Machine Learning Assignment - 04

A1

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix, classification_report
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.decomposition import PCA

def load_data():
    """Load and preprocess face emotion data"""
    df = pd.read_csv('face_data_multi.csv')
    X = df.iloc[:, 1:].values / 255.0
    y = df.iloc[:, 0].values

    pca = PCA(n_components=100)
    X_reduced = pca.fit_transform(X)
    print(f"Explained variance ratio: {np.sum(pca.explained_variance_ratio_):.2f}")

    return train_test_split(X_reduced, y, test_size=0.2, random_state=42)

#  for A1
X_train, X_test, y_train, y_test = load_data()
knn = KNeighborsClassifier(n_neighbors=3)
knn.fit(X_train, y_train)
y_pred = knn.predict(X_test)


cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(10, 8))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues',
            xticklabels=['Neutral', 'Happy', 'Sad', 'Angry'],
            yticklabels=['Neutral', 'Happy', 'Sad', 'Angry'])
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()

print("\nClassification Report:")
print(classification_report(y_test, y_pred,
                           target_names=['Neutral', 'Happy', 'Sad', 'Angry']))
```

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Explained variance ratio: 0.90
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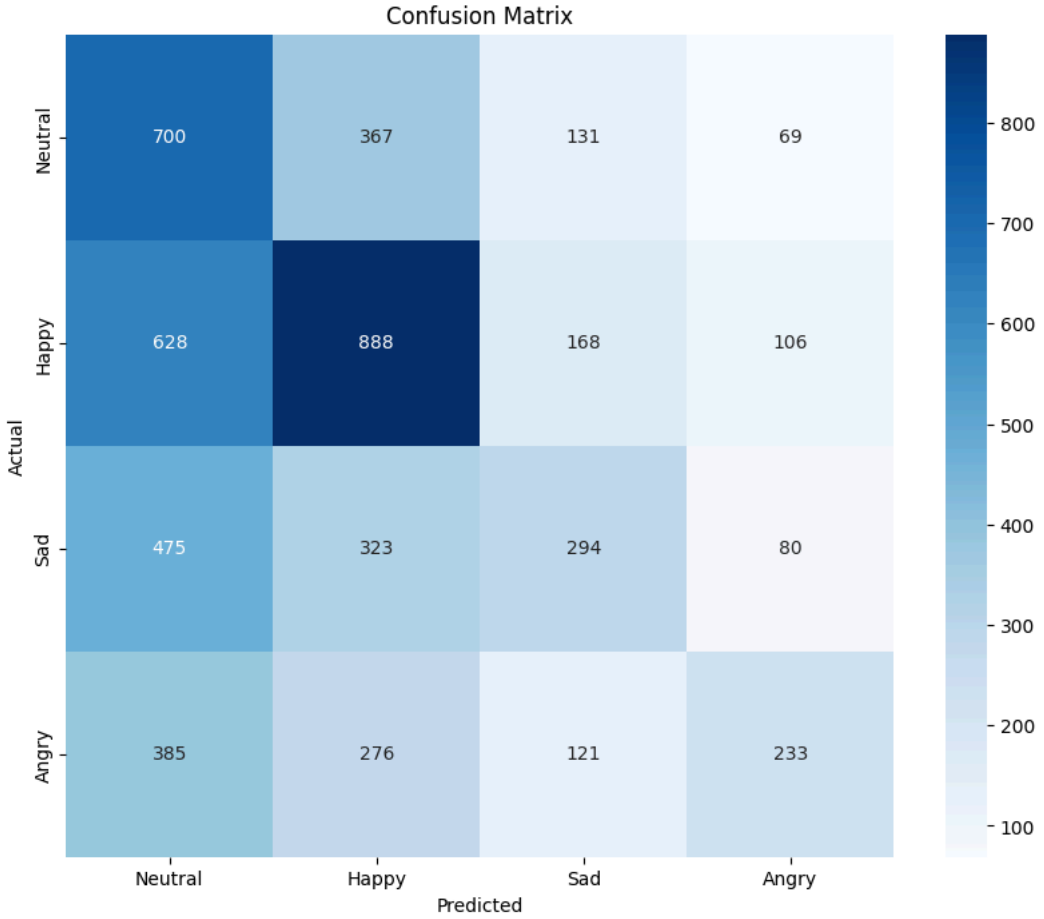



```
Classification Report:
              precision    recall  f1-score   support

     Neutral       0.32      0.55      0.41      1267
       Happy       0.48      0.50      0.49      1790
         Sad       0.41      0.25      0.31      1172
       Angry       0.48      0.23      0.31      1015

    accuracy                           0.40      5244
   macro avg       0.42      0.38      0.38      5244
weighted avg       0.43      0.40      0.39      5244
```

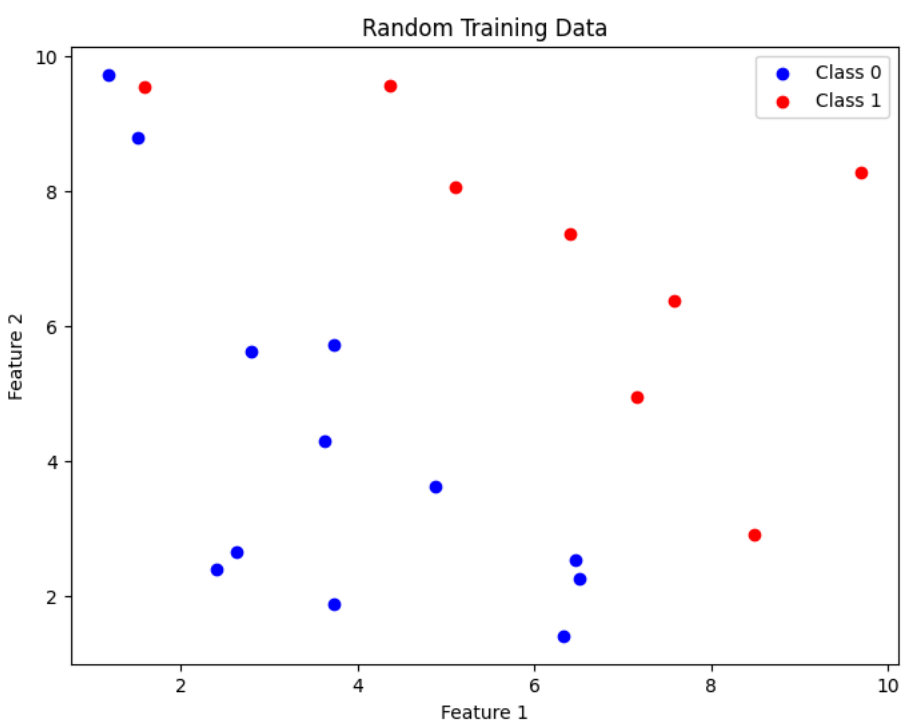
A2

```
# New cell
from sklearn.metrics import mean_squared_error, r2_score
from math import sqrt

# Calculate regression metrics
y_prob = knn.predict_proba(X_test)
mse = mean_squared_error(y_test, np.argmax(y_prob, axis=1))
rmse = sqrt(mse)
r2 = r2_score(y_test, np.argmax(y_prob, axis=1))
mape = np.mean(np.abs((y_test - np.argmax(y_prob, axis=1)) / y_test)) * 100

print("Regression Metrics:")
print(f"MSE: {mse:.4f}")
print(f"RMSE: {rmse:.4f}")
print(f"MAPE: {mape:.4f}%")
print(f"R2 Score: {r2:.4f}")
```

```
Regression Metrics:
MSE: 1.8545
RMSE: 1.3618
MAPE: nan%
R2 Score: -0.6811
C:\Users\saran\AppData\Local\Temp\ipykernel_25456\4076067588.py:10: RuntimeWarning: divide by zero encountered in divide
  mape = np.mean(np.abs((y_test - np.argmax(y_prob, axis=1)) / y_test)) * 100
C:\Users\saran\AppData\Local\Temp\ipykernel_25456\4076067588.py:10: RuntimeWarning: invalid value encountered in divide
  mape = np.mean(np.abs((y_test - np.argmax(y_prob, axis=1)) / y_test)) * 100
```

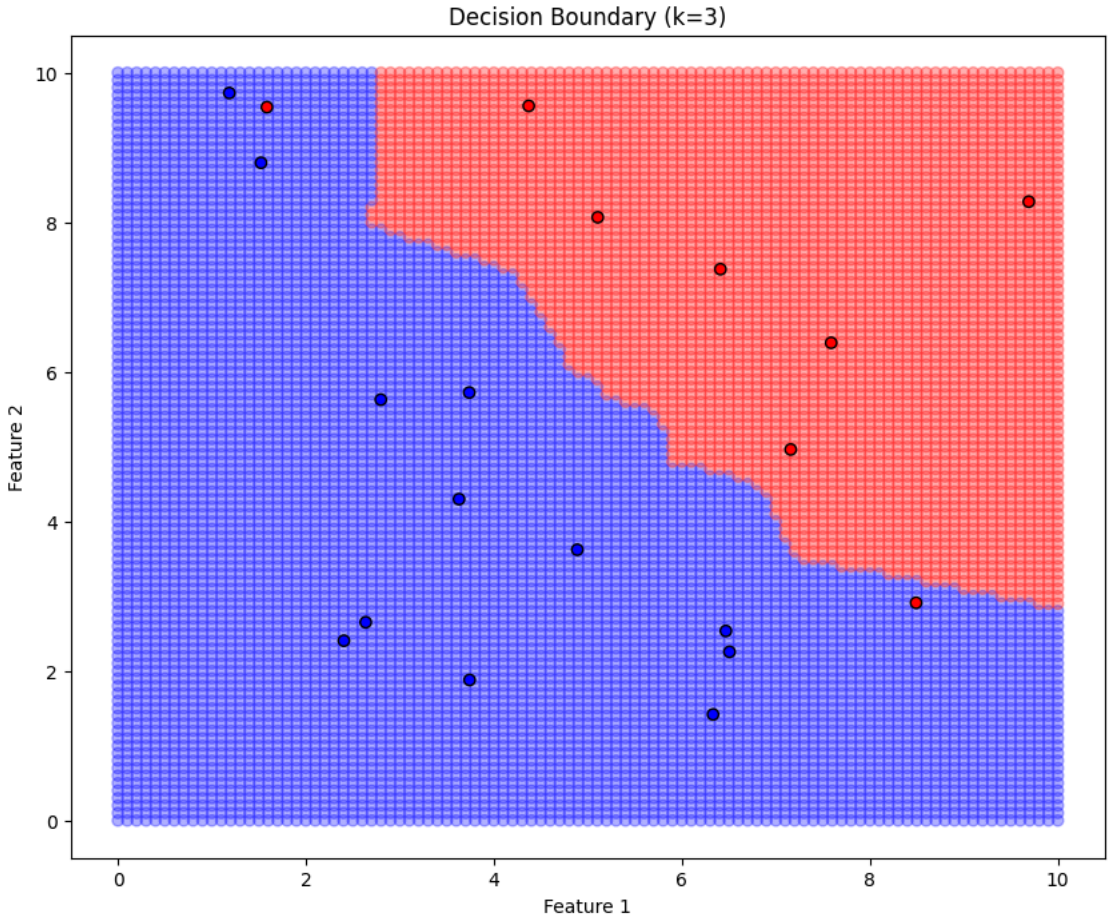
A3

```
np.random.seed(42)
X_random = np.random.uniform(1, 10, (20, 2))
y_random = np.where(X_random[:, 0] + X_random[:, 1] > 11, 1, 0)

plt.figure(figsize=(8, 6))
plt.scatter(X_random[y_random == 0, 0], X_random[y_random == 0, 1],
           color='blue', label='Class 0')
plt.scatter(X_random[y_random == 1, 0], X_random[y_random == 1, 1],
           color='red', label='Class 1')
plt.xlabel('Feature 1')
plt.ylabel('Feature 2')
plt.title('Random Training Data')
plt.legend()
plt.show()
```



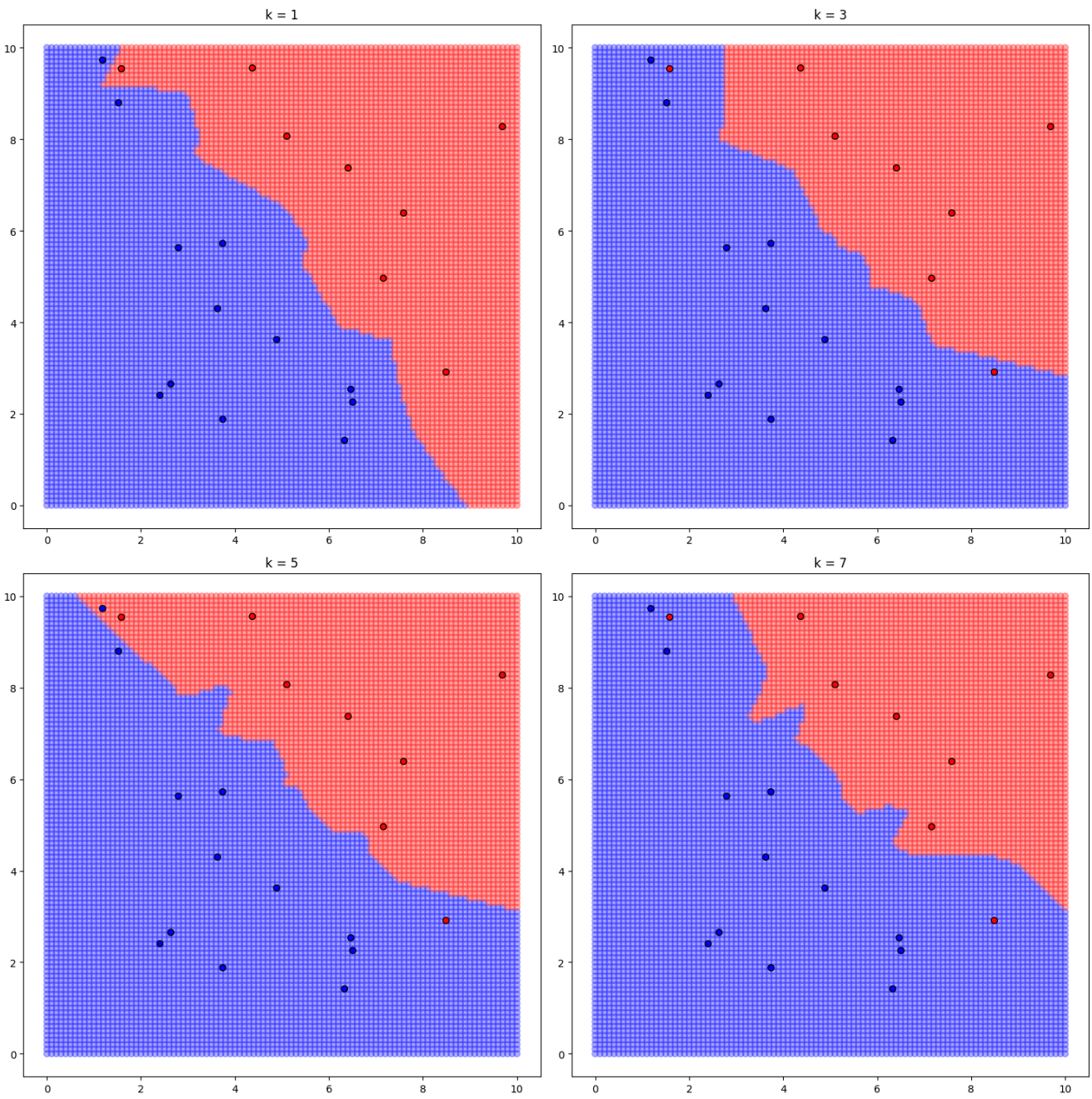
A4

```
x = np.arange(0, 10.1, 0.1)
y = np.arange(0, 10.1, 0.1)
xx, yy = np.meshgrid(x, y)
test_points = np.c_[xx.ravel(), yy.ravel()]


knn_random = KNeighborsClassifier(n_neighbors=3)
knn_random.fit(X_random, y_random)
grid_pred = knn_random.predict(test_points)

plt.figure(figsize=(10, 8))
plt.scatter(test_points[:, 0], test_points[:, 1],
           c=grid_pred, cmap='bwr', alpha=0.3)
plt.scatter(X_random[:, 0], X_random[:, 1],
           c=y_random, cmap='bwr', edgecolor='black')
plt.title('Decision Boundary (k=3)')
plt.xlabel('Feature 1')
plt.ylabel('Feature 2')
plt.show()
```



A5

```
k_values = [1, 3, 5, 7]
fig, axes = plt.subplots(2, 2, figsize=(15, 15))
axes = axes.ravel()

for idx, k in enumerate(k_values):
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_random, y_random)
    grid_pred = knn.predict(test_points)

    axes[idx].scatter(test_points[:, 0], test_points[:, 1],
                      c=grid_pred, cmap='bwr', alpha=0.3)
    axes[idx].scatter(X_random[:, 0], X_random[:, 1],
                      c=y_random, cmap='bwr', edgecolor='black')
    axes[idx].set_title(f'k = {k}')

plt.tight_layout()
plt.show()
```



A6

```
X_pca = X_train[:, :2]
y_pca = y_train
```

```
x = np.arange(X_pca[:, 0].min(), X_pca[:, 0].max(), 0.1
y = np.arange(X_pca[:, 1].min(), X_pca[:, 1].max(), 0.1
xx, yy = np.meshgrid(x, y)
test_points = np.c_[xx.ravel(), yy.ravel()]


knn = KNeighborsClassifier(n_neighbors=3)
knn.fit(X_pca, y_pca)
grid_pred = knn.predict(test_points)

plt.figure(figsize=(10, 8))
plt.scatter(test_points[:, 0], test_points[:, 1],
           c=grid_pred, cmap='viridis', alpha=0.3)
plt.scatter(X_pca[:, 0], X_pca[:, 1],
           c=y_pca, cmap='viridis', edgecolor='black')
plt.title('Project Data Decision Boundary (k=3)')
plt.xlabel('PCA Component 1')
plt.ylabel('PCA Component 2')
plt.colorbar(label='Emotion Class')
plt.show()
```