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MEDICAL BASED DECISION SUPPORT SYSTEM FOR DIABETES AND REVERS DIABETES USING ML ALGORITHM

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Abstract: Diabetes is a chronic metabolic disorder characterized by persistently high blood glucose levels, either due to inadequate insulin production or the body's impaired response to insulin. Managing confidential healthcare data is crucial due to the widespread prevalence and significant health impacts of diabetes. Despite its global significance, there is a lack of real-time applications for early prediction and dietary guidance for diabetes this application seeks to address this issue by creating an application that provides early diabetes predictions and identifies potential reversals through advanced machine learning technique KNN offers tailored dietary plans. This real-time medical system, developed using Microsoft tools like Visual Studio and SQL Server offer significant advantages for hospitals, providing valuable support for their operations. doctors. This system achieves 92.2%accurate result in prediction of diabetes and reverse diabetes using KNN Algorithm.

Keyword: KNN, Diabetes Chronic, Machine Learning

I. INTRODUCTION

Diabetes mellitus, a collection of metabolic disorders, is a leading cause of death among patients. impacting millions globally. Early detection is crucial due to the potential for serious complications that can arise condition. Numerous studies have investigated diabetes identification, typically focusing on complex techniques without thoroughly comparing common methods. Diabetes is characterized by increased blood sugar levels, leading to symptoms such as more urination, more thirst, hunger, and weight loss. Without ongoing treatment, diabetes can result in life-threatening complications. Diagnosis generally involves measuring a 2-hour post-load plasma glucose level importance of timely identification to prevent serious health outcomes. An automation for diabetes prediction using efficient machine learning algorithms is crucial. This real-time application would provide significant support to hospitals and healthcare providers in managing patients more effectively. Our proposed system is designed to improve disease management and treatment. prediction processes, enabling healthcare professionals to deliver superior patient care.

II. RELATED WORK

MD Kamrul Hasan et al [1] address the challenges in accurately predicting diabetes due to limited labeled data and outliers in datasets. The authors propose a robust framework for diabetes prediction using the Pima Indian Diabetes Dataset, incorporating preprocessing steps like outlier rejection, filling missing values, data standardization, feature selection, and K-fold cross-validation. Various machine learning models, including K-Nearest Neighbors, Decision Trees, Random Forest, AdaBoost, Naive Bayes, XGBoost, and Multilayer Perceptron, were utilized, with a weighted ensembling approach proving most effective. The proposed model outperformed existing methods, demonstrating the importance of comprehensive preprocessing and model ensembling in improving diabetes prediction.

Priya K Lakshmi et al [2] Introduces an innovative approach to diabetes prediction by leveraging advanced data mining techniques and machine learning algorithms. The proposed system surpasses traditional methods by integrating a web interface that processes inputs such as insulin levels and age. By applying information mining in the medical domain, the research underscores the significance of accurate dataset classification for effective healthcare decision-making. Explores various algorithms, including k-nearest neighbor (KNN) and k-means, to identify key factors contributing to diabetes. It also introduces a cloud-based prediction model and a computerized insulin delivery system.

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Additionally, an internet-based AI application is developed to facilitate diabetes detection and management. Further innovates by combining chemical sensors and biomarkers with Naive Bayes machine learning techniques, enabling diabetes assessment without prior preparation. Unlike existing systems that rely on Support Vector Machines (SVM), the Naive Bayes classifier enhances prediction accuracy through its simplicity, minimal data requirements, and superior performance in handling large datasets. This system highlights the advantages of Naive Bayes in terms of operational efficiency and reduced query recovery time while addressing challenges related to data preprocessing and training. Future work will focus on improving patient information accuracy and expanding datasets to further enhance prediction reliability and early disease detection.

Sidong Wei, Xuejiao Zhao and Chunyan Miao et al [3] Investigates the application of various machine learning techniques for diabetes identification and prediction, focusing on models such as Deep Neural Networks (DNN), Decision Trees, Support Vector Machines (SVM), Logistic Regression, and Naive Bayes. Building on earlier studies, including the pioneering "ADAP" algorithm by J.W. Smith in 1988 and subsequent models like Asha's hybrid Genetic Algorithm and Back Propagation Network, this System aims to explore, compare, and optimize these classifiers. The experiment involves selecting the best data preprocessors, optimizing classifier parameters, and comparing their performance. Data preprocessing techniques such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), imputation, scaling, and normalization were evaluated, with scaling significantly improving accuracy across all classifiers. The Pima Indian diabetes dataset, which contains eight critical features related to diabetes onset, was used to test these classifiers. DNN, with its dense layers mimicking neural networks, emerged as the most effective model, achieving optimal accuracy after parameter optimization. The study highlights the importance of preprocessing, careful feature selection, and the role of DNN in enhancing the accuracy of diabetes prediction. Future work should focus on further improving DNN's performance, possibly by incorporating advanced techniques like drop-out layers and regularization. This comprehensive analysis underscores the potential of machine learning in the timely diagnosis of diabetes, ultimately aiding in the prevention of life-threatening complications.

Durgadevi M and R Kalpana et al [4] Presents the performance of five classification approaches—Ant-Miner, CN2, Radial Basis Function (RBF) network, Bagging, and Adaboost—in predicting type II diabetes mellitus using three datasets: PIMA, US, and AIM’94. Data mining's role in clinical research has grown, driven by the need for non-linear analysis, increased data availability, and overworked medical professionals. Predictive analytics, using algorithms to enhance diagnostic accuracy, supports physicians in decision-making without replacing their expertise. The Ant-Miner method demonstrated the highest performance, particularly due to its simple rule set, which aids in predicting diabetes, though its effectiveness varied across datasets. RBF showed low agreement with the PIMA dataset but performed better with the other datasets. Adaboost maintained consistent performance across all datasets, while Bagging underperformed with PIMA and AIM’94 but showed moderate agreement with the US dataset. Future research could focus on hybrid algorithms to further improve classification accuracy, aiming for a perfect agreement level indicated by a kappa value of 1.

Lakshmi K S and G Santhosh Kumar et al [5] Introduces a novel method for extracting valid association rules from medical transcripts, focusing on the associations between diseases, symptoms, medications, and the most prominent age groups for developing specific diseases. By integrating Natural Language Processing (NLP) tools with data mining algorithms like Apriori and FP-Growth, the study effectively uncovers patterns in medical records, particularly concerning diabetic disorders. The methodology involves processing both unstructured and semi-structured documents, extracting relevant medical terms using UMLS ontology, and generating association rules in forms such as SYMPTOM → DISEASE and DISEASE → MEDICINE. The use of support, confidence, and lift measures ensures the relevance and accuracy of the rules. While the study highlights the utility of this method in identifying co-occurring diseases and treatment patterns, it notes that a larger dataset could reveal new insights. The findings demonstrate that this approach is clinically valid and can be extended to other medical domains, offering a valuable tool for processing and analyzing vast amounts of medical data.

Berina Alic, Lelja Gurbeta and Almir Badnjevic et al [6] Provides a comprehensive overview of the application of Artificial Neural Networks (ANNs) and Bayesian Networks (BNs) in classifying diabetes and cardiovascular diseases (CVD), based on a review of literature published between 2008 and 2017. It highlights that multilayer feedforward neural networks, particularly those utilizing the Levenberg-Marquardt algorithm, are the most commonly employed type of ANN, consistently demonstrating superior performance in classification tasks. In contrast, while Naive Bayesian Networks are favored for their simplicity and speed, they tend to exhibit slightly lower performance compared to ANNs in both diabetes and CVD classification. A comparative analysis of 20 selected papers reveals that ANNs consistently outperform BNs, indicating that ANNs offer a more reliable approach for early disease classification. The study underscores the effectiveness of ANNs in medical classification tasks and emphasizes the critical role of machine learning models in enhancing early diagnosis and treatment planning.

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Jian-Xun, Chen, Shih-Li, Su, and Che-ha Chang et al [7] Introduces an innovative system for generating personalized diabetes care plans using a combination of Case-Based Reasoning (CBR) and ontology reasoning. The system automates the process of creating tailored care plans by matching patient profiles with a case database and consulting a diabetes care ontology when no direct match is found. The system's modular design includes user interface, CBR, ontology reasoning, and knowledge construction modules, enabling it to provide consistent and efficient diabetes care while conserving medical resources. The system highlights the importance of integrating expertise from various healthcare fields to build a comprehensive care ontology, and it outlines the system's potential for expansion to other chronic diseases. The study emphasizes that this approach not only enhances care quality but also paves the way for future decision support systems in healthcare. This details the development, functionality, and potential applications of a personalized diabetes care system.

Slone, Elliot B, Nilmini Wickramasignhe and Steve Goldberg et al [8] Discusses the development and pilot testing of an innovative, low-cost, cloud-based diabetes coaching support system designed to improve patient compliance and diabetes management on a global scale. The system leverages affordable cloud technology to empower trained diabetes coaches to monitor and support patients remotely, addressing the limitations of traditional methods such as phone calls and home visits. By using this approach, the system aims to reduce the burden on healthcare providers while maintaining effective patient care. This initiative addresses the growing global diabetes crisis by integrating wireless monitoring and coaching, offering a scalable solution that enhances patient compliance and supports healthcare systems facing financial constraints. It outlines the development, objectives, and potential impact of a novel cloud-based diabetes coaching system.

Alotaibi Maryam M et al [9] Introduces the SAED system, an intelligent mobile diabetes management and educational tool designed for type 2 diabetes patients in Saudi Arabia. The system comprises two main components: a mobile patient/healthcare provider interface and an intelligent diabetes management module that includes a database, decision support based on fuzzy logic, SMS reminders, and an educational module. Developed in collaboration with Kingston University's MINT Research Centre, the SAED system aims to optimize daily blood glucose monitoring, treatment, and lifestyle management without imposing restrictions on patients. The system is tailored to meet the specific needs of Saudi patients, leveraging the widespread use of smartphones in the country to deliver effective mobile health services. Future research will evaluate the system's effectiveness through a long-term trial in Saudi Arabia, including testing its impact on HbA1c levels and assessing its usability through questionnaires. outlines the development, objectives, and future evaluation plans of the SAED system.

Imane Chakour et al [10] Introduces a novel multi-agent system for diabetes diagnosis that leverages machine learning algorithms to enhance diagnostic accuracy. It evaluates three well-known algorithms—artificial neural networks (ANN), support vector machines (SVM), and logistic regression (LR)—within a multi-agent framework, where a controller agent aggregates their outputs through a majority vote. This approach addresses the challenges and gaps in integrating machine learning algorithms with multi-agent systems, aiming to improve distributed diagnostic support. The system, implemented using the Jade platform, features agents dedicated to classification and data handling, and uses the Weka tool for algorithm processing. The proposed method demonstrates improved performance by combining the strengths of different models and provides a robust solution for diagnosing diabetes from a comprehensive dataset. The paper outlines the implementation, evaluation, and future development of this agent-based machine learning system, emphasizing its potential to advance medical diagnostic processes. This provides an overview of the paper's objectives, methods, and contributions, highlighting the development of a multi-agent system for enhancing diabetes diagnosis through machine learning techniques.

Palerm Cesar C et al [11] Evaluates a mathematical model designed to simulate glucose and insulin dynamics specifically for type 1 diabetic patients, a critical step in developing closed-loop insulin delivery systems. Unlike previous models derived from non-diabetic subjects, this study uses data from hyperinsulinemic-euglycemic clamp experiments with meal challenges in type 1 diabetic patients to optimize model parameters.

By integrating the subcutaneous insulin infusion model from Wilinska et al. with the existing Hovorka model, the study demonstrates that the model can accurately capture individual patient dynamics, making it a reliable tool for simulating patient behavior under experimental conditions. The research further addresses the challenges of parameter estimation in glucose metabolism models by employing a hybrid optimization approach that combines global and local methods, resulting in improved accuracy and performance. The findings support the model's potential as a foundation for further development, including the incorporation of factors like circadian variations, physical activity, and stress responses, essential for advancing closed-loop control systems for diabetes management. Provides a comprehensive overview of the study's objectives, methodologies, and outcomes, highlighting its contribution to the development of more accurate and individualized models for insulin delivery systems in type 1 diabetes.

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Santhosh Kumar Sharma et al [12] presents a comprehensive approach to enhancing diabetes detection, focusing on the application of machine learning within a cloud-based environment. Recognizing the critical need for early detection of diabetes, particularly in rural areas with limited healthcare access, the study proposes an automated eHealth cloud system that leverages an Extreme Learning Machine (ELM) as an Artificial Neural Network (ANN) for classification tasks. The methodology involves several stages, including data preprocessing, feature selection using Principal Component Analysis (PCA), and classification via ELM. The cloud-based system is designed to offer continuous healthcare services, utilizing three virtual machines (vCPU-4, vCPU-8, and vCPU-16) to optimize performance. The research highlights the importance of feature normalization and the efficacy of feature selection techniques such as PCA, Information Gain Attribute Selection, and Linear Discriminant Analysis (LDA). The proposed model has been tested in both standalone and cloud environments, with extensive experimentation comparing the ELM's performance to other traditional classifiers like KNN, Naive Bayes, MLP, RF, DT, and SVM. The study emphasizes the model's ability to overcome challenges associated with traditional ELM, such as random weight initialization and large hidden node requirements, by tuning hidden layer nodes and leveraging cloud resources. The proposed system demonstrates significant potential for real-time diabetes detection, offering a scalable solution that can be adapted for various healthcare applications, including remote monitoring and early diagnosis in underserved communities.

Fareeha Anwar a, Qurat-Ul-Ain a, Muhammad Yasir Ejaz a, Amir Mosavi et al [13] explores the significant advances in diabetes diagnosis using various machine learning and deep learning techniques. The study highlights the importance of early diabetes detection to prevent severe complications such as kidney failure, stroke, blindness, heart attacks, and limb amputation and includes a comprehensive survey of different methodologies over the last decade, utilizing datasets like the Pima Indian Diabetes Dataset (PIDD), ECG signals, and retinal images. Techniques discussed include Backpropagation Neural Networks, Feed Forward ANN, Small World FANN, Support Vector Machines, fuzzy logic, and hybrid models combining deep learning with statistical methods. The study also covers the application of convolutional neural networks (CNNs), ECG signal processing, E-Nose technology, and Bayesian network classifiers in diabetes diagnosis. Additionally, the research emphasizes the need for more public diabetes datasets and suggests combining deep learning with other algorithms for enhanced accuracy. The study provides a critical analysis of these approaches, noting that while deep learning models like CNNs and DNNs offer promising results, they require significant computational resources. The study concludes by advocating for further exploration of heart rate-based methods due to their lower bandwidth and computational complexity, which could facilitate deployment on mobile or cloud platforms.

KM Jyoti Rani et al [14] Presents results from high blood glucose levels due to insulin deficiency or resistance, leading to severe health complications such as blindness, kidney failure, and heart disease. This study involved the classification of diabetic patient data using various machine learning algorithms, including Naïve Bayes, J48, REP Tree, and Random Tree, applied to a dataset from hospital warehouses. The research explored multiple approaches, such as using Decision Tree and Naïve Bayes algorithms for faster detection, examining patterns within the PIMA dataset, and addressing the class imbalance problem using the CART algorithm. Additional methods like k-Nearest Neighbors, logistic regression, and Decision Tree classifiers were also evaluated for their effectiveness in predicting diabetes. The study highlights the potential for extending and improving the automation of diabetes analysis and suggests the application of these machine learning algorithms to diagnose other diseases in future work.

Ivan Contreras, Josep Vehi [15] highlights the significant potential of artificial intelligence (AI) to transform diabetes management through various applications. These studies focus on critical management areas, including blood glucose control strategies, prediction of blood glucose levels, detection of adverse glycemic events, insulin bolus calculators, risk and patient stratification, and lifestyle support systems. AI techniques like fuzzy learning, artificial neural networks, and reinforcement learning have been applied to develop tools for personalized glycemic control, optimize insulin delivery, and enhance decision-making in diabetes care. Additionally, AI has been used in the development of decision support systems, particularly for Type 2 Diabetes (T2D) and gestational diabetes (GDM), aimed at improving adherence to treatment, promoting lifestyle modifications, and preventing complications. The system demonstrates AI's growing role in enhancing diabetes management, particularly in closed-loop systems and predictive models, suggesting a promising future for AI-driven advancements in this field.

Many research works done on predicting diabetes disease using efficient machine learning algorithms and methods, few works just presented idea and few works done implementation. Several papers have utilized tools like Python, R, and Weka, focusing on static datasets lacking real-time applications or the ability for reverse diabetes prediction. In practice, doctors usually perform manual diagnoses on patients. based on various tests, a process demanding substantial medical expertise, time, equipment, and expense. The proposed system offers an innovative method for predicting and reversing diabetes through machine learning techniques. learning algorithms. Unlike earlier models that relied on static data, this system works with dynamic datasets.

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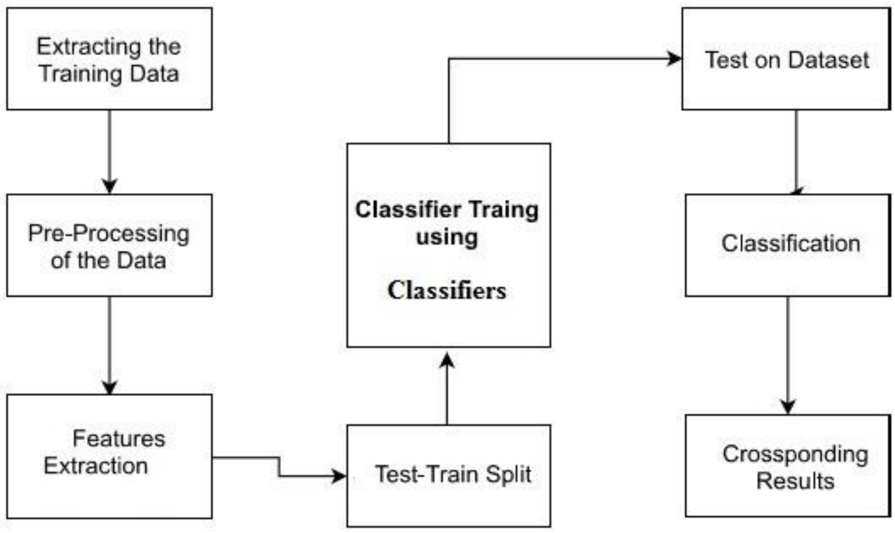
It is designed as a GUI-based application for hospitals, enhancing the experience for both doctors and patients. unique development. This real-time application harnesses machine learning models for immediate predictions, a feature not previously realized. By clicking a single button, the system can predict the likelihood of diabetes. and reverse diabetes. It employs a broader range of parameters and larger datasets for prediction, thereby enhancing accuracy and reliability. he current approach has several drawbacks, including the exclusion of reverse diabetes prediction and the limitation of previous works to theoretical models. There is a noticeable absence of real-time implementations, with a reliance on static datasets, which restricts the system's adaptability to new data. Additionally, the process demands considerable time and requires the use of specialized medical equipment, further contributing to higher cost implications.

III. PROPOSED METHODOLOGY

Medical datasets containing disease information undergo processing through machine learning algorithms. Particularly, supervised learning algorithms are utilized to scrutinize these datasets, with the goal of attaining high accuracy and efficiency. By employing these advanced algorithms enhanced outcomes are achieved. Diabetes and Reverse Diabetes Prediction Process.



A. Extracting Data:

The dataset is collected from https://www.kaggle.com/datasets/saurabh00007/diabetescsv. Which contains parameters like Age, Gender, BMI, HbA1c level, Smoking history, Hypertension, Heart disease, and Blood Glucose level.

B. Pre-processing of the data

data preprocessing, which is essential for preparing the raw data for analysis. This involves tasks such as cleaning the data, handling missing values, normalizing or standardizing the data, and removing any outliers. Preprocessing ensures that the data is in a suitable form for model training, improving the model's performance and robustness.

C. Feature extraction

Feature extraction involves selecting the relevant parameters for the model. In this case, the selected features might include:

Age: The patient's age.
Gender: Male or Female.
BMI: Body Mass Index, a measure of body fat.
HbA1c level: A measure of blood sugar levels over the past three months.
Smoking history: Whether the patient has a history of smoking.
Hypertension: Whether the patient has high blood pressure.
Heart disease: Whether the patient has heart disease.
Blood Glucose level: The current blood sugar level of the patient.

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D. Test-Train Split:

The dataset is split into two parts:
Training Set: Used to train the KNN model. Typically, 70-80% of the data is used for training.
Test Set: Used to evaluate the model's performance. The remaining 20-30% of the data is reserved for testing.

E. Classifier Training using KNN:

The KNN algorithm is trained using the training dataset. The KNN classifier predicts the outcome that is diabetic, non-diabetic, or potential for diabetes reversal) based on the proximity of a data point to its nearest neighbors in the feature space.

F. Test on Dataset:

The trained KNN model is then tested on the test dataset to assess its performance. This step involves using the model to predict the diabetes status for the test data and comparing these predictions to the actual outcomes.

G. Classification:

For each data point in the test set, the KNN classifier predicts whether the patient has diabetes, does not have diabetes, or is showing signs that might indicate the potential for diabetes reversal.

H. Results Discussion

We have develop a real-time application designed to benefit society, utilizing Microsoft technologies. Our project focuses on utilizing diabetes datasets trained using the K-nearest neighbors (KNN) algorithm, yielding highly promising results. Our KNN algorithm implementation is designed to handle dynamic inputs effectively. datasets efficiently. With our proprietary KNN library, we have achieved an impressive accuracy rate of approximately 92.2%. Moreover, our prediction process operates swiftly, typically completing within 1500 milliseconds. Constraint KNN Algorithm Accuracy 92.2 % Time (milli secs) 1606 Incorrectly Classified (Recall) 7.8 %.

IV. CONCLUSION

Diabetes is a significant factor in global death rates. Detecting this condition early can significantly impact outcomes, prompting the building of machine learning models. Our system is dedicated to pinpointing and potentially reversing diabetes by analyzing specific parameters. It aids healthcare Experts in early diabetes prediction play a crucial role in enabling timely and personalized interventions. Leveraging a variety of ML methods enhances the accuracy of predictions. Through automation, our system employs efficient data science or machine learning algorithms, notably utilizing the effective supervised learning technique KNN Algorithm. This approach efficiently processes medical data to produce predictive insights. In this work we got an accuracy of 92.2% using KNN algorithm. Future work Our system currently provides general diet recommendations, but it lacks patient-specific guidance, which could be enhanced by incorporating personalized diet recommendations. Additionally, a query module could be introduced, enabling patients to post questions to doctors and receive tailored responses. Expanding the size of the datasets and including more parameters would improve the accuracy of diabetes prediction. Furthermore, adding a module for patient appointments would streamline the process of scheduling consultations, enhancing overall system functionality.

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