

Initial Results and Code

March 16, 2021

```
[1]: pip install pandas
```

```
Requirement already satisfied: pandas in /opt/conda/lib/python3.7/site-packages
(1.0.3)
Requirement already satisfied: pytz>=2017.2 in /opt/conda/lib/python3.7/site-
packages (from pandas) (2020.1)
Requirement already satisfied: python-dateutil>=2.6.1 in
/opt/conda/lib/python3.7/site-packages (from pandas) (2.8.1)
Requirement already satisfied: numpy>=1.13.3 in /opt/conda/lib/python3.7/site-
packages (from pandas) (1.19.5)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.7/site-
packages (from python-dateutil>=2.6.1->pandas) (1.15.0)
Note: you may need to restart the kernel to use updated packages.
```

```
[2]: pip install sklearn
```

```
Requirement already satisfied: sklearn in /opt/conda/lib/python3.7/site-packages
(0.0)
Requirement already satisfied: scikit-learn in /opt/conda/lib/python3.7/site-
packages (from sklearn) (0.22.2.post1)
Requirement already satisfied: scipy>=0.17.0 in /opt/conda/lib/python3.7/site-
packages (from scikit-learn->sklearn) (1.4.1)
Requirement already satisfied: numpy>=1.11.0 in /opt/conda/lib/python3.7/site-
packages (from scikit-learn->sklearn) (1.19.5)
Requirement already satisfied: joblib>=0.11 in /opt/conda/lib/python3.7/site-
packages (from scikit-learn->sklearn) (0.15.1)
Note: you may need to restart the kernel to use updated packages.
```

```
[3]: pip install numpy
```

```
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages
(1.19.5)
Note: you may need to restart the kernel to use updated packages.
```

```
[4]: pip install keras
```

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Requirement already satisfied: keras in /opt/conda/lib/python3.7/site-packages
(2.4.3)
```

Requirement already satisfied: scipy>=0.14 in /opt/conda/lib/python3.7/site-packages (from keras) (1.4.1)
Requirement already satisfied: pyyaml in /opt/conda/lib/python3.7/site-packages (from keras) (5.3.1)
Requirement already satisfied: numpy>=1.9.1 in /opt/conda/lib/python3.7/site-packages (from keras) (1.19.5)
Requirement already satisfied: h5py in /opt/conda/lib/python3.7/site-packages (from keras) (2.10.0)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages (from h5py->keras) (1.15.0)
Note: you may need to restart the kernel to use updated packages.

```
[5]: pip install tensorflow
```

Requirement already satisfied: tensorflow in /opt/conda/lib/python3.7/site-packages (2.4.1)
Requirement already satisfied: flatbuffers~=1.12.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.12)
Requirement already satisfied: h5py~=2.10.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (2.10.0)
Requirement already satisfied: wheel~=0.35 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.36.2)
Requirement already satisfied: typing-extensions~=3.7.4 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (3.7.4.2)
Requirement already satisfied: tensorboard~=2.4 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (2.4.1)
Requirement already satisfied: numpy~=1.19.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.19.5)
Requirement already satisfied: gast==0.3.3 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.3.3)
Requirement already satisfied: termcolor~=1.1.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: protobuf>=3.9.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (3.11.4)
Requirement already satisfied: opt-einsum~=3.3.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (3.3.0)
Requirement already satisfied: six~=1.15.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.15.0)
Requirement already satisfied: wrapt~=1.12.1 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.12.1)
Requirement already satisfied: tensorflow-estimator<2.5.0,>=2.4.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (2.4.0)
Requirement already satisfied: absl-py~=0.10 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.12.0)
Requirement already satisfied: astunparse~=1.6.3 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.6.3)
Requirement already satisfied: keras-preprocessing~=1.1.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.1.2)

Requirement already satisfied: grpcio~=1.32.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.32.0)

Requirement already satisfied: google-pasta~=0.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.2.0)

Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (1.8.0)

Requirement already satisfied: requests<3,>=2.21.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (2.23.0)

Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (0.4.3)

Requirement already satisfied: setuptools>=41.0.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (46.1.3.post20200325)

Requirement already satisfied: werkzeug>=0.11.15 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (1.0.1)

Requirement already satisfied: markdown>=2.6.8 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (3.3.4)

Requirement already satisfied: google-auth<2,>=1.6.3 in /opt/conda/lib/python3.7/site-packages (from tensorboard~=2.4->tensorflow) (1.16.1)

Requirement already satisfied: chardet<4,>=3.0.2 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (3.0.4)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (2020.4.5.2)

Requirement already satisfied: urllib3!=1.25.0,!1.25.1,<1.26,>=1.21.1 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (1.25.9)

Requirement already satisfied: idna<3,>=2.5 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (2.9)

Requirement already satisfied: requests-oauthlib>=0.7.0 in /opt/conda/lib/python3.7/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.4->tensorflow) (1.3.0)

Requirement already satisfied: importlib-metadata; python_version < "3.8" in /opt/conda/lib/python3.7/site-packages (from markdown>=2.6.8->tensorboard~=2.4->tensorflow) (1.6.0)

Requirement already satisfied: cachetools<5.0,>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (4.1.0)

Requirement already satisfied: rsa<4.1,>=3.1.4 in /opt/conda/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (4.0)

Requirement already satisfied: pyasn1-modules>=0.2.1 in /opt/conda/lib/python3.7/site-packages (from google-

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auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (0.2.8)
Requirement already satisfied: oauthlib>=3.0.0 in /opt/conda/lib/python3.7/site-
packages (from requests-oauthlib>=0.7.0->google-auth-
oauthlib<0.5,>=0.4.1->tensorboard~=2.4->tensorflow) (3.0.1)
Requirement already satisfied: zipp>=0.5 in /opt/conda/lib/python3.7/site-
packages (from importlib-metadata; python_version <
"3.8"->markdown>=2.6.8->tensorboard~=2.4->tensorflow) (3.1.0)
Requirement already satisfied: pyasn1>=0.1.3 in /opt/conda/lib/python3.7/site-
packages (from rsa<4.1,>=3.1.4->google-
auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (0.4.8)
Note: you may need to restart the kernel to use updated packages.
```

```
[6]: pip install matplotlib
```

```
Requirement already satisfied: matplotlib in /opt/conda/lib/python3.7/site-
packages (3.2.1)
Requirement already satisfied: python-dateutil>=2.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib) (2.8.1)
Requirement already satisfied: cyclor>=0.10 in /opt/conda/lib/python3.7/site-
packages (from matplotlib) (0.10.0)
Requirement already satisfied: numpy>=1.11 in /opt/conda/lib/python3.7/site-
packages (from matplotlib) (1.19.5)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib) (1.2.0)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.7/site-
packages (from python-dateutil>=2.1->matplotlib) (1.15.0)
Note: you may need to restart the kernel to use updated packages.
```

```
[7]: pip install pydot
```

```
Requirement already satisfied: pydot in /opt/conda/lib/python3.7/site-packages
(1.4.2)
Requirement already satisfied: pyparsing>=2.1.4 in
/opt/conda/lib/python3.7/site-packages (from pydot) (2.4.7)
Note: you may need to restart the kernel to use updated packages.
```

```
[8]: pip install graphviz
```

```
Requirement already satisfied: graphviz in /opt/conda/lib/python3.7/site-
packages (0.16)
Note: you may need to restart the kernel to use updated packages.
```

```
[9]: import pandas as pd
from sklearn import preprocessing
import numpy as np
np.random.seed(1)
```

```
import keras
from keras.models import Model
from keras.layers import Activation, Dense, Dropout, Input, LSTM, concatenate
from keras import optimizers
import tensorflow as tf
tf.random.set_seed(1)
import pydot
```

[10]: *#Function to calculate Exponential Moving Average using simple moving average*

```
def ema(values, i):
    #Simple moving average
    sma = np.mean(values[:, 3])
    ema_values = [sma]
    k = 2 / (1 + i)
    for i in range(len(his) - i, len(his)):
        close = his[i][3]
        ema_values.append(close * k + ema_values[-1] * (1 - k))
    return ema_values[-1]
```

[11]: *#history_points represents the set number of days that affect the next*
history_points = 50

[12]: *#Import .csv data and remove the Date attribute*

```
data = pd.read_csv('SPY.csv')
data = data.drop('Date', axis=1)
data = data.values
```

[13]: *#Normalize the data to a MinMaxScaler*

```
data_normaliser = preprocessing.MinMaxScaler()
data_normalised = data_normaliser.fit_transform(data)
```

[14]: *#Using history_points, open, close, high, low, volume, data, points create*
→OpenHighLowChart and next day open values

```
ohlc_v_histories_normalised = np.array([data_normalised[i:i + history_points].
    →copy() for i in range(len(data_normalised) - history_points)])
next_day_open_values_normalised = np.array([data_normalised[:, 0][i +
    →history_points].copy() for i in range(len(data_normalised) -
    →history_points)])
next_day_open_values_normalised = np.
    →expand_dims(next_day_open_values_normalised, -1)
```

[15]: next_day_open_values = np.array([data[:, 0][i + history_points].copy() for i in
 →range(len(data) - history_points)])
next_day_open_values = np.expand_dims(next_day_open_values, -1)

```
[16]: #Normalize the data to a MinMaxScaler  
y_normaliser = preprocessing.MinMaxScaler()  
y_normaliser.fit(next_day_open_values)
```

```
[16]: MinMaxScaler(copy=True, feature_range=(0, 1))
```

```
[17]: #Create technical indicators using simple and exponential moving average  
technical_indicators = []  
for his in ohlcv_histories_normalised:  
    #Simple moving average of the closing price  
    sma = np.mean(his[:, 3])  
    macd = ema(his, 12) - ema(his, 26)  
    #Add the simple and exponential moving average to the technical indicator  
    technical_indicators.append(np.array([sma,macd,]))
```

```
[18]: technical_indicators = np.array(technical_indicators)  
  
tech_ind_scaler = preprocessing.MinMaxScaler()  
technical_indicators_normalised = tech_ind_scaler.  
    ↪fit_transform(technical_indicators)
```

```
[19]: assert ohlcv_histories_normalised.shape[0] == next_day_open_values_normalised.  
    ↪shape[0] == technical_indicators_normalised.shape[0], "data shapes are_  
    ↪inconsistent"
```

```
[20]: #Data Preparation  
#Split the data into Training and Testing 9-1 ratio  
test_split = 0.9  
#Split number (6322)  
n = int(ohlcv_histories_normalised.shape[0] * test_split)
```

```
[21]: ohlcv_train = ohlcv_histories_normalised[:n]  
tech_ind_train = technical_indicators_normalised[:n]  
y_train = next_day_open_values_normalised[:n]
```

```
[22]: ohlcv_test = ohlcv_histories_normalised[n:]  
tech_ind_test = technical_indicators_normalised[n:]  
y_test = next_day_open_values_normalised[n:]  
  
unscaled_y_test = next_day_open_values[n:]
```

```
[23]: print(ohlcv_train.shape)  
print(ohlcv_test.shape)
```

```
(6322, 50, 6)
```

```
(703, 50, 6)
```

```

[24]: #Create LSTM model
      #Define two sets of inputs
      lstm_input = Input(shape=(history_points, 6), name='lstm_input')
      dense_input = Input(shape=(technical_indicators_normalised.shape[1],),
      ↪name='tech_input')

[25]: #First branch operates on the first input
      x = LSTM(history_points, name='lstm_0')(lstm_input)
      x = Dropout(0.2, name='lstm_dropout_0')(x)
      lstm_branch = Model(inputs=lstm_input, outputs=x)

[26]: #Second branch operates on the second input
      y = Dense(20, name='tech_dense_0')(dense_input)
      y = Activation("relu", name='tech_relu_0')(y)
      y = Dropout(0.2, name='tech_dropout_0')(y)
      technical_indicators_branch = Model(inputs=dense_input, outputs=y)

[27]: #Combine the output of the two branches
      combined = concatenate([lstm_branch.output, technical_indicators_branch.
      ↪output], name='concatenate')

[28]: z = Dense(64, activation="sigmoid", name='dense_pooling')(combined)
      z = Dense(1, activation="linear", name='dense_out')(z)

[29]: #Model will accept the inputs of the two branches and then output a single value
      model = Model(inputs=[lstm_branch.input, technical_indicators_branch.input],
      ↪outputs=z)
      adam = optimizers.Adam(lr=0.0005)
      model.compile(optimizer=adam, loss='mse')

[30]: #Print model diagram
      from keras.utils import plot_model
      tf.keras.utils.plot_model(model, to_file='model.png', show_shapes=True)

('Failed to import pydot. You must `pip install pydot` and install graphviz
(https://graphviz.gitlab.io/download/), ', 'for `pydotprint` to work.')

[31]: #Train Model model.fit(x_train, y_train, validation_data = (x_test, y_test),
      ↪epochs = 100, batch_size = 64, verbose = 1)
      model.fit(x=[ohlcv_train, tech_ind_train], y=y_train, batch_size=32,
      ↪epochs=history_points, shuffle=True, validation_split=0.1)

```

Epoch 1/50

178/178 [=====] - 9s 37ms/step - loss: 0.1805 -
val_loss: 0.0060

Epoch 2/50

178/178 [=====] - 6s 32ms/step - loss: 0.0014 -

```

val_loss: 0.0032
Epoch 3/50
178/178 [=====] - 6s 33ms/step - loss: 9.0594e-04 -
val_loss: 5.2866e-04
Epoch 4/50
178/178 [=====] - 6s 32ms/step - loss: 7.6005e-04 -
val_loss: 2.5086e-04
Epoch 5/50
178/178 [=====] - 6s 32ms/step - loss: 6.3473e-04 -
val_loss: 1.7366e-04
Epoch 6/50
178/178 [=====] - 6s 33ms/step - loss: 5.6505e-04 -
val_loss: 2.6322e-04
Epoch 7/50
178/178 [=====] - 6s 32ms/step - loss: 4.4788e-04 -
val_loss: 1.4584e-04
Epoch 8/50
178/178 [=====] - 6s 33ms/step - loss: 4.3198e-04 -
val_loss: 2.6031e-04
Epoch 9/50
178/178 [=====] - 6s 33ms/step - loss: 3.7250e-04 -
val_loss: 1.8484e-04
Epoch 10/50
178/178 [=====] - 6s 32ms/step - loss: 3.2943e-04 -
val_loss: 1.7774e-04
Epoch 11/50
178/178 [=====] - 6s 32ms/step - loss: 2.8809e-04 -
val_loss: 3.8735e-04
Epoch 12/50
178/178 [=====] - 6s 32ms/step - loss: 2.5150e-04 -
val_loss: 9.7225e-04
Epoch 13/50
178/178 [=====] - 6s 32ms/step - loss: 2.3261e-04 -
val_loss: 2.9564e-04
Epoch 14/50
178/178 [=====] - 6s 33ms/step - loss: 2.0428e-04 -
val_loss: 2.7359e-04
Epoch 15/50
178/178 [=====] - 6s 32ms/step - loss: 1.6716e-04 -
val_loss: 1.6657e-04
Epoch 16/50
178/178 [=====] - 6s 32ms/step - loss: 1.6480e-04 -
val_loss: 4.0306e-04
Epoch 17/50
178/178 [=====] - 6s 33ms/step - loss: 1.4587e-04 -
val_loss: 2.3041e-04
Epoch 18/50
178/178 [=====] - 6s 32ms/step - loss: 1.3768e-04 -

```



```

val_loss: 3.3396e-04
Epoch 19/50
178/178 [=====] - 6s 33ms/step - loss: 1.3082e-04 -
val_loss: 3.3412e-04
Epoch 20/50
178/178 [=====] - 6s 33ms/step - loss: 1.3234e-04 -
val_loss: 1.3238e-04
Epoch 21/50
178/178 [=====] - 6s 32ms/step - loss: 1.2970e-04 -
val_loss: 2.1762e-04
Epoch 22/50
178/178 [=====] - 6s 32ms/step - loss: 1.2348e-04 -
val_loss: 8.5117e-05
Epoch 23/50
178/178 [=====] - 6s 32ms/step - loss: 1.1573e-04 -
val_loss: 7.1877e-05
Epoch 24/50
178/178 [=====] - 6s 32ms/step - loss: 1.1672e-04 -
val_loss: 1.0376e-04
Epoch 25/50
178/178 [=====] - 6s 31ms/step - loss: 1.1639e-04 -
val_loss: 2.7646e-04
Epoch 26/50
178/178 [=====] - 6s 32ms/step - loss: 1.0649e-04 -
val_loss: 7.0091e-05
Epoch 27/50
178/178 [=====] - 6s 32ms/step - loss: 1.1338e-04 -
val_loss: 3.5387e-04
Epoch 28/50
178/178 [=====] - 6s 32ms/step - loss: 1.1724e-04 -
val_loss: 1.6329e-04
Epoch 29/50
178/178 [=====] - 6s 31ms/step - loss: 1.1154e-04 -
val_loss: 1.5559e-04
Epoch 30/50
178/178 [=====] - 6s 32ms/step - loss: 1.1647e-04 -
val_loss: 8.4815e-05
Epoch 31/50
178/178 [=====] - 6s 32ms/step - loss: 1.1257e-04 -
val_loss: 7.3133e-05
Epoch 32/50
178/178 [=====] - 6s 32ms/step - loss: 1.0414e-04 -
val_loss: 5.4363e-05
Epoch 33/50
178/178 [=====] - 6s 32ms/step - loss: 1.0121e-04 -
val_loss: 1.1910e-04
Epoch 34/50
178/178 [=====] - 6s 32ms/step - loss: 1.1464e-04 -

```

```
val_loss: 1.4560e-04
Epoch 35/50
178/178 [=====] - 6s 32ms/step - loss: 1.0329e-04 -
val_loss: 1.5857e-04
Epoch 36/50
178/178 [=====] - 6s 32ms/step - loss: 1.0198e-04 -
val_loss: 1.9201e-04
Epoch 37/50
178/178 [=====] - 6s 32ms/step - loss: 1.0479e-04 -
val_loss: 8.9917e-05
Epoch 38/50
178/178 [=====] - 6s 32ms/step - loss: 1.1059e-04 -
val_loss: 8.0025e-05
Epoch 39/50
178/178 [=====] - 6s 32ms/step - loss: 9.7159e-05 -
val_loss: 4.1494e-04
Epoch 40/50
178/178 [=====] - 6s 32ms/step - loss: 1.1652e-04 -
val_loss: 1.2758e-04
Epoch 41/50
178/178 [=====] - 6s 32ms/step - loss: 1.1206e-04 -
val_loss: 1.3997e-04
Epoch 42/50
178/178 [=====] - 6s 32ms/step - loss: 1.0116e-04 -
val_loss: 9.2593e-05
Epoch 43/50
178/178 [=====] - 6s 33ms/step - loss: 9.2469e-05 -
val_loss: 3.8650e-05
Epoch 44/50
178/178 [=====] - 6s 32ms/step - loss: 1.1257e-04 -
val_loss: 1.5640e-04
Epoch 45/50
178/178 [=====] - 6s 32ms/step - loss: 1.0092e-04 -
val_loss: 2.8553e-04
Epoch 46/50
178/178 [=====] - 6s 32ms/step - loss: 1.0463e-04 -
val_loss: 8.8256e-05
Epoch 47/50
178/178 [=====] - 6s 31ms/step - loss: 9.4947e-05 -
val_loss: 8.2154e-05
Epoch 48/50
178/178 [=====] - 6s 32ms/step - loss: 1.0147e-04 -
val_loss: 1.5089e-04
Epoch 49/50
178/178 [=====] - 6s 32ms/step - loss: 1.0448e-04 -
val_loss: 4.3716e-05
Epoch 50/50
178/178 [=====] - 6s 32ms/step - loss: 1.0445e-04 -
```

val_loss: 1.6957e-04

[31]: <tensorflow.python.keras.callbacks.History at 0x7f8b2aa2c9d0>

```
[32]: #Model evaluation
evaluation = model.evaluate([ohlc_test, tech_ind_test], y_test)
print(evaluation)
```

22/22 [=====] - 0s 11ms/step - loss: 0.0010
0.0010283744195476174

```
[33]: #Predict and check model performance
y_test_predicted = model.predict([ohlc_test, tech_ind_test])
y_predicted = model.predict([ohlc_histories_normalised, technical_indicators])
```

```
[34]: #Denormalization or scaler inverse
y_test_predicted = y_normaliser.inverse_transform(y_test_predicted)
y_predicted = y_normaliser.inverse_transform(y_predicted)
```

```
[35]: assert unscaled_y_test.shape == y_test_predicted.shape, "data shapes are_
      ↪inconsistent"
```

```
[36]: #Calculate Root Mean Square Error performance
rmse = np.mean(np.square(unscaled_y_test - y_test_predicted))
scaled_mse = rmse / (np.max(unscaled_y_test) - np.min(unscaled_y_test)) * 100
print(scaled_mse)
```

76.2622006792431

```
[37]: import matplotlib.pyplot as plt
      #Plot
      plt.gcf().set_size_inches(18, 9, forward=True)
      real = plt.plot(unscaled_y_test[0:-1], label='real')
      #Shift test predictions for plotting
      pred = plt.plot(y_test_predicted[0:-1], label='predicted')
      #Plot baseline and prediction
      plt.legend(['Real', 'Predicted'])
      plt.show()
```



```
[38]: #Save model for trade program  
model.save(f'time_series_model.h5')
```