In [1]:

```
pip install pygad
```

```
Requirement already satisfied: pygad in c:\users\poorn\appdata\local\programs\pyth
on\python311\lib\site-packages (3.0.1)
Requirement already satisfied: cloudpickle in c:\users\poorn\appdata\local\program
s\python\python311\lib\site-packages (from pygad) (2.2.1)
Requirement already satisfied: matplotlib in c:\users\poorn\appdata\local\programs
\python\python311\lib\site-packages (from pygad) (3.7.1)
Requirement already satisfied: numpy in c:\users\poorn\appdata\local\programs\pyth
on\python311\lib\site-packages (from pygad) (1.24.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\poorn\appdata\local\pr
ograms\python\python311\lib\site-packages (from matplotlib->pygad) (1.0.7)
Requirement already satisfied: cycler>=0.10 in c:\users\poorn\appdata\local\progra
ms\python\python311\lib\site-packages (from matplotlib->pygad) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\poorn\appdata\local\p
rograms\python\python311\lib\site-packages (from matplotlib->pygad) (4.39.4)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\poorn\appdata\local\p
rograms\python\python311\lib\site-packages (from matplotlib->pygad) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\users\poorn\appdata\local\pro
grams\python\python311\lib\site-packages (from matplotlib->pygad) (23.1)
Requirement already satisfied: pillow>=6.2.0 in c:\users\poorn\appdata\local\progr
ams\python\python311\lib\site-packages (from matplotlib->pygad) (9.5.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\poorn\appdata\local\pr
ograms\python\python311\lib\site-packages (from matplotlib->pygad) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\poorn\appdata\loca
l\programs\python\python311\lib\site-packages (from matplotlib->pygad) (2.8.2)
Requirement already satisfied: six>=1.5 in c:\users\poorn\appdata\local\programs\p
ython\python311\lib\site-packages (from python-dateutil>=2.7->matplotlib->pygad)
(1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

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]:

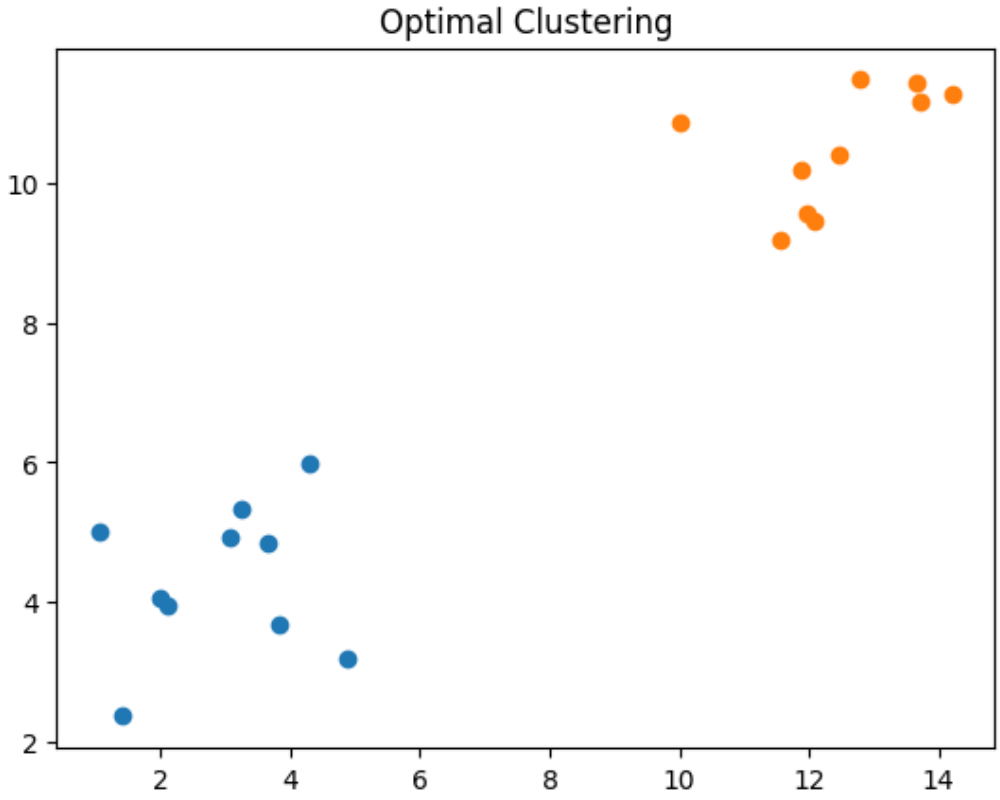
```
c1 = numpy.array([cluster1_x1, cluster1_x2]).T
c2 = numpy.array([cluster2_x1, cluster2_x2]).T
data = numpy.concatenate((c1, c2), axis=0)
data
```

Out[4]:

```
array([[ 1.99776746,  4.06609061],
       [ 4.28474095,  5.9854268 ],
       [ 2.10662706,  3.94056872],
       [ 3.83873075,  3.68920351],
       [ 3.24606985,  5.33738895],
       [ 1.39675362,  2.36302944],
       [ 3.05811615,  4.91405013],
       [ 3.65063614,  4.83785176],
       [ 1.05395706,  4.99871541],
       [ 4.86526453,  3.18643886],
       [12.45371256, 10.40963989],
       [13.67135724, 11.44063255],
       [11.98166844,  9.55021817],
       [11.87335382, 10.18547645],
       [12.77336452, 11.47477603],
       [11.55739749,  9.17730079],
       [14.20843946, 11.26868726],
       [12.08313441,  9.46006011],
       [13.72860513, 11.15263863],
       [10.00224958, 10.87338247]])
```

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 [7]:

```
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_length
 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[cl]
 clusters_sum_dist = numpy.array(clusters_sum_dist)
 return cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum_dists
```

```
  Cell In[7], line 10
    cluster_centers.append(solution[feature_vector_length*clust_idx:feature_vector
_length
    ^
IndentationError: expected an indented block after 'for' statement on line 9
```

In [ ]:

```
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 [16]:

```
num_clusters = 2
num_genes = num_clusters * data.shape[1]
ga_instance = pygad.GA(num_generations=100,
 sol_per_pop=10,
num_parents_mating=5,
init_range_low=-6,
init_range_high=20,
keep_parents=2,
num_genes=num_genes,
fitness_func=fitness_func,
suppress_warnings=True)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[16], line 10
      1 num_clusters = 2
      2 num_genes = num_clusters * data.shape[1]
      3 ga_instance = pygad.GA(num_generations=100,
      4  sol_per_pop=10,
      5 num_parents_mating=5,
      6 init_range_low=-6,
      7 init_range_high=20,
      8 keep_parents=2,
      9 num_genes=num_genes,
---> 10 fitness_func=fitness_func,
     11 suppress_warnings=True)

NameError: name 'fitness_func' is not defined
```

In [12]:

```
best_solution, best_solution_fitness, best_solution_idx = ga_instance.best_solution()
print("Best solution is {bs}".format(bs=best_solution))
print("Fitness of the best solution is {bsf}".format(bsf=best_solution_fitness))
print("Best solution found after {gen} generations".format(gen=ga_instance.best_solution_fitness
```

```
  Cell In[12], line 4
    print("Best solution found after {gen} generations".format(gen=ga_instance.bes
t_solution_fitness)

^
SyntaxError: incomplete input
```

In [13]:

```
cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum= cluster_data
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[13], line 1
----> 1 cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_s
um= cluster_data

NameError: name 'cluster_data' is not defined
```

In [11]:

```
for cluster_idx in range(num_clusters):
 cluster_x = data[clusters[cluster_idx], 0]
 cluster_y = data[clusters[cluster_idx], 1]
 matplotlib.pyplot.scatter(cluster_x, cluster_y)
 matplotlib.pyplot.scatter(cluster_centers[cluster_idx, 0], cluster_centers[cluster_idx, 1])
matplotlib.pyplot.title("Clustering using PyGAD")
matplotlib.pyplot.show()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[11], line 1
----> 1 for cluster_idx in range(num_clusters):
      2  cluster_x = data[clusters[cluster_idx], 0]
      3  cluster_y = data[clusters[cluster_idx], 1]

NameError: name 'num_clusters' is not defined
```

In [ ]:

In [ ]: