```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor
from sklearn.model_selection import train_test_split, cross_val_score, GridSearchCV
from sklearn.linear_model import LogisticRegression, LogisticRegressionCV
from mord import LogisticIT
from dmba.metric import AIC_score
from dmba import classificationSummary
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from imblearn.over_sampling import RandomOverSampler
from imblearn.under_sampling import RandomUnderSampler

%matplotlib inline
```

```
fraud = pd.read_csv('Online Payments Fraud.csv')
fraud.head()
```

	step	type	amount	nameOrig	oldbalanceOrg	newbalanceOrig	name
0	1	PAYMENT	9839.64	C1231006815	170136.0	160296.36	M197978
1	1	PAYMENT	1864.28	C1666544295	21249.0	19384.72	M204428
2	1	TRANSFER	181.00	C1305486145	181.0	0.00	C55326
3	1	CASH_OUT	181.00	C840083671	181.0	0.00	C3899
4	1	PAYMENT	11668.14	C2048537720	41554.0	29885.86	M123070

```
#Getting familiar with data

fraud.describe()
```

	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest
count	6.362620e+06	6.362620e+06	6.362620e+06	6.362620e+06	6.362620e+06
mean	2.433972e+02	1.798619e+05	8.338831e+05	8.551137e+05	1.100702e+06
std	1.423320e+02	6.038582e+05	2.888243e+06	2.924049e+06	3.399180e+06
min	1.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
25%	1.560000e+02	1.338957e+04	0.000000e+00	0.000000e+00	0.000000e+00
50%	2.390000e+02	7.487194e+04	1.420800e+04	0.000000e+00	1.327057e+05
75%	3.350000e+02	2.087215e+05	1.073152e+05	1.442584e+05	9.430367e+05
max	7.430000e+02	9.244552e+07	5.958504e+07	4.958504e+07	3.560159e+08

```
# Checking the NA Values

fraud.isna().sum()
```

```
step              0
type              0
amount            0
nameOrig          0
oldbalanceOrg     0
newbalanceOrig    0
nameDest          0
oldbalanceDest    0
newbalanceDest    0
isFraud           0
isFlaggedFraud    0
dtype: int64
```

```
fraud.dropna(inplace = True)
```

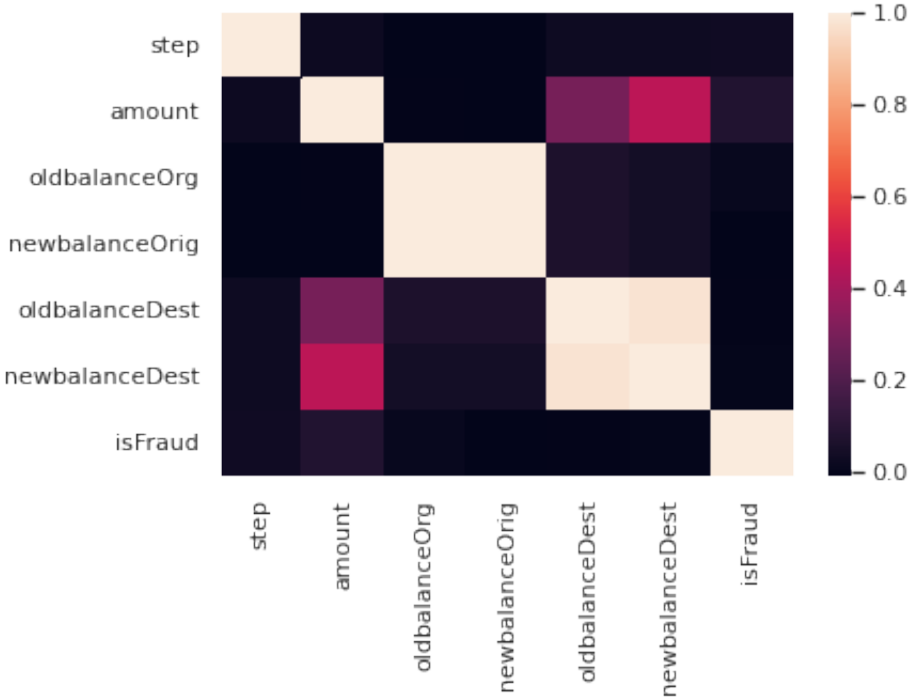
```
#Knowing the data types of the columns

fraud.dtypes
```

```
step                int64
type               object
amount            float64
nameOrig           object
oldbalanceOrg     float64
newbalanceOrig    float64
nameDest           object
oldbalanceDest    float64
newbalanceDest    float64
isFraud             int64
isFlaggedFraud      int64
dtype: object
```

```
#Changing class type variables to object

fraud['isFraud'] = fraud['isFraud'].astype('int')
```

```
corr_mat = fraud[['step','type','amount','nameOrig','oldbalanceOrg',
                  'newbalanceOrig','nameDest','oldbalanceDest',
                  'newbalanceDest','isFraud']].corr()
sns.heatmap(corr_mat)
```

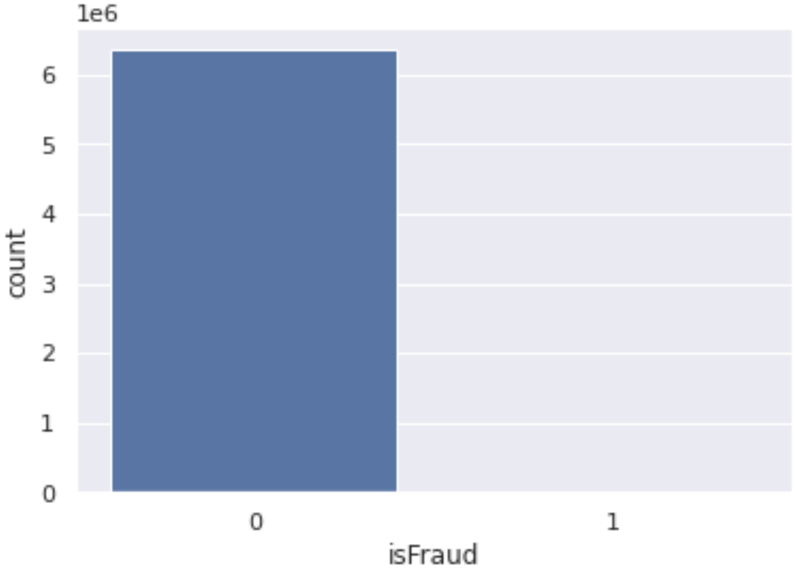
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f16dbb3d2d0>
```



```
fraud.isFraud.value_counts() / len(fraud) * 100
```

```
0    99.870918
1     0.129082
Name: isFraud, dtype: float64
```

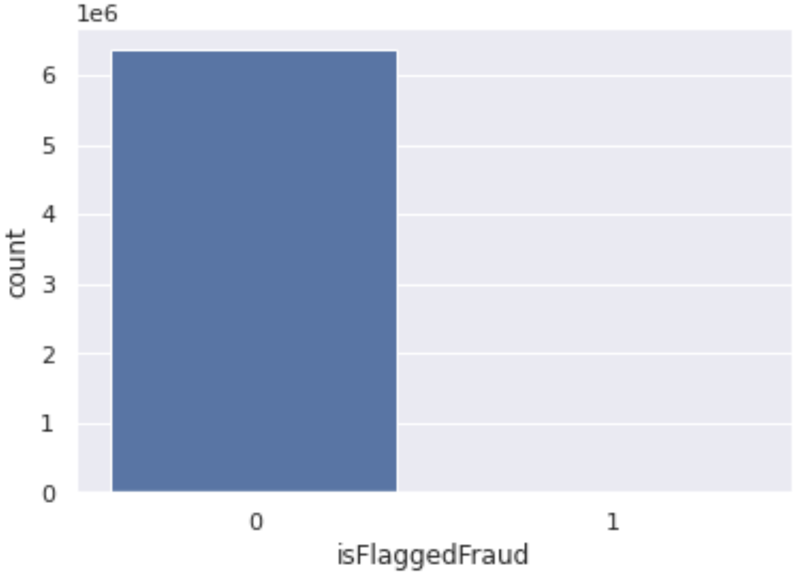
```
sns.set_theme(style="darkgrid")
ax = sns.countplot(x="isFraud", data=fraud)
```



```
fraud.isFlaggedFraud.value_counts() / len(fraud) * 100
```

```
0    99.999749
1     0.000251
Name: isFlaggedFraud, dtype: float64
```

```
sns.set_theme(style="darkgrid")
ax = sns.countplot(x="isFlaggedFraud", data=fraud)
```

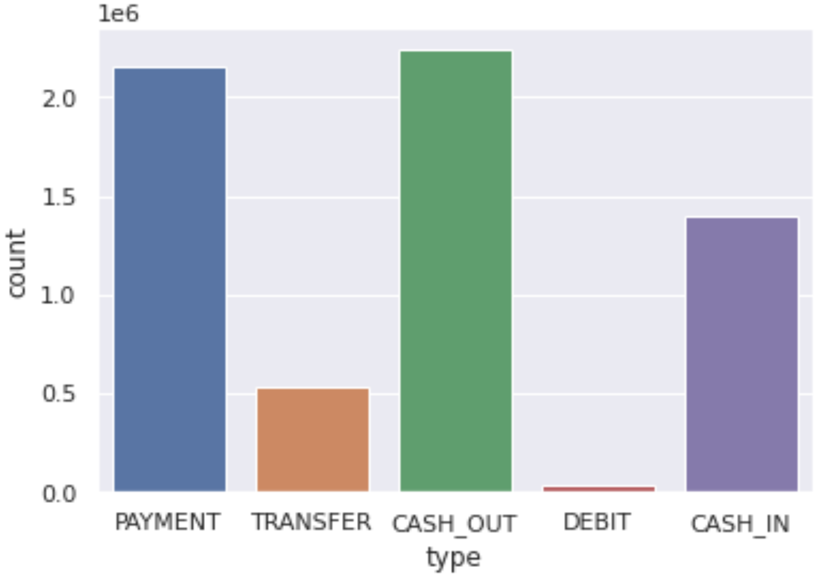


```
fraud.drop(['isFlaggedFraud'], inplace = True, axis=1)
```

```
fraud.type.value_counts() / len(fraud) * 100
```

```
    CASH_OUT    35.166331
    PAYMENT     33.814608
    CASH_IN     21.992261
    TRANSFER     8.375622
    DEBIT        0.651178
    Name: type, dtype: float64
```

```
sns.set_theme(style="darkgrid")
ax = sns.countplot(x="type", data=fraud)
```



```
fraud.groupby('isFraud').type.value_counts() / len(fraud) * 100
```

```
    isFraud  type
    0        CASH_OUT    35.101641
             PAYMENT     33.814608
             CASH_IN     21.992261
             TRANSFER     8.311230
             DEBIT        0.651178
    1        CASH_OUT     0.064690
             TRANSFER     0.064392
    Name: type, dtype: float64
```

```
fraud = fraud.loc[fraud['type'].isin(['CASH_OUT','TRANSFER']),:]
print('The updated data now has', len(fraud), 'transactions.')
```

```
    The updated data now has 2770409 transactions.
```

```
print('Number of transactions where amount is negative: ' +
      str(sum(fraud['amount'] < 0)))
```

```
    Number of transactions where amount is negative: 0
```

```
print('Number of transactions where amount is zero: ' +
      str(sum(fraud['amount'] == 0)))
```

```
    Number of transactions where amount is zero: 16
```

```
fraud = fraud.loc[fraud['amount'] > 0, :]
print('The updated data now has', len(fraud), 'transactions.')
```

```
    The updated data now has 2770393 transactions.
```

```
fraud['origBalance_inacc'] = (fraud['oldbalanceOrg'] - fraud['amount']) - fraud['ne
fraud['destBalance_inacc'] = (fraud['oldbalanceDest'] + fraud['amount']) - fraud['r
```

```
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: SettingWithCop
    A value is trying to be set on a copy of a slice from a DataFrame.
    Try using .loc[row_indexer,col_indexer] = value instead

    See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/st
      """Entry point for launching an IPython kernel.
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: SettingWithCop
    A value is trying to be set on a copy of a slice from a DataFrame.
    Try using .loc[row_indexer,col_indexer] = value instead

    See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/st
```

```
fraud.drop(['nameOrig', 'nameDest'], inplace = True, axis=1)
```

```
fraud = pd.get_dummies(fraud, columns = ['type'])
```

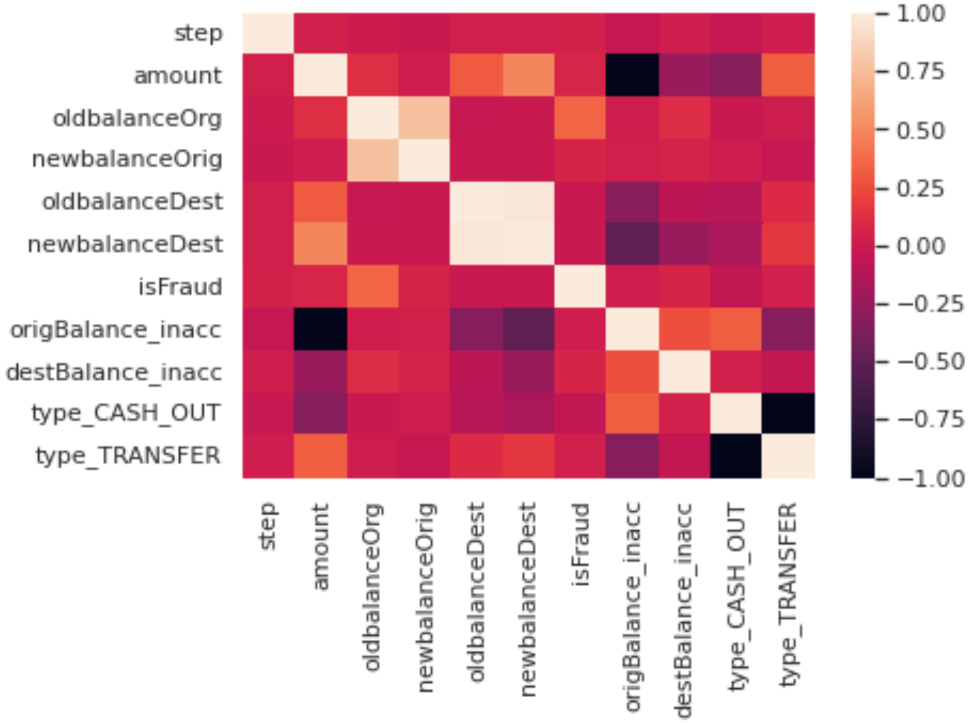
```
fraud['type_CASH_OUT'] = fraud['type_CASH_OUT'].astype('int')
fraud['type_TRANSFER'] = fraud['type_TRANSFER'].astype('int')
```

```
fraud.head()
```

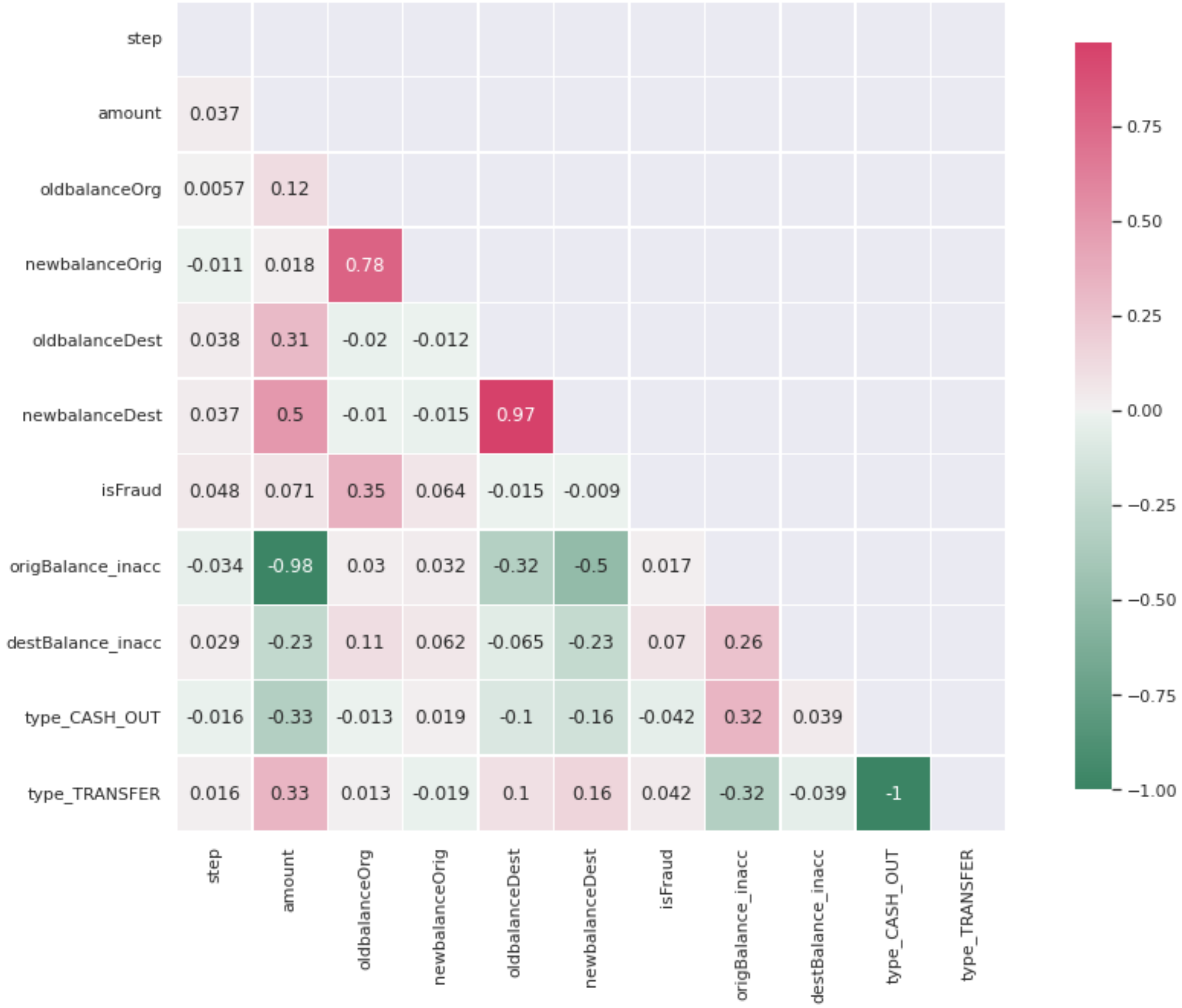
	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newbalanceDe
2	1	181.00	181.0	0.0	0.0	0.
3	1	181.00	181.0	0.0	21182.0	0.
15	1	229133.94	15325.0	0.0	5083.0	51513.
19	1	215310.30	705.0	0.0	22425.0	0.
24	1	311685.89	10835.0	0.0	6267.0	2719172.

```
corr_mat = fraud[['step','amount','oldbalanceOrg','newbalanceOrig',
                  'oldbalanceDest','newbalanceDest','isFraud',
                  'origBalance_inacc','destBalance_inacc','type_CASH_OUT',
                  'type_TRANSFER']].corr()
sns.heatmap(corr_mat)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f16b3f9f810>
```



```
corr = fraud.corr()
mask = np.triu(np.ones_like(corr, dtype=np.bool))
f, ax = plt.subplots(figsize=(16, 10))
cmap = sns.diverging_palette(150, 1, as_cmap=True)
sns.heatmap(corr, mask=mask, cmap=cmap, vmax=None, center=0,square=True, annot=True
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: DeprecationWar
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/dev

<matplotlib.axes._subplots.AxesSubplot at 0x7f16e363f8d0>
```



	step	amount	oldbalanceOrg	newbalanceOrig	oldbalanceDest	newbalanceDest	isFraud	origBalance_inacc	destBalance_inacc	type_CASH_OUT	type_TRANSFER
step											
amount	0.037										
oldbalanceOrg	0.0057	0.12									
newbalanceOrig	-0.011	0.018	0.78								
oldbalanceDest	0.038	0.31	-0.02	-0.012							
newbalanceDest	0.037	0.5	-0.01	-0.015	0.97						
isFraud	0.048	0.071	0.35	0.064	-0.015	-0.009					
origBalance_inacc	-0.034	-0.98	0.03	0.032	-0.32	-0.5	0.017				
destBalance_inacc	0.029	-0.23	0.11	0.062	-0.065	-0.23	0.07	0.26			
type_CASH_OUT	-0.016	-0.33	-0.013	0.019	-0.1	-0.16	-0.042	0.32	0.039		
type_TRANSFER	0.016	0.33	0.013	-0.019	0.1	0.16	0.042	-0.32	-0.039	-1	

```
X = fraud.drop(columns = ['isFraud'])
y = fraud['isFraud']

X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.3, random_state =


print('Training   : ', X_train.shape,y_train.shape)
print('Test       : ', X_test.shape,y_test.shape)
```

```
Training   :  (1939275, 10) (1939275,)
Test       :  (831118, 10) (831118,)
```

```
ros = RandomOverSampler(sampling_strategy = 'auto', random_state=0)
X_resampled, y_resampled = ros.fit_resample(X_train, y_train)
```

```
y_resampled.value_counts()
```

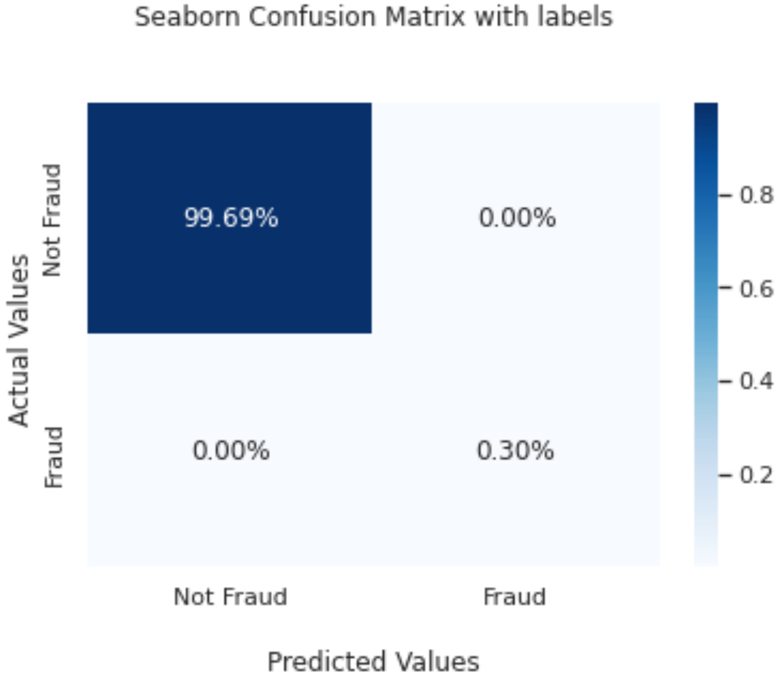
```
0    1933620
1    1933620
Name: isFraud, dtype: int64
```

```
from sklearn.metrics import confusion_matrix, accuracy_score, f1_score, precision_s
def model_validation(y_test,y_predicted):
  print('Accuracy Score:',accuracy_score(y_test,y_predicted))
  print('F1 Score:', f1_score(y_test,y_predicted))
  print('Precision Score:', precision_score(y_test, y_predicted ))
  print('Recall Score:', recall_score(y_test,y_predicted))
```

```
def classification_matrix(y_test,y_predicted):
#Generate the confusion matrix
  cf_matrix = confusion_matrix(y_test, y_predicted)



  ax = sns.heatmap(cf_matrix/np.sum(cf_matrix), annot=True,
            fmt='.2%', cmap='Blues')

  ax.set_title('Seaborn Confusion Matrix with labels\n\n');
  ax.set_xlabel('\nPredicted Values')
  ax.set_ylabel('Actual Values ');

  ## Ticket labels - List must be in alphabetical order
  ax.xaxis.set_ticklabels(['Not Fraud','Fraud'])
  ax.yaxis.set_ticklabels(['Not Fraud','Fraud'])

  ## Display the visualization of the Confusion Matrix.
  plt.show()
```

```
#Decision Tree Classifier


model_dt = DecisionTreeClassifier(random_state = 1)
model_dt.fit(X_resampled, y_resampled)

y_pred_dt = model_dt.predict(X_test)

model_validation(y_test,y_pred_dt)
classification_matrix(y_test,y_pred_dt)
```

```
    Accuracy Score: 0.9999795456240871
    F1 Score: 0.9966528844260681
    Precision Score: 0.9976350019708317
    Recall Score: 0.9956726986624705
```



```
# fit a logistic regression (set penalty=l2 and C=1e42 to avoid regularization)
logit_reg = LogisticRegression(penalty="l2", C=1e42, solver='liblinear')
logit_reg.fit(X_resampled, y_resampled)

print('intercept ', logit_reg.intercept_[0])
print(pd.DataFrame({'coeff': logit_reg.coef_[0]}, index=X.columns).transpose())
print()
print('AIC', AIC_score(y_test, logit_reg.predict(X_test), df = len(X_train.columns)
```

```
intercept  -5.736969431625143e-10
                   step    amount  oldbalanceOrg  newbalanceOrig  oldbalanceDest
coeff -2.956569e-09  0.000003        0.00001       -0.000011        0.000004

       newbalanceDest  origBalance_inacc  destBalance_inacc  type_CASH_OUT  \
coeff       -0.000005           0.000018           0.000011  -8.297223e-10

       type_TRANSFER
coeff   2.560254e-10

AIC 533467.2310032197
```

```
logit_reg_pred = logit_reg.predict(X_test)
logit_reg_proba = logit_reg.predict_proba(X_test)
logit_result = pd.DataFrame({'actual': y_test,
                             'p(0)': [p[0] for p in logit_reg_proba],
                             'p(1)': [p[1] for p in logit_reg_proba],
                             'predicted': logit_reg_pred })

print(logit_result)
```

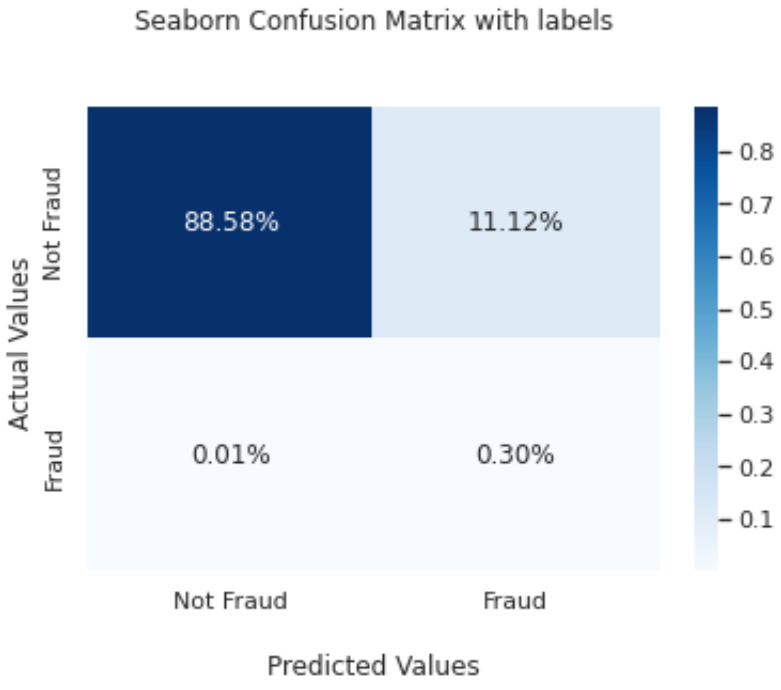
```
         actual      p(0)          p(1)  predicted
3413712       0  0.656827  3.431726e-01          0
87438         0  0.630698  3.693023e-01          0
2251312       0  0.963454  3.654552e-02          0
2985085       0  0.927908  7.209242e-02          0
103959        0  1.000000  9.276304e-10          0
...         ...       ...           ...        ...
3159912       0  0.686980  3.130203e-01          0
2465610       0  0.999728  2.720038e-04          0
5343110       0  1.000000  2.484911e-08          0
3785614       0  0.851498  1.485023e-01          0
5885170       0  0.851497  1.485027e-01          0

[831118 rows x 4 columns]
```

```
classificationSummary(y_train, logit_reg.predict(X_train))
classificationSummary(y_test, logit_reg.predict(X_test))
```

```
Confusion Matrix (Accuracy 0.8887)

       Prediction
Actual       0       1
     0 1717954  215666
     1     141    5514
Confusion Matrix (Accuracy 0.8888)

       Prediction
Actual      0      1
     0 736190  92386
     1     70   2472
```

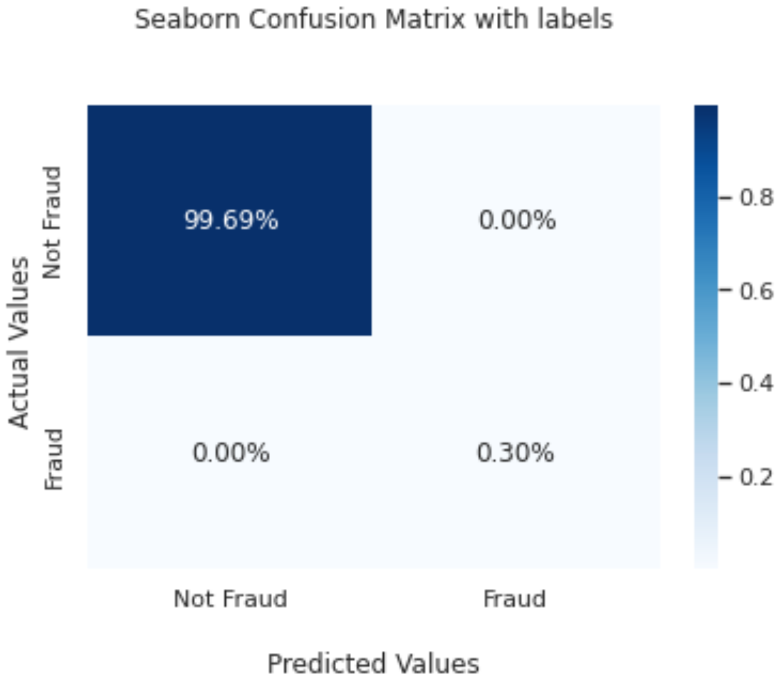
```
model_dt = LogisticRegression(penalty="l2", C=1e42, solver='liblinear')
model_dt.fit(X_resampled, y_resampled)

y_pred_dt = model_dt.predict(X_test)

model_validation(y_test,y_pred_dt)
classification_matrix(y_test,y_pred_dt)
```

```
Accuracy Score: 0.8887570717996722
F1 Score: 0.05075975359342916
Precision Score: 0.026060005481878177
Recall Score: 0.9724626278520849
```

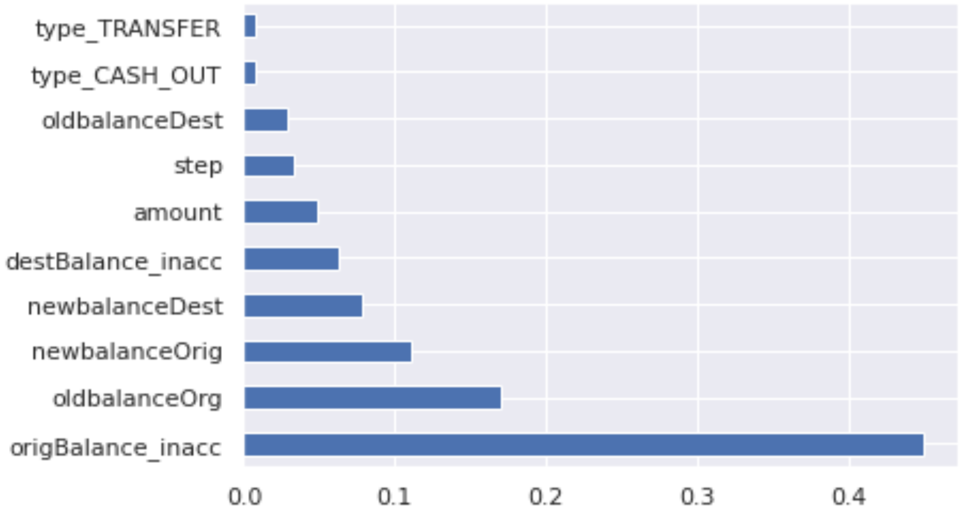

Seaborn Confusion Matrix with labels

```
model_rfc = RandomForestClassifier(random_state = 1)
model_rfc.fit(X_resampled, y_resampled)

y_pred_rfc = model_rfc.predict(X_test)

model_validation(y_test,y_pred_rfc)
classification_matrix(y_test,y_pred_rfc)
```

```
    Accuracy Score: 0.9999867648155858
    F1 Score: 0.997832512315271
    Precision Score: 0.9996052112120016
    Recall Score: 0.996066089693155
```



```
PE = fraud.drop(columns = ['isFraud'])

feat_importances = pd.Series(model_rfc.feature_importances_, index=PE.columns)
feat_importances.nlargest(15).plot(kind="barh")
plt.show()
```



✓ 1s completed at 5:33 PM