In [ ]:

```
import pandas as pd
import requests
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import json
%matplotlib inline

import warnings
warnings.filterwarnings('ignore')
```

In [ ]:

```
# api key untuk ekstrak data dari web alpha vantage
api_key = "2A3KMY0GNM9JUBKA"
```

In [ ]:

```
# HISTORICAL DATA ~ TIME_SERIES_DAILY
def get_historical_data(symbol, start_date = None):
    api_url = f'https://www.alphavantage.co/query?function=TIME_SERIES_DAILY_ADJUSTED&symbol={symbol}&apikey={api_key}&o
    raw_df = requests.get(api_url).json()
    df = pd.DataFrame(raw_df[f'Time Series (Daily)']).T
    df = df.rename(columns = {'1. open': 'open', '2. high': 'high', '3. low': 'low', '4. close': 'close',
                              '5. adjusted close': 'adj close', '6. volume': 'volume'})
    for i in df.columns:
        df[i] = df[i].astype(float)
    df.index = pd.to_datetime(df.index)
#     delete kolom 'dividen amount' dan kolom 'split coefficient'
    df = df.iloc[::-1].drop(['7. dividend amount', '8. split coefficient'], axis = 1)
    if start_date:
        df = df[df.index >= start_date]
    return df
```

Untuk contoh percobaan kami mencoba mengambil data historis dari saham microsoft, dengan tanggal 2010-01-01 sebagai tanggal mulainya data historis diambil.

```
In [ ]: msft_hist = get_historical_data('MSFT', '2010-01-01')
        msft_hist
```

```
Out[179]:
                open     high     low    close   adj close       volume
2010-01-04     30.62   31.100   30.59   30.950   23.906734   38409100.0
2010-01-05     30.85   31.100   30.64   30.960   23.914459   49749600.0
2010-01-06     30.88   31.080   30.52   30.770   23.767697   58182400.0
2010-01-07     30.63   30.700   30.19   30.452   23.522064   50559700.0
2010-01-08     30.28   30.880   30.24   30.660   23.682729   51197400.0
       ...       ...      ...     ...      ...         ...          ...
2021-12-06    323.95  327.450  319.23  326.190  326.190000   30032556.0
2021-12-07    331.64  335.800  330.10  334.920  334.920000   31021936.0
2021-12-08    335.31  335.500  330.80  334.970  334.970000   24760988.0
2021-12-09    334.41  336.489  332.12  333.100  333.100000   22214158.0
2021-12-10    334.98  343.000  334.79  342.540  342.540000   38095694.0

3007 rows × 6 columns
```

Note the dataframe has:

- Date (YYY-MM-DD) as an index
- Open (price the stock started as)
- High (highest price stock reached that day)
- Low (lowest price stock reached that day)
- Close (price the stock ended the day as)
- adj close (The adjusted closing price factors in anything that might affect the stock price after the market closes.)
- Volume (how many shares were traded that day)
- dividend amount (the amount of dividend to give into the shareholder)
- split coefficient (stock split)

mengelola missing value

In [ ]:

```
msft_hist.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 3007 entries, 2010-01-04 to 2021-12-10
Data columns (total 6 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   open       3007 non-null   float64
 1   high       3007 non-null   float64
 2   low        3007 non-null   float64
 3   close      3007 non-null   float64
 4   adj close  3007 non-null   float64
 5   volume     3007 non-null   float64
dtypes: float64(6)
memory usage: 164.4 KB
```

Dari hasil diatas, dapat dikatakan dataset yang diperoleh tidak ada nilai yang kosong.

pemilihan fitur

Setelah analisis masing-masing pengertian dari setiap fitur, fitur 'adj close' di buang karena data tersebut dikatakan cukup sama dengan kolom 'close'. keduanya merepresentasikan harga penutupan pada suatu saham.

In [ ]:

```
def drop_feature(df):
    return df.drop(['adj close'], axis = 1)
```

In [ ]:

```
msft_hist = drop_feature(msft_hist)
```

In [ ]:

```
msft_hist
```

Out[183]:

	open	high	low	close	volume
2010-01-04	30.62	31.100	30.59	30.950	38409100.0
2010-01-05	30.85	31.100	30.64	30.960	49749600.0
2010-01-06	30.88	31.080	30.52	30.770	58182400.0
2010-01-07	30.63	30.700	30.19	30.452	50559700.0
2010-01-08	30.28	30.880	30.24	30.660	51197400.0
...	...	...	...	...	...
2021-12-06	323.95	327.450	319.23	326.190	30032556.0
2021-12-07	331.64	335.800	330.10	334.920	31021936.0
2021-12-08	335.31	335.500	330.80	334.970	24760988.0
2021-12-09	334.41	336.489	332.12	333.100	22214158.0
2021-12-10	334.98	343.000	334.79	342.540	38095694.0

3007 rows × 5 columns

Untuk fitur yang akan dipakai dalam pembuatan model pada tahap 4, kami memutuskan untuk menggunakan kolom 'open', 'high', 'low', 'close', dan 'volume'. karena ke empat fitur tersebut cukup merepresentasikan harga dari suatu saham.

normalisasi

In [ ]:

```
# normalisasi menggunakan formula normalisasi min - max
def normalise_min_max(df):
    return (df - df.min()) / (df.max() - df.min())
```

In [ ]:

```
msft_hist = normalise_min_max(msft_hist)
```

In [ ]:

```
msft_hist.head()
```

Out[186]:

	open	high	low	close	volume
2010-01-04	0.023419	0.023839	0.024603	0.024805	0.099341
2010-01-05	0.024135	0.023839	0.024760	0.024836	0.135701
2010-01-06	0.024228	0.023778	0.024384	0.024242	0.162738
2010-01-07	0.023450	0.022614	0.023351	0.023249	0.138298
2010-01-08	0.022362	0.023165	0.023508	0.023899	0.140343

pengelompokkan data training dan data testing

berikut adalah fungsi (manual / tanpa bantuan library) untuk memisahkan dataset menjadi data training dan data testing.

In [ ]:

```
# contoh data testingnya, 20% dari dataset
def train_test_split(df, test_size=0.2):
    split_row = len(df) - int(test_size * len(df))
    train_data = df.iloc[:split_row]
    test_data = df.iloc[split_row:]
    return train_data, test_data
```

In [ ]:

```
train, test = train_test_split(msft_hist, test_size=0.2)
```

In [ ]:

```
# train.tail()
test.head()
```

Out[189]:

```
                open      high       low     close    volume
2019-07-26  0.364756  0.362678  0.368016  0.369666  0.037231
2019-07-29  0.368270  0.362157  0.365105  0.368697  0.029434
2019-07-30  0.364041  0.361269  0.366451  0.366573  0.030206
2019-07-31  0.364632  0.359032  0.351676  0.353827  0.099949
2019-08-01  0.354275  0.360411  0.357467  0.359419  0.106229
```

berikut adalah fungsi untuk memisahkan dataset menjadi data training dan data testing denga bantuan library sklearn.

In [ ]:

```
from sklearn.model_selection import train_test_split
```

In [ ]:

```python
y1 = pd.DataFrame(msft_hist['close'])
y1
```

Out[191]:

```
               close
2010-01-04  0.024805
2010-01-05  0.024836
2010-01-06  0.024242
2010-01-07  0.023249
2010-01-08  0.023899
       ...       ...
2021-12-06  0.947142
2021-12-07  0.974414
2021-12-08  0.974570
2021-12-09  0.968729
2021-12-10  0.998219

3007 rows × 1 columns
```

In [ ]:

```python
X_train, X_test, y_train, y_test = train_test_split(msft_hist, y1, train_size = 0.8, shuffle=False)
```

In [ ]:

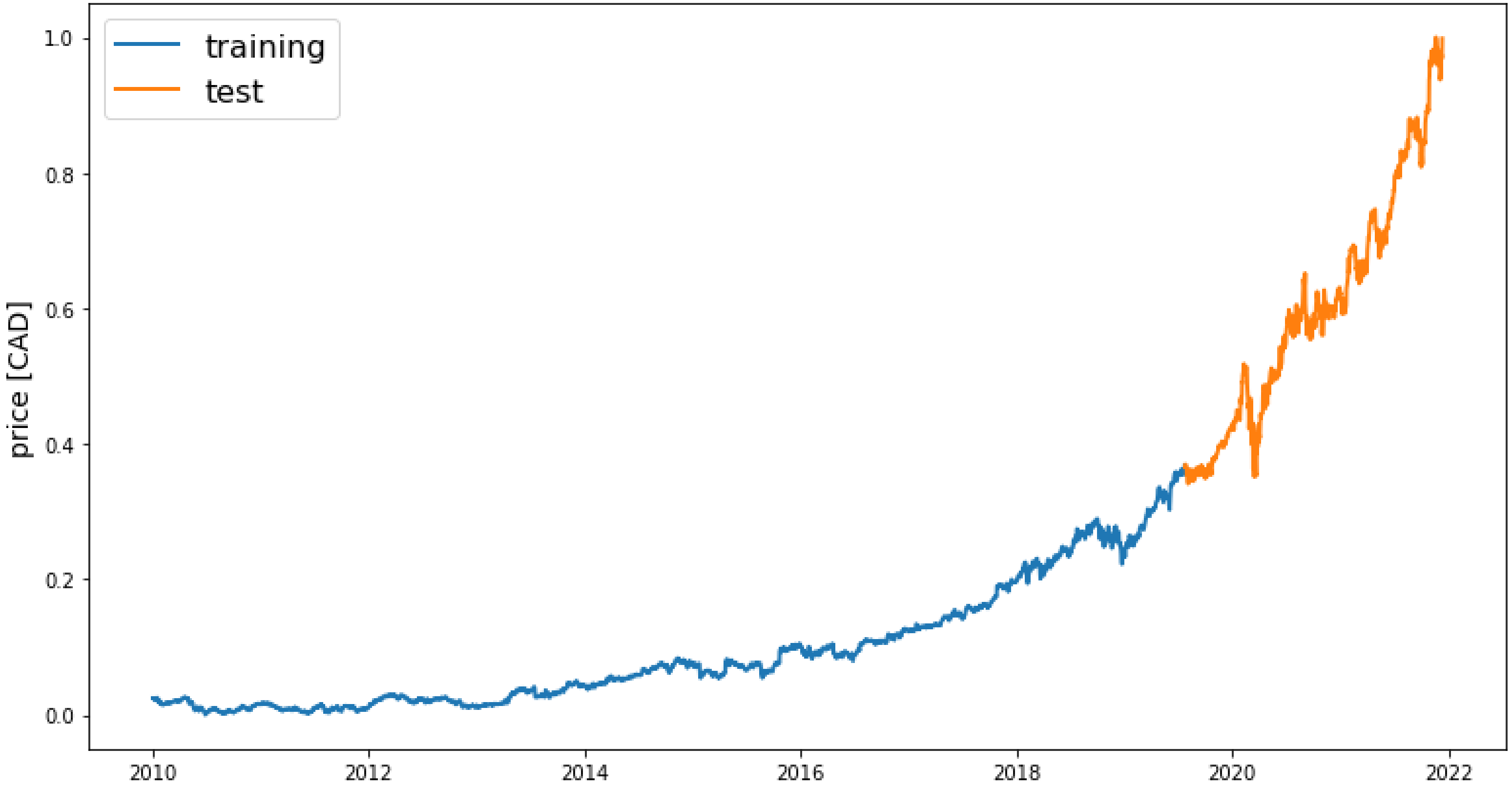
```python
# X_train.tail()
# X_test.head()
# y_train.tail()
# y_test.head()
```

fungsi untuk membuat visualisasi dataset berdasarkan data testing dan data training

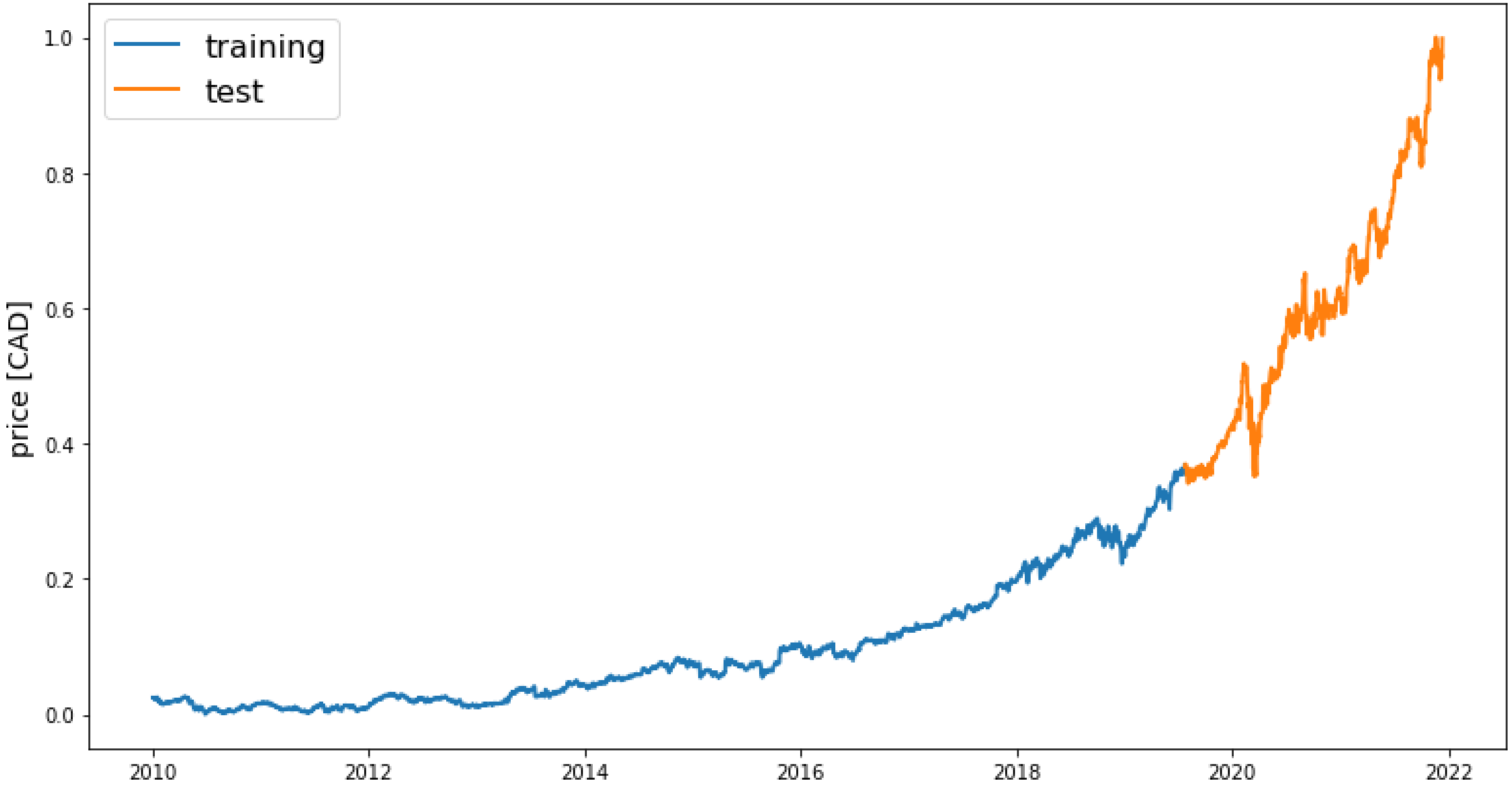
```
In [ ]: def line_plot(line1, line2, label1=None, label2=None, title='', lw=2):
            fig, ax = plt.subplots(1, figsize=(13, 7))
            ax.plot(line1, label=label1, linewidth=lw)
            ax.plot(line2, label=label2, linewidth=lw)
            ax.set_ylabel('price [CAD]', fontsize=14)
            ax.set_title(title, fontsize=16)
            ax.legend(loc='best', fontsize=16)
```

visualisasi data testing dengan data training

```
In [ ]: target_col = 'close'
        line_plot(X_train[target_col], X_test[target_col], 'training', 'test', title='')
```



```
In [ ]: line_plot(y_train, y_test, 'training', 'test', title='')
```



hasil eksplorasi dan persiapan data dari tahap 3 :

data training dan data testing dengan ukuran perbandingan 80% dan 20% dari dataset. untuk masing-masing data, terdapat fitur 'open', 'high', 'low', 'close', dan 'volume'. Dari ke empat fitur tersebut cukup merepresentasikan harga dari suatu saham.

#Modeling

projek kami, sistem prediksi tren harga saham merupakan salah satu projek yang termasuk dalam percobaan prediksi/forecast *time series* data. *time series data* merupakan jenis data yang memiliki titik data yang diindeks atau diurutkan dalam urutan berbasis waktu. *time series forecast* adalah salah satu metode untuk membuat model untuk memprediksi nilai masa depan berdasarkan data deret waktu saat ini dan historis.

dalam tahap modeling di pembuatan projek, kami melakukan beberapa eksperimen kepada beberapa algoritma machine learning. salah satu algoritma yang akan digunakan dalam eksperimen antara lain:

- linear regression model
- support vector regression
- LSTM (long short term memory) model
- Facebook’s open-source Prophet model, prophet
- ..

algoritma diatas merupakan algoritma yang sering digunakan untuk membuat prediksi data *time-series*.

setelah melakukan beberapa eksperimen diatas, dari hasil data prediksi akan kami lakukan evaluasi menggunakan Mean Squared Error (MAE) untuk memilih model mana yang paling optimal untuk digunakan dalam projek kami.

eksperimen menggunkan simple linear regression

In [ ]:

```
from sklearn.linear_model import LinearRegression
import seaborn as sns
import math
```

In [ ]:

```
x = msft_hist["open"].values.reshape(-1,1)
y = msft_hist["close"].values.reshape(-1,1)
```

In [ ]:

```
# X_train_lr ,X_test_lr ,y_train_lr, y_test_lr = train_test_split(x, y, train_size = 0.8, shuffle=False)
```

```
In [ ]: msft_hist.head()
```

Out[207]:

	open	high	low	close	volume
2010-01-04	0.023419	0.023839	0.024603	0.024805	0.099341
2010-01-05	0.024135	0.023839	0.024760	0.024836	0.135701
2010-01-06	0.024228	0.023778	0.024384	0.024242	0.162738
2010-01-07	0.023450	0.022614	0.023351	0.023249	0.138298
2010-01-08	0.022362	0.023165	0.023508	0.023899	0.140343

```
In [ ]: msft_hist.corr()
```

Out[208]:

	open	high	low	close	volume
open	1.000000	0.999912	0.999905	0.999821	-0.328207
high	0.999912	1.000000	0.999857	0.999899	-0.325544
low	0.999905	0.999857	1.000000	0.999911	-0.331467
close	0.999821	0.999899	0.999911	1.000000	-0.328926
volume	-0.328207	-0.325544	-0.331467	-0.328926	1.000000

```
In [ ]: x_temp = msft_hist.open.to_numpy();
        y_temp = msft_hist.close.to_numpy();
        x_temp = x_temp.reshape(-1,1)
        y_temp = y_temp.reshape(-1,1)
        np.size(x_temp)
```

```
Out[226]: 3007
```

In [ ]:

```
msft_hist.head(5)
```

Out[227]:

	open	high	low	close	volume
2010-01-04	0.023419	0.023839	0.024603	0.024805	0.099341
2010-01-05	0.024135	0.023839	0.024760	0.024836	0.135701
2010-01-06	0.024228	0.023778	0.024384	0.024242	0.162738
2010-01-07	0.023450	0.022614	0.023351	0.023249	0.138298
2010-01-08	0.022362	0.023165	0.023508	0.023899	0.140343

In [ ]:

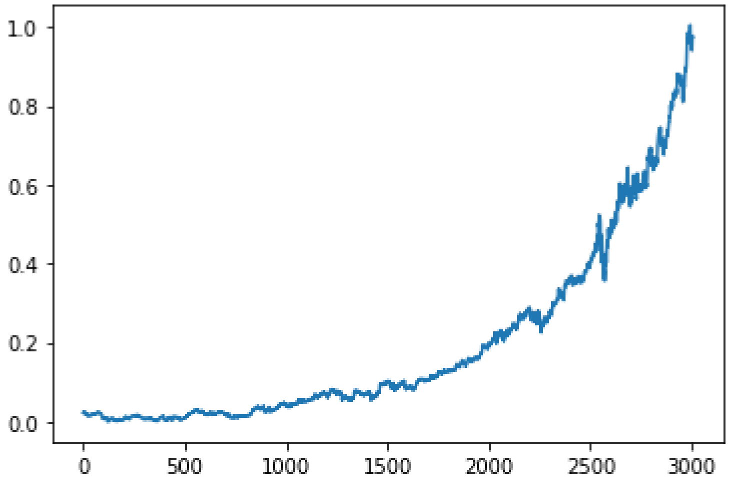
```
model_temp = LinearRegression()
model_temp.fit(x_temp,y_temp)
result = []
i = 0
while i < 3007:
  temp_result = model_temp.predict(x_temp[i].reshape(-1, 1))
  result.append(temp_result[0].tolist())
  i += 1
```

In [ ]:

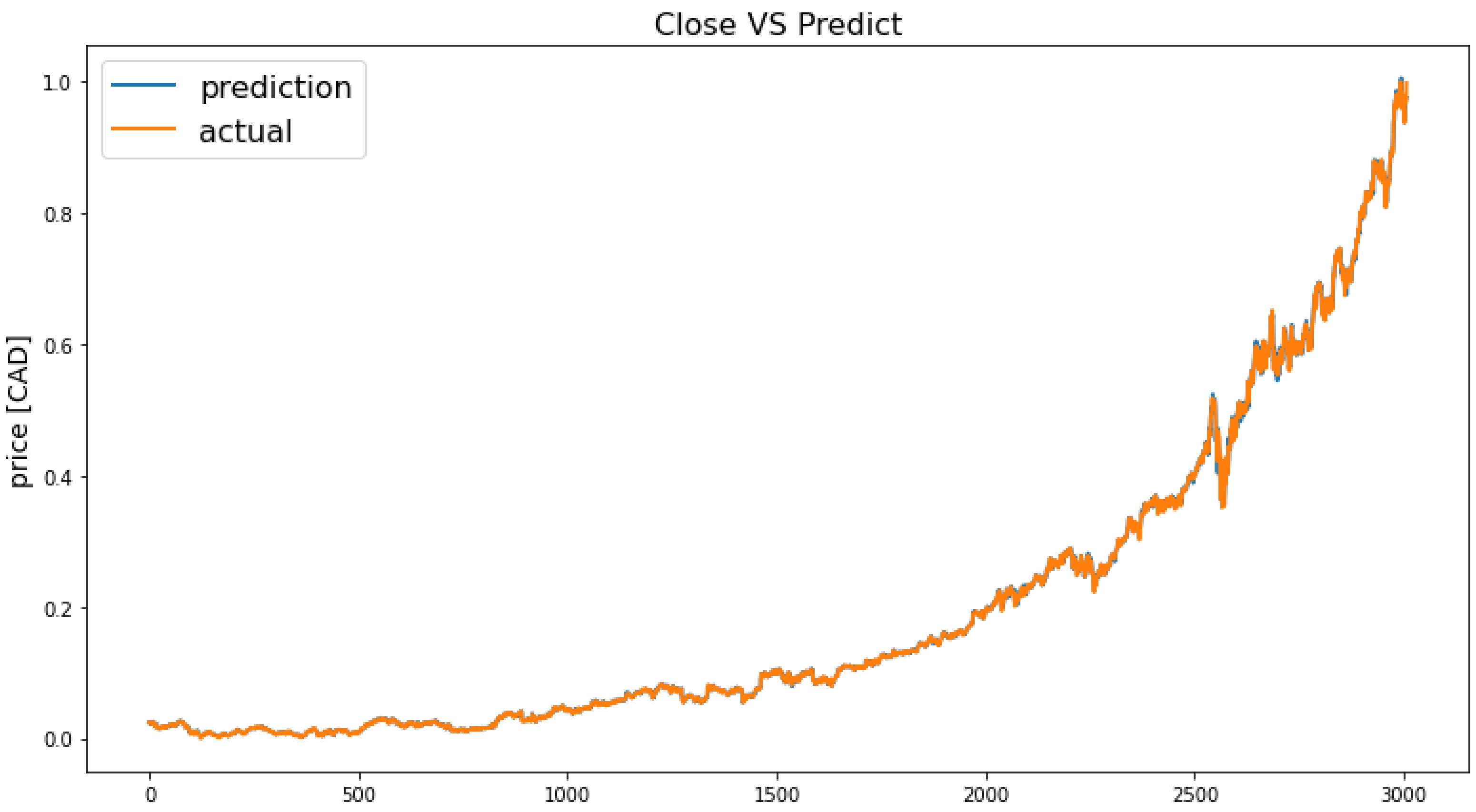
```
close_arr = y_temp.tolist()
open_arr = x_temp.tolist()
```

```
In [ ]: plt.plot(result)
```

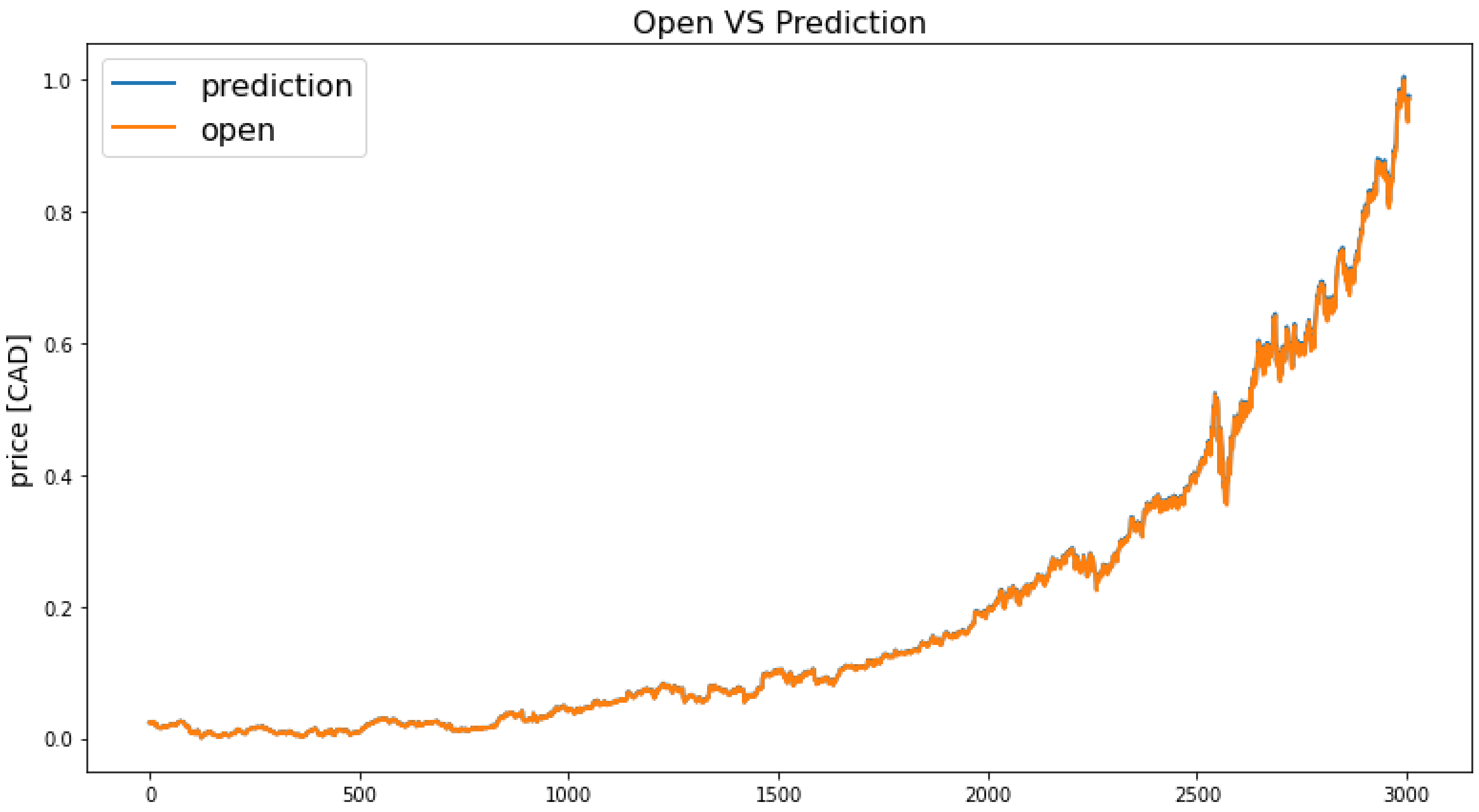
```
Out[230]: [<matplotlib.lines.Line2D at 0x7f0dcc5a2c50>]
```



```
In [ ]: line_plot(result, close_arr, 'prediction', 'actual', title='Close VS Predict')
```

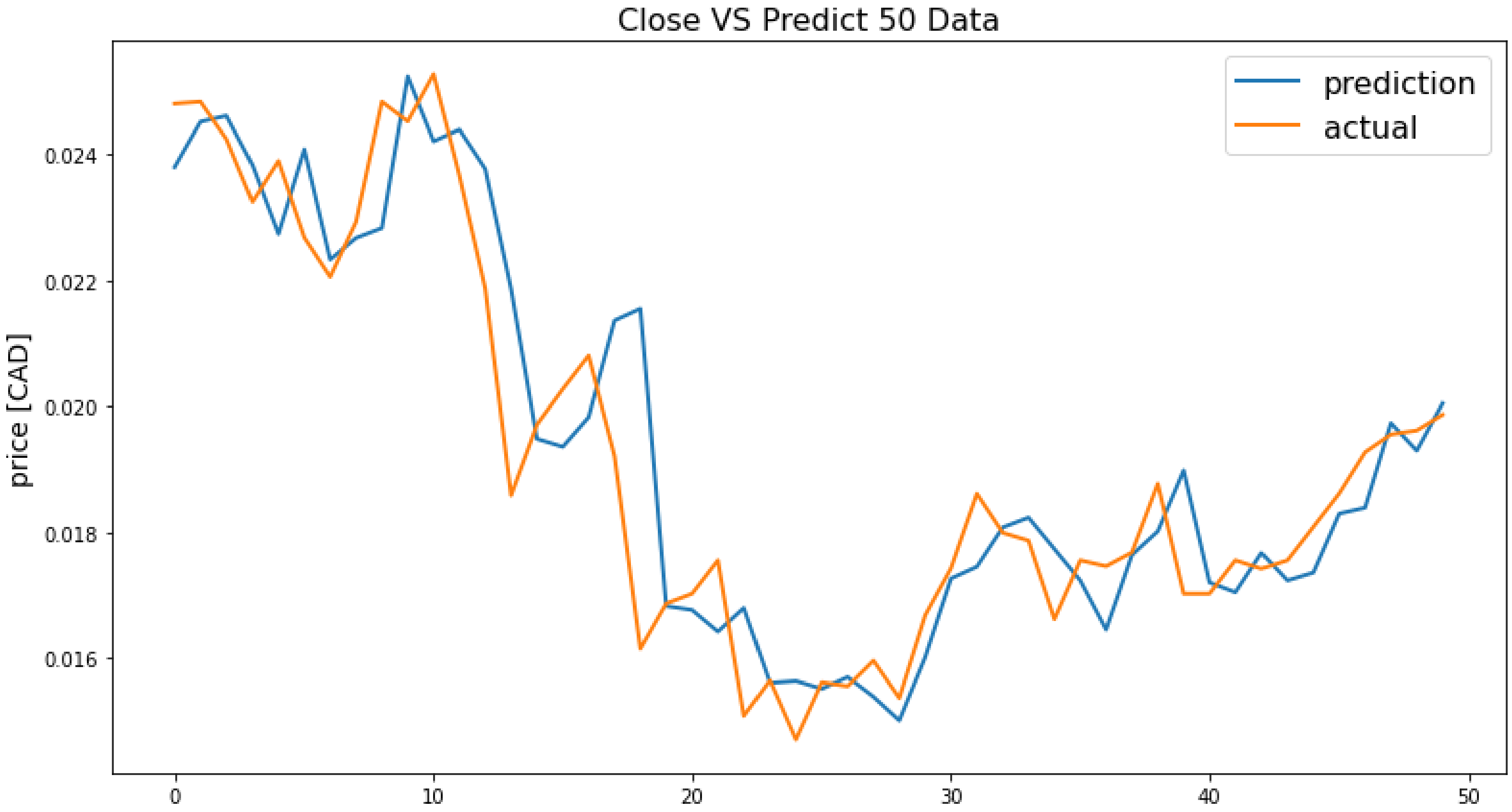


```
In [ ]: line_plot(result, open_arr, 'prediction', 'open', title='Open VS Prediction')
```

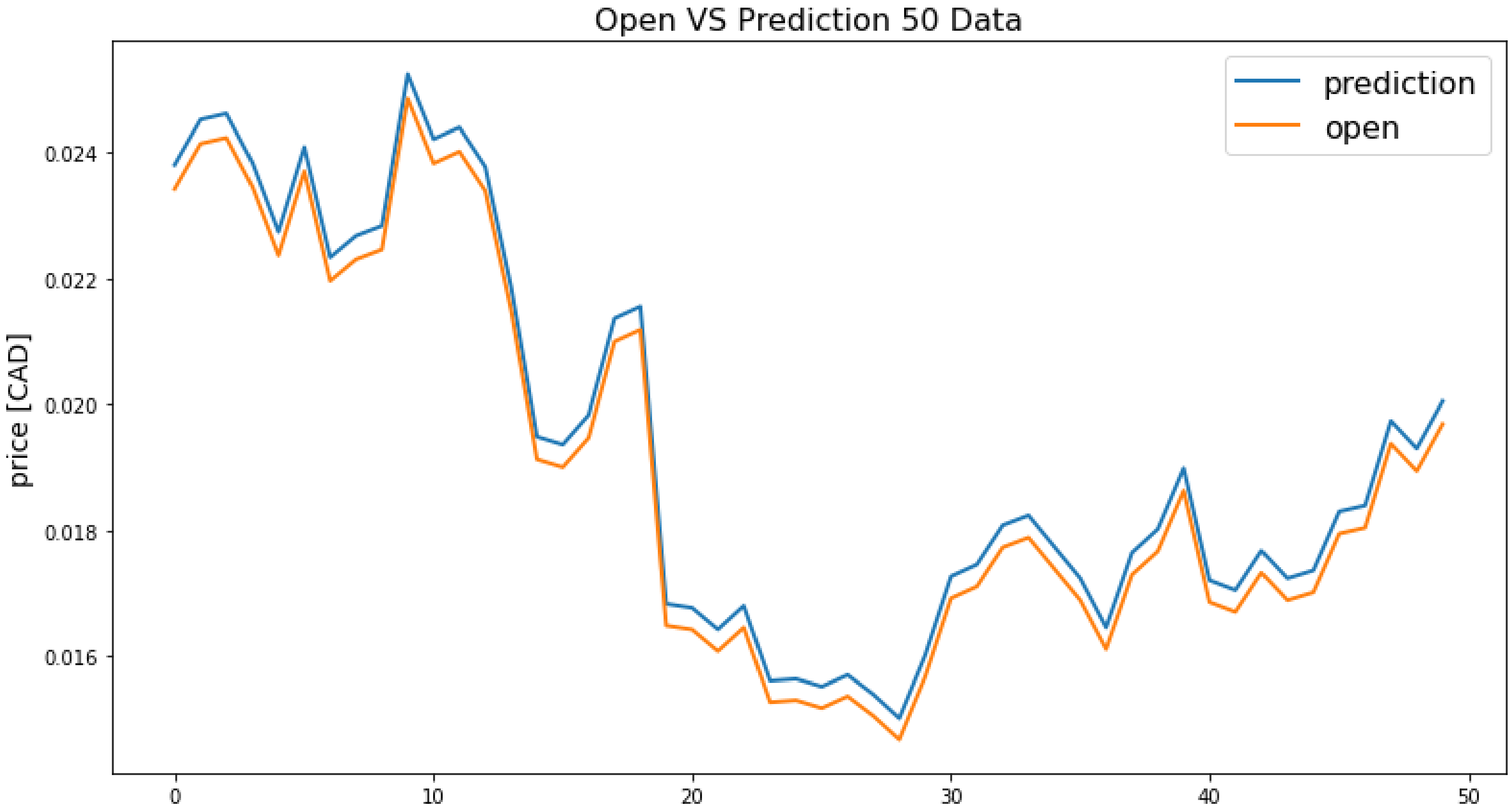


50 Data

```
In [ ]: line_plot(result[:50], close_arr[:50], 'prediction', 'actual', title='Close VS Predict 50 Data')
```



```
In [ ]: line_plot(result[:50], open_arr[:50], 'prediction', 'open', title='Open VS Prediction 50 Data')
```



In [ ]:

```
print('Mean Absolute Error:', metrics.mean_absolute_error(close_arr, result))
print('Mean Squared Error:', metrics.mean_squared_error(close_arr, result))
print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(close_arr, result)))
```

```
Mean Absolute Error: 0.0024125192246256828
Mean Squared Error: 1.944219065587727e-05
Root Mean Squared Error: 0.004409329955432828
```

eksperimen menggunakan support vector regression

referensi :

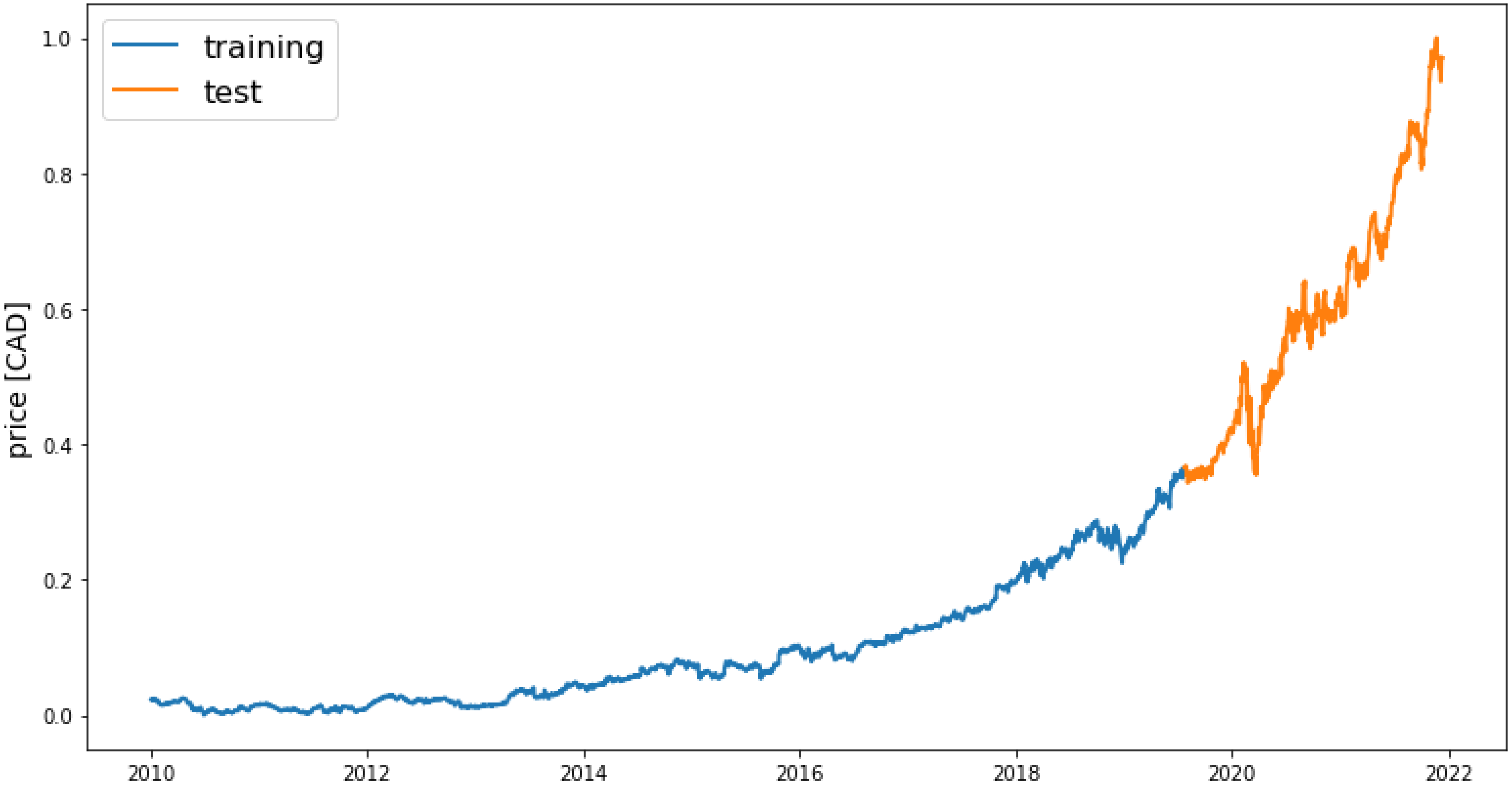
- https://medium.com/it-paragon/how-we-transform-to-machine-learning-bc397dce1692 (https://medium.com/it-paragon/how-we-transform-to-machine-learning-bc397dce1692)
- https://medium.com/it-paragon/support-vector-machine-regression-cf65348b6345 (https://medium.com/it-paragon/support-vector-machine-regression-cf65348b6345)
- https://towardsdatascience.com/walking-through-support-vector-regression-and-lstms-with-stock-price-prediction-45e11b620650 (https://towardsdatascience.com/walking-through-support-vector-regression-and-lstms-with-stock-price-prediction-45e11b620650)
- https://itnext.io/learning-data-science-predict-stock-price-with-support-vector-regression-svr-2c4fdc36662 (https://itnext.io/learning-data-science-predict-stock-price-with-support-vector-regression-svr-2c4fdc36662)

In [ ]:

```
from sklearn.svm import SVR
from sklearn.metrics import mean_absolute_error
```

```
In [ ]: # Data Preparation
        X_train_svr, X_test_svr, y_train_svr, y_test_svr = train_test_split(msft_hist, y, train_size = 0.8, shuffle=False)

        # Visualisasi Data
        target_col = 'open'
        line_plot(X_train[target_col], X_test[target_col], 'training', 'test', title='')
```



In [ ]:

```
X_train_svr.head()
```

Out[243]:

	open	high	low	close	volume
2010-01-04	0.023419	0.023839	0.024603	0.024805	0.099341
2010-01-05	0.024135	0.023839	0.024760	0.024836	0.135701
2010-01-06	0.024228	0.023778	0.024384	0.024242	0.162738
2010-01-07	0.023450	0.022614	0.023351	0.023249	0.138298
2010-01-08	0.022362	0.023165	0.023508	0.023899	0.140343

In [ ]:

```
drop_cols = ['high','low','close','volume']
X_train_svr = X_train_svr.drop(drop_cols, axis = 1)
X_test_svr = X_test_svr.drop(drop_cols, axis = 1)
```

In [ ]:

```
# X_train_svr
# y_train_svr
```

In [ ]:

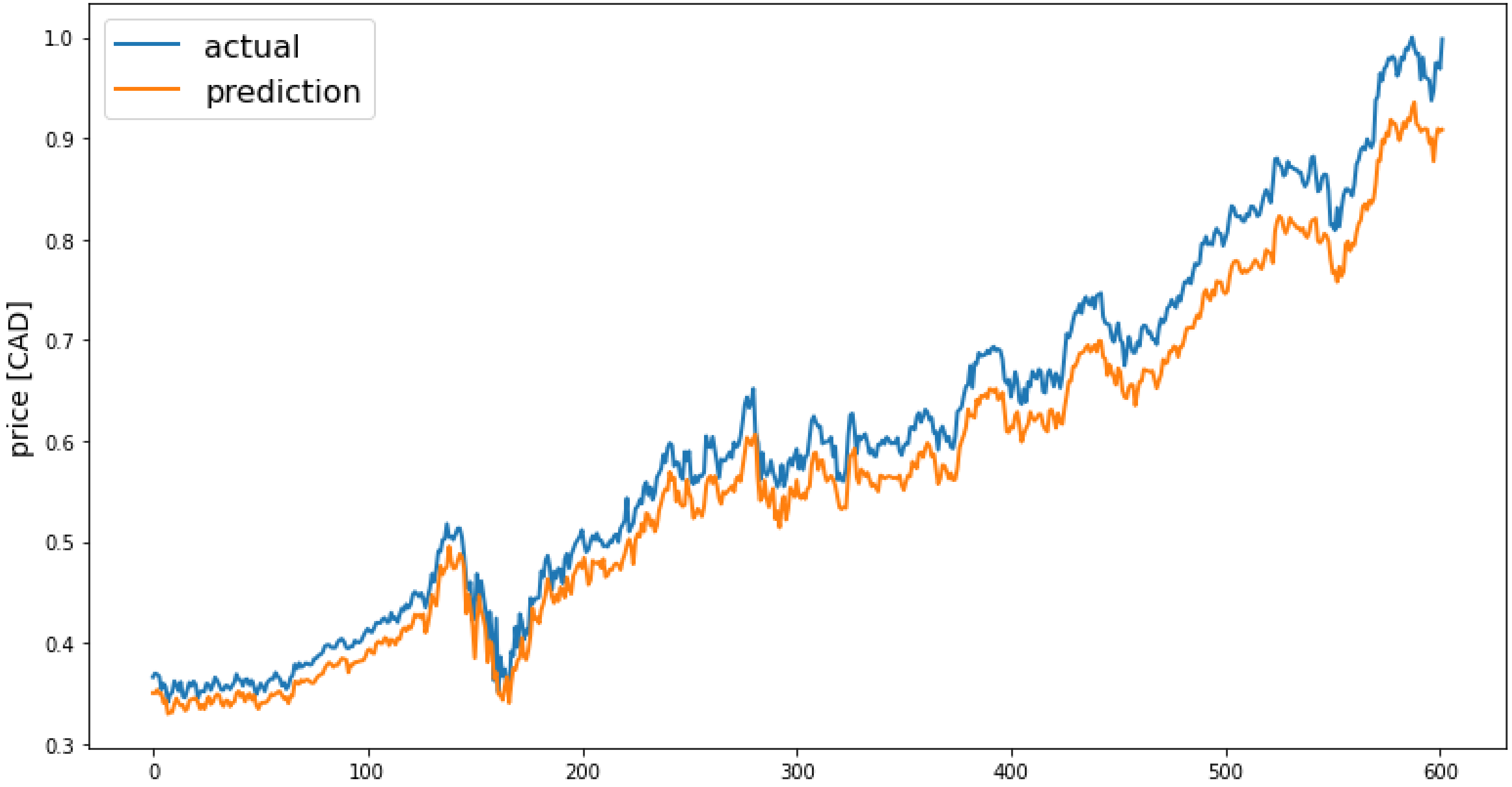
```
# Model & Train; Model SVR menggunakan nilai Epsilon 0.01 dan Gamma 0.01, dan kernel -> rbf
svr_rbf = SVR(kernel= 'rbf', epsilon=1e-2, gamma=1e-2)
svr_rbf.fit(X_train_svr, y_train_svr.ravel())
```

Out[246]:

```
SVR(epsilon=0.01, gamma=0.01)
```

```
In [ ]: # Prediction
        preds_svr = svr_rbf.predict(X_test_svr)

        #visualisasi
        line_plot(y_test_svr, preds_svr, 'actual', 'prediction', title='')
```



In [ ]:

```python
from sklearn import metrics
print('Mean Absolute Error:', metrics.mean_absolute_error(y_test_svr, preds_svr))
print('Mean Squared Error:', metrics.mean_squared_error(y_test_svr, preds_svr))
print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(y_test_svr, preds_svr)))
```

```
Mean Absolute Error: 0.035422100148647516
Mean Squared Error: 0.0015325113985150288
Root Mean Squared Error: 0.039147303847328099
```

eksperiemen menggunakan LSTM (long short term memory)

referensi :

- https://medium.com/swlh/stock-price-prediction-with-pytorch-37f52ae84632 (https://medium.com/swlh/stock-price-prediction-with-pytorch-37f52ae84632)
- https://towardsdatascience.com/cryptocurrency-price-prediction-using-deep-learning-70cfca50dd3a (https://towardsdatascience.com/cryptocurrency-price-prediction-using-deep-learning-70cfca50dd3a)

In [ ]:

```python
#import library
from keras.models import Sequential
from keras.layers import Activation, Dense, Dropout, LSTM
from sklearn.metrics import mean_absolute_error
from sklearn.preprocessing import MinMaxScaler
```

In [ ]:

```
#menyiapkan dataset, lalu membentuk lagi dataset menjadi data testing dan training
ds_msft = get_historical_data('MSFT', '2010-01-01')
ds_close = ds_msft.iloc[:,4:5].values

scaler = MinMaxScaler(feature_range = (0, 1))
scaled_ds_close = scaler.fit_transform(ds_close)

step = 21

X_train = []
y_train = []

for i in range(step, scaled_ds_close.shape[0]):
    X_train.append(scaled_ds_close[i-step:i, 0])
    y_train.append(scaled_ds_close[i, 0])

stockFeature = np.array(X_train[:-1])
stockLabel = np.array(y_train[:-1])

n = len(ds_close)
split = int(n*0.8)

X_train_lstm = stockFeature[:split]
X_test_lstm = stockFeature[split:]
y_train_lstm = stockLabel[:split]
y_test_lstm = stockLabel[split:]

X_train_lstm = np.reshape(X_train_lstm, (X_train_lstm.shape[0], X_train_lstm.shape[1], 1))
X_test_lstm = np.reshape(X_test_lstm, (X_test_lstm.shape[0], X_test_lstm.shape[1], 1))
```

In [ ]:

```
#membangun model lstm
model = Sequential()

model.add(LSTM(units=40, return_sequences=True))
model.add(Dropout(0.15))

model.add(LSTM(units=40, return_sequences=True))
model.add(Dropout(0.15))

model.add(LSTM(units=40))
model.add(Dropout(0.15))

model.add(Dense(1))
#prediksi dengan model lstm

model.compile(optimizer='adam', loss='mean_squared_error')
model.fit(X_train_lstm, y_train_lstm, epochs=20, batch_size=100)
```

```
Epoch 1/20
25/25 [==============================] - 7s 44ms/step - loss: 0.0042
Epoch 2/20
25/25 [==============================] - 1s 41ms/step - loss: 3.6676e-04
Epoch 3/20
25/25 [==============================] - 1s 41ms/step - loss: 2.6354e-04
Epoch 4/20
25/25 [==============================] - 1s 40ms/step - loss: 2.0090e-04
Epoch 5/20
25/25 [==============================] - 1s 41ms/step - loss: 2.0090e-04
Epoch 6/20
25/25 [==============================] - 1s 40ms/step - loss: 1.8101e-04
Epoch 7/20
25/25 [==============================] - 1s 41ms/step - loss: 1.6236e-04
Epoch 8/20
25/25 [==============================] - 1s 41ms/step - loss: 1.6428e-04
Epoch 9/20
25/25 [==============================] - 1s 42ms/step - loss: 1.7893e-04
Epoch 10/20
25/25 [==============================] - 1s 40ms/step - loss: 1.5204e-04
Epoch 11/20
25/25 [==============================] - 1s 41ms/step - loss: 1.5203e-04
```

```
Epoch 12/20
25/25 [==============================] - 1s 40ms/step - loss: 1.4460e-04
Epoch 13/20
25/25 [==============================] - 1s 41ms/step - loss: 1.5474e-04
Epoch 14/20
25/25 [==============================] - 1s 40ms/step - loss: 1.3738e-04
Epoch 15/20
25/25 [==============================] - 1s 41ms/step - loss: 1.3034e-04
Epoch 16/20
25/25 [==============================] - 1s 41ms/step - loss: 2.0247e-04
Epoch 17/20
25/25 [==============================] - 1s 41ms/step - loss: 1.4904e-04
Epoch 18/20
25/25 [==============================] - 1s 42ms/step - loss: 1.4196e-04
Epoch 19/20
25/25 [==============================] - 1s 41ms/step - loss: 1.1695e-04
Epoch 20/20
25/25 [==============================] - 1s 41ms/step - loss: 1.2430e-04
```

Out[316]:

```
<keras.callbacks.History at 0x7f0dbdc77a50>
```

In [ ]:

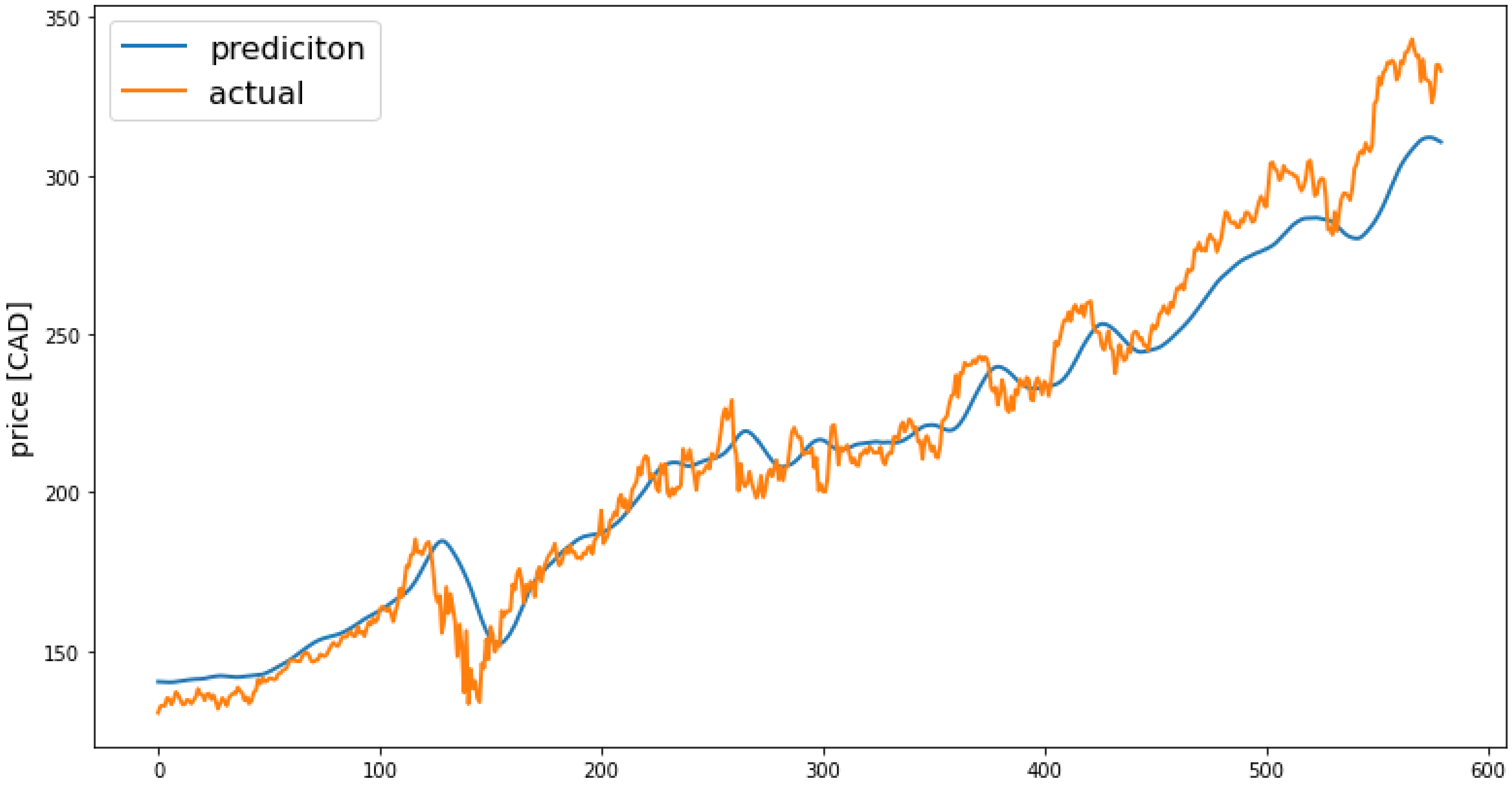
```
#hitung nilai MAE
preds = model.predict(X_test_lstm)
mean_absolute_error(preds, y_test_lstm)
```

Out[317]:

```
0.028076997816577717
```

```
In [ ]: # menggabungkan hasil prediction ke dataframe
        lstm_predictions = model.predict(X_test_lstm)

        lstm_predictions = scaler.inverse_transform(lstm_predictions)
        y_test_lstm = scaler.inverse_transform(y_test_lstm.reshape(-1,1))
        # visualisasi prediksi dan actual values
        line_plot(lstm_predictions, y_test_lstm, 'prediciton', 'actual', title='')
```


prediciton
actual
price [CAD]