A NOVEL APPROACH TO OPTIMIZE PREDICTION METHOD FOR CHRONIC KIDNEY DISEASE WITH THE HELP OF MACHINE LEARNING ALOGRITHM

**1Sai Srinivas Vellela**

Asst. Professor, Dept. of CSE,

Chalapathi Institute of Technology,

Guntur, AP, India

sais1916@gmail.com

**2Lakshma Reddy Vuyyuru**

**Asst.** Professor, Dept. of CSE,

Koneru Lakshmaiah Education Foundation,

Vaddeswaram, AP, India

lakshmareddy@kluniversity.in

**3 Khader Basha Sk**

Asst. Professor, Dept. of CSE,

Chalapathi Institute of Technology,

Guntur, AP, India.

khaderbasha576@gmail.com

**4Dr Naga Malleswara Rao Purimetla**

Assoc. Professor, Dept. of CSE,

Chalapathi Institute of Technology,

Guntur, AP, India

nmrao85@gmail.com

**5Ahamad Sharif Sk**

Asst. Professor, Dept. of CSE,

KHIT, Chowdavaram

Guntur, AP, India

[ahmedsk.01@gmail.com](mailto:ahmedsk.01@gmail.com)

**6 DrM Venkateswara Rao**

Professor, Dept. Of CSE,

NRI Institute of Technology,

Vijayawada, AP, India

muvva.venky@gmail.com

**ABSTRACT:** **The loss of kidney function is called Chronic Kidney Disease (CKD). Over a period of years or months, Chronic Kidney Disease is an uncharacteristic functioning of kidney or a failure of renal function expanding, it also recognized as Chronic Renal Disease.** **On the healthcare system, CKD: Chronic kidney disease represents a heavy burden, with the increasing amount of patients, at an end-stage, high risk of progression renal disease, and poor prognosis of mortality and morbidity. Sometimes, this disease symptoms are not noticeable, and also per year, a significant amount of lives are lost. So, concerned about kidney disease is required in very primary stage. Now Machine Learning (ML) techniques are using, for some major health risks’ awareness, like detection of brain tumor, prediction of diabetics, detection of covid-19, and detection of kidney diseases, and many more. Hence in this analysis, the prediction of the disease can be done, by taking the help of machines learning classifiers. They are Random Forest, Logistic Regression and KNN. Our aim is to differentiate the performance of various machine learning algorithms that are primarily based on its accuracy. In terms of F1-score, Recall and accuracy, this approach can give reliable and effective results**.

**Keywords**- **LR: Logistic Regression, RF: Random Forest, Chronic Kidney Disease, K-Nearest Neighbors (KNN)**

**I.INTRODUCTION**

Kidneys are about the size of a fist. The two organs are in bean-shape. They are located one on each side of the spine, just below the rib cage. Every day, to produce about 1 to 2 quarts of urine, 120 to 150 quarts of blood is filtered by kidneys. Urine helps to body in removing waste products and excess fluids, it is the key function of kidneys. Excretion and re-absorption’s highly complex steps are involved in the urine production. This is the necessary process, we can able to maintain a stable balance in body chemicals with the help of that. With the critical regulation of the body's salt, by the kidneys, the function of other organs will be affected to produce hormones, and potassium and acid content is performed at the same time. For example, calcium metabolism is controlled by a hormone which is produced by the kidneys, that regulate blood pressure, and stimulates red blood cell production etc. By a gradual loss of kidney function Chronic kidney disease occurred, CKD is a major issue, throughout the world over time, from the world population 14% suffers from this disease. To stay alive, over 2 million people throughout the world, currently receive treatment with dialysis or a kidney transplant, still, the percentage of people who need treatment to live, is only10%. When compared with breast cancer or prostate cancer, more deaths caused by Chronic kidney disease.

There are approximately, 1 million cases of Chronic Kidney Disease (CKD), every year in India. Kidney functionality’s gradual loss is produced by it, and it is very dangerous to kidney. However, symptoms of this disease grow gradually and it is unpredictable, and also it is not unique to the disorder. At an early stage, the detection of CKD is very important. From the blood, wastes and excess fluids are filtered by kidneys, in excrement, which are going to excrete. At CKD’s early stage, a few symptoms or signs will be observed. It makes its way as an actual channel and ground-breaking, that liberates the body from return supplements, parlous substances and squander, basic substances like, amino acids, hormones, insulin and other liberates the body and parlous substances. The things will flip out gravely, however. For suggesting that, any variety of nephritis that returns at some stage in the world, “Chronic Kidney Disease” is used. It incorporates with any deviation, by paying very little heed which is going to create a man feel manufacture complexities or unwell or not, most likely from the limit customary, or the urinary organ structure “Infection”. It is a typical problem which, anyone at any age may influenced. About 3 million people, who are at risk of CKD, are assessed by it, within the United Kingdom.

To the 21st century’s global health agenda, an important threat is posed by Chronic diseases. In developing countries, chronic diseases’ rising its prevalence, and it also has serious consequences. Hypertension, diabetes, and obesity are the common risk factors that are increasing rapidly, especially in the poor people, that results in developing nations are not at all prepared to cope with even deeper and greater burdens. Primarily, on infectious diseases, the reason is the focus of global health community, and chronic diseases, lack of consciousness has been a lack of exposure, especially in chronic kidney disease. By developed countries, to put concentration on it and to adopt chronic disease strategies like, more inclusive, cost-effective, preventive which having very important need. The details of chronic kidney disease patients will be stored by many hospitals. Through analysing these data, in decision-making, different helpful patterns can be found. It is possible to discover many kinds of knowledge on this data and also in prediction using this knowledge, everything will happen by using data mining techniques. There is a more number of people, on whom chronic kidney disease be affected. Maximum number of people from Bangladesh, are not concerned about this disease. The amount of affected people is increasing day by day by the disease, as a result. It could be controlled by people, if detection or prediction can be done, to know that whether they are affected by the disease or going to be affected. For not to be affected by the disease, people could take some necessary steps. By the help of Predictives, prediction of the disease can be done. Classification, categorization, regression are several methods that can be used there. Among those all, classification is the best, this is the thinking of most of the people. It will helpful for predicting Chronic Kidney disease, after accomplishing the research. People could know about the disease and also about their health condition. By using a machine learning algorithm, prediction of the disease is the main objective of the research, and also giving a message if a person has a risk of the disease.

In artificial intelligence basically, by studying the pattern recognition and computational learning’s theory, this Machine learning has been developed. ML is an exciting field which put focus on multiple variables, by studying huge amounts of data, it presupposes algorithms, computational methods, and analysis techniques. Health specialists and doctors carry out scintillate and flawless diagnoses, ML undertakes to aid them for determining patients at high risk, choosing the best-fit medicines for them, and most importantly with the help of minimal cost from Medical Sciences’ perspective, improving patients’ physical condition. With the availability of biomedical data, for developing disease prediction models, the use of machine-learning techniques in healthcare become common.

Depends on the results and discussions, evaluated and proper actions can be taken to study the prognosis rate of disease, by using different machine learning algorithms. Even though in this study, some algorithms are implemented. They are K Nearest Neighbors, Logistic Regression, Random Forest. several supervised learning classification algorithms also there. Accuracy or execution rate of each algorithm is different. Each algorithm has their own unique properties, with that they can get their own recognitions. In this study, predicting the disease with the help of data from chronic kidney patient’s machine learning algorithms will be implemented to know which algorithm will give the best result.

Predicting results of patients remains an important for individuals, researchers, medical and health care systems in diagnosis of CKD. The quality of life can be improved to a greater extent, by an early detection of CKD. Machine learning algorithms performed an important rule and applied it to predict chronic kidney diseases. Hence, a novel approach to optimize prediction method for chronic kidney disease is presented, in this analysis.

**II.LITERATURE SURVEY**

M. A., Wakil, Zaki, Z., Shah, K., Sher, F., et. al.,[1], with the help of University of California Irvine (UCI) machine learning repository’s data, authors can be able to study about human activities. Implementation of Random Forest, Logistic Regression and KNN among others can be done to study about human activity based on smart-phone. The comparison between the accuracy rates shows that most accurate prediction is given by logistic regression.

Roseline Bosede Ogunrinde, Adebayo Olusola Adetunmbi, Olayinka Ayodele Jongbo, Bukola Badeji-Ajisafe, et. al., [2] has discussed about the Development of an ensemble approach to CKD diagnosis. Two ensembles approaches are employed by this analysis, they are Random Subspace methods and Bagging on three base-learners of k Nearest Neighbours, Decision Tree and Naive Bayes for improving models classification performance.

B.Bharathi, S.Revathy, P.Jeyanthi, M.Ramesh et. al., [3] presented CKD Prediction, by using machine learning Models.To predict CKD and to propose best Prediction framework for CKD, this analysis uses data transformation, data preprocessing and various classifiers. The results of the framework show promising outputs for the better prediction of CKD at an early stage.

Sai Vaishnavi Avilala, Devika RV., and Subramaniyaswamy et. al., [4] using Naive Bayes, for CKD prediction, Random Forest and KNN presents a Comparative Study of Classifier. The overall performance is compared by them, for that they used classifiers with other current classifiers.After conducted research, the outcome is that the performance of RF classifier is finest than NB and KNN.

K Prasanna Lakshmi, Chittampalli Likhitha, V Ganapathi Raju, K. Gayathri Praharshitha, et. al,[5] presented Prediction of CKD, by using Data Science.This research work is to diagnose CKD depend on the classification report, performance factors and primarily concentrate on finding the best suitable classification algorithm which can be used.

Jae Won Chung, Muning Wang, Zixian Wang, Xilin Jiang, Yantong Cui, Anqi Zheng et. al., [6] presents ML based prediction system based on, CKD using Associative Classification Techniques. Based on machine learning techniques with the help of chronic kidney disease(CKD) dataset, from the UCI machine learning data warehouse, this study analyzes the disease which is named as chronic kidney disease. For 400 instances of chronic kidney patients, CKD is detected and the results are compared with 10-fold-cross-validation testing, by Apriori association technique.

David L. Cook, David Y. Gaitonde, Md. Ian and M. Rivera, et. al., [7] presents Chronic Kidney Disease’s Detection and Evaluation. For providing education, implementing early interventions, and planning for advanced renal disease, a multidisciplinary approach is needed in between primary care nephrologists, physicians and other subspecialists. For effective management, this works like a key.

John stankovic and Asif Salekin, et.al [8] novel approach is used by them. 400 records and 25 attributes were found on a dataset, which results a prone of the patient is CKD or not. Neural Network algorithms, KNN, Random Forest are used, in order to achieve the result. For feature reduction, Wrapper methodology is used by them, which finds CKD with high accuracy.

Sharma, S., Sharma, V., Sharma, A. et. al. [9] diagnosing the Chronic Kidney Disease (CKD), they evaluated different types of classification methods. 400 instances and 24 attributes were consisted by this dataset, for this analysis. 12 classification techniques were tested by authors, with the help of CKD results. For the performance measurement, some predictor parameters are used, they are Precision, Prognostic accuracy, sensitivity and specificity.

Vinod Sharma, Sahil Sharma, and Atul Sharma, et.al [10], on various datasets, each 400 records and 24 attributes, tested 12 different classification algorithms. They comparison between expected results, and actual results, they are metrics, that used to measure the performance of the classifiers in order to determine accuracy, predictive accuracy, precision, sensitivity and specificity. Note: CKD is not an uncommon.

Radha, N., Ramya, S. et. al. [11] to diagnose the CKD on Naive Bayes, Decision Tree and K-Nearest Neighbor are the entirely different algorithms, then the expected results were carried out. When there have a comparison between all, the algorithm named, K Nearest Neighbour, delivers a better result, this is suggested by the expected outcome. The expectation is to take classification algorithms into consideration.

**III. PREDICTING** **CHRONIC**

**KIDNEY DISEASE**

In this section, a novel approach to optimize prediction method for chronic kidney disease, by using machine learning is presented. The block diagram of presented approach is shown in Fig. 1.

Data Input

Data Pre-processing

Feature Selection

Feature extraction

Machine learning classifier

Test set (2/3 rd of data)

Training set (2/3rd of data)

Classification Algorithm

K -Nearest Neighbor

Random forest

Logistic Regression

Evaluation Metrics

Predict the result

**FIG: 1 BLOCK DIAGRAM FOR PREDICTING CHRONIC KIDNEY DISEASE**

From the UCI machine learning repository, 400 chronic kidney disease datasets are used, in this analysis. There are 25 attributes, in this dataset, in that predictive variables are 24 and 1 is from decision class.

24 attributes are there in predictive, in that some attributes are numerical and some of them are nominal. Therefore, nominal values are contained by this dataset, can able to convert nominal attributes into numerical attributes and numeric value is converted with the help of mapping function. Full of numeric values are presented in our dataset. The unrefined medical data is pre-processed by it. Missing values need to be removed, to enhance prediction capabilities, and also for the machine learning models, will make them useful. Data-transformation is limited, for processing the non-numerical data. In the form of ‘present’, ‘not present’, ‘normal’, ‘abnormal’, ‘yes’, ‘no’, ‘good’, and ‘poor’, there is non-numerical data, in the dataset and that non-numerical data are identified and transformed into numerical values. For nominal attributes, ‘0’ replaced with ‘abnormal‘, ‘not present’, ‘no’, and ‘poor’ values and ‘1’ is replaced with ‘yes’, ‘normal’, ‘present’, and ‘good’ values.

When developing a predictive model, to reduce the number of input variables we use the process called Feature selection. It is desirable, to reduce the count of input variables for both reduce the computational cost of modeling and in some cases, to improve the performance of the model. To achieve efficient data reduction, Feature selection methods can be used in data pre-processing. This is very useful, for finding accurate data models.

In pre-processing stage, the distorted or encoded data is brought to such a state to make the machine can easily analyze it. As in the form of group of data objects, a dataset can be observed. Data objects are labelled, by a number of features through which the basic features of an object can be ensured. The features that physical mass of an object or the time, at which an event can be ensured. Missing values either eliminated or estimated values, the dataset may consist of them. With the value of mean, median or mode of help of respective feature, filling the missing values, is the most common method for dealing. Data pre-processing should be completed, before data’s all features were used in selection. The attribute selection process has been attached to reduce dimensionality. From the presented dataset, we should collect small subsets of relevant features, to obtain improved prediction rates. Particularly, from the kidney disease dataset to figure out and to take all the inputs, the classified model is needed. In this dataset, Random Forest, Logistic Regression, Decision Tree, and K-Nearest Neighbors, are the four different types of machine learning approaches, which are to be implemented.

For training as well as testing, three distinct classifiers receive extracted Features that have been tagged with the appropriate diseases. This study performed, to evaluate the performance of CKD or not CKD, by using three Machine learning algorithms. They are: KNN, Random Forest and Logistic Regression. For testing and training the samples, the dataset is divided into two groups. 30%: 70% is the ratio between testing data and training data, these models are evaluated, by using the testing set.

Logistic Regression, Random Forest and K-Nearest Neighbor, are the machine learning algorithms that used to classify CKD.

Logistic regression: It’s a mathematical model. It uses logistical functions to model a binary dependent variable in its basic form, if there are more complicated extensions. It is a form of binary regression, logistics model’s parameter can be measured with the help of Regression analysis. For the two possible values, the model has a dependent variable, which is named as statistical Binary Logistic. Ex: suggesting the two values ”0” or ”1”, for pass or fail.

Random Forest Classifier: Depending on an ensemble tree, it is a learning algorithm. By Random Forest, on a randomly selected feature vector, a combination of many decision trees consisted, from the training data set, where each tree is well trained. Individually, each tree of the forest, classifies it and yields a certain classification result for a test sample, which is new. By depending on over all trees, the test data’s predicted class is decided, with majority of votes in the network, by the Random Forest.

K-Nearest Neighbor: Due to its versatility, in machine learning, it is one of the most used algorithms. Moreover, like other algorithms the learning stage also not required for this. In 1970, for pattern recognition and statistical estimation can be done with the help of KNN. In data mining, there are names as Classified algorithm and also Lazy algorithm, for K-Neighborhood. The consideration of space, is from the range between the two points, in mathematics. Within the distance, there are several matrices; the distance from Euclidean is counted as the distance from the universe among all.

Here, the accuracy, Recall and F1 score evaluation metrics are used, in this analysis. The outcomes are predicted, by using these evaluation metrics.

**IV. RESULT ANALYSIS**

In this section, there is a discussion on Machine Learning performance of a Novel Approach is used for Chronic Kidney Disease, to Optimize Prediction Method.

The performance metrics like Accuracy, Recall and F1 score are measured, based on these values. By the terms, these factors of classification measurement are calculated. They are: TP: True Positive, FP: False Positive, TN: True Negative and FN: False Negative. Here,

True Positive: If a sample is predicted correctly as positive and in actual it is positive.

True Negative: If a sample is predicted correctly as negative and in actual it is negative.

False positive: If a sample is incorrectly predicted as negative but in actual it is positive.

False Negative: If a sample is predicted incorrectly as positive but in actual it is positive.

Accuracy:It measures the ability of the system to make correct predictions, it is a performance parameter, and is expressed as,

Recall: To the total number of observations in actual class, it is the ratio of correctly predicted positive observations. and is expressed as,

F1-Score:

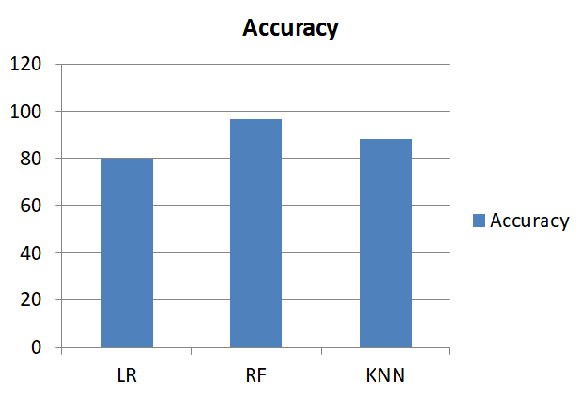
A weighted average of the precision and recall, is consider as F1-Score. For the good performance of the classification algorithm, it must be one, and for the bad performance of the classification, it must be zero,

In terms of recall, accuracy and F1 score, the performance of a novel approach ML based chronic disease prediction is evaluated, and is represented in below Table 1.

**Table: 1 COMPARISON OF PERFORMANCE TABLE**

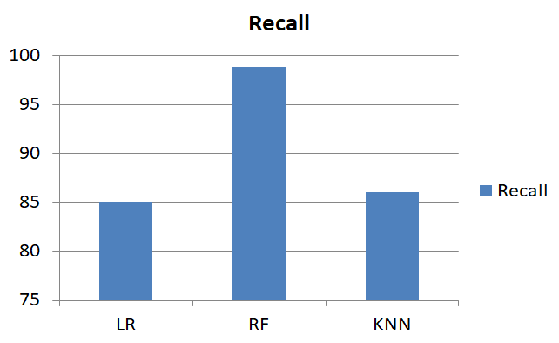
|  |  |  |  |
| --- | --- | --- | --- |
| **ML models** | **Accuracy** | **Recall** | **F1 score** |
| LR | 80 | 85 | 91 |
| RF | 96.8 | 98.9 | 99.2 |
| KNN | 88 | 86 | 92 |

In terms of F1 score, recall and accuracy, the performance of a novel approach ML based chronic disease prediction. The Random Forest has highest accuracy rate than the other ML models.

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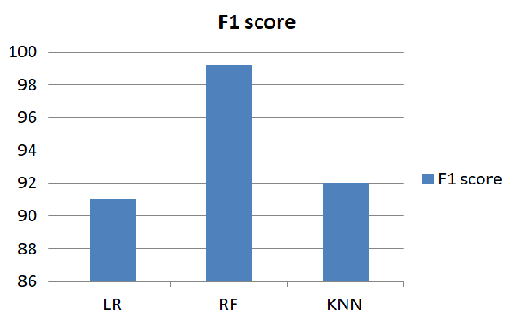
**Fig. 2: Accuracy Comparison Graph**

In this accuracy comparison graph, LR, RF and KNN, RF shows higher accuracy.



**Fig. 3: Recall Comparison Graph**

In fig.3, RF shows higher recall when compared with LR and KNN.



**Fig. 4: F1 Score Comparison Graph**

In fig.4, LR, RF and KNN comparision graph, RF shows higher F1 Score.

Therefore presented novel approach to optimize using ML (Machine Learning) based prediction of CKD has better results compared to other ML classifiers. This presented model predicted the CKD very effectively and accurately.

**V. CONCULSION**

In this analysis, a novel approach to optimize prediction method by using Machine learning to predict chronic Kidney disease is presented. Here LR, RF and KNN are used for novel approach method by using machine learning. The UCL ML repository dataset is used in this approach for training and testing the presented model. The novel ML accurately predicts the chronic kidney disease as CKD or Non-CKD. The presented model performance is evaluated in terms of recall F1 score and accuracy. This novel ML model of RF has better and accurate results compared to LR, KNN ML classifiers. This presented model plays a significant role in the medical & science fields for analyzing the performance of CKD prediction with variant medical data with high degree of accuracy.

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