DBSCAN CLUSTERING

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Density Based Clustering Methods

Density based clustering is a clustering technique that employs density parameter (local cluster criterion) or explicitly constructed density functions.

The major features of Density Based Clustering is following:

- It can discover clusters of arbitrary shape
- It can handle noisy data points
- Only single scan/iteration is required to do the clustering.
- It needs density parameter

There are several density based clustering techniques developed. Among which we shall focus on **DBSCAN**.

DBSCAN stands for ***D****ensity-****B****ased* ***S****patial* ***C****lustering* of ***A****pplications* with ***N****oise*. It can find arbitrary shaped clusters and clusters with noise (i.e., outliers).

DBSCAN

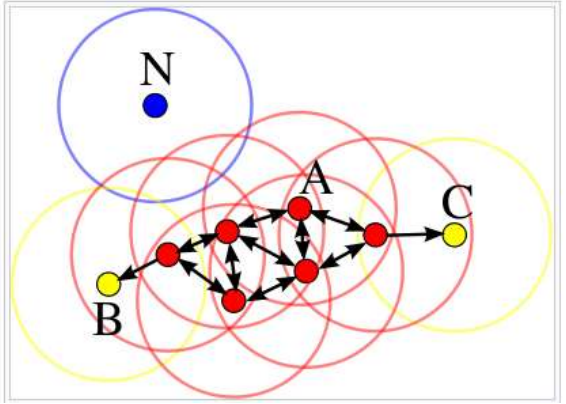
The main idea behind **DBSCAN** is that a point belongs to a cluster if it is close to many points from that cluster.

There are two key parameters of **DBSCAN**:

eps: The distance that specifies the neighborhoods. Two points are considered to be neighbors if the distance between them are less than or equal to eps.

minPts: Minimum number of data points to define a cluster.

Based on these two parameters, points are classified as core point, border point, or outlier:



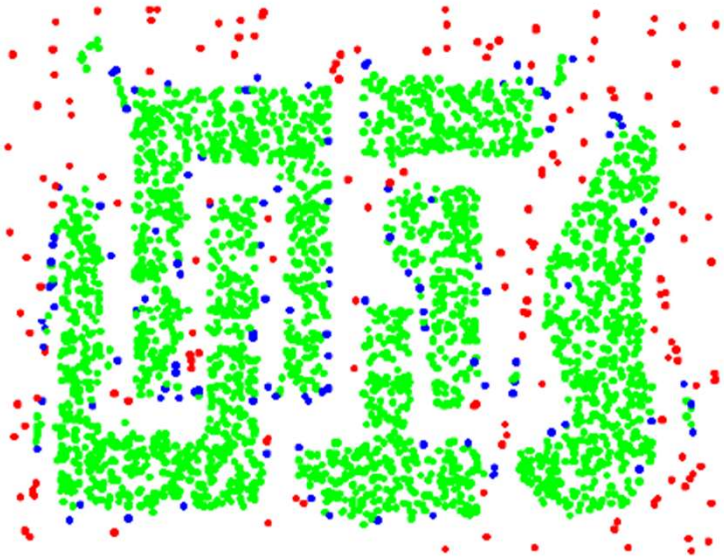
Core point: A point is a core point if there are at least **minPts** number of points (including the point itself) in its surrounding area with radius **eps**.

Border point: A point is a border point if it is reachable from a core point and there are less than **minPts** number of points within its surrounding area.

Outlier or Noise: A point is an outlier/noise if it is not a core point and not reachable from any core points.

DBSCAN

Original Points



Point types: core,
border and noise

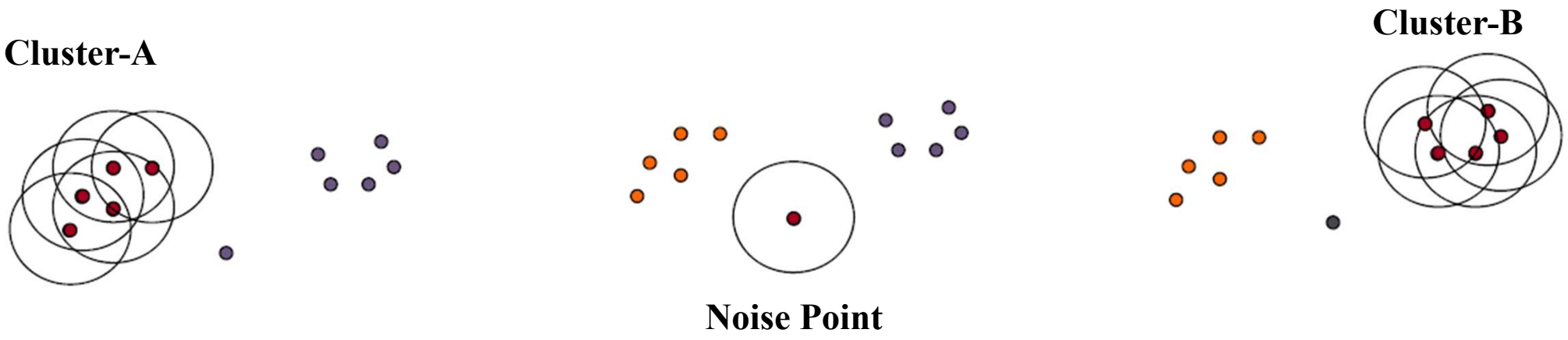
Eps = 10, MinPts = 4

DBSCAN

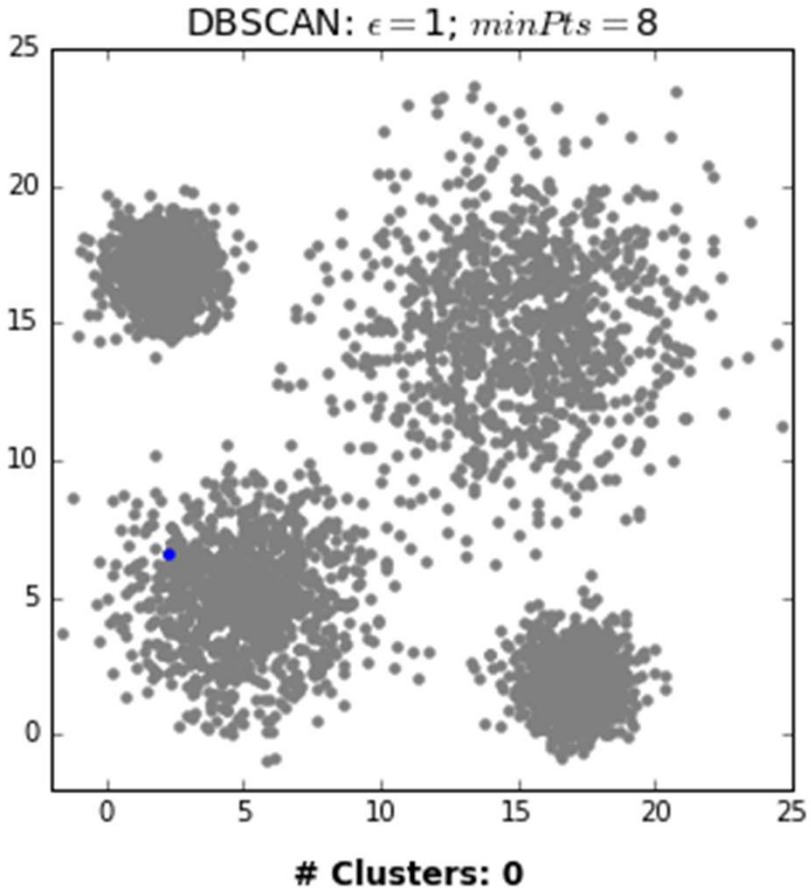
Following is the algorithm of DBSCAN:

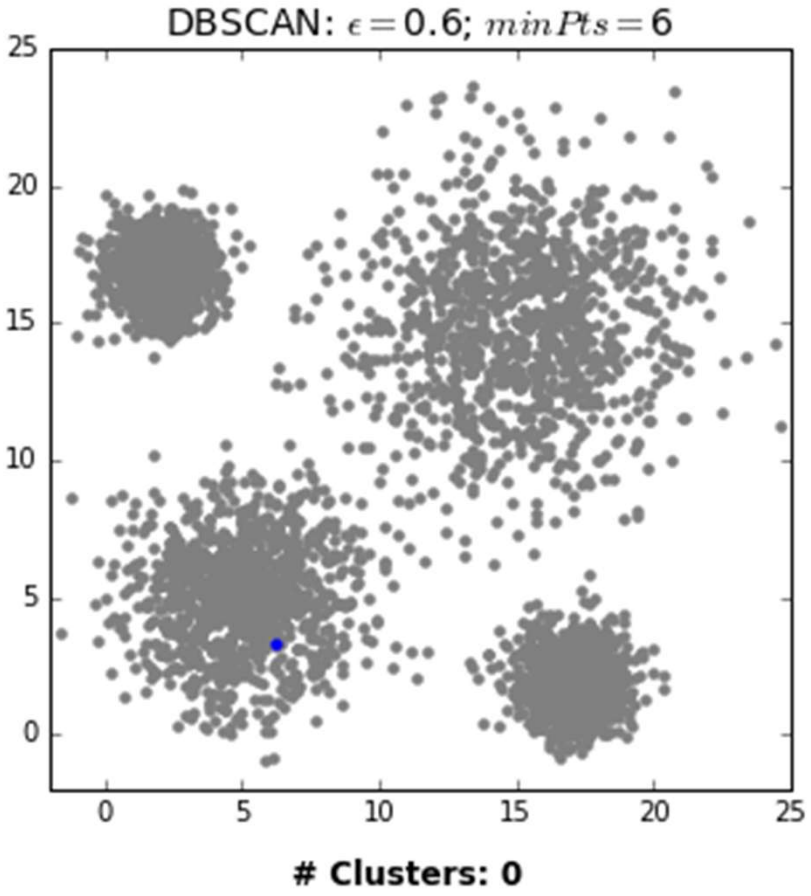
Suppose the dataset is denoted by D and $\boldsymbol{x}$ is a point / object in the dataset.

For each $\boldsymbol{x} \in D$
  If $\boldsymbol{x}$ is not yet assigned to any cluster
    If $\boldsymbol{x}$ is a core point **then**
      Collect all the points which are density-reachable (i.e. within radius eps) from $\boldsymbol{x}$ and assign them to a new cluster.
    Else assign $\boldsymbol{x}$ Noise



DBSCAN


DBSCAN: $\epsilon = 1$; $minPts = 8$
25
20
15
10
5
0
0
5
10
15
20
25
Clusters: 0


DBSCAN: $\epsilon = 0.6$; $minPts = 6$
25
20
15
10
5
0
0
5
10
15
20
25
Clusters: 0

DBSCAN

How to choose the optimum value of minPts and eps?

- Take a range of values of **minPts**, as suitable for your data.
- Take a range of values of **eps**, as suitable for your data.
- For each of the pair of values of (minPts, eps) fit the DBSCAN and compute the Silhouette Score.
- The pair of values (minPts, eps) which gives the best Silhouette Score, are the optimum values of minPts and eps.

DBSCAN

Pros:

- Does not require to specify number of clusters beforehand.
- Performs well with arbitrary shapes clusters.
- DBSCAN is robust to outliers and able to detect the outliers.

Cons:

- In some cases, determining an appropriate distance of neighborhood (eps) is not easy and it requires domain knowledge.
- If clusters are very different in terms of in-cluster densities, DBSCAN is not well suited to define clusters. The characteristics of clusters are defined by the combination of eps-minPts parameters. Since we pass in one eps-minPts combination to the algorithm, it cannot generalize well to clusters with much different densities.

Thank You