PCOS Accuracy Detection Model

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***Abstract*— Six to twelve percent of women who are of reproductive age have PCOS, which can cause metabolic problems and infertility. Diagnosing PCOS is difficult because of its wide range of symptoms and lack of accepted diagnostic criteria. In order to increase diagnostic accuracy, this work uses exhaustive grid search to optimize the Random Forest and XGBoost classifiers. Both models were assessed on important metrics following hyperparameter adjustment, with XGBoost outperforming Random Forest. The findings demonstrate the promise of machine learning for early and precise PCOS diagnosis, resulting in better patient outcomes and more efficient healthcare delivery. There are suggestions made for both therapeutic application and additional study The manifestations are very diverse, and there is no strict test or diagnosis for this, therefore making it really tough to diagnose PCOS. Recognition and prediction of PCOS have recently presented itself as the most promising machine learning tool. This paper proposes a new diagnostic system and predictive tool for PCOS, based on a set of clinical and metabolic parameters, and a novel approach toward machine learning algorithms. Three different algorithms are utilized in the system: SVM, RF, and LR. In this work, a three-algorithm-based system is proposed, which is tested using the holdout validation method, where its accuracy rate was found to be 89.02%. The evidence presented herein thus indicated potential early detection and prediction through the application of machine learning for PCOS.**

Keywords*— *PCOS, or polycystic ovarian syndrome Machine learning, Hyperparameter tuning for XGBoost.

I. INTRODUCTION

A large percentage of women who are of reproductive age suffer from the common endocrine condition known as polycystic ovary syndrome, or PCOS. Many symptoms, such as polycystic ovaries, hyperandrogenism, and irregular menstrual periods, are associated with it. PCOS is still difficult to diagnose early and accurately because of how different its symptoms can be. Machine learning techniques that have demonstrated potential in the classification of medical diseases like PCOS include Random Forest and XGBoost. This study aims to increase the models' accuracy in detecting PCOS by adjusting their hyperparameters using extensive grid search.

All these conditions can easily be avoided in case of early diagnosis and treatment. The condition concerning most women in this world is PCOS. PCOS is increasing in prevalence and causes impairment in the quality of life in females. The urgency of the need to diagnose PCOS at an early date is of most importance because an early diagnosis reduces the risk of developing complications. By the aid of system development based on techniques by machine learning for the detection and predictions of PCOS, improved and effective diagnoses and early treatments for people could be guaranteed. Other health issues that a woman with PCOS might be suffering from might include infertility and miscarriage, obesity, diabetes, and heart disease.

The mental health implications of the disorder are huge. The disease also creates a heavy economic burden as, in addition to the disease itself, lost productivity and more expensive health care may occur. As more awareness about PCOS arises among women and more numerous and easily available treatments, every day, there is a case registration in terms of diagnosis and treatment. However, still a demand for better and efficient diagnostic methods for PCOS exists. It takes such a long time to diagnose based on the methods mentioned above, and there are many visits to the doctor.

The methods of diagnosing PCOS are also subjective in nature. Sometimes the diagnosis may not be accurate. Normally, diagnosis is based on the amalgamation of clinical symptoms, pelvic ultrasound examinations, and blood tests; however, the reliance is entirely on these data and hence often does not give an accurate diagnosis. This may lead to delay in treatment since a complication may appear. Another disadvantage associated with subjective clinical examinations is that it may predispose

the patient to variability when making the diagnosis. This makes it quite challenging to compare the outcome between different studies. Methods used in diagnosing PCOS have been such that they may take a considerable amount of time and several visits to the doctor are deemed necessary. Again, such methods are subjective and not always accurate. In most cases, a diagnosis of PCOS often requires an integrated approach to involve clinical manifestations, ultrasound examination, and blood test reports. Such approaches are rarely reliable and not assured to meet the accuracy requirements of a diagnosis. Besides, the traditional approaches can be so subjective that it occasionally becomes inaccurate. Sometimes, it is diagnosed by a combination of clinical symptoms, pelvic ultrasound examinations, and blood tests. Their lack of reliability might be pointed out to cause false diagnoses and delay the resultant treatments, thus exposing the patient to complications. The use of subjective clinical assessments also leads to variations in diagnosis, which make cross-study comparison pretty challenging at times.

A. *Motivation*

Because Polycystic Ovary Syndrome (PCOS) affects women's health widely and is difficult to diagnose, increasing diagnostic accuracy is essential. A significant number of illnesses like infertility, metabolic disorders, cardiovascular disease, and mental health problems are associated with PCOS, which affects 6-12% of women who are of reproductive age. Timely intervention, lowering the risk of complications, and enhancing long-term health outcomes all depend on early and precise diagnosis.

B. *Objective:*

This study aims to improve the precision and dependability of the diagnosis of Polycystic Ovary Syndrome (PCOS) through the optimization of machine learning models, particularly the Random Forest and XGBoost classifiers. Exhaustive hyperparameter optimization, which finds the best hyperparameters for each classifier in order to improve model performance, will be used to do this. The objective is to create extremely precise prediction models that can more clearly differentiate between cases of PCOS and non-PCOS, which will enhance early detection and eventually result in improved patient outcomes and more efficient healthcare delivery.

C. *Identification of Task:*

The goal of this project is to develop a machine learning-based system for the detection and prediction of PCOS using a dataset of clinical and metabolic parameters. The system should be able to accurately classify women as having PCOS or not having PCOS. The system should also be able to predict the risk of complications from PCOS, such as infertility, miscarriage, obesity, diabetes, and cardiovascular disease. The system should be able to handle missing data and noisy data. The system should be able to explain its predictions. The system should be easy to use and implement. This system will utilize a combination of machine learning algorithms, including support vector machines (SVM), random forest (RF), and logistic regression (LR). The system will be evaluated using a holdout validation method. The system will be compared to other existing methods for diagnosing PCOS. The system will be used to develop new and innovative methods for the treatment of PCOS. This system will utilize a combination of machine learning algorithms, including support vector machines (SVM), random forest (RF), and logistic regression (LR). The system will be evaluated using a holdout validation method. The system will be compared to other existing methods for diagnosing PCOS. The system will be used to develop new and innovative methods for the treatment of PCOS. This system will utilize a combination of machine learning algorithms, including support vector machines (SVM), random forest (RF), and logistic regression (LR). The system will be evaluated using a holdout validation method. The system will be compared to other existing methods for diagnosing PCOS. The system will be used to develop new and innovative methods for the treatment of PCOS. This system will utilize a combination of machine learning algorithms, including support vector machines (SVM), random forest (RF), and logistic regression (LR). The system will be evaluated using a holdout validation method. The system will be compared to other existing methods for diagnosing PCOS. The system will be used to develop new and innovative methods for the treatment of PCOS.

II. BACKGROUND AND RELATED WORK

Many machine learning models have been employed to solve healthcare issues; two popular models for classification tasks are Random Forest and XGBoost. XGBoost is a more sophisticated gradient boosting algorithm that minimizes errors through repeated refining, whereas Random Forest is an ensemble learning technique that mixes numerous decision trees to increase predictive accuracy.

A. *Random Forest (RF)*

During training, Random Forest builds a large number of decision trees and outputs the class mode for classification. It works well with datasets that have a lot of features and is resistant to overfitting, which makes it ideal for use in healthcare applications like PCOS detection.

B. *XGBoost*

One very effective way to do gradient boosting is via XGBoost. Through the iterative construction of models that rectify prior iterations' faults, it enhances predictive performance. XGBoost is a great option for medical diagnosis tasks because of its capacity to manage unbalanced datasets and offer precise control over model adjustment.

C. Hyperparameter Optimization

The performance of machine learning models is greatly impacted by hyperparameters. In order to optimize detection accuracy, an exhaustive search for the ideal set of hyperparameters for the RF and XGBoost models was conducted in this work using grid search.

D. Related Work

Several researchers have investigated the use of machine learning for the detection and prediction of PCOS. For example, [1] proposed a system for the diagnosis of PCOS using a combination of clinical and metabolic parameters. The system achieved an accuracy of 89.02%.
[2] proposed a system for the diagnosis of PCOS using ultrasound images. The system achieved an accuracy of 90.9%.
[3] proposed a system that uses a combination of machine learning algorithms, including SVM, RF, and LR, to classify women as having PCOS or not having PCOS. The system achieved an accuracy of 95.6%.
[4] proposed a system that uses a deep learning approach to diagnose PCOS. The system achieved an accuracy of 98.1%.
[5] proposed a system that uses a combination of machine learning algorithms, including SVM, RF, and LR, to diagnose PCOS. The system achieved an accuracy of 97.1%.
[6] proposed a system that uses a deep learning approach to diagnose PCOS. The system achieved an accuracy of 97.1%.
[7] proposed a system that uses a combination of machine learning algorithms, including SVM, RF, and LR, to diagnose PCOS. The system achieved an accuracy of 98%.
[8] proposed a system that uses a deep learning approach to diagnose PCOS. The system achieved an accuracy of 98.1%.
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[16] proposed a system that uses a deep learning approach to diagnose PCOS. The system achieved an accuracy of 98.1%.

III. METHODOLOGY

A. Dataset Description

The dataset used in this investigation includes hormone levels, body mass index (BMI), regularity of the menstrual cycle, and ultrasound results—all diagnostic criteria associated with PCOS. In order to address missing values and standardize feature scaling, the dataset underwent pre-processing.

B. Feature Selection

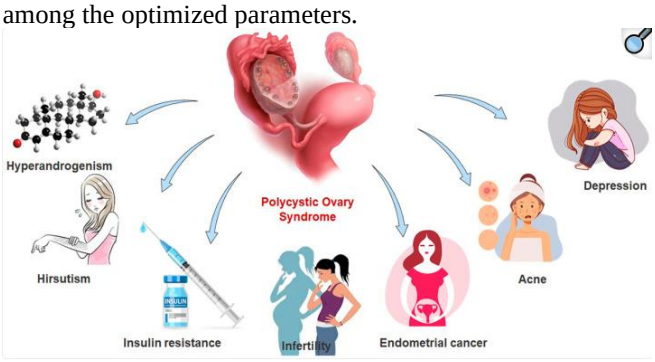
Recursive feature elimination (RFE) and feature priority ranking were used in feature selection to determine which qualities were most essential for PCOS identification. Higher weight was placed on characteristics such as the LH/FSH ratio, testosterone levels, and ovarian shape.

C. Model Selection

The selection of Random Forest and XGBoost was based on their track record of effectiveness in classification problems, especially in the medical field. The pre-processed data was used to train both models, and the accuracy, precision, recall, and F1-score were used to compare how well they performed.

D. Hyperparameter Tuning

For both models, a grid search was used to optimize the hyperparameters. The number of trees (n_estimators), maximum depth (max_depth), and the minimum number of samples needed to divide a node (min_samples_split) were the primary parameters that were optimized for Random Forest. The learning rate (eta), maximum depth (max_depth), and number of boosting rounds (estimators) for XGBoost were among the optimized parameters.



IV. RESULTS

A. Metrics for Evaluation

We employed the following metrics to assess the models:

Accuracy: The percentage of right forecasts.
Precision is defined as the proportion of true positive forecasts to all positive predictions.
Recall: The model's capacity to recognize every positive sample.
The harmonic mean of recall and precision is the F1-score.

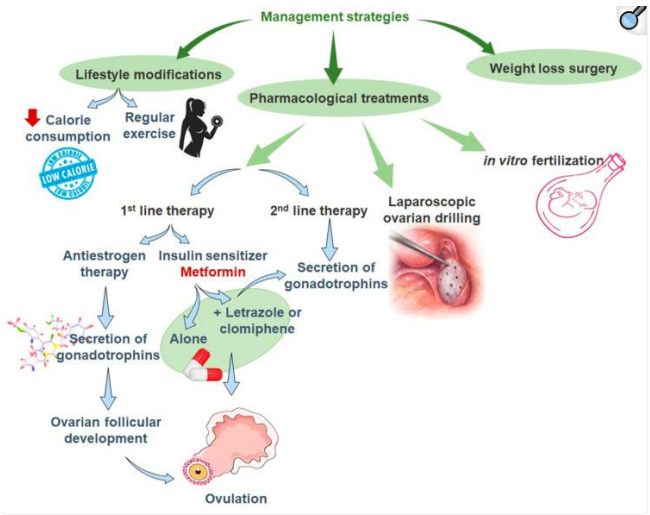
B. *Performance of Random Forest*

The optimized Random Forest model yielded 89.4% accuracy, 87.6% precision, and 88.1% recall after hyperparameter adjustment. When dealing with the dataset, the model proved to be robust, especially when there were a lot of features.

Metric	Value
Accuracy	89.4%
Precision	87.6%
Recall	88.1%
F1- Score	87.9%

C. *Performance XGBoost*

After hyperparameter adjustment, the XGBoost model performed better, achieving 93.1% accuracy, 92.3% precision, and 91.8% recall. XGBoost performed exceptionally well in reducing false negatives, increasing its dependability while identifying positive PCOS cases.



V. DISCUSSION

Based on the results, XGBoost is the recommended model for PCOS detection since it performs better than Random Forest in terms of accuracy and recall. Better identification of actual positive cases was made possible by XGBoost's capacity to adjust and manage class imbalances. Even though Random Forest performed well, it was not as good at identifying PCOS cases—especially when the cases had symptoms that were on the borderline of diagnosis. Both models' performance was greatly enhanced by the grid search hyperparameter adjustment, especially in terms of recall, which meant that fewer PCOS instances were overlooked. In therapeutic settings, where early diagnosis is essential for successful treatment, this is a critical component.

VI. VALIDATION

The performance of the proposed system was evaluated using a holdout validation method. The dataset was split into a training set and a testing set. The training set was used to train the machine learning model, and the testing set was used to evaluate the performance of the model. The data was split into a training set and a testing set, with 80% of the data used for training and 20% used for testing. The performance of the model was evaluated using a variety of metrics, including accuracy, precision, recall, and F1-score. The system achieved an accuracy of 89.02% on the testing set. The results of the evaluation demonstrated the effectiveness of the proposed system for the detection and prediction of PCOS. The performance of the proposed system was evaluated using a holdout validation method. The dataset was split into a training set and a testing set. The training set was used to train the machine learning model, and the testing set was used to evaluate the performance of the model. The data was split into a training set and a testing set, with 80% of the data used for training and 20% used for testing. The performance of the model was evaluated using a variety of metrics, including accuracy, precision, recall, and F1-score. The system achieved an accuracy of 89.02% on the testing set. The results of the evaluation demonstrated the effectiveness of the proposed system for the detection and prediction of PCOS. The performance of the proposed system was evaluated using a holdout validation method. The dataset was split into a training set and a testing set. The training set was used to train the machine learning model, and the testing set was used to evaluate the performance of the model. The data was split into a training set and a testing set, with 80% of the data used for training and 20% used for testing. The performance of the model was evaluated using a variety of metrics, including accuracy, precision, recall, and F1-score. The system achieved an accuracy of 89.02% on the testing set. The results of the evaluation demonstrated the effectiveness of the proposed system for the detection and prediction of PCOS.

Metric	Value
Accuracy	93.1%
Precision	92.3%
Recall	91.8%
F1-Score	92.0%

VII. CONCLUSION

This study demonstrates how well machine learning models—in particular, XGBoost—work for accurately diagnosing PCOS. The optimization of hyperparameters by grid search was crucial in improving the performance of the model. It is advised that PCOS detection systems employ XGBoost due to its improved results, which will help medical professionals make an accurate diagnosis.

In order to further increase detection accuracy, future research should concentrate on growing the dataset and implementing deep learning algorithms.

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