In [1]:
```
import os
os.chdir('C:\\Users\\breje\\OneDrive\\Desktop\\ML Dataset\\Deep Learning - Jo
```

In [2]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.preprocessing import MinMaxScaler
```

In [3]:
```
data = pd.read_csv('AirPassengers.csv', index_col='Month', parse_dates=True)
data.head()
```

Out[3]:

Month	#Passengers
1949-01-01	112
1949-02-01	118
1949-03-01	132
1949-04-01	129
1949-05-01	121

In [4]:
```
data.tail()
```

Out[4]:

Month	#Passengers
1960-08-01	606
1960-09-01	508
1960-10-01	461
1960-11-01	390
1960-12-01	432

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

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 144 entries, 1949-01-01 to 1960-12-01
Data columns (total 1 columns):
#Passengers    144 non-null int64
dtypes: int64(1)
memory usage: 2.2 KB
```

In [6]:
```
data.shape
```

Out[6]: (144, 1)

In [7]:
```
train = data[:120]
test = data[120:]
```

In [8]:
```
train
```

Out[8]:

Month	#Passengers
1949-01-01	112
1949-02-01	118
1949-03-01	132
1949-04-01	129
1949-05-01	121
...	...
1958-08-01	505
1958-09-01	404
1958-10-01	359
1958-11-01	310
1958-12-01	337

120 rows × 1 columns

In [9]:
```
test
```

Out[9]:

Month	#Passengers
1959-01-01	360
1959-02-01	342
1959-03-01	406
1959-04-01	396
1959-05-01	420
1959-06-01	472
1959-07-01	548
1959-08-01	559
1959-09-01	463
1959-10-01	407
1959-11-01	362
1959-12-01	405
1960-01-01	417
1960-02-01	391
1960-03-01	419
1960-04-01	461
1960-05-01	472
1960-06-01	535
1960-07-01	622
1960-08-01	606
1960-09-01	508
1960-10-01	461
1960-11-01	390
1960-12-01	432

In [10]:
```
from sklearn.preprocessing import MinMaxScaler
```

In [11]:
```
scale = MinMaxScaler()
```

In [12]:
```
train_scaled = scale.fit_transform(train)
```

In [13]:
```
test_scaled = scale.transform(test)
```

In [14]:
```
from keras.preprocessing.sequence import TimeseriesGenerator
```

```
Using TensorFlow backend.
```

In [15]:
```
generator = TimeseriesGenerator(train_scaled, train_scaled, length=12, batch_
```

In [16]:
```
X, y = generator[0]
```

In [17]:
```
X = np.array(X)
y = np.array(y)
```

In [18]:
```
X.shape, y.shape
```

Out[18]:
```
((1, 12, 1), (1, 1))
```

In [19]:
```
validate_generator = TimeseriesGenerator(test_scaled, test_scaled, length=12,
```

In [20]:
```
from keras.models import Sequential
from keras.layers import Dense, LSTM, Dropout
from keras.callbacks import EarlyStopping
```

In [21]:
```
model = Sequential()
model.add(LSTM(12, return_sequences=True, input_shape=(12,1)))
model.add(Dropout(0.2))
model.add(LSTM(12, return_sequences=True))
model.add(Dropout(0.2))
model.add(LSTM(1, return_sequences=False))
model.add(Dropout(0.2))
model.add(Dense(1))
```

In [22]:
```
model.compile(optimizer='adam', loss='mse')
```

In [23]:
```
early_stop = EarlyStopping(monitor='val_loss', patience=5)
```

In [24]:
```
model.fit(generator, epochs=20, callbacks=[early_stop], validation_data=valic
```

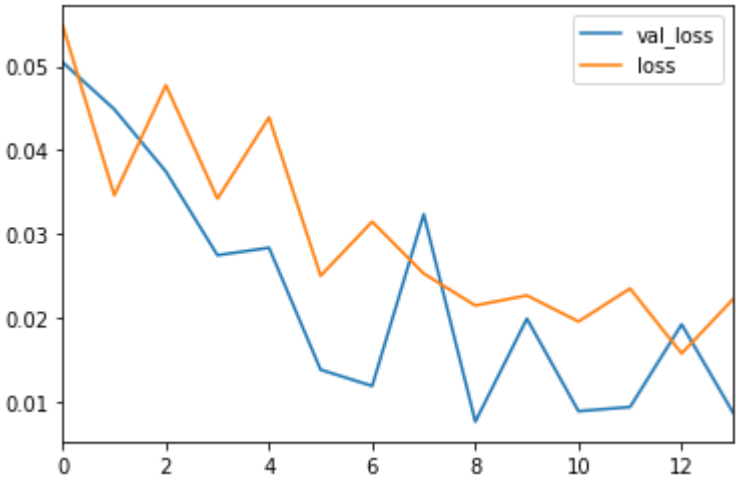
```
Epoch 1/20
108/108 [==============================] - 20s 185ms/step - loss: 0.0549 -
val_loss: 0.0505
Epoch 2/20
108/108 [==============================] - 9s 84ms/step - loss: 0.0346 - va
l_loss: 0.0449
Epoch 3/20
108/108 [==============================] - 9s 88ms/step - loss: 0.0477 - va
l_loss: 0.0374
Epoch 4/20
108/108 [==============================] - 9s 82ms/step - loss: 0.0342 - va
l_loss: 0.0274
Epoch 5/20
108/108 [==============================] - 9s 87ms/step - loss: 0.0439 - va
l_loss: 0.0283
Epoch 6/20
108/108 [==============================] - 9s 83ms/step - loss: 0.0250 - va
l_loss: 0.0138
Epoch 7/20
108/108 [==============================] - 9s 80ms/step - loss: 0.0314 - va
l_loss: 0.0118
Epoch 8/20
108/108 [==============================] - 10s 94ms/step - loss: 0.0252 - v
al_loss: 0.0323
Epoch 9/20
108/108 [==============================] - 9s 83ms/step - loss: 0.0214 - va
l_loss: 0.0076
Epoch 10/20
108/108 [==============================] - 10s 88ms/step - loss: 0.0226 - v
al_loss: 0.0199
Epoch 11/20
108/108 [==============================] - 10s 88ms/step - loss: 0.0195 - v
al_loss: 0.0088
Epoch 12/20
108/108 [==============================] - 10s 97ms/step - loss: 0.0235 - v
al_loss: 0.0093
Epoch 13/20
108/108 [==============================] - 9s 83ms/step - loss: 0.0157 - va
l_loss: 0.0192
Epoch 14/20
108/108 [==============================] - 9s 83ms/step - loss: 0.0222 - va
l_loss: 0.0086
```

Out[24]:
```
<keras.callbacks.callbacks.History at 0x1b78a86f888>
```

In [25]:
```
model_perf = pd.DataFrame(model.history.history)
```

In [26]:
```
model_perf.plot()
```

Out[26]: <matplotlib.axes._subplots.AxesSubplot at 0x1b785eef388>



In [27]:
```
X_test = []
y_test = []
for i in range(12, test_scaled.shape[0]):
    X_test.append(test_scaled[i-12:i])
    y_test.append(test_scaled[i,0])
```

In [28]:
```
X_test = np.array(X_test)
y_test = np.array(y_test)
```

In [29]:
```
y_pred = model.predict(X_test)
```

In [30]:
```
from sklearn.metrics import mean_squared_error
```

In [31]:
```
mean_squared_error(y_test, y_pred)
```

Out[31]: 0.07439369709549169