

Neural Network

Stock Prediction & Sentiment Analysis - Part Three

Predicting Future Prices

[\[Udemy\]](#)

```
from helpers import *
import numpy as np
import pandas as pd
from importlib import reload
import IPython.display
from sklearn.preprocessing import MinMaxScaler
import matplotlib.pyplot as plt
plt.style.use('ggplot')
from keras.models import Sequential, load_model
from keras.layers import LSTM, Dense, Dropout
from sklearn.model_selection import train_test_split
%matplotlib inline
```

2023-01-20 14:17:55.962450: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: SSE4.1 SSE4.2 To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.

Getting newest data from Yahoo Finance

```
import yfinance as yf
bitcoin = pd.DataFrame(yf.download("BTC-USD", period="10y"))
# bitcoin = pd.read_csv("BTC-USD.csv")
```

[*****100%*****] 1 of 1 completed

```
head_tail_horz(bitcoin, 5, "Bitcoin Data")
```

Bitcoin Data

head(5)

	Open	High	Low	Close	Adj Close	Volume
Date						
2014-09-17	465.86	468.17	452.42	457.33	457.33	21,056,800
2014-09-18	456.86	456.86	413.10	424.44	424.44	34,483,200
2014-09-19	424.10	427.83	384.53	394.80	394.80	37,919,700
2014-09-20	394.67	423.30	389.88	408.90	408.90	36,863,600
2014-09-21	408.08	412.43	393.18	398.82	398.82	26,580,100

tail(5)

	Open	High	Low	Close	Adj Close	Volume
Date						
2023-01-16	20,882.22	21,360.88	20,715.75	21,169.63	21,169.63	26,792,494,050
2023-01-17	21,175.83	21,438.66	20,978.53	21,161.52	21,161.52	24,999,983,362
2023-01-18	21,161.05	21,564.50	20,541.54	20,688.78	20,688.78	30,005,625,418
2023-01-19	20,686.75	21,163.01	20,685.38	21,086.79	21,086.79	21,152,848,261
2023-01-20	21,073.94	21,388.67	20,919.13	21,388.67	21,388.67	22,447,878,144

Using the most recent 5,000 records as data

```
bc_data = bitcoin[['Close']].tail(5000)
bc_data = bc_data.set_index(pd.to_datetime(bc_data.index))
```

```
fancy_plot(pd.DataFrame(bc_data), title="Bitcoin Data Initial View",
           xlabel="Dates", ylabel="Price", cmap="spring")
```

Bitcoin Data Initial View



```
see(bc_data.describe(), "bc_data.describe()")
```

```
bc_data.describe()
```

	Close
count	3,048.00
mean	12,900.29
std	16,139.70
min	178.10
25%	685.08
50%	7,182.92
75%	16,940.59
max	67,566.83

Instantiating Scaler

```
scaler = MinMaxScaler()  
bc_scaled = pd.DataFrame(scaler.fit_transform(bc_data),  
                          columns=["Close"], index = bc_data.index)
```

```
head_tail_horz(bc_scaled, 5, "Scaled Data")
```

Scaled Data

head(5)		tail(5)	
	Close		Close
Date		Date	
2014-09-17	0.00	2023-01-16	0.31
2014-09-18	0.00	2023-01-17	0.31
2014-09-19	0.00	2023-01-18	0.30
2014-09-20	0.00	2023-01-19	0.31
2014-09-21	0.00	2023-01-20	0.31

Splitting Data

- `steps_in` - number of days fed in, from which to determine the future stock prices
- `steps_out` - the number of days into the future for which we want to get predictions
- `end` - from whatever point the function currently is in the data up through the number of steps that are being used as input to get the following specified number of days / timestamps to have predicted

```
def split_data(data, steps_in, steps_out):
    inputs, targets = [], []

    for i in range(len(data)):
        output_start = i + steps_in
        output_end = output_start + steps_out

        if output_end > len(data):
            break

        data_in, data_out = data[i: output_start], data[output_start : output_end]

        inputs.append(data_in)
        targets.append(data_out)

    return np.array(inputs), np.array(targets)
```

Results Visualization

- `results.history` will be an attribute that comes from the model

```
def visualize_results(results):
    history = results.history
    plt.figure(figsize=(13,7), facecolor="#cyan")
    plt.plot(history['val_loss'])
    plt.plot(history['loss'])
    plt.legend(['val_loss', 'loss'])
    plt.title("Model Loss")
```

```

plt.xlabel("Number of Epochs")
plt.ylabel("Loss Level")
plt.show()

plt.figure(figsize=(13,7), facecolor="#cyan")
plt.plot(history['val_accuracy'])
plt.plot(history['accuracy'])
plt.legend(['val_accuracy', 'accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Number of Epochs")
plt.ylabel("Accuracy")
plt.show()

```

Defining Parameters & Reshaping for LSTM

```

steps_in = 30
steps_out = 10
num_features = 1

inputs, targets = split_data(list(bc_scaled.Close), steps_in, steps_out)

```

Make sure inputs have correct dimensions for LSTM

```
print("inputs.shape = ", inputs.shape)
```

```
inputs.shape = (3009, 30)
```

Defining Model

- try other activation functions as well

```

model = Sequential()
model.add(LSTM(30, activation='softsign', return_sequences=True, input_shape=(steps_in,
model.add(LSTM(10, activation='softsign', return_sequences=True))
model.add(LSTM(20, activation='softsign', return_sequences=True))
model.add(LSTM(20, activation='softsign', return_sequences=True))
model.add(LSTM(30, activation='softsign', return_sequences=True))
model.add(LSTM(10, activation='softsign'))
model.add(Dense(steps_out))

model.summary()

```

```
Model: "sequential_1"
```

```

-----
Layer (type)                Output Shape                Param #
=====
lstm_6 (LSTM)                (None, 30, 30)             3840

```

lstm_7 (LSTM)	(None, 30, 10)	1640
lstm_8 (LSTM)	(None, 30, 20)	2480
lstm_9 (LSTM)	(None, 30, 20)	3280
lstm_10 (LSTM)	(None, 30, 30)	6120
lstm_11 (LSTM)	(None, 10)	1640
dense_1 (Dense)	(None, 10)	110

```

=====
Total params: 19,110
Trainable params: 19,110
Non-trainable params: 0
-----

```

Compile Model

```
model.compile(optimizer='adam', loss='mse', metrics=['accuracy'])
```

Training the Model

```
# results = model.fit(inputs, targets,
#                       epochs=300, batch_size=32, validation_split=0.1)
```

Epoch 1/300

```
85/85 [=====] - 6s 38ms/step - loss: 0.0418 - accuracy: 0.1215
- val_loss: 0.0195 - val_accuracy: 0.0731
```

Epoch 2/300

```
85/85 [=====] - 3s 31ms/step - loss: 0.0038 - accuracy: 0.0783
- val_loss: 0.0225 - val_accuracy: 0.0764
```

Epoch 3/300

```
85/85 [=====] - 3s 31ms/step - loss: 0.0033 - accuracy: 0.0812
- val_loss: 0.0129 - val_accuracy: 0.0797
```

Epoch 4/300

```
85/85 [=====] - 3s 31ms/step - loss: 0.0028 - accuracy: 0.0905
- val_loss: 0.0173 - val_accuracy: 0.0963
```

Epoch 5/300

```
85/85 [=====] - 3s 31ms/step - loss: 0.0029 - accuracy: 0.1019
- val_loss: 0.0095 - val_accuracy: 0.0764
```

Epoch 6/300

85/85 [=====] - 3s 31ms/step - loss: 0.0025 - accuracy: 0.1093
- val_loss: 0.0086 - val_accuracy: 0.0764
Epoch 7/300
85/85 [=====] - 3s 31ms/step - loss: 0.0026 - accuracy: 0.1123
- val_loss: 0.0107 - val_accuracy: 0.0997
Epoch 8/300
85/85 [=====] - 3s 31ms/step - loss: 0.0022 - accuracy: 0.1208
- val_loss: 0.0042 - val_accuracy: 0.0764
Epoch 9/300
85/85 [=====] - 3s 31ms/step - loss: 0.0022 - accuracy: 0.1097
- val_loss: 0.0137 - val_accuracy: 0.0897
Epoch 10/300
85/85 [=====] - 3s 31ms/step - loss: 0.0019 - accuracy: 0.1045
- val_loss: 0.0094 - val_accuracy: 0.0930
Epoch 11/300
85/85 [=====] - 3s 31ms/step - loss: 0.0019 - accuracy: 0.1230
- val_loss: 0.0029 - val_accuracy: 0.0698
Epoch 12/300
85/85 [=====] - 3s 30ms/step - loss: 0.0018 - accuracy: 0.1152
- val_loss: 0.0092 - val_accuracy: 0.0897
Epoch 13/300
85/85 [=====] - 3s 31ms/step - loss: 0.0019 - accuracy: 0.1045
- val_loss: 0.0058 - val_accuracy: 0.0532
Epoch 14/300
85/85 [=====] - 3s 30ms/step - loss: 0.0018 - accuracy: 0.1108
- val_loss: 0.0079 - val_accuracy: 0.0831
Epoch 15/300
85/85 [=====] - 3s 30ms/step - loss: 0.0016 - accuracy: 0.1082
- val_loss: 0.0031 - val_accuracy: 0.0698
Epoch 16/300
85/85 [=====] - 3s 30ms/step - loss: 0.0016 - accuracy: 0.1219
- val_loss: 0.0075 - val_accuracy: 0.0598
Epoch 17/300
85/85 [=====] - 3s 30ms/step - loss: 0.0017 - accuracy: 0.1152
- val_loss: 0.0055 - val_accuracy: 0.0532
Epoch 18/300
85/85 [=====] - 3s 31ms/step - loss: 0.0015 - accuracy: 0.1326
- val_loss: 0.0050 - val_accuracy: 0.0598
Epoch 19/300
85/85 [=====] - 3s 30ms/step - loss: 0.0016 - accuracy: 0.1182
- val_loss: 0.0128 - val_accuracy: 0.0731
Epoch 20/300
85/85 [=====] - 3s 30ms/step - loss: 0.0015 - accuracy: 0.1174

- val_loss: 0.0028 - val_accuracy: 0.0631
Epoch 21/300
85/85 [=====] - 3s 31ms/step - loss: 0.0014 - accuracy: 0.1189
- val_loss: 0.0092 - val_accuracy: 0.0731
Epoch 22/300
85/85 [=====] - 3s 30ms/step - loss: 0.0015 - accuracy: 0.1425
- val_loss: 0.0035 - val_accuracy: 0.0698
Epoch 23/300
85/85 [=====] - 3s 30ms/step - loss: 0.0013 - accuracy: 0.1134
- val_loss: 0.0045 - val_accuracy: 0.0731
Epoch 24/300
85/85 [=====] - 3s 30ms/step - loss: 0.0013 - accuracy: 0.1244
- val_loss: 0.0059 - val_accuracy: 0.0631
Epoch 25/300
85/85 [=====] - 3s 30ms/step - loss: 0.0012 - accuracy: 0.1274
- val_loss: 0.0041 - val_accuracy: 0.0664
Epoch 26/300
85/85 [=====] - 3s 30ms/step - loss: 0.0012 - accuracy: 0.1208
- val_loss: 0.0031 - val_accuracy: 0.0764
Epoch 27/300
85/85 [=====] - 3s 30ms/step - loss: 0.0012 - accuracy: 0.1274
- val_loss: 0.0061 - val_accuracy: 0.0963
Epoch 28/300
85/85 [=====] - 3s 30ms/step - loss: 0.0013 - accuracy: 0.1329
- val_loss: 0.0046 - val_accuracy: 0.0598
Epoch 29/300
85/85 [=====] - 3s 30ms/step - loss: 0.0012 - accuracy: 0.1230
- val_loss: 0.0029 - val_accuracy: 0.0698
Epoch 30/300
85/85 [=====] - 3s 31ms/step - loss: 0.0012 - accuracy: 0.1270
- val_loss: 0.0073 - val_accuracy: 0.1030
Epoch 31/300
85/85 [=====] - 3s 30ms/step - loss: 0.0012 - accuracy: 0.1182
- val_loss: 0.0087 - val_accuracy: 0.0731
Epoch 32/300
85/85 [=====] - 3s 30ms/step - loss: 0.0011 - accuracy: 0.1215
- val_loss: 0.0059 - val_accuracy: 0.0764
Epoch 33/300
85/85 [=====] - 3s 30ms/step - loss: 0.0011 - accuracy: 0.1182
- val_loss: 0.0043 - val_accuracy: 0.0797
Epoch 34/300
85/85 [=====] - 3s 30ms/step - loss: 0.0010 - accuracy: 0.1311
- val_loss: 0.0040 - val_accuracy: 0.0764

Epoch 35/300

85/85 [=====] - 3s 30ms/step - loss: 9.6310e-04 - accuracy: 0.1226 - val_loss: 0.0051 - val_accuracy: 0.0764

Epoch 36/300

85/85 [=====] - 3s 31ms/step - loss: 0.0011 - accuracy: 0.1178 - val_loss: 0.0065 - val_accuracy: 0.0864

Epoch 37/300

85/85 [=====] - 3s 32ms/step - loss: 9.7725e-04 - accuracy: 0.1326 - val_loss: 0.0067 - val_accuracy: 0.0797

Epoch 38/300

85/85 [=====] - 3s 31ms/step - loss: 9.5105e-04 - accuracy: 0.1204 - val_loss: 0.0031 - val_accuracy: 0.0864

Epoch 39/300

85/85 [=====] - 3s 31ms/step - loss: 0.0010 - accuracy: 0.1208 - val_loss: 0.0058 - val_accuracy: 0.0797

Epoch 40/300

85/85 [=====] - 3s 31ms/step - loss: 9.7657e-04 - accuracy: 0.1230 - val_loss: 0.0079 - val_accuracy: 0.0864

Epoch 41/300

85/85 [=====] - 3s 31ms/step - loss: 9.3205e-04 - accuracy: 0.1123 - val_loss: 0.0057 - val_accuracy: 0.0897

Epoch 42/300

85/85 [=====] - 3s 31ms/step - loss: 0.0010 - accuracy: 0.1219 - val_loss: 0.0053 - val_accuracy: 0.0831

Epoch 43/300

85/85 [=====] - 3s 31ms/step - loss: 8.7966e-04 - accuracy: 0.1322 - val_loss: 0.0063 - val_accuracy: 0.0764

Epoch 44/300

85/85 [=====] - 3s 31ms/step - loss: 8.6629e-04 - accuracy: 0.1141 - val_loss: 0.0047 - val_accuracy: 0.0897

Epoch 45/300

85/85 [=====] - 3s 31ms/step - loss: 8.2316e-04 - accuracy: 0.1311 - val_loss: 0.0053 - val_accuracy: 0.0731

Epoch 46/300

85/85 [=====] - 3s 31ms/step - loss: 8.8688e-04 - accuracy: 0.1267 - val_loss: 0.0067 - val_accuracy: 0.0797

Epoch 47/300

85/85 [=====] - 3s 31ms/step - loss: 8.2620e-04 - accuracy: 0.1171 - val_loss: 0.0088 - val_accuracy: 0.0997

Epoch 48/300

85/85 [=====] - 3s 31ms/step - loss: 8.1818e-04 - accuracy: 0.1152 - val_loss: 0.0049 - val_accuracy: 0.0797

Epoch 49/300

85/85 [=====] - 3s 31ms/step - loss: 8.7089e-04 - accuracy:
0.1219 - val_loss: 0.0085 - val_accuracy: 0.0664
Epoch 50/300
85/85 [=====] - 3s 31ms/step - loss: 8.0206e-04 - accuracy:
0.1226 - val_loss: 0.0073 - val_accuracy: 0.0797
Epoch 51/300
85/85 [=====] - 3s 30ms/step - loss: 8.4406e-04 - accuracy:
0.1233 - val_loss: 0.0061 - val_accuracy: 0.0897
Epoch 52/300
85/85 [=====] - 3s 30ms/step - loss: 7.7688e-04 - accuracy:
0.1112 - val_loss: 0.0087 - val_accuracy: 0.0897
Epoch 53/300
85/85 [=====] - 3s 30ms/step - loss: 8.1359e-04 - accuracy:
0.1078 - val_loss: 0.0069 - val_accuracy: 0.0797
Epoch 54/300
85/85 [=====] - 3s 30ms/step - loss: 7.8715e-04 - accuracy:
0.1230 - val_loss: 0.0060 - val_accuracy: 0.0764
Epoch 55/300
85/85 [=====] - 3s 30ms/step - loss: 7.7232e-04 - accuracy:
0.1222 - val_loss: 0.0078 - val_accuracy: 0.0797
Epoch 56/300
85/85 [=====] - 3s 30ms/step - loss: 7.8082e-04 - accuracy:
0.1178 - val_loss: 0.0081 - val_accuracy: 0.0963
Epoch 57/300
85/85 [=====] - 3s 30ms/step - loss: 8.8682e-04 - accuracy:
0.1196 - val_loss: 0.0086 - val_accuracy: 0.0731
Epoch 58/300
85/85 [=====] - 3s 31ms/step - loss: 8.2810e-04 - accuracy:
0.1292 - val_loss: 0.0056 - val_accuracy: 0.0797
Epoch 59/300
85/85 [=====] - 4s 47ms/step - loss: 7.4195e-04 - accuracy:
0.1281 - val_loss: 0.0076 - val_accuracy: 0.0864
Epoch 60/300
85/85 [=====] - 3s 31ms/step - loss: 7.1575e-04 - accuracy:
0.1160 - val_loss: 0.0058 - val_accuracy: 0.0764
Epoch 61/300
85/85 [=====] - 3s 31ms/step - loss: 7.4441e-04 - accuracy:
0.1267 - val_loss: 0.0062 - val_accuracy: 0.0764
Epoch 62/300
85/85 [=====] - 3s 30ms/step - loss: 7.9483e-04 - accuracy:
0.1204 - val_loss: 0.0055 - val_accuracy: 0.0797
Epoch 63/300
85/85 [=====] - 3s 30ms/step - loss: 7.0560e-04 - accuracy:

0.1270 - val_loss: 0.0044 - val_accuracy: 0.0664
Epoch 64/300
85/85 [=====] - 3s 31ms/step - loss: 7.5139e-04 - accuracy:
0.1204 - val_loss: 0.0074 - val_accuracy: 0.0631
Epoch 65/300
85/85 [=====] - 3s 30ms/step - loss: 7.0803e-04 - accuracy:
0.1385 - val_loss: 0.0070 - val_accuracy: 0.0864
Epoch 66/300
85/85 [=====] - 3s 30ms/step - loss: 7.0084e-04 - accuracy:
0.1256 - val_loss: 0.0057 - val_accuracy: 0.1063
Epoch 67/300
85/85 [=====] - 3s 30ms/step - loss: 7.5172e-04 - accuracy:
0.1307 - val_loss: 0.0059 - val_accuracy: 0.0831
Epoch 68/300
85/85 [=====] - 3s 30ms/step - loss: 7.5686e-04 - accuracy:
0.1174 - val_loss: 0.0066 - val_accuracy: 0.0797
Epoch 69/300
85/85 [=====] - 3s 30ms/step - loss: 7.3525e-04 - accuracy:
0.1274 - val_loss: 0.0058 - val_accuracy: 0.0731
Epoch 70/300
85/85 [=====] - 3s 30ms/step - loss: 7.3589e-04 - accuracy:
0.1230 - val_loss: 0.0110 - val_accuracy: 0.0831
Epoch 71/300
85/85 [=====] - 3s 30ms/step - loss: 7.1121e-04 - accuracy:
0.1377 - val_loss: 0.0050 - val_accuracy: 0.0731
Epoch 72/300
85/85 [=====] - 3s 30ms/step - loss: 7.2211e-04 - accuracy:
0.1115 - val_loss: 0.0090 - val_accuracy: 0.0897
Epoch 73/300
85/85 [=====] - 3s 31ms/step - loss: 7.0899e-04 - accuracy:
0.1259 - val_loss: 0.0085 - val_accuracy: 0.0731
Epoch 74/300
85/85 [=====] - 3s 30ms/step - loss: 7.0108e-04 - accuracy:
0.1233 - val_loss: 0.0058 - val_accuracy: 0.0698
Epoch 75/300
85/85 [=====] - 3s 30ms/step - loss: 7.0091e-04 - accuracy:
0.1215 - val_loss: 0.0064 - val_accuracy: 0.0864
Epoch 76/300
85/85 [=====] - 3s 31ms/step - loss: 7.6846e-04 - accuracy:
0.1289 - val_loss: 0.0048 - val_accuracy: 0.0631
Epoch 77/300
85/85 [=====] - 3s 31ms/step - loss: 6.8950e-04 - accuracy:
0.1097 - val_loss: 0.0096 - val_accuracy: 0.0797

Epoch 78/300

85/85 [=====] - 3s 30ms/step - loss: 6.9475e-04 - accuracy: 0.1182 - val_loss: 0.0058 - val_accuracy: 0.0897

Epoch 79/300

85/85 [=====] - 3s 31ms/step - loss: 7.9552e-04 - accuracy: 0.1215 - val_loss: 0.0063 - val_accuracy: 0.0963

Epoch 80/300

85/85 [=====] - 3s 31ms/step - loss: 7.0129e-04 - accuracy: 0.1407 - val_loss: 0.0096 - val_accuracy: 0.0963

Epoch 81/300

85/85 [=====] - 3s 31ms/step - loss: 7.0560e-04 - accuracy: 0.1145 - val_loss: 0.0091 - val_accuracy: 0.0731

Epoch 82/300

85/85 [=====] - 3s 31ms/step - loss: 7.0910e-04 - accuracy: 0.1374 - val_loss: 0.0084 - val_accuracy: 0.0631

Epoch 83/300

85/85 [=====] - 3s 31ms/step - loss: 6.8388e-04 - accuracy: 0.1355 - val_loss: 0.0073 - val_accuracy: 0.0831

Epoch 84/300

85/85 [=====] - 3s 30ms/step - loss: 6.7370e-04 - accuracy: 0.1226 - val_loss: 0.0070 - val_accuracy: 0.0831

Epoch 85/300

85/85 [=====] - 3s 30ms/step - loss: 6.8801e-04 - accuracy: 0.1322 - val_loss: 0.0084 - val_accuracy: 0.0664

Epoch 86/300

85/85 [=====] - 3s 31ms/step - loss: 7.5738e-04 - accuracy: 0.1178 - val_loss: 0.0065 - val_accuracy: 0.0831

Epoch 87/300

85/85 [=====] - 3s 30ms/step - loss: 7.2653e-04 - accuracy: 0.1289 - val_loss: 0.0090 - val_accuracy: 0.1030

Epoch 88/300

85/85 [=====] - 3s 30ms/step - loss: 7.0931e-04 - accuracy: 0.1318 - val_loss: 0.0065 - val_accuracy: 0.0797

Epoch 89/300

85/85 [=====] - 3s 30ms/step - loss: 6.7266e-04 - accuracy: 0.1174 - val_loss: 0.0059 - val_accuracy: 0.0797

Epoch 90/300

85/85 [=====] - 3s 30ms/step - loss: 6.7035e-04 - accuracy: 0.1056 - val_loss: 0.0064 - val_accuracy: 0.1196

Epoch 91/300

85/85 [=====] - 3s 31ms/step - loss: 6.8614e-04 - accuracy: 0.1222 - val_loss: 0.0073 - val_accuracy: 0.0797

Epoch 92/300

85/85 [=====] - 3s 31ms/step - loss: 6.8775e-04 - accuracy:
0.1326 - val_loss: 0.0111 - val_accuracy: 0.0797
Epoch 93/300
85/85 [=====] - 3s 31ms/step - loss: 6.4939e-04 - accuracy:
0.1304 - val_loss: 0.0055 - val_accuracy: 0.0664
Epoch 94/300
85/85 [=====] - 3s 30ms/step - loss: 6.5714e-04 - accuracy:
0.1274 - val_loss: 0.0070 - val_accuracy: 0.1030
Epoch 95/300
85/85 [=====] - 3s 31ms/step - loss: 6.9424e-04 - accuracy:
0.1304 - val_loss: 0.0048 - val_accuracy: 0.1163
Epoch 96/300
85/85 [=====] - 3s 30ms/step - loss: 6.7166e-04 - accuracy:
0.1252 - val_loss: 0.0054 - val_accuracy: 0.0963
Epoch 97/300
85/85 [=====] - 3s 30ms/step - loss: 6.3780e-04 - accuracy:
0.1311 - val_loss: 0.0091 - val_accuracy: 0.1130
Epoch 98/300
85/85 [=====] - 3s 30ms/step - loss: 7.0911e-04 - accuracy:
0.1256 - val_loss: 0.0046 - val_accuracy: 0.1063
Epoch 99/300
85/85 [=====] - 3s 30ms/step - loss: 6.6487e-04 - accuracy:
0.1278 - val_loss: 0.0025 - val_accuracy: 0.1262
Epoch 100/300
85/85 [=====] - 3s 30ms/step - loss: 6.8354e-04 - accuracy:
0.1244 - val_loss: 0.0038 - val_accuracy: 0.1096
Epoch 101/300
85/85 [=====] - 3s 30ms/step - loss: 7.1050e-04 - accuracy:
0.1326 - val_loss: 0.0049 - val_accuracy: 0.0963
Epoch 102/300
85/85 [=====] - 3s 30ms/step - loss: 6.7002e-04 - accuracy:
0.1392 - val_loss: 0.0031 - val_accuracy: 0.0963
Epoch 103/300
85/85 [=====] - 3s 31ms/step - loss: 6.4597e-04 - accuracy:
0.1381 - val_loss: 0.0054 - val_accuracy: 0.1130
Epoch 104/300
85/85 [=====] - 3s 31ms/step - loss: 6.8828e-04 - accuracy:
0.1274 - val_loss: 0.0037 - val_accuracy: 0.1196
Epoch 105/300
85/85 [=====] - 3s 30ms/step - loss: 6.5226e-04 - accuracy:
0.1296 - val_loss: 0.0045 - val_accuracy: 0.1130
Epoch 106/300
85/85 [=====] - 3s 30ms/step - loss: 6.3622e-04 - accuracy:

0.1436 - val_loss: 0.0032 - val_accuracy: 0.0930
Epoch 107/300
85/85 [=====] - 3s 30ms/step - loss: 6.0724e-04 - accuracy:
0.1595 - val_loss: 0.0046 - val_accuracy: 0.1096
Epoch 108/300
85/85 [=====] - 3s 31ms/step - loss: 6.6556e-04 - accuracy:
0.1555 - val_loss: 0.0062 - val_accuracy: 0.1196
Epoch 109/300
85/85 [=====] - 3s 30ms/step - loss: 7.2952e-04 - accuracy:
0.1318 - val_loss: 0.0035 - val_accuracy: 0.1163
Epoch 110/300
85/85 [=====] - 3s 30ms/step - loss: 6.6560e-04 - accuracy:
0.1366 - val_loss: 0.0078 - val_accuracy: 0.1561
Epoch 111/300
85/85 [=====] - 3s 30ms/step - loss: 6.2964e-04 - accuracy:
0.1322 - val_loss: 0.0045 - val_accuracy: 0.1329
Epoch 112/300
85/85 [=====] - 3s 30ms/step - loss: 6.2669e-04 - accuracy:
0.1455 - val_loss: 0.0037 - val_accuracy: 0.1163
Epoch 113/300
85/85 [=====] - 3s 30ms/step - loss: 5.8901e-04 - accuracy:
0.1425 - val_loss: 0.0062 - val_accuracy: 0.1362
Epoch 114/300
85/85 [=====] - 3s 30ms/step - loss: 6.6107e-04 - accuracy:
0.1440 - val_loss: 0.0049 - val_accuracy: 0.1495
Epoch 115/300
85/85 [=====] - 3s 30ms/step - loss: 6.1637e-04 - accuracy:
0.1311 - val_loss: 0.0062 - val_accuracy: 0.1894
Epoch 116/300
85/85 [=====] - 3s 31ms/step - loss: 6.0117e-04 - accuracy:
0.1555 - val_loss: 0.0041 - val_accuracy: 0.1528
Epoch 117/300
85/85 [=====] - 3s 30ms/step - loss: 5.8827e-04 - accuracy:
0.1448 - val_loss: 0.0041 - val_accuracy: 0.1561
Epoch 118/300
85/85 [=====] - 3s 30ms/step - loss: 5.7926e-04 - accuracy:
0.1451 - val_loss: 0.0048 - val_accuracy: 0.0997
Epoch 119/300
85/85 [=====] - 3s 31ms/step - loss: 5.4910e-04 - accuracy:
0.1488 - val_loss: 0.0053 - val_accuracy: 0.1229
Epoch 120/300
85/85 [=====] - 3s 30ms/step - loss: 6.2500e-04 - accuracy:
0.1459 - val_loss: 0.0064 - val_accuracy: 0.1528

Epoch 121/300
85/85 [=====] - 3s 30ms/step - loss: 5.3693e-04 - accuracy: 0.1555 - val_loss: 0.0049 - val_accuracy: 0.1196

Epoch 122/300
85/85 [=====] - 3s 30ms/step - loss: 6.1282e-04 - accuracy: 0.1507 - val_loss: 0.0031 - val_accuracy: 0.1130

Epoch 123/300
85/85 [=====] - 3s 30ms/step - loss: 6.8861e-04 - accuracy: 0.1433 - val_loss: 0.0039 - val_accuracy: 0.1163

Epoch 124/300
85/85 [=====] - 3s 31ms/step - loss: 5.7419e-04 - accuracy: 0.1440 - val_loss: 0.0053 - val_accuracy: 0.1130

Epoch 125/300
85/85 [=====] - 3s 31ms/step - loss: 5.1554e-04 - accuracy: 0.1555 - val_loss: 0.0079 - val_accuracy: 0.1595

Epoch 126/300
85/85 [=====] - 3s 30ms/step - loss: 5.4679e-04 - accuracy: 0.1448 - val_loss: 0.0053 - val_accuracy: 0.1296

Epoch 127/300
85/85 [=====] - 3s 31ms/step - loss: 5.4618e-04 - accuracy: 0.1355 - val_loss: 0.0063 - val_accuracy: 0.1229

Epoch 128/300
85/85 [=====] - 3s 31ms/step - loss: 5.1107e-04 - accuracy: 0.1544 - val_loss: 0.0050 - val_accuracy: 0.0997

Epoch 129/300
85/85 [=====] - 3s 30ms/step - loss: 5.4139e-04 - accuracy: 0.1514 - val_loss: 0.0063 - val_accuracy: 0.1196

Epoch 130/300
85/85 [=====] - 3s 30ms/step - loss: 5.1625e-04 - accuracy: 0.1422 - val_loss: 0.0061 - val_accuracy: 0.1030

Epoch 131/300
85/85 [=====] - 3s 31ms/step - loss: 5.4909e-04 - accuracy: 0.1588 - val_loss: 0.0034 - val_accuracy: 0.1196

Epoch 132/300
85/85 [=====] - 3s 30ms/step - loss: 5.4460e-04 - accuracy: 0.1473 - val_loss: 0.0046 - val_accuracy: 0.1196

Epoch 133/300
85/85 [=====] - 3s 31ms/step - loss: 5.0959e-04 - accuracy: 0.1433 - val_loss: 0.0064 - val_accuracy: 0.1661

Epoch 134/300
85/85 [=====] - 3s 30ms/step - loss: 4.7570e-04 - accuracy: 0.1503 - val_loss: 0.0056 - val_accuracy: 0.1262

Epoch 135/300

85/85 [=====] - 3s 30ms/step - loss: 5.1218e-04 - accuracy:
0.1518 - val_loss: 0.0044 - val_accuracy: 0.1030
Epoch 136/300
85/85 [=====] - 3s 31ms/step - loss: 5.4856e-04 - accuracy:
0.1558 - val_loss: 0.0041 - val_accuracy: 0.1030
Epoch 137/300
85/85 [=====] - 3s 30ms/step - loss: 5.2817e-04 - accuracy:
0.1496 - val_loss: 0.0055 - val_accuracy: 0.1329
Epoch 138/300
85/85 [=====] - 3s 30ms/step - loss: 5.8363e-04 - accuracy:
0.1621 - val_loss: 0.0047 - val_accuracy: 0.1262
Epoch 139/300
85/85 [=====] - 3s 31ms/step - loss: 4.9244e-04 - accuracy:
0.1381 - val_loss: 0.0071 - val_accuracy: 0.0963
Epoch 140/300
85/85 [=====] - 3s 30ms/step - loss: 4.8839e-04 - accuracy:
0.1592 - val_loss: 0.0058 - val_accuracy: 0.1196
Epoch 141/300
85/85 [=====] - 3s 31ms/step - loss: 4.6628e-04 - accuracy:
0.1518 - val_loss: 0.0045 - val_accuracy: 0.1130
Epoch 142/300
85/85 [=====] - 3s 30ms/step - loss: 4.7037e-04 - accuracy:
0.1595 - val_loss: 0.0068 - val_accuracy: 0.1163
Epoch 143/300
85/85 [=====] - 3s 30ms/step - loss: 5.0768e-04 - accuracy:
0.1499 - val_loss: 0.0059 - val_accuracy: 0.1096
Epoch 144/300
85/85 [=====] - 3s 31ms/step - loss: 5.1482e-04 - accuracy:
0.1499 - val_loss: 0.0080 - val_accuracy: 0.1130
Epoch 145/300
85/85 [=====] - 3s 30ms/step - loss: 4.7787e-04 - accuracy:
0.1473 - val_loss: 0.0065 - val_accuracy: 0.1694
Epoch 146/300
85/85 [=====] - 3s 31ms/step - loss: 4.6040e-04 - accuracy:
0.1400 - val_loss: 0.0049 - val_accuracy: 0.1163
Epoch 147/300
85/85 [=====] - 3s 31ms/step - loss: 5.0855e-04 - accuracy:
0.1525 - val_loss: 0.0072 - val_accuracy: 0.1229
Epoch 148/300
85/85 [=====] - 3s 31ms/step - loss: 5.8927e-04 - accuracy:
0.1577 - val_loss: 0.0047 - val_accuracy: 0.1229
Epoch 149/300
85/85 [=====] - 3s 30ms/step - loss: 4.8796e-04 - accuracy:

0.1425 - val_loss: 0.0088 - val_accuracy: 0.1362
Epoch 150/300
85/85 [=====] - 3s 30ms/step - loss: 4.5753e-04 - accuracy:
0.1588 - val_loss: 0.0049 - val_accuracy: 0.1063
Epoch 151/300
85/85 [=====] - 3s 31ms/step - loss: 5.3493e-04 - accuracy:
0.1477 - val_loss: 0.0060 - val_accuracy: 0.1229
Epoch 152/300
85/85 [=====] - 3s 30ms/step - loss: 4.9014e-04 - accuracy:
0.1322 - val_loss: 0.0059 - val_accuracy: 0.1030
Epoch 153/300
85/85 [=====] - 3s 31ms/step - loss: 4.4538e-04 - accuracy:
0.1643 - val_loss: 0.0060 - val_accuracy: 0.1728
Epoch 154/300
85/85 [=====] - 3s 31ms/step - loss: 4.2098e-04 - accuracy:
0.1540 - val_loss: 0.0076 - val_accuracy: 0.1628
Epoch 155/300
85/85 [=====] - 3s 31ms/step - loss: 4.1275e-04 - accuracy:
0.1614 - val_loss: 0.0061 - val_accuracy: 0.1462
Epoch 156/300
85/85 [=====] - 3s 31ms/step - loss: 4.7991e-04 - accuracy:
0.1444 - val_loss: 0.0105 - val_accuracy: 0.1495
Epoch 157/300
85/85 [=====] - 3s 31ms/step - loss: 4.5790e-04 - accuracy:
0.1359 - val_loss: 0.0068 - val_accuracy: 0.1096
Epoch 158/300
85/85 [=====] - 2s 29ms/step - loss: 4.2864e-04 - accuracy:
0.1451 - val_loss: 0.0050 - val_accuracy: 0.1063
Epoch 159/300
85/85 [=====] - 35s 418ms/step - loss: 4.6062e-04 - accuracy:
0.1411 - val_loss: 0.0071 - val_accuracy: 0.1561
Epoch 160/300
85/85 [=====] - 3s 32ms/step - loss: 4.3296e-04 - accuracy:
0.1555 - val_loss: 0.0056 - val_accuracy: 0.1063
Epoch 161/300
85/85 [=====] - 3s 34ms/step - loss: 4.6370e-04 - accuracy:
0.1569 - val_loss: 0.0052 - val_accuracy: 0.1694
Epoch 162/300
85/85 [=====] - 3s 33ms/step - loss: 4.2650e-04 - accuracy:
0.1599 - val_loss: 0.0053 - val_accuracy: 0.1096
Epoch 163/300
85/85 [=====] - 3s 33ms/step - loss: 4.2959e-04 - accuracy:
0.1558 - val_loss: 0.0058 - val_accuracy: 0.0930

Epoch 164/300
85/85 [=====] - 3s 32ms/step - loss: 4.2439e-04 - accuracy: 0.1584 - val_loss: 0.0087 - val_accuracy: 0.1329

Epoch 165/300
85/85 [=====] - 3s 32ms/step - loss: 4.9272e-04 - accuracy: 0.1348 - val_loss: 0.0087 - val_accuracy: 0.1362

Epoch 166/300
85/85 [=====] - 3s 33ms/step - loss: 4.4624e-04 - accuracy: 0.1311 - val_loss: 0.0068 - val_accuracy: 0.1229

Epoch 167/300
85/85 [=====] - 3s 32ms/step - loss: 4.3777e-04 - accuracy: 0.1429 - val_loss: 0.0098 - val_accuracy: 0.1495

Epoch 168/300
85/85 [=====] - 3s 32ms/step - loss: 4.2943e-04 - accuracy: 0.1392 - val_loss: 0.0069 - val_accuracy: 0.0930

Epoch 169/300
85/85 [=====] - 3s 33ms/step - loss: 3.9924e-04 - accuracy: 0.1473 - val_loss: 0.0096 - val_accuracy: 0.1628

Epoch 170/300
85/85 [=====] - 3s 32ms/step - loss: 4.4346e-04 - accuracy: 0.1551 - val_loss: 0.0072 - val_accuracy: 0.1296

Epoch 171/300
85/85 [=====] - 3s 32ms/step - loss: 6.4226e-04 - accuracy: 0.1381 - val_loss: 0.0075 - val_accuracy: 0.1561

Epoch 172/300
85/85 [=====] - 3s 32ms/step - loss: 4.8951e-04 - accuracy: 0.1451 - val_loss: 0.0051 - val_accuracy: 0.1030

Epoch 173/300
85/85 [=====] - 3s 32ms/step - loss: 4.2746e-04 - accuracy: 0.1392 - val_loss: 0.0081 - val_accuracy: 0.1063

Epoch 174/300
85/85 [=====] - 3s 32ms/step - loss: 3.6426e-04 - accuracy: 0.1418 - val_loss: 0.0086 - val_accuracy: 0.1528

Epoch 175/300
85/85 [=====] - 3s 32ms/step - loss: 3.5567e-04 - accuracy: 0.1636 - val_loss: 0.0066 - val_accuracy: 0.1262

Epoch 176/300
85/85 [=====] - 3s 33ms/step - loss: 3.6010e-04 - accuracy: 0.1514 - val_loss: 0.0069 - val_accuracy: 0.1561

Epoch 177/300
85/85 [=====] - 3s 32ms/step - loss: 3.5592e-04 - accuracy: 0.1569 - val_loss: 0.0056 - val_accuracy: 0.1296

Epoch 178/300

85/85 [=====] - 3s 32ms/step - loss: 5.0159e-04 - accuracy:
0.1337 - val_loss: 0.0105 - val_accuracy: 0.1196
Epoch 179/300
85/85 [=====] - 3s 32ms/step - loss: 4.2262e-04 - accuracy:
0.1466 - val_loss: 0.0084 - val_accuracy: 0.1229
Epoch 180/300
85/85 [=====] - 3s 32ms/step - loss: 3.4586e-04 - accuracy:
0.1566 - val_loss: 0.0069 - val_accuracy: 0.1561
Epoch 181/300
85/85 [=====] - 3s 33ms/step - loss: 3.1170e-04 - accuracy:
0.1654 - val_loss: 0.0061 - val_accuracy: 0.1030
Epoch 182/300
85/85 [=====] - 3s 32ms/step - loss: 3.3171e-04 - accuracy:
0.1562 - val_loss: 0.0072 - val_accuracy: 0.1661
Epoch 183/300
85/85 [=====] - 3s 32ms/step - loss: 3.4481e-04 - accuracy:
0.1544 - val_loss: 0.0063 - val_accuracy: 0.1262
Epoch 184/300
85/85 [=====] - 3s 33ms/step - loss: 3.4205e-04 - accuracy:
0.1581 - val_loss: 0.0104 - val_accuracy: 0.1329
Epoch 185/300
85/85 [=====] - 3s 33ms/step - loss: 3.2161e-04 - accuracy:
0.1518 - val_loss: 0.0073 - val_accuracy: 0.1229
Epoch 186/300
85/85 [=====] - 3s 32ms/step - loss: 3.0185e-04 - accuracy:
0.1662 - val_loss: 0.0085 - val_accuracy: 0.1694
Epoch 187/300
85/85 [=====] - 3s 32ms/step - loss: 3.6765e-04 - accuracy:
0.1636 - val_loss: 0.0103 - val_accuracy: 0.1329
Epoch 188/300
85/85 [=====] - 3s 32ms/step - loss: 3.8963e-04 - accuracy:
0.1562 - val_loss: 0.0069 - val_accuracy: 0.1628
Epoch 189/300
85/85 [=====] - 3s 32ms/step - loss: 4.1327e-04 - accuracy:
0.1673 - val_loss: 0.0065 - val_accuracy: 0.1329
Epoch 190/300
85/85 [=====] - 3s 32ms/step - loss: 4.4322e-04 - accuracy:
0.1403 - val_loss: 0.0051 - val_accuracy: 0.1694
Epoch 191/300
85/85 [=====] - 3s 33ms/step - loss: 3.7202e-04 - accuracy:
0.1643 - val_loss: 0.0095 - val_accuracy: 0.1628
Epoch 192/300
85/85 [=====] - 3s 32ms/step - loss: 3.2286e-04 - accuracy:

0.1599 - val_loss: 0.0080 - val_accuracy: 0.1296
Epoch 193/300
85/85 [=====] - 3s 32ms/step - loss: 2.7958e-04 - accuracy:
0.1536 - val_loss: 0.0092 - val_accuracy: 0.1561
Epoch 194/300
85/85 [=====] - 3s 32ms/step - loss: 2.8039e-04 - accuracy:
0.1496 - val_loss: 0.0081 - val_accuracy: 0.1329
Epoch 195/300
85/85 [=====] - 3s 32ms/step - loss: 3.2775e-04 - accuracy:
0.1584 - val_loss: 0.0097 - val_accuracy: 0.1495
Epoch 196/300
85/85 [=====] - 3s 32ms/step - loss: 2.8586e-04 - accuracy:
0.1525 - val_loss: 0.0078 - val_accuracy: 0.1595
Epoch 197/300
85/85 [=====] - 3s 32ms/step - loss: 2.7544e-04 - accuracy:
0.1562 - val_loss: 0.0093 - val_accuracy: 0.1694
Epoch 198/300
85/85 [=====] - 3s 32ms/step - loss: 3.2142e-04 - accuracy:
0.1592 - val_loss: 0.0060 - val_accuracy: 0.1063
Epoch 199/300
85/85 [=====] - 3s 32ms/step - loss: 2.7187e-04 - accuracy:
0.1629 - val_loss: 0.0082 - val_accuracy: 0.1429
Epoch 200/300
85/85 [=====] - 3s 32ms/step - loss: 2.6597e-04 - accuracy:
0.1640 - val_loss: 0.0070 - val_accuracy: 0.1429
Epoch 201/300
85/85 [=====] - 3s 32ms/step - loss: 3.2387e-04 - accuracy:
0.1584 - val_loss: 0.0076 - val_accuracy: 0.1661
Epoch 202/300
85/85 [=====] - 3s 32ms/step - loss: 3.6524e-04 - accuracy:
0.1532 - val_loss: 0.0067 - val_accuracy: 0.1528
Epoch 203/300
85/85 [=====] - 3s 33ms/step - loss: 5.4724e-04 - accuracy:
0.1581 - val_loss: 0.0089 - val_accuracy: 0.1561
Epoch 204/300
85/85 [=====] - 3s 32ms/step - loss: 3.8675e-04 - accuracy:
0.1614 - val_loss: 0.0090 - val_accuracy: 0.1395
Epoch 205/300
85/85 [=====] - 3s 32ms/step - loss: 3.0705e-04 - accuracy:
0.1444 - val_loss: 0.0097 - val_accuracy: 0.1495
Epoch 206/300
85/85 [=====] - 3s 32ms/step - loss: 2.5721e-04 - accuracy:
0.1728 - val_loss: 0.0077 - val_accuracy: 0.1595

Epoch 207/300
85/85 [=====] - 3s 32ms/step - loss: 2.5332e-04 - accuracy: 0.1665 - val_loss: 0.0072 - val_accuracy: 0.1130

Epoch 208/300
85/85 [=====] - 3s 33ms/step - loss: 2.4559e-04 - accuracy: 0.1555 - val_loss: 0.0078 - val_accuracy: 0.1462

Epoch 209/300
85/85 [=====] - 3s 33ms/step - loss: 2.4151e-04 - accuracy: 0.1640 - val_loss: 0.0075 - val_accuracy: 0.1362

Epoch 210/300
85/85 [=====] - 3s 31ms/step - loss: 2.4307e-04 - accuracy: 0.1569 - val_loss: 0.0102 - val_accuracy: 0.1561

Epoch 211/300
85/85 [=====] - 3s 33ms/step - loss: 2.8063e-04 - accuracy: 0.1562 - val_loss: 0.0076 - val_accuracy: 0.1229

Epoch 212/300
85/85 [=====] - 3s 33ms/step - loss: 2.3956e-04 - accuracy: 0.1654 - val_loss: 0.0080 - val_accuracy: 0.1296

Epoch 213/300
85/85 [=====] - 3s 32ms/step - loss: 3.4750e-04 - accuracy: 0.1558 - val_loss: 0.0077 - val_accuracy: 0.1694

Epoch 214/300
85/85 [=====] - 3s 32ms/step - loss: 2.8845e-04 - accuracy: 0.1688 - val_loss: 0.0073 - val_accuracy: 0.1262

Epoch 215/300
85/85 [=====] - 3s 32ms/step - loss: 2.5575e-04 - accuracy: 0.1651 - val_loss: 0.0086 - val_accuracy: 0.0930

Epoch 216/300
85/85 [=====] - 3s 32ms/step - loss: 2.3991e-04 - accuracy: 0.1610 - val_loss: 0.0071 - val_accuracy: 0.1262

Epoch 217/300
85/85 [=====] - 3s 32ms/step - loss: 2.2856e-04 - accuracy: 0.1710 - val_loss: 0.0091 - val_accuracy: 0.1728

Epoch 218/300
85/85 [=====] - 3s 32ms/step - loss: 2.3022e-04 - accuracy: 0.1832 - val_loss: 0.0080 - val_accuracy: 0.1561

Epoch 219/300
85/85 [=====] - 3s 32ms/step - loss: 2.1673e-04 - accuracy: 0.1773 - val_loss: 0.0083 - val_accuracy: 0.1495

Epoch 220/300
85/85 [=====] - 3s 32ms/step - loss: 2.2031e-04 - accuracy: 0.1562 - val_loss: 0.0103 - val_accuracy: 0.1561

Epoch 221/300

85/85 [=====] - 3s 32ms/step - loss: 2.1981e-04 - accuracy:
0.1725 - val_loss: 0.0101 - val_accuracy: 0.1262
Epoch 222/300
85/85 [=====] - 3s 32ms/step - loss: 2.1127e-04 - accuracy:
0.1743 - val_loss: 0.0086 - val_accuracy: 0.1130
Epoch 223/300
85/85 [=====] - 3s 32ms/step - loss: 2.6292e-04 - accuracy:
0.1680 - val_loss: 0.0074 - val_accuracy: 0.1130
Epoch 224/300
85/85 [=====] - 3s 32ms/step - loss: 6.6618e-04 - accuracy:
0.1558 - val_loss: 0.0083 - val_accuracy: 0.1163
Epoch 225/300
85/85 [=====] - 3s 33ms/step - loss: 3.7488e-04 - accuracy:
0.1677 - val_loss: 0.0063 - val_accuracy: 0.1462
Epoch 226/300
85/85 [=====] - 3s 33ms/step - loss: 6.9396e-04 - accuracy:
0.1625 - val_loss: 0.0060 - val_accuracy: 0.1429
Epoch 227/300
85/85 [=====] - 3s 32ms/step - loss: 4.6574e-04 - accuracy:
0.1662 - val_loss: 0.0079 - val_accuracy: 0.1096
Epoch 228/300
85/85 [=====] - 3s 33ms/step - loss: 2.9066e-04 - accuracy:
0.1610 - val_loss: 0.0086 - val_accuracy: 0.1495
Epoch 229/300
85/85 [=====] - 3s 34ms/step - loss: 2.5942e-04 - accuracy:
0.1529 - val_loss: 0.0078 - val_accuracy: 0.1262
Epoch 230/300
85/85 [=====] - 3s 32ms/step - loss: 2.7177e-04 - accuracy:
0.1699 - val_loss: 0.0086 - val_accuracy: 0.1362
Epoch 231/300
85/85 [=====] - 3s 32ms/step - loss: 2.6413e-04 - accuracy:
0.1680 - val_loss: 0.0084 - val_accuracy: 0.1395
Epoch 232/300
85/85 [=====] - 3s 32ms/step - loss: 2.1452e-04 - accuracy:
0.1780 - val_loss: 0.0084 - val_accuracy: 0.1130
Epoch 233/300
85/85 [=====] - 3s 32ms/step - loss: 2.0841e-04 - accuracy:
0.1828 - val_loss: 0.0089 - val_accuracy: 0.1595
Epoch 234/300
85/85 [=====] - 3s 33ms/step - loss: 2.0179e-04 - accuracy:
0.1909 - val_loss: 0.0082 - val_accuracy: 0.1130
Epoch 235/300
85/85 [=====] - 3s 32ms/step - loss: 2.0802e-04 - accuracy:

0.1754 - val_loss: 0.0072 - val_accuracy: 0.1296
Epoch 236/300
85/85 [=====] - 3s 33ms/step - loss: 2.0091e-04 - accuracy:
0.1765 - val_loss: 0.0081 - val_accuracy: 0.1063
Epoch 237/300
85/85 [=====] - 3s 32ms/step - loss: 2.3854e-04 - accuracy:
0.1736 - val_loss: 0.0078 - val_accuracy: 0.1163
Epoch 238/300
85/85 [=====] - 3s 32ms/step - loss: 2.2894e-04 - accuracy:
0.1717 - val_loss: 0.0083 - val_accuracy: 0.1229
Epoch 239/300
85/85 [=====] - 3s 32ms/step - loss: 2.1624e-04 - accuracy:
0.1824 - val_loss: 0.0080 - val_accuracy: 0.1296
Epoch 240/300
85/85 [=====] - 3s 33ms/step - loss: 2.2339e-04 - accuracy:
0.1769 - val_loss: 0.0094 - val_accuracy: 0.1395
Epoch 241/300
85/85 [=====] - 3s 33ms/step - loss: 4.0529e-04 - accuracy:
0.1699 - val_loss: 0.0068 - val_accuracy: 0.1528
Epoch 242/300
85/85 [=====] - 3s 32ms/step - loss: 3.7847e-04 - accuracy:
0.1754 - val_loss: 0.0086 - val_accuracy: 0.1229
Epoch 243/300
85/85 [=====] - 3s 32ms/step - loss: 2.3826e-04 - accuracy:
0.1846 - val_loss: 0.0081 - val_accuracy: 0.1196
Epoch 244/300
85/85 [=====] - 3s 32ms/step - loss: 1.8986e-04 - accuracy:
0.1883 - val_loss: 0.0077 - val_accuracy: 0.1196
Epoch 245/300
85/85 [=====] - 3s 32ms/step - loss: 1.9554e-04 - accuracy:
0.1747 - val_loss: 0.0078 - val_accuracy: 0.1296
Epoch 246/300
85/85 [=====] - 3s 32ms/step - loss: 1.8324e-04 - accuracy:
0.1854 - val_loss: 0.0091 - val_accuracy: 0.1528
Epoch 247/300
85/85 [=====] - 3s 32ms/step - loss: 1.8523e-04 - accuracy:
0.1743 - val_loss: 0.0089 - val_accuracy: 0.1296
Epoch 248/300
85/85 [=====] - 3s 31ms/step - loss: 1.7693e-04 - accuracy:
0.1891 - val_loss: 0.0074 - val_accuracy: 0.1329
Epoch 249/300
85/85 [=====] - 3s 32ms/step - loss: 1.8544e-04 - accuracy:
0.1843 - val_loss: 0.0082 - val_accuracy: 0.1196

Epoch 250/300
85/85 [=====] - 3s 31ms/step - loss: 1.7698e-04 - accuracy: 0.1865 - val_loss: 0.0088 - val_accuracy: 0.1395

Epoch 251/300
85/85 [=====] - 3s 31ms/step - loss: 1.8378e-04 - accuracy: 0.1758 - val_loss: 0.0064 - val_accuracy: 0.1163

Epoch 252/300
85/85 [=====] - 3s 32ms/step - loss: 2.8670e-04 - accuracy: 0.1665 - val_loss: 0.0106 - val_accuracy: 0.1030

Epoch 253/300
85/85 [=====] - 3s 31ms/step - loss: 3.3275e-04 - accuracy: 0.1680 - val_loss: 0.0071 - val_accuracy: 0.0997

Epoch 254/300
85/85 [=====] - 3s 31ms/step - loss: 2.0433e-04 - accuracy: 0.1758 - val_loss: 0.0085 - val_accuracy: 0.1362

Epoch 255/300
85/85 [=====] - 3s 31ms/step - loss: 1.8857e-04 - accuracy: 0.1769 - val_loss: 0.0077 - val_accuracy: 0.1561

Epoch 256/300
85/85 [=====] - 3s 31ms/step - loss: 1.8027e-04 - accuracy: 0.1606 - val_loss: 0.0090 - val_accuracy: 0.1661

Epoch 257/300
85/85 [=====] - 3s 31ms/step - loss: 1.7712e-04 - accuracy: 0.1824 - val_loss: 0.0073 - val_accuracy: 0.1196

Epoch 258/300
85/85 [=====] - 3s 31ms/step - loss: 1.8213e-04 - accuracy: 0.1684 - val_loss: 0.0085 - val_accuracy: 0.1561

Epoch 259/300
85/85 [=====] - 3s 31ms/step - loss: 1.8197e-04 - accuracy: 0.1832 - val_loss: 0.0073 - val_accuracy: 0.1628

Epoch 260/300
85/85 [=====] - 3s 32ms/step - loss: 2.0240e-04 - accuracy: 0.1621 - val_loss: 0.0082 - val_accuracy: 0.1561

Epoch 261/300
85/85 [=====] - 3s 32ms/step - loss: 2.3078e-04 - accuracy: 0.1813 - val_loss: 0.0076 - val_accuracy: 0.0963

Epoch 262/300
85/85 [=====] - 3s 32ms/step - loss: 1.8620e-04 - accuracy: 0.1784 - val_loss: 0.0087 - val_accuracy: 0.1196

Epoch 263/300
85/85 [=====] - 3s 31ms/step - loss: 1.7584e-04 - accuracy: 0.1795 - val_loss: 0.0084 - val_accuracy: 0.1429

Epoch 264/300

85/85 [=====] - 3s 31ms/step - loss: 4.6043e-04 - accuracy:
0.1688 - val_loss: 0.0097 - val_accuracy: 0.1628
Epoch 265/300
85/85 [=====] - 3s 32ms/step - loss: 4.9060e-04 - accuracy:
0.1684 - val_loss: 0.0068 - val_accuracy: 0.1229
Epoch 266/300
85/85 [=====] - 3s 33ms/step - loss: 3.0577e-04 - accuracy:
0.1677 - val_loss: 0.0102 - val_accuracy: 0.1462
Epoch 267/300
85/85 [=====] - 3s 35ms/step - loss: 2.4937e-04 - accuracy:
0.1857 - val_loss: 0.0109 - val_accuracy: 0.1595
Epoch 268/300
85/85 [=====] - 3s 32ms/step - loss: 4.5277e-04 - accuracy:
0.1691 - val_loss: 0.0082 - val_accuracy: 0.1096
Epoch 269/300
85/85 [=====] - 3s 32ms/step - loss: 4.6092e-04 - accuracy:
0.1595 - val_loss: 0.0141 - val_accuracy: 0.1694
Epoch 270/300
85/85 [=====] - 3s 33ms/step - loss: 2.7472e-04 - accuracy:
0.1658 - val_loss: 0.0086 - val_accuracy: 0.1362
Epoch 271/300
85/85 [=====] - 3s 32ms/step - loss: 1.9118e-04 - accuracy:
0.1913 - val_loss: 0.0088 - val_accuracy: 0.1628
Epoch 272/300
85/85 [=====] - 3s 32ms/step - loss: 1.7644e-04 - accuracy:
0.1798 - val_loss: 0.0092 - val_accuracy: 0.1561
Epoch 273/300
85/85 [=====] - 3s 32ms/step - loss: 1.7394e-04 - accuracy:
0.1968 - val_loss: 0.0095 - val_accuracy: 0.1761
Epoch 274/300
85/85 [=====] - 3s 34ms/step - loss: 1.6944e-04 - accuracy:
0.1843 - val_loss: 0.0094 - val_accuracy: 0.1528
Epoch 275/300
85/85 [=====] - 3s 33ms/step - loss: 1.6645e-04 - accuracy:
0.1913 - val_loss: 0.0084 - val_accuracy: 0.1595
Epoch 276/300
85/85 [=====] - 3s 32ms/step - loss: 1.5933e-04 - accuracy:
0.1950 - val_loss: 0.0082 - val_accuracy: 0.1462
Epoch 277/300
85/85 [=====] - 3s 31ms/step - loss: 1.6282e-04 - accuracy:
0.1843 - val_loss: 0.0095 - val_accuracy: 0.1595
Epoch 278/300
85/85 [=====] - 3s 31ms/step - loss: 1.7163e-04 - accuracy:

0.1913 - val_loss: 0.0087 - val_accuracy: 0.1595
Epoch 279/300
85/85 [=====] - 3s 31ms/step - loss: 1.6696e-04 - accuracy:
0.1883 - val_loss: 0.0074 - val_accuracy: 0.1495
Epoch 280/300
85/85 [=====] - 3s 31ms/step - loss: 1.7976e-04 - accuracy:
0.1850 - val_loss: 0.0075 - val_accuracy: 0.1561
Epoch 281/300
85/85 [=====] - 3s 30ms/step - loss: 1.6432e-04 - accuracy:
0.1824 - val_loss: 0.0093 - val_accuracy: 0.1595
Epoch 282/300
85/85 [=====] - 3s 32ms/step - loss: 1.6231e-04 - accuracy:
0.1942 - val_loss: 0.0081 - val_accuracy: 0.1661
Epoch 283/300
85/85 [=====] - 3s 33ms/step - loss: 1.7167e-04 - accuracy:
0.1743 - val_loss: 0.0078 - val_accuracy: 0.1595
Epoch 284/300
85/85 [=====] - 3s 33ms/step - loss: 1.6507e-04 - accuracy:
0.1972 - val_loss: 0.0082 - val_accuracy: 0.1561
Epoch 285/300
85/85 [=====] - 3s 32ms/step - loss: 1.6498e-04 - accuracy:
0.1865 - val_loss: 0.0081 - val_accuracy: 0.1429
Epoch 286/300
85/85 [=====] - 3s 32ms/step - loss: 1.6122e-04 - accuracy:
0.1839 - val_loss: 0.0095 - val_accuracy: 0.1595
Epoch 287/300
85/85 [=====] - 3s 32ms/step - loss: 1.9508e-04 - accuracy:
0.1957 - val_loss: 0.0060 - val_accuracy: 0.1561
Epoch 288/300
85/85 [=====] - 3s 32ms/step - loss: 9.5596e-04 - accuracy:
0.1521 - val_loss: 0.0097 - val_accuracy: 0.1096
Epoch 289/300
85/85 [=====] - 3s 32ms/step - loss: 4.4825e-04 - accuracy:
0.1581 - val_loss: 0.0101 - val_accuracy: 0.1528
Epoch 290/300
85/85 [=====] - 3s 32ms/step - loss: 2.4948e-04 - accuracy:
0.1917 - val_loss: 0.0095 - val_accuracy: 0.1429
Epoch 291/300
85/85 [=====] - 3s 32ms/step - loss: 2.1302e-04 - accuracy:
0.1739 - val_loss: 0.0078 - val_accuracy: 0.1262
Epoch 292/300
85/85 [=====] - 3s 32ms/step - loss: 2.3691e-04 - accuracy:
0.1662 - val_loss: 0.0086 - val_accuracy: 0.1296

```
Epoch 293/300
85/85 [=====] - 3s 32ms/step - loss: 1.7278e-04 - accuracy:
0.1880 - val_loss: 0.0093 - val_accuracy: 0.1495
Epoch 294/300
85/85 [=====] - 3s 32ms/step - loss: 1.5853e-04 - accuracy:
0.1894 - val_loss: 0.0089 - val_accuracy: 0.1595
Epoch 295/300
85/85 [=====] - 3s 32ms/step - loss: 1.6417e-04 - accuracy:
0.1891 - val_loss: 0.0083 - val_accuracy: 0.1495
Epoch 296/300
85/85 [=====] - 3s 32ms/step - loss: 1.5662e-04 - accuracy:
0.1835 - val_loss: 0.0081 - val_accuracy: 0.1495
Epoch 297/300
85/85 [=====] - 3s 31ms/step - loss: 1.5482e-04 - accuracy:
0.1998 - val_loss: 0.0096 - val_accuracy: 0.1661
Epoch 298/300
85/85 [=====] - 3s 31ms/step - loss: 1.8015e-04 - accuracy:
0.1813 - val_loss: 0.0088 - val_accuracy: 0.1761
Epoch 299/300
85/85 [=====] - 3s 31ms/step - loss: 1.7617e-04 - accuracy:
0.2094 - val_loss: 0.0084 - val_accuracy: 0.1628
Epoch 300/300
85/85 [=====] - 3s 31ms/step - loss: 1.6028e-04 - accuracy:
0.1839 - val_loss: 0.0089 - val_accuracy: 0.1694
```

```
# model.save("forecasting_mode.h5")
```

```
model.load("forecasting_mode.h5")
```

Visualizing the Results

```
plt.figure(figsize=(12,4))

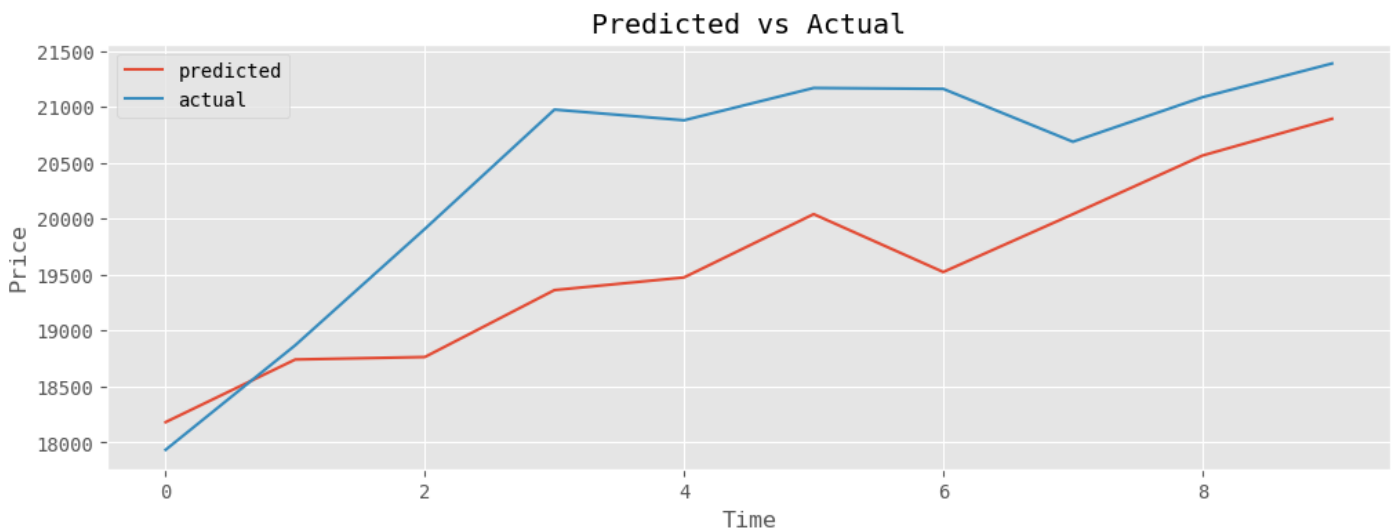
predictions = model.predict(inputs[-1].reshape(1, steps_in, num_features)).tolist()[0]
predictions = scaler.inverse_transform(np.array(predictions).reshape(-1,1)).tolist()
actual = scaler.inverse_transform(targets[-1].reshape(-1,1))

# print("predicted ", predictions)
plt.plot(predictions, label='predicted')
# print("actual ", actual.tolist())
plt.plot(actual.tolist(), label='actual')

plt.title("Predicted vs Actual")
plt.xlabel("Time")
plt.ylabel('Price')
```

```
plt.legend()
plt.show()
```

1/1 [=====] - 0s 24ms/step



Visualizing Forecast Predictions

```
predictions = model.predict(np.array(bc_scaled.tail(steps_in)).reshape(1, steps_in, num
predictions = scaler.inverse_transform(np.array(predictions).reshape(-1,1)).tolist()

predictions = pd.DataFrame(predictions,
                            index=pd.date_range(start=bc_scaled.index[-1],
                                                  periods=len(predictions), freq="D"),
                            columns=bc_scaled.columns)

# print(preds)

periods = 10

actual = pd.DataFrame(scaler.inverse_transform(bc_scaled.tail(periods)),
                     index = bc_scaled.Close.tail(periods).index,
                     columns = bc_scaled.columns)

actual = pd.concat([actual, predictions.head(1)])

plt.figure(figsize=(12,4))
plt.plot(actual, label='actuals')
plt.plot(predictions, label='predictions')
plt.ylabel("price")
plt.xlabel('dates')
plt.title(f'Forecasting the next {len(predictions)} days')
plt.legend()
plt.show()
```

1/1 [=====] - 0s 25ms/step

Forecasting the next 10 days

