In [17]:

```
#Roll No-33238
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
```

In [18]:

```
df = pd.read_csv('/home/pict/Downloads/archive (15)/Mall_Customers.csv')
```

In [19]:

```
plt.rcParams['figure.dpi'] = 300
plt.rcParams['savefig.dpi'] = 300
```

In [20]:

```
plt.rcParams["figure.figsize"] = (8,5)
```

In [21]:

```
df.head(10)
```

Out[21]:

	CustomerID	Genre	Age	Annual Income (k$)	Spending Score (1-100)
0	1	Male	19	15	39
1	2	Male	21	15	81
2	3	Female	20	16	6
3	4	Female	23	16	77
4	5	Female	31	17	40
5	6	Female	22	17	76
6	7	Female	35	18	6
7	8	Female	23	18	94
8	9	Male	64	19	3
9	10	Female	30	19	72

In [22]:

```
df.isnull().sum()
```

Out[22]:

```
CustomerID                0
Genre                     0
Age                       0
Annual Income (k$)        0
Spending Score (1-100)    0
dtype: int64
```

In [23]:

```
for i in df.columns:
    print( i, len( df[df[i] == 0] ) )
```

```
CustomerID 0
Genre 0
Age 0
Annual Income (k$) 0
Spending Score (1-100) 0
```

In [24]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 5 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   CustomerID              200 non-null    int64
 1   Genre                   200 non-null    object
 2   Age                     200 non-null    int64
 3   Annual Income (k$)      200 non-null    int64
 4   Spending Score (1-100)  200 non-null    int64
dtypes: int64(4), object(1)
memory usage: 7.9+ KB
```

In [25]:

```
df.describe()
```

Out[25]:

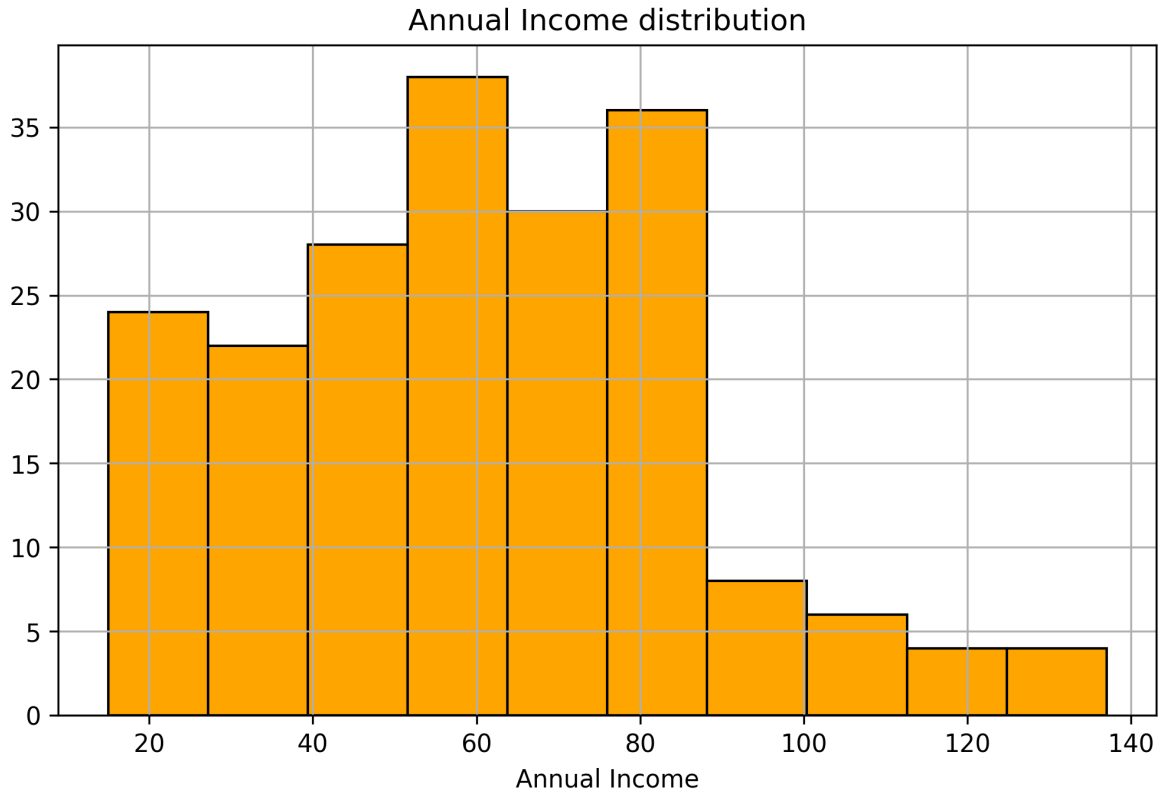
	CustomerID	Age	Annual Income (k$)	Spending Score (1-100)
count	200.000000	200.000000	200.000000	200.000000
mean	100.500000	38.850000	60.560000	50.200000
std	57.879185	13.969007	26.264721	25.823522
min	1.000000	18.000000	15.000000	1.000000
25%	50.750000	28.750000	41.500000	34.750000
50%	100.500000	36.000000	61.500000	50.000000
75%	150.250000	49.000000	78.000000	73.000000
max	200.000000	70.000000	137.000000	99.000000

In [26]:

```
plt.plot(figsize=(8,5))
plt.hist(df["Annual Income (k$)"], color='orange', edgecolor='k')
plt.title("Annual Income distribution")
plt.xlabel("Annual Income")
plt.grid(True)
plt.show
```

Out[26]:

```
<function matplotlib.pyplot.show(close=None, block=None)>
```

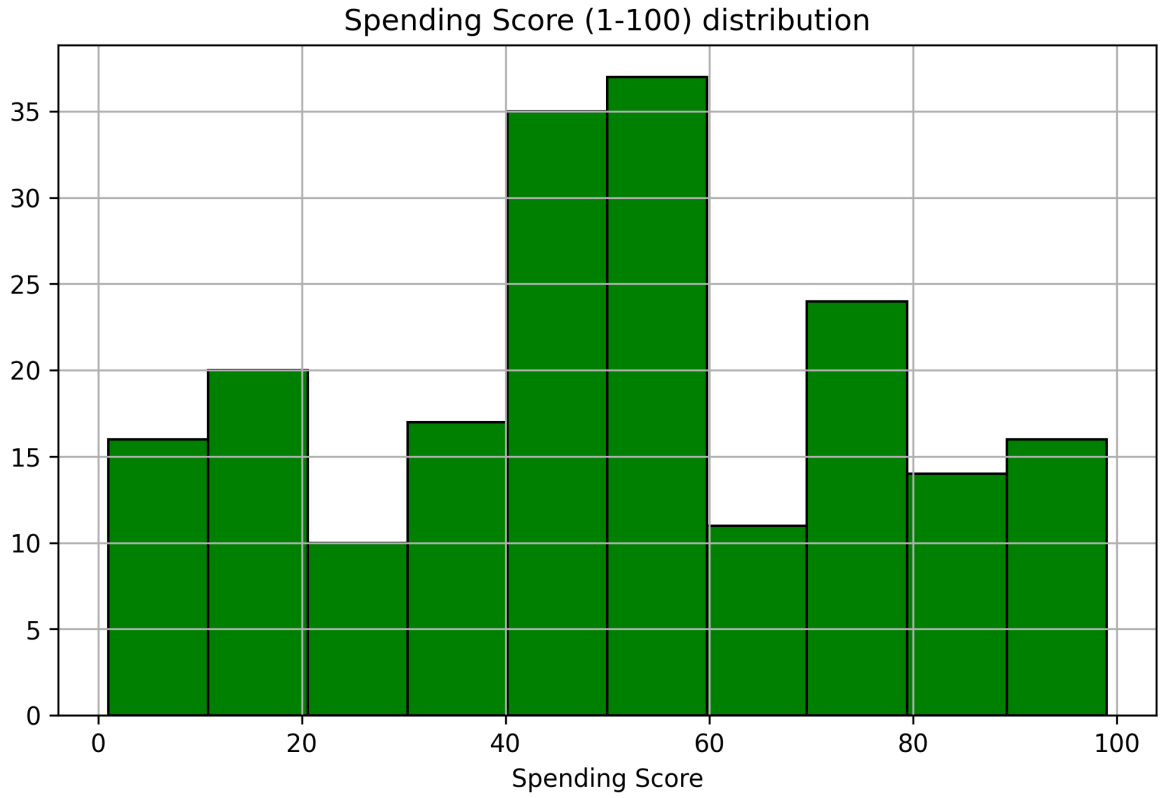


In [27]:

```
plt.plot(figsize=(8,5))
plt.hist(df["Spending Score (1-100)"], color='green', edgecolor='k')
plt.title("Spending Score (1-100) distribution")
plt.xlabel("Spending Score")
plt.grid(True)
plt.show
```

Out[27]:

```
<function matplotlib.pyplot.show(close=None, block=None)>
```

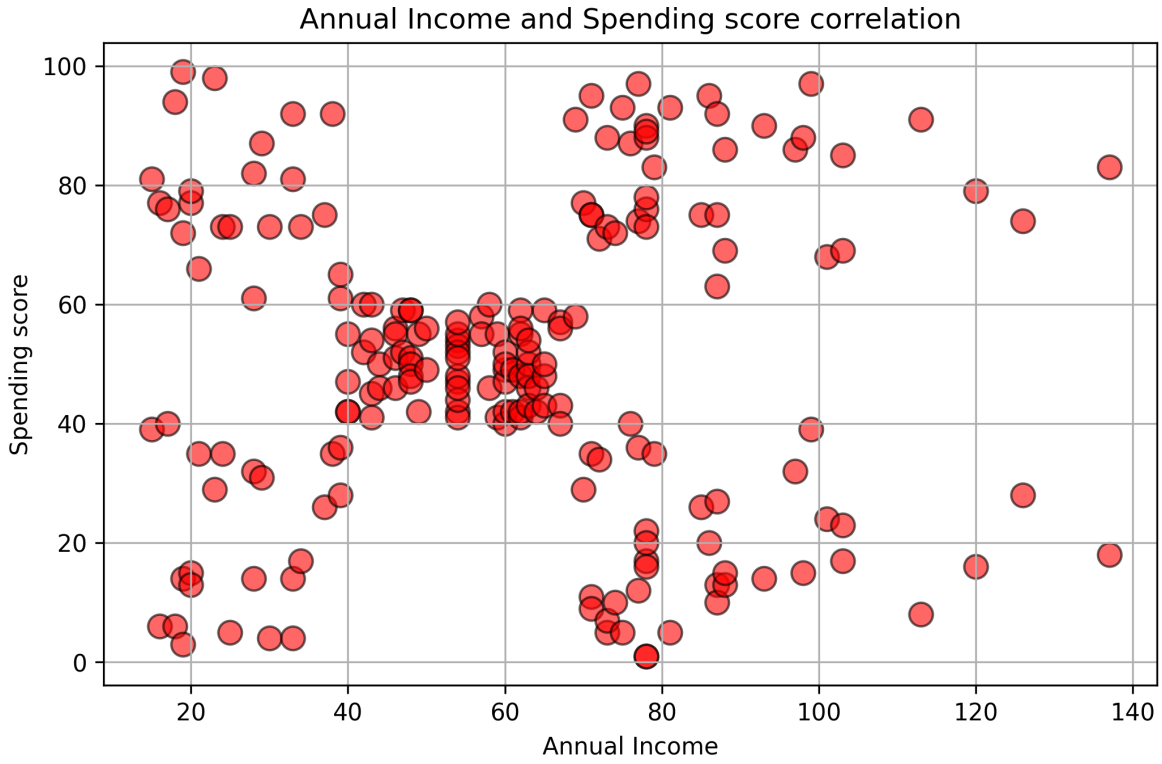


In [28]:

```
plt.plot(figsize=(8,5))
plt.scatter(df["Annual Income (k$)"], df["Spending Score (1-100)"], color='red', ed
plt.title("Annual Income and Spending score correlation")
plt.xlabel("Annual Income")
plt.ylabel("Spending score")
plt.grid(True)
plt.show
```

Out[28]:

```
<function matplotlib.pyplot.show(close=None, block=None)>
```

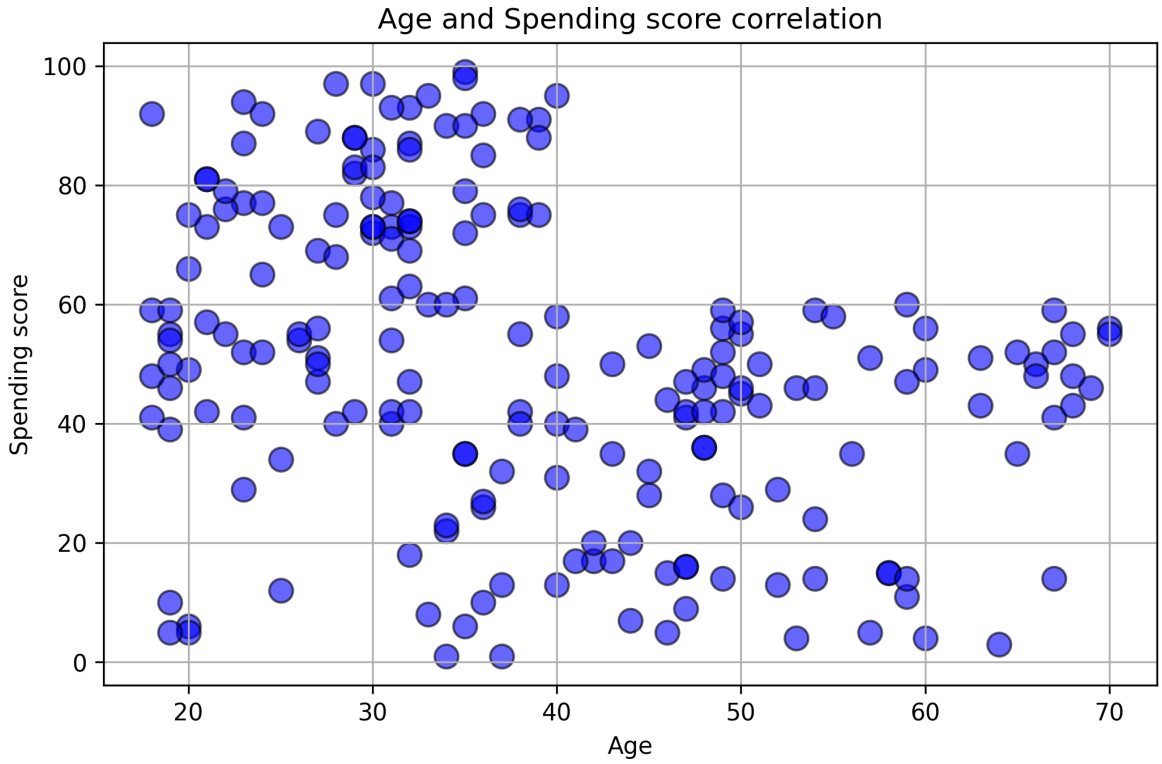


In [29]:

```
plt.plot(figsize=(8,5))
plt.scatter(df["Age"], df["Spending Score (1-100)"], color='blue', edgecolor='k', a
plt.title("Age and Spending score correlation")
plt.xlabel("Age")
plt.ylabel("Spending score")
plt.grid(True)
plt.show
```

Out[29]:

```
<function matplotlib.pyplot.show(close=None, block=None)>
```



In [30]:

```
X = df.iloc[ : , 3:].values
print(X[:10], "\n\n")
print(X[-10:])
```

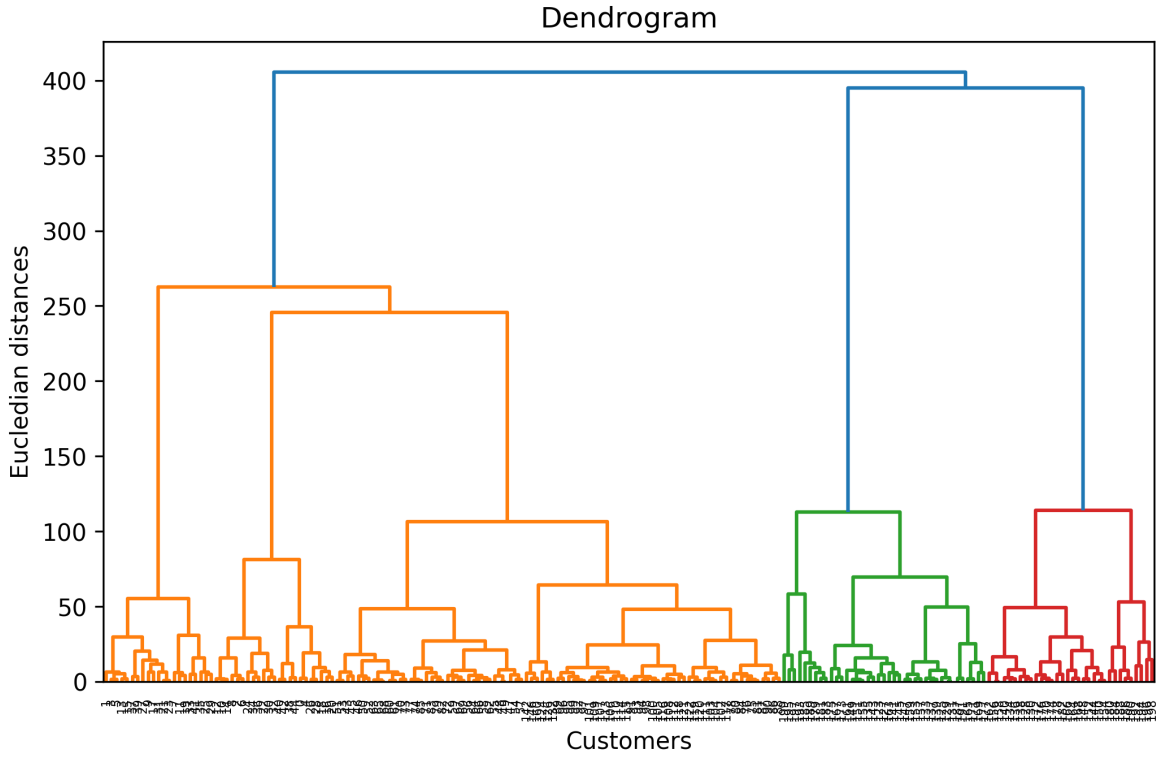
```
[[15 39]
 [15 81]
 [16  6]
 [16 77]
 [17 40]
 [17 76]
 [18  6]
 [18 94]
 [19  3]
 [19 72]]


[[103  23]
 [103  69]
 [113   8]
 [113  91]
 [120  16]
 [120  79]
 [126  28]
 [126  74]
 [137  18]
 [137  83]]
```

In [48]:

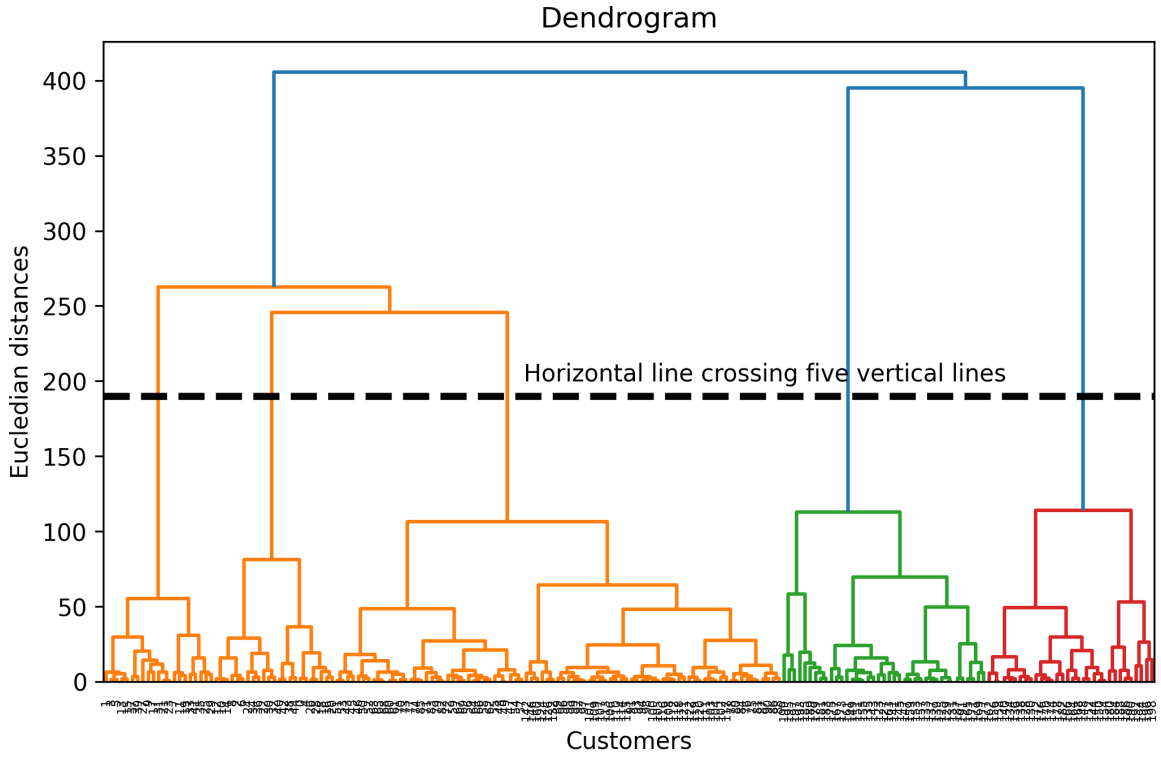
```
import scipy.cluster.hierarchy as sch

sch.dendrogram(sch.linkage(X, method='ward'))
plt.title("Dendrogram")
plt.xlabel("Customers")
plt.ylabel("Eucledian distances")
plt.show()
```



In [58]:

```
sch.dendrogram(sch.linkage(X, method='ward'))
plt.title("Dendrogram")
plt.xlabel("Customers")
plt.ylabel("Eucledian distances")
plt.hlines(y=190,xmin=0 , xmax=2000, lw=3, linestyles="--", color='black')#3
plt.text(x=800, y=200, s="Horizontal line crossing five vertical lines", fontsize=1
plt.show()
```



In [59]:

```
from sklearn.cluster import AgglomerativeClustering
hc = AgglomerativeClustering(n_clusters=5, affinity='euclidean', linkage='ward')
y_hc = hc.fit_predict(X)
```

In [61]:

```
print("X: ", X[:10])

print("y_hc: ", y_hc)
```

```
X:  [[15 39]
 [15 81]
 [16  6]
 [16 77]
 [17 40]
 [17 76]
 [18  6]
 [18 94]
 [19  3]
 [19 72]]

y_hc:  [4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4
3 4 3 4 3 4
 3 4 3 4 3 4 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1
 1 1 1 1 1 1 1 1 1 1 1 2 1 2 1 2 0 2 0 2 1 2 0 2 0 2 0 2 0 2 1 2 0 2
1 2
 0 2 0 2 0 2 0 2 0 2 0 2 1 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2
2 0
 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2]
```

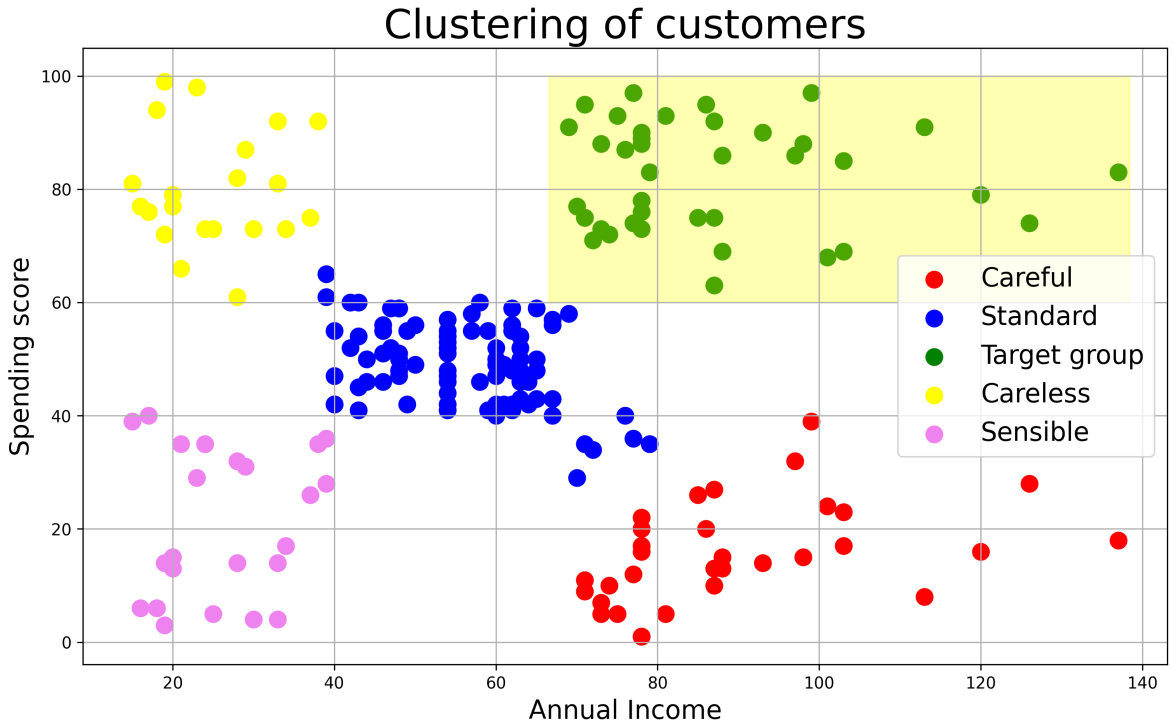
In [39]:

```
plt.figure(figsize=(12,7))
plt.scatter(X[y_hc == 0, 0], X[y_hc == 0, 1], s=100, c='red', label='Careful')
plt.scatter(X[y_hc == 1, 0], X[y_hc == 1, 1], s=100, c='blue', label='Standard')
plt.scatter(X[y_hc == 2, 0], X[y_hc == 2, 1], s=100, c='green', label='Target group
plt.scatter(X[y_hc == 3, 0], X[y_hc == 3, 1], s=100, c='yellow', label='Careless')
plt.scatter(X[y_hc == 4, 0], X[y_hc == 4, 1], s=100, c='violet', label='Sensible')

plt.title("Clustering of customers", fontsize=25)
plt.xlabel("Annual Income", fontsize=16)
plt.ylabel("Spending score", fontsize=16)
plt.legend(fontsize=16)
plt.grid(True)

plt.axhspan(ymin=60, ymax=100, xmin=0.43, xmax=0.965, alpha=0.3, color="yellow")

plt.show()
```



In [36]:

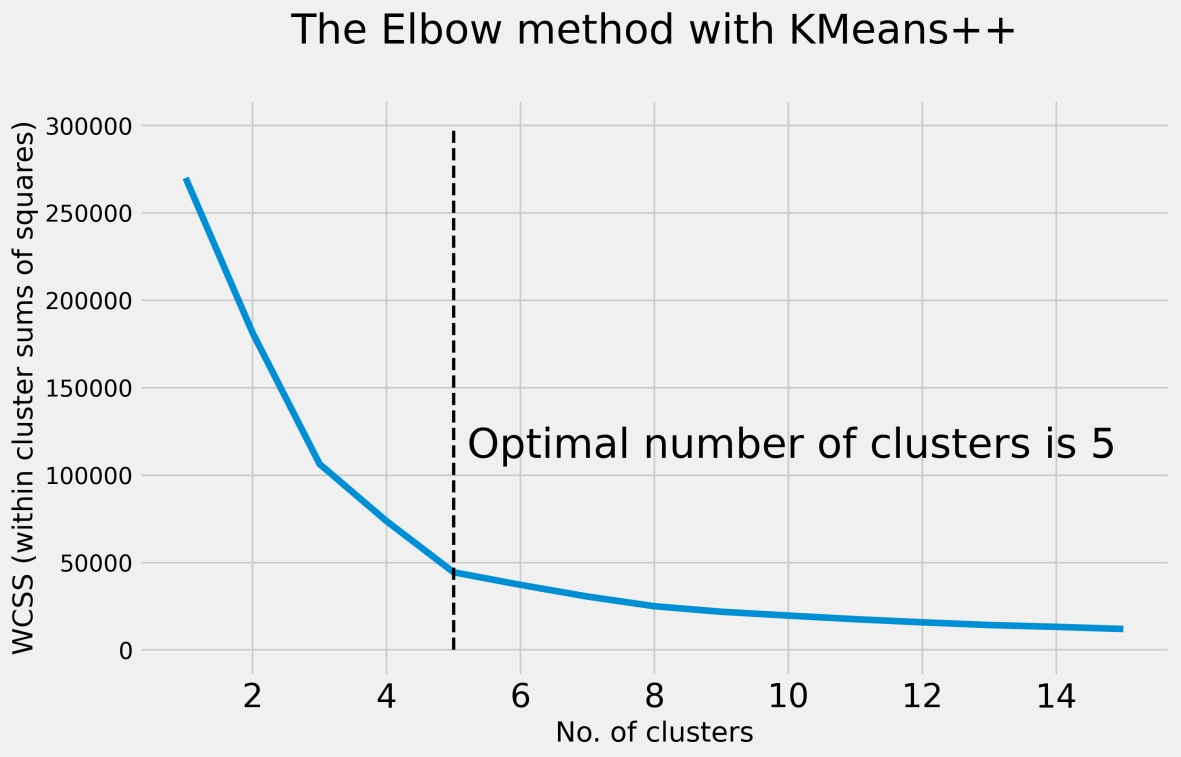
```
from sklearn.cluster import KMeans
wcss = []
for i in range(1,16):
    kmeans = KMeans(n_clusters=i, init='k-means++')
    kmeans.fit(X)
    wcss.append(kmeans.inertia_)

with plt.style.context(('fivethirtyeight')):   #To set background style of plot
    plt.figure(figsize=(10,6))
    plt.plot(range(1,16), wcss)
    plt.title("The Elbow method with KMeans++\n", fontsize=25)
    plt.xlabel("No. of clusters")
    plt.ylabel("WCSS (within cluster sums of squares)")
    plt.xticks(fontsize=20)

    plt.vlines(x=5, ymin=0, ymax=300000, linestyle="--", color="black", lw=2)

    plt.text(x=5.2, y=110000, s="Optimal number of clusters is 5", fontsize=25)

    plt.show()
```



In [37]:

```
km = KMeans(n_clusters=5, max_iter=100)
km.fit(X)
y_km = km.fit_predict(X)
```

In [38]:

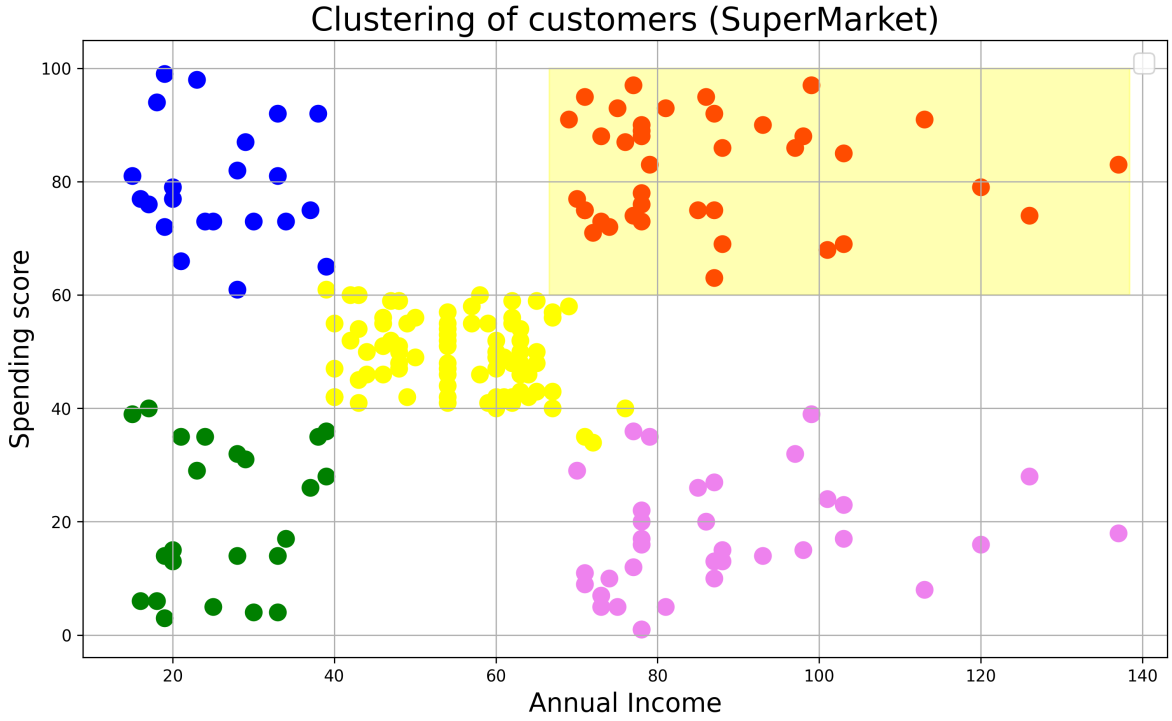
```
plt.figure(figsize=(12,7))
plt.scatter(X[y_km == 0, 0], X[y_km == 0, 1], s=100, c='blue')
plt.scatter(X[y_km == 1, 0], X[y_km == 1, 1], s=100, c='red')
plt.scatter(X[y_km == 2, 0], X[y_km == 2, 1], s=100, c='violet')
plt.scatter(X[y_km == 3, 0], X[y_km == 3, 1], s=100, c='green')
plt.scatter(X[y_km == 4, 0], X[y_km == 4, 1], s=100, c='yellow')

plt.title("Clustering of customers (SuperMarket)", fontsize=20)
plt.xlabel("Annual Income", fontsize=16)
plt.ylabel("Spending score", fontsize=16)
plt.legend(fontsize=16)
plt.grid(True)

plt.axhspan(ymin=60, ymax=100, xmin=0.43, xmax=0.965, alpha=0.3, color="yellow")

plt.show()
```

```
No artists with labels found to put in legend.  Note that artists whos
e label start with an underscore are ignored when legend() is called w
ith no argument.
```



In [ ]: