Density-based spatial clustering of applications with noise (DBSCAN)

- 17119 - Hare Sankaran RV

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from itertools import cycle, islice
from sklearn import cluster
```

In [34]:
```
figsize = (10,10)
point_size=150
point_border=0.8


def plot_dataset(dataset, xlim=(-15, 15), ylim=(-15, 15)):
    plt.figure(figsize=figsize)
    plt.scatter(dataset[:,0], dataset[:,1], s=point_size, color="#00B3E9", edgecolor='black', lw=point_bo
rder)
    plt.show()

def plot_clustered_dataset(dataset, y_pred, xlim=(-15, 15), ylim=(-15, 15), neighborhood=False, epsil
on=0.5):

    fig, ax = plt.subplots(figsize=figsize)

    colors = np.array(list(islice(cycle(['#df8efd', '#78c465', '#ff8e34',
                                         '#f65e97', '#a65628', '#984ea3',
                                         '#999999', '#e41a1c', '#dede00']),
                                  int(max(y_pred) + 1))))
    colors = np.append(colors, '#BECBD6')


    if neighborhood:
        for point in dataset:
            circle1 = plt.Circle(point, epsilon, color='#666666', fill=False, zorder=0, alpha=0.3)
            ax.add_artist(circle1)

    ax.scatter(dataset[:, 0], dataset[:, 1], s=point_size, color=colors[y_pred], zorder=10, edgecolor='bla
ck', lw=point_border)

    plt.show()

def plot_dbscan_grid(dataset, eps_values, min_samples_values):

    fig = plt.figure(figsize=(16, 20))
    plt.subplots_adjust(left=.02, right=.98, bottom=0.001, top=.96, wspace=.05,
                        hspace=0.25)


    plot_num = 1

    for i, min_samples in enumerate(min_samples_values):
        for j, eps in enumerate(eps_values):
            ax = fig.add_subplot( len(min_samples_values) , len(eps_values), plot_num)

            dbscan = cluster.DBSCAN(eps=eps, min_samples=min_samples)
            y_pred_2 = dbscan.fit_predict(dataset)

            colors = np.array(list(islice(cycle(['#df8efd', '#78c465', '#ff8e34',
                                                 '#f65e97', '#a65628', '#984ea3',
                                                 '#999999', '#e41a1c', '#dede00']),
                                          int(max(y_pred_2) + 1))))
            colors = np.append(colors, '#BECBD6')


            for point in dataset:
                circle1 = plt.Circle(point, eps, color='#666666', fill=False, zorder=0, alpha=0.3)
                ax.add_artist(circle1)

            ax.text(0, -0.03, 'Epsilon: {} \nMin_samples: {}'.format(eps, min_samples), transform=ax.transA
xes, fontsize=16, va='top')
            ax.scatter(dataset[:, 0], dataset[:, 1], s=50, color=colors[y_pred_2], zorder=10, edgecolor='blac
k', lw=0.5)


            plt.xticks(())
```

```
        plt.yticks(())
        plot_num = plot_num + 1

    plt.show()
```

In [117]:
```
from sklearn.metrics import silhouette_score
from sklearn.preprocessing import StandardScaler
```

In [36]:
```
df = pd.read_csv("ATM.csv",header=None)
dataset_1 = df.values
```

In [118]:
```
df.shape
```

Out[118]: (50, 2)

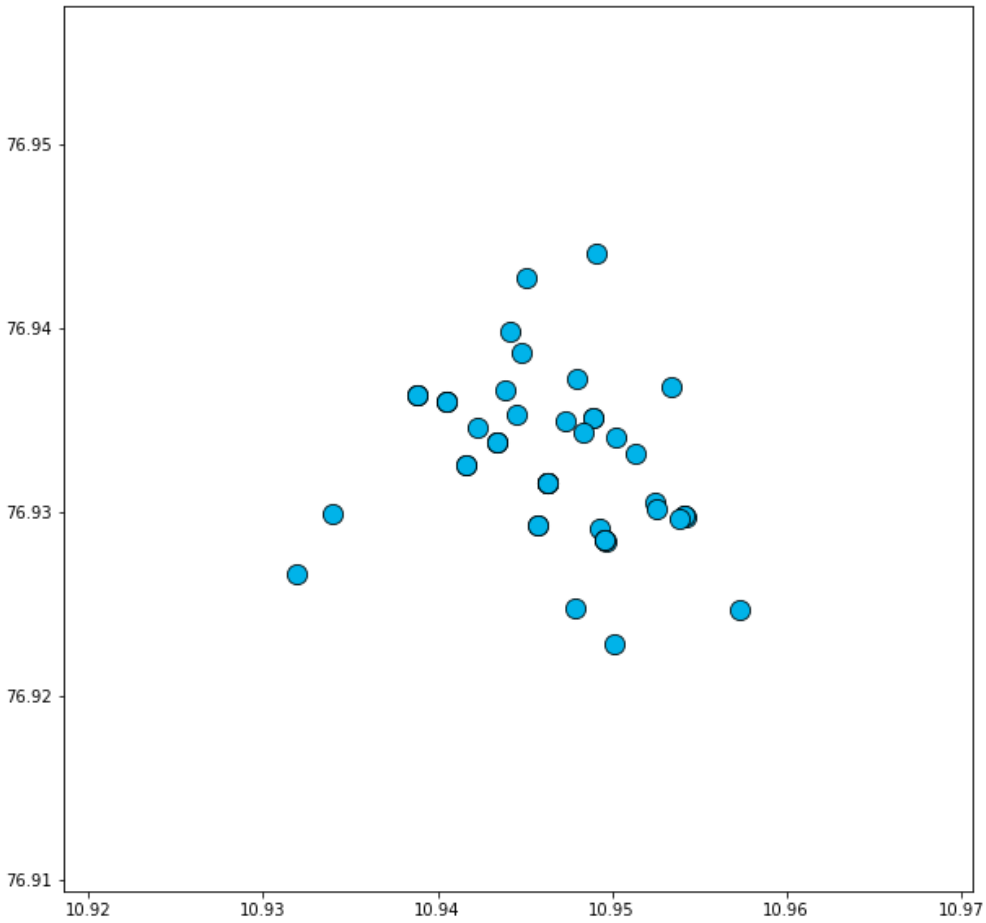
In [119]:
```
df.head()
```

Out[119]:

	0	1
0	10.94231	76.93460
1	10.94627	76.93156
2	10.94891	76.93509
3	10.94413	76.93978
4	10.94053	76.93599

Plotting the dataset as it is

In [71]:
```
plot_dataset(df.values)
```



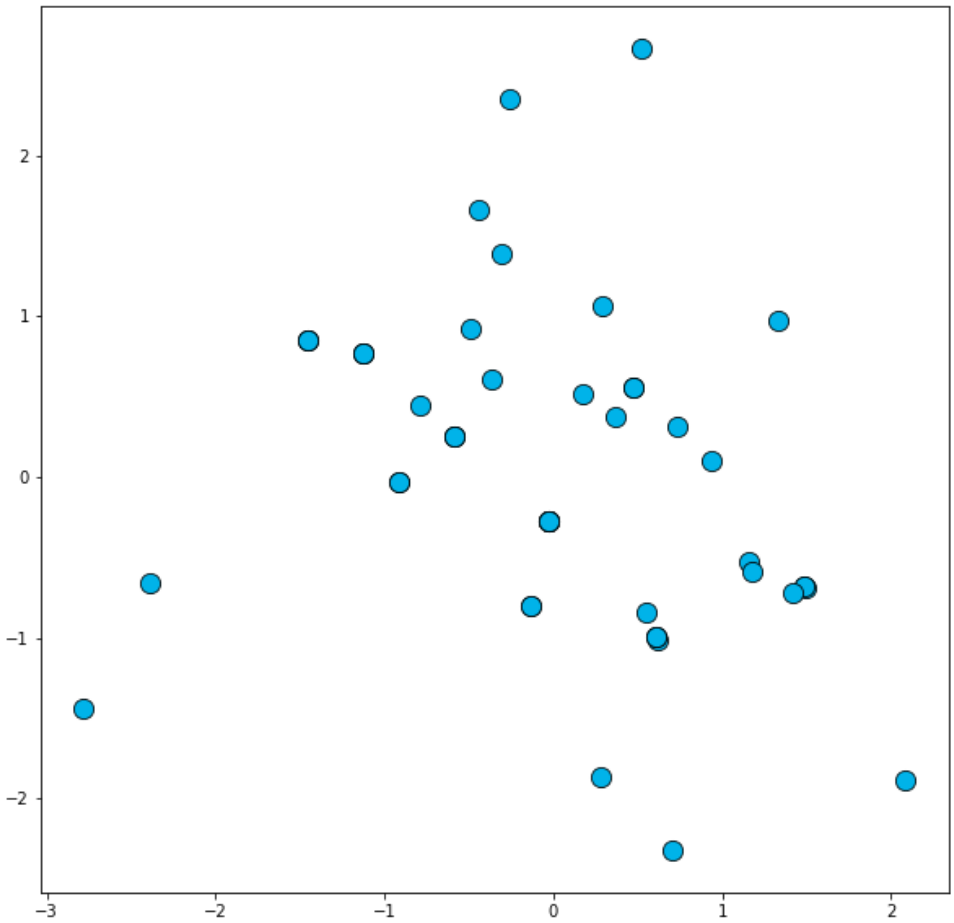
Normalizing the data

In [37]:
```
scaler = StandardScaler()
scaler.fit(df)
X_scale = scaler.transform(df)
df_scale = pd.DataFrame(X_scale, columns=df.columns)
df_scale.head()
```

Out[37]:

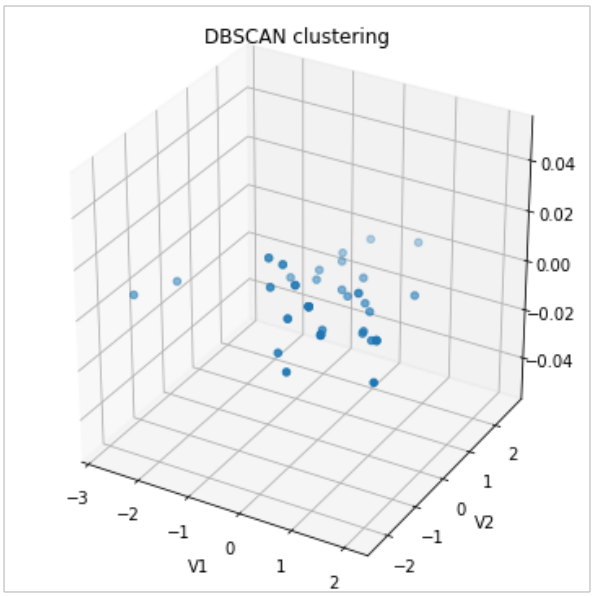
	0	1
0	-0.787419	0.444804
1	-0.029328	-0.270270
2	0.476066	0.560063
3	-0.439003	1.663252
4	-1.128177	0.771762

In [38]:
```
dataset_1 = df_scale.values
plot_dataset(dataset_1)
```



In [39]:
```
from mpl_toolkits.mplot3d import Axes3D
```

In [45]:
```
fig = plt.figure(figsize=(5,5))
ax = Axes3D(fig)
ax.scatter(dataset_1[:, 0], dataset_1[:, 1], s=20, cmap="viridis")
plt.title("DBSCAN clustering")
plt.xlabel("V1")
plt.ylabel("V2")
plt.show()
```



DBSCAN Clustering with default params

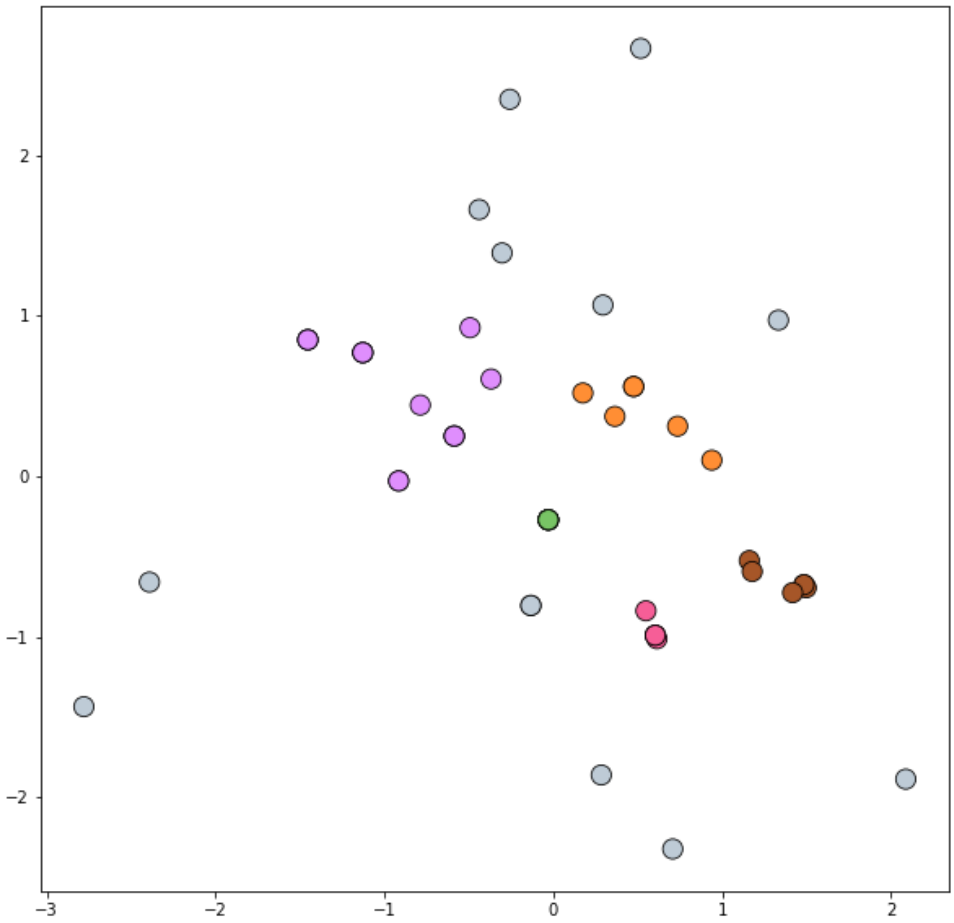
In [50]:
```
from sklearn import cluster,metrics

dbscan = cluster.DBSCAN()
clustering_labels_1 = dbscan.fit_predict(dataset_1)


n_clusters_ = len(set(clustering_labels_1)) - (1 if -1 in clustering_labels_1 else 0)
n_noise_ = list(clustering_labels_1).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
print("Silhouette Coefficient: %0.3f" % metrics.silhouette_score(df_scale, clustering_labels_1))
```

```
Estimated number of clusters: 5
Estimated number of noise points: 13
Silhouette Coefficient: 0.350
```

In [24]:
```
clustering_labels_1
```

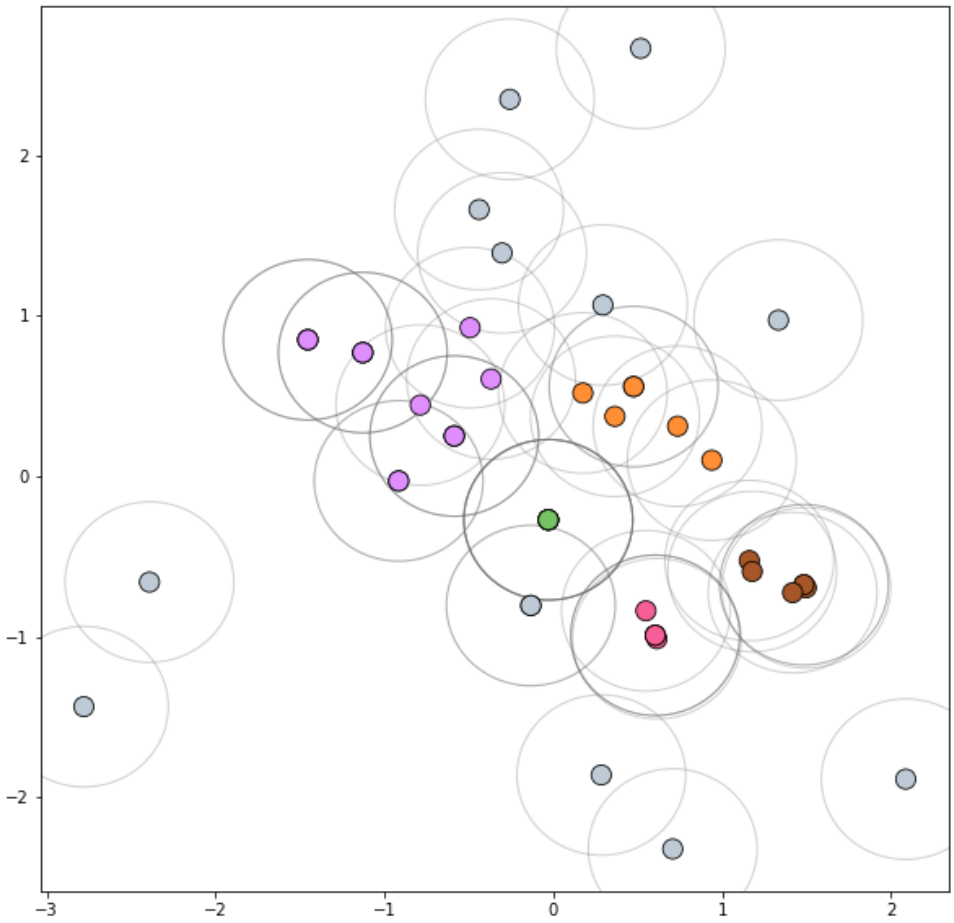
Out[24]:
```
array([ 0,  1,  2, -1,  0,  1, -1,  0,  0,  3, -1, -1, -1, -1, -1,  0,  0,
        0,  1,  2,  2, -1,  4,  3,  4, -1,  1,  0, -1,  0,  0,  0, -1, -1,
        0,  0,  0,  1, -1,  4,  3,  4,  2,  4,  3,  2,  4,  3,  1,  2])
```

In [23]:
```
plot_clustered_dataset(dataset_1, clustering_labels_1)
```



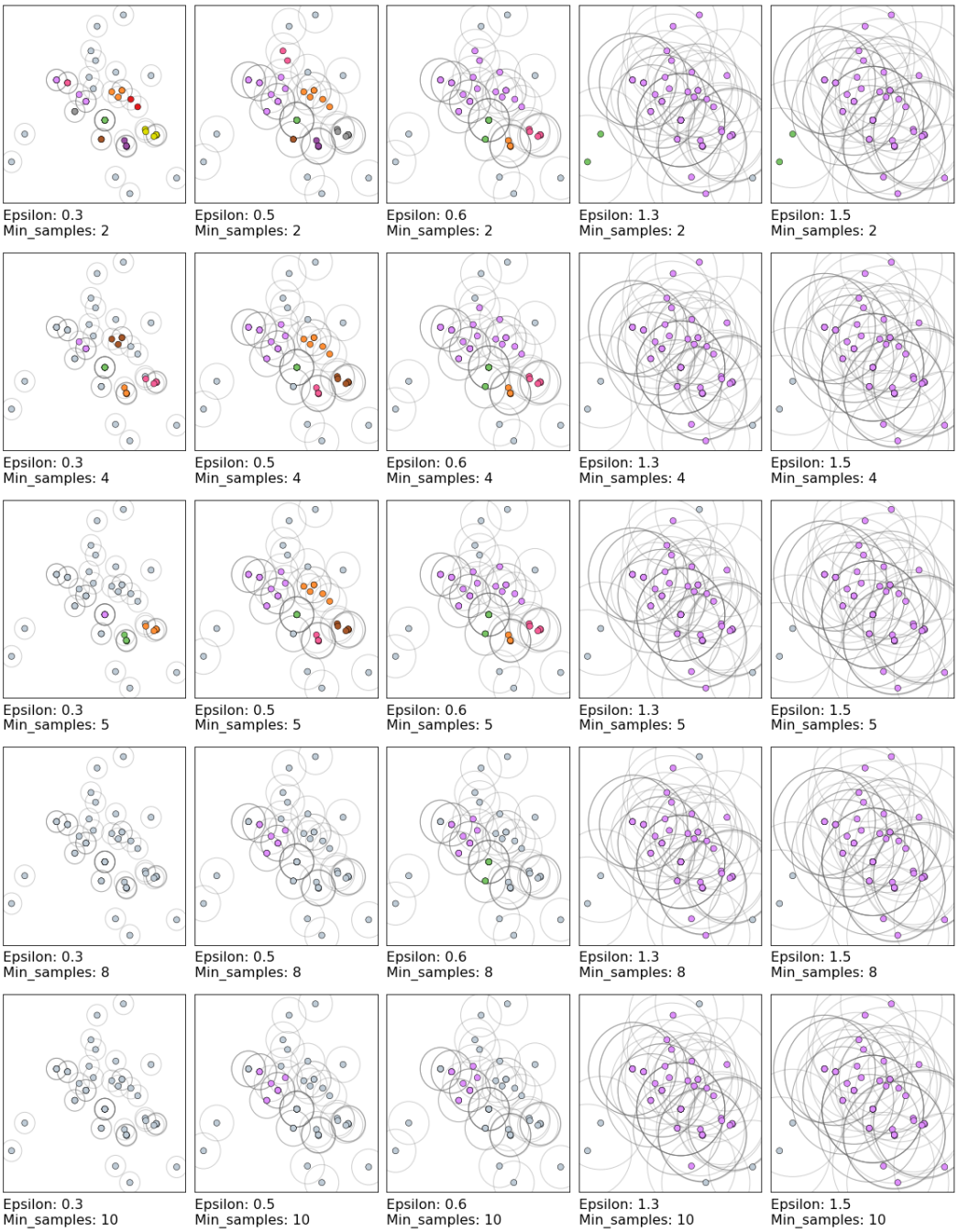
Neighbourhood

In [25]:
```
plot_clustered_dataset(dataset_1, clustering_labels_1, neighborhood=True)
```



Grid of DBSCAN Clusters

In [116]:
```
eps_values = [0.3, 0.5, 0.6, 1.3, 1.5]
min_samples_values = [2, 4, 5, 8, 10]

plot_dbscan_grid(dataset_1, eps_values, min_samples_values)
```



In [91]:
```
from itertools import product
eps_values = np.arange(0.5,1.7,0.1)
min_samples = np.arange(2,10)
dbscan_params = list(product(eps_values, min_samples))
no_of_clusters = []
sil_score = []
epsvalues = []
min_samp = []

for p in dbscan_params:
    dbscan_cluster = cluster.DBSCAN(eps=p[0], min_samples=p[1]).fit(df_scale)
    epsvalues.append(p[0])
    min_samp.append(p[1])
    no_of_clusters.append(len(np.unique(dbscan_cluster.labels_))-1)
    sil_score.append(silhouette_score(df, dbscan_cluster.labels_))
    eps_min = list(zip(no_of_clusters, sil_score, epsvalues,min_samp))


eps_min_df = pd.DataFrame(eps_min, columns=['no_of_clusters', 'silhouette_score', 'epsilon_values', '
minimum_points'])
eps_min_df
```

Out[91]:

	no_of_clusters	silhouette_score	epsilon_values	minimum_points
0	7	0.415271	0.5	2
1	5	0.345351	0.5	3
2	5	0.345351	0.5	4
3	5	0.345351	0.5	5
4	3	0.151078	0.5	6
...	...	...	...	...
91	1	0.489871	1.6	5
92	1	0.489871	1.6	6
93	1	0.489871	1.6	7
94	1	0.489871	1.6	8
95	1	0.489871	1.6	9

96 rows × 4 columns

In [98]:
```
eps_min_df.sort_values(by=['no_of_clusters'],ascending=False)
```

Out[98]:

	no_of_clusters	silhouette_score	epsilon_values	minimum_points
0	7	0.415271	0.5	2
1	5	0.345351	0.5	3
2	5	0.345351	0.5	4
3	5	0.345351	0.5	5
11	4	0.246006	0.6	5
...	...	...	...	...
46	1	0.385537	1.0	8
45	1	0.407942	1.0	7
44	1	0.428787	1.0	6
43	1	0.428787	1.0	5
95	1	0.489871	1.6	9

96 rows × 4 columns

In [86]:
```
eps_min_df.sort_values(by=['silhouette_score'],ascending=False)
```

Out[86]:

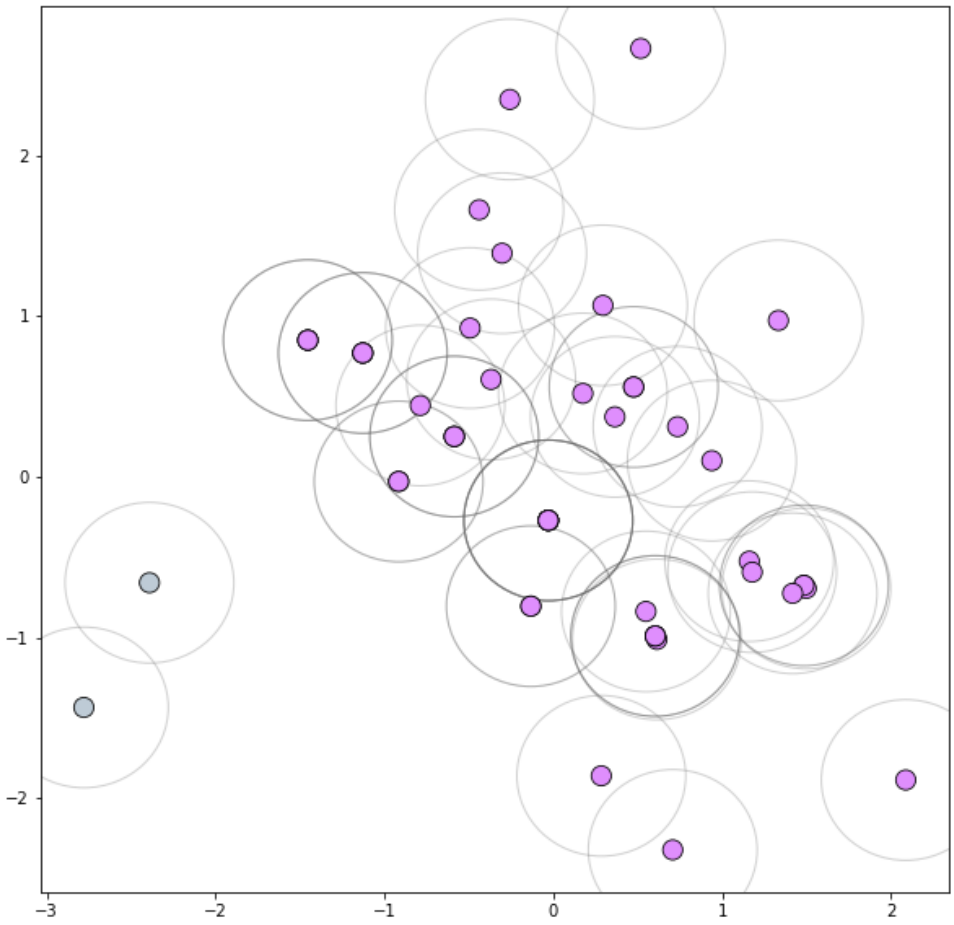
	no_of_clusters	silhouette_score	epsilon_values	minimum_points
95	1	0.489871	1.6	9
83	1	0.489871	1.5	5
72	1	0.489871	1.4	2
74	1	0.489871	1.4	4
75	1	0.489871	1.4	5
...	...	...	...	...
15	1	0.135394	0.6	9
7	1	0.113308	0.5	9
6	1	0.113308	0.5	8
13	2	0.090264	0.6	7
14	2	0.051684	0.6	8

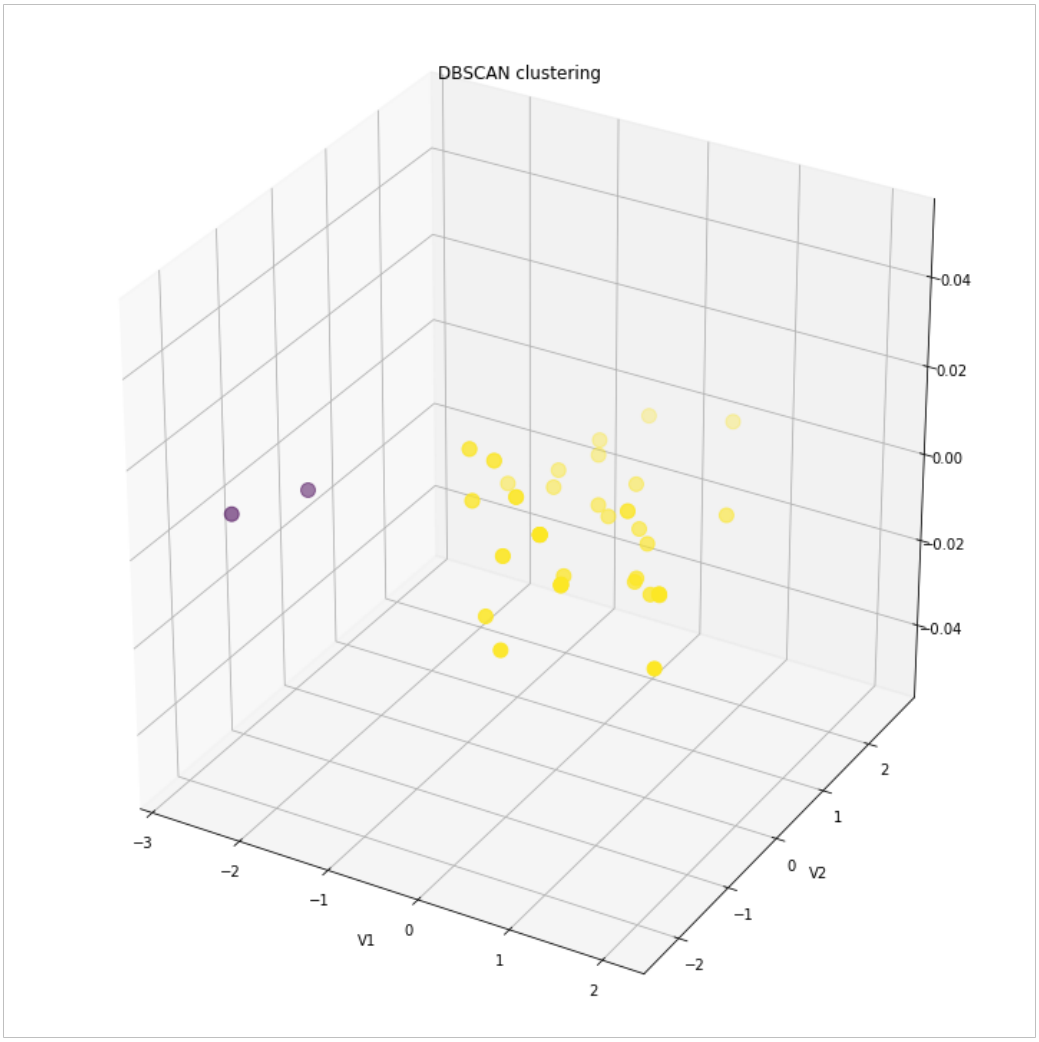
96 rows × 4 columns

Purely clustering based on high Silhoutte Index will give only 1 cluster. So you have to be clever enough to identify trade off between Silhoutte & No_of_clusters for better clustering

In [114]:
```
dbscan = cluster.DBSCAN(eps=1.6, min_samples=9)
clustering_labels_1 = dbscan.fit_predict(dataset_1)


n_clusters_ = len(set(clustering_labels_1)) - (1 if -1 in clustering_labels_1 else 0)
n_noise_ = list(clustering_labels_1).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
print("Silhouette Coefficient: %0.3f" % metrics.silhouette_score(df_scale, clustering_labels_1))

plot_clustered_dataset(dataset_1, clustering_labels_1,neighborhood=True)

fig = plt.figure(figsize=(10,10))
ax = Axes3D(fig)
ax.scatter(dataset_1[:, 0], dataset_1[:, 1], c=clustering_labels_1 ,s=100, cmap="viridis")
plt.title("DBSCAN clustering")
plt.xlabel("V1")
plt.ylabel("V2")
plt.show()
```

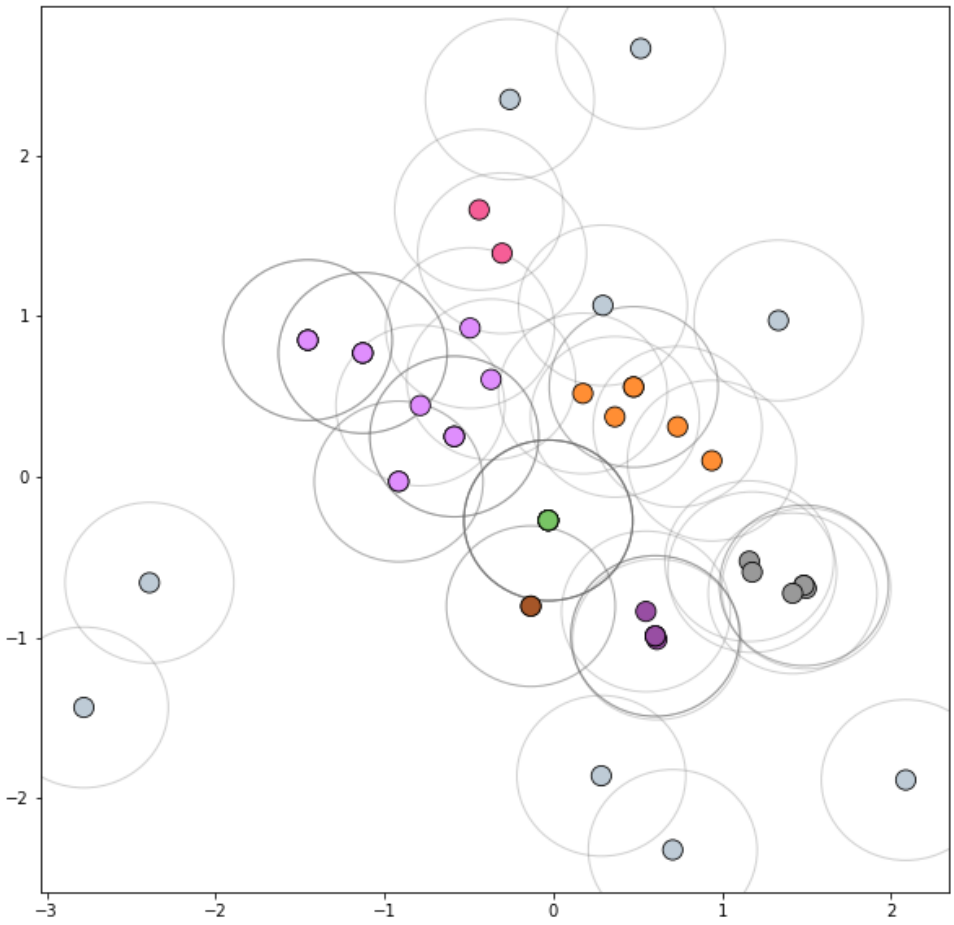
Estimated number of clusters: 1
Estimated number of noise points: 2
Silhouette Coefficient: 0.466

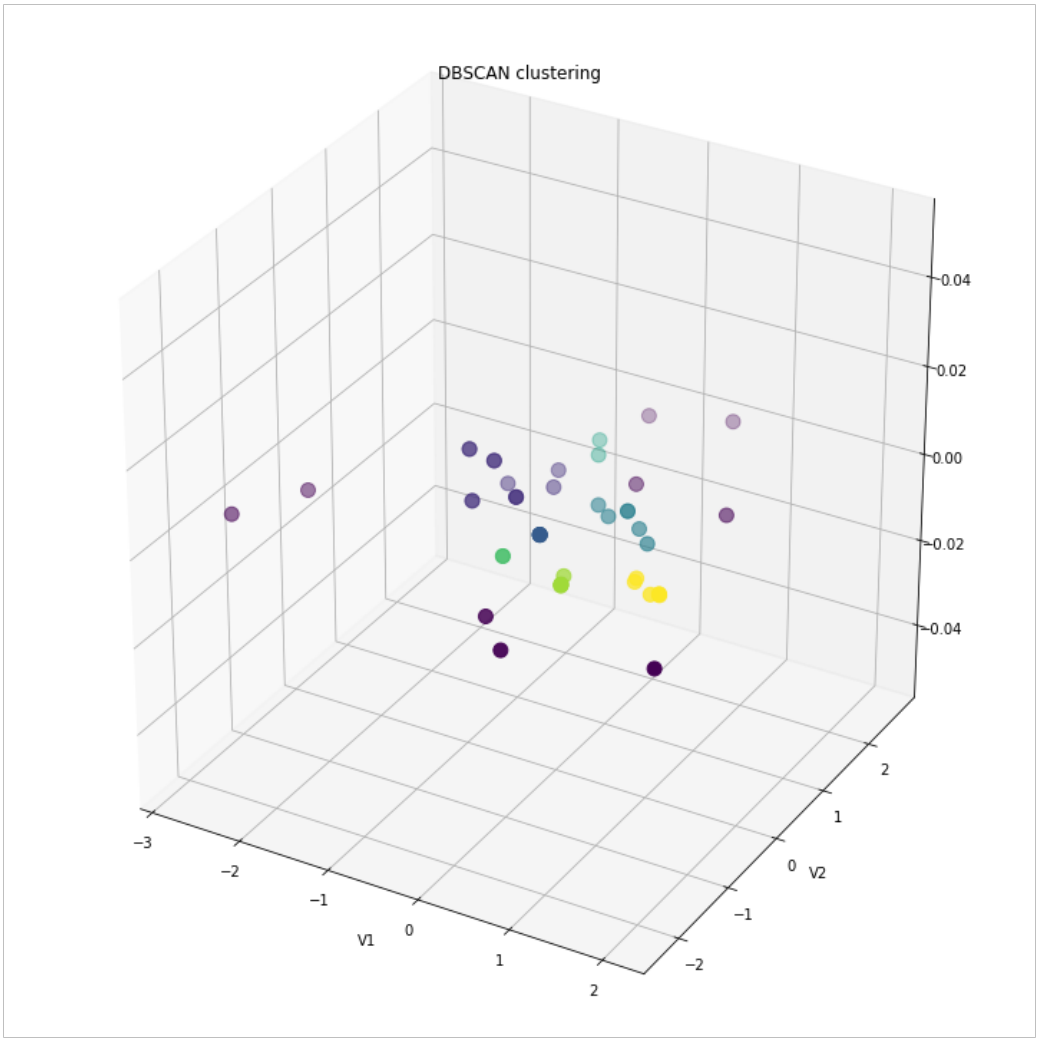



DBSCAN clustering
0.04
0.02
0.00
−0.02
−0.04
−3
−2
−1
V1
0
1
2
2
1
0
V2
−1
−2

In [113]:
```
dbscan = cluster.DBSCAN(eps=0.5, min_samples=2)
clustering_labels_1 = dbscan.fit_predict(dataset_1)


n_clusters_ = len(set(clustering_labels_1)) - (1 if -1 in clustering_labels_1 else 0)
n_noise_ = list(clustering_labels_1).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
print("Silhouette Coefficient: %0.3f" % metrics.silhouette_score(df_scale, clustering_labels_1))

plot_clustered_dataset(dataset_1, clustering_labels_1,neighborhood=True)

fig = plt.figure(figsize=(10,10))
ax = Axes3D(fig)
ax.scatter(dataset_1[:, 0], dataset_1[:, 1], c=clustering_labels_1 ,s=100, cmap="viridis")
plt.title("DBSCAN clustering")
plt.xlabel("V1")
plt.ylabel("V2")
plt.show()
```

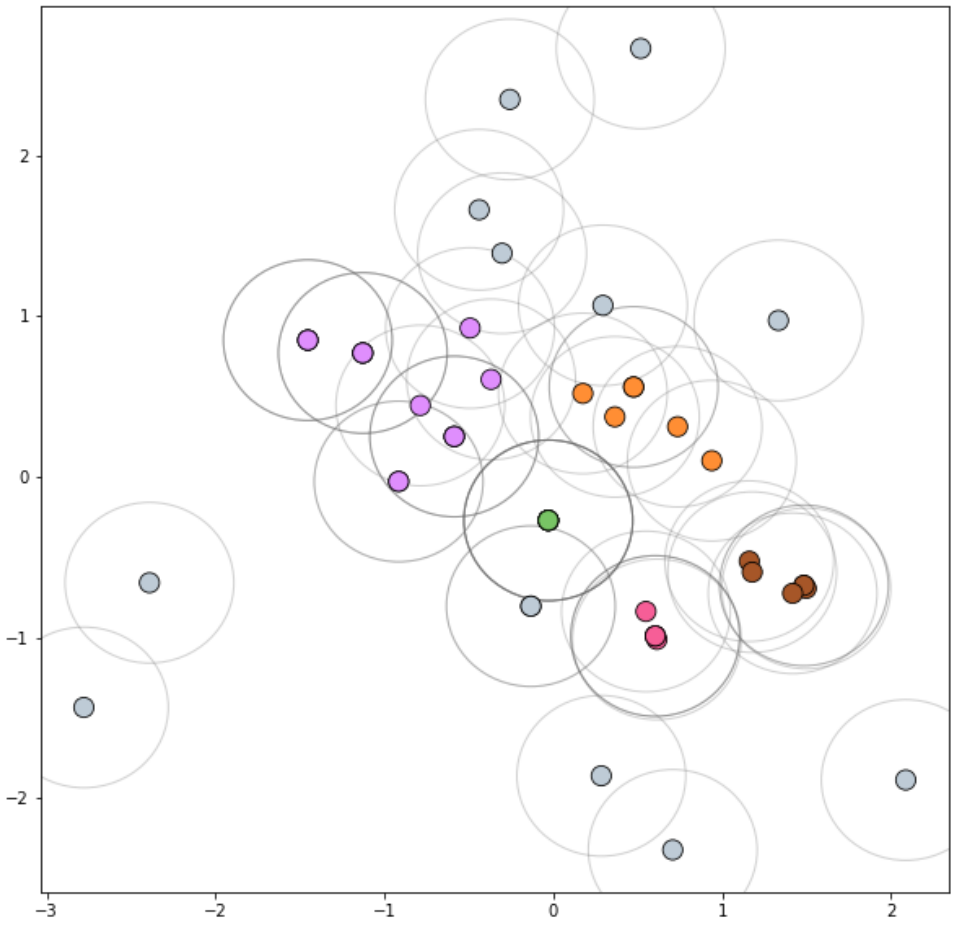
Estimated number of clusters: 7
Estimated number of noise points: 9
Silhouette Coefficient: 0.420

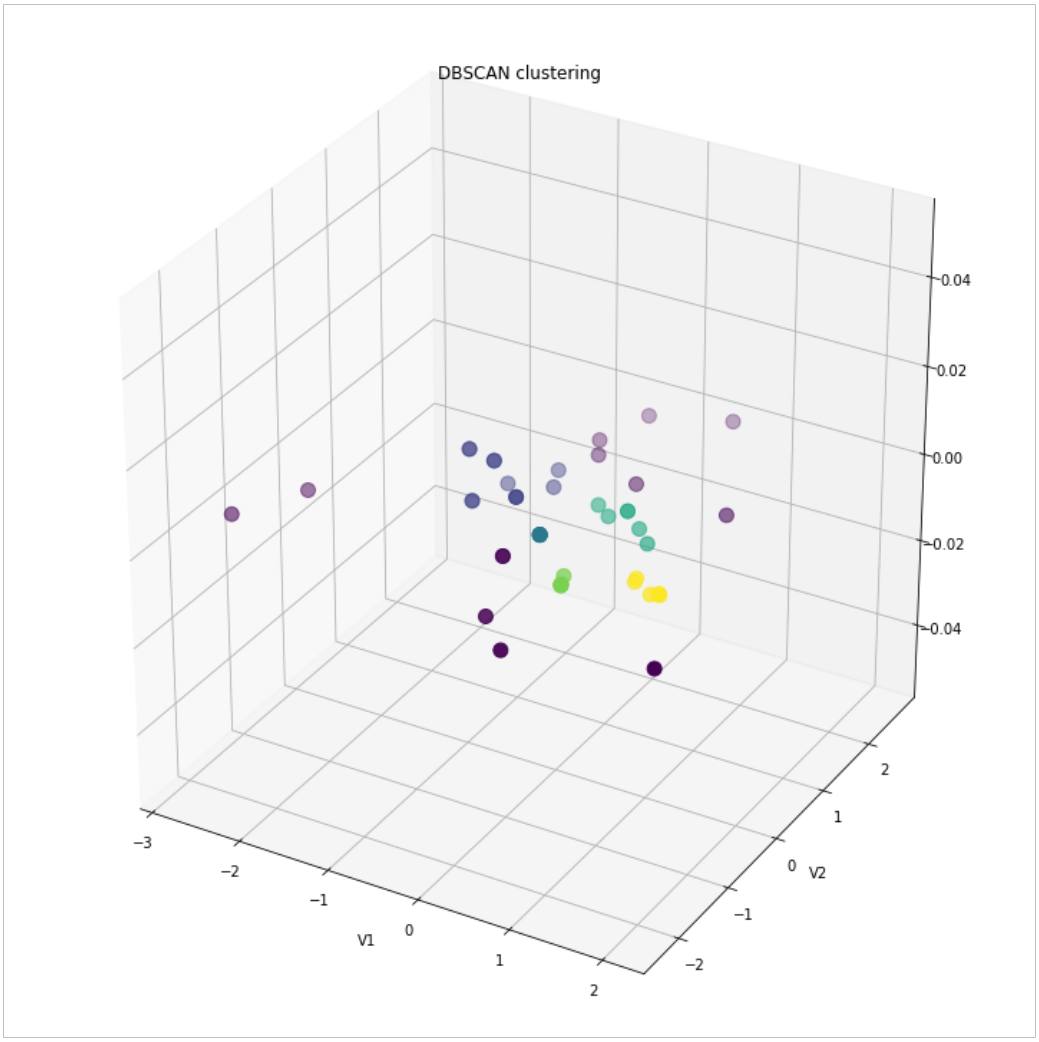



DBSCAN clustering
0.04
0.02
0.00
−0.02
−0.04
−3
−2
−1
0
1
2
V1
2
1
0
−1
−2
V2

In [112]:
```
dbscan = cluster.DBSCAN(eps=0.5, min_samples=3)
clustering_labels_1 = dbscan.fit_predict(dataset_1)


n_clusters_ = len(set(clustering_labels_1)) - (1 if -1 in clustering_labels_1 else 0)
n_noise_ = list(clustering_labels_1).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
print("Silhouette Coefficient: %0.3f" % metrics.silhouette_score(df_scale, clustering_labels_1))

plot_clustered_dataset(dataset_1, clustering_labels_1,neighborhood=True)

fig = plt.figure(figsize=(10,10))
ax = Axes3D(fig)
ax.scatter(dataset_1[:, 0], dataset_1[:, 1], c=clustering_labels_1 ,s=100, cmap="viridis")
plt.title("DBSCAN clustering")
plt.xlabel("V1")
plt.ylabel("V2")
plt.show()
```

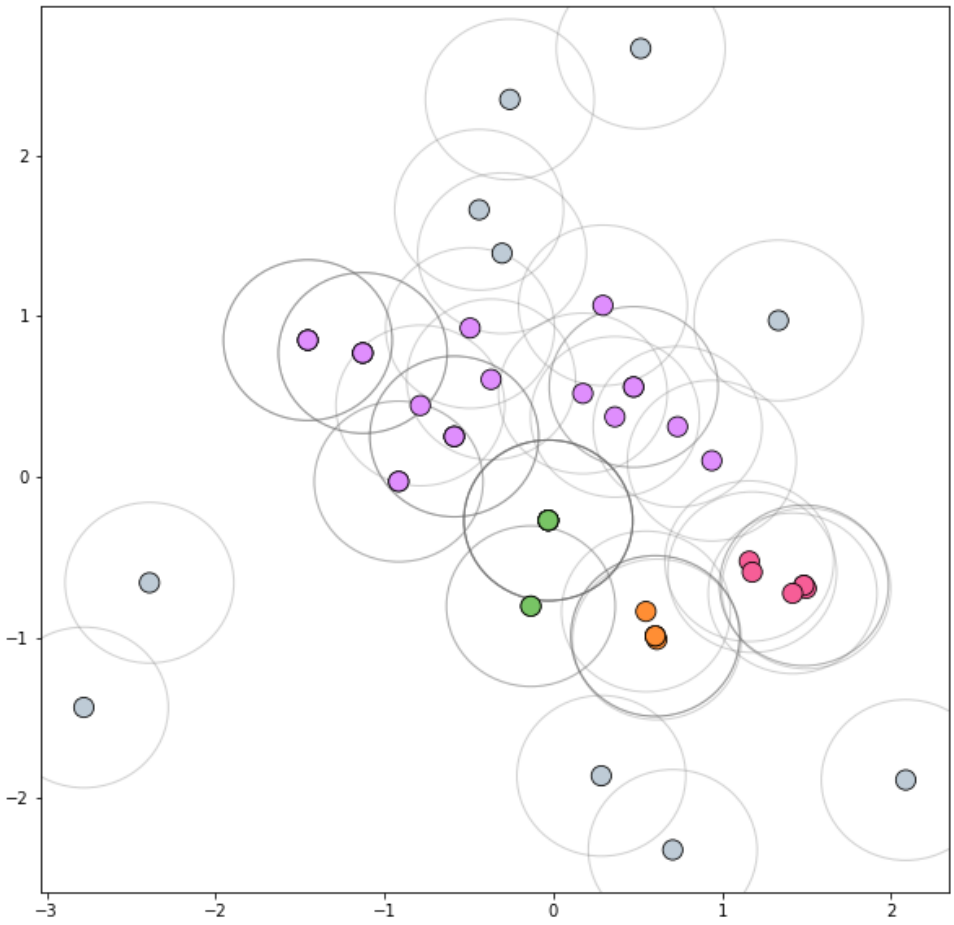
Estimated number of clusters: 5
Estimated number of noise points: 13
Silhouette Coefficient: 0.350

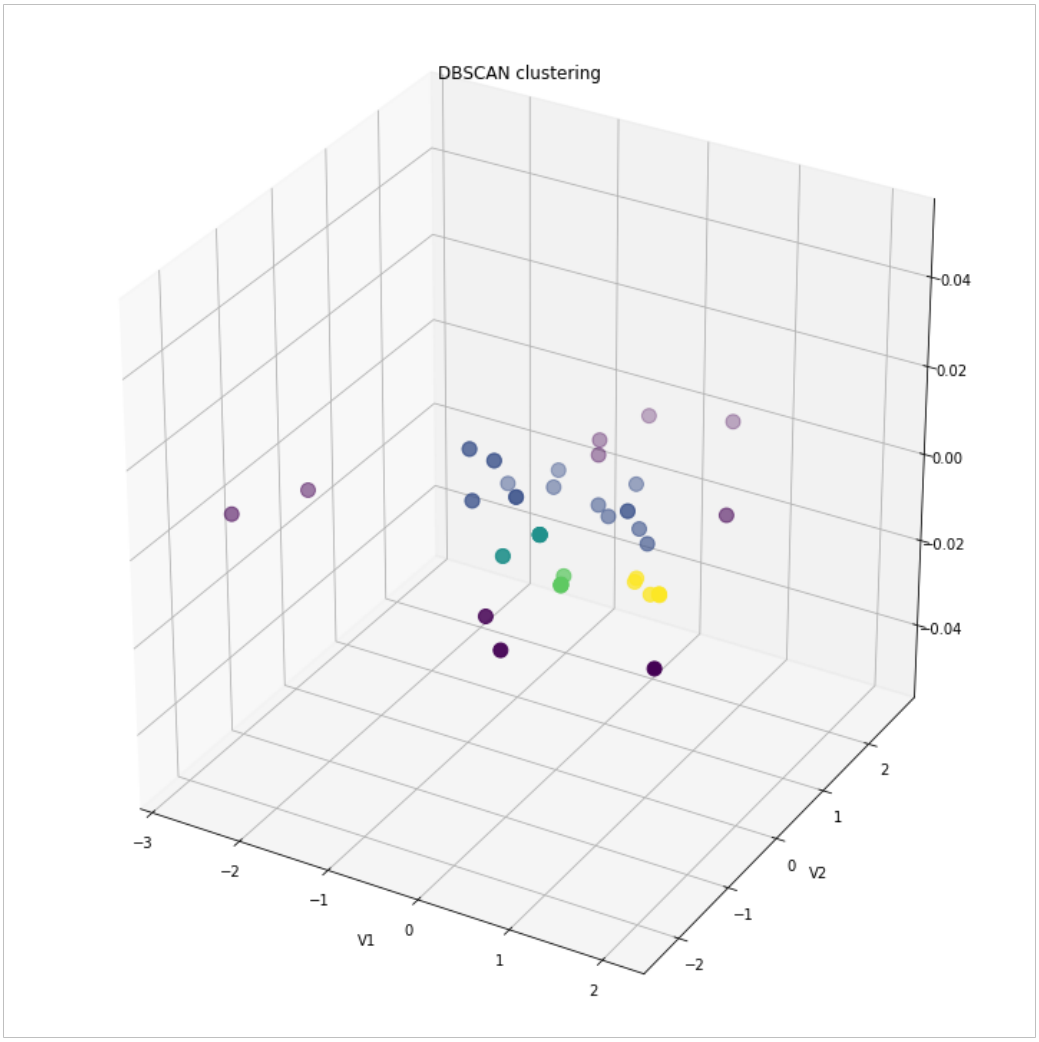



DBSCAN clustering
0.04
0.02
0.00
−0.02
−0.04
−3
−2
−1
V1
0
1
2
2
1
0
V2
−1
−2

In [111]:
```
dbscan = cluster.DBSCAN(eps=0.6, min_samples=5)
clustering_labels_1 = dbscan.fit_predict(dataset_1)


n_clusters_ = len(set(clustering_labels_1)) - (1 if -1 in clustering_labels_1 else 0)
n_noise_ = list(clustering_labels_1).count(-1)
print('Estimated number of clusters: %d' % n_clusters_)
print('Estimated number of noise points: %d' % n_noise_)
print("Silhouette Coefficient: %0.3f" % metrics.silhouette_score(df_scale, clustering_labels_1))

plot_clustered_dataset(dataset_1, clustering_labels_1,neighborhood=True)

fig = plt.figure(figsize=(10,10))
ax = Axes3D(fig)
ax.scatter(dataset_1[:, 0], dataset_1[:, 1], c=clustering_labels_1 ,s=100, cmap="viridis")
plt.title("DBSCAN clustering")
plt.xlabel("V1")
plt.ylabel("V2")
plt.show()
```

Estimated number of clusters: 4
Estimated number of noise points: 10
Silhouette Coefficient: 0.266




DBSCAN clustering
0.04
0.02
0.00
−0.02
−0.04
−3
−2
−1
V1
0
1
2
2
1
0
V2
−1
−2