In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.neural_network import MLPClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import silhouette_samples, silhouette_score
from sklearn.metrics import confusion_matrix,classification_report,roc_auc_score,accu
```

In [41]:
```
df=pd.read_csv('bank_marketing_part1_Data.csv')
```

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

Out[3]:

	spending	advance_payments	probability_of_full_payment	current_balance	credit_limit	min_payment_amt
0	19.94	16.92	0.8752	6.675	3.763	3.252
1	15.99	14.89	0.9064	5.363	3.582	3.336
2	18.95	16.42	0.8829	6.248	3.755	3.368
3	10.83	12.96	0.8099	5.278	2.641	5.182
4	17.99	15.86	0.8992	5.890	3.694	2.068

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

Out[4]: (210, 7)

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 210 entries, 0 to 209
Data columns (total 7 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   spending                      210 non-null    float64
 1   advance_payments              210 non-null    float64
 2   probability_of_full_payment   210 non-null    float64
 3   current_balance               210 non-null    float64
 4   credit_limit                  210 non-null    float64
 5   min_payment_amt               210 non-null    float64
 6   max_spent_in_single_shopping  210 non-null    float64
dtypes: float64(7)
memory usage: 11.6 KB
```

In [6]:
```
df.describe().T
```

Out[6]:

	count	mean	std	min	25%	50%	75%	max
spending	210.0	14.847524	2.909699	10.5900	12.27000	14.35500	17.305000	21.1800
advance_payments	210.0	14.559286	1.305959	12.4100	13.45000	14.32000	15.715000	17.2500
probability_of_full_payment	210.0	0.870999	0.023629	0.8081	0.85690	0.87345	0.887775	0.9183
current_balance	210.0	5.628533	0.443063	4.8990	5.26225	5.52350	5.979750	6.6750
credit_limit	210.0	3.258605	0.377714	2.6300	2.94400	3.23700	3.561750	4.0330
min_payment_amt	210.0	3.700201	1.503557	0.7651	2.56150	3.59900	4.768750	8.4560
max_spent_in_single_shopping	210.0	5.408071	0.491480	4.5190	5.04500	5.22300	5.877000	6.5500

In [7]:
```
df.isnull().sum()
```

Out[7]:
```
spending                        0
advance_payments                0
probability_of_full_payment     0
current_balance                 0
credit_limit                    0
min_payment_amt                 0
max_spent_in_single_shopping    0
dtype: int64
```

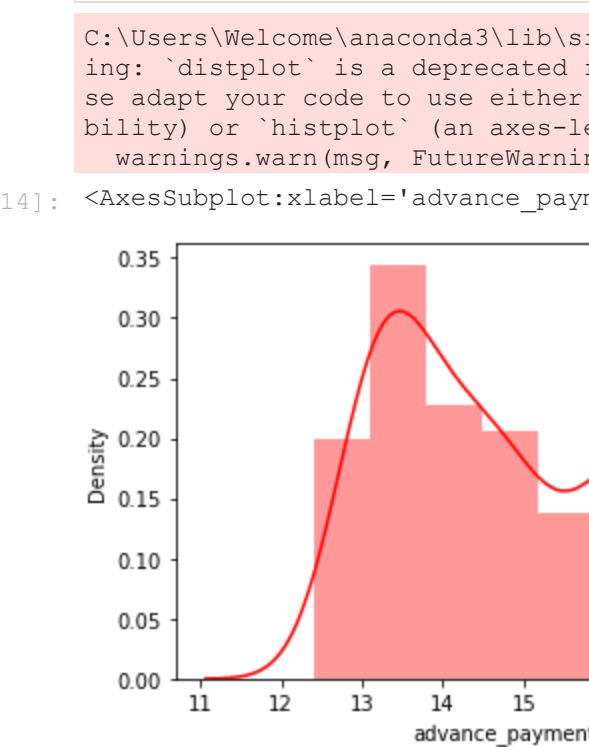
In [9]:
```
dups = df.duplicated()
print('Number of duplicate rows = %d' % (dups.sum()))
```

Number of duplicate rows = 0

In [10]:
```
sns.distplot(df['spending'], color = "r")
```

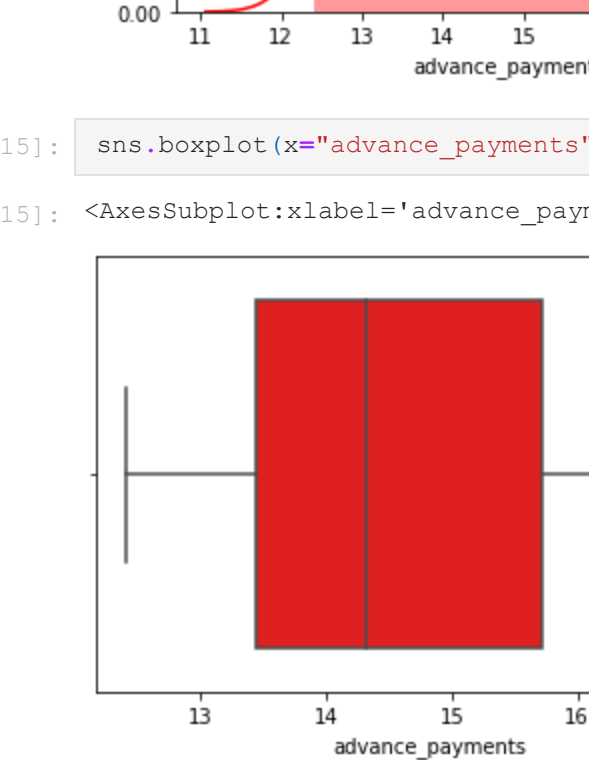
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[10]: <AxesSubplot:xlabel='spending', ylabel='Density'>



In [13]:
```
sns.boxplot(x="spending" ,color = "r", data=df)
```

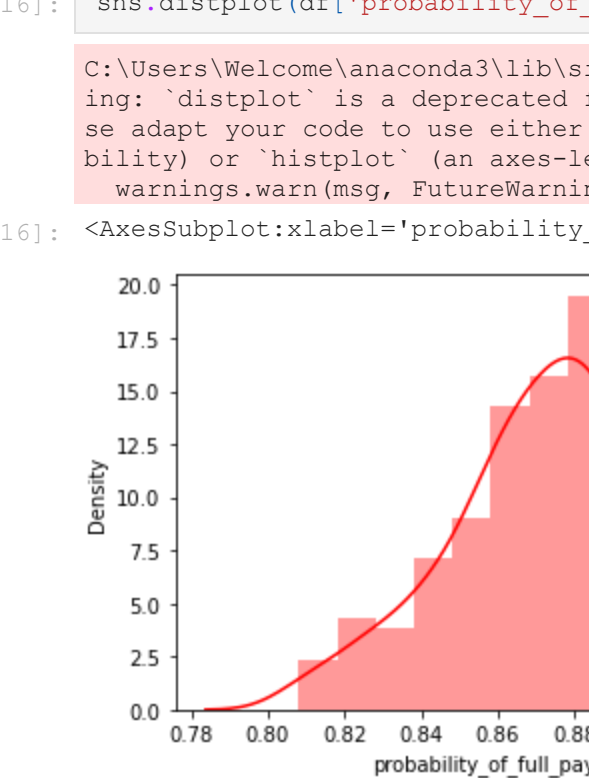
Out[13]: <AxesSubplot:xlabel='spending'>



In [14]:
```
sns.distplot(df['advance_payments'], color = "r")
```

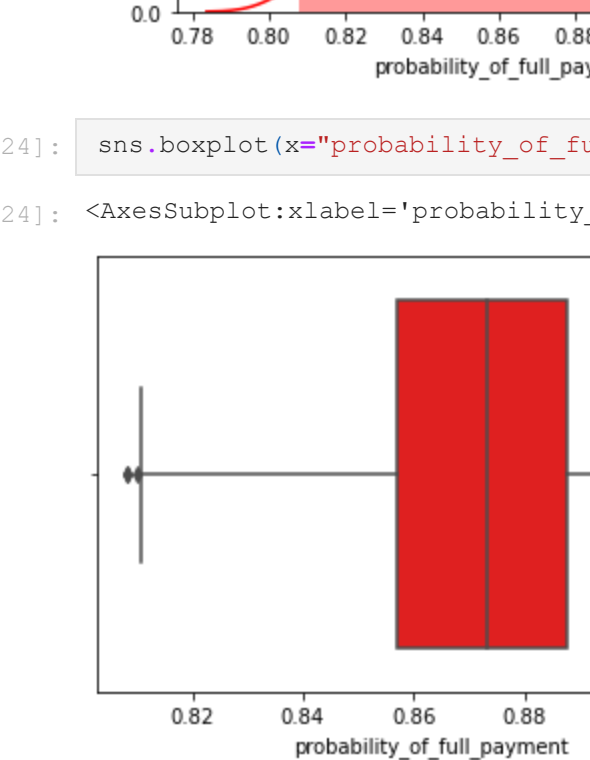
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[14]: <AxesSubplot:xlabel='advance_payments', ylabel='Density'>



In [15]:
```
sns.boxplot(x="advance_payments" ,color = "r", data=df)
```

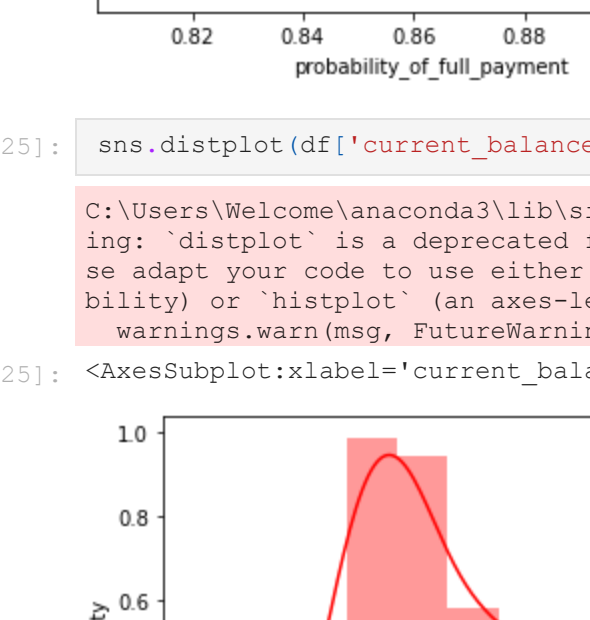
Out[15]: <AxesSubplot:xlabel='advance_payments'>



In [16]:
```
sns.distplot(df['probability_of_full_payment'], color = "r")
```

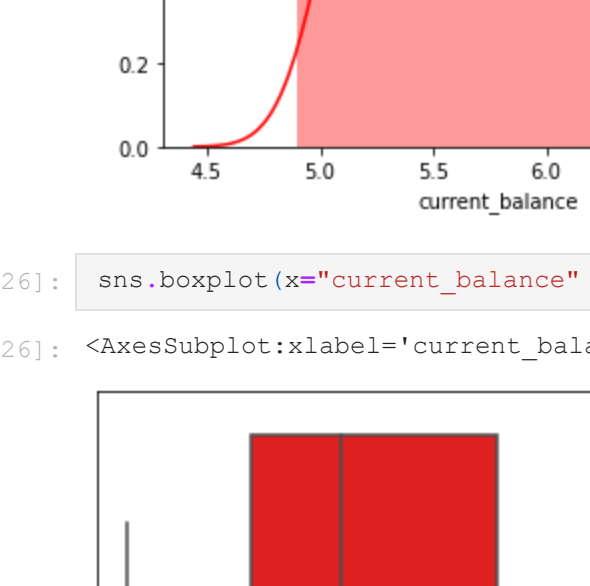
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[16]: <AxesSubplot:xlabel='probability_of_full_payment', ylabel='Density'>



In [24]:
```
sns.boxplot(x="probability_of_full_payment" ,color = "r", data=df)
```

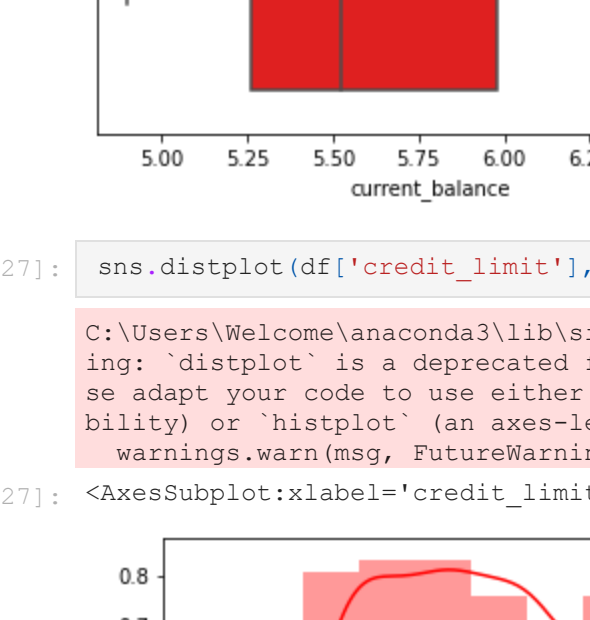
Out[24]: <AxesSubplot:xlabel='probability_of_full_payment'>



In [25]:
```
sns.distplot(df['current_balance'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[25]: <AxesSubplot:xlabel='current_balance', ylabel='Density'>



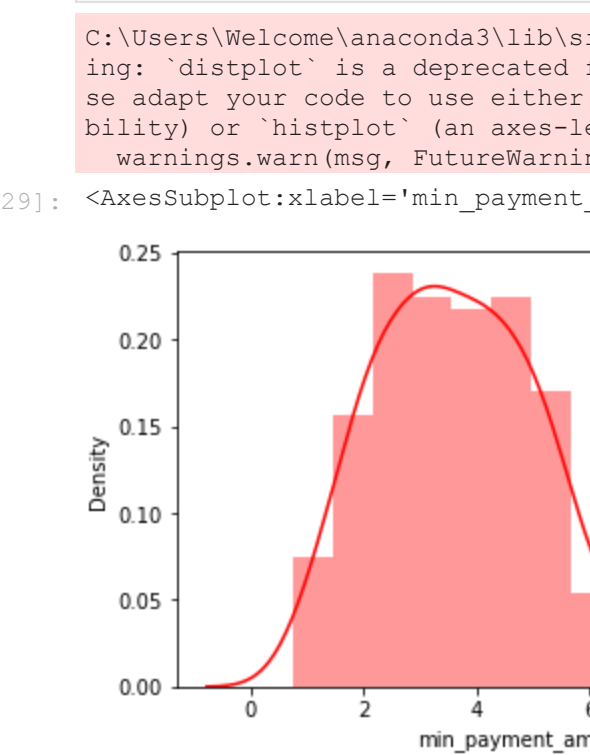
In [26]:
```
sns.boxplot(x="current_balance" ,color = "r", data=df)
```

Out[26]: <AxesSubplot:xlabel='current_balance'>

In [27]:
```
sns.distplot(df['credit_limit'], color = "r")
```

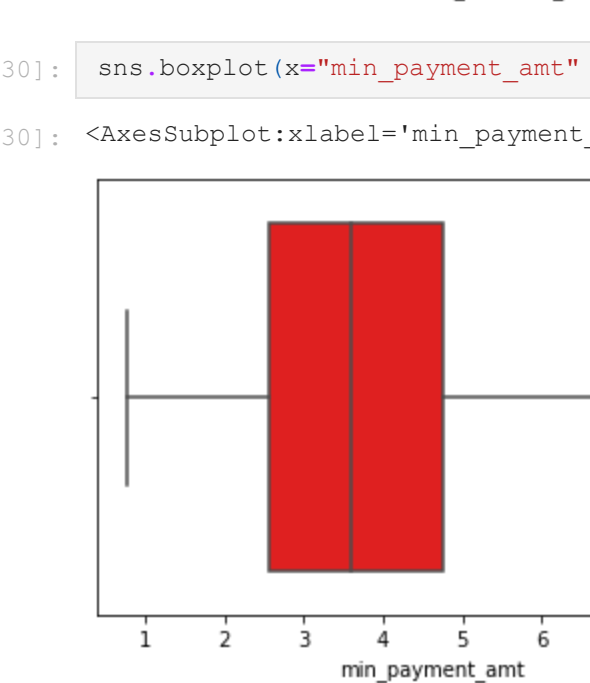
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[27]: <AxesSubplot:xlabel='credit_limit', ylabel='Density'>



In [28]:
```
sns.boxplot(x="credit_limit" ,color = "r", data=df)
```

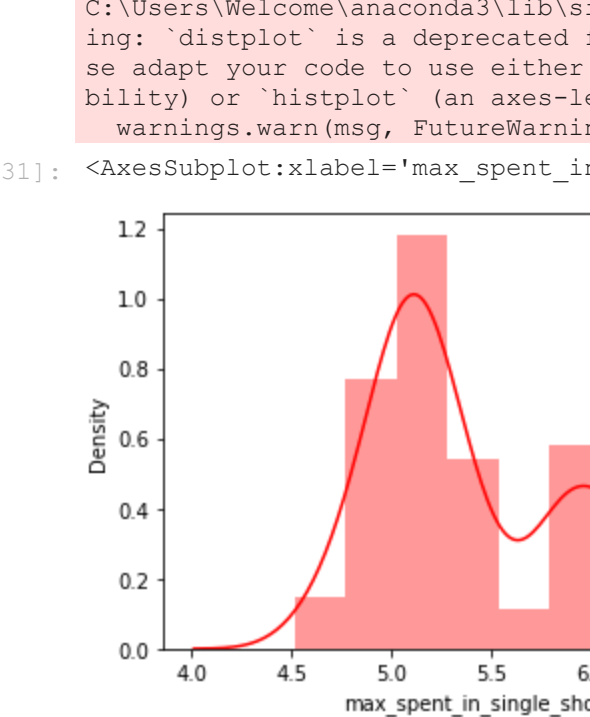
Out[28]: <AxesSubplot:xlabel='credit_limit'>



In [29]:
```
sns.distplot(df['min_payment_amt'], color = "r")
```

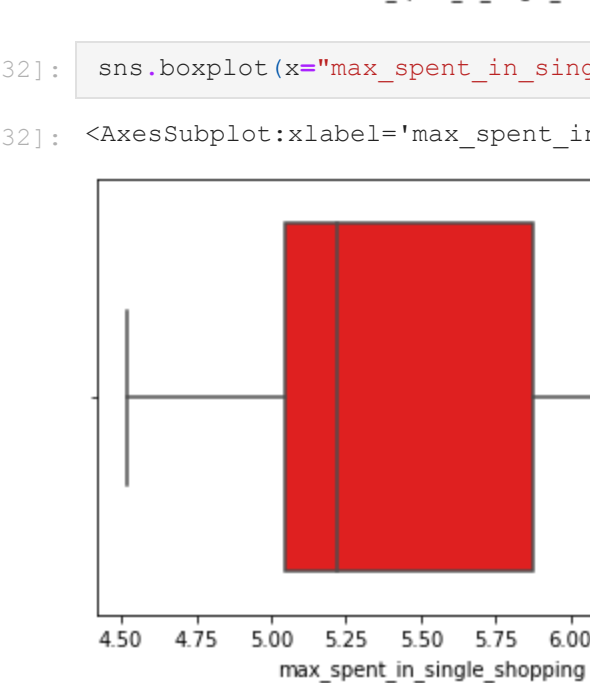
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

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



In [30]:
```
sns.boxplot(x="min_payment_amt" ,color = "r", data=df)
```

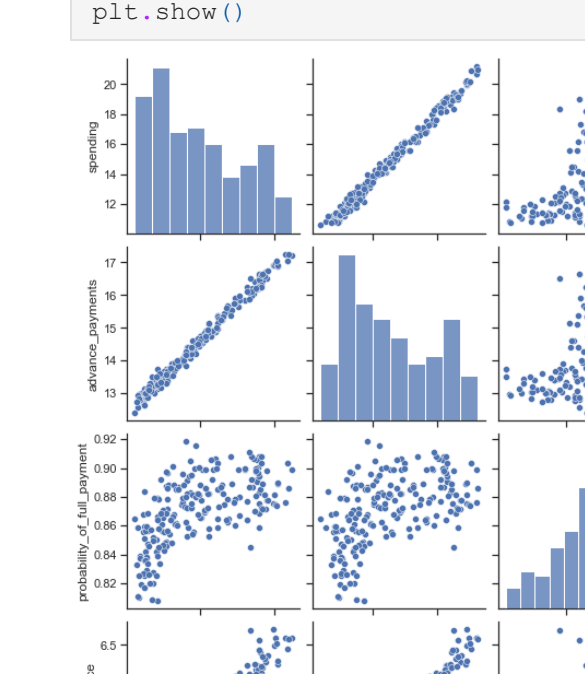
Out[30]: <AxesSubplot:xlabel='min_payment_amt'>



In [31]:
```
sns.distplot(df['max_spent_in_single_shopping'], color = "r")
```

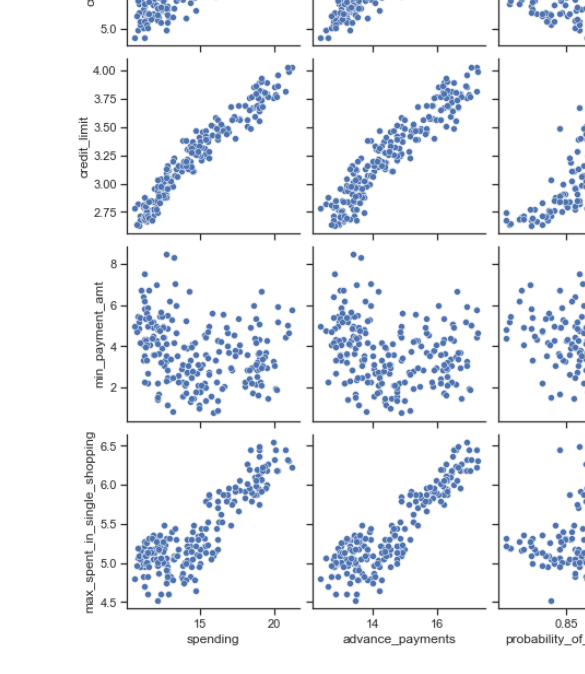
```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarn
ing: `distplot` is a deprecated function and will be removed in a future version. Plea
se adapt your code to use either `displot` (a figure-level function with similar flexi
bility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[31]: <AxesSubplot:xlabel='max_spent_in_single_shopping', ylabel='Density'>

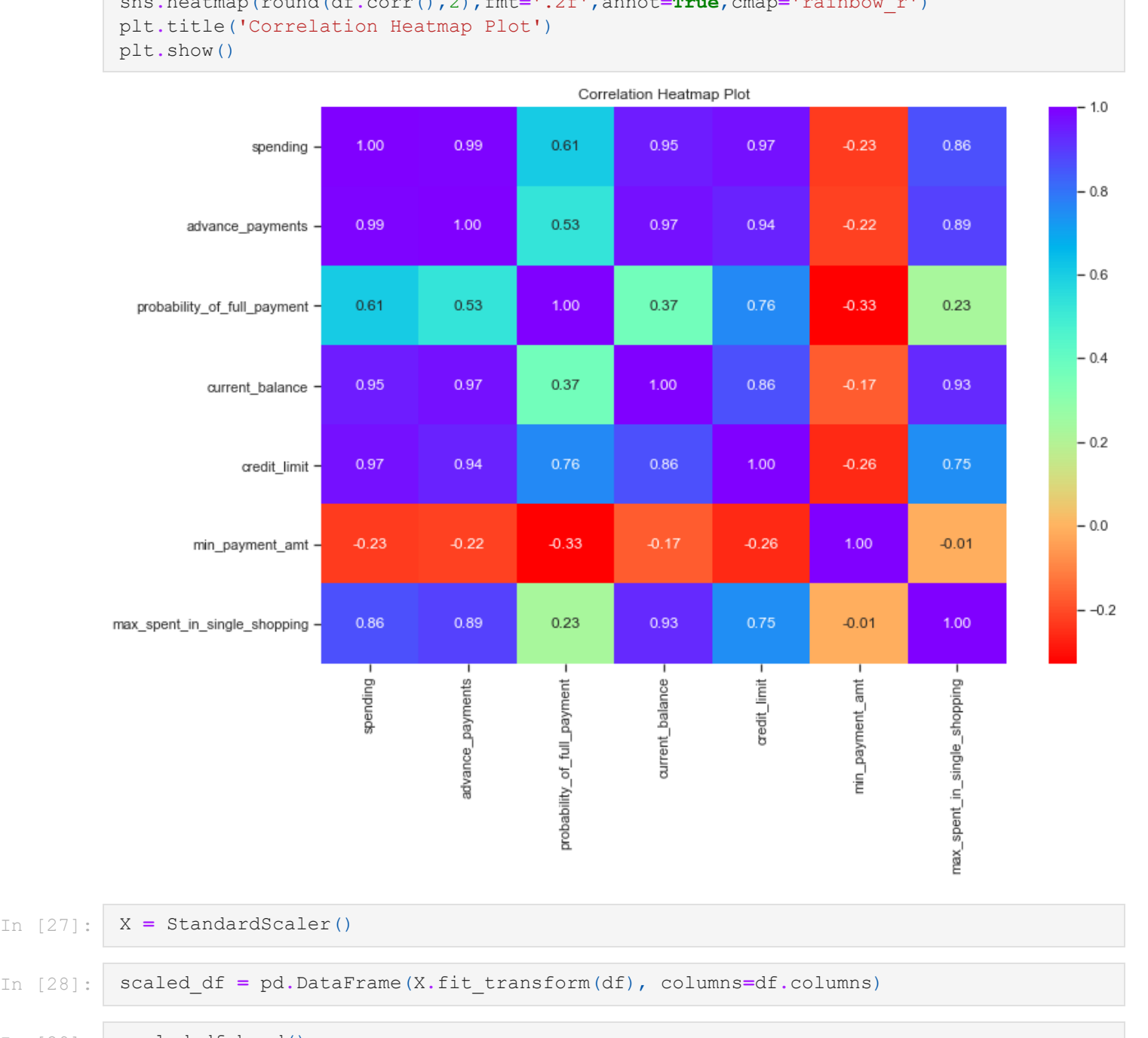


In [32]:
```
sns.boxplot(x="max_spent_in_single_shopping" ,color = "r", data=df)
```

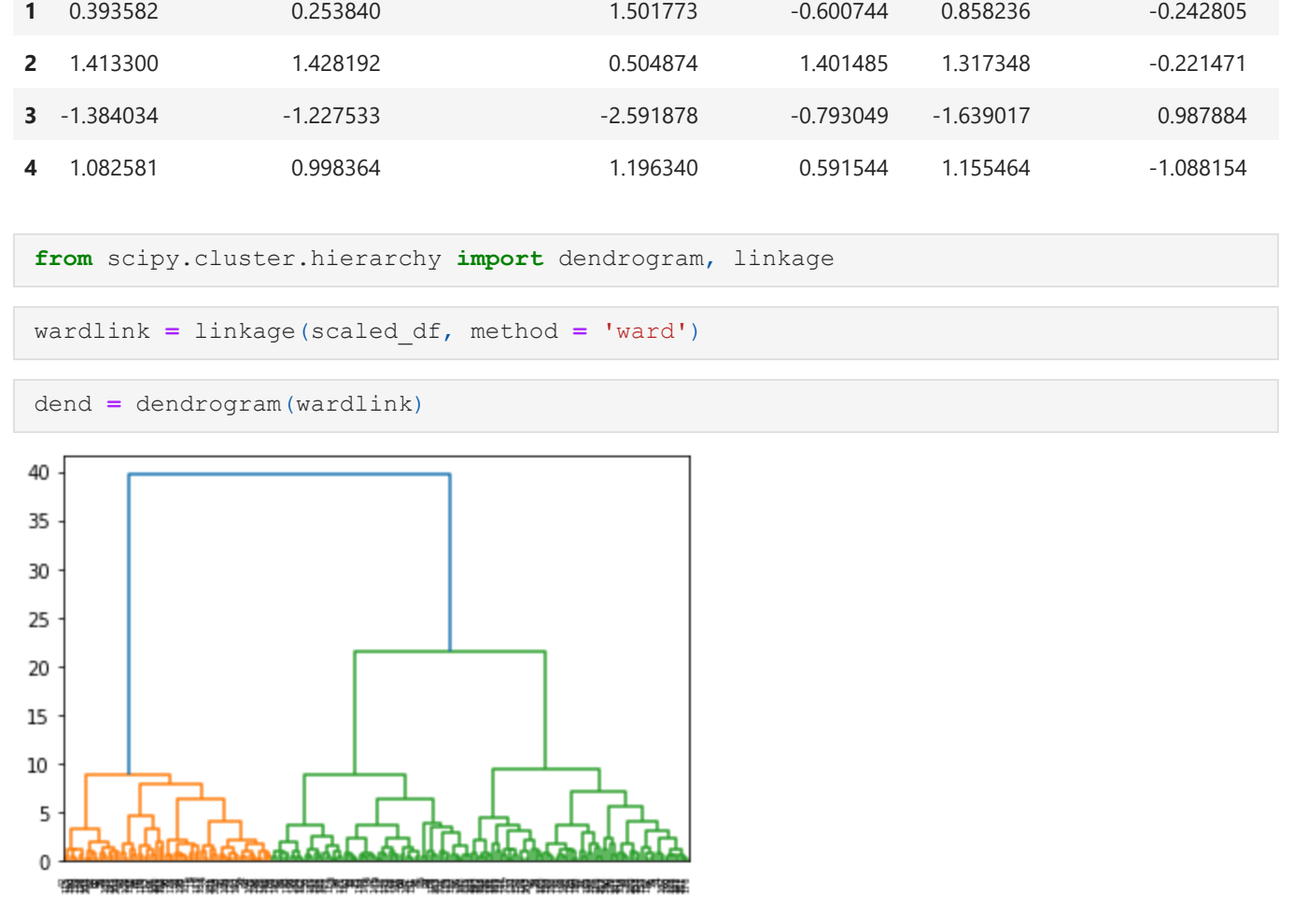
Out[32]: <AxesSubplot:xlabel='max_spent_in_single_shopping'>



```
sns.pairplot(df[df.dtypes[(df.dtypes=='int64')|(df.dtypes=='float64')].index])
plt.show()
```



```
plt.figure(figsize=(12,5))
sns.heatmap(round(df.corr(),2),fmt='.2f',annot=True,cmap='rainbow_r')
plt.title('Correlation Heatmap Plot')
plt.show()
```




```
X = StandardScaler()
```

```
scaled_df = pd.DataFrame(X.fit_transform(df), columns=df.columns)
```

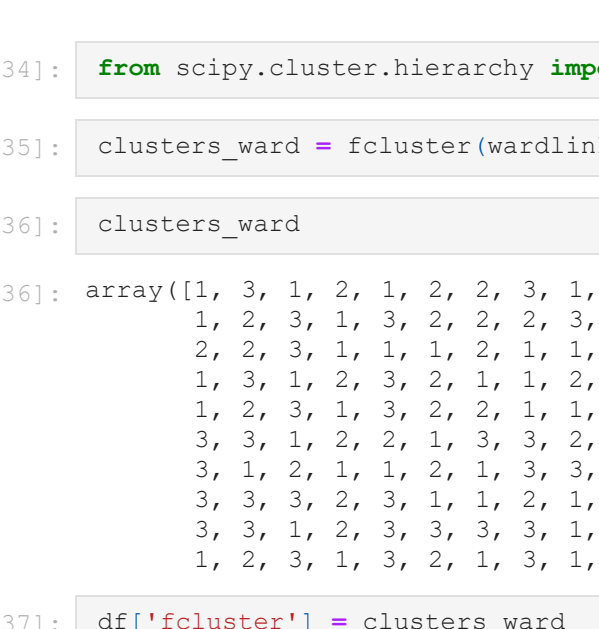
```
scaled_df.head()
```

	spending	advance_payments	probability_of_full_payment	current_balance	credit_limit	min_payment_amt
0	1.754355	1.811968	0.178230	2.367533	1.338579	-0.298806
1	0.393582	0.253840	1.501773	-0.600744	0.858236	-0.242805
2	1.413300	1.428192	0.504874	1.401485	1.317348	-0.221471
3	-1.384034	-1.227533	-2.591878	-0.793049	-1.639017	0.987884
4	1.082581	0.998364	1.196340	0.591544	1.155464	-1.088154

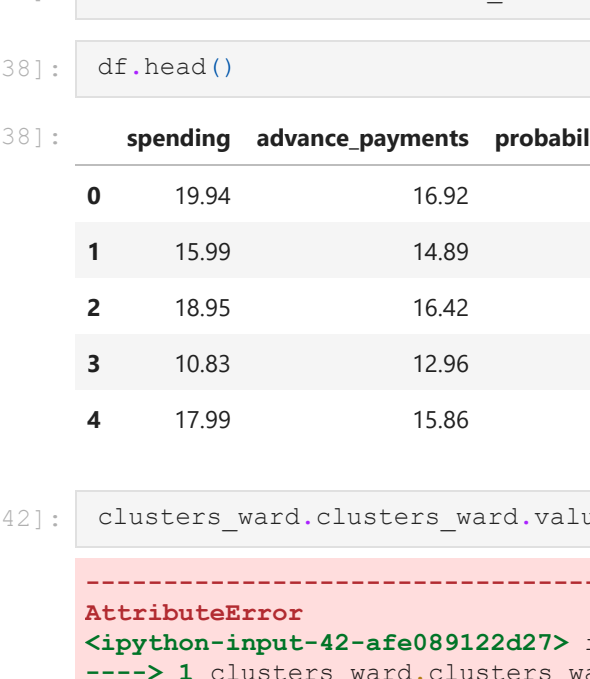
```
from scipy.cluster.hierarchy import dendrogram, linkage
```

```
wardlink = linkage(scaled_df, method = 'ward')
```

```
dend = dendrogram(wardlink)
```



```
dend = dendrogram(wardlink, truncate_mode = 'lastp', p=10)
```



In [34]:
```
from scipy.cluster.hierarchy import fcluster
```

In [35]:
```
clusters_ward = fcluster(wardlink, 3, criterion='maxclust')
```

In [36]:
```
clusters_ward
```

Out[36]:
```
array([1, 3, 1, 2, 1, 2, 2, 3, 1, 2, 1, 3, 2, 1, 3, 2, 3, 2, 3, 2, 2, 2,
       1, 2, 3, 1, 3, 2, 2, 2, 3, 2, 2, 3, 2, 2, 2, 2, 2, 1, 1, 3, 1, 1,
       2, 2, 3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 2, 2, 1, 3, 2, 2, 3, 3, 1,
       1, 3, 1, 2, 3, 2, 1, 1, 2, 1, 3, 2, 1, 3, 3, 3, 3, 1, 2, 3, 3, 1,
       1, 2, 3, 1, 3, 2, 2, 1, 1, 2, 1, 2, 1, 3, 1, 3, 1, 1, 2, 2, 2, 1,
       3, 3, 1, 2, 2, 1, 3, 3, 2, 1, 3, 2, 2, 2, 3, 3, 1, 2, 3, 3, 2, 3,
       3, 1, 2, 1, 1, 2, 1, 3, 3, 3, 2, 2, 3, 2, 1, 2, 3, 2, 3, 2, 3, 3,
       3, 3, 3, 2, 3, 1, 1, 2, 1, 1, 1, 2, 1, 3, 3, 3, 3, 2, 3, 1, 1, 1,
       3, 3, 1, 2, 3, 3, 3, 3, 1, 1, 3, 3, 3, 2, 3, 3, 2, 1, 3, 1, 1, 2,
       1, 2, 3, 1, 3, 2, 1, 3, 1, 3, 1, 3], dtype=int32)
```

In [37]:
```
df['fcluster'] = clusters_ward
```

In [38]:
```
df.head()
```

Out[38]:

	spending	advance_payments	probability_of_full_payment	current_balance	credit_limit	min_payment_amt
0	19.94	16.92	0.8752	6.675	3.763	3.252
1	15.99	14.89	0.9064	5.363	3.582	3.336
2	18.95	16.42	0.8829	6.248	3.755	3.368
3	10.83	12.96	0.8099	5.278	2.641	5.182
4	17.99	15.86	0.8992	5.890	3.694	2.068

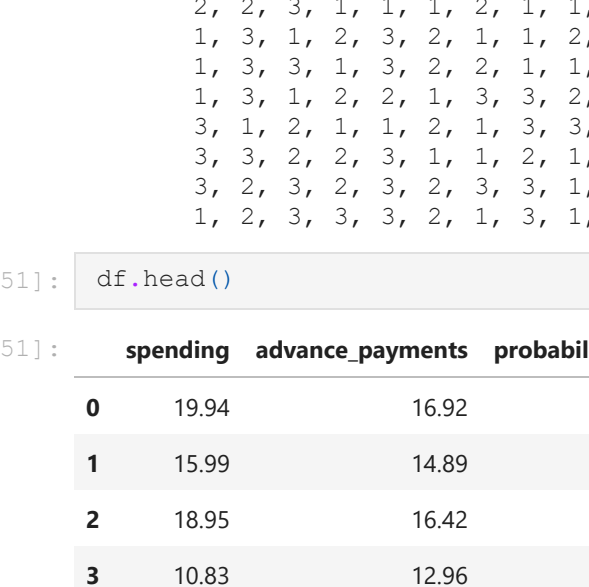
In [42]:
```
clusters_ward.clusters_ward.value_counts().sort_index()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-42-afe089122d27> in <module>
----> 1 clusters_ward.clusters_ward.value_counts().sort_index()

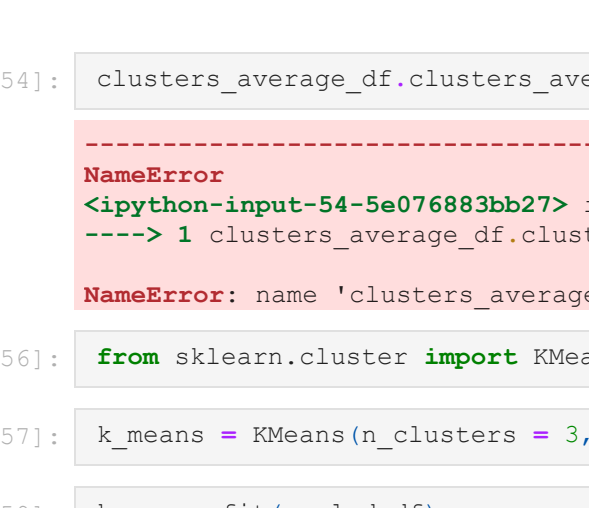
AttributeError: 'numpy.ndarray' object has no attribute 'clusters_ward'
```

In [44]:
```
Wardlink_1 = linkage(scaled_df, method = 'average')
```

In [46]:
```
dend_1 = dendrogram(Wardlink_1)
```



In [47]:
```
dend = dendrogram(Wardlink_1, truncate_mode = 'lastp', p=10)
```



In [48]:
```
clusters_average = fcluster(Wardlink_1, 3, criterion='maxclust')
```

In [49]:
```
clusters_average
```

Out[49]:
```
array([1, 3, 1, 2, 1, 3, 2, 2, 1, 2, 1, 1, 2, 1, 3, 3, 3, 2, 2, 2, 2, 2,
       1, 2, 3, 1, 3, 2, 2, 2, 2, 2, 2, 3, 2, 2, 2, 2, 2, 1, 1, 3, 1, 1,
       2, 2, 3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 2, 2, 1, 3, 2, 2, 1, 3, 1,
       1, 3, 1, 2, 3, 2, 1, 1, 2, 1, 3, 2, 1, 3, 3, 3, 3, 1, 2, 1, 1, 1,
       1, 3, 3, 1, 3, 2, 2, 1, 1, 1, 2, 1, 3, 1, 3, 1, 3, 1, 1, 2, 3, 1,
       1, 3, 1, 2, 2, 1, 3, 3, 2, 1, 3, 2, 2, 2, 3, 3, 1, 2, 3, 3, 2, 3,
       3, 1, 2, 1, 1, 2, 1, 3, 3, 3, 2, 2, 2, 2, 1, 2, 3, 2, 3, 2, 3, 1,
       3, 3, 2, 2, 3, 1, 1, 2, 1, 1, 1, 2, 1, 3, 3, 2, 3, 2, 3, 1, 1, 1,
       3, 2, 3, 2, 3, 2, 3, 3, 1, 1, 3, 1, 3, 2, 3, 3, 2, 1, 3, 1, 1, 2,
       1, 2, 3, 3, 3, 2, 1, 3, 1, 3, 3, 1], dtype=int32)
```

In [51]:
```
df.head()
```

Out[51]:

	spending	advance_payments	probability_of_full_payment	current_balance	credit_limit	min_payment_amt
0	19.94	16.92	0.8752	6.675	3.763	3.252
1	15.99	14.89	0.9064	5.363	3.582	3.336
2	18.95	16.42	0.8829	6.248	3.755	3.368
3	10.83	12.96	0.8099	5.278	2.641	5.182
4	17.99	15.86	0.8992	5.890	3.694	2.068

In [54]:
```
clusters_average_df.clusters_average.value_counts().sort_index()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-54-5e076883bb27> in <module>
----> 1 clusters_average_df.clusters_average.value_counts().sort_index()

NameError: name 'clusters_average_df' is not defined
```

In [56]:
```
from sklearn.cluster import KMeans
```

In [57]:
```
k_means = KMeans(n_clusters = 3, random_state = 10)
```

In [59]:
```
k_means.fit(scaled_df)
```

Out[59]: KMeans(n_clusters=3, random_state=10)

In [60]:
```
k_means.labels_
```

Out[60]:
```
array([1, 2, 1, 0, 1, 0, 0, 2, 1, 0, 1, 2, 0, 1, 2, 0, 2, 0, 0, 0, 0, 0,
       1, 0, 2, 1, 2, 0, 0, 0, 2, 0, 0, 2, 0, 0, 0, 0, 0, 1, 1, 2, 1, 1,
       0, 0, 2, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 2, 0, 0, 2, 2, 1,
       1, 2, 1, 0, 2, 0, 1, 1, 0, 1, 2, 0, 1, 2, 2, 2, 2, 1, 0, 2, 1, 2,
       1, 0, 2, 1, 2, 0, 0, 1, 1, 1, 0, 1, 2, 1, 2, 1, 2, 1, 1, 0, 0, 1,
       2, 2, 1, 0, 0, 1, 2, 2, 0, 1, 2, 0, 0, 0, 2, 2, 1, 0, 2, 2, 0, 2,
       2, 1, 0, 1, 1, 0, 1, 2, 2, 2, 0, 0, 2, 0, 1, 0, 2, 0, 2, 0, 2, 2,
       0, 2, 2, 0, 2, 1, 1, 0, 1, 1, 1, 0, 1, 2, 2, 2, 2, 0, 2, 1, 1, 1,
       2, 0, 2, 0, 2, 2, 2, 2, 1, 1, 0, 2, 2, 0, 0, 2, 0, 1, 2, 1, 1, 0,
       1, 0, 2, 1, 2, 0, 1, 2, 1, 2, 2, 2])
```

In [61]:
```
wss = []
```

In [62]:
```
for i in range (1,11):
    KM = KMeans(n_clusters=i, random_state=1)
    KM.fit(scaled_df)
    wss.append(KM.inertia_)
```

In [63]:
```
wss
```

Out[63]:
```
[1469.9999999999998,
 659.171754487041,
 430.6589731513006,
 371.38509060801096,
 327.21278165661346,
 289.31599538959495,
 262.98186570162267,
 241.81894656086033,
 223.91254221002725,
 206.39612184786694]
```

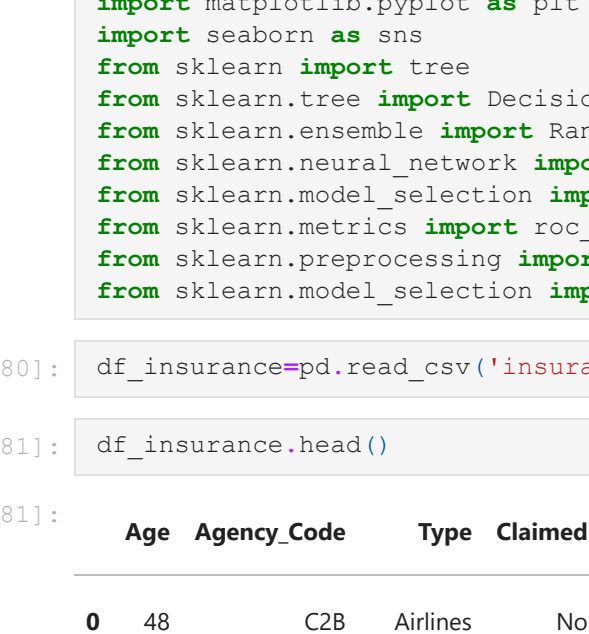
In [72]:
```
k_means = KMeans(n_clusters = 3, random_state = 1)
k_means.fit(scaled_df)
labels = k_means.labels_
```

In [73]:
```
silhouette_score(scaled_df,labels,random_state=1)
```

Out[73]: 0.4007270552751299

In [74]:
```
plt.plot(range(1,11),wss)
```

Out[74]: [<matplotlib.lines.Line2D at 0x14e38eb85e0>]



In [75]:
```
df["silhouette_score",'Kmeans_clusters'] = labels
```

In [76]:
```
df.head()
```

Out[76]:

	spending	advance_payments	probability_of_full_payment	current_balance	credit_limit	min_payment_amt
0	19.94	16.92	0.8752	6.675	3.763	3.252
1	15.99	14.89	0.9064	5.363	3.582	3.336
2	18.95	16.42	0.8829	6.248	3.755	3.368
3	10.83	12.96	0.8099	5.278	2.641	5.182
4	17.99	15.86	0.8992	5.890	3.694	2.068

In [79]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn import tree
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import roc_auc_score,roc_curve,classification_report,confusion_ma
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV
```

In [80]:
```
df_insurance=pd.read_csv('insurance_part2_data.csv')
```

In [81]:
```
df_insurance.head()
```

Out[81]:

	Age	Agency_Code	Type	Claimed	Commision	Channel	Duration	Sales	Product Name	Destination
0	48	C2B	Airlines	No	0.70	Online	7	2.51	Customised Plan	ASIA
1	36	EPX	Travel Agency	No	0.00	Online	34	20.00	Customised Plan	ASIA
2	39	CWT	Travel Agency	No	5.94	Online	3	9.90	Customised Plan	Americas
3	36	EPX	Travel Agency	No	0.00	Online	4	26.00	Cancellation Plan	ASIA
4	33	JZI	Airlines	No	6.30	Online	53	18.00	Bronze Plan	ASIA

In [82]:
```
df_insurance.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3000 entries, 0 to 2999
Data columns (total 10 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Age           3000 non-null   int64
 1   Agency_Code   3000 non-null   object
 2   Type          3000 non-null   object
 3   Claimed       3000 non-null   object
 4   Commision     3000 non-null   float64
 5   Channel       3000 non-null   object
 6   Duration      3000 non-null   int64
 7   Sales         3000 non-null   float64
 8   Product Name  3000 non-null   object
 9   Destination   3000 non-null   object
dtypes: float64(2), int64(2), object(6)
memory usage: 234.5+ KB
```

In [83]:
```
df_insurance.shape
```

Out[83]: (3000, 10)

In [84]:
```
df_insurance.isnull().sum()
```

Out[84]:
```
Age             0
Agency_Code     0
Type            0
Claimed         0
Commision       0
Channel         0
Duration        0
Sales           0
Product Name    0
Destination     0
dtype: int64
```

In [85]:
```
df_insurance.describe(include="all").T
```

Out[85]:

	count	unique	top	freq	mean	std	min	25%	50%	75%	max
Age	3000	NaN	NaN	NaN	38.091	10.4635	8	32	36	42	84
Agency_Code	3000	4	EPX	1365	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Type	3000	2	Travel Agency	1837	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Claimed	3000	2	No	2076	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Commision	3000	NaN	NaN	NaN	14.5292	25.4815	0	0	4.63	17.235	210.21
Channel	3000	2	Online	2954	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Duration	3000	NaN	NaN	NaN	70.0013	134.053	-1	11	26.5	63	4580
Sales	3000	NaN	NaN	NaN	60.2499	70.734	0	20	33	69	539
Product Name	3000	5	Customised Plan	1136	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Destination	3000	3	ASIA	2465	NaN	NaN	NaN	NaN	NaN	NaN	NaN

In [86]:
```
dups = df_insurance.duplicated()
print('Number of duplicate rows = %d' % (dups.sum()))
```

Number of duplicate rows = 139

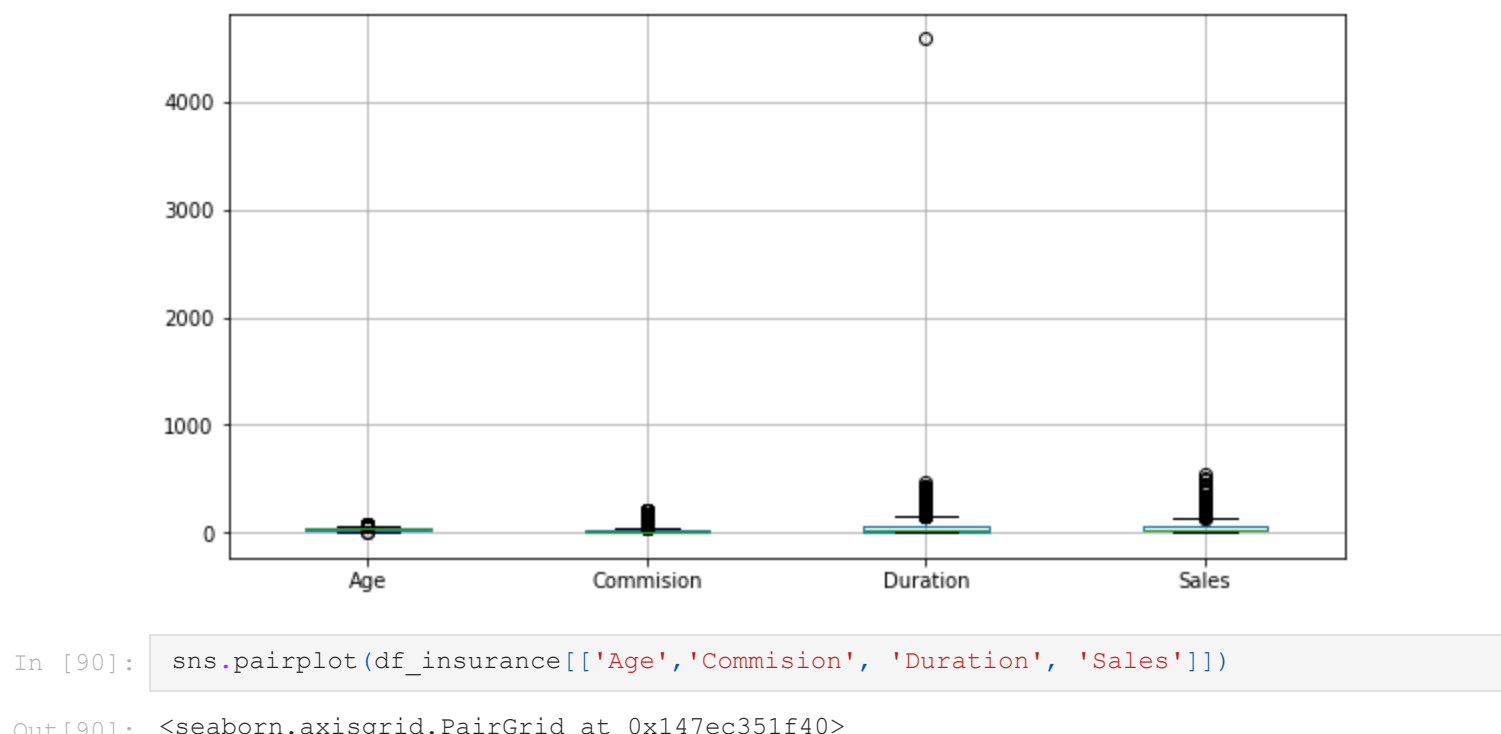
In [87]:
```
df_insurance.drop_duplicates(inplace=True)
```

In [88]:
```
dups = df_insurance.duplicated()
print('Number of duplicate rows = %d' % (dups.sum()))
print(df_insurance.shape)
```

Number of duplicate rows = 0
(2861, 10)

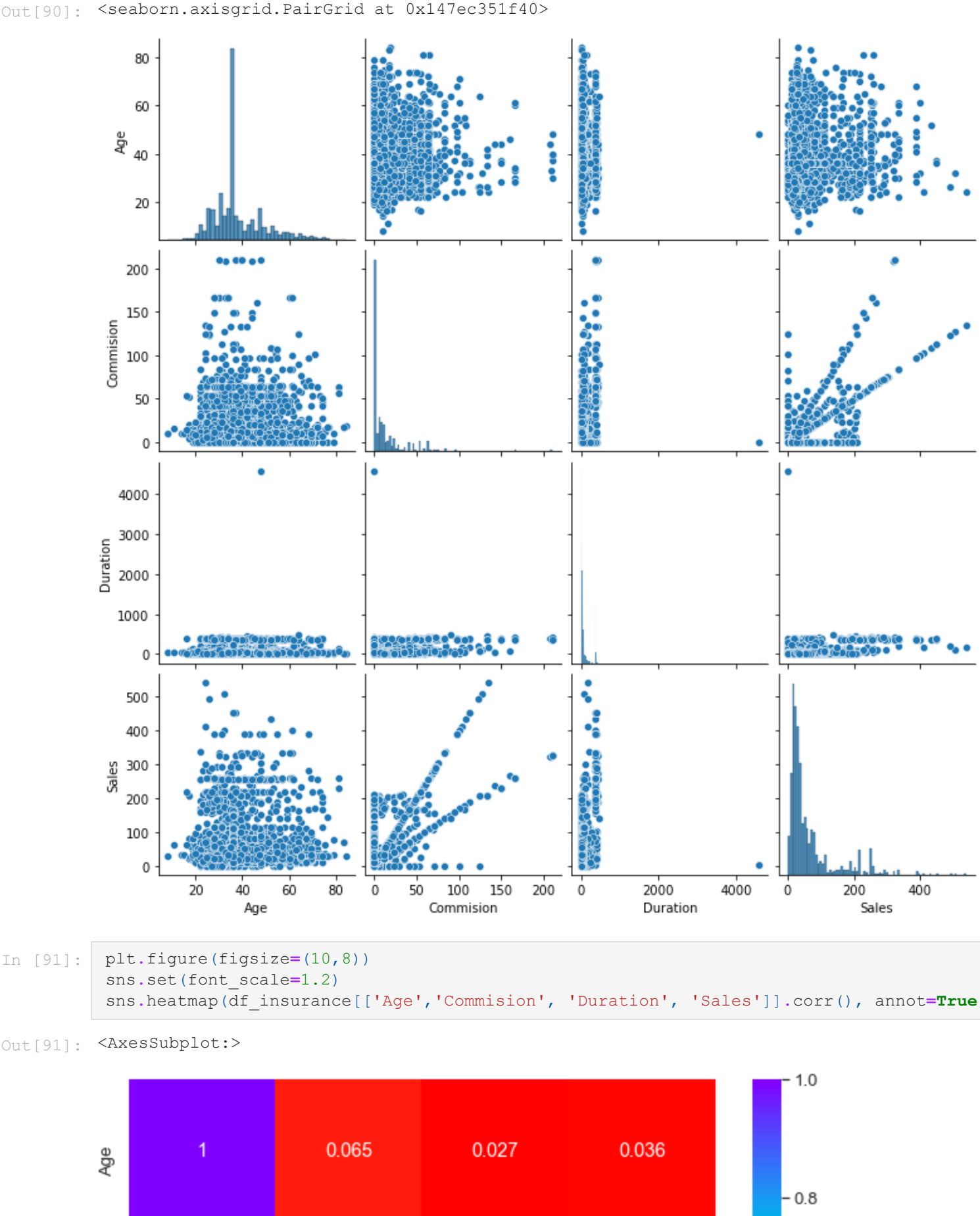
In [89]:
```
plt.figure(figsize=(10,5))
df_insurance[['Age','Commision', 'Duration', 'Sales']].boxplot()
```

Out[89]: <AxesSubplot:>



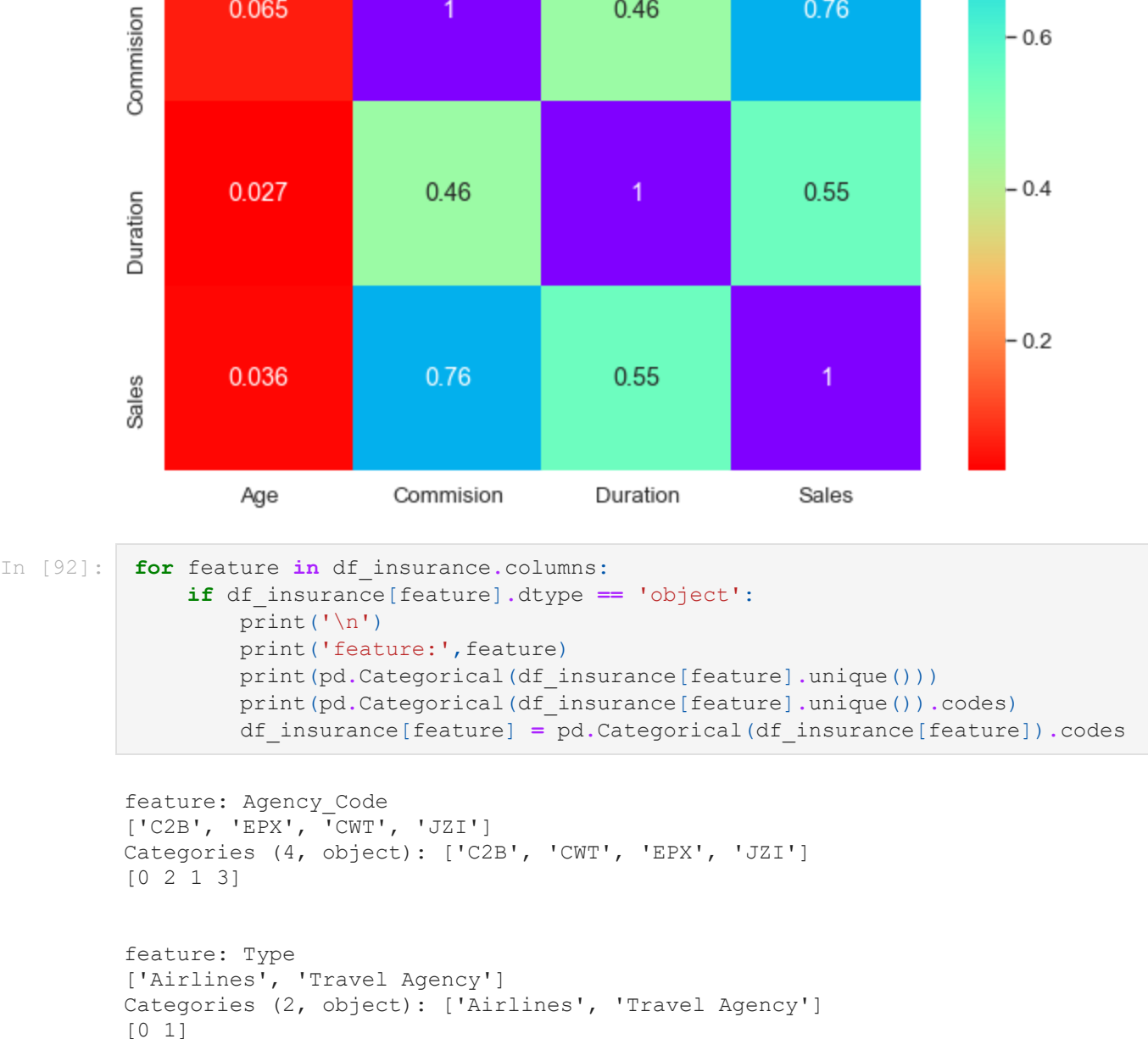
```
In [90]: sns.pairplot(df_insurance[['Age','Commision', 'Duration', 'Sales']])
```

```
Out[90]: <seaborn.axisgrid.PairGrid at 0x147ec351f40>
```



```
In [91]: plt.figure(figsize=(10,8))
         sns.set(font_scale=1.2)
         sns.heatmap(df_insurance[['Age','Commision', 'Duration', 'Sales']].corr(), annot=True
```

```
Out[91]: <AxesSubplot:>
```




```
In [92]: for feature in df_insurance.columns:
             if df_insurance[feature].dtype == 'object':
                 print('\n')
                 print('feature:',feature)
                 print(pd.Categorical(df_insurance[feature].unique()))
                 print(pd.Categorical(df_insurance[feature].unique()).codes)
                 df_insurance[feature] = pd.Categorical(df_insurance[feature]).codes
```

```
feature: Agency_Code
['C2B', 'EPX', 'CWT', 'JZI']
Categories (4, object): ['C2B', 'CWT', 'EPX', 'JZI']
[0 2 1 3]


feature: Type
['Airlines', 'Travel Agency']
Categories (2, object): ['Airlines', 'Travel Agency']
[0 1]


feature: Claimed
['No', 'Yes']
Categories (2, object): ['No', 'Yes']
[0 1]


feature: Channel
['Online', 'Offline']
Categories (2, object): ['Offline', 'Online']
[1 0]


feature: Product Name
['Customised Plan', 'Cancellation Plan', 'Bronze Plan', 'Silver Plan', 'Gold Plan']
Categories (5, object): ['Bronze Plan', 'Cancellation Plan', 'Customised Plan', 'Gold
[2 1 0 4 3]


feature: Destination
['ASIA', 'Americas', 'EUROPE']
Categories (3, object): ['ASIA', 'Americas', 'EUROPE']
[0 1 2]
```

```
In [93]: df_insurance.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2861 entries, 0 to 2999
Data columns (total 10 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Age           2861 non-null   int64
 1   Agency_Code   2861 non-null   int8
 2   Type          2861 non-null   int8
 3   Claimed       2861 non-null   int8
 4   Commision     2861 non-null   float64
 5   Channel       2861 non-null   int8
 6   Duration      2861 non-null   int64
 7   Sales         2861 non-null   float64
 8   Product Name  2861 non-null   int8
 9   Destination   2861 non-null   int8
dtypes: float64(2), int64(2), int8(6)
memory usage: 128.5 KB
```

```
In [43]: df_insurance.head()
```

	Age	Agency_Code	Type	Commision	Channel	Duration	Sales	Product Name	Destination
0	48	0	0	0.70	1	7	2.51	2	0
1	36	2	1	0.00	1	34	20.00	2	0
2	39	1	1	5.94	1	3	9.90	2	1
3	36	2	1	0.00	1	4	26.00	1	0
4	33	3	0	6.30	1	53	18.00	0	0

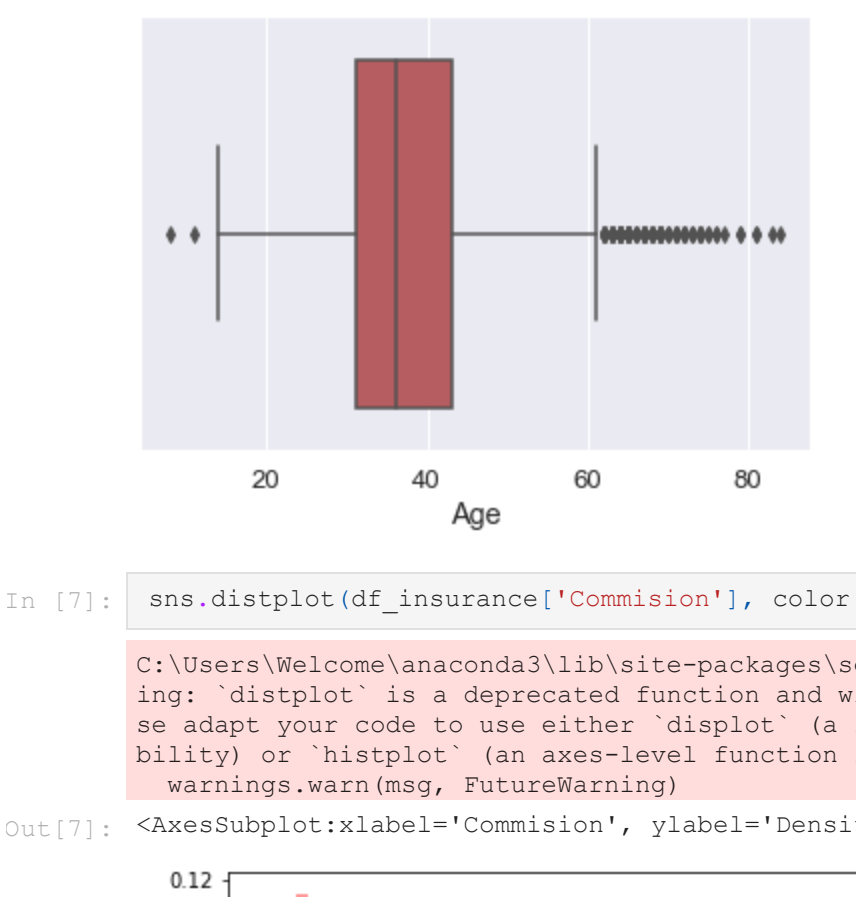
```
In [94]: df_insurance.Claimed.value_counts(normalize=True)
```

```
Out[94]: 0    0.680531
         1    0.319469
         Name: Claimed, dtype: float64
```

```
In [110]: sns.distplot(df_insurance['Age'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

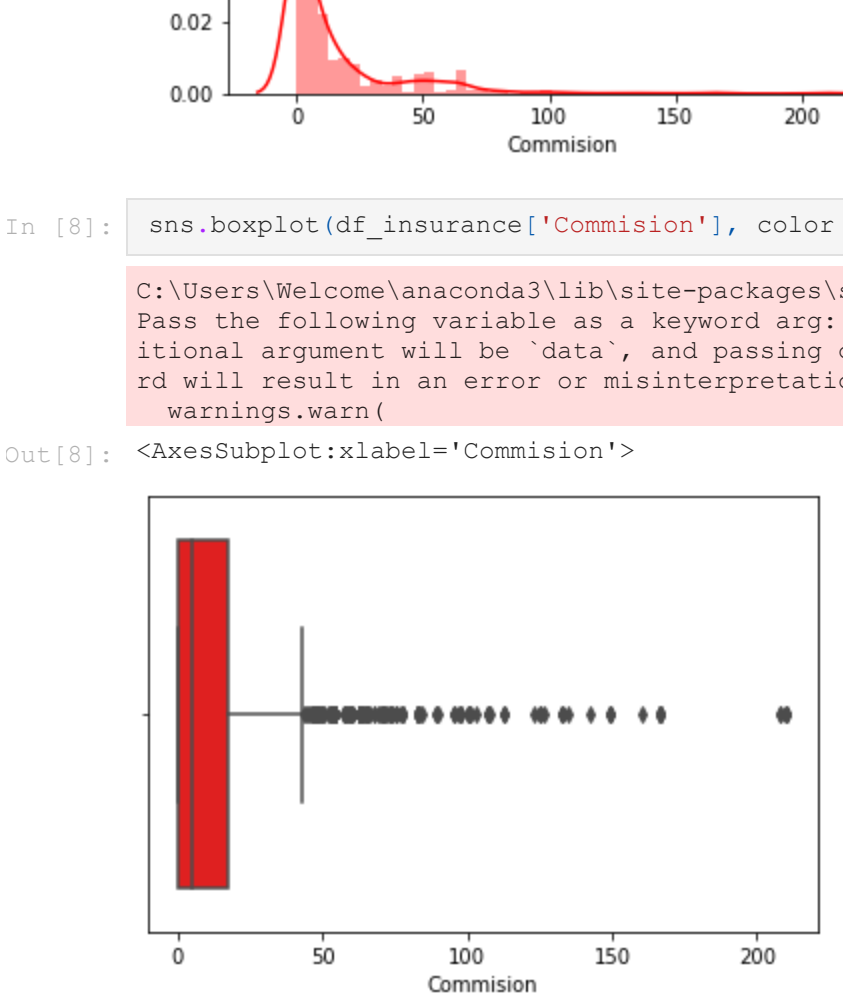
```
Out[110]: <AxesSubplot:xlabel='Age', ylabel='Density'>
```



```
In [111]: sns.boxplot(df_insurance['Age'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

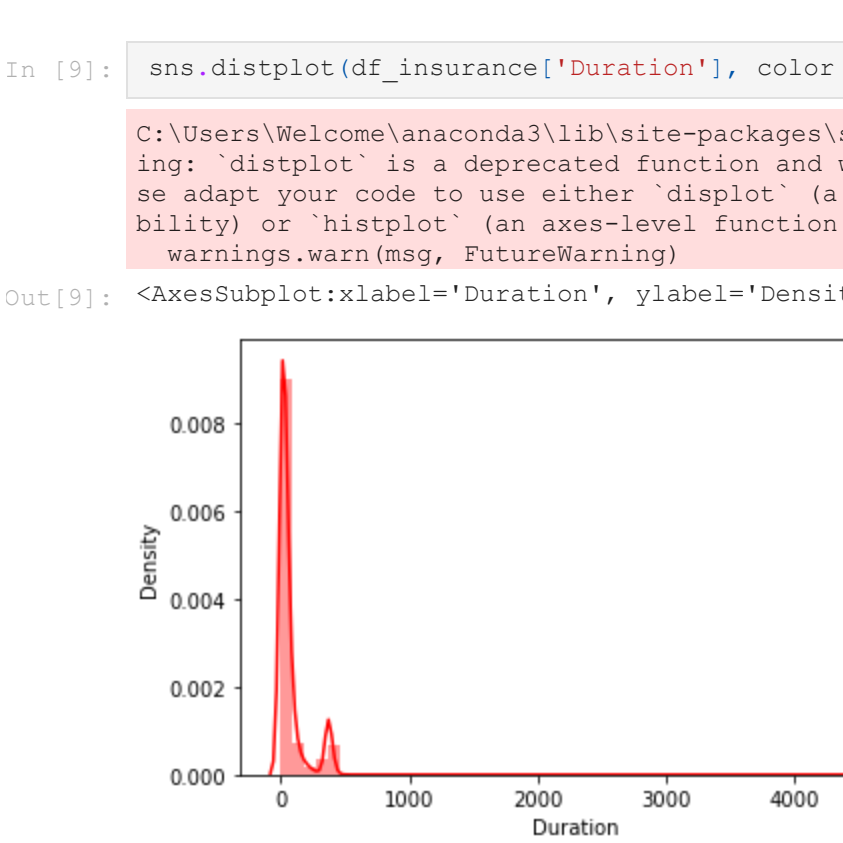
```
Out[111]: <AxesSubplot:xlabel='Age'>
```



```
In [7]: sns.distplot(df_insurance['Commision'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

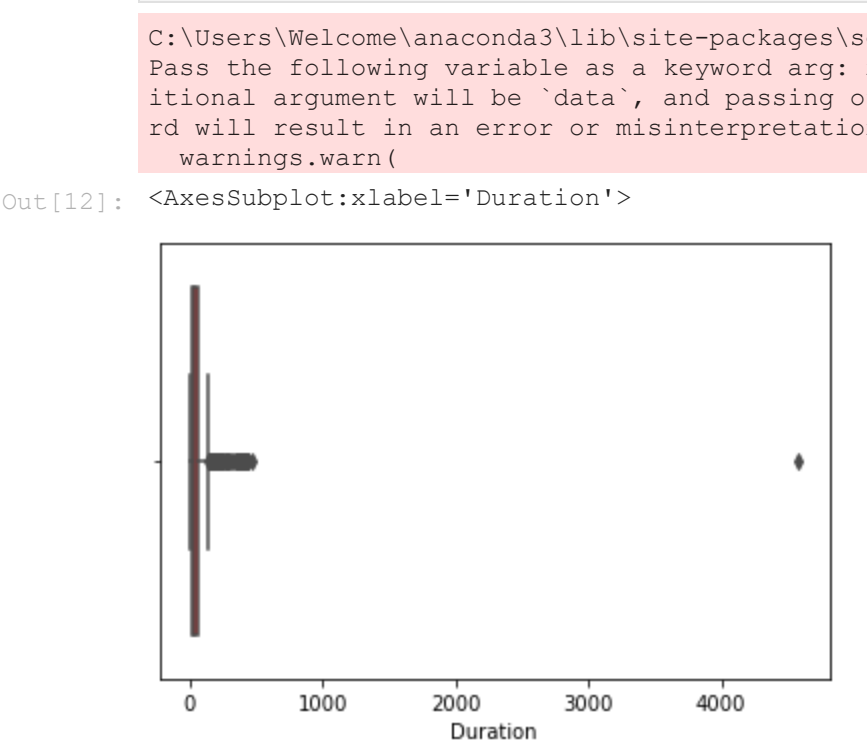
```
Out[7]: <AxesSubplot:xlabel='Commision', ylabel='Density'>
```



```
In [8]: sns.boxplot(df_insurance['Commision'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

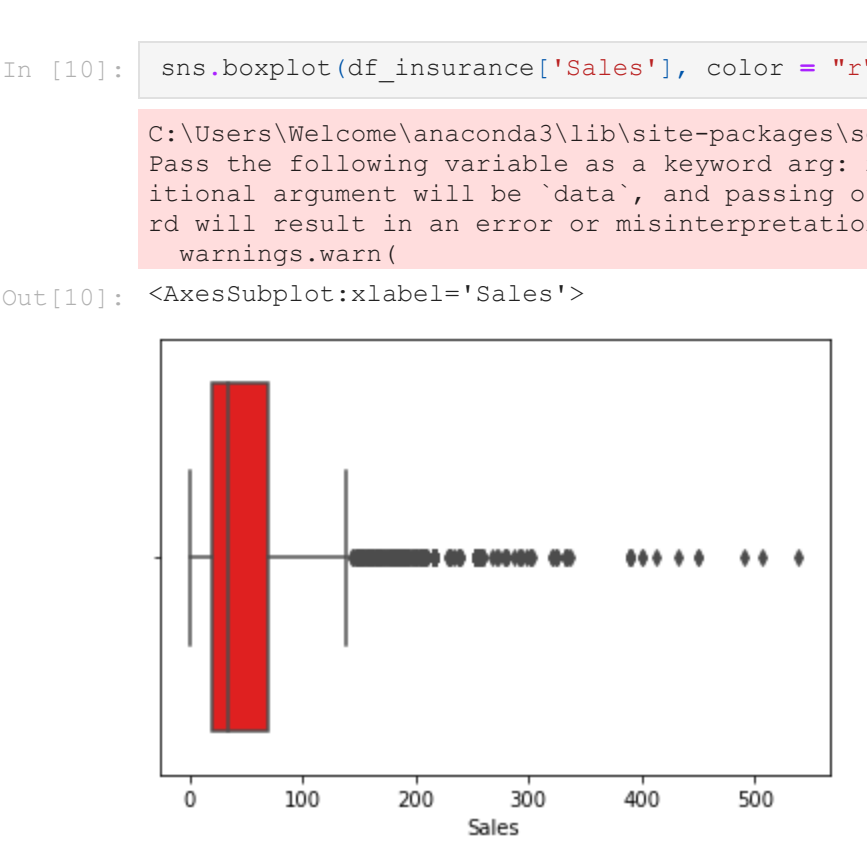
```
Out[8]: <AxesSubplot:xlabel='Commision'>
```



```
In [9]: sns.distplot(df_insurance['Duration'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

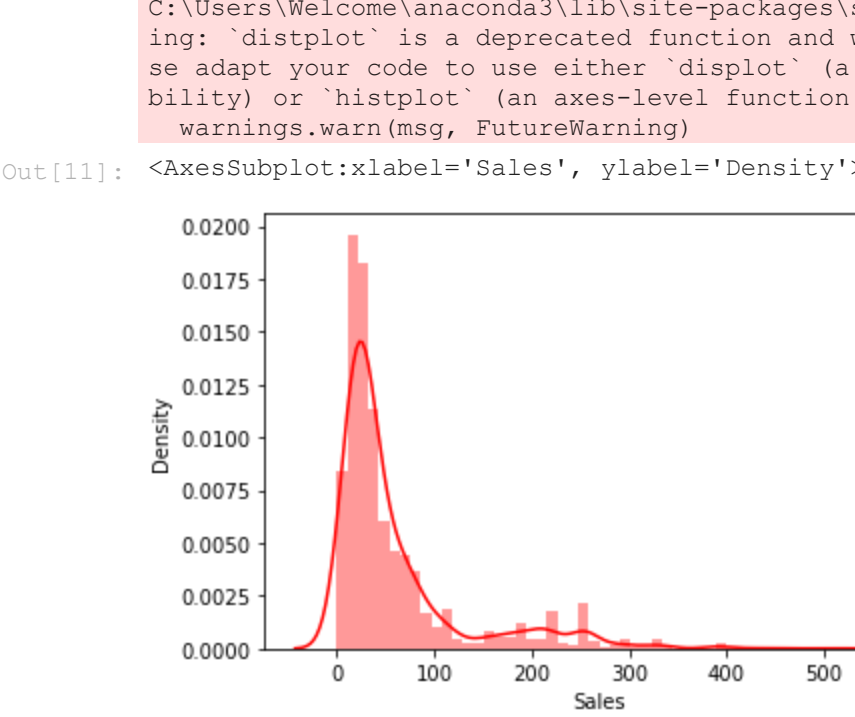
```
Out[9]: <AxesSubplot:xlabel='Duration', ylabel='Density'>
```



```
In [12]: sns.boxplot(df_insurance['Duration'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

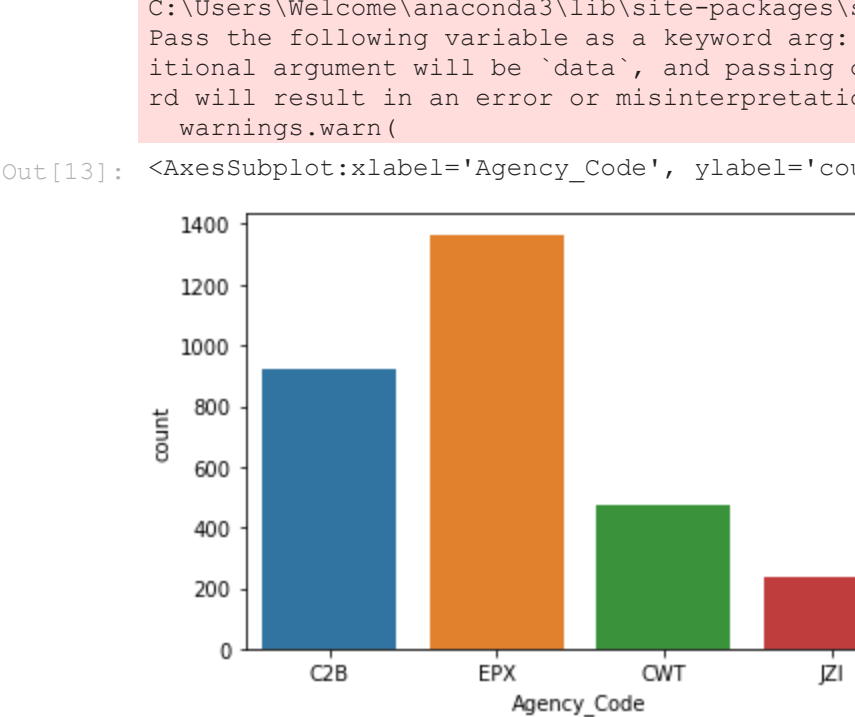
```
Out[12]: <AxesSubplot:xlabel='Duration'>
```



```
In [10]: sns.boxplot(df_insurance['Sales'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

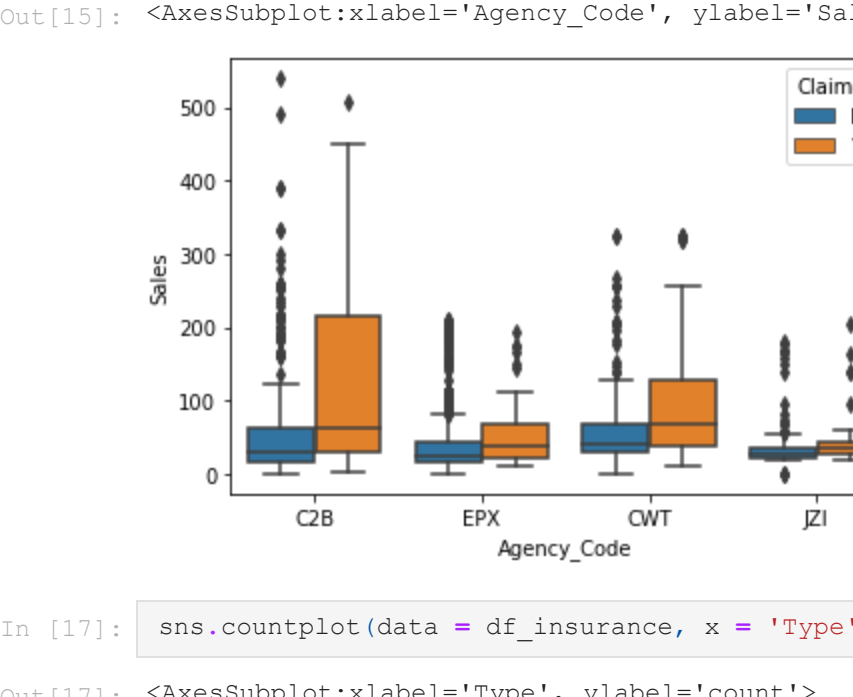
```
Out[10]: <AxesSubplot:xlabel='Sales'>
```



```
In [11]: sns.distplot(df_insurance['Sales'], color = "r")
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

```
Out[11]: <AxesSubplot:xlabel='Sales', ylabel='Density'>
```



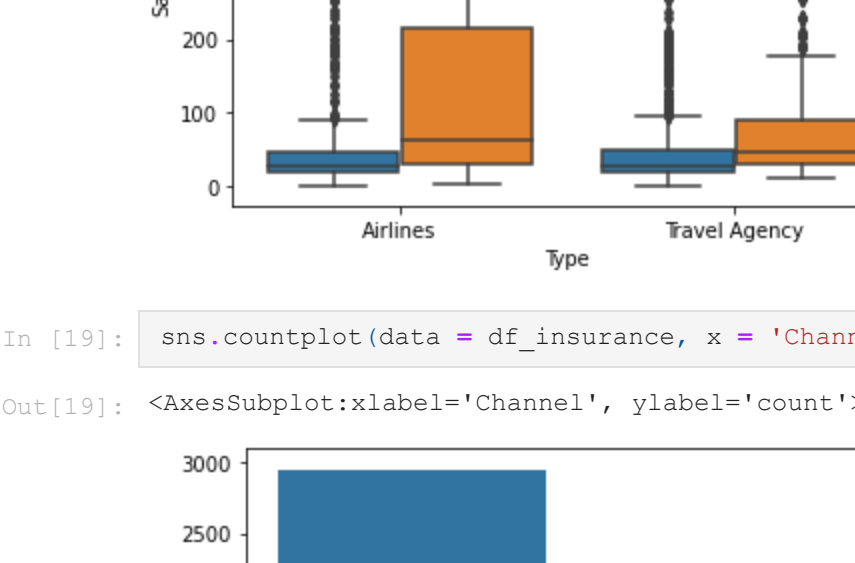
```
In [13]: sns.countplot(df_insurance['Agency_Code'])
```

```
C:\Users\Welcome\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

```
Out[13]: <AxesSubplot:xlabel='Agency_Code', ylabel='count'>
```

```
In [15]: sns.boxplot(data = df_insurance, x = 'Agency_Code', y = 'Sales', hue = 'Claimed')
```

```
Out[15]: <AxesSubplot:xlabel='Agency_Code', ylabel='Sales'>
```

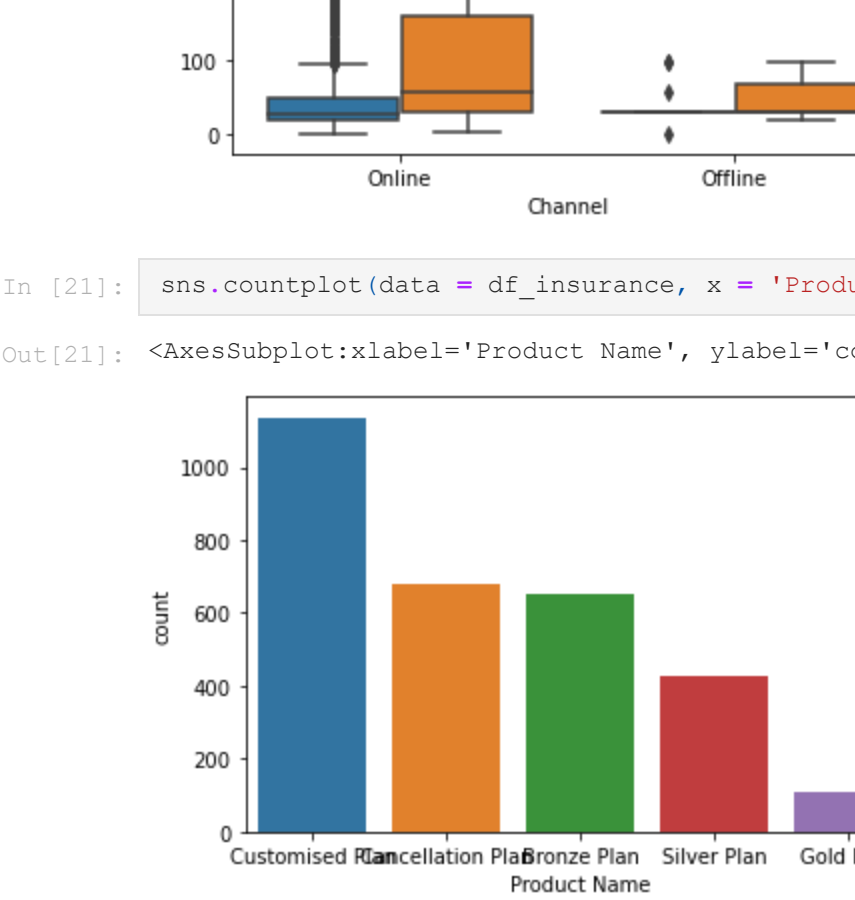


```
In [17]: sns.countplot(data = df_insurance, x = 'Type')
```

```
Out[17]: <AxesSubplot:xlabel='Type', ylabel='count'>
```

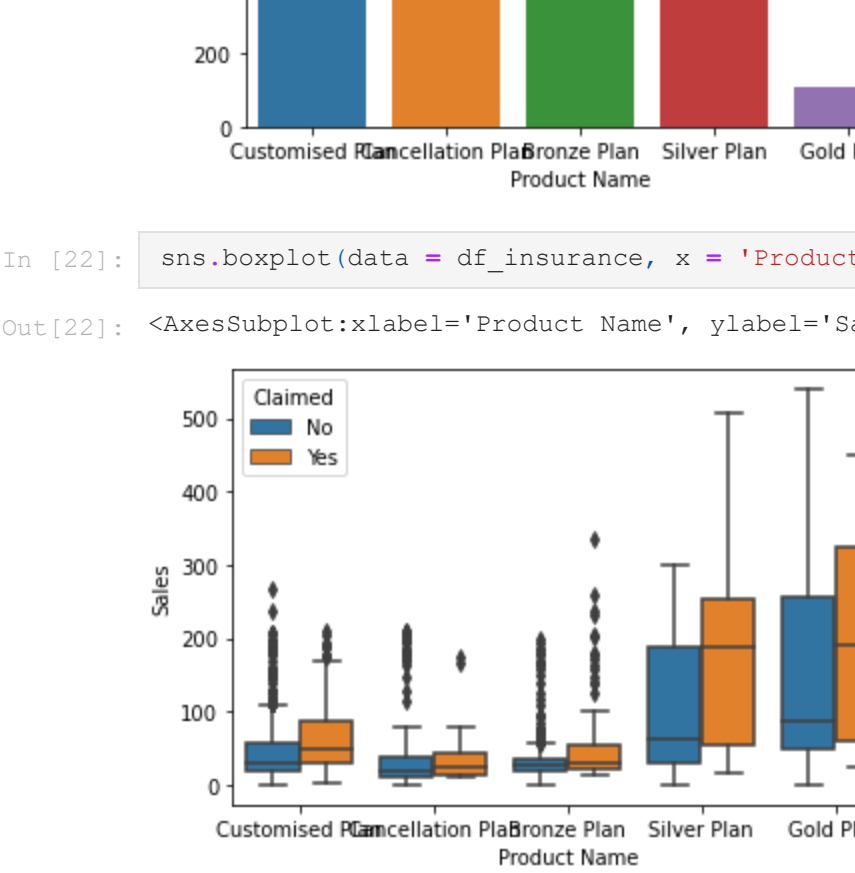
```
In [18]: sns.boxplot(data = df_insurance, x = 'Type', y = 'Sales', hue = 'Claimed')
```

```
Out[18]: <AxesSubplot:xlabel='Type', ylabel='Sales'>
```



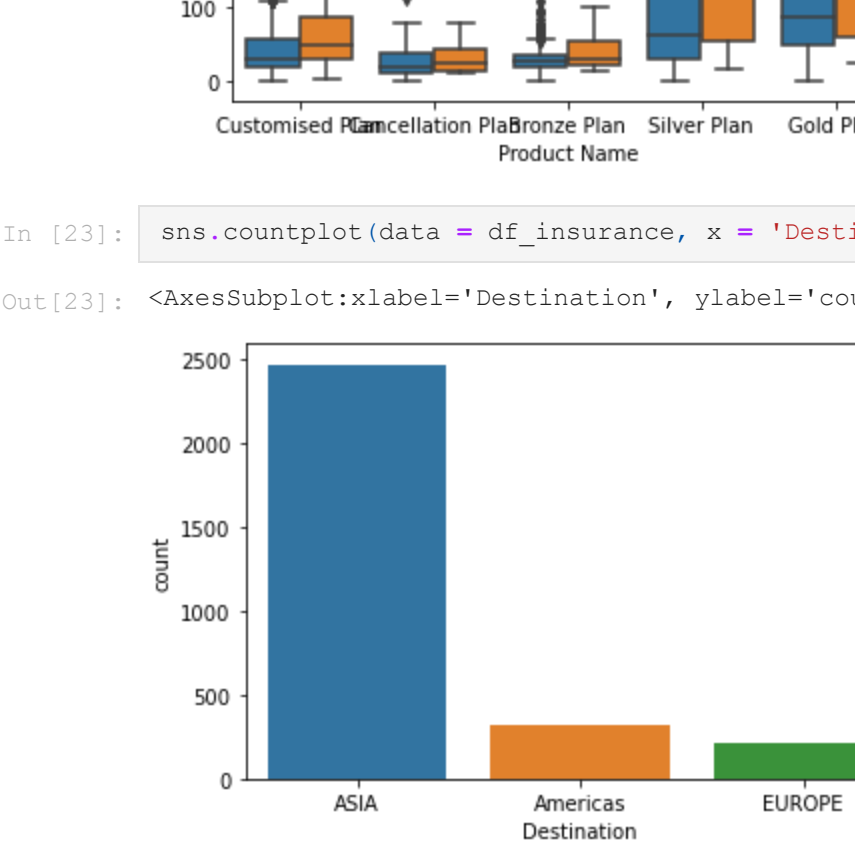
```
In [19]: sns.countplot(data = df_insurance, x = 'Channel')
```

```
Out[19]: <AxesSubplot:xlabel='Channel', ylabel='count'>
```



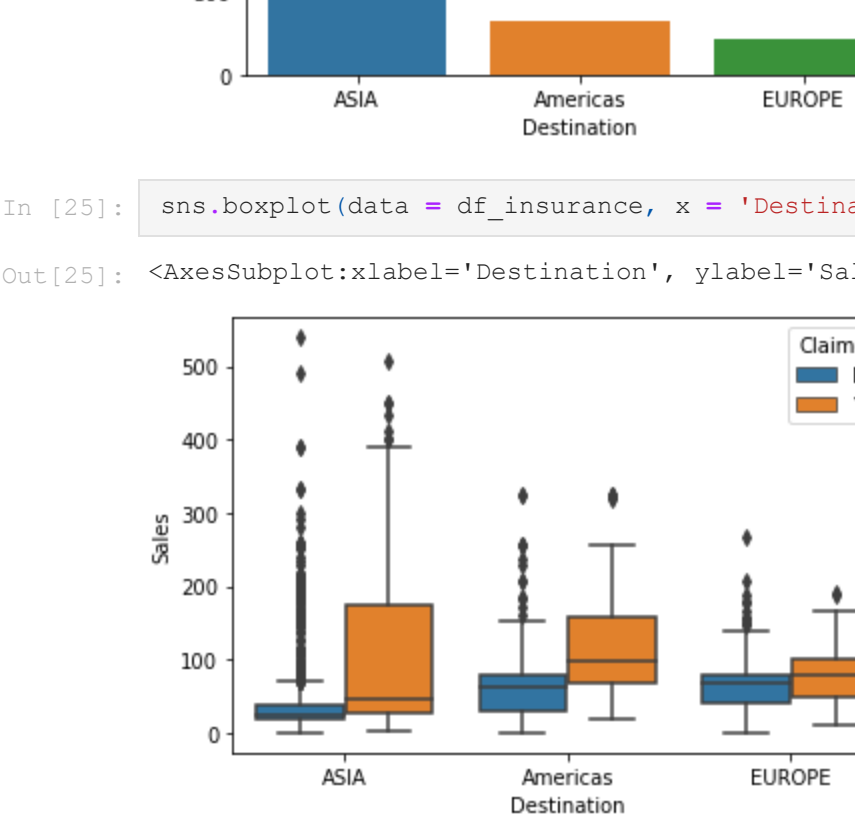
```
In [20]: sns.boxplot(data = df_insurance, x = 'Channel', y = 'Sales', hue = 'Claimed')
```

```
Out[20]: <AxesSubplot:xlabel='Channel', ylabel='Sales'>
```



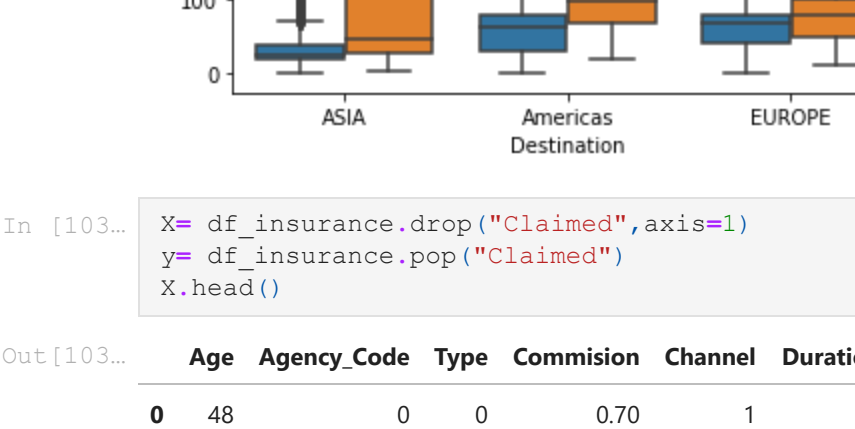
```
In [21]: sns.countplot(data = df_insurance, x = 'Product Name')
```

```
Out[21]: <AxesSubplot:xlabel='Product Name', ylabel='count'>
```



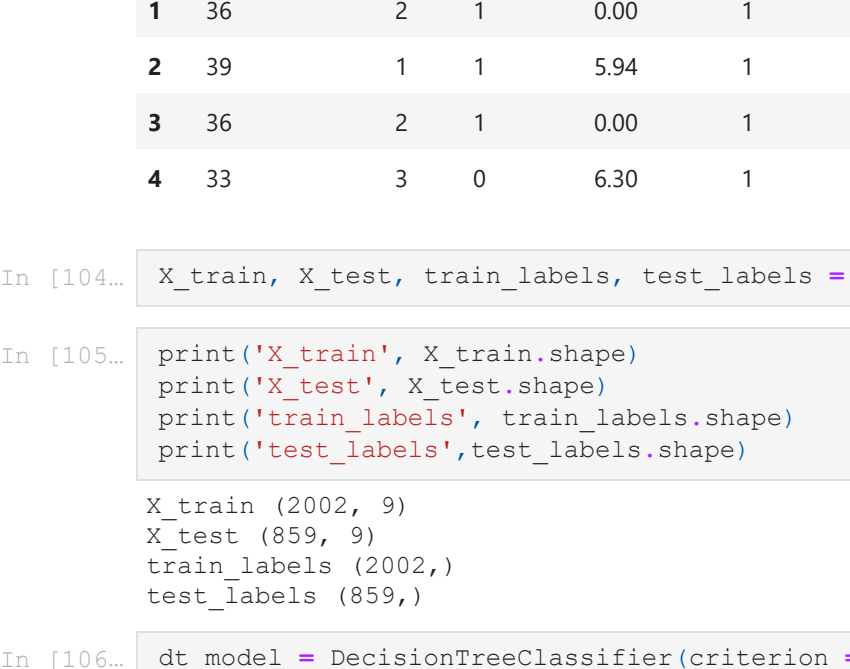
```
In [22]: sns.boxplot(data = df_insurance, x = 'Product Name', y = 'Sales', hue = 'Claimed')
```

```
Out[22]: <AxesSubplot:xlabel='Product Name', ylabel='Sales'>
```



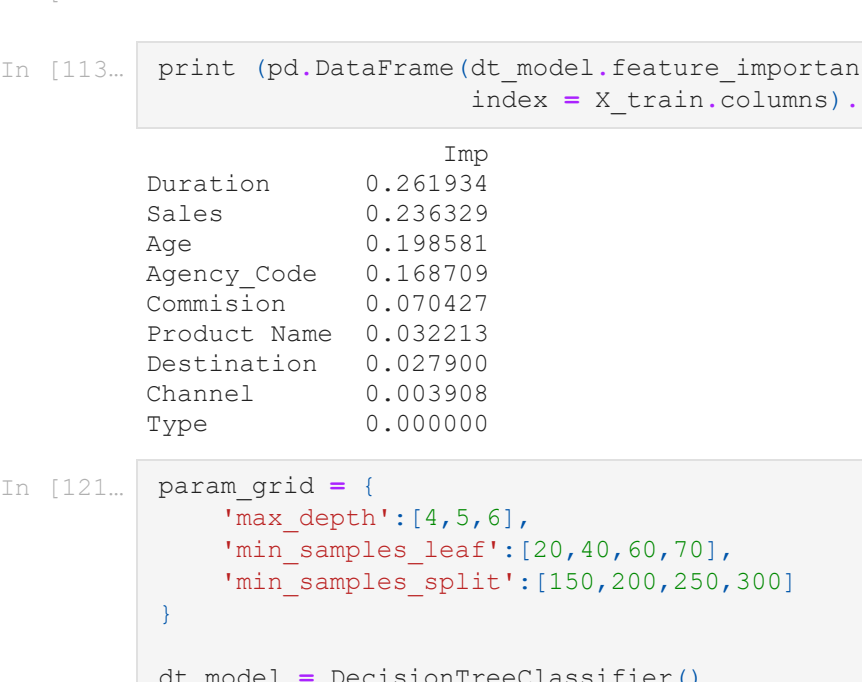
```
In [23]: sns.countplot(data = df_insurance, x = 'Destination')
```

```
Out[23]: <AxesSubplot:xlabel='Destination', ylabel='count'>
```



```
In [25]: sns.boxplot(data = df_insurance, x = 'Destination', y = 'Sales', hue = 'Claimed')
```

```
Out[25]: <AxesSubplot:xlabel='Destination', ylabel='Sales'>
```



```
In [103]: X= df_insurance.drop("Claimed",axis=1)
          y= df_insurance.pop("Claimed")
          X.head()
```

Out[103]:

	Age	Agency_Code	Type	Commision	Channel	Duration	Sales	Product Name	Destination
0	48	0	0	0.70	1	7	2.51	2	0
1	36	2	1	0.00	1	34	20.00	2	0
2	39	1	1	5.94	1	3	9.90	2	1
3	36	2	1	0.00	1	4	26.00	1	0
4	33	3	0	6.30	1	53	18.00	0	0

```
In [104]: X_train, X_test, train_labels, test_labels = train_test_split(X, y, test_size = .30,
```

```
In [105]: print('X_train',X_train.shape)
          print('X_test',X_test.shape)
          print('train_labels',train_labels.shape)
          print('test_labels',test_labels.shape)
```

```
X_train (2002, 9)
X_test (859, 9)
train_labels (2002,)
test_labels (859,)
```

```
In [106]: dt_model = DecisionTreeClassifier(criterion = 'gini' )
```

```
In [107]: dt_model.fit(X_train, train_labels)
```

```
Out[107]: DecisionTreeClassifier()
```

```
In [115]: print (pd.DataFrame(dt_model.feature_importances_, columns = ["Imp"],
                              index = X_train.columns).sort_values('Imp', ascending = False))
```

```
                   Imp
Duration      0.261934
Sales         0.236329
Age           0.198581
Agency_Code   0.168709
Commision     0.070427
Product Name  0.032213
Destination   0.027900
Channel       0.003908
Type          0.000000
```

```
In [120]: param_grid = {
              'max_depth':[4,5,6],
              'min_samples_leaf':[20,40,60,70],
              'min_samples_split':[150,200,250,300]
          }

          dt_model = DecisionTreeClassifier()

          grid_search = GridSearchCV(estimator = dt_model, param_grid = param_grid, cv = 10)
```

```
In [121]: grid_search.fit(X_train, train_labels)
```

```
Out[121]: GridSearchCV(cv=10, estimator=DecisionTreeClassifier(),
                       param_grid={'max_depth': [4, 5, 6],
                                   'min_samples_leaf': [20, 40, 60, 70],
                                   'min_samples_split': [150, 200, 250, 300]})
```

```
In [124]: DecisionTreeClassifier(max_depth= 4,min_samples_leaf = 20, min_samples_split= 150)
```

```
Out[124]: DecisionTreeClassifier(max_depth=4, min_samples_leaf=20, min_samples_split=150)
```

```
In [125]: reg_dt_model= DecisionTreeClassifier(criterion = 'gini', max_depth= 4,min_samples_lea
```

```
In [126]: reg_dt_model.fit(X_train, train_labels)
```

```
Out[126]: DecisionTreeClassifier(max_depth=4, min_samples_leaf=20, min_samples_split=150)
```

```
In [128]: insurance_prediction_tree_regularized= open(bank_marketing_part1_Data.csv)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-128-0d9ab75e7fe5> in <module>
----> 1 insurance_prediction_tree_regularized= open(bank_marketing_part1_Data.csv)

NameError: name 'bank_marketing_part1_Data' is not defined
```

```
In [129]: ytrain_predict_dt=reg_dt_model.predict(X_train)
```

```
In [130]: ytest_predict_dt=reg_dt_model.predict(X_test)
```

```
In [ ]:
```

```
In [108]: print (pd.DataFrame(dt_model.feature_importances_, columns = ["Imp"], index = X_train
```

```
                   Imp
Age           0.198581
Agency_Code   0.168709
Type          0.000000
Commision     0.070427
Channel       0.003908
Duration      0.261934
Sales         0.236329
Product Name  0.032213
Destination   0.027900
```

```
In [ ]:
```

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In [ ]:
```

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In [ ]:
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