Genetic Algorithm

In [1]:
```
pip install pygad
```

```
Requirement already satisfied: pygad in c:\users\pavan\appdata\local\programs\python\python311\lib\site-packages (3.
0.1)
Requirement already satisfied: cloudpickle in c:\users\pavan\appdata\local\programs\python\python311\lib\site-packag
es (from pygad) (2.2.1)
Requirement already satisfied: matplotlib in c:\users\pavan\appdata\local\programs\python\python311\lib\site-package
s (from pygad) (3.7.1)
Requirement already satisfied: numpy in c:\users\pavan\appdata\local\programs\python\python311\lib\site-packages (fr
om pygad) (1.24.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-p
ackages (from matplotlib->pygad) (1.0.7)
Requirement already satisfied: cycler>=0.10 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-packa
ges (from matplotlib->pygad) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-
packages (from matplotlib->pygad) (4.39.4)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-
packages (from matplotlib->pygad) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-pa
ckages (from matplotlib->pygad) (23.1)
Requirement already satisfied: pillow>=6.2.0 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-pack
ages (from matplotlib->pygad) (9.5.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\pavan\appdata\local\programs\python\python311\lib\site-p
ackages (from matplotlib->pygad) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\pavan\appdata\local\programs\python\python311\lib\si
te-packages (from matplotlib->pygad) (2.8.2)
Requirement already satisfied: six>=1.5 in c:\users\pavan\appdata\local\programs\python\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 [21]:
```
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 [22]:
```
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[22]:
```
array([[ 2.61727448,  4.09294686],
       [ 1.3886728 ,  2.0665912 ],
       [ 2.269472  ,  4.29524717],
       [ 2.74280356,  5.33514512],
       [ 2.80651725,  5.7489644 ],
       [ 2.012647  ,  2.22491435],
       [ 3.39883912,  4.61758126],
       [ 3.29307506,  4.53799499],
       [ 4.621203  ,  5.25367272],
       [ 0.30472263,  4.52727173],
       [10.46276011,  9.14488955],
       [13.24617786,  9.58320377],
       [11.24107034,  9.84852588],
       [12.69522943,  9.70735538],
       [11.40863786, 11.5880983 ],
       [13.00902508,  8.71335429],
       [11.32379145, 11.88466224],
       [14.62667321, 11.78666346],
       [13.85887284,  8.83167629],
       [12.81756089, 10.79561036]])
```

In [23]:

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

In [24]:

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

In [25]:
```
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[clust_idx]]))
    clusters_sum_dist = numpy.array(clusters_sum_dist)
    return cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum_dist
```

In [32]:
```
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
```

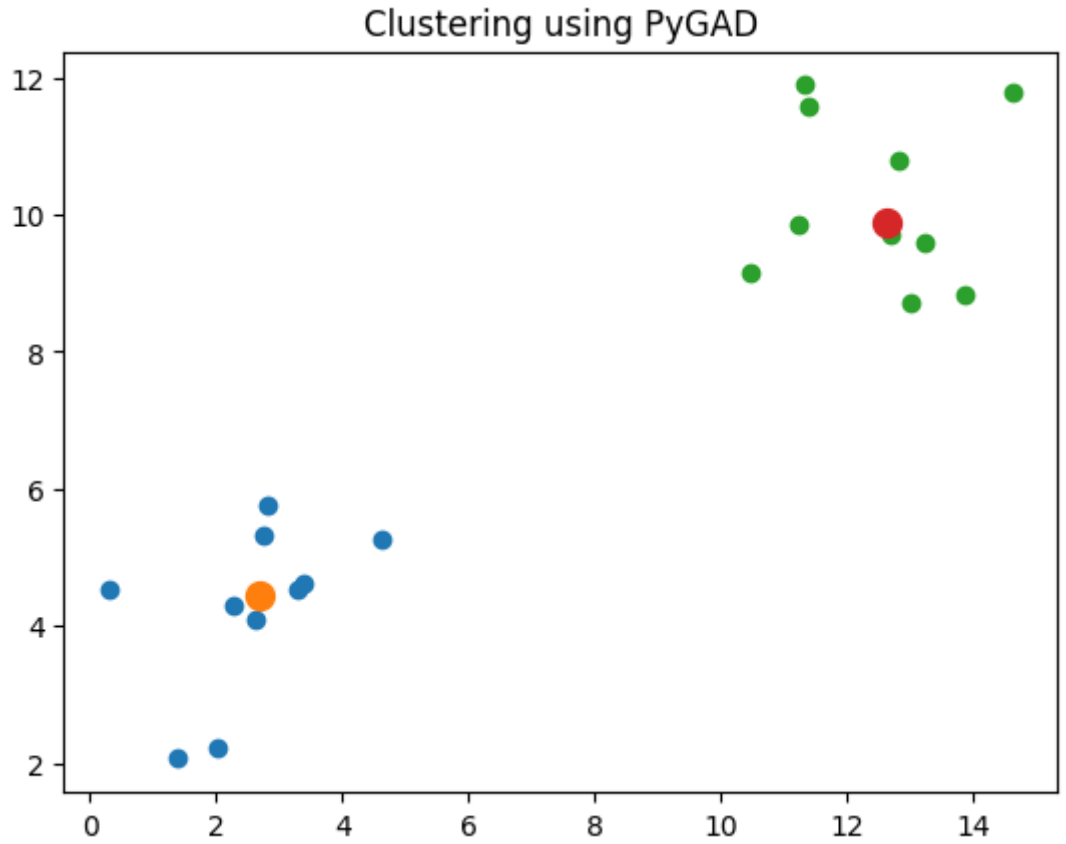
In [33]:
```
num_clusters = 2
num_genes = num_clusters * data.shape[1]

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 [41]:
```
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_generation))
```

```
Best solution is [ 2.69882558  4.43543547 12.63395375  9.87957534]
Fitness of the best solution is 0.03397769442326835
Best solution found after 94 generations
```

In [43]:
```
cluster_centers, all_clusters_dists, cluster_indices, clusters, clusters_sum_dist= cluster_data(best_solution, best_sc
```

In [45]:
```
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()
```



In [ ]: