```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_west.csv')
data_west_o = np.array(data_west.FLOW)

#EXRTEND DATA
array_to_concatinate = data_west_o
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])
```

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

early_stopping_cb = keras.callbacks.EarlyStopping(patience=15, 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_1016_west.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)

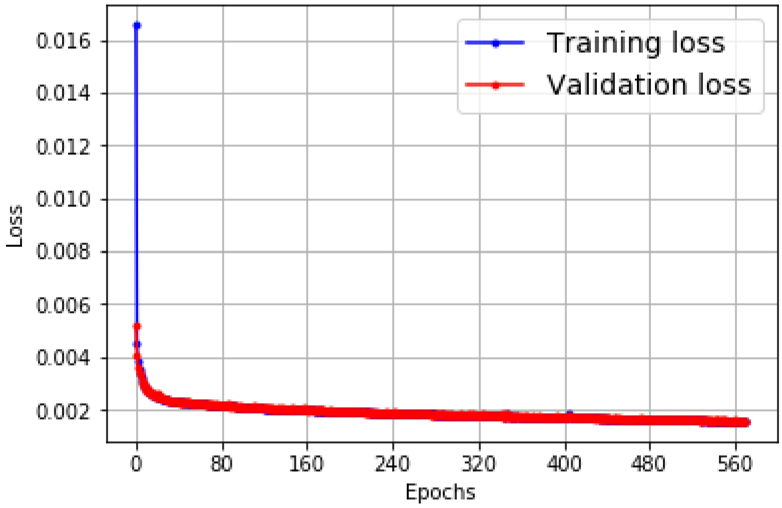
valid_time = int(0.9 * time_reshaped.shape[0])
y_time_test = time_reshaped[valid_time:, n_steps:, 0]
print(y_time_test[-1, :].shape)

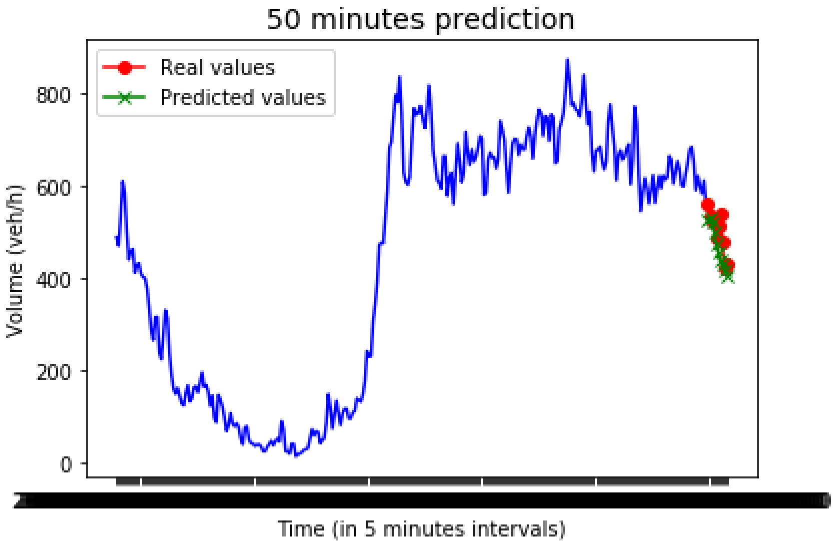
def plot_prediction(y_real_resacled, y_pred_rescaled, flow_not_reshaped, time_not_reshape
    plt.figure()
    plt.title("50 minutes prediction", fontsize=14)
    plt.plot(time_not_reshaped[-300:-forecast], flow_not_reshaped[-300:-forecast], 'b-')
    plt.plot(y_time_test[-1, :], y_real_resacled, 'ro-',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

```
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 561/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 562/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 563/700
7499/7499 [==============================] - 11s 1ms/sample - loss: 0.0016 - l
Epoch 564/700
7499/7499 [==============================] - 11s 1ms/sample - loss: 0.0016 - l
Epoch 565/700
7499/7499 [==============================] - 11s 1ms/sample - loss: 0.0016 - l
Epoch 566/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 567/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 568/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 569/700
7499/7499 [==============================] - 11s 1ms/sample - loss: 0.0016 - l
Epoch 570/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
Epoch 571/700
7499/7499 [==============================] - 11s 2ms/sample - loss: 0.0016 - l
(10, 1)
(10, 1)
(10,)
```


Training loss
Validation loss
Loss
Epochs


50 minutes prediction
Real values
Predicted values
Volume (veh/h)
Time (in 5 minutes intervals)