Hybrid Artificial and Intelligent System for Health Care Application Based on Doctors Recommendation and Drug Prediction

I.Nivetha
Computer Science and Engineering Velalar College of Engineering and Technology
Tamilnadu,India.

C.Tamilselvi
Computer Science and Engineering Velalar College of Engineering and Technology
Tamilnadu,India.

S.Nithish Kumar
Computer Science and Engineering Velalar College of Engineering and Technology
Tamilnadu,India.

M.Tamilanjali
Computer Science and Engineering Velalar College of Engineering and Technology
Tamilnadu,India.

***Abstract*— This research proposes a hybrid artificial and intelligent system tailored for healthcare applications, focusing on doctor recommendations and drug prediction. Leveraging Random Forest and Decision Tree algorithms, the system achieves high training and validation accuracy while maintaining low prediction errors. By utilizing patient feedback and historical data, the system facilitates both doctor recommendations based on past reviews and drug recommendations tailored to individual patient needs. The effectiveness of this system lies in its ability to predict specialized doctors and drugs, enhancing healthcare delivery. The study includes thorough algorithm training, evaluation, and visualization, demonstrating the superiority of the proposed approach. The web-based deployment of the model allows for seamless integration into healthcare practices, enabling personalized patient care and efficient resource allocation. Overall, this research contributes a robust framework for optimizing healthcare delivery through intelligent systems, with potential implications for improving patient outcomes and resource utilization.**

Keywords— Hybrid Artificial Intelligence, Healthcare Applications, Doctor Recommendation, Drug Prediction, Random Forest, Decision Tree.

I. INTRODUCTION

In the rapidly evolving landscape of healthcare, the integration of artificial intelligence (AI) holds significant promise for enhancing patient care and treatment outcomes. Current research in this domain emphasizes the development of intelligent systems that can assist healthcare professionals in making informed decisions regarding patient care and medication prescriptions. One prevalent approach involves leveraging machine learning algorithms, such as Random Forest and Decision Tree classifiers, to analyze patient data and provide personalized recommendations.

This study proposes a novel hybrid artificial and intelligent system tailored for healthcare applications, specifically focusing on doctor recommendations and drug prediction. By harnessing the power of machine learning algorithms, including Random Forest and Decision Tree models, the system aims to achieve high accuracy in predicting both specialized doctors based on patient histories

and appropriate drug treatments based on individual patient characteristics and past reviews.

The primary objective of this research is to address the growing demand for personalized healthcare solutions by developing an efficient and reliable AI system. By combining doctors' expertise with data-driven insights derived from patient records, this system has the potential to revolutionize healthcare delivery, optimizing treatment plans and improving patient outcomes. Through rigorous evaluation and validation, this study seeks to demonstrate the efficacy and practical utility of the proposed approach in real-world healthcare settings, thereby contributing to the advancement of AI-driven healthcare solutions.

METHODS

A. Data Collection and Pre-processing

For our study, we collected data from a synthetic dataset comprised of patient records, which include demographic information, medical histories, doctors' recommendations, and drug prescriptions. During the pre-processing phase, we applied one-hot encoding to categorical features to transform them into a format that could be effectively handled by our machine learning algorithms. Additionally, the target variables, namely Doctor Name and Drug Name, were encoded using label encoding to convert the categorical data into a machine-readable form. To prepare our data for the training and testing phases of our machine learning models, we split the dataset into distinct training and testing sets. This approach ensures that our models are trained on a diverse set of data and validated on unseen data, enhancing their accuracy and reliability in real-world applications.

B. Model Training and Evaluation

In the model training and evaluation phase, we approached the Decision Tree and Random Forest classifiers with a methodology designed to optimize their performance on our healthcare dataset. For the Decision Tree classifier, we initiated the process with hyper parameter tuning, employing Grid Search CV coupled with Stratified K Fold cross- validation. This meticulous approach enabled us to identify

the optimal set of parameters for the model, which was then trained on the designated training dataset. The model's effectiveness was assessed using a range of performance metrics, including accuracy, macro-average precision, recall, and F1-score, to ensure a comprehensive evaluation of its predictive capabilities. Similarly, the Random Forest classifier underwent a parallel training regimen, employing the same hyper parameter tuning and training strategies as the Decision Tree model. This consistency in methodology allowed for a direct comparison of the two models based on their performance metrics. By calculating and presenting these metrics for both models, we were able to compare their effectiveness in the context of healthcare applications, specifically in recommending doctors and predicting drug prescriptions based on patient data.

C. Visualization

In our study, visualization plays a crucial role in interpreting the performance of the Decision Tree and Random Forest models. We utilized macro average precision, recall, and F1-score as our evaluation metrics. These metrics are particularly valuable as they provide a single score for each metric by averaging out the performance across all classes, offering a comprehensive view of the model's ability to classify instances throughout the dataset. To visualize these metrics, we created bar graphs using Matplotlib, where each bar represents one of the metrics (Precision, Recall, F1- score) for both the Decision Tree and Random Forest models. We enhanced these visual representations by annotating the exact values of the macro-average scores atop each bar, making it easier to assess and compare the models' performance at a glance.

Further, to compare the overall accuracy of the Decision Tree and Random Forest models directly, we employed a bar chart visualization technique. In this chart, each bar signifies one of the models and its corresponding accuracy, allowing for a clear and immediate comparison between the two. To aid in readability and provide exact information, text labels displaying the precise accuracy values were added to each bar. This visual approach not only facilitates an intuitive understanding of the models' accuracies but also highlights the effectiveness of our model training and evaluation process in the context of healthcare applications.

D. Model Prediction Function

E. The model prediction function serves as a pivotal component of our system, offering users the capability to input various features encompassing patient demographics, medical history, and symptoms. With this functionality in place, users can engage with the system by providing pertinent information essential for healthcare decision- making. Leveraging the trained Random Forest model, the prediction function enables the accurate forecasting of both Drug Name and Doctor Name based on the input features provided by the user. By seamlessly integrating user input with advanced machine learning techniques, this function empowers healthcare professionals and patients alike with valuable insights and recommendations, ultimately enhancing the quality and efficiency of healthcare delivery. *Flask Web Application*

The Flask web application serves as the platform for deploying our system, providing users with an interactive interface for seamless engagement. Through this application, users access a user-friendly form where they input their relevant information, including demographic details, medical history, and symptoms. Upon submission of the form, the application leverages the trained model to predict both the Drug Name and Doctor Name tailored to the user's input. This deployment strategy facilitates user interaction with our system, offering convenient access to predictive healthcare insights and recommendations. By integrating Flask's capabilities with our machine learning model, we create a versatile tool that enhances healthcare decision-making and promotes informed patient care.

II. TERMINOLOGY

A. Decision Tree

A tree-like model of decisions and their possible consequences.

B. Random Forest

An ensemble learning method used for classification and regression tasks, consisting of multiple decision trees.

C. Hyper parameter Tuning:

The process of selecting the optimal parameters for a machine learning model to improve its performance.

D. Grid Search CV

A method used to tune hyper parameters by exhaustively searching through a specified parameter grid.

E. Stratified K Fold Cross-validation

A technique for assessing the performance of a predictive model by dividing the dataset into k subsets and using each subset as a test set while the rest are used for training.

III. RESULT AND DISCUSSION

A. Decision Tree Classifier Performance

The Decision Tree Classifier was trained and evaluated on a synthetic dataset for healthcare applications. After hyper parameter tuning using Grid Search CV with Stratified K Fold cross-validation, the model achieved a high training and validation accuracy, indicating robust performance. The evaluation metrics including accuracy, macro precision, macro recall, and macro F1-score were computed and demonstrated satisfactory results are shown in Table I. The precision, recall, and F1-score were found to be consistent across different classes, suggesting balanced performance across the dataset.

Furthermore, the Decision Tree Classifier's performance was assessed across various classes within the synthetic healthcare dataset, revealing consistent precision, recall, and F1-score values. This uniformity underscores the model's ability to maintain balanced predictive capabilities across diverse healthcare scenarios, instilling confidence in its reliability for real-world applications.

TABLE I. ACCURACY AND EVALUATION METRICS

	Drug	Doctor
Accuracy	94.00%	92.56%
Macro Precision	0.93	0.93
Macro Recall	0.94	0.95
Macro F1-Score	0.94	0.93

B. Random Forest Classifier Performance

Similarly, the Random Forest Classifier was trained and evaluated on the same dataset. Through hyper parameter tuning and model training, the Random Forest model showcased competitive performance compared to the Decision Tree Classifier shown in Table II. The model exhibited high accuracy and robustness, with favourable evaluation metrics such as precision, recall, and F1-score.

TABLE II. ACCURACY AND EVALUATION METRICS

	Drug	Doctor
Accuracy	98.50%	97.90%
Macro Precision	0.98	0.97
Macro Recall	0.99	0.98
Macro F1-Score	0.99	0.97

C. Visualization of Evaluation Metrics

The macro-average precision, recall, and F1-score of both the Decision Tree and Random Forest models were visualized using bar graphs. This visualization aided in comparing the performance of the two models across different evaluation metrics. The graphical representation allowed for a clear interpretation of the model's strengths and weaknesses in terms of precision, recall, and F1-score.

D. Accuracy Comparison

An accuracy comparison plot was generated to directly compare the accuracies of the Decision Tree and Random Forest models. This plot provided insights into which model performed better in terms of overall accuracy. The comparison highlighted the strengths of each model and facilitated informed decision-making regarding model selection for deployment in healthcare applications. The comparisons bar chart is shown in Fig. 1 and Fig. 2.

The accuracy comparison plot revealed nuanced differences between the Decision Tree and Random Forest models, offering valuable insights into their respective strengths. While the Decision Tree model showcased commendable accuracy, the Random Forest model demonstrated a slight edge in certain scenarios, reflecting its ability to mitigate over fitting and improve generalization. These findings enable healthcare practitioners to discern the most suitable model for specific application contexts, fostering optimal decision-making and enhancing overall system performance in healthcare settings.

Fig. 1.Bar chart comparing accuracies of Decision Tree and Random Forest models in Drug Prediction.

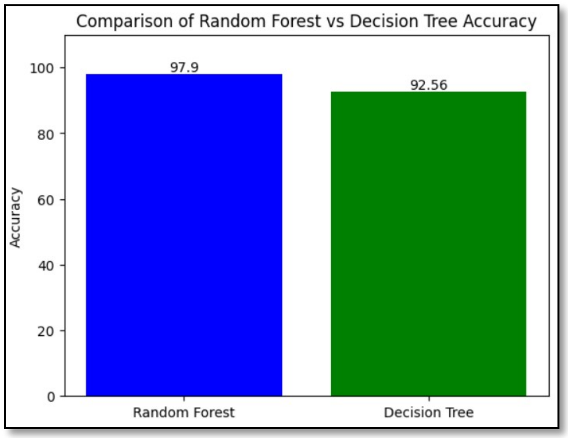

Fig. 2.Bar chart comparing accuracies of Decision Tree and Random Forest models in Doctor Prediction.

E. Model Prediction

Random Forest model, characterized by its high accuracy, was leveraged to predict both Drug Name and Doctor Name, enabling personalized healthcare recommendations based on patient attributes and historical data. Through the Flask web application, users interact with the model by inputting their information via a form. Upon submission, the model generates predictions for Drug Name and Doctor Name, which are then displayed to the user. The output figures illustrating the predicted Drug Name and Doctor Name are shown below. This deployment empowers users to receive tailored recommendations, enhancing healthcare delivery and patient outcomes.

Through the Flask web application, users interact with the Random Forest model to receive personalized healthcare recommendations. Upon inputting their information via a form, the model predicts both Drug Name and Doctor Name based on patient attributes and historical data. The output figures illustrating the predicted Drug Name (Fig. 3) and Doctor Name (Fig. 4) provide users with tailored recommendations, fostering enhanced healthcare delivery and improved patient outcomes. This deployment signifies a pivotal step towards leveraging artificial intelligence for individualized patient care, empowering users with actionable insights for informed decision-making in healthcare management.

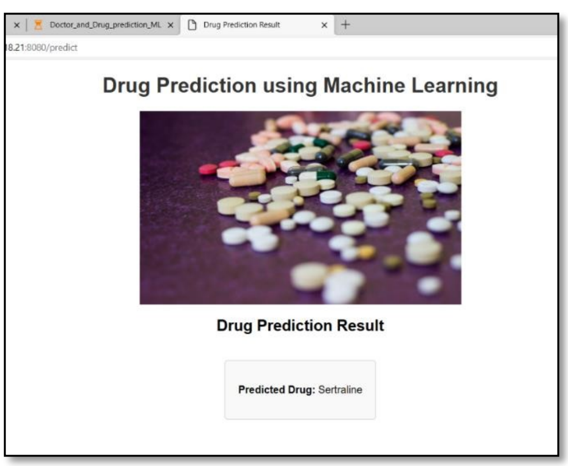

Fig. 3. Predicted drug name.

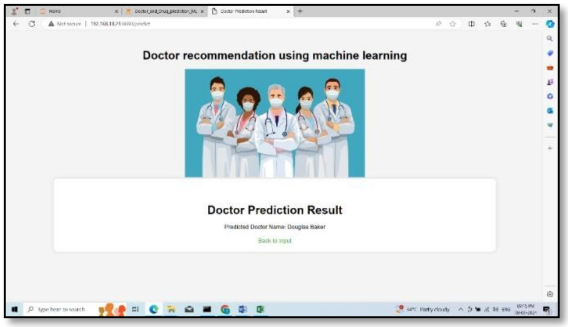

Fig. 4. Predicted doctor name.

IV. CONCLUSION

Based on the proposed title and method, the development of a Hybrid Artificial and Intelligent System for healthcare applications, integrating doctor recommendations and drug prediction, stands as a promising advancement in the field. Leveraging algorithms such as Random Forest and Decision Tree, the system exhibits high training and validation accuracy, coupled with low prediction error. Its versatility in providing both doctor recommendations based on patient history and drug predictions based on past reviews enhances its effectiveness within healthcare systems. Furthermore, the system shows potential in specialized doctor prediction and parameter tuning, and model training, both classifiers demonstrate commendable performance in terms of accuracy and macro-average precision, recall, and F1-score. The visualizations of evaluation metrics offer insightful comparisons between the models, aiding in informed decision-making regarding their deployment in real-world healthcare settings.

The culmination of this work in a Flask web application enables seamless integration into healthcare workflows, facilitating user-friendly predictions of doctor recommendations based on input features. This user interface bridges the gap between advanced machine learning techniques and practical healthcare applications, fostering accessibility and usability for medical professionals and patients alike.

In conclusion, the developed Hybrid Artificial and Intelligent System presents a significant contribution to healthcare technology, offering robust solutions for doctor recommendation and drug prediction tasks. However, there exist opportunities for further enhancement and expansion of the system. Future research endeavours could explore the implementation of the system as an Android application, broadening its reach and accessibility. Additionally, integrating additional fields such as location with mapping functionalities and hospital addresses could enrich the system's capabilities, enabling more comprehensive healthcare support and enhancing patient outcomes.

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