IML_Heart_Disease_Prediction

May 6, 2024

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Relevant Modules

For more information on linear regression, gradiant descent, and the cost function, visit the assignment in the main branch of the github repository in the following code.

[2]:
```
import numpy as np #Numerical Operations
import pandas as pd #Data Manipulation
import matplotlib.pyplot as plt #Plotting
import warnings #Warning Handling Module
import seaborn as sns #Heatmap for Confusion Matrix
from sklearn import metrics #Model Metrics
from sklearn.metrics import confusion_matrix, mean_squared_error #Confusion␣
↪Matrix and MSE
from sklearn.preprocessing import StandardScaler, MinMaxScaler #Standardization␣
↪and Min-Max Normalization
from sklearn.linear_model import LogisticRegression, LinearRegression␣
↪#Regression Training
from sklearn.naive_bayes import GaussianNB #Naive Bayes Classifier
from sklearn.decomposition import PCA #Principal Component Analysis
from sklearn.exceptions import DataConversionWarning #Data Warning
from sklearn.feature_selection import SelectKBest, f_regression #Feature␣
↪Selection
from sklearn.tree import DecisionTreeClassifier #Regression model

warnings.filterwarnings("ignore") #Mute warnings in output

test = pd.read_csv('https://raw.githubusercontent.com/VoluSign/UNCC/main/
↪test_heart.csv')#*
train = pd.read_csv('https://raw.githubusercontent.com/VoluSign/UNCC/main/
↪train_heart.csv')#*
```

Functions

[3]:
```
#Standardization
def Standardize(X_test,X_train):
  sc = StandardScaler()
  X_train = sc.fit_transform(X_train)
  X_test = sc.transform(X_test)
  return X_test,X_train

#Normalization
def Normalize(X_test,X_train):
  scaler = MinMaxScaler()
  X_train = scaler.fit_transform(X_train)
  X_test = scaler.transform(X_test)
  return X_test,X_train

def disMetrics(y_test, y_pred):
  #Display Model Metrics
  print("Accuracy:", metrics.accuracy_score(y_test,y_pred))
  print("Precision:", metrics.precision_score(y_test,y_pred))
  print("Recall:", metrics.recall_score(y_test,y_pred))
  print("F1 score:", metrics.f1_score(y_pred, y_test, average="weighted"))

def conMatrix(y_test, y_pred):
  #Create Confusion Matrix
  class_names = [0,1]
  fig, ax = plt.subplots()
  tick_marks = np.arange(len(class_names))
  plt.xticks(tick_marks, class_names)
  plt.yticks(tick_marks, class_names)
  #Create heatmap
  sns.heatmap(pd.DataFrame(confusion_matrix(y_test, y_pred)), annot = True,␣
 ↪fmt='g')
  #Plot Confusion Matrix
  plt.tight_layout()
  plt.title('Confusion Matrix')
  plt.ylabel('Actual')
  plt.xlabel('Predicted')

def reset(test_X, train_X, test_target, train_target):
  #Create dataframe for data
  X__test = pd.DataFrame(test_X).drop(columns=['target'])
  Y__test = pd.DataFrame(test_target)
  X__train = pd.DataFrame(train).drop(columns=['target'])
  Y__train = pd.DataFrame(train_target)
  X_train, X_test, y_train, y_test = X__train, X__test, Y__train, Y__test
  return X_train, X_test, y_train, y_test
```

Feature Selection

[4]:
```
#Split the data into training and testing sets
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
# Configure to select all features
fs = SelectKBest(score_func=f_regression, k='all')

# Learn relationship from training data
fs.fit(X_train, y_train)

#Get column names
column_names = X_train.columns

feature_weights = {}
for i in range(len(fs.scores_)):
    feature_weights[column_names[i]] = fs.scores_[i]

feature_weights = pd.DataFrame.from_dict(feature_weights, orient='index',␣
 ↪columns=['Feature Weight']).round(2).transpose()

feature_weights.head()
```

[4]:
```
                  age    sex      cp  trestbps   chol   fbs  restecg  thalach  \
Feature Weight  56.79  86.69  238.56     20.09  10.33  1.74    18.84    222.8

                 exang  oldpeak   slope      ca   thal
Feature Weight  242.88   243.45  138.68  174.88  131.8
```

Linear Regression

[5]:
```
# Linear regression model based on heavily weighted features
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
X_train = X_train.drop(columns=['chol','trestbps','age','sex', 'cp', 'fbs',␣
 ↪'restecg', 'exang'])
X_test = X_test.drop(columns=['chol','trestbps','age','sex', 'cp', 'fbs',␣
 ↪'restecg', 'exang'])
X_test, X_train = Standardize(X_test, X_train)  # Standardizes features
model = LinearRegression()  # Linear Regression Model
model.fit(X_train, y_train)  # Model Training
y_pred = model.predict(X_test)  # Predict on test set

print("Mean Squared Error:", mean_squared_error(y_test, y_pred))
```

```
Mean Squared Error: 0.15014826710024817
```

Chol has small effect, can be turned into classification problem using sigmoid function.

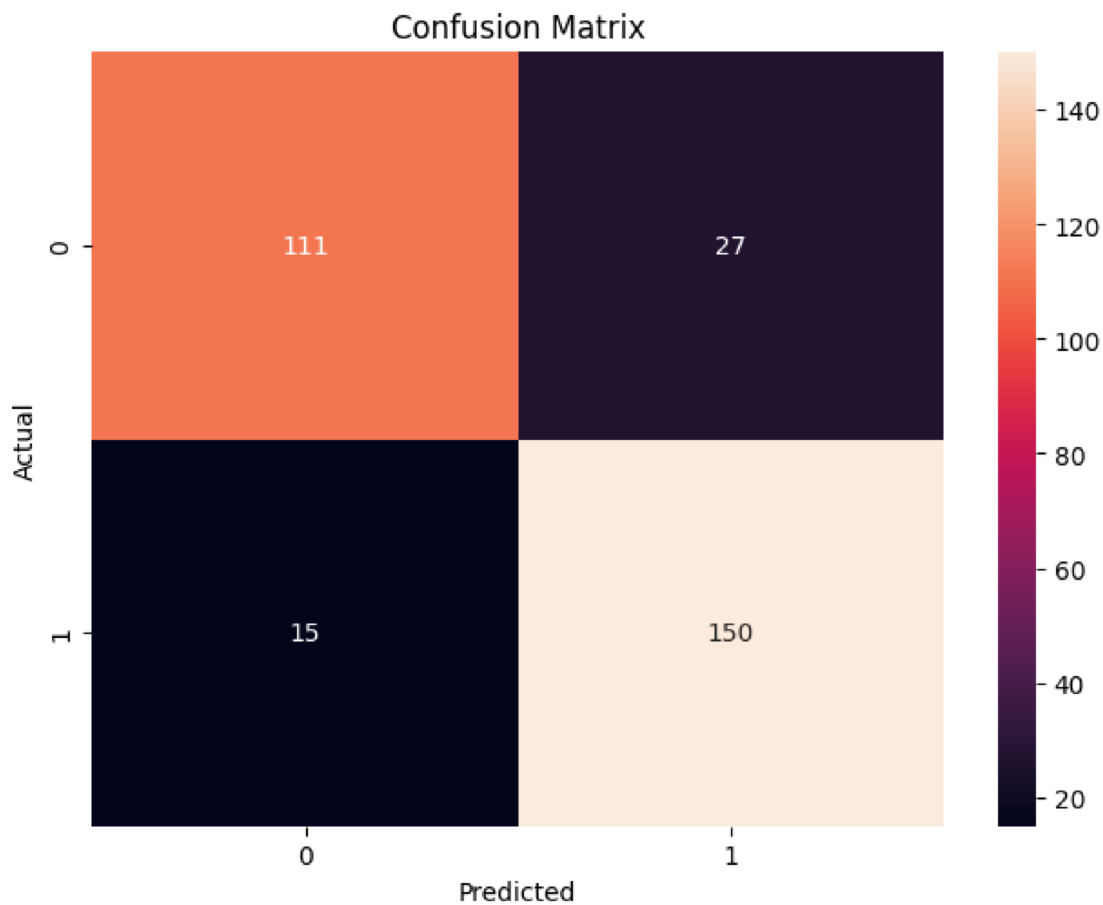
Logistic Regression

[6]:
```
#Logistic Regression Model
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
X_test,X_train = Standardize(X_test,X_train) #Standardizes features
model = LogisticRegression(random_state=0) #Logistic Regression Model
model.fit(X_train, y_train) #Model Training
y_pred = model.predict(X_test) #Predict on test set

disMetrics(y_test, y_pred)
```

```
Accuracy: 0.8613861386138614
Precision: 0.847457627118644
Recall: 0.9090909090909091
F1 score: 0.862104631515783
```

[7]:
```
#Logistic Regression Model With Reularization
model = LogisticRegression(penalty='l2', C=1, random_state=0) #Logistic␣
 ↪Regression Model With Reularization (lambda = .03)
model.fit(X_train, y_train) #Model Training
y_pred = model.predict(X_test) #Predict on test set

disMetrics(y_test, y_pred)
conMatrix(y_test, y_pred)
```

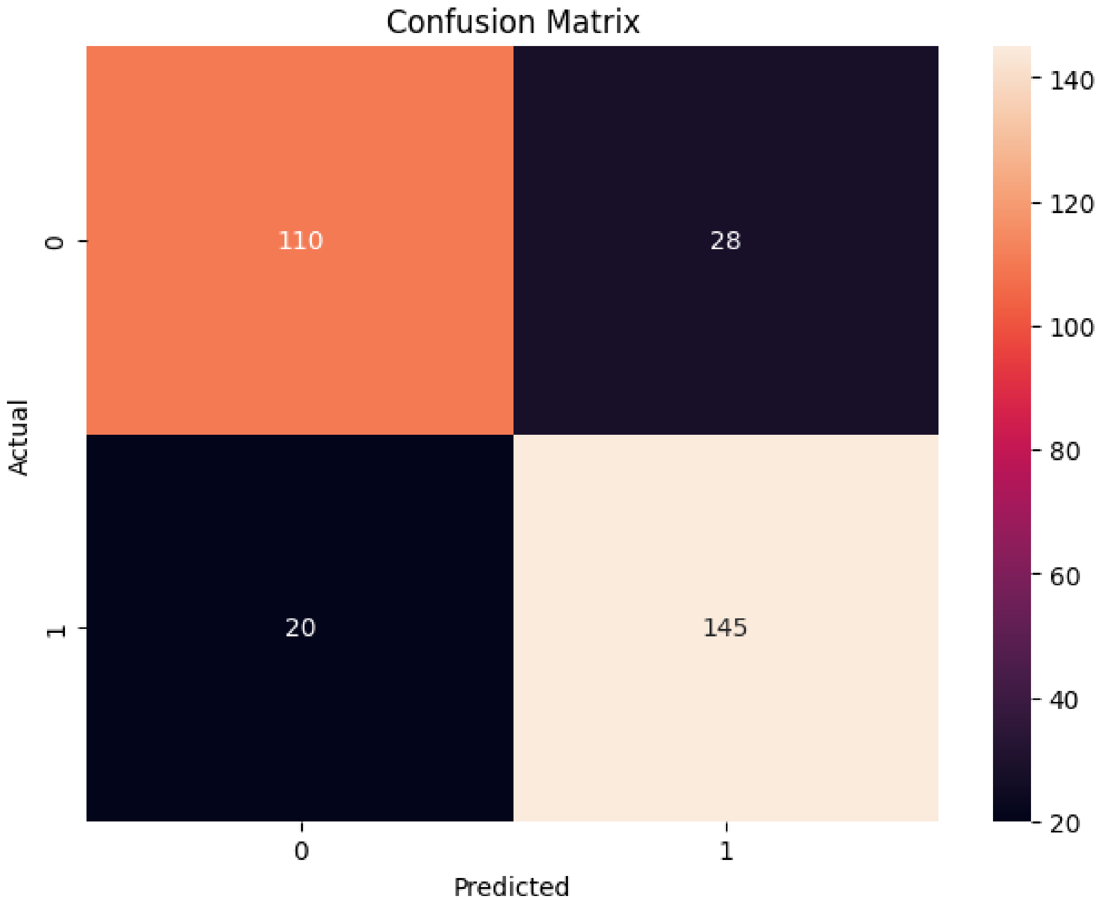
```
Accuracy: 0.8613861386138614
Precision: 0.847457627118644
Recall: 0.9090909090909091
F1 score: 0.862104631515783
```



[8]:
```
#PCA Extraction
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
X_train, X_test = Standardize(X_train, X_test)

# Best PCA feature extraction for this data
principal = PCA(n_components=10)
principal.fit(X_train)
X_train_pca = principal.transform(X_train)
X_test_pca = principal.transform(X_test)

# Training logistic regression model
model = LogisticRegression(random_state=0)
model.fit(X_train_pca, y_train)

# Predictions
y_pred = model.predict(X_test_pca)

disMetrics(y_test, y_pred)
```

```
conMatrix(y_test, y_pred)
```

```
Accuracy: 0.8415841584158416
Precision: 0.838150289017341
Recall: 0.8787878787878788
F1 score: 0.8420738302744872
```



Naive Bayesian Classification

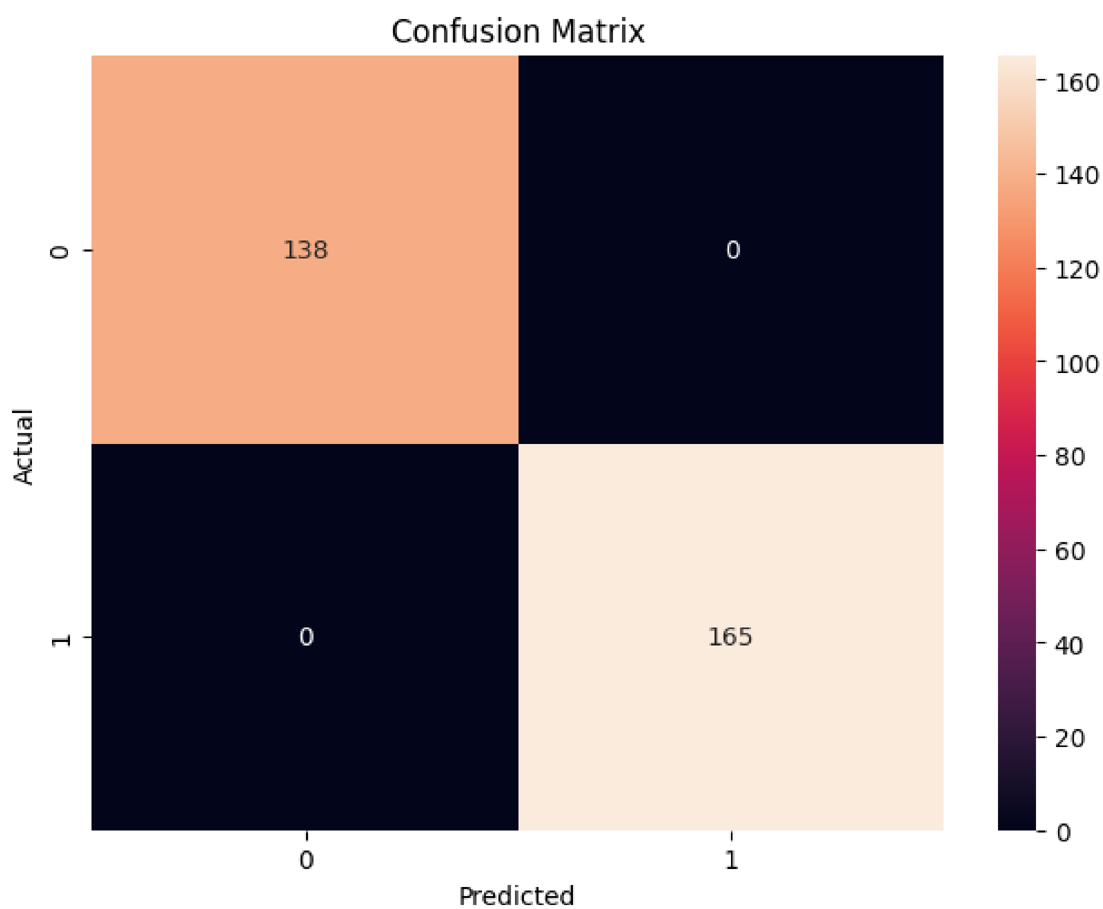
[9]:
```
#Naive Bayesian Classification
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
X_test,X_train = Standardize(X_test,X_train)
model = GaussianNB()
model.fit(X_train, y_train)
y_pred = model.predict(X_test)

disMetrics(y_test, y_pred)
```

```
Accuracy: 0.834983498349835
Precision: 0.8362573099415205
Recall: 0.8666666666666667
F1 score: 0.8353436534129604
```

Decision Tree Classification

[10]:
```
#Decision Tree Classification
X_train, X_test, y_train, y_test = reset(test, train, test.target, train.target)
X_test,X_train = Standardize(X_test,X_train)
model = DecisionTreeClassifier(random_state=0)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)

disMetrics(y_test, y_pred)
conMatrix(y_test, y_pred)
```

```
Accuracy: 1.0
Precision: 1.0
Recall: 1.0
F1 score: 1.0
```



References

Floyd, T. (2024). UNCC Repository [Computer software]. https://github.com/VoluSign/UNCC

Deeba, F. (2024). Introduction-to-ML Notebooks. https://github.com/Farah-Deeba-UNCC/Introduction-to-ML/

Dev Batra. (March, 2024). Heart Disease Prediction, Version 1. Retrieved from https://www.kaggle.com/datasets/devbatrax/heart-disease-prediction?resource=download.