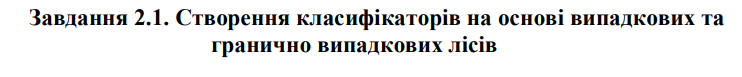
**ЛАБОРАТОРНА РОБОТА № 4**

**Тема**: ДОСЛІДЖЕННЯ МЕТОДІВ АНСАМБЛЕВОГО НАВЧАННЯ ТА СТВОРЕННЯ РЕКОМЕНДАЦІЙНИХ СИСТЕМ

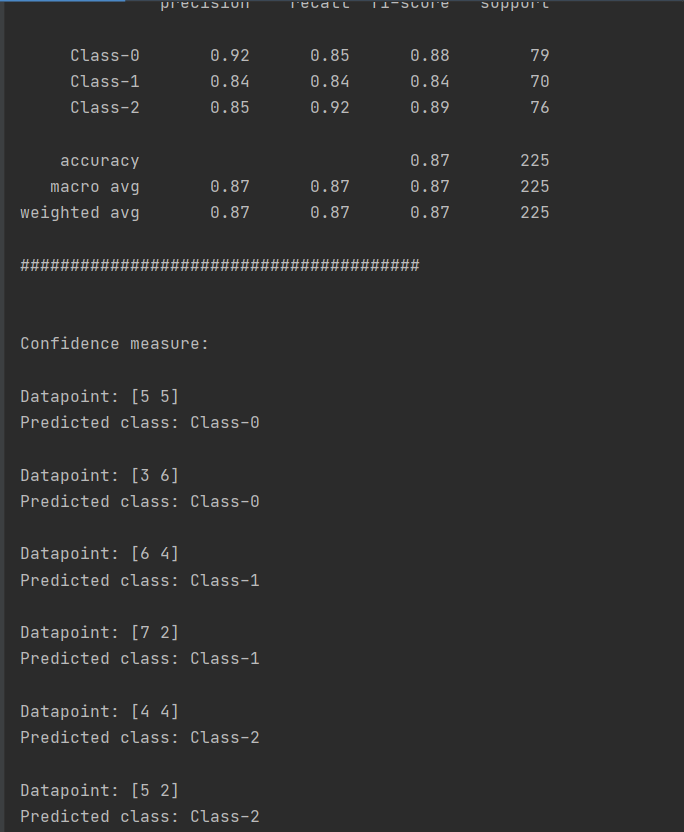
**Мета**: використовуючи спеціалізовані бібліотеки та мову програмування Python дослідити методи ансамблів у машинному навчанні та створити рекомендаційні системи.

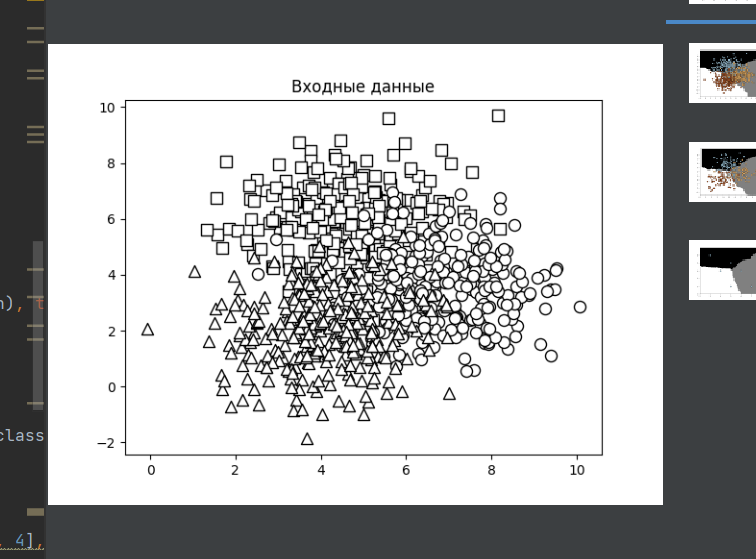
**Хід роботи:**

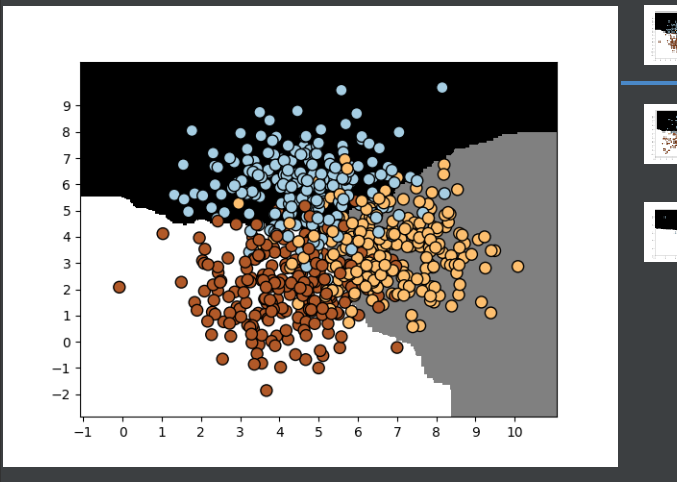
**Task1**

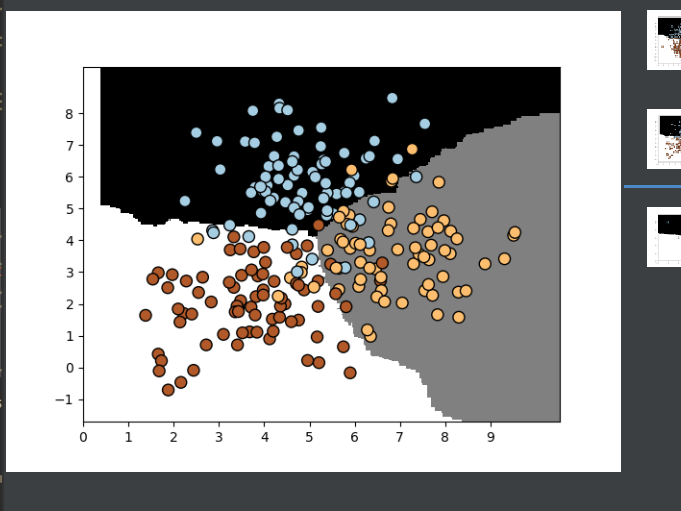
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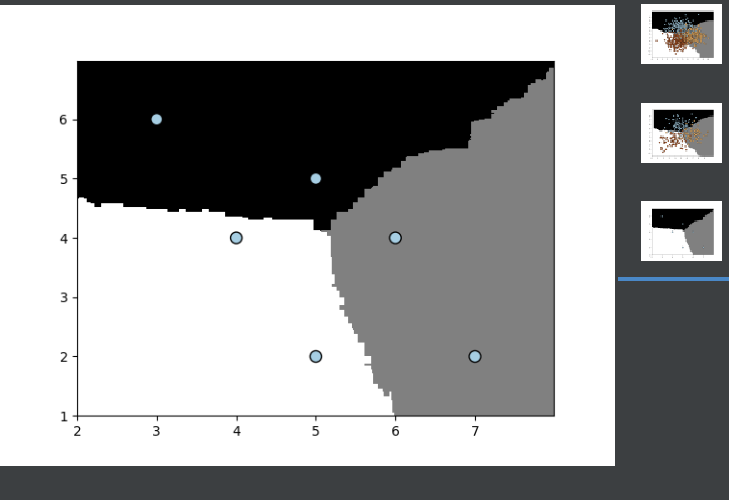
**--classifier-type erf**

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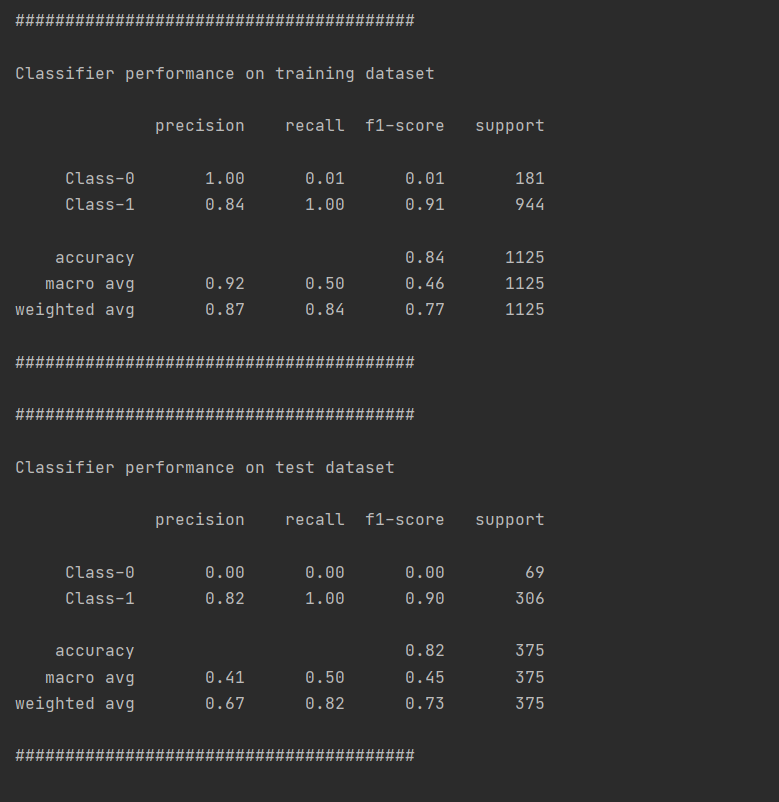
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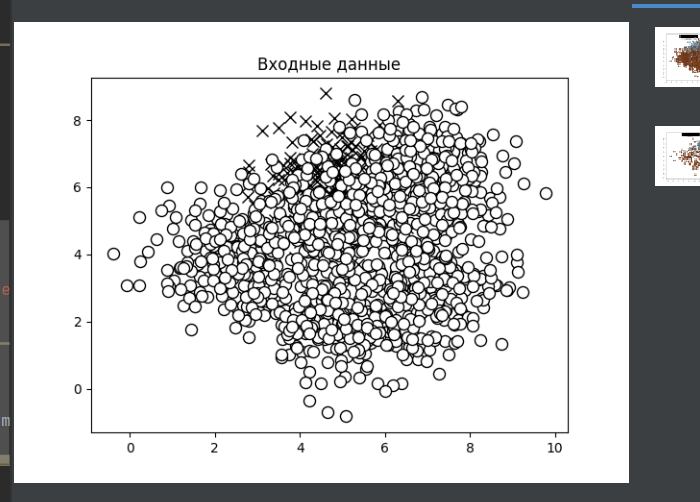
import argparse  
import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.metrics import classification\_report  
from sklearn.model\_selection import train\_test\_split  
from sklearn.ensemble import RandomForestClassifier, ExtraTreesClassifier  
from sklearn.metrics import classification\_report,confusion\_matrix  
  
from utilities import visualize\_classifier  
  
def build\_arg\_parser():  
 parser = argparse.ArgumentParser(description='Classify data using Ensemble Learning techniques')  
 parser.add\_argument('--classifier-type', dest='classifier\_type', required=True, choices=['rf', 'erf'], help="Type of classifier to use; can be either 'rf' of 'erf'")  
 return parser  
  
  
if \_\_name\_\_=='\_\_main\_\_':  
 args = build\_arg\_parser().parse\_args()  
 classifier\_type = args.classifier\_type  
  
 input\_file = 'data\_random\_forests.txt'  
 data = np.loadtxt(input\_file, delimiter=',')  
 X, y = data[:, :-1], data[:, -1]  
  
 class\_0 = np.array(X[y==0])  
 class\_1 = np.array(X[y==1])  
 class\_2 = np.array(X[y==2])  
  
 plt.figure()  
 plt.scatter(class\_0[:, 0], class\_0[:, 1], s=75, facecolors='white', edgecolors='black', linewidths=1, marker='s')  
 plt.scatter(class\_1[:, 0], class\_1[:, 1], s=75, facecolors='white', edgecolors='black', linewidths=1, marker='o')  
 plt.scatter(class\_2[:, 0], class\_2[:, 1], s=75, facecolors='white', edgecolors='black', linewidths=1, marker='^')  
 plt.title('Входные данные')  
  
 X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.25, random\_state=5)  
  
 params = {'n\_estimators': 100, 'max\_depth': 4, 'random\_state': 0}  
  
 if classifier\_type == 'rf':  
 classifier = RandomForestClassifier(\*\*params)  
 else:  
 classifier = ExtraTreesClassifier(\*\*params)  
  
  
 classifier.fit(X\_train, y\_train)  
 visualize\_classifier(classifier, X\_train, y\_train)  
  
  
 y\_test\_pred = classifier.predict(X\_test)  
 visualize\_classifier(classifier, X\_test, y\_test)  
  
 class\_names = ['Class-0', 'Class-1', 'Class-2']  
 print('\n' + '#'\*40)  
 print('\nClassifier performance on training dataset\n')  
 print(classification\_report(y\_train, classifier.predict(X\_train), target\_names = class\_names))  
 print('#'\*40 + '\n')  
  
 print('#'\*40)  
 print('\nClassifier performance on test dataset\n')  
 print(classification\_report(y\_test, y\_test\_pred, target\_names=class\_names))  
 print('#'\*40 + '\n')  
  
  
 test\_datapoints = np.array([[5, 5], [3, 6], [6, 4], [7, 2], [4, 4], [5, 2]])  
  
 print("\nConfidence measure:")  
 for datapoint in test\_datapoints:  
 probabilities = classifier.predict\_proba([datapoint])[0]  
 predicted\_class = 'Class-' + str(np.argmax(probabilities))  
 print('\nDatapoint:', datapoint)  
 print('Predicted class:', predicted\_class)  
  
 # Visualize the datapoints  
 visualize\_classifier(classifier, test\_datapoints, [0]\*len(test\_datapoints))  
  
 plt.show()

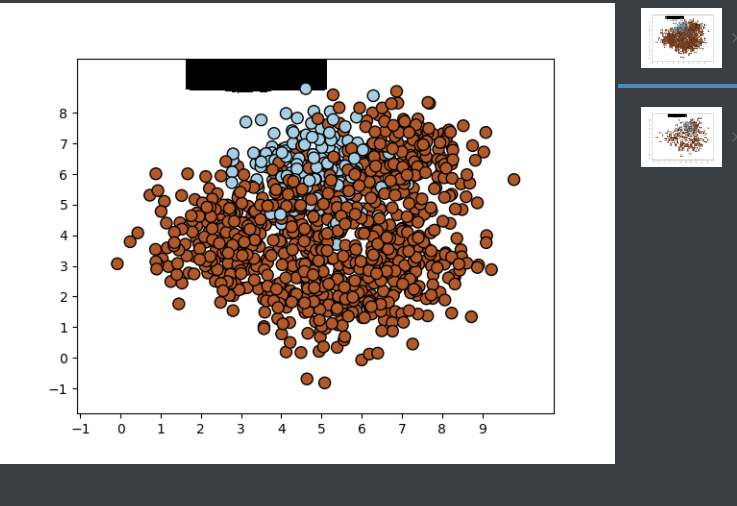
Використання випадкових дерев та граничних випадкових дерев дозволяє ефективно класифікувати дані, з двох методів останній має кращий результат.

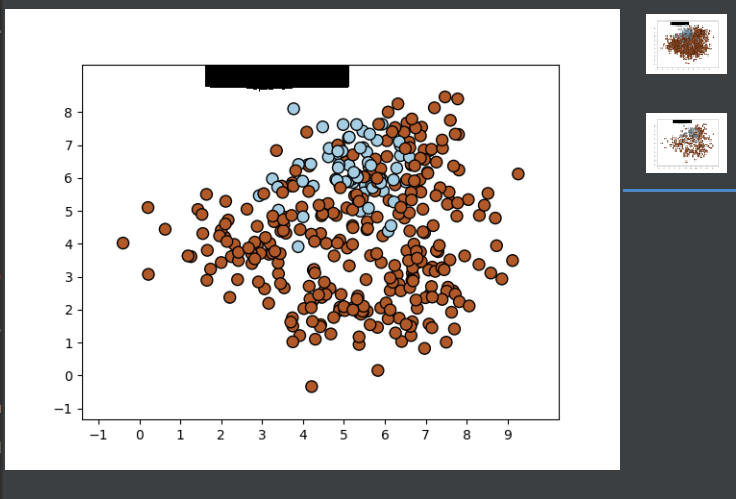
**Task2**

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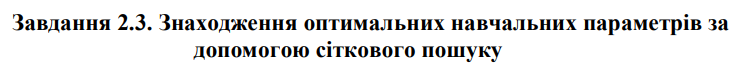
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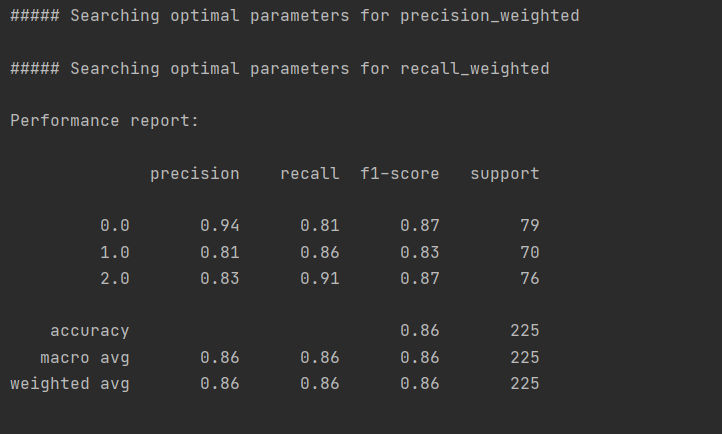
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import sys  
import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.ensemble import RandomForestClassifier, ExtraTreesClassifier  
from sklearn.model\_selection import train\_test\_split  
from sklearn.metrics import classification\_report,confusion\_matrix  
  
from utilities import visualize\_classifier  
  
input\_file = 'data\_imbalance.txt'  
data = np.loadtxt(input\_file, delimiter=',')  
X, y = data[:, :-1], data[:, -1]  
  
class\_0 = np.array(X[y == 0])  
class\_1 = np.array(X[y == 1])  
  
plt.figure()  
plt.scatter(class\_0[:, 0], class\_0[:, 1], s=75, facecolors='black', edgecolors='black', linewidths=1, marker='x')  
plt.scatter(class\_1[:, 0], class\_1[:, 1], s=75, facecolors='white', edgecolors='black', linewidths=1, marker='o')  
plt.title('Входные данные')  
  
X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.25, random\_state=5)  
  
params = {'n\_estimators': 100, 'max\_depth': 4, 'random\_state': 0}  
  
if len(sys.argv) > 1:  
 if sys.argv[1] == 'balance':  
 params = {'n\_estimators': 100, 'max\_depth': 4, 'random\_state': 0, 'class\_weight': 'balanced'}  
 else:  
 raise TypeError("Invalid input argument; should be 'balance'")  
  
classifier = ExtraTreesClassifier(\*\*params)  
classifier.fit(X\_train, y\_train)  
  
visualize\_classifier(classifier, X\_train, y\_train)  
y\_test\_pred = classifier.predict(X\_test)  
visualize\_classifier(classifier, X\_test, y\_test)  
  
class\_names = ['Class-0', 'Class-1']  
print('\n' + '#' \* 40)  
print('\nClassifier performance on training dataset\n')  
print(classification\_report(y\_train, classifier.predict(X\_train), target\_names=class\_names))  
print('#' \* 40 + '\n')  
  
print('#' \* 40)  
print('\nClassifier performance on test dataset\n')  
print(classification\_report(y\_test, y\_test\_pred, target\_names=class\_names))  
print('#' \* 40 + '\n')  
  
plt.show()

Завдяки балансуванню даних було отримано коректні результати та ефективно класифіковано дані

**Task3**

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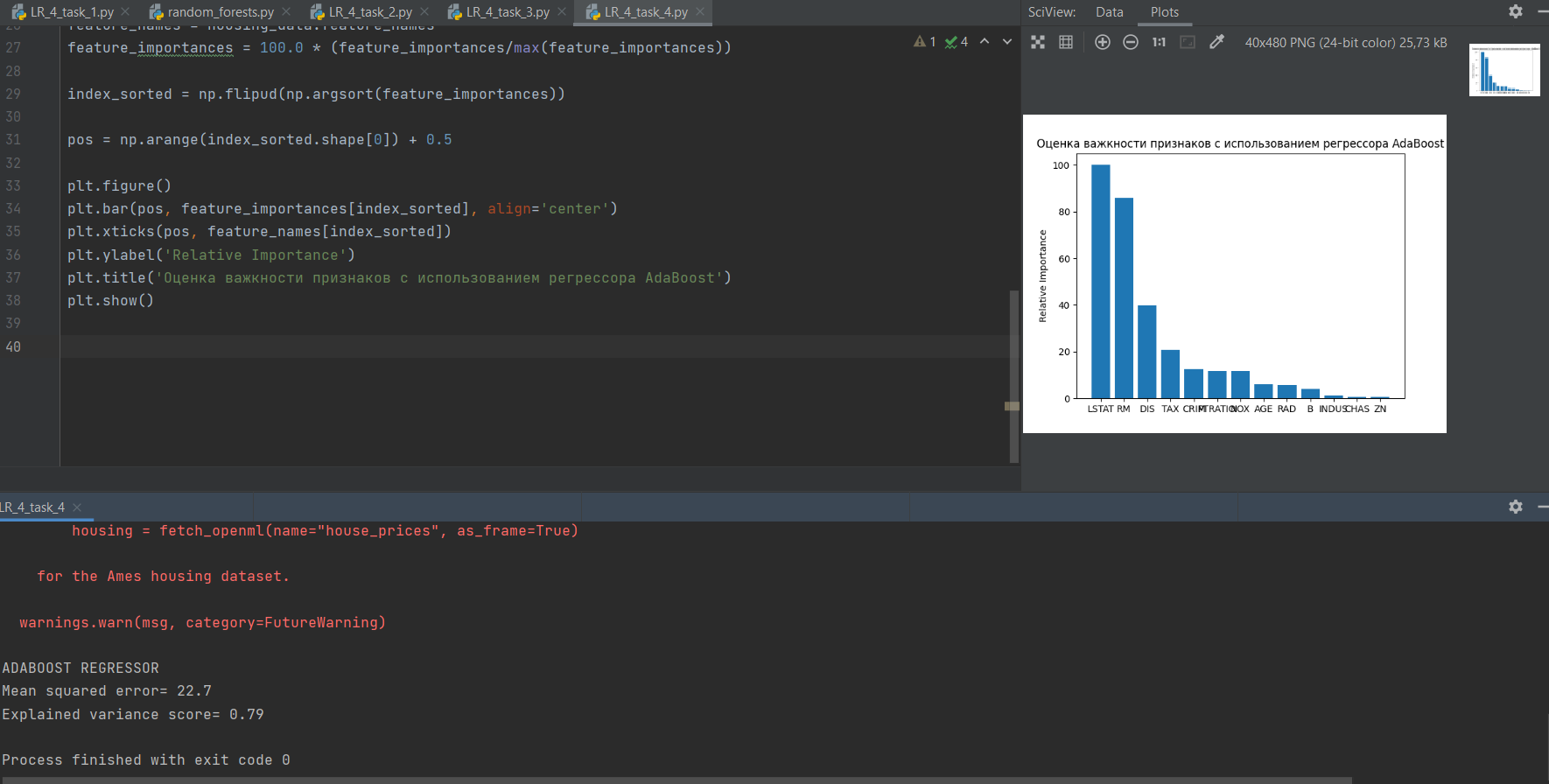
**Не працює**

# print("\nGrid scores for the parameter grid:")  
# for params, avg\_score, in classifier.cv\_results\_:  
# print(params, '-->', round(avg\_score, 3))  
# print("\nBest parameters:", classifier.best\_params\_)

import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.ensemble import RandomForestClassifier, ExtraTreesClassifier  
from sklearn.model\_selection import train\_test\_split  
from sklearn.model\_selection import GridSearchCV  
from sklearn.metrics import classification\_report,confusion\_matrix  
  
from utilities import visualize\_classifier  
  
  
input\_file = 'data\_random\_forests.txt'  
data = np.loadtxt(input\_file, delimiter=',')  
X, y = data[:, :-1], data[:, -1]  
  
class\_0 = np.array(X[y == 0])  
class\_1 = np.array(X[y == 1])  
class\_2 = np.array(X[y == 2])  
X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.25, random\_state=5)  
  
parameter\_grid = [{'n\_estimators': [100], 'max\_depth': [2, 4, 7, 12, 16]}, {'max\_depth': [4], 'n\_estimators': [25, 50, 100, 250]}]  
metrics = ['precision\_weighted', 'recall\_weighted']  
  
for metric in metrics:  
 print("\n##### Searching optimal parameters for", metric)  
  
classifier = GridSearchCV(ExtraTreesClassifier(random\_state=0), parameter\_grid, cv=5, scoring=metric)  
classifier.fit(X\_train, y\_train)  
  
# print("\nGrid scores for the parameter grid:")  
# for params, avg\_score, in classifier.cv\_results\_:  
# print(params, '-->', round(avg\_score, 3))  
# print("\nBest parameters:", classifier.best\_params\_)  
  
y\_pred = classifier.predict(X\_test)  
print("\nPerformance report:\n")  
print(classification\_report(y\_test, y\_pred))

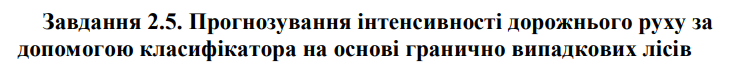
**Task4**

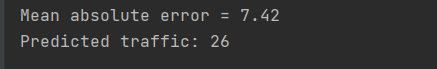
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import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.tree import DecisionTreeRegressor  
from sklearn.ensemble import AdaBoostRegressor  
from sklearn import datasets  
from sklearn.metrics import mean\_squared\_error, explained\_variance\_score  
from sklearn.model\_selection import train\_test\_split  
from sklearn.utils import shuffle  
  
housing\_data = datasets.load\_boston()  
  
X, y = shuffle(housing\_data.data, housing\_data.target, random\_state=7)  
X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=7)  
  
regressor = AdaBoostRegressor(DecisionTreeRegressor(max\_depth=4), n\_estimators=400, random\_state=7)  
regressor.fit(X\_train, y\_train)  
  
y\_pred = regressor.predict(X\_test)  
mse = mean\_squared\_error(y\_test, y\_pred)  
evs = explained\_variance\_score(y\_test, y\_pred)  
print("\nADABOOST REGRESSOR")  
print("Mean squared error=", round(mse, 2))  
print("Explained variance score=", round(evs, 2))  
  
feature\_importances = regressor.feature\_importances\_  
feature\_names = housing\_data.feature\_names  
feature\_importances = 100.0 \* (feature\_importances/max(feature\_importances))  
  
index\_sorted = np.flipud(np.argsort(feature\_importances))  
  
pos = np.arange(index\_sorted.shape[0]) + 0.5  
  
plt.figure()  
plt.bar(pos, feature\_importances[index\_sorted], align='center')  
plt.xticks(pos, feature\_names[index\_sorted])  
plt.ylabel('Relative Importance')  
plt.title('Оценка важкности признаков с использованием регрессора AdaBoost')  
plt.show()

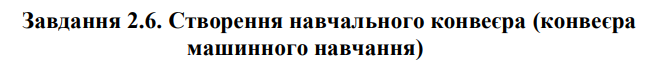
**Task5**

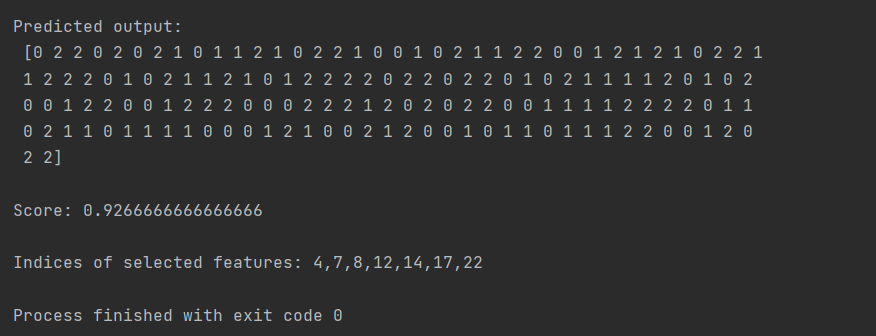
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import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.metrics import classification\_report, mean\_absolute\_error  
from sklearn.model\_selection import train\_test\_split, cross\_val\_score  
from sklearn.ensemble import ExtraTreesRegressor  
from sklearn import preprocessing  
  
input\_file = 'traffic\_data.txt'  
data = []  
with open(input\_file, 'r') as f:  
 for line in f.readlines():  
 items = line[:-1].split(',')  
 data.append(items)  
  
data = np.array(data)  
  
label\_encoder = []  
X\_encoded = np.empty(data.shape)  
for i, item in enumerate(data[0]):  
 if item.isdigit():  
 X\_encoded[:, i] = data[:, i]  
 else:  
 label\_encoder.append(preprocessing.LabelEncoder())  
 X\_encoded[:, i] = label\_encoder[-1].fit\_transform(data[:, i])  
  
X = X\_encoded[:, :-1].astype(int)  
Y = X\_encoded[:, -1].astype(int)  
  
X\_train, X\_test, Y\_train, Y\_test = train\_test\_split(X, Y, test\_size=0.25, random\_state=5)  
params = {'n\_estimators': 100, 'max\_depth': 4, 'random\_state': 0}  
regressor = ExtraTreesRegressor(\*\*params)  
regressor.fit(X\_train, Y\_train)  
  
Y\_pred = regressor.predict(X\_test)  
print("Mean absolute error =", round(mean\_absolute\_error(Y\_test, Y\_pred), 2))  
  
test\_datapoint = ['Saturday', '10:20', 'Atlanta', 'no']  
test\_datapoint\_encoded = [-1] \* len(test\_datapoint)  
count = 0  
  
for i, item in enumerate(test\_datapoint):  
 if item.isdigit():  
 test\_datapoint\_encoded[i] = int(test\_datapoint[i])  
 else:  
 test\_datapoint\_encoded[i] = int(label\_encoder[count].transform([test\_datapoint[i]]))  
 count = count + 1  
  
test\_datapoint\_encoded = np.array(test\_datapoint\_encoded)  
  
print("Predicted traffic:", int(regressor.predict([test\_datapoint\_encoded])[0]))

**Task6**

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from sklearn.datasets import \_samples\_generator  
from sklearn.feature\_selection import SelectKBest, f\_regression  
from sklearn.pipeline import Pipeline  
from sklearn.ensemble import ExtraTreesClassifier  
  
X, y = \_samples\_generator.make\_classification(n\_samples=150, n\_features=25, n\_classes=3, n\_informative=6, n\_redundant=0, random\_state=7)  
  
k\_best\_selector = SelectKBest(f\_regression, k=9)  
classifier = ExtraTreesClassifier(n\_estimators=60, max\_depth=4)  
  
processor\_pipeline = Pipeline([('selector', k\_best\_selector), ('erf', classifier)])  
processor\_pipeline.set\_params(selector\_\_k=7, erf\_\_n\_estimators=30)  
processor\_pipeline.fit(X, y)  
  
output = processor\_pipeline.predict(X)  
print("\nPredicted output:\n", output)  
  
print("\nScore:", processor\_pipeline.score(X, y))  
status = processor\_pipeline.named\_steps['selector'].get\_support()  
selected = [i for i, x in enumerate(status) if x]  
print("\nIndices of selected features:", ','.join([str(x) for x in selected]))

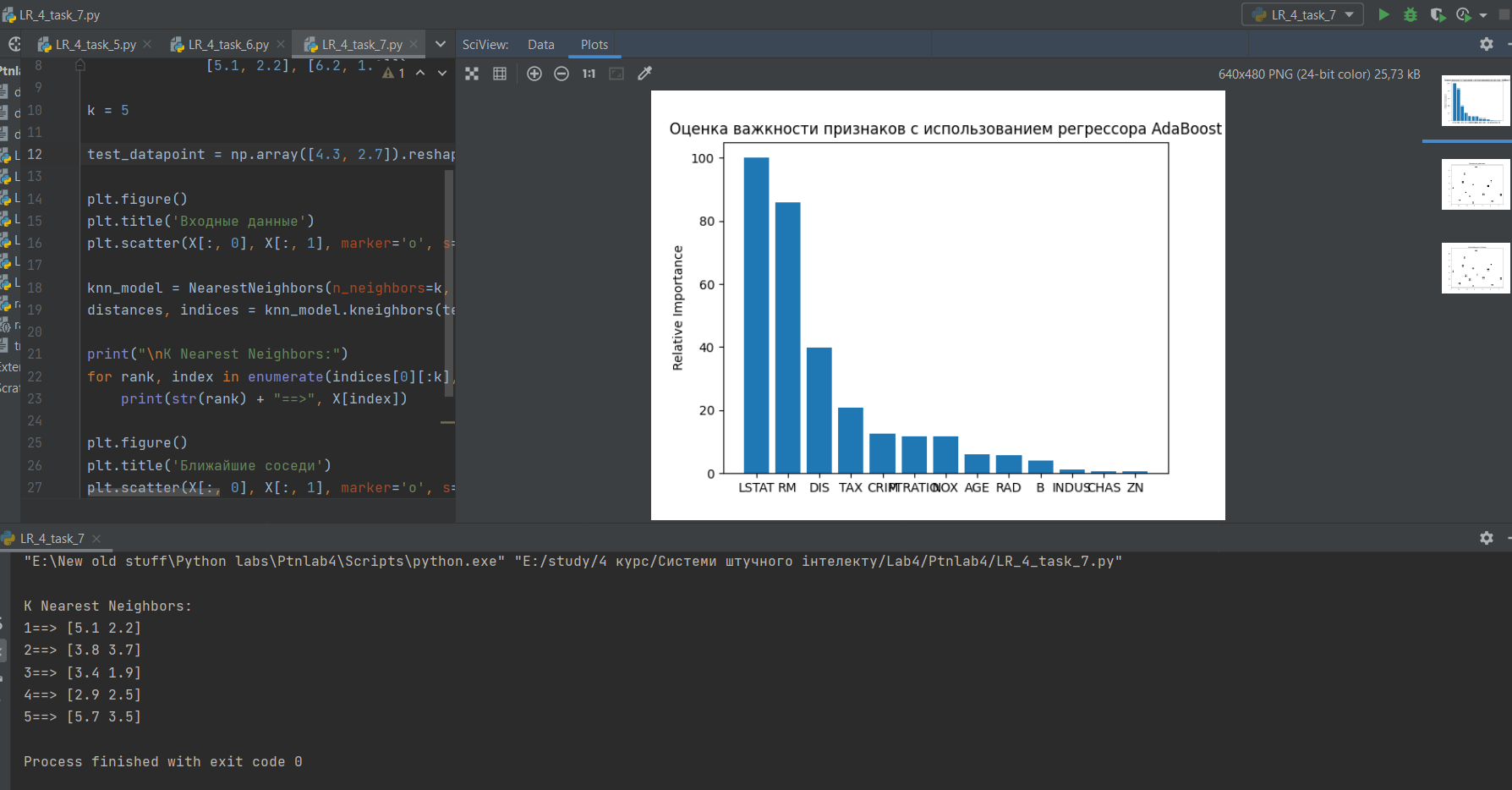
**Predicted output – спрогнозовані результати для всіх вхідних даних**

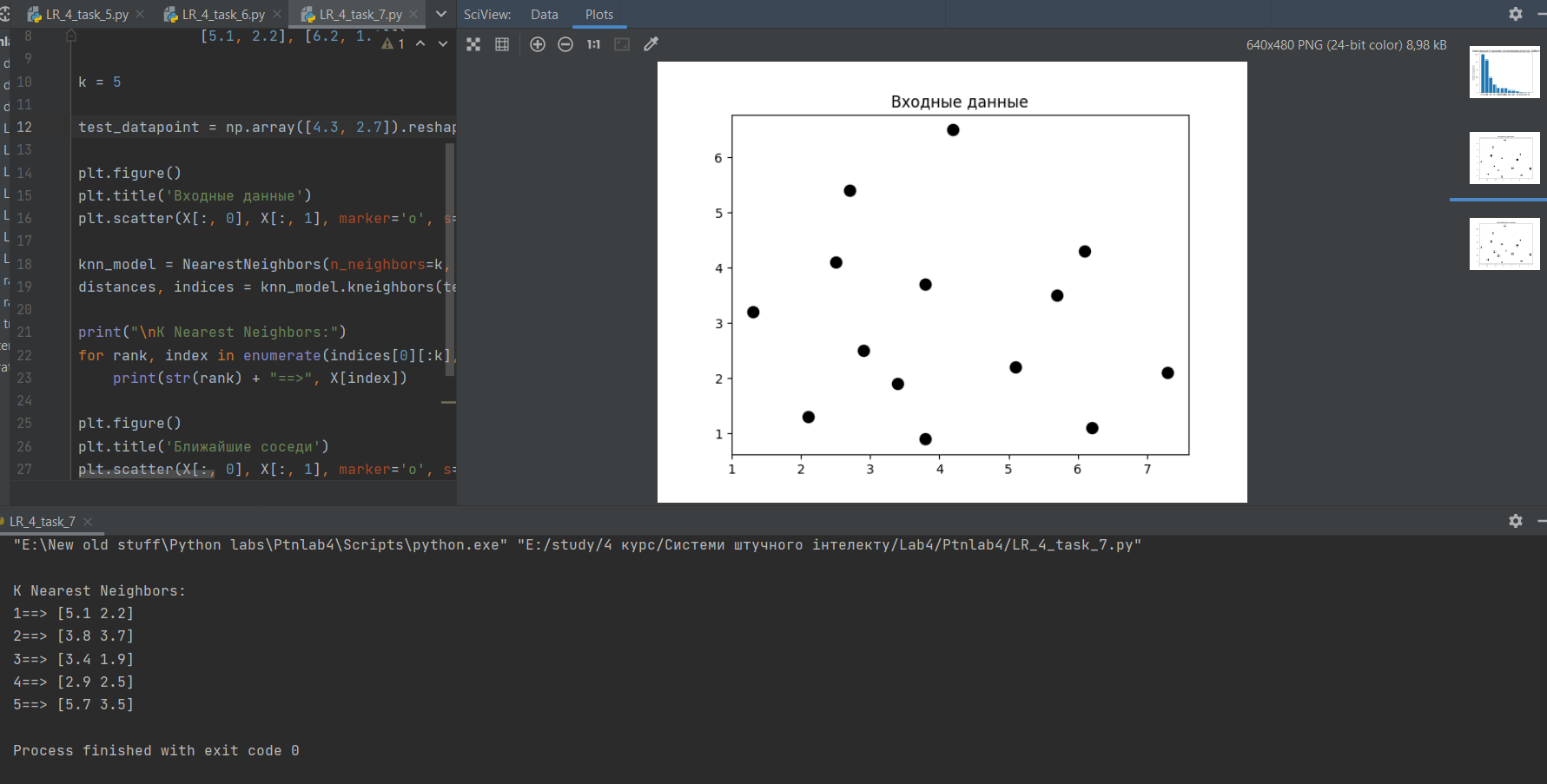
**Score – обчислення оцінки з використанням маркованих тренувальних даних**

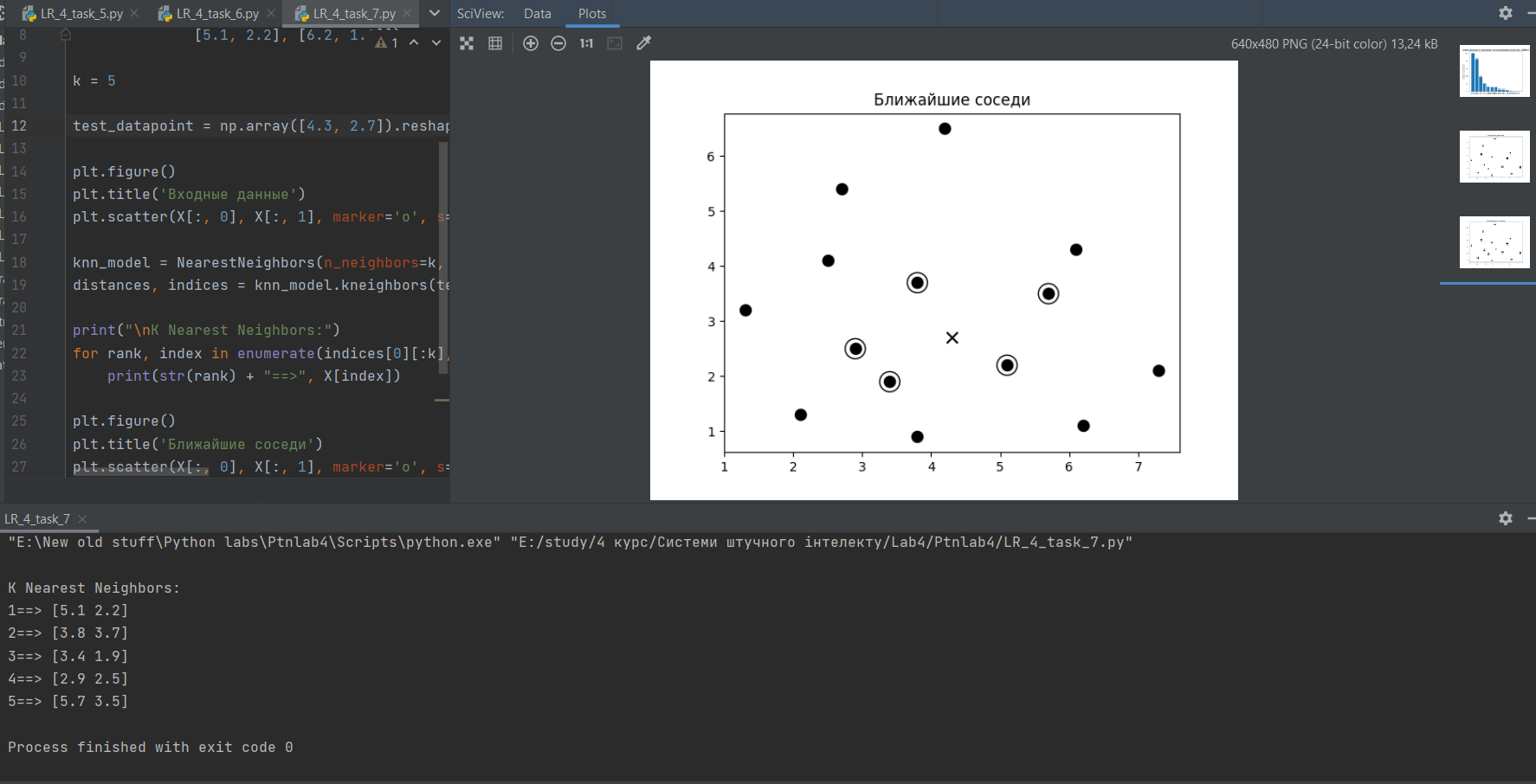
**Indices of selected features – індекси обраних ознак**

**Task7**

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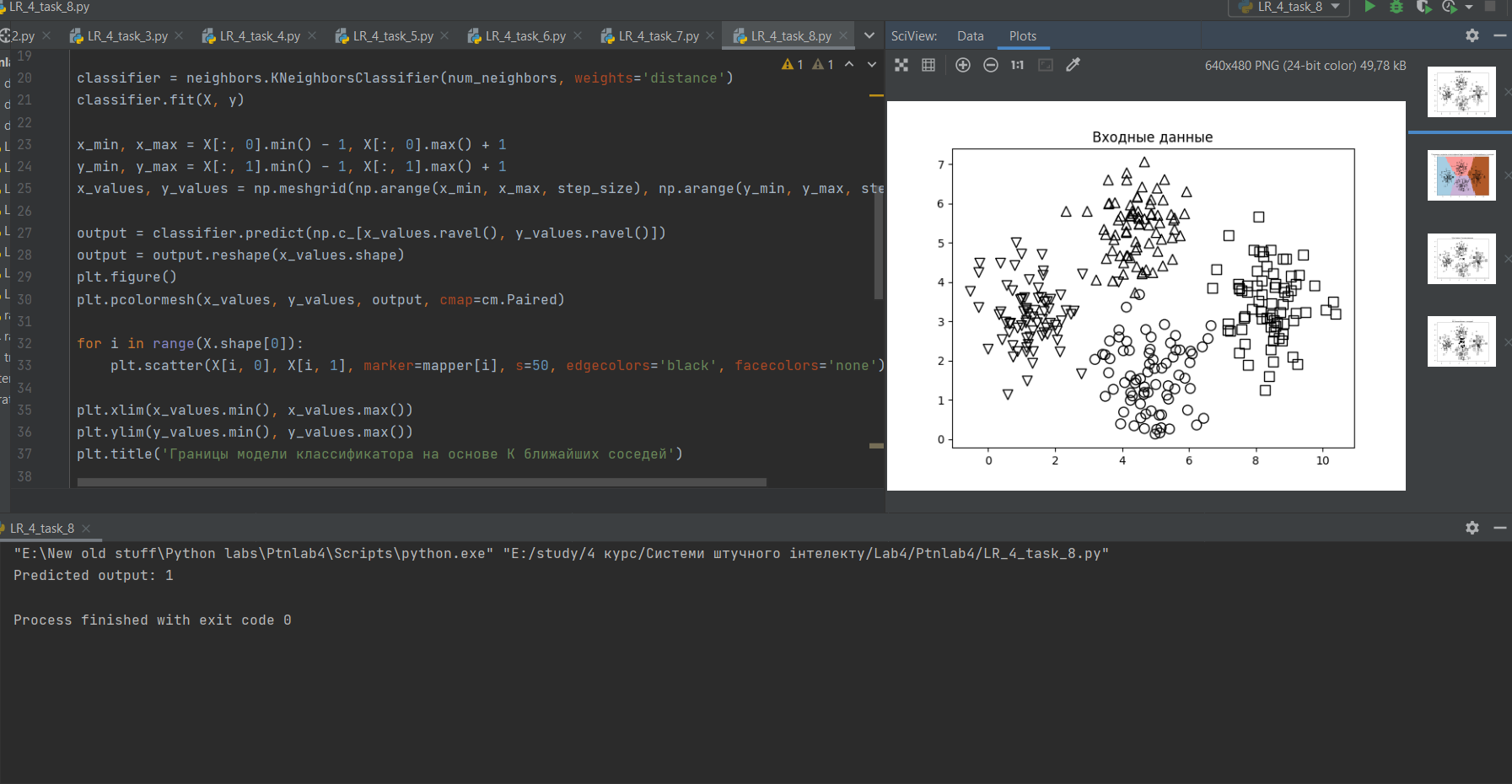
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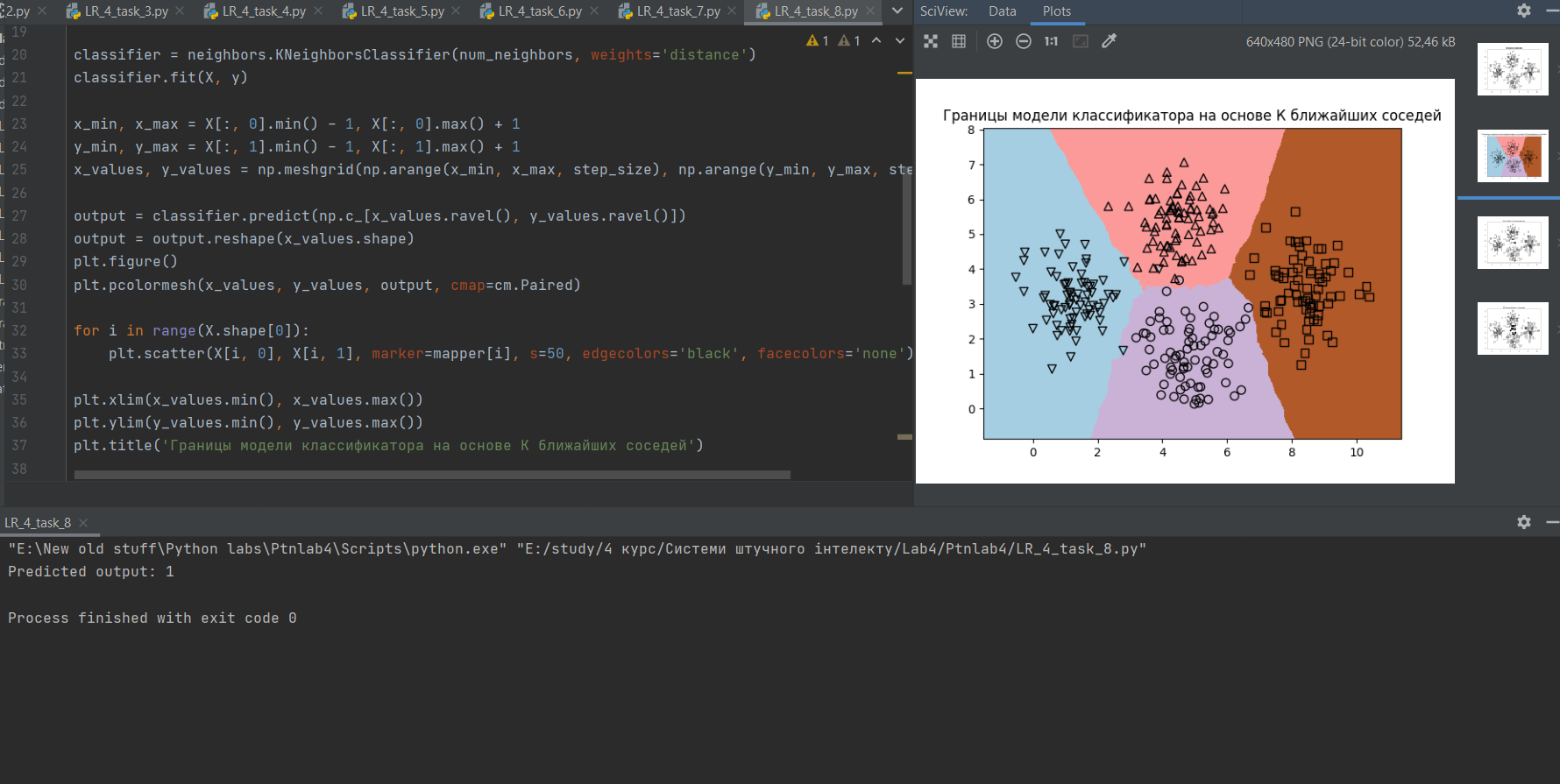
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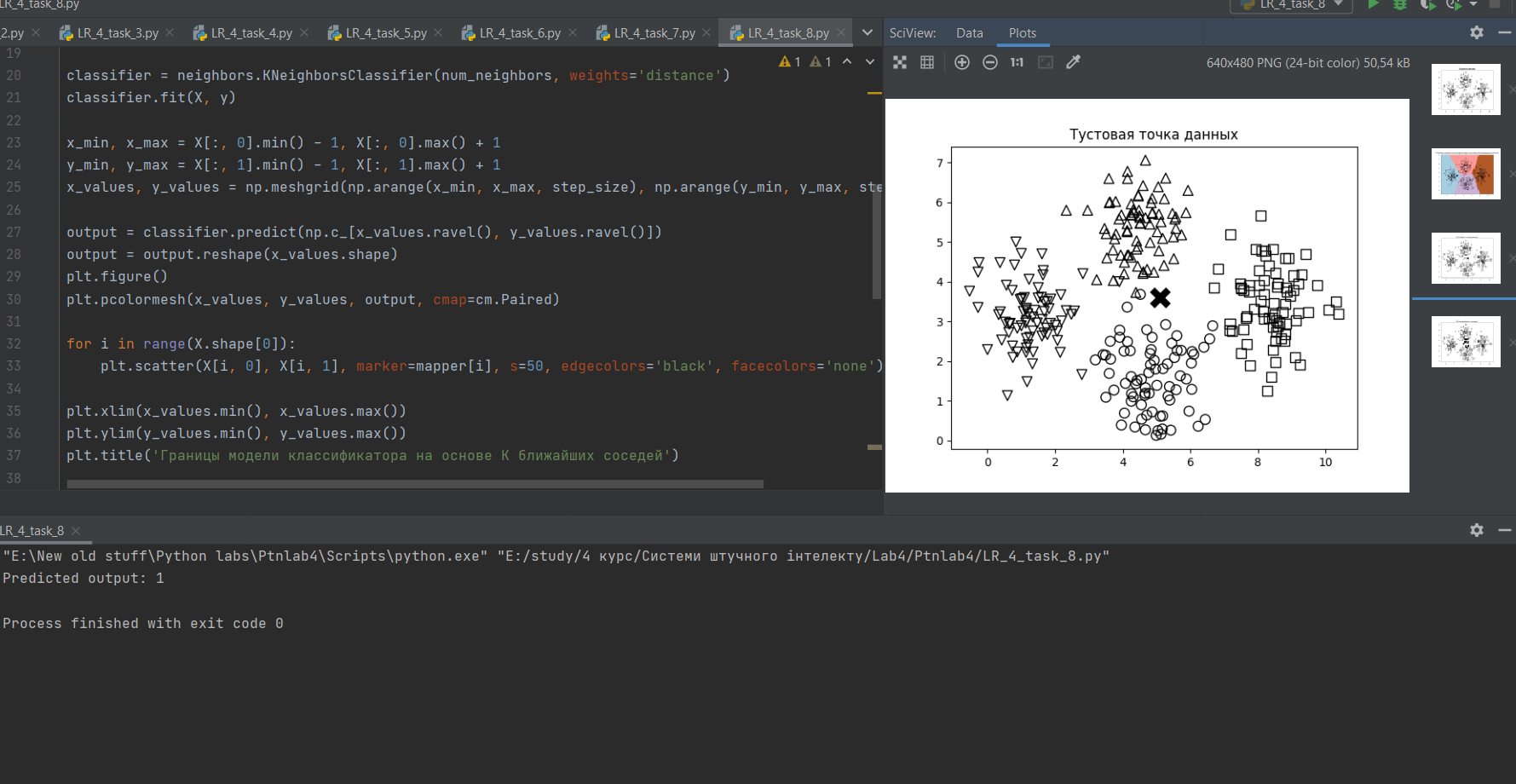
import numpy as np  
import matplotlib.pyplot as plt  
from sklearn.neighbors import NearestNeighbors  
  
X = np.array([[2.1, 1.3], [1.3, 3.2], [2.9, 2.5], [2.7, 5.4],  
 [3.8, 0.9], [7.3, 2.1], [4.2, 6.5], [3.8, 3.7],  
 [2.5, 4.1], [3.4, 1.9], [5.7, 3.5], [6.1, 4.3],  
 [5.1, 2.2], [6.2, 1.1]])  
  
k = 5  
  
test\_datapoint = np.array([4.3, 2.7]).reshape(1, -1)  
  
plt.figure()  
plt.title('Входные данные')  
plt.scatter(X[:, 0], X[:, 1], marker='o', s=75, color='black')  
  
knn\_model = NearestNeighbors(n\_neighbors=k, algorithm='ball\_tree').fit(X)  
distances, indices = knn\_model.kneighbors(test\_datapoint)  
  
print("\nK Nearest Neighbors:")  
for rank, index in enumerate(indices[0][:k], start=1):  
 print(str(rank) + "==>", X[index])  
  
plt.figure()  
plt.title('Ближайшие соседи')  
plt.scatter(X[:, 0], X[:, 1], marker='o', s=75, color='k')  
plt.scatter(X[indices][0][:][:, 0], X[indices][0][:][:, 1], marker='o', s=250, color='k', facecolors='none')  
plt.scatter(test\_datapoint[0][0], test\_datapoint[0][1], marker='x', s=75, color='k')  
plt.show()

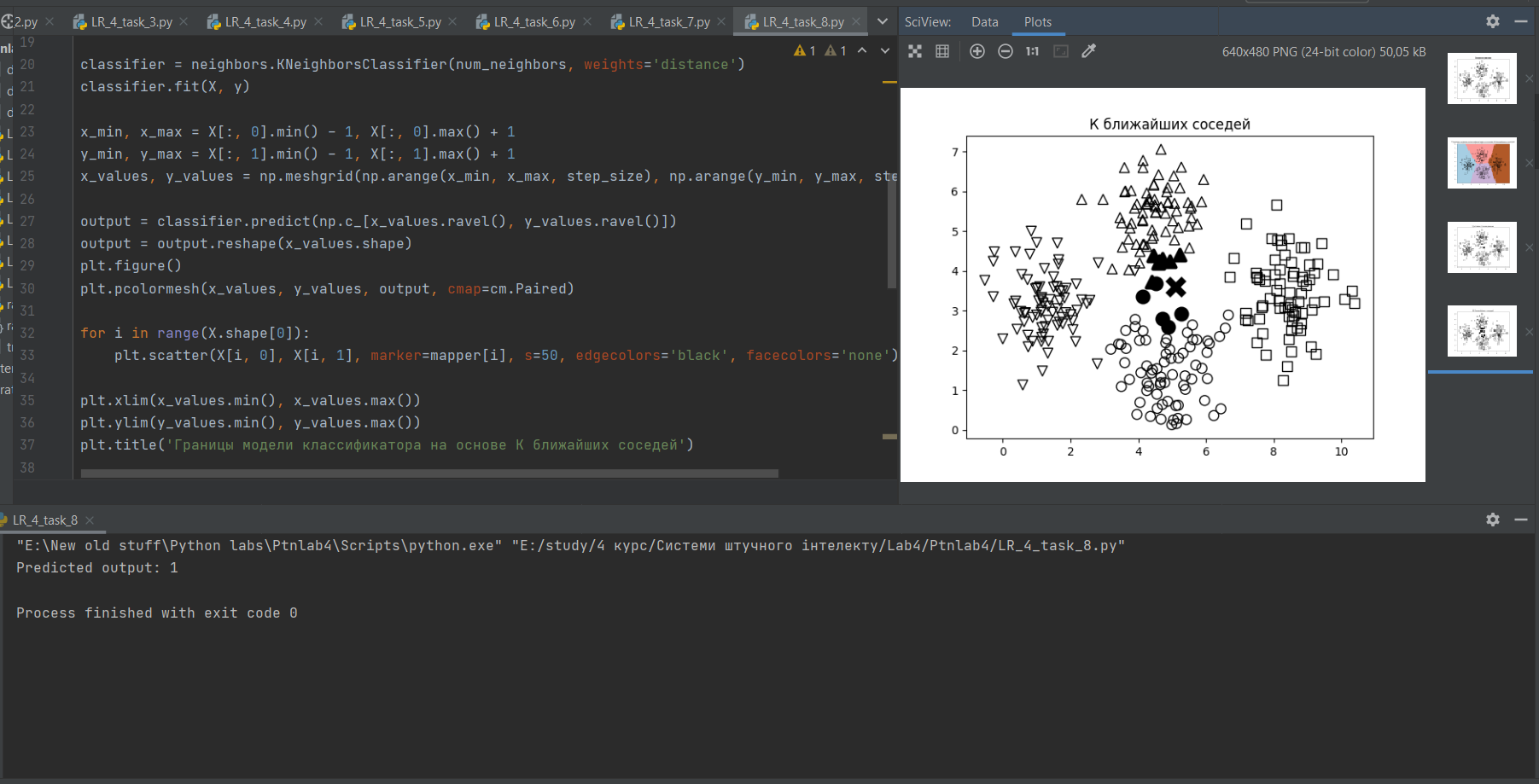
**Task8**

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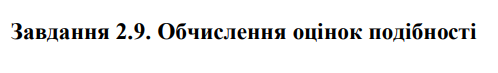
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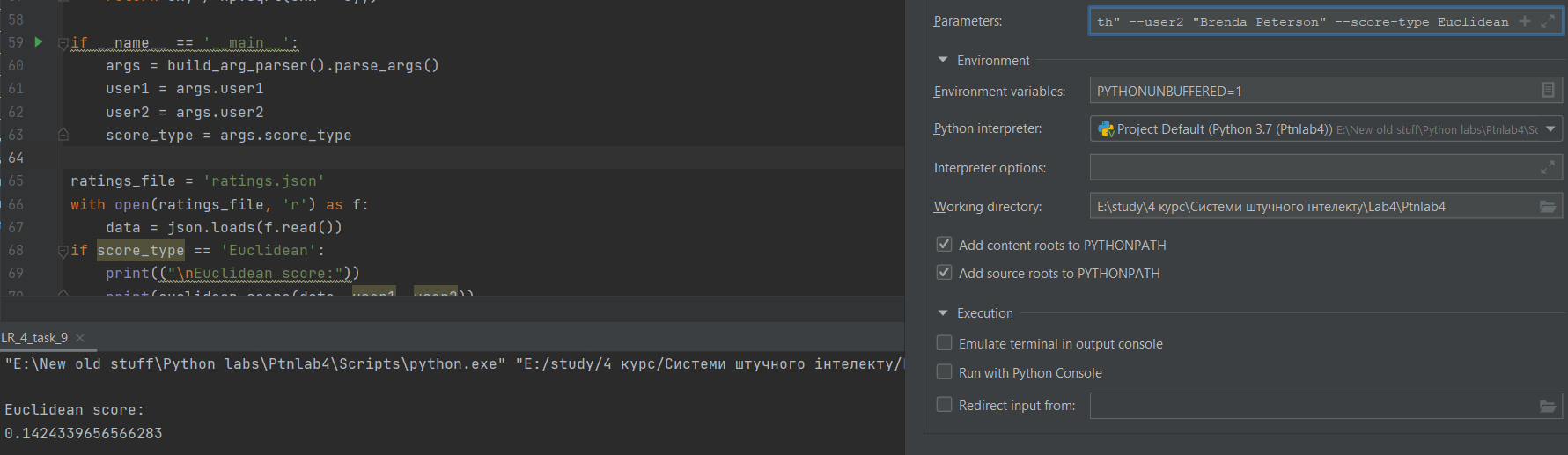
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import numpy as np  
import matplotlib.pyplot as plt  
import matplotlib.cm as cm  
from sklearn import neighbors, datasets  
  
input\_file = 'data.txt'  
data = np.loadtxt(input\_file, delimiter=',')  
X, y = data[:, :-1], data[:, -1].astype(int)  
  
plt.figure()  
plt.title('Входные данные')  
marker\_shapes = 'v^os'  
mapper = [marker\_shapes[i] for i in y]  
for i in range(X.shape[0]):  
 plt.scatter(X[i, 0], X[i, 1], marker=mapper[i], s=75, edgecolors='black', facecolor='none')  
  
num\_neighbors = 12  
step\_size = 0.01  
  
classifier = neighbors.KNeighborsClassifier(num\_neighbors, weights='distance')  
classifier.fit(X, y)  
  
x\_min, x\_max = X[:, 0].min() - 1, X[:, 0].max() + 1  
y\_min, y\_max = X[:, 1].min() - 1, X[:, 1].max() + 1  
x\_values, y\_values = np.meshgrid(np.arange(x\_min, x\_max, step\_size), np.arange(y\_min, y\_max, step\_size))  
  
output = classifier.predict(np.c\_[x\_values.ravel(), y\_values.ravel()])  
output = output.reshape(x\_values.shape)  
plt.figure()  
plt.pcolormesh(x\_values, y\_values, output, cmap=cm.Paired)  
  
for i in range(X.shape[0]):  
 plt.scatter(X[i, 0], X[i, 1], marker=mapper[i], s=50, edgecolors='black', facecolors='none')  
  
plt.xlim(x\_values.min(), x\_values.max())  
plt.ylim(y\_values.min(), y\_values.max())  
plt.title('Границы модели классификатора на основе К ближайших соседей')  
  
test\_datapoint = [5.1, 3.6]  
plt.figure()  
plt.title('Тустовая точка данных')  
for i in range(X.shape[0]):  
 plt.scatter(X[i, 0], X[i, 1], marker=mapper[i], s=75, edgecolors='black', facecolors='none')  
  
plt.scatter(test\_datapoint[0], test\_datapoint[1], marker='x', linewidths=6, s=200, facecolors='black')  
  
\_, indices = classifier.kneighbors([test\_datapoint])  
indices = indices.astype(int)[0]  
  
plt.figure()  
plt.title('К ближайших соседей')  
for i in indices:  
 plt.scatter(X[i, 0], X[i, 1], marker=mapper[y[i]], linewidths=3, s=100, facecolors='black')  
  
plt.scatter(test\_datapoint[0], test\_datapoint[1], marker='x', linewidths=6, s=200, facecolors='black')  
  
for i in range(X.shape[0]):  
 plt.scatter(X[i, 0], X[i, 1], marker=mapper[i], s=75, edgecolors='black', facecolors='none')  
  
print("Predicted output:", classifier.predict([test\_datapoint])[0])  
plt.show()

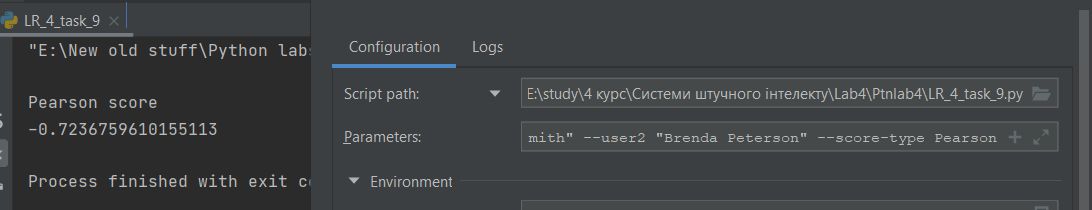
**Task9**

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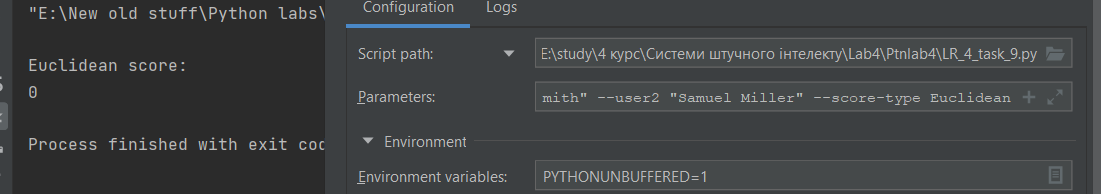
David Smith та Brenda Peterson Euclidean

****

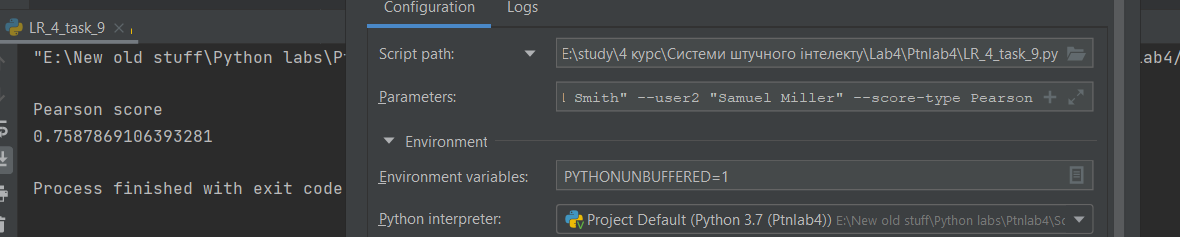
David Smith та Brenda Peterson Pearson



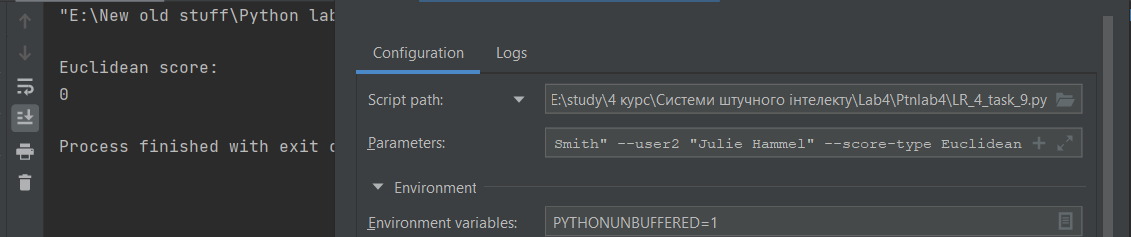
David Smith та Samuel Miller Euclidean

****

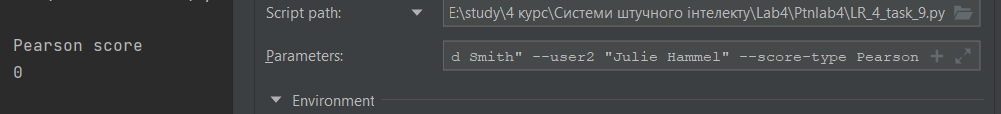
David Smith та Samuel Miller Pearson

****

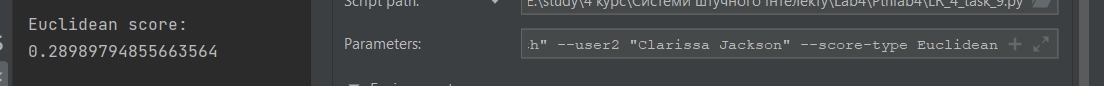
David Smith та Julie Hammel Euclidean

****

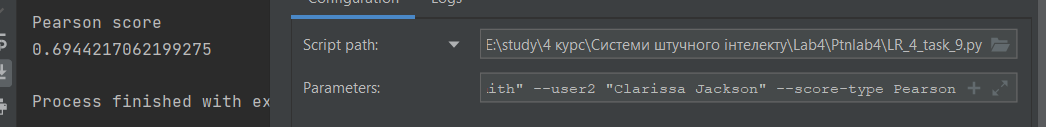
David Smith та Julie Hammel Pearson



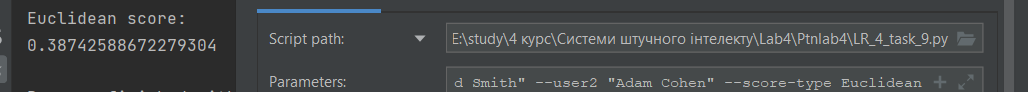
David Smith та Clarissa Jackson Euclidean



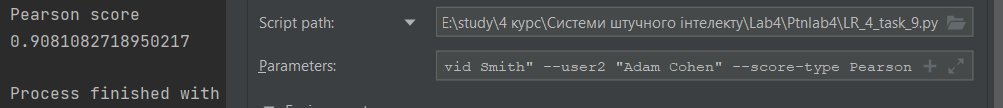
David Smith та Clarissa Jackson Pearson

****

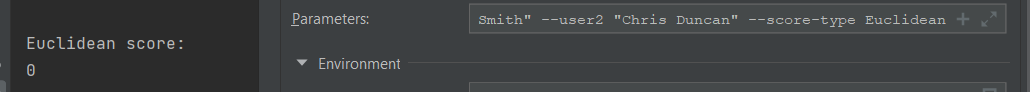
David Smith та Adam Cohen Euclidean



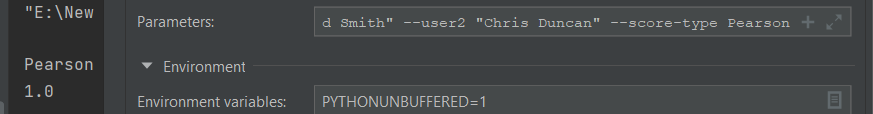
David Smith та Adam Cohen Pearson



David Smith та Chris Duncan Euclidean

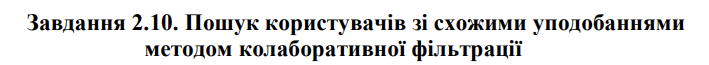


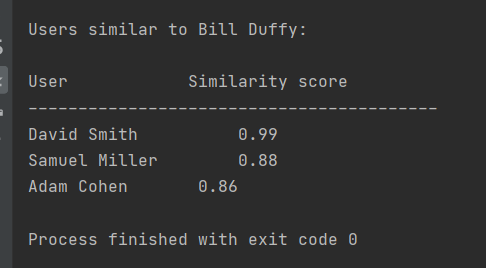
David Smith та Chris Duncan Pearson

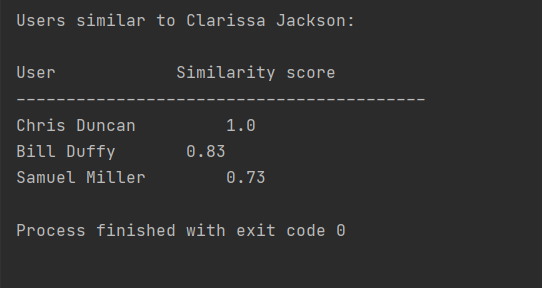
****

import argparse  
import json  
import numpy as np  
  
def build\_arg\_parser():  
 parser = argparse.ArgumentParser(description='Compute similarity score')  
 parser.add\_argument('--user1', dest='user1', required=True, help='First user')  
 parser.add\_argument('--user2', dest='user2', required=True, help='Second user')  
 parser.add\_argument('--score-type', dest='score\_type', required=True, choices=['Euclidean', 'Pearson'], help='Similarity metric to be used')  
 return parser  
  
  
def euclidean\_score(dataset, user1, user2):  
 if user1 not in dataset:  
 raise TypeError('Cannot find' + user1 + 'in the dataset')  
 if user2 not in dataset:  
 raise TypeError('Cannot find' + user2 + 'in the dataset')  
 common\_movies = {}  
 for item in dataset[user1]:  
 if item in dataset[user2]:  
 common\_movies[item] = 1  
 if len(common\_movies) == 0:  
 return 0  
 squared\_diff = []  
 for item in dataset[user1]:  
 if item in dataset[user2]:  
 squared\_diff.append(np.square(dataset[user1][item] - dataset[user2][item]))  
 return 1/(1 + np.sqrt(np.sum(squared\_diff)))  
  
  
def pearson\_score(dataset, user1, user2):  
 if user1 not in dataset:  
 raise TypeError('Cannot find' + user1 + 'in the dataset')  
 if user2 not in dataset:  
 raise TypeError('Cannot find' + user2 + 'in the dataset')  
 common\_movies = {}  
 for item in dataset[user1]:  
 if item in dataset[user2]:  
 common\_movies[item] = 1  
 num\_ratings = len(common\_movies)  
 if num\_ratings == 0:  
 return 0  
 user1\_sum = np.sum([dataset[user1][item] for item in common\_movies])  
 user2\_sum = np.sum([dataset[user2][item] for item in common\_movies])  
  
 user1\_squared\_sum = np.sum([np.square(dataset[user1][item]) for item in common\_movies])  
 user2\_squared\_sum = np.sum([np.square(dataset[user2][item]) for item in common\_movies])  
 sum\_of\_products = np.sum([dataset[user1][item] \* dataset[user2][item] for item in common\_movies])  
  
 Sxy = sum\_of\_products - (user1\_sum \* user2\_sum / num\_ratings)  
 Sxx = user1\_squared\_sum - np.square(user1\_sum) / num\_ratings  
 Syy = user2\_squared\_sum - np.square(user2\_sum) / num\_ratings  
  
 if Sxx \* Syy == 0:  
 return 0  
  
 return Sxy / np.sqrt(Sxx \* Syy)  
  
if \_\_name\_\_ == '\_\_main\_\_':  
 args = build\_arg\_parser().parse\_args()  
 user1 = args.user1  
 user2 = args.user2  
 score\_type = args.score\_type  
  
ratings\_file = 'ratings.json'  
with open(ratings\_file, 'r') as f:  
 data = json.loads(f.read())  
if score\_type == 'Euclidean':  
 print(("\nEuclidean score:"))  
 print(euclidean\_score(data, user1, user2))  
else:  
 print("\nPearson score")  
 print(pearson\_score(data, user1, user2))

**Task10**

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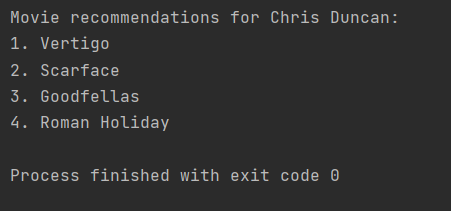
****

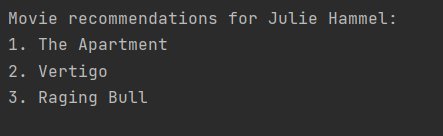
****

import argparse  
import json  
import numpy as np  
from compute\_scores import pearson\_score  
  
  
def build\_arg\_parser():  
 parser = argparse.ArgumentParser(description='Find users who are similar to the input user ')  
 parser.add\_argument('--user', dest='user', required=True, help='Input user')  
 return parser  
  
  
def find\_similar\_users(dataset, user, num\_users):  
 if user not in dataset:  
 raise TypeError('Cannot find' + user + ' in the dataset')  
 scores = np.array([[x, pearson\_score(dataset, user, x)] for x in dataset if x != user])  
 scores\_sorted = np.argsort(scores[:, 1])[::-1]  
 top\_users = scores\_sorted[:num\_users]  
 return scores[top\_users]  
  
  
if \_\_name\_\_ == '\_\_main\_\_':  
 args = build\_arg\_parser().parse\_args()  
 user = args.user  
 ratings\_file = 'ratings.json'  
  
with open(ratings\_file, 'r') as f:  
 data = json.loads(f.read())  
  
print('\nUsers similar to ' + user + ':\n')  
similar\_users = find\_similar\_users(data, user, 3)  
print('User\t\t\tSimilarity score')  
print('-'\*41)  
for item in similar\_users:  
 print(item[0], '\t\t', round(float(item[1]), 2))

**Task11**

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import argparse  
import json  
import numpy as np  
  
from compute\_scores import pearson\_score  
from collaborative\_filtering import find\_similar\_users  
  
  
def build\_arg\_parser():  
 parser = argparse.ArgumentParser(description='Find the movie recommendations for the given user')  
 parser.add\_argument('--user', dest='user', required=True,  
 help='Input user')  
 return parser  
  
  
def get\_recommendations(dataset, input\_user):  
 if input\_user not in dataset:  
 raise TypeError('Cannot find ' + input\_user + ' in the dataset')  
  
 overall\_scores = {}  
 similarity\_scores = {}  
  
 for user in [x for x in dataset if x != input\_user]:  
 similarity\_score = pearson\_score(dataset, input\_user, user)  
  
 if similarity\_score <= 0:  
 continue  
  
 filtered\_list = [x for x in dataset[user] if x not in \  
 dataset[input\_user] or dataset[input\_user][x] == 0]  
  
 for item in filtered\_list:  
 overall\_scores.update({item: dataset[user][item] \* similarity\_score})  
 similarity\_scores.update({item: similarity\_score})  
  
 if len(overall\_scores) == 0:  
 return ['No recommendations possible']  
  
 movie\_scores = np.array([[score / similarity\_scores[item], item]  
 for item, score in overall\_scores.items()])  
  
 movie\_scores = movie\_scores[np.argsort(movie\_scores[:, 0])[::-1]]  
  
 movie\_recommendations = [movie for \_, movie in movie\_scores]  
  
 return movie\_recommendations  
  
  
if \_\_name\_\_ == '\_\_main\_\_':  
 args = build\_arg\_parser().parse\_args()  
 user = args.user  
  
 ratings\_file = 'ratings.json'  
  
 with open(ratings\_file, 'r') as f:  
 data = json.loads(f.read())  
  
 print("\nMovie recommendations for " + user + ":")  
 movies = get\_recommendations(data, user)  
 for i, movie in enumerate(movies):  
 print(str(i + 1) + '. ' + movie)

**https://gitlab.com/2019-2023/ipz19-3/lysovyi-maksym/AI**

**Висновок:** використовуючи спеціалізовані бібліотеки та мову програмування Python дослідив методи ансамблів у машинному навчанні та створив рекомендаційні системи.