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Multiple Health Disease Prediction

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***Abstract*: Predicting multiple health diseases using machine learning (ML) has become increasingly vital for early diagnosis and intervention. The proposed solution focuses on developing robust and accurate predictive models that can simultaneously forecast the likelihood of multiple health conditions based on individual patient data. The dataset comprises diverse health parameters, including lifestyle factors, and clinical indicators.**

***Keywords*: Machine Learning, SVM, Random Forest, Gradient Boosting.**

1. Introduction

Multiple Disease Prediction has become a critical area of research and application in the field of healthcare, aiming to forecast the likelihood of individuals developing multiple diseases. This proactive approach leverages advanced technologies, particularly machine learning algorithms, to analyze complex datasets comprising patient information, medical histories, genetic markers, lifestyle factors, and environmental influences. By identifying patterns, trends, and risk factors across various diseases, Multiple Disease Prediction plays a pivotal role in early detection, risk and personalized intervention strategies. The traditional Healthcare paradigm often focuses on diagnosing and treating diseases after their onset, which may result in higher healthcare costs and sub optimal patient outcomes. In contrast, Multiple Disease Prediction shift s the paradigm towards preventive healthcare, enabling healthcare providers to identify individuals at high risk of developing multiple diseases and intervene proactively. This shift not only improves patient outcomes but also contributes to cost savings by reducing the burden of advanced disease management.

The integration of machine learning algorithms such as Support Vector Machine (SVM), Random Forest and Gradient Boosting has significantly enhanced the accuracy and effectiveness of Multiple Disease Prediction models. These algorithms excel in handling diverse data types, capturing nonlinear relationships, and identifying intricate patterns that may not be apparent through traditional statistical methods alone.

As the healthcare landscape continues to evolve with advancements in technology and data analytics, Multiple Disease Prediction holds immense promise for improving population health, optimizing healthcare resource allocation, and fostering a preventive healthcare approach. This research paper aims to explore the principles, methodologies, applications, challenges, and future directions of Multiple Disease Prediction, highlighting its potential impact on public health, clinical practice, and healthcare policy.

2. Motivation

Early Intervention and Prevention: Early intervention enables preventive measures and lifestyle interventions to reduce the likelihood of disease development.

Reduction in Healthcare Costs: By addressing health issues at an earlier stage, the overall financial burden on healthcare systems can be minimized.

Promoting Health Awareness: The project aspires to contribute to the promotion of health awareness by providing users with valuable information about their health risks. In essence, the project is driven by a commitment to utilize technology for the betterment of public health, with a focus on early detection and prevention of diseases.

3. Objectives

1. Improved Patient Outcomes: To timely predict the diseases can lead to more effective and targeted treatment plans.
2. Precautionary Measures and Advice: To Prioritize user education and health awareness.
3. Medical Consultant Recommendation: To emphasize the importance of seeking professional medical advice for accurate diagnosis and treatment.
4. Promote Health Awareness: To point out the importance of adopting preventive healthcare practices and making informed decisions about lifestyle choices.
5. To create an impactful health prediction system that contributes to disease prevention and overall improvements in public health outcome.

4. Literature Survey

The literature survey explores the landscape of multiple health disease prediction using machine learning algorithms, focusing on the advancements and challenges in this field. It investigates existing studies and research on disease prediction models for various diseases such as diabetes, mental health disorders, and cardiovascular disease (CVD). The survey aims to identify gaps in current knowledge and guide the development of the project by understanding the

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methodologies, algorithms, and datasets used in similar studies.

Comparing different supervised machine learning algorithms for disease prediction: This research aims to identify key trends among different types of supervised machine learning algorithms like Support Vector Machine (SVM), Naïve Bayes (NB), Random Forest (RF), Logistic Regression (LR), Decision Tree (DT), and Artificial Neural Network (ANN), their performance accuracies, and the types of diseases being studied like breast cancer, heart disease, diabetes, and Parkinson's disease. In addition, the advantages and limitations of different supervised machine learning algorithms are summarized which will help readers better understand current trends and hotspots of disease prediction models using supervised machine learning algorithms and formulate their research goals accordingly [1].

Multi disease prediction model using improved SVM radial bias technique in healthcare monitoring system:

This research attempted to study comparative performances of different supervised machine learning algorithms in disease prediction. It is found that the Support Vector Machine (SVM) algorithm is applied most frequently (in 29 studies) followed by the Naïve Bayes algorithm (in 23 studies). However, the Random Forest (RF) algorithm showed superior accuracy comparatively. Of the 17 studies where it was applied, RF showed the highest accuracy in 9 of them, i.e., 53%. This was followed by SVM which topped in 41% of the studies it was considered [2].

Heart Disease Prediction:

Several studies have explored the use of machine learning, including Support Vector Machine (SVM), for heart disease prediction. Rajendra Acharya (2017) developed an SVM based model to predict heart disease using a combination of demographic, clinical, and electrocardiogram (ECG) features. Their study achieved high accuracy in detecting heart disease, underscoring the potential of SVM in this domain.

Additionally, Paniagua (2019) utilized SVM to predict heart disease based on features such as blood pressure, cholesterol levels, and medical history. These studies highlight the applicability and effectiveness of SVM in heart disease prediction [3].

Multiple disease prediction using Machine learning algorithm: In this paper, machine learning algorithms- support vector machine (SVM), Naïve Bayes and decision tree are used. Despite the fact that various data mining classification algorithms exist for predicting heart disease, there is inadequate data for predicting heart disease in a diabetic individual. The decision tree model consistently beat the Naive Bayes and SVM models, author says it for best performance in forecasting the likelihood of heart disease in diabetes individuals [4].

Multiple Disease Prediction System: System uses different algorithms like Decision Tree, Naïve Bayes, SVM, ANN, KNN, Random Forest algorithms and chooses the algorithm with the best accuracy for each of the disease. Diabetes disease prediction model used KNN algorithm, heart disease prediction model uses the XGboost algorithm and liver disease prediction model use the random forest algorithm as they gave the best accuracy accordingly. The UI eases the use and accepts the valid range of inputs and predict the disease [5].

Multiple Disease Prediction Using Machine Learning: This research paper involves comparing multiple training models, selecting the SVM model based on its high accuracy, implementing the model using libraries such as pandas, numpy, scikit-learn, and pickle, and integrating the trained model into an application for disease prediction. Focusing on heart disease, diabetes, and Parkinson's diseases, they utilized the single model i.e. Support Vector Machines (SVM) model to develop a multi-disease prediction framework with a high accuracy [6].

Heart disease prediction using machine learning techniques:

Classification algorithms based on supervised learning which is a type of machine learning can make diagnoses of cardiovascular diseases easy. Algorithms like K-Nearest Neighbor (KNN), Random Forest are used to classify people who have a heart disease from people who do not. Two supervised machine learning algorithms are used in this paper which are, K- Nearest Neighbor (K-NN) and Random Forest. The prediction accuracy obtained by K- Nearest Neighbor (K-NN) is 86.885% and the prediction accuracy obtained by Random Forest algorithm is 81.967% [7].

Disease prediction from various symptoms using Machine Learning: Different machine learning models were used to examine the prediction of disease for available input dataset. But they used Weighted KNN model which was of high accuracy, because in the weighted KNN model the value of K varied. This value changed according to their dataset i.e. it was small and large for the training set. Due to this variation, it proved to be the most accurate model as compared to the other ML algorithms. They utilized raw information and distinguished them on the basis of gender, age group, and symptoms [8].

Feasible Prediction of Multiple Diseases using Machine Learning: The system employs a comprehensive dataset of medical records and symptoms of various diseases, which are then analyzed using machine learning techniques such as decision trees, support vector machines, and random forests.

The system's predictions are highly accurate, and it can assist medical professionals in making more informed decisions and providing better treatment plans for patients. Ultimately, the viable multiple disease prediction system using Machine Learning has the potential to improve healthcare outcomes and reduce healthcare costs by predicting and preventing disease early [9].

Multi-Disease Prediction Using Machine Learning Algorithm: The current system does a great job predicting illnesses by analyzing patient symptoms with the Naive Bayes method, showing high accuracy in tests. To make it even better, we could explore advanced machine-learning techniques like deep learning for improved accuracy and efficiency. By expanding the dataset to include a wider range of patients and illnesses, we could enhance the system's performance. Making the technology user- friendly in clinical settings through an intuitive interface accessible to both patients and healthcare professionals would further boost its effectiveness, ultimately leading to better patient outcomes and improved healthcare delivery [10].

Table 1
Literature Survey

S. No.	Title	Author	Year	Description
1	Multiple Disease Prediction System	Ankush Singh et al.,	2022	System uses different algorithms like Decision Tree, Naïve Bayes, etc. and chooses the algorithm with the best accuracy for each of the disease. Diabetes disease prediction model used KNN algorithm, heart disease uses theXGboost algorithm and liver uses the random forest algorithm as they gave the best accuracy accordingly [1].
2	Multiple Disease Prediction Using Machine Learning	Prashant et al.,	2023	Focusing on heart disease, diabetes, and Parkinson's disease. They utilized the single model i.e. Support Vector Machines (SVM) model to develop a multi-disease prediction framework with a high accuracy [2].
3	Disease prediction from various symptoms using machine learning	Rinkal Keniya, et al.,	2020	Weighted KNN model is used which is of high accuracy, because in the weighted KNN model the value of K varied [3].
4	An Approach to Detect Multiple Health Diseases Using Machine Learning Algorithm	Indukuri Mohit et al.,	2021	The aim is to develop a disease- predicting web app that uses the concept of machine learning- based predictionsabout various diseases like Breast cancer,Diabetes, and heart diseases. Support Vector Machine, Random Forest and Naïve Bayes algorithms were used to predict the diseases [4].
5	Heart Disease Prediction	Rajendra Acharya et al.,	2017 2019	Several studies have explored the use of machine learning, including SVM, for heart disease prediction. Authordeveloped an SVM based model topredict heart disease using a combinationof demographic, clinical and electrocardiogram (ECG) features. This utilized SVM to predict heart disease based on features such as blood pressure,cholesterol levels, and medical history [5].
6	Comparison with Other Models in multi-disease prediction	Ahmad et al.,	2019	Several studies have compared SVM with other machine learning algorithms fordisease prediction compared SVM with Random Forest and Artificial Neural Networks (ANN) for heart disease prediction, demonstrating the competitive performance of SVM in terms of accuracy and interpretability [6].
7	Machine Learning for Disease Prediction	Liang et al.,	2015 2019	Liang (2019) employed SVM to predict multiple diseases based on electronic health records, demonstrating the model'sefficacy in identifying disease patterns. Similarly, Deo (2015) utilized SVM fordisease prediction using clinical data,emphasizing the importance of featureselection and model optimization Techniques [7].
8	Comparing different Supervised machine learning algorithms for disease prediction.	Shahadat Uddin et al.,	2019	The advantages and limitations of different supervised machine learning algorithms are summarized. This research aims to identify key trends among different types of supervised machine learning algorithms [8].
9	Multi-disease prediction model using improved SVM-radial bias technique in healthcare monitoring system.	Karthikeyan et al.,	2020	This research attempted to study comparative performances of different supervised machine learning algorithms in disease prediction. SVM topped in 41% of the studies it was considered [9].
10	Feasible Prediction of Multiple Diseases using Machine Learning	Banoth Ramesh et al.,	2023	The system employs a comprehensivedataset of medical records and symptoms of various diseases, which are then analyzed using machine learning techniques such as decision trees, support vector machines, and random forests [10].
11	Multiple disease prediction using Machine learning algorithm	K. Arumugam et al.,	2021	The paper utilizes machine learning algorithms (support vector machine, naive Bayes, decision tree) to predict heartdisease. Notably, the decision tree consistently outperforms naive Bayes and support vector machine, demonstrating superior effectiveness in forecasting heart disease, particularly in individuals with diabetes [11].
12	Multi-Disease Prediction Using Machine Learning Algorithm	Visumathi J et al.,	2023	Besides using Naïve Bayes and otheralgorithms, and to make it even better, advanced machine-learning techniques likedeep learning for improved accuracy and efficiency can be explored. By expanding the dataset to include a wider range of patients and illnesses, and making the technology user-friendly in clinical settings the system's performance could be enhanced [12].

An Approach to Detect Multiple Health Diseases Using Machine Learning Algorithm: This work was made seamless and usable by the mass public. The team made a medical test web application that makes predictions about various diseases using the concept of machine learning. In this work, their aim to develop a disease-predicting web app that uses the concept of machine learning-based predictions about various diseases like Breast cancer, Diabetes, and heart diseases. Support Vector Machine, Random Forest and Naïve Bayes algorithms were used to predict the diseases [11].

Machine Learning for Disease Prediction: Machine learning models have been extensively utilized for disease prediction in various domains. Liang (2019) employed SVM to predict multiple diseases based on electronic health records, demonstrating the model's efficacy in identifying disease patterns. Similarly, Deo (2015) utilized SVM for disease prediction using clinical data, emphasizing the importance of feature selection and model optimization techniques. These studies establish the relevance and effectiveness of machine learning algorithms in disease prediction [12].

5. System Design

In the system design phase, we determined UML diagrams, which provide us with a clear overview of the system even before we start the coding phase, as well as facilitate the coding process by defining functions, roles, classes, and interactions between users.

Using UML techniques, we built:

- Architecture diagram
- Use Case diagram
- Class diagram
- Sequence diagram

Architecture diagram:

The machine learning algorithm is trained on a set of data, which may include training data, data transformation and processed data. This data can include user input such as symptoms. The algorithm then learns from this data to identify patterns and relationships between the symptoms and diseases. Once trained, the algorithm can be used to predict diseases based on new user input

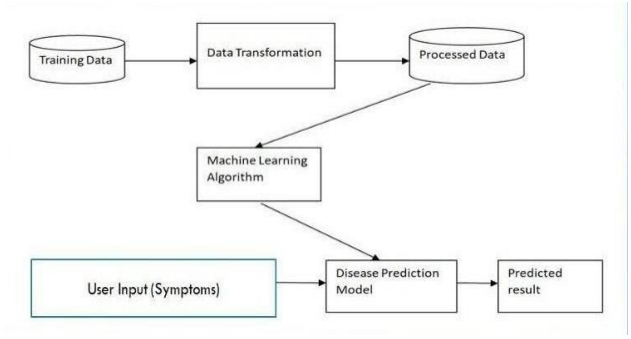

Fig. 1. Architecture diagram

Use Case Diagram:

The benefit of use case diagrams is mostly based on communication between the request team and the user group. A use case specification document should cover the following areas:

- Actors - participating in and interacting in this use case.
- Preconditions - must be met for the use case to work.
- Unconditional - defines the various states in which the system is expected to be after it is executed. The Use Case diagram lists the basic events that will occur when the system is executed. It includes all the primary actions that the system must perform.

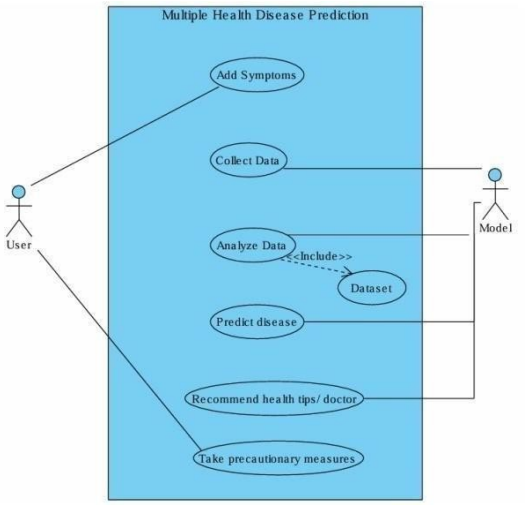

Fig. 2. Use case diagram

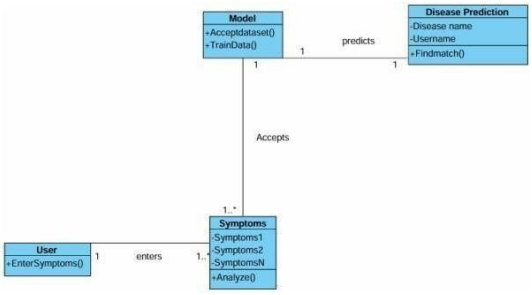

Fig. 3. Class diagram

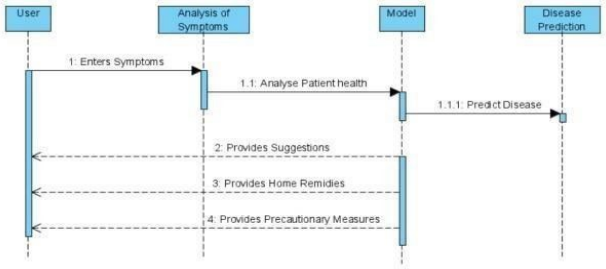

Fig. 4. Sequence diagram

6. Methodology

The proposed methodology involves utilizing multiple training models for disease prediction, comparing their performance, and implementing the Support Vector Machines (SVM) model, Random Forest ensembled with Gradient Boosting among which SVM achieved a high accuracy of 89%. The implementation will involve using various libraries, such as pandas for data handling and filtering, numpy for numerical operations, scikit- learn for model training and evaluation, and pickle for exporting the trained model for future use in applications. Sub module of scikit-learn is used for data preprocessing tasks like scaling and label encoding.

Data Handling and Filtering:

- Public Datasets: Existing anonymized datasets with health information can be used for training purposes.

This collected data will be a mix of:

- Demographic: Age, gender, ethnicity etc.
- Clinical: Lab results, diagnoses, medications etc.
- Biometric: Blood pressure, heart rate, sleep data etc.
- Lifestyle: Diet, exercise, smoking habits etc.

Data Handling and Filtering:

The first step in the project implementation is to handle and filter the data using the pandas library. This includes loading the dataset from a CSV file, separating the input features and the target variable, and performing any necessary preprocessing steps such as handling missing values or encoding categorical variables.

SVM Model Training:

Based on the comparison results, the SVM model, which achieved the highest accuracy of 89% will be selected for further implementation. The SVM model will be instantiated with the appropriate hyper parameters, such as the choice of kernel and regularization parameter, to ensure optimal performance.

Random Forest Model Training:

During prediction, Random Forest aggregates the predictions of all the individual trees to make a final prediction. This aggregation reduces over fitting compared to a single decision tree and often leads to more robust and accurate predictions. Random Forest also provides valuable insights into feature importance, making it useful for understanding the underlying relationships within the data. Overall, its ability to handle high-dimensional data, handle missing values, and reduce variance while maintaining accuracy makes it a widely used and trusted algorithm in the machine learning community.

Gradient Boosting Model Training:

Gradient Boosting is a powerful ensemble learning technique that combines multiple weak learners, typically decision trees, to create a strong predictive model. Here, Gradient Boosting is ensembled with Random Forest and voting is done between both of them. During the training process, Gradient Boosting works iteratively to improve the model's accuracy by sequentially fitting new models to the errors made by the previous models. It starts by fitting an initial model to the data and then fitting subsequent models to the residuals or errors of the previous models. Each new model focuses on reducing the errors that the previous ones couldn't capture effectively. This iterative process continues until a predefined number of models are created or until a specified level of accuracy is reached. Gradient Boosting is known for its ability to handle complex relationships in data, handle missing values, and avoid over fitting, making it a popular choice for various machine learning tasks, including regression and classification problems.

Model Selection (Prediction) and Comparison:

Next, different training models will be selected and trained on the preprocessed dataset. The models will be trained to predict the disease in accordance to the dataset. In addition to SVM, other models such as random forest and gradient boosting will be considered. Random Forest and gradient boosting will be ensembled to get more accuracy. Each model will be evaluated using appropriate metrics like accuracy, precision, recall, this step will allow for a comprehensive comparison of the models performance.

Finalizing the Trained Model:

Once the SVM, Random Forest and Gradient boosting model is trained and fine-tuned, it will be finalized. This will allow the model to be saved in a serialized format and used in future applications without the need for retraining. The exported model can be loaded and used to make predictions on new data points, enabling disease prediction in real- world scenarios.

7. Working

User visits the home page where he/she needs to click on the “let’s predict” button. Once they click on “let’s predict” button, the user will be redirected to next page where they can read live health news. Upon clicking on that, it will be redirected to the web page of the news. Further scrolling down, the lists of diseases are present. The user should select the appropriate disease. After selecting the disease, the user accesses the ‘prediction page’.

A. For Diabetes

a. They fill in details such as age and also the other symptoms such as polyuria, polydipsia, sudden weight loss and weakness etc. for diabetes.
b. Upon successful submission of the details, the result page is displayed where the result is given (either diabetic or non- diabetic) along with advice, suggestions/precautionary measures.

B. For Mental Health Disorder

a. They fill in details required.
b. Upon successful submission of the details, a result page is opened containing the three disorders, those are bipolar type-1, bipolar type-2 depression and normal along with advice, suggestions/precautionary measures.

C. For Cardiovascular

a. They fill in the necessary details.
b. After successful submission of the details, the result is occurred in the result page along with advice, suggestions/precautionary measures.

8. Results

By comparing SVM, Random Forest (RF) and Gradient Boosting (GB), SVM performed the best among other two machine learning classifiers with the accuracy of 89.80%. SVM was used to build the model for diabetes prediction.

Table 2

Techniques	Accuracy (%)
RF and GB	81.08
SVM	89.80

At the beginning the user will be in the Home page. The user will click “Let’s Predict”.

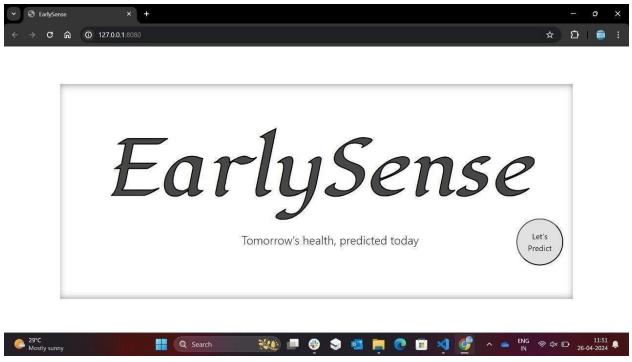

Fig. 5.

Once the user clicks on “Let’s Predict”, the user will be redirected to home page where live news about healthcare will be updated. Scroll to the page for further details.

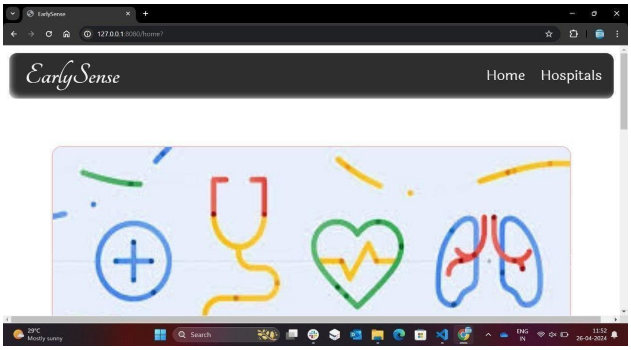

Fig. 6.

After scrolling, the user will get the list of diseases. Here the user can check whether he/she is prone to those diseases or not. The user can click any one from the list of diseases.

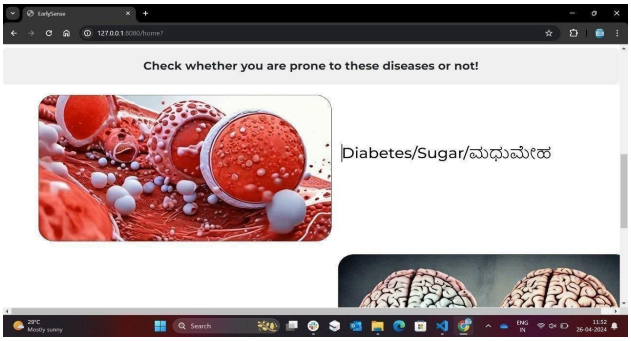

Fig. 7.

If the user clicks on “Diabetes”, the user will be redirected to the symptoms page. This is done through support vector machine algorithm. In this page the user needs to answer in Yes/No to the listed symptoms. After answering the symptoms, the user should click “Predict”.

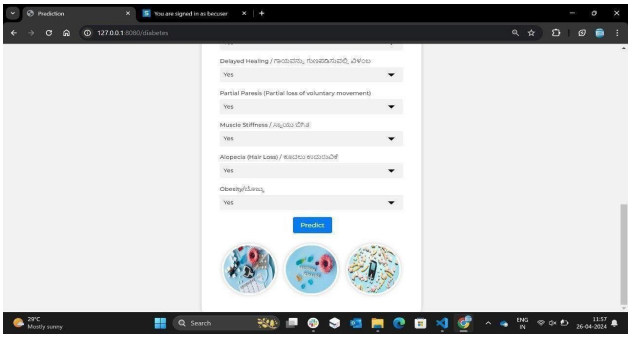

Fig. 8.

The user will be redirected to result page where the result is displayed whether the user has diabetes or not based on the provided information. In addition, the home remedies and suggestions are also displayed in the result page.

If the user clicks on “Mental Health Disorder”, the user will be redirected to the symptoms page. This is done using random forest and gradient boosting algorithm. In this page the user needs answer any one of the options (seldom, most often, sometimes or usually) to the listed symptoms. After answering the symptoms, the user should click “Predict”.

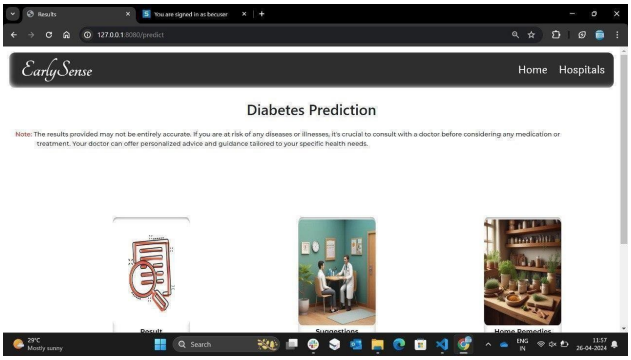

Fig. 9.

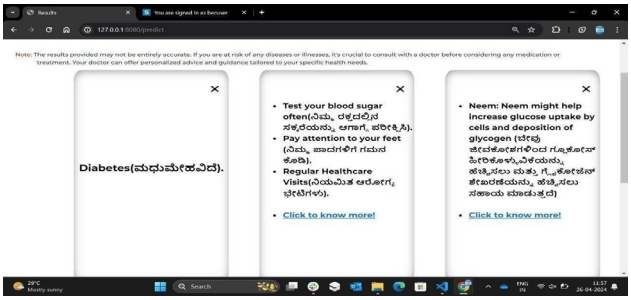

Fig. 10.

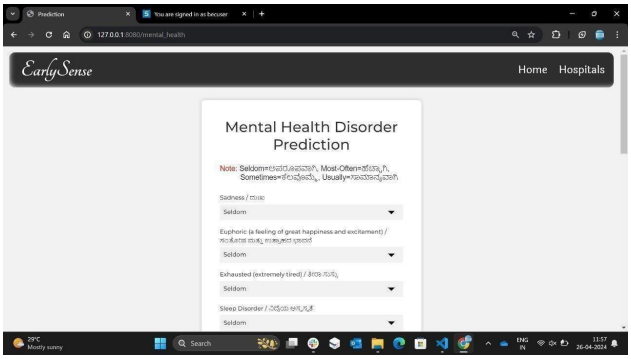

Fig. 11.

The user will be redirected to result page where the result is displayed whether the user has mental Health disorder or not based on the provided information. In addition, the remedies are also displayed in the result page.

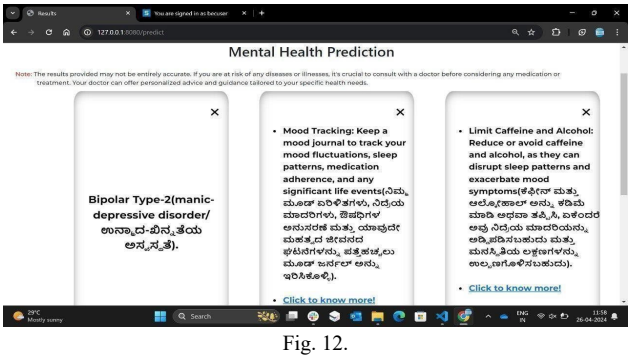

Fig. 12.

If the user clicks on “cardiovascular disease”, the user will be redirected to the symptoms page. This is done using random forest and gradient boosting algorithm. In this page the user needs to provide the required information. After filling in the

information, the user should click “Predict”.

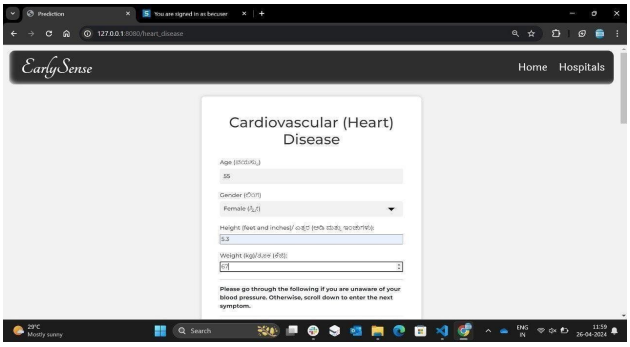

Fig. 13.

The user will be redirected to result page where the result is displayed whether the user has cardiovascular disease not based on the provided information. In addition, the home remedies and suggestions are also displayed in the result page.

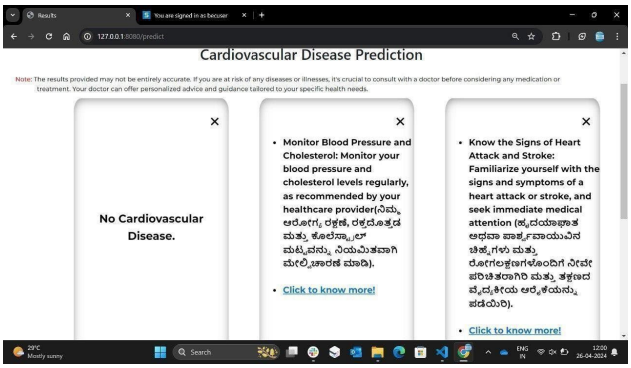

Fig. 14.

9. Conclusion

Explored the application of machine learning techniques for the prediction of multiple diseases, with a specific focus on cardiovascular disease, diabetes, and Mental health disorder. We utilized the Support Vector Machines (SVM), Random Forest, Gradient boosting model to develop a multi-disease prediction framework and achieved a high accuracy of 89% from SVM model. The findings of this study demonstrate the potential of machine learning in revolutionizing disease prediction and improving patient outcomes. The implementation of the all three model involved handling and filtering the data using libraries like pandas, performing model selection and comparison, training and fine tuning the SVM model, evaluating its performance, and exporting the trained model for future use. The integration of the trained model into an application enables disease prediction in real-world scenarios, empowering healthcare professionals, researchers, and individuals to make informed decisions regarding disease risk assessment and management. Accurate disease prediction using machine learning models has the potential to facilitate earlyinterventions, personalized treatment plans, and targeted disease management strategies. It can assist healthcare providers in making informed decisions, enhance patient care, and improve resource allocation within healthcare systems. The literature survey conducted as part of this research project highlighted the growing body of knowledge on machine learning based disease prediction, specifically focusing on the application of SVM, Random Forest, Gradient boosting models. Comparative analyses with other machine learning algorithms, feature selection techniques, and optimization methods were explored, providing valuable insights for future research.

10. Future Work

Incorporating additional data sources, such as genetic information, lifestyle data, and environmental factors, could enhance the accuracy and effectiveness of disease predictions. Exploring advanced machine learning algorithms like deep learning and ensemble methods may further improve prediction accuracy. Developing personalized treatment plans based on predictions, including prevention strategies and lifestyle recommendations, is a key focus for future work. Additionally, collecting user feedback to improve the system and collaborating with healthcare providers for better integration into clinical practice are important steps. Ensuring data security and privacy, expanding the scope to include more diseases, implementing real- time health monitoring, and providing tools for long-term health management are also part of the future plans.

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