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Prediction of Chronic Kidney Disease using Deep Belief Network

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1.Abstract- This paper is proposed to develop an intelligent system that utilizes medical data analysis to predict and diagnose chronic kidney disease (CKD) at an early stage, with improved performance and accuracy compared to existing methods. As Chronic kidney disease (CKD) is still a health concern despite advances in surgical care and treatment. CKD's growth in recent years has gained much interest from researchers around the world in developing high-performance methods for diagnosis, treatment and preventive therapy. Improved performance can be accomplished by learning the features that are in the concern of the problem. In addition to the clinical examination, analysis of the medical data for the patients can help the health care partners to predict the disease in early stage. Although there are many tries to build intelligent systems to predict the CKD by analysis the health data, the performance of these systems still need enhancement.

Keywords - Categorical Cross-entropy, Chronic kidney Disease, Deep Belief Network, Deep Learning, Softmax classifier.

2.Introduction

Kidney disease has become a typical disease with severe problems [1]. Kidney disease is described as a heterogeneous cluster of disorders affecting the structure and performance of the urinary organ. It is widely known that even delicate anomalies in measures of the composition and quality of urinary organs are still associated with increased risk of complications in alternate organ systems [2]. There are four stages of Kidney diseases:

1. NO Kidney Disease (NKD)
2. Chronic Kidney Disease (CKD)
3. Acute Kidney Injury (AKI)
4. End Stage Kidney Disease (ESKD)

Around 10% of the inhabitance in the world suffers from chronic kidney ailment (CKD), leading to millions of deaths every year [3]. The main factors specified as a reason for the disease are [4]:

• Obesity and hypertension: Many medical conditions can cause KD.

• Family history: If anyone in your family has kidney disease, dialysis, or kidney transplantation, you may be more likely to develop kidney disease than someone without this family history.

• Medicines: Some medicines can cause or exacerbate kidney disease, such as over-thecounter pain medicines.

• Age and race: Older people and certain racial groups may have a higher chance of developing renal disease.

The diagnosis of kidney disease in early stage saves the patient from serious complications. To predict the kidney diseases, the factors that cause it must be studied carefully. All these factors can be translated into data to predict kidney disease and suggest a medical protocol to improve the patient health state.Deep Learning (DL) methods are used to automate the extraction and interpretation of the functions, hence models based on these techniques achieve high performance. Deep learning is a machine learning focuses on learning to describe and construct multiple levels.

3.Proposed Model:

The methodology of our research consists of sequence steps including data collection, pre-processing, deep learningbased feature engineering and classification followed by evaluation. These computational steps are graphically presented in the below Figure .

4.Deep Belief Neural Network:

Deep Belief Networks are interactive systems that built on stacking RBM that trained with CD The algorithm that determines the optimum locale for each layer and the next stacked RBM layer takes those optimally trained values and searches for the optimum locale again that is the cause of the greedy algorithm for learning works of DBN training layer by layer.The RBM is a pre-trained by the **Contrasitive Driver-gence** training algorithm using training data.RBM is a two-layer **bipartisan** graphic design with a collection of visible unit v, a set of invisible units h, and symmetrical relations defined by a weight matrix W between these two layers. Two algorithms are used to train the RBM model

4.1 Contrastive divergence: During training, the RBM learns to reconstruct the input data by minimizing the difference between the actual input data and the reconstructed data. This is achieved using a process called contrastive divergence.it iteratively updates the model parameters based on the difference between predicted and actual output, the model can learn to better approximate the distribution of the training data.

4.2 Greedy layer by layer algorithm: Start with a single-layer neural network and train it on the data. Add a new layer to the network and connect it to the previous layer. Initialize weights randomly. Freeze the weights of the previous layer and train the new layer on the output of the previous layer. Repeat steps 2 and 3 for each additional layer until the desired number of layers is reached. Fine-tune the entire network using backpropagation to adjust the weights of all layers.

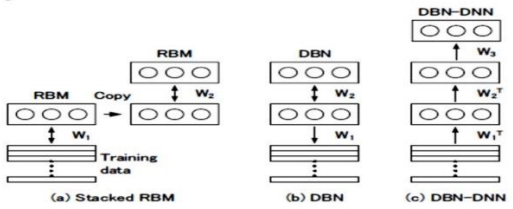


FIGURE 4. Model architecture of deep belief network classifier.

4.3 Data Set :

The proposed model uses UCI Dataset [29]. It consists of 25 attributes, 14 nominal, 11numeric and 1 class attribute which represent the data of 400 patients out of which 250 states are CKD and 150 are not.

4.4 Dataset Pre-processing:

Classifying data with missing values is a challenge. The used dataset has missing values, which reduce the efficiency, so it must be removed before analyzing data.So here we used mode imputation method to fill missing values in the UCI dataset. The mode imputation is used for nominal attributes which takes the most frequent value per column and for the numerical attributes the median imputation is used in which using the mid-range value of the attribute.

4.5 Fine-Tuning:

we would first freeze the weights of the pre-trained model, preventing them from changing during training, and then train the model on the new dataset using backpropagation to adjust the weights of the final layers. fine-tuning refers to the process of taking a pre-trained model and further training it on a specific task or dataset. Fine-tuning is typically done by adjusting the weights of the pre-trained model using backpropagation to better fit the new task or dataset.

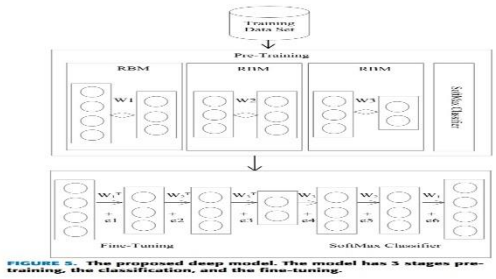
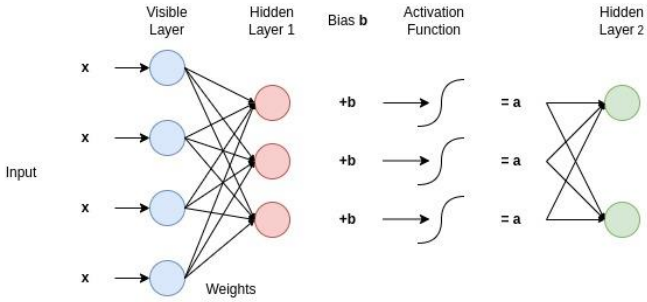


FIGURE 3. The proposed deep model. The model has 3 stages pre-training, the classification, and the fine-tuning.

4.6 Softmax Classifier:

The Softmax function is an activation function which is applied to the output of the model to obtain a probability distribution over the possible classes. The class with the highest probability is then chosen as the predicted class label for the input.



4.7 Testing Data:

It is the data we use to train an algorithm or a machine learning model to predict the outcome you design your model to predict.

4.8 Testing Data:

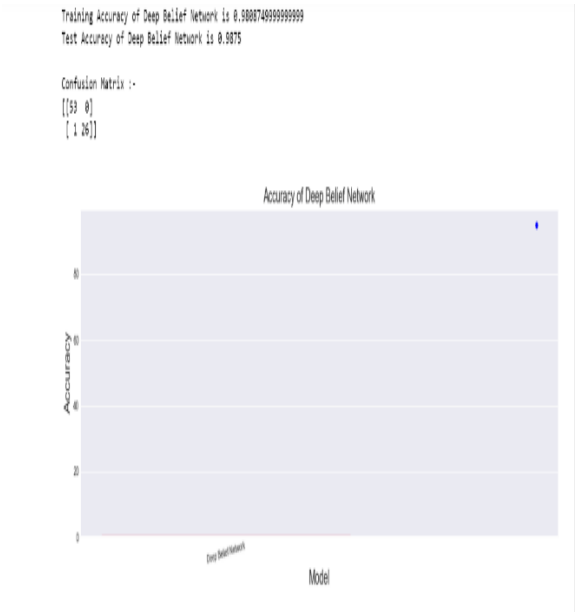
The trained 70% of the data is used to test the further 30% data in the UCI dataset which is given as input to the model.

5.Results and Discussion:

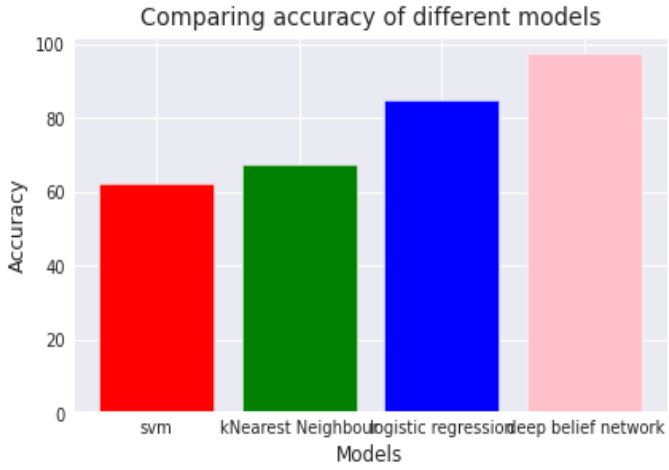
The dataset is randomly divided in two parts; the first part contains 70% of overall collection of data to train the model. The second part is used for testing and it contains the reminder of the dataset (30%). Six performance measures are used to evaluate and validate the proposed model. In this model we caluculated Accuracy. Next equation show how this measure is computed:

$$Accuracy = \frac{tp+tn}{tp+f_p+f_n+tn}$$

Obtained Accuracy of deep belief neural network is 98.75%.



Comparing deep belief neural network with other neural networks:



6.Conclusion:

The model is built by using **DBN** with **SoftMax classifier .**The proposed model achieves a better performance when compared with existing models with an accuracy of **98.75%** because local optimal and weighting factors are done in one step.This paper presents an intelligent model of **deep neural network** for prediction and classification of chronic kidney disease dataset using a deep belief network.So, the proposed model presents proper predictor and classifier for **Chronic Kidney Disease.** Finally, the results of comparison revealed that the proposed model is effective in classification of CKD dataset. Out of 400 patients 250 patients are suffering from CKD and 150 are not with CKD.

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