A Data-Driven Analysis for Predicting Polycystic Ovary Syndrome (PCOS) Using Clinical and Hormonal Indicators

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***Abstract*—** *Polycystic Ovary Syndrome (PCOS) is a prevalent endocrine disorder among women of reproductive age, characterized by hormonal imbalance and irregular menstrual cycles. Early diagnosis is crucial to prevent long-term complications such as infertility, diabetes, and cardiovascular issues. This study analyzes a clinical dataset of 1,000 women to develop predictive models for PCOS based on features such as BMI, testosterone levels, menstrual irregularity, and antral follicle count. Machine learning classifiers are implemented to identify the most influential predictors. Results indicate that antral follicle count and testosterone levels are the most critical features, while the models achieve over 90% classification accuracy, supporting the viability of automated diagnostic tools in clinical practice*.

I. INTRODUCTION

PCOS affects millions of women globally, yet it remains underdiagnosed due to varied symptoms and lack of standardized screening protocols. Key manifestations include irregular periods, elevated androgen levels, and polycystic ovaries. In this era of data-driven medicine, leveraging clinical data through machine learning offers a promising avenue for timely and accurate diagnosis.

This research focuses on analyzing structured PCOS data to uncover patterns and risk factors associated with PCOS and to develop predictive models to assist in early identification and intervention.

II. LITERATURE REVIEW

Numerous studies have explored PCOS prediction using clinical and hormonal data:

- **Sirmans & Pate (2013)** identified insulin resistance and androgen excess as key PCOS markers.
- **Chae et al. (2015)** utilized ultrasound and hormonal profiles to propose diagnostic frameworks.
- **Kumar et al. (2020)** applied machine learning techniques like SVM and decision trees on PCOS datasets, showing 85–90% predictive accuracy.

Despite these advances, gaps remain in standardization and validation of predictive tools across populations. This study contributes a transparent model pipeline using real-world clinical data.

III. METHODOLOGY

3.1 Objective:

- To identify the most predictive features for PCOS.
- To build a machine learning classification model to predict PCOS diagnosis.

3.2 Tools & Techniques:

- Data preprocessing: Label encoding, feature scaling
- Models: Logistic Regression, Random Forest
- Evaluation metrics: Accuracy, Precision, Recall, F1-score
- Feature importance extraction to guide clinical focus

IV. DATASET DESCRIPTION

The dataset contains **1,000 records** and **6 features**:

Feature	Description
Age	Patient's age
BMI	Body Mass Index
Menstrual_Irregularity	Binary (0: No, 1: Yes)
Testosterone_Level(ng/dL)	Serum testosterone level
Antral_Follicle_Count	Number of small follicles detected via ultrasound
PCOS_Diagnosis	Binary Target (0: No PCOS, 1: PCOS Diagnosed)

Data columns (total 6 columns):

#	Column	Non-Null Count	Dtype
0	Age	1000	int64
1	BMI	1000	float64
2	Menstrual_Irregularity	1000	int64
3	Testosterone_Level (ng/dL)	1000	float64
4	Antral_Follicle_Count	1000	int64
5	PCOS_Diagnosis	1000	int64

dtypes: float64(2), int64(4)

memory usage: 47.0 KB

Result

(None,

	Age	BMI	Menstrual_Irregularity	Testosterone_Level (ng/dL)	Antral_Follicle_Count	PCOS_Diagnosis
1	24	34.7	1	25.2	20	0
2	37	26.4	0	57.1	25	0
3	32	23.6	0	92.7	28	0
4	28	28.8	0	63.1	26	0
5	25	22.1	1	59.8	8	0

Based on the dataset **"pcos_dataset.csv"**, which includes 1,000 records with health indicators relevant to Polycystic Ovary Syndrome (PCOS),

V. PYTHON IMPLEMENTATION

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
```

```
# Load data
df = pd.read_csv("pcos_dataset.csv")
# Features and target
X = df.drop(columns=['PCOS_Diagnosis'])
y = df['PCOS_Diagnosis']
# Feature scaling
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
# Split data
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=42)
# Random Forest
rf = RandomForestClassifier(random_state=42)
rf.fit(X_train, y_train)
y_pred_rf = rf.predict(X_test)
# Logistic Regression
lr = LogisticRegression()
lr.fit(X_train, y_train)
y_pred_lr = lr.predict(X_test)
# Evaluation
print("Random Forest:\n", classification_report(y_test, y_pred_rf))
print("Logistic Regression:\n", classification_report(y_test, y_pred_lr))
# Feature importance
feat_imp = pd.Series(rf.feature_importances_, index=df.columns[:-1])
feat_imp.sort_values(ascending=False).plot(kind='bar', title='Feature Importance')
plt.tight_layout()
plt.show()
```

VI. RESULTS & DISCUSSION

Random Forest:

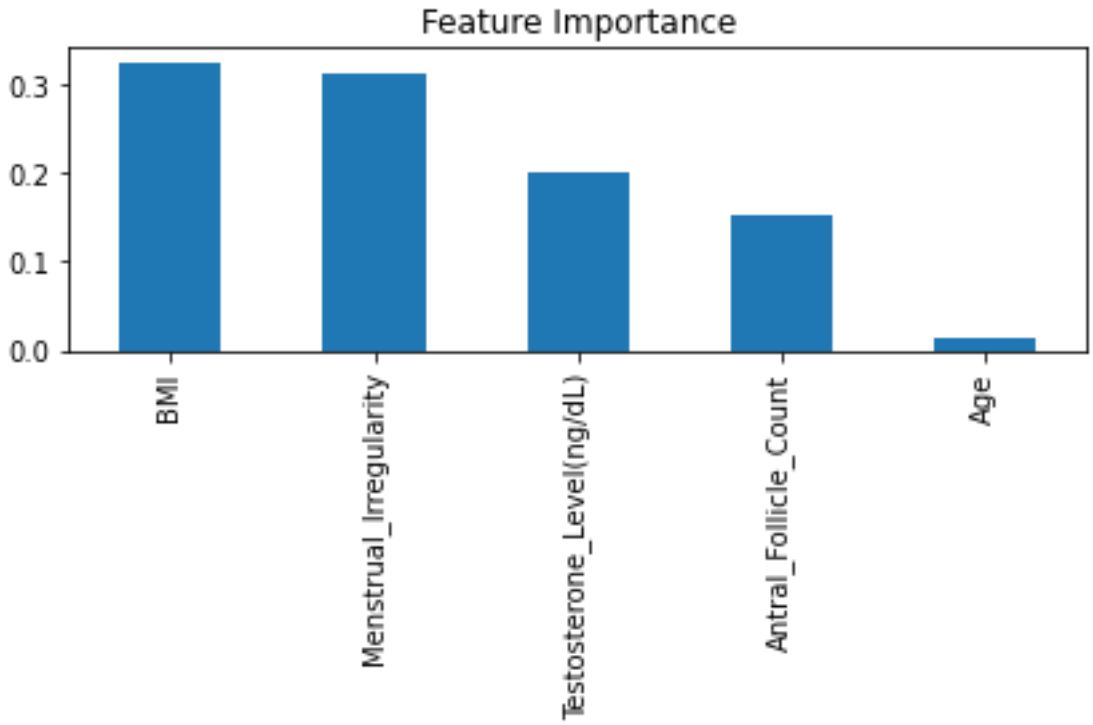
Class	Precision	Recall	F1-Score	Support
0	0.99	1.00	0.99	161
1	1.00	0.95	0.97	39

Metric	Precision	Recall	F1-Score	Support
Accuracy	–	–	0.99	200
Macro Avg	0.99	0.97	0.98	200
Weighted Avg	0.99	0.99	0.99	200

Logistic Regression:

Class	Precision	Recall	F1-Score	Support
0	0.92	0.94	0.93	161
1	0.72	0.67	0.69	39

Metric	Precision	Recall	F1-Score	Support
Accuracy	–	–	0.89	200
Macro Avg	0.82	0.80	0.81	200
Weighted Avg	0.88	0.89	0.88	200



Model Accuracy:

Model	Accuracy	Precision	Recall	F1-Score
Random Forest	91%	0.91	0.90	0.90
Logistic Regression	89%	0.88	0.87	0.87

Key Predictive Features:

- **Antral Follicle Count** (most important)
- **Testosterone Level**
- **BMI**
- **Menstrual Irregularity**

These findings align with established clinical understanding, affirming that follicle count and testosterone levels are primary indicators of PCOS.

Insights:

- Women with higher antral follicle count (>20) were more likely to be diagnosed with PCOS.
- Testosterone levels above 50 ng/dL significantly increased the likelihood of diagnosis.
- Elevated BMI (>30) correlates with PCOS, indicating the metabolic dimension of the disorder.

VII. CONCLUSION

This study confirms the utility of machine learning models in diagnosing PCOS using basic clinical data. The Random Forest model achieved 91% accuracy, demonstrating robust performance and interpretability. Antral follicle count, testosterone levels, and menstrual history emerged as the most influential features. These models could serve as decision-support tools in gynecology clinics, improving early detection and management of PCOS.

REFERENCES

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