```
#importing libraries and dataset
import numpy as np
import pandas as pd
import tensorflow as tf
import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score
from tensorflow.keras.optimizers import Adam
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras import Model, Sequential
from tensorflow.keras.layers import Dense, Dropout
from sklearn.model_selection import train_test_split
from tensorflow.keras.losses import MeanSquaredLogarithmicError

PATH_TO_DATA = 'http://storage.googleapis.com/download.tensorflow.org/data/ec
g.csv'
data = pd.read_csv(PATH_TO_DATA, header=None)
data.head()
```

```
        0         1         2         3         4         5         6    \
0 -0.112522 -2.827204 -3.773897 -4.349751 -4.376041 -3.474986 -2.181408
1 -1.100878 -3.996840 -4.285843 -4.506579 -4.022377 -3.234368 -1.566126
2 -0.567088 -2.593450 -3.874230 -4.584095 -4.187449 -3.151462 -1.742940
3  0.490473 -1.914407 -3.616364 -4.318823 -4.268016 -3.881110 -2.993280
4  0.800232 -0.874252 -2.384761 -3.973292 -4.338224 -3.802422 -2.534510

        7         8         9    ...       131       132       133       134
\
0 -1.818286 -1.250522 -0.477492  ...  0.792168  0.933541  0.796958  0.578621
1 -0.992258 -0.754680  0.042321  ...  0.538356  0.656881  0.787490  0.724046
2 -1.490659 -1.183580 -0.394229  ...  0.886073  0.531452  0.311377 -0.021919
3 -1.671131 -1.333884 -0.965629  ...  0.350816  0.499111  0.600345  0.842069
4 -1.783423 -1.594450 -0.753199  ...  1.148884  0.958434  1.059025  1.371682

        135       136       137       138       139  140
0  0.257740  0.228077  0.123431  0.925286  0.193137  1.0
1  0.555784  0.476333  0.773820  1.119621 -1.436250  1.0
2 -0.713683 -0.532197  0.321097  0.904227 -0.421797  1.0
3  0.952074  0.990133  1.086798  1.403011 -0.383564  1.0
4  1.277392  0.960304  0.971020  1.614392  1.421456  1.0

[5 rows x 141 columns]
```

```
data.shape
```

```
(4998, 141)
```

```
features = data.drop(140, axis=1)
target = data[140]
x_train, x_test, y_train, y_test = train_test_split(
    features, target, test_size=0.2, stratify=target
```

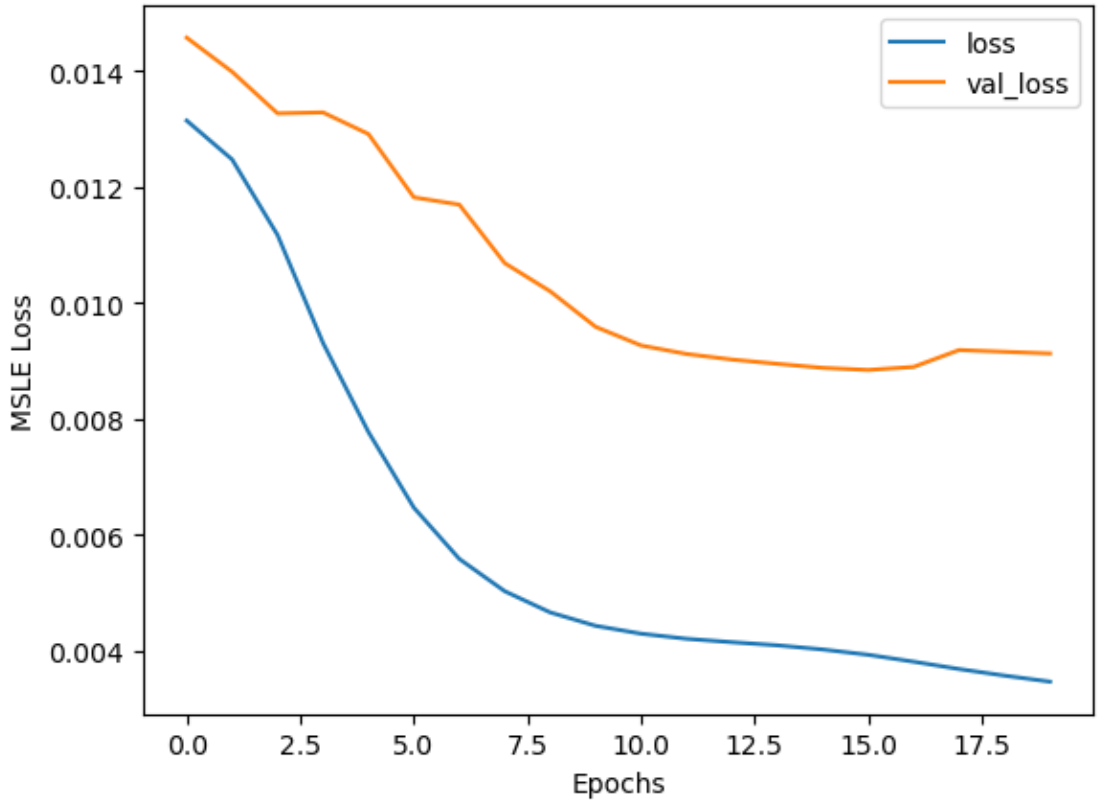
```
)
train_index = y_train[y_train == 1].index
train_data = x_train.loc[train_index]

min_max_scaler = MinMaxScaler(feature_range=(0, 1))
x_train_scaled = min_max_scaler.fit_transform(train_data.copy())
x_test_scaled = min_max_scaler.transform(x_test.copy())

class AutoEncoder(Model):
  def __init__(self, output_units, ldim=8):
    super().__init__()
    self.encoder = Sequential([
      Dense(64, activation='relu'),
      Dropout(0.1),
      Dense(32, activation='relu'),
      Dropout(0.1),
      Dense(16, activation='relu'),
      Dropout(0.1),
      Dense(ldim, activation='relu')
    ])
    self.decoder = Sequential([
      Dense(16, activation='relu'),
      Dropout(0.1),
      Dense(32, activation='relu'),
      Dropout(0.1),
      Dense(64, activation='relu'),
      Dropout(0.1),
      Dense(output_units, activation='sigmoid')
    ])

  def call(self, inputs):
    encoded = self.encoder(inputs)
    decoded = self.decoder(encoded)
    return decoded

model = AutoEncoder(output_units=x_train_scaled.shape[1])
model.compile(loss='msle', metrics=['mse'], optimizer='adam')
epochs = 20

history = model.fit(
    x_train_scaled,
    x_train_scaled,
    epochs=epochs,
    batch_size=512,
    validation_data=(x_test_scaled, x_test_scaled)
)
```

```
Epoch 1/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 1s 16ms/step - loss: 0.0131 - mse: 0.0287 - val_loss
: 0.0146 - val_mse: 0.0333
Epoch 2/20
```

```
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 3ms/step - loss: 0.0126 - mse: 0.0275 - val_loss:
0.0140 - val_mse: 0.0320
Epoch 3/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0114 - mse: 0.0247 - val_loss:
0.0133 - val_mse: 0.0303
Epoch 4/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0095 - mse: 0.0206 - val_loss:
0.0133 - val_mse: 0.0304
Epoch 5/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0079 - mse: 0.0172 - val_loss:
0.0129 - val_mse: 0.0296
Epoch 6/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0067 - mse: 0.0146 - val_loss:
0.0118 - val_mse: 0.0272
Epoch 7/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0057 - mse: 0.0125 - val_loss:
0.0117 - val_mse: 0.0269
Epoch 8/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0051 - mse: 0.0112 - val_loss:
0.0107 - val_mse: 0.0248
Epoch 9/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0047 - mse: 0.0103 - val_loss:
0.0102 - val_mse: 0.0238
Epoch 10/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0045 - mse: 0.0100 - val_loss:
0.0096 - val_mse: 0.0225
Epoch 11/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0043 - mse: 0.0096 - val_loss:
0.0093 - val_mse: 0.0219
Epoch 12/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0041 - mse: 0.0092 - val_loss:
0.0091 - val_mse: 0.0216
Epoch 13/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0042 - mse: 0.0093 - val_loss:
0.0090 - val_mse: 0.0214
Epoch 14/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0042 - mse: 0.0095 - val_loss:
0.0089 - val_mse: 0.0212
Epoch 15/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0040 - mse: 0.0089 - val_loss:
0.0089 - val_mse: 0.0211
Epoch 16/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0040 - mse: 0.0091 - val_loss:
0.0088 - val_mse: 0.0210
Epoch 17/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0038 - mse: 0.0085 - val_loss:
0.0089 - val_mse: 0.0211
Epoch 18/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0037 - mse: 0.0083 - val_loss:
0.0092 - val_mse: 0.0218
```

```
Epoch 19/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0036 - mse: 0.0080 - val_loss:
0.0092 - val_mse: 0.0216
Epoch 20/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 4ms/step - loss: 0.0034 - mse: 0.0078 - val_loss:
0.0091 - val_mse: 0.0215
```

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.xlabel('Epochs')
plt.ylabel('MSLE Loss')
plt.legend(['loss', 'val_loss'])
plt.show()
```




```
#finding threshold for anomaly and doing predictions
def find_threshold(model, x_train_scaled):
  reconstructions = model.predict(x_train_scaled)
  reconstruction_errors = tf.keras.losses.msle(reconstructions, x_train_scale
d)
  threshold = np.mean(reconstruction_errors.numpy()) \
   + np.std(reconstruction_errors.numpy())
  return threshold

def get_predictions(model, x_test_scaled, threshold):
  predictions = model.predict(x_test_scaled)
```

```
  errors = tf.keras.losses.msle(predictions, x_test_scaled)
  anomaly_mask = pd.Series(errors) > threshold
  preds = anomaly_mask.map(lambda x: 0.0 if x == True else 1.0)
  return preds

threshold = find_threshold(model, x_train_scaled)
print(f"Threshold: {threshold}")
```

```
73/73 ━━━━━━━━━━━━━━━━━━━━ 0s 559us/step
Threshold: 0.006959527680224278
```

```
predictions = get_predictions(model, x_test_scaled, threshold)
accuracy_score(predictions, y_test)
```

```
32/32 ━━━━━━━━━━━━━━━━━━━━ 0s 387us/step
```

```
0.936
```