

Initial Results and Code

March 25, 2021

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

```
Requirement already satisfied: pandas in /opt/conda/lib/python3.7/site-packages
(1.0.3)
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: pytz>=2017.2 in /opt/conda/lib/python3.7/site-
packages (from pandas) (2020.1)
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: 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)
Requirement already satisfied: scipy>=0.17.0 in /opt/conda/lib/python3.7/site-
packages (from scikit-learn->sklearn) (1.4.1)
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
```

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

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: pyyaml in /opt/conda/lib/python3.7/site-packages (from keras) (5.3.1)
Requirement already satisfied: scipy>=0.14 in /opt/conda/lib/python3.7/site-packages (from keras) (1.4.1)
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: protobuf>=3.9.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (3.11.4)
Requirement already satisfied: astunparse~=1.6.3 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.6.3)
Requirement already satisfied: numpy~=1.19.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.19.5)
Requirement already satisfied: h5py~=2.10.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (2.10.0)
Requirement already satisfied: opt-einsum~=3.3.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (3.3.0)
Requirement already satisfied: gast==0.3.3 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.3.3)
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: tensorboard~=2.4 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (2.4.1)
Requirement already satisfied: grpcio~=1.32.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.32.0)
Requirement already satisfied: flatbuffers~=1.12.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.12)
Requirement already satisfied: wheel~=0.35 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.36.2)
Requirement already satisfied: six~=1.15.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.15.0)
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: wrapt~=1.12.1 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.12.1)
Requirement already satisfied: google-pasta~=0.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.2.0)
Requirement already satisfied: termcolor~=1.1.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.1.0)

Requirement already satisfied: absl-py~=0.10 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (0.12.0)

Requirement already satisfied: keras-preprocessing~=1.1.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow) (1.1.2)

Requirement already satisfied: setuptools in /opt/conda/lib/python3.7/site-packages (from protobuf>=3.9.2->tensorflow) (46.1.3.post20200325)

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

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: 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: 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: 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: 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: pyasn1-modules>=0.2.1 in /opt/conda/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (0.2.8)

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: 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: 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: 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: 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: 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: 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: pyasn1<0.5.0,>=0.4.6 in /opt/conda/lib/python3.7/site-packages (from pyasn1-modules>=0.2.1->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: kiwisolver>=1.0.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib) (1.2.0)
Requirement already satisfied: numpy>=1.11 in /opt/conda/lib/python3.7/site-packages (from matplotlib) (1.19.5)
Requirement already satisfied: python-dateutil>=2.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib) (2.8.1)
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: cycycler>=0.10 in /opt/conda/lib/python3.7/site-packages (from matplotlib) (0.10.0)
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 pydotplus`

Requirement already satisfied: pydotplus in /opt/conda/lib/python3.7/site-packages (2.0.2)
Requirement already satisfied: pyparsing>=2.0.1 in /opt/conda/lib/python3.7/site-packages (from pydotplus) (2.4.7)
Note: you may need to restart the kernel to use updated packages.

[9]: `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.

```
[10]: 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)
```

```
[11]: #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]
```

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

```
[13]: #Import .csv data and remove the Date attribute
      data = pd.read_csv('SPY.csv')
      data = data.drop('Date', axis=1)
      data = data.drop('Adj Close', axis=1)
      data = data.values
```

```
[14]: #Normalize the data to a MinMaxScaler
      data_normaliser = preprocessing.MinMaxScaler()
      data_normalised = data_normaliser.fit_transform(data)
```

```
[15]: #Using history_points, open, close, high, low, volume, data, points create
      ↪OpenHighLowChart and next day open values
      ohlcv_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)
```

```
[16]: 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)
```

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

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

```
[18]: #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,]))
```

```
[19]: technical_indicators = np.array(technical_indicators)

tech_ind_scaler = preprocessing.MinMaxScaler()
technical_indicators_normalised = tech_ind_scaler.
    ↪fit_transform(technical_indicators)
```

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

```
[21]: #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)
```

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

```
[23]: 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:]
```

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

```
(6322, 50, 5)
(703, 50, 5)
```

```
[25]: #Create LSTM model
      #Define two sets of inputs
      lstm_input = Input(shape=(history_points, 5), name='lstm_input')
      dense_input = Input(shape=(technical_indicators_normalised.shape[1],),
      ↪name='tech_input')
```

```
[26]: #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)
```

```
[27]: #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)
```

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

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

```
[30]: #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')
```

```
[31]: #Print model diagram
      import pydot
      import pydotplus
      import graphviz
      from keras.utils.vis_utils import plot_model
      plot_model(model, to_file='model_plot.png', show_shapes=True,
      ↪show_layer_names=True)
```

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

```
[32]: #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 [=====] - 8s 35ms/step - loss: 0.1816 -  
val_loss: 0.0053  
Epoch 2/50  
178/178 [=====] - 5s 30ms/step - loss: 0.0012 -  
val_loss: 0.0019  
Epoch 3/50  
178/178 [=====] - 5s 29ms/step - loss: 8.2286e-04 -  
val_loss: 1.9965e-04  
Epoch 4/50  
178/178 [=====] - 5s 28ms/step - loss: 6.8733e-04 -  
val_loss: 1.6722e-04  
Epoch 5/50  
178/178 [=====] - 5s 29ms/step - loss: 5.9437e-04 -  
val_loss: 1.6238e-04  
Epoch 6/50  
178/178 [=====] - 5s 29ms/step - loss: 5.1363e-04 -  
val_loss: 5.6247e-04  
Epoch 7/50  
178/178 [=====] - 5s 29ms/step - loss: 4.3446e-04 -  
val_loss: 2.8220e-04  
Epoch 8/50  
178/178 [=====] - 5s 29ms/step - loss: 3.9332e-04 -  
val_loss: 2.0411e-04  
Epoch 9/50  
178/178 [=====] - 5s 29ms/step - loss: 3.4700e-04 -  
val_loss: 8.1840e-05  
Epoch 10/50  
178/178 [=====] - 5s 29ms/step - loss: 3.1097e-04 -  
val_loss: 1.0283e-04  
Epoch 11/50  
178/178 [=====] - 5s 29ms/step - loss: 2.6432e-04 -  
val_loss: 3.3485e-04  
Epoch 12/50  
178/178 [=====] - 5s 29ms/step - loss: 2.3694e-04 -  
val_loss: 4.5100e-04  
Epoch 13/50  
178/178 [=====] - 5s 29ms/step - loss: 2.1160e-04 -  
val_loss: 2.9730e-04  
Epoch 14/50  
178/178 [=====] - 5s 28ms/step - loss: 1.9145e-04 -  
val_loss: 1.2025e-04  
Epoch 15/50  
178/178 [=====] - 5s 28ms/step - loss: 1.6249e-04 -
```



```

val_loss: 7.9187e-05
Epoch 16/50
178/178 [=====] - 5s 28ms/step - loss: 1.5389e-04 -
val_loss: 1.5905e-04
Epoch 17/50
178/178 [=====] - 5s 28ms/step - loss: 1.4801e-04 -
val_loss: 6.7272e-05
Epoch 18/50
178/178 [=====] - 5s 28ms/step - loss: 1.3777e-04 -
val_loss: 2.1031e-04
Epoch 19/50
178/178 [=====] - 5s 28ms/step - loss: 1.3018e-04 -
val_loss: 1.9101e-04
Epoch 20/50
178/178 [=====] - 5s 28ms/step - loss: 1.3026e-04 -
val_loss: 5.6308e-05
Epoch 21/50
178/178 [=====] - 5s 28ms/step - loss: 1.3083e-04 -
val_loss: 1.0275e-04
Epoch 22/50
178/178 [=====] - 5s 27ms/step - loss: 1.1945e-04 -
val_loss: 7.3819e-05
Epoch 23/50
178/178 [=====] - 5s 28ms/step - loss: 1.1876e-04 -
val_loss: 5.3316e-05
Epoch 24/50
178/178 [=====] - 5s 28ms/step - loss: 1.1321e-04 -
val_loss: 7.2847e-05
Epoch 25/50
178/178 [=====] - 5s 29ms/step - loss: 1.1379e-04 -
val_loss: 1.9193e-04
Epoch 26/50
178/178 [=====] - 5s 28ms/step - loss: 1.0913e-04 -
val_loss: 5.8016e-05
Epoch 27/50
178/178 [=====] - 5s 28ms/step - loss: 1.1329e-04 -
val_loss: 2.9341e-04
Epoch 28/50
178/178 [=====] - 5s 28ms/step - loss: 1.1809e-04 -
val_loss: 9.9973e-05
Epoch 29/50
178/178 [=====] - 5s 28ms/step - loss: 1.1838e-04 -
val_loss: 9.6906e-05
Epoch 30/50
178/178 [=====] - 5s 28ms/step - loss: 1.1411e-04 -
val_loss: 5.1586e-05
Epoch 31/50
178/178 [=====] - 5s 28ms/step - loss: 1.1226e-04 -

```

```

val_loss: 4.6670e-05
Epoch 32/50
178/178 [=====] - 5s 28ms/step - loss: 1.0264e-04 -
val_loss: 6.3160e-05
Epoch 33/50
178/178 [=====] - 5s 28ms/step - loss: 1.0502e-04 -
val_loss: 7.6875e-05
Epoch 34/50
178/178 [=====] - 5s 28ms/step - loss: 1.1307e-04 -
val_loss: 9.7018e-05
Epoch 35/50
178/178 [=====] - 5s 29ms/step - loss: 1.0657e-04 -
val_loss: 1.3218e-04
Epoch 36/50
178/178 [=====] - 5s 30ms/step - loss: 1.0168e-04 -
val_loss: 2.5959e-04
Epoch 37/50
178/178 [=====] - 5s 28ms/step - loss: 1.0760e-04 -
val_loss: 9.0648e-05
Epoch 38/50
178/178 [=====] - 5s 28ms/step - loss: 1.0874e-04 -
val_loss: 4.8204e-05
Epoch 39/50
178/178 [=====] - 5s 27ms/step - loss: 9.8711e-05 -
val_loss: 3.6766e-04
Epoch 40/50
178/178 [=====] - 5s 26ms/step - loss: 1.1701e-04 -
val_loss: 4.3219e-05
Epoch 41/50
178/178 [=====] - 5s 27ms/step - loss: 1.1273e-04 -
val_loss: 1.7114e-04
Epoch 42/50
178/178 [=====] - 5s 26ms/step - loss: 1.0346e-04 -
val_loss: 1.0875e-04
Epoch 43/50
178/178 [=====] - 5s 27ms/step - loss: 9.1268e-05 -
val_loss: 3.4208e-05
Epoch 44/50
178/178 [=====] - 5s 27ms/step - loss: 1.1551e-04 -
val_loss: 9.1323e-05
Epoch 45/50
178/178 [=====] - 5s 26ms/step - loss: 1.0399e-04 -
val_loss: 3.2151e-04
Epoch 46/50
178/178 [=====] - 5s 26ms/step - loss: 1.0522e-04 -
val_loss: 8.4018e-05
Epoch 47/50
178/178 [=====] - 5s 27ms/step - loss: 9.5427e-05 -

```

```

val_loss: 1.2586e-04
Epoch 48/50
178/178 [=====] - 5s 27ms/step - loss: 1.0524e-04 -
val_loss: 9.4939e-05
Epoch 49/50
178/178 [=====] - 5s 26ms/step - loss: 1.0543e-04 -
val_loss: 2.9855e-05
Epoch 50/50
178/178 [=====] - 5s 27ms/step - loss: 1.0243e-04 -
val_loss: 6.3389e-05

```

[32]: <tensorflow.python.keras.callbacks.History at 0x7f410949dd50>

```

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

```

```

22/22 [=====] - 0s 8ms/step - loss: 4.1959e-04
0.0004195899819023907

```

```

[34]: print(ohlc_test.shape)
print(tech_ind_test.shape)

```

```

(703, 50, 5)
(703, 2)

```

```

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

```

```

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

```

```

[37]: assert unscaled_y_test.shape == y_test_predicted.shape, "data shapes are
↳inconsistent"

```

```

[38]: #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)

```

```

31.115932817299914

```

```

[39]: 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()
```



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