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import matplotlib as mpl
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
from sklearn.preprocessing import MinMaxScaler
from scipy import stats
import seaborn as sns
import tensorflow as tf
from tensorflow import keras
import sklearn
import sys
import io

def plot_learning_curves(loss, val_loss):
    plt.figure()
    plt.plot(np.arange(len(loss)), loss, "b.-", label="Training loss")
    plt.plot(np.arange(len(val_loss)), val_loss, "r.-", label="Validation loss")
    plt.gca().xaxis.set_major_locator(mpl.ticker.MaxNLocator(integer=True))
    plt.legend(fontsize=14)
    plt.xlabel("Epochs")
    plt.ylabel("Loss")
    plt.grid(True)

n_steps = 50
forecast = 10

#EXTRACT FLOW, Z SCORE, OUTLIERS
data_west = pd.read_csv('denoised_data_1015_south.csv')
data_west_o = np.array(data_west.FLOW)
print(data_west_o.shape)

#EXRTEND DATA
array_to_concatinate = data_west_o[177:]
for iter in range(35):
    data_west_o = np.concatenate([data_west_o, array_to_concatinate])

#SCALE AND RESHAPE DATA
scaler = MinMaxScaler()
array = data_west_o.reshape(-1, 1)
array_scaled = scaler.fit_transform(array)

flow_resaped = array_scaled[:len(array_scaled) - (len(array_scaled) % (n_steps+forecast))]
print(flow_resaped.shape)
#TRAIN SET, VALIDATION SET, TEST SET
test = int(0.7 * flow_resaped.shape[0])
valid = int(0.9 * flow_resaped.shape[0])

X_train = flow_resaped[:test, :n_steps]
X_valid = flow_resaped[test:valid, :n_steps]
X_test = flow_resaped[valid:, :n_steps]
print(X_test.shape)
print(X_test[-1:].shape)

#prepare targets
Y = np.empty((flow_resaped.shape[0], n_steps, forecast))
for step_ahead in range(1, forecast + 1):
    Y[:, :, step_ahead - 1] = flow_resaped[:, step_ahead:step_ahead + n_steps, 0]

y_train = Y[:test]
y_valid = Y[test:valid]
y_test = Y[valid:]

#DEFINE AND COMPILE MODEL
model = keras.models.Sequential([
    keras.layers.LSTM(20, return_sequences=True, input_shape=[None, 1]),
    keras.layers.LSTM(20, return_sequences=True),
    keras.layers.TimeDistributed(keras.layers.Dense(forecast))
])

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def last_time_step_mse(Y_true, Y_pred):
    return keras.metrics.mean_squared_error(Y_true[:, -1], Y_pred[:, -1])

model.compile(loss="mse", optimizer="adam", metrics=[last_time_step_mse])

early_stopping_cb = keras.callbacks.EarlyStopping(patience=10, restore_best_weights=True)
history = model.fit(X_train, y_train, epochs=700,
                    validation_data=(X_valid, y_valid), callbacks=[early_stopping_cb])

model.save("lstm_1014_south.h5")
plot_learning_curves(history.history["loss"], history.history["val_loss"])

#50 MINS PREDICTION
flow_unscaled = array[(len(array) - (len(array) % (n_steps + forecast)))].reshape(-1, (n
y_test_unscaled = flow_unscaled[valid:, n_steps:, 0]
y_real_rescaled = y_test_unscaled[-1, :].reshape(-1, 1)
print(y_real_rescaled.shape)

flow_not_resaped = array[(len(array) - (len(array) % (n_steps+forecast)))])

#flow prediction
y_pred = model.predict(X_test[-1, :].reshape(-1, n_steps, 1)) #shape (1, 50, 10)
y_pred = y_pred[-1,-1,:].reshape(-1,1)
y_pred_rescaled = scaler.inverse_transform(y_pred).reshape(-1, 1) #shape (10, 1)
print(y_pred_rescaled.shape)

#time
time_not_resaped = np.array(data_west['TIME'][(len(data_west['TIME']) - (len(data_west[
time_resaped = np.array(data_west['TIME'][(len(data_west['TIME']) - (len(data_west['TIM
    reshaped(-1, (n_steps+forecast), 1)

valid_time = int(0.9 * time_resaped.shape[0])
y_time_test = time_resaped[valid_time:, n_steps:, 0]
print(y_time_test[-1, :].shape)

def plot_prediction(y_real_resaped, y_pred_rescaled, flow_not_resaped, time_not_resaped
    plt.figure()
    plt.title("50 minutes prediction", fontsize=14)
    plt.plot(time_not_resaped[-300:-forecast], flow_not_resaped[-300:-forecast], 'b-')
    plt.plot(y_time_test[-1, :], y_real_resaped, 'ro-', label = 'Real values')
    plt.plot(y_time_test[-1, :], y_pred_rescaled, 'gx-', label = 'Predicted values')
    plt.legend(loc="upper left")
    plt.xlabel("Time (in 5 minutes intervals)")
    plt.ylabel('Volume (veh/h)')

plot_prediction(y_real_rescaled, y_pred_rescaled, flow_not_resaped, time_not_resaped, y
plt.show()

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(17168,)
(10197, 60, 1)
(1020, 50, 1)
(1, 50, 1)
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/ops/nn_impls.py:115:
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the
Train on 7137 samples, validate on 2040 samples
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/ops/nn_impls.py:115:
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
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Epoch 2/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0121 - 1
Epoch 3/700
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Epoch 4/700
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7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 188/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 189/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 190/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 191/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 192/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 193/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 194/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 195/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 196/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 197/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 198/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 199/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 200/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 201/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
```

```
Epoch 202/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 203/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 204/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 205/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 206/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 207/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 208/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 209/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0049 - 1a
Epoch 210/700
7137/7137 [=====] - 15s 2ms/sample - loss: 0.0049 - 1a
Epoch 211/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 212/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 213/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 214/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 215/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 216/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 217/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 218/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 219/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 220/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 221/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 222/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 223/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 224/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 225/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 226/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 227/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
Epoch 228/700
7137/7137 [=====] - 14s 2ms/sample - loss: 0.0048 - 1a
(10, 1)
(10, 1)
(10, )
```



