

Classification And Prediction Of Chronic Kidney Disease Using Novel Decision Tree Algorithm By Comparing Random Forest For Obtaining Better Accuracy

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ABSTRACT

Aim: Chronic Kidney Disease (CKD), also referred to as long-term nephrotic syndrome, has risen exponentially in importance. A person may only remain missing their kidneys for an estimate of 18 days, which creates a huge need for hemodialysis and kidney replacements. The main objective of this study aims to find the best-suited algorithm that will give us the most ideal prediction. We will be comparing Novel Decision Tree with Random forest to find out which of these can give us the best accuracy. **Material and Methods:** The study used 143 samples with Novel Decision Tree and Random Forest is executed with varying training and testing splits for predicting the accuracy for kidney disease prediction with the G-power value of 80% and the kidney datasets were gathered from different websites, together with data from more recent studies, a criterion of 0.05%, a reliability range of 95%, a means, and a confidence interval. The performance of the classifiers are evaluated based on their accuracy rate using the chronic kidney disease dataset. **Results:** The accuracy of predicting kidney disease in Novel Decision Tree (96.66%) and Random Forest (62.25%) is obtained. By using independent samples t-tests, it can be shown that there is a statistically 2-tailed notable change in efficiency seen between two algorithms of 0.000 ($p < 0.05$). **Conclusion:** The report's findings suggest that the Innovative can be used to predict kidney illness Decision Tree (DT) algorithm appears to be significantly better than the Random Forest (RF) with improved accuracy.

Keywords

Chronic Kidney Disease, Novel Decision Tree algorithm, Random Forest, Machine learning, Accuracy, Prediction.

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INTRODUCTION

The prediction of Chronic Kidney disease and to increase the accuracy of predicting the disease using Novel Decision Tree and comparing it with Random Forest. In the last decade, The greatest cause of death worldwide is still severe kidney disease (CKD), also known as chronic renal impairment (Naqvi et al. 2021). Deficiency of water intake, tobacco, eating poorly, getting too little sleep, and many other things can lead to Hemodialysis. In 2016, this illness impacted 753 million people worldwide, 417 million of whom were women and 336 million were men. The condition is typically only discovered until it is very advanced, and this can occasionally result in renal failure (Senan et al. 2021). This study presented a system that makes use of backpropagation neural networks and the Random Forest technique, among other data mining approaches. Here, they evaluated the two algorithms and discovered that the Back Propagation approach produces the greatest results since it makes use of the Multilayer Feedforward Network, a deep learning network (Almustafa 2021). In this, they suggested creating a CKD prediction system utilizing machine learning methods including Naive Bayes, Support Vector Machine, K-Nearest Neighbor, Logistic Regression, Innovative Decision Tree, Random Forest, and Multi-Layer Recurrent neural network Algorithm. These are used, and the effectiveness of each is evaluated against the outcomes for reliability, sharpness, and recall. The Random Forest is finally selected to construct this system (Chen et al. 2021) ("Website," n.d.; Aswini et al. 2021). When dialysis or a kidney transplant are the only treatments left to save the patient's life, CKD is frequently discovered in its later stages. However, early detection can help prevent renal failure (Munir et al. 2021). The Glomerular Filtration Rate (GFR) should be periodically monitored as it is the most accurate indicator of kidney function and a good indicator of the stages of renal disease. Age, gender, race, and blood creatinine levels are used to determine GFR. GFR values allow for the classification of CKD into six phases (Dalle Carbonare et al. 2021).

Numerous studies have been conducted utilising machine learning algorithms to categorise the chronic kid-

ney. More than 60 articles were published in IEEE explore and nearly 3930 articles were found in google scholar. The positive articles that have been published with the machine learning algorithm for predicting kidney disease were exposed mostly using the Novel Decision tree algorithm with an output accuracy of 98.71 ((Arif-Ul-Islam, Arif-Ul-Islam, and Ripon 2019). From this survey, it is observed that many research works involve classification and predicting kidneys so that it helps to take treatment (Chan 2020). There are also some other publications in which they got other machine algorithms as their highest accuracy algorithms are linear regression, logistic regression, SVM (Schutte 2017). The study takes into account the practical issues of data gathering and emphasizes the necessity of domain knowledge when applying machine learning to predict CKD status. (Parabhoi et al. 2021; Beulah et al. 2022). The classifiers are logistic regression with an accuracy of 83%, Convolutional Neural Network with an accuracy of 73%, K-Nearest Neighbor with 70% of accuracy achieved (Almustafa 2021). The current study employs feature extraction, data aggregation, data preprocessing, a system for handling missing values, and all of these techniques to predict CKD status from clinical data (Ekanayake and Herath 2020). Our team has extensive knowledge and research experience that has translate into high quality publications(Chellapa et al. 2020; Lavanya, Kannan, and Arivalagan 2021; Raj R, D, and S 2020; Shilpa-Jain et al. 2021; S, R, and P 2021; Ramadoss, Padmanaban, and Subramanian 2022; Wu et al. 2020; Kalidoss, Umapathy, and Rani Thirunavukkarasu 2021; Kaja et al. 2020; Antink et al. 2020; Paul et al. 2020; Malaikolundhan et al. 2020)

The existing research study predicts the classification using a dataset but it does not group them (Vasalotti 2020). Another research paper has developed a prediction model using AI techniques which are based on a deep CNN to detect chronic kidney failure patients (Ja and Jojoa 2017). Most relevant articles lack accuracy scores for the DT classifier for innovative disease detections to predict kidney disease (Rambabova-Bushljetik et al. 2021). Therefore the study aims to increase the accuracy of predicting the likelihood of kidney failure and improve the prediction model using the Novel Decision tree (Ilyas et al. 2021).

MATERIALS AND METHODS

This research study was carried out in the Artificial Intelligence Laboratory at the Department of Computer Science and Engineering, Saveetha School

of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai. This research study uses two groups, the Novel Decision Tree algorithm, and Random Forest (RF) algorithm. The g-power tool was used to predict each sample size, yielding 286 total sample sizes and 143 number of respondents each category with 80% of G power values and 95% reliability (Senan et al. 2021).

The data set used for this experiment is obtained from the kaggle open-access dataset, (https://www.kaggle.com/datasets/mansoordaku/ckdisease?select=kidney_disease.csv) one of the most popular if not the most well-liked online groups for practitioners of data science and artificial intelligence. Users can use it to search for and locate the required datasets and also provides a customizable Jupyter notebook environment with free GPU and 6 hours of runtime. The dataset consists of 76 attributes. The attributes are bp, sg, su, RBC, PCC, BGR, and 20 others. The dataset has 401 rows and 26 columns which consists of data for the symptoms that relate to chronic kidney disease which also includes duplicate, null and missing values. Pre-processing of the datasets is done to remove the duplicate and null values with the help of functions that are provided by Microsoft excel. The dataset that is collected consists of all numerical forms; there is no need to convert the data. The unwanted attributes that are not necessary for the prediction are removed.

The testing setup uses Core i5 with 2.25 GHz with 8 gigabytes of random access memory. In this proposed system 50GB hard disk and 8GB RAM for the execution of the Algorithm. The system type used was a 64-bit Operating System, X64 and it is windows operating system. To use a machine-learning algorithm the one of the Integrated Development Environment called Spyder software with pre-installed libraries or Google collab can be used for replacement. The proposed system for the classification of heart disease prediction involves the following steps: correlation between columns, Exploratory data analysis (EDA), feature extraction, and classification.

NOVEL DECISION TREE ALGORITHM

The supervised algorithms category includes Novel Decision Tree. Both segmentation and stagnation can be done with novel decision trees. The decision variable in the classification Novel Decision Tree is qualitative. The Information Gain, an optimization algorithm used to assess bilateral divides, should be

determined in order to design an Innovative decision tree. The information is split, the Inequality score is determined and the divides are all evaluated before the final split is created. Following completion of this step and creation of the parent node, the tree can then be built by first selecting when to cease the massive tree growth by generating the terminal node and establishing the highest plant deep, and then by employing recurrent dissociation. Sequential dividing is a technique used to construct the tree, and the final node is used for the final prediction.

Pseudocode for Novel Decision Tree is shown below:

```
from sklearn.tree import DecisionTreeClassifier
seed = 7
kfold = model_selection.KFold(n_splits=45, random_state=seed)
model = DecisionTreeClassifier()
model.fit(X_train,Y_train)
accuracy_score(Y_test,model.predict(X_test))
```

RANDOM FOREST ALGORITHM

The Random Forest Technique is frequently employed for both analysis and regression issues. This algorithm can be used in various places such as banking, prediction works, health, stock markets, artificial intelligence, etc. The confusion matrix will integrate them into a forest-like framework to provide predictions that are more precise and stable. Subsets from both datasets and attributes are selected arbitrarily and get trained. using this method overfitting of data can be lowered. This algorithm takes lower training time than many other algorithms on large datasets with maintaining the precision the accuracy when a huge part of data is not present.

Pseudocode for Random Forest Algorithm

```
from sklearn.ensemble import RandomForestClassifier
max_accuracy = 0
for x in range(2000):
    rf = RandomForestClassifier(random_state=x)
    rf.fit(X_train,Y_train)
    Y_pred_rf = rf.predict(X_test)
    current_accuracy = round(accuracy_score(Y_pred_rf,Y_test)*100,2)
    if(current_accuracy>max_accuracy):
        max_accuracy = current_accuracy
        best_x = x
print(max_accuracy)
print(best_x)
rf = RandomForestClassifier(random_state=best_x)
rf.fit(X_train,Y_train)
Y_pred_rf = rf.predict(X_test)
```

STATISTICAL ANALYSIS

The statistical analysis is applied using Statistical Package for Social Sciences (SPSS) for descriptive statistical analysis such as mean, standard deviation and standard error were carried out for each group (Munir et al. 2021). The test was performed to compare variables across the study groups. Hence the independent variables in this study is mean, entropy, variance, and contrast. The dependent variables are accuracy, bp, rbc. The independent sample t-test is performed to compare the accuracy performance of both Group-1 and Group-2 using the DT and the RF algorithms.

RESULTS

The Novel Decision Tree classifier (DT) takes input in the form of symptoms from the dataset and produces output with an accuracy value of around 96%. The mean accuracy and loss values using the T-test for both the algorithms along with the standard derivation are shown in Table 3. The performances of the classifiers are measured by accuracy value. The dataset consists of 76 attributes. Here Novel Decision Tree and Random Forest algorithms are used. The DT algorithm and RF are compared with 10 samples by applying 70% of training data and 30% of testing datasets.

Table 1 contains the accuracy for the Novel Decision Tree classifier with N = 10

Table 1

Accuracy and Loss of a Novel Decision Tree for N = 10 With the help of an innovative decision tree, kidney illness can be predicted with 96.66% reliability.

Iterations	Accuracy(%)
1	96.66
2	95.12
3	96.78
4	94.43
5	96.92
6	93.13
7	97.10
8	92.33
9	97.85
10	91.11

Table 2 contains the accuracy for the Random Forest classifier with N = 10. The Random Forest classifier input is taken from the dataset and it gives an output accuracy of 62.25%.

Table 2

Reliability and Damage of Random Forest for N = 10. Using Random Forest, it is possible to anticipate renal illness with an accuracy of 62.25%.

Iterations	Accuracy(%)
1	62.25
2	61.23
3	63.14
4	60.34
5	64.33
6	59.23
7	65.90
8	57.22
9	65.90
10	57.22

Table 3 the statistical analysis of Novel Decision Tree and Random Forest Mean accuracy value and Standard deviation are observed that the DT algorithm performed better than the RF algorithm.

The DT algorithm obtained 2.31 standard deviations with 0.73 standard error while the RF algorithm

Table 3

The Novel Decision Tree Algorithm performed best in terms of accuracy and error in the group statistics (Mean of Novel Decision Tree Algorithm is 92.19%, higher than Random Forest Algorithm, 61.72%). Additionally determined were the mean difference and confidence interval mean.

	Group	N	Mean	Std. Deviation	Std. Error Mean
Accuracy	Novel Decision Tree	10	95.1430	2.31026	.73057
	Random Forest	10	61.7280	2.97053	.93936

obtained 2.97 standard deviations with .93 standard error. Accuracy and the Loss for both the algorithms are presented in a bar graph in Fig 1.

Table 4 it is observed that Novel Decision Tree has better significance than Random Forest with the value of $p = 0.000$. Finally, we compared the mean accuracy of the DT and the RF algorithms and it shows that the DT is significantly better than the RF algorithm.

Table 5 it is observed that the Novel Decision Tree proved with better and higher accuracy (96.66%) than

Table 4

Independent Sample Test for findings provide further evidence and confidence interval. 95% probability value was taken into account, and a P-value of 0.00 (less than 0.005) is deemed statistically significant.

		Levene's test for equality of variances		T-test for equality means with 95% confidence interval						
		f	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference	Lower	Upper
Accuracy	Equal variances assumed	.856	.367	28.079	18	.000	33.41500	1.19001	30.91487	35.91513
	Equal Variances not assumed			28.079	16.971	.000	33.41500	1.19001	30.90396	35.92604

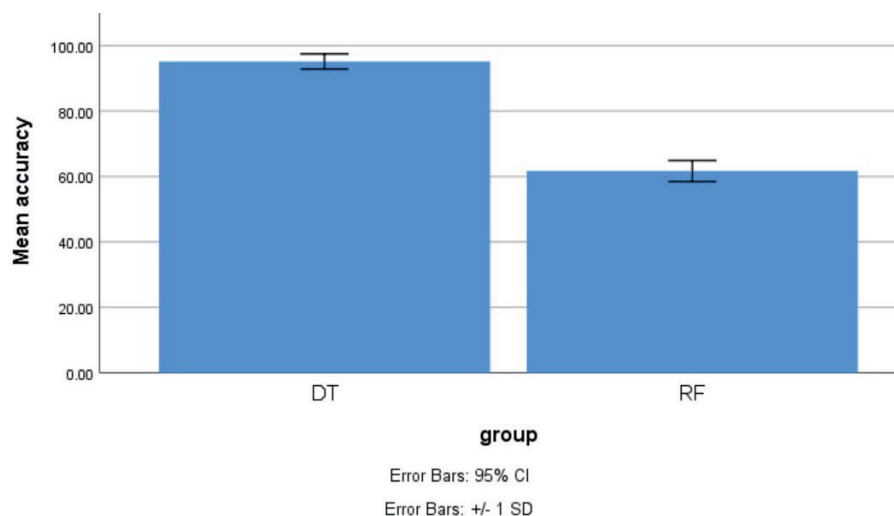


Fig. 1. Bar Chart representing the comparison of Mean Accuracy of Novel Decision Tree Algorithm and Random Forest algorithms. Mean accuracy of the Novel Decision Tree Algorithm appears to be better than Random Forest algorithm. The X-axis represents Novel Novel Decision Tree Algorithm and Random Forest algorithms and Y-axis represents the mean accuracy \pm 1 SD.

Table 5

Comparison of the Novel Decision Tree Algorithm and Random Forest Algorithm with their accuracy

CLASSIFIER	ACCURACY(%)
Novel Decision Tree	96.66%
Random Forest	62.25%

Random Forest (62.25%). Also it shows the accuracy values for both the Novel Decision Tree and Random Forest algorithm.

Figure 1 has the mean accuracy of the two algorithms has been shown and compared the mean error and the graph shows that Novel Decision tree is better than the RF algorithm

The Novel DT model obtained 96.66% and the RF algorithm already predicted 62.25% performance value. Finally, we compared the mean error of DT and RF algorithms as shown in Fig. 1. Therefore the Novel DT is significantly better than the RF algorithm.

DISCUSSION

With increased accuracy, Innovative Decision Tree seems to perform noticeably better than Random Forest. The Novel Decision Tree classifier shows a significant difference in terms of accuracy score, speed, and performance when compared to the Random Forest classifier.

To support this work the finding is similar to (Ekanayake and Herath 2020) have found, with the Novel Decision Tree classifier with 77% accuracy performing better than the Random Forest classifier. Consequently, chronic kidney disease can be accurately predicted using the Innovative Decision Tree (Kurata, Tanaka, and Nangaku 2021) also have similar findings where Novel Decision Tree is better than Random Forest classifier and so it can be implemented in the detection of kidney disease. (Sreeji, Sreeji, and Balusamy 2021) presents a methodology to control the disease using a suitable diet plan. In this research, classifiers are constructed using different algorithms like Multiclass Decision Jungle, Multiclass Decision Forest, Multiclass Neural Network, and Multiclass Logistic Regression (Sreeji, Sreeji, and Balusamy 2021). An allowable potassium zone is predicted depending on the blood potassium levels of the patient. one of the researched classification algorithms recommends a diet placed based on the predicted potassium zone (Krishnan et al., n.d.). The proposed and evaluated Kernel-based Extreme Learning Machine (ELM) to pre-

dict Chronic Kidney Disease. The performance of four kernel-based ELM, namely RBF-ELM, Linear-ELM, Polynomial-ELM, Wavelet-ELM is compared with the performance of standard ELM. The above methodologies were compared on metrics of sensitivity and specificity. Radial Basis Function – Extreme Learning Machine (RBF-ELM) showed higher prediction rates (Vassalotti 2020; V. and Nalini 2019).

Most of the previous work done is based on the data from the specific dataset. In the proposed work the lack of accuracy in predicting chronic kidney disease is improved by machine learning algorithms (Ilyas et al. 2021). In the future, this work can be extended to find how likely nondiabetic people can have kidney failure in the next few years. Artificial intelligence can also be used in the future to predict the severity of kidney failure (“Digital Risk Management for Data Attacks against State Evaluation” 2019). Even more, data can be accumulated over the existing data, and also datasets of feature set selection can be used. Deep Neural networks can be used for those datasets which will have a significant difference in terms of accuracy and real-world implementation ((Vassalotti 2020; V. and Nalini 2019)).

CONCLUSION

In this research, Chronic kidney disease prediction is performed using the kidney disease symptoms dataset for Novel Decision Tree and Random Forest. The accuracy value of the Novel Decision Tree classifier is 96.66% whereas the accuracy value of Random Forest is 62.25%. The quality of Chronic kidney disease prediction and accuracy using Novel Decision Tree appears to be better than RF.

DECLARATION

Conflicts of Interests

No conflict of interest in this manuscript.

Authors Contributions

Author RJ was involved in data collection, data analysis, and manuscript writing. Author UP was involved in conceptualization, data validation, and critical review of the manuscripts.

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