In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
import datetime
%matplotlib inline
warnings.filterwarnings('ignore')
```

In [2]:
```
df=pd.read_excel('Coustomer Segmentation.xlsx')
```

In [3]:
```
df.head()
```

Out[3]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom

In [4]:
```
df.shape
```

Out[4]:
```
(541909, 8)
```

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   InvoiceNo    541909 non-null  object
 1   StockCode    541909 non-null  object
 2   Description  540455 non-null  object
 3   Quantity     541909 non-null  int64
 4   InvoiceDate  541909 non-null  datetime64[ns]
 5   UnitPrice    541909 non-null  float64
 6   CustomerID   406829 non-null  float64
 7   Country      541909 non-null  object
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 33.1+ MB
```

In [6]:
```
df.isnull().sum().sort_values(ascending=False)
```

Out[6]:
```
CustomerID     135080
Description      1454
InvoiceNo           0
StockCode           0
Quantity            0
InvoiceDate         0
UnitPrice           0
Country             0
dtype: int64
```

In [7]:
```
df=df.dropna()
df.isnull().sum().sort_values(ascending=False)
```

Out[7]:
```
InvoiceNo      0
StockCode      0
Description    0
Quantity       0
InvoiceDate    0
UnitPrice      0
CustomerID     0
Country        0
dtype: int64
```

In [8]:
```
df.describe()

# we can see that quantuity has negative values
```

Out[8]:

	Quantity	UnitPrice	CustomerID
count	406829.000000	406829.000000	406829.000000
mean	12.061303	3.460471	15287.690570
std	248.693370	69.315162	1713.600303
min	-80995.000000	0.000000	12346.000000
25%	2.000000	1.250000	13953.000000
50%	5.000000	1.950000	15152.000000
75%	12.000000	3.750000	16791.000000
max	80995.000000	38970.000000	18287.000000

In [9]:
```
for i in df.columns:
    print(i , '=' , len(df[i].unique()))
```

```
InvoiceNo = 22190
StockCode = 3684
Description = 3896
Quantity = 436
InvoiceDate = 20460
UnitPrice = 620
CustomerID = 4372
Country = 37
```

In [10]:
```
df=df.drop(df[df['Quantity']<0].index)
```

In [11]:
```
df.describe()
```

Out[11]:

	Quantity	UnitPrice	CustomerID
count	397924.000000	397924.000000	397924.000000
mean	13.021823	3.116174	15294.315171
std	180.420210	22.096788	1713.169877
min	1.000000	0.000000	12346.000000
25%	2.000000	1.250000	13969.000000
50%	6.000000	1.950000	15159.000000
75%	12.000000	3.750000	16795.000000
max	80995.000000	8142.750000	18287.000000

In [12]:
```
# adding a column named amount spent
df['AmountSpent']=df['Quantity']*df['UnitPrice']
```

In [13]:
```
df.head()
```

Out[13]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	AmountSpent
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom	15.30
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom	22.00
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34

In [14]:
```
df['InvDay']=df['InvoiceDate'].dt.date
df['InvTime']=df['InvoiceDate'].dt.time
df['month']=df['InvoiceDate'].dt.month_name()
df['day']=df['InvoiceDate'].dt.day_name()
df.head()
```

Out[14]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	AmountSpent	InvDay	InvTime	month	day
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom	15.30	2010-12-01	08:26:00	December	Wednesday
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34	2010-12-01	08:26:00	December	Wednesday
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom	22.00	2010-12-01	08:26:00	December	Wednesday
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34	2010-12-01	08:26:00	December	Wednesday
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom	20.34	2010-12-01	08:26:00	December	Wednesday

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In [15]:
```
# Top 5 Customers with the highest no of orders

tf=df.groupby(by=['CustomerID','Country'], as_index=False)['InvoiceNo'].count()
tf.sort_values(by='InvoiceNo', ascending=False).iloc[:5]
```

Out[15]:

	CustomerID	Country	InvoiceNo
4019	17841.0	United Kingdom	7847
1888	14911.0	EIRE	5677
1298	14096.0	United Kingdom	5111
334	12748.0	United Kingdom	4596
1670	14606.0	United Kingdom	2700

In [16]:
```
# Highest money spent by customers
hm=df[['CustomerID','Country','AmountSpent']]
hm.sort_values(by='AmountSpent', ascending=False).iloc[:5]
```

Out[16]:

	CustomerID	Country	AmountSpent
540421	16446.0	United Kingdom	168469.60
61619	12346.0	United Kingdom	77183.60
222680	15098.0	United Kingdom	38970.00
173382	16029.0	United Kingdom	8142.75
348325	17450.0	United Kingdom	7144.72

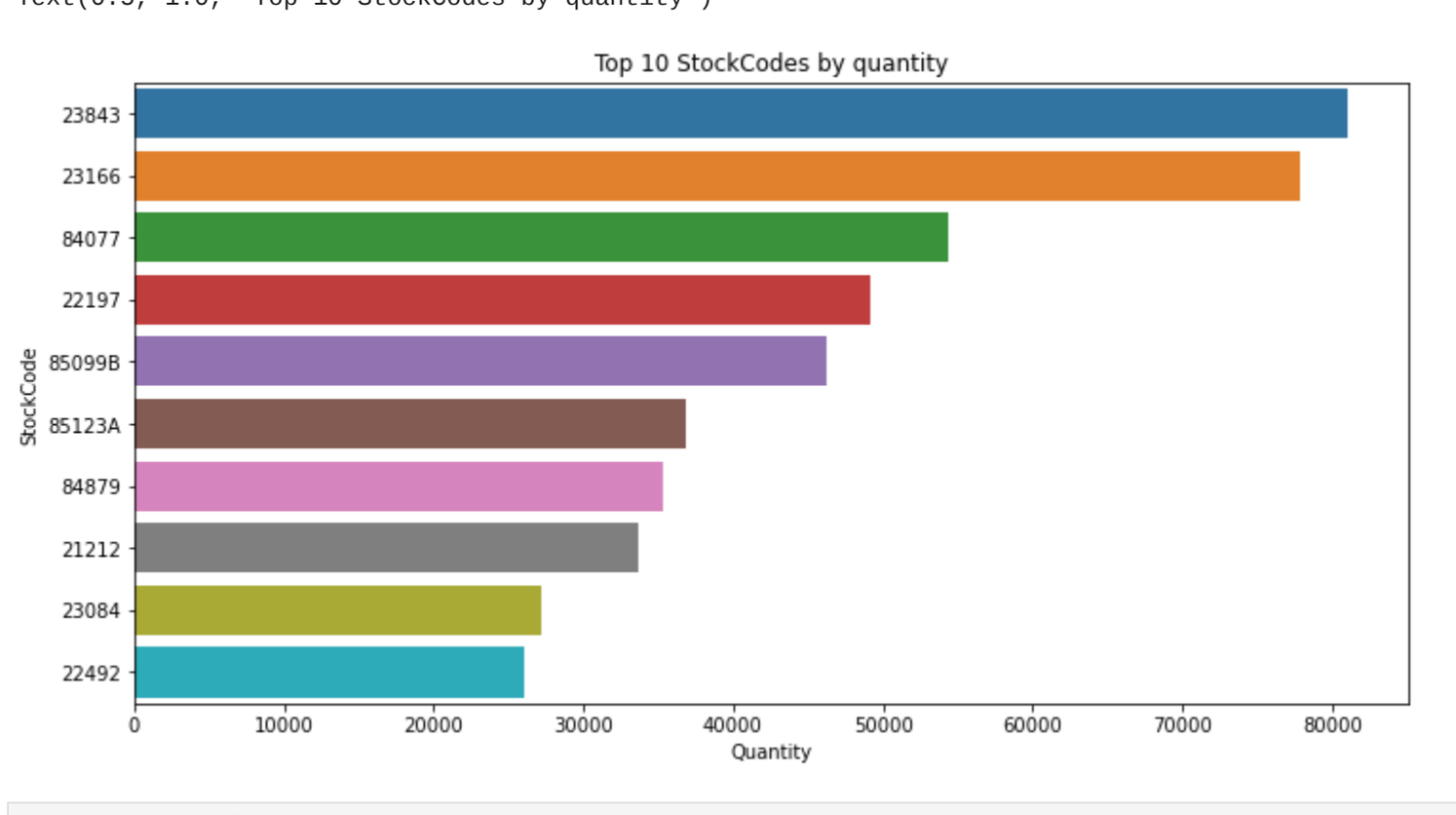
In [17]:
```
# TOP 10 STOCKCODES BY QUANTITY
df4=df.groupby('StockCode').sum()
df4.sort_values(['Quantity'], ascending=False,inplace=True)
df4.reset_index(inplace=True)
df5=df4[['StockCode','Quantity']][:10]
df5
```

Out[17]:

	StockCode	Quantity
0	23843	80995
1	23166	77916
2	84077	54415
3	22197	49183
4	85099B	46181
5	85123A	36782
6	84879	35362
7	21212	33693
8	23084	27202
9	22492	26076

In [18]:
```
# top 10 StockCodes by quantity
plt.figure(figsize=(12,6))
sns.barplot(x=df5['Quantity'],y=df5['StockCode'])
plt.title('Top 10 StockCodes by quantity')
```

Out[18]:
```
Text(0.5, 1.0, 'Top 10 StockCodes by quantity')
```



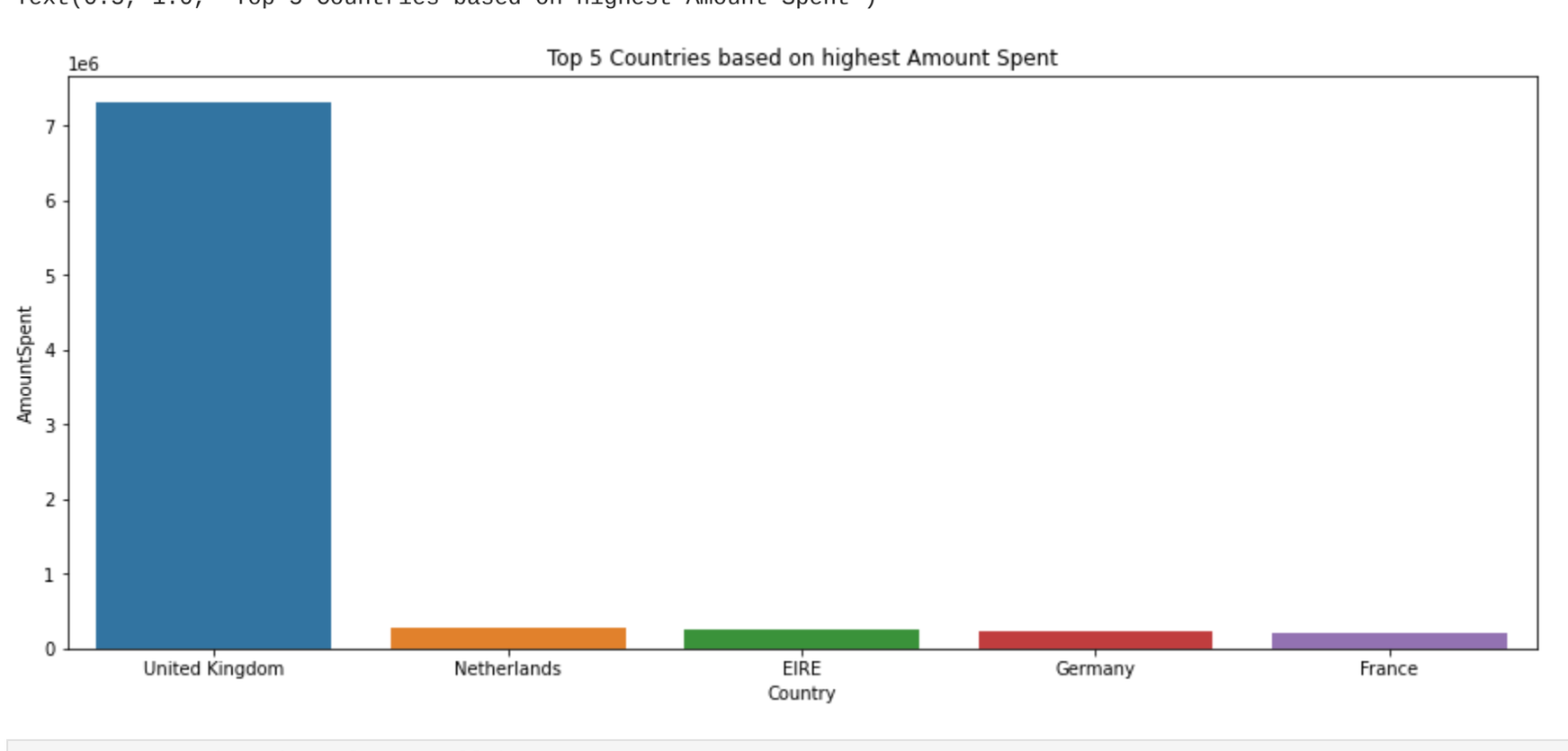
In [19]:
```
TopCountries=df.groupby('Country')['AmountSpent'].sum().reset_index().sort_values('AmountSpent',ascending=False)
TopCountries
```

Out[19]:

	Country	AmountSpent
35	United Kingdom	7308391.554
23	Netherlands	285446.340
10	EIRE	265545.900
14	Germany	228867.140
13	France	209024.050
0	Australia	138521.310
30	Spain	61577.110
32	Switzerland	56443.950
3	Belgium	41196.340
31	Sweden	38378.330
19	Japan	37416.370
24	Norway	36165.440
26	Portugal	33439.890
12	Finland	22546.080
29	Singapore	21279.290
6	Channel Islands	20450.440
9	Denmark	18955.340
18	Italy	17483.240
7	Cyprus	13590.380
1	Austria	10198.680
25	Poland	7334.650
17	Israel	7221.690
15	Greece	4760.520
16	Iceland	4310.000
5	Canada	3666.380
33	USA	3580.390
22	Malta	2725.590
36	Unspecified	2667.070
34	United Arab Emirates	1902.280
20	Lebanon	1693.880
21	Lithuania	1661.060
11	European Community	1300.250
4	Brazil	1143.600
27	RSA	1002.310
8	Czech Republic	826.740
2	Bahrain	548.400
28	Saudi Arabia	145.920

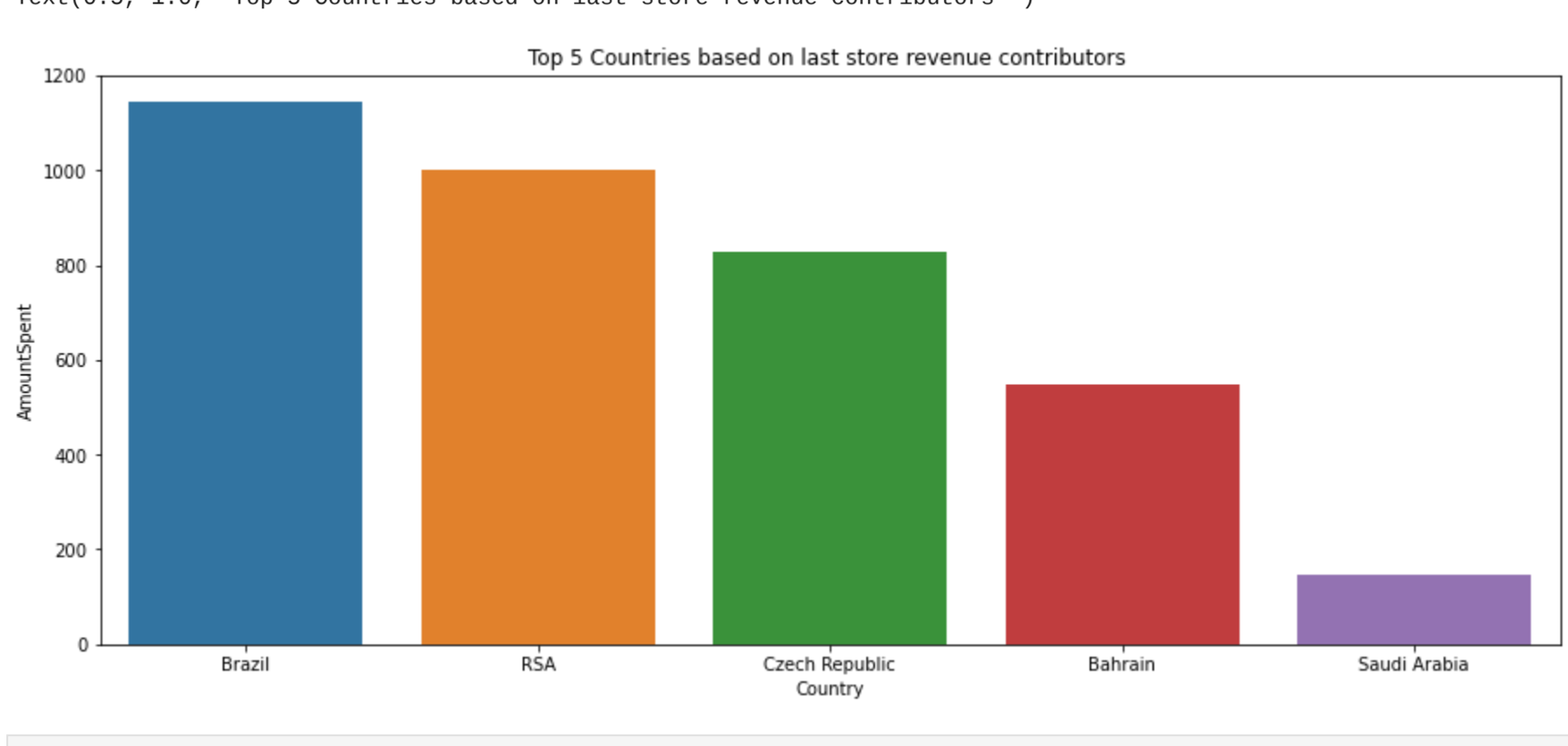
In [20]:
```
# top 5 countries where maximum sale happens.
plt.figure(figsize=(15,6))
sns.barplot(x=TopCountries['Country'].head(5),y=TopCountries['AmountSpent'].head(5))
plt.title('Top 5 Countries based on highest Amount Spent')
```

Out[20]:
```
Text(0.5, 1.0, 'Top 5 Countries based on highest Amount Spent')
```



In [21]:
```
# top 5 countries where least sell happens.
plt.figure(figsize=(15,6))
sns.barplot(x=TopCountries['Country'].tail(5),y=TopCountries['AmountSpent'].tail(5))
plt.title('Top 5 Countries based on last store revenue contributors ')
```

Out[21]:
```
Text(0.5, 1.0, 'Top 5 Countries based on last store revenue contributors ')
```



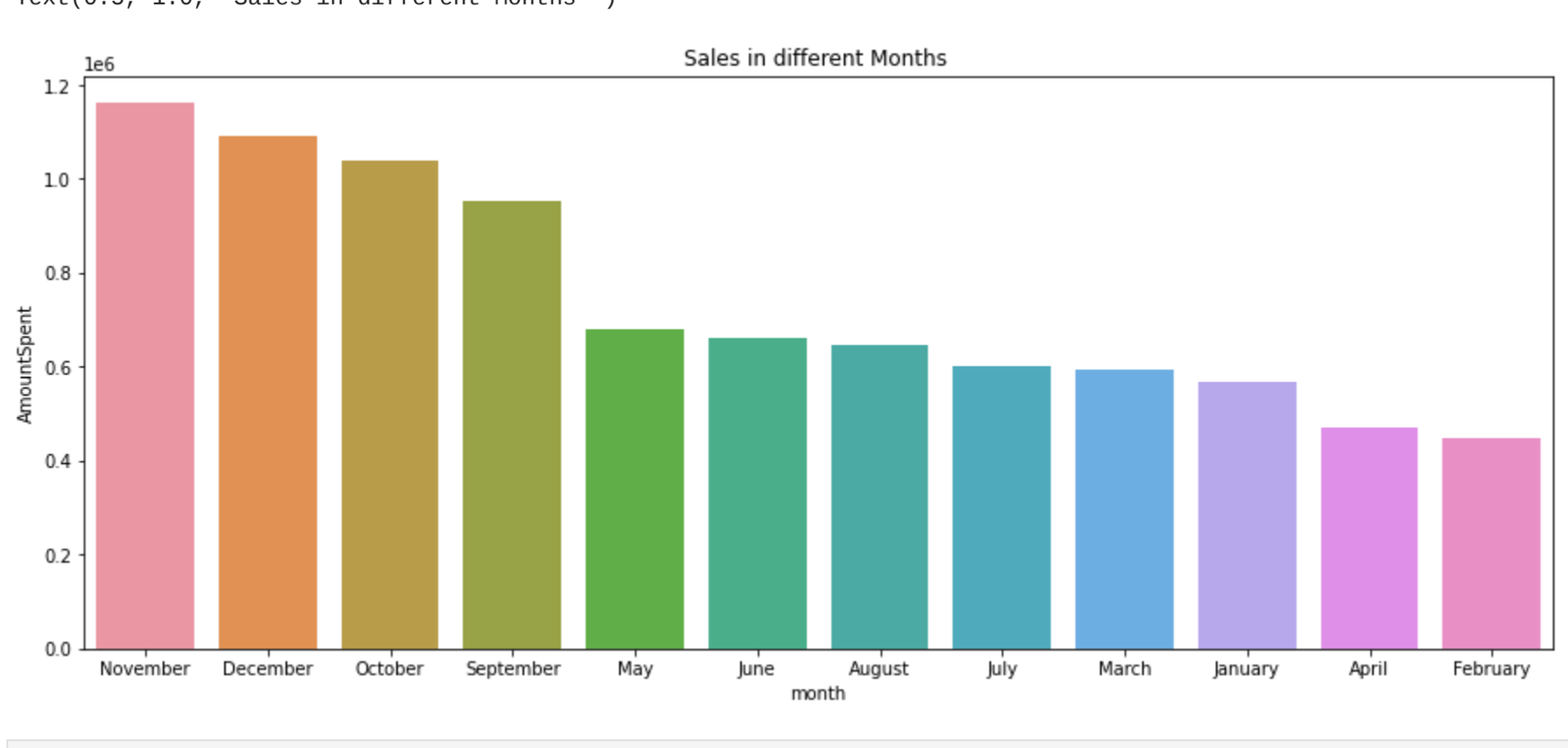
In [22]:
```
# sales by month
SalesbyMonth=df.groupby('month')['AmountSpent'].sum().reset_index().sort_values('AmountSpent',ascending=False)
SalesbyMonth
```

Out[22]:

	month	AmountSpent
9	November	1161817.380
2	December	1090906.680
10	October	1039318.790
11	September	952838.382
8	May	678594.560
6	June	661213.690
1	August	645343.900
5	July	600091.011
7	March	595500.760
4	January	569445.040
0	April	469200.361
3	February	447137.350

In [23]:
```
# Sales different months.
plt.figure(figsize=(15,6))
sns.barplot(x=SalesbyMonth['month'],y=SalesbyMonth['AmountSpent'])
plt.title('Sales in different Months ')
```

Out[23]:
```
Text(0.5, 1.0, 'Sales in different Months ')
```



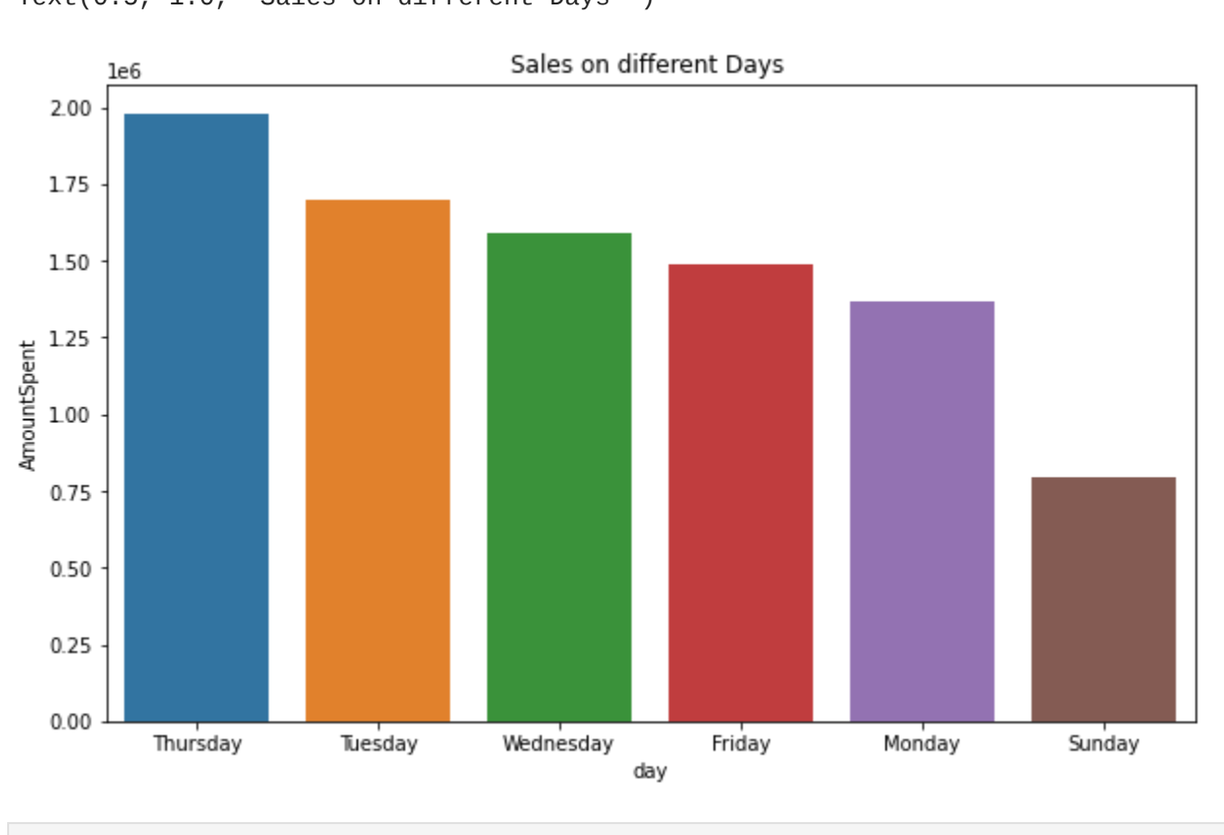
In [24]:
```
# sales on day
sales_on_day_basis=df.groupby('day')['AmountSpent'].sum().reset_index().sort_values('AmountSpent',ascending=False)
sales_on_day_basis
```

Out[24]:

	day	AmountSpent
3	Thursday	1976859.070
4	Tuesday	1700634.631
5	Wednesday	1588336.170
0	Friday	1485917.401
1	Monday	1367146.411
2	Sunday	792514.221

In [25]:
```
plt.figure(figsize=(10,6))
sns.barplot(x=sales_on_day_basis['day'],y=sales_on_day_basis['AmountSpent'])
plt.title('Sales on different Days ')
```

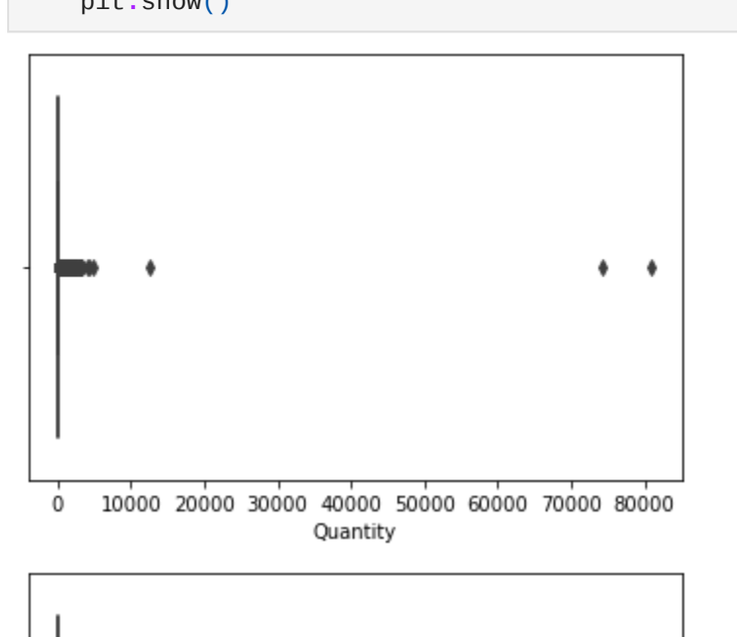
Out[25]:
```
Text(0.5, 1.0, 'Sales on different Days ')
```

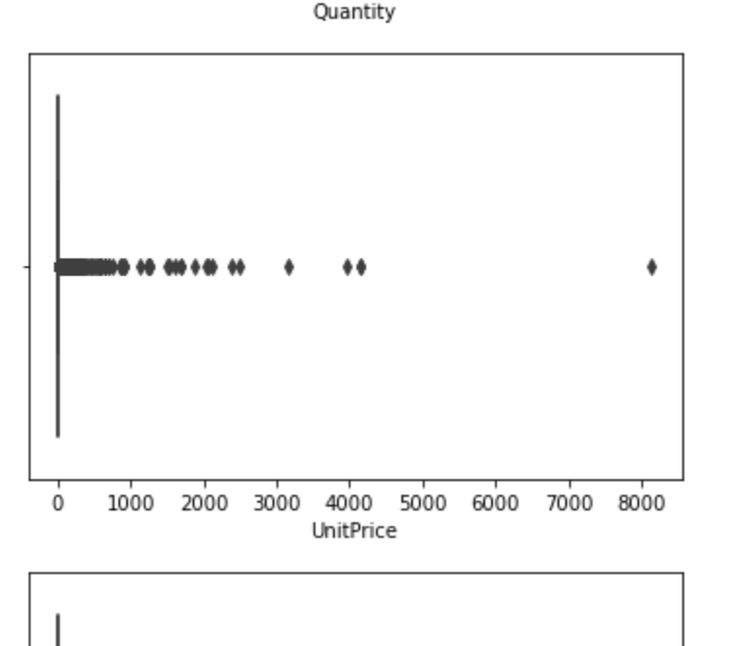


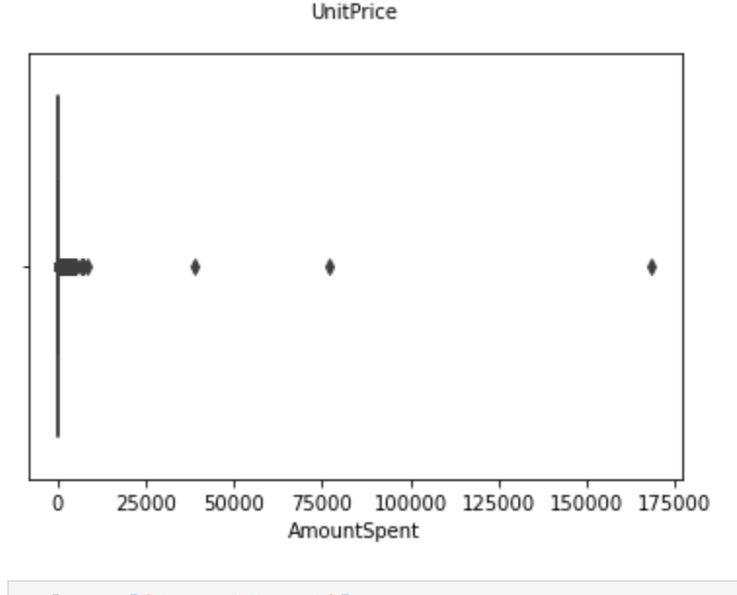
In [ ]:

In [ ]:

In [26]:
```
# outliers
for i in df[['Quantity','UnitPrice','AmountSpent']] :
    sns.boxplot(df[i])
    plt.show()
```



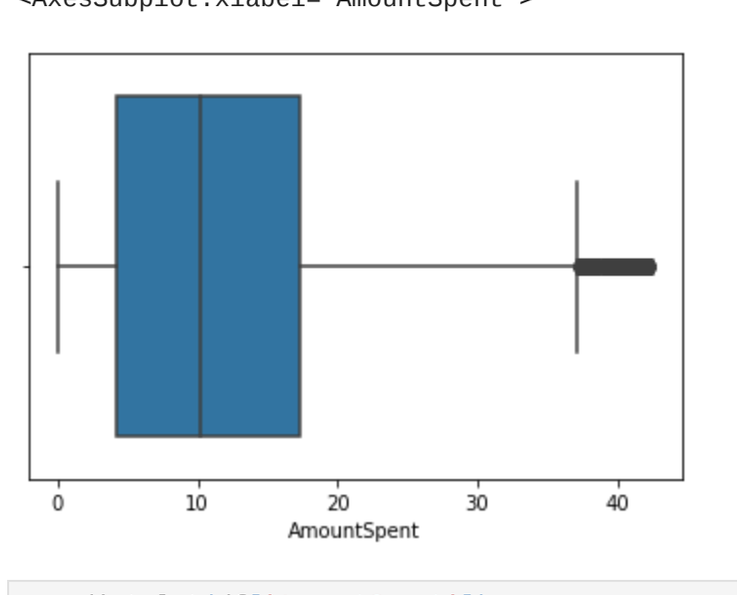




In [27]:
```
cols = ['AmountSpent']

Q1 = df[cols].quantile(0.25)
Q3 = df[cols].quantile(0.75)
IQR = Q3 - Q1

df = df[~((df[cols] < (Q1 - 1.5 * IQR)) |(df[cols] > (Q3 + 1.5 * IQR))).any(axis=1)]
```

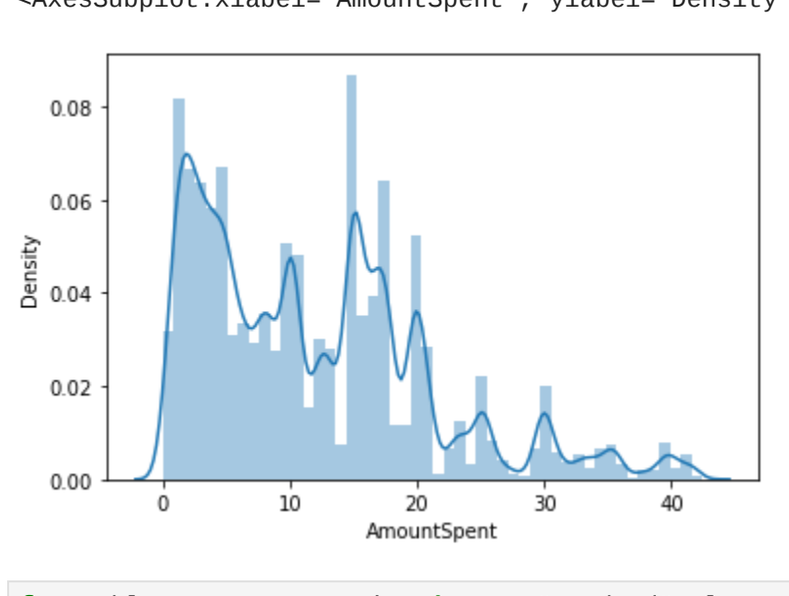
In [28]:
```
sns.boxplot(df['AmountSpent'])
```

Out[28]:
```
<AxesSubplot:xlabel='AmountSpent'>
```



In [29]:
```
sns.distplot(df['AmountSpent'])
```

Out[29]:
```
<AxesSubplot:xlabel='AmountSpent', ylabel='Density'>
```



In [30]:
```
from sklearn.preprocessing import StandardScaler
col_names = ['CustomerID','Quantity','UnitPrice']
features = df[col_names]
scaler = StandardScaler().fit(features.values)
features = scaler.transform(features.values)
scaled_features = pd.DataFrame(features, columns = col_names)
scaled_features.head()
```

Out[30]:

	CustomerID	Quantity	UnitPrice
0	1.480393	-0.080345	-0.068362
1	1.480393	-0.080345	0.224636
2	1.480393	0.006193	0.001400
3	1.480393	-0.080345	0.224636
4	1.480393	-0.080345	0.224636

In [31]:
```
# Machine learning
```

In [32]:
```
# convert amount spent to int
df['AmountSpent']=df['AmountSpent'].astype('int64')
df['UnitPrice']=df['UnitPrice'].astype(int)
df['CustomerID']=df['CustomerID'].astype('int64')
```

In [33]:
```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
```

In [34]:
```
df['itm_description']=le.fit_transform(df['Description'])
df['Country']=le.fit_transform(df['Country'])
```

In [35]:
```
df=df.drop(columns=['StockCode','Description','InvDay','InvTime','month','day'])
```

In [36]:
```
df.head()
```

Out[36]:

	InvoiceNo	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	AmountSpent	itm_description
0	536365	6	2010-12-01 08:26:00	2	17850	35	15	3666
1	536365	6	2010-12-01 08:26:00	3	17850	35	20	3674
2	536365	8	2010-12-01 08:26:00	2	17850	35	22	849
3	536365	6	2010-12-01 08:26:00	3	17850	35	20	1792
4	536365	6	2010-12-01 08:26:00	3	17850	35	20	2741

In [37]:
```
df.drop_duplicates(inplace=True)
```

In [38]:
```
df.shape
```

Out[38]:
```
(361471, 8)
```

In [39]:
```
X = df[['CustomerID','AmountSpent']].values
```

In [40]:
```
X
```

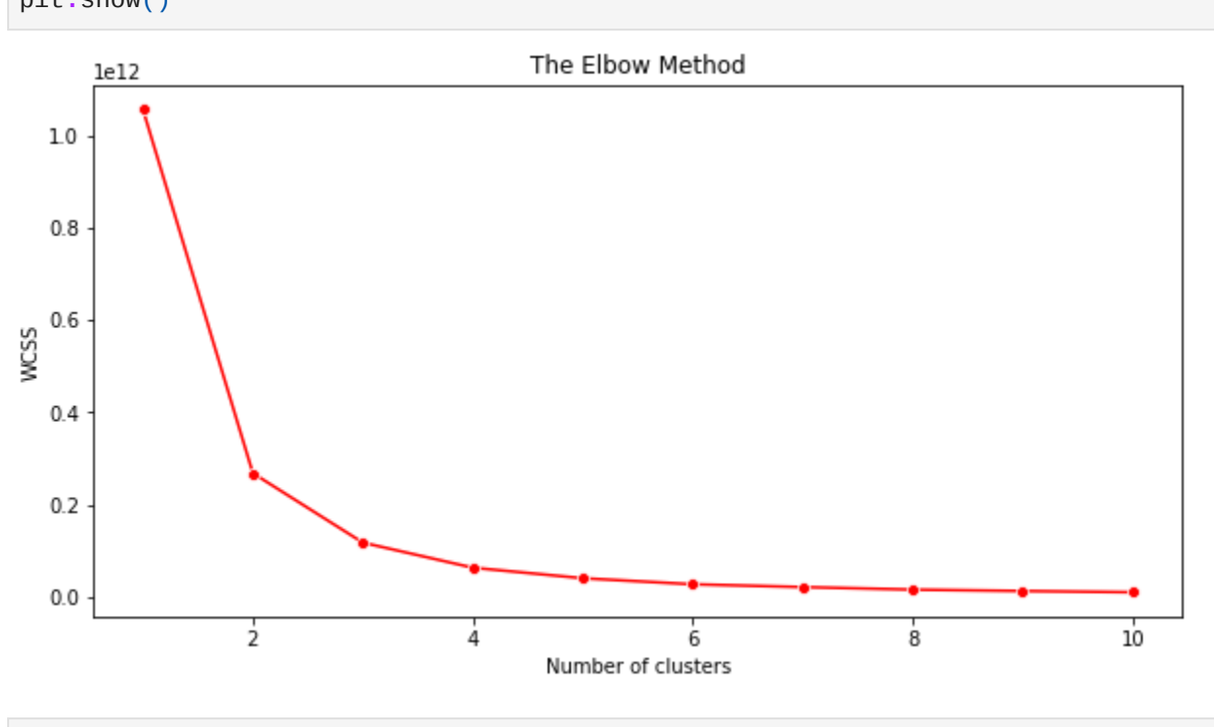
Out[40]:
```
array([[17850,    15],
       [17850,    20],
       [17850,    22],
       ...,
       [12680,    16],
       [12680,    16],
       [12680,    14]], dtype=int64)
```

In [41]:
```
from sklearn.cluster import KMeans
```

In [42]:
```
wcss = []

for i in range(1,11):
    kmeans = KMeans(n_clusters=i, init='k-means++', random_state=42)
    kmeans.fit(X)
    wcss.append(kmeans.inertia_)

print(wcss)
```

```
[1056094549035.9456, 267892799728.5738, 117385450851.28531, 63086005805.92973, 40232387068.49605, 27167706568.13997, 21087338299.3576, 15610787422.421764, 12562521609.04785, 989799
0046.93588]
```

In [43]:
```
fig = plt.figure(figsize=(10,5))
sns.lineplot(range(1,11), wcss, marker='o', color='red')

plt.title('The Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')

plt.show()
```

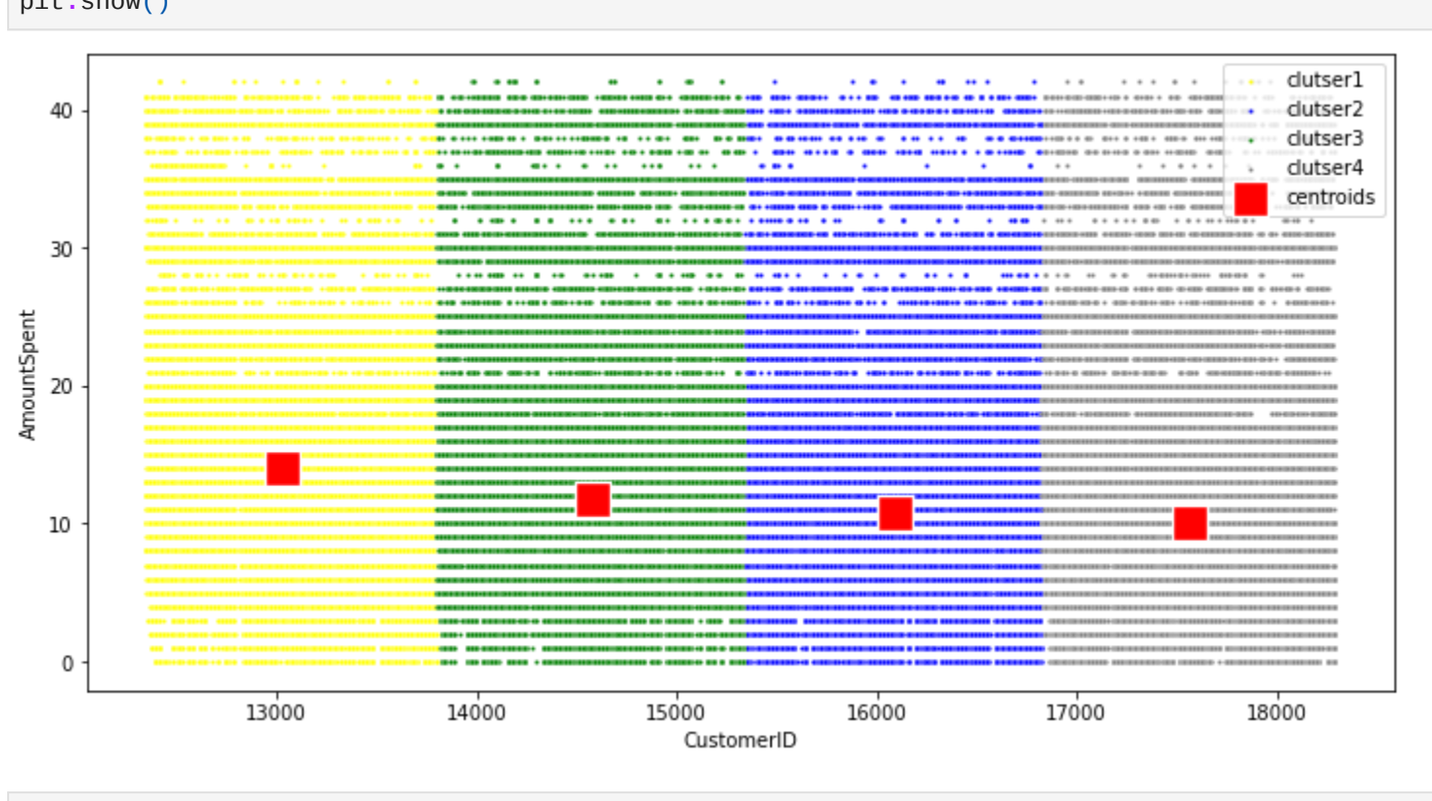


In [44]:
```
kmeans = KMeans(n_clusters=4, init='k-means++', random_state=10)
y_means = kmeans.fit_predict(X)
```

In [45]:
```
y_means
```

Out[45]:
```
array([3, 3, 3, ..., 0, 0, 0])
```

In [46]:
```
#visualisuing the clusters
plt.figure(figsize=(12,6))

sns.scatterplot(data = X, x = X[y_means==0,0],y = X[y_means==0,1], color='yellow', label='clutser1',s=5)
sns.scatterplot(data = X, x = X[y_means==1,0],y = X[y_means==1,1], color='blue', label='clutser2',s=5)
sns.scatterplot(data = X, x = X[y_means==2,0],y = X[y_means==2,1], color='green', label='clutser3',s=5)
sns.scatterplot(data = X, x = X[y_means==3,0],y = X[y_means==3,1], color='grey', label='clutser4',s=5)
# sns.scatterplot(data = X, x = X[y_means==4,0],y = X[y_means==4,1], color='orange', label='clutser5',s=50)

sns.scatterplot(data=X,x=kmeans.cluster_centers_[:,0], y=kmeans.cluster_centers_[:,1], color='red',label='centroids', s=300, marker=',')
plt.xlabel('CustomerID')
plt.ylabel('AmountSpent')
plt.show()
```



In [47]:
```
from sklearn.metrics import silhouette_score
silhouette_score(X, kmeans.labels_ , metric='euclidean')
```

Out[47]:
```
0.5887866618401485
```

In [48]:
```
from scipy.cluster import hierarchy
```

In [49]:
```
# plt.figure(figsize=(18,8))

# dendrogram = hierarchy.dendrogram(hierarchy.linkage(X,'average'))
# plt.title('Dendrogram')
# plt.xlabel('Customers')
# plt.ylabel('Euclidean Distance')
# plt.axhline(50,color='red')
# plt.show()
```

In [50]:
```
tuned_clustering = KMeans(n_clusters=4, init='k-means++', random_state=10)

label = tuned_clustering.fit_predict(X)
```

In [51]:
```
label
```

Out[51]:
```
array([3, 3, 3, ..., 0, 0, 0])
```

In [ ]:
```
silhouette_score(X, tuned_clustering.labels_, metric='euclidean')
```

In [ ]:
```
from sklearn.cluster import AgglomerativeClustering
```

In [ ]:
```
clustering_model = AgglomerativeClustering(n_clusters=4,affinity='euclidean')
```

In [ ]:
```
clustering_model.fit(X)
```

In [ ]:
```
clustering_prediction = clustering_model.fit_predict(X)
clustering_prediction
```

In [ ]:
```
silhouette_score(X, clustering_prediction, metric='euclidean')
```

In [ ]:
```
plt.figure(figsize=(16,10))
plt.scatter(X[clustering_prediction==0,0],
            X[clustering_prediction==0,1], s=30, c='green',
           label='cluster1')


plt.scatter(X[clustering_prediction==1,0],
            X[clustering_prediction==1,1], s=30,
            c='red',label='cluster2')

plt.scatter(X[clustering_prediction==2,0],
            X[clustering_prediction==2,1], s=30,
            c='blue',label='cluster3')

plt.scatter(X[clustering_prediction==3,0],
            X[clustering_prediction==3,1], s=30,
            c='orange',label='cluster4')


plt.xlabel('CustomerID')
plt.ylabel('itm_description')
plt.legend()
plt.grid()
plt.show()
```

In [ ]:
```
from sklearn.cluster import DBSCAN
clustering_model = DBSCAN(eps=9, min_samples=4)
```

In [ ]:
```
clustering_model.fit(X)
```

In [ ]:
```
predict_labels = clustering_model.labels_
predict_labels
```

In [ ]:
```
plt.scatter(X[:,0], X[:,1], c=predict_labels)

plt.xlabel('Annual Income')
plt.ylabel('Spending Score')
plt.title('DBSCAN')

plt.show()
```

In [ ]: