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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

n_steps = 50
forecast = 10

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)

#LOAD DATA
data_west = pd.read_csv('denoised_data_1015_east.csv')
data_west_o = np.array(data_west.FLOW)
# #EXTEND DATA
array_to_concatinate = data_west_o[288:]
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) - (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] #first 50, last 10
X_valid = flow_resaped[test:valid, :n_steps]
X_test = flow_resaped[valid:, :n_steps]

#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:]

# # NEW MODEL TO FIT HYPERPARAMETERS
model = keras.models.Sequential([
    keras.layers.SimpleRNN(20, return_sequences=True, input_shape=[None, 1]),
    keras.layers.SimpleRNN(20, return_sequences=True),
    keras.layers.TimeDistributed(keras.layers.Dense(forecast))
]).

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])

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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("rnn_1015_east.h5")
plot_learning_curves(history.history["loss"], history.history["val_loss"])

#50 minutes forecast
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
    reshape(-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")
    plt.ylabel('Volume')

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

```



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(10545, 60, 1)
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WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/ops/resource_variable_ops.py:111:
Instructions for updating:
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```
Call initializer instance with the dtype argument instead of passing it to the
Train on 7381 samples, validate on 2109 samples
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Epoch 1/700
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```
7381/7381 [=====] - 4s 500us/sample - loss: 0.0486 -
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Epoch 2/700
```

```
7381/7381 [=====] - 3s 403us/sample - loss: 0.0120 -
```

```
Epoch 3/700
```

```
7381/7381 [=====] - 3s 411us/sample - loss: 0.0109 -
```

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Epoch 4/700
```

```
7381/7381 [=====] - 3s 404us/sample - loss: 0.0105 -
```

```
Epoch 5/700
```

```
7381/7381 [=====] - 3s 411us/sample - loss: 0.0102 -
```

```
Epoch 6/700
```

```
7381/7381 [=====] - 3s 410us/sample - loss: 0.0101 -
```

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Epoch 7/700
```

```
7381/7381 [=====] - 3s 408us/sample - loss: 0.0099 -
```

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Epoch 8/700
```

```
7381/7381 [=====] - 3s 415us/sample - loss: 0.0098 -
```

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Epoch 9/700
```

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7381/7381 [=====] - 3s 407us/sample - loss: 0.0098 -
```

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Epoch 10/700
```

```
7381/7381 [=====] - 3s 408us/sample - loss: 0.0097 -
```

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Epoch 11/700
```

```
7381/7381 [=====] - 3s 414us/sample - loss: 0.0097 -
```

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Epoch 12/700
```

```
7381/7381 [=====] - 3s 412us/sample - loss: 0.0096 -
```

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Epoch 13/700
```

```
7381/7381 [=====] - 3s 426us/sample - loss: 0.0095 -
```

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Epoch 14/700
```

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7381/7381 [=====] - 3s 424us/sample - loss: 0.0095 -
```

```
Epoch 15/700
```

```
7381/7381 [=====] - 3s 425us/sample - loss: 0.0094 -
```

```
Epoch 16/700
```

```
7381/7381 [=====] - 3s 416us/sample - loss: 0.0094 -
```

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Epoch 17/700
```

```
7381/7381 [=====] - 3s 407us/sample - loss: 0.0093 -
```

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Epoch 18/700
```

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7381/7381 [=====] - 3s 413us/sample - loss: 0.0093 -
```

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Epoch 19/700
```

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7381/7381 [=====] - 3s 415us/sample - loss: 0.0092 -
```

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Epoch 20/700
```

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7381/7381 [=====] - 3s 408us/sample - loss: 0.0091 -
```

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Epoch 21/700
```

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7381/7381 [=====] - 3s 410us/sample - loss: 0.0092 -
```

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Epoch 22/700
```

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7381/7381 [=====] - 3s 409us/sample - loss: 0.0091 -
```

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Epoch 23/700
```

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7381/7381 [=====] - 3s 412us/sample - loss: 0.0090 -
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Epoch 24/700
```

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7381/7381 [=====] - 3s 420us/sample - loss: 0.0090 -
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Epoch 25/700
```

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7381/7381 [=====] - 3s 413us/sample - loss: 0.0088 -
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Epoch 26/700
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7381/7381 [=====] - 3s 419us/sample - loss: 0.0088 -
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Epoch 27/700
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```
7381/7381 [=====] - 3s 406us/sample - loss: 0.0087 -
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Epoch 28/700
7381/7381 [=====] - 3s 410us/sample - loss: 0.0086 - 1
Epoch 29/700
7381/7381 [=====] - 3s 405us/sample - loss: 0.0085 - 1
Epoch 30/700
7381/7381 [=====] - 3s 423us/sample - loss: 0.0085 - 1
Epoch 31/700
7381/7381 [=====] - 3s 415us/sample - loss: 0.0083 - 1
Epoch 32/700
7381/7381 [=====] - 3s 413us/sample - loss: 0.0080 - 1
Epoch 33/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0078 - 1
Epoch 34/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0077 - 1
Epoch 35/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0076 - 1
Epoch 36/700
7381/7381 [=====] - 3s 403us/sample - loss: 0.0076 - 1
Epoch 37/700
7381/7381 [=====] - 3s 411us/sample - loss: 0.0074 - 1
Epoch 38/700
7381/7381 [=====] - 3s 407us/sample - loss: 0.0074 - 1
Epoch 39/700
7381/7381 [=====] - 3s 411us/sample - loss: 0.0073 - 1
Epoch 40/700
7381/7381 [=====] - 3s 417us/sample - loss: 0.0073 - 1
Epoch 41/700
7381/7381 [=====] - 3s 407us/sample - loss: 0.0072 - 1
Epoch 42/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0072 - 1
Epoch 43/700
7381/7381 [=====] - 3s 411us/sample - loss: 0.0072 - 1
Epoch 44/700
7381/7381 [=====] - 3s 416us/sample - loss: 0.0071 - 1
Epoch 45/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0071 - 1
Epoch 46/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0071 - 1
Epoch 47/700
7381/7381 [=====] - 3s 410us/sample - loss: 0.0071 - 1
Epoch 48/700
7381/7381 [=====] - 3s 407us/sample - loss: 0.0070 - 1
Epoch 49/700
7381/7381 [=====] - 3s 407us/sample - loss: 0.0070 - 1
Epoch 50/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0070 - 1
Epoch 51/700
7381/7381 [=====] - 3s 408us/sample - loss: 0.0071 - 1
Epoch 52/700
7381/7381 [=====] - 3s 411us/sample - loss: 0.0069 - 1
Epoch 53/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0070 - 1
Epoch 54/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0069 - 1
Epoch 55/700
7381/7381 [=====] - 3s 401us/sample - loss: 0.0069 - 1
Epoch 56/700
7381/7381 [=====] - 3s 404us/sample - loss: 0.0069 - 1
Epoch 57/700
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7381/7381 [=====] - 3s 410us/sample - loss: 0.0070 - 
Epoch 58/700
7381/7381 [=====] - 3s 410us/sample - loss: 0.0068 - 
Epoch 59/700
7381/7381 [=====] - 3s 413us/sample - loss: 0.0068 - 
Epoch 60/700
7381/7381 [=====] - 3s 416us/sample - loss: 0.0069 - 
Epoch 61/700
7381/7381 [=====] - 3s 412us/sample - loss: 0.0068 - 
Epoch 62/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0068 - 
Epoch 63/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0069 - 
Epoch 64/700
7381/7381 [=====] - 3s 413us/sample - loss: 0.0068 - 
Epoch 65/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0068 - 
Epoch 66/700
7381/7381 [=====] - 3s 409us/sample - loss: 0.0067 - 
Epoch 67/700
7381/7381 [=====] - 3s 411us/sample - loss: 0.0067 - 
Epoch 68/700
7381/7381 [=====] - 3s 404us/sample - loss: 0.0067 - 
Epoch 69/700
7381/7381 [=====] - 3s 406us/sample - loss: 0.0067 - 
Epoch 70/700
7381/7381 [=====] - 3s 410us/sample - loss: 0.0068 - 
Epoch 71/700
7381/7381 [=====] - 3s 410us/sample - loss: 0.0067 - 
Epoch 72/700
7381/7381 [=====] - 3s 418us/sample - loss: 0.0067 - 
(10, 1)
(10, 1)
(10, )

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