LAB MANUAL

Unit III – Machine Learning

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Lab 3. Clustering Energy Consumption Patterns for Smart Cities

Objective

This lab focuses on using clustering techniques to identify patterns in energy consumption data for smart cities. By understanding these patterns, city planners and utility providers can optimize energy distribution, reduce waste, and promote sustainability in urban areas.

Problem

Urban areas experience fluctuating energy demands based on factors such as population density, time of day, and weather conditions. Identifying clusters of similar energy consumption patterns can provide insights into high-demand areas, predict peak usage, and implement efficient energy-saving strategies. The goal is to use clustering algorithms to group similar energy consumption profiles, enabling smart city initiatives to optimize resources and promote sustainable living.

Solution

To create the Classifying Waste Types for Recycling (to classify them into different categories: Plastic, Metal, Organic,) using classification algorithms

following steps:

1. Import required libraries
2. Prepare the dataset
    1. Load Dataset
    2. Data cleaning and preprocessing
    3. Select features and normalize the data
3. Elbow Method to find the optimal number of clusters
4. Evaluate the model performance
5. Visualization

Procedures

1. Import required libraries

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
```

2. Prepare the dataset

2.1 Load Dataset

```
df = pd.read_csv("energy_data.csv")
df.head()
```

	timestamp	location	energy_consumption	temperature
0	2023-01-01 00:00:00	Industrial	139.101364	33.820542
1	2023-01-01 01:00:00	Residential	247.109808	26.392602
2	2023-01-01 02:00:00	Industrial	233.934693	25.027439
3	2023-01-01 03:00:00	Industrial	243.013532	27.107712
4	2023-01-01 04:00:00	Residential	313.502582	27.326153

2.2 Data cleaning and preprocessing

```
df['timestamp'] = pd.to_datetime(df['timestamp'])
df = df.dropna()  # Drop missing values
df = df.set_index('timestamp')
```

2.3 Select features and normalize the data

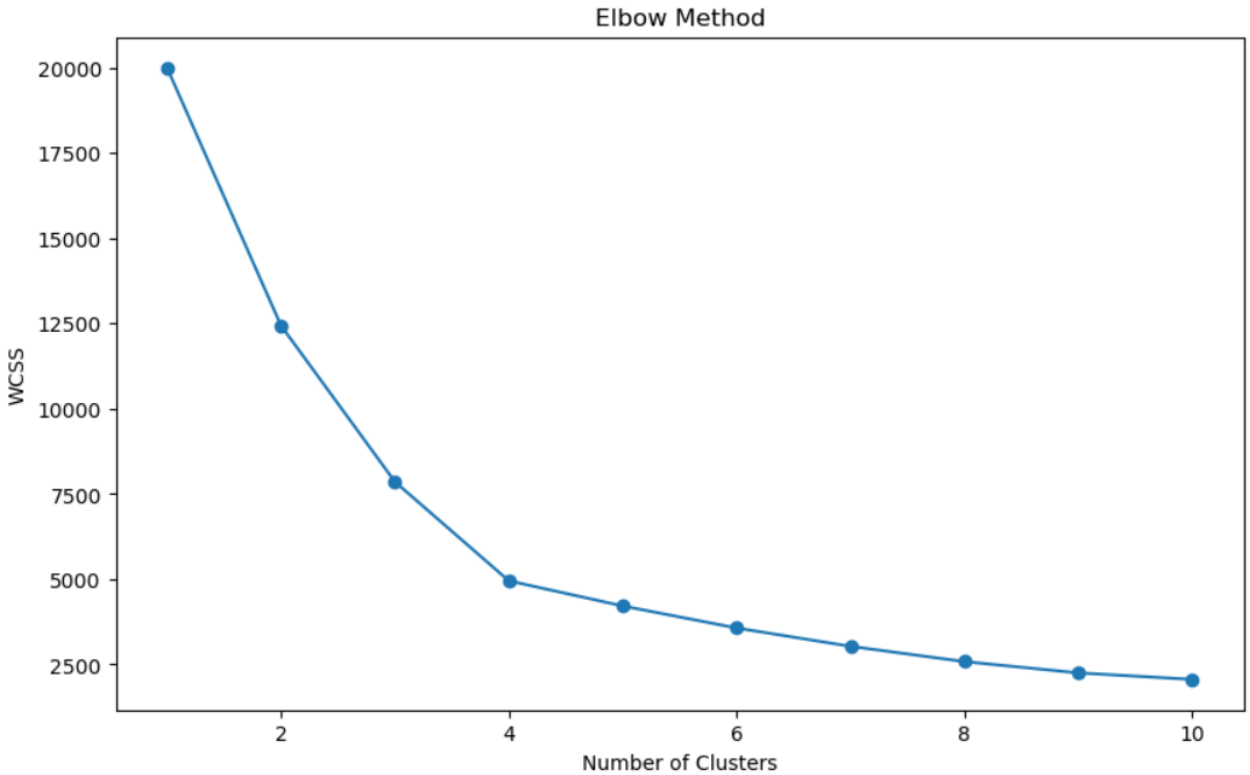
```
X = df[['energy_consumption', 'temperature']]
```

```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

3. Elbow Method to find the optimal number of clusters

```
wcss = []
for i in range(1, 11):
    kmeans = KMeans(n_clusters=i, init='k-means++', random_state=42)
    kmeans.fit(X_scaled)
    wcss.append(kmeans.inertia_)

# Plotting the Elbow Method
plt.figure(figsize=(10, 6))
plt.plot(range(1, 11), wcss, marker='o', linestyle='-')
plt.title('Elbow Method')
plt.xlabel('Number of Clusters')
plt.ylabel('WCSS')
plt.show()
```



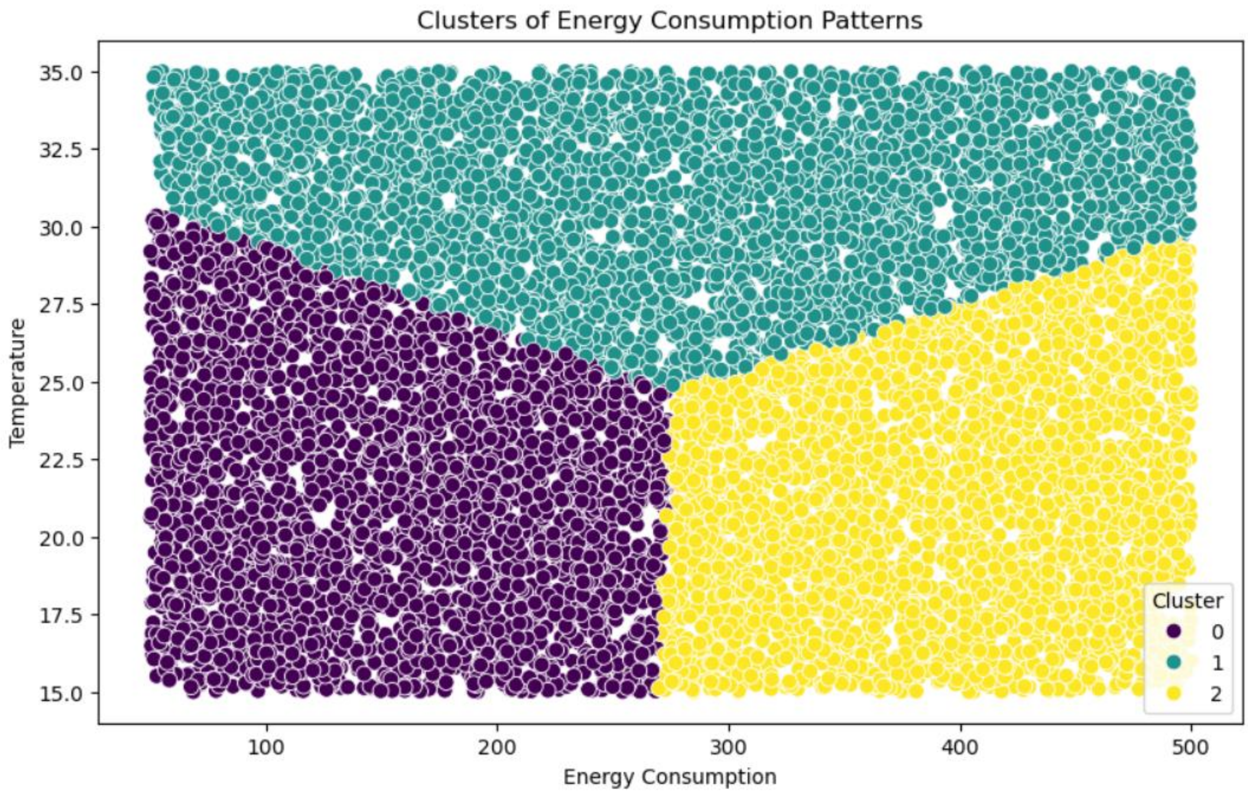
4. Evaluate the model performance

```
from sklearn.metrics import silhouette_score
silhouette_avg = silhouette_score(X_scaled, df['cluster'])
print(f'Silhouette Score: {silhouette_avg:.2f}')
```

```
Silhouette Score: 0.38
```

5. Visualization

```
plt.figure(figsize=(10, 6))
sns.scatterplot(x='energy_consumption', y='temperature', hue='cluster', data=df, palette='viridis', s=60)
plt.title('Clusters of Energy Consumption Patterns')
plt.xlabel('Energy Consumption')
plt.ylabel('Temperature')
plt.legend(title='Cluster')
plt.show()
```


Clusters of Energy Consumption Patterns
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
Temperature
100
200
300
400
500
Energy Consumption
Cluster
0
1
2