Name : Shobhit Mirjankar

Batch : C32

Roll No : 1902101

In [1]:

```
# Importing libraries

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:

```
# Reading the dataset

dataset = pd.read_csv('dataset.csv')
dataset
```

Out[2]:

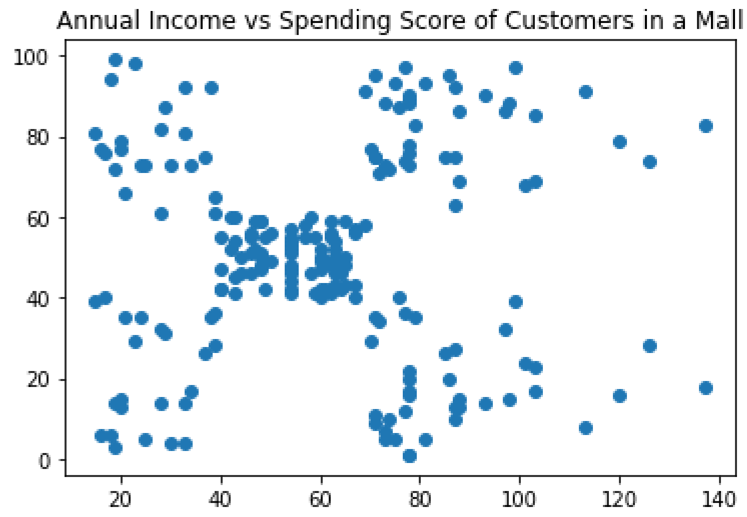
	Annual Income (k$)	Spending Score (1-100)
0	15	39
1	15	81
2	16	6
3	16	77
4	17	40
...	...	...
195	120	79
196	126	28
197	126	74
198	137	18
199	137	83

200 rows × 2 columns

In [3]:

```
# Visualizing the dataset

plt.scatter(dataset['Annual Income (k$)'],dataset['Spending Score (1-100)'])
plt.title('Annual Income vs Spending Score of Customers in a Mall')
plt.show()
```



Preparing Edge Table

In [4]:

```
# Computing edge distance for each pair of nodes

def euclidean(x,y):
    return np.linalg.norm(x - y)

def compute_edge_table(dataset):
    edge_table = pd.DataFrame(columns=['u', 'v', 'distance'])
    for i,node1 in dataset.iterrows():
        for j,node2 in dataset.loc[i+1:].iterrows():
            dist = np.round(euclidean(node1,node2),4)
            edge_table.loc[len(edge_table)] = [i,j,dist]
    edge_table = edge_table.astype({"u":"int","v":"int"})
    return edge_table


edge_table = compute_edge_table(dataset)
print('Edge Table : ')
edge_table
```

```
Edge Table :
```

Out[4]:

	u	v	distance
0	0	1	42.0000
1	0	2	33.0151
2	0	3	38.0132
3	0	4	2.2361
4	0	5	37.0540
...	...	...	...
19895	196	198	14.8661
19896	196	199	56.0892
19897	197	198	57.0701
19898	197	199	14.2127
19899	198	199	65.0000

19900 rows × 3 columns

In [5]:

```
# Sorting Edge Table in ascending order of distances

edge_table = edge_table.sort_values(by=['distance'])
print('Sorted Edge Table : ')
edge_table
```

```
Sorted Edge Table :
```

Out[5]:

	u	v	distance
8424	48	49	0.0000
10857	65	68	0.0000
17416	129	131	0.0000
18955	156	158	0.0000
15627	107	113	1.0000
...	...	...	...
1562	7	198	141.1984
1371	6	199	141.7392
1754	8	199	142.5623
2320	11	198	143.1258
593	2	199	143.4225

19900 rows × 3 columns

Kruskal's Algorithm for Minimum Spanning Tree

In [6]:

```
# Disjoint Set Operations for implementing Kruskal's Algorithm

rank = [0 for _ in range(len(dataset))]
parent = [i for i in range(len(dataset))]

def find_parent(u):
    if u == parent[u]:
        return u
    parent[u] = find_parent(parent[u])
    return parent[u]

def union(u,v):
    u = find_parent(u)
    v = find_parent(v)
    if rank[u] < rank[v]:
        parent[u] = v
    elif rank[v] < rank[u]:
        parent[v] = u
    else:
        parent[u] = v
        rank[v] += 1
```

In [7]:

```
# Kruskal's Algorithm for finding Minimum Spanning Tree

def kruskal(dataset,edge_table,num_of_clusters):
    edges_needed = len(dataset) - num_of_clusters
    edges_added = 0
    for index,row in edge_table.iterrows():
        u = int(row.u)
        v = int(row.v)
        if find_parent(u) != find_parent(v):
            union(u,v)
            edges_added += 1
            if edges_added == edges_needed:
                break
    for index,row in dataset.iterrows():
        parent[int(index)] = find_parent(int(index))
```

Clustering using Minimum Spanning Tree

In [8]:

```
# Performing Clustering using MST and visualizing clusters

def MST_Clustering(dataset,k):
    dataset['cluster'] = 0
    kruskal(dataset,edge_table,k)

    for index,row in dataset.iterrows():
        dataset['cluster'][index] = parent[int(index)]
    dataset['cluster'] = pd.factorize(dataset['cluster'])[0]
    return dataset

def visualize_clusters(result):
    k = len(dataset['cluster'].unique())
    for i in range(k):
        plt.scatter(result[result['cluster']==i]['Annual Income (k$)'],
                    result[result['cluster']==i]['Spending Score (1-100)'],
                   label = 'Cluster '+ str(i+1))
    plt.title('Clusters formed using MST')
    plt.xlabel('Annual Income (k$)')
    plt.ylabel('Spending Score (1-100)')
    plt.legend()
    plt.show()
```

In [9]:

```
# Forming 7 clusters

rank = [0 for _ in range(len(dataset))]
parent = [i for i in range(len(dataset))]
k = int(input('Enter number of clusters : '))
result = MST_Clustering(dataset,k)
result
```

```
Enter number of clusters : 7
```

Out[9]:

	Annual Income (k$)	Spending Score (1-100)	cluster
0	15	39	0
1	15	81	0
2	16	6	0
3	16	77	0
4	17	40	0
...	...	...	...
195	120	79	3

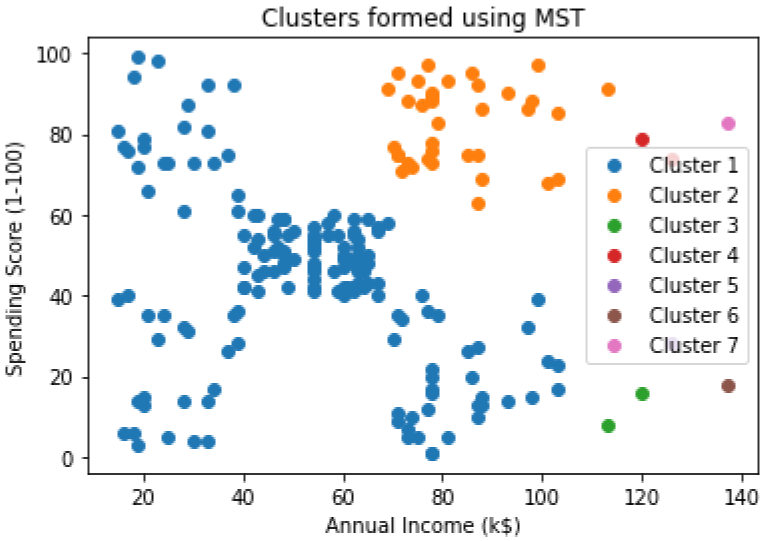
	Annual Income (k$)	Spending Score (1-100)	cluster
196	126	28	4
197	126	74	3
198	137	18	5
199	137	83	6

200 rows × 3 columns

In [10]:

```
# Visualizing 7 clusters

visualize_clusters(result)
```



In [11]:

```
# Forming 10 clusters

rank = [0 for _ in range(len(dataset))]
parent = [i for i in range(len(dataset))]
k = int(input('Enter number of clusters : '))
result = MST_Clustering(dataset,k)
result
```

```
Enter number of clusters : 10
```

Out[11]:

	Annual Income (k$)	Spending Score (1-100)	cluster
0	15	39	0
1	15	81	0
2	16	6	0
3	16	77	0
4	17	40	0
...	...	...	...
195	120	79	6
196	126	28	7
197	126	74	6
198	137	18	8

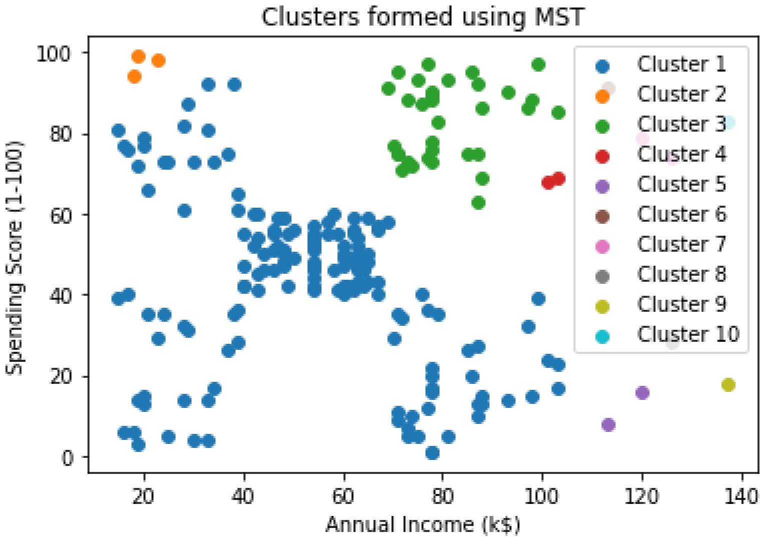
	Annual Income (k$)	Spending Score (1-100)	cluster
199	137	83	9

200 rows × 3 columns

In [12]:

```
# Visualizing 10 clusters

visualize_clusters(result)
```


Clusters formed using MST
Spending Score (1-100)
Annual Income (k$)
● Cluster 1
● Cluster 2
● Cluster 3
● Cluster 4
● Cluster 5
● Cluster 6
● Cluster 7
● Cluster 8
● Cluster 9
● Cluster 10