Early prediction of diabetes using Feature Transformation and hybrid Random Forest Algorithm

B. Senthil Kumar, R. Gunavathi

Abstract: Diabetes is the most common chronic disease among the world. Early prediction of these will assist the physicians to provide the improved treatment. Machine learning approaches are widely used for predicting the disease at the earlier stage. However the selecting the significant features and the suitable classifier are still reduces the diagnosis accuracy. In this paper the PCA based feature transformation and the hybrid random forest classifier is utilized for diabetes prediction. PCA attempt to identify the best subset of transformed components that greatly improves the classification result. The system is compared with priori machine learning approaches to evaluate the efficiency of this work. The experimental result shows that the present study enhances the prediction accuracy.

Keywords: Diabetes prediction, PCA, Random forest, machine learning, feature transformation

I. INTRODUCTION

The chronic diseases are continual and their effects are permanent. The chronic condition affects the human’s quality of life. Among the chronic diseases, diabetes is the most common disease present all over the world. The mortality rate is increase among the adults due to this chronic condition. People and government spend major budgets is spend on diabetes [1]. Diabetes was the fifth cause for mortality in women’s and eighth cause for both sexes [2]. If it is continues large Number of people’s quality of life will be affected. The only solution is to predict this chronic condition in early stage to improve the treatment and reduce the morality rate due to diabetes.

Diagnosing the diabetes in a still remains a challenging task among the researchers. The data mining technique play an important role in predict the diseases in early stage. Most of the studies [3-5] consider the machine learning algorithms for classifying the diseases. The issue in these techniques is to find the significant features from dataset and the suitable classifier. The proper selection of these two approaches is a challenging issue. This leads to the improper result with very low accuracy [6].

To overcome the above disadvantages the PCA based feature transformation is introduced in this study. The PCA tries to identify the best subset of transformed components which result in the improved accuracy. The ensemble pruning with back propagation neural network (BPNN) is introduced to improve the performance of Random forest. The hybrid random classifier provides the efficient result with the transformed features.

The remaining section of this study is organized as follows: section II describes the literature review of feature transformation and diabetes classification. Section III describes the dataset used in this approach and the proposed methodology. The experimental setup and the result are discussed in section IV. Eventually the summary of the study and the direction for future research is discussed in section V.

II. RELATED WORKS

The literature on feature selection approach for dimensionality reduction and classifying the disease using machine learning algorithms in medical dataset is discussed in this section. Mykola Pechenizky et al [7] performed the medical diagnostics process by applying the PCA based attribute transformation. The author proved that feature transformation provide better result than feature selection process for disease classification. The experiment was carried out with five different datasets like Diabetes, Heart, Cancer, Liver and Thyroid with 3-nearest neighbour classifier. TalhaMahboob Alam et al [2] introduced the Diabetes diagnosis model based on PCA based feature transformation technique. This study finds that diagnosis of diabetes has strong correlation with the two features body mass index and glucose level that was take out by aprior approach. The artificial neural network was used for prediction that achieved the 75.5% accuracy. Selvakuberan et al [8] presents the merits of data mining technique in diabetes prediction using ranker search method feature selection and Dagging classifier. The prediction model achieves 81.72 % accuracy. In addition the performance of this study is compared with 23 classification algorithm with weka tool. Deepthi Sisodia and Dilip Singh Sisodia [9] applies the three best performing machine learning algorithms such as Decision tree, Support Vector Machine (SVM) and Naïve Bayes (NB) on pima dataset to predict the diabetes. Among them Naïve bayes obtain the great accuracy of 76.30%.

Berina Alić et al [10] utilizes the approaches Artificial Neural Networks and NB for both diabetes and cardiovascular diseases (CVD) classification. The NB achieves highest accuracy 99.51% and 97.92% on diabetes and CVD dataset respectively. HarleenKaur and VinitaKumari [11] introduced the supervised machine learning technique on Pima dataset. The linear kernel SVM got 89 % accuracy compared to other approaches such as KNN, ANN, multifactor dimensionality reduction.
Tsehay Admassu Assegie, Pramod Sekharan Nair [12] investigates the performance of various machine learning methods on diagnosing the diabetes. Linear support vector machine got the highest accuracy of 78.39% accuracy compared to Gaussian naïve bayes and random forest.

From the literature it is clear that the prior research does not obtain the better accuracy on diabetes prediction. Therefore the proposed model presents a novel method with PCA based feature transformation and hybrid random forest classifier.

### III. DATASET

**Pima Indians diabetes dataset**

Pima dataset is publically available in UCI machine learning repository which has 9 attributes with 768 patient records. The information is collected from the females with the age group of 21 years above in Pima Indian heritage. Among the 9 attributes the last one is the binary class attribute.

### IV. PROPOSED METHOD

The early diabetes prediction model consists of two significant phase: feature transformation and Classification. The PCA method is applied in the present study for feature transformation and Hybrid random forest classifier is utilized for classification. The proposed architecture is shown in figure 1.

![Architecture of the proposed model](image)

#### Feature transformation using PCA

Feature transformation is performed to generate a set of features. The PCA is a most popular method which is adopted for feature transformation in the present study. This method is based on mining the axes on data that displays highest variability [7]. PCA provides the great support for supervised learning which spreads out the information’s in news format.

A significant problem is to decide whether a PCA-based feature transformation approach is appropriate for a certain problem or not. Meanwhile the major objective of PCA is to mine new uncorrelated features, it is logical to present some correlation-based criterion with a possibility to define a threshold value. One of such criteria is the Kaiser-Meyer-Olkin (KMO) criterion that accounts for both total and partial correlation:

\[
KMO = \frac{\sum_i \sum_j r_{ij}^2}{\sum_i \sum_j r_{ij}^2 + \sum_i \sum_j a_{ij}^2}
\]

(1)

Where \(R\) denotes the correlation matrix and \(A\) denotes the partial correlation matrix. \(r_{ij} = r(x^{(i)}, x^{(j)})\) represents the elements in \(R\) and \(a_{ij}\) represents the elements in \(A\).
\[ a_{ij}^2 x_{ij} = \frac{-R_{ij}}{R_{ii}R_{jj}} \]  

(2)

Where \( a_{ij}^2 x_{ij} \) symbolizes the partial correlation coefficient for \( x^{(i)} \) and \( x^{(j)} \). Here \( i \) and \( j \) act as \( X_{ij} \) (fixed controller) and \( R_{kl} \) (algebraic complement) in R.

When two attributes exchange a common factor with other attributes then their partial coefficient will be small that representing the distinctive variance they share. Likewise KMO value will be comes under the following factor

1. if \( a_{ij} \) close to zero then KMO value is close to one
2. if \( a_{ij} \) close to one then KMO value is close to zero

Popelínský [13] recommends using KMO with greater than 0.6 values for PCA. The study [13] showed that PCA with KMO > 0.5 will provide the great result.

**Classification**

During the training process only one type of rules can be learned by a single tree. In some cases the logic rule does not examine the connection among the input and output efficiently due to random subspace algorithm and bagging. These trees will reduce the overall performance of the system. Therefore ensemble pruning method has to be introduced to enhance the performance of the Random forest. In the proposed approach the back propagation (BP) neural network is utilized to develop a hybrid random forest. The neural weight in BP estimates the effects of inputs [14]. The Architecture of the proposed classification method is explained in figure 2.

![Figure 2. Architecture of the proposed hybrid Random forest](image)

In this study, the output of each tree constitutes the input vector of the BP network, and the predicted data label is the output of the network. After training the network, the tree importance is evaluated. Based on the tree importance, a forward search method is applied to identify the tree set with optimum overall performance. The in-depth detail of the hybrid random forest approach is given in the previous work [15]. The algorithm of the classifier is given in table 1.

**Hybrid RF Algorithm**

**Algorithm**

- Step 1. Upload the Training dataset
- Step 2. Training the basic RF
- Step 3. Training the BP network
- Step 4. Calculating tree importance
- Step 5. Outputting the optimal tree set

The Combination of PCA and Hybrid RF is worked well for the proposed research idea. The Feature transformation and the classification performed on those features provide the efficient result which is described in the following section.

**V. EXPERIMENTAL RESULT**

The experimental setup and performance result is discussed in this section. The experiment was carried out with Netbeans IDE and MySQL database. The publically available Pima dataset is utilized in the proposed prediction model. The feature transformation improves the accuracy compared to feature selection approach. The classification model provides better result on the transformed features. The efficiency of the proposed model is evaluated by the performance metrics such as precision, recall, f-measures and accuracy. The table 1 presents the result of precision, recall and f-measures.
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| Algorithm                  | Precision | Recall | F-measures | Accuracy |
|----------------------------|-----------|--------|------------|----------|
| Neural network             | 0.78      | 0.88   | 0.861      | 87.4     |
| LR                         | 0.817     | 0.924  | 0.894      | 90.7     |
| J48                        | 0.86      | 0.915  | 0.902      | 92.1     |
| CART                       | 0.74      | 0.876  | 0.824      | 89.1     |
| Hybrid Random Forest       | 0.923     | 0.969  | 0.962      | 96.9     |

The performance of the proposed techniques on Pima dataset is shown in Figure 3 and 4. The combination of the proposed techniques (PCA and Hybrid RF) achieves the highest accuracy compared to other machine learning techniques.

Figure 3. Performance Result Comparison

Figure 4. Accuracy comparison Chart

Figure 4 gives the accuracy comparison chart of proposed approach. The 96.9 is the greatest accuracy achieved by the present study. The other machine learning techniques are used in this study in order to evaluate the performance of the present work. Compared to those approaches the proposed study provides the better result for diabetes prediction.

VI. CONCLUSION

The present model proposed the early diabetes prediction model using feature transformation and classification techniques. Few prior classifiers for diabetes prediction are also discussed in terms of accuracy. The PCA method which is utilized for feature transformation provides the efficient result in reducing the components. The proposed hybrid random forest generates the great accuracy on the transformed feature. The present prediction model achieves 99% accuracy. In future the present study can be applied for other disease classifications like cancer, nervous related disease classification, liver disease classification etc.,

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