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# AI for Diabetes Management

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**ABSTRACT**

Diabetes is a chronic metabolic disorder that affects millions of people worldwide and poses significant health risks if left untreated. Early detection of diabetes and its complications such as retinopathy and nephropathy are crucial for timely intervention and patient recovery. This report explores the use of decision tree-based algorithms, including Random Forest and XG Boost, to predict diabetes risk based on indicators of retinopathy and nephropathy . Using Django and SQLite, we develop a predictive model and evaluate its accuracy for early diagnosis and preventive treatment.

Keywords: Retinopathy , Nephropathy ,XG Boost.

## Introduction

Artificial intelligence (AI) has emerged as a promising tool in the field of healthcare, offering innovative solutions for disease management, diagnosis and treatment. In diabetes management, AI has significant potential for early detection and intervention of complications such as diabetic retinopathy and nephropathy. These complications are the most common consequences of diabetes, often leading to vision loss and kidney damage if left untreated. Using artificial intelligence technologies to monitor and manage these complications could revolutionize patient care, enabling timely interventions and improving outcomes.

Diabetic retinopathy is a microvascular complication of diabetes characterized by damage to the blood vessels in the retina. It is the leading cause of visual impairment and blindness among working adults worldwide. Diabetic nephropathy refers to kidney damage caused by diabetes, leading to a progressive decline in kidney function and eventually end-stage kidney disease. Early detection and treatment of diabetic nephropathy are critical to prevent complications and improve long-term outcomes in patients with diabetes.

Diabetes is a widespread and long-term disease that affects millions of people worldwide. If not treated properly, it can cause serious health problems. Early detection of diabetes and its complications such as retinopathy (eye damage) and nephropathy (kidney damage) are critical for early treatment and better patient outcomes. This project investigates the use of special computer programs called decision tree-based algorithms, Random Forest and XG Boost to predict diabetes risk based on signs of retinopathy and nephropathy. We use a combination of Django and SQLite tools to build a predictive model. This model helps us determine how likely someone is to develop diabetes and whether we can treat them in time to prevent it from getting worse of.

## 2.Methodlogy and Analysis.

- **Data Collection:** Obtain a dataset containing relevant features such as patient demographics, medical history, retinopathy and nepropathy indicators, and diabetes status.
- **Data Preprocessing:** The important steps involved in data preprocessing, including handling missing values, coding categorical variables, and normalizing numerical characteristics to ensure the suitability of the data set for model development.
- **Feature Selection Techniques:** Discuss the various feature selection techniques used to identify the most influential predictors of diabetes risk assessment, with special emphasis on indicators of retinopathy and nephropathy.
- **Model Development Strategies:** Decision Trees: Explain the construction of decision tree models to classify individuals into diabetic and non-diabetic classes based on selected characteristics. –

  Random Forest: Describe the construction of decision trees to improve forecast accuracy and model reliability.

` XG Boost: Introduce the implementation of gradient boosting using decision trees and highlight its role in improving prediction performance.

- **Model Evaluation Metrics:** Provide a comprehensive evaluation of each model using standard metrics such as precision, accuracy, recall, and F1 scores derived from cross-validation and validation analysis of data.
- **Integration with Django and SQLite**: Web Application Development: Describe the process of developing a user-friendly web application using the Django framework to implement a predictive model. - Backend Database Management: Explain the use of SQLite as a backend database to store user data and model predictions, ensuring seamless integration and efficient data management.

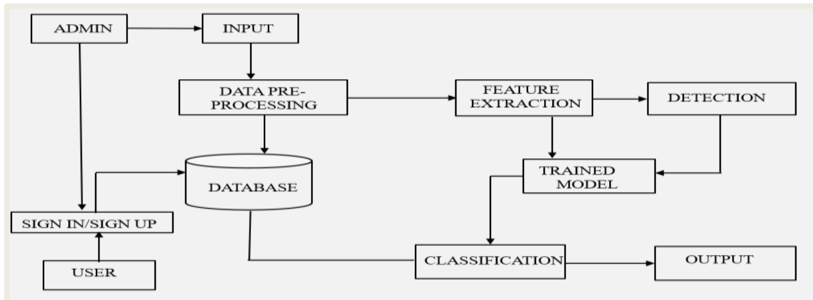


Fig 1.Architecture diagram

Fig 1 shows an architectural diagram where the system administrator is probably responsible for managing the system, where the system administrator uses the user's diabetes report to enter the diabetes user report into the system. Enter here the initial data that will be entered into the system. Data preprocessing helps us prepare the data for a machine learning model. This may include data cleansing, data transformation and data scaling. Feature extraction separates features from data. Features are the characteristics of the data that a machine learning model uses to make predictions. A trained model is a machine learning model trained on a dataset of identified data. With the help of the model, predictions can be made based on new, never-before-seen data. The database stores the data used by the system Login/Register function allows users to login to the system or create a new account to access the details of the generated reports. Classification uses a trained model to classify new data. The output is the result of the classification process. The result can be shown to the user, which is stored in the database. The user here is the person who interacts with the system. The user can see the result produced by the system.

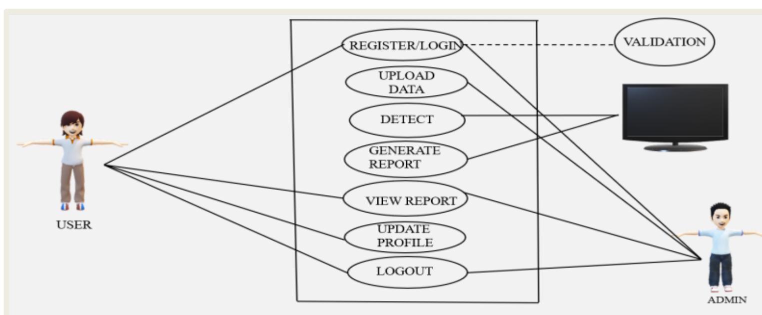


Fig 2.Usecase diagram

Fig 2 shows the use case diagram here. Registration/login verification helps the user interact with the system to register a new account or log in to an existing account. The system verifies the user's credentials. The administrator downloads the stream from the user report. The use case is a system that automatically detects whether a patient has diabetes or not. The system generates a report based on the uploaded data or the detection process. The user views the report generated by the system. The user updates their profile information. The user logs out of the system.

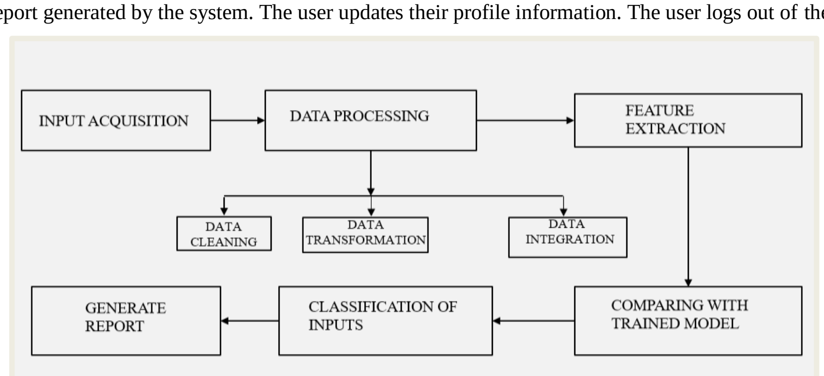


Fig 3. Block Diagram

Fig 3 shows a block diagram. Data Cleaning refers to the process of cleaning the raw data. Data cleaning may involve removing errors, inconsistencies, and missing values from the data. Data Transformation block refers to the process of transforming the data into a format that is suitable for further processing. Data transformation involves formatting the data, scaling the data, or encoding the data. Data Integration refers to the process of combining data from multiple sources into a single dataset. Data Comparison refers to the process of comparing data with other datasets or with a predefined set of rules. Data comparison may be used to identify outliers, anomalies, or trends in the data..

Feature Extraction refers to the process of extracting features from the data. Features are the characteristics of the data that will be used by a machine learning model. Data Processing is a general term that refers to any process that is applied to the data. Data processing may involve variety of techniques, those are as filtering, sorting, aggregating, or analyzing the data. Generate Report refers to the process of generating a report that summarizes the results of the data processing. The report may be presented in text format.

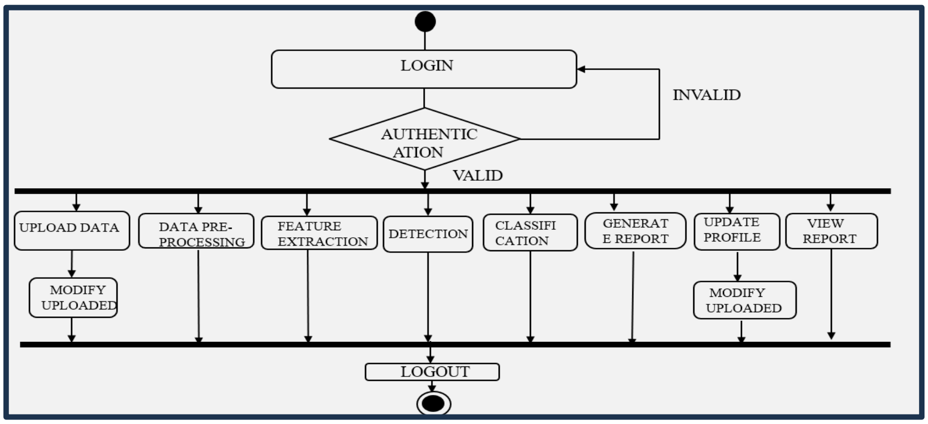


Fig 4. Activity Diagram

An activity diagram visually represents the flow of actions and decisions within the system. It is a type of flow diagram used in the Unified Modeling Language (UML) to describe the behavioral aspects of a system, especially the successive steps of a process. Fig 4 shows the operation diagram. Login is the first function where the user enters his credentials (username and password) to access the system. Validation : The system checks the credentials provided by the user to determine if they are valid. Two results are possible: Valid and Invalid. If the credentials are valid, the system will proceed to the next function, after which the user will be notified and likely redirected to the login function. After a successful login, the function allows the system administrator to upload data to the system. The system preprocesses the downloaded data. This may require cleaning, transforming or formatting the data to prepare it for further processing. The system extracts properties from the data. Features are characteristics of data that can be used for analysis. The system classifies the data according to the extracted features. The system prepares a report based on the uploaded data and classification results. The user can also update their profile information. The user can view reports generated by the system. The user logs out of the system.

## 3.Algorithm Steps

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|---|---|
| **Step 1: Data Collection**<br>**Step 2: Preprocessing**<br>**Example: Resize images to 100x100 pixels and normalize pixel values**<br>**def preprocess_image(image):**<br>**resized_image = tf.image.resize(image, (100, 100))**<br>**normalized_image = resized_image / 255.0 # Normalize pixel values**<br>**return normalized_image**<br>**Step 3: Feature Extraction using CNN**<br>**model = models.Sequential([**<br>**layers.Conv2D(32, (3, 3), activation='relu', input_shape=(100, 100, 3)),**<br>**layers.MaxPooling2D((2, 2)),**<br>**layers.Conv2D(64, (3, 3), activation='relu'),**<br>**layers.MaxPooling2D((2, 2)),**<br>**layers.Conv2D(64, (3, 3), activation='relu'),**<br>**layers.Flatten(),**<br>**layers.Dense(64, activation='relu'),**<br>**layers.Dense(1, activation='sigmoid')**<br>**])** | **Step 4: Model Selection**<br>**model. Compile(optimizer='Adam',**<br>**loss='binary_crossentropy',**<br>**metrics=['accuracy'])**<br>**Step 5: Training**<br>**Assuming X_train, y_train, X_test, y_test are prepared**<br>**X_train, X_val, y_train, y_val = train_test_split(X_train, y_train, test_size=0.2, random_state=42)**<br>**history = model.fit(X_train, y_train, epochs=10, batch_size=32, validation_data=(X_val, y_val))**<br>**Step 6: Evaluation**<br>**y_pred = model.predict(X_test)**<br>**y_pred_binary = (y_pred > 0.5).astype(np.int32)**<br>**accuracy = accuracy_score(y_test, y_pred_binary)**<br>**precision = precision_score(y_test, y_pred_binary)**<br>**recall = recall_score(y_test, y_pred_binary)**<br>**f1 = f1_score(y_test, y_pred_binary)**<br>**print("Accuracy:", accuracy)**<br>**print("Precision:", precision)**<br>**print("Recall:", recall)**<br>**print("F1 Score:", f1)** |

## Result and Discussions

The training process involves optimizing the model parameters using the Adam optimizer and minimizing binary crossentropy loss across 10 epochs with a batch size of 32. Training and validation metrics, including accuracy and loss, are monitored to prevent overfitting. Evaluation on a separate test set assesses the model's generalization performance, with metrics such as accuracy, precision, recall, and F1 score indicating its effectiveness in detecting diabetes-related retinopathy and neuropathy. High accuracy reflects generalizability, while precision and recall balance false positives and negatives. Continuous monitoring and potential optimizations are vital for ensuring the model's reliability and effectiveness in real-world applications.

## 4.Conclusion

Overall, our project concludes that, Users following personalized exercise recommendations, food recommendations and utilizing predictive analytics are expected to experience better blood glucose control. The user-friendly interface and tailored recommendations are anticipated to increase user engagement, promoting consistent data input and interactions. The integration of predictive analytics enables users and healthcare professionals to make informed decisions, leading to proactive adjustments in treatment plans.

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