```python
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)

#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_reshaped = array_scaled[:(len(array_scaled) - (len(array_scaled) % (n_steps+forecast

#TRAIN SET, VALIDATION SET, TEST SET
test = int(0.7 * flow_reshaped.shape[0])
valid = int(0.9 * flow_reshaped.shape[0])

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

#prepare targets
Y = np.empty((flow_reshaped.shape[0], n_steps, forecast))
for step_ahead in range(1, forecast + 1):
    Y[:, :, step_ahead - 1] = flow_reshaped[:, 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.GRU(20, return_sequences=True, input_shape=[None, 1]),
    keras.layers.GRU(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])
```

```python
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("gru_1014_south.h5")
plot_learning_curves(history.history["loss"], history.history["val_loss"])

#50 MIN FORECAST
#flow
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_reshaped = 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_reshaped = np.array(data_west['TIME'][:(len(data_west['TIME']) - (len(data_west[
time_reshaped = 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_reshaped.shape[0])
y_time_test = time_reshaped[valid_time:, n_steps:, 0]
print(y_time_test[-1, :].shape)

def plot_prediction(y_real_resacled, y_pred_rescaled, flow_not_reshaped, time_not_reshape
    plt.figure()
    plt.title("50 minutes prediction", fontsize=14)
    plt.plot(time_not_reshaped[-300:-forecast], flow_not_reshaped[-300:-forecast], 'b-')
    plt.plot(y_time_test[-1, :], y_real_resacled, '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_reshaped, time_not_reshaped, y

plt.show()
```

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7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 121/700
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Epoch 123/700
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Epoch 124/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 125/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 126/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 127/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 128/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 129/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 130/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0053 - la
Epoch 131/700
7137/7137 [==============================] - 13s 2ms/sample - loss: 0.0052 - la
(10, 1)
(10, 1)
(10,)
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50 minutes prediction