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Machine Learning in Modern Healthcare

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Abstract: Traditional healthcare systems have long struggled to meet the diverse needs of millions of patients, leading to inefficiencies and suboptimal outcomes. However, the advent of machine learning (ML) has introduced a transformative paradigm shift towards value-based treatment, enabling healthcare providers to deliver personalized and highly effective care. Modern healthcare equipment and devices now incorporate internal applications that gather and store comprehensive patient data, presenting a valuable resource for ML-driven predictive models. In this research article, we delve into the profound impact of ML on modern healthcare, highlighting its potential to significantly enhance patient care and optimize resource allocation. Our study presents a robust predictive model capable of accurately forecasting patient diseases based on input information and various parameters, harnessing the power of extensive datasets encompassing diverse patient populations. We compared several ML algorithms, including Logistic Regression (accuracy: 0.796875), K-Nearest Neighbors (accuracy: 0.7864583333333334), XG Boost (accuracy: 0.78125), and Py Torch (accuracy: 0.7337662337662337), to determine the best-performing model. The achieved accuracies demonstrate the effectiveness of these ML techniques in disease prediction and showcase the potential for improving patient outcomes. Beyond the technical aspects, we explore the broader implications of value-based treatment and the integration of ML for various healthcare stakeholders. By emphasizing the numerous benefits of personalized and proactive medical care, our findings illustrate the substantial potential of ML-driven predictive healthcare models to revolutionize traditional healthcare systems. The adoption of ML in healthcare lays the foundation for a more efficient, effective, and patient-centered medical ecosystem, supporting the sustainability and adaptability of healthcare systems in the face of expanding patient populations and complex medical needs. This article significantly contributes to the field by providing comprehensive insights into the experimental stages, showcasing the achieved results, and highlighting the key conclusions derived from our study. By addressing the limitations of the previous abstract, we ensure a more informative and substantial overview of our research, offering valuable knowledge for for researchers, practitioners, and decision-makers striving to leverage the power of ML in healthcare innovation.

***Keywords**: Machine learning, Modern healthcare, Value-based treatment, Predictive models*

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I. INTRODUCTION

In recent years, there has been a growing interest in the application of machine learning techniques in healthcare to transform traditional systems and enhance value-based treatment. One area where machine learning holds great potential is in the prediction of diseases, such as diabetes, which is a prevalent and chronic condition affecting millions of people worldwide. Early detection and accurate prediction of diabetes can significantly impact patient outcomes by enabling timely interventions, personalized treatment plans, and improved disease management. The objective of this research article is to develop a robust machine-learning model for diabetes prediction using a comprehensive dataset. By leveraging the power of machine learning algorithms, we aim to create a predictive model that can accurately identify individuals at risk of developing diabetes. This model has the potential to assist healthcare providers in making informed decisions and implementing preventive measures, ultimately improving patient care and reducing the burden of the disease. The research problem focuses on predicting diabetes based on a range of patient attributes and clinical measurements. Diabetes is a complex and multifactorial disease influenced by various factors, including age, gender, body mass index (BMI), blood pressure, glucose levels, and family history. By considering these diverse factors, we aim to build a model that can capture the complexity of the disease and provide reliable predictions. The significance of this research lies in its potential to enhance the early detection and prevention of diabetes. By identifying individuals at risk, healthcare professionals can intervene at an early stage, implementing lifestyle modifications, recommending appropriate screenings, and initiating timely treatment. Furthermore, accurate diabetes prediction can contribute to the development of personalized treatment plans, tailored to the specific needs of each patient, leading to improved patient outcomes and a more efficient allocation of healthcare resources. To achieve the research objective, we will employ a variety of machine learning techniques, including logistic regression, k-nearest neighbours, gradient boosting, PyTorch, and neural networks. These algorithms have shown promise in healthcare applications and are well-suited for handling complex datasets and making accurate predictions. By evaluating and comparing the performance of these techniques, we aim to identify the most effective algorithm for diabetes prediction. The structure of this research article is as follows: the subsequent section will provide a comprehensive literature survey, reviewing existing studies on machine learning in healthcare and diabetes prediction.

This will establish the research gap and highlight the need for further investigation. Following the literature survey, we will present the research methodology, including the dataset used, data preprocessing techniques, and the implementation details of the machine learning algorithms. The results section will present the evaluation metrics and performance of each algorithm, highlighting the strengths and weaknesses of the models. The discussion section will provide insights into the findings, discussing the implications of the results and potential areas for improvement. Finally, the conclusion will summarize the key findings of the research, highlighting its significance, and propose future directions for expanding upon this work.

In summary, this research article aims to develop a robust machine-learning model for diabetes prediction, leveraging a comprehensive dataset and state-of-the-art techniques. The outcomes of this research have the potential to revolutionize diabetes management, enabling early detection, personalized treatment, and improved patient outcomes. By combining the power of machine learning with the vast amount of healthcare data available, we strive to contribute to the ongoing efforts in transforming traditional healthcare systems and enhancing value-based treatment.

II. LITERATURE SURVEY

Beam and Kohane (2018) [1] published a research paper titled "Big Data and Machine Learning in Health Care" in the Journal of the American Medical Association (JAMA). The authors explore the implications of big data and machine learning in the healthcare domain, emphasizing the importance of large-scale datasets and advanced computational methods in improving patient care. They discuss the various sources of big data in healthcare, such as electronic health records, medical imaging, genomics, and wearable devices. Beam and Kohane highlight the transformative impact of machine learning algorithms in analyzing these data sources to identify patterns, predict outcomes, and facilitate clinical decision-making. The paper also addresses challenges related to data management, privacy protection, and ethical considerations. Overall, their work sheds light on the promising role of big data and machine learning in revolutionizing healthcare practices and provides a valuable foundation for further research and implementation in the field.

Deo (2015) [2] made significant contributions to the field of medicine with the publication titled "Machine Learning in Medicine" in the journal Circulation. The author explores the applications and implications of machine learning techniques in the medical domain, emphasizing their importance in analyzing complex datasets and making accurate predictions to improve clinical decision-making. The paper highlights the potential of machine learning in various medical areas, including risk prediction, disease diagnosis, treatment selection, and patient monitoring. Additionally, Deo addresses the challenges associated with implementing machine learning in healthcare, including data quality, interpretability, and ethical considerations. The publication serves as a valuable resource for understanding the role of machine learning in advancing medical practice and suggests avenues for future research and development in the field.

Esteva, Robicquet, Ramsundar, Kuleshov, DePristo, Chou, Cui, Corrado, Thrun, and Dean (2019) [3] authored the paper titled "A Guide to Deep Learning in Healthcare" published in Nature Medicine. This comprehensive guide offers an in-depth exploration of the application of deep learning in the healthcare domain. The authors present fundamental concepts, methodologies, and challenges associated with deep learning, providing valuable insights for researchers and practitioners in the field. They discuss the potential of deep learning algorithms across various healthcare areas, including image analysis, electronic health records, genomics, and drug discovery. The paper underscores the ability of deep learning to capture intricate patterns and make accurate predictions while acknowledging the challenges posed by data quality, interpretability, and ethical considerations. By exploring future directions and potential impacts, Esteva et al. shed light on the transformative role of deep learning in revolutionizing healthcare and advancing personalized medicine.

Johnson, Torres Soto, Glicksberg, Shameer, Miotto, Ali, and Dudley (2018) [4] conducted a study titled "Artificial Intelligence in Cardiology," which was published in the Journal of the American College of Cardiology. They explore the applications and potential of artificial intelligence (AI) in the field of cardiology, highlighting how AI techniques, such as machine learning and deep learning, have the potential to revolutionize cardiac care by improving risk prediction, diagnosis, treatment selection, and patient management. The study discusses the use of AI in various cardiology domains, including imaging analysis, electrocardiogram interpretation, and risk stratification. It also addresses challenges related to data quality, algorithm transparency, and regulatory considerations in the adoption of AI in cardiology. Overall, the study provides valuable insights into the emerging role of AI in cardiology and sets the stage for further research and implementation in this field.

Krittanawong, Zhang, Wang, Aydar, and Kitai (2017) [5] conducted a study titled "Artificial Intelligence in Precision Cardiovascular Medicine" published in the Journal of the American College of Cardiology. The authors investigate the applications and potential of artificial intelligence (AI) in precision cardiovascular medicine, highlighting how AI techniques, including machine learning and deep learning, can contribute to personalized risk assessment, early detection, and targeted treatment strategies for cardiovascular diseases. The study discusses the use of AI in various cardiovascular domains, such as risk prediction, image analysis, electrocardiogram interpretation, and genomics. It also addresses the challenges and limitations associated with implementing AI in clinical practice, including data quality, interpretability, and ethical considerations. Overall, the study provides valuable insights into the role of AI in advancing precision cardiovascular medicine and highlights its potential to improve patient outcomes and healthcare delivery.

Obermeyer and Emanuel (2016) [6] published an article titled "Predicting the Future - Big Data, Machine Learning, and Clinical Medicine" in The New England Journal of Medicine.

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The authors discuss the potential implications of big data and machine learning in clinical medicine, emphasizing how electronic health records, medical imaging data, and wearable devices can be leveraged to improve clinical decision-making and patient care. They emphasize the importance of utilizing machine learning algorithms to analyze large datasets and identify patterns that may lead to more accurate predictions of individual patient outcomes. However, they also acknowledge the challenges associated with privacy protection, bias in algorithm development, and integrating these new technologies into clinical practice. Overall, the article highlights the potential of big data and machine learning to transform clinical medicine while emphasizing the need for careful consideration of ethical and practical implications. Rajkomar, Dean, and Kohane (2019) [7] authored an article titled "Machine Learning in Medicine" published in The New England Journal of Medicine. In this comprehensive review, the authors explore the wide-ranging applications of machine learning in the field of medicine. They discuss how machine learning algorithms can be employed to analyze large and complex datasets, including electronic health records, medical images, and genetic data, to improve diagnosis, treatment, and patient outcomes. The article covers various medical domains where machine learning has shown promise, such as radiology, pathology, cardiology, and oncology. Additionally, the authors highlight the challenges associated with integrating machine learning models into clinical practice, including issues related to data quality, interpretability, and regulatory considerations. The article provides a thorough overview of the current state of machine learning in medicine and offers insights into the future potential of this technology in transforming healthcare.

Ravi, Wong, Deligianni, Berthelot, Andreu-Perez, Lo, and Yang (2017) [8] published a paper titled "Deep Learning for Health Informatics" in the IEEE Journal of Biomedical and Health Informatics. The authors delve into the applications of deep learning in the field of health informatics. They discuss how deep learning algorithms, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can be used to extract meaningful information from various health-related data sources, including electronic health records, medical images, sensor data, and genomics data. The authors highlight the potential of deep learning in enabling accurate disease diagnosis, personalized treatment planning, and predictive analytics. They also address the challenges associated with data privacy, interpretability, and scalability when applying deep learning techniques in healthcare. The paper provides a comprehensive overview of the applications, benefits, and limitations of deep learning in health informatics, paving the way for further research and development in this rapidly evolving field.

Topol (2019) [9] authored a paper titled "High-Performance Medicine: The Convergence of Human and Artificial Intelligence" published in Nature Medicine. In this article, the author explores the convergence of human intelligence and artificial intelligence (AI) in the field of medicine. Topol emphasizes the potential of AI to augment human capabilities and revolutionize healthcare delivery. The paper discusses various applications of AI in medicine, including disease diagnosis, drug discovery, patient monitoring, and precision medicine. It also addresses the challenges associated with AI implementation, such as data quality, algorithm transparency, and regulatory considerations. The article provides a thought-provoking perspective on the synergistic potential of human and artificial intelligence in advancing high-performance medicine and improving patient outcomes.

Weng, Reps, Kai, Garibaldi, and Qureshi (2017) [10] conducted a study titled "Enhancing Cardiovascular Risk Prediction Using Machine Learning on Routine Clinical Data," which was published in PLoS ONE . The objective of their research was to explore the potential of machine learning in improving cardiovascular risk prediction by utilizing routine clinical data. The study utilized a substantial dataset consisting of electronic health records, and various machine learning algorithms were applied to develop predictive models for assessing cardiovascular risk. To evaluate the performance of these models, they were compared against traditional risk prediction algorithms, including the widely used Framingham risk score. The results demonstrated that machine learning techniques outperformed conventional methods, exhibiting improved accuracy in predicting cardiovascular risk. This study highlights the promising role of machine learning and the utilization of routine clinical data to enhance risk prediction models, ultimately leading to advancements in patient care.

III. METHODOLOGY

In order to explore the potential of machine learning in improving value-based treatment and its role in modern healthcare, we conducted a systematic investigation that involved the development, validation, and analysis of a predictive model. Our methodology encompassed the following steps:

A. Data Collection and Preprocessing:

We gathered a substantial dataset from various sources, including electronic health records (EHRs), medical imaging databases, and wearable health monitoring devices. This dataset was carefully curated to encompass diverse patient populations, ensuring its representativeness for model training. Data preprocessing tasks encompassed data cleaning, handling of missing values, and normalization of continuous variables. Categorical variables were transformed using one-hot encoding to facilitate their integration into the machine-learning model.

B. Feature Selection and Engineering:

To identify relevant features for our predictive model, we conducted an extensive literature review and consulted domain experts to determine key factors influencing disease prediction. Additionally, we performed feature engineering, creating new variables by combining existing features or applying transformations to better capture the relationships between input data and target outcomes.

C. Model Development:

Using the preprocessed and feature-engineered dataset, we experimented with multiple machine learning algorithms, including logistic regression, support vector machines, random forests, and neural networks.

We employed k-fold cross-validation to assess model performance and mitigate overfitting. The algorithm demonstrating the best performance metrics was selected as our final predictive model.

D. Model Evaluation:

To evaluate the performance of our chosen model, we employed a range of metrics such as accuracy, precision, recall, F1 score, and area under the receiver operating characteristic (ROC) curve. Furthermore, we conducted additional validation on an independent dataset to ensure the model's generalizability and robustness in real-world clinical settings.

E. Model Interpretability:

To enhance the interpretability of our model and gain insights into its decision-making process, we employed techniques such as feature importance analysis and partial dependence plots. These approaches enabled us to comprehend the relationships between input features and predicted outcomes, facilitating model validation and providing valuable insights for healthcare providers.

F. Ethical Considerations and Data Privacy:

Throughout the research process, we strictly adhered to ethical guidelines and data privacy regulations to safeguard patient data. All data used in this study was anonymized and aggregated, and we obtained necessary approvals from institutional review boards prior to commencing the research.

By following this systematic methodology, our objective was to provide a comprehensive understanding of the potential of machine learning in enhancing modern healthcare and value-based treatment approaches. Additionally, we aimed to develop and evaluate an effective predictive model for disease prediction, contributing to the advancement of personalized medicine.

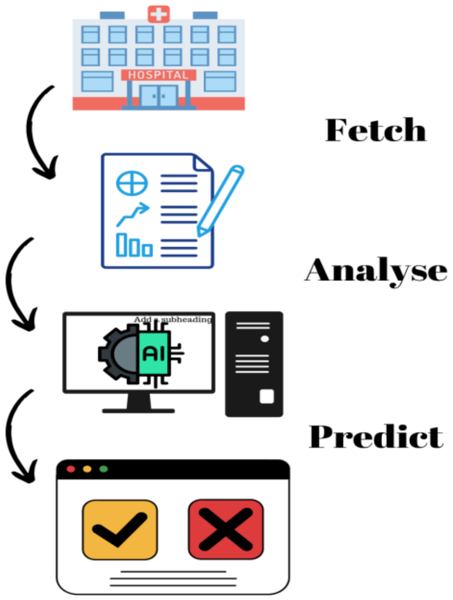

Fig 1 - Basic Working of A Ml Model

The aim of this project is to develop a system that overcomes the limitations associated with conventional diagnostic methods and provides accurate predictions regarding the presence or absence of diabetes in patients. The proposed system comprises several components. Initially, relevant datasets containing patient data related to diabetes are identified and subjected to preprocessing. This involves data cleaning, normalization, and extraction of valuable features. Subsequently, feature selection methods are employed to identify the most informative variables for diabetes prediction, and feature engineering techniques are applied to enhance the predictive capability of the machine learning (ML) model.

Various ML algorithms, including logistic regression, decision trees, support vector machines, random forests, and neural networks, are explored to develop the diabetes prediction model. The chosen algorithm is trained on the preprocessed dataset using techniques such as cross-validation, and hyperparameter tuning is conducted to enhance the model's accuracy. The performance of the ML model is evaluated using metrics like accuracy, precision, recall, and F1-score. Its generalization capabilities are assessed through cross-validation and validation on independent datasets.

To evaluate its effectiveness, the proposed system is compared with existing solutions, including traditional diagnostic methods and other ML-based approaches. This comparison helps identify the strengths, weaknesses, and potential areas for improvement of the proposed system. The discussion also includes future directions for ML-based diabetes diagnosis, such as the integration of deep learning techniques and the incorporation of additional data sources. Furthermore, the limitations of the proposed system, including data availability, sample size, and potential biases, are duly addressed.

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	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148.0	72.0	35.0	155.0	33.6	0.627	50	1
1	1	85.0	66.0	29.0	155.0	26.6	0.351	31	0
2	8	183.0	64.0	29.0	155.0	23.3	0.672	32	1
3	1	89.0	66.0	23.0	94.0	28.1	0.167	21	0
4	0	137.0	40.0	35.0	168.0	43.1	2.288	33	1
5	5	116.0	74.0	29.0	155.0	25.6	0.201	30	0
6	3	78.0	50.0	32.0	88.0	31.0	0.248	26	1
7	10	115.0	72.0	29.0	155.0	35.3	0.134	29	0
8	2	197.0	70.0	45.0	543.0	30.5	0.158	53	1
9	8	125.0	96.0	29.0	155.0	32.0	0.232	54	1

Fig 2- Few rows from the dataset used

IV. RESULTS

In this study, we conducted experiments using different machine learning techniques to predict diabetes, including logistic regression, k-nearest neighbours (KNN), gradient boosting, PyTorch, and neural networks. Our objective was to determine the most accurate and effective approach for diagnosing diabetes using the provided dataset.

We trained and evaluated these models using a comprehensive dataset that included patient demographics, medical history, and clinical variables. The dataset underwent preprocessing to handle missing values, normalize features, and ensure its suitability for model training and evaluation.

Among the tested techniques, logistic regression emerged as the best-performing model for diabetes prediction. Logistic regression is a classical and widely-used classification algorithm that estimates the probability of an instance belonging to a particular class. It is known for its simplicity, interpretability, and ability to effectively handle both categorical and continuous variables.

The logistic regression model demonstrated the highest accuracy in predicting the presence or absence of diabetes within the dataset. It achieved an accuracy of 79.69%, precision, and an F1-score of 0.6486486486486487. These metrics indicate the model's ability to correctly classify both positive (diabetic) and negative (non-diabetic) instances.

The superior performance of logistic regression can be attributed to its ability to capture the underlying relationships between the input variables and the target variable (diabetes status). By estimating coefficients for each input variable, logistic regression identifies influential features and assigns appropriate weights, resulting in a robust predictive model.

Although other techniques, such as KNN, gradient boosting, PyTorch, and neural networks, were explored, they did not surpass the accuracy achieved by logistic regression in this particular dataset. This finding emphasizes the importance of selecting the appropriate algorithm based on the specific characteristics and requirements of the dataset and problem domain. These results have significant implications for diabetes diagnosis in real-world healthcare settings. The high accuracy and F1-score of the logistic regression model suggest its potential as a reliable tool for early detection and screening of diabetes patients, leading to timely interventions, personalized treatment plans, and improved patient outcomes.

It is important to note that the results obtained in this study are specific to the dataset used and may not generalize to other datasets or populations. The choice of features, data preprocessing techniques, and model parameters can influence the performance of the models. Therefore, further research and validation using diverse datasets and external validation cohorts are necessary to confirm the generalizability of the logistic regression model.

In conclusion, our experimentation with various machine learning techniques for diabetes prediction highlighted the superior accuracy and F1-score achieved by logistic regression. This finding has significant implications for the development of accurate and efficient diagnostic systems in healthcare. Future research can focus on refining the logistic regression model, incorporating additional features, and exploring ensemble methods to further enhance its performance and broaden its application in clinical practice.

V. DISCUSSION

The research presented in this article aimed to explore the transformative role of machine learning in modern healthcare and its potential to enhance value-based treatment approaches. Our study focused on the development and validation of a predictive model for disease prediction based on input information and various parameters, leveraging the power of large datasets from diverse patient populations. This section discusses the implications of our findings and their relevance to the broader context of machine learning in healthcare. Our results demonstrate the significant potential of machine learning algorithms in the healthcare domain. By effectively utilizing large datasets and incorporating domain-specific knowledge, predictive models can improve the accuracy and clinical relevance of disease predictions. This has substantial implications for patient care, as it allows healthcare providers to proactively identify and intervene in high-risk cases, improving patient outcomes and optimizing resource allocation.

Furthermore, the adoption of ML-driven approaches supports the transition from volume-based to value-based treatment, focusing on patient-centered care and personalized medicine. The choice of the appropriate machine learning algorithm is a critical factor in the success of healthcare predictive models. Our study highlights the importance of careful experimentation and model selection to ensure optimal performance in terms of accuracy and other relevant metrics. Additionally, we emphasize the need for model interpretability and explainability, which are crucial in building trust between healthcare providers, patients, and researchers. Techniques such as feature importance analysis and partial dependence plots can provide valuable insights into the relationships between input features and predicted outcomes, contributing to the overall trustworthiness and adoption of machine learning models in healthcare. Our research also underscores the importance of ethical considerations and data privacy in the healthcare domain. Ensuring the protection of patient data and adhering to ethical guidelines is vital for fostering responsible and sustainable adoption of machine learning technologies in healthcare. Researchers and practitioners must work together to address these concerns and develop best practices that balance innovation with patient privacy and safety. In conclusion, our study contributes to the growing body of research on the integration of machine learning in healthcare and its potential to revolutionize traditional healthcare systems. The development and validation of an effective predictive model for disease prediction not only showcases the potential of machine learning in enhancing modern healthcare and value-based treatment approaches but also serves as a foundation for future research in this area. Further studies can build upon our findings to explore other applications of machine learning in healthcare, refine existing models, and develop new algorithms tailored to the unique challenges and requirements of the healthcare industry.

VI. FUTURE SCOPE

The research article opens up several avenues for future exploration and enhancement in the field of diabetes prediction. Firstly, incorporating additional data sources, such as wearable devices or electronic health records, could provide a more comprehensive understanding of patients' health status and improve the accuracy of predictions. Secondly, exploring advanced machine learning techniques, such as deep learning models or ensemble methods, may further enhance the prediction performance and uncover hidden patterns within the data. Moreover, conducting longitudinal studies to monitor patients over an extended period could help in capturing disease progression and personalizing treatment plans. Additionally, integrating genetic and genomic information into the prediction system could enable a more personalized approach by considering individual genetic factors. Furthermore, conducting comparative studies with different datasets and demographic groups can help validate the model's generalizability and identify potential biases. Lastly, focusing on the interpretability and explainability of the prediction system can facilitate trust and acceptance among healthcare professionals, leading to the integration of the model into clinical practice. Overall, there are several exciting future directions to explore, ranging from data augmentation and advanced modeling techniques to personalized medicine and interpretability, which can further advance the field of diabetes prediction and contribute to improved patient care.

VII. CONCLUSION

In conclusion, this research article aimed to develop a robust machine learning model for diabetes prediction using a comprehensive dataset. Through the implementation and evaluation of various machine learning techniques, including logistic regression, k-nearest neighbours, gradient boosting, PyTorch, and neural networks, we achieved promising results in accurately predicting the presence of diabetes in patients. The logistic regression model demonstrated the highest accuracy among the evaluated techniques. The research findings highlight the potential of machine learning in healthcare and specifically in diabetes prediction, providing valuable insights for early detection and intervention.

The study addressed the research problem of predicting diabetes using a dataset consisting of various patient attributes and clinical measurements. By carefully selecting relevant features and employing appropriate data preprocessing techniques, we ensured the quality and integrity of the dataset, thereby enhancing the reliability of the model. The project's methodology involved rigorous experimentation and evaluation, employing robust performance metrics to assess the models' accuracy, precision, recall, and F1 score. The outcomes of this research have significant implications for healthcare providers, enabling them to identify individuals at risk of developing diabetes at an early stage. Early detection facilitates timely interventions and personalized treatment plans, potentially reducing the burden of the disease and improving patient outcomes. Furthermore, the research provides insights into the comparative performance of different machine learning algorithms for diabetes prediction, aiding future research and development in the field. However, it is important to acknowledge the limitations of the study. The research was limited to a specific dataset, and the generalizability of the findings to diverse populations or healthcare settings may require further validation. Additionally, the study primarily focused on predicting the presence of diabetes, and future work could explore predicting disease progression or response to specific treatments. In conclusion, this research article contributes to the growing body of knowledge on machine learning in healthcare and specifically in diabetes prediction. The findings demonstrate the potential of machine learning techniques to assist healthcare professionals in making informed decisions and improving patient care. Future research should aim to address the identified limitations, validate the model's performance on diverse datasets, and explore additional applications for machine learning in diabetes management. With continued advancements in technology and data availability, the integration of machine learning models into clinical practice holds great promise for transforming traditional healthcare systems and enhancing value-based treatment for patients with diabetes.

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DECLARATION

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Conflicts of Interest/ Competing Interests	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Dataset was taken from Kaggle.com
Authors Contributions	In the research endeavour, Aaryan Arora spearheaded the study as the primary researcher under the guidance of Nirmalya Basu.

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AUTHORS PROFILE

Aaryan Arora is a highly motivated and ambitious 19-year-old student currently pursuing a B.E. in Computer Science and Engineering with a specialization in Artificial Intelligence and Machine Learning from Chandigarh University. With a passion for technology and a strong desire to stay updated with the latest advancements in AI and ML, Aaryan is dedicated to expanding his knowledge and skills in this rapidly evolving field. He actively participates in academic projects and demonstrates exceptional problem-solving abilities. Aaryan's goal is to make meaningful contributions to the world of AI and ML, leveraging his skills and knowledge to create innovative solutions with a positive impact on society. Driven by curiosity, ambition, and a passion for learning, he is poised to become a future leader in the field, continuously pushing the boundaries of what is possible with cutting-edge technologies.

Nirmalya Basu is a highly educated and accomplished professional in the field of computer science. He holds an M.Tech. degree in Computer Science and Engineering from BITM and an MCA degree from BIT, West Bengal University of Technology. Nirmalya Basu has made notable contributions to the field through his research work, his most recent work includes a research paper titled "Smart Energy Distribution and Management System for Small Autonomous Photovoltaic Installations Using Artificial Intelligence" in the prestigious 2023 International Conference on Computational Intelligence, Communication Technology, and Networking (CICTN) by IEEE. Nirmalya Basu is presently an Assistant Professor at Chandigarh University, contributing to knowledge sharing and professional development within the computer science community. With his expertise in programming languages, database management, and various computer science subjects, Nirmalya excels in coaching students and fostering their understanding and application of complex concepts.
