**ЛАБОРАТОРНА РОБОТА № 1**

**ПОПЕРЕДНЯ ОБРОБКА ТА КОНТРОЛЬОВАНА**

**КЛАСИФІКАЦІЯ ДАНИХ**

***Мета роботи:*** використовуючи спеціалізовані бібліотеки та мову програмування Python дослідити попередню обробку та класифікацію даних.

Завдання 1.

from sklearn import preprocessing  
  
input\_labels = ['red', 'black', 'red', 'green', 'black', 'yellow', 'white']  
  
encoder = preprocessing.LabelEncoder()  
encoder.fit(input\_labels)  
  
  
print("\nLabel mapping: ")  
for i, item in enumerate(encoder.classes\_):  
 print(item, '-->', i)  
  
test\_labels = ['green', 'red', 'black']  
encoded\_values = encoder.transform(test\_labels)  
print(f"\nLabels = {test\_labels}")  
print(f"Encoded values = {list(encoded\_values)}")  
  
encoded\_values = [3, 0, 4, 1]  
decoded\_list = encoder.inverse\_transform(encoded\_values)  
print(f"\nEncoded values = {encoded\_values}")  
print(f"Decoded labels = {list(decoded\_list)}")

**Результат виконання:**

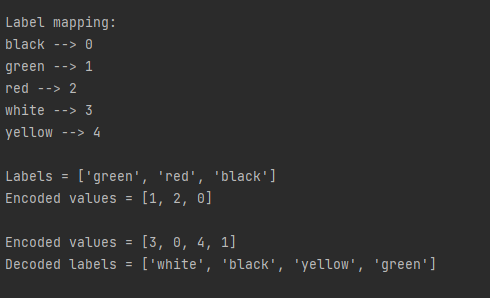
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Рис.1 - Результат виконання

Завдання 2



import numpy as np  
from sklearn import preprocessing  
  
input\_data = np.array([[4.6, 9.9, -3.5, -2.9, 4.1, 3.3,  
 -2.2, 8.8, -6.1, 3.9, 1.4, 2.2]])  
data\_binarized = preprocessing.Binarizer(threshold=2.2).transform(input\_data)  
print(f"\nBinarized data:\n{data\_binarized}")  
  
print("\nBEFORE: ")  
print(f"Mean = {input\_data.mean(axis=0)}")  
print(f"Std deviation = {input\_data.std(axis=0)}")  
  
data\_scaled = preprocessing.scale(input\_data)  
print("\nAFTER: ")  
print(f"Mean = {data\_scaled.mean(axis=0)}")  
print(f"Std deviation = {data\_scaled.std(axis=0)}")  
  
data\_scaled\_minmax = preprocessing.MinMaxScaler(feature\_range=(0,1))  
data\_scaled\_minmax = data\_scaled\_minmax.fit\_transform(input\_data)  
print(f"\nMin max scaled data:\n{data\_scaled\_minmax}")  
data\_normalized\_l1 = preprocessing.normalize(input\_data, norm='l1')  
data\_normalized\_l2 = preprocessing.normalize(input\_data, norm='l2')  
  
print(f"\nL1 normalized data:\n{data\_normalized\_l1}");  
print(f"\nL2 normalized data:\n{data\_normalized\_l2}");

**Результат виконання:**

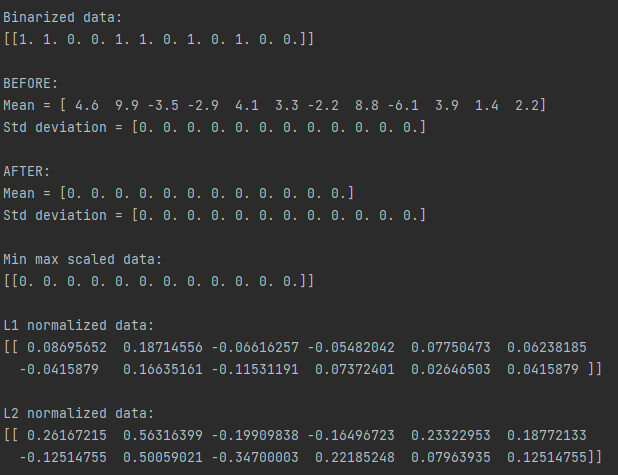
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Рис.2 - Результат виконання

Завдання 3.

import numpy as np  
from sklearn import linear\_model  
from utilities import visualize\_classifier  
  
X = np.array([[3.1, 7.2], [4, 6.7], [2.9, 8], [5.1, 4.5],  
 [6, 5], [5.6, 5], [3.3, 0.4],  
 [3.9, 0.9], [2.8, 1],  
 [0.5, 3.4], [1, 4], [0.6, 4.9]])  
y = np.array([0, 0, 0, 1, 1, 1, 2, 2, 2, 3, 3, 3])  
  
classifier = linear\_model.LogisticRegression(solver='liblinear', C=1)  
  
classifier.fit(X, y)  
  
visualize\_classifier(classifier, X, y)

**Результат виконання:**

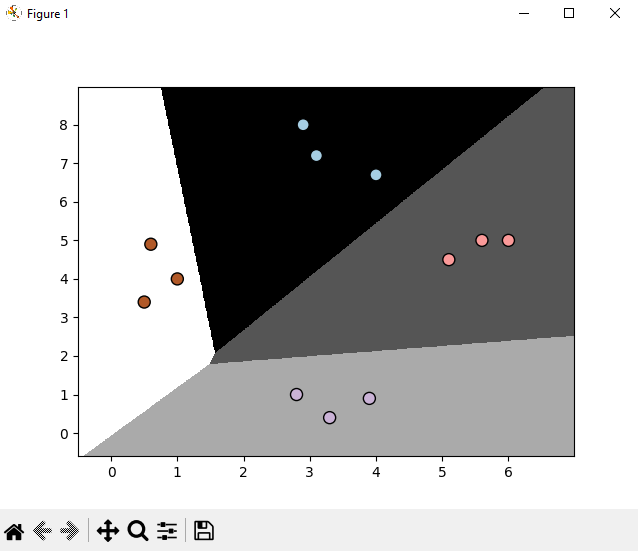
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Рис.3 - Результат виконання

Завдання 4.

import numpy as np  
from utilities import visualize\_classifier  
from sklearn.naive\_bayes import GaussianNB  
from sklearn.model\_selection import train\_test\_split  
from sklearn.model\_selection import cross\_val\_score  
  
input\_file = 'data\_multivar\_nb.txt'  
data = np.loadtxt(input\_file, delimiter=',')  
X, y = data[:, :-1], data[:, -1]  
  
  
classifier = GaussianNB()  
classifier.fit(X, y)  
  
  
y\_pred = classifier.predict(X)  
  
  
accuracy = 100.0 \* (y == y\_pred).sum() / X.shape[0]  
print(f"Accuracy of Naive Bayes classifier = {round(accuracy,2)}%")  
  
  
visualize\_classifier(classifier, X, y)  
X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=3)  
classifier\_new = GaussianNB()  
classifier\_new.fit(X\_train, y\_train)  
y\_test\_pred = classifier\_new.predict(X\_test)  
  
  
accuracy = 100.0 \* (y\_test == y\_test\_pred).sum()/X\_test.shape[0]  
print(f"Accuracy of the new classifier = {round(accuracy, 2)}%")  
  
  
visualize\_classifier(classifier\_new, X\_test, y\_test)  
  
num\_folds = 3  
accuracy\_values = cross\_val\_score(classifier, X, y, scoring='accuracy', cv=num\_folds)  
print("Accuracy: " + str(round(100 \* accuracy\_values.mean(), 2)) + "%")  
  
precision\_values = cross\_val\_score(classifier, X, y, scoring='precision\_weighted', cv=num\_folds)  
print("Precision: " + str(round(100 \* precision\_values.mean(), 2)) + "%")  
  
recall\_values = cross\_val\_score(classifier, X, y, scoring='precision\_weighted', cv=num\_folds)  
print("Recall: " + str(round(100 \* recall\_values.mean(), 2)) + "%")  
  
f1\_values = cross\_val\_score(classifier, X, y, scoring='f1\_weighted', cv=num\_folds)  
print("F1: " + str(round(100 \* f1\_values.mean(), 2)) + "%")

**Результат виконання:**

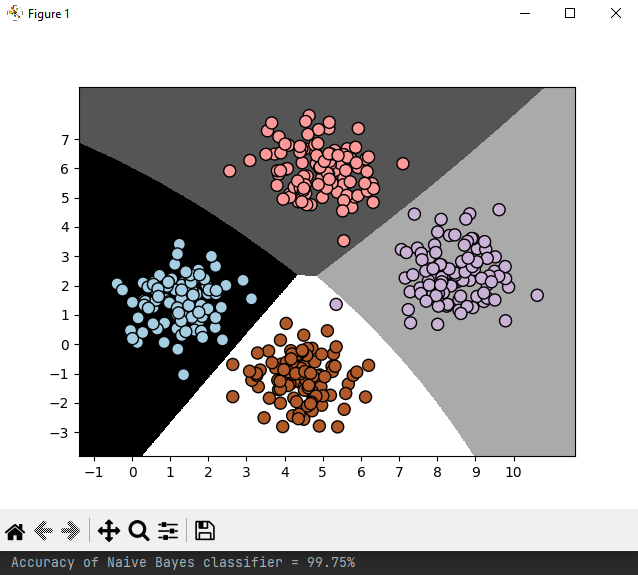
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Рис.4 - Результат виконання

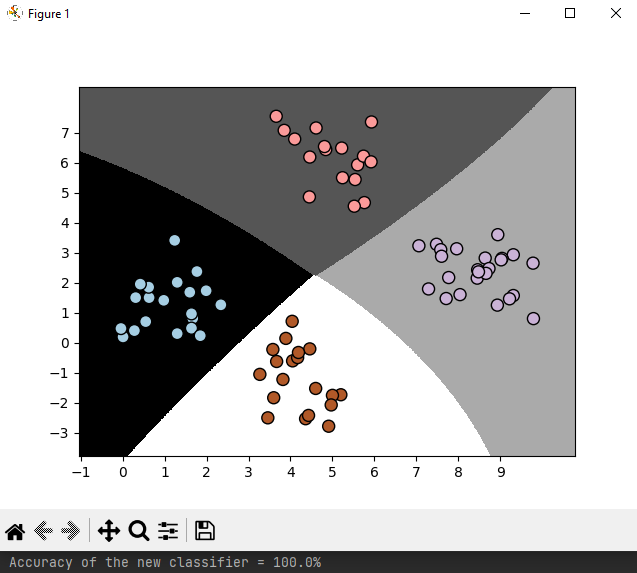


Рис.5 - Результат виконання

Завдання 5.

import pandas as pd  
import numpy as np  
import matplotlib.pyplot as plt  
  
from sklearn.metrics import confusion\_matrix  
from sklearn.metrics import accuracy\_score  
from sklearn.metrics import recall\_score  
from sklearn.metrics import precision\_score  
from sklearn.metrics import f1\_score  
from sklearn.metrics import roc\_curve  
from sklearn.metrics import roc\_auc\_score  
  
df = pd.read\_csv('data\_metrics.csv')  
df.head()  
thresh = 0.5  
df['predicted\_RF'] = (df.model\_RF >= 0.5).astype('int')  
df['predicted\_LR'] = (df.model\_LR >= 0.5).astype('int')  
df.head()  
  
print(confusion\_matrix(df.actual\_label.values, df.predicted\_RF.values))  
  
  
def find\_TP(y\_true, y\_pred):  
 # counts the number of true positives (y\_true = 1, y\_pred = 1)  
 return sum((y\_true == 1) & (y\_pred == 1))  
  
  
def find\_FN(y\_true, y\_pred):  
 # counts the number of false negatives (y\_true = 1, y\_pred = 0)  
 return sum((y\_true == 1) & (y\_pred == 0))  
  
  
def find\_FP(y\_true, y\_pred):  
 # counts the number of false positives (y\_true = 0, y\_pred = 1)  
 return sum((y\_true == 0) & (y\_pred == 1))  
  
  
def find\_TN(y\_true, y\_pred):  
 # counts the number of true negatives (y\_true = 0, y\_pred = 0)  
 return sum((y\_true == 0) & (y\_pred == 0))  
  
  
print('TP:', find\_TP(df.actual\_label.values, df.predicted\_RF.values))  
print('FN:', find\_FN(df.actual\_label.values, df.predicted\_RF.values))  
print('FP:', find\_FP(df.actual\_label.values, df.predicted\_RF.values))  
print('TN:', find\_TN(df.actual\_label.values, df.predicted\_RF.values))  
  
  
def find\_conf\_matrix\_values(y\_true, y\_pred):  
 # calculate TP, FN, FP, TN  
 TP = find\_TP(y\_true, y\_pred)  
 FN = find\_FN(y\_true, y\_pred)  
 FP = find\_FP(y\_true, y\_pred)  
 TN = find\_TN(y\_true, y\_pred)  
 return TP, FN, FP, TN  
  
  
def voitko\_confusion\_matrix(y\_true, y\_pred):  
 TP, FN, FP, TN = find\_conf\_matrix\_values(y\_true, y\_pred)  
 return np.array([[TN, FP], [FN, TP]])  
  
  
voitko\_confusion\_matrix(df.actual\_label.values, df.predicted\_RF.values)  
  
assert np.array\_equal(voitko\_confusion\_matrix(df.actual\_label.values, df.predicted\_RF.values),  
 confusion\_matrix(df.actual\_label.values,  
 df.predicted\_RF.values)), 'my\_confusion\_matrix() is not correct for RF'  
assert np.array\_equal(voitko\_confusion\_matrix(df.actual\_label.values, df.predicted\_LR.values),  
 confusion\_matrix(df.actual\_label.values,  
 df.predicted\_LR.values)), 'my\_confusion\_matrix() is not correct for LR'  
  
print(accuracy\_score(df.actual\_label.values, df.predicted\_RF.values))  
  
  
def koptiaiev\_accuracy\_score(y\_true, y\_pred): # calculates the fraction of samples  
 TP, FN, FP, TN = find\_conf\_matrix\_values(y\_true, y\_pred)  
 return (TP + TN) / (TP + TN + FP + FN)  
  
  
assert koptiaiev\_accuracy\_score(df.actual\_label.values, df.predicted\_RF.values) == accuracy\_score(  
 df.actual\_label.values, df.predicted\_RF.values), 'my\_accuracy\_score failed on RF'  
assert koptiaiev\_accuracy\_score(df.actual\_label.values, df.predicted\_LR.values) == accuracy\_score(  
 df.actual\_label.values, df.predicted\_LR.values), 'my\_accuracy\_score failed on LR'  
print('Accuracy RF:%.3f' % (koptiaiev\_accuracy\_score(df.actual\_label.values, df.predicted\_RF.values)))  
  
print(recall\_score(df.actual\_label.values, df.predicted\_RF.values))  
  
  
def koptiaiev\_recall\_score(y\_true, y\_pred):  
 # calculates the fraction of positive samples predicted correctly  
 TP, FN, FP, TN = find\_conf\_matrix\_values(y\_true, y\_pred)  
 return TP / (TP + FN)  
  
  
assert koptiaiev\_recall\_score(df.actual\_label.values, df.predicted\_RF.values) == recall\_score(df.actual\_label.values,  
 df.predicted\_RF.values), 'voitko\_accuracy\_score failed on RF'  
assert koptiaiev\_recall\_score(df.actual\_label.values, df.predicted\_LR.values) == recall\_score(df.actual\_label.values,  
 df.predicted\_LR.values), 'voitko\_accuracy\_score failed on LR'  
  
print('Recall RF: %.3f' % (koptiaiev\_recall\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('Recall LR: %.3f' % (koptiaiev\_recall\_score(df.actual\_label.values, df.predicted\_LR.values)))  
  
precision\_score(df.actual\_label.values, df.predicted\_RF.values)  
  
  
def koptiaiev\_precision\_score(y\_true, y\_pred):  
 # calculates the fraction of predicted positives samples that are actually positive  
 TP, FN, FP, TN = find\_conf\_matrix\_values(y\_true, y\_pred)  
 return TP / (TP + FP)  
  
  
assert koptiaiev\_precision\_score(df.actual\_label.values, df.predicted\_RF.values) == precision\_score(  
 df.actual\_label.values, df.predicted\_RF.values), 'my\_accuracy\_score failed on RF'  
assert koptiaiev\_precision\_score(df.actual\_label.values, df.predicted\_LR.values) == precision\_score(  
 df.actual\_label.values, df.predicted\_LR.values), 'my\_accuracy\_score failed on LR'  
  
print('Precision RF: %.3f' % (koptiaiev\_precision\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('Precision LR: %.3f' % (koptiaiev\_precision\_score(df.actual\_label.values, df.predicted\_LR.values)))  
  
f1\_score(df.actual\_label.values, df.predicted\_RF.values)  
  
  
def koptiaiev\_f1\_score(y\_true, y\_pred): # calculates the F1 score  
 recall = koptiaiev\_recall\_score(y\_true, y\_pred)  
 precision = koptiaiev\_precision\_score(y\_true, y\_pred)  
 return 2 \* (precision \* recall) / (precision + recall)  
  
  
assert koptiaiev\_f1\_score(df.actual\_label.values, df.predicted\_RF.values) == f1\_score(df.actual\_label.values,  
 df.predicted\_RF.values), 'my\_accuracy\_score failed on RF'  
assert koptiaiev\_f1\_score(df.actual\_label.values, df.predicted\_LR.values) == f1\_score(df.actual\_label.values,  
 df.predicted\_LR.values), 'my\_accuracy\_score failed on LR'  
  
print('F1 RF: %.3f' % (koptiaiev\_f1\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('F1 LR: %.3f' % (koptiaiev\_f1\_score(df.actual\_label.values, df.predicted\_LR.values)))  
print('scores with threshold = 0.5')  
  
print('Accuracy RF: % .3f' % (koptiaiev\_accuracy\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('Recall RF: %.3f' % (koptiaiev\_recall\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('Precision RF: % .3f' % (koptiaiev\_precision\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('F1 RF: %.3f' % (koptiaiev\_f1\_score(df.actual\_label.values, df.predicted\_RF.values)))  
print('')  
  
threshold = 0.75  
  
print(f'Scores with threshold = {threshold}')  
print('Accuracy RF: % .3f' % (koptiaiev\_accuracy\_score(df.actual\_label.values, (df.model\_RF >= threshold).astype('int').values)))  
print('Recall RF: %.3f' % (koptiaiev\_recall\_score(df.actual\_label.values, (df.model\_RF >= threshold).astype('int').values)))  
print('Precision RF: %.3f' % (koptiaiev\_precision\_score(df.actual\_label.values, (df.model\_RF >= threshold).astype('int').values)))  
print('F1 RF: %.3f' % (koptiaiev\_f1\_score(df.actual\_label.values, (df.model\_RF >= threshold).astype('int').values)))  
  
fpr\_RF, tpr\_RF, thresholds\_RF = roc\_curve(df.actual\_label.values,df.model\_RF.values)  
fpr\_LR, tpr\_LR, thresholds\_LR = roc\_curve(df.actual\_label.values, df.model\_LR.values)  
  
plt.plot(fpr\_RF, tpr\_RF, 'r-', label='RF')  
plt.plot(fpr\_LR, tpr\_LR, 'b-', label='LR')  
plt.plot([0, 1], [0, 1], 'k-', label='random')  
plt.plot([0, 0, 1, 1], [0, 1, 1, 1], 'g-', label='perfect')  
plt.legend()  
plt.xlabel('False Positive Rate')  
plt.ylabel('True Positive Rate')  
plt.show()  
  
auc\_RF = roc\_auc\_score(df.actual\_label.values, df.model\_RF.values)  
auc\_LR = roc\_auc\_score(df.actual\_label.values, df.model\_LR.values)  
print('AUC RF:%.3f' % auc\_RF)  
print('AUC LR:%.3f' % auc\_LR)  
  
plt.plot(fpr\_RF, tpr\_RF, 'r-', label='RF AUC: %.3f' % auc\_RF)  
plt.plot(fpr\_LR, tpr\_LR, 'b-', label='LR AUC: %.3f' % auc\_LR)  
plt.plot([0, 1], [0, 1], 'k-', label='random')  
plt.plot([0, 0, 1, 1], [0, 1, 1, 1], 'g-', label='perfect')  
plt.legend()  
plt.xlabel('False Positive Rate')  
plt.ylabel('True Positive Rate')  
plt.show()

Результат виконання:

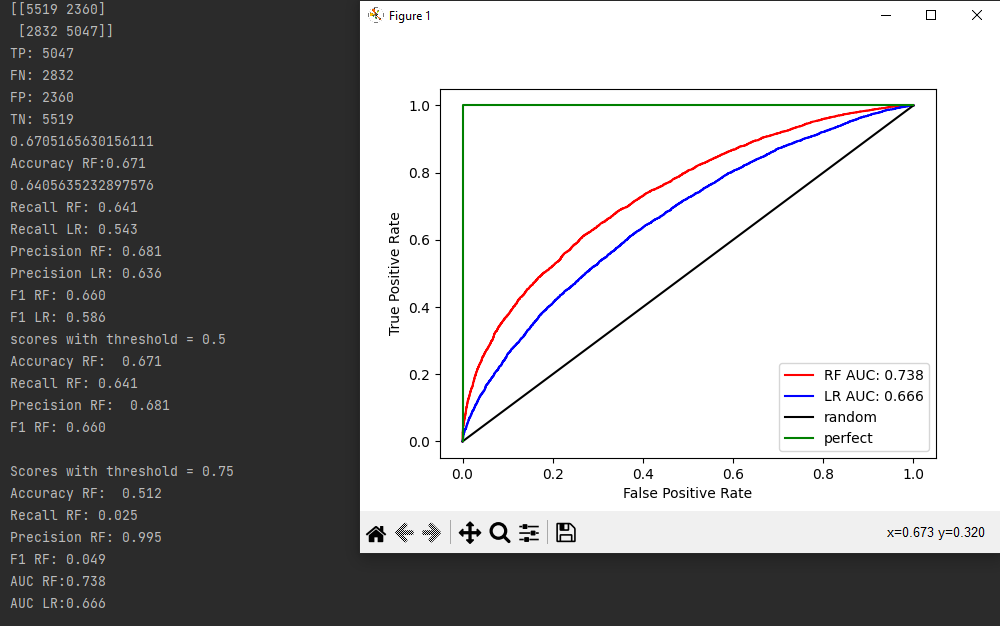
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Рис. 6 - Результат виконання

Завдання 6.

import numpy as np  
from sklearn.model\_selection import train\_test\_split  
from sklearn import svm  
from sklearn import metrics  
  
  
from utilities import visualize\_classifier  
input\_file = 'data\_multivar\_nb.txt'  
  
data = np.loadtxt(input\_file, delimiter=',')  
X, y = data[:, :-1], data[:, -1]  
  
X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y.astype(int), test\_size=0.2, random\_state=3)  
  
cls = svm.SVC(kernel='linear')  
cls.fit(X\_train, y\_train)  
pred = cls.predict(X\_test)  
print("Accuracy:", metrics.accuracy\_score(y\_test, y\_pred=pred))  
  
print("Precision: ", metrics.precision\_score(y\_test, y\_pred=pred, average='macro'))  
  
print("Recall", metrics.recall\_score(y\_test, y\_pred=pred, average='macro'))  
print(metrics.classification\_report(y\_test, y\_pred=pred))  
  
visualize\_classifier(cls, X\_test, y\_test)

Результат виконання:

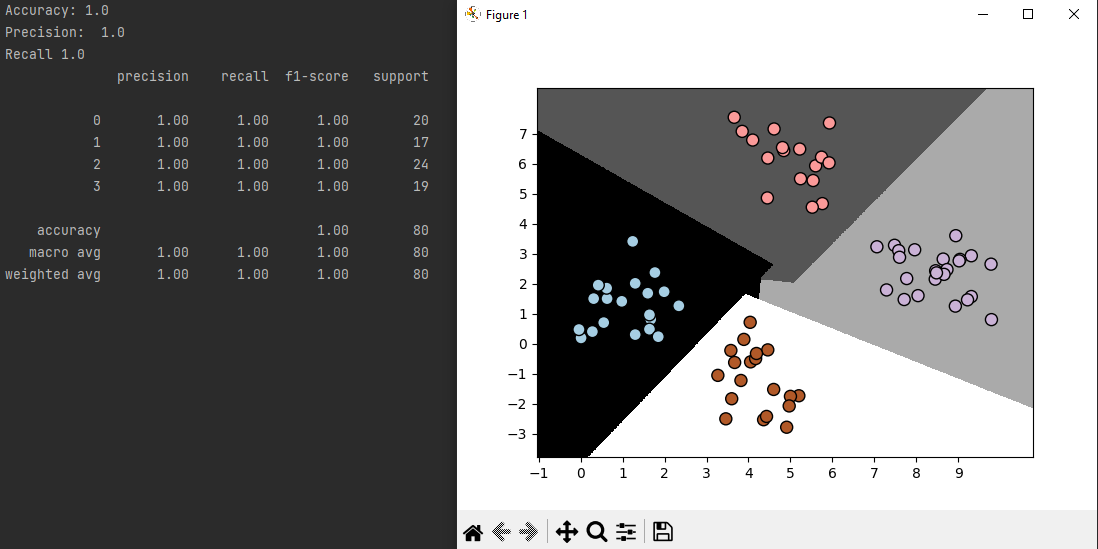


Рис. 7 - Результат виконання

**Висновок**: в ході виконання лабораторної роботи ми навчилися використовувати спеціалізовані бібліотеки та мову програмування Python для дослідження попередньої обробки та класифікації даних.