```
import pandas as pd
import numpy as np
import tensorflow as tf
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split

from sklearn.preprocessing import StandardScaler
from sklearn.metrics import confusion_matrix, recall_score, accuracy_score, precision_score

RANDOM_SEED = 2021
TEST_PCT = 0.3
LABELS = ["Normal","Fraud"]
```

Loading...

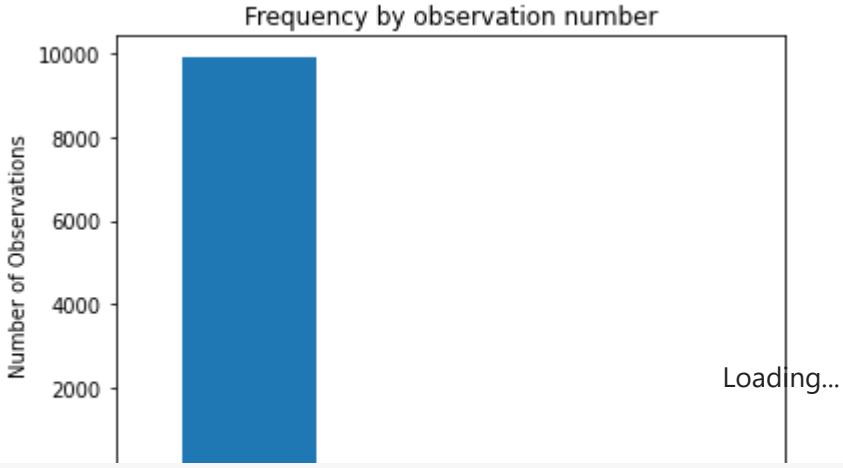
```
dataset = pd.read_csv("creditcard.csv")
```

```
#check for any null values
print("Any nulls in the dataset",dataset.isnull().values.any())
print('-------')
print("No. of unique labels",len(dataset['Class'].unique()))
print("Label values",dataset.Class.unique())

#0 is for normal credit card transcation
#1 is for fraudulent credit card transcation
print('-------')
print("Break down of Normal and Fraud Transcations")
print(pd.value_counts(dataset['Class'],sort=True))
```

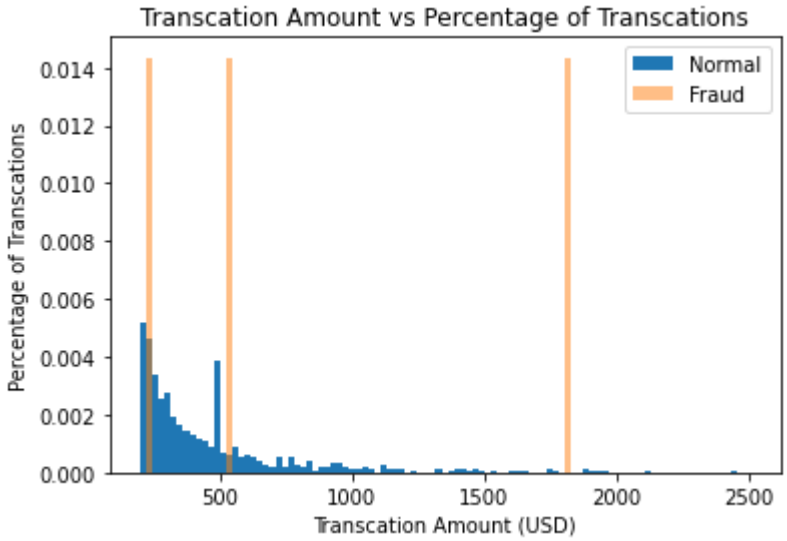
```
Any nulls in the dataset True
-------
No. of unique labels 3
Label values [ 0.  1. nan]
-------
Break down of Normal and Fraud Transcations
0.0    9926
1.0      38
Name: Class, dtype: int64
```

```
#visualizing the imbalanced dataset
count_classes = pd.value_counts(dataset['Class'],sort=True)
count_classes.plot(kind='bar',rot=0)
plt.xticks(range(len(dataset['Class'].unique())),dataset.Class.unique())
plt.title("Frequency by observation number")
plt.xlabel("Class")
plt.ylabel("Number of Observations")
```

```
Text(0, 0.5, 'Number of Observations')
```




```
#Save the normal and fradulent transcations in seperate dataframe
normal_dataset = dataset[dataset.Class == 0]
fraud_dataset = dataset[dataset.Class == 1]

#Visualize transcation amounts for normal and fraudulent transcations
bins = np.linspace(200,2500,100)
plt.hist(normal_dataset.Amount,bins=bins,alpha=1,density=True,label='Normal')
plt.hist(fraud_dataset.Amount,bins=bins,alpha=0.5,density=True,label='Fraud')
plt.legend(loc='upper right')
plt.title("Transcation Amount vs Percentage of Transcations")
plt.xlabel("Transcation Amount (USD)")
plt.ylabel("Percentage of Transcations")
plt.show()
```




```
dataset
```

	Time	V1	V2	V3	V4	V5	V6	V7	
0	0	-1.359807	-0.072781	2.536347	1.378155	-0.338321	0.462388	0.239599	0.0
1	0	1.191857	0.266151	0.166480	0.448154	0.060018	-0.082361	-0.078803	0.0
2	1	-1.358354	-1.340163	1.773209	0.379780	-0.503198	1.800499	0.791461	0.2
3	1	-0.966272	-0.185226	1.792993	-0.863291	-0.010309	1.247203	0.237609	0.3
4	2	-1.158233	0.877737	1.548718	0.403034	-0.407193	0.095921	0.592941	-0.2
...	...	...	...	...	Loading...	...	...	...	
9960	14837	1.286884	-0.124610	0.148283	-0.259343	0.248357	0.896718	-0.626627	0.2
9961	14854	1.318742	0.496408	0.114876	0.695262	0.170133	-0.537180	0.025492	-0.2
9962	14857	1.241757	0.419587	0.806183	0.894811	-0.507886	-1.118126	0.018908	-0.3
9963	14861	1.304800	-0.052885	0.415235	-0.081725	-0.223525	0.097752	-0.561240	0.0
9964	14864	-1.747939	3.712444	NaN	NaN	NaN	NaN	NaN	

9965 rows x 31 columns

```
sc = StandardScaler()
dataset['Time'] = sc.fit_transform(dataset['Time'].values.reshape(-1,1))
dataset['Amount'] = sc.fit_transform(dataset['Amount'].values.reshape(-1,1))
```

```
raw_data = dataset.values
#The last element contains if the transcation is normal which is represented by 0 and if frau
labels = raw_data[:,-1]

#The other data points are the electrocadriogram data
data = raw_data[:,0:-1]

train_data,test_data,train_labels,test_labels = train_test_split(data,labels,test_size = 0.2,
```

```
min_val = tf.reduce_min(train_data)
max_val = tf.reduce_max(train_data)

train_data = (train_data - min_val) / (max_val - min_val)
test_data = (test_data - min_val) / (max_val - min_val)

train_data = tf.cast(train_data,tf.float32)
test_data = tf.cast(test_data,tf.float32)
```

```
train_labels = train_labels.astype(bool)
test_labels = test_labels.astype(bool)

#Creating normal and fraud datasets
normal_train_data = train_data[~train_labels]
normal_test_data = test_data[~test_labels]
```

```
fraud_train_data = train_data[train_labels]
fraud_test_data = test_data[test_labels]
print("No. of records in Fraud Train Data=",len(fraud_train_data))
print("No. of records in Normal Train Data=",len(normal_train_data))
print("No. of records in Fraud Test Data=",len(fraud_test_data))
print("No. of records in Normal Test Data=",len(normal_test_data))
```

```
No. of records in Fraud Train Data= 30
No. of records in Normal Train Data= 7942
No. of records in Fraud Test Data= 9
No. of records in Normal Test Data= 1984
```

Loading...

```
nb_epoch = 50
batch_size = 64
input_dim = normal_train_data.shape[1]
#num of columns,30
encoding_dim = 14
hidden_dim1 = int(encoding_dim / 2)
hidden_dim2 = 4
learning_rate = 1e-7
```

```
#input layer
input_layer = tf.keras.layers.Input(shape=(input_dim,))

#Encoder
encoder = tf.keras.layers.Dense(encoding_dim,activation="tanh",activity_regularizer = tf.kera
encoder = tf.keras.layers.Dropout(0.2)(encoder)
encoder = tf.keras.layers.Dense(hidden_dim1,activation='relu')(encoder)
encoder = tf.keras.layers.Dense(hidden_dim2,activation=tf.nn.leaky_relu)(encoder)

#Decoder
decoder = tf.keras.layers.Dense(hidden_dim1,activation='relu')(encoder)
decoder = tf.keras.layers.Dropout(0.2)(decoder)
decoder = tf.keras.layers.Dense(encoding_dim,activation='relu')(decoder)
decoder = tf.keras.layers.Dense(input_dim,activation='tanh')(decoder)

#Autoencoder
autoencoder = tf.keras.Model(inputs = input_layer,outputs = decoder)
autoencoder.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 30)]              0

 dense (Dense)               (None, 14)                434

 dropout (Dropout)           (None, 14)                0
```

```
 dense_1 (Dense)             (None, 7)                 105

 dense_2 (Dense)             (None, 4)                 32

 dense_3 (Dense)             (None, 7)                 35

 dropout_1 (Dropout)         (None, 7)                 0

 dense_4 (Dense)             (None, 14)                112

 dense_5 (Dense)             (None, 30)                450

=================================================================
Total params: 1,168
Trainable params: 1,168
Non-trainable params: 0
_________________________________________________________________
```

```
cp = tf.keras.callbacks.ModelCheckpoint(filepath="autoencoder_fraud.h5",mode='min',monitor='v
#Define our early stopping
early_stop = tf.keras.callbacks.EarlyStopping(
                monitor='val_loss',
                min_delta=0.0001,
                patience=10,
                verbose=11,
                mode='min',
                restore_best_weights=True
)
```

```
autoencoder.compile(metrics=['accuracy'],loss= 'mean_squared_error',optimizer='adam')
```

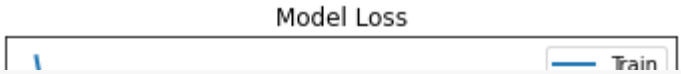
```
history = autoencoder.fit(normal_train_data,normal_train_data,epochs = nb_epoch,
                          batch_size = batch_size,shuffle = True,
                          validation_data = (test_data,test_data),
                          verbose=1,
                          callbacks = [cp,early_stop]).history
```

```
Epoch 1/50
119/125 [===========================>..] - ETA: 0s - loss: 0.0874 - accuracy: 0.0081
Epoch 1: val_loss did not improve from inf
125/125 [==============================] - 1s 4ms/step - loss: 0.0844 - accuracy: 0.008
Epoch 2/50
123/125 [============================>.] - ETA: 0s - loss: 0.0056 - accuracy: 0.0819
Epoch 2: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 0.0056 - accuracy: 0.082
Epoch 3/50
119/125 [===========================>..] - ETA: 0s - loss: 0.0021 - accuracy: 0.1036
Epoch 3: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 0.0020 - accuracy: 0.103
Epoch 4/50
119/125 [===========================>..] - ETA: 0s - loss: 7.2833e-04 - accuracy: 0.104
Epoch 4: val_loss did not improve from inf
```

```
125/125 [==============================] - 0s 3ms/step - loss: 7.1673e-04 - accuracy: 0
Epoch 5/50
108/125 [========================>.....] - ETA: 0s - loss: 3.7958e-04 - accuracy: 0.116
Epoch 5: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 3.7210e-04 - accuracy: 0
Epoch 6/50
120/125 [===========================>..] - ETA: 0s - loss: 2.7484e-04 - accuracy: 0.113
Epoch 6: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 2.7400e-04 - accuracy: 0
Epoch 7/50
105/125 [========================>.....] - ETA: 0s - loss: 2.2777e-04 - accuracy: 0.118
Epoch 7: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 2.2658e-04 - accuracy: 0
Epoch 8/50
119/125 [===========================>..] - ETA: 0s - loss: 2.0484e-04 - accuracy: 0.120
Epoch 8: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 2.0565e-04 - accuracy: 0
Epoch 9/50
114/125 [==========================>...] - ETA: 0s - loss: 1.9466e-04 - accuracy: 0.116
Epoch 9: val_loss did not improve from inf
125/125 [==============================] - 0s 3ms/step - loss: 1.9388e-04 - accuracy: 0
Epoch 10/50
124/125 [============================>.] - ETA: 0s - loss: 1.8703e-04 - accuracy: 0.124
Epoch 10: val_loss did not improve from inf
Restoring model weights from the end of the best epoch: 1.
125/125 [==============================] - 0s 3ms/step - loss: 1.8699e-04 - accuracy: 0
Epoch 10: early stopping
```



```
plt.plot(history['loss'],linewidth = 2,label = 'Train')
plt.plot(history['val_loss'],linewidth = 2,label = 'Test')
plt.legend(loc='upper right')
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')

#plt.ylim(ymin=0.70,ymax=1)

plt.show()
```




```
test_x_predictions = autoencoder.predict(test_data)
mse = np.mean(np.power(test_data - test_x_predictions, 2),axis = 1)
error_df = pd.DataFrame({'Reconstruction_error':mse,
                         'True_class':test_labels})
```

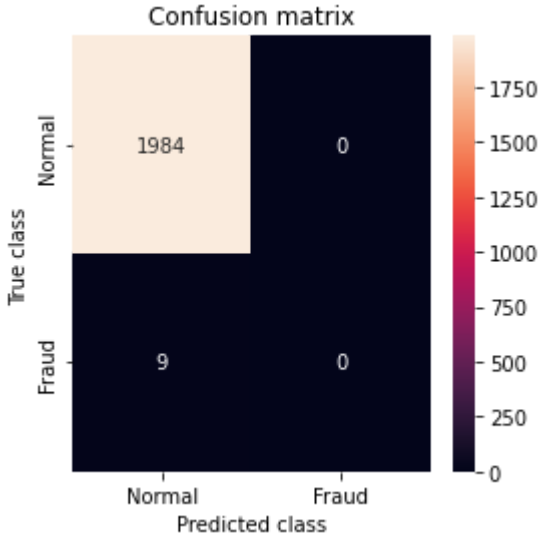
```
63/63 [==============================] - 0s 1ms/step
```

Loading...

```
threshold_fixed = 50
groups = error_df.groupby('True_class')
fig,ax = plt.subplots()

for name,group in groups:
        ax.plot(group.index,group.Reconstruction_error,marker='o',ms = 3.5,linestyle='',
                label = "Fraud" if  name==1 else "Normal")
ax.hlines(threshold_fixed,ax.get_xlim()[0],ax.get_xlim()[1],colors="r",zorder=100,label="Thre
ax.legend()
plt.title("Reconstructions error for normal and fraud data")
plt.ylabel("Reconstruction error")
plt.xlabel("Data point index")
plt.show()
```


```
threshold_fixed = 52
pred_y = [1 if e > threshold_fixed else 0
          for e in
        error_df.Reconstruction_error.values]
error_df['pred'] = pred_y
conf_matrix = confusion_matrix(error_df.True_class,pred_y)

plt.figure(figsize = (4,4))
sns.heatmap(conf_matrix,xticklabels = LABELS,yticklabels = LABELS,annot = True,fmt="d")
plt.title("Confusion matrix")
```

```
plt.ylabel("True class")
plt.xlabel("Predicted class")
plt.show()

#Print Accuracy,Precision and Recall
print("Accuracy :",accuracy_score(error_df['True_class'],error_df['pred']))
print("Recall :",recall_score(error_df['True_class'],error_df['pred']))
print("Precision :",precision_score(error_df['True_class'],error_df['pred']))
```



Loading...

```
Accuracy : 0.9954841946813848
Recall : 0.0
Precision : 0.0
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Undefin
  _warn_prf(average, modifier, msg_start, len(result))
```

Loading...