Stock Market Analysis using CNN-LSTM model

This project is about analysis of Stock Market and providing suggestions and predictions to the stockholders. For this, we used CNN-LSTM approach to create a blank model, then use it to train on stock market data. Further implementation is discussed below...

In [1]:

```
# This Python 3 environment comes with many helpful analytics libraries installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-pytho
n
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list all files
under the input directory

import os
#for dirname, _, filenames in os.walk('/kaggle/input'):
#    for filename in filenames:
#        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that gets preserve
d as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be saved outside of
the current session
```

Data Preprocessing and Analysis

In [2]:

```
import math
import seaborn as sns
import datetime as dt
from datetime import datetime
sns.set_style("whitegrid")
from pandas.plotting import autocorrelation_plot
import matplotlib.pyplot as plt
%matplotlib inline
plt.style.use("ggplot")
```

First we'd read the CSV file and then drop the null columns. Then we'd check the columns (some not all)

In [3]:

```
#1DP18XAREYFRWP4I
import requests
import csv
from tqdm import tqdm
key = "1DP18XAREYFRWP4I"

def request_stock_price_list(symbol, size, token):
    q_string = 'https://www.alphavantage.co/query?function=TIME_SERIES_DAILY_ADJUSTED&sym
bol={}&outputsize={}&apikey={}'

    print("Retrieving stock price data from Alpha Vantage (This may take a while)...")
    r = requests.get(q_string.format(symbol, size, token))
    print("Data has been successfully downloaded...")
    date = []
    colnames = list(range(0, 7))
    df = pd.DataFrame(columns = colnames)
```

```
    print("Sorting the retrieved data into a dataframe...")
    for i in tqdm(r.json()['Time Series (Daily)'].keys()):
        date.append(i)
        row = pd.DataFrame.from_dict(r.json()['Time Series (Daily)'][i], orient='index')
.reset_index().T[1:]
        df = pd.concat([df, row], ignore_index=True)
    df.columns = ["open", "high", "low", "close", "adjusted close", "volume", "dividend
amount", "split cf"]
    df['date'] = date
    return df
```

In [4]:

```
cv1 = request_stock_price_list('IBM', 'full', key)
print(cv1.head)
cv1.to_csv('data.csv')
```

```
Retrieving stock price data from Alpha Vantage (This may take a while)...
Data has been successfully downloaded...
Sorting the retrieved data into a dataframe...
100%|██████████| 5556/5556 [01:44<00:00, 53.37it/s]
<bound method NDFrame.head of          open     high      low    close adjusted close    vol
ume  \
0      118.62   119.61   117.53   118.5           118.5    8918702
1       115.0  116.335   114.56  115.81          115.81    3322012
2      116.16   117.27   116.08  116.73          116.73    3220802
3      116.79   117.94   116.04  116.79          116.79    4914995
4       116.0   118.81   115.19  116.47          116.47    6417218
...       ...      ...      ...     ...             ...        ...
5551    92.75    92.94    90.19   90.25  52.2266076272   13737600
5552    94.44    94.44     90.0   91.56  52.9846891341   16697600
5553    95.87    95.94     93.5   94.37  54.6108029006   10369100
5554    96.75    96.81    93.69   94.81  54.8654256968   11105400
5555     98.5    98.81    96.37   96.75  55.9880807527    9551800

     dividend amount split cf        date
0             0.0000      1.0  2021-11-29
1             0.0000      1.0  2021-11-26
2             0.0000      1.0  2021-11-24
3             0.0000      1.0  2021-11-23
4             0.0000      1.0  2021-11-22
...              ...      ...         ...
5551          0.0000      1.0  1999-11-05
5552          0.0000      1.0  1999-11-04
5553          0.0000      1.0  1999-11-03
5554          0.0000      1.0  1999-11-02
5555          0.0000      1.0  1999-11-01

[5556 rows x 9 columns]>
```

In [5]:

```
# For data preprocessing and analysis part
data = pd.read_csv('../input/price-volume-data-for-all-us-stocks-etfs/Stocks/abe.us.txt')
#data = pd.read_csv('../input/nifty50-stock-market-data/COALINDIA.csv')
#data = pd.read_csv('../input/stock-market-data/stock_market_data/nasdaq/csv/ABCO.csv')
#data = pd.read_csv('./data.csv')
# Any CSV or TXT file can be added here....
data.dropna(inplace=True)
data.head()
```

Out[5]:

	Date	Open	High	Low	Close	Volume	OpenInt
0	**2005-02-25**	**6.4987**	**6.6009**	**6.4668**	**6.5753**	**55766**	**0**
1	**2005-02-28**	**6.6072**	**6.7669**	**6.5944**	**6.6263**	**49343**	**0**
2	**2005-03-01**	**6.6391**	**6.6773**	**6.6072**	**6.6072**	**31643**	**0**

	Date	Open	High	Low	Close	Volume	OpenInt
3	2005-03-02	6.5753	6.6072	6.5434	6.5816	27101	0
4	2005-03-03	6.5753	6.6135	6.5562	6.5944	17387	0

In [6]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 3190 entries, 0 to 3189
Data columns (total 7 columns):
 #   Column   Non-Null Count  Dtype  
---  ------   --------------  -----  
 0   Date     3190 non-null   object 
 1   Open     3190 non-null   float64
 2   High     3190 non-null   float64
 3   Low      3190 non-null   float64
 4   Close    3190 non-null   float64
 5   Volume   3190 non-null   int64  
 6   OpenInt  3190 non-null   int64  
dtypes: float64(4), int64(2), object(1)
memory usage: 199.4+ KB
```

In [7]:

```
data.describe()
```

Out[7]:

	Open	High	Low	Close	Volume	OpenInt
count	3190.000000	3190.000000	3190.000000	3190.000000	3190.000000	3190.0
mean	11.599416	11.712848	11.484610	11.605599	28444.870846	0.0
std	2.350376	2.365621	2.327065	2.341989	37525.175821	0.0
min	5.860300	5.905000	5.834700	5.841100	106.000000	0.0
25%	10.534000	10.655000	10.413750	10.554000	8147.750000	0.0
50%	11.981000	12.067000	11.899000	11.988500	17741.500000	0.0
75%	13.271000	13.386750	13.189000	13.295750	36167.250000	0.0
max	18.130000	19.151000	17.842000	17.925000	634041.000000	0.0

In [8]:

```
data.isnull().sum()
```

Out[8]:

```
Date        0
Open        0
High        0
Low         0
Close       0
Volume      0
OpenInt     0
dtype: int64
```

In [9]:

```
data.reset_index(drop=True, inplace=True)
data.fillna(data.mean(), inplace=True)
data.head()
```

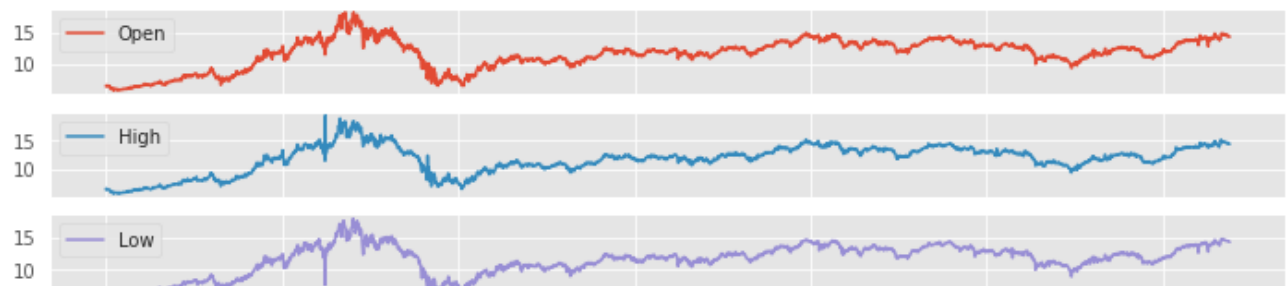
Out[9]:

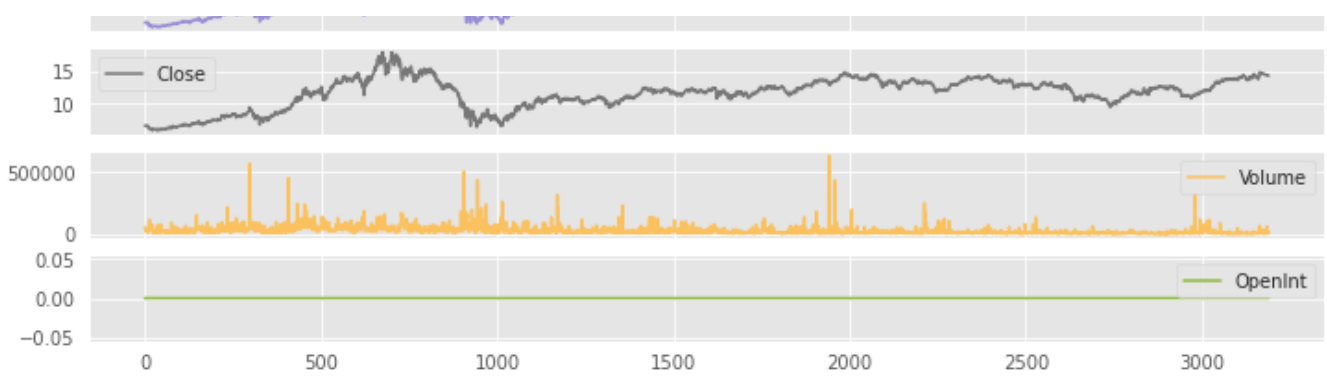
	Date	Open	High	Low	Close	Volume	OpenInt
0	2005-02-25	6.4987	6.6009	6.4668	6.5753	55766	0
1	2005-02-28	6.6072	6.7669	6.5944	6.6263	49343	0

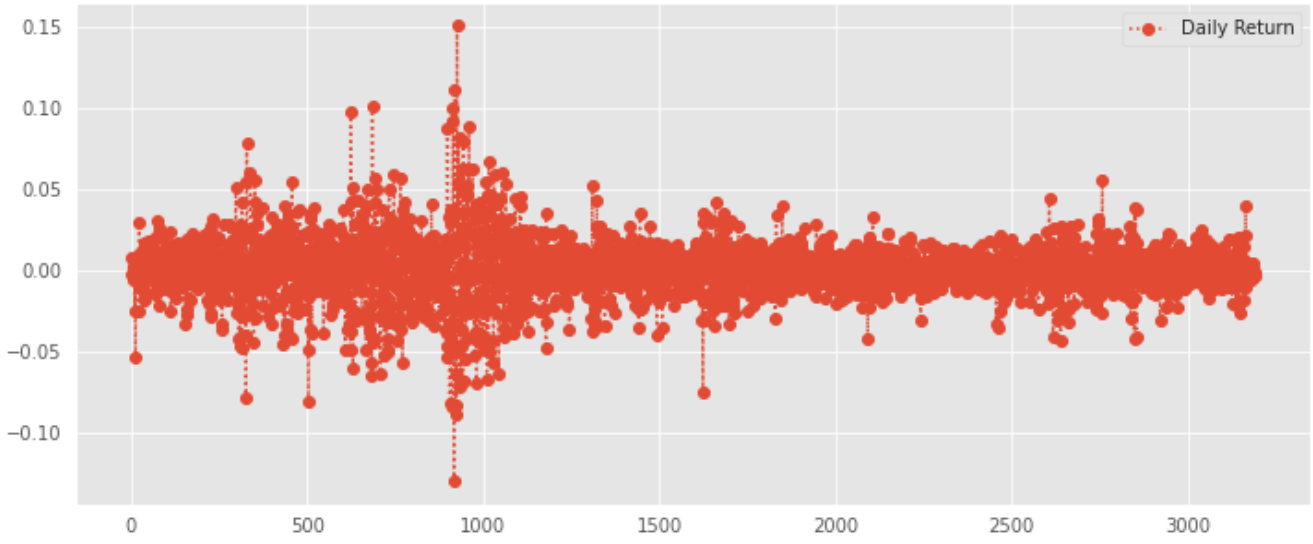
	Date	Open	High	Low	Close	Volume	OpenInt
2	2005-03-01	6.6391	6.6778	6.4879	6.5078	31643	0
3	2005-03-02	6.5753	6.6072	6.5434	6.5816	27101	0
4	2005-03-03	6.5753	6.6135	6.5562	6.5944	17387	0

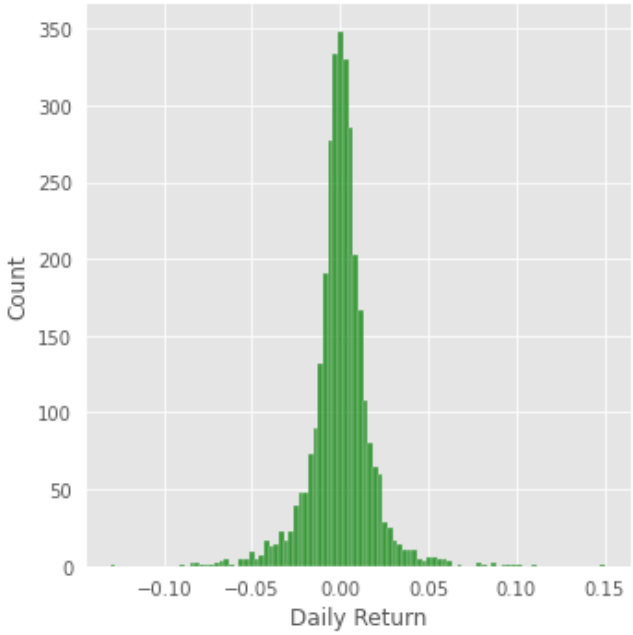
In [10]:

```
data.plot(legend=True,subplots=True, figsize = (12, 6))
plt.show()
#data['Close'].plot(legend=True, figsize = (12, 6))
#plt.show()
#data['Volume'].plot(legend=True,figsize=(12,7))
#plt.show()

data.shape
data.size
data.describe(include='all').T
data.dtypes
data.nunique()
ma_day = [10,50,100]

for ma in ma_day:
    column_name = "MA for %s days" %(str(ma))
    data[column_name]=pd.DataFrame.rolling(data['Close'],ma).mean()

data['Daily Return'] = data['Close'].pct_change()
# plot the daily return percentage
data['Daily Return'].plot(figsize=(12,5),legend=True,linestyle=':',marker='o')
plt.show()

sns.displot(data['Daily Return'].dropna(),bins=100,color='green')
plt.show()

date=pd.DataFrame(data['Date'])
closing_df1 = pd.DataFrame(data['Close'])
close1  = closing_df1.rename(columns={"Close": "data_close"})
close2=pd.concat([date,close1],axis=1)
close2.head()

data.reset_index(drop=True, inplace=True)
data.fillna(data.mean(), inplace=True)
data.head()

data.nunique()

data.sort_index(axis=1,ascending=True)

cols_plot = ['Open', 'High', 'Low','Close','Volume','MA for 10 days','MA for 50 days','MA
for 100 days','Daily Return']
axes = data[cols_plot].plot(marker='.', alpha=0.7, linestyle='None', figsize=(11, 9), su
bplots=True)
for ax in axes:
    ax.set_ylabel('Daily trade')

plt.plot(data['Close'], label="Close price")
plt.xlabel("Timestamp")
plt.ylabel("Closing price")
df = data
print(df)

data.isnull().sum()
```









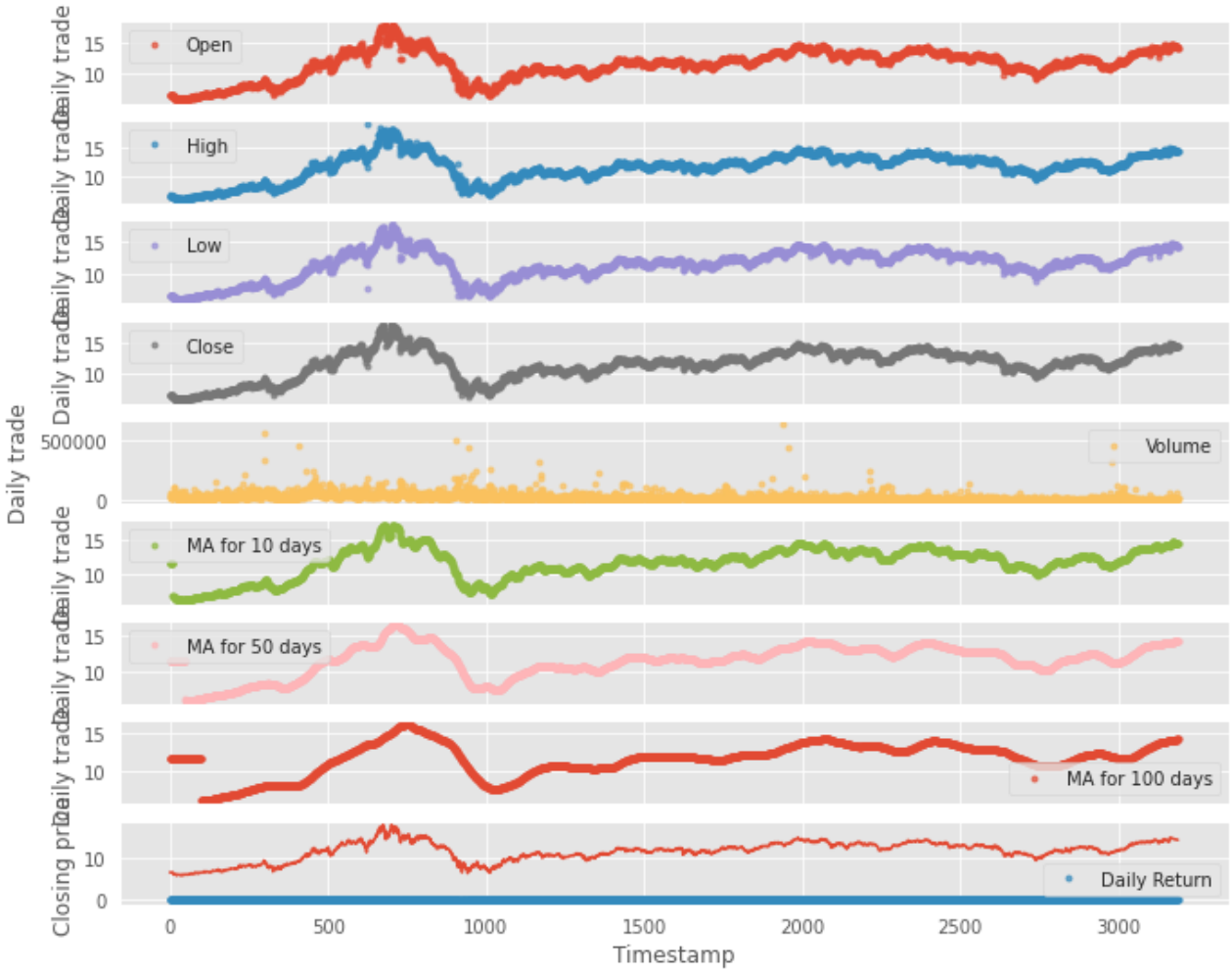
	Date	Open	High	Low	Close	Volume	OpenInt	\
0	2005-02-25	6.4987	6.6009	6.4668	6.5753	55766	0	
1	2005-02-28	6.6072	6.7669	6.5944	6.6263	49343	0	
2	2005-03-01	6.6391	6.6773	6.6072	6.6072	31643	0	
3	2005-03-02	6.5753	6.6072	6.5434	6.5816	27101	0	
4	2005-03-03	6.5753	6.6135	6.5562	6.5944	17387	0	
...	...	...	...	...	...	...	...	...
3185	2017-11-06	14.3998	14.4802	14.3900	14.4400	62423	0	
3186	2017-11-07	14.4400	14.4400	14.4000	14.4000	6722	0	
3187	2017-11-08	14.3400	14.4352	14.3400	14.3781	6304	0	
3188	2017-11-09	14.3300	14.3737	14.2800	14.3200	18761	0	
3189	2017-11-10	14.2500	14.3000	14.2400	14.3000	10658	0	

	MA for 10 days	MA for 50 days	MA for 100 days	Daily Return
0	11.60878	11.625272	11.649354	0.000388
1	11.60878	11.625272	11.649354	0.007756
2	11.60878	11.625272	11.649354	-0.002882
3	11.60878	11.625272	11.649354	-0.003875
4	11.60878	11.625272	11.649354	0.001945

```
...              ...             ...             ...            ...
3185        14.44648        14.344662       14.136796       0.003893
3186        14.43071        14.355862       14.142926      -0.002770
3187        14.42077        14.361972       14.150117      -0.001521
3188        14.40677        14.369792       14.155817      -0.004041
3189        14.39377        14.371792       14.160597      -0.001397

[3190 rows x 11 columns]
```

Out[10]:

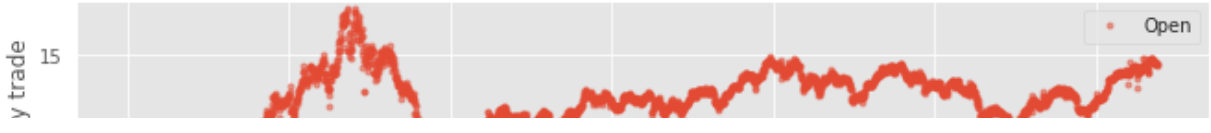
```
Date                0
Open                0
High                0
Low                 0
Close               0
Volume              0
OpenInt             0
MA for 10 days      0
MA for 50 days      0
MA for 100 days     0
Daily Return        0
dtype: int64
```

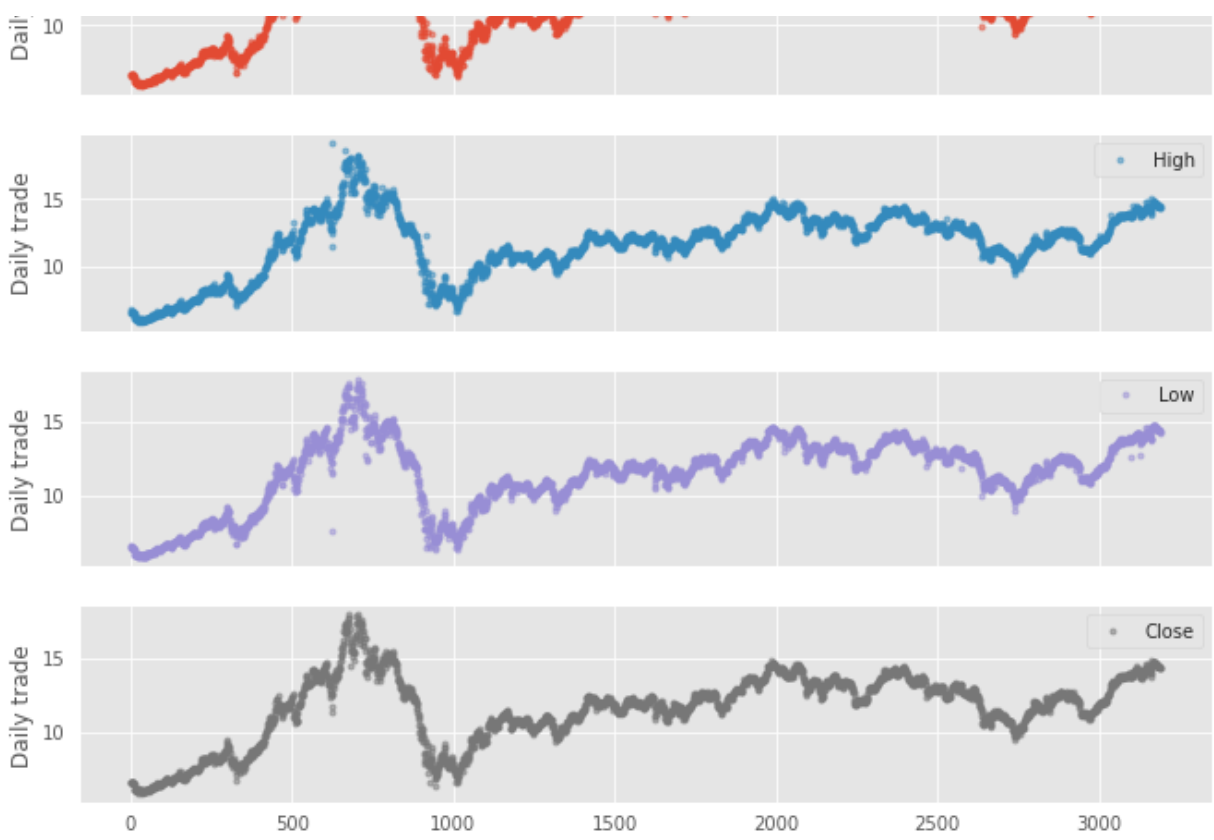


After that, we'll visualize the data for understanding, this is shown below...

In [11]:

```
cols_plot = ['Open', 'High', 'Low','Close']
axes = data[cols_plot].plot(marker='.', alpha=0.5, linestyle='None', figsize=(11, 9), su
bplots=True)
for ax in axes:
    ax.set_ylabel('Daily trade')
```





Then we'd print the data after making changes and dropping null data

In [12]:

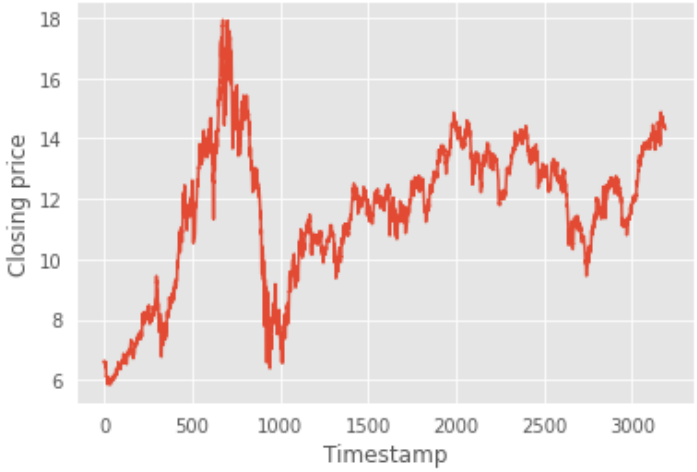
```
plt.plot(data['Close'], label="Close price")
plt.xlabel("Timestamp")
plt.ylabel("Closing price")
df = data
print(df)

df.describe().transpose()
```

```
            Date      Open      High       Low     Close  Volume  OpenInt  \
0     2005-02-25    6.4987    6.6009    6.4668    6.5753   55766        0
1     2005-02-28    6.6072    6.7669    6.5944    6.6263   49343        0
2     2005-03-01    6.6391    6.6773    6.6072    6.6072   31643        0
3     2005-03-02    6.5753    6.6072    6.5434    6.5816   27101        0
4     2005-03-03    6.5753    6.6135    6.5562    6.5944   17387        0
...          ...       ...       ...       ...       ...     ...      ...
3185  2017-11-06   14.3998   14.4802   14.3900   14.4400   62423        0
3186  2017-11-07   14.4400   14.4400   14.4000   14.4000    6722        0
3187  2017-11-08   14.3400   14.4352   14.3400   14.3781    6304        0
3188  2017-11-09   14.3300   14.3737   14.2800   14.3200   18761        0
3189  2017-11-10   14.2500   14.3000   14.2400   14.3000   10658        0

      MA for 10 days  MA for 50 days  MA for 100 days  Daily Return
0           11.60878       11.625272        11.649354      0.000388
1           11.60878       11.625272        11.649354      0.007756
2           11.60878       11.625272        11.649354     -0.002882
3           11.60878       11.625272        11.649354     -0.003875
4           11.60878       11.625272        11.649354      0.001945
...              ...             ...              ...           ...
3185        14.44648       14.344662        14.136796      0.003893
3186        14.43071       14.355862        14.142926     -0.002770
3187        14.42077       14.361972        14.150117     -0.001521
3188        14.40677       14.369792        14.155817     -0.004041
3189        14.39377       14.371792        14.160597     -0.001397

[3190 rows x 11 columns]
```

Out[12]:

	count	mean	std	min	25%	50%	75%	max

	count	mean	std	min	25%	50%	75%	max
Open	3190.0	11.599416	2.350376	5.860300	10.534000	11.981000	13.271000	18.130000
High	3190.0	11.712848	2.365621	5.905000	10.655000	12.067000	13.386750	19.151000
Low	3190.0	11.484610	2.327065	5.834700	10.413750	11.899000	13.189000	17.842000
Close	3190.0	11.605599	2.341989	5.841100	10.554000	11.988500	13.295750	17.925000
Volume	3190.0	28444.870846	37525.175821	106.000000	8147.750000	17741.500000	36167.250000	634041.000000
OpenInt	3190.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MA for 10 days	3190.0	11.608780	2.321162	5.963080	10.577125	11.962700	13.297200	17.329400
MA for 50 days	3190.0	11.625272	2.231059	6.037646	10.591696	11.933450	13.269480	16.618460
MA for 100 days	3190.0	11.649354	2.113346	6.221377	10.632551	11.876775	13.200810	16.042560
Daily Return	3190.0	0.000388	0.017010	-0.130345	-0.006439	0.000484	0.007807	0.150503



In [13]:

```
X = data.drop(['Date', 'Close'], axis=1)
Y = data['Close']

X.shape,Y.shape

from mlxtend.feature_selection import SequentialFeatureSelector as sfs
from sklearn.linear_model import LinearRegression

lreg = LinearRegression()
sfs1 = sfs(lreg, k_features=2, forward=False, verbose=2, scoring='neg_mean_squared_error
')

sfs1 = sfs1.fit(X, Y)

feat_names = list(sfs1.k_feature_names_)
print(feat_names)

# creating a new dataframe using the above variables and adding the target variable
new_data = data[feat_names]
new_data['Close'] = data['Close']

# first five rows of the new data
new_data.head()

new_data.shape, data.shape

df = new_data
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   9 out of   9 | elapsed:    0.1s finished

[2021-11-30 02:51:18] Features: 8/2 -- score: -0.011305106736314 23[Parallel(n_jobs=1)]: U
sing backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   8 out of   8 | elapsed:    0.2s finished
```

```
[2021-11-30 02:51:18] Features: 7/2 -- score: -0.011114316874792215[Parallel(n_jobs=1)]:
Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   7 out of   7 | elapsed:    0.1s finished

[2021-11-30 02:51:19] Features: 6/2 -- score: -0.011080371541763374[Parallel(n_jobs=1)]:
Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   6 out of   6 | elapsed:    0.1s finished

[2021-11-30 02:51:19] Features: 5/2 -- score: -0.011080371541730121[Parallel(n_jobs=1)]:
Using backend SequentialBackend with 1 concurrent workers.
```

```
['High', 'Low']
```

```
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:    0.1s finished

[2021-11-30 02:51:19] Features: 4/2 -- score: -0.011086733169734618[Parallel(n_jobs=1)]:
Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   4 out of   4 | elapsed:    0.0s finished

[2021-11-30 02:51:19] Features: 3/2 -- score: -0.011860213917250834[Parallel(n_jobs=1)]:
Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    0.0s remaining:    0.0s
[Parallel(n_jobs=1)]: Done   3 out of   3 | elapsed:    0.0s finished

[2021-11-30 02:51:19] Features: 2/2 -- score: -0.014047232655157732/opt/conda/lib/python3
.7/site-packages/ipykernel_launcher.py:19: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_g
uide/indexing.html#returning-a-view-versus-a-copy
```

The data has been analysed but it must be converted into data of shape [100,1] to make it easier for CNN to train on... Else it won't select necessary features and the model will fail

In [14]:

```
from sklearn.model_selection import train_test_split

X = []
Y = []
window_size=100
for i in range(1 , len(df) - window_size -1 , 1):
    first = df.iloc[i,2]
    temp = []
    temp2 = []
    for j in range(window_size):
        temp.append((df.iloc[i + j, 2] - first) / first)
    temp2.append((df.iloc[i + window_size, 2] - first) / first)
    X.append(np.array(temp).reshape(100, 1))
    Y.append(np.array(temp2).reshape(1, 1))

x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size=0.2, shuffle=True)

train_X = np.array(x_train)
test_X = np.array(x_test)
train_Y = np.array(y_train)
test_Y = np.array(y_test)

train_X = train_X.reshape(train_X.shape[0],1,100,1)
test_X = test_X.reshape(test_X.shape[0],1,100,1)

print(len(train_X))
print(len(test_X))
```

```
2470
618
```

Training part

This part has 2 subparts: CNN and LSTM

For CNN, the layers are created with sizes 64,128,64. In every layer, TimeDistributed function is added to track the features with respect to time. In between them, Pooling layers are added.

After that, it's passed to Bi-LSTM layers

In [15]:

```
# For creating model and training
import tensorflow as tf
from tensorflow.keras.layers import Conv1D, LSTM, Dense, Dropout, Bidirectional, TimeDist
ributed
from tensorflow.keras.layers import MaxPooling1D, Flatten
from tensorflow.keras.regularizers import L1, L2
from tensorflow.keras.metrics import Accuracy
from tensorflow.keras.metrics import RootMeanSquaredError

model = tf.keras.Sequential()

# Creating the Neural Network model here...
model.add(TimeDistributed(Conv1D(64, kernel_size=1, activation='relu', input_shape=(None
, 100, 1))))
model.add(TimeDistributed(MaxPooling1D(2)))
model.add(TimeDistributed(Conv1D(128, kernel_size=1, activation='relu')))
model.add(TimeDistributed(MaxPooling1D(2)))
model.add(TimeDistributed(Conv1D(64, kernel_size=1, activation='relu')))
model.add(TimeDistributed(MaxPooling1D(2)))
model.add(TimeDistributed(Flatten()))
# model.add(Dense(5, kernel_regularizer=L2(0.01)))
model.add(Bidirectional(LSTM(100, return_sequences=True)))
model.add(Dropout(0.25))
model.add(Bidirectional(LSTM(100, return_sequences=False)))
model.add(Dropout(0.5))
model.add(Dense(1, activation='linear'))
model.compile(optimizer='adam', loss='mse', metrics=['mse', 'mae'])

history = model.fit(train_X, train_Y, validation_data=(test_X,test_Y), epochs=40,batch_s
ize=40, verbose=1, shuffle =True)
```

```
2021-11-30 02:51:29.364191: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudart.so.11.0
2021-11-30 02:51:33.189587: I tensorflow/compiler/jit/xla_cpu_device.cc:41] Not creating
XLA devices, tf_xla_enable_xla_devices not set
2021-11-30 02:51:33.192989: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcuda.so.1
2021-11-30 02:51:33.231406: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.232035: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1720] Foun
d device 0 with properties:
pciBusID: 0000:00:04.0 name: Tesla P100-PCIE-16GB computeCapability: 6.0
coreClock: 1.3285GHz coreCount: 56 deviceMemorySize: 15.90GiB deviceMemoryBandwidth: 681.
88GiB/s
2021-11-30 02:51:33.232078: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudart.so.11.0
2021-11-30 02:51:33.257671: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublas.so.11
2021-11-30 02:51:33.257744: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublasLt.so.11
2021-11-30 02:51:33.273068: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcufft.so.10
2021-11-30 02:51:33.281980: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcurand.so.10
2021-11-30 02:51:33.307966: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcusolver.so.10
```

```
2021-11-30 02:51:33.314817: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcusparse.so.11
2021-11-30 02:51:33.318693: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudnn.so.8
2021-11-30 02:51:33.318865: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.319625: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.321347: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1862] Addi
ng visible gpu devices: 0
2021-11-30 02:51:33.322668: I tensorflow/core/platform/cpu_feature_guard.cc:142] This Ten
sorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the f
ollowing CPU instructions in performance-critical operations:  AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flag
s.
2021-11-30 02:51:33.322933: I tensorflow/compiler/jit/xla_gpu_device.cc:99] Not creating
XLA devices, tf_xla_enable_xla_devices not set
2021-11-30 02:51:33.323102: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.323709: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1720] Foun
d device 0 with properties:
pciBusID: 0000:00:04.0 name: Tesla P100-PCIE-16GB computeCapability: 6.0
coreClock: 1.3285GHz coreCount: 56 deviceMemorySize: 15.90GiB deviceMemoryBandwidth: 681.
88GiB/s
2021-11-30 02:51:33.323768: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudart.so.11.0
2021-11-30 02:51:33.323796: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublas.so.11
2021-11-30 02:51:33.323825: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublasLt.so.11
2021-11-30 02:51:33.323858: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcufft.so.10
2021-11-30 02:51:33.323885: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcurand.so.10
2021-11-30 02:51:33.323906: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcusolver.so.10
2021-11-30 02:51:33.323930: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcusparse.so.11
2021-11-30 02:51:33.323951: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudnn.so.8
2021-11-30 02:51:33.324042: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.324708: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:33.325256: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1862] Addi
ng visible gpu devices: 0
2021-11-30 02:51:33.326208: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudart.so.11.0
2021-11-30 02:51:34.787188: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1261] Devi
ce interconnect StreamExecutor with strength 1 edge matrix:
2021-11-30 02:51:34.787234: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1267]
0
2021-11-30 02:51:34.787244: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1280] 0:
N
2021-11-30 02:51:34.789968: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:34.790766: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:34.791430: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:941] s
uccessful NUMA node read from SysFS had negative value (-1), but there must be at least o
ne NUMA node, so returning NUMA node zero
2021-11-30 02:51:34.792031: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1406] Crea
ted TensorFlow device (/job:localhost/replica:0/task:0/device:GPU:0 with 14957 MB memory)
-> physical GPU (device: 0, name: Tesla P100-PCIE-16GB, pci bus id: 0000:00:04.0, compute
capability: 6.0)
```

```
2021-11-30 02:51:35.205084: I tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:11
6] None of the MLIR optimization passes are enabled (registered 2)
2021-11-30 02:51:35.216561: I tensorflow/core/platform/profile_utils/cpu_utils.cc:112] CP
U Frequency: 2000179999 Hz

Epoch 1/40

2021-11-30 02:51:40.817424: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublas.so.11
2021-11-30 02:51:41.581227: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcublasLt.so.11
2021-11-30 02:51:41.604846: I tensorflow/stream_executor/platform/default/dso_loader.cc:4
9] Successfully opened dynamic library libcudnn.so.8

62/62 [==============================] - 14s 37ms/step - loss: 0.0128 - mse: 0.0128 - mae
: 0.0789 - val_loss: 0.0028 - val_mse: 0.0028 - val_mae: 0.0377
Epoch 2/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0023 - mse: 0.0023 - mae:
0.0359 - val_loss: 0.0021 - val_mse: 0.0021 - val_mae: 0.0322
Epoch 3/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0022 - mse: 0.0022 - mae:
0.0335 - val_loss: 0.0021 - val_mse: 0.0021 - val_mae: 0.0342
Epoch 4/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0021 - mse: 0.0021 - mae:
0.0330 - val_loss: 0.0019 - val_mse: 0.0019 - val_mae: 0.0310
Epoch 5/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0018 - mse: 0.0018 - mae:
0.0307 - val_loss: 0.0018 - val_mse: 0.0018 - val_mae: 0.0299
Epoch 6/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0294 - val_loss: 0.0016 - val_mse: 0.0016 - val_mae: 0.0288
Epoch 7/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0019 - mse: 0.0019 - mae:
0.0318 - val_loss: 0.0018 - val_mse: 0.0018 - val_mae: 0.0305
Epoch 8/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0018 - mse: 0.0018 - mae:
0.0307 - val_loss: 0.0018 - val_mse: 0.0018 - val_mae: 0.0312
Epoch 9/40
62/62 [==============================] - 1s 13ms/step - loss: 0.0021 - mse: 0.0021 - mae:
0.0346 - val_loss: 0.0019 - val_mse: 0.0019 - val_mae: 0.0313
Epoch 10/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0302 - val_loss: 0.0016 - val_mse: 0.0016 - val_mae: 0.0291
Epoch 11/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0305 - val_loss: 0.0017 - val_mse: 0.0017 - val_mae: 0.0294
Epoch 12/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0018 - mse: 0.0018 - mae:
0.0303 - val_loss: 0.0021 - val_mse: 0.0021 - val_mae: 0.0356
Epoch 13/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0302 - val_loss: 0.0026 - val_mse: 0.0026 - val_mae: 0.0379
Epoch 14/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0300 - val_loss: 0.0017 - val_mse: 0.0017 - val_mae: 0.0295
Epoch 15/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0294 - val_loss: 0.0016 - val_mse: 0.0016 - val_mae: 0.0290
Epoch 16/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0291 - val_loss: 0.0020 - val_mse: 0.0020 - val_mae: 0.0340
Epoch 17/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0018 - mse: 0.0018 - mae:
0.0312 - val_loss: 0.0018 - val_mse: 0.0018 - val_mae: 0.0316
Epoch 18/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0296 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0281
Epoch 19/40
62/62 [==============================] - 1s 13ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0298 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0284
Epoch 20/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0285 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0285
```

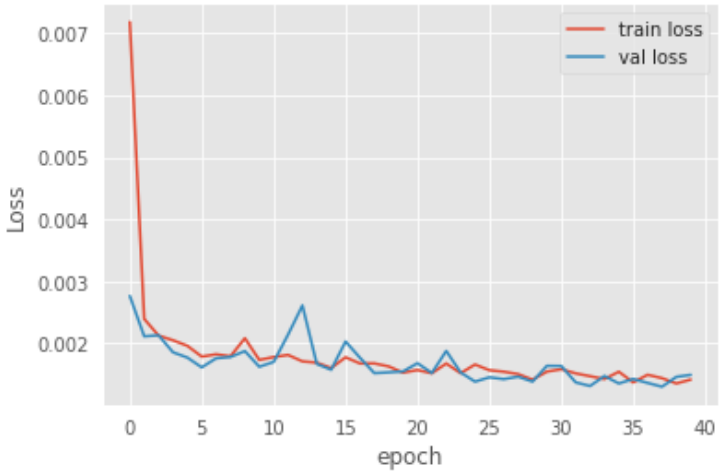
```
Epoch 21/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0292 - val_loss: 0.0017 - val_mse: 0.0017 - val_mae: 0.0299
Epoch 22/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0295 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0279
Epoch 23/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0299 - val_loss: 0.0019 - val_mse: 0.0019 - val_mae: 0.0315
Epoch 24/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0295 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0288
Epoch 25/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0017 - mse: 0.0017 - mae:
0.0295 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0270
Epoch 26/40
62/62 [==============================] - 1s 12ms/step - loss: 0.0014 - mse: 0.0014 - mae:
0.0279 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0276
Epoch 27/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0287 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0275
Epoch 28/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0289 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0282
Epoch 29/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae:
0.0274 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0273
Epoch 30/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0287 - val_loss: 0.0016 - val_mse: 0.0016 - val_mae: 0.0303
Epoch 31/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0289 - val_loss: 0.0016 - val_mse: 0.0016 - val_mae: 0.0310
Epoch 32/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0293 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0271
Epoch 33/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0279 - val_loss: 0.0013 - val_mse: 0.0013 - val_mae: 0.0267
Epoch 34/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae:
0.0274 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0280
Epoch 35/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae:
0.0295 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0271
Epoch 36/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0012 - mse: 0.0012 - mae:
0.0259 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0277
Epoch 37/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0284 - val_loss: 0.0014 - val_mse: 0.0014 - val_mae: 0.0272
Epoch 38/40
62/62 [==============================] - 1s 11ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0285 - val_loss: 0.0013 - val_mse: 0.0013 - val_mae: 0.0264
Epoch 39/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0013 - mse: 0.0013 - mae:
0.0270 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0279
Epoch 40/40
62/62 [==============================] - 1s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae:
0.0273 - val_loss: 0.0015 - val_mse: 0.0015 - val_mae: 0.0280
```

In [16]:

```
plt.plot(history.history['loss'], label='train loss')
plt.plot(history.history['val_loss'], label='val loss')
plt.xlabel("epoch")
plt.ylabel("Loss")
plt.legend()
```

Out[16]:

```
<matplotlib.legend.Legend at 0x7fbb700b8790>
```

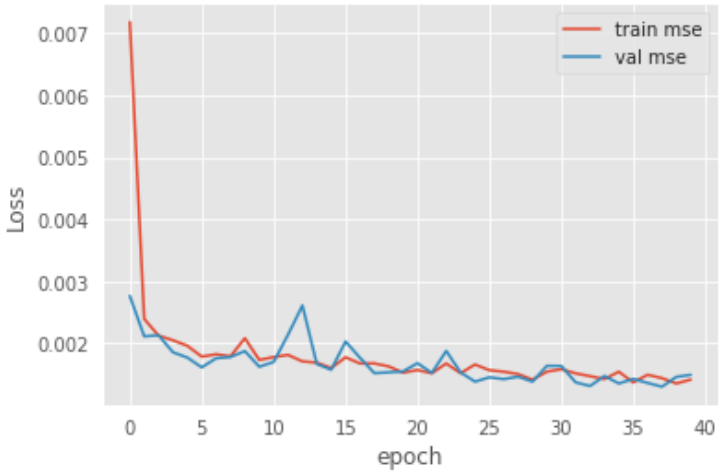


In [17]:

```
plt.plot(history.history['mse'], label='train mse')
plt.plot(history.history['val_mse'], label='val mse')
plt.xlabel("epoch")
plt.ylabel("Loss")
plt.legend()
```

Out[17]:

```
<matplotlib.legend.Legend at 0x7fb71c970b50>
```

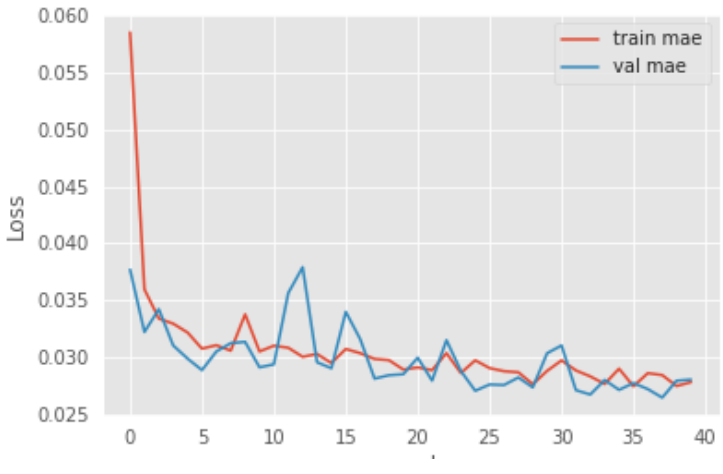


In [18]:

```
plt.plot(history.history['mae'], label='train mae')
plt.plot(history.history['val_mae'], label='val mae')
plt.xlabel("epoch")
plt.ylabel("Loss")
plt.legend()
```

Out[18]:

```
<matplotlib.legend.Legend at 0x7fb71c88eb10>
```



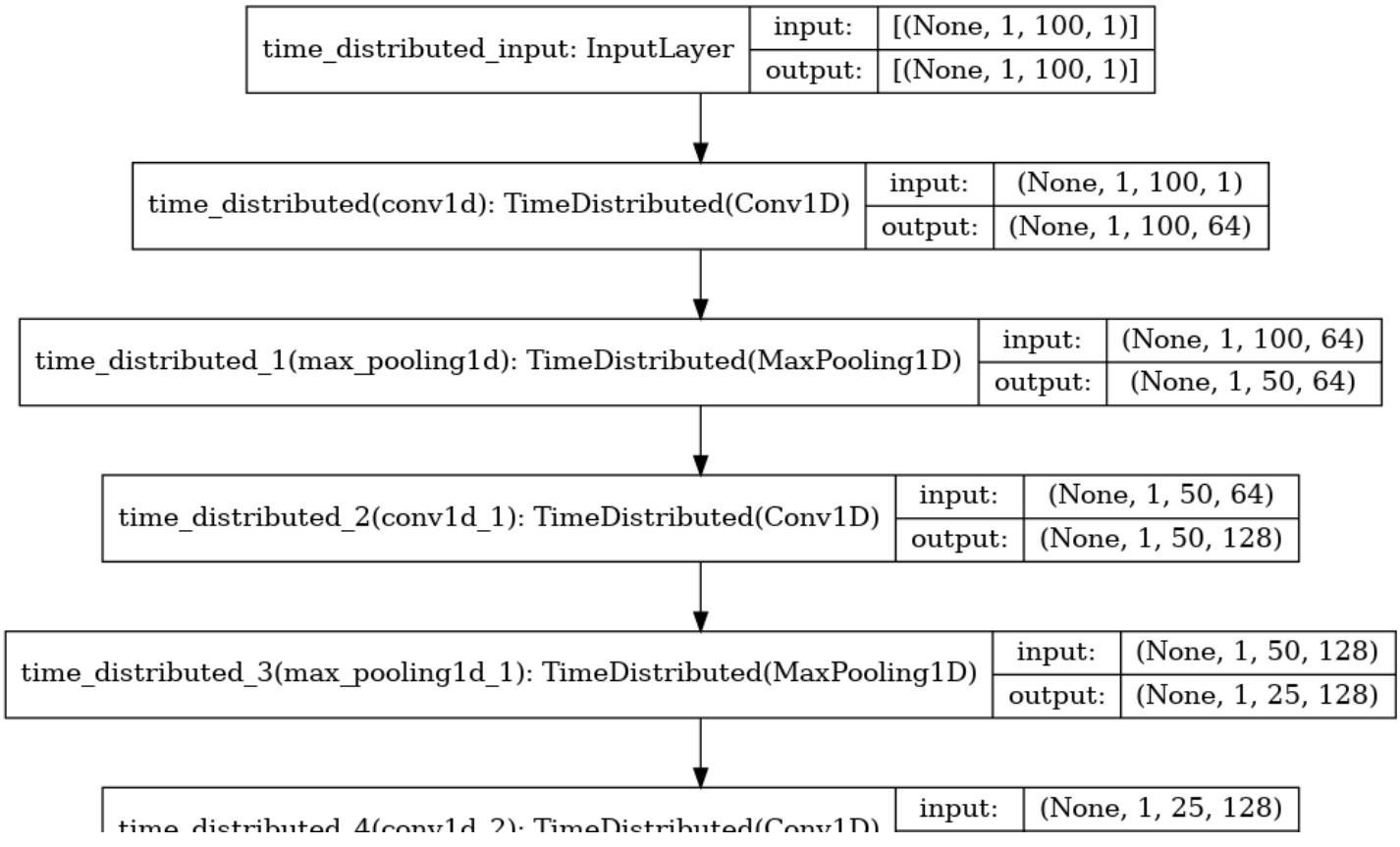
epoch

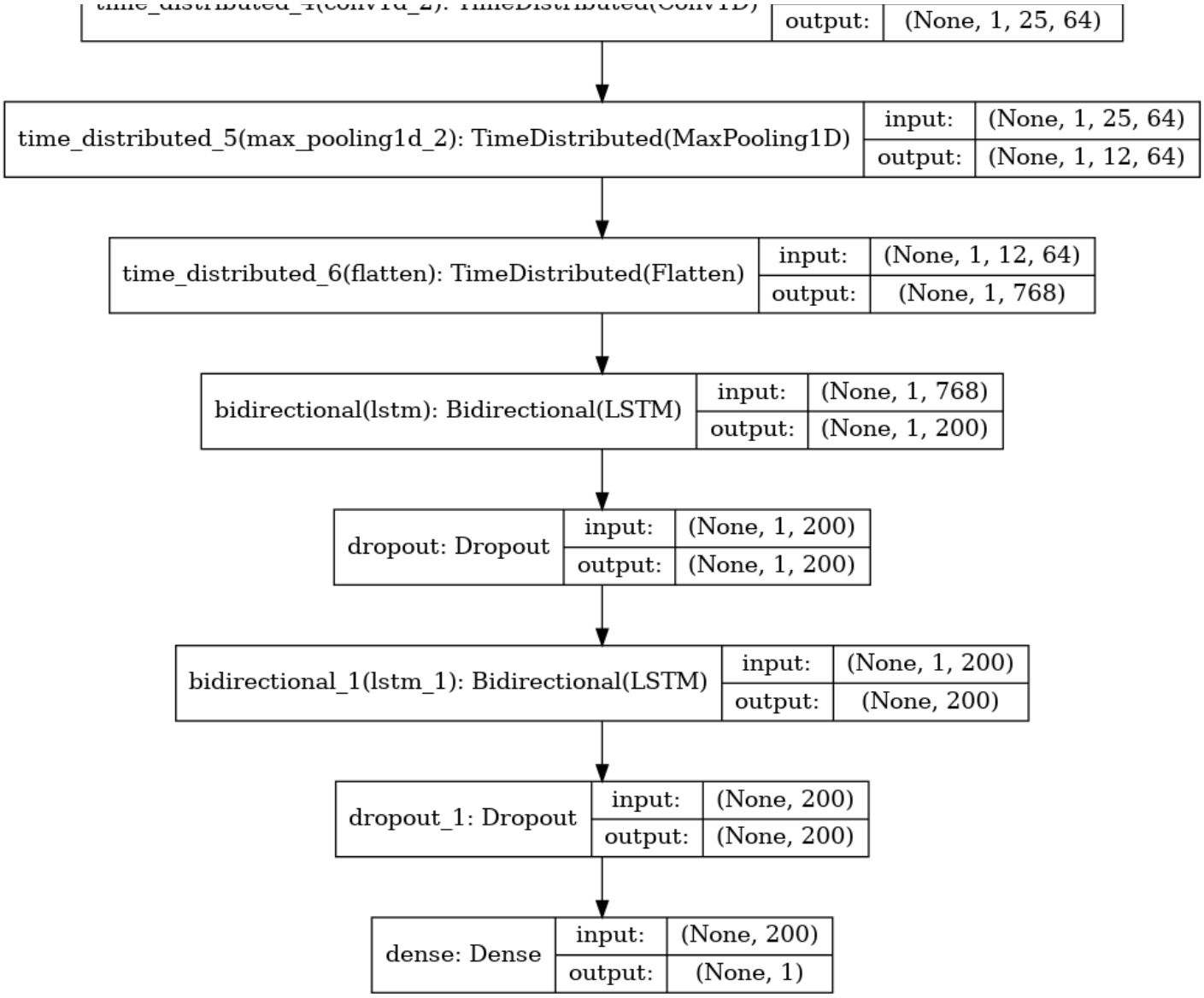
In [19]:

```
# After the model has been constructed, we need to train
from tensorflow.keras.utils import plot_model
print(model.summary())
plot_model(model, to_file='model.png', show_shapes=True, show_layer_names=True)
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
time_distributed (TimeDistri (None, 1, 100, 64)        128
_________________________________________________________________
time_distributed_1 (TimeDist (None, 1, 50, 64)         0
_________________________________________________________________
time_distributed_2 (TimeDist (None, 1, 50, 128)        8320
_________________________________________________________________
time_distributed_3 (TimeDist (None, 1, 25, 128)        0
_________________________________________________________________
time_distributed_4 (TimeDist (None, 1, 25, 64)         8256
_________________________________________________________________
time_distributed_5 (TimeDist (None, 1, 12, 64)         0
_________________________________________________________________
time_distributed_6 (TimeDist (None, 1, 768)            0
_________________________________________________________________
bidirectional (Bidirectional (None, 1, 200)            695200
_________________________________________________________________
dropout (Dropout)            (None, 1, 200)            0
_________________________________________________________________
bidirectional_1 (Bidirection (None, 200)               240800
_________________________________________________________________
dropout_1 (Dropout)          (None, 200)               0
_________________________________________________________________
dense (Dense)                (None, 1)                 201
=================================================================
Total params: 952,905
Trainable params: 952,905
Non-trainable params: 0
_________________________________________________________________
None
```

Out[19]:





In [20]:

```
model.evaluate(test_X, test_Y)
```

```
20/20 [==============================] - 0s 5ms/step - loss: 0.0015 - mse: 0.0015 - mae:
0.0280
```

Out[20]:

```
[0.0014896756038069725, 0.0014896756038069725, 0.028016122058033943]
```

In [21]:

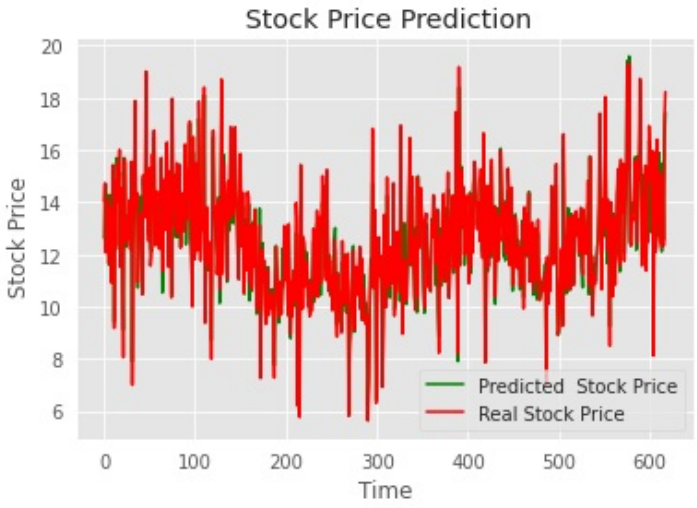
```
from sklearn.metrics import explained_variance_score
from sklearn.metrics import r2_score
from sklearn.metrics import max_error

# predict probabilities for test set
yhat_probs = model.predict(test_X, verbose=0)
# predict crisp classes for test set
yhat_classes = model.predict_classes(test_X, verbose=0)
# reduce to 1d array
yhat_probs = yhat_probs[:, 0]
yhat_classes = yhat_classes[:, 0]

var = explained_variance_score(test_Y.reshape(-1,1), yhat_probs)
print('Variance: %f' % var)

r2 = r2_score(test_Y.reshape(-1,1), yhat_probs)
print('R2 Score: %f' % var)

var2 = max_error(test_Y.reshape(-1,1), yhat_probs)
print('Max Error: %f' % var2)
```

```
Variance: 0.939601
R2 Score: 0.939601
Max Error: 0.205356
```

```
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/sequential.py:450:
UserWarning: `model.predict_classes()` is deprecated and will be removed after 2021-01-01
. Please use instead:* `np.argmax(model.predict(x), axis=-1)`,   if your model does multi
-class classification   (e.g. if it uses a `softmax` last-layer activation).* `(model.pre
dict(x) > 0.5).astype("int32")`,   if your model does binary classification   (e.g. if it
uses a `sigmoid` last-layer activation).
  warnings.warn('`model.predict_classes()` is deprecated and '
```

In [22]:

```
predicted  = model.predict(test_X)
test_label = test_Y.reshape(-1,1)
predicted = np.array(predicted[:,0]).reshape(-1,1)
len_t = len(train_X)
for j in range(len_t , len_t + len(test_X)):
    temp = data.iloc[j,3]
    test_label[j - len_t] = test_label[j - len_t] * temp + temp
    predicted[j - len_t] = predicted[j - len_t] * temp + temp
plt.plot(predicted, color = 'green', label = 'Predicted  Stock Price')
plt.plot(test_label, color = 'red', label = 'Real Stock Price')
plt.title(' Stock Price Prediction')
plt.xlabel('Time')
plt.ylabel(' Stock Price')
plt.legend()
plt.show()
```



Testing part

In this part, the model is saved and loaded back again. Then, it's made to train again but with different data to check it's loss and prediction

In [23]:

```
# First we need to save a model
model.save("model.h5")
```

In [24]:

```
# Load model
new_model = tf.keras.models.load_model("./model.h5")
```

In [25]:

```
new_model.summary()
```

```
Model: "sequential"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
time_distributed (TimeDistri (None, 1, 100, 64)        128
_________________________________________________________________
time_distributed_1 (TimeDist (None, 1, 50, 64)         0
_________________________________________________________________
time_distributed_2 (TimeDist (None, 1, 50, 128)        8320
_________________________________________________________________
time_distributed_3 (TimeDist (None, 1, 25, 128)        0
_________________________________________________________________
time_distributed_4 (TimeDist (None, 1, 25, 64)         8256
_________________________________________________________________
time_distributed_5 (TimeDist (None, 1, 12, 64)         0
_________________________________________________________________
time_distributed_6 (TimeDist (None, 1, 768)            0
_________________________________________________________________
bidirectional (Bidirectional (None, 1, 200)            695200
_________________________________________________________________
dropout (Dropout)            (None, 1, 200)            0
_________________________________________________________________
bidirectional_1 (Bidirection (None, 200)               240800
_________________________________________________________________
dropout_1 (Dropout)          (None, 200)               0
_________________________________________________________________
dense (Dense)                (None, 1)                 201
=================================================================
Total params: 952,905
Trainable params: 952,905
Non-trainable params: 0
_________________________________________________________________
```

In [26]:

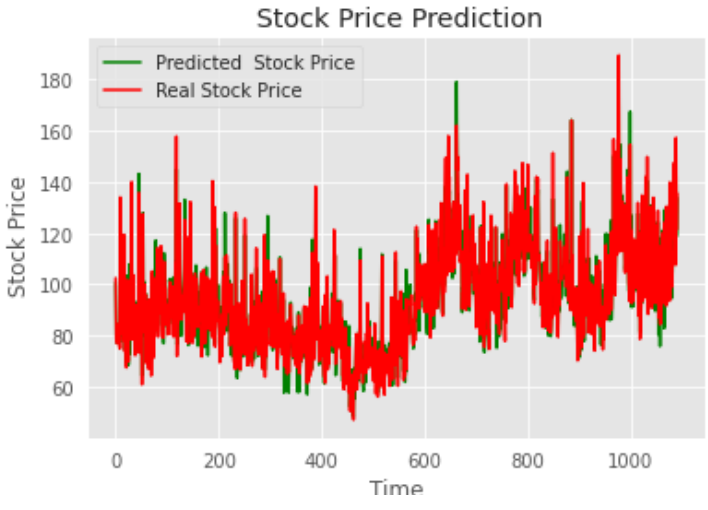
```
# For data preprocessing and analysis part
#data2 = pd.read_csv('../input/price-volume-data-for-all-us-stocks-etfs/Stocks/aaoi.us.tx
t')
#data2 = pd.read_csv('../input/nifty50-stock-market-data/SBIN.csv')
#data2 = pd.read_csv('../input/stock-market-data/stock_market_data/nasdaq/csv/ACTG.csv')
data2 = pd.read_csv('./data.csv')
# Any CSV or TXT file can be added here....
data2.dropna(inplace=True)
data2.head()

data2.reset_index(drop=True, inplace=True)
data2.fillna(data.mean(), inplace=True)
data2.head()
df2 = data2.drop('date', axis=1)

print(df2)

X = []
Y = []
window_size=100
for i in range(1 , len(df2) - window_size -1 , 1):
    first = df2.iloc[i,4]
    temp = []
    temp2 = []
    for j in range(window_size):
        temp.append((df2.iloc[i + j, 4] - first) / first)
    # for j in range(week):
    temp2.append((df2.iloc[i + window_size, 4] - first) / first)
    # X.append(np.array(stock.iloc[i:i+window_size,4]).reshape(50,1))
    # Y.append(np.array(stock.iloc[i+window_size,4]).reshape(1,1))
    # print(stock2.iloc[i:i+window_size,4])
    X.append(np.array(temp).reshape(100, 1))
    Y.append(np.array(temp2).reshape(1, 1))

x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size=0.2, shuffle=True)

train_X = np.array(x_train)
test_X = np.array(x_test)
train_Y = np.array(y_train)
```

```
test_Y = np.array(y_test)

train_X = train_X.reshape(train_X.shape[0],1,100,1)
test_X = test_X.reshape(test_X.shape[0],1,100,1)

print(len(train_X))
print(len(test_X))
```

```
      Unnamed: 0    open     high     low   close  adjusted close     volume  \
0              0  118.62  119.610  117.53  118.50      118.500000    8918702
1              1  115.00  116.335  114.56  115.81      115.810000    3322012
2              2  116.16  117.270  116.08  116.73      116.730000    3220802
3              3  116.79  117.940  116.04  116.79      116.790000    4914995
4              4  116.00  118.810  115.19  116.47      116.470000    6417218
...          ...     ...      ...     ...     ...             ...        ...
5551        5551   92.75   92.940   90.19   90.25       52.226608   13737600
5552        5552   94.44   94.440   90.00   91.56       52.984689   16697600
5553        5553   95.87   95.940   93.50   94.37       54.610803   10369100
5554        5554   96.75   96.810   93.69   94.81       54.865426   11105400
5555        5555   98.50   98.810   96.37   96.75       55.988081    9551800

      dividend amount  split cf
0                 0.0       1.0
1                 0.0       1.0
2                 0.0       1.0
3                 0.0       1.0
4                 0.0       1.0
...               ...       ...
5551              0.0       1.0
5552              0.0       1.0
5553              0.0       1.0
5554              0.0       1.0
5555              0.0       1.0

[5556 rows x 9 columns]
4363
1091
```

In [27]:

```
predicted  = model.predict(test_X)
test_label = test_Y.reshape(-1,1)
predicted = np.array(predicted[:,0]).reshape(-1,1)
len_t = len(train_X)
for j in range(len_t , len_t + len(test_X)):
    temp = data2.iloc[j,3]
    test_label[j - len_t] = test_label[j - len_t] * temp + temp
    predicted[j - len_t] = predicted[j - len_t] * temp + temp
plt.plot(predicted, color = 'green', label = 'Predicted  Stock Price')
plt.plot(test_label, color = 'red', label = 'Real Stock Price')
plt.title(' Stock Price Prediction')
plt.xlabel('Time')
plt.ylabel(' Stock Price')
plt.legend()
plt.show()
```



EDA

In [28]:

```
dataX = pd.read_csv('./data.csv')
dataY = pd.read_csv('./data.csv')
dataX.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5556 entries, 0 to 5555
Data columns (total 10 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Unnamed: 0       5556 non-null   int64  
 1   open             5556 non-null   float64
 2   high             5556 non-null   float64
 3   low              5556 non-null   float64
 4   close            5556 non-null   float64
 5   adjusted close   5556 non-null   float64
 6   volume           5556 non-null   int64  
 7   dividend amount  5556 non-null   float64
 8   split cf         5556 non-null   float64
 9   date             5556 non-null   object 
dtypes: float64(7), int64(2), object(1)
memory usage: 434.2+ KB
```

In [29]:

```
dataX.head()
```

Out[29]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
0	0	118.62	119.610	117.53	118.50	118.50	8918702	0.0	1.0	2021-11-29
1	1	115.00	116.335	114.56	115.81	115.81	3322012	0.0	1.0	2021-11-26
2	2	116.16	117.270	116.08	116.73	116.73	3220802	0.0	1.0	2021-11-24
3	3	116.79	117.940	116.04	116.79	116.79	4914995	0.0	1.0	2021-11-23
4	4	116.00	118.810	115.19	116.47	116.47	6417218	0.0	1.0	2021-11-22

In [30]:

```
start_date = '2020-01-01'
end_date = '2021-11-29'

start = '2018-01-01'
end = '2020-01-01'

fill = (dataX['date']>=start_date) & (dataX['date']<=end_date)
dataX = dataX.loc[fill]
dataX
```

Out[30]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
0	0	118.62	119.610	117.53	118.50	118.500000	8918702	0.0	1.0	2021-11-29
1	1	115.00	116.335	114.56	115.81	115.810000	3322012	0.0	1.0	2021-11-26
2	2	116.16	117.270	116.08	116.73	116.730000	3220802	0.0	1.0	2021-11-24
3	3	116.79	117.940	116.04	116.79	116.790000	4914995	0.0	1.0	2021-11-23
4	4	116.00	118.810	115.19	116.47	116.470000	6417218	0.0	1.0	2021-11-22
...	...	...	...	...	...	...	...	...	...	...

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
477	477	134.51	135.860	133.92	135.31	117.011071	4345952	0.0	1.0	2020-01-08
478	478	133.69	134.960	133.40	134.19	116.042537	3267592	0.0	1.0	2020-01-07
479	479	133.42	134.240	133.20	134.10	115.964708	2421128	0.0	1.0	2020-01-06
480	480	133.57	134.860	133.56	134.34	116.172251	2373470	0.0	1.0	2020-01-03
481	481	135.00	135.920	134.77	135.42	117.106195	3148461	0.0	1.0	2020-01-02

482 rows × 10 columns

In [31]:

```
fill2 = (dataY['date']>=start) & (dataY['date']<=end)
dataY = dataY.loc[fill2]
dataY
```

Out[31]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
482	482	132.53	134.12	132.40	134.04	115.912822	3777504	0.0	1.0	2019-12-31
483	483	135.20	135.30	132.50	132.81	114.849164	4118929	0.0	1.0	2019-12-30
484	484	135.00	135.75	134.87	135.27	116.976481	2752185	0.0	1.0	2019-12-27
485	485	134.98	135.31	134.65	134.91	116.665166	2129654	0.0	1.0	2019-12-26
486	486	135.61	135.62	134.61	134.98	116.725700	1202087	0.0	1.0	2019-12-24
...	...	...	...	...	...	...	...	...	...	...
980	980	162.66	163.91	161.70	163.47	129.027615	5101023	0.0	1.0	2018-01-08
981	981	162.44	162.90	161.10	162.49	128.254097	5162075	0.0	1.0	2018-01-05
982	982	159.65	162.32	159.37	161.70	127.630546	7363843	0.0	1.0	2018-01-04
983	983	157.34	159.81	156.33	158.49	125.096879	9439063	0.0	1.0	2018-01-03
984	984	154.50	154.81	153.54	154.25	121.750227	4195225	0.0	1.0	2018-01-02

503 rows × 10 columns

In [32]:

```
dataX.describe()
```

Out[32]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf
count	482.000000	482.000000	482.000000	482.000000	482.000000	482.000000	4.820000e+02	482.000000	482.000000
mean	240.500000	129.382080	130.691720	128.092867	129.364751	117.791043	5.454886e+06	0.027095	1.000095
std	139.285678	11.382857	11.114856	11.592091	11.353678	11.831698	3.339263e+06	0.208783	0.002095
min	0.000000	94.600000	97.740000	90.560000	94.770000	82.819007	1.761122e+06	0.000000	1.000000
25%	120.250000	121.250000	122.623500	120.102500	121.105000	109.567533	3.644222e+06	0.000000	1.000000
50%	240.500000	126.325000	127.320000	125.045000	126.160000	115.419744	4.655173e+06	0.000000	1.000000
75%	360.750000	139.672500	140.467500	138.757500	139.572500	130.352392	6.115408e+06	0.000000	1.000000
max	481.000000	156.820000	158.750000	155.420000	156.760000	141.053047	3.806353e+07	1.640000	1.046000

In [33]:

```
dataY.describe()
```

Out[33]:

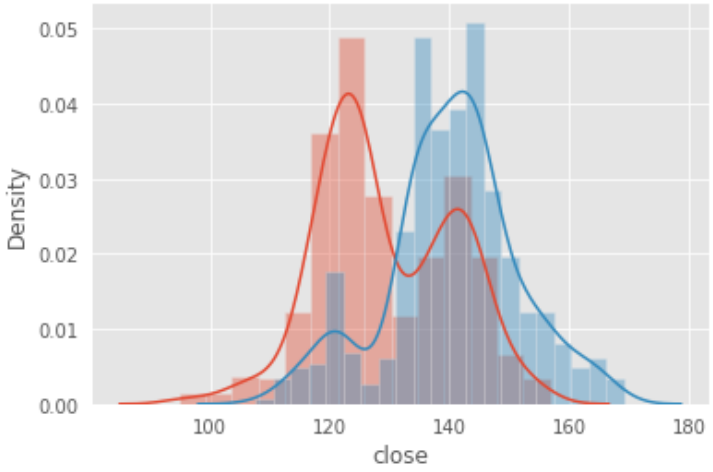
	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf
count	503.000000	503.000000	503.000000	503.000000	503.000000	503.000000	5.030000e+02	503.000000	503.0
mean	733.000000	140.470239	141.512740	139.348929	140.416143	115.933517	4.590926e+06	0.025129	1.0
std	145.347859	11.156349	11.144803	11.149435	11.121441	7.991439	2.880224e+06	0.197923	0.0
min	482.000000	108.000000	111.000000	105.940000	107.570000	88.768396	1.202087e+06	0.000000	1.0
25%	607.500000	134.485000	135.305000	133.570000	134.360000	114.105468	3.067226e+06	0.000000	1.0
50%	733.000000	140.720000	141.780000	139.790000	140.850000	116.651352	3.783614e+06	0.000000	1.0
75%	858.500000	146.635000	147.300000	145.540000	146.385000	120.536160	5.033500e+06	0.000000	1.0
max	984.000000	170.000000	171.130000	168.150000	169.120000	133.487186	2.206367e+07	1.620000	1.0

In [34]:

```
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn.model_selection import train_test_split,GridSearchCV,RandomizedSearchCV
from sklearn.linear_model import LinearRegression,Ridge,Lasso
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor,GradientBoostingRegressor
from sklearn.metrics import r2_score,mean_squared_error

sns_plot = sns.distplot(dataX['close'])
sns_plot2 = sns.distplot(dataY['close'])
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

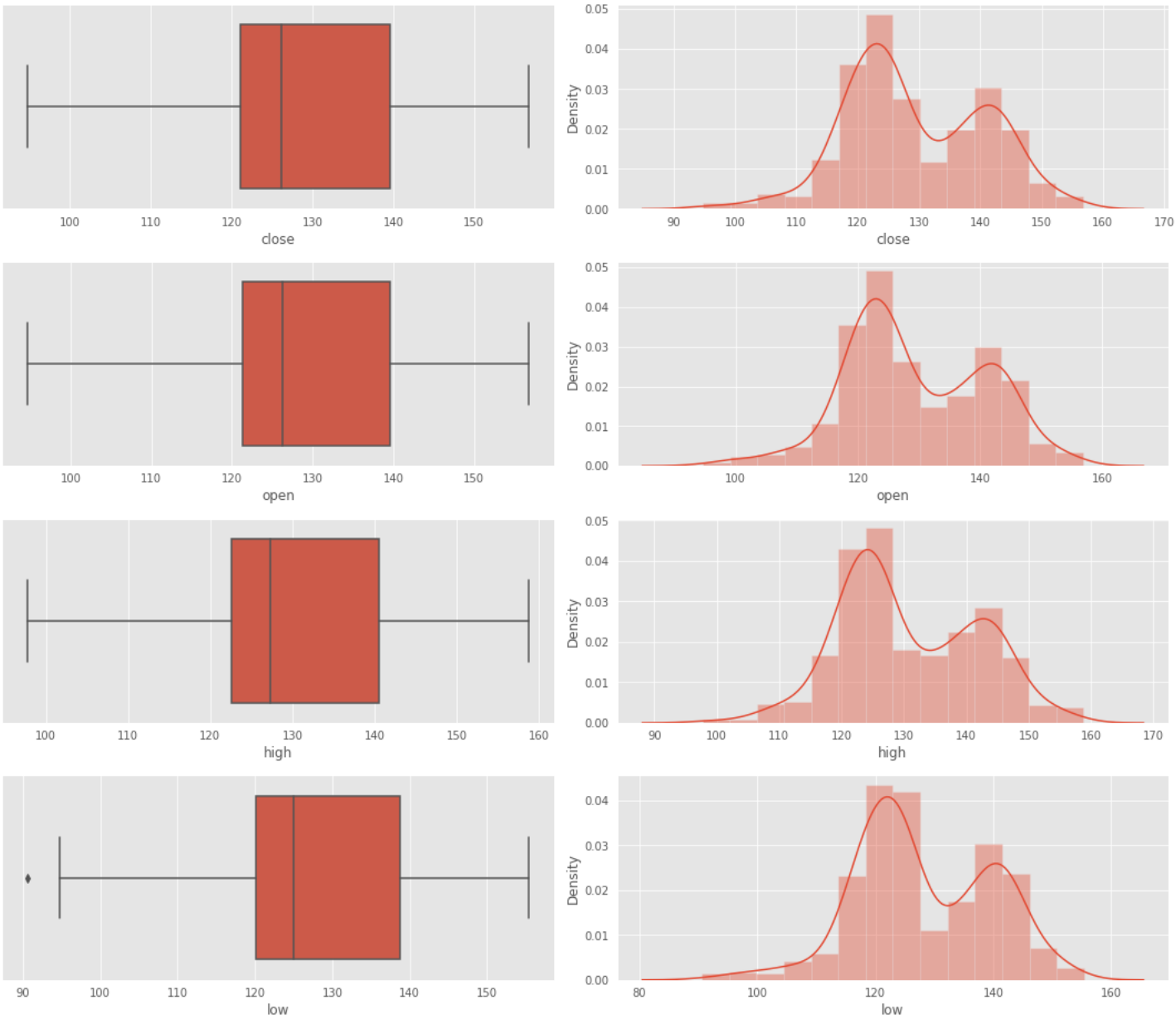


In [35]:

```
fig, ax = plt.subplots(4, 2, figsize = (15, 13))
sns.boxplot(x= dataX["close"], ax = ax[0,0])
sns.distplot(dataX['close'], ax = ax[0,1])
sns.boxplot(x= dataX["open"], ax = ax[1,0])
sns.distplot(dataX['open'], ax = ax[1,1])
sns.boxplot(x= dataX["high"], ax = ax[2,0])
sns.distplot(dataX['high'], ax = ax[2,1])
sns.boxplot(x= dataX["low"], ax = ax[3,0])
sns.distplot(dataX['low'], ax = ax[3,1])
plt.tight_layout()
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
```

```
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

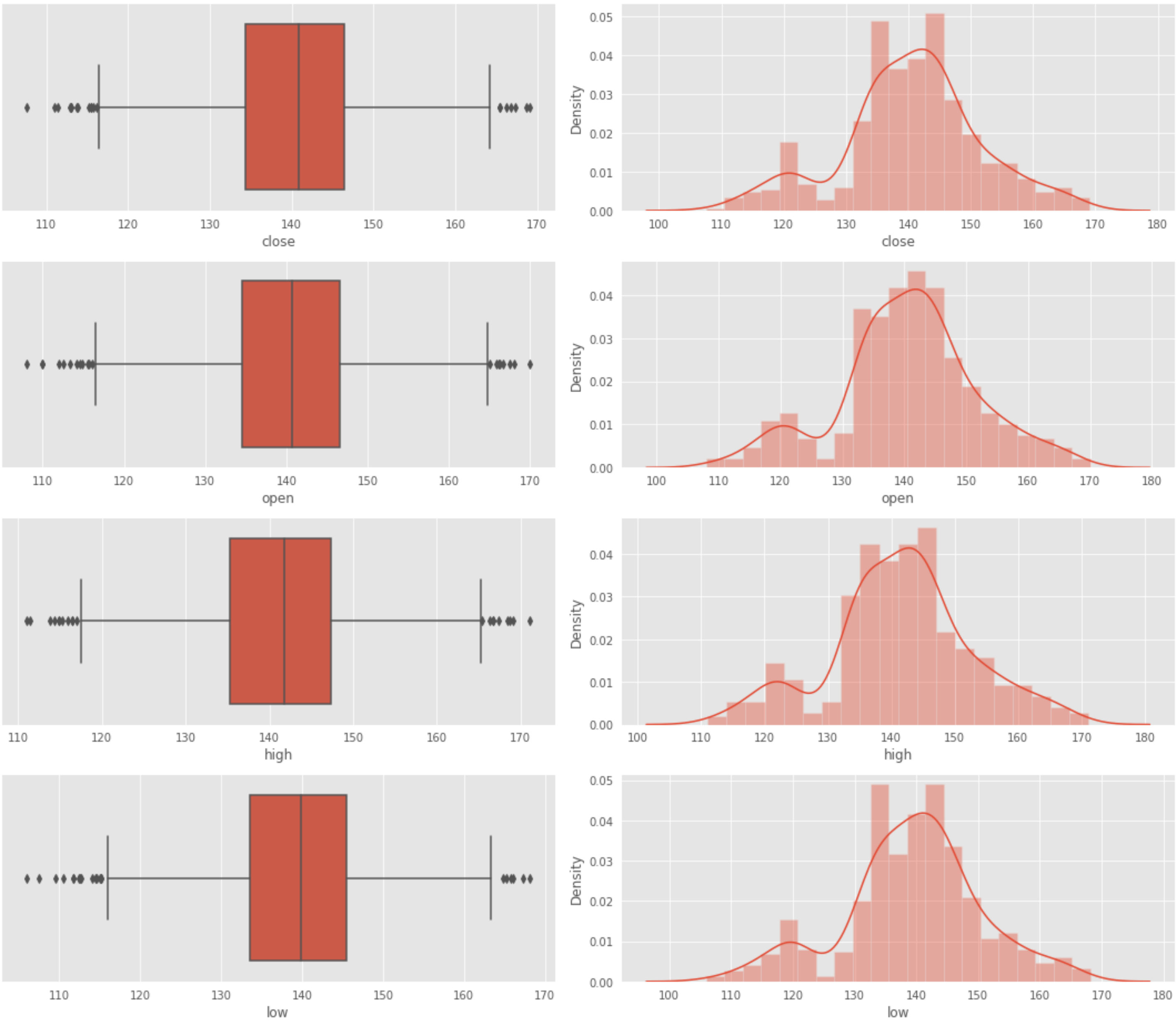


In [36]:

```
fig, ax = plt.subplots(4, 2, figsize = (15, 13))
sns.boxplot(x= dataY["close"], ax = ax[0,0])
sns.distplot(dataY['close'], ax = ax[0,1])
sns.boxplot(x= dataY["open"], ax = ax[1,0])
sns.distplot(dataY['open'], ax = ax[1,1])
sns.boxplot(x= dataY["high"], ax = ax[2,0])
sns.distplot(dataY['high'], ax = ax[2,1])
sns.boxplot(x= dataY["low"], ax = ax[3,0])
sns.distplot(dataY['low'], ax = ax[3,1])
plt.tight_layout()
```

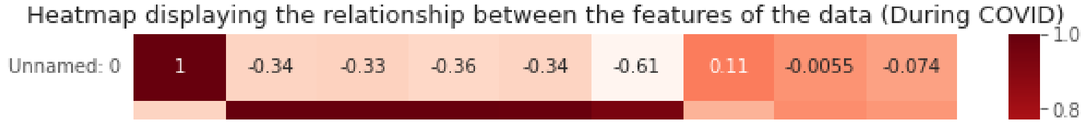
```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
```

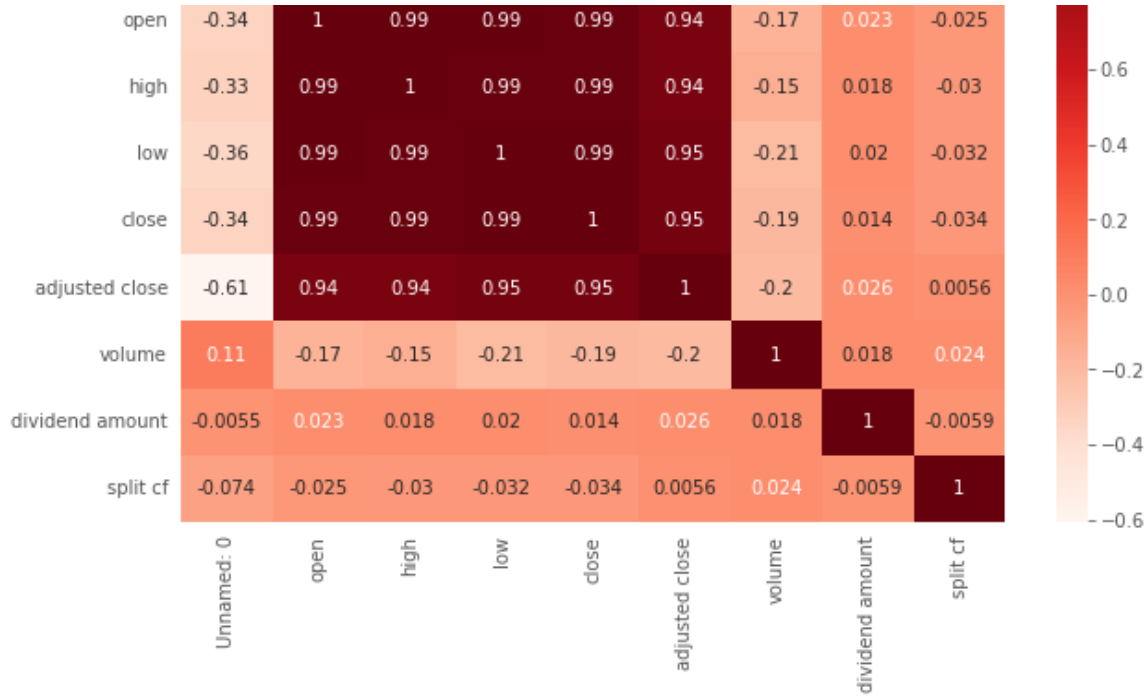
```
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [37]:

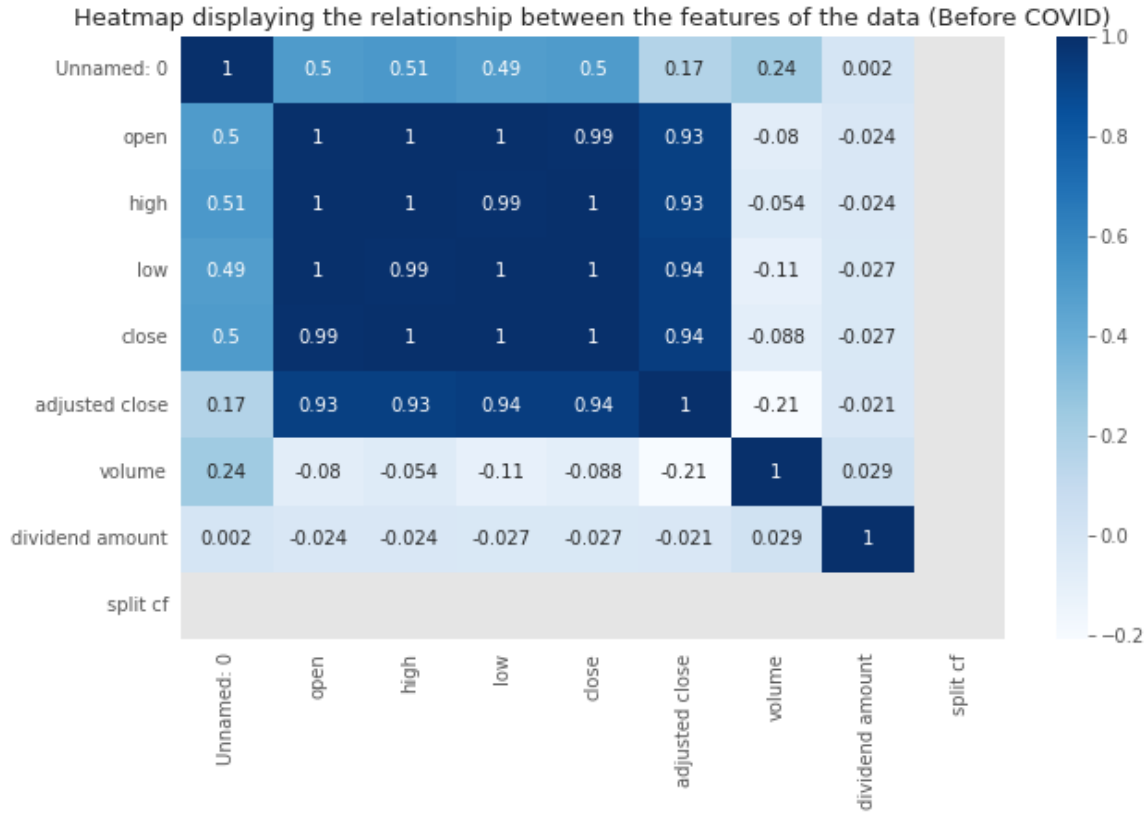
```
plt.figure(figsize=(10,6))
sns.heatmap(dataX.corr(),cmap=plt.cm.Reds,annot=True)
plt.title('Heatmap displaying the relationship between the features of the data (During C
OVID)',
          fontsize=13)
plt.show()
```





In [38]:

```
plt.figure(figsize=(10,6))
sns.heatmap(dataY.corr(),cmap=plt.cm.Blues,annot=True)
plt.title('Heatmap displaying the relationship between the features of the data (Before C
OVID)',
          fontsize=13)
plt.show()
```



In [39]:

```
# For other company....
cv2 = request_stock_price_list('RELIANCE.BSE', 'full', key)
print(cv2.head)
cv2.to_csv('data2.csv')

dataX = pd.read_csv('./data2.csv')
dataY = pd.read_csv('./data2.csv')
dataX.info()
```

Retrieving stock price data from Alpha Vantage (This may take a while)

```
Retrieving stock price data from Alpha Vantage (This may take a while)...
Data has been successfully downloaded...
Sorting the retrieved data into a dataframe...

100%|██████████| 4164/4164 [01:00<00:00, 69.17it/s]

<bound method NDFrame.head of             open       high        low      close adjusted
close    volume  \
0         2412.0     2500.0     2400.0     2442.5         2442.5    451870
1         2470.0    2477.45     2403.0  2412.1499      2412.1499    397321
2         2375.5     2502.8     2358.0  2494.3999      2494.3999    476931
3      2381.3999  2410.8501     2344.0  2350.8999      2350.8999   1856369
4         2339.0     2401.5  2309.3999  2386.1499      2386.1499    457139
...          ...        ...        ...        ...            ...       ...
4159   394.7115   409.2889   394.3751   404.3176        87.1294  16969845
4160    392.469   401.0658   390.6747   393.1791         84.729  13446517
4161   392.8427    399.197   385.9277   396.1319        85.3654  16954266
4162   399.9444   407.3827   395.8329   396.8048        85.5104  10059943
4163   388.7685   407.0464   388.7685   405.9997        87.4919  11842921

     dividend amount  split cf        date
0             0.0000       1.0  2021-11-29
1             0.0000       1.0  2021-11-26
2             0.0000       1.0  2021-11-25
3             0.0000       1.0  2021-11-24
4             0.0000       1.0  2021-11-23
...              ...       ...         ...
4159          0.0000       1.0  2005-01-07
4160          0.0000       1.0  2005-01-06
4161          0.0000       1.0  2005-01-05
4162          0.0000       1.0  2005-01-04
4163          0.0000       1.0  2005-01-03

[4164 rows x 9 columns]>
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4164 entries, 0 to 4163
Data columns (total 10 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   Unnamed: 0       4164 non-null   int64
 1   open             4164 non-null   float64
 2   high             4164 non-null   float64
 3   low              4164 non-null   float64
 4   close            4164 non-null   float64
 5   adjusted close   4164 non-null   float64
 6   volume           4164 non-null   int64
 7   dividend amount  4164 non-null   float64
 8   split cf         4164 non-null   float64
 9   date             4164 non-null   object
dtypes: float64(7), int64(2), object(1)
memory usage: 325.4+ KB
```

In [40]:

```
start_date = '2020-01-01'
end_date = '2021-11-29'

start = '2018-01-01'
end = '2020-01-01'

fill = (dataX['date']>=start_date) & (dataX['date']<=end_date)
dataX = dataX.loc[fill]
dataX
```

Out[40]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
0	0	2412.0000	2500.0000	2400.0000	2442.5000	2442.5000	451870	0.0	1.0	2021-11-29
1	1	2470.0000	2477.4500	2403.0000	2412.1499	2412.1499	397321	0.0	1.0	2021-11-26
2	2	2375.5000	2502.8000	2358.0000	2494.3999	2494.3999	476931	0.0	1.0	2021-11-25

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
3	3	2381.3999	2410.8501	2344.0000	2350.8999	2350.8999	1856369	0.0	1.0	2021-11-24
4	4	2339.0000	2401.5000	2309.3999	2386.1499	2386.1499	457139	0.0	1.0	2021-11-23
...	...	...	...	...	...	...	...	...	...	...
469	469	1519.9995	1533.9995	1514.4495	1525.0495	1500.1978	509038	0.0	1.0	2020-01-07
470	470	1526.9995	1527.9995	1497.4995	1501.4995	1477.0316	457443	0.0	1.0	2020-01-06
471	471	1534.3995	1541.2995	1523.3995	1537.2495	1512.1990	357456	0.0	1.0	2020-01-03
472	472	1513.9995	1540.7995	1512.9995	1535.3495	1510.3299	733200	0.0	1.0	2020-01-02
473	473	1516.0995	1527.3995	1505.3495	1509.6995	1485.0979	461171	0.0	1.0	2020-01-01

474 rows × 10 columns

In [41]:

```
fill2 = (dataY['date']>=start) & (dataY['date']<=end)
dataY = dataY.loc[fill2]
dataY
```

Out[41]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf	date
473	473	1516.0995	1527.3995	1505.3495	1509.6995	1485.0979	461171	0.0	1.0	2020-01-01
474	474	1544.6995	1544.6995	1509.0995	1514.0995	1489.4262	298520	0.0	1.0	2019-12-31
475	475	1542.9995	1546.9995	1528.2995	1544.1995	1519.0357	374974	0.0	1.0	2019-12-30
476	476	1524.9995	1545.7995	1521.4495	1542.1495	1517.0191	490080	0.0	1.0	2019-12-27
477	477	1545.9495	1553.2995	1510.9495	1515.9495	1491.2461	582675	0.0	1.0	2019-12-26
...	...	...	...	...	...	...	...	...	...	...
958	958	920.4997	925.8497	919.4497	922.9997	897.4240	410556	0.0	1.0	2018-01-05
959	959	918.9997	921.7997	915.9997	920.2497	894.7502	241196	0.0	1.0	2018-01-04
960	960	924.4497	927.1997	913.2997	916.3497	890.9583	520663	0.0	1.0	2018-01-03
961	961	914.9997	919.1997	907.2497	911.3997	886.1454	1779802	0.0	1.0	2018-01-02
962	962	921.9997	922.9997	909.6997	911.5497	886.2913	244978	0.0	1.0	2018-01-01

490 rows × 10 columns

In [42]:

```
dataX.describe()
```

Out[42]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf
count	474.000000	474.000000	474.000000	474.000000	474.000000	474.000000	4.740000e+02	474.000000	474.000000
mean	236.500000	1953.239692	1977.124080	1925.387901	1949.614691	1941.479689	1.148593e+06	0.028481	1.000020
std	136.976275	378.827940	377.669256	377.601744	377.490721	383.669825	6.773073e+06	0.438297	0.000437
min	0.000000	919.999700	951.999700	875.699700	883.849700	869.446800	6.484700e+04	0.000000	1.000000
25%	118.250000	1731.837500	1754.662500	1714.137500	1729.987500	1717.989700	2.998212e+05	0.000000	1.000000
50%	236.500000	2013.850000	2045.550000	1990.925000	2007.300000	2000.862500	4.758745e+05	0.000000	1.000000
75%	354.750000	2170.825000	2194.675000	2139.500000	2167.175000	2163.562475	9.260610e+05	0.000000	1.000000
max	473.000000	2740.000000	2750.000000	2708.000000	2731.500000	2731.500000	1.187279e+08	7.000000	1.009516

In [43]:

```
dataY.describe()
```

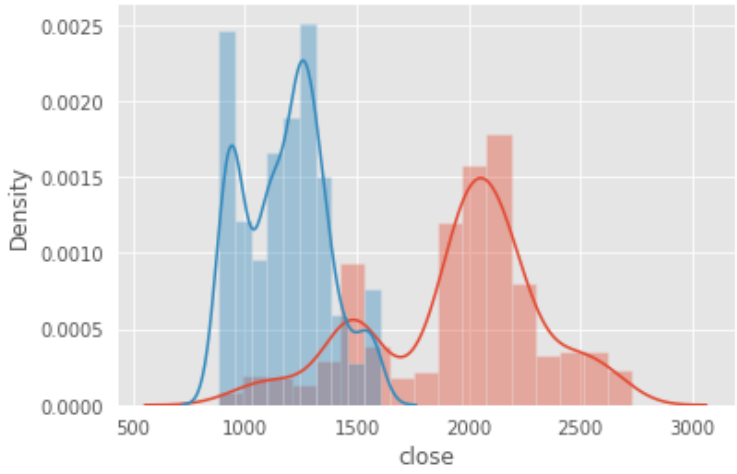
Out[43]:

	Unnamed: 0	open	high	low	close	adjusted close	volume	dividend amount	split cf
count	490.00000	490.000000	490.000000	490.000000	490.000000	490.000000	4.900000e+02	490.000000	490.0
mean	717.50000	1182.485761	1194.496168	1168.685966	1181.144638	1155.626630	5.672558e+05	0.025270	1.0
std	141.59508	185.207018	186.587684	182.842687	184.419946	184.076833	5.363404e+05	0.395444	0.0
min	473.00000	879.999700	895.999700	872.099700	882.799700	858.337900	1.488160e+05	0.000000	1.0
25%	595.25000	999.624700	1012.524700	990.762200	1002.462200	974.684650	3.096382e+05	0.000000	1.0
50%	717.50000	1207.499600	1223.449600	1195.999600	1210.324600	1184.755450	4.345385e+05	0.000000	1.0
75%	839.75000	1297.999600	1314.699600	1283.862100	1296.824600	1271.188050	6.224218e+05	0.000000	1.0
max	962.00000	1611.199500	1617.799500	1595.649500	1605.149500	1578.992500	6.718394e+06	6.438700	1.0

In [44]:

```
sns_plot = sns.distplot(dataX['close'])
sns_plot2 = sns.distplot(dataY['close'])
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

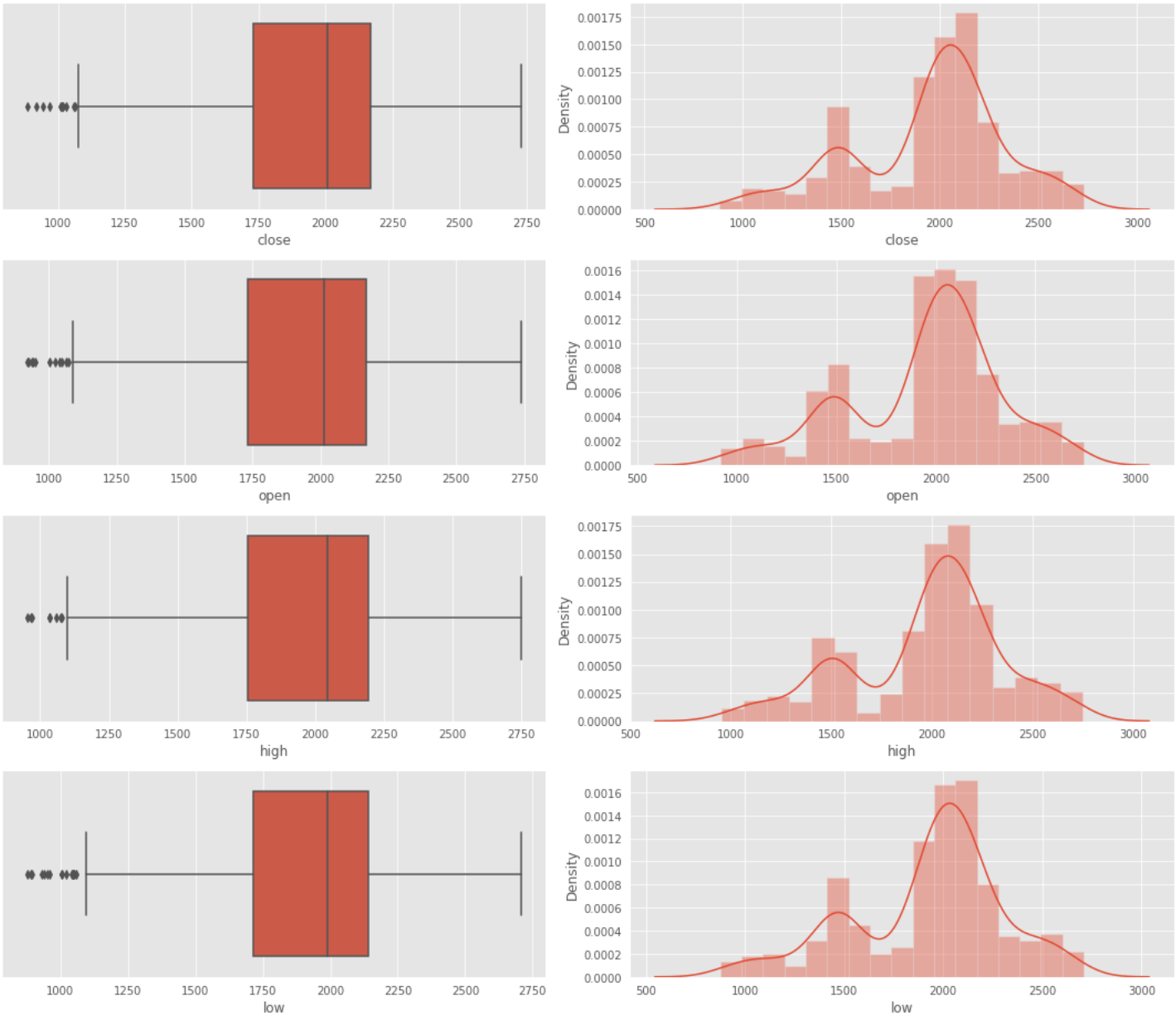


In [45]:

```
fig, ax = plt.subplots(4, 2, figsize = (15, 13))
sns.boxplot(x= dataX["close"], ax = ax[0,0])
sns.distplot(dataX['close'], ax = ax[0,1])
sns.boxplot(x= dataX["open"], ax = ax[1,0])
sns.distplot(dataX['open'], ax = ax[1,1])
sns.boxplot(x= dataX["high"], ax = ax[2,0])
sns.distplot(dataX['high'], ax = ax[2,1])
sns.boxplot(x= dataX["low"], ax = ax[3,0])
sns.distplot(dataX['low'], ax = ax[3,1])
plt.tight_layout()
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
```

```
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

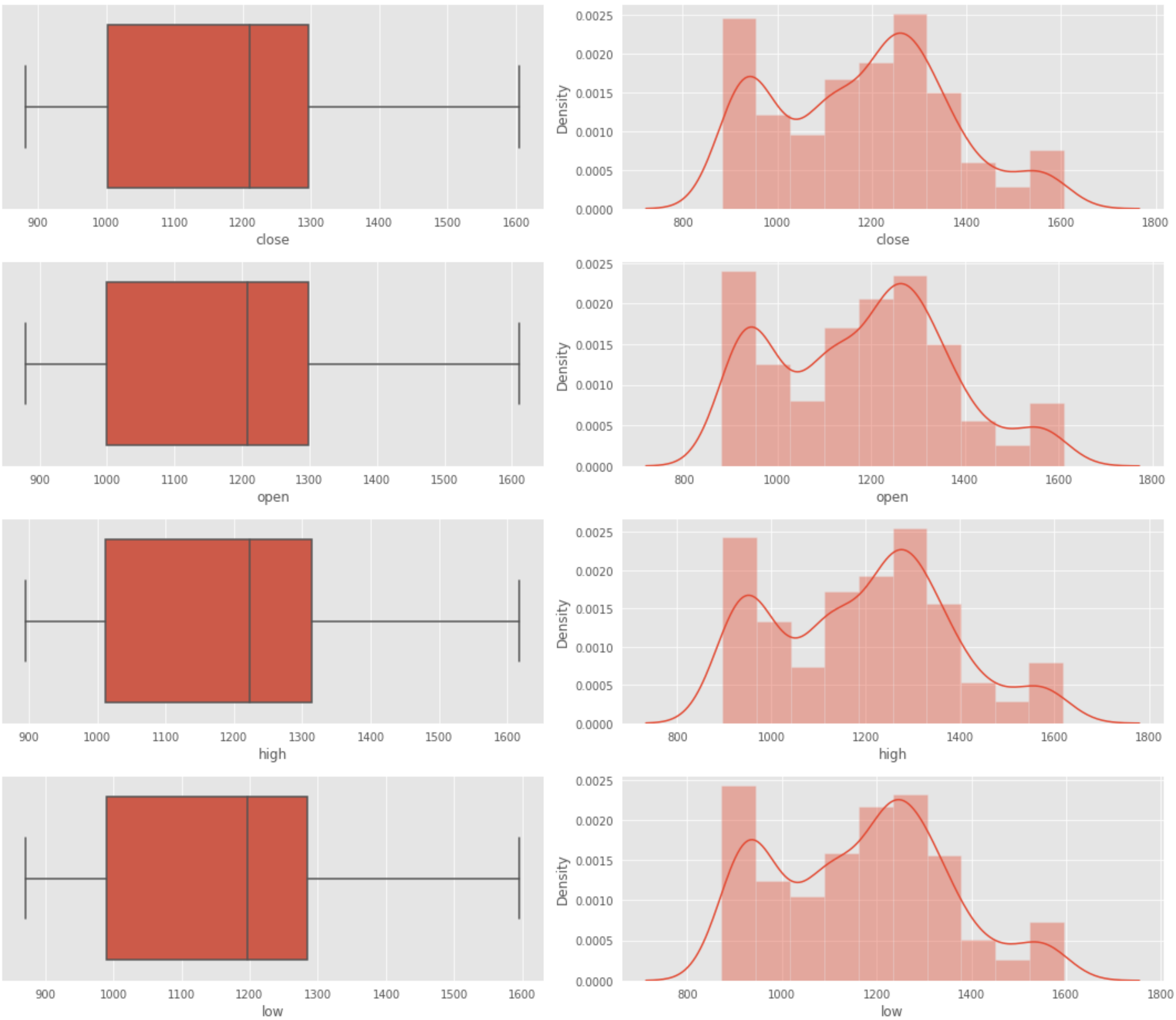


In [46]:

```
fig, ax = plt.subplots(4, 2, figsize = (15, 13))
sns.boxplot(x= dataY["close"], ax = ax[0,0])
sns.distplot(dataY['close'], ax = ax[0,1])
sns.boxplot(x= dataY["open"], ax = ax[1,0])
sns.distplot(dataY['open'], ax = ax[1,1])
sns.boxplot(x= dataY["high"], ax = ax[2,0])
sns.distplot(dataY['high'], ax = ax[2,1])
sns.boxplot(x= dataY["low"], ax = ax[3,0])
sns.distplot(dataY['low'], ax = ax[3,1])
plt.tight_layout()
```

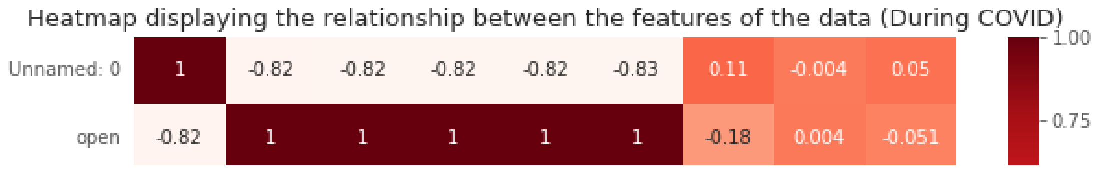
```
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
```

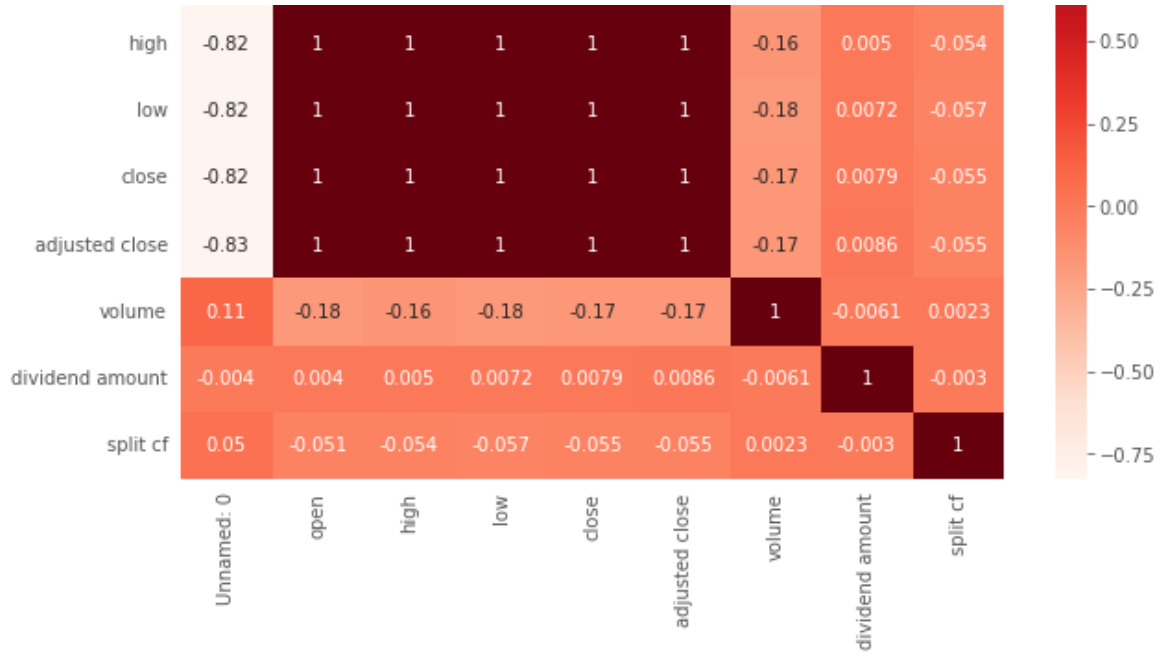
```
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
/opt/conda/lib/python3.7/site-packages/seaborn/distributions.py:2619: FutureWarning: `dis
tplot` is a deprecated function and will be removed in a future version. Please adapt you
r code to use either `displot` (a figure-level function with similar flexibility) or `his
tplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [47]:

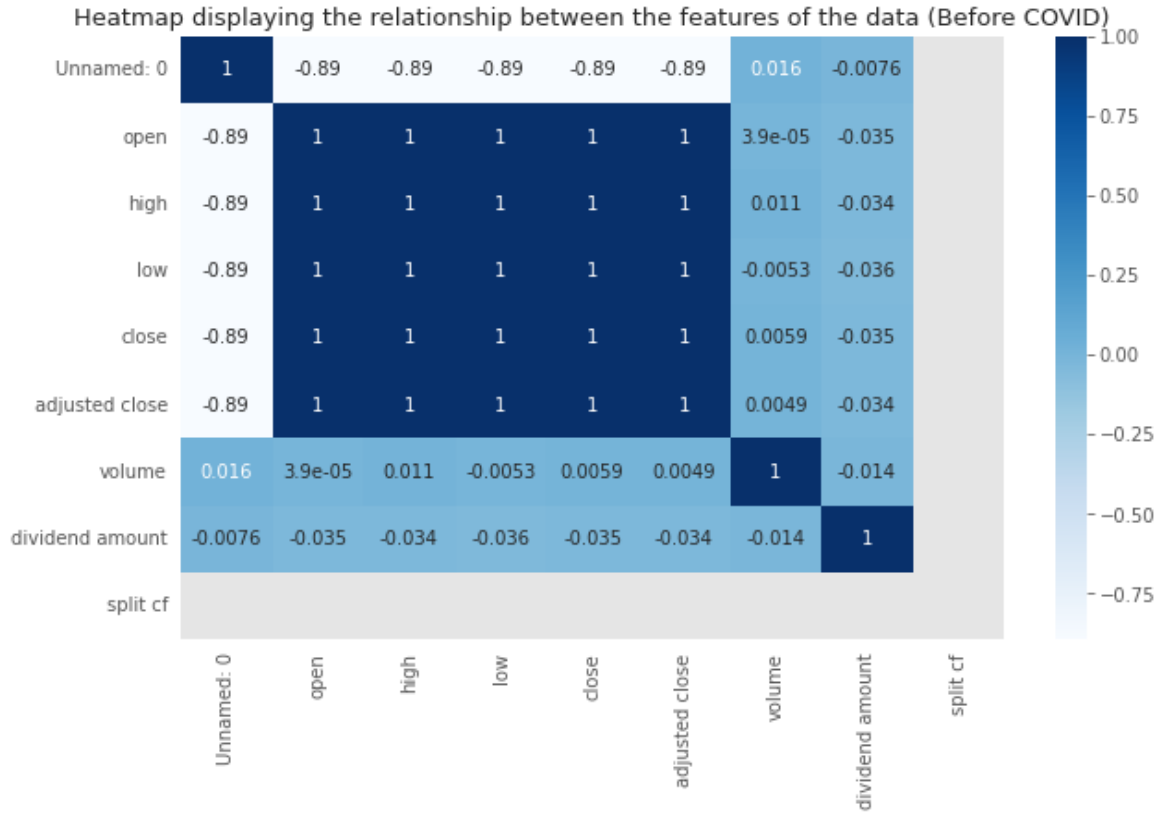
```
plt.figure(figsize=(10,6))
sns.heatmap(dataX.corr(),cmap=plt.cm.Reds,annot=True)
plt.title('Heatmap displaying the relationship between the features of the data (During C
OVID)',
          fontsize=13)
plt.show()
```





In [48]:

```
plt.figure(figsize=(10,6))
sns.heatmap(dataY.corr(),cmap=plt.cm.Blues,annot=True)
plt.title('Heatmap displaying the relationship between the features of the data (Before COVID)',
          fontsize=13)
plt.show()
```



In [ ]: