prophet-bitcoin-predictor

November 21, 2023

1 INITIALIZATION

[ ]:

```
```

[75]:

```
!pip install yfinance
!pip install scikit-learn
```

```
Requirement already satisfied: yfinance in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages
(0.2.32)
Requirement already satisfied: pandas>=1.3.0 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (2.1.3)
Requirement already satisfied: numpy>=1.16.5 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (1.26.2)
Requirement already satisfied: requests>=2.31 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (2.31.0)
Requirement already satisfied: multitasking>=0.0.7 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (0.0.11)
Requirement already satisfied: lxml>=4.9.1 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (4.9.3)
Requirement already satisfied: appdirs>=1.4.4 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (1.4.4)
Requirement already satisfied: pytz>=2022.5 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (2023.3.post1)
Requirement already satisfied: frozendict>=2.3.4 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (2.3.8)
Requirement already satisfied: peewee>=3.16.2 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (3.17.0)
Requirement already satisfied: beautifulsoup4>=4.11.1 in
```

```
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (4.12.2)
Requirement already satisfied: html5lib>=1.1 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
yfinance) (1.1)
Requirement already satisfied: soupsieve>1.2 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
beautifulsoup4>=4.11.1->yfinance) (2.5)
Requirement already satisfied: six>=1.9 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
html5lib>=1.1->yfinance) (1.16.0)
Requirement already satisfied: webencodings in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
html5lib>=1.1->yfinance) (0.5.1)
Requirement already satisfied: python-dateutil>=2.8.2 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
pandas>=1.3.0->yfinance) (2.8.2)
Requirement already satisfied: tzdata>=2022.1 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
pandas>=1.3.0->yfinance) (2023.3)
Requirement already satisfied: charset-normalizer<4,>=2 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
requests>=2.31->yfinance) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
requests>=2.31->yfinance) (3.4)
Requirement already satisfied: urllib3<3,>=1.21.1 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
requests>=2.31->yfinance) (2.1.0)
Requirement already satisfied: certifi>=2017.4.17 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
requests>=2.31->yfinance) (2023.11.17)
Collecting scikit-learn
  Downloading scikit_learn-1.3.2-cp312-cp312-win_amd64.whl.metadata (11 kB)
Requirement already satisfied: numpy<2.0,>=1.17.3 in
c:\users\vishr\appdata\local\programs\python\python312\lib\site-packages (from
scikit-learn) (1.26.2)
Collecting scipy>=1.5.0 (from scikit-learn)
  Downloading scipy-1.11.4-cp312-cp312-win_amd64.whl.metadata (60 kB)
     ---------------------------------------- 0.0/60.4 kB ? eta -:--:--
     ------ --------------------------------- 10.2/60.4 kB ? eta -:--:--
     -------------------------------------- 60.4/60.4 kB 643.1 kB/s eta 0:00:00
Collecting joblib>=1.1.1 (from scikit-learn)
  Using cached joblib-1.3.2-py3-none-any.whl.metadata (5.4 kB)
Collecting threadpoolctl>=2.0.0 (from scikit-learn)
  Using cached threadpoolctl-3.2.0-py3-none-any.whl.metadata (10.0 kB)
Downloading scikit_learn-1.3.2-cp312-cp312-win_amd64.whl (9.1 MB)
   ---------------------------------------- 0.0/9.1 MB ? eta -:--:--
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   -------- ------------------------------- 2.0/9.1 MB 21.6 MB/s eta 0:00:01
   ------------ --------------------------- 2.8/9.1 MB 19.7 MB/s eta 0:00:01
   ---------------- ----------------------- 3.7/9.1 MB 21.4 MB/s eta 0:00:01
   -------------------- ------------------- 4.8/9.1 MB 21.8 MB/s eta 0:00:01
   ------------------------- -------------- 5.8/9.1 MB 21.6 MB/s eta 0:00:01
   ------------------------------ --------- 7.0/9.1 MB 21.3 MB/s eta 0:00:01
   ----------------------------------- ---- 8.0/9.1 MB 22.3 MB/s eta 0:00:01
   -------------------------------------- - 8.9/9.1 MB 22.7 MB/s eta 0:00:01
   ---------------------------------------- 9.1/9.1 MB 20.9 MB/s eta 0:00:00
Using cached joblib-1.3.2-py3-none-any.whl (302 kB)
Downloading scipy-1.11.4-cp312-cp312-win_amd64.whl (43.7 MB)
   ---------------------------------------- 0.0/43.7 MB ? eta -:--:--
    --------------------------------------- 1.0/43.7 MB 32.4 MB/s eta 0:00:02
   -- ------------------------------------- 2.5/43.7 MB 32.4 MB/s eta 0:00:02
   --- ------------------------------------ 4.0/43.7 MB 31.6 MB/s eta 0:00:02
   ---- ----------------------------------- 5.2/43.7 MB 30.2 MB/s eta 0:00:02
   ------ --------------------------------- 6.6/43.7 MB 30.3 MB/s eta 0:00:02
   ------- -------------------------------- 8.0/43.7 MB 30.0 MB/s eta 0:00:02
   -------- ------------------------------- 8.9/43.7 MB 28.5 MB/s eta 0:00:02
   -------- ------------------------------- 9.5/43.7 MB 25.4 MB/s eta 0:00:02
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   ------------ --------------------------- 13.2/43.7 MB 25.2 MB/s eta 0:00:02
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   ---------------- ----------------------- 18.0/43.7 MB 23.4 MB/s eta 0:00:02
   ----------------- ---------------------- 19.1/43.7 MB 23.4 MB/s eta 0:00:02
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   -------------------- ------------------- 22.5/43.7 MB 25.2 MB/s eta 0:00:01
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   ----------------------- ---------------- 25.7/43.7 MB 24.2 MB/s eta 0:00:01
   ------------------------ --------------- 26.9/43.7 MB 24.2 MB/s eta 0:00:01
   ------------------------- -------------- 28.0/43.7 MB 24.3 MB/s eta 0:00:01
   -------------------------- ------------- 28.8/43.7 MB 25.1 MB/s eta 0:00:01
   --------------------------- ------------ 30.0/43.7 MB 24.2 MB/s eta 0:00:01
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   ----------------------------- ---------- 32.1/43.7 MB 24.2 MB/s eta 0:00:01
   ------------------------------ --------- 32.9/43.7 MB 24.2 MB/s eta 0:00:01
   ------------------------------- -------- 34.1/43.7 MB 23.4 MB/s eta 0:00:01
   ------------------------------- -------- 35.0/43.7 MB 23.4 MB/s eta 0:00:01
   -------------------------------- ------- 35.8/43.7 MB 23.4 MB/s eta 0:00:01
   --------------------------------- ------ 37.0/43.7 MB 23.4 MB/s eta 0:00:01
   ---------------------------------- ----- 37.9/43.7 MB 23.4 MB/s eta 0:00:01
   ----------------------------------- ---- 38.7/43.7 MB 22.6 MB/s eta 0:00:01
   ------------------------------------ --- 39.6/43.7 MB 22.6 MB/s eta 0:00:01
   ------------------------------------ --- 40.3/43.7 MB 23.4 MB/s eta 0:00:01
   ------------------------------------- -- 41.3/43.7 MB 22.5 MB/s eta 0:00:01
   -------------------------------------- - 42.4/43.7 MB 22.6 MB/s eta 0:00:01
   ---------------------------------------  43.4/43.7 MB 22.6 MB/s eta 0:00:01
   ---------------------------------------  43.7/43.7 MB 21.8 MB/s eta 0:00:01
   ---------------------------------------  43.7/43.7 MB 21.8 MB/s eta 0:00:01
   ---------------------------------------  43.7/43.7 MB 21.8 MB/s eta 0:00:01
   ---------------------------------------  43.7/43.7 MB 21.8 MB/s eta 0:00:01
   ---------------------------------------- 43.7/43.7 MB 15.6 MB/s eta 0:00:00
Using cached threadpoolctl-3.2.0-py3-none-any.whl (15 kB)
Installing collected packages: threadpoolctl, scipy, joblib, scikit-learn
Successfully installed joblib-1.3.2 scikit-learn-1.3.2 scipy-1.11.4
threadpoolctl-3.2.0
```

[39]:

```
import pandas as pd
import numpy as np
import yfinance as yf
from datetime import datetime
from datetime import timedelta
import plotly.graph_objects as go
from prophet import Prophet
from prophet.plot import plot_plotly, plot_components_plotly
import warnings

warnings.filterwarnings('ignore')
pd.options.display.float_format = '${:,.2f}'.format
```

2 DATA COLLECTION

[40]:

```
today=datetime.today().strftime('%Y-%m-%d')
start_date = '1950-01-01' #Collects all the data from the start of listing of␣
 ↪BTC
data = yf.download('BTC-USD', start_date, today)
```

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

[41]:

```
data
```

[41]:

```
                Open      High       Low     Close  Adj Close     Volume
Date
2014-09-17   $465.86   $468.17   $452.42   $457.33    $457.33   21056800
2014-09-18   $456.86   $456.86   $413.10   $424.44    $424.44   34483200
2014-09-19   $424.10   $427.83   $384.53   $394.80    $394.80   37919700
2014-09-20   $394.67   $423.30   $389.88   $408.90    $408.90   36863600
2014-09-21   $408.08   $412.43   $393.18   $398.82    $398.82   26580100
…                …        …        …         …         …          …
```

```
2023-11-16 $37,879.98 $37,934.62 $35,545.47 $36,154.77 $36,154.77  26007385366
2023-11-17 $36,164.82 $36,704.48 $35,901.23 $36,596.68 $36,596.68  22445028430
2023-11-18 $36,625.37 $36,839.28 $36,233.31 $36,585.70 $36,585.70  11886022717
2023-11-19 $36,585.77 $37,509.36 $36,414.60 $37,386.55 $37,386.55  12915986553
2023-11-20 $37,374.07 $37,756.82 $36,882.53 $37,476.96 $37,476.96  20888209068

[3352 rows x 6 columns]
```

3 DATA PRE-PROCESSING

[55]:
```
data.reset_index(inplace=True)
data.columns
```

[55]:
```
Index(['index', 'Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume'],
dtype='object')
```

[56]:
```
data.isnull().any()
data.isnull().sum()
```

[56]:
```
index        0
Date         0
Open         0
High         0
Low          0
Close        0
Adj Close    0
Volume       0
dtype: int64
```

[57]:
```
data
```

[57]:
```
      index       Date       Open       High        Low      Close  Adj Close  \
0         0 2014-09-17    $465.86    $468.17    $452.42    $457.33    $457.33
1         1 2014-09-18    $456.86    $456.86    $413.10    $424.44    $424.44
2         2 2014-09-19    $424.10    $427.83    $384.53    $394.80    $394.80
3         3 2014-09-20    $394.67    $423.30    $389.88    $408.90    $408.90
4         4 2014-09-21    $408.08    $412.43    $393.18    $398.82    $398.82
…     …        …          …          …          …          …          …
3347   3347 2023-11-16 $37,879.98 $37,934.62 $35,545.47 $36,154.77 $36,154.77
3348   3348 2023-11-17 $36,164.82 $36,704.48 $35,901.23 $36,596.68 $36,596.68
3349   3349 2023-11-18 $36,625.37 $36,839.28 $36,233.31 $36,585.70 $36,585.70
3350   3350 2023-11-19 $36,585.77 $37,509.36 $36,414.60 $37,386.55 $37,386.55
3351   3351 2023-11-20 $37,374.07 $37,756.82 $36,882.53 $37,476.96 $37,476.96

           Volume
0        21056800
```

```
1        34483200
2        37919700
3        36863600
4        26580100
…            …
3347  26007385366
3348  22445028430
3349  11886022717
3350  12915986553
3351  20888209068

[3352 rows x 8 columns]
```

```
[58]: data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3352 entries, 0 to 3351
Data columns (total 8 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   index      3352 non-null   int64
 1   Date       3352 non-null   datetime64[ns]
 2   Open       3352 non-null   float64
 3   High       3352 non-null   float64
 4   Low        3352 non-null   float64
 5   Close      3352 non-null   float64
 6   Adj Close  3352 non-null   float64
 7   Volume     3352 non-null   int64
dtypes: datetime64[ns](1), float64(5), int64(2)
memory usage: 209.6 KB
```

```
[59]: data_for_prophet=data[['Date','Open']]
      data_for_prophet
```

```
[59]:
           Date       Open
0    2014-09-17    $465.86
1    2014-09-18    $456.86
2    2014-09-19    $424.10
3    2014-09-20    $394.67
4    2014-09-21    $408.08
…        …           …
3347 2023-11-16 $37,879.98
3348 2023-11-17 $36,164.82
3349 2023-11-18 $36,625.37
3350 2023-11-19 $36,585.77
3351 2023-11-20 $37,374.07
```

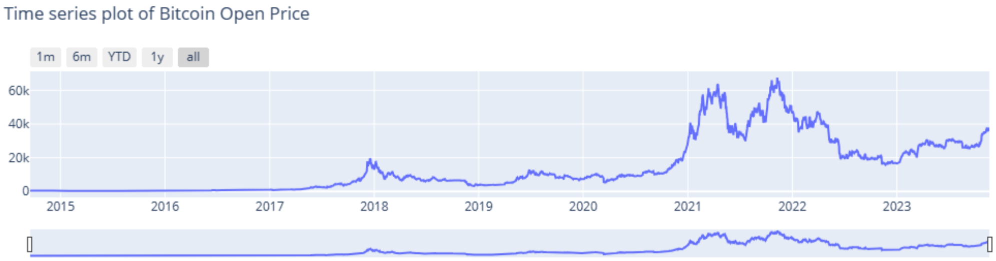
```
[3352 rows x 2 columns]
```

[60]:
```
new_column_names={
    "Date":"ds",
    "Open":"y",
}
data_for_prophet.rename(columns=new_column_names,inplace=True)
data_for_prophet
```

[60]:
```
             ds          y
0    2014-09-17    $465.86
1    2014-09-18    $456.86
2    2014-09-19    $424.10
3    2014-09-20    $394.67
4    2014-09-21    $408.08
…           …          …
3347 2023-11-16 $37,879.98
3348 2023-11-17 $36,164.82
3349 2023-11-18 $36,625.37
3350 2023-11-19 $36,585.77
3351 2023-11-20 $37,374.07

[3352 rows x 2 columns]
```

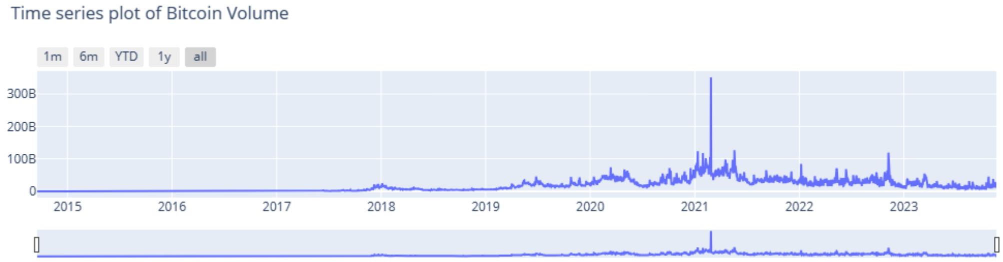
4 DATA VISUALIZATION

[61]:
```
import plotly.graph_objects as go

x = data_for_prophet["ds"]
y = data_for_prophet["y"]

fig = go.Figure()
fig.add_trace(go.Scatter(x=x, y=y))

# Set title
fig.update_layout(
    title_text="Time series plot of Bitcoin Open Price"
)

fig.update_layout(
    xaxis=dict(
        rangeselector=dict(
            buttons=list(
                [
                    dict(count=1, label="1m", step="month",␣
 ↪stepmode="backward"),
                    dict(count=6, label="6m", step="month",␣
↪stepmode="backward"),
                    dict(count=1, label="YTD", step="year", stepmode="todate"),
                    dict(count=1, label="1y", step="year", stepmode="backward"),
                    dict(step="all"),
                ]
            ),
            visible=True
        ),
        rangeslider=dict(visible=True),
        type="date"
    )
)

# Show the plot
fig.show()
```

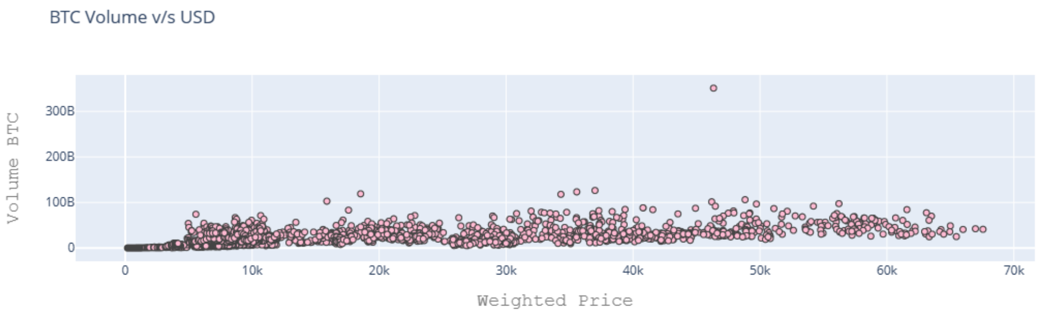


[62]:

```
import plotly.graph_objects as go

x = data["Date"]
y = data["Volume"]

fig = go.Figure()
fig.add_trace(go.Scatter(x=x, y=y))

# Set title
fig.update_layout(
    title_text="Time series plot of Bitcoin Volume"
)

fig.update_layout(
    xaxis=dict(
        rangeselector=dict(
            buttons=list(
                [
                    dict(count=1, label="1m", step="month",␣
 ↪stepmode="backward"),
                    dict(count=6, label="6m", step="month",␣
 ↪stepmode="backward"),
                    dict(count=1, label="YTD", step="year", stepmode="todate"),
                    dict(count=1, label="1y", step="year", stepmode="backward"),
                    dict(step="all"),
                ]
            ),
            visible=True
        ),
        rangeslider=dict(visible=True),
        type="date"
    )
)

# Show the plot
fig.show()
```



[63]:
```
import plotly.offline as pyo
pyo.init_notebook_mode(connected=True)


#BTC Volume vs USD visualization
trace = go.Scattergl(
    x = data['Close'].astype(float),
    y = data['Volume'].astype(float),
    mode = 'markers',
    marker = dict(
        color = '#FFBAD2',
        line = dict(width = 1)
    )
)
layout = go.Layout(
    title='BTC Volume v/s USD',
    xaxis=dict(
        title='Weighted Price',
        titlefont=dict(
            family='Courier New, monospace',
            size=18,
            color='#7f7f7f'
        )
    ),
    yaxis=dict(
        title='Volume BTC',
        titlefont=dict(
            family='Courier New, monospace',
            size=18,
            color='#7f7f7f'
        )))
data = [trace]
fig = go.Figure(data=data, layout=layout)
pyo.iplot(fig, filename='compare_webgl')
```



5 MODEL TRAINING

[64]:
```
#Create a Prophet model object to train it
model = Prophet(
    seasonality_mode="multiplicative",
)

model.fit(data_for_prophet)
```

```
21:15:06 - cmdstanpy - INFO - Chain [1] start processing
```

```
21:15:07 - cmdstanpy - INFO - Chain [1] done processing
```

```
[64]: <prophet.forecaster.Prophet at 0x23b6dd70050>
```

```
[65]: import pickle
      pickle.dump(model,open('Forecaster.pkl','wb'))
```

6 FORECASTING

```
[66]: future=model.make_future_dataframe(periods=365)
      future
```

```
[66]:               ds
      0     2014-09-17
      1     2014-09-18
      2     2014-09-19
      3     2014-09-20
      4     2014-09-21
      …            …
      3712 2024-11-15
      3713 2024-11-16
      3714 2024-11-17
      3715 2024-11-18
      3716 2024-11-19

      [3717 rows x 1 columns]
```

```
[67]: forecast=model.predict(future)
      forecast
```

```
[67]:               ds      trend  yhat_lower  yhat_upper  trend_lower  trend_upper  \
      0     2014-09-17     $61.64  $-5,687.78   $5,830.86       $61.64       $61.64
      1     2014-09-18     $62.34  $-5,316.41   $5,568.55       $62.34       $62.34
      2     2014-09-19     $63.04  $-5,657.41   $5,629.58       $63.04       $63.04
      3     2014-09-20     $63.74  $-5,212.90   $5,957.94       $63.74       $63.74
      4     2014-09-21     $64.45  $-5,367.89   $5,316.26       $64.45       $64.45
      …            …          …           …           …            …            …
      3712 2024-11-15 $14,482.46  $-1,452.28  $34,357.97     $-765.58   $29,162.68
      3713 2024-11-16 $14,462.73    $-895.93  $34,974.65     $-841.59   $29,240.96
      3714 2024-11-17 $14,443.00  $-1,278.04  $34,302.92     $-917.61   $29,319.25
      3715 2024-11-18 $14,423.27  $-1,937.35  $35,406.88     $-993.62   $29,397.54
      3716 2024-11-19 $14,403.54  $-1,117.38  $34,820.11   $-1,069.64   $29,475.82

            multiplicative_terms  multiplicative_terms_lower  \
      0                   $-0.15                      $-0.15
      1                   $-0.15                      $-0.15
      2                   $-0.16                      $-0.16
```

```
3                   $-0.16                      $-0.16
4                   $-0.16                      $-0.16
…                    …                         …
3712                 $0.14                       $0.14
3713                 $0.14                       $0.14
3714                 $0.13                       $0.13
3715                 $0.13                       $0.13
3716                 $0.12                       $0.12

      multiplicative_terms_upper  weekly  weekly_lower  weekly_upper  yearly  \
0                         $-0.15  $-0.00        $-0.00        $-0.00  $-0.15
1                         $-0.15   $0.00         $0.00         $0.00  $-0.15
2                         $-0.16  $-0.00        $-0.00        $-0.00  $-0.15
3                         $-0.16  $-0.00        $-0.00        $-0.00  $-0.16
4                         $-0.16   $0.00         $0.00         $0.00  $-0.16
…                          …     …           …           …     …
3712                       $0.14  $-0.00        $-0.00        $-0.00   $0.14
3713                       $0.14  $-0.00        $-0.00        $-0.00   $0.14
3714                       $0.13   $0.00         $0.00         $0.00   $0.13
3715                       $0.13   $0.00         $0.00         $0.00   $0.12
3716                       $0.12  $-0.00        $-0.00        $-0.00   $0.12

      yearly_lower  yearly_upper  additive_terms  additive_terms_lower  \
0           $-0.15        $-0.15           $0.00                 $0.00
1           $-0.15        $-0.15           $0.00                 $0.00
2           $-0.15        $-0.15           $0.00                 $0.00
3           $-0.16        $-0.16           $0.00                 $0.00
4           $-0.16        $-0.16           $0.00                 $0.00
…            …           …             …                   …
3712         $0.14         $0.14           $0.00                 $0.00
3713         $0.14         $0.14           $0.00                 $0.00
3714         $0.13         $0.13           $0.00                 $0.00
3715         $0.12         $0.12           $0.00                 $0.00
3716         $0.12         $0.12           $0.00                 $0.00

      additive_terms_upper       yhat
0                    $0.00     $52.39
1                    $0.00     $52.99
2                    $0.00     $53.23
3                    $0.00     $53.78
4                    $0.00     $54.33
…                    …        …
3712                 $0.00 $16,506.83
3713                 $0.00 $16,421.75
3714                 $0.00 $16,326.87
3715                 $0.00 $16,236.30
3716                 $0.00 $16,102.56
```

```
[3717 rows x 19 columns]
```

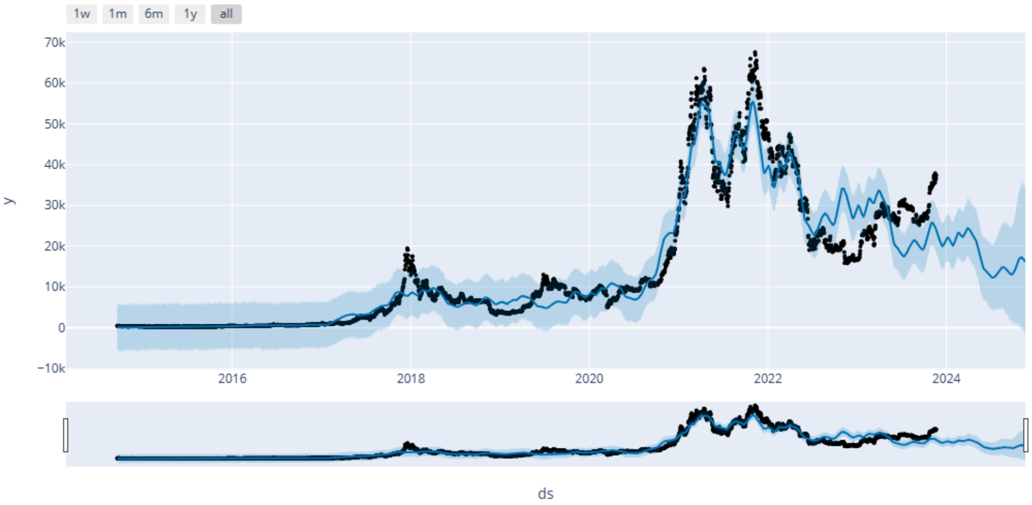
[68]:
```
forecast[['ds','yhat','yhat_lower','yhat_upper']]
```

[68]:
```
              ds       yhat  yhat_lower  yhat_upper
0     2014-09-17     $52.39  $-5,687.78   $5,830.86
1     2014-09-18     $52.99  $-5,316.41   $5,568.55
2     2014-09-19     $53.23  $-5,657.41   $5,629.58
3     2014-09-20     $53.78  $-5,212.90   $5,957.94
4     2014-09-21     $54.33  $-5,367.89   $5,316.26
…         …          …          …           …
3712 2024-11-15 $16,506.83  $-1,452.28  $34,357.97
3713 2024-11-16 $16,421.75    $-895.93  $34,974.65
3714 2024-11-17 $16,326.87  $-1,278.04  $34,302.92
3715 2024-11-18 $16,236.30  $-1,937.35  $35,406.88
3716 2024-11-19 $16,102.56  $-1,117.38  $34,820.11

[3717 rows x 4 columns]
```

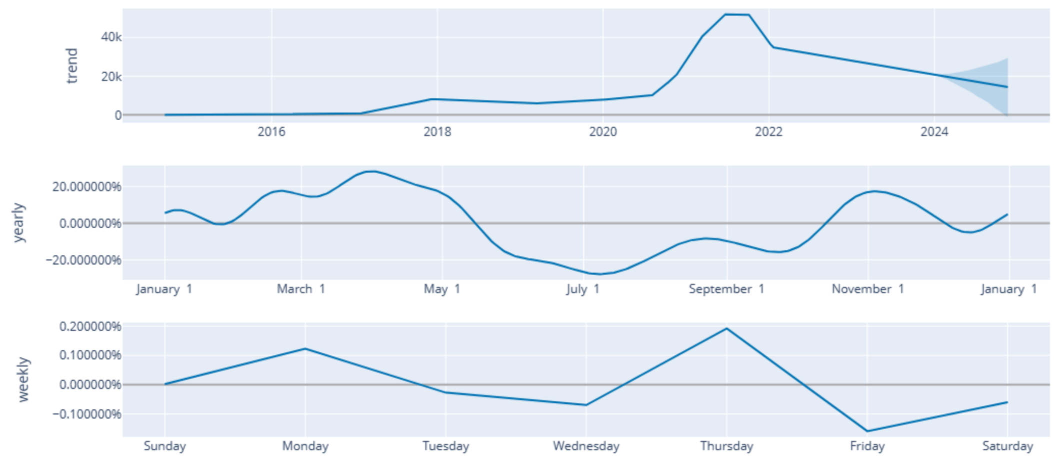
[69]:
```
next_day=(datetime.today()+timedelta(days=1)).strftime('%Y-%m-%d')
forecast[forecast['ds']==next_day]['yhat'].item()
```

[69]:
```
23773.90382949392
```

[71]:
```
plot_plotly(model,forecast)
```



[72]:
```
plot_components_plotly(model,forecast)
```



7 VALIDATION

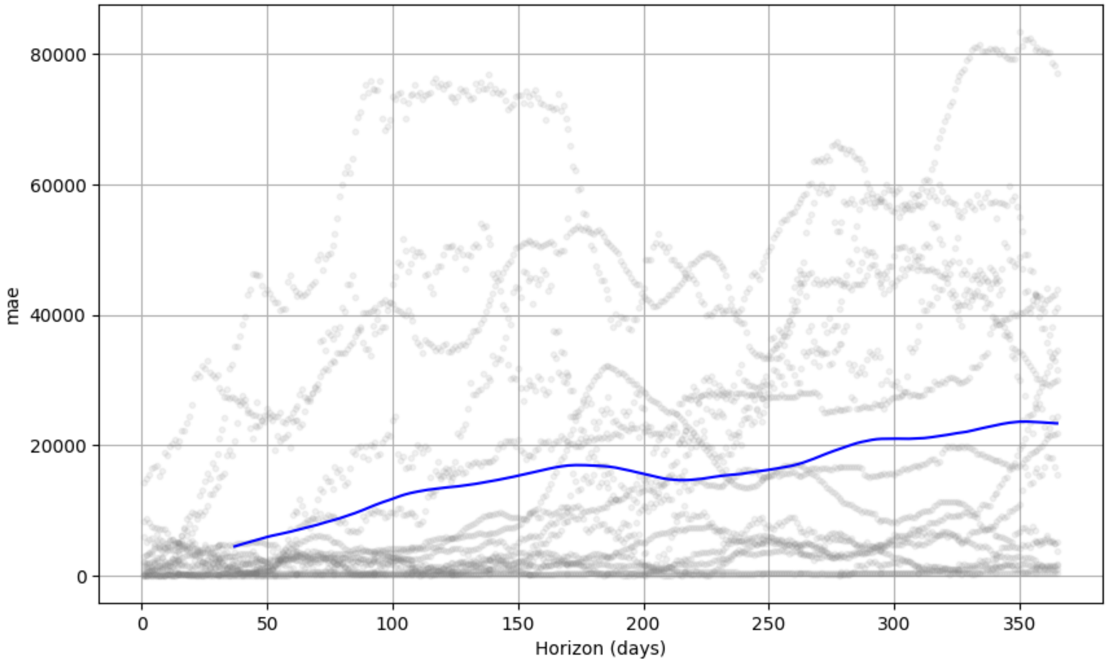
[73]:
```
from prophet.diagnostics import performance_metrics
from prophet.plot import plot_cross_validation_metric
from prophet.diagnostics import cross_validation

# Perform Cross-Validation
df_cv = cross_validation(model, initial='365 days', period='180 days',␣
 ↪horizon='365 days')

# Compute performance metrics
df_p = performance_metrics(df_cv)
print(df_p.head())

# Visualize performance metrics
fig = plot_cross_validation_metric(df_cv, metric='mae')
```

```
Seasonality has period of 365.25 days which is larger than initial window.
Consider increasing initial.
  0%|
| 0/15 [00:00<?, ?it/s]21:16:12 - cmdstanpy - INFO - Chain [1] start processing
21:16:12 - cmdstanpy - INFO - Chain [1] done processing
  7%|
| 1/15 [00:00<00:04,  2.95it/s]21:16:13 - cmdstanpy - INFO - Chain [1] start
```

```
processing
21:16:13 - cmdstanpy - INFO - Chain [1] done processing
 13%|
| 2/15 [00:00<00:04,  2.71it/s]21:16:13 - cmdstanpy - INFO - Chain [1] start
processing
21:16:13 - cmdstanpy - INFO - Chain [1] done processing
 20%|
| 3/15 [00:01<00:04,  2.53it/s]21:16:13 - cmdstanpy - INFO - Chain [1] start
processing
21:16:14 - cmdstanpy - INFO - Chain [1] done processing
 27%|
| 4/15 [00:01<00:05,  1.98it/s]21:16:14 - cmdstanpy - INFO - Chain [1] start
processing
21:16:15 - cmdstanpy - INFO - Chain [1] done processing
 33%|
| 5/15 [00:02<00:05,  1.72it/s]21:16:15 - cmdstanpy - INFO - Chain [1] start
processing
21:16:15 - cmdstanpy - INFO - Chain [1] done processing
 40%|
| 6/15 [00:03<00:05,  1.60it/s]21:16:16 - cmdstanpy - INFO - Chain [1] start
processing
21:16:16 - cmdstanpy - INFO - Chain [1] done processing
 47%|
| 7/15 [00:04<00:06,  1.29it/s]21:16:17 - cmdstanpy - INFO - Chain [1] start
processing
21:16:17 - cmdstanpy - INFO - Chain [1] done processing
 53%|
| 8/15 [00:05<00:06,  1.13it/s]21:16:18 - cmdstanpy - INFO - Chain [1] start
processing
21:16:19 - cmdstanpy - INFO - Chain [1] done processing
 60%|
| 9/15 [00:06<00:05,  1.02it/s]21:16:19 - cmdstanpy - INFO - Chain [1] start
processing
21:16:20 - cmdstanpy - INFO - Chain [1] done processing
 67%|
| 10/15 [00:07<00:04,  1.00it/s]21:16:20 - cmdstanpy - INFO - Chain [1] start
processing
21:16:21 - cmdstanpy - INFO - Chain [1] done processing
 73%|
| 11/15 [00:08<00:04,  1.03s/it]21:16:21 - cmdstanpy - INFO - Chain [1] start
processing
21:16:23 - cmdstanpy - INFO - Chain [1] done processing
 80%|
| 12/15 [00:10<00:03,  1.25s/it]21:16:23 - cmdstanpy - INFO - Chain [1] start
processing
21:16:24 - cmdstanpy - INFO - Chain [1] done processing
 87%|
| 13/15 [00:12<00:02,  1.34s/it]21:16:24 - cmdstanpy - INFO - Chain [1] start
```

```
processing
21:16:25 - cmdstanpy - INFO - Chain [1] done processing
 93%|
     | 14/15 [00:13<00:01,  1.21s/it]21:16:25 - cmdstanpy - INFO - Chain [1]
start processing
21:16:26 - cmdstanpy - INFO - Chain [1] done processing
100%|
    | 15/15 [00:14<00:00,  1.04it/s]
```

```
  horizon            mse       rmse        mae  mape  mdape  smape  coverage
0 37 days $68,810,497.34 $8,295.21 $4,438.49 $0.28  $0.20  $0.25     $0.16
1 38 days $72,837,450.01 $8,534.49 $4,548.13 $0.29  $0.21  $0.25     $0.16
2 39 days $77,291,752.50 $8,791.57 $4,664.25 $0.29  $0.21  $0.26     $0.16
3 40 days $82,080,280.71 $9,059.82 $4,782.83 $0.29  $0.21  $0.26     $0.16
4 41 days $86,899,438.51 $9,321.99 $4,898.16 $0.30  $0.22  $0.27     $0.16
```



8 PERFORMANCE METRICS

[77]:
```
from datetime import datetime
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score
import numpy as np

# Prepare the data for calculating and visualizing performance metrics
y_true = data_for_prophet['y']
forecast_based_on_data = forecast[forecast['ds'] <= datetime(2023, 11, 20)]
```

```python
# Extract yhat column from the filtered DataFrame
y_pred = forecast_based_on_data['yhat']

# Mean Squared Error (MSE)
mse = mean_squared_error(y_true=y_true, y_pred=y_pred)
print(f"Mean Squared Error (MSE): {mse}")

# Mean Absolute Error (MAE)
mae = mean_absolute_error(y_true=y_true, y_pred=y_pred)
print(f"Mean Absolute Error (MAE): {mae}")

# R-squared (R2)
r2 = r2_score(y_true=y_true, y_pred=y_pred)
print(f"R-squared (R2): {r2}")

# Root Mean Squared Error (RMSE)
rmse = np.sqrt(mse)
print(f"Root Mean Squared Error (RMSE): {rmse}")
```

```
Mean Squared Error (MSE): 19178199.67176853
Mean Absolute Error (MAE): 2796.582551703893
R-squared (R2): 0.9251720737281792
Root Mean Squared Error (RMSE): 4379.292142774735
```

[ ]: