MANE 4962 HW 2

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Problem 1:

In [ ]:
```
from sklearn import datasets
from sklearn.model_selection import train_test_split
from sklearn import svm
from sklearn.metrics import accuracy_score
import numpy as np

# Load the Iris dataset
iris = datasets.load_iris()
X = iris.data  # all original features
y = iris.target

# Define new features
# Feature 1: Ratio of petal length to sepal length (Petal length / Sepal lengt
# Feature 2: Product of sepal width and petal width (Sepal width * Petal width
X_new = np.zeros((X.shape[0], 2))
X_new[:, 0] = X[:, 2] / X[:, 0]  # Petal length / Sepal length
X_new[:, 1] = X[:, 1] * X[:, 3]  # Sepal width * Petal width

# Splitting the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(
    X_new, y,
    test_size=0.40,
    train_size=0.60,
    random_state=123,
    shuffle=True,
    stratify=y)

# Training the SVM classifier
clf = svm.SVC()
clf.fit(X_train, y_train)

# Making predictions and calculating accuracy
preds = clf.predict(X_test)
acc = accuracy_score(y_test, preds)

print('Accuracy score:', acc)
```

```
Accuracy score: 0.9166666666666666
```

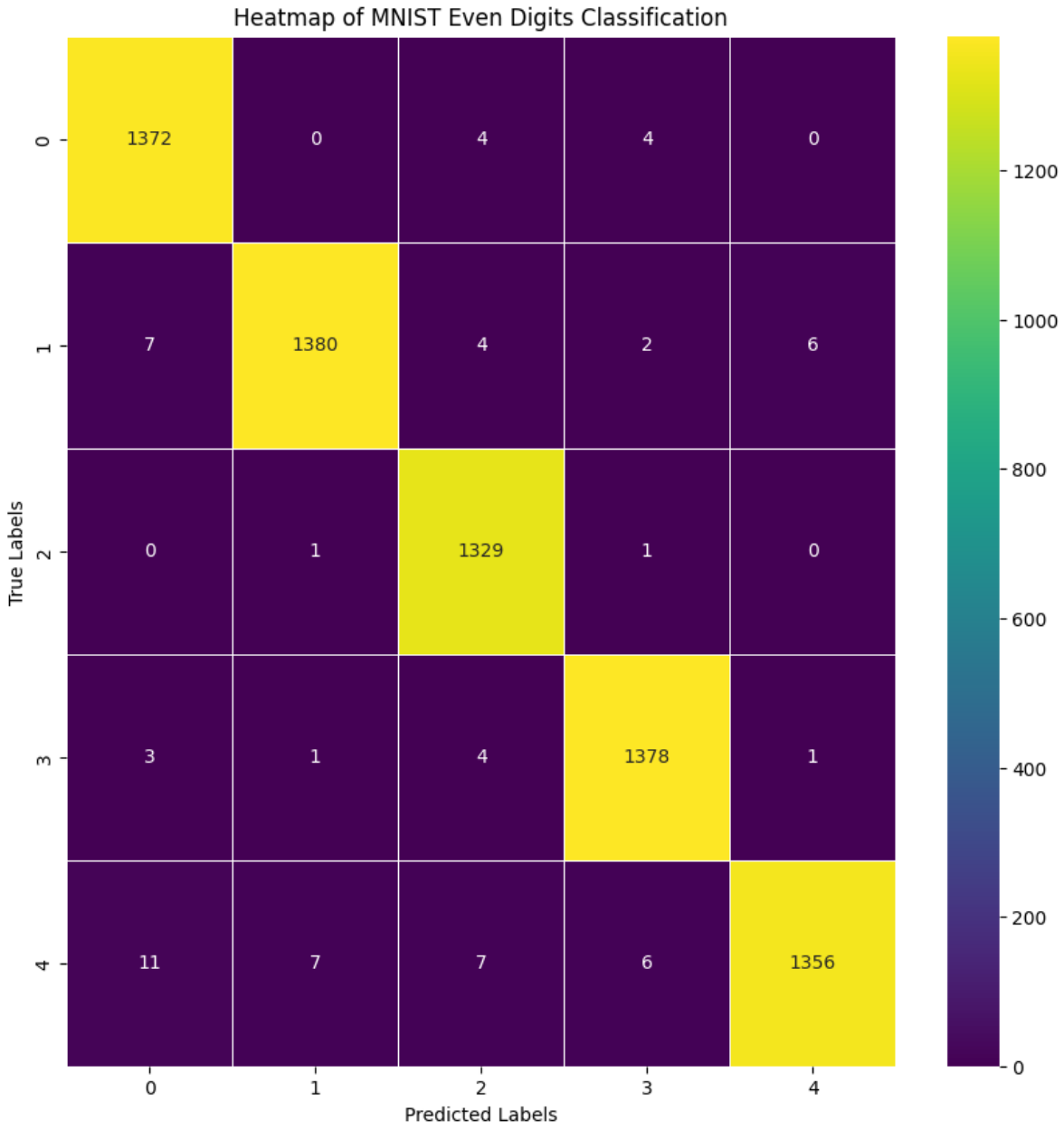
Problem 2:

In [ ]:

```python
from sklearn.datasets import fetch_openml
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix, classification_report
from sklearn.model_selection import train_test_split
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np

# Fetch the MNIST dataset
mnist = fetch_openml('mnist_784', version=1)

# Assuming y is a pandas Series after fetching the MNIST dataset
X, y = mnist['data'], mnist['target'].astype(np.int)
even_digit_indices = [i for i, digit in enumerate(y) if digit % 2 == 0]
X_even, y_even = X.iloc[even_digit_indices], y.iloc[even_digit_indices]


# Split the dataset into a training set and a test set
X_train, X_test, y_train, y_test = train_test_split(X_even, y_even, test_size=

# Initialize the KNN classifier with 3 neighbors
knn_clf = KNeighborsClassifier(n_neighbors=3)

# Fit the classifier on the training data
knn_clf.fit(X_train, y_train)

# Predict the test data
y_pred = knn_clf.predict(X_test)

# Generate the confusion matrix
cm = confusion_matrix(y_test, y_pred)

# Plot the confusion matrix
plt.figure(figsize=(10, 10))
ax = sns.heatmap(cm, annot=True, fmt='d', linewidths=.5, cmap='viridis')
plt.title('Heatmap of MNIST Even Digits Classification')
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.show()

# Count the number of correctly classified 6's
sixes_correctly_classified = cm[3, 3]  # Index 3 corresponds to the digit '6'

print(f"Number of 6's correctly classified: {sixes_correctly_classified}")
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/datasets/_openml.py:968: Futu
reWarning: The default value of `parser` will change from `'liac-arff'` to `'
auto'` in 1.4. You can set `parser='auto'` to silence this warning. Therefore
, an `ImportError` will be raised from 1.4 if the dataset is dense and pandas
is not installed. Note that the pandas parser may return different data types
. See the Notes Section in fetch_openml's API doc for details.
  warn(
<ipython-input-6-675fa7b022e5>:13: DeprecationWarning: `np.int` is a deprecat
ed alias for the builtin `int`. To silence this warning, use `int` by itself.
Doing this will not modify any behavior and is safe. When replacing `np.int`,
you may wish to use e.g. `np.int64` or `np.int32` to specify the precision. I
```

```
f you wish to review your current use, check the release note link for additi
onal information.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/de
vdocs/release/1.20.0-notes.html#deprecations (https://numpy.org/devdocs/relea
se/1.20.0-notes.html#deprecations)
  X, y = mnist['data'], mnist['target'].astype(np.int)
```



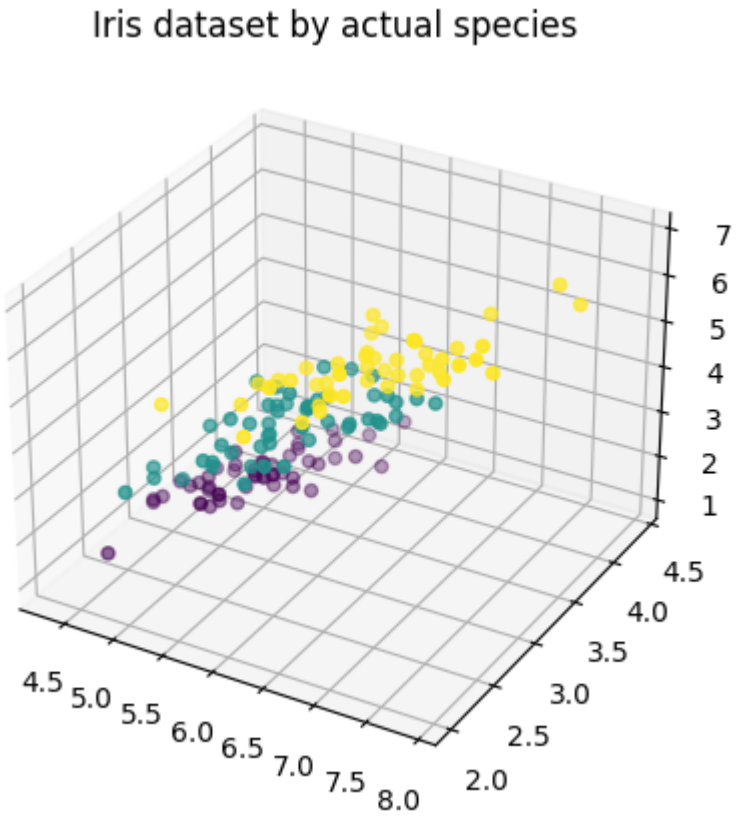

```
Number of 6's correctly classified: 1378
```

Problem 3:

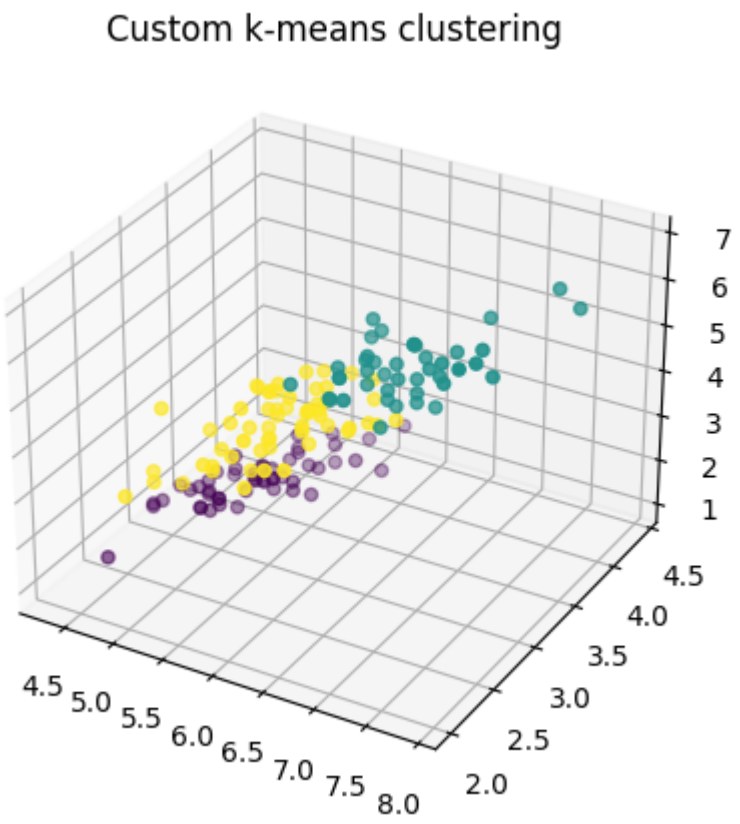
In [ ]:

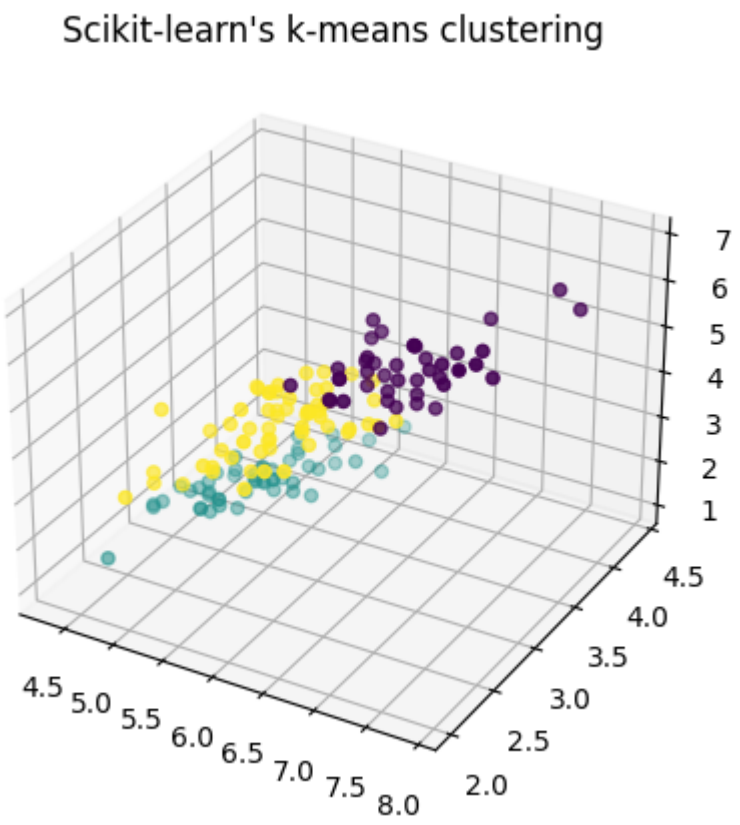
```
from sklearn.datasets import load_iris
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from sklearn.cluster import KMeans

# Load Iris dataset
iris = load_iris()
X = iris.data[:, :3]  # Selecting only the first three features

# K-Means Algorithm
def k_means(X, k, max_iters=100):
    # Randomly initialize centroids
    centroids = X[np.random.choice(X.shape[0], k, replace=False)]

    for i in range(max_iters):
        # Assign clusters
        clusters = np.argmin(np.linalg.norm(X[:, np.newaxis] - centroids, axis

        # Update centroids
        new_centroids = np.array([X[clusters == j].mean(axis=0) for j in range

        # Check for convergence (if centroids do not change)
        if np.all(centroids == new_centroids):
            break
        centroids = new_centroids

    return clusters, centroids

# Visualizing the Iris dataset in 3D
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(X[:, 0], X[:, 1], X[:, 2], c=iris.target)
ax.set_title('Iris dataset by actual species')
plt.show()

# Cluster with the custom k-means algorithm
k = 3  # Number of clusters
clusters_custom, centroids_custom = k_means(X, k)

# Cluster with scikit-learn's k-means
kmeans_sklearn = KMeans(n_clusters=k, random_state=42)
clusters_sklearn = kmeans_sklearn.fit_predict(X)

# Visualize clustering results from the custom method
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(X[:, 0], X[:, 1], X[:, 2], c=clusters_custom)
ax.set_title('Custom k-means clustering')
plt.show()

# Visualize clustering results from scikit-learn's method
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(X[:, 0], X[:, 1], X[:, 2], c=clusters_sklearn)
```

```
ax.set_title("Scikit-learn's k-means clustering")
plt.show()
```




```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: Futur
eWarning: The default value of `n_init` will change from 10 to 'auto' in 1.4.
Set the value of `n_init` explicitly to suppress the warning
  warnings.warn(
```





What happens when you vary the number of clusters?

- k = 2 (decrease the number of cluster)

When the number of clusters was set to two, both the custom implementation and scikit-learn's k-means algorithm merged two of the three Iris species into a single cluster.

- k = 5 (increase the number of cluster)

Increasing the number of clusters to five led to over-segmentation, where the algorithms artificially split natural groups into smaller, less meaningful subgroups.