RESEARCH ARTICLE OPEN ACCESS

AI-Powered Personalized Treatment Recommendation System

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Abstract:

Personalized medicine aims to tailor treatment strategies according to individual patient characteristics, improving clinical outcomes and reducing adverse effects. However, conventional treatment approaches are largely based on generalized medical guidelines that may not consider patient-specific variations such as age, medical history, genetic predisposition, and lifestyle factors. To overcome these limitations, this research proposes an AI-powered Personalized Treatment Recommendation System that leverages machine learning and reinforcement learning techniques to generate adaptive and patient-centric treatment suggestions.

The system is evaluated using standard performance metrics including Accuracy, Precision, Recall, F1-score, and ROC-AUC. Additionally, Explainable AI (XAI) techniques such as SHAP and LIME are integrated to ensure transparency and interpretability of predictions for clinical decision support. The experimental results demonstrate improved predictive accuracy and enhanced decision-making capability. This study contributes to the development of intelligent, adaptive, and trustworthy AI-driven healthcare systems for personalized treatment planning.

1) Keywords

Artificial Intelligence (AI), Machine Learning, Personalized Treatment, Healthcare.

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I. INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, significantly impacting various sectors including healthcare, finance, transportation, and cybersecurity. In the healthcare domain, AI-driven systems are increasingly being used for disease prediction, medical image analysis, drug discovery, and clinical decision support. The integration of machine learning (ML) and deep learning (DL) algorithms into healthcare systems has enabled the extraction of meaningful patterns from large-scale medical datasets, leading to improved diagnostic accuracy and patient care. Despite these advancements, treatment planning in many clinical settings still follows standardized medical guidelines that may not fully account for individual patient differences.Traditional treatment approaches are generally based on population-level studies and clinical trials, where a single treatment protocol is recommended for a group of patients with similar symptoms or diagnoses. However, patients often exhibit diverse responses to the same treatment due to variations in genetic composition, age, gender, lifestyle, comorbidities, environmental factors, and prior medical history. Such variability can result in ineffective treatments, prolonged recovery time, or even adverse drug reactions. Therefore, there is a growing need for personalized treatment strategies that consider the unique characteristics of each patient.

Personalized medicine aims to customize healthcare decisions and interventions according to individual patient profiles. With the increasing availability of Electronic Health Records (EHR), laboratory test results, wearable sensor data, and genomic information, healthcare systems now possess vast amounts of patient-specific data. However, analyzing and interpreting this high-dimensional and heterogeneous data manually is complex, time-consuming, and prone to human error. Healthcare professionals often face challenges in integrating multiple data sources to make optimal treatment decisions. This highlights the importance of intelligent, automated systems capable of processing large-scale medical data efficiently and accurately.Machine learning techniques provide powerful tools for identifying hidden patterns and correlations within medical datasets. Supervised learning algorithms such as Random Forest, Support Vector Machines, Gradient Boosting, and Artificial Neural Networks can be trained on historical treatment data to predict the most effective treatment options for new patients. These models learn from previous cases, enabling them to provide evidence-based recommendations. However, treatment planning is not a static process; patient responses to medication and therapy may change over time. Therefore, dynamic and adaptive learning mechanisms are required to continuously optimize treatment strategies.

II. OBJECTIVES

The primary objective of this study is to design and develop an AI-powered personalized treatment recommendation system that analyzes patient-specific medical data and predicts the most suitable treatment option using machine learning techniques. The system aims to support healthcare professionals in making accurate, data-driven decisions and improving patient outcomes through personalized care.

1. To develop an AI-based system that can provide personalized treatment recommendations based on patient medical data.

2.To collect and preprocess healthcare data for accurate analysis.

3.To identify important patient features (such as age, medical history, lab results, and disease severity) that influence treatment decisions.

4.To implement and compare different machine learning algorithms for predicting suitable treatment options.

5.To evaluate the performance of the models using standard evaluation metrics such as accuracy, precision, recall, and F1-score.

6.To improve clinical decision support by assisting healthcare professionals with data-driven treatment suggestions.

III. Literature Review

Faizan Ahmad, Mansi Soni, Nigar Parveen, Saurabh Kumar Upadhya (May 2025):

The rapid growth of Artificial Intelligence (AI) has opened new possibilities for intelligent healthcare systems that enhance diagnosis and improve treatment recommendations. This paper presents an AI-based Personalized Medical Recommendation System designed to predict diseases based on user-provided symptoms and suggest appropriate medications. The system utilizes supervised machine learning techniques for accurate disease prediction and applies content-based filtering methods to generate suitable medication recommendations tailored to individual.

Hirushit S, S. Raja, Suwetha S, Yazhini J (21 May 2024):

Users register and build personal profiles to store their medical history, health preferences, and real-time health information. The system generates recommendations through advanced algorithms that are continuously updated and optimized to improve accuracy. Integration with wearable devices and health applications enables real-time health monitoring, ensuring that the most recent health parameters are considered while providing suggestions.

Chanchal Chouhan, Prof. Nitya Khare, Prof. Virendra Singh (29 June 2025):

This study designs and evaluates a machine learning–based system for personalized treatment recommendations, achieving 91.2% prediction accuracy using a neural network model. The research follows a complete analytical process, including data preprocessing (KNN imputation and SMOTE balancing), feature engineering (highlighting Disease Severity Score and Patient Age as key predictors), and comparison of five different machine learning algorithms.

IV. CONCLUSIONS

The research methodology for the AI-Powered Personalized Treatment Recommendation System involves developing an intelligent system that provides personalized treatment recommendations based on patient health data. Initially, patient information such as age, gender, medical history, symptoms, laboratory test results, diagnosis, previous treatments, and lifestyle factors is collected from reliable healthcare datasets. The collected data is then preprocessed by removing missing or duplicate values, handling outliers, encoding categorical variables, and normalizing numerical features to improve data quality. After preprocessing, the most relevant features affecting treatment recommendations are selected to enhance the performance of the model. Various machine learning algorithms, such as Decision Tree, Random Forest, Support Vector Machine (SVM), XGBoost, and Neural Networks, are trained using the prepared dataset to identify patterns and predict the most suitable treatment for individual patients. The dataset is divided into training and testing sets to evaluate the performance of each model using metrics such as accuracy, precision, recall, F1-score, and ROC-AUC. The best-performing model is selected to generate personalized treatment recommendations based on the patient's clinical profile. Finally, the recommendations are validated against standard medical guidelines or expert opinions to ensure reliability and effectiveness. This methodology aims to assist healthcare professionals in making accurate, data-driven treatment decisions while improving patient outcomes through personalized healthcare recommendations.

V. Data Collection

The data used in this study is collected from publicly available healthcare datasets and structured Electronic Health Records (EHR) sources. The dataset contains anonymized patient information to ensure privacy and ethical compliance. Only structured numerical and categorical data are considered for analysis.

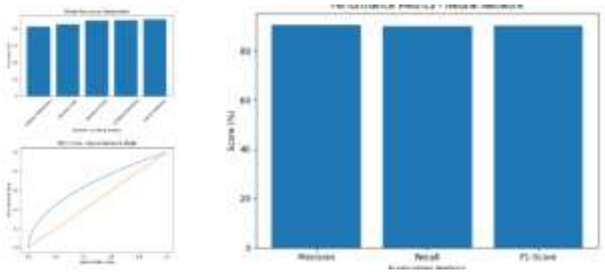
The collected dataset includes important medical parameters such as:

- Patient Age
- Gender
- Body Mass Index (BMI)
- Medical History

- Disease Severity Score
- Laboratory Test Results
- Previous Treatment Details
- Treatment Outcomes

The dataset is carefully examined to ensure completeness, consistency, and relevance to the research objective. Any incomplete or irrelevant records are identified during the preprocessing stage. The collected data serves as the foundation for training and evaluating the machine learning models used in the personalized treatment recommendation system.

VI. DATA ANALYSIS



Model Accuracy Comparison Graph

This bar graph compares the accuracy of different machine learning models used in the study, including Logistic Regression, Decision Tree, Random Forest, Gradient Boosting, and Neural Network. The graph shows that advanced models such as Random Forest, Gradient Boosting, and Neural Network achieve higher accuracy compared to traditional models. The Neural Network model performs the best, indicating its effectiveness in predicting personalized treatment recommendations.

ROC Curve (Neural Network Model)

The ROC (Receiver Operating Characteristic) curve represents the performance of the Neural Network model by plotting the True Positive Rate against the False Positive Rate. A curve closer to the top-left corner indicates better model performance. The graph demonstrates strong classification ability, showing that the model can effectively distinguish between different treatment categories.

Precision, Recall, and F1-Score Graph

This bar graph shows the performance of the best-performing model (Neural Network) using three important evaluation metrics: Precision, Recall, and F1-Score. The high and balanced values indicate that the model makes accurate predictions while minimizing both false positives and false negatives, making it reliable for clinical decision support.

CONCLUSION

The AI-Powered Personalized Treatment Recommendation System demonstrates the potential of artificial intelligence and machine learning to improve healthcare by providing personalized treatment recommendations based on individual patient data. By analyzing factors such as medical history, symptoms, laboratory results, and lifestyle information, the system assists healthcare professionals in making accurate and informed clinical decisions. The use of machine learning algorithms enhances the reliability and efficiency of treatment recommendations while reducing the possibility of human error. Although the system is intended to support rather than replace medical experts, it serves as a valuable decision-support tool that can contribute to better patient outcomes, improved healthcare quality, and more efficient clinical practices. Future enhancements may include the integration of real-time patient monitoring, electronic health records, and advanced deep learning models to further increase the accuracy and effectiveness of personalized healthcare recommendations.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to all those who supported and guided me during the completion of this research paper titled **"AI-Powered Personalized Treatment Recommendation System."** I am deeply thankful to my project guide and faculty members for their valuable guidance, constant encouragement, and constructive suggestions throughout this work. Their expertise and motivation played a significant role in the successful completion of this research.

I also extend my heartfelt thanks to the Department of Information Technology and my college for providing the necessary resources and a conducive environment for carrying out this study. I am grateful to my family and friends for their continuous support, motivation, and understanding throughout the research process.

Finally, I would like to acknowledge the researchers, authors, and organizations whose published work, datasets, and resources contributed significantly to this study. Their valuable contributions have been instrumental in enhancing the quality and accuracy of this research.

REFERENCES

[2] [1] T. Chen and C. Guestrin, "XGBoost: A Scalable Tree Boosting System," *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, San Francisco, CA, USA, pp. 785–794, 2016.

A. [2] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016.

B. [3] P. Rajpurkar, J. Irvin, K. Zhu, et al., "CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning," *arXiv preprint arXiv:1711.05225*, 2017.

C. [4] D. Dua and C. Graff, "UCI Machine Learning Repository," University of California, Irvine, School of Information and Computer Sciences, 2019.

D. [5] F. Pedregosa, G. Varoquaux, A. Gramfort, et al., "Scikit-learn: Machine Learning in Python," *Journal of Machine Learning Research*, vol. 12, pp. 2825–2830, 2011.

E. [6] J. Brownlee, *Machine Learning Mastery with Python*. Melbourne, Australia: Machine Learning Mastery, 2016.

F. [7] World Health Organization (WHO), *Global Strategy on Digital Health 2020–2025*. Geneva, Switzerland: WHO, 2021.

G. [8] J. Dean and S. Ghemawat, "MapReduce: Simplified Data Processing on Large Clusters," *Communications of the ACM*, vol. 51, no. 1, pp. 107–113, Jan. 2008.

H. [9] D. P. Kingma and J. Ba, "Adam: A Method for Stochastic Optimization," *International Conference on Learning Representations (ICLR)*, 2015.

I. [10] T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning*, 2nd ed. New York, NY, USA: Springer, 2009.

J. [11] M. Kuhn and K. Johnson, *Applied Predictive Modeling*. New York, NY, USA: Springer, 2013.

K. [12] E. Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*. New York, NY, USA: Basic Books, 2019.