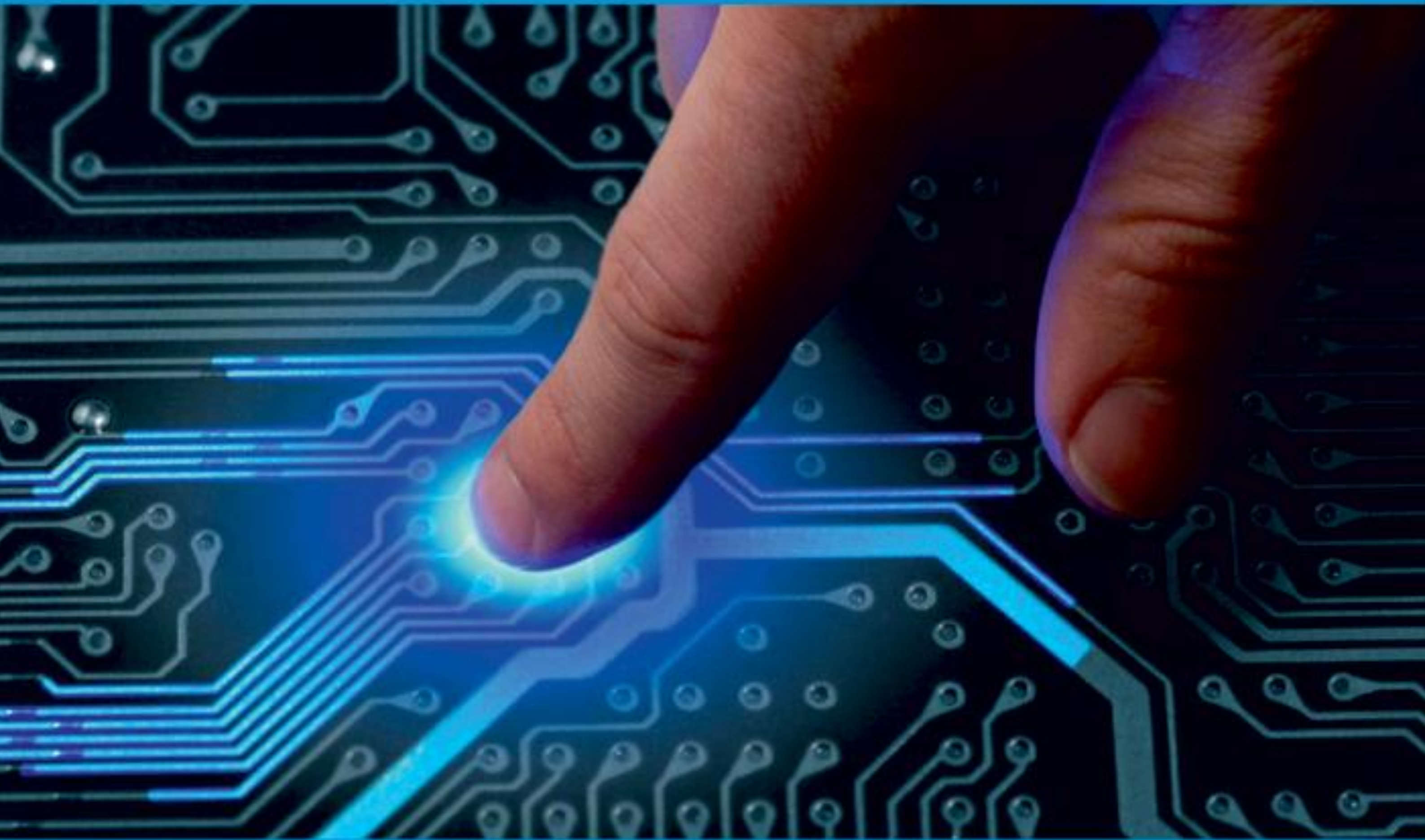
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1205129 |

Machine Learning for Chronic Kidney Disease: A Survey

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ABSTRACT: Chronic kidney disease is a non-contagious disease which has come up as a primary factor contributing to mortality worldwide. The recent rise in the count of individuals ailing from CKD comes from the rise in diseases like hypertension , diabetes and obesity. Since the condition has silent progression, one might not even be aware that he/she has kidney disease until the condition is advanced. Early detection and intervention play a signifying role in slowing down the advancement of CKD and improving patient outcomes. In past few years, Machine Learning techniques have surfaced as potent instruments for early detection of CKD. This literature survey paper gives an overview of the present ML approaches employed in CKD detection, the various algorithms used for attribute selection and classification, their working and future work that remains to be undertaken.

KEYWORDS*:* Chronic Kidney Disease, Machine Learning, Prediction

I. LITERATURE REVIEW

KOMMURI VENKATRAO and SHAIK KAREEMULLA [1] proposed a deep learning hybrid network model (HDLNet) for early CKD detection and prediction. Deep Separable Convolution Neural Network (DSCNN) was utilized for the early detection. Capsule Network (CapsNet)was used to extract processing attributes of characteristics chosen to indicate a kidney issue. to speed up the categorization process, the Aquila Optimization Algorithm (AO) method was used. Diagnosis of kidney illness as CKD or non-CKD was done using the Sooty Tern Optimization Algorithm (STOA). The metrics for evaluating performance were accuracy, sensitivity, MCC, PPV, FPR, FNR, and specificity. The utilization of clustering approach to improve the efficacy of categorization and reduce instances of incorrect categorization is the future work of this paper

JIONGMING QIN et.al [2] proposed a method for diagnosing CKD. The large number of absent values within the University of California Irvine (UCI) repository, were filled in using KNN, which selects several complete samples with the most similar measurements to handle the missing data for each insufficient sample. Six machine learning algorithms k-nearest neighbor , support vector machine ,logistic regression, naive Bayes classifier ,random forest, and feed forward neural network were used. They proposed integrating random forest and logistic regression by using perceptron to battle the misjudgments produced by the used models.

LINTA ANTONY et.al [3] developed a system to classify a patient into classes of 'CKD' or 'Non-CKD' Their primary aim was to implement and contrast the effectivenss of various unsupervised algorithms and pick out the finest combinations that could provide better accuracy and detection. They implemented five unsupervised algorithms, K-

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Means Clustering, DB-Scan, I-Forest, and Autoencoder ,and integrated them with various methods for selection of features. Future scope includes detection of five different levels of CKD in a similar manner.

Utomo Pujianto et.al [4] used data mining methods such as classification and clustering. They used K-Means algorithm as a clustering algorithm and Support Vector Machine algorithm as a classification algorithm. Various non-linear kernels such as polynomial kernels, RBF kernels, and sigmoid kernels are employed in the classification tasks. The utmost accuracy in classification with three clusters, four clusters, and five clusters are generated by using the RBF kernel.

A. Nishanth and S. Rishikesan [5] proposed that attributes of different medical tests can be investigated to identify which attributes contain useful information about CKD. The overall cost of analysis was done with different techniques for healthy patients on a dataset with several attributes of those who have CKD. Random forest ,C4.5, One Rule and Naïve Bayes methods was used to find out the important attributes. Analysis suggested that serum creatinine, hemoglobin, Diabetes Mellitus, and hypertension are the most salient attributes in identifying CKD.

RUEY KEI CHIU et.al [6] apply the technologies of artificial neural networks like Back-Propagation Network (BPN), Generalized Feed Forward Neural Networks (GRNN), and Modular Neural Network (MNN). Comparison of sensitivity, accuracy, and specificity among three models is also per formed and subsequently the model with highest performance is chosen for system development. The prototype is then deployed to the Google cloud platform by using Google Application Engine. Future scope includes further model modification and testing for the intelligence models deployed in the paper. User interface deployed in the current Google cloud computing platform can be enhanced further.

Sankhadeep Chatterjee et.al [7] proposed a Cuckoo Search (CS) trained Neural Network (NN) or NN-CS based model to detect Chronic Kidney Disease. It overcomes the problem of using local search-based learning algorithms to train NNs.The model has been weighed up with well-known classifiers like Multilayer Perceptron Feedforward Network (MLP-FFN) and also with NN supported by Genetic Algorithm (NN-GA). The future work may be focused on studying other such optimization techniques to train NNs

Muhammet Sinan BAŞARSLAN and Fatih KAYAALP [8] used the Correlation Based Attribute Selection (CBAS) method and Fuzzy Rough Set Based attribute selection (FRSBAS) method to determine attributes. Two data sets obtained by each selection of attribute method and the unprocessed data are classified by Logistic Regression ,k-Nearest Neighbor, Navie Bayes and Random Forest. The test and training data are separated by 5-fold cross validation. It was remarked that the application of FRSBAS method performed better in all classification algorithms. Among attribute selection methods, FRSBAS was more successful than CBAS.

Maithili Desai [9] had proposed a framework for diagnosis and prevention of CKD with the use of machine learning to autonomously detect and also to extract pertinent data like blood pressure, body ph levels ,sugar level, and complete body. They used more than 600 clinical records. They have used Naïve Bayes and decision trees for classification using WEKA tool. It was seen that decision tree performed better than Naïve Bayes.

W. Gunarathne et.al [10],used Microsoft Azure to forecast the condition of the patient ailing from CKD.By considering 19 attributes out of 30, they contrasted few algorithms:- Multiclass Decision Regression, Multiclass Decision Forest, Linear regrestion, Multiclass Decision Jungle and Multiclass Neural Network. They found that Multiclass Decision and Linear regression are the best.

Bhagavan Gudethi [11] aspired to predict CKD at first stage by using machine learning algorithms. KNN, Support Vector Machine and Logistic Regression were used. The performances were determined mainly on the basis of precision. It was seen that Support Vector Machine predicts CKD better than K-Nearest Neighbours and Logistic Regression.. Since a dataset of only 600 samples was used, future scope includes using a larger dataset or contrasting the results of this dataset with a another dataset

LAMBODAR JENA, & RAMAKRUSHNA SWAIN [12] proposed a methodology to predict CKD by using two algorithms i.e. Naive Bayes and Multilayer Perceptron. These algorithms are accomplished using WEKA tool to analyse accuracy. Outputs are contrasted on the basis of accuracy obtained . Kappa statistics ,correctly classified instances, RMSE metric and mean absolute error were the metrics. The findings showed MLP classifier to outperform

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Naïve Bayes classifier in all metrics specified.. In future we shall consider some more classification algorithms distributed in nature and analyse their performance with the same dataset and also by changing the dataset.

SATIRA WIBAWA et.al [13] designed a study to diagnose CKD based on 24 attribute which includes symptoms, signs and risk factors of CKD. The starting features were identified using method of Correlation-based Feature Selection (CFS). On the classification stage, AdaBoost was used for enhancing classification result. Three classifiers k-Nearest Neighbour (kNN), Support Vector Machine and Naive Bayes applied to examine the effect of CFS and AdaBoost in enhancing classification result. Three different classifications were done. The first, classification conducted by only the base classifier. In the second method, classification was conducted after features was selected by CFS. In the third method, selected features were trained by AdaBoost learning. Classification was evaluated by using four parameters, namely accuracy; precision; recall and f-measure. Based on four parameter of evaluation, CFS and AdaBoost were successful in improving CKD diagnosis. There was increment in all classification methods. The best result was achieved by kNN classifier with high accuracy.

MOUMITA BHATTACHARYA et.al [14] used a hierarchical metaclassifier to evaluate CKD stages. Their method outperforms standard classifiers and other meta-classifiers in finding stages 4 and 5 of CKD. Even when the set of features is reduced and number of records is pronouncedly decreased, the model's performance is maintained. Lower stage evaluation of CKD is the future work prescribed .

ASIF SALEKIN, & JOHN STANKOVIC [15] evaluated three classifiers: k-nearest neighbours, neural networks and random forest to battle noisy and missing values. They have implemented feature reduction using two methods: LASSO regularization and wrapper method. Results showed random forest with a reduced attribute set of 12 members has highest accuracy .A 57% RMSE reduction was also obtained. According to them haemoglobin, specific gravity, diabetes mellitus, hypertension etc. along with earlier used albumin and serum creatinine are very important attributes for CKDCost can be cut down using only five attributes: specific gravity, haemoglobin, albumin, diabetes mellitus and hypertension.

JINGHE ZHANG et.al [16] used frame works for the early diagnosis of CKD in diabetes patients using longitudinal EHR data. The proposed WB-SLR framework is capable of getting more accurate predictions.. The technique of random forest can be implemented as future work. This can decrease the correlation between single models in ensemble and further improve accuracy.Toreduce multicollinearity, regularization was also introduced.

D.N.LOKUARACHCHI et.al [17] used ankle swelling, KDQOL scale and other risk factors for prediction of CKDu. The main method used is Neural Networks Other technologies may be utilised for prediction of CKDu using the above elements. This is the future work that can be carried out.

BILAL KHAN et.al [18] compared seven ML algorithms empirically. SVM ,NB, MLP, LR, , J48, CHIRP and NBTree, were used. The results show superior performance for CHIRP on an average using different evaluation metrics. Finally, when comparing the overall error metrics, MAE, RAE%, RMSE, and RRSE% CHIRP performance is the minimal error rate as contrasted to other employed techniques. Moreover, comparing overall accuracy metrics, precision, recall, F-measure CHIRP performance is 0.998 for all these three metrics and better performance of CHIRP as contrasted with entire utilized techniques. Therefore, CHIRP proved to be more promising.

PRONAB GHOSH [19] This study concluded that the DNN has better performance in identifying the advancement of CKD patients to ESRD compared with other machine learning-based models. Furthermore, it provides a potentially more important and different perspective for clinicians' understanding of CKD. That is, haematuria may be an important predictor of the advancement of DN and urolithiasis. We compared the DNN model with other machine learning-based models and found that the DNN model performed the best in all CKD stages.

PING LIANG et.al [20] proposed four distinct algorithms to achieve a precise expectation rate over the introduced dataset. Contrasting all presented approaches, the fruitful results were obtained from GB classifier. These models effectively generate a high accuracy rate while AB, and LDA provides a low score. Besides the GB classifier requires a lot of time when compared to others to provide a prediction and highest predictable score in both ROC and AUC curves. Since an exact pace of expectation is without a doubt reliant on the pre-processing strategy, the methods of the pre-processing must deal with cautiously to accomplish recognized outcomes precisely.

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SARAH FALLMANN, & LIMING CHEN [21] proposed the hypothesis built using correlations between sleep-wake behaviour and chronic diseases. To detect disease effectively, a multidimensional feature vector is set using an LSTM algorithm was applied combining actigraph data with clinical features. The work has been tested and evaluated on diverse use case scenarios, which includes 2-classes disease prediction issues (non-specific disease versus disease affected) and 3-classes early disease prediction issues (non-specific-disease affected, early stage, and disease affected), for four particular chronic disease, as such, hypertension, diabetes, sleep apnea and CKD. The work is showing good results, varying for dissimilar use cases, resulting from current differences in chronic disease features. The future research will dig deeper to find which other chronic diseases can be predicted using sleep-wake behaviour investigation, and why some of them perform below precise value.

Dibaba Adeba Debal & Tilahun Melak Sitote [22] carried out both binary and multi clas classification . They employed Random Forest , Support Vector Machine and Decision Tree algorithms for classification. Dataset was collected from St. Paulo's Hospital, Ethiopia. Selection of features has been done by recursive elimination using cross validation and analysis of variance. Tenfold cross-validation was used for evaluation. It was seen that Random Forest has superior performance than SVM and Decision Tree. Future work involves using both unsupervised and supervised algorithms and building a mobile-based system .

Hamida Ilyas et.al [23] proposed a model to detect CKD on various stages of progression. They have used Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation for estimation of GFR value. Random Forest classifiers and multiclass J48 are used to classify CKD into different stages. J48 outperformed Random Forest.

Table.1 containing the List of Papers Surveyed including the authors, Year of Publication, Algorithm used and Accuracy in percentage.

Title	Authors	Year	Algorithm Used	Accuracy (%)
A Hybrid Deep Learning Neural Network Model with Intelligent IOT for Identification and Classification of Chronic Kidney Disease	KOMMURI VENKATRAO, & SHAIK KAREEMULLA	2023	Deep Separable Convolution Neural Network (DSCNN)	95.08
A Machine Learning Methodology for recognition of Chronic Kidney Disease	JIONGMING QIN, LIN CHEN, YUHUA LIU , CHUANJUN LIU, CHANGHAO FENG & BIN CHEN	2019	KNN	99.73
A Comprehensive Unsupervised Framework for Prediction Chronic Kidney Disease	LINTA ANTONY, SAMI AZAM , EVAIGNATIOUS , RYANA QUADIR, ABHIJITH REDDY BEERAVOLU , MIRJAM JONKMAN & FRISO DE BOER	2021	K- Means Clustering, DB-Scan, I-Forest, and Autoencoder	99
Detection of Chronic Kidney Disease using Support Vector Machine With Purified K-Means Clusters	Utomo Pujianto , Nur A'yuni Ramadhani & Aji Prasetya Wibawa	2018	Support Vector Machine(SVM) and K-Means	96.2
Cost based important attributed identification for early prediction of Chronic Kidney Disease	A. Nishanth and S. Rishikesan,	2018	Random forest, C4.5, One Rule and Naïve Bayes	91.04
Intelligent Systems on the cloud for the early identification of Chronic Kidney Disease	RUEY KEI CHIU , RENEE Y. CHEN, SHINAN WANG , SHENG-JEN JIAN	2012	Back-propagation network (BPN), generalized feed forward neural networks (GRNN)	72.04

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Sparse Disease Prophecy Record Data for the Early Detection of Chronic Kidney Disease in Diabetic Patients	JINGHE ZHANG, JAMES HARRISON , KAMRAN KOWSARI MEHDI BOUKHECHBA, JENNIFER LOBO, & LAURA BARNES	2020	AVF, BPS, ATV, Bagged SLR	78.69
Prediction of CKD using KDQOL score for Swelling and Risk Factor Analysis using Neural Networks method	D.N.LOKUARACHCHI, J.V.THARINDU MANOJ, M.N.H.WEERASOORIYA, M.N.M.WASEEM, NISHANTHA DHARSHANA KASTHURIRATHNE	2020	KNN	77.27
A Comprehensive Unsupervised Framework for Diagnosis Chronic Kidney Disease	LINTAANTONY, SAMI AZAM, EVA REDDY BEERAVOLU, MIRJAM JONKMAN, AFRIN, ATQIYA ABIDA ANJUM, & ALIZA AHMED KHAN & D FRISO DE BOER	2021	auto encoder, Isolation forest, DB-scan and Kmeans	96.7
Performance analysis of fuzzy rough set-based and correlation-based Attribute selection methods on prediction of Chronic Kidney Disease	Muhammed Sinan BAŞARSLAN and Fatih Kayaalp	2016	Fuzzy Rough Set Based attribute selection (FRSBAS) and Correlation Based attribute selection (CBAS) method	85
Early detection and avoidance of Chronic Kidney Disease	Maithili Desai	2019	Naïve Bayes and Decision tree methods	84
Identifying Important Attributes for early diagnosis of Chronic Kidney Disease	Anandarajah Nishanth and Tharmarajah	2017	Multiclass Neural Network, Multiclass Decision Regression, Multiclass dataset. Decision Jungle, and Multiclass Decision Forest	89
A Novel Approach to Detect Chronic Kidney Disease using Machine Learning Algorithms Techniques	BHAVYA GUDETI, SHASHVI MISHRA, AMIT KUMAR TYAGI, & SHAVETA MALIK	2020	Logistic Regression, KNN and Support Vector Machine(SVM)	78.75
Chronic Disease Risk Prediction using Distributed Machine Learning Classifiers	LAMBODAR JENA, & RAMAKRUSHNA SWAIN	2017	Naive Bayes and Multilayer Perceptron	95
Boosted Classifier and Features Selection for Enhancing Chronic Kidney Disease Diagnose	SATIRA WIBAWA, DENDI MAYSANJAYA, & AGUS WIRAHADI PUTRA	2021	Correlation-based Feature Selection (CFS), KNN, SVM	97.5
Evaluating Chronic Kidney Disease from Office Visit Records Using Hierarchical Meta-Classification of an Imbalanced Dataset	CLAUDINE JURKOVITZ, MOUMITA BHATTACHARYA A , HAGIT SHATKAY	2017	RF-Heir-MC	92
Detection of Chronic Kidney Disease and Selecting Important Predictive Attributes	ASIF SALEKIN, & JOHN STANKOVIC	2016	neural networks, random forest, and k-nearest neighbours	99.3

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A Comprehensive Unsupervised Framework for Diagnosis Chronic Kidney Disease	LINTA ANTONY, SAMI AZAM, EVA REDDY BEERAVOLU, MIRJAM JONKMAN, AFRIN, ATQIYA ABIDA ANJUM, & ALIZA AHMED KHAN & D FRISO DE BOER	2021	auto encoder, Isolation forest, DB-scan and Kmeans	96.7
An Empirical Assessing of Machine Learning Techniques for Chronic Kidney Disease Prophecy	BILAL KHAN, RASHID NASEEM, FAZAL MUHAMMAD, GHULAM, ABBAS SUNGHWAN KIM	2020	NBTree, LR, NB, J48, MLP SVM, and CHIRP	85.9
Deep Learning Identifies Intelligible Predictors of Poor Prognosis in Chronic Kidney Disease	PING LIANG, JIANNAN YANG, WELIAN WANG, GUANJIE YUAN, MIN HAN, QINGPENG ZHANG, & ZHEN LI	2020	LASSO, XGBoost, Random Forest, DNN	88.5
Optimization of Detection Method for Chronic Kidney Disease Using Machine Learning Algorithm	PRONAB GHOSH, F.M.JAVED MEHEDI SHAMRAT, SHAHANA SHULTANA, SAIMA AFRIN, ATQIYA ABIDA ANJUM, & ALIZA AHMED KHAN	2020	SVM, AdaBoost, Gradient Boosting, LDA	97.91
Detecting Chronic Diseases from Sleep-Wake Behaviour and Clinical Features	SARAH FALLMANN, & LIMING CHEN	2018	LSTM	89.72
Cuckoo search coupled Artificial Neural Network technique in prediction of Chronic Kidney Disease	Sankhadeep Chatterjee , Soumen Banerjee & Soumya Sen	2017	Cuckoo Search (CS) trained Neural Network (NN) or NN-CS	99.2
Chronic Kidney Disease recognition using machine learning algorithm	Dibaba Adeba Debal & Tilahun Melak Sitote	2022	XGBoost	82.56
Chronic Kidney Disease identification using Random Forest Algorithm	Hamida Ilyas	2021	Random Forest	96

II. CONCLUSION

CKD is one of the non-communicable diseases spreading all over the world and manual diagnosis is very difficult because it has very little symptoms. If any symptoms are present, they overlap with other diseases. In current paper a survey is made for various machine learning techniques utilized in CKD diagnosis. It covers the methodologies adapted and their contribution to the real world. The future work is as follows:- Larger dataset needs to be collected. Also proper selection of attributes needs to be ready so as to improve the clinical efficiency of the results. A user friendly interface further can be built to view the results.

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