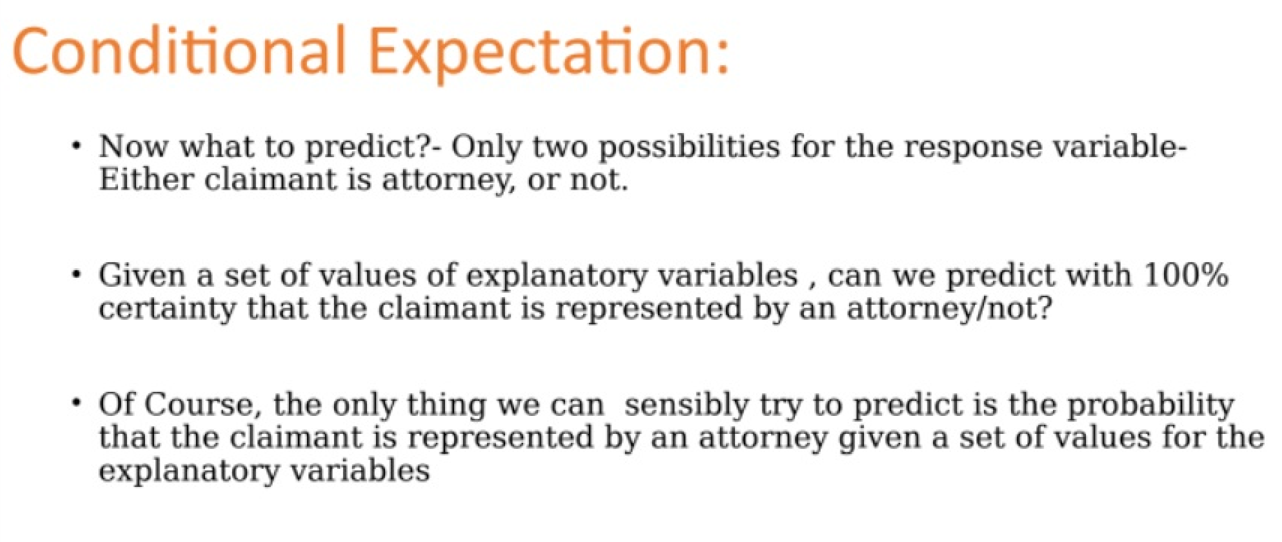
Overview

- CASENUM- Case number to identify the claim, a numeric vector
- ATTORNEY Whether the claimant is represented by an attorney (=1 if yes and =2 if no)
- CLMSEX Claimant’s gender (=1 if male and =2 if female), a numeric vector
- CLMINSUR Whether or not the driver of the claimant’s vehicle was uninsured (=1 if yes, =2 if no)
- SEATBELT Whether or not the claimant was wearing a seatbelt/child restraint (=1 if yes, =2 if no)
- CLMAGE Claimant’s age, a numeric vector
- LOSS The claimant’s total economic loss (in thousands)

Problem Statement

In [76]:
```python
from PIL import ImageGrab
ImageGrab.grabclipboard()
```

Out[76]:



In [ ]:
```python
# Importing libraries
```

In [11]:
```python
import pandas as pd
import numpy as np
import statsmodels.api as sm
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stat
import warnings
warnings.filterwarnings('ignore')
from sklearn.linear_model import LogisticRegression
```

In [ ]:
```python
# Load the dataset
```

In [12]:
```python
df = pd.read_csv('claimants.csv')
df.head()
```

Out[12]:

	CASENUM	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
0	5	0	0.0	1.0	0.0	50.0	34.940
1	3	1	1.0	0.0	0.0	18.0	0.891
2	66	1	0.0	1.0	0.0	5.0	0.330
3	70	0	0.0	1.0	1.0	31.0	0.037
4	96	1	0.0	1.0	0.0	30.0	0.038

In [9]:
```python
# shape of the dataset
df.shape
```

Out[9]:
```
(1340, 7)
```

In [75]:

```
df.CLMINSUR.unique()
```

Out[75]:

```
array([1., 0.])
```

In [13]:

```
# Dropping the case number columns as it has Unique values and it is not contributing to the inferences
df.drop('CASENUM', axis=1, inplace = True)
df.head()
```

Out[13]:

	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
0	0	0.0	1.0	0.0	50.0	34.940
1	1	1.0	0.0	0.0	18.0	0.891
2	1	0.0	1.0	0.0	5.0	0.330
3	0	0.0	1.0	1.0	31.0	0.037
4	1	0.0	1.0	0.0	30.0	0.038

Desciptive Statistics

In [36]:

```
df.describe()
```

Out[36]:

	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
count	1340.000000	1328.000000	1299.000000	1292.000000	1151.000000	1340.000000
mean	0.488806	0.558735	0.907621	0.017028	28.414422	3.806307
std	0.500061	0.496725	0.289671	0.129425	20.304451	10.636903
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	1.000000	0.000000	9.000000	0.400000
50%	0.000000	1.000000	1.000000	0.000000	30.000000	1.069500
75%	1.000000	1.000000	1.000000	0.000000	43.000000	3.781500
max	1.000000	1.000000	1.000000	1.000000	95.000000	173.604000

In [21]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1340 entries, 0 to 1339
Data columns (total 6 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   ATTORNEY  1340 non-null   int64  
 1   CLMSEX    1328 non-null   float64
 2   CLMINSUR  1299 non-null   float64
 3   SEATBELT  1292 non-null   float64
 4   CLMAGE    1151 non-null   float64
 5   LOSS      1340 non-null   float64
dtypes: float64(5), int64(1)
memory usage: 62.9 KB
```

Count of Duplicated Rows

In [4]:

```
df.duplicated().sum()
```

Out[4]:

```
26
```

In [5]:

```
df[df.duplicated()].shape
```

Out[5]:

```
(26, 6)
```

print the duplicated rows

print the duplicated rows

In [39]:

```
df[df.duplicated()]
```

Out[39]:

	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
77	1	1.0	1.0	0.0	NaN	0.000
162	1	1.0	1.0	0.0	NaN	0.800
439	1	0.0	1.0	0.0	57.0	3.889
697	1	0.0	1.0	0.0	NaN	0.400
773	0	0.0	1.0	0.0	NaN	4.395
779	1	1.0	1.0	0.0	NaN	0.000
788	1	0.0	1.0	0.0	NaN	0.150
834	0	1.0	1.0	0.0	48.0	1.050
866	1	1.0	1.0	0.0	30.0	0.300
942	0	1.0	1.0	0.0	8.0	0.100
970	1	0.0	1.0	0.0	11.0	0.500
982	1	0.0	1.0	0.0	NaN	1.000
990	0	1.0	1.0	0.0	43.0	8.490
1049	1	1.0	1.0	0.0	NaN	0.050
1075	0	0.0	1.0	0.0	7.0	0.640
1120	0	1.0	1.0	0.0	NaN	1.000
1121	1	1.0	1.0	0.0	NaN	0.500
1132	1	1.0	1.0	0.0	NaN	0.050
1152	1	0.0	1.0	0.0	NaN	0.150
1186	1	0.0	1.0	0.0	NaN	0.040
1231	1	0.0	1.0	0.0	NaN	0.100
1234	1	1.0	1.0	0.0	NaN	1.640
1260	1	0.0	1.0	0.0	0.0	0.440
1269	0	1.0	1.0	0.0	NaN	3.500
1304	1	1.0	1.0	0.0	NaN	0.500
1320	1	1.0	1.0	0.0	NaN	0.540

In [23]:

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

Out[23]:

```
ATTORNEY      0
CLMSEX       12
CLMINSUR     41
SEATBELT     48
CLMAGE      189
LOSS          0
dtype: int64
```

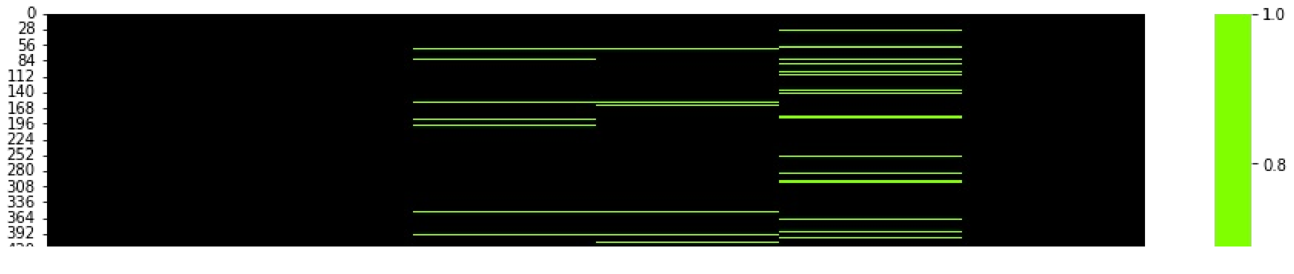
Missing Values

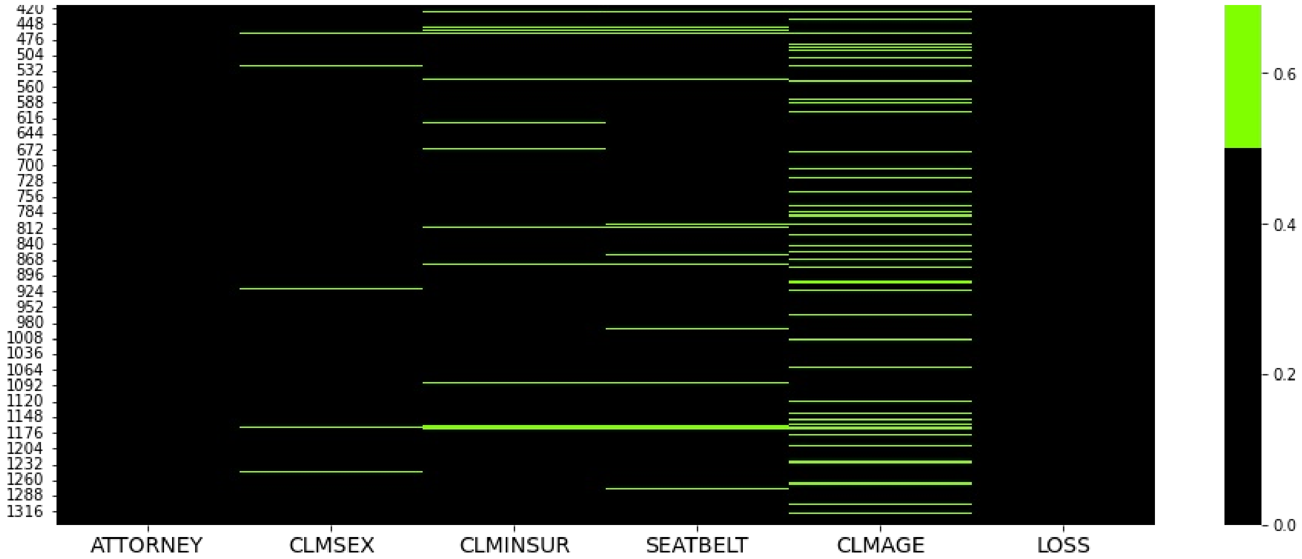
In [40]:

```
plt.figure(figsize = (16,9))
plt.xticks(fontsize = 14)
cols= df.columns
colors = ['#000000','#7FFF00']
sns.heatmap(df[cols].isnull(), cmap = sns.color_palette(colors))
```

Out[40]:

```
<AxesSubplot:>
```





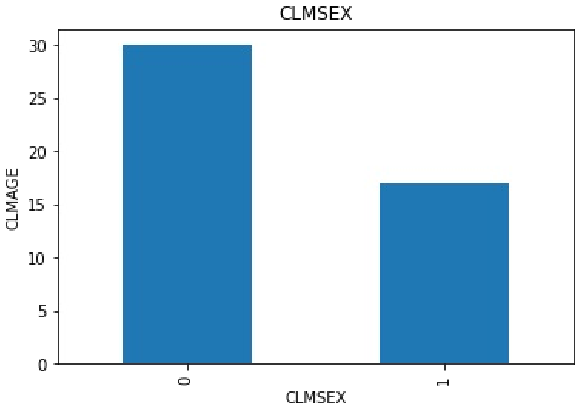
Exploratory Data Analysis

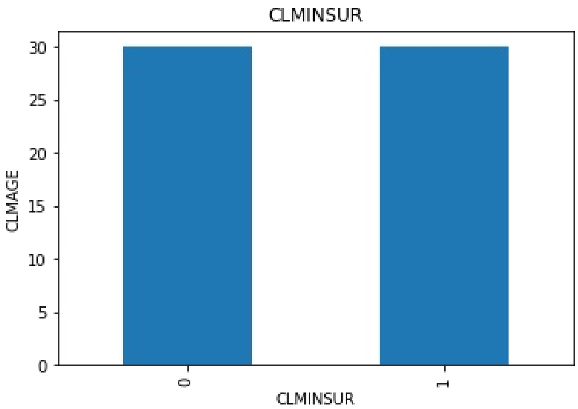
Since there are many missing values, we need to find the relationship between missing values and SalesPrice

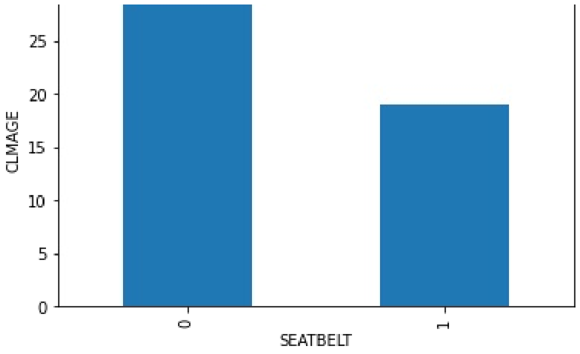
Let's plot some diagram for this relationship

In [27]:

```
features_with_na = [features for features in df.columns if df[features].isnull().sum()>1]

for feature in features_with_na:
    if feature!="CLMAGE":
        data=df.copy()

# Let's make a variable that indicates 1 if the observation was missing or zero
        data[feature]=np.where(data[feature].isnull(),1,0)

# Let's calculate the mean SalePrice where the information is missing or present
        data.groupby(feature)['CLMAGE'].median().plot.bar()
        plt.ylabel('CLMAGE')
        plt.title(feature)
        plt.show()
```

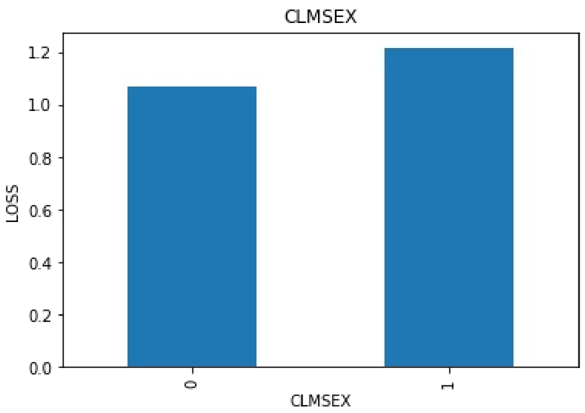


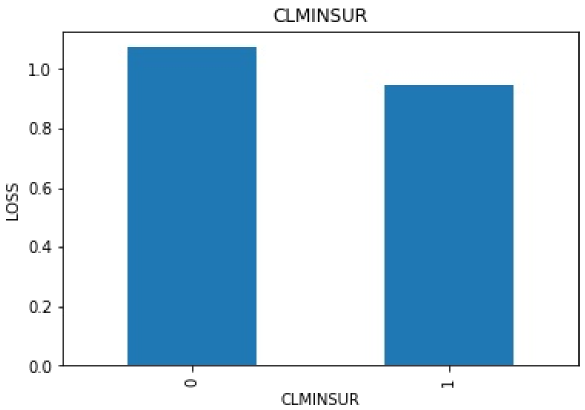


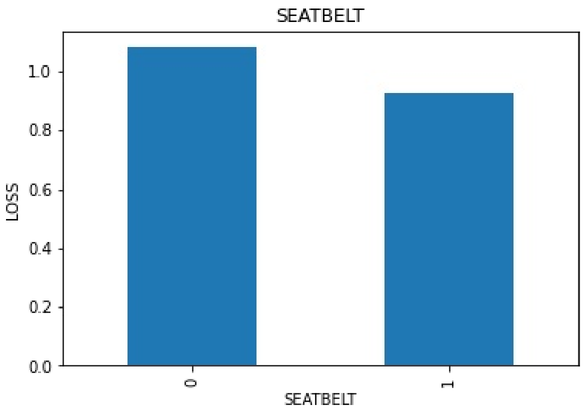


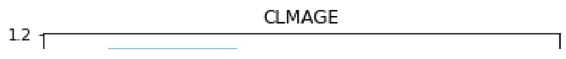
In [28]:

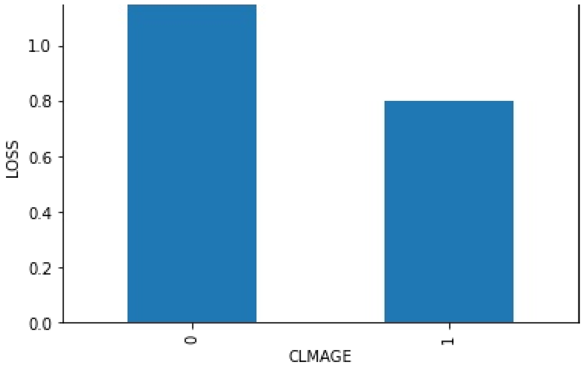
```python
features_with_na = [features for features in df.columns if df[features].isnull().sum()>1]

for feature in features_with_na:
    data=df.copy()

# Let's make a variable that indicates 1 if the observation was missing or zero
    data[feature]=np.where(data[feature].isnull(),1,0)

# Let's calculate the mean SalePrice where the information is missing or present
    data.groupby(feature)['LOSS'].median().plot.bar()
    plt.ylabel('LOSS')
    plt.title(feature)
    plt.show()
```





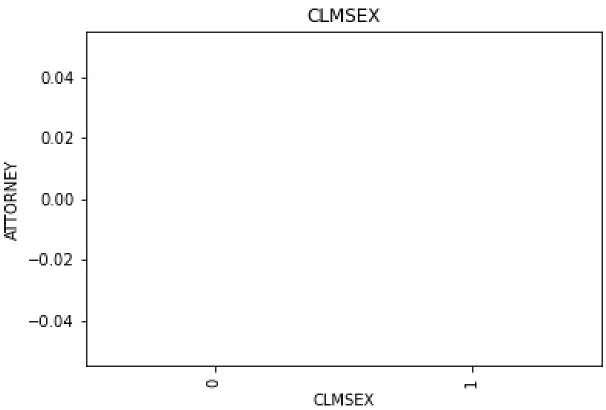


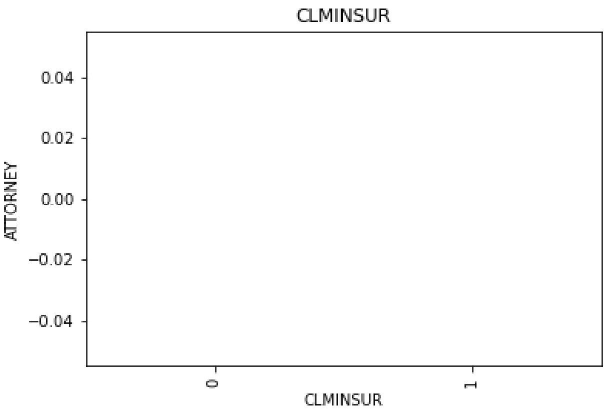


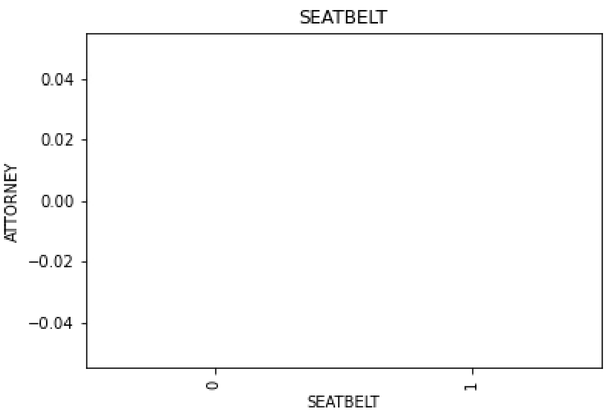


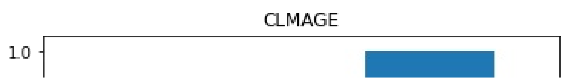
In [45]:

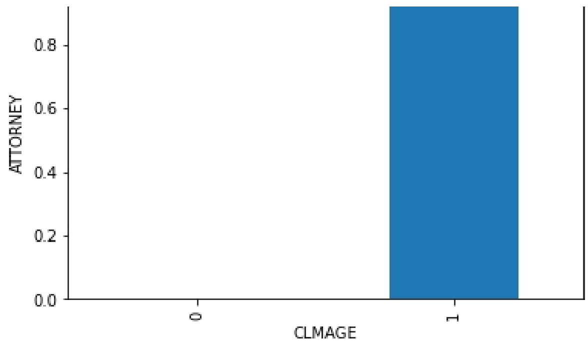
```python
features_with_na = [features for features in df.columns if df[features].isnull().sum()>1]

for feature in features_with_na:
    data=df.copy()

# Let's make a variable that indicates 1 if the observation was missing or zero
    data[feature]=np.where(data[feature].isnull(),1,0)

# Let's calculate the mean SalePrice where the information is missing or present
    data.groupby(feature)['ATTORNEY'].median().plot.bar()
    plt.ylabel('ATTORNEY')
    plt.title(feature)
    plt.show()
```









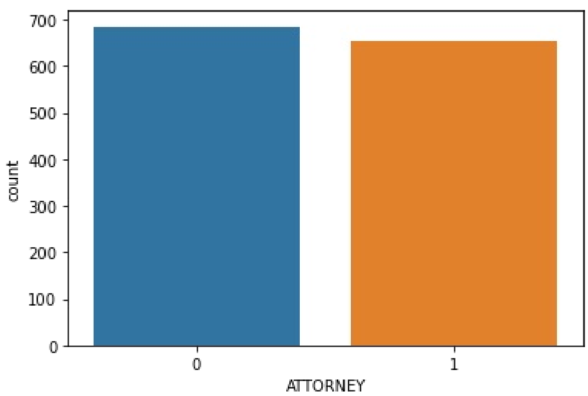


In [7]:
```
df.CLMINSUR.mode()[0]
```
Out[7]:
```
1.0
```

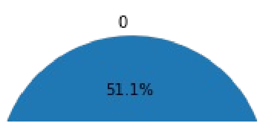
In [26]:
```
df.CLMAGE.median()
```
Out[26]:
```
28.414422241529106
```

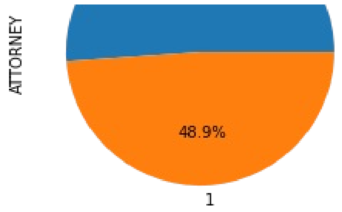
In [17]:
```
#Fill nan values with mode of the categorical column
df["CLMSEX"].fillna(df.CLMSEX.mode()[0],inplace=True) # df.CLMSEX.mode() = 1
df["CLMINSUR"].fillna(df.CLMINSUR.mode()[0],inplace=True) # df.CLMINSUR.mode() = 1
df["SEATBELT"].fillna(df.SEATBELT.mode()[0],inplace=True) # df.SEATBELT.mode() = 0

df.CLMAGE.fillna(df.CLMAGE.median(),inplace=True) # df.CLMAGE.median() = 28.41
df.isnull().sum()
```
Out[17]:
```
ATTORNEY    0
CLMSEX      0
CLMINSUR    0
SEATBELT    0
CLMAGE      0
LOSS        0
dtype: int64
```

In [10]:
```
sns.countplot(x="ATTORNEY",data=df)
```
Out[10]:
```
<AxesSubplot:xlabel='ATTORNEY', ylabel='count'>
```

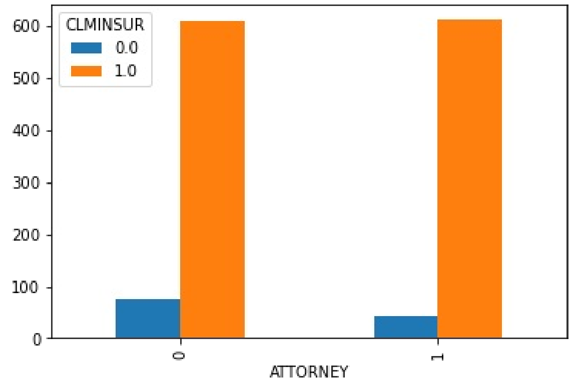


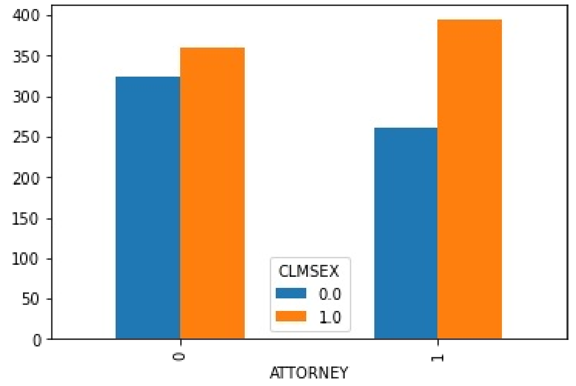
In [11]:
```
df['ATTORNEY'].value_counts().plot(kind='pie',autopct='%.1f%%')
```
Out[11]:
```
<AxesSubplot:ylabel='ATTORNEY'>
```

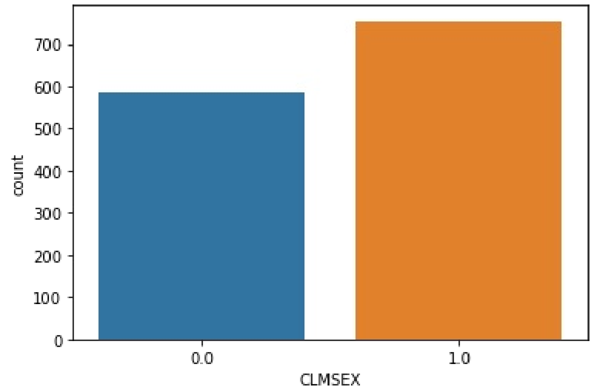




The target in the Data is Balanced. One of the value counts is not more than the other approximately equally distrubuted

In [12]:
```
pd.crosstab(df.ATTORNEY,df.CLMINSUR).plot(kind="bar")
```
Out[12]:
```
<AxesSubplot:xlabel='ATTORNEY'>
```


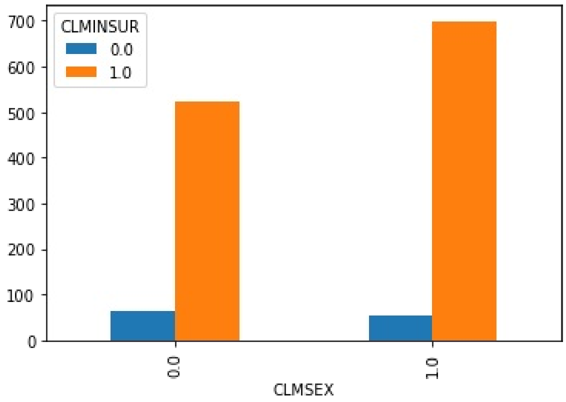
In [59]:
```
pd.crosstab(df.ATTORNEY,df.CLMSEX).plot(kind="bar")
```
Out[59]:
```
<AxesSubplot:xlabel='ATTORNEY'>
```


In [13]:
```
sns.countplot(x="CLMSEX",data=df)
```
Out[13]:
```
<AxesSubplot:xlabel='CLMSEX', ylabel='count'>
```


In [14]:

```
pd.crosstab(df.CLMSEX,df.CLMINSUR).plot(kind="bar")
```

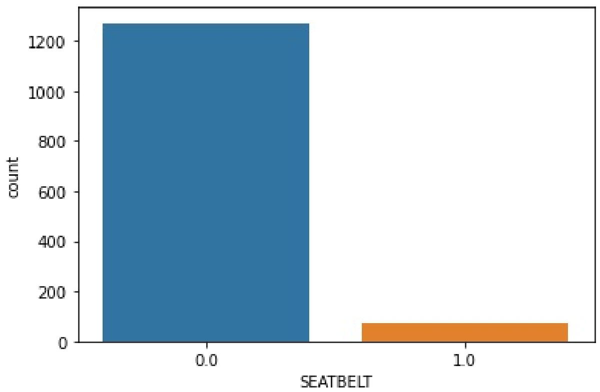
Out[14]: <AxesSubplot:xlabel='CLMSEX'>



In [15]:

```
sns.countplot(x="SEATBELT",data=df)
```

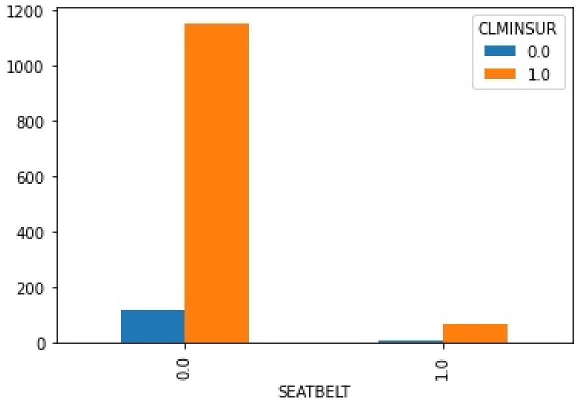
Out[15]: <AxesSubplot:xlabel='SEATBELT', ylabel='count'>



In [16]:

```
pd.crosstab(df.SEATBELT,df.CLMINSUR).plot(kind="bar")
```

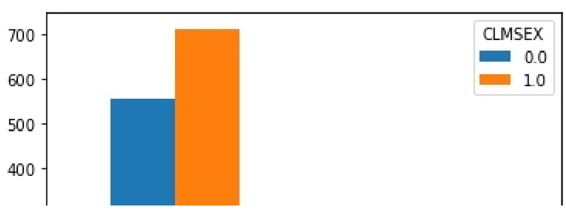
Out[16]: <AxesSubplot:xlabel='SEATBELT'>

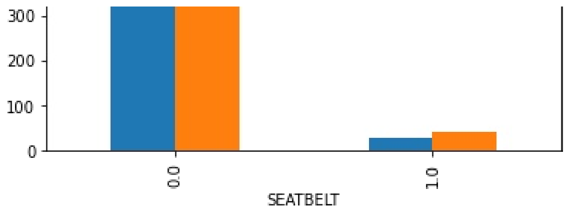


In [58]:

```
pd.crosstab(df.SEATBELT,df.CLMSEX).plot(kind="bar")
```

Out[58]: <AxesSubplot:xlabel='SEATBELT'>

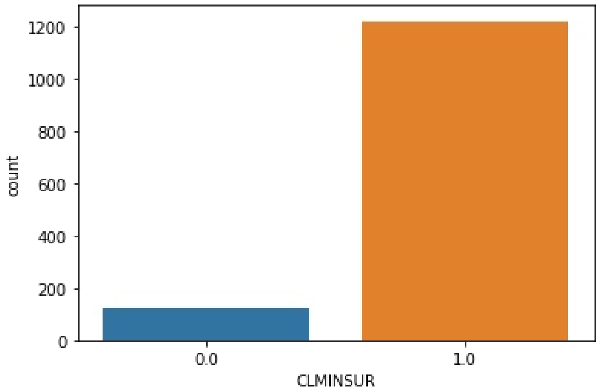




In [17]:

```
sns.countplot(x="CLMINSUR",data=df)
```

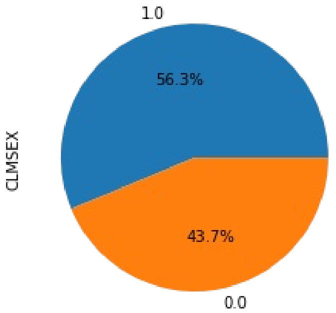
Out[17]: <AxesSubplot:xlabel='CLMINSUR', ylabel='count'>



In [18]:

```
df['CLMSEX'].value_counts().plot(kind='pie',autopct='%.1f%%')
```

Out[18]: <AxesSubplot:ylabel='CLMSEX'>



In [19]:

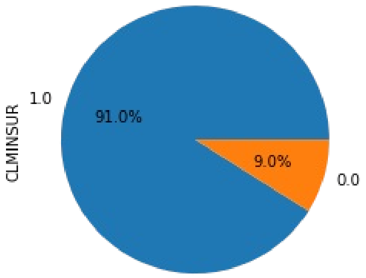
```
df.columns
```

Out[19]: Index(['ATTORNEY', 'CLMSEX', 'CLMINSUR', 'SEATBELT', 'CLMAGE', 'LOSS'], dtype='object')

In [20]:

```
df['CLMINSUR'].value_counts().plot(kind='pie',autopct='%.1f%%')
```

Out[20]: <AxesSubplot:ylabel='CLMINSUR'>

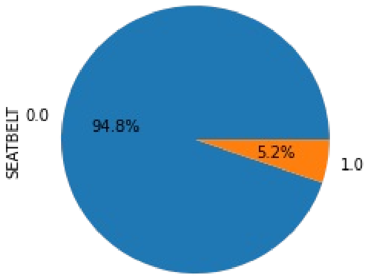


In [21]:

```
df['SEATBELT'].value_counts().plot(kind='pie',autopct='%.1f%%')
```

Out[21]:

```
<AxesSubplot:ylabel='SEATBELT'>
```

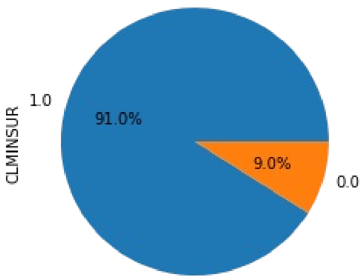


In [22]:

```
df['CLMINSUR'].value_counts().plot(kind='pie',autopct='%.1f%%')
```

Out[22]:

```
<AxesSubplot:ylabel='CLMINSUR'>
```

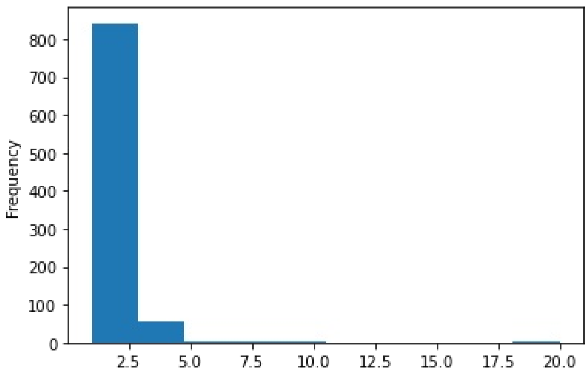


In [23]:

```
df['LOSS'].value_counts().plot(kind='hist')
```

Out[23]:

```
<AxesSubplot:ylabel='Frequency'>
```

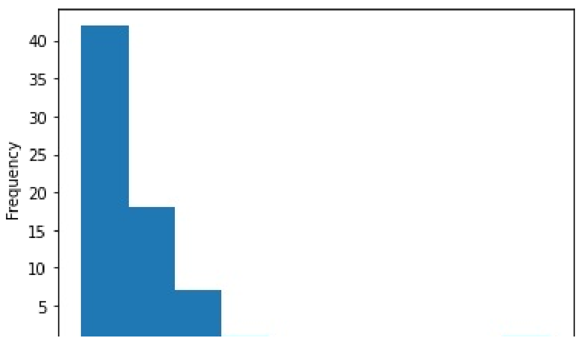


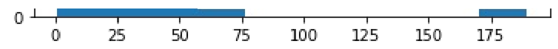
In [27]:

```
df['CLMAGE'].value_counts().plot(kind='hist')
```

Out[27]:

```
<AxesSubplot:ylabel='Frequency'>
```





In [33]:
```python
df.CLMAGE.sort_values()
```

Out[33]:
```
1260     0.0
608      0.0
74       0.0
615      0.0
1252     0.0
        ...
618     83.0
853     84.0
1057    86.0
737     88.0
635     95.0
Name: CLMAGE, Length: 1340, dtype: float64
```

In [47]:
```python
df[df.CLMAGE.values<18]
```

Out[47]:

	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
2	1	0.0	1.0	0.0	5.0	0.330
6	0	0.0	1.0	0.0	9.0	3.538
12	1	0.0	1.0	0.0	7.0	1.678
15	1	1.0	0.0	0.0	9.0	0.053
18	1	0.0	1.0	0.0	3.0	0.000
...	...	...	...	...	...	...
1328	0	0.0	1.0	0.0	14.0	0.400
1331	0	1.0	1.0	0.0	3.0	0.950
1332	1	1.0	1.0	0.0	9.0	0.000
1334	1	1.0	1.0	0.0	16.0	0.060
1338	0	1.0	0.0	0.0	8.0	3.177

493 rows × 6 columns

In [44]:
```python
df['CLMAGE']<18
```

Out[44]:
```
0       False
1       False
2        True
3       False
4       False
        ...
1335    False
1336    False
1337    False
1338     True
1339    False
Name: CLMAGE, Length: 1340, dtype: bool
```

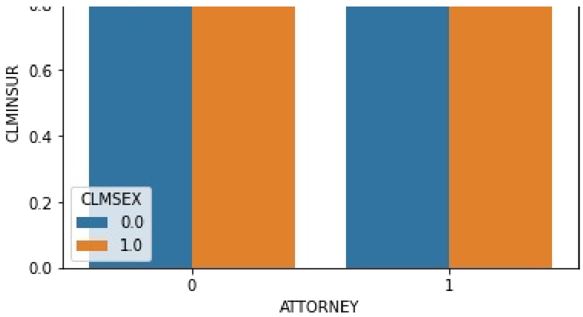
In [53]:
```python
df.columns
```

Out[53]:
```
Index(['ATTORNEY', 'CLMSEX', 'CLMINSUR', 'SEATBELT', 'CLMAGE', 'LOSS'], dtype='object')
```

ATTORNEY Yes or No Vs CLMSEX

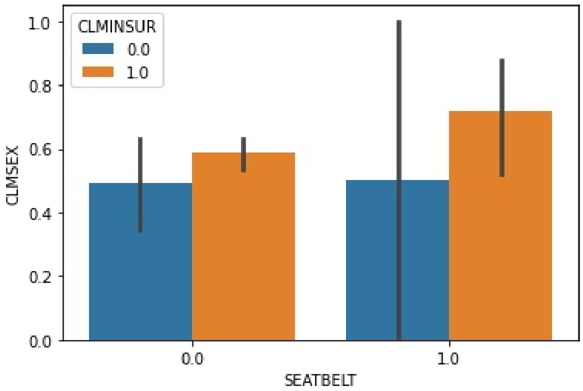
In [60]:
```python
sns.barplot('ATTORNEY','CLMINSUR',hue='CLMSEX',data=df)
```

Out[60]:
```
<AxesSubplot:xlabel='ATTORNEY', ylabel='CLMINSUR'>
```



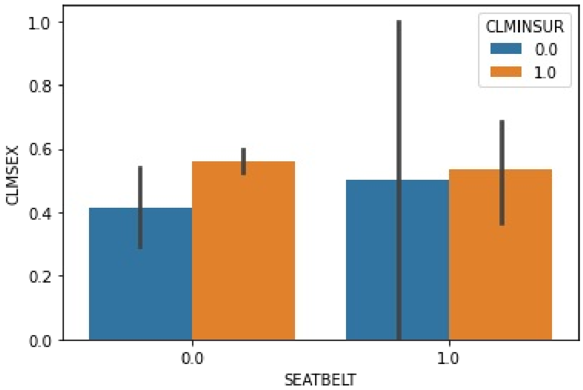
In [66]:
```
sns.barplot('SEATBELT','CLMSEX',hue='CLMINSUR',data=df[df['CLMAGE']<18])
```

Out[66]: <AxesSubplot:xlabel='SEATBELT', ylabel='CLMSEX'>



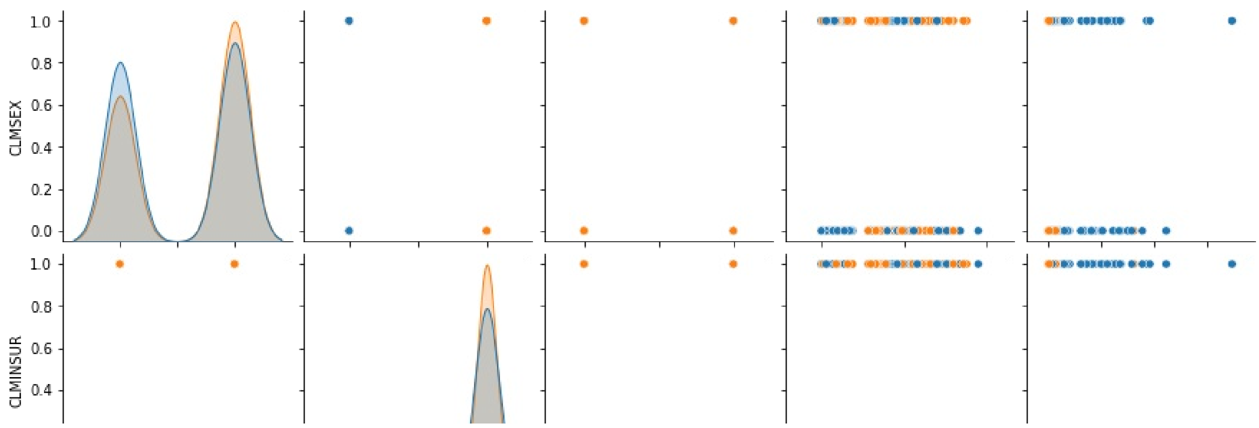
In [67]:
```
sns.barplot('SEATBELT','CLMSEX',hue='CLMINSUR',data=df[df['CLMAGE']>18])
```

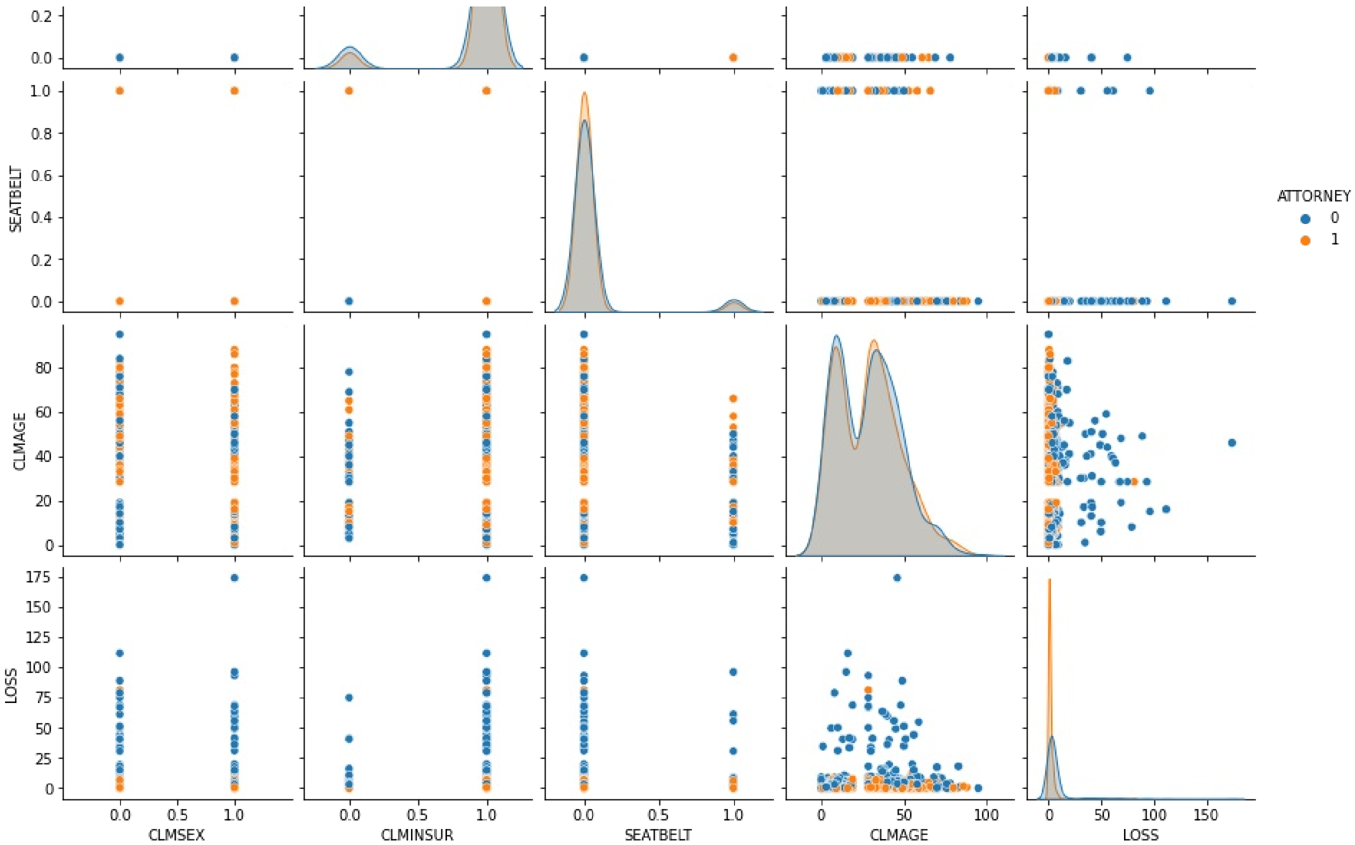
Out[67]: <AxesSubplot:xlabel='SEATBELT', ylabel='CLMSEX'>



In [68]:
```
sns.pairplot(df, hue = 'ATTORNEY')
```

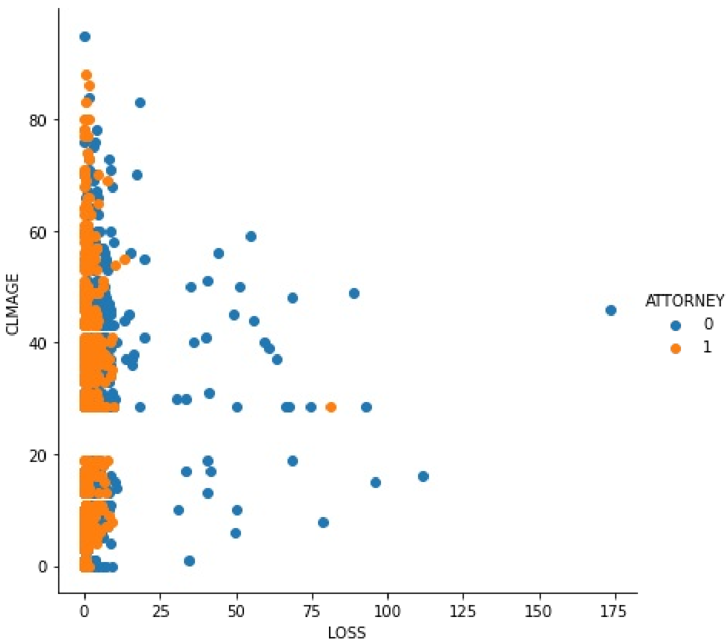
Out[68]: <seaborn.axisgrid.PairGrid at 0x219a5bd3e50>





In [69]:

```
sns.FacetGrid(df, hue = 'ATTORNEY', size = 6).map(plt.scatter,"LOSS",'CLMAGE').add_legend()
plt.show()
```

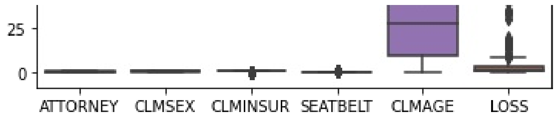


Outlier Detection using Boxplot

In [71]:

```
sns.boxplot(data =df,orient = "v")
```

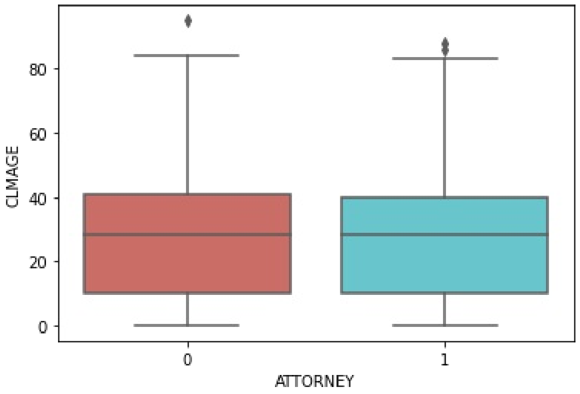
Out[71]: <AxesSubplot:>



In [73]:

```python
sns.boxplot(x="ATTORNEY",y="CLMAGE",data=df,palette = "hls")
```

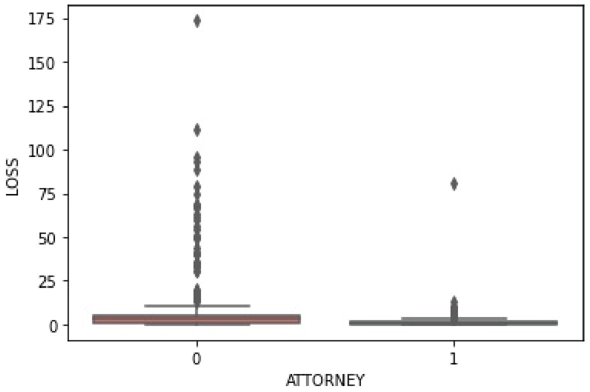
Out[73]: <AxesSubplot:xlabel='ATTORNEY', ylabel='CLMAGE'>



In [74]:

```python
sns.boxplot(x="ATTORNEY",y="LOSS",data=df,palette="hls")
```

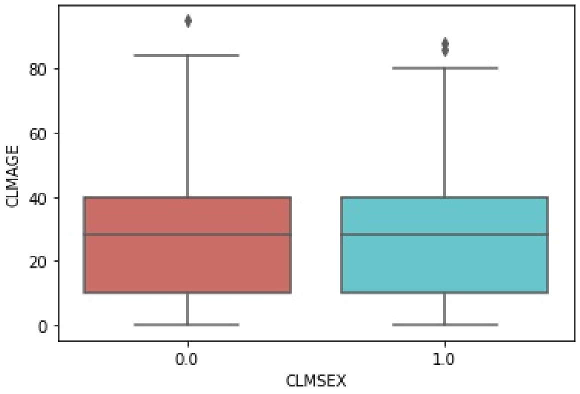
Out[74]: <AxesSubplot:xlabel='ATTORNEY', ylabel='LOSS'>



In [77]:

```python
sns.boxplot(x="CLMSEX",y="CLMAGE",data=df,palette="hls")
```

Out[77]: <AxesSubplot:xlabel='CLMSEX', ylabel='CLMAGE'>



In [18]:

```python
#Dividing our data into input and output variables
x = df.iloc[:,1:]
y = df.iloc[:,0]
```

In [23]:

```
x
```

Out[23]:

	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
0	0.0	1.0	0.0	50.0	34.940
1	1.0	0.0	0.0	18.0	0.891
2	0.0	1.0	0.0	5.0	0.330
3	0.0	1.0	1.0	31.0	0.037
4	0.0	1.0	0.0	30.0	0.038
...	...	...	...	...	...
1335	0.0	1.0	0.0	30.0	0.576
1336	1.0	1.0	0.0	46.0	3.705
1337	1.0	1.0	0.0	39.0	0.099
1338	1.0	0.0	0.0	8.0	3.177
1339	1.0	1.0	0.0	30.0	0.688

1340 rows × 5 columns

In [19]:

```
y
```

Out[19]:

```
0       0
1       1
2       1
3       0
4       1
       ..
1335    1
1336    0
1337    1
1338    0
1339    1
Name: ATTORNEY, Length: 1340, dtype: int64
```

In [20]:

```
# Building a Logistic Regression and fitting the values
classifier = LogisticRegression()
classifier.fit(x,y)
```

Out[20]:

```
LogisticRegression()
```

In [21]:

```
classifier.intercept_
```

Out[21]:

```
array([-0.13616435])
```

In [22]:

```
classifier.coef_
```

Out[22]:

```
array([[ 0.31756644,  0.50430419, -0.52798522,  0.00680276, -0.32257734]])
```

In [83]:

```
# Predicting for x dataset
y_pred = classifier.predict(x)
```

In [84]:

```
# Creating a datframe to with actual value and predicted value
predict = pd.DataFrame({'Actual':y,'Predicted':y_pred})
predict.head()
```

Out[84]:

	Actual	Predicted
0	0	0
1	1	1
2	1	1
3	0	1
4	1	1

In [88]:
```
# Confusion Matrix to check the Model accuracy
from sklearn.metrics import confusion_matrix
cm = confusion_matrix (y,y_pred)
cm
```

Out[88]:
```
array([[435, 250],
       [147, 508]], dtype=int64)
```

In [91]:
```
# Calculting Accuracy for the model
# Accuracy = (TP + TN / TP + TN + FP +FN )* 100
((435+508)/(435+250+147+508))*100
```

Out[91]:
```
70.3731343283582
```

In [94]:
```
# Classification Report
from sklearn.metrics import classification_report
print(classification_report(y,y_pred))
```

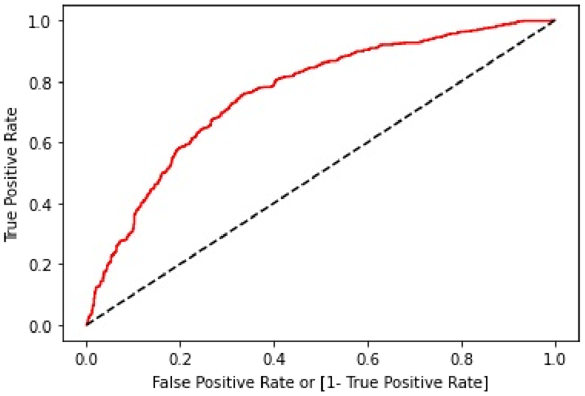
```
              precision    recall  f1-score   support

           0       0.75      0.64      0.69       685
           1       0.67      0.78      0.72       655

    accuracy                           0.70      1340
   macro avg       0.71      0.71      0.70      1340
weighted avg       0.71      0.70      0.70      1340
```

In [ ]:
```
# ROC curve
```

In [96]:
```
from sklearn.metrics import roc_curve, roc_auc_score
```

In [105…
```
fpr, tpr, thresholds = roc_curve(y, classifier.predict_proba(x)[:,1])

auc = roc_auc_score(y, y_pred)

plt.plot(fpr, tpr, color='red', label='logistic model (area = %0.2f)'%auc)
plt.plot([0,1], [0,1], 'k--')
plt.xlabel('False Positive Rate or [1- True Positive Rate]')
plt.ylabel('True Positive Rate')
```

Out[105…
```
Text(0, 0.5, 'True Positive Rate')
```



In [109…
```
classifier.predict_proba(x)[:,0]
```

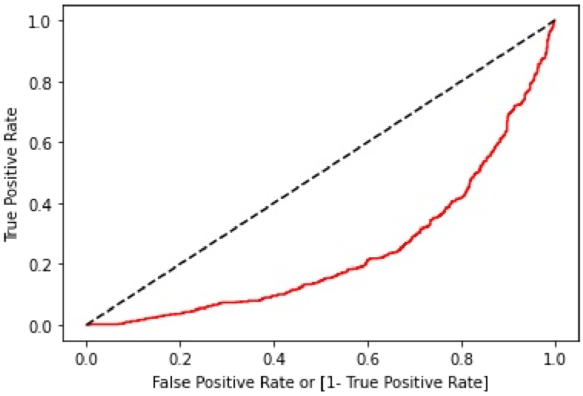
Out[109…
```
array([0.99997503, 0.4913874 , 0.42154373, ..., 0.28153744, 0.68381839,
       0.33466588])
```

In [106…
```
fpr, tpr, thresholds = roc_curve(y, classifier.predict_proba(x)[:,0])
```

```python
auc = roc_auc_score(y, y_pred)

plt.plot(fpr, tpr, color='red', label='logistic model (area = %0.2f)'%auc)
plt.plot([0,1], [0,1], 'k--')
plt.xlabel('False Positive Rate or [1- True Positive Rate]')
plt.ylabel('True Positive Rate')
```

Out[106…

```
Text(0, 0.5, 'True Positive Rate')
```



In [107…

```python
auc
```

Out[107…

```
0.7053045077171672
```

In [108…

```python
classifier.predict_proba(x)
```

Out[108…

```
array([[9.99975026e-01, 2.49742515e-05],
       [4.91387400e-01, 5.08612600e-01],
       [4.21543727e-01, 5.78456273e-01],
       ...,
       [2.81537440e-01, 7.18462560e-01],
       [6.83818393e-01, 3.16181607e-01],
       [3.34665878e-01, 6.65334122e-01]])
```

In [111…

```python
y_pred.reshape(-1,1)
```

Out[111…

```
array([[0],
       [1],
       [1],
       ...,
       [1],
       [0],
       [1]], dtype=int64)
```

In [ ]:

In [ ]: