Importing required libraries

In [223…

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import random
from sklearn.metrics import euclidean_distances
```

Function to get neighbours within epsilon

In [224…

```
def get_neighbors(vectors, epsilon) ### Function to get neighbours within ep
    distances = euclidean_distances(vectors)
    neighbor_indices = np.argwhere(distances < epsilon)
    dbscan_dict = dict()
    for index in neighbor_indices:
        if index[0] in dbscan_dict:
            dbscan_dict[index[0]].append(index[1])
        else:
            dbscan_dict[index[0]] = [index[1]]
    return dbscan_dict
```

Function to get list of points having specific number of neighbours

In [225…

```
def num_neighbor(dbscan_dict):
    num_neighbo### Function to get neighbours within epsilonr_list = dict()
    for i,(key,value) in enumerate (dbscan_dict.items()):
        #print(len(value))
        if len(value) in num_neighbor_list:
            num_neighbor_list[len(value)].append(key)
        else:
            temp = []
            temp.append(key)
            num_neighbor_list[len(value)] = temp

    return num_neighbor_list
```

Function to define point as core, non-core and outliers

In [226…

```
def defining_points(MinPts,num_neighbor_list):
    cores, non_cores, outliers = list(), list(), list()

    [cores.extend(num_neighbor_list[i])
     for i in num_neighbor_list if i >= MinPts]

    [non_cores.extend(num_neighbor_list[i])
     for i in num_neighbor_list if i < MinPts and i > 1]

    [outliers.extend(num_neighbor_list[i])
     for i in num_neighbor_list if i == 1]

    return cores,non_cores,outliers
```

Function to create clusters

In [227…

```
def cluster_with_stack(eps, minPts, df):

    #initiating cluster number
    C = 1
    #initiating stacks to maintain
    current_stack = set()
    unvisited = list(df.index)
    clusters = []


    while (len(unvisited) != 0): #run until all points have been visited

        #identifier for first point of a cluster
        first_point = True

        #choose a random unvisited point
        current_stack.add(random.choice(unvisited))

        while len(current_stack) != 0: #run until a cluster is complete

            #pop current point from stack
            curr_idx = current_stack.pop()

            #check if point iscore, neighbour or border
            if curr_idx in cores:
                iscore = True
                isborder = False
                isnoise = False

            if curr_idx in non_cores:
                iscore = False
                isborder = True
                isnoise = False

            if curr_idx in outliers:
                iscore = False
                isborder = False
                isnoise = True
            neigh_indexes = dbscan_dict[curr_idx]
            #print(neigh_indexes, iscore, isborder, isnoise)

            #dealing with an edge case
            if (isborder & first_point):
                #for first border point, we label it aand its neighbours as
                clusters.append((curr_idx, 0))
                clusters.extend(list(zip(neigh_indexes,[0 for _ in range(len

                #label as visited
                unvisited.remove(curr_idx)
                unvisited = [e for e in unvisited if e not in neigh_indexes]

                continue

            unvisited.remove(curr_idx) #remove point from unvisited list


            neigh_indexes = set(neigh_indexes) & set(unvisited) #look at onl

            if iscore: #if current point is a core
                first_point = False

                clusters.append((curr_idx,C)) #assign to a cluster
                current_stack.update(neigh_indexes) #add neighbours to a sta

            elif isborder: #if current point is a border point
                clusters.append((curr_idx,C))

                continue

            elif isnoise: #if current point is noise
                clusters.append((curr_idx, 0))

                continue

        if not first_point:
            #increment cluster number
            C+=1

    return clusters
```

Executing for moons dataset

In [228…

```
epsilon = 0.25
minPts = 3
df = pd.read_csv('moons.csv')
df = df.rename(columns={'Xmoons_X1': 'X',
                        'Xmoons_X2': 'Y'})
df = df.reset_index(drop=False)
df.head()
```

Out[228]:

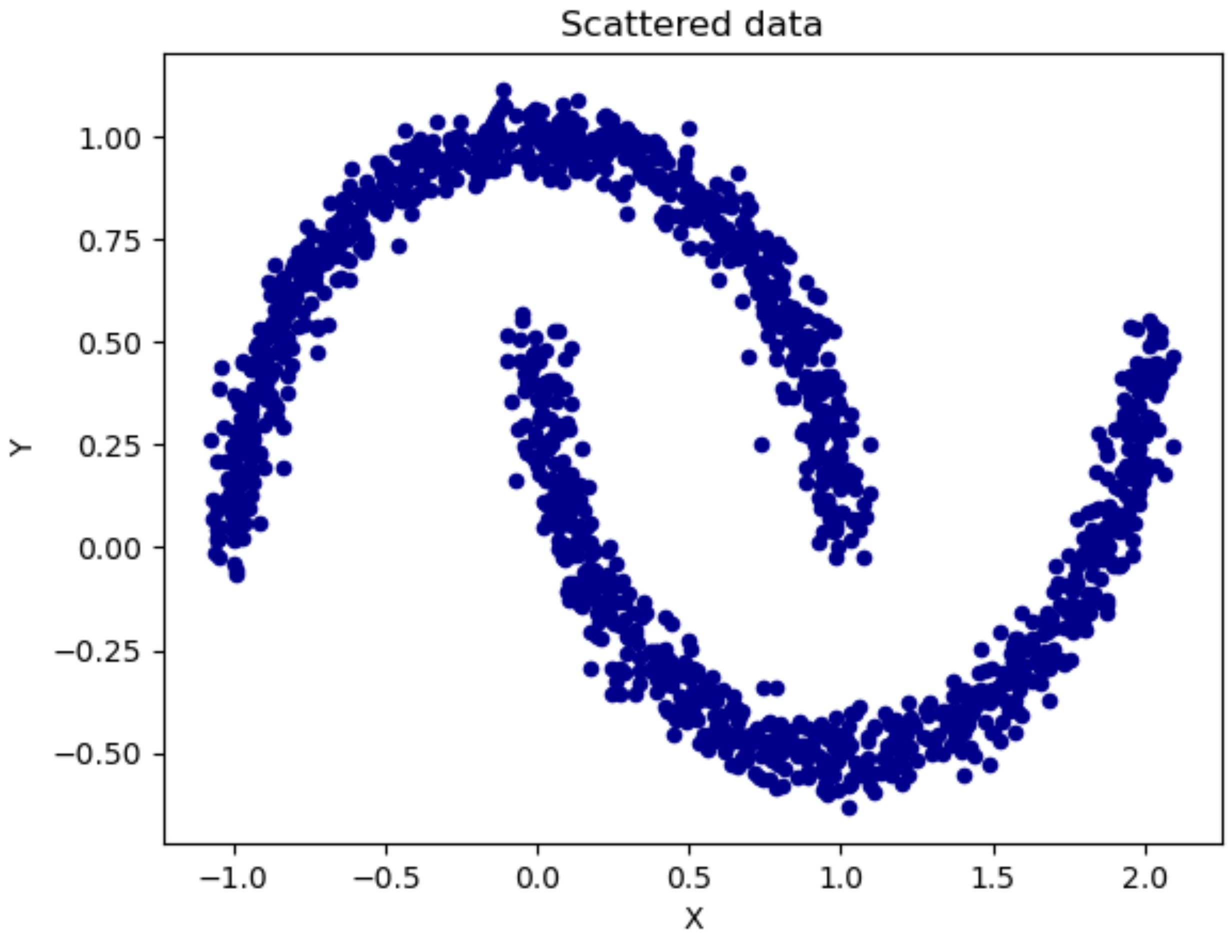
	index	X	Y
0	0	-0.378142	0.940750
1	1	0.933566	0.153805
2	2	2.048309	0.498172
3	3	0.947891	0.162473
4	4	2.000739	0.183700

In [229…

```
df.plot.scatter(x='X', y='Y', c='DarkBlue')
plt.title("Scattered data")
```

Out[229]:

```
Text(0.5, 1.0, 'Scattered data')
```



In [230…

```
dbscan_dict = {}
vectors = df[["X", "Y"]].to_numpy()
dbscan_dict = get_neighbors(vectors, epsilon)
```

In [231…

```
num_neighbor_list = num_neighbor(dbscan_dict)
cores,non_cores,outliers = defining_points(minPts,num_neighbor_list)
```

In [232...

```
#data
clustered = cluster_with_stack(eps, minPts, df)

idx , cluster = list(zip(*clustered))
cluster_df = pd.DataFrame(clustered, columns = ["index", "cluster"])
```

In [233...

```
merged_df = pd.merge(df, cluster_df, on ='index')
```

In [234...

```
merged_df
```

Out[234]:

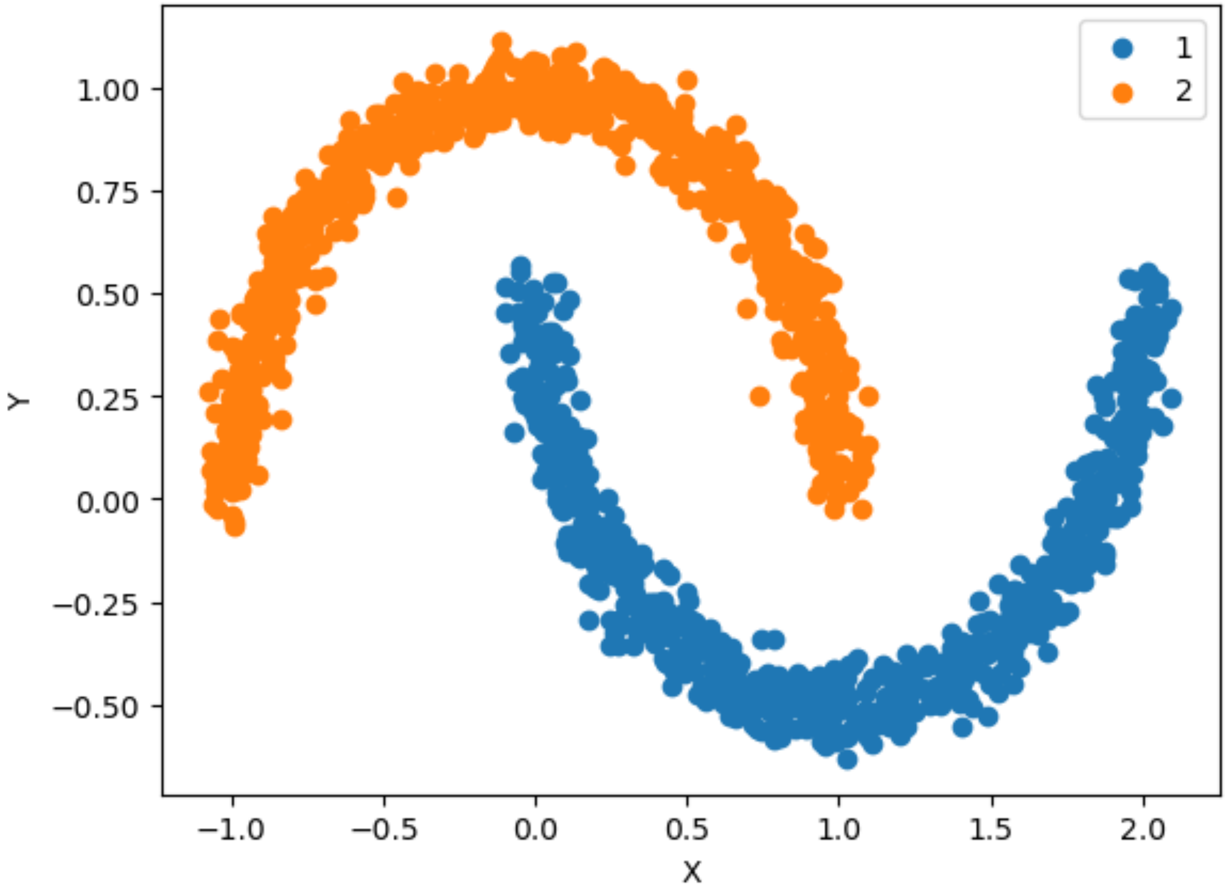
	index	X	Y	cluster
0	0	-0.378142	0.940750	2
1	1	0.933566	0.153805	2
2	2	2.048309	0.498172	1
3	3	0.947891	0.162473	2
4	4	2.000739	0.183700	1
...	...	...	...	...
1495	1495	-0.022346	0.425338	1
1496	1496	0.090974	0.098361	1
1497	1497	1.390850	-0.439987	1
1498	1498	-0.652389	0.769648	2
1499	1499	-0.900280	0.195603	2

1500 rows × 4 columns

In [235...

```
plt.figure(figsize=(10,7))

fig, ax = plt.subplots()

for cluster, df_cluster in merged_df.groupby('cluster'):
    ax.scatter(df_cluster['X'], df_cluster['Y'], label=cluster)

ax.legend()
ax.set_xlabel('X')
ax.set_ylabel('Y')

plt.show()
```

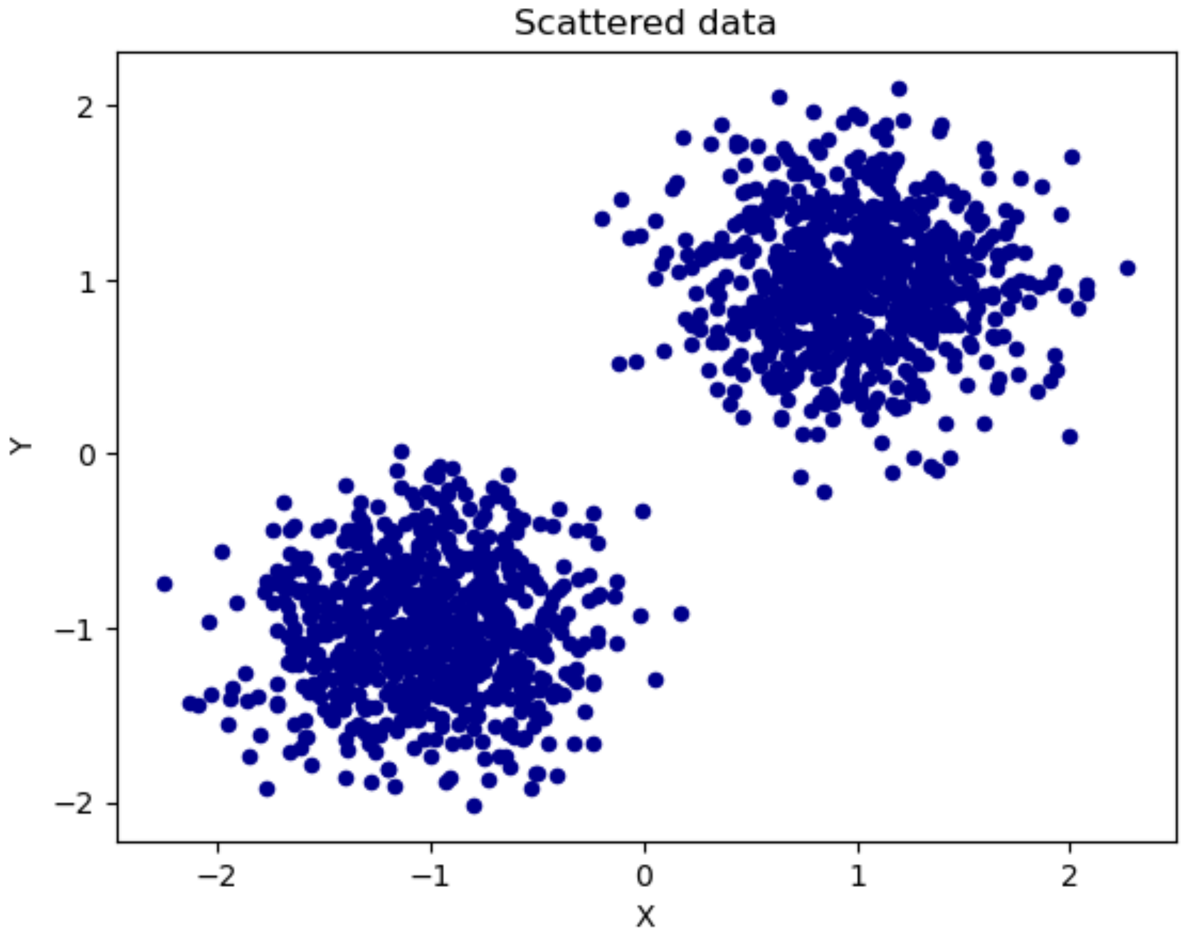
```
<Figure size 1000x700 with 0 Axes>
```



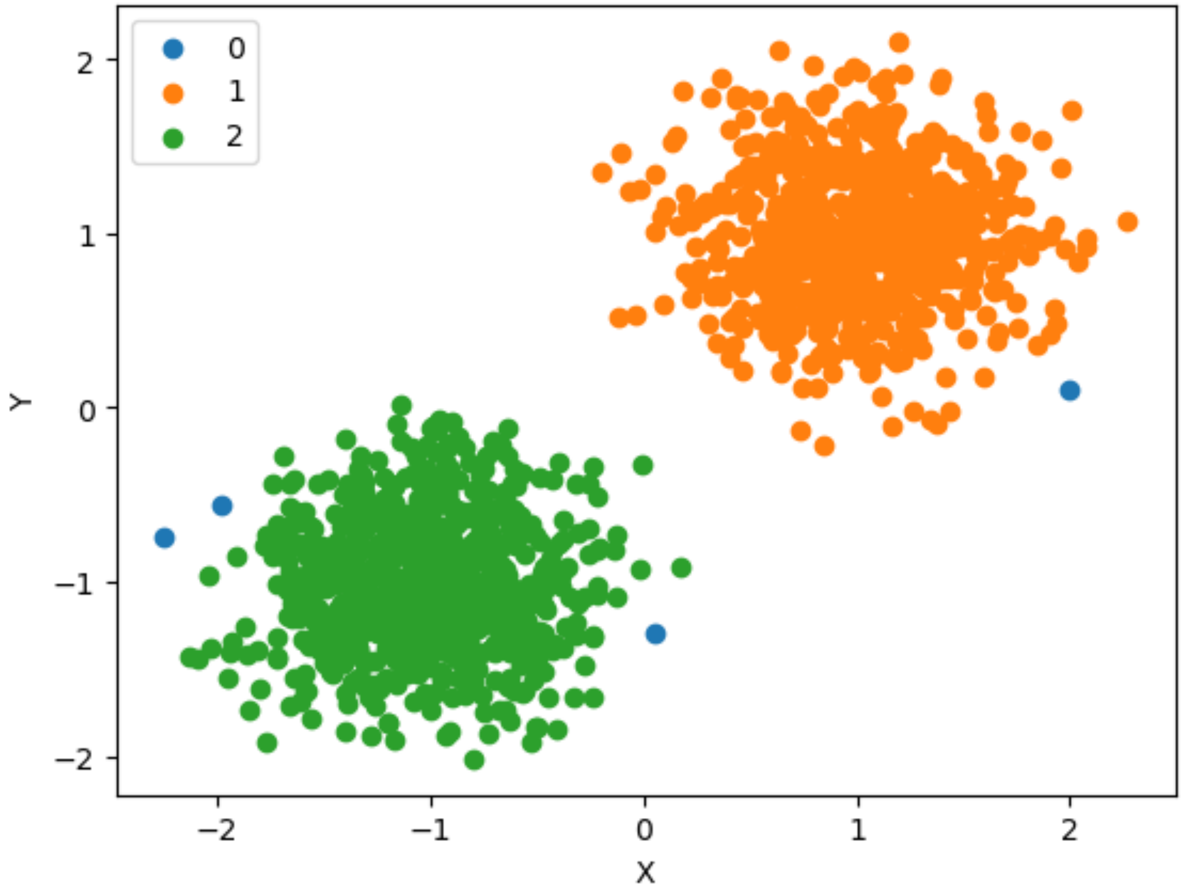
Executing for blobs dataset

In [236…

```
#epsilon = 7.5, MinPts = 3
df = pd.read_csv('blobs.csv')
df = df.rename(columns={'Xblobs_X1': 'X',
                        'Xblobs_X2': 'Y'})
df = df.reset_index(drop=False)
df.head()

epsilon = 0.25
minPts = 3


df.plot.scatter(x='X', y='Y', c='DarkBlue')
plt.title("Scattered data")

dbscan_dict = {}
vectors = df[["X", "Y"]].to_numpy()
dbscan_dict = get_neighbors(vectors, epsilon)

num_neighbor_list = num_neighbor(dbscan_dict)
cores,non_cores,outliers = defining_points(minPts,num_neighbor_list)

#data
clustered = cluster_with_stack(eps, minPts, df)

idx , cluster = list(zip(*clustered))
cluster_df = pd.DataFrame(clustered, columns = ["index", "cluster"])

merged_df = pd.merge(df, cluster_df, on ='index')


plt.figure(figsize=(10,7))

fig, ax = plt.subplots()

for cluster, df_cluster in merged_df.groupby('cluster'):
    ax.scatter(df_cluster['X'], df_cluster['Y'], label=cluster)

ax.legend()
ax.set_xlabel('X')
ax.set_ylabel('Y')

plt.show()
```


Scattered data
Y
2
1
0
−1
−2
−2
−1
0
1
2
X

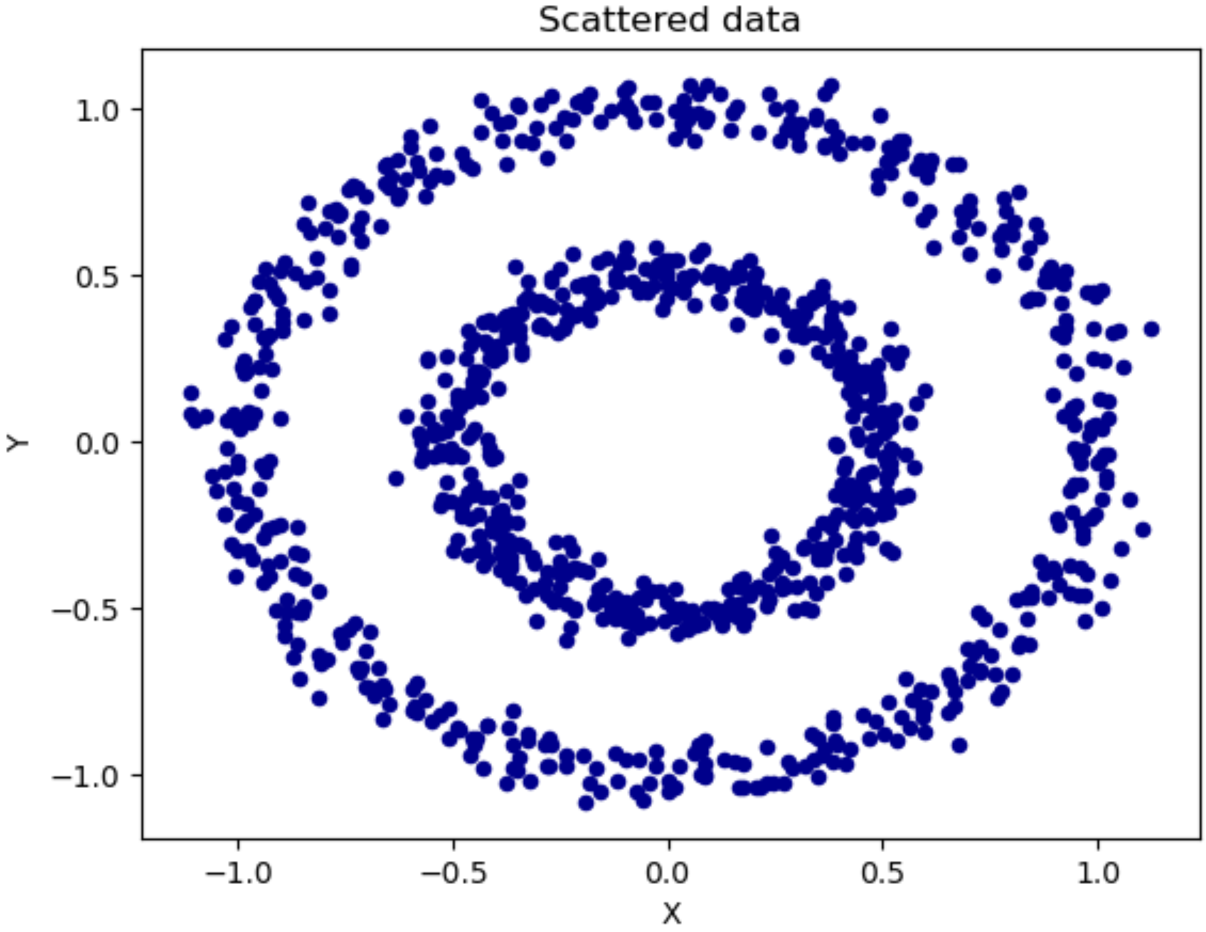
```
<Figure size 1000x700 with 0 Axes>
```


0
1
2
Y
2
1
0
−1
−2
−2
−1
0
1
2
X

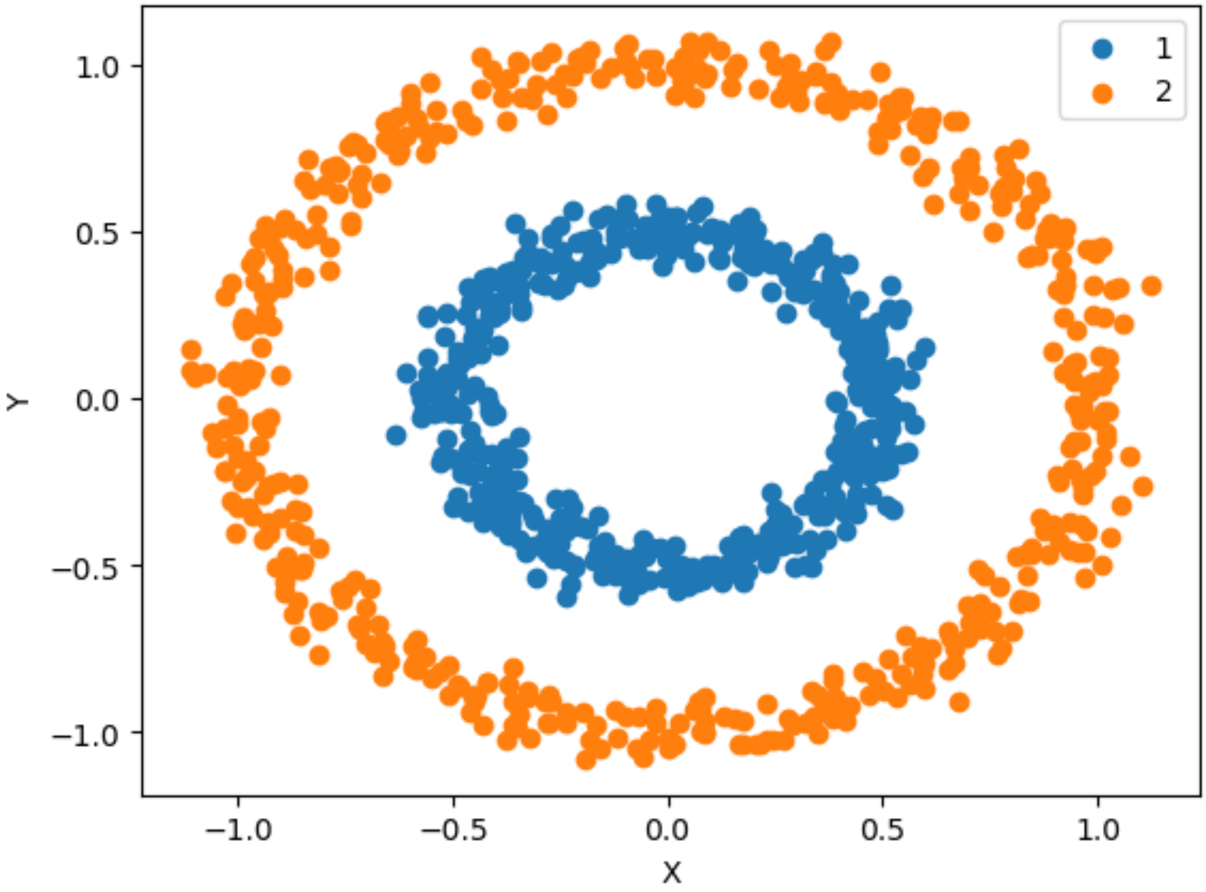
Executing for circle dataset

In [237…

```
df = pd.read_csv('circle.csv')
df = df.rename(columns={'Xcircle_X1': 'X',
                        'Xcircle_X2': 'Y'})
df = df.reset_index(drop=False)
df.head()

epsilon = 0.1
minPts = 3

df.plot.scatter(x='X', y='Y', c='DarkBlue')
plt.title("Scattered data")

dbscan_dict = {}
vectors = df[["X", "Y"]].to_numpy()
dbscan_dict = get_neighbors(vectors, epsilon)

num_neighbor_list = num_neighbor(dbscan_dict)
cores,non_cores,outliers = defining_points(minPts,num_neighbor_list)

#data
clustered = cluster_with_stack(eps, minPts, df)

idx , cluster = list(zip(*clustered))
cluster_df = pd.DataFrame(clustered, columns = ["index", "cluster"])

merged_df = pd.merge(df, cluster_df, on ='index')

plt.figure(figsize=(10,7))

fig, ax = plt.subplots()

for cluster, df_cluster in merged_df.groupby('cluster'):
    ax.scatter(df_cluster['X'], df_cluster['Y'], label=cluster)

ax.legend()
ax.set_xlabel('X')
ax.set_ylabel('Y')

plt.show()
```


Scattered data
1.0
0.5
0.0
−0.5
−1.0
Y
−1.0
−0.5
0.0
0.5
1.0
X

```
<Figure size 1000x700 with 0 Axes>
```


● 1
● 2
1.0
0.5
0.0
−0.5
−1.0
Y
−1.0
−0.5
0.0
0.5
1.0
X