated Report Generation

This will generate the reports of the seating plan system for future improvement, it will show all the reports like seating statistics, room utilization, etc.

5.6 Support for Different Exam Formats

We will add features to support different exams formats like online exams, competitive exams, etc. Each of the given formats has their different set of rules that must be followed by the system. The system will adapt according to the selection of exam format and make the system flexible for every type of situation.

5.7 Advanced Visualization Tools

We will add graphical representation of seating plans so that the user can easily understand seating distribution. This feature will make the system more interactive for the user.

5.8 Multi-language support

In future, the system will support multiple language systems for making the usability better. Users can select their preferred favourite language to work with the system. It is especially useful in different regions.

5.9 Real-Time Notifications System

A notification system will be added in the future so that the user will get informed about all the updates. They will be notified about seating plan generation or changes. Notification can be sent using SMS or email, it will improve the process.

5.10 Role-Based Multi-User Access

The system will have user roles based access to the system like admin, staff or observer. Each role can have specific permission to the system. This layer will provide more security and controls to the system. It will make the system more professional to use.

5.11 Integration with Attendance Systems

The system can be linked with attendance systems for real-time tracking. Attendance will be marked based on the seating system. It reduces the manual effort and ensures accurate records.

6. RESULT

The experimental results clearly demonstrate that the proposed Smart Seat Allocation System significantly improves the efficiency, reliability, and scalability of examination seating arrangements compared to traditional methods. The integration of multiple algorithmic techniques plays a crucial role in achieving optimal performance.

6.1 Experimental Setup

The proposed Smart Seat Allocation System was evaluated using a dataset of up to 1500 students in a real-time examination environment. A total of 25 rooms were considered for the allocation process. Each room had a different seating configuration, which makes the system more realistic and applicable to real-world examination scenarios where classroom structures are not uniform. The system is designed to accept dynamic inputs, allowing the user to define the structure of each room individually. These inputs include the number of rows, number of columns, and bench capacity for each room. This flexibility ensures that the system can adapt to varying infrastructure without requiring any fixed layout assumptions.

Let the total number of rooms be for the process of allocation :

$R = 25$

Each room i (where i=1,2,3,...,25) is defined by:

- Number of rows = r_i
- Number of columns = c_i
- Bench capacity = b_i
- The seating capacity of each room is calculated as: $\text{Capacity}_i = r_i \times c_i \times b_i$

The total seating capacity of all rooms is computed using:

Total Capacity = $\sum_{i=1}^{R}(r_i \times c_i \times b_i)$

6.2 Allocation Results

The system successfully allocated all students across the available rooms.

Let: S = Total Students ≈ 1500 A = Allocated Students

Then allocation efficiency is: Allocation Efficiency = $(A/S) \times 100$

Substituting values:

Allocation Efficiency = $(1500/1500) \times 100 = 100\%$

- Allocated Students = 1500
- Unallocated Students = 0

The result confirms that the system ensures complete allocation without any loss or duplication, even with uneven room capacities.

6.3 Resource Utilization

The system efficiently utilizes the available seating resources while maintaining proper spacing between students to avoid overcrowding.

Let: Total Capacity ≈ 2000

The space utilization is calculated as:

Space Utilization = $(1500/2000) \times 100 = 75\%$

This shows that approximately 75% of the available seats are utilized, which reflects an optimal balance between efficiency and spacing constraints. The system avoids overfilling the rooms while still making effective use of the available infrastructure.

Such utilization ensures that:

- Students are properly distributed across rooms

- Overcrowding is avoided
- Seating constraints (like spacing and fairness) are maintained

The experimental results clearly demonstrate that the proposed Smart Seat Allocation System is efficient, scalable, and reliable for real-world examination environments. The system successfully allocated up to 1500 students within an approximate seating capacity of 2000 seats, achieving 100% allocation efficiency while maintaining proper spacing and constraints. The calculated space utilization of 75% indicates that the system makes effective use of available resources without causing overcrowding.

7. CONCLUSION

To improve the fairness of the examination management system, a web-based intelligent seating allocation system has been proposed to make the task easy. In this system, it is the combination of MERN Stack and add multiple algorithms such as Sorting, Hashing, Greedy Approach, Constraint Satisfaction Problem, Color Graphing and Round Robin scheduling. The main goal to develop this system is to reduce the manual effort of making seating plans and ensure the cheating free and fair distribution of students in the rooms for examination. We have tested our system with up to 1500 students and show that the system is reliable and efficient. The system is much faster than the manual methods because our system will easily generate the seating plans within a few seconds and manual methods take several hours. We have used multiple algorithms to make the generation of seating plans so easy for the user and it will also achieve the fair distribution of the students in the rooms. When we use the approach of multiple algorithms, it plays an important role in achieving speed and accuracy in the seating allocation for examinations. Hashing is used for randomness, Sorting helps in organizing the students data efficiently, Constraint Satisfaction Problem ensures all the constraints, Color Graphing prevents the conflict between adjacent positions, Greedy algorithm is used to assign seats quickly, Round RObin scheduling is used to distribute the students across all the rooms. The addition of a secure web-based user friendly interface increases the usability of the system. The dashboard in the central control unit of our system even the non-technical person can also easily use the system effectively. Overall, the proposed system provides a highly scalable, efficient, and reliable solution for modern examination management.

REFERENCES

1. *P. K. Yadav and S. Sharma, "Web-Based Examination Management System Using MERN Stack," International Journal of Computer Applications, vol. 183, no. 45, pp. 15–21, 2023.*
2. *R. Gupta and A. Verma, "Automated Seating Arrangement System Using Optimization Techniques," International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, pp. 1020–1025, 2020.*
3. *S. Kumar, N. Jain, and P. Singh, "Smart Examination Seating Arrangement System Using Constraint Satisfaction Approach," International Journal of Advanced Research in Computer Science, vol. 11, no. 4, pp. 45–50, 2022.*
4. *M. Patel and D. Shah, "Design and Implementation of Online Exam Cell Management System," International Journal of Innovative Technology and Exploring Engineering, vol. 8, no. 9, pp. 1200–1205, 2019.*
5. *K. Mishra and R. Dubey, "Efficient Resource Allocation Using Greedy Algorithms in Educational Systems," International Journal of Computer Science Trends and Technology, vol. 7, no. 3, pp. 89–94, 2019.*
6. *T. Singh and V. Gupta, "Application of Graph Coloring in Student Seating Arrangement to Avoid Conflicts," International Journal of Scientific Research in Computer Science, vol. 10, no. 2, pp. 33–38, 2021.*
7. *J. Patel, H. Mehta, and S. Desai, "Secure Web- Based Student Management System with Authentication," International Journal of Computer Engineering and Applications, vol. 14, no. 1, pp. 55–60, 2020.*
8. *K. R. Joshi and M. N. Patil, "Round Robin Scheduling for Fair Resource Distribution in Academic Systems," International Journal of Computer Applications, vol. 182, no. 12, pp. 25–30, 2018.*
9. *L. Wang and Y. Chen, "Hybrid Algorithm Approach for Optimization Problems in Scheduling Systems," IEEE Access, vol. 8, pp. 112345–112356, 2020.*
10. *S. Roy and P. Banerjee, "A Scalable Web-Based System for Automated Academic Management," International Journal of Information Technology, vol. 12, no. 2, pp. 567–573, 2021.*
11. *Saurabh Chauhan, Dharamveer Singh, Atul Kumar Singh (2022) "Artificial Intelligence In The Military: An Overview Of The Capabilities, Applications, And Challenges", Journal of Survey in Fisheries Sciences, Vol 9 (2) pp 984-991. https://doi.org/10.53555/sfs.v9i2.2911*

12. *Kiran, Dharamveer Singh, Nitin Goyal, (2023) "Analysis Of How Digital Marketing Affect By Voice Search", Journal of Survey in Fisheries Sciences, Vol. 30 (2) 407-412.*
https://doi.org/10.53555/sfs.v10i3.2890
13. *Yukti Tyagi, Dharamveer Singh, Ramander Singh, Sudhir Dawra (2024) "Analysis Of The Most Recent Trojans On The Android Operating System", Educational Administration: Theory and Practice, Vol. 30(2) 1320-1327.*
https://doi.org/10.53555/kuey.v30i2.6846
14. *Shivanee Singh, Dharamveer Singh, Ravindra Chauhan (2023) "Manufacturing Industry: A Sustainability Perspective On Cloud And Edge Computing", Journal of Survey in Fisheries Sciences, pp 1592-1598.*
https://doi.org/10.53555/sfs.v10i2.2889