


In [43]:  pip install pygad

Requirement already satisfied: pygad in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (3.0.1)Note: you may need to restart the kernel to use updated packages.

Requirement already satisfied: cloudpickle in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from pygad) (2.2.1)


Requirement already satisfied: matplotlib in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from pygad) (3.7.1)


Requirement already satisfied: numpy in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from pygad) (1.24.3)

Requirement already satisfied: contourpy>=1.0.1 in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from matplotlib->pygad) (1.0.7)

Requirement already satisfied: cycler>=0.10 in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from matplotlib->pygad) (0.11.0)

Requirement already satisfied: fonttools>=4.22.0 in c:\users\chinta pavani\appdata\local\programs\python\python311\lib\site-packages (from matplotlib->pygad) (4.22.0)

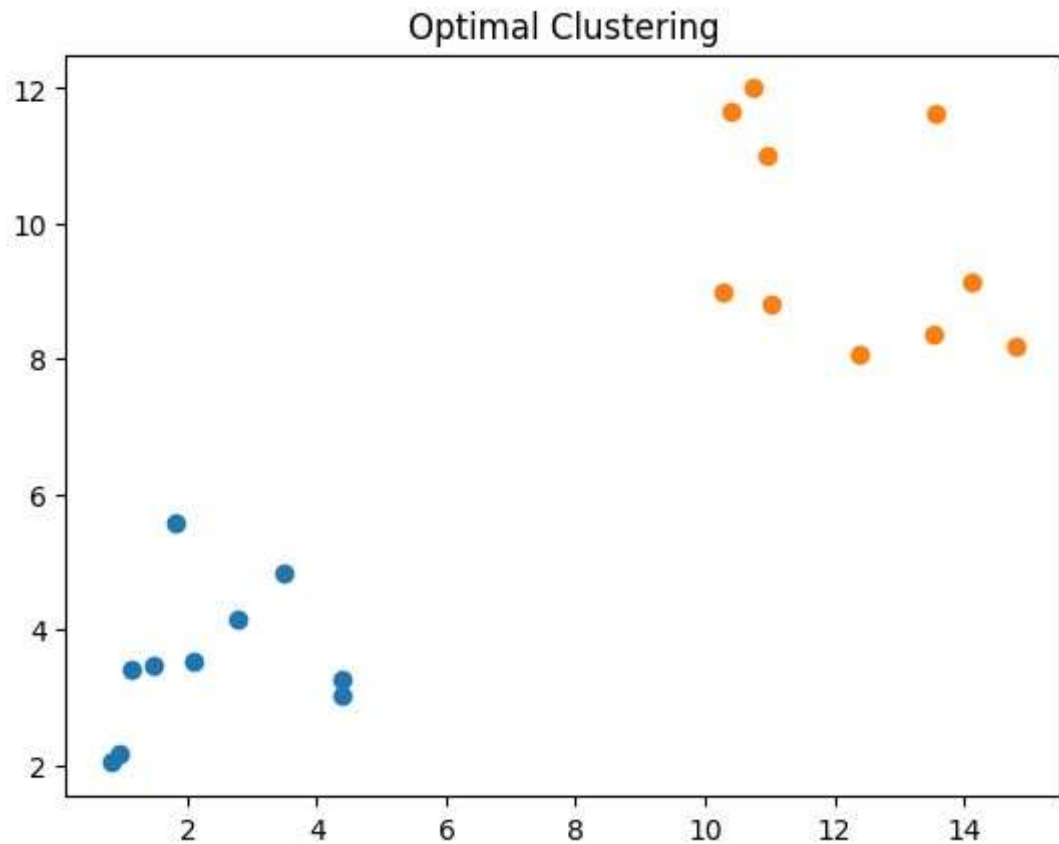
In [44]:  `import numpy`
`import matplotlib.pyplot`
`import pygad`

In [45]:  `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 [46]: ▶ 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[46]: array([[ 0.94967446,  2.17533983],  
[ 1.81238873,  5.56360421],  
[ 1.1337907 ,  3.42300445],  
[ 4.37889977,  3.0230836 ],  
[ 2.08705237,  3.53723311],  
[ 1.46593602,  3.47108224],  
[ 0.82223992,  2.03405237],  
[ 2.77976982,  4.14312448],  
[ 3.4883491 ,  4.83573169],  
[ 4.37714651,  3.25838175],  
[11.015522 ,  8.81060409],  
[10.74679591, 11.996733 ],  
[14.79859085,  8.18366598],  
[12.38811227,  8.06960769],  
[10.28878516,  8.98518618],  
[13.52909535,  8.37347725],  
[10.95020021, 11.01559026],  
[13.56113256, 11.61672966],  
[14.13027625,  9.14620113],  
[10.38802154, 11.66358198]])
```

```
In [47]: ▶ matplotlib.pyplot.scatter(cluster1_x1, cluster1_x2)
matplotlib.pyplot.scatter(cluster2_x1, cluster2_x2)
matplotlib.pyplot.title("Optimal Clustering")
matplotlib.pyplot.show()
```



```
In [48]: ▶ def euclidean_distance(X, Y):
return numpy.sqrt(numpy.sum(numpy.power(X - Y, 2), axis=1))
```

```
In [49]: ▶ 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*(clust_idx+1)])
        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_sum_dist = numpy.array(clusters_sum_dist)
    return cluster_centers, all_clusters_dists, cluster_indices, clusters,
```

```
In [50]: ▶ 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 [51]: ▶ 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)
    ga_instance.run()
```

```
In [52]: ▶ 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.get_generations()))
```

```
Best solution is [ 2.14950979  3.56668145 12.06979512  9.5896742 ]
Fitness of the best solution is 0.027408195183288634
Best solution found after 97 generations
```

```
In [55]: ▶ cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum_dist = cluster_data(best_solution, best_solution_idx)
```

```
In [66]: ▶ 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], linewidths=5)
matplotlib.pyplot.title("Clustering using PyGAD")
matplotlib.pyplot.show()
```

--
NameError Traceback (most recent call last)

Cell In[66], line 5

```
3     cluster_y = data[clusters[cluster_idx], 1]
4     matplotlib.pyplot.scatter(cluster_x, cluster_y)
----> 5     matplotlib.pyplot.scatter(cluster_centers[cluster_idx, 0], cluster_centers[cluster_idx, 1], linewidths=5)
6     matplotlib.pyplot.title("Clustering using PyGAD")
7     matplotlib.pyplot.show()
```

NameError: name 'cluster_centers' is not defined

