10.lstm-seq2seq

September 29, 2021

[1]:
```
import sys
import warnings

if not sys.warnoptions:
    warnings.simplefilter('ignore')
```

[2]:
```
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
from sklearn.preprocessing import MinMaxScaler
from datetime import datetime
from datetime import timedelta
from tqdm import tqdm
sns.set()
tf.compat.v1.random.set_random_seed(1234)
```

[3]:
```
df = pd.read_csv('../dataset/GOOG-year.csv')
df.head()
```

[3]:
```
         Date        Open        High         Low       Close   Adj Close  \
0  2016-11-02  778.200012  781.650024  763.450012  768.700012  768.700012
1  2016-11-03  767.250000  769.950012  759.030029  762.130005  762.130005
2  2016-11-04  750.659973  770.359985  750.560974  762.020020  762.020020
3  2016-11-07  774.500000  785.190002  772.549988  782.520020  782.520020
4  2016-11-08  783.400024  795.632996  780.190002  790.510010  790.510010

    Volume
0  1872400
1  1943200
2  2134800
3  1585100
4  1350800
```

[4]:
```
minmax = MinMaxScaler().fit(df.iloc[:, 4:5].astype('float32')) # Close index
df_log = minmax.transform(df.iloc[:, 4:5].astype('float32')) # Close index
```

```
df_log = pd.DataFrame(df_log)
df_log.head()
```

[4]:

	0
0	0.112708
1	0.090008
2	0.089628
3	0.160459
4	0.188066

0.1 Split train and test

I will cut the dataset to train and test datasets,

1. Train dataset derived from starting timestamp until last 30 days
2. Test dataset derived from last 30 days until end of the dataset

So we will let the model do forecasting based on last 30 days, and we will going to repeat the experiment for 10 times. You can increase it locally if you want, and tuning parameters will help you by a lot.

[5]:
```
test_size = 30
simulation_size = 10

df_train = df_log.iloc[:-test_size]
df_test = df_log.iloc[-test_size:]
df.shape, df_train.shape, df_test.shape
```

[5]: ((252, 7), (222, 1), (30, 1))

[10]:
```
class Model:
    def __init__(
        self,
        learning_rate,
        num_layers,
        size,
        size_layer,
        output_size,
        forget_bias = 0.1,
    ):
        def lstm_cell(size_layer):
            return tf.nn.rnn_cell.LSTMCell(size_layer, state_is_tuple = False)

        rnn_cells = tf.nn.rnn_cell.MultiRNNCell(
            [lstm_cell(size_layer) for _ in range(num_layers)],
            state_is_tuple = False,
        )
        self.X = tf.placeholder(tf.float32, (None, None, size))
```

```
        self.Y = tf.placeholder(tf.float32, (None, output_size))
        drop = tf.contrib.rnn.DropoutWrapper(
            rnn_cells, output_keep_prob = forget_bias
        )
        self.hidden_layer = tf.placeholder(
            tf.float32, (None, num_layers * 2 * size_layer)
        )
        _, last_state = tf.nn.dynamic_rnn(
            drop, self.X, initial_state = self.hidden_layer, dtype = tf.float32
        )

        with tf.variable_scope('decoder', reuse = False):
            rnn_cells_dec = tf.nn.rnn_cell.MultiRNNCell(
                [lstm_cell(size_layer) for _ in range(num_layers)],␣
↪state_is_tuple = False
            )
            drop_dec = tf.contrib.rnn.DropoutWrapper(
                rnn_cells_dec, output_keep_prob = forget_bias
            )
            self.outputs, self.last_state = tf.nn.dynamic_rnn(
                drop_dec, self.X, initial_state = last_state, dtype = tf.float32
            )

        self.logits = tf.layers.dense(self.outputs[-1], output_size)
        self.cost = tf.reduce_mean(tf.square(self.Y - self.logits))
        self.optimizer = tf.train.AdamOptimizer(learning_rate).minimize(
            self.cost
        )

def calculate_accuracy(real, predict):
    real = np.array(real) + 1
    predict = np.array(predict) + 1
    percentage = 1 - np.sqrt(np.mean(np.square((real - predict) / real)))
    return percentage * 100

def anchor(signal, weight):
    buffer = []
    last = signal[0]
    for i in signal:
        smoothed_val = last * weight + (1 - weight) * i
        buffer.append(smoothed_val)
        last = smoothed_val
    return buffer
```

[7]:
```
num_layers = 1
size_layer = 128
timestamp = 5
```

```
epoch = 300
dropout_rate = 0.8
future_day = test_size
learning_rate = 0.01
```

[11]:
```
def forecast():
    tf.reset_default_graph()
    modelnn = Model(
        learning_rate, num_layers, df_log.shape[1], size_layer, df_log.
↪shape[1], dropout_rate
    )
    sess = tf.InteractiveSession()
    sess.run(tf.global_variables_initializer())
    date_ori = pd.to_datetime(df.iloc[:, 0]).tolist()

    pbar = tqdm(range(epoch), desc = 'train loop')
    for i in pbar:
        init_value = np.zeros((1, num_layers * 2 * size_layer))
        total_loss, total_acc = [], []
        for k in range(0, df_train.shape[0] - 1, timestamp):
            index = min(k + timestamp, df_train.shape[0] - 1)
            batch_x = np.expand_dims(
                df_train.iloc[k : index, :].values, axis = 0
            )
            batch_y = df_train.iloc[k + 1 : index + 1, :].values
            logits, last_state, _, loss = sess.run(
                [modelnn.logits, modelnn.last_state, modelnn.optimizer, modelnn.
↪cost],
                feed_dict = {
                    modelnn.X: batch_x,
                    modelnn.Y: batch_y,
                    modelnn.hidden_layer: init_value,
                },
            )
            init_value = last_state
            total_loss.append(loss)
            total_acc.append(calculate_accuracy(batch_y[:, 0], logits[:, 0]))
        pbar.set_postfix(cost = np.mean(total_loss), acc = np.mean(total_acc))

    future_day = test_size

    output_predict = np.zeros((df_train.shape[0] + future_day, df_train.
↪shape[1]))
    output_predict[0] = df_train.iloc[0]
    upper_b = (df_train.shape[0] // timestamp) * timestamp
    init_value = np.zeros((1, num_layers * 2 * size_layer))
```

```python
    for k in range(0, (df_train.shape[0] // timestamp) * timestamp, timestamp):
        out_logits, last_state = sess.run(
            [modelnn.logits, modelnn.last_state],
            feed_dict = {
                modelnn.X: np.expand_dims(
                    df_train.iloc[k : k + timestamp], axis = 0
                ),
                modelnn.hidden_layer: init_value,
            },
        )
        init_value = last_state
        output_predict[k + 1 : k + timestamp + 1] = out_logits

    if upper_b != df_train.shape[0]:
        out_logits, last_state = sess.run(
            [modelnn.logits, modelnn.last_state],
            feed_dict = {
                modelnn.X: np.expand_dims(df_train.iloc[upper_b:], axis = 0),
                modelnn.hidden_layer: init_value,
            },
        )
        output_predict[upper_b + 1 : df_train.shape[0] + 1] = out_logits
        future_day -= 1
        date_ori.append(date_ori[-1] + timedelta(days = 1))

    init_value = last_state

    for i in range(future_day):
        o = output_predict[-future_day - timestamp + i:-future_day + i]
        out_logits, last_state = sess.run(
            [modelnn.logits, modelnn.last_state],
            feed_dict = {
                modelnn.X: np.expand_dims(o, axis = 0),
                modelnn.hidden_layer: init_value,
            },
        )
        init_value = last_state
        output_predict[-future_day + i] = out_logits[-1]
        date_ori.append(date_ori[-1] + timedelta(days = 1))

    output_predict = minmax.inverse_transform(output_predict)
    deep_future = anchor(output_predict[:, 0], 0.3)

    return deep_future[-test_size:]
```

[12]:

```python
results = []
for i in range(simulation_size):
```

```python
    print('simulation %d'%(i + 1))
    results.append(forecast())
```

```
W0813 21:47:16.666563 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69f3ff7908>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:47:16.753933 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69fd7aa860>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:47:16.834197 140095600830272 deprecation.py:323] From <ipython-
input-10-f89ab136c7c7>:41: dense (from tensorflow.python.layers.core) is
deprecated and will be removed in a future version.
Instructions for updating:
Use keras.layers.dense instead.
```

```
simulation 1
```

```
train loop: 100%|      | 300/300 [01:36<00:00,  3.11it/s, acc=97.9,
cost=0.00101]
W0813 21:48:54.353741 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69fd79e9e8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:48:54.437589 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69f2dedeb8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
```

```
simulation 2
```

```
train loop: 100%|      | 300/300 [01:38<00:00,  3.05it/s, acc=98.3,
cost=0.00069]
W0813 21:50:34.225154 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69f35367f0>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:50:34.305581 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f696417da20>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
```

```
simulation 3
```

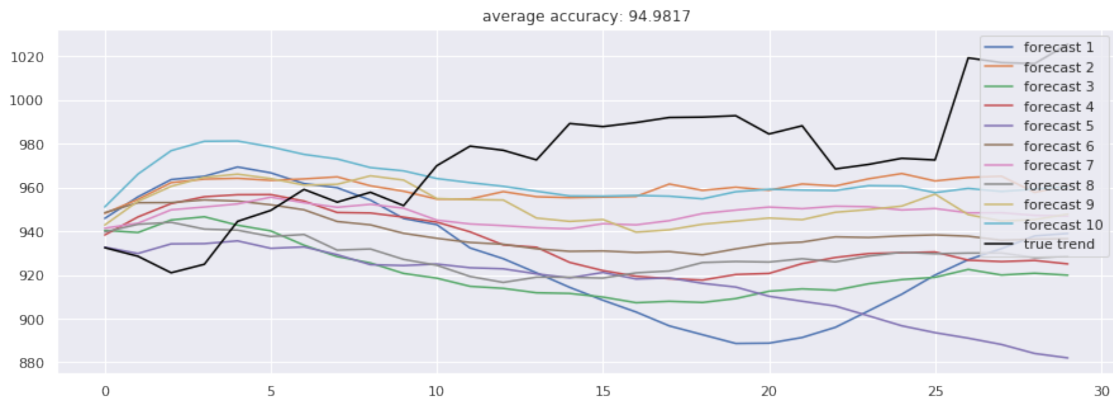
```
train loop: 100%|      | 300/300 [01:38<00:00,  3.06it/s, acc=97.7,
cost=0.00117]
W0813 21:52:13.825603 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69e80d60f0>: Using a
concatenated state is slower and will soon be deprecated.  Use
```

```
state_is_tuple=True.
W0813 21:52:13.908980 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f695cdf5518>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 4

train loop: 100%|     | 300/300 [01:37<00:00,  3.08it/s, acc=98.4,
cost=0.000614]
W0813 21:53:52.767824 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f695d0ed1d0>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:53:52.849310 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693eab10f0>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 5

train loop: 100%|     | 300/300 [01:38<00:00,  3.03it/s, acc=98.2,
cost=0.000755]
W0813 21:55:32.572073 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693ed38cf8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:55:32.654169 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693c7376a0>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 6

train loop: 100%|     | 300/300 [01:38<00:00,  3.07it/s, acc=98.3,
cost=0.000681]
W0813 21:57:12.073868 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693ce4e080>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 21:57:12.156364 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693a339e80>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 7

train loop: 100%|     | 300/300 [01:38<00:00,  3.01it/s, acc=97.7,
cost=0.00126]
W0813 21:58:51.933507 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693ab0ffd0>: Using a
```

```
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 8

W0813 21:58:52.153095 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693801aba8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
train loop: 100%|      | 300/300 [01:38<00:00,  3.04it/s, acc=98.5,
cost=0.000589]
W0813 22:00:31.650501 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f69380c7f98>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 22:00:31.732362 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f6935bf8ef0>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 9

train loop: 100%|      | 300/300 [01:38<00:00,  3.01it/s, acc=98.4,
cost=0.000625]
W0813 22:02:11.445839 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f6936470550>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0813 22:02:11.528598 140095600830272 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f693387feb8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 10

train loop: 100%|      | 300/300 [01:39<00:00,  3.08it/s, acc=96.8,
cost=0.0027]
```

[13]:

```python
accuracies = [calculate_accuracy(df['Close'].iloc[-test_size:].values, r) for r␣
 ↪in results]

plt.figure(figsize = (15, 5))
for no, r in enumerate(results):
    plt.plot(r, label = 'forecast %d'%(no + 1))
plt.plot(df['Close'].iloc[-test_size:].values, label = 'true trend', c =␣
 ↪'black')
plt.legend()
plt.title('average accuracy: %.4f'%(np.mean(accuracies)))
plt.show()
```


average accuracy: 94.9817
1020
1000
980
960
940
920
900
880
0
5
10
15
20
25
30
forecast 1
forecast 2
forecast 3
forecast 4
forecast 5
forecast 6
forecast 7
forecast 8
forecast 9
forecast 10
true trend

```
[ ]:
```