how-to-forecast

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	Volume
0	2016-11-02	778.200012	781.650024	763.450012	768.700012	768.700012	1872400
1	2016-11-03	767.250000	769.950012	759.030029	762.130005	762.130005	1943200
2	2016-11-04	750.659973	770.359985	750.560974	762.020020	762.020020	2134800
3	2016-11-07	774.500000	785.190002	772.549988	782.520020	782.520020	1585100
4	2016-11-08	783.400024	795.632996	780.190002	790.510010	790.510010	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 Forecast

This example is using model 1.lstm, if you want to use another model, need to tweak a little bit, but I believe it is not that hard.

I want to forecast 30 days ahead! So just change `test_size` to forecast `t + N` ahead.

Also, I want to simulate 10 times, 10 variances of forecasted patterns. Just change `simulation_size`.

[5]:
```
simulation_size = 10
num_layers = 1
size_layer = 128
timestamp = 5
epoch = 300
dropout_rate = 0.8
test_size = 30
learning_rate = 0.01

df_train = df_log
df.shape, df_train.shape
```

[5]:
```
((252, 7), (252, 1))
```

[6]:
```
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)
        )
        self.outputs, self.last_state = tf.nn.dynamic_rnn(
            drop, self.X, initial_state = self.hidden_layer, 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]:
```
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))

    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], 0.4)

    return deep_future
```

[8]:
```
results = []
for i in range(simulation_size):
    print('simulation %d'%(i + 1))
    results.append(forecast())
```

```
WARNING: Logging before flag parsing goes to stderr.
W0818 12:00:52.795618 140214804277056 deprecation.py:323] From <ipython-
input-6-d01d21f09afe>:12: LSTMCell.__init__ (from
tensorflow.python.ops.rnn_cell_impl) is deprecated and will be removed in a
future version.
Instructions for updating:
This class is equivalent as tf.keras.layers.LSTMCell, and will be replaced by
that in Tensorflow 2.0.
W0818 12:00:52.799092 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f8644897400>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
W0818 12:00:52.801252 140214804277056 deprecation.py:323] From <ipython-
input-6-d01d21f09afe>:16: MultiRNNCell.__init__ (from
```

```
tensorflow.python.ops.rnn_cell_impl) is deprecated and will be removed in a
future version.
Instructions for updating:
This class is equivalent as tf.keras.layers.StackedRNNCells, and will be
replaced by that in Tensorflow 2.0.

simulation 1

W0818 12:00:53.121960 140214804277056 lazy_loader.py:50]
The TensorFlow contrib module will not be included in TensorFlow 2.0.
For more information, please see:
  * https://github.com/tensorflow/community/blob/master/rfcs/20180907-contrib-
sunset.md
  * https://github.com/tensorflow/addons
  * https://github.com/tensorflow/io (for I/O related ops)
If you depend on functionality not listed there, please file an issue.

W0818 12:00:53.125179 140214804277056 deprecation.py:323] From <ipython-
input-6-d01d21f09afe>:27: dynamic_rnn (from tensorflow.python.ops.rnn) is
deprecated and will be removed in a future version.
Instructions for updating:
Please use `keras.layers.RNN(cell)`, which is equivalent to this API
W0818 12:00:53.314420 140214804277056 deprecation.py:506] From
/usr/local/lib/python3.6/dist-packages/tensorflow/python/ops/init_ops.py:1251:
calling VarianceScaling.__init__ (from tensorflow.python.ops.init_ops) with
dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the
constructor
W0818 12:00:53.321002 140214804277056 deprecation.py:506] From
/usr/local/lib/python3.6/dist-
packages/tensorflow/python/ops/rnn_cell_impl.py:961: calling Zeros.__init__
(from tensorflow.python.ops.init_ops) with dtype is deprecated and will be
removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the
constructor
W0818 12:00:53.718872 140214804277056 deprecation.py:323] From <ipython-
input-6-d01d21f09afe>:29: dense (from tensorflow.python.layers.core) is
deprecated and will be removed in a future version.
Instructions for updating:
Use keras.layers.dense instead.
train loop: 100%|      | 300/300 [01:17<00:00,  3.90it/s, acc=95.9,
cost=0.00437]
W0818 12:02:12.766668 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85be966eb8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
```

```
simulation 2

train loop: 100%|      | 300/300 [01:18<00:00,  3.81it/s, acc=96.2,
cost=0.00386]
W0818 12:03:31.524121 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85b4c59dd8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 3

train loop: 100%|      | 300/300 [01:17<00:00,  3.86it/s, acc=95.9,
cost=0.00421]
W0818 12:04:49.292782 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85ac67f5f8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 4

train loop: 100%|      | 300/300 [01:17<00:00,  3.85it/s, acc=95.1,
cost=0.00617]
W0818 12:06:07.690939 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85209545f8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 5

train loop: 100%|      | 300/300 [01:18<00:00,  3.81it/s, acc=96.8,
cost=0.00293]
W0818 12:07:26.842436 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85089d1128>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 6

train loop: 100%|      | 300/300 [01:17<00:00,  3.82it/s, acc=97.3,
cost=0.00178]
W0818 12:08:45.222193 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f85082c6160>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 7

train loop: 100%|      | 300/300 [01:16<00:00,  3.94it/s, acc=97.5,
cost=0.00161]
W0818 12:10:01.933482 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f84fc7de208>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.
```

```
simulation 8

train loop: 100%|      | 300/300 [01:17<00:00,  3.81it/s, acc=97.5,
cost=0.00156]
W0818 12:11:20.348971 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f84fc7127b8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 9

train loop: 100%|      | 300/300 [01:18<00:00,  3.81it/s, acc=96.7,
cost=0.00297]
W0818 12:12:39.812369 140214804277056 rnn_cell_impl.py:893]
<tensorflow.python.ops.rnn_cell_impl.LSTMCell object at 0x7f84f6ed44a8>: Using a
concatenated state is slower and will soon be deprecated.  Use
state_is_tuple=True.

simulation 10

train loop: 100%|      | 300/300 [01:17<00:00,  3.98it/s, acc=97.5,
cost=0.00179]
```

[10]:
```
date_ori = pd.to_datetime(df.iloc[:, 0]).tolist()
for i in range(test_size):
    date_ori.append(date_ori[-1] + timedelta(days = 1))
date_ori = pd.Series(date_ori).dt.strftime(date_format = '%Y-%m-%d').tolist()
date_ori[-5:]
```

[10]:
```
['2017-11-27', '2017-11-28', '2017-11-29', '2017-11-30', '2017-12-01']
```

0.2 Sanity check

Some of our models might not have stable gradient, so forecasted trend might really hangwired. You can use many methods to filter out unstable models.

This method is very simple, 1. If one of element in forecasted trend lower than min(original trend). 2. If one of element in forecasted trend bigger than max(original trend) * 2.

If both are true, reject that trend.

[13]:
```
accepted_results = []
for r in results:
    if (np.array(r[-test_size:]) < np.min(df['Close'])).sum() == 0 and \
    (np.array(r[-test_size:]) > np.max(df['Close']) * 2).sum() == 0:
        accepted_results.append(r)
len(accepted_results)
```

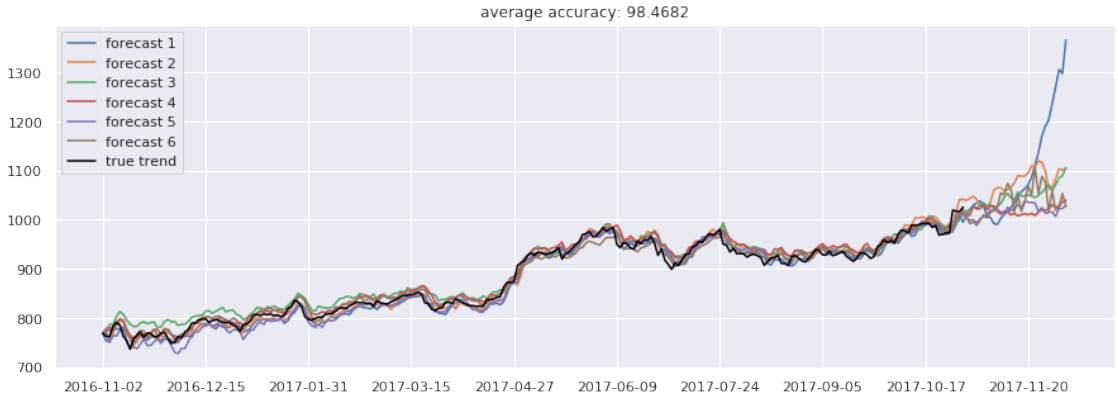
[13]:
```
6
```

[14]:
```
accuracies = [calculate_accuracy(df['Close'].values, r[:-test_size]) for r in␣
 ↪accepted_results]

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

x_range_future = np.arange(len(results[0]))
plt.xticks(x_range_future[::30], date_ori[::30])

plt.show()
```



[ ]:
```

```