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INTELLIGENT DIAGNOSIS OF CHRONIC KIDNEY DISEASE THROUGH MACHINE LEARNING MODELS

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ABSTRACT- **Everyone is aware that the kidneys are a vital organ in the body, with primary functions like excretion and osmoregulation. Simply explained, the kidney and excretion system gather and eliminate all harmful and superfluous substances from the body. Chronic Kidney Disease is brought on by a kidney issue. Chronic kidney disease (CKD) is a non-communicable illness that affects 10-15% of the world's population and has a considerable impact on morbidity, mortality, and hospital admission rates for patients worldwide. To reduce the effects of the patient's health difficulties, early and accurate detection of the phases of CKD is thought to be essential. A disorder known as chronic kidney disease (CKD) is defined by a long-term decline of kidney function. It depicts a medical condition that harms the kidneys and has an impact on a person's overall health. End-stage renal disease and the patient's eventual mortality can result from improper disease diagnosis and treatment. Many studies on the early identification of CKD have been conducted utilizing machine learning approaches. This project aims to develop a system for predicting Chronic Kidney Disease (CKD) using machine learning method. Specifically, the proposed system employs an Artificial Neural Network (ANN) to predict CKD. The dataset used for training and testing the models is the Chronic Kidney Disease dataset from the UCI Machine Learning Repository. The proposed system also built a web application using Flask framework where the users can enter the details and predict whether the CKD is there or not, which makes the system easier and accessible to every individual. The study contributes to the field of medical diagnosis and highlights the potential of using machine learning techniques for improving CKD prediction.**

1. INTRODUCTION

CKD is an incurable condition of kidney associated with higher risk of many other diseases such as heart failure, anemia, and bone disease. Kidneys are very adaptable. However symptoms will reveal kidney damage slowly. In many cases, patients do not feel symptoms until disease is in last stage. Figure 1 shows the common symptoms that are overlapped with other disease. Some forms of kidney disease are treatable by avoiding symptoms. It helps patients to keep the disease from getting worse by restoring few kidney functions. Especially in case CKD, dialysis and kidney transplant are two major treatment options for end-stage kidney disease. Due to high treatment cost, only 10% of people receive dialysis or kidney transplant worldwide [2].Each year, more than one million individuals from 112 low earning countries suffer and die due to kidney failure [5].Patients having acquired immunodeficiency syndrome (AIDS) have more complication in kidney disease due to deficiency of glomeruli filters also known as enthrones. The medication used for Human Immunodeficiency Viruses (HIV)can also infect the cells in kidney. It is very important to detect, control, progression of CKD in early stage. Increasing interest in automated diagnosis and rapid development in machine learning methods has played an important role in healthcare. Although many researches have used machine learning techniques to classify CKD in multiple stages.

However, a few researcher has identified relation of CKD with HIV. Therefore, the sooner the diagnosis will be, the better the plausibility will be to decrease the surge of the disease. Prompt detection will enhance the chance of slowing or stopping its progression in its primary stages. To apply prediction algorithms in machine learning can be a brilliant idea for detecting the occurrence of CKD. This research study has enlisted some widely used machine learning algorithms from several articles & journals and applied them to predict CKD. The proposed study attempts to take and find out the optimum algorithm to predict CKD. Several algorithms have been used already such as RF, DT, ADB, GB, KNN, XGB, GNB, EXT and used

performance measures like accuracy precision and recall f1-score to determine their performance meticulously. So in this paper we try to achieve CKD detection through a different technique like ANN (artificial neural network).

2. OBJECTIVE

This project's goal is to create a machine learning system and deep learning model for anticipating chronic kidney disease based on a variety of patient characteristics and laboratory test results. In order to examine the data and create precise predictions, the model will take a deep learning method, which can aid clinicians in the early diagnosis and treatment of chronic kidney disease. By detecting high-risk individuals before symptoms appear, the study seeks to improve patient outcomes while ultimately lowering the expense of treating advanced stage chronic renal disease.

2.1 PROBLEM STATEMENT

The problem addressed in previous paper is the selection of an effective machine learning algorithm for predicting Chronic Kidney Disease (CKD) using clinical data. Specifically, the authors explore the use of Support Vector Machine (SVM) as one of the four machine learning algorithms to predict CKD. SVM is a powerful classification algorithm that has been used successfully in various healthcare applications. However, the authors recognize that the selection of the most appropriate algorithm for CKD prediction remains a challenge.

Therefore, the authors aim to evaluate the performance of SVM in predicting CKD using clinical data and compare it with other machine learning algorithms such as K-nearest neighbors (KNN), logistic regression (LR), and decision tree classifiers. By comparing the accuracy and reliability of each algorithm, the authors hope to identify the best approach for predicting CKD, which could assist doctors in making informed decisions about patient care.

2.2 Existing System

Predictive analytics for healthcare using machine learning is a challenged task to help doctors decide the exact treatments for saving lives. In this paper, we present machine learning techniques for predicting the chronic kidney disease using clinical data.

Four machine learning methods are explored including K-nearest neighbors (KNN), support vector machine (SVM), logistic regression (LR), and decision tree classifiers. These predictive models are constructed from chronic kidney disease dataset and the performance of these models are compared together in order to select the best classifier for predicting the chronic kidney disease

Disadvantage Of Existing System

- Works comparably well when there is an understandable margin of dissociation between classes
- It is more productive in high dimensional spaces.

2.3 Proposed System

In the proposed system the core objective is to propose and implement a machine learning prediction model for chronic kidney disease using Artificial Neural Network (ANN) where due importance is given to accuracy. We have downloaded the CKD dataset from the UCI repository. The dataset contains two groups (CKD represented by 1 and non-CKD represented by 0) of chronic kidney disease in the downloaded information. The Artificial Neural Network (ANN)

has best accuracy is selected for analysis and implementation so better prediction results are produced.

The proposed system model is trained on the preprocessed and selected features. The model's performance is evaluated on a validation set. The trained model is deployed as a web, where users can input their demographic and clinical data to obtain a prediction of their CKD status. The system's results are displayed in a user-friendly manner. The proposed system provides a reliable and efficient solution for predicting Chronic Kidney Disease using machine learning techniques.

Advantages of Proposed System

- It has the ability to learn and model non-linear and complex relationships.
- ANN learns from sample data sets is a significant advantage.

3. RELATED WORKS

Different researchers had conducted experiments on chronic kidney disease before and obtained the accuracy of several machine learning algorithms using various tools. Chittora et al. [3] applied seven classifier algorithms in their research: Chi-square Automatic interaction detector, Artificial Neural Network, C5.0, linear Support Vector Machine (LSVM) with penalty L1 & with penalty L2, RF and Logistic Regression (LR). They measured the accuracy, AUC curve, precision, and recall, and finally, they concluded that the algorithm which achieved the highest accuracy was the linear model. The results have been computed individually for each classifier, correlation-based feature selection, least absolute shrinkage and selection operator regression, synthetic minority over-sampling method with full features, Wrapper method feature selection and full features. According to this research, LSVM got the maximum accuracy in all experiments amongst all the classifiers. Conversely, Logistic and KNN did not achieve sufficient goals. Sathyaraj et al. [4] proposed a hybrid model that can perform better to diagnose CKD by collecting data from the UCI ML repository, and in order to get a clean data set, they followed pre-processing steps such as label encoding, as well as min-max normalizing. Eventually, they found that the AdaBoost and Random Forest algorithms maintained a better accuracy rate. Wang et al. [5] used a regression model to portend the risk of CKD considering six factors such as sex, age, s moking habit, hemoglobin and urine protein level. They experimented on three regression models: RF, XGBoost, and a ResNet neural network model. Finally, XGBoost acquired the best outcome with a 0.5523 R2 score. Shirahatti et al. [6] put forward a classified system to create public awareness that can rate the probability of getting affected by CKD using ML algorithms. They collected required information from clinical history, Electronic Medical Records (EMR), and laboratory tests. They conducted a comparative study between various Machine learning algorithms, with and without preprocessing, which concluded that Random Forest Algorithm performed with an accuracy of 100 %. Xiao et al.

4. METHODLOGY OF PROJECT

Deep learning methods will be used by the machine learning model to assess the data and produce precise forecasts for chronic kidney disease. Using the proper metrics, the model's performance and accuracy will be assessed, and the findings will be contrasted with those of currently used clinical prediction models.

MODULE NAMES:

- Data Collection
- Dataset

- Importing the necessary libraries
- Splitting the dataset
- Model selection
- Apply the model and plot the graphs for accuracy and loss
- Accuracy on test set
- Saving the Trained Model

1.Data Collection:

TIn the first step we make the data collection process. This is the first real step towards the real development of a machine learning model. This is a critical step that will cascade in how good the model will be, the more and better data that we get; the better our model will perform. There are several techniques to collect the data, like web scraping, manual interventions and etc. In the first module, we developed the system to get the input dataset for the training and testing purpose. The dataset is given in the model folder. The dataset is referred from the popular dataset repository called UC Irvine Machine Learning Repository and kaggle.

2.Dataset

In this module, we describe about the dataset features. The dataset consists of 401 individual data. There are 26 columns in the dataset.

3.Importing the necessary libraries

We will be using Python language for this. First we will import the necessary libraries such as keras for building the main model, sklearn for splitting the training and test data, PIL for converting the images into array of numbers and other libraries such as pandas, numpy, matplotlib and tensorflow.

4.Splitting the dataset

In this module, the CKD dataset will be divided into training and testing sets. Split the dataset into Train and Test. 80% train data and 20% test data. This will be done to train the model on a subset of the data, validate the model's performance, and test the model on unseen data to evaluate its accuracy.

5. Model selection

Order selection is used to find the complexity of the neural network that optimizes the generalization performance. That is the number of neurons that minimize the error in the selection instances.

Input selection (or feature selection) is used to find the set of inputs that produce the best generalization. The genetic algorithm has been applied here, but it does not reduce the selection error value, so we leave all input variables.

A. Defining the Keras Model

Models in Keras are defined as a sequence of layers in which each layer is added one after another. The input should contain input features and is specified when creating the first layer with the input_dims argument. Here inputs_dims will be 8.

Now a question arises that how can we decide the number of layers and number of neurons in each layer?.

It is quite difficult to know how many layers we should use. Generally for this Keras tuner is used, which takes a range of layers, a range of neurons, and some activation functions. and then by permutation and combination, it tries to find which is best suited. But one disadvantage of this is it takes lots of time. You can refer to the documentation of it Keras Tuner for more details.
In this example, a fully connected network with a three-layer is used which is defined using the Dense Class. The first argument takes the number of neurons in that layer and, and the activation argument takes the activation function as an input. Here ReLU is used as an activation function in the first two layers and sigmoid in the last layer as it is a binary classification problem.

B. Compile Keras Model

While compiling we must specify the loss function to calculate the errors, the optimizer for updating the weights and any metrics.
In this case, we will use "binary_crossentropy" as the loss argument as it is a binary classification problem.
Here we will take optimizer as "adam" as it automatically tunes itself and gives good results in a wide range of problems and finally we will collect and report the classification accuracy through metrics argument.

C. Fitting The Keras Model

Now we will fit our model on the loaded data by calling the fit() function on the model.
The training process will run for a fixed number of iterations through the dataset which is specified using the epochs argument. The number of dataset rows should be and are updated within each epoch, and set using the batch_size argument.
Here, We will run for 100 epochs and a batch size of 64.

D. Evaluate Keras Model

The evaluation of the model on the dataset can be done using the evaluate() function. It takes two arguments i.e, input and output. It will generate a prediction for each input and output pair and collect scores, including the average loss and any metrics such as accuracy.
The evaluate() function will return a list with two values first one is the loss of the model and the second will be the accuracy of the model on the dataset. We are only interested in reporting the accuracy and hence we ignored the loss value.

E. Make Predictions

Prediction can be done by calling the predict() function on the model. Here sigmoid activation function is used on the output layer, so the predictions will be a probability in the range between 0 and 1.

6. Apply the model and plot the graphs for accuracy and loss

Once the model is built, it will be applied to the validation set to evaluate its accuracy and loss. The accuracy and loss will be plotted as a function of the number of epochs to visualize the performance of the model. We will compile the model and apply it using fit function. The batch size will be 64. Then we will plot the graphs for accuracy and loss. We got average validation accuracy of 97% and average training accuracy of 90%.

7. Accuracy on test set

After training and evaluating the model on the validation set, the accuracy of the model will be assessed on the test set. The accuracy on the test set will be an important metric for evaluating the model's performance. We got an accuracy of 97% on test set.

8. Saving the Trained Model

Once you're confident enough to take your trained and tested model into the production-ready environment, the first step is to save it into a .h5 or .pkl file using a library like pickle.
Make sure you have pickle installed in your environment.
Next, let's import the module and dump the model into .pkl file.

5.ALGORITHM USED IN PROJECT

- **Artificial Neural Network (ANN)**

Artificial Neural Network (ANN) uses the processing of the brain as a basis to develop algorithms that can be used to model complex patterns and prediction problems.
Consider an example of a digital logic gate that takes an input and gives an output. "OR" gate, which takes two inputs. If one or both the inputs are "On," then we get "On" in output. If both the inputs are "Off," then we get "Off" in output. Here the output depends upon input. Our brain does not perform the same task. The outputs to inputs relationship keep changing because of the neurons in our brain, which are "learning".

6.PROJECT REQUIREMENT

6.1 HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design. It should what the system do and not how it should be implemented.

- PROCESSOR : DUAL CORE 2 DUOS.
- RAM : 4GB DD RAM
- HARD DISK : 250 GB

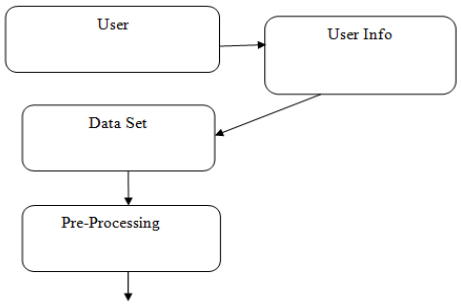
6.2 SOFTWARE REQUIREMENTS

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification. It is useful in estimating cost, planning team activities, performing tasks and tracking the teams and tracking the team's progress throughout the development activity.

- FRONT END : PYTHON
- OPERATING SYSTEM : WINDOWS 7
- IDE :Spyder3
- Framework : Flask

7. DATA FLOW DIAGRAM

Level-0:



Level-1

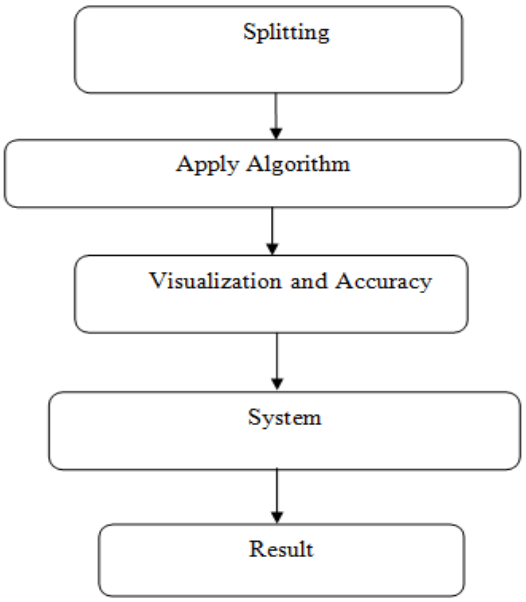


Fig:1 Flow Diagram

8.SYSTEM ARCHITECTURE

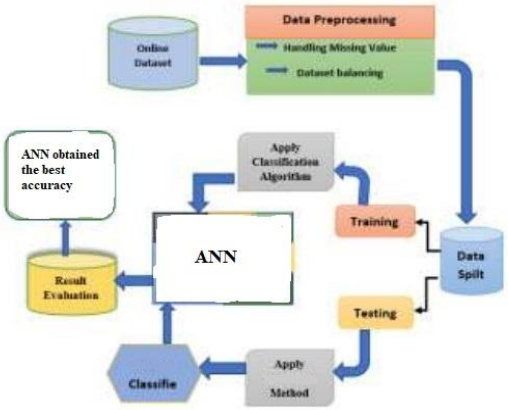
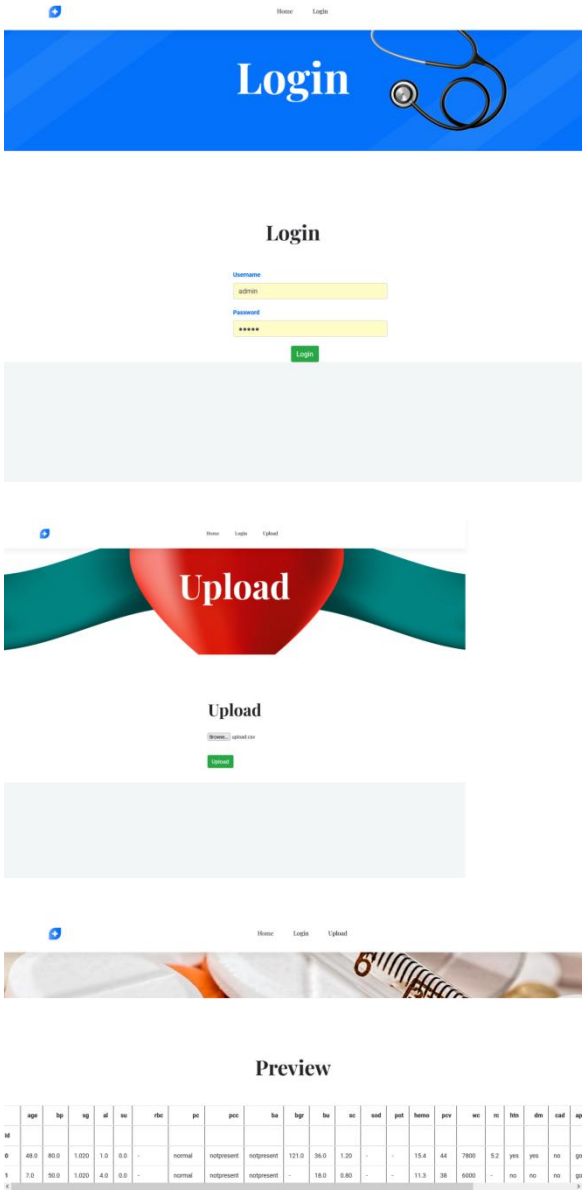


Fig:2 SYSTEM ARCHITECTURE OF PROJECT

8. RESULTS

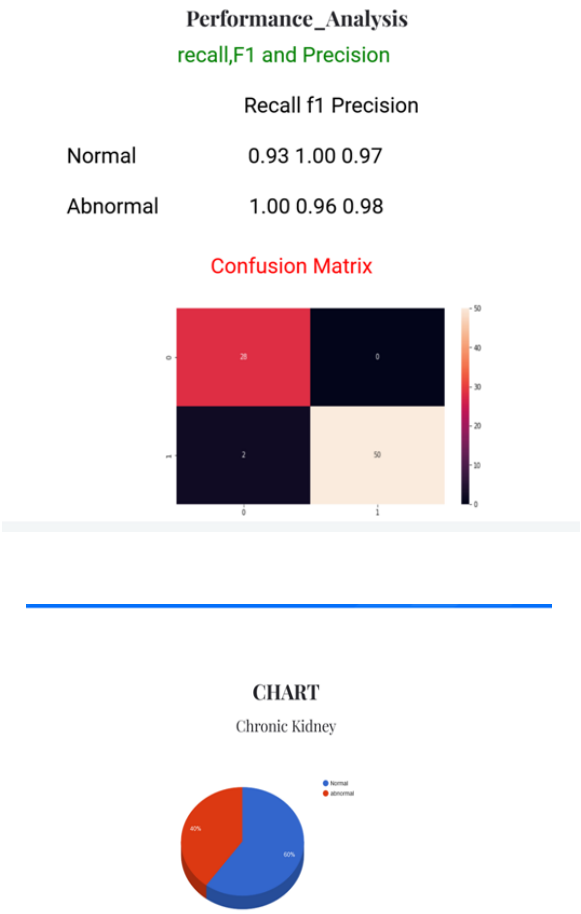



Home
Login
Upload
Prediction
Performance_analysis
Prediction


Chronic Kidney Disease
Prediction
AGE:
12
BLOOD_PRESSURE:
22
ALBUMIN:
22
SUGAR:
34
RED_BLOOD_CELLS:
Normal
PUS_CELL:
Normal
PUS_CELL_CLUMPS:
Present
BACTERIA:
Present
BLOOD_GLUCOSE_RANDOM:
33
BLOOD_UREA:
67
SERUM_CREATININE:
34
POTASSIUM:
565
WHITE_BLOOD_CELL_COUNT:
345
HYPERTENSION:
yes
DIABETES_MELLITUS:
yes
CORONARY_ARTERY_DISEASE:
yes
PEDAL_DEMA:
yes
ANAEMIA :
yes
Predict
Prediction is:


Chronic Kidney Disease
Prediction
AGE:
age
BLOOD_PRESSURE:
blood_pressure
ALBUMIN:
Albumin
SUGAR:
sugar
RED_BLOOD_CELLS:
Normal
PUS_CELL:
Normal
PUS_CELL_CLUMPS:
Present
BACTERIA:
Present
BLOOD_GLUCOSE_RANDOM:
blood_glucose
BLOOD_UREA:
blood_urea
SERUM_CREATININE:
Serum_Creatin
POTASSIUM:
Potassium
WHITE_BLOOD_CELL_COUNT:
white_blood_cc
HYPERTENSION:
yes
DIABETES_MELLITUS:
yes
CORONARY_ARTERY_DISEASE:
yes
PEDAL_DEMA:
yes
ANAEMIA :
yes
Predict
Prediction is:Normal


Chronic Kidney Disease
Prediction
AGE:
age
BLOOD_PRESSURE:
blood_pressure
ALBUMIN:
Albumin
SUGAR:
sugar
RED_BLOOD_CELLS:
Normal
PUS_CELL:
Normal
PUS_CELL_CLUMPS:
Present
BACTERIA:
Present
BLOOD_GLUCOSE_RANDOM:
blood_glucose
BLOOD_UREA:
blood_urea
SERUM_CREATININE:
Serum_Creatin
POTASSIUM:
Potassium
WHITE_BLOOD_CELL_COUNT:
white_blood_cc
HYPERTENSION:
yes
DIABETES_MELLITUS:
yes
CORONARY_ARTERY_DISEASE:
yes
PEDAL_DEMA:
yes
ANAEMIA :
yes
Predict
Prediction is:Abnormal



9. FUTURE ENHANCEMENT

There are several avenues for future work to improve the proposed system for predicting Chronic Kidney Disease (CKD) using Artificial Neural Network (ANN):
Exploring different neural network architectures: Different neural network architectures can be explored to improve the performance of the ANN model. For example, convolutional neural networks (CNNs) can be used to extract features from images or time-series data, improving the accuracy of CKD prediction.
Optimizing hyperparameters: The performance of the ANN model can be further improved by optimizing hyperparameters such as the number of hidden layers, the number of neurons per layer, and the learning rate. This can be achieved through techniques such as grid search or Bayesian optimization.

10 . CONCLUSION

In conclusion, the proposed system for predicting Chronic Kidney Disease (CKD) using Artificial Neural Network (ANN) is an effective and reliable solution for healthcare professionals and patients. The system leverages the power of machine learning algorithms to achieve higher accuracy in CKD prediction compared to existing systems, such as K-Nearest

Neighbors (KNN) and Extra Tree Classifier (ETC). The proposed system offers several advantages, including improved accuracy, efficiency, flexibility, reduced errors, and improved healthcare outcomes. By enabling early detection and intervention of CKD, the proposed system has the potential to improve the quality of life for patients and reduce healthcare costs. The success of the proposed system depends on the quality and quantity of data used for training and testing the model. Further research can be conducted to explore the use of additional data sources, feature engineering techniques, and optimization algorithms to further improve the accuracy and reliability of CKD prediction. Overall, the proposed system offers a promising solution for CKD prediction using machine learning techniques, with potential benefits for healthcare and patient outcomes.

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