Ukol 3: predikce cen akcii

18.6. Matyas Vondra

Predikuji cenu akcii AAPL pomoci cen AAPL, META, GOOGL, AMZN a MSFT

Priprava dat

In [319…
```
import numpy as np
from sklearn.preprocessing import MinMaxScaler
```

In [320…
```
import yfinance as yf
import pandas as pd
tickers_list = ["AAPL", "META", "GOOGL", "AMZN", "MSFT"]

# Stažení dat:
import yfinance as yf
data = yf.download(tickers_list,'2018-1-1')['Adj Close']
```

```
[**********100%**********]  5 of 5 completed
```

In [321…
```
data
```

Out[321]:

Date	AAPL	AMZN	GOOGL	META	MSFT
2018-01-02	40.831585	59.450500	53.660500	181.419998	80.562042
2018-01-03	40.824482	60.209999	54.576000	184.669998	80.936974
2018-01-04	41.014103	60.479500	54.787998	184.330002	81.649345
2018-01-05	41.481064	61.457001	55.514500	186.850006	82.661629
2018-01-08	41.326992	62.343498	55.710499	188.279999	82.745987
…	…	…	…	…	…
2023-06-12	183.789993	126.570000	123.639999	271.049988	331.850006
2023-06-13	183.309998	126.660004	123.830002	271.320007	334.290009
2023-06-14	183.949997	126.419998	123.669998	273.350006	337.339996
2023-06-15	186.009995	127.110001	125.089996	281.829987	348.100006
2023-06-16	184.919998	125.489998	123.529999	281.000000	342.329987

1374 rows × 5 columns

In [381…
```
prices = data.values.reshape(-1,1) # prevod na array
```

In [323…
```
prices = (np.log(prices)) # logaritmus cen, kvuli volatilite
```

In [324…
```
prices.shape # petinasobek poctu radku puvodnich dat
```

Out[324]:
```
(6870, 1)
```

In [325…
```
# Normalizace dat
scaler = MinMaxScaler(feature_range=(0, 1))
prices = scaler.fit_transform(prices)
```

10 % testovacich dat

In [382…
```
# Rozdělení dat na trénovací a testovací sady
train_size = int(len(prices) * 0.90)
train, test = prices[0:train_size, :], prices[train_size:len(prices), :]
```

In [327…
```
train
```

Out[327]:
```
array([[0.07331607],
       [0.22898526],
       [0.18652734],
       ...,
       [0.58612533],
       [0.41179952],
       [0.42403613]])
```

In [328…
```
# Funkce pro vytvoření datové sady pro LSTM
def create_dataset(dataset, look_back=1):
    dataX, dataY = [], []
    # zde uprava range pro 5 promennych:
    for i in range(0, len(dataset) - look_back - 1, 5):
        a = dataset[i:(i + look_back), 0]
        dataX.append(a)
        dataY.append(dataset[i + look_back, 0])
    return np.array(dataX), np.array(dataY)
```

In [383…
```
# Vytvoření trénovací a testovací sady
look_back = 5*2  # časový okamžik do minulosti
# v pripade predikce 10% dat mi nevychazely moc dobre vysledky
# s dlouhym look_back. Pouzivam tedy pouze dva dny dozadu

trainX, trainY = create_dataset(train, look_back)
testX, testY = create_dataset(test, look_back)
```

Toto jsem vytvoril bez logaritmovani a standardizace pro overeni spravne tvorby X a Y.

V tomto pripade predikujeme AAPL na 5 pozorovani dozadu, tedy ze vsech akcii z jednoho predchoziho dne

In [384…
```
trainX[1]
```

Out[384]:
```
array([ 40.82448196,  60.20999908,  54.57600021, 184.66999817,
        80.93697357])
```

In [385…
```
trainY[1]
```

Out[385]:
```
41.014102935791016
```

In [373…
```
# Změna tvaru vstupních dat
trainX = np.reshape(trainX, (trainX.shape[0], 1, trainX.shape[1]))
testX = np.reshape(testX, (testX.shape[0], 1, testX.shape[1]))
```

In [374…
```
trainX.shape # pocet pozorovani, pocet promennych, pocet pozorovani do minul
```

Out[374]:
```
(1303, 1, 10)
```

In [375…
```
from keras.models import Sequential
from keras.layers import Dense, LSTM, Dropout

# Vytvoření a kompilace LSTM modelu
model = Sequential()
model.add(LSTM(4, input_shape=(1, look_back)))
model.add(Dense(2))
model.add(Dropout(0.2))
model.add(Dense(1))
model.compile(loss='mean_squared_error', optimizer='adam')

model.summary()
```

```
Model: "sequential_30"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 lstm_22 (LSTM)               (None, 4)                 240

 dense_45 (Dense)             (None, 2)                 10

 dropout_18 (Dropout)         (None, 2)                 0

 dense_46 (Dense)             (None, 1)                 3

=================================================================
Total params: 253
Trainable params: 253
Non-trainable params: 0
_________________________________________________________________
```

In [376…
```
# Trénování modelu
model.fit(trainX, trainY, epochs=100, batch_size=1, verbose=1)
```

```
Epoch 1/100
1303/1303 [==============================] - 6s 2ms/step - loss: 0.0278
Epoch 2/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0091
Epoch 3/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0066
Epoch 4/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0065
Epoch 5/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0060
Epoch 6/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0059
Epoch 7/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0059
Epoch 8/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0057
Epoch 9/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0063
Epoch 10/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0050
Epoch 11/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 12/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0057
Epoch 13/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 14/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0058
Epoch 15/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0054
Epoch 16/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0062
Epoch 17/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0056
Epoch 18/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0056
Epoch 19/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0060
Epoch 20/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 21/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 22/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0057
Epoch 23/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0059
Epoch 24/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0063
Epoch 25/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0053
Epoch 26/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0060
Epoch 27/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 28/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
```

```
Epoch 29/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0054
Epoch 30/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0055
Epoch 31/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0054
Epoch 32/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0047
Epoch 33/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0057
Epoch 34/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0052
Epoch 35/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0056
Epoch 36/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 37/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0059
Epoch 38/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 39/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 40/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0061
Epoch 41/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0052
Epoch 42/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0056
Epoch 43/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0059
Epoch 44/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 45/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0054
Epoch 46/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 47/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0053
Epoch 48/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0054
Epoch 49/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0054
Epoch 50/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0053
Epoch 51/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 52/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0054
Epoch 53/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0061
Epoch 54/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 55/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0058
Epoch 56/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0050
```

```
Epoch 57/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0057
Epoch 58/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0055
Epoch 59/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0057
Epoch 60/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0049
Epoch 61/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0059
Epoch 62/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0057
Epoch 63/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0050
Epoch 64/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0054
Epoch 65/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 66/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 67/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0055
Epoch 68/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0059
Epoch 69/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 70/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0059
Epoch 71/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0061
Epoch 72/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0065
Epoch 73/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 74/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0053
Epoch 75/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0053
Epoch 76/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0052
Epoch 77/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 78/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0053
Epoch 79/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0053
Epoch 80/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 81/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 82/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0052
Epoch 83/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0058
Epoch 84/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0057
```

```
Epoch 85/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0062
Epoch 86/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0055
Epoch 87/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0056
Epoch 88/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 89/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0055
Epoch 90/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0053
Epoch 91/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0055
Epoch 92/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0055
Epoch 93/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0058
Epoch 94/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0061
Epoch 95/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0060
Epoch 96/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0056
Epoch 97/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0058
Epoch 98/100
1303/1303 [==============================] - 4s 3ms/step - loss: 0.0054
Epoch 99/100
1303/1303 [==============================] - 3s 3ms/step - loss: 0.0052
Epoch 100/100
1303/1303 [==============================] - 3s 2ms/step - loss: 0.0057
```

Out[376]: <keras.callbacks.History at 0x7fe2c9479a80>

In [336…

```python
# Predikce cen
trainPredict = model.predict(trainX)
testPredict = model.predict(testX)

# Inverzní transformace predikcí a skutečných hodnot pro zpětné porovnání
trainPredict = scaler.inverse_transform(trainPredict)
trainY_i = scaler.inverse_transform([trainY])
```

```
39/39 [==============================] - 0s 2ms/step
5/5 [==============================] - 0s 2ms/step
```

In [337…

```python
# Inverzní transformace testovacích dat
testYr = scaler.inverse_transform([testY])[0]
testPredictr = scaler.inverse_transform(testPredict)
testPredictr= [i[0] for i in testPredictr]
```

In [338…

```python
# Výpočet MAPE v logaritmech
mape = np.mean(np.abs((testYr - testPredictr) / testYr)) * 100
print(f"MAPE: {mape}%")
```

```
MAPE: 2.013097930425758%
```

In [339…
```
# Výpočet MAPE v reálných hodnotách
mape = np.mean(np.abs((np.exp(testYr) - np.exp(testPredictr)) / np.exp(testY
print(f"MAPE: {mape}%")
```

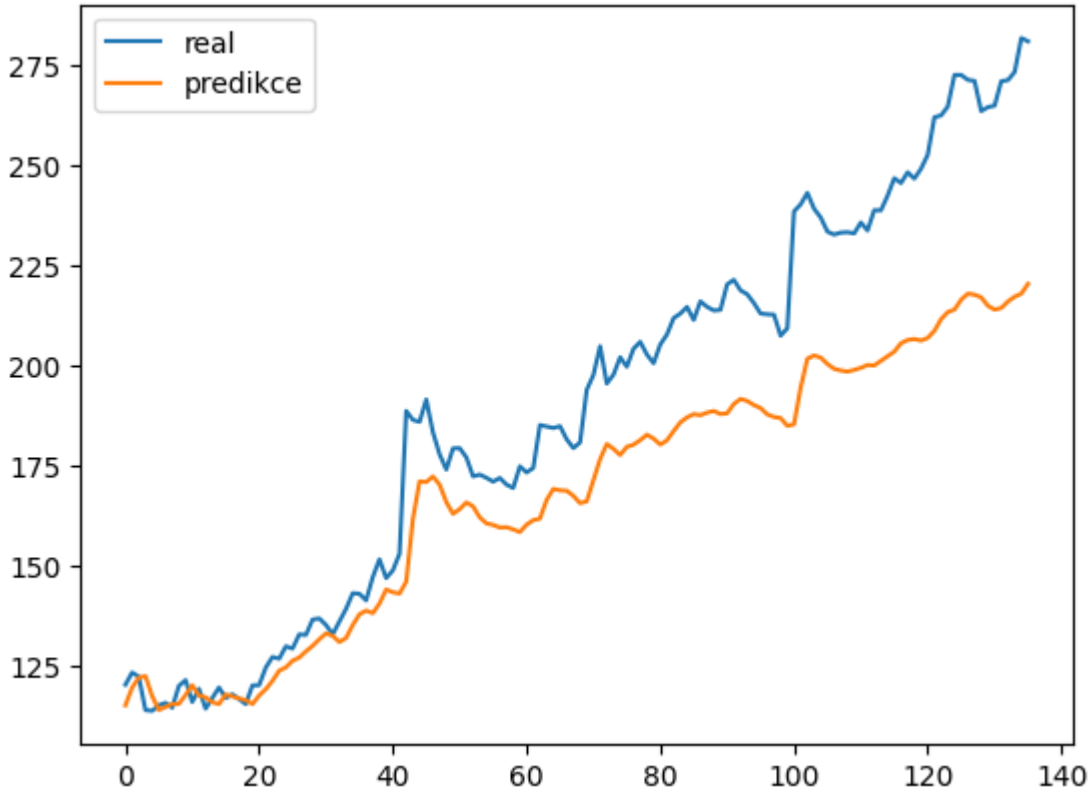
```
MAPE: 10.024492160249816%
```

In [340…
```
# pozor je to v procentech!!
```

In [341…
```
import matplotlib.pyplot as plt
```

In [342…
```
pd.DataFrame({"real": np.exp(testYr), "predikce": np.exp(testPredictr)}).plo
```

Out[342]: <Axes: >



5% testovacich dat

S vetsim mnozstvim trenovacich dat bylo mozne pouzit vetsi lookback

In [343…
```
# Rozdělení dat na trénovací a testovací sady
train_size = int(len(prices) * 0.95)
train, test = prices[0:train_size, :], prices[train_size:len(prices), :]
```

In [344…
```
# Vytvoření trénovací a testovací sady
look_back = 5*10  # časový okamžik do minulosti 10 dni
trainX, trainY = create_dataset(train, look_back)
testX, testY = create_dataset(test, look_back)
```

In [345…
```
# Změna tvaru vstupních dat
trainX = np.reshape(trainX, (trainX.shape[0], 1, trainX.shape[1]))
```

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

In [346…

```
from keras.models import Sequential
from keras.layers import Dense, LSTM, Dropout

# Vytvoření a kompilace LSTM modelu
model = Sequential()
model.add(LSTM(28, input_shape=(1, look_back)))
model.add(Dense(14))
model.add(Dropout(0.2))
model.add(Dense(1))
model.compile(loss='mean_squared_error', optimizer='adam')

model.summary()
```

```
Model: "sequential_28"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm_21 (LSTM)              (None, 28)                8848

 dense_41 (Dense)            (None, 14)                406

 dropout_17 (Dropout)        (None, 14)                0

 dense_42 (Dense)            (None, 1)                 15

=================================================================
Total params: 9,269
Trainable params: 9,269
Non-trainable params: 0
_________________________________________________________________
```

In [347…

```
# Trénování modelu
model.fit(trainX, trainY, epochs=100, batch_size=1, verbose=1)
```

```
Epoch 1/100
1295/1295 [==============================] - 6s 3ms/step - loss: 0.0078
Epoch 2/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0034
Epoch 3/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0026
Epoch 4/100
1295/1295 [==============================] - 5s 3ms/step - loss: 0.0021
Epoch 5/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0015
Epoch 6/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0016
Epoch 7/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0014
Epoch 8/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0015
Epoch 9/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0014
Epoch 10/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0015
Epoch 11/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 12/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 13/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 14/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 15/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 16/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0014
Epoch 17/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 18/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 19/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 20/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0014
Epoch 21/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 22/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 23/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 24/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 25/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 26/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 27/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0013
Epoch 28/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
```

```
Epoch 29/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 30/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 31/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0013
Epoch 32/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 33/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 34/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 35/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 36/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 37/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 38/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 39/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 40/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 41/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 42/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 43/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0012
Epoch 44/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 45/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 46/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 47/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0012
Epoch 48/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 49/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 50/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 51/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 52/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 53/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 54/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 55/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 56/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
```

```
Epoch 57/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 58/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 59/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 60/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 61/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 62/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 63/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 64/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 65/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 66/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 67/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 68/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 69/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 70/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 71/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 72/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 73/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 74/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 75/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 76/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 77/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 78/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 79/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 80/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0012
Epoch 81/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 82/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 83/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 84/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0011
```

```
Epoch 85/100
1295/1295 [==============================] - 3s 3ms/step - loss: 0.0012
Epoch 86/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 87/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 88/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 89/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 90/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 91/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 92/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 93/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0011
Epoch 94/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 95/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0013
Epoch 96/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0011
Epoch 97/100
1295/1295 [==============================] - 4s 3ms/step - loss: 0.0013
Epoch 98/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 99/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
Epoch 100/100
1295/1295 [==============================] - 3s 2ms/step - loss: 0.0012
```

Out[347]: <keras.callbacks.History at 0x7fe2c9aa1d20>

In [348…

```python
# Predikce cen
trainPredict = model.predict(trainX)
testPredict = model.predict(testX)

# Inverzní transformace predikcí a skutečných hodnot pro zpětné porovnání
trainPredict = scaler.inverse_transform(trainPredict)
trainY_i = scaler.inverse_transform([trainY])
```

```
41/41 [==============================] - 1s 2ms/step
2/2 [==============================] - 0s 5ms/step
```

In [349…

```python
# Inverzní transformace testovacích dat
testYr = scaler.inverse_transform([testY])[0]
testPredictr = scaler.inverse_transform(testPredict)
testPredictr= [i[0] for i in testPredictr]
```

In [350…

```python
# Výpočet MAPE v logaritmech
mape = np.mean(np.abs((testYr - testPredictr) / testYr)) * 100
print(f"MAPE: {mape}%")
```

```
MAPE: 2.7623599757343724%
```

In [351…
```
# Výpočet MAPE v reálných hodnotách
mape = np.mean(np.abs((np.exp(testYr) - np.exp(testPredictr)) / np.exp(testY
print(f"MAPE: {mape}%")
```

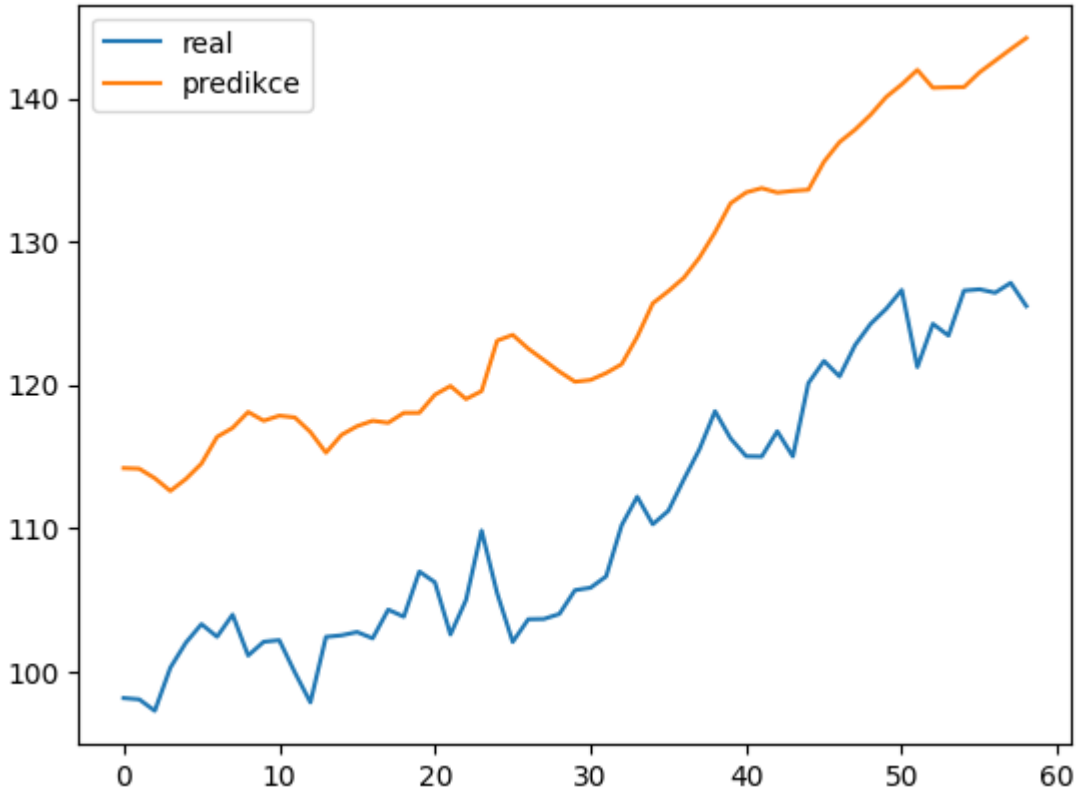
```
MAPE: 13.875089123790977%
```

In [352…
```
# pozor je to v procentech!!
```

In [353…
```
import matplotlib.pyplot as plt
```

In [354…
```
pd.DataFrame({"real": np.exp(testYr), "predikce": np.exp(testPredictr)}).plo
```

Out[354]: <Axes: >



Porovnani s 1D konvoluci

In [355…
```
import pandas as pd
import numpy as np

def create_lagged_dataset(series, n_lags):
    if not isinstance(series, pd.Series):
        series = pd.Series(series)

    df = pd.DataFrame()

    for i in range(n_lags + 1):
        df['lag_' + str(i)] = series.shift(i)

    df = df.iloc[n_lags:]
```

```
    return df
```

In [356…
```
y= prices
ymax = max(y)
ymin = min(y)
y = [(i-ymin)/(ymax - ymin) for i in y]
price_data = create_lagged_dataset(y, 10)
```

In [357…
```
price_data.shape
```

Out[357]: (6860, 11)

In [358…
```
price_data # kazda hodnota je vysvetlena deveti predchozimi
```

Out[358]:

	lag_0	lag_1	lag_2	
10	[0.07516413350634044]	[0.35682561747745]	[0.6986289892416693]	[0.1935370
11	[0.23609581223339626]	[0.07516413350634044]	[0.35682561747745]	[0.698628
12	[0.1951434922730173]	[0.23609581223339626]	[0.07516413350634044]	[0.3568
13	[0.6978654116174101]	[0.1951434922730173]	[0.23609581223339626]	[0.0751641
14	[0.3604566548012589]	[0.6978654116174101]	[0.1951434922730173]	[0.2360958
...	...	...	...	
6865	[0.6991895530624417]	[0.9612982347395551]	[0.8737918118967314]	[0.53722
6866	[0.5385442980823325]	[0.6991895530624417]	[0.9612982347395551]	[0.87379
6867	[0.532021471814939]	[0.5385442980823325]	[0.6991895530624417]	[0.961298
6868	[0.8725697327014563]	[0.532021471814939]	[0.5385442980823325]	[0.699189
6869	[0.9543723869549106]	[0.8725697327014563]	[0.532021471814939]	[0.538544

6860 rows × 11 columns

In [359…
```
X = np.array(price_data.loc[:, price_data.columns  != "lag_0"])
Y = np.array(price_data["lag_0"])
```

In [360…
```
X.shape
```

Out[360]: (6860, 10)

In [361…
```
X = X.reshape((X.shape[0], X.shape[1], 1)) # konvoluce vzdy potrebuji treti
```

In [362…
```
X.shape
```

Out[362]: (6860, 10, 1)

In [363…
```
from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.2, r
```

In [364…
```
# kvuli value error: prevod array na tensor
X_train = np.asarray(X_train).astype('float32')
Y_train = np.asarray(Y_train).astype('float32')
X_test = np.asarray(X_test).astype('float32')
Y_test = np.asarray(Y_test).astype('float32')
```

In [365…
```
from keras.models import Sequential
from keras.layers import Dense, Conv1D, Flatten

model = Sequential()
model.add(Conv1D(64, 4, activation='relu', input_shape=(10, 1)))
model.add(Conv1D(16, 3, activation='relu'))
model.add(Conv1D(8, 2, activation='relu'))
model.add(Flatten()) # zplosteni, ze tri dimenzi zase do klasicke matice
model.add(Dense(32, activation='relu')) # klasicka skrya vrstva
model.add(Dense(1, activation='relu')) # vystupni funkce, 1 neuron

model.compile(loss='mae', optimizer="adam")

model.summary()
```

```
Model: "sequential_29"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 conv1d_12 (Conv1D)           (None, 7, 64)             320

 conv1d_13 (Conv1D)           (None, 5, 16)             3088

 conv1d_14 (Conv1D)           (None, 4, 8)              264

 flatten_3 (Flatten)          (None, 32)                0

 dense_43 (Dense)             (None, 32)                1056

 dense_44 (Dense)             (None, 1)                 33

=================================================================
Total params: 4,761
Trainable params: 4,761
Non-trainable params: 0
_________________________________________________________________
```

In [366…
```
model.fit(X_train, Y_train, epochs=100, batch_size=32, verbose=1)
```

```
Epoch 1/100
172/172 [==============================] - 40s 3ms/step - loss: 0.0876
Epoch 2/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0097
Epoch 3/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0094
Epoch 4/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0081
Epoch 5/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0088
Epoch 6/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0087
Epoch 7/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0088
Epoch 8/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0087
Epoch 9/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0083
Epoch 10/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0079
Epoch 11/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0080
Epoch 12/100
172/172 [==============================] - 1s 3ms/step - loss: 0.0077
Epoch 13/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0084
Epoch 14/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0085
Epoch 15/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0087
Epoch 16/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0075
Epoch 17/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0083
Epoch 18/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0087
Epoch 19/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0083
Epoch 20/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0078
Epoch 21/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0082
Epoch 22/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0085
Epoch 23/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0078
Epoch 24/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0085
Epoch 25/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0079
Epoch 26/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0080
Epoch 27/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0077
Epoch 28/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0082
```

```
Epoch 29/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0075
Epoch 30/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0078
Epoch 31/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0080
Epoch 32/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0084
Epoch 33/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0081
Epoch 34/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0080
Epoch 35/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0078
Epoch 36/100
172/172 [==============================] - 1s 3ms/step - loss: 0.0086
Epoch 37/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0083
Epoch 38/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0078
Epoch 39/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0076
Epoch 40/100
172/172 [==============================] - 1s 5ms/step - loss: 0.0077
Epoch 41/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0086
Epoch 42/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0079
Epoch 43/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0080
Epoch 44/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0079
Epoch 45/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0074
Epoch 46/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0078
Epoch 47/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0072
Epoch 48/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0073
Epoch 49/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0078
Epoch 50/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0075
Epoch 51/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0085
Epoch 52/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0075
Epoch 53/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0073
Epoch 54/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0082
Epoch 55/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0094
Epoch 56/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0071
```

```
Epoch 57/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0086
Epoch 58/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0074
Epoch 59/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0077
Epoch 60/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0080
Epoch 61/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0076
Epoch 62/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0079
Epoch 63/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0074
Epoch 64/100
172/172 [==============================] - 1s 3ms/step - loss: 0.0075
Epoch 65/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0078
Epoch 66/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0075
Epoch 67/100
172/172 [==============================] - 1s 3ms/step - loss: 0.0075
Epoch 68/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0084
Epoch 69/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0077
Epoch 70/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0074
Epoch 71/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0075
Epoch 72/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0074
Epoch 73/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0076
Epoch 74/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0076
Epoch 75/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0071
Epoch 76/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0074
Epoch 77/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0073
Epoch 78/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0079
Epoch 79/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0077
Epoch 80/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0077
Epoch 81/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0075
Epoch 82/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0080
Epoch 83/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0073
Epoch 84/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0075
```

```
Epoch 85/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0080
Epoch 86/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0073
Epoch 87/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0068
Epoch 88/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0072
Epoch 89/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0074
Epoch 90/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0073
Epoch 91/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0077
Epoch 92/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0075
Epoch 93/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0072
Epoch 94/100
172/172 [==============================] - 1s 4ms/step - loss: 0.0078
Epoch 95/100
172/172 [==============================] - 0s 3ms/step - loss: 0.0076
Epoch 96/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0072
Epoch 97/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0072
Epoch 98/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0072
Epoch 99/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0071
Epoch 100/100
172/172 [==============================] - 0s 2ms/step - loss: 0.0071
```

Out[366]: <keras.callbacks.History at 0x7fe2c94991e0>

In [367…
```python
# Predikce cen
testPredict = model.predict(X_test)
```

```
43/43 [==============================] - 0s 2ms/step
```

In [368…
```python
# Inverzní transformace testovacích dat
testYr = scaler.inverse_transform([Y_test])[0]
testPredictr = scaler.inverse_transform(testPredict)
testPredictr= [i[0] for i in testPredictr]
```

In [369…
```python
# Výpočet MAPE v logaritmech
mape = np.mean(np.abs((testYr - testPredictr) / testYr)) * 100
print(f"MAPE: {mape}%")
```

```
MAPE: 0.5568657475726406%
```

In [370…
```python
# Výpočet MAPE v reálných hodnotách
mape = np.mean(np.abs((np.exp(testYr) - np.exp(testPredictr)) / np.exp(testY
print(f"MAPE: {mape}%")
```

```
MAPE: 2.6915640511107406%
```

Metriky byly sice vyborne, ale nejsem si jisty, jestli vse funguje jak ma. Graf je bohuzel uplny binec

In [371…
```
pd.DataFrame({"real": np.exp(testYr), "predikce": np.exp(testPredictr)}).plo
```

Out[371]: <Axes: >