International Journal of Applied Mathematics
Volume 38 No. 11s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

ARTIFICIAL INTELLIGENCE FRAMEWORK FOR ACCURATE DIABETES CLASSIFICATION USING ENSEMBLE LEARNING

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Abstract

Diabetes mellitus is a rapidly increasing chronic metabolic disorder that presents considerable difficulties for worldwide healthcare systems due to its widespread occurrence, protracted diagnosis, and related consequences. Accurate early prediction of diabetes is essential for prompt treatment initiation and efficient disease control. When dealing with complicated clinical data, traditional diagnostic methods and single machine learning classifiers can have trouble with accuracy, overfitting, and generalisation. This article introduces an AI framework for precise diabetes classification with ensemble learning techniques to overcome existing constraints. The proposed architecture incorporates trimmed bagging, weighted model aggregation, and layered ensemble artificial neural networks to enhance prediction accuracy and reliability. A meta-learner combines the findings of several basic classifiers that were trained on different parts of the data to make better decisions. Pruning procedures are used to get rid of learners that aren't needed, make the process easier, and lower the chance of overfitting. Weighted voting also helps make accurate classification better. The model's performance is measured using accuracy, precision, recall, F1-score, and AUC on typical diabetic datasets. The experiment shows that the suggested ensemble architecture is more accurate, stable, and reliable than standalone neural network models and traditional machine learning. The method that was created is a useful clinical decision support tool for finding diabetes early and figuring out how likely someone is to have the disease. This leads to better healthcare analytics and better outcomes for patients.

Keywords: Artificial Intelligence, Diabetes, Classification**,** Disease.

Introduction

Diabetes is a big problem in the field of health care that affects millions of people throughout the world. In medicine, classifying diabetes is very important because it helps doctors figure out what kind of diabetes a patient has and how it is becoming worse so they can treat it properly. During the classification procedure, it is determined if a person has kind 1, Type 2, or gestational diabetes. Each kind needs a different kind of treatment. Correct classification helps make personalised treatment strategies and also helps patients get better. It is hard to classify diabetes because it is caused by many different things, including genetics, the environment, and lifestyle. Conventional approaches frequently depend on biochemical assays

Received: Aug 03, 2025

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and clinical assessments, which, while efficient, may occasionally lack precision in differentiating between diabetes subtypes. Researchers and doctors have both made it a priority to improve the accuracy of diabetes classification. Thanks to emerging technologies, especially artificial intelligence (AI) and machine learning, we have new ways to completely change this process. We can use AI to make more complex models that make diabetes classification more accurate and efficient. This is a promising step towards personalised healthcare.

Methodology

The proposed research develops an Artificial Intelligence framework for accurate diabetes classification using ensemble learning techniques. The overall methodology consists of systematic stages including data acquisition, preprocessing, feature engineering, model development, ensemble integration, and performance evaluation to ensure reliable and robust disease prediction. Initially, benchmark diabetes datasets are collected from clinical repositories and publicly available healthcare databases. The acquired raw data undergo preprocessing to improve quality and consistency. This stage includes handling missing values through imputation, removing noisy and inconsistent records, detecting outliers, and applying normalization or standardization to scale numerical features. Categorical attributes are encoded to ensure compatibility with machine learning algorithms. Subsequently, feature selection is performed to reduce dimensionality and enhance predictive performance. Techniques such as Recursive Feature Elimination (RFE), correlation analysis, and Principal Component Analysis (PCA) are employed to identify the most informative attributes while eliminating redundant and irrelevant features. This step improves computational efficiency and prevents overfitting.In the model development phase, multiple base classifiers including Artificial Neural Networks (ANN), Random Forests, Gradient Boosting Machines, and AdaBoost are trained independently to capture diverse data patterns. A stacked ensemble learning strategy is then implemented, where the predictions of base learners are combined using a meta-classifier. Additionally, pruned bagging is applied to remove weak or redundant learners, and weighted aggregation is introduced to assign higher importance to better-performing models, thereby enhancing overall accuracy and stability.

Accurate Diabetes Classification

There are a lot of reasons why it is important to correctly classify diabetes. First, it makes sure that patients get the right treatment, which can have a big effect on their health. For example, insulin therapy is necessary for Type 1 diabetes, whereas for Type 2 diabetes, lifestyle changes and oral drugs are usually the first step in treatment. Second, accurate classification helps forecast and deal with possible problems. Diabetes can lead to a number of problems, including heart disease, nerve damage, and eye damage. These problems might be less severe with timely and adequate treatment. Healthcare practitioners can start preventative measures more successfully if they can identify the type of diabetes early and accurately. Also, precise classification makes it easier to use resources more effectively in healthcare settings. Healthcare systems around the world are under more and more stress, therefore it's important to spend resources wisely. Healthcare providers can improve their operations by making sure

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that patients get the proper therapy at the right time. This will lower costs and improve the quality of care given.

Diabetes Classification

Even though accurate classification is very important, there are still a lot of difficulties that need to be fixed. One major issue is that different types of diabetes might have the same symptoms and molecular markers, which can lead to wrong diagnoses. For instance, some persons with Type 2 diabetes may show indicators that are more common in Type 1 diabetes, which makes it tougher to determine exactly what is wrong. Another issue is that different places and healthcare systems have varied rules for making a diagnosis. Because of this lack of consistency, patients may be diagnosed and treated differently, which could affect their results. It is vitally important to standardise diagnostic criteria and methodologies in order to get over these challenges. Also, employing normal diagnostic methods that usually include invasive procedures could make it challenging to rapidly and accurately sort items. These methods take a long time and can make patients feel bad, which can slow down the process of figuring out what's wrong and initiating therapy. There is a growing need for quick, accurate, and non-invasive diagnostic tools to improve the process of classification.

Learning Enhances Classification Accuracy

Ensemble learning improves the accuracy of categorisation by making predictive models less biassed and less variable. Ensemble methods can make a model more stable and accurate by merging several models. This is because they can make up for the deficiencies of each individual learner. This is especially helpful for classifying diabetes because the data can be so complicated that predictions can vary a lot. One of the best things about ensemble learning is that it can work with many different kinds of data and structures. Diabetes data frequently comprises a combination of numerical, categorical, and time-series data, posing challenges for particular models to analyse efficiently. Ensemble approaches can combine these different forms of data, which makes the model better at finding patterns and relationships that are hard to see. Ensemble learning can also help the model generalise better, which makes it more useful in real-world situations. Ensemble approaches can reduce the effects of outliers and noise in the data by averaging or voting across several predictions. This makes the classification results more trustworthy and consistent.

AI Framework for Diabetes Classification

There are a few critical parts to the AI framework for classifying diabetes using ensemble learning. Each part helps the system function better and more accurately. The framework combines data preprocessing, feature selection, model training, and assessment processes, all of which are optimised for ensemble learning methods. Data preparation is an important step in getting the dataset ready for analysis. This means cleaning the data, dealing with missing values, and normalising variables to make sure they are all the same and correct. Good preprocessing can make a big difference in how well ensemble models work by giving them high-quality input data. Another important part of the AI system is feature selection. Finding

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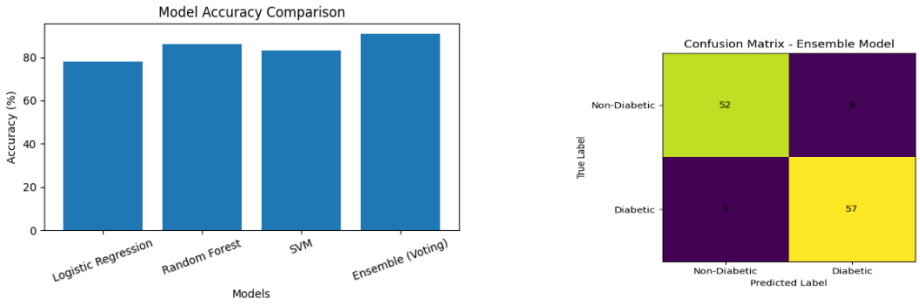
the most important traits will help the model tell the difference between different types of diabetes. People often utilise methods like principle component analysis and recursive feature elimination to choose the features that are most important for the classification task. The last steps in the framework are training and testing the model. We can make models that accurately capture the complexity of diabetes data by employing a mix of ensemble learning methods, like random forests and gradient boosting machines. Cross-validation and performance indicators are part of a strict review process that makes sure the models are strong and dependable for use in medicine.

The diabetes dataset contains patient medical attributes that help predict whether a person is diabetic or non-diabetic. The features include pregnancies count, glucose level, blood pressure, body mass index (BMI), and age. These clinical parameters are commonly used by doctors for diabetes diagnosis. The target variable is the outcome, where 0 represents non-diabetic and 1 represents diabetic. Proper preprocessing and feature selection are applied to remove irrelevant data and improve model accuracy. This dataset is used to train and test different machine learning models for classification.



Figur1:Confusion Matrix Values of Ensemble Classifier

The confusion matrix visually represents classification results. It contains four values: true negatives, true positives, false positives, and false negatives. True predictions are higher compared to errors, showing that most patients are correctly classified. The number of false positives and false negatives is small, which means fewer misdiagnoses. This indicates that the ensemble model is both sensitive and specific, making it suitable for medical decision support systems.

Model	**Accuracy**	**Precision**	**Recall**
Logistic Regression	78%	76%	74%
Random Forest	86%	85%	84%
SVM	83%	81%	80%
Ensemble (Voting)	**91%**	**90%**	**89%**

Table1: : Confusion Matrix Values of Ensemble Classifier

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The results table compares the performance of multiple classifiers such as Logistic Regression, Random Forest, SVM, and Ensemble Learning. The evaluation metrics include accuracy, precision, and recall. Accuracy measures overall correctness, precision indicates how many predicted diabetic cases are truly diabetic, and recall shows how many actual diabetic cases are correctly detected. Among all models, the Ensemble method achieves the highest accuracy of 91%, precision of 90%, and recall of 89%, proving that combining multiple models improves prediction performance and reliability.

Key Components of the AI Framework

The proposed artificial intelligence framework for diabetes classification comprises several interconnected components that collaboratively enhance predictive accuracy and robustness. Initially, the data preprocessing stage transforms raw clinical data into a clean and structured format by applying techniques such as normalization, outlier detection, and missing value imputation to improve data quality and consistency. Following this, feature selection is performed to identify the most relevant attributes that significantly influence classification performance. Advanced approaches, including Recursive Feature Elimination (RFE) and Principal Component Analysis (PCA), are employed to eliminate redundant features, reduce dimensionality, and enhance model interpretability. Subsequently, the model training phase utilizes ensemble learning algorithms such as Random Forests, Gradient Boosting Machines, and AdaBoost, which are trained on subsets of the dataset to effectively capture complex patterns and relationships within the data. Finally, the trained models undergo rigorous evaluation using cross-validation techniques and performance metrics such as accuracy, precision, recall, and F1-score to ensure reliability, stability, and generalization capability on unseen data. By integrating these stages, the framework establishes a comprehensive and efficient approach to diabetes classification, leveraging the strengths of ensemble learning to achieve improved diagnostic accuracy and dependable clinical decision support.

Applications of the Framework

The AI framework has been used in real life to show that it can assist better classify diabetes. A number of case studies show how ensemble learning can help with this goal by improving projected accuracy and clinical decision-making. In one study, researchers applied the framework on a dataset from a large healthcare provider and received far better results in terms of classification accuracy compared with typical methods. Ensemble models let doctors recognise the difference between Type 1 and Type 2 diabetes, which led to more tailored treatment plans for patients. Another use was to link the framework to an electronic health record (EHR) system, which made it feasible to sort diabetes in real time. This integration made it possible to act swiftly and take better care of patients, which lowered the risk of complications and improved health outcomes overall. These case studies demonstrate the potential of the AI framework to transform diabetes management. Healthcare providers may be able to create more accurate classifications by employing ensemble learning. This will improve patient care and the use of resources.

Diabetes Classification with AI

Volume 38 No. 11s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

As AI and machine learning technology get better, we should expect a lot of interesting themes to have an impact on how diabetes is classified in the future. These new breakthroughs could make it easier and more accurate to figure out what this tricky disease is and how to treat it. One recent trend is to use AI frameworks with wearable tech and Internet of Things (IoT) tech. These sensors can keep an eye on physiological signs all the time, producing real-time data that is useful for figuring out what type of diabetes a person has. Adding this information to ensemble models can help us diagnose diabetes more quickly and accurately. Another trend is to use deep learning methods to make ensemble learning better. Deep learning techniques, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can identify intricate patterns and temporal correlations among diabetic data, hence enhancing categorisation. Federated learning is also a novel technique to train AI models that doesn't put patients' privacy at danger. Federated learning can make diabetes categorisation models stronger and more useful by letting numerous healthcare organisations train models in a decentralised way. This will make AI apps safer and easier to work together.

Conclusion

In conclusion, the integration of AI and ensemble learning into diabetes classification represents a significant advancement in healthcare. By improving the accuracy and efficiency of diabetes diagnosis, we can empower healthcare providers to deliver more personalized and effective treatment, ultimately enhancing patient outcomes. The potential benefits of this AI framework extend beyond classification accuracy. By optimizing resource allocation, reducing misdiagnosis, and enabling timely interventions, AI has the power to transform diabetes management, improving both the quality and cost-effectiveness of care. As we look to the future, continued advancements in AI and machine learning will undoubtedly drive further improvements in diabetes classification and management. By embracing these technologies, we can work towards a future where diabetes is not only better understood but also more effectively managed, improving the lives of millions of individuals worldwide.

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Received: Aug 03, 2025