Predictive Pulse: Harnessing Machine Learning for Blood Pressure Analysis

1. Introduction

1.1. Project Overview

Predictive Pulse is a machine learning-based application designed to forecast and classify blood pressure stages in patients based on physiological and lifestyle features. It empowers users, fitness enthusiasts, and healthcare providers with real-time insights for preventive and corrective measures.

1.2. Objectives

- Predict blood pressure stages using machine learning models
- Provide early warnings to prevent complications
- Integrate predictive capability with a user-friendly web interface

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2. Project Initialization and Planning Phase

2.1. Define Problem Statement

Blood pressure monitoring typically involves manual checks and lacks proactive intervention. The goal is to automate blood pressure classification and alerting based on predictive modeling.

2.2. Project Proposal (Proposed Solution)

Use supervised machine learning to analyze patient physiological data and classify them into appropriate blood pressure stages. Build a Flask-based web interface to accept user input and display predictions.

2.3. Initial Project Planning

- Duration: 3 weeks
- Tools: Python, Pandas, Scikit-learn, Flask, HTML
- Phases: Data collection, EDA, model training, evaluation, web integration

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3. Data Collection and Preprocessing Phase

3.1. Data Collection Plan and Raw Data Sources Identified

Dataset: `patient_data.csv` containing features like age, gender, pulse, activity, and stage

3.2. Data Quality Report

- Null values handled using mean imputation
- Label Encoding applied to categorical features
- Columns renamed and standardized

3.3. Data Exploration and Preprocessing

- Descriptive stats (mean, std, etc.)
- Visualizations (countplot, pairplot, boxplot)
- Encoding, null value treatment, feature selection

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4. Model Development Phase

4.1. Feature Selection Report

Final features used: - age - gender - pulse - activity_level

4.2. Model Selection Report

Tested models: - Logistic Regression - Random Forest Classifier - Decision Tree Classifier - Gaussian Naive Bayes

4.3. Initial Model Training Code, Model Validation and Evaluation Report

Best Model: Random Forest Classifier Accuracy: ~95% on test data Evaluation Metrics: Accuracy Score, Classification Report

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5. Model Optimization and Tuning Phase

5.1. Hyperparameter Tuning Documentation

Random Forest tuned using: - n_estimators - max_depth - random_state

5.2. Performance Metrics Comparison Report

Model	Accuracy
Logistic Regression	89%
Random Forest	95%
Decision Tree	91%
Naive Bayes	87%

5.3. Final Model Selection Justification

Random Forest was selected for its high accuracy, stability, and performance across evaluation metrics.

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6. Results

6.1. Output Screenshots

- Home page input form
- Predicted result display (Stage classification)
- Console accuracy metrics

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7. Advantages & Disadvantages

Advantages:

- Real-time prediction
- Web interface for accessibility
- High accuracy from ensemble models

Disadvantages:

- Dataset size may limit generalization
- Input format must be structured (numeric)

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8. Conclusion

Predictive Pulse successfully demonstrates a practical application of machine learning for proactive healthcare. By predicting blood pressure stages, it allows for early intervention and better patient outcomes.

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9. Future Scope

- Integration with wearable devices (e.g., Fitbit, Apple Watch)
- Mobile app deployment
- Real-time streaming data input
- Cloud-based deployment (Render/Heroku)

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10. Appendix

10.1. Source Code

- `train_model.py`: Trains and saves model
- `app.py`: Flask backend
- `index.html`: Frontend UI

10.2. GitHub & Project Demo Link

GitHub: https://github.com/Viswatejajada/Predictive-Pulse-Harnessing-Machine-Learning-for-Blood-Pressure-Analysis