```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_1016_west.csv')
data_west_o = np.array(data_west.FLOW)

#EXRTEND 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_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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```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=1000,
                    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"])
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(1, 50, 1)
Train on 7381 samples, validate on 2109 samples
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7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 215/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0051 - la
Epoch 216/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 217/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 218/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 219/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 220/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 221/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 222/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 223/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 224/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 225/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 226/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 227/1000
7381/7381 [==============================] - 11s 1ms/sample - loss: 0.0051 - la
Epoch 228/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 229/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 230/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 231/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 232/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 233/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0051 - la
Epoch 234/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 235/1000
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7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 236/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 237/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 238/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 239/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 240/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 241/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 242/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 243/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0050 - la
Epoch 244/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 245/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 246/1000
7381/7381 [==============================] - 11s 1ms/sample - loss: 0.0050 - la
Epoch 247/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 248/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 249/1000
7381/7381 [==============================] - 11s 1ms/sample - loss: 0.0050 - la
Epoch 250/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 251/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 252/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 253/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 254/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 255/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 256/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 257/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 258/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 259/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 260/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 261/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 262/1000
7381/7381 [==============================] - 11s 1ms/sample - loss: 0.0049 - la
Epoch 263/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
Epoch 264/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0050 - la
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Epoch 265/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 266/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 267/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 268/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 269/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 270/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 271/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 272/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 273/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 274/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 275/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 276/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 277/1000
7381/7381 [==============================] - 11s 1ms/sample - loss: 0.0049 - la
Epoch 278/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 279/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 280/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 281/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 282/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 283/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 284/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 285/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 286/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 287/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 288/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 289/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 290/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 291/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 292/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 293/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 294/1000
```

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7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 295/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 296/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 297/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 298/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0049 - la
Epoch 299/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0049 - la
Epoch 300/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0048 - la
Epoch 301/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 302/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 303/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 304/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 305/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 306/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 307/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 308/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 309/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 310/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 311/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 312/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0048 - la
Epoch 313/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 314/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 315/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 316/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 317/1000
7381/7381 [==============================] - 12s 2ms/sample - loss: 0.0048 - la
Epoch 318/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 319/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0049 - la
Epoch 320/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 321/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 322/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
Epoch 323/1000
7381/7381 [==============================] - 11s 2ms/sample - loss: 0.0048 - la
```

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Epoch 324/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 325/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 326/1000
7381/7381 [==============================] – 12s 2ms/sample – loss: 0.0048 – l
Epoch 327/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 328/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 329/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0049 – l
Epoch 330/1000
7381/7381 [==============================] – 12s 2ms/sample – loss: 0.0048 – l
Epoch 331/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 332/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 333/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 334/1000
7381/7381 [==============================] – 11s 2ms/sample – loss: 0.0048 – l
Epoch 335/1000
7381/7381 [==============================] – 12s 2ms/sample – loss: 0.0048 – l
```