Logistic Regression Project Report

Heart Disease

By

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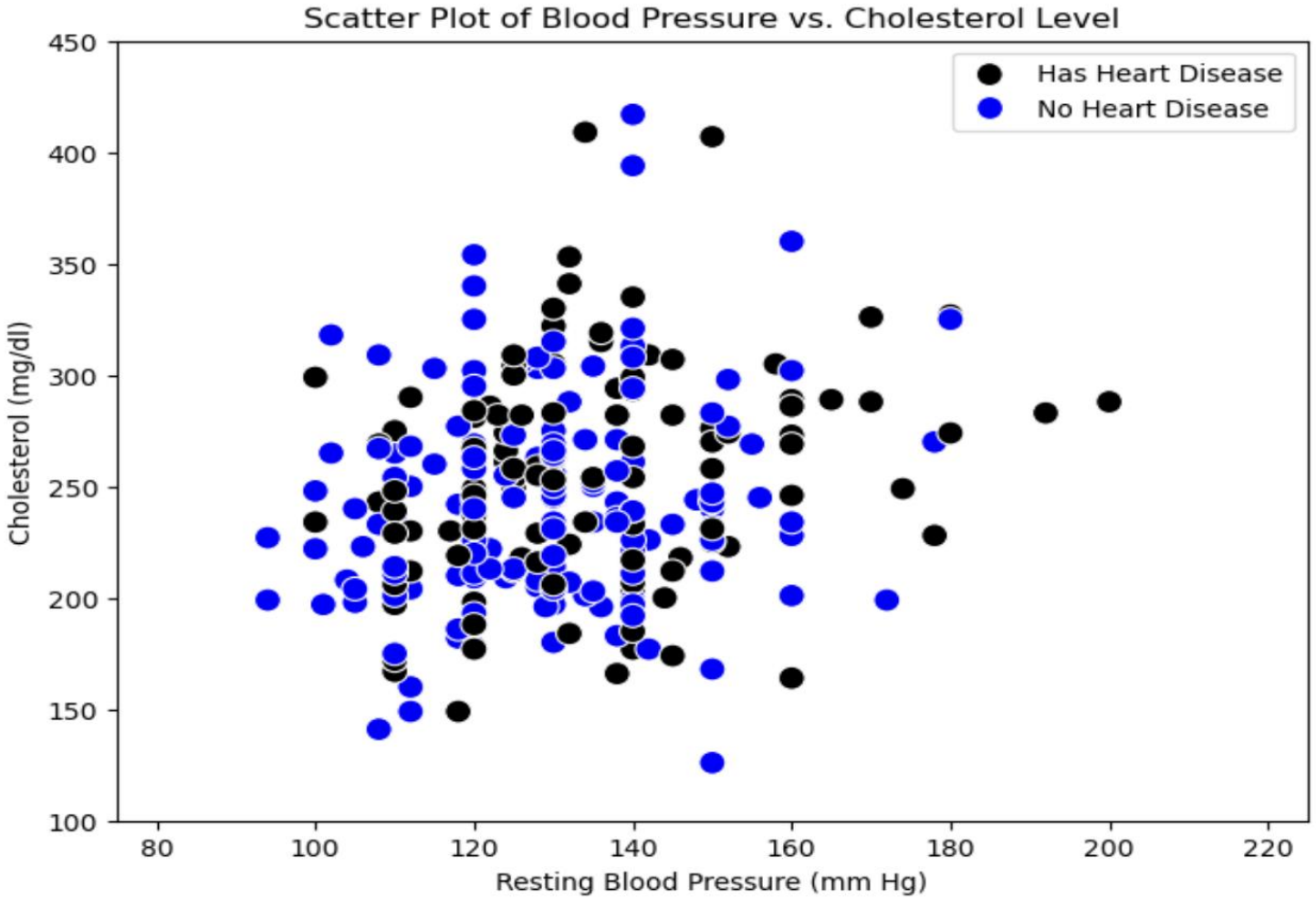
Logistic Regression: Speaks to the need to assign the likelihood of an event especially when there is no clear individual causal factor, but multiple independent variables associated with the likelihood of an event.



Gathered Extensive Variables on Patient Data to Run a Logistic Regression for Heart Disease:

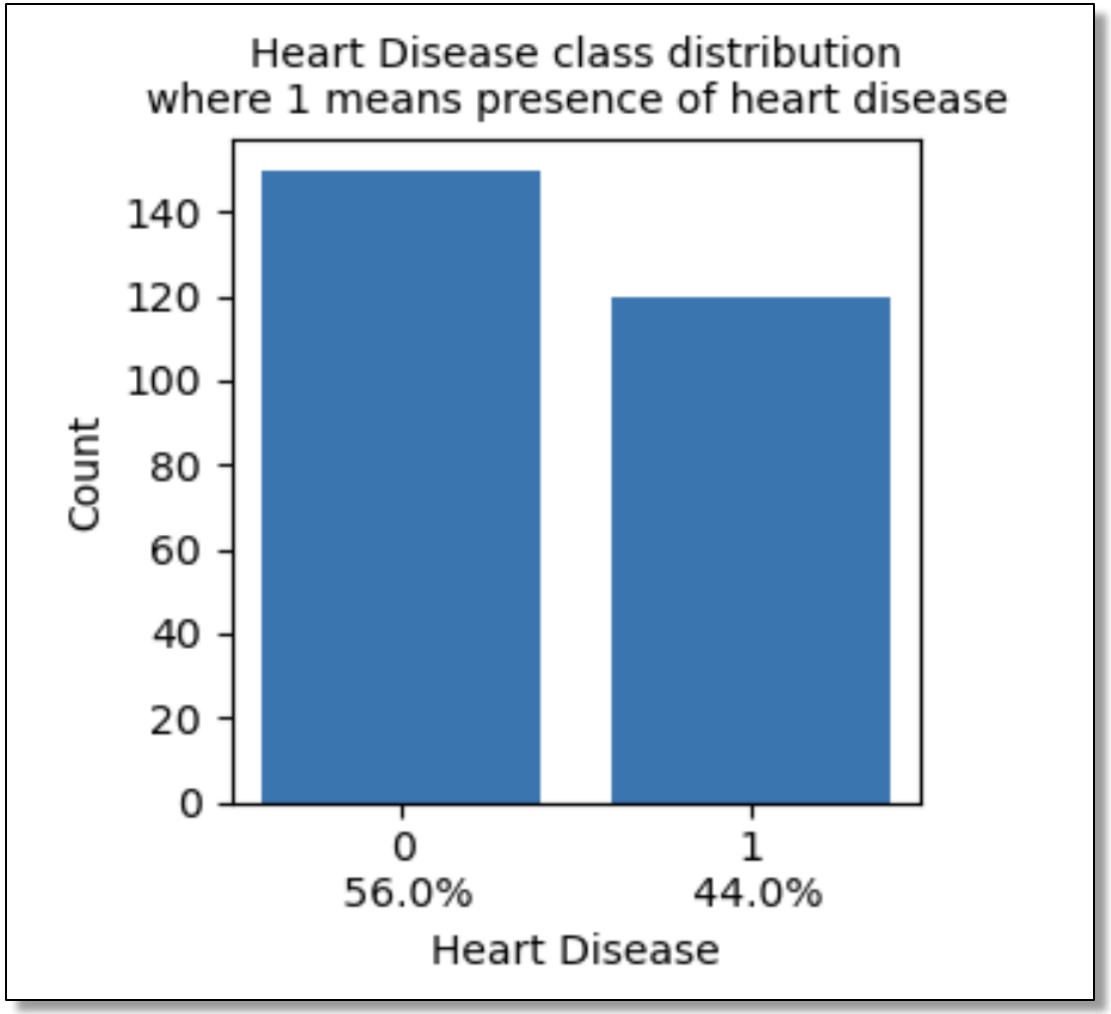
```
The data have  270  rows and  14  columns

column names:

age_yr
sex_M_F
chest_pain_value
resting_BP_mm_Hg
cholesterol_mg_dl
fasting_blood_sugar_high
ECG_value
max_HR
exercise_angina
ST_depresssion_exercise
ST_slope_peak
number_vessels_involved
defect_diag
heart_disease
```

Further Detail

```
age_yr
resting_BP_mm_Hg
choleterol_mg_dl
fasting_blood_sugar_high
max_HR
exercise_angina
ST_depresssion_exercise
number_vessels_involved
heart_disease
sex_M_F_0
sex_M_F_1
chest_pain_value_1
chest_pain_value_2
chest_pain_value_3
chest_pain_value_4
ECG_value_0
ECG_value_1
ECG_value_2
ST_slope_peak_1
ST_slope_peak_2
ST_slope_peak_3
defect_diag_3
defect_diag_6
defect_diag_7
```



Purpose

- Develop a Logistic Regression to Predict the Likelihood of Heart Disease
- Accomplish this with an extensive number of health indicators.
- Use both quantitative variables and categorical variables
- Use all features to build the Logistic Regression Model.
- Use Machine Learning Methods to Maximize the performance of the Logistic Regression
- Evaluate with a Confusion Matrix.
- Develop a Probability Classifier for Resting Blood Pressure (mm Hg) vs. Cholesterol Level (mg/dl)

The Model Building Cycle Using Linear Classifiers

(a) train/test split

(b) create an object of the class associated with the algorithm to be used--in this case LogisticRegression

(c) build an actual model using the "fit" method from the class (applied to the training set)

(d) predict with the built model using the "predict" method from the class (training set and test set)

(e) compute performance metrics (in this case, accuracy) for the training and test predictions

```
Xtrain, Xtest, ytrain, ytest = train_test_split(dflog[['cholesterol_mg_dl','resting_BP_mm_Hg']],
                                                dflog['heart_disease'],
                                                train_size = 0.80,
                                                random_state = 42)
```

```
LogisticRegression(C=1000, max_iter=500, solver='liblinear')
```

```
LogisticRegression(max_iter=500, solver='newton-cg')
```

The Model Building Cycle Using Linear Classifiers

```
Xtrain, Xtest, ytrain, ytest = train_test_split(dflog[['cholesterol_mg_dl','resting_BP_mm_Hg']],
                                                dflog['heart_disease'],
                                                train_size = 0.80,
                                                random_state = 42)
```

```
LogisticRegression(C=1000, max_iter=500, solver='liblinear')
```

```
print("Classification Report for Training Data")
print(classification_report(ytrain, classifier.predict(Xtrain)))
```

```
Classification Report for Training Data
              precision    recall  f1-score   support

           0       0.61      0.78      0.68       117
           1       0.61      0.40      0.48        99

    accuracy                           0.61       216
   macro avg       0.61      0.59      0.58       216
weighted avg       0.61      0.61      0.59       216
```

```
print("Classification Report for Test Data")
print(classification_report(ytest, classifier.predict(Xtest)))
```

```
Classification Report for Test Data
              precision    recall  f1-score   support

           0       0.63      0.82      0.71        33
           1       0.45      0.24      0.31        21

    accuracy                           0.59        54
   macro avg       0.54      0.53      0.51        54
weighted avg       0.56      0.59      0.56        54
```

```
LogisticRegression(max_iter=500, solver='newton-cg')
```

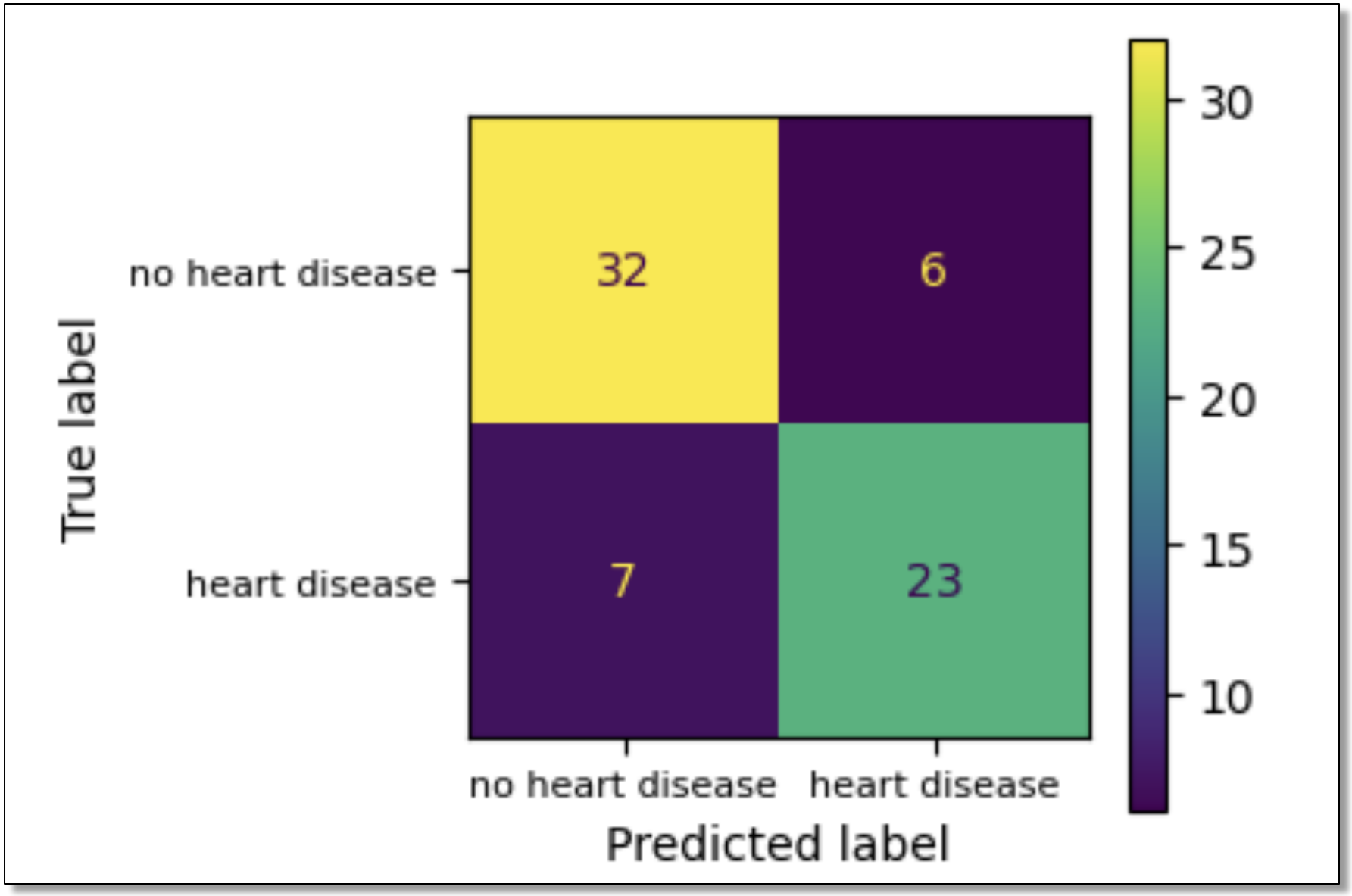
```
print("[Training] Accuracy score: (ylrstrat, y_predict_training)",
      f'{accuracy_score(ylrstrat, y_predict_training):.2f}')
```

```
[Training] Accuracy score: (ylrstrat, y_predict_training) 0.89
```

```
print("[Test] Accuracy score: (ytestlrstrat, y_predict_test) [**note reversed order]",
      f'{accuracy_score(ytestlrstrat, y_predict_test):.2f}')
```

```
[Test] Accuracy score: (ytestlrstrat, y_predict_test) [**note reversed order] 0.81
```

Confusion Matrix for newton-cg linear classifier



Discovering an Optimal C Value (Regularization Parameter) for newton-cg linear Classifier

```
LogisticRegression
LogisticRegression(max_iter=500, solver='newton-cg')
```

[Training Accuracy for C=1]

	precision	recall	f1-score	support
0	0.88	0.91	0.89	112
1	0.88	0.84	0.86	90
accuracy			0.88	202
macro avg	0.88	0.88	0.88	202
weighted avg	0.88	0.88	0.88	202

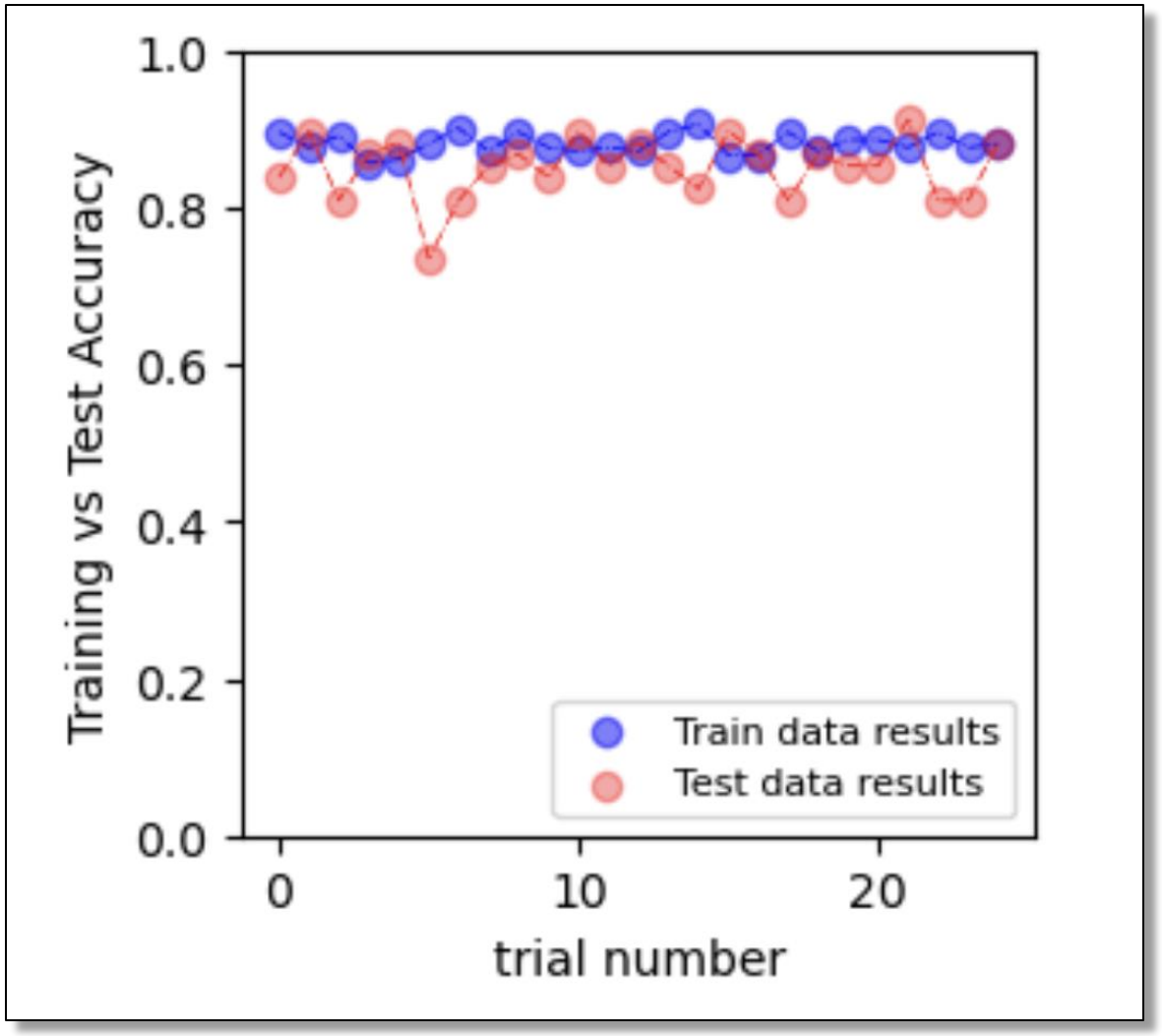
[Training Accuracy for C=10]

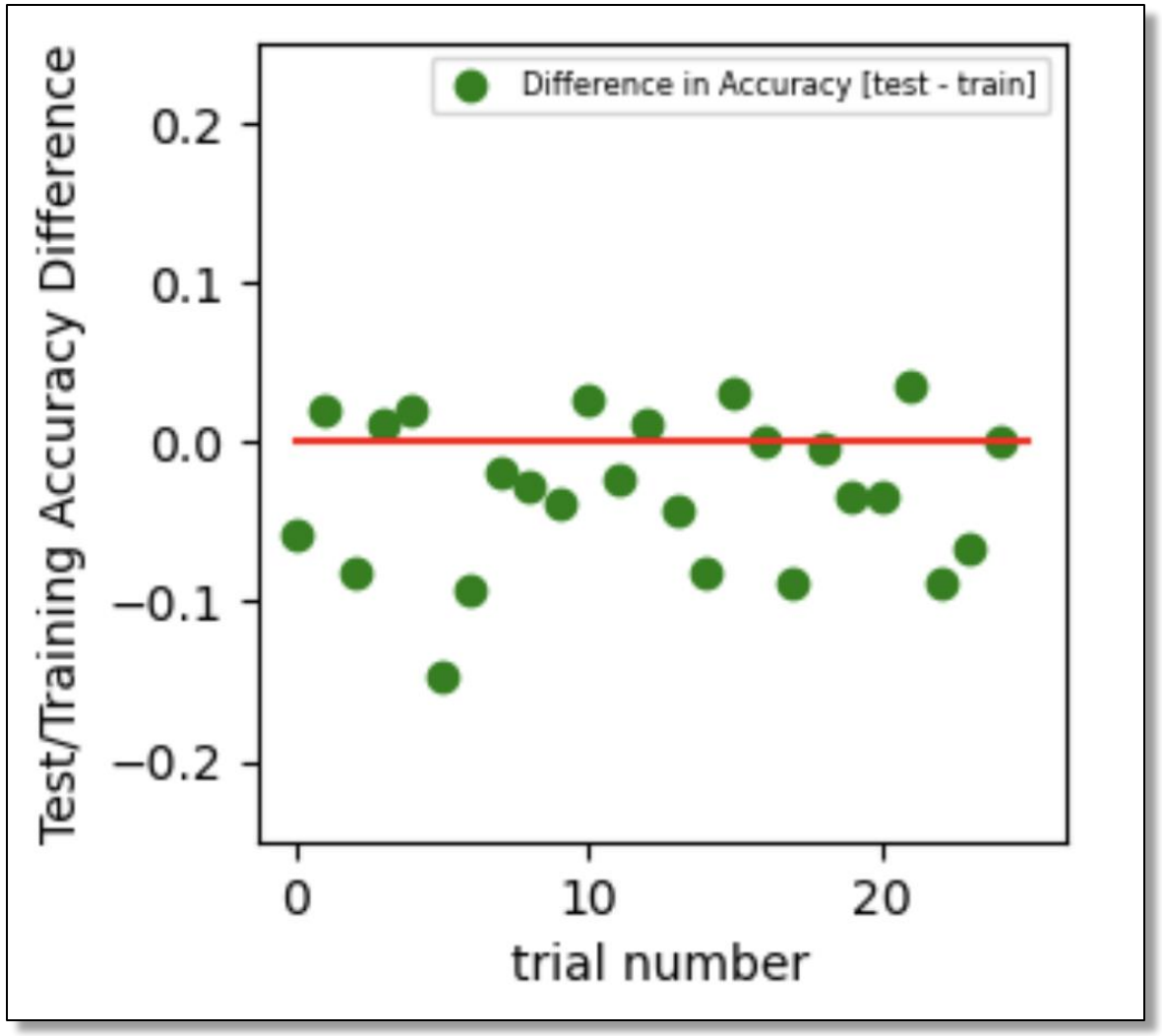
	precision	recall	f1-score	support
0	0.89	0.93	0.91	112
1	0.91	0.86	0.88	90
accuracy			0.90	202
macro avg	0.90	0.89	0.89	202
weighted avg	0.90	0.90	0.90	202

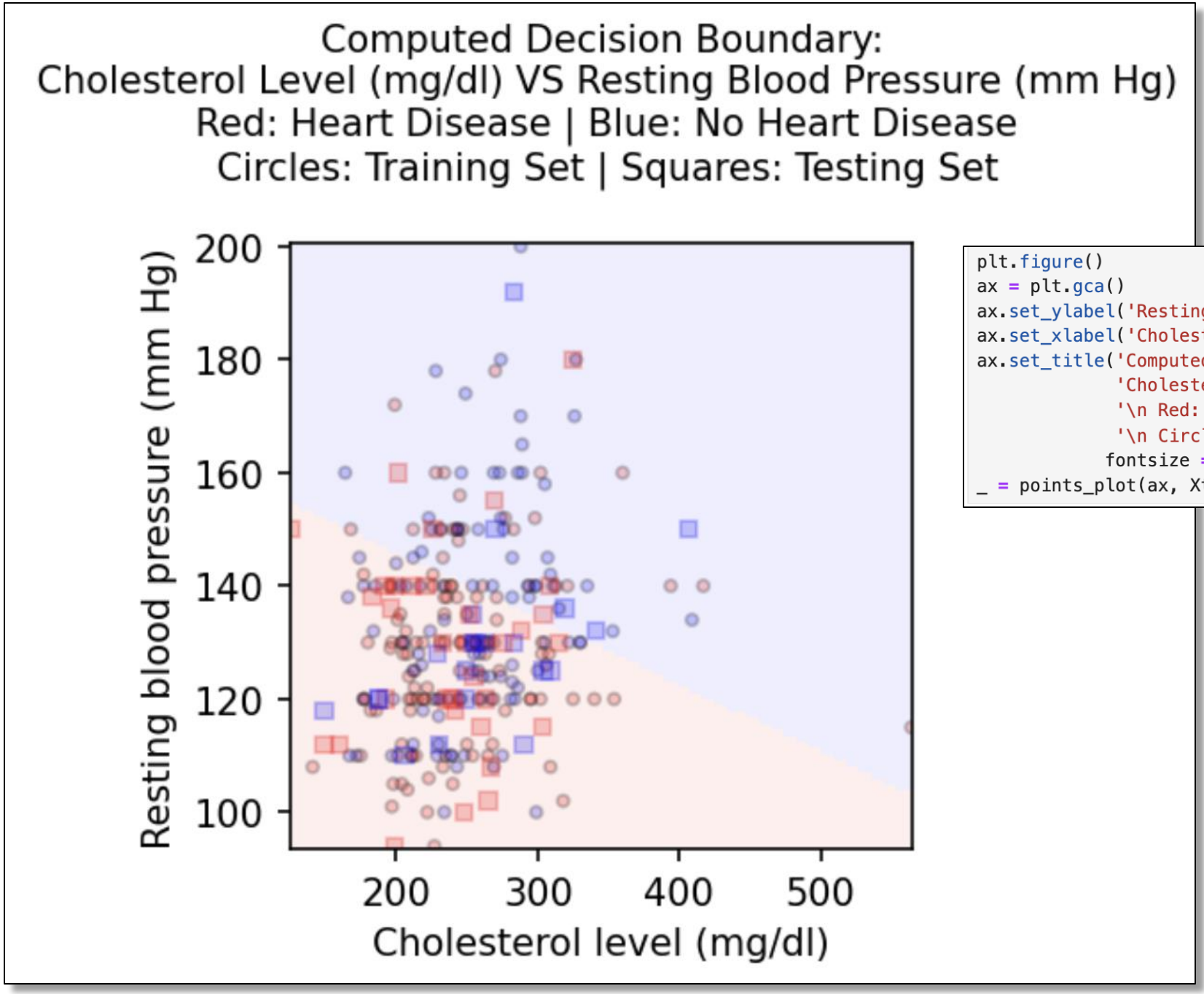
```
print("Logistic Regression Weighted coefficients for linear:", best_estimator.coef_)
```

```
Logistic Regression Weighted coefficients for linear: [[-0.0067498   0.45052203  0.41301556  0.01076425  0.002496   -0.2150339
   0.14821705 -0.01590518  0.31524247  0.22654272  0.14303985  0.61583979
   0.30112849]]
```

Reasonably Consistent Model Performance for newton-cg linear classifier

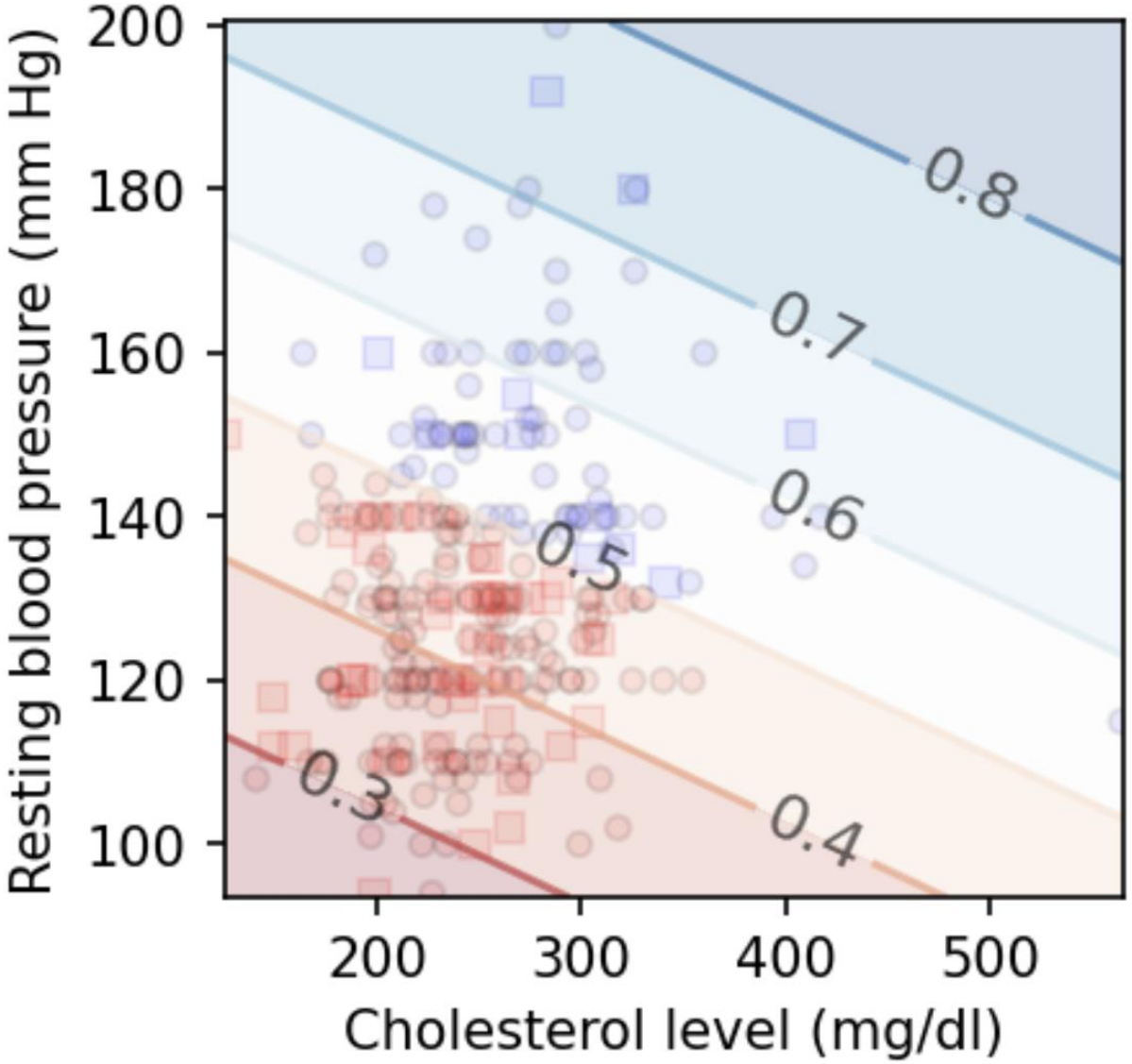







```
plt.figure()
ax = plt.gca()
ax.set_ylabel('Resting blood pressure (mm Hg)')
ax.set_xlabel('Cholesterol level (mg/dl)')
ax.set_title('Computed Decision Boundary:\n ' +
             'Cholesterol Level (mg/dl) VS Resting Blood Pressure (mm Hg)' +
             '\n Red: Heart Disease | Blue: No Heart Disease' +
             '\n Circles: Training Set | Squares: Testing Set\n',
            fontsize = 10)
_ = points_plot(ax, Xtrain, Xtest, ytrain, ytest, classifier, alpha = 0.2)
```

Probability Classifier for Resting Blood Pressure (mm Hg) vs. Cholesterol Level (mg/dl)



Sigmoidal Like Partial Dependence Plots Generated by SVM Classifier