Week 11

October 23, 2024

[1]:
```
import numpy as np
import matplotlib.pyplot as plt
import scipy.cluster.hierarchy as sch
from scipy.spatial.distance import pdist, squareform

points = np.array(
    [(1, 1), (3, 2), (9, 1), (3, 7), (7, 2), (9, 7), (4, 8), (8, 3), (1, 4)]
)

euclidean_dist = squareform(pdist(points, metric="euclidean"))
manhattan_dist = squareform(pdist(points, metric="cityblock"))
minkowski_dist = squareform(pdist(points, metric="minkowski", p=3))

print("Euclidean Distance:\n", euclidean_dist)
print("Manhattan Distance:\n", manhattan_dist)
print("Minkowski Distance:\n", minkowski_dist)

linkage_methods = ["single", "complete", "average", "centroid", "ward"]
plt.figure(figsize=(15, 10))

for i, method in enumerate(linkage_methods):
    plt.subplot(3, 2, i + 1)
    Z = sch.linkage(points, method=method)
    sch.dendrogram(Z)
    plt.title(f"Dendrogram - {method.capitalize()} Linkage")

plt.tight_layout()
plt.show()

sse = []
for k in range(1, len(points)):
    Z = sch.linkage(points, method="ward")
    clusters = sch.fcluster(Z, k, criterion="maxclust")

    total_sse = 0
    for j in range(1, k + 1):
        cluster_points = points[clusters == j]
```

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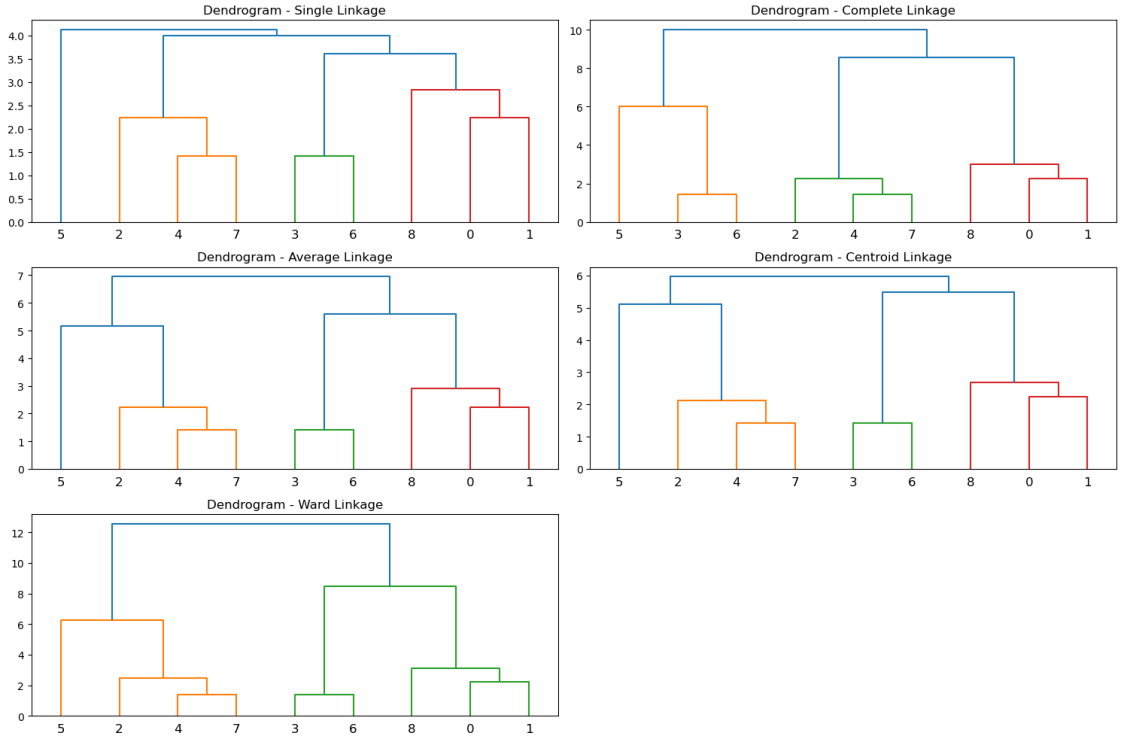
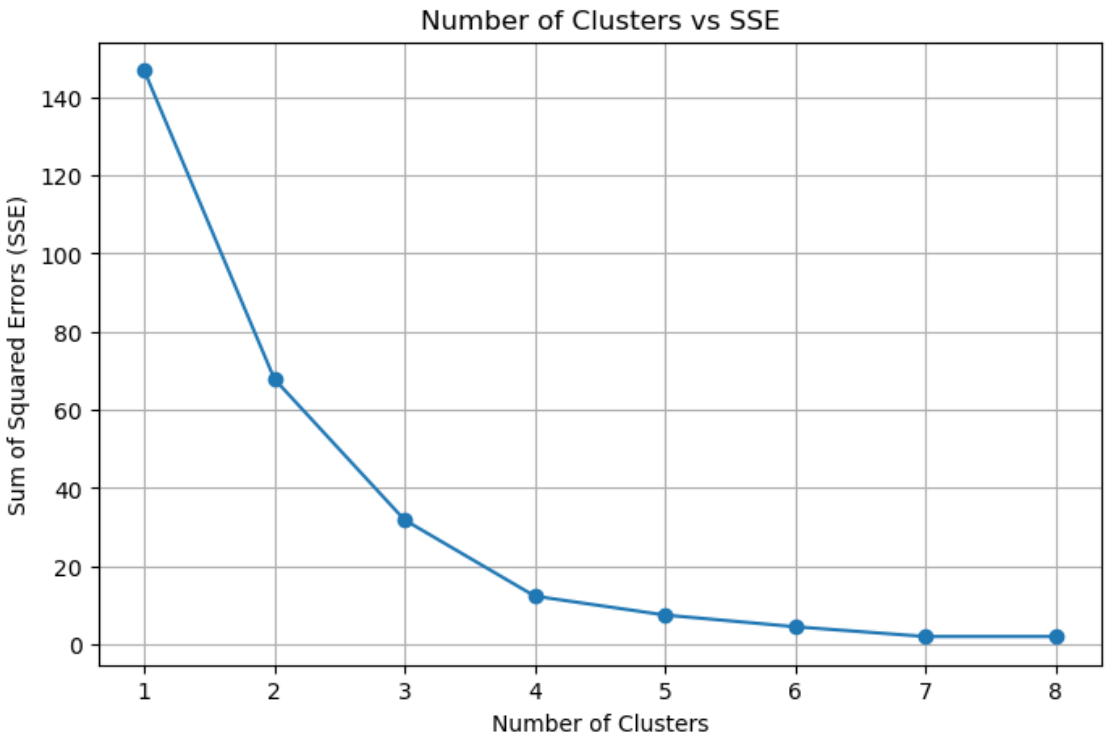
        if len(cluster_points) > 0:
            centroid = cluster_points.mean(axis=0)
        total_sse += np.sum((cluster_points - centroid) ** 2)
    sse.append(total_sse)

plt.figure(figsize=(8, 5))
plt.plot(range(1, len(points)), sse, marker="o")
plt.title("Number of Clusters vs SSE")
plt.xlabel("Number of Clusters")
plt.ylabel("Sum of Squared Errors (SSE)")
plt.grid()
plt.show()
```

```
Euclidean Distance:
 [[ 0.          2.23606798  8.          6.32455532  6.08276253 10.
   7.61577311  7.28010989  3.        ]
 [ 2.23606798  0.          6.08276253  5.          4.          7.81024968
   6.08276253  5.09901951  2.82842712]
 [ 8.          6.08276253  0.          8.48528137  2.23606798  6.
   8.60232527  2.23606798  8.54400375]
 [ 6.32455532  5.          8.48528137  0.          6.40312424  6.
   1.41421356  6.40312424  3.60555128]
 [ 6.08276253  4.          2.23606798  6.40312424  0.          5.38516481
   6.70820393  1.41421356  6.32455532]
 [10.          7.81024968  6.          6.          5.38516481  0.
   5.09901951  4.12310563  8.54400375]
 [ 7.61577311  6.08276253  8.60232527  1.41421356  6.70820393  5.09901951
   0.          6.40312424  5.        ]
 [ 7.28010989  5.09901951  2.23606798  6.40312424  1.41421356  4.12310563
   6.40312424  0.          7.07106781]
 [ 3.          2.82842712  8.54400375  3.60555128  6.32455532  8.54400375
   5.          7.07106781  0.        ]]
Manhattan Distance:
 [[ 0.  3.  8.  8.  7. 14. 10.  9.  3.]
 [ 3.  0.  7.  5.  4. 11.  7.  6.  4.]
 [ 8.  7.  0. 12.  3.  6. 12.  3. 11.]
 [ 8.  5. 12.  0.  9.  6.  2.  9.  5.]
 [ 7.  4.  3.  9.  0.  7.  9.  2.  8.]
 [14. 11.  6.  6.  7.  0.  6.  5. 11.]
 [10.  7. 12.  2.  9.  6.  0.  9.  7.]
 [ 9.  6.  3.  9.  2.  5.  9.  0.  8.]
 [ 3.  4. 11.  5.  8. 11.  7.  8.  0.]]
Minkowski Distance:
 [[0.         2.08008382 8.         6.07317794 6.00924501 8.99588289
  7.17905435 7.05400406 3.        ]
 [2.08008382 0.         6.00924501 5.         4.         6.98636803
  6.00924501 5.01329793 2.5198421 ]
 [8.         6.00924501 0.         7.5595263  2.08008382 6.
```

```
 7.76393608 2.08008382 8.13822304]
[6.07317794 5.         7.5595263  0.         5.73879355 6.
 1.25992105 5.73879355 3.27106631]
[6.00924501 4.         2.08008382 5.73879355 0.         5.10446872
 6.24025147 1.25992105 6.07317794]
[8.99588289 6.98636803 6.         6.         5.10446872 0.
 5.01329793 4.02072576 8.13822304]
[7.17905435 6.00924501 7.76393608 1.25992105 6.24025147 5.01329793
 0.         5.73879355 4.49794145]
[7.05400406 5.01329793 2.08008382 5.73879355 1.25992105 4.02072576
 5.73879355 0.         7.00679612]
[3.         2.5198421  8.13822304 3.27106631 6.07317794 8.13822304
 4.49794145 7.00679612 0.        ]]
```




Number of Clusters vs SSE
Sum of Squared Errors (SSE)
Number of Clusters
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8

[ ]: