Early Prediction of Chronic kidney Disease in Autoimmune Disorder Patients Using Machine Learning Techniques

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***Abstract*—CKD is chronic condition it can lead to Severe kidney failure it causes undiscovered. develop chronic inflammation of the kidneys, making them vulnerable to CKD. Early discovery should be done so that effective measures can be taken against CKD. approach based on clinical features of patient with auto-immune disease is proposed in this paper. The proposed method may it considers the Logistic Regression model, SVM model, and Random Forest model. The results obtain and show the accuracy of the proposed model is 98%, so it is regarded as an early predicts the CKD. Early discovery should be done so that effective measures can be taken against CKD.**

A machine learning approach based on clinical features of patients with autoimmune diseases is proposed in this paper. The proposed method may consider the Logistic Regression model, SVM model, and Random Forest model. The results obtained show that the accuracy of the proposed model is better, so it is regarded as an early predictor of CKD.

***Index Terms*—Chronic Kidney Disease, Autoimmune Diseases, Machine Learning, Early Detection, Healthcare Analytics**

I. INTRODUCTION

Chronic kidney disease, is a very large-scale malfunctioning kidneys because of various reasons. The progression is very smooth, and the affected person is not checked for this problem until it is very severe. If a patient is suffering from any autoimmune diseases, such as SLE or RA, then the chances of developing a compromised kidney multiply.

It involves the tests from the laboratory, which they only performed when the symptoms when it occurs. thus, there is the possibility of late diagnosis. The rise in volume in the health sector and the advent of AI have increased the successful use of Machine Learning in predictive modelling at early stages of diseases. This research aims to predict CKD at an early stage in auto-immune patients with the use of ML algorithms. Logistic Regression and Support Vector Machine represent two popular classifiers for binary classification problems occurring in health care.

II. RELATED WORK

We Can apply the method for CKD prediction on clinical datasets. two popular classifiers for binary classification problems occurring in health care. However, works reported in recent times prove that the methods based on ensemble learning, such as Random Forest, while treating nonlinearities.

But this research based on CKD predictions are general, it not involves in autoimmune disease-specific variables. In this research, this autoimmune-related variables will be considered for more accurate prediction.

III. PROPOSED METHODOLOGY

3.1 Dataset Description

The dataset contains demographic details, clinical parameters, kidney function indicators, and laboratory attributes of autoimmune disorder patients. The target variable describes the condition of a patient having CKD or not.

3.2 Data Preprocessing

• Missing value treatment using imputation techniques
• Label encoding of categorical attributes
• Feature scaling using Standardization

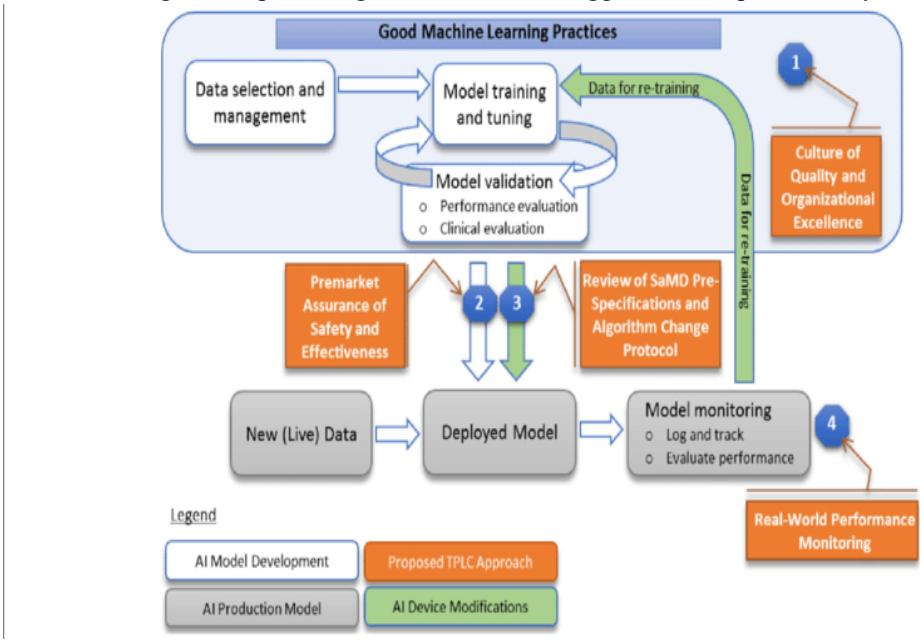
3.3 Machine Learning Models

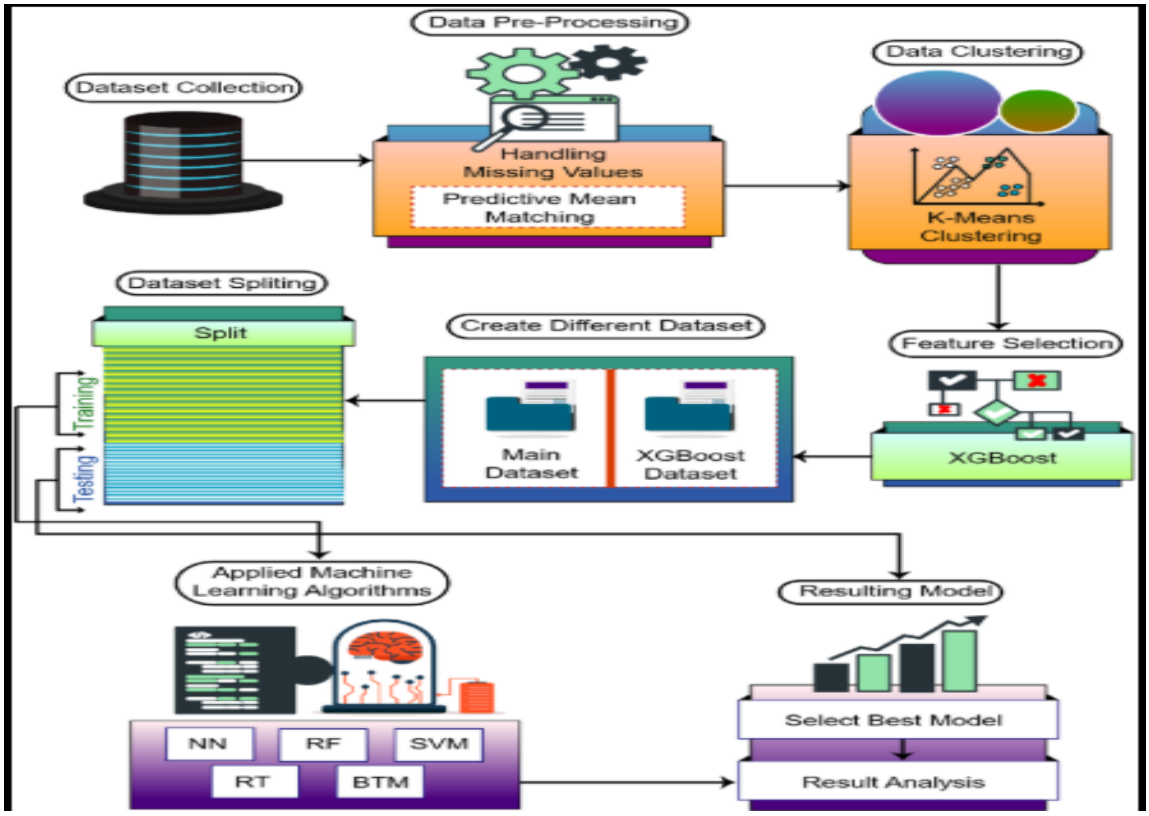
The models implemented are the following:

- Logistic Regression
- Support Vector Machine (SVM)
- Random Forest Classifier

3.4 System Architecture

Figure 1 depicts the general flow of the suggested CKD prediction system.





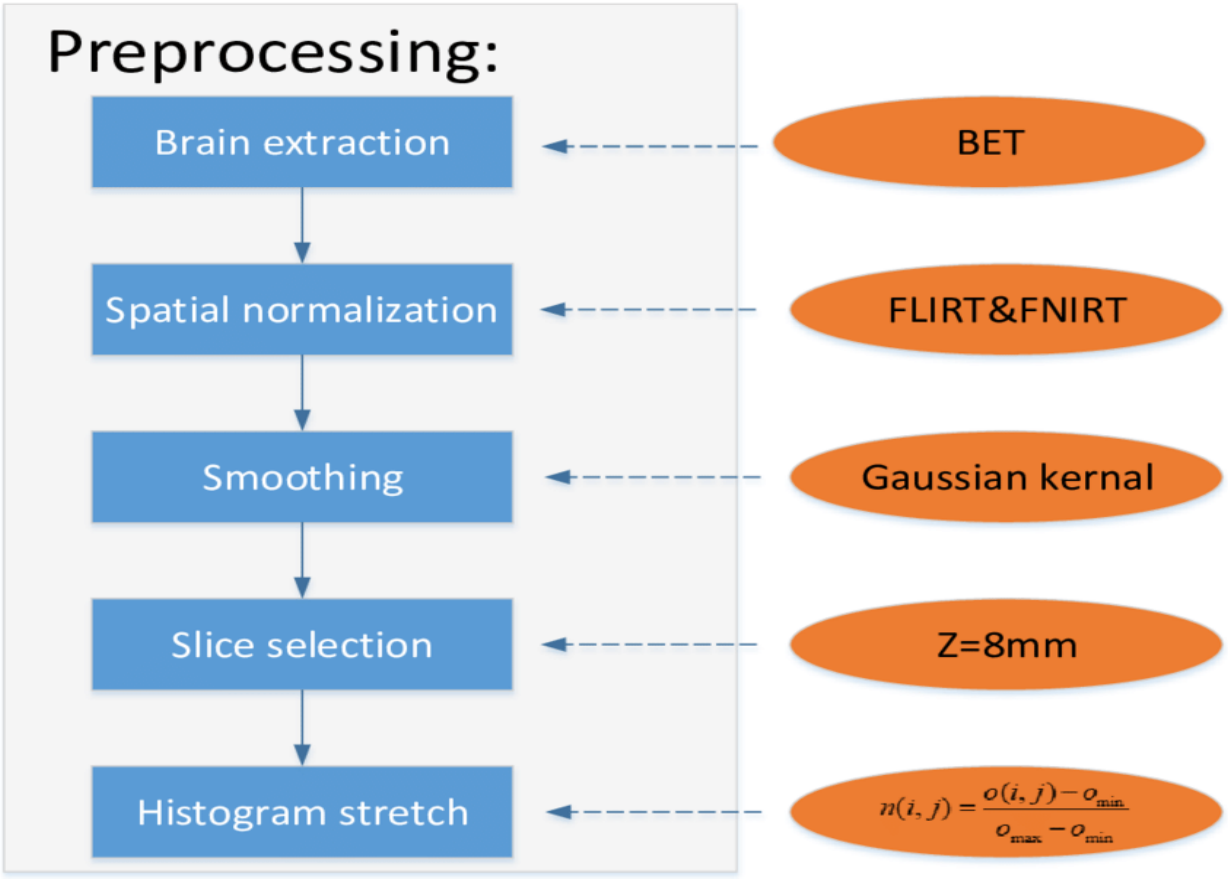


Figure 2: System architecture of the proposed CKD prediction model

The system follows the following sequence: patient data collection, preprocessing of the data, and feature selection. It then trains the models to predict the presence of CKD on the pre-processed data.

IV. EXPERIMENTAL RESULTS

4.1 Evaluation Metrics

Accuracy, precision, recall, F1-score, and ROC–AUC are used in finding the performance of the models. Recall is considered because, in medical diagnosis, it is important to keep the number of false negatives low.

4.2 performance comparison

Table 1. Comparison of Machine Learning Models

Model	Accuracy	Precision	Recall	F1-Score
Logistic Regression	94.2%	93.1%	92.0%	92.5%
Support Vector Machine (SVM)	96.1%	95.4%	95.0%	95.2%
Random Forest	**98.3%**	**97.9%**	**97.2%**	**97.5%**

4.3 Confusion Matrix

		Predicted Class: Positive	Predicted Class: Negative	
Actual Class	Positive	True Positive (TP)	False Negative (FN) **Type II Error**	**Sensitivity** $\frac{TP}{(TP+FN)}$
	Negative	False Positive (FP) **Type I Error**	True Negative (TN)	**Specificity** $\frac{TN}{(TN+FP)}$
		Precision $\frac{TP}{(TP+FP)}$	**Negative Predictive Value** $\frac{TN}{(TN+FN)}$	**Accuracy** $\frac{TP+TN}{(TP+TN+FP+FN)}$

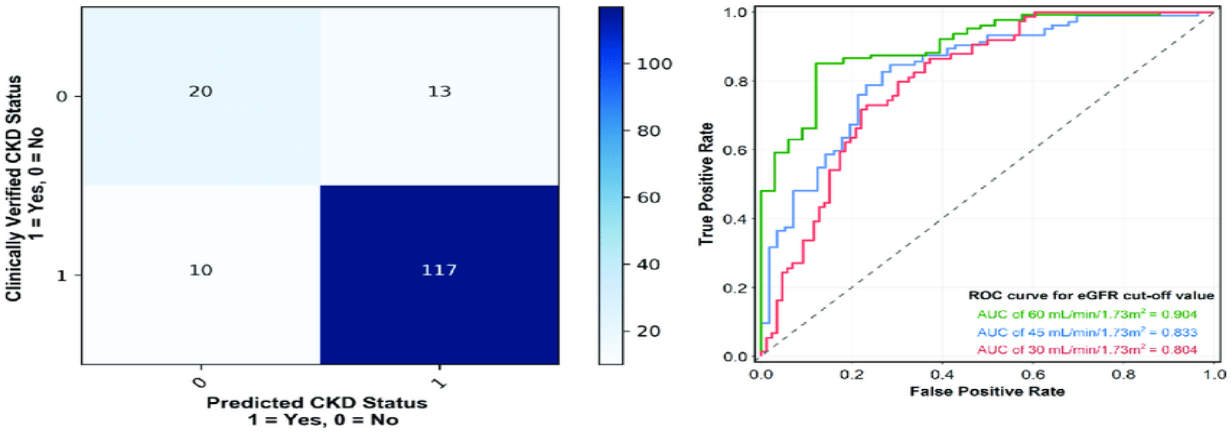
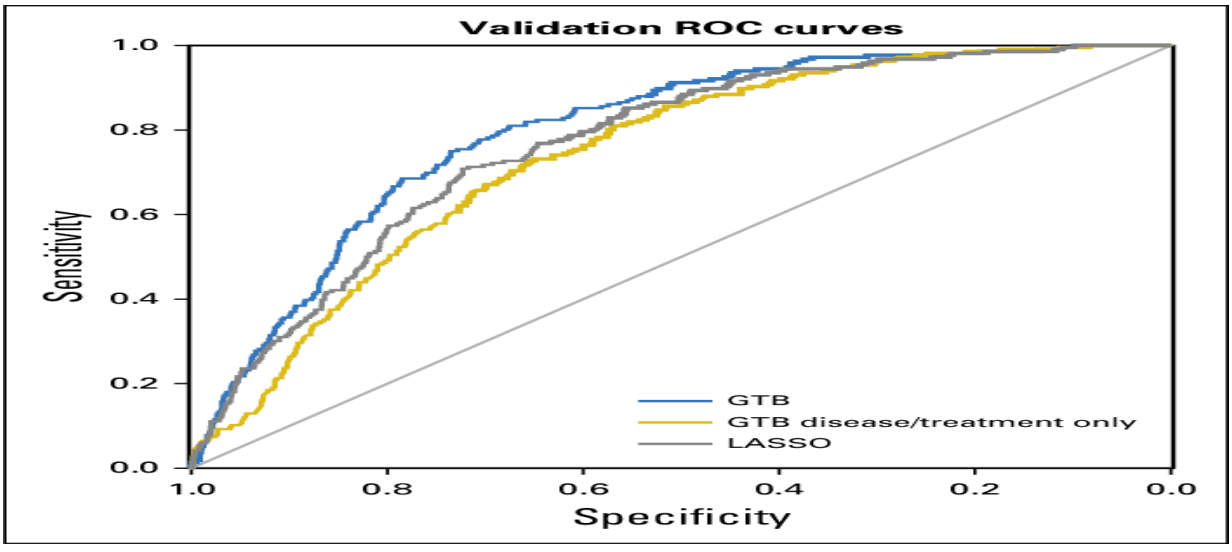


Figure 3: Confusion matrix of Random Forest classifier

The confusion matrix is indicating a low false-negative rate, which is crucial for early detection of CKD.

4.4 ROC Curve



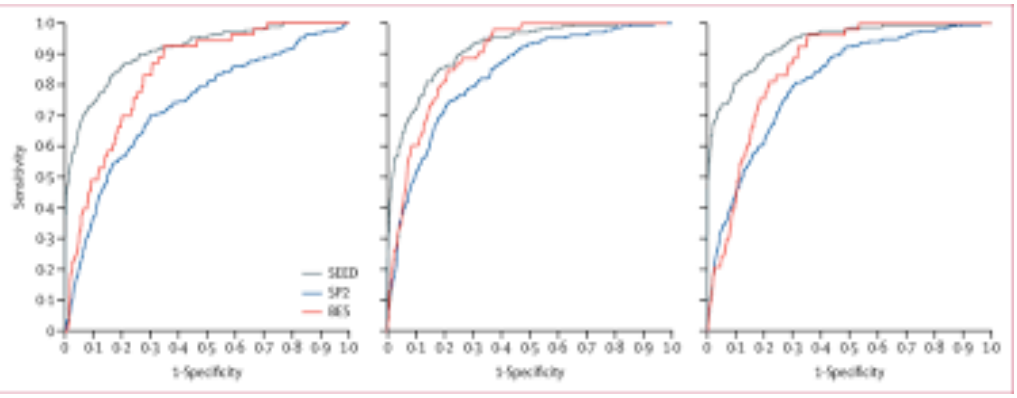


Figure 4: ROC curve for the prediction of CKD using Random Forest
The ROC curve indicates high discriminative performance with an AUC value near 1.

V. DISCUSSION

The experimental results show that the Random Forest classifier with regard to predicting CKD. with the inclusion of autoimmune-related indicators. Thus, the proposed system can support clinicians in identifying high-risk patients at an early stage.

VI. CONCLUSION

paper proposed an approach for the prediction of CKD using machine-learning, The presented results confirm that ensemble learning techniques, mainly Random Forest, provide better accuracy and recall. Future work will be the integration of deep-learning models, real-time clinical data, and deployment of the system as a web-based clinical decision-support platform.

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