worksheet_07

February 25, 2024

1 Worksheet 07

Name:
UID:

1.0.1 Topics

- Density-Based Clustering

1.0.2 Density-Based Clustering

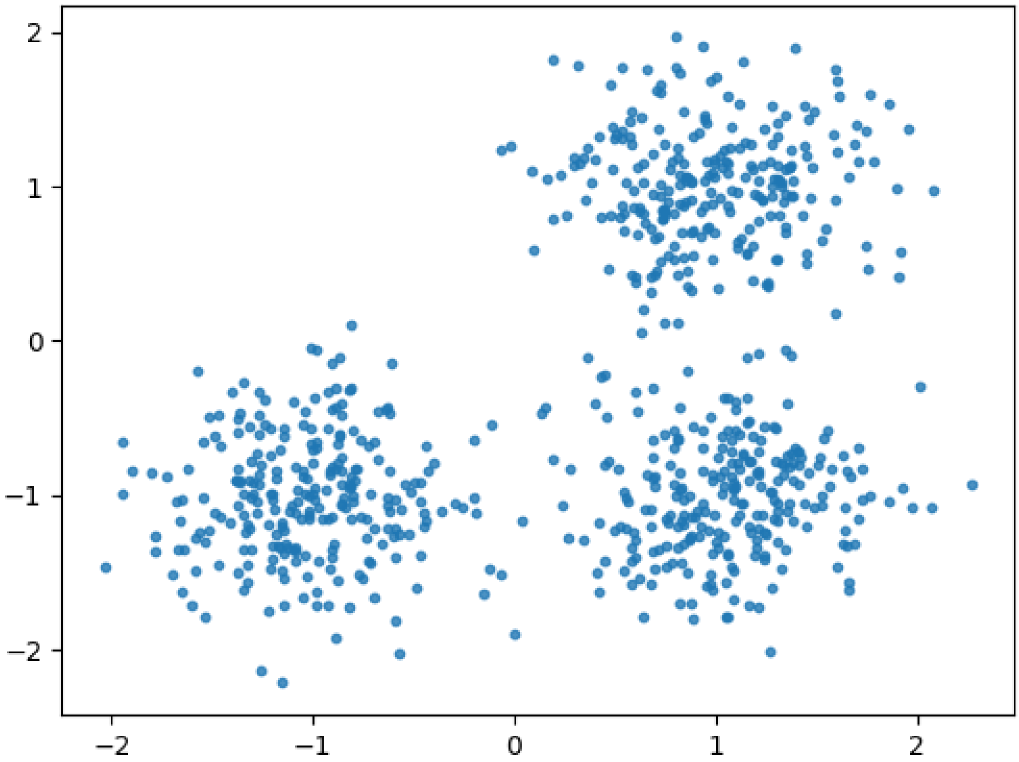
Follow along with the live coding of the DBScan algorithm.

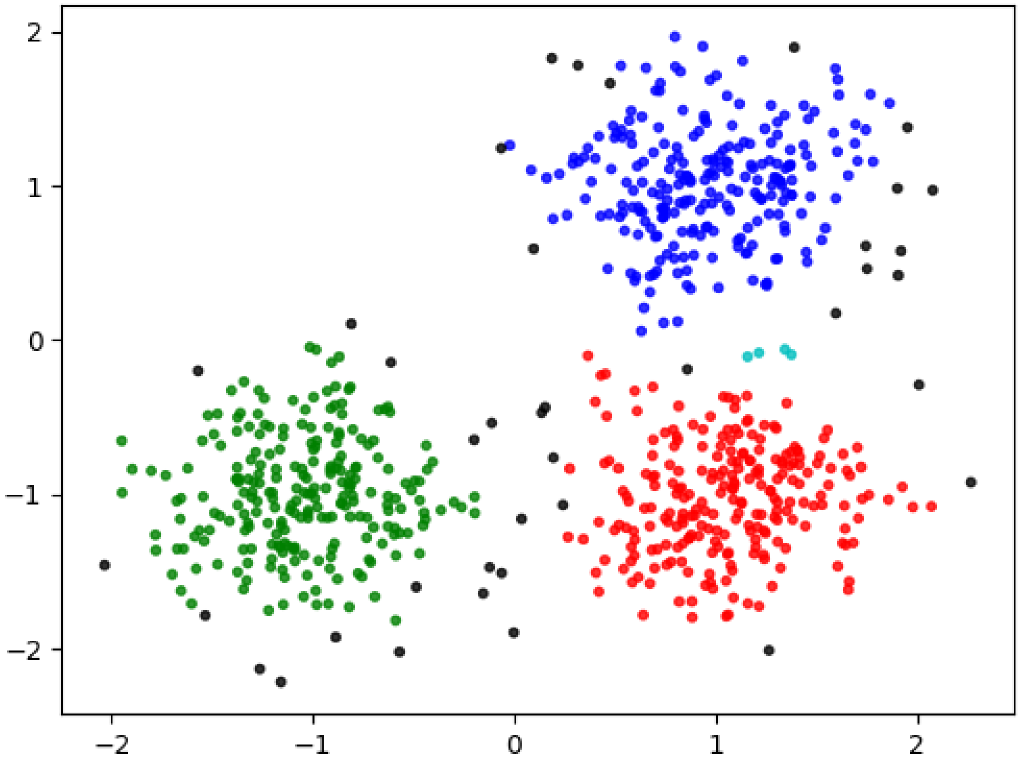
[5]:

```
import numpy as np
import matplotlib.pyplot as plt
import sklearn.datasets as datasets

centers = [[1, 1], [-1, -1], [1, -1]]
X, _ = datasets.make_blobs(n_samples=750, centers=centers, cluster_std=0.4,
                            random_state=0)

print(X)
plt.scatter(X[:,0],X[:,1],s=10, alpha=0.8)
plt.show()



class DBC():

    def __init__(self, dataset, min_pts, epsilon):
        self.dataset = dataset
        self.min_pts = min_pts
        self.epsilon = epsilon
        self.assignments = [-1 for x in range(len(self.dataset))]

    def dbscan(self):
        """
        returns a list of assignments. The index of the
        assignment should match the index of the data point
```

```python
        in the dataset.
        """


        cluster_id = 0 #changed cluster num to cluster id cause it makes more sense to me
        for i in range(len(self.dataset)):
            if not self.is_unassigned(i) :
                continue
            if self.is_core_point(i):
                #start building new cluster
                self.make_cluster(i, cluster_id=cluster_id)
                cluster_id += 1


        return self.assignments


    def is_core_point(self, i):

        return len(self.get_neigborhood(i)) >= self.min_pts

    def is_unassigned(self, i):
        return self.assignments[i] == -1

    def get_neigborhood(self, i):
        neighborhood = []
        for j in range(len(self.dataset)):
            if i != j and self.distance(i, j) <= self.epsilon:
                neighborhood.append(j)
        return neighborhood


    def get_unassigned_neigborhood(self, i):
        neighborhood = self.get_neigborhood(i)
        return [point for point in neighborhood if self.is_unassigned(point)]


    def distance(self, i, j):
        return np.linalg.norm(self.dataset[i] - self.dataset[j])

    def make_cluster(self, i, cluster_id):
        self.assignments[i] = cluster_id
        neighbors_queue = self.get_unassigned_neigborhood(i) #maybe get a stack or a double ended queue

        while len(neighbors_queue) > 0:
            next_pt = neighbors_queue.pop()
            if not self.is_unassigned(next_pt): #Todo: Make this a function and improve data structure
                continue
            self.assignments[next_pt] = cluster_id #Note: border points will be assigmend to the cluster in a last come last serve basis
            if self.is_core_point(next_pt):
                #self.assignments[next_pt] = cluster_id
                neighbors_queue += self.get_unassigned_neigborhood(next_pt)


        return

clustering = DBC(X, 3, .2).dbscan()
colors = np.array([x for x in 'bgrcmykbgrcmykbgrcmykbgrcmyk'])
colors = np.hstack([colors] * 200)
plt.scatter(X[:, 0], X[:, 1], color=colors[clustering].tolist(), s=10, alpha=0.8)
plt.show()
```

```
[[ 0.84022039  1.14802236]
 [-1.15474834 -1.2041171 ]
 [ 0.67863613  0.72418009]
 …
 [ 0.26798858 -1.27833405]
 [-0.88628813 -0.30293249]
 [ 0.60046048 -1.29605472]]
```


2
1
0
−1
−2
−2
−1
0
1
2


2
1
0
−1
−2
−2
−1
0
1
2

1.1 Challenge Problem

Using the code above and the template provided below, create the animation below of the DBScan algorithm.

[6]:

```
from IPython.display import Image
Image(filename="dbscan_2.gif", width=500, height=500)
```

[6]:

```
<IPython.core.display.Image object>
```

Hints:

- First animate the dbscan algorithm for the dataset used in class (before trying to create the above dataset)
- Take a snapshot of the assignments when the point gets assigned to a cluster
- Confirm that the snapshot works by saving it to a file
- Don't forget to close the matplotlib plot after saving the figure
- Gather the snapshots in a list of images that you can then save as a gif using the code below
- Use `ax.set_aspect('equal')` so that the circles don't appear to be oval shaped
- To create the above dataset you need two blobs for the eyes. For the mouth you can use the following process to generate (x, y) pairs:
    - Pick an x at random in an interval that makes sense given where the eyes are positioned
    - For that x generate y that is 0.2 * x^2 plus a small amount of randomness
    - `zip` the x's and y's together and append them to the dataset containing the blobs

[4]:

```
import numpy as np
from PIL import Image as im
import matplotlib.pyplot as plt
import sklearn.datasets as datasets



TEMPFILE = 'temp.png'

class DBC():

    def __init__(self, dataset, min_pts, epsilon):
        self.dataset = dataset
        self.min_pts = min_pts
        self.epsilon = epsilon
        self.snaps = []
        self.assignments = [-1 for x in range(len(self.dataset))]


    '''A get function to return the x axis of the point i in the dataset'''
    def getX(self,i):
        return self.dataset[i,0]



    '''A get function to return the y axis of the point i in the dataset'''
    def getY(self,i):
        return self.dataset[i,1]


    def snapshot(self,i):
        fig, ax = plt.subplots()

        '''This colors variables follows the same one as the gif '''
        colors = np.array([x for x in 'gcrmykbgrcmykbgrcmykbgrcmyk'])
        colors = np.hstack([colors] * 200)
        '''
        I need the x and y axis of the dataset to plot the point i for the␣
↪circle. This way the circle will be centered around the point i

        '''
        x = self.dataset[:,0]
        y = self.dataset[:,1]

        coloring = []

        '''Because the example gif has the unassigned points as blue I will do␣
↪the same.'''
        for j in range(len(self.dataset)):
            if self.assignments[j] == -1:
                coloring.append('b')
            else:
                coloring.append(colors[self.assignments[j]])

        '''Here we create the sanpshot of the current state of the dataset and␣
↪the clusters. and use the coloring we assigned in the above for loop'''
        ax.scatter(x, y, s=10, linewidth=0.25, color=coloring)


        '''Here we create the circle and center it around the point i. I tried␣
↪to make the circle just as big as in the example gif. I did fill = false to␣
↪make it transparent and edgecolor to make the circle black.'''
        cir = plt.Circle(xy=[self.getX(i), self.getY(i)], radius=.25 , fill =␣
↪False, edgecolor= 'black' ) # create circle around the point assigned
        ax.add_patch(cir)
        ax.set_xlim(min(x)-1,max(x)+1)
        ax.set_ylim(min(y)-1, max(y)+1)
        ax.set_aspect('equal') # necessary or else the circles appear to be␣
↪oval shaped

        fig.savefig(TEMPFILE)
        plt.close()

        return im.fromarray(np.asarray(im.open(TEMPFILE)))


    def dbscan(self):
        cluster_id = 0 #changed cluster num to cluster id cause it makes more␣
↪sense to me
        for i in range(len(self.dataset)):
            if not self.is_unassigned(i) :
                continue
            if self.is_core_point(i):
                #start building new cluster
                self.make_cluster(i, cluster_id=cluster_id)
                cluster_id += 1


        return self.assignments


    def is_core_point(self, i):

        return len(self.get_neigborhood(i)) >= self.min_pts

    def is_unassigned(self, i):
        return self.assignments[i] == -1

    def get_neigborhood(self, i):
        neighborhood = []
        for j in range(len(self.dataset)):
            if i != j and self.distance(i, j) <= self.epsilon:
                neighborhood.append(j)
        return neighborhood


    def get_unassigned_neigborhood(self, i):
        neighborhood = self.get_neigborhood(i)
        return [point for point in neighborhood if self.is_unassigned(point)]


    def distance(self, i, j):
        return np.linalg.norm(self.dataset[i] - self.dataset[j])
```

```python
    def make_cluster(self, i, cluster_id):
        self.assignments[i] = cluster_id
        neighbors_queue = self.get_unassigned_neigborhood(i) #maybe get a stack or a double ended queue

        while len(neighbors_queue) > 0:
            next_pt = neighbors_queue.pop()
            if not self.is_unassigned(next_pt): #Todo: Make this a function and improve data structure
                continue
            self.assignments[next_pt] = cluster_id #Note: border points will be assigmend to the cluster in a last come last serve basis
            if self.is_core_point(next_pt):
                neighbors_queue += self.get_unassigned_neigborhood(next_pt)

                '''I snap after each point is assigned to a cluster, This makes it so that you can see the points get assigned to the cluster in the gif as well as seeing
                the circle move around in the gif'''

                self.snaps.append(self.snapshot(next_pt))



        return



'''
Centers of the eyes are about one interval apart, this is great for the face
since the eyes are the same distance from the center of the face.
and are spaced apart enough'''



centers = [[1, 2], [-1, 2]]
eyes, _= datasets.make_blobs(n_samples=350,centers=centers, cluster_std=0.2, random_state=0)



'''the x axis of the mouth is between the interval of -2 and 2 This is great for the face and a wide smile
The way im using the given function multiplying it by 4 and subtracting two so its in the range [-2,2]'''
mouth_x = 4 * np.random.random(500)-2
```

```
'''I am using the given formuia to create a smiley face, the y axis is a function of the x axis, because mouth_x is a numpy array I can use the formula on the entire array at once.'''
mouth_y =   0.2 * mouth_x**2 + 0.1 * np.random.randn(*mouth_x.shape)




mouth = zip(mouth_x, mouth_y)

face = np.append(eyes, list(mouth), axis=0)



dbc = DBC(face, 2, .2)
clustering = dbc.dbscan()

dbc.snaps[0].save(
    'Result_GRADER_LOOK_HERE_FOR_THE_GIF.gif',
    optimize=False,
    save_all=True,
    append_images=dbc.snaps[1:],
    loop=0,
    duration=25
)
```