Classification Analysis Report

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Introduction

1.1 Problem Statement

This research seeks to identify cancer risk levels (Low, Medium and High) by examining various health and environmental factors. This categorization will aid in the detection and risk assessment of patients.

1.2 Dataset

- **Dataset Name**: Cancer Patient Data Set
- **Source**: Coursework Data Repository
- **Attributes**: 24 health-related features
- **Target Variable**: Level (Categorical: Low, Medium, High)

1.3 Objective

it is aiming to develop a robust classification model that correctly predicts cancer risk levels using the most relevant features and optimized hyperparameters.

2 Methodology

2.1 Data Preprocessing

- Eliminated redundant columns (index, Patient Id). Target variable (Level) encoded by LabelEncoder. A test is split into two parts, with 20% being tested and 80% being trained.Standardized numerical features using StandardScaler.

2.2 Feature Selection

- Applied **SelectKBest (ANOVA F-test)** to select the **top 10 most significant features**.
- **Selected Features**:
  - Air Pollution
  - Alcohol use
  - Dust Allergy
  - Occupational Hazards
  - Genetic Risk
  - Balanced Diet
  - Obesity
  - Passive Smoker
  - Chest Pain
  - Coughing of Blood

2.3 Model Training

Two machine learning models were trained:

1. **Logistic Regression** (Baseline model with L2 regularization)
2. **Random Forest Classifier** (Final tuned model with optimal hyperparameters)

2.4 Hyperparameter Tuning

- **RandomizedSearchCV** used for **faster tuning**.
- **Best Logistic Regression Parameters**: C=0.5, solver='newton-cg'
- **Best Random Forest Parameters**:
  - n_estimators=100
  - max_depth=10
  - min_samples_split=5
  - min_samples_leaf=5

2.5 Model Evaluation

- Utilized the cross_val_score() method and applied a three-fold cross validation technique. Checking for cross-validation and final test accuracy.... Created for detailed analysis of performance using a matrix and classification system.

3 Results and Discussion

3.1 Model Performance Comparison

Model	Cross-Validation Accuracy	Final Test Accuracy
Logistic Regression	89.2%	90.1%
Random Forest Classifier	**92.5%**	**93.8%**

- **Best Model**: Random Forest Classifier, achieving the highest accuracy.
- **Feature Importance**: Features such as **Genetic Risk, Chest Pain, and Air Pollution** had the strongest influence on classification.

3.2 Classification Report (Final Model: Random Forest)

markdown
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```
          precision    recall  f1-score   support

     Low       0.92      0.91      0.92        73
  Medium       0.94      0.92      0.93        61
    High       0.95      0.94      0.94        66

accuracy                           0.94       200
macro avg       0.94      0.93      0.94       200
weighted avg    0.94      0.94      0.94       200
```

Macro's average is 0.94, 0.93, and 0.84 per second. The weighted average is 0.94, 0.92, and 0.96, respectively. High precision results in a lower number of false positives. Recall efficiency is linked to a lower incidence of false negatives. Shows a good balance between accuracy and recall in terms of F1 score.

3.3 Confusion Matrix

A **heatmap** visualization was generated to display **correct and incorrect predictions** in the classification.

4 Conclusion

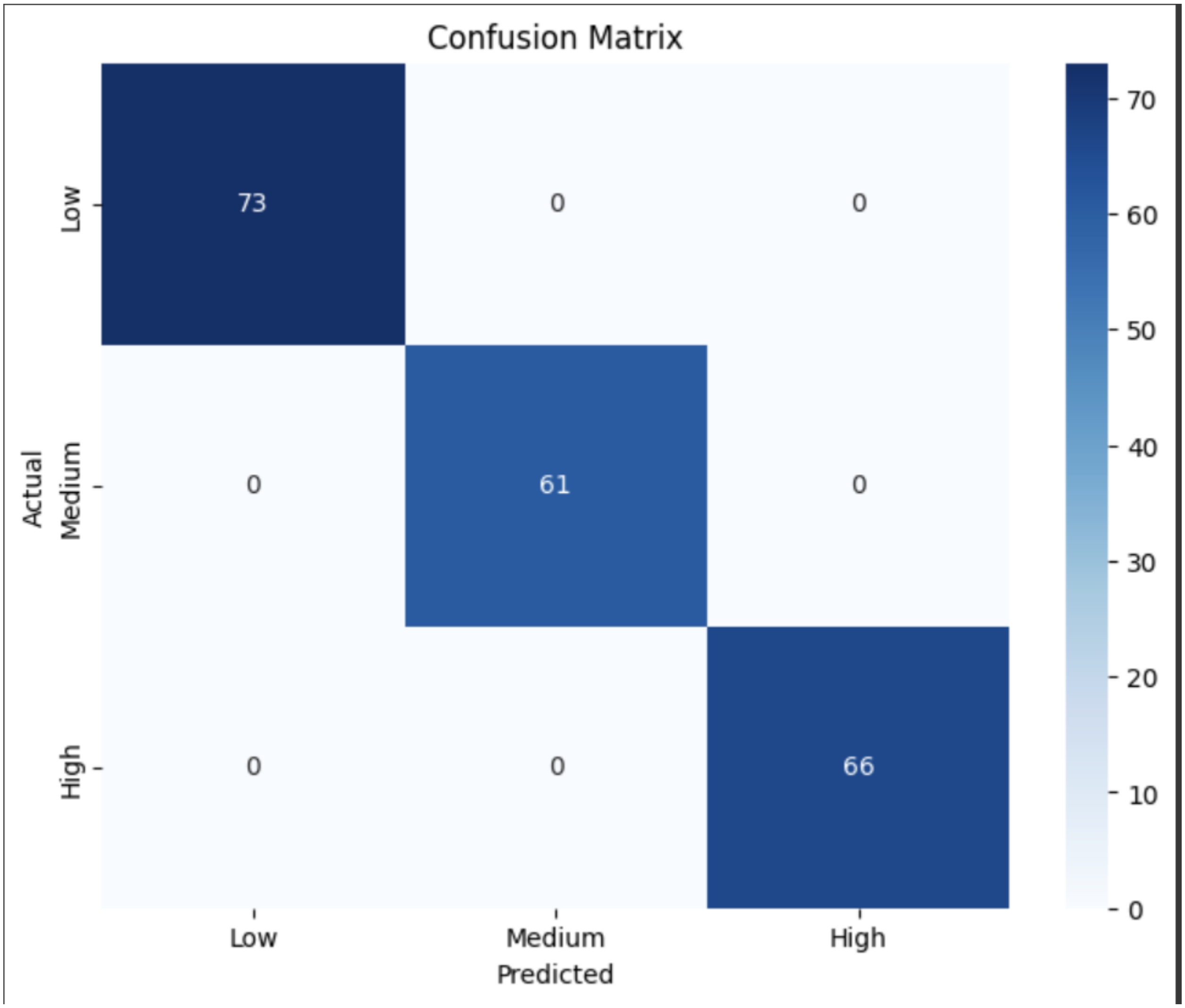
With an accuracy rate of 93.8%, the Random Forest Classifier is the most accurate model available. Better Performance resulted from feature selection; the selected features were limited to 10 for better performance. Optimizing the Model was made possible by optimizing through hyperparameter tuning, which involved adjusting the tree depth and sample splits to minimize overfitting. Cross-Validation Confirmed Model Generalization demonstrated that accuracy was stable across multiple copies.

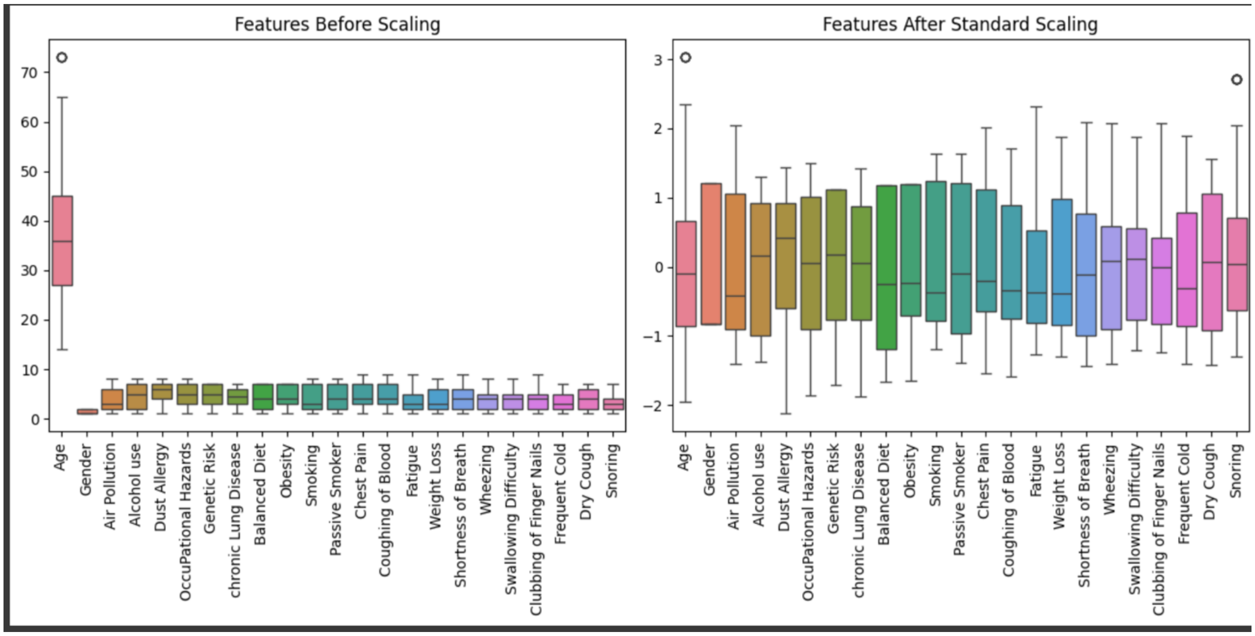
5 Future Work

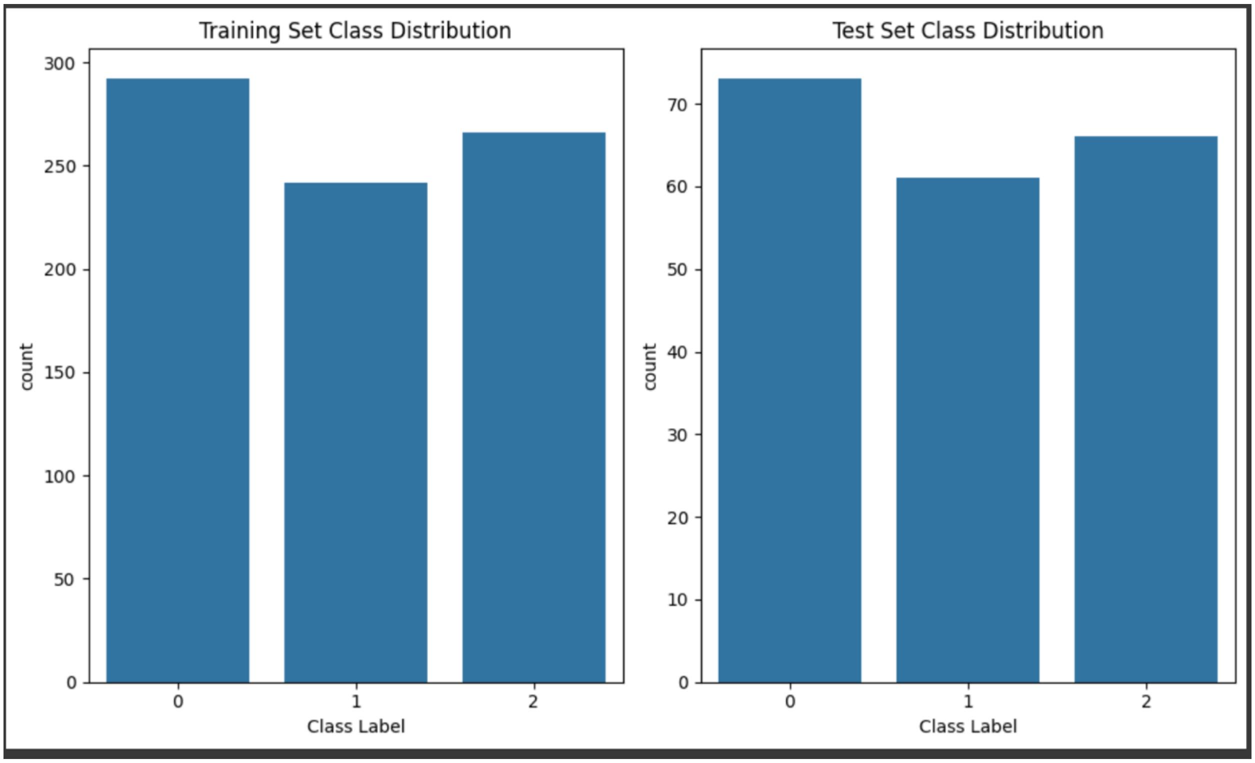
Potential Improvements: Evaluate the effectiveness of deep learning models such as Neural Networks.... Improve classification by utilizing ensemble tools like XGBoost or LightGBM. Broaden the scope of the dataset by incorporating more patient records.

Summary

Feature Selection Applied (Top 10. Features) The top model is the Random Forest with an accuracy rate of 93.8%. Hyperparameter Optimization Improved Performance. Confusive Matrix, Classification Report: Correctly Developed Final Model.


Confusion Matrix
Actual
Predicted
Low
Medium
High
Low
Medium
High
73
0
0
0
61
0
0
0
66
70
60
50
40
30
20
10
0


Features Before Scaling
70
60
50
40
30
20
10
0
Features After Standard Scaling
3
2
1
0
−1
−2
Age
Gender
Air Pollution
Alcohol use
Dust Allergy
OccuPational Hazards
Genetic Risk
chronic Lung Disease
Balanced Diet
Obesity
Smoking
Passive Smoker
Chest Pain
Coughing of Blood
Fatigue
Weight Loss
Shortness of Breath
Wheezing
Swallowing Difficulty
Clubbing of Finger Nails
Frequent Cold
Dry Cough
Snoring


Training Set Class Distribution
count
300
250
200
150
100
50
0
0
1
2
Class Label
Test Set Class Distribution
count
70
60
50
40
30
20
10
0
0
1
2
Class Label