In [1]:

```
pip install pygad
```

```
Collecting pygadNote: you may need to restart the kernel to use updated pa
ckages.

  Downloading pygad-3.0.1-py3-none-any.whl (67 kB)
                                              0.0/68.0 kB ? eta -:--:--
     ------------                             20.5/68.0 kB ? eta -:--:--
     ------------                             20.5/68.0 kB ? eta -:--:--
     ------------                             20.5/68.0 kB ? eta -:--:--
     ------------                             20.5/68.0 kB ? eta -:--:--
     ------------                             20.5/68.0 kB ? eta -:--:--
     ----------------------                  41.0/68.0 kB 122.9 kB/s eta 0:
00:01
     ---------------------------------------- 68.0/68.0 kB 185.0 kB/s eta 0:
00:00
Collecting cloudpickle (from pygad)
  Downloading cloudpickle-2.2.1-py3-none-any.whl (25 kB)
Requirement already satisfied: matplotlib in c:\users\gowthami\appdata\loc
al\programs\python\python311\lib\site-packages (from pygad) (3.7.1)
Requirement already satisfied: numpy in c:\users\gowthami\appdata\local\pr
ograms\python\python311\lib\site-packages (from pygad) (1.24.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\gowthami\appda
ta\local\programs\python\python311\lib\site-packages (from matplotlib->pyg
ad) (1.0.7)
Requirement already satisfied: cycler>=0.10 in c:\users\gowthami\appdata\l
ocal\programs\python\python311\lib\site-packages (from matplotlib->pygad)
(0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\gowthami\appd
ata\local\programs\python\python311\lib\site-packages (from matplotlib->py
gad) (4.39.4)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\gowthami\appd
ata\local\programs\python\python311\lib\site-packages (from matplotlib->py
gad) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\users\gowthami\appdat
a\local\programs\python\python311\lib\site-packages (from matplotlib->pyga
d) (23.0)
Requirement already satisfied: pillow>=6.2.0 in c:\users\gowthami\appdata
\local\programs\python\python311\lib\site-packages (from matplotlib->pyga
d) (9.5.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\gowthami\appda
ta\local\programs\python\python311\lib\site-packages (from matplotlib->pyg
ad) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\gowthami\a
ppdata\local\programs\python\python311\lib\site-packages (from matplotlib-
>pygad) (2.8.2)
Requirement already satisfied: six>=1.5 in c:\users\gowthami\appdata\local
\programs\python\python311\lib\site-packages (from python-dateutil>=2.7->m
atplotlib->pygad) (1.16.0)
Installing collected packages: cloudpickle, pygad
Successfully installed cloudpickle-2.2.1 pygad-3.0.1
```

In [2]:

```
import numpy
import matplotlib.pyplot
import pygad
```

In [3]:

```
 cluster1_num_samples = 10
cluster1_x1_start = 0
cluster1_x1_end = 5
cluster1_x2_start = 2
cluster1_x2_end = 6
cluster1_x1 = numpy.random.random(size=(cluster1_num_samples))
cluster1_x1 = cluster1_x1 * (cluster1_x1_end - cluster1_x1_start) + cluster1_x1_start
cluster1_x2 = numpy.random.random(size=(cluster1_num_samples))
cluster1_x2 = cluster1_x2 * (cluster1_x2_end - cluster1_x2_start) + cluster1_x2_start
cluster2_num_samples = 10
cluster2_x1_start = 10
cluster2_x1_end = 15
cluster2_x2_start = 8
cluster2_x2_end = 12
cluster2_x1 = numpy.random.random(size=(cluster2_num_samples))
cluster2_x1 = cluster2_x1 * (cluster2_x1_end - cluster2_x1_start) + cluster2_x1_start
cluster2_x2 = numpy.random.random(size=(cluster2_num_samples))
cluster2_x2 = cluster2_x2 * (cluster2_x2_end - cluster2_x2_start) + cluster2_x2_start
```

In [4]:

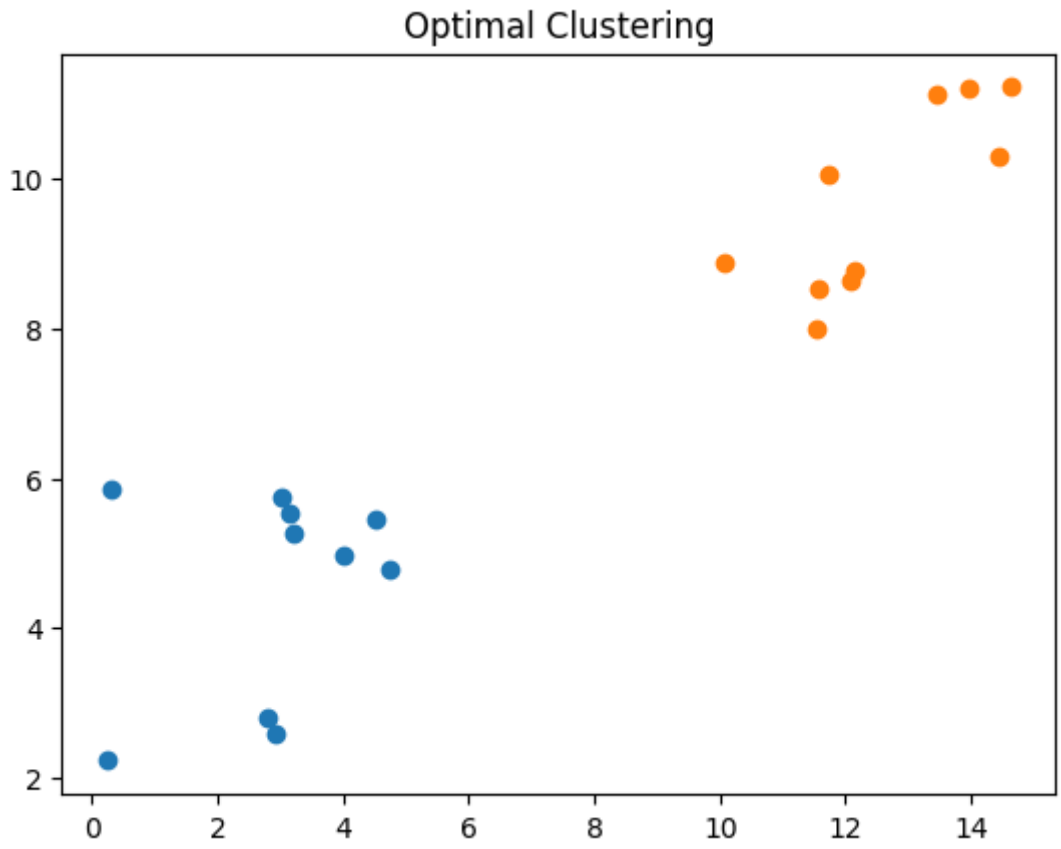
```
c1 = numpy.array([cluster1_x1, cluster1_x2]).T
c2 = numpy.array([cluster2_x1, cluster2_x2]).T
data = numpy.concatenate((c1, c2), axis=0)
data
```

Out[4]:

```
array([[ 3.19498971,  5.26824487],
       [ 4.7512663 ,  4.79012222],
       [ 4.51605642,  5.43910617],
       [ 3.14103999,  5.5448918 ],
       [ 3.01532003,  5.75824621],
       [ 0.3051457 ,  5.84105103],
       [ 2.8074246 ,  2.79578365],
       [ 4.00978512,  4.96137711],
       [ 2.91310154,  2.57790331],
       [ 0.23731362,  2.22134424],
       [13.97874086, 11.22247283],
       [11.7414585 , 10.06456851],
       [14.44216996, 10.29121276],
       [11.54517446,  8.00007573],
       [12.07178733,  8.64880332],
       [14.62779826, 11.22894165],
       [10.07604968,  8.87524255],
       [13.46924836, 11.14349171],
       [11.5727193 ,  8.52500632],
       [12.14322771,  8.78773035]])
```

In [5]:

```
matplotlib.pyplot.scatter(cluster1_x1, cluster1_x2)
matplotlib.pyplot.scatter(cluster2_x1, cluster2_x2)
matplotlib.pyplot.title("Optimal Clustering")
matplotlib.pyplot.show()
```



In [6]:

```
def euclidean_distance(X, Y):
 return numpy.sqrt(numpy.sum(numpy.power(X - Y, 2), axis=1))
```

In [8]:

```
def cluster_data(solution, solution_idx):
    global num_cluster, data
    feature_vector_length = data.shape[1]
    cluster_centers = []
    all_clusters_dists = []
    clusters = []
    clusters_sum_dist = []
    for clust_idx in range(num_clusters):
        cluster_centers.append(solution[feature_vector_length*clust_idx:feature_vector_l
        cluster_center_dists = euclidean_distance(data, cluster_centers[clust_idx])
        all_clusters_dists.append(numpy.array(cluster_center_dists))
    cluster_centers = numpy.array(cluster_centers)
    all_clusters_dists = numpy.array(all_clusters_dists)
    cluster_indices = numpy.argmin(all_clusters_dists, axis=0)
    for clust_idx in range(num_clusters):
        clusters.append(numpy.where(cluster_indices == clust_idx)[0])

    if len(clusters[clust_idx]) == 0:
        clusters_sum_dist.append(0)
    else:
        clusters_sum_dist.append(numpy.sum(all_clusters_dists[clust_idx, clusters[clust_
    clusters_sum_dist = numpy.array(clusters_sum_dist)
    return cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum_
```

In [9]:

```
def fitness_func(ga_instance,solution, solution_idx):
    _, _, _, _, clusters_sum_dist = cluster_data(solution, solution_idx)
    fitness = 1.0 / (numpy.sum(clusters_sum_dist) + 0.00000001)
    return fitness
```

In [ ]:

```

```