```python
import pandas as pd
data =pd.read_csv("/content/yahoo_stock.csv")

import pandas as pd
import numpy as np

# Assuming you have your data loaded in a DataFrame called 'data' with
a 'Close' column and a DatetimeIndex

# 1. Rolling Window Features
# Moving Averages
data['MA_5'] = data['Close'].rolling(window=5).mean()
data['MA_10'] = data['Close'].rolling(window=10).mean()
data['MA_20'] = data['Close'].rolling(window=20).mean()

# RSI (Relative Strength Index) - You might need to install the 'ta'
library
# !pip install ta==0.10.0
# from ta.momentum import RSIIndicator
# rsi_indicator = RSIIndicator(close=data['Close'], window=14) #
Default window is 14
# data['RSI'] = rsi_indicator.rsi()

# MACD (Moving Average Convergence Divergence)
# from ta.trend import MACD
# macd_indicator = MACD(close=data['Close'], window_slow=26,
window_fast=12, window_sign=9) # Default windows
# data['MACD'] = macd_indicator.macd()
# data['MACD_Signal'] = macd_indicator.macd_signal()
# data['MACD_Diff'] = macd_indicator.macd_diff()

# Bollinger Bands
# from ta.volatility import BollingerBands
# bb_indicator = BollingerBands(close=data['Close'], window=20,
window_dev=2) # Default window and deviation
# data['BB_High'] = bb_indicator.bollinger_hband()
# data['BB_Low'] = bb_indicator.bollinger_lband()

# 2. Lagged Return Features
data['Return_1'] = data['Close'].pct_change(1)  # 1-day lagged return
data['Return_5'] = data['Close'].pct_change(5)  # 5-day lagged return
# ... add more lags as needed

# 3. Sentiment Score Lags (Assuming you have a 'Sentiment_Score'
column)
# data['Sentiment_Lag_1'] = data['Sentiment_Score'].shift(1)
# data['Sentiment_Lag_2'] = data['Sentiment_Score'].shift(2)
# ... add more sentiment lags as needed
```

```
# Drop rows with NaN values introduced by lagging/rolling
data.dropna(inplace=True)

import pandas as pd
import numpy as np
from sklearn.preprocessing import MinMaxScaler
from statsmodels.tsa.arima.model import ARIMA
from sklearn.metrics import mean_squared_error
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, GRU, Dense, Dropout
from tensorflow.keras.callbacks import EarlyStopping
# from transformers import TFAutoModelForSequenceClassification

# 1. ARIMA Model (Baseline)
# Assuming your data is in a DataFrame called 'data' with a 'Close'
column as the target variable

# Split data into train and test sets
train_data = data['Close'][:-30]  # Use all but the last 30 days for
training
test_data = data['Close'][-30:]   # Use the last 30 days for testing

# Grid search for ARIMA parameters (p, d, q)
# This is a simplified example; you might want to expand the search
space
best_arima_model = None
best_mse = float('inf')

for p in range(1, 6):
    for d in range(0, 3):
        for q in range(1, 6):
            try:
                model = ARIMA(train_data, order=(p, d, q))
                model_fit = model.fit()
                predictions = model_fit.predict(start=len(train_data),
end=len(data)-1)
                mse = mean_squared_error(test_data, predictions)

                if mse < best_mse:
                    best_mse = mse
                    best_arima_model = model_fit
            except:
                continue

print("Best ARIMA Model:", best_arima_model.summary())


# 2. Deep Learning Models (LSTM, GRU, Transformer)
# Data Preprocessing
# Scale the data using MinMaxScaler
```

```
scaler = MinMaxScaler()
data['Close_Scaled'] =
scaler.fit_transform(data['Close'].values.reshape(-1, 1))

# Create sequences for LSTM/GRU/Transformer input
def create_sequences(dataset, look_back=60):
    X, Y = [], []
    for i in range(len(dataset)-look_back-1):
        a = dataset[i:(i+look_back), 0]
        X.append(a)
        Y.append(dataset[i + look_back, 0])
    return np.array(X), np.array(Y)

look_back = 60  # Number of previous days to consider
X, Y = create_sequences(data[['Close_Scaled']].values, look_back)

# Split into train and test sets
train_size = int(len(X) * 0.8)
X_train, X_test = X[:train_size], X[train_size:]
Y_train, Y_test = Y[:train_size], Y[train_size:]

# LSTM Model
model_lstm = Sequential()
model_lstm.add(LSTM(units=50, return_sequences=True,
input_shape=(X_train.shape[1], 1)))
model_lstm.add(Dropout(0.2))
model_lstm.add(LSTM(units=50))
model_lstm.add(Dropout(0.2))
model_lstm.add(Dense(units=1))
model_lstm.compile(optimizer='adam', loss='mean_squared_error')

# GRU Model
model_gru = Sequential()
model_gru.add(GRU(units=50, return_sequences=True,
input_shape=(X_train.shape[1], 1)))
model_gru.add(Dropout(0.2))
model_gru.add(GRU(units=50))
model_gru.add(Dropout(0.2))
model_gru.add(Dense(units=1))
model_gru.compile(optimizer='adam', loss='mean_squared_error')

# # Transformer Encoder Model (Requires 'transformers' library)
# # !pip install transformers==4.31.0
# model_transformer =
TFAutoModelForSequenceClassification.from_pretrained("bert-base-
uncased", num_labels=1)
# model_transformer.compile(optimizer='adam',
loss='mean_squared_error')

# Training the models
```

```
early_stopping = EarlyStopping(monitor='val_loss', patience=10)

model_lstm.fit(X_train, Y_train, epochs=100, batch_size=32,
validation_split=0.2, callbacks=[early_stopping])
model_gru.fit(X_train, Y_train, epochs=100, batch_size=32,
validation_split=0.2, callbacks=[early_stopping])
# model_transformer.fit(X_train, Y_train, epochs=100, batch_size=32,
validation_split=0.2, callbacks=[early_stopping])

# ... (Evaluation and prediction code)
```

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```

```
  return get_prediction_index(
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
.py:837: FutureWarning: No supported index is available. In the next
version, calling this method in a model without a supported index will
result in an exception.
  return get_prediction_index(
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
.py:473: ValueWarning: An unsupported index was provided. As a result,
forecasts cannot be generated. To use the model for forecasting, use
one of the supported classes of index.
  self._init_dates(dates, freq)
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
.py:473: ValueWarning: An unsupported index was provided. As a result,
forecasts cannot be generated. To use the model for forecasting, use
one of the supported classes of index.
  self._init_dates(dates, freq)
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
.py:473: ValueWarning: An unsupported index was provided. As a result,
forecasts cannot be generated. To use the model for forecasting, use
one of the supported classes of index.
  self._init_dates(dates, freq)
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/statespace/
sarimax.py:978: UserWarning: Non-invertible starting MA parameters
found. Using zeros as starting parameters.
  warn('Non-invertible starting MA parameters found.'
/usr/local/lib/python3.11/dist-packages/statsmodels/base/model.py:607:
ConvergenceWarning: Maximum Likelihood optimization failed to
converge. Check mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
.py:837: ValueWarning: No supported index is available. Prediction
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one of the supported classes of index.
  self._init_dates(dates, freq)
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
```

```
.py:473: ValueWarning: An unsupported index was provided. As a result,
forecasts cannot be generated. To use the model for forecasting, use
one of the supported classes of index.
  self._init_dates(dates, freq)
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/statespace/
sarimax.py:966: UserWarning: Non-stationary starting autoregressive
parameters found. Using zeros as starting parameters.
  warn('Non-stationary starting autoregressive parameters'
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/statespace/
sarimax.py:978: UserWarning: Non-invertible starting MA parameters
found. Using zeros as starting parameters.
  warn('Non-invertible starting MA parameters found.'
/usr/local/lib/python3.11/dist-packages/statsmodels/base/model.py:607:
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converge. Check mle_retvals
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/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
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  return get_prediction_index(
/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/base/tsa_model
```

```
.py:837: FutureWarning: No supported index is available. In the next
version, calling this method in a model without a supported index will
result in an exception.
  return get_prediction_index(

Best ARIMA Model:                                SARIMAX Results

======================================================================
========
Dep. Variable:                  Close   No. Observations:
1757
Model:                 ARIMA(4, 2, 5)   Log Likelihood                -
8213.583
Date:                Thu, 08 May 2025   AIC
16447.166
Time:                        15:15:43   BIC
16501.868
Sample:                             0   HQIC
16467.384
                               - 1757

Covariance Type:                  opg

======================================================================
========
                 coef    std err          z      P>|z|      [0.025
0.975]
----------------------------------------------------------------------
--------
ar.L1         -1.7349      0.024    -71.483      0.000      -1.782
-1.687
ar.L2         -1.6179      0.041    -39.088      0.000      -1.699
-1.537
ar.L3         -1.5805      0.037    -43.286      0.000      -1.652
-1.509
ar.L4         -0.8188      0.020    -41.513      0.000      -0.857
-0.780
ma.L1          0.6027      0.025     23.838      0.000       0.553
0.652
ma.L2         -0.1536      0.023     -6.639      0.000      -0.199
-0.108
ma.L3          0.0580      0.028      2.095      0.036       0.004
0.112
ma.L4         -0.7589      0.023    -32.590      0.000      -0.804
-0.713
ma.L5         -0.7411      0.023    -32.615      0.000      -0.786
-0.697
sigma2       674.8478      7.539     89.519      0.000     660.072
689.623
======================================================================
```

```
=============
Ljung-Box (L1) (Q):                   0.00   Jarque-Bera (JB):
45237.86
Prob(Q):                              0.96   Prob(JB):
0.00
Heteroskedasticity (H):               9.01   Skew:
-2.01
Prob(H) (two-sided):                  0.00   Kurtosis:
27.55
======================================================================
=============

Warnings:
[1] Covariance matrix calculated using the outer product of gradients
(complex-step).

/usr/local/lib/python3.11/dist-packages/keras/src/layers/rnn/
rnn.py:200: UserWarning: Do not pass an `input_shape`/`input_dim`
argument to a layer. When using Sequential models, prefer using an
`Input(shape)` object as the first layer in the model instead.
  super().__init__(**kwargs)

Epoch 1/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 6s 56ms/step - loss: 0.0351 - val_loss:
0.0051
Epoch 2/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0023 - val_loss:
5.3021e-04
Epoch 3/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 43ms/step - loss: 0.0018 - val_loss:
5.4367e-04
Epoch 4/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 43ms/step - loss: 0.0019 - val_loss:
0.0022
Epoch 5/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 65ms/step - loss: 0.0018 - val_loss:
0.0022
Epoch 6/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 46ms/step - loss: 0.0017 - val_loss:
7.8853e-04
Epoch 7/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0015 - val_loss:
4.7397e-04
Epoch 8/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 49ms/step - loss: 0.0015 - val_loss:
4.9679e-04
Epoch 9/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 50ms/step - loss: 0.0016 - val_loss:
5.4831e-04
Epoch 10/100
```

```
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 50ms/step - loss: 0.0012 - val_loss:
4.7071e-04
Epoch 11/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 64ms/step - loss: 0.0014 - val_loss:
0.0013
Epoch 12/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0014 - val_loss:
8.6712e-04
Epoch 13/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 47ms/step - loss: 0.0013 - val_loss:
0.0012
Epoch 14/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 48ms/step - loss: 0.0014 - val_loss:
6.8090e-04
Epoch 15/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 52ms/step - loss: 0.0014 - val_loss:
8.0063e-04
Epoch 16/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 63ms/step - loss: 0.0012 - val_loss:
4.0821e-04
Epoch 17/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 43ms/step - loss: 0.0013 - val_loss:
0.0012
Epoch 18/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 45ms/step - loss: 0.0012 - val_loss:
8.4784e-04
Epoch 19/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0011 - val_loss:
7.5163e-04
Epoch 20/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 45ms/step - loss: 0.0010 - val_loss:
8.5244e-04
Epoch 21/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0011 - val_loss:
4.9510e-04
Epoch 22/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 43ms/step - loss: 8.9698e-04 - val_loss:
4.6183e-04
Epoch 23/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 44ms/step - loss: 9.5512e-04 - val_loss:
0.0019
Epoch 24/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 0.0012 - val_loss:
3.5585e-04
Epoch 25/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 45ms/step - loss: 9.4805e-04 - val_loss:
7.1613e-04
Epoch 26/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 40ms/step - loss: 9.1135e-04 - val_loss:
```

```
3.6856e-04
Epoch 27/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 53ms/step - loss: 9.8542e-04 - val_loss:
6.8438e-04
Epoch 28/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 45ms/step - loss: 0.0011 - val_loss:
8.1294e-04
Epoch 29/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 42ms/step - loss: 0.0010 - val_loss:
4.2311e-04
Epoch 30/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 1s 41ms/step - loss: 0.0010 - val_loss:
0.0020
Epoch 31/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 45ms/step - loss: 0.0010 - val_loss:
0.0012
Epoch 32/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 58ms/step - loss: 9.6591e-04 - val_loss:
8.0765e-04
Epoch 33/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 51ms/step - loss: 9.1288e-04 - val_loss:
3.2759e-04
Epoch 34/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 42ms/step - loss: 9.4805e-04 - val_loss:
0.0013
Epoch 35/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 52ms/step - loss: 8.7568e-04 - val_loss:
5.1763e-04
Epoch 36/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 46ms/step - loss: 9.0904e-04 - val_loss:
0.0015
Epoch 37/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 64ms/step - loss: 0.0010 - val_loss:
6.2885e-04
Epoch 38/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 8.0650e-04 - val_loss:
4.5001e-04
Epoch 39/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 44ms/step - loss: 8.2076e-04 - val_loss:
4.1956e-04
Epoch 40/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 51ms/step - loss: 7.9497e-04 - val_loss:
6.7898e-04
Epoch 41/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 48ms/step - loss: 8.6144e-04 - val_loss:
6.4355e-04
Epoch 42/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 55ms/step - loss: 8.2288e-04 - val_loss:
0.0010
```

```
Epoch 43/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 43ms/step - loss: 8.0908e-04 - val_loss:
5.2910e-04
Epoch 1/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 6s 69ms/step - loss: 0.0667 - val_loss:
0.0094
Epoch 2/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 76ms/step - loss: 0.0043 - val_loss:
0.0015
Epoch 3/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 56ms/step - loss: 0.0020 - val_loss:
2.3197e-04
Epoch 4/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 55ms/step - loss: 0.0017 - val_loss:
6.5147e-04
Epoch 5/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 59ms/step - loss: 0.0014 - val_loss:
3.4611e-04
Epoch 6/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 62ms/step - loss: 0.0014 - val_loss:
2.9220e-04
Epoch 7/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 69ms/step - loss: 0.0016 - val_loss:
0.0010
Epoch 8/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 60ms/step - loss: 0.0014 - val_loss:
2.6911e-04
Epoch 9/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 64ms/step - loss: 0.0013 - val_loss:
6.4227e-04
Epoch 10/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 63ms/step - loss: 0.0013 - val_loss:
4.5072e-04
Epoch 11/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 2s 60ms/step - loss: 0.0011 - val_loss:
3.4316e-04
Epoch 12/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 3s 73ms/step - loss: 0.0013 - val_loss:
3.4298e-04
Epoch 13/100
35/35 ━━━━━━━━━━━━━━━━━━━━ 5s 64ms/step - loss: 0.0012 - val_loss:
5.2630e-04

<keras.src.callbacks.history.History at 0x7c71307d13d0>
```

```
import pandas as pd
import numpy as np
from sklearn.metrics import mean_squared_error, mean_absolute_error
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras.models import Sequential
```

```
from tensorflow.keras.layers import LSTM, Dense, Dropout
# ... (Import other necessary libraries)

# ... (Assuming you have your data loaded in a DataFrame called
'data')

# 1. Data Preprocessing (Scaling and Creating Sequences)
# ... (Same as in previous code for LSTM/GRU)

# 2. Time-Series Cross-Validation (Rolling Window)
def timeseries_train_test_split(X, y, test_size=30):
    """Splits time-series data into train and test sets using a
rolling window."""
    train_X, test_X = X[:-test_size], X[-test_size:]
    train_y, test_y = y[:-test_size], y[-test_size:]
    return train_X, test_X, train_y, test_y

# 3. Model Training and Evaluation
def evaluate_model(model, X, y, test_size=30):
    """Trains and evaluates a model using time-series cross-
validation."""

    train_X, test_X, train_y, test_y = timeseries_train_test_split(X,
y, test_size)

    # Train the model
    model.fit(train_X, train_y, epochs=100, batch_size=32, verbose=0)

    # Make predictions
    predictions = model.predict(test_X)

    # Inverse transform to get actual prices
    predictions = scaler.inverse_transform(predictions)
    actual_prices = scaler.inverse_transform(test_y.reshape(-1, 1))

    # Calculate metrics
    rmse = np.sqrt(mean_squared_error(actual_prices, predictions))
    mae = mean_absolute_error(actual_prices, predictions)

    # Directional accuracy
    actual_returns = np.diff(actual_prices.flatten())
    predicted_returns = np.diff(predictions.flatten())
    directional_accuracy = np.mean((actual_returns > 0) ==
(predicted_returns > 0)) * 100

    return rmse, mae, directional_accuracy

# Example usage:
# Create your LSTM/GRU model (model_lstm, model_gru)
# ...
```

```
# Evaluate the LSTM model
rmse, mae, directional_accuracy = evaluate_model(model_lstm, X, Y)
print("LSTM - RMSE:", rmse)
print("LSTM - MAE:", mae)
print("LSTM - Directional Accuracy:", directional_accuracy)

# Evaluate the GRU model
# ... (Similar for other models)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 261ms/step
LSTM - RMSE: 41.098247417709466
LSTM - MAE: 28.70799967447915
LSTM - Directional Accuracy: 44.827586206896555
```

```
# Visualization & Interpretation using XGBoost and SHAP
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import shap
import xgboost as xgb
from sklearn.model_selection import train_test_split

# Ensure inline plotting in Jupyter Notebook:
%matplotlib inline

# Load and preprocess the dataset
try:
    df = pd.read_csv('yahoo_stock.csv')  # Try current directory first
except FileNotFoundError:
    try:
        df = pd.read_csv('/content/yahoo_stock.csv')  # Try /content/
if in Colab
    except FileNotFoundError:
        print("Error: yahoo_stock.csv not found. Please make sure the
file is in the correct location.")
        # You might want to add code here to handle the error (e.g.,
exit, prompt for file path)

df['Date'] = pd.to_datetime(df['Date'])
df = df.sort_values('Date')
df['Day'] = df['Date'].dt.day
df['Month'] = df['Date'].dt.month
df['Year'] = df['Date'].dt.year
df['DayOfWeek'] = df['Date'].dt.dayofweek

# Define features and target
features = ['Open', 'High', 'Low', 'Volume', 'Day', 'Month', 'Year',
'DayOfWeek']
target = 'Close'
```

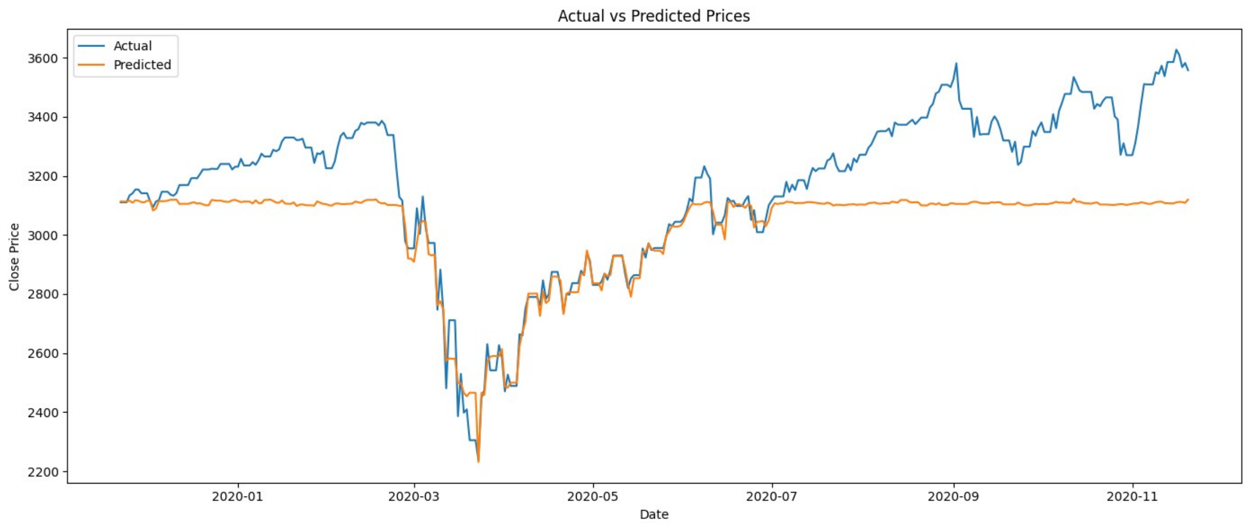
```python
X = df[features]
y = df[target]

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, shuffle=False)

# Train model
model = xgb.XGBRegressor(objective='reg:squarederror',
n_estimators=100)
model.fit(X_train, y_train)

# Predict and plot actual vs predicted
predictions = model.predict(X_test)
plt.figure(figsize=(14, 6))
plt.plot(df['Date'].iloc[-len(y_test):], y_test.values,
label='Actual')
plt.plot(df['Date'].iloc[-len(y_test):], predictions,
label='Predicted')
plt.xlabel('Date')
plt.ylabel('Close Price')
plt.title('Actual vs Predicted Prices')
plt.legend()
plt.tight_layout()
plt.show()  # Display the plot within the Jupyter Notebook


# (Optional) Safe SHAP Interpretation using TreeExplainer only
# ... You can uncomment and use this section if you want to generate
SHAP plots
# explainer = shap.TreeExplainer(model)
# shap_values = explainer.shap_values(X_test)
# shap.summary_plot(shap_values, X_test, show=False)
# plt.savefig('shap_summary_plot.png') # Save to a file if needed
# plt.show() # Or display within the notebook
```



Actual vs Predicted Prices
Actual
Predicted
Close Price
3600
3400
3200
3000
2800
2600
2400
2200
2020-01
2020-03
2020-05
2020-07
2020-09
2020-11
Date