PREDICTIVE PULSE:
HARNESSING MACHINE LEARNING FOR BLOOD PRESSURE ANALYSIS

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1. Abstract

This project presents *Predictive Pulse*, a web-based application designed to assist in early detection and classification of hypertension stages using machine learning techniques. The system leverages historical patient data and physiological indicators to accurately predict the blood pressure stage, helping users and healthcare professionals monitor risks efficiently.

2. Introduction

Hypertension, often termed as the 'silent killer,' affects millions globally. Early-stage identification is critical for timely intervention. Traditional diagnostic methods are time-consuming and depend heavily on manual interpretation. Predictive Pulse addresses this gap by providing a machine learning-based classification tool capable of analyzing key indicators to predict hypertension stages.

3. Objectives

- Develop a user-friendly web app for predicting hypertension stages.

- Perform comprehensive exploratory data analysis (EDA) on patient health records.

- Train and evaluate machine learning models for high accuracy.

- Visualize feature importances for better interpretability.

4. Methodology

- Dataset: 1825 patient records containing features like age, gender, systolic/diastolic ranges, symptoms, history, and treatment behavior.

- Preprocessing:

- Label encoding of categorical features.

- Handling of ranges like “111 - 120”.

- Target variable: Stages (e.g., NORMAL, HYPERTENSION Stage-1, Stage-2, HYPERTENSIVE CRISIS).

- Exploratory Data Analysis:

- Class balance visualization.

- Feature distribution and relationships.

- Modeling:

- Used RandomForestClassifier for multi-class classification.

- Achieved 100% accuracy.

- Web Application:

- Flask backend using app.py

- Model stored via pickle

- Interactive frontend.

5. Tools & Technologies

- Programming Language: Python

- Libraries: scikit-learn, pandas, matplotlib, seaborn

- Framework: Flask

- IDE: VS Code

- Platform: Web Browser

6. Results

- The Random Forest model achieved 100% accuracy on the test set.

- Feature importance highlighted Systolic, Diastolic, Severity, and ControlledDiet as key factors.

- The web application functions with real-time predictions based on form inputs.

7. Conclusion

Predictive Pulse successfully demonstrates how machine learning can enhance hypertension diagnosis by offering a fast, interactive, and accurate system. It provides actionable insights based on patient data and empowers users to take preventive steps based on personalized predictions.

8. Future Scope

- Incorporate numeric range handling via binning or embeddings.

- Expand dataset size for generalizability.

- Deploy to cloud (e.g., Render, AWS).

- Add doctor-specific dashboards and PDF report generation.