In [176]:
```
# Python library  to access financial data from Yahoo Finance
import pandas as  pd
import yfinance as yf
import matplotlib.pyplot as plt
```

In [177]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import precision_score
```

In [178]:
```
#Bitcoin
bitcoin_ticker_temp = yf.Ticker("BTC-USD")
bitcoin_ticker_temp
```

Out[178]: yfinance.Ticker object <BTC-USD>

In [179]:
```
bitcoin_ticker = bitcoin_ticker_temp.history(period= "max")
bitcoin_ticker
```

Out[179]:

Date	Open	High	Low	Close	Volume	Dividen
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200	
2014-09-19 00:00:00+00:00	424.102997	427.834991	384.532013	394.795990	37919700	
2014-09-20 00:00:00+00:00	394.673004	423.295990	389.882996	408.903992	36863600	
2014-09-21 00:00:00+00:00	408.084991	412.425995	393.181000	398.821014	26580100	
...	...	...	...	...	...	
2024-01-02 00:00:00+00:00	44187.140625	45899.707031	44176.949219	44957.968750	39335274536	
2024-01-03 00:00:00+00:00	44961.601562	45503.242188	40813.535156	42848.175781	46342323118	
2024-01-04 00:00:00+00:00	42855.816406	44770.023438	42675.175781	44179.921875	30448091210	
2024-01-05 00:00:00+00:00	44192.980469	44353.285156	42784.718750	44162.691406	32336029347	
2024-01-06 00:00:00+00:00	44178.953125	44227.632812	43495.597656	43732.027344	22734772224	

3399 rows × 7 columns

In [180]:
```
type(bitcoin_ticker), bitcoin_ticker.shape, bitcoin_ticker.dtypes
```

Out[180]:
```
(pandas.core.frame.DataFrame,
 (3399, 7),
 Open            float64
 High            float64
 Low             float64
 Close           float64
 Volume            int64
 Dividends       float64
 Stock Splits    float64
 dtype: object)
```

In [181]:
```
index=bitcoin_ticker.index
index
```

Out[181]:
```
DatetimeIndex(['2014-09-17 00:00:00+00:00', '2014-09-18 00:00:00+00:00',
               '2014-09-19 00:00:00+00:00', '2014-09-20 00:00:00+00:00',
               '2014-09-21 00:00:00+00:00', '2014-09-22 00:00:00+00:00',
               '2014-09-23 00:00:00+00:00', '2014-09-24 00:00:00+00:00',
               '2014-09-25 00:00:00+00:00', '2014-09-26 00:00:00+00:00',
               ...
               '2023-12-28 00:00:00+00:00', '2023-12-29 00:00:00+00:00',
               '2023-12-30 00:00:00+00:00', '2023-12-31 00:00:00+00:00',
               '2024-01-01 00:00:00+00:00', '2024-01-02 00:00:00+00:00',
               '2024-01-03 00:00:00+00:00', '2024-01-04 00:00:00+00:00',
               '2024-01-05 00:00:00+00:00', '2024-01-06 00:00:00+00:00'],
              dtype='datetime64[ns, UTC]', name='Date', length=3399, freq=None)
```

In [182]:
```
columns=bitcoin_ticker.columns
columns
```

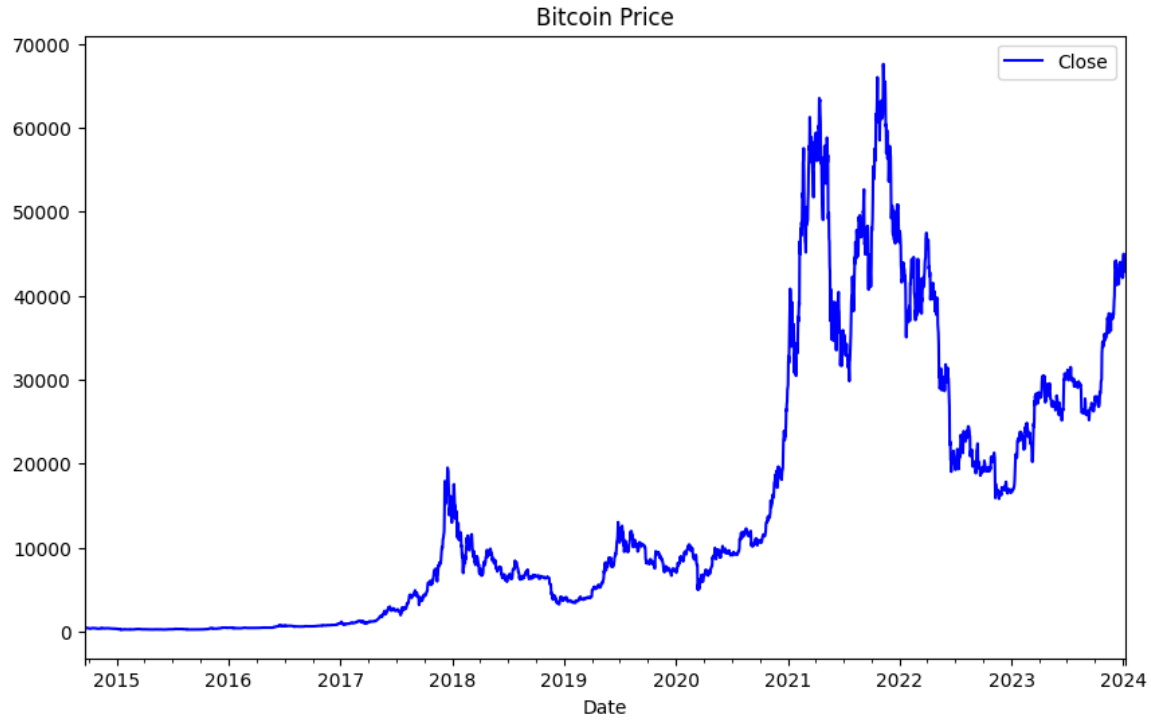
Out[182]:
```
Index(['Open', 'High', 'Low', 'Close', 'Volume', 'Dividends', 'Stock Splits'], dty
pe='object')
```

In [183]:
```
y=bitcoin_ticker["Close"]
y
```

Out[183]:
```
Date
2014-09-17 00:00:00+00:00      457.334015
2014-09-18 00:00:00+00:00      424.440002
2014-09-19 00:00:00+00:00      394.795990
2014-09-20 00:00:00+00:00      408.903992
2014-09-21 00:00:00+00:00      398.821014
                                  ...
2024-01-02 00:00:00+00:00    44957.968750
2024-01-03 00:00:00+00:00    42848.175781
2024-01-04 00:00:00+00:00    44179.921875
2024-01-05 00:00:00+00:00    44162.691406
2024-01-06 00:00:00+00:00    43732.027344
Name: Close, Length: 3399, dtype: float64
```

In [184]:
```
bitcoin_ticker.plot(y=["Close"], use_index = True, style='b-', figsize=(10, 6))
plt.title("Bitcoin Price")
```

Out[184]: Text(0.5, 1.0, 'Bitcoin Price')



Data Preprocessing

In [185]:
```
bitcoin_ticker.head()
```

Out[185]:

Date	Open	High	Low	Close	Volume	Dividends	Stock Splits
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	0.0	0.0
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200	0.0	0.0
2014-09-19 00:00:00+00:00	424.102997	427.834991	384.532013	394.795990	37919700	0.0	0.0
2014-09-20 00:00:00+00:00	394.673004	423.295990	389.882996	408.903992	36863600	0.0	0.0
2014-09-21 00:00:00+00:00	408.084991	412.425995	393.181000	398.821014	26580100	0.0	0.0

In [186]:
```
bitcoin_ticker.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 3399 entries, 2014-09-17 00:00:00+00:00 to 2024-01-06 00:00:00+00:0
0
Data columns (total 7 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Open          3399 non-null   float64
 1   High          3399 non-null   float64
 2   Low           3399 non-null   float64
 3   Close         3399 non-null   float64
 4   Volume        3399 non-null   int64  
 5   Dividends     3399 non-null   float64
 6   Stock Splits  3399 non-null   float64
dtypes: float64(6), int64(1)
memory usage: 212.4 KB
```

In [187]:
```
bitcoin_ticker.describe()
```

Out[187]:

	Open	High	Low	Close	Volume	Dividends	Sto Spl
count	3399.000000	3399.000000	3399.000000	3399.000000	3.399000e+03	3399.0	339
mean	14623.628052	14965.554282	14255.630014	14635.017063	1.657556e+10	0.0	(
std	16219.066822	16608.185105	15783.328575	16221.943183	1.908233e+10	0.0	(
min	176.897003	211.731003	171.509995	178.102997	5.914570e+06	0.0	(
25%	915.801514	924.028015	899.312012	919.622986	1.588645e+08	0.0	(
50%	8246.849609	8414.227539	8071.120605	8250.969727	1.156880e+10	0.0	(
75%	23853.489258	24409.812500	23462.214844	23876.561523	2.692564e+10	0.0	(
max	67549.734375	68789.625000	66382.062500	67566.828125	3.509679e+11	0.0	(

In [188]:
```
bitcoin_ticker=bitcoin_ticker.drop(["Dividends"], axis=1)
```

In [189]:
```
bitcoin_ticker=bitcoin_ticker.drop(["Stock Splits"], axis=1)
```

In [190]:
```
bitcoin_ticker
```

Out[190]:

Date	Open	High	Low	Close	Volume
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200
2014-09-19 00:00:00+00:00	424.102997	427.834991	384.532013	394.795990	37919700
2014-09-20 00:00:00+00:00	394.673004	423.295990	389.882996	408.903992	36863600
2014-09-21 00:00:00+00:00	408.084991	412.425995	393.181000	398.821014	26580100
...	...	...	...	...	...
2024-01-02 00:00:00+00:00	44187.140625	45899.707031	44176.949219	44957.968750	39335274536
2024-01-03 00:00:00+00:00	44961.601562	45503.242188	40813.535156	42848.175781	46342323118
2024-01-04 00:00:00+00:00	42855.816406	44770.023438	42675.175781	44179.921875	30448091210
2024-01-05 00:00:00+00:00	44192.980469	44353.285156	42784.718750	44162.691406	32336029347
2024-01-06 00:00:00+00:00	44178.953125	44227.632812	43495.597656	43732.027344	22734772224

3399 rows × 5 columns

Setting up our target variable for machine learning:

Create a new column 'Tomorrow' representing the closing prices of the next trading day by shifting the 'Close' prices upward.

In [191]:
```
bitcoin_ticker['Tomorrow'] = bitcoin_ticker['Close'].shift(-1)
```

In [192]:
```
bitcoin_ticker.head(1)
```

Out[192]:

Date	Open	High	Low	Close	Volume	Tomorrow
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	424.440002

In [193]:
```
bitcoin_ticker['Target'] = bitcoin_ticker['Tomorrow']>bitcoin_ticker['Close']
bitcoin_ticker.head(2)
```

Out[193]:

Date	Open	High	Low	Close	Volume	Tomorrow	Target
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	424.440002	False
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200	394.795990	False

In [194]:
```
bitcoin_ticker['Target'] = (bitcoin_ticker['Tomorrow']>bitcoin_ticker['Close']).asty
bitcoin_ticker.head(2)
```

Out[194]:

Date	Open	High	Low	Close	Volume	Tomorrow	Target
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	424.440002	0
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200	394.795990	0

In [195]:
```
type(bitcoin_ticker), bitcoin_ticker.shape, bitcoin_ticker.dtypes
```

Out[195]:
```
(pandas.core.frame.DataFrame,
 (3399, 7),
 Open        float64
 High        float64
 Low         float64
 Close       float64
 Volume        int64
 Tomorrow    float64
 Target        int32
 dtype: object)
```

Training an initial machine learning mode

In [196]:
```
model = RandomForestClassifier(n_estimators=100, min_samples_split=100, random_state
model
```

Out[196]:
```
RandomForestClassifier
RandomForestClassifier(min_samples_split=100, random_state=1)
```

In [197]:
```
bitcoin_train = bitcoin_ticker.iloc[:-100]
bitcoin_train.shape
```

Out[197]: (3299, 7)

In [198]:
```
bitcoin_test = bitcoin_ticker.iloc[-100:]
bitcoin_test.shape
```

Out[198]: (100, 7)

In [199]:
```
predictors=["Close", "Volume", "Open", "High", "Low" ]
predictors
```

Out[199]: ['Close', 'Volume', 'Open', 'High', 'Low']

In [200]:
```
bitcoin_train[predictors].head(1)
```

Out[200]:

Date	Close	Volume	Open	High	Low
2014-09-17 00:00:00+00:00	457.334015	21056800	465.864014	468.174011	452.421997

In [201]:
```
bitcoin_train["Target"].head(3)
```

Out[201]:
```
Date
2014-09-17 00:00:00+00:00    0
2014-09-18 00:00:00+00:00    0
2014-09-19 00:00:00+00:00    1
Name: Target, dtype: int32
```

In [202]:
```
model.fit(bitcoin_train[predictors], bitcoin_train["Target"])
```

Out[202]:
```
▾                    RandomForestClassifier
RandomForestClassifier(min_samples_split=100, random_state=1)
```

In [203]:
```
preds = model.predict(bitcoin_test[predictors])
preds
```

Out[203]:
```
array([1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0,
       0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
       1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0])
```

In [204]:
```
precision_score(bitcoin_test["Target"], preds)
```

Out[204]: 0.5416666666666666

In [ ]:
```
```

In [205]:
```
preds = pd.Series(preds, index=bitcoin_test.index, name="Predictions")
preds
```

Out[205]:
```
Date
2023-09-29 00:00:00+00:00    1
2023-09-30 00:00:00+00:00    1
2023-10-01 00:00:00+00:00    0
2023-10-02 00:00:00+00:00    0
2023-10-03 00:00:00+00:00    0
                            ..
2024-01-02 00:00:00+00:00    1
2024-01-03 00:00:00+00:00    1
2024-01-04 00:00:00+00:00    0
2024-01-05 00:00:00+00:00    0
2024-01-06 00:00:00+00:00    0
Name: Predictions, Length: 100, dtype: int32
```

In [206]:
```
precision_score(bitcoin_test["Target"], preds)
```

Out[206]:
```
0.5416666666666666
```

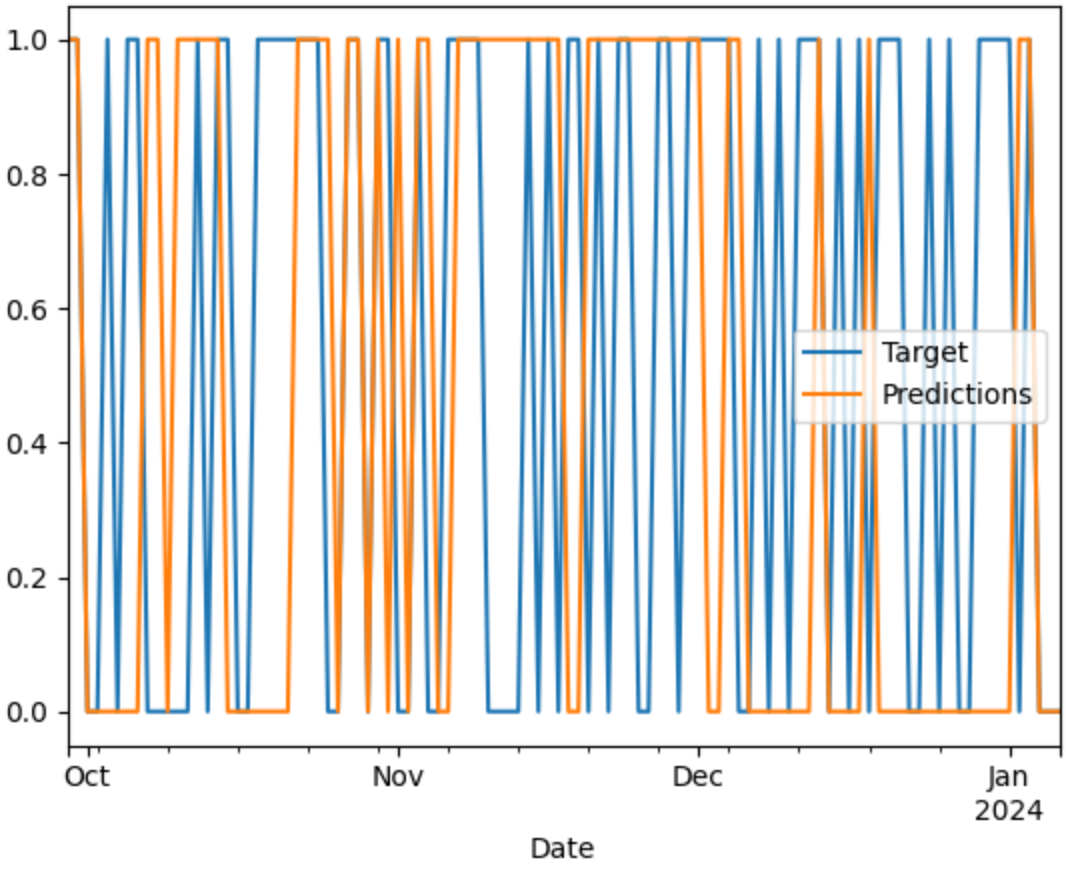
In [207]:
```
combined = pd.concat([bitcoin_test["Target"], preds], axis =1)
combined.head(5)
```

Out[207]:

Date	Target	Predictions
2023-09-29 00:00:00+00:00	1	1
2023-09-30 00:00:00+00:00	1	1
2023-10-01 00:00:00+00:00	0	0
2023-10-02 00:00:00+00:00	0	0
2023-10-03 00:00:00+00:00	1	0

In [208]:
```
combined.plot()
```

Out[208]: <Axes: xlabel='Date'>



Building a Backtesting system

In [209]:
```
def predict(bitcoint_train, bitcoint_test, predictors, model):
    model.fit(bitcoint_train[predictors], bitcoint_train["Target"])
    preds = model.predict(bitcoint_test[predictors])
    preds = pd.Series(preds, index=bitcoint_test.index, name="Predictions")
    combined = pd.concat([bitcoint_test["Target"], preds], axis=1)
    return combined
```

In [210]:
```
bitcoin_ticker.shape
```

Out[210]: (3399, 7)

In [211]:
```
bitcoin_ticker.iloc[0:2500]
```

Out[211]:

Date	Open	High	Low	Close	Volume	T
2014-09-17 00:00:00+00:00	465.864014	468.174011	452.421997	457.334015	21056800	42
2014-09-18 00:00:00+00:00	456.859985	456.859985	413.104004	424.440002	34483200	39
2014-09-19 00:00:00+00:00	424.102997	427.834991	384.532013	394.795990	37919700	40
2014-09-20 00:00:00+00:00	394.673004	423.295990	389.882996	408.903992	36863600	39
2014-09-21 00:00:00+00:00	408.084991	412.425995	393.181000	398.821014	26580100	40
...	...	...	...	...	...	
2021-07-17	31397.308594	31935.945312	31223.990234	31533.068359	18895018942	3179

In [212]:
```
for i in range(500, bitcoin_ticker.shape[0], 250):
    print(i)
```

```
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
```

In [213]:
```
def backtest(data, model, predictors, start=300, step=100):
    all_predictions = []

    for i in range(start, data.shape[0], step):
        train = data.iloc[0:i].copy()
        test = data.iloc[i:(i+step)].copy()
        predictions = predict(bitcoin_train, test, predictors, model)
        all_predictions.append(predictions)

    return pd.concat(all_predictions)
```

In [214]:
```
predictions = backtest(bitcoin_ticker, model, predictors)
predictions
```

Out[214]:

Date	Target	Predictions
2015-07-14 00:00:00+00:00	0	0
2015-07-15 00:00:00+00:00	0	0
2015-07-16 00:00:00+00:00	1	1
2015-07-17 00:00:00+00:00	0	0
2015-07-18 00:00:00+00:00	0	1
...	...	...
2024-01-02 00:00:00+00:00	0	1
2024-01-03 00:00:00+00:00	1	1
2024-01-04 00:00:00+00:00	0	0
2024-01-05 00:00:00+00:00	0	0
2024-01-06 00:00:00+00:00	0	0

3099 rows × 2 columns

In [215]:
```
precision_score(predictions["Target"], predictions["Predictions"])
```

Out[215]: 0.7293478260869565

In [ ]:
```
"""
Analysis of Results:
The precision scores obtained from both the single test set (precision_score(bitcoin
and the backtesting process (precision_score(predictions["Target"], predictions["Pre
the model's ability to correctly classify positive instances (in this case, predicti

"""
```

In [ ]:

In [ ]:

In [ ]:

In [ ]: