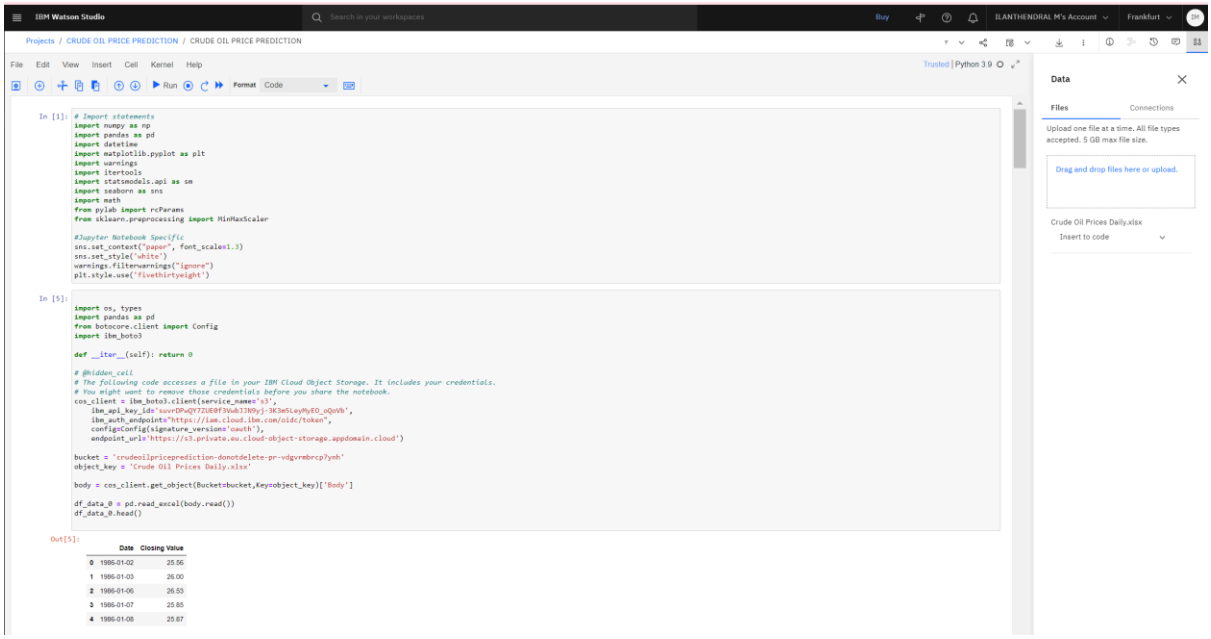
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In [1]:
# Import statements
import numpy as np
import pandas as pd
import datetime
import matplotlib.pyplot as plt
import warnings
import itertools
import statsmodels.api as sm
import seaborn as sns
import math
from pylab import rcParams
from sklearn.preprocessing import MinMaxScaler
#Jupyter Notebook Specific
sns.set_context("paper", font_scale=1.3)
sns.set_style('white')
warnings.filterwarnings("ignore")
plt.style.use('fivethirtyeight')
In [5]:
import os, types
import pandas as pd
from botocore.client import Config
import ibm_boto3
def __iter__(self): return 0
# @hidden_cell
# The following code accesses a file in your IBM Cloud Object Storage. It includes your credentials.
# You might want to remove those credentials before you share the notebook.
cos_client = ibm_boto3.client(service_name='s3',
ibm_api_key_id='uvr0PwQY7ZUE0f9ub17N0yj-3K3mSLeyMyEO_oQaVb',
ibm_auth_endpoint="https://iam.cloud.ibm.com/oidc/token",
config=Config(signature_version='oauth'),
endpoint_url='https://s3.private.eu.cloud-object-storage.appdomain.cloud')
bucket = 'crudeoilpricepredictiion-donotdelete-pr-vdgvrebrcp7ynh'
object_key = 'Crude Oil Prices Daily.xlsx'
body = cos_client.get_object(Bucket=bucket,Key=object_key)['Body']
df_data_0 = pd.read_excel(body.read())
df_data_0.head()
Out[5]:
Date Closing Value
0 1986-01-02 25.56
1 1986-01-03 26.00
2 1986-01-06 26.53
3 1986-01-07 25.85
4 1986-01-08 25.87
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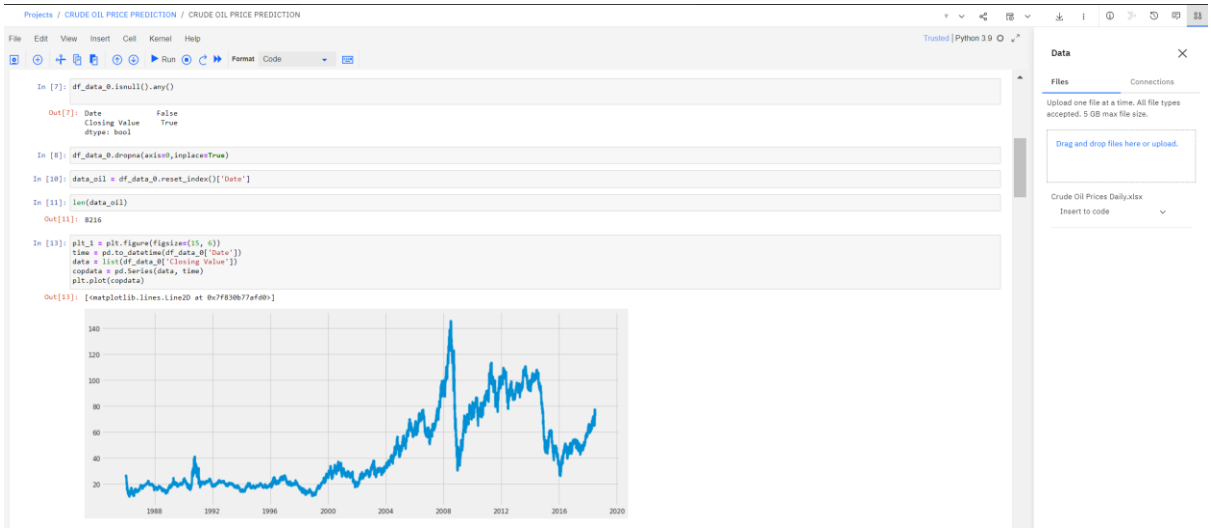
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In [7]:
df_data_0.isnull().any()
Out[7]:
Date False
Closing Value True
dtype: bool
In [8]:
df_data_0.dropna(axis=0,inplace=True)
In [10]:
data_oil = df_data_0.reset_index()['Date']
In [11]:
len(data_oil)
Out[11]:
8216
In [13]:
plt_1 = plt.figure(figsize=(15, 6))
time = pd.to_datetime(df_data_0['Date'])
data = list(df_data_0['Closing Value'])
copdata = pd.Series(data, time)
plt.plot(copdata)
Out[13]:
<matplotlib.lines.Line2D at 0x7f830b77afd0>
140
120
100
80
60
40
20
1988
1992
1996
2000
2004
2008
2012
2016
2020
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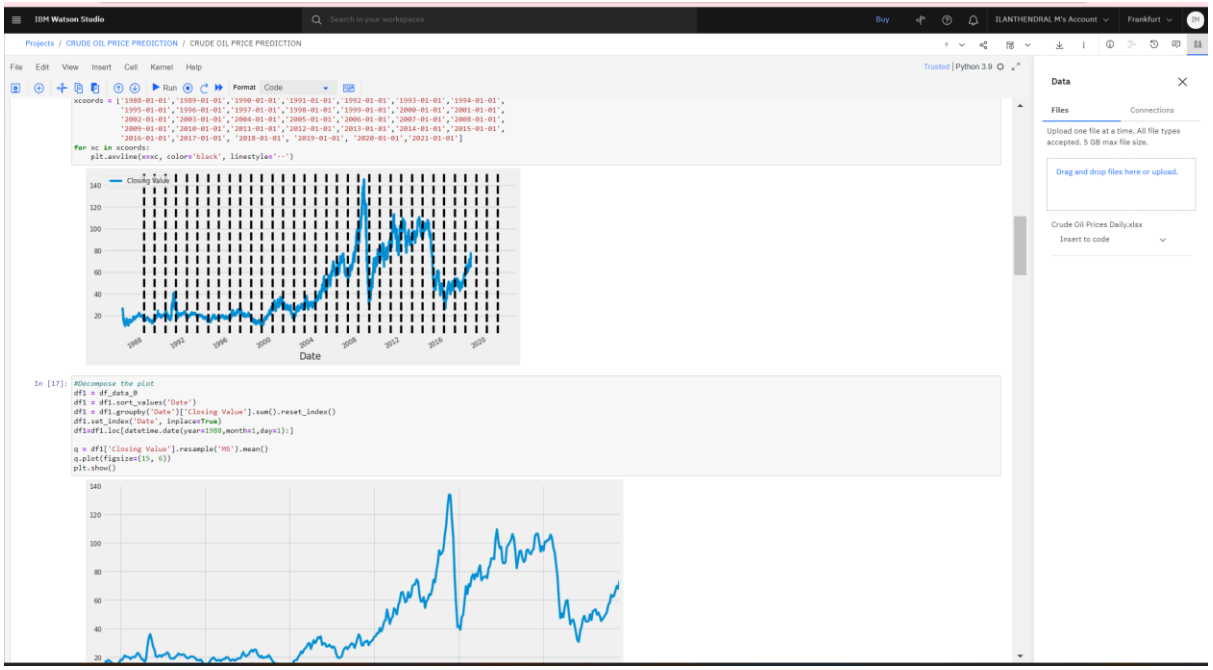
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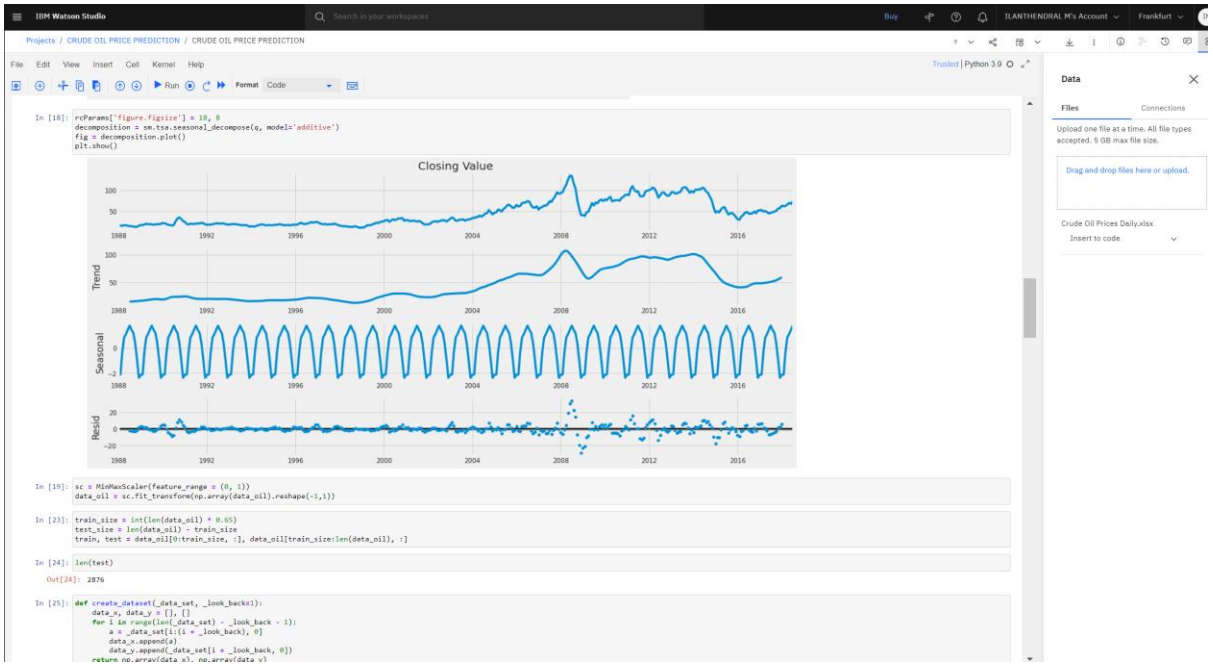
Closing Value
Date
In [17]:
#Decompose the plot
df1 = df_data_0
df1 = df1.sort_values('Date')
df1 = df1.groupby('Date')['Closing Value'].sum().reset_index()
df1.set_index('Date', inplace=True)
df1=df1.loc[datetime.date(year=1988,month=1,day=1):]
q = df1['Closing Value'].resample('MS').mean()
q.plot(figsize=(15, 6))
plt.show()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In [18]:
rcParams['figure.figsize'] = 10, 8
decomposition = sm.tsa.seasonal_decompose(q, model='additive')
fig = decomposition.plot()
plt.show()
Closing Value
Trend
Seasonal
Resid
In [19]:
sc = MinMaxScaler(feature_range = (0, 1))
data_oil = sc.fit_transform(np.array(data_oil).reshape(-1,1))
In [23]:
train_size = int(len(data_oil) * 0.65)
test_size = len(data_oil) - train_size
train, test = data_oil[0:train_size, :], data_oil[train_size:len(data_oil), :]
In [24]:
len(test)
Out[24]:
2876
In [25]:
def create_dataset(_data_set, _look_back=1):
data_x, data_y = [], []
for i in range(len(_data_set) - _look_back - 1):
a = _data_set[i:(i + _look_back), 0]
data_x.append(a)
data_y.append(_data_set[i + _look_back, 0])
return np.array(data_x), np.array(data_y)

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In [28]:
```
regressor = Sequential()
regressor.add(LSTM(units = 60, return_sequences = True, input_shape = (X_train.shape[1], 1)))
regressor.add(Dropout(0.1))

regressor.add(LSTM(units = 60, return_sequences = True))
regressor.add(Dropout(0.1))

regressor.add(LSTM(units = 60))
regressor.add(Dropout(0.1))

regressor.add(Dense(units = 1))

regressor.compile(optimizer = 'adam', loss = 'mean_squared_error')
# early_stopping = EarlyStopping(monitor='val_loss',patience=20)
history =regressor.fit(X_train, Y_train, epochs = 20, batch_size = 64,validation_data=(X_test, Y_test),verbose=1)
# history =regressor.fit(X_train, Y_train, epochs = 100, batch_size = 64,validation_data=(X_test, Y_test), callbacks=[early_stopping],shuffle=False,verbo
```

```
Epoch 1/20
84/84 [==============================] - 7s 37ms/step - loss: 0.0095 - val_loss: 4.6844e-06
Epoch 2/20
84/84 [==============================] - 2s 27ms/step - loss: 5.5193e-04 - val_loss: 0.0010
Epoch 3/20
84/84 [==============================] - 2s 24ms/step - loss: 4.8525e-04 - val_loss: 1.3721e-04
Epoch 4/20
84/84 [==============================] - 2s 28ms/step - loss: 4.8271e-04 - val_loss: 2.8378e-04
Epoch 5/20
84/84 [==============================] - 2s 25ms/step - loss: 4.4876e-04 - val_loss: 2.1780e-04
Epoch 6/20
84/84 [==============================] - 2s 27ms/step - loss: 4.0779e-04 - val_loss: 1.3980e-04
Epoch 7/20
84/84 [==============================] - 2s 23ms/step - loss: 4.1373e-04 - val_loss: 2.0241e-04
Epoch 8/20
84/84 [==============================] - 2s 26ms/step - loss: 3.5424e-04 - val_loss: 3.2804e-04
Epoch 9/20
84/84 [==============================] - 2s 26ms/step - loss: 3.7755e-04 - val_loss: 6.8814e-05
Epoch 10/20
84/84 [==============================] - 2s 29ms/step - loss: 3.5605e-04 - val_loss: 2.8357e-04
Epoch 11/20
84/84 [==============================] - 2s 28ms/step - loss: 3.2133e-04 - val_loss: 5.7816e-04
Epoch 12/20
84/84 [==============================] - 2s 28ms/step - loss: 3.2639e-04 - val_loss: 2.7981e-04
Epoch 13/20
84/84 [==============================] - 2s 28ms/step - loss: 3.0551e-04 - val_loss: 0.0014
Epoch 14/20
84/84 [==============================] - 2s 29ms/step - loss: 3.2560e-04 - val_loss: 9.1151e-04
Epoch 15/20
84/84 [==============================] - 2s 24ms/step - loss: 2.9090e-04 - val_loss: 6.9674e-05
```

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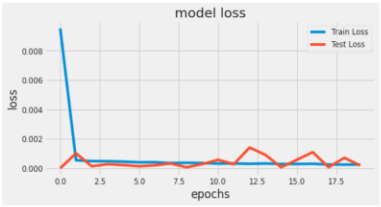
In [32]:
```
print('Train Mean Absolute Error:', mean_absolute_error(Y_train[0], train_predict[:,0]))
print('Train Root Mean Squared Error:',np.sqrt(mean_squared_error(Y_train[0], train_predict[:,0])))
print('Test Mean Absolute Error:', mean_absolute_error(Y_test[0], test_predict[:,0]))
print('Test Root Mean Squared Error:',np.sqrt(mean_squared_error(Y_test[0], test_predict[:,0])))
plt.figure(figsize=(8,4))
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Test Loss')
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epochs')
plt.legend(loc='upper right')
plt.show();
```

```
Train Mean Absolute Error: 651452159318545.8
Train Root Mean Squared Error: 768561729052668.4
Test Mean Absolute Error: 1.1510667509622272e+16
Test Root Mean Squared Error: 1.4298628039561374e+16
```



In [33]:
```
aa=[x for x in range(180)]
plt.figure(figsize=(8,4))
plt.plot(aa, Y_test[0][:180], marker='.', label="actual")
plt.plot(aa, test_predict[:,0][:180], 'r', label="prediction")
plt.tight_layout()
sns.despine(top=True)
plt.subplots_adjust(left=0.07)
plt.ylabel('Price', size=15)
plt.xlabel('Time step', size=15)
plt.legend(fontsize=15)
plt.show();
```

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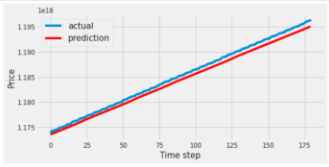
```
In [33]: aa=[x for x in range(180)]
         plt.figure(figsize=(8,4))
         plt.plot(aa, Y_test[0][:180], marker='.', label="actual")
         plt.plot(aa, test_predict[:,0][:180], 'r', label="prediction")
         plt.tight_layout()
         sns.despine(top=True)
         plt.subplots_adjust(left=0.07)
         plt.ylabel('Price', size=15)
         plt.xlabel('Time step', size=15)
         plt.legend(fontsize=15)
         plt.show();
```




```
In [34]: regressor.save("crude_oil.h5")
```

```
In [35]: #test the model
         look_back = 10
         trainPredictPlot = np.empty_like(data_oil)
         trainPredictPlot[:,:] = np.nan
         trainPredictPlot[look_back:len(train_predict)+look_back,:] = train_predict

         testPredictPlot = np.empty_like(data_oil)
         testPredictPlot[:,:] = np.nan
         testPredictPlot[len(train_predict)+(look_back*2)+1:len(data_oil)-1,:] = test_predict

         plt.plot(sc.inverse_transform(data_oil))
         plt.plot(trainPredictPlot)
         plt.plot(testPredictPlot)
         plt.show()
```

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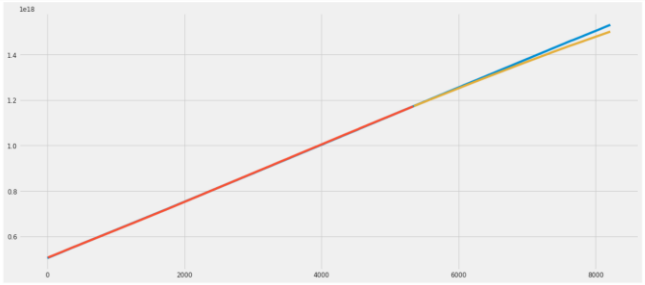


```
In [36]: len(test)
```

```
Out[36]: 2876
```

```
In [43]: x_input = test[2865:].reshape(1,-1)
         x_input.shape
```

```
Out[43]: (1, 11)
```

```
In [44]: temp_input = list(x_input[0])
         temp_list = temp_input[0].tolist()
```

```
In [45]: temp_input
```

```
Out[45]: [0.9985685415964971,
          0.9988211519029975,
          0.9989053553384977,
          0.9989895587739979,
          0.9990737622094981,
          0.9991579656449983,
          0.9994105759514988,
          0.9994947793869988,
          0.9996631862579992,
          0.9997473896934994,
          1.0]
```

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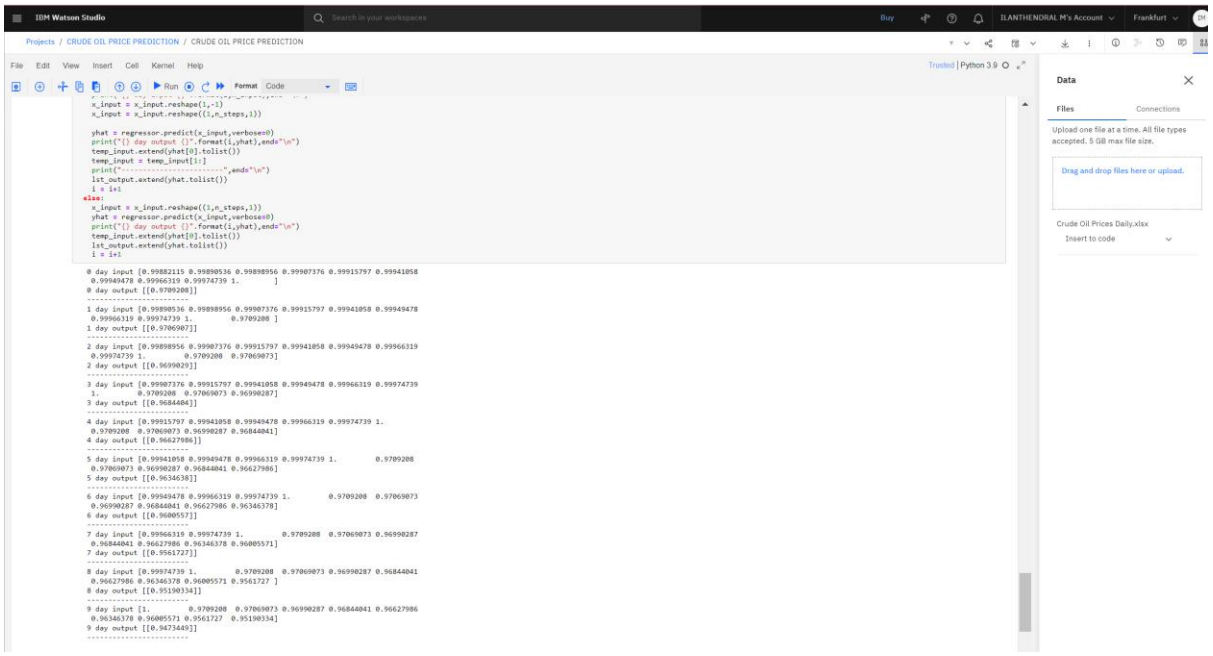
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x_input = x_input.reshape(1,-1)
x_input = x_input.reshape((1,n_steps,1))
yhat = regressor.predict(x_input,verbose=0)
print("{} day output {}".format(i,yhat),ends="\n")
temp_input.extend(yhat[0].tolist())
temp_input = temp_input[1:]
print("-----------",ends="\n")
lst_output.extend(yhat.tolist())
i = i+1
else:
x_input = x_input.reshape((1,n_steps,1))
yhat = regressor.predict(x_input,verbose=0)
print("{} day output {}".format(i,yhat),ends="\n")
temp_input.extend(yhat[0].tolist())
lst_output.extend(yhat.tolist())
i = i+1
0 day input [0.99882115 0.99890536 0.99898956 0.99907376 0.99915797 0.99941058
0.99949478 0.99966319 0.99974739 1.]
0 day output [[0.9709208]]
1 day input [0.99890536 0.99898956 0.99907376 0.99915797 0.99941058 0.99949478
0.99966319 0.99974739 1. 0.9709208]
1 day output [[0.97069073]]
2 day input [0.99898956 0.99907376 0.99915797 0.99941058 0.99949478 0.99966319
0.99974739 1. 0.9709208 0.97069073]
2 day output [[0.9699029]]
3 day input [0.99907376 0.99915797 0.99941058 0.99949478 0.99966319 0.99974739
1. 0.9709208 0.97069073 0.96990287]
3 day output [[0.9684404]]
4 day input [0.99915797 0.99941058 0.99949478 0.99966319 0.99974739 1.
0.9709208 0.97069073 0.96990287 0.96844041]
4 day output [[0.96627986]]
5 day input [0.99941058 0.99949478 0.99966319 0.99974739 1. 0.9709208
0.97069073 0.96990287 0.96844041 0.96627986]
5 day output [[0.9634638]]
6 day input [0.99949478 0.99966319 0.99974739 1. 0.9709208 0.97069073
0.96990287 0.96844041 0.96627986 0.96346378]
6 day output [[0.9600557]]
7 day input [0.99966319 0.99974739 1. 0.9709208 0.97069073 0.96990287
0.96844041 0.96627986 0.96346378 0.96005571]
7 day output [[0.9561727]]
8 day input [0.99974739 1. 0.9709208 0.97069073 0.96990287 0.96844041
0.96627986 0.96346378 0.96005571 0.9561727]
8 day output [[0.95190334]]
9 day input [1. 0.9709208 0.97069073 0.96990287 0.96844041 0.96627986
0.96346378 0.96005571 0.9561727 0.95190334]
9 day output [[0.9473449]]
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