

## mlp\_updated

November 24, 2024

```
[22]: %pip install keras tensorflow
#Dataset transform: We change parameters with the Illinois dataset.
#Future selection showed that Precipitation, Temperature max and min and Solar
    ↪ radiation are the factors that significantly impact the yield.
# With Adaptive optimizer (ADAM)
#1. Normal dataset: Y=0.75, Yhat= 0.782, MAE = 0.01040
    ↪##### Y=0.78272 , Yhat=0.865 , MAE= 0.01288
#2. We changed the Solar radiation: Y=0.75, Yhat = 0.756, MAE= 0.01886
    ↪##### Y=0.78272 ,Yhat= 0.800 , MAE= 0.01726
#3. We changed the Precipitation: Y=0.75, Yhat = 0.760 , MAE= 0.01995
    ↪##### Y=0.78272 ,Yhat= 0.807 , MAE= 0.01474
#4. We changed the Min_Temperature: Y=0.75, Yhat = 0.757 , MAE= 0.01677
    ↪##### Y=0.78272 ,Yhat= 0.791 , MAE=0.01285
#5. We changed the Max_Temperature: Y=0.75, Yhat = 0.752, MAE= 0.01648
    ↪##### Y=0.78272 ,Yhat= 0.812 , MAE=0.01699
#6. We changed All the 4 parameters: Y=0.75, Yhat = 0.772 , MAE= 0.01538
    ↪##### Y=0.78272 ,Yhat= 0.820 , MAE= 0.01382

# With Stochastic Gradient Descent (SGD)
#1. Normal dataset: Y=0.75, Yhat= 0.791, MAE = 0.01564
    ↪##### Y=0.78272 ,Yhat= 0.896 , MAE= 0.01915
#2. We changed the Solar radiation: Y=0.75, Yhat = 0.772, MAE= 0.02294
    ↪##### Y=0.78272, Yhat=0.793, MAE=0.02420
#3. We changed the Precipitation: Y=0.75, Yhat = 0.794 , MAE= 0.01483
    ↪##### Y=0.78272, Yhat=0.821, MAE=0.01723
#4. We changed the Min_Temperature: Y=0.75, Yhat = 0.771 , MAE= 0.01459
    ↪##### Y=0.78272 ,Yhat= 0.813 , MAE= 0.01605
#5. We changed the Max_Temperature: Y=0.75, Yhat = 0.776, MAE= 0.01629
    ↪##### Y=0.78272 ,Yhat= 0.826 , MAE= 0.01634
#6. We changed All the 4 parameters: Y=0.75, Yhat = 0.797, MAE= 0.01988
    ↪##### Y=0.78272 ,Yhat= 0.888 , MAE=
```

Requirement already satisfied: keras in h:\anaconda\lib\site-packages (3.6.0)

Requirement already satisfied: tensorflow in h:\anaconda\lib\site-packages  
(2.18.0)

Requirement already satisfied: absl-py in h:\anaconda\lib\site-packages (from  
keras) (2.1.0)

Requirement already satisfied: numpy in h:\anaconda\lib\site-packages (from keras) (1.26.4)

Requirement already satisfied: rich in h:\anaconda\lib\site-packages (from keras) (13.7.1)

Requirement already satisfied: namex in h:\anaconda\lib\site-packages (from keras) (0.0.8)

Requirement already satisfied: h5py in h:\anaconda\lib\site-packages (from keras) (3.11.0)

Requirement already satisfied: optree in h:\anaconda\lib\site-packages (from keras) (0.13.1)

Requirement already satisfied: ml-dtypes in h:\anaconda\lib\site-packages (from keras) (0.4.1)

Requirement already satisfied: packaging in h:\anaconda\lib\site-packages (from keras) (24.1)

Requirement already satisfied: tensorflow-intel==2.18.0 in h:\anaconda\lib\site-packages (from tensorflow) (2.18.0)

Requirement already satisfied: astunparse>=1.6.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (1.6.3)

Requirement already satisfied: flatbuffers>=24.3.25 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (24.3.25)

Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (0.6.0)

Requirement already satisfied: google-pasta>=0.1.1 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (0.2.0)

Requirement already satisfied: libclang>=13.0.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (18.1.1)

Requirement already satisfied: opt-einsum>=2.3.2 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (3.4.0)

Requirement already satisfied: protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<6.0.0dev,>=3.20.3 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (4.25.3)

Requirement already satisfied: requests<3,>=2.21.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (2.32.3)

Requirement already satisfied: setuptools in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (75.1.0)

Requirement already satisfied: six>=1.12.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (1.16.0)

Requirement already satisfied: termcolor>=1.1.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (2.5.0)

Requirement already satisfied: typing-extensions>=3.6.6 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (4.11.0)

Requirement already satisfied: wrapt>=1.11.0 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (1.14.1)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in h:\anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow) (1.68.0)

Requirement already satisfied: tensorboard<2.19,>=2.18 in h:\anaconda\lib\site-

packages (from tensorflow-intel==2.18.0->tensorflow) (2.18.0)  
Requirement already satisfied: markdown-it-py>=2.2.0 in h:\anaconda\lib\site-packages (from rich->keras) (2.2.0)  
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in h:\anaconda\lib\site-packages (from rich->keras) (2.15.1)  
Requirement already satisfied: wheel<1.0,>=0.23.0 in h:\anaconda\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.18.0->tensorflow) (0.44.0)  
Requirement already satisfied: mdurl~=0.1 in h:\anaconda\lib\site-packages (from markdown-it-py>=2.2.0->rich->keras) (0.1.0)  
Requirement already satisfied: charset-normalizer<4,>=2 in h:\anaconda\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.18.0->tensorflow) (3.3.2)  
Requirement already satisfied: idna<4,>=2.5 in h:\anaconda\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.18.0->tensorflow) (3.7)  
Requirement already satisfied: urllib3<3,>=1.21.1 in h:\anaconda\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.18.0->tensorflow) (2.2.3)  
Requirement already satisfied: certifi>=2017.4.17 in h:\anaconda\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.18.0->tensorflow) (2024.8.30)  
Requirement already satisfied: markdown>=2.6.8 in h:\anaconda\lib\site-packages (from tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow) (3.4.1)  
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in h:\anaconda\lib\site-packages (from tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow) (0.7.2)  
Requirement already satisfied: werkzeug>=1.0.1 in h:\anaconda\lib\site-packages (from tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow) (3.0.3)  
Requirement already satisfied: MarkupSafe>=2.1.1 in h:\anaconda\lib\site-packages (from werkzeug>=1.0.1->tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow) (2.1.3)  
Note: you may need to restart the kernel to use updated packages.

```
[23]: # plt.figure(9)
# plt.plot(lsIndex, lsSN)
# plt.xlabel('time (day)')
# plt.ylabel('soil nitrogen (gN/m^2d)')
# plt.title('Soil Nitrogen')
# plt.show()

# print('##### LAI #####')
# print(lsLAI)
# print('##### Grain Values #####')

# print('##### lsNUP #####')
# print(lsNUP)
```

```
[24]: %pip install scikeras
```

Requirement already satisfied: scikeras in h:\anaconda\lib\site-packages (0.13.0)

Requirement already satisfied: keras>=3.2.0 in h:\anaconda\lib\site-packages (from scikeras) (3.6.0)

Requirement already satisfied: scikit-learn>=1.4.2 in h:\anaconda\lib\site-packages (from scikeras) (1.5.1)

Requirement already satisfied: absl-py in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (2.1.0)

Requirement already satisfied: numpy in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (1.26.4)

Requirement already satisfied: rich in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (13.7.1)

Requirement already satisfied: namex in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (0.0.8)

Requirement already satisfied: h5py in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (3.11.0)

Requirement already satisfied: optree in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (0.13.1)

Requirement already satisfied: ml-dtypes in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (0.4.1)

Requirement already satisfied: packaging in h:\anaconda\lib\site-packages (from keras>=3.2.0->scikeras) (24.1)

Requirement already satisfied: scipy>=1.6.0 in h:\anaconda\lib\site-packages (from scikit-learn>=1.4.2->scikeras) (1.13.1)

Requirement already satisfied: joblib>=1.2.0 in h:\anaconda\lib\site-packages (from scikit-learn>=1.4.2->scikeras) (1.4.2)

Requirement already satisfied: threadpoolctl>=3.1.0 in h:\anaconda\lib\site-packages (from scikit-learn>=1.4.2->scikeras) (3.5.0)

Requirement already satisfied: typing-extensions>=4.5.0 in h:\anaconda\lib\site-packages (from optree->keras>=3.2.0->scikeras) (4.11.0)

Requirement already satisfied: markdown-it-py>=2.2.0 in h:\anaconda\lib\site-packages (from rich->keras>=3.2.0->scikeras) (2.2.0)

Requirement already satisfied: pygments<3.0.0,>=2.13.0 in h:\anaconda\lib\site-packages (from rich->keras>=3.2.0->scikeras) (2.15.1)

Requirement already satisfied: mdurl~=0.1 in h:\anaconda\lib\site-packages (from markdown-it-py>=2.2.0->rich->keras>=3.2.0->scikeras) (0.1.0)

Note: you may need to restart the kernel to use updated packages.

```
[29]: # first neural network with keras tutorial
import tensorflow as tf
from tensorflow import keras
from numpy import loadtxt
from keras.models import Sequential
from keras.layers import Dense
#from keras.wrappers.scikit_learn import KerasRegressor
from scikeras.wrappers import KerasClassifier, KerasRegressor
from sklearn.model_selection import cross_val_score
```

```

from sklearn.model_selection import KFold
from sklearn.datasets import make_regression
from sklearn.preprocessing import MinMaxScaler
from sklearn.metrics import mean_absolute_error
from numpy import asarray
from numpy import unique
from numpy import argmax
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.model_selection import train_test_split
import numpy as np
from tensorflow.keras.utils import plot_model
from sklearn.preprocessing import StandardScaler
#from keras.optimizers import SGD

```

```

[35]: # load the dataset
dataset = loadtxt('Data/datas.csv', delimiter=',') #('Dataset_transformAll.
↪ csv', delimiter=',') # #('Audrey_Dataset.csv', delimiter=',')
# split into input (X) and output (y) variables
#X = dataset[:,0:7]
#y = dataset[:,7]

```

```

[37]: #####
#Dataset transform: We change parameters with the Illinois dataset.
#Future selection showed that Precipitation, Temperature max and min and Solar_
↪ radiation are the factors that significantly impact the yield.
#1. Normal dataset: Y=0.75, Yhat= 0.774, MAE = 0.00901
#2. We changed the Solar radiation: Y=0.75, Yhat = 0.785, MAE= 0.01315
#3. We changed the Precipitation: Y=0.75, Yhat = 0.788 , MAE= 0.01014
#4. We changed the Min_Temperature: Y=0.75, Yhat = 0.773 , MAE= 0.01182
#5. We changed the Max_Temperature: Y=0.75, Yhat = 0.763 , MAE= 0.02105
#6. We changed All the 4 parameters: Y=0.75, Yhat = 0.771 , MAE= 0.01477
#####

```

```

[39]: #EXERCICE3

X, y = make_regression(n_samples=181, n_features=7, noise=0.1, random_state=1)
n_train = 75
trainX, testX = X[:n_train, :], X[n_train:, :]
trainy, testy = y[:n_train], y[n_train:]

trainy = trainy.reshape(len(trainy), 1)
testy = testy.reshape(len(testy), 1)
# created scaler
scaler = StandardScaler()
# fit scaler on training dataset
scaler.fit(trainy)

```

```
# transform training dataset
trainy = scaler.transform(trainy)
# transform test dataset
testy = scaler.transform(testy)
```

```
[41]: #EXERCICE3
model = Sequential()
model.add(Dense(20, input_dim=7, activation='relu',
    ↪kernel_initializer='normal'))
model.add(Dense(1, kernel_initializer='normal', activation='linear'))
```

H:\Anaconda\Lib\site-packages\keras\src\layers\core\dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

```
super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

```
[43]: #EXERCICE 3
print(model.summary())
```

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 20)	160
dense_1 (Dense)	(None, 1)	21

Total params: 181 (724.00 B)

Trainable params: 181 (724.00 B)

Non-trainable params: 0 (0.00 B)

None

```
[45]: #EXERCICE 3
# compile model
sgd = tf.keras.optimizers.SGD(learning_rate=0.01, decay=0.0, momentum=0.7,
    ↪nesterov=False)
model.compile(loss='mean_squared_error', optimizer=sgd)
```

H:\Anaconda\Lib\site-packages\keras\src\optimizers\base\_optimizer.py:86: UserWarning: Argument `decay` is no longer supported and will be ignored.

```
warnings.warn(
```

```
[47]: #EXERCICE 3  
# fit model  
history = model.fit(trainX, trainy, validation_data=(testX, testy), epochs=100, ▮  
        verbose=2)
```

```
Epoch 1/100  
3/3 - 1s - 185ms/step - loss: 0.9924 - val_loss: 0.5916  
Epoch 2/100  
3/3 - 0s - 13ms/step - loss: 0.9842 - val_loss: 0.5880  
Epoch 3/100  
3/3 - 0s - 13ms/step - loss: 0.9715 - val_loss: 0.5804  
Epoch 4/100  
3/3 - 0s - 13ms/step - loss: 0.9537 - val_loss: 0.5682  
Epoch 5/100  
3/3 - 0s - 12ms/step - loss: 0.9358 - val_loss: 0.5555  
Epoch 6/100  
3/3 - 0s - 13ms/step - loss: 0.9137 - val_loss: 0.5431  
Epoch 7/100  
3/3 - 0s - 14ms/step - loss: 0.8893 - val_loss: 0.5290  
Epoch 8/100  
3/3 - 0s - 13ms/step - loss: 0.8621 - val_loss: 0.5111  
Epoch 9/100  
3/3 - 0s - 13ms/step - loss: 0.8291 - val_loss: 0.4901  
Epoch 10/100  
3/3 - 0s - 13ms/step - loss: 0.7865 - val_loss: 0.4671  
Epoch 11/100  
3/3 - 0s - 13ms/step - loss: 0.7385 - val_loss: 0.4388  
Epoch 12/100  
3/3 - 0s - 12ms/step - loss: 0.6845 - val_loss: 0.4053  
Epoch 13/100  
3/3 - 0s - 13ms/step - loss: 0.6148 - val_loss: 0.3635  
Epoch 14/100  
3/3 - 0s - 12ms/step - loss: 0.5493 - val_loss: 0.3204  
Epoch 15/100  
3/3 - 0s - 13ms/step - loss: 0.4745 - val_loss: 0.2796  
Epoch 16/100  
3/3 - 0s - 12ms/step - loss: 0.4070 - val_loss: 0.2402  
Epoch 17/100  
3/3 - 0s - 12ms/step - loss: 0.3424 - val_loss: 0.1995  
Epoch 18/100  
3/3 - 0s - 13ms/step - loss: 0.2764 - val_loss: 0.1575  
Epoch 19/100  
3/3 - 0s - 12ms/step - loss: 0.2111 - val_loss: 0.1216  
Epoch 20/100  
3/3 - 0s - 12ms/step - loss: 0.1614 - val_loss: 0.0951  
Epoch 21/100
```

3/3 - 0s - 13ms/step - loss: 0.1238 - val\_loss: 0.0743  
Epoch 22/100  
3/3 - 0s - 12ms/step - loss: 0.0951 - val\_loss: 0.0593  
Epoch 23/100  
3/3 - 0s - 13ms/step - loss: 0.0760 - val\_loss: 0.0484  
Epoch 24/100  
3/3 - 0s - 13ms/step - loss: 0.0608 - val\_loss: 0.0411  
Epoch 25/100  
3/3 - 0s - 12ms/step - loss: 0.0516 - val\_loss: 0.0350  
Epoch 26/100  
3/3 - 0s - 13ms/step - loss: 0.0431 - val\_loss: 0.0306  
Epoch 27/100  
3/3 - 0s - 12ms/step - loss: 0.0372 - val\_loss: 0.0271  
Epoch 28/100  
3/3 - 0s - 12ms/step - loss: 0.0323 - val\_loss: 0.0244  
Epoch 29/100  
3/3 - 0s - 13ms/step - loss: 0.0286 - val\_loss: 0.0220  
Epoch 30/100  
3/3 - 0s - 12ms/step - loss: 0.0257 - val\_loss: 0.0203  
Epoch 31/100  
3/3 - 0s - 14ms/step - loss: 0.0236 - val\_loss: 0.0191  
Epoch 32/100  
3/3 - 0s - 13ms/step - loss: 0.0219 - val\_loss: 0.0180  
Epoch 33/100  
3/3 - 0s - 13ms/step - loss: 0.0208 - val\_loss: 0.0170  
Epoch 34/100  
3/3 - 0s - 12ms/step - loss: 0.0198 - val\_loss: 0.0163  
Epoch 35/100  
3/3 - 0s - 13ms/step - loss: 0.0190 - val\_loss: 0.0159  
Epoch 36/100  
3/3 - 0s - 12ms/step - loss: 0.0179 - val\_loss: 0.0155  
Epoch 37/100  
3/3 - 0s - 12ms/step - loss: 0.0176 - val\_loss: 0.0154  
Epoch 38/100  
3/3 - 0s - 12ms/step - loss: 0.0167 - val\_loss: 0.0150  
Epoch 39/100  
3/3 - 0s - 12ms/step - loss: 0.0161 - val\_loss: 0.0148  
Epoch 40/100  
3/3 - 0s - 12ms/step - loss: 0.0157 - val\_loss: 0.0145  
Epoch 41/100  
3/3 - 0s - 13ms/step - loss: 0.0153 - val\_loss: 0.0142  
Epoch 42/100  
3/3 - 0s - 13ms/step - loss: 0.0151 - val\_loss: 0.0139  
Epoch 43/100  
3/3 - 0s - 14ms/step - loss: 0.0147 - val\_loss: 0.0137  
Epoch 44/100  
3/3 - 0s - 13ms/step - loss: 0.0144 - val\_loss: 0.0135  
Epoch 45/100



3/3 - 0s - 13ms/step - loss: 0.0141 - val\_loss: 0.0134  
Epoch 46/100  
3/3 - 0s - 12ms/step - loss: 0.0140 - val\_loss: 0.0137  
Epoch 47/100  
3/3 - 0s - 12ms/step - loss: 0.0136 - val\_loss: 0.0136  
Epoch 48/100  
3/3 - 0s - 12ms/step - loss: 0.0134 - val\_loss: 0.0135  
Epoch 49/100  
3/3 - 0s - 12ms/step - loss: 0.0133 - val\_loss: 0.0137  
Epoch 50/100  
3/3 - 0s - 12ms/step - loss: 0.0129 - val\_loss: 0.0136  
Epoch 51/100  
3/3 - 0s - 12ms/step - loss: 0.0126 - val\_loss: 0.0134  
Epoch 52/100  
3/3 - 0s - 13ms/step - loss: 0.0124 - val\_loss: 0.0131  
Epoch 53/100  
3/3 - 0s - 12ms/step - loss: 0.0122 - val\_loss: 0.0127  
Epoch 54/100  
3/3 - 0s - 13ms/step - loss: 0.0121 - val\_loss: 0.0125  
Epoch 55/100  
3/3 - 0s - 12ms/step - loss: 0.0119 - val\_loss: 0.0124  
Epoch 56/100  
3/3 - 0s - 12ms/step - loss: 0.0117 - val\_loss: 0.0125  
Epoch 57/100  
3/3 - 0s - 12ms/step - loss: 0.0116 - val\_loss: 0.0125  
Epoch 58/100  
3/3 - 0s - 12ms/step - loss: 0.0115 - val\_loss: 0.0125  
Epoch 59/100  
3/3 - 0s - 18ms/step - loss: 0.0114 - val\_loss: 0.0125  
Epoch 60/100  
3/3 - 0s - 12ms/step - loss: 0.0113 - val\_loss: 0.0125  
Epoch 61/100  
3/3 - 0s - 12ms/step - loss: 0.0111 - val\_loss: 0.0123  
Epoch 62/100  
3/3 - 0s - 12ms/step - loss: 0.0110 - val\_loss: 0.0123  
Epoch 63/100  
3/3 - 0s - 12ms/step - loss: 0.0109 - val\_loss: 0.0124  
Epoch 64/100  
3/3 - 0s - 12ms/step - loss: 0.0108 - val\_loss: 0.0125  
Epoch 65/100  
3/3 - 0s - 12ms/step - loss: 0.0106 - val\_loss: 0.0125  
Epoch 66/100  
3/3 - 0s - 14ms/step - loss: 0.0105 - val\_loss: 0.0127  
Epoch 67/100  
3/3 - 0s - 14ms/step - loss: 0.0103 - val\_loss: 0.0127  
Epoch 68/100  
3/3 - 0s - 13ms/step - loss: 0.0102 - val\_loss: 0.0128  
Epoch 69/100

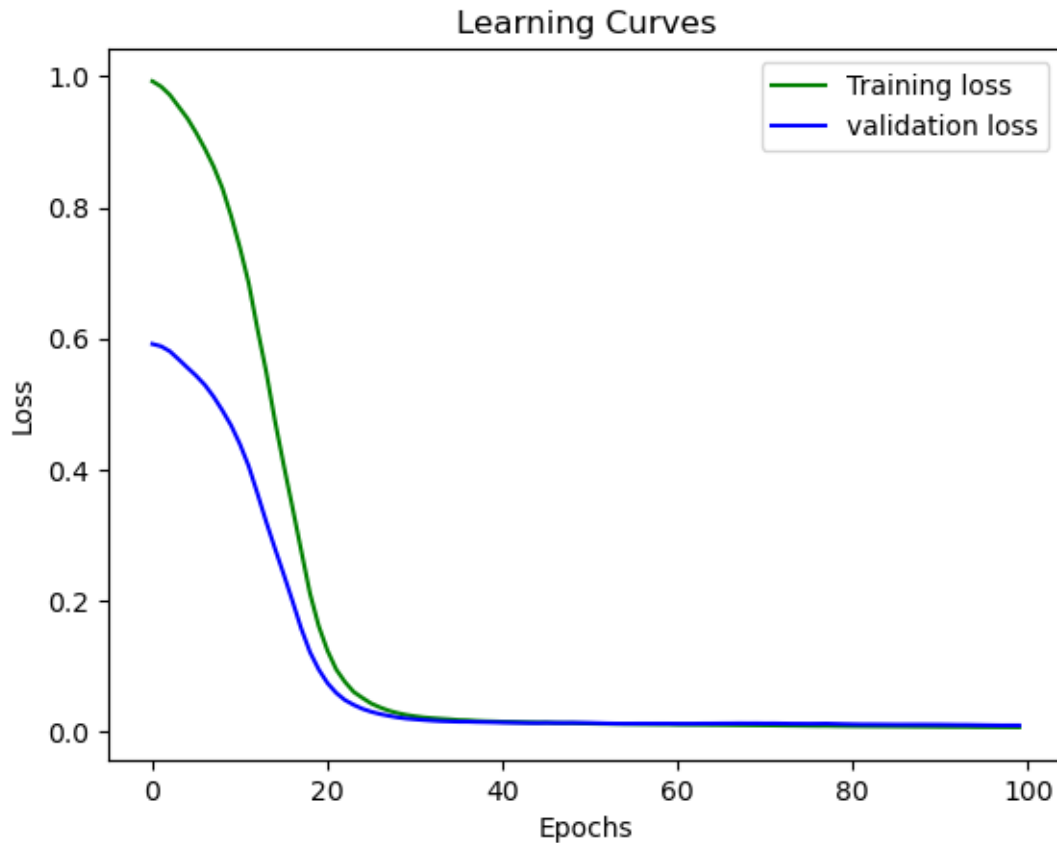
3/3 - 0s - 13ms/step - loss: 0.0101 - val\_loss: 0.0128  
Epoch 70/100  
3/3 - 0s - 13ms/step - loss: 0.0100 - val\_loss: 0.0128  
Epoch 71/100  
3/3 - 0s - 12ms/step - loss: 0.0099 - val\_loss: 0.0126  
Epoch 72/100  
3/3 - 0s - 12ms/step - loss: 0.0098 - val\_loss: 0.0127  
Epoch 73/100  
3/3 - 0s - 12ms/step - loss: 0.0096 - val\_loss: 0.0125  
Epoch 74/100  
3/3 - 0s - 12ms/step - loss: 0.0095 - val\_loss: 0.0123  
Epoch 75/100  
3/3 - 0s - 12ms/step - loss: 0.0094 - val\_loss: 0.0123  
Epoch 76/100  
3/3 - 0s - 12ms/step - loss: 0.0092 - val\_loss: 0.0122  
Epoch 77/100  
3/3 - 0s - 12ms/step - loss: 0.0091 - val\_loss: 0.0123  
Epoch 78/100  
3/3 - 0s - 12ms/step - loss: 0.0091 - val\_loss: 0.0124  
Epoch 79/100  
3/3 - 0s - 12ms/step - loss: 0.0089 - val\_loss: 0.0121  
Epoch 80/100  
3/3 - 0s - 12ms/step - loss: 0.0087 - val\_loss: 0.0118  
Epoch 81/100  
3/3 - 0s - 12ms/step - loss: 0.0086 - val\_loss: 0.0115  
Epoch 82/100  
3/3 - 0s - 12ms/step - loss: 0.0085 - val\_loss: 0.0113  
Epoch 83/100  
3/3 - 0s - 12ms/step - loss: 0.0084 - val\_loss: 0.0113  
Epoch 84/100  
3/3 - 0s - 12ms/step - loss: 0.0083 - val\_loss: 0.0112  
Epoch 85/100  
3/3 - 0s - 13ms/step - loss: 0.0082 - val\_loss: 0.0111  
Epoch 86/100  
3/3 - 0s - 12ms/step - loss: 0.0081 - val\_loss: 0.0110  
Epoch 87/100  
3/3 - 0s - 13ms/step - loss: 0.0080 - val\_loss: 0.0110  
Epoch 88/100  
3/3 - 0s - 13ms/step - loss: 0.0079 - val\_loss: 0.0110  
Epoch 89/100  
3/3 - 0s - 12ms/step - loss: 0.0079 - val\_loss: 0.0110  
Epoch 90/100  
3/3 - 0s - 12ms/step - loss: 0.0077 - val\_loss: 0.0109  
Epoch 91/100  
3/3 - 0s - 13ms/step - loss: 0.0076 - val\_loss: 0.0109  
Epoch 92/100  
3/3 - 0s - 12ms/step - loss: 0.0076 - val\_loss: 0.0107  
Epoch 93/100

```
3/3 - 0s - 12ms/step - loss: 0.0075 - val_loss: 0.0106
Epoch 94/100
3/3 - 0s - 13ms/step - loss: 0.0075 - val_loss: 0.0105
Epoch 95/100
3/3 - 0s - 12ms/step - loss: 0.0073 - val_loss: 0.0103
Epoch 96/100
3/3 - 0s - 12ms/step - loss: 0.0072 - val_loss: 0.0101
Epoch 97/100
3/3 - 0s - 12ms/step - loss: 0.0072 - val_loss: 0.0099
Epoch 98/100
3/3 - 0s - 12ms/step - loss: 0.0071 - val_loss: 0.0098
Epoch 99/100
3/3 - 0s - 12ms/step - loss: 0.0070 - val_loss: 0.0098
Epoch 100/100
3/3 - 0s - 12ms/step - loss: 0.0069 - val_loss: 0.0098
```

```
[48]: #EXERCICE 3
      # evaluate the model
      train_mse = model.evaluate(trainX, trainy, verbose=0)
      test_mse = model.evaluate(testX, testy, verbose=0)
```

```
[49]: #EXERCICE 3
      print('Train: %.3f, Test: %.3f' % (train_mse, test_mse))
      # plot loss during training
      plt.title('Loss / Mean Squared Error')
      plt.plot(history.history['loss'], 'g', label='Training loss')
      plt.plot(history.history['val_loss'], 'b', label='validation loss')
      plt.title('Learning Curves')
      plt.xlabel('Epochs')
      plt.ylabel('Loss')
      plt.legend()
      plt.show()
```

Train: 0.007, Test: 0.010



```
[50]: # # #ESSAI 3 -----OK#####
X = dataset[:,0:7]
y = dataset[:,7]
scalarX, scalarY = MinMaxScaler(feature_range=(0,1)),  
    ↪MinMaxScaler(feature_range=(0,0.75))
scalarX.fit(X)
scalarY.fit(y.reshape(94,1))
X = scalarX.transform(X)
y=np.array(y).reshape(94,1)
y = scalarY.transform(y)
```

```
[55]: #print(y)
```

```
[57]: # define the keras model ####OK
model = Sequential()
model.add(Dense(20, input_dim=7, kernel_initializer='normal',  
    ↪activation='relu')) #kernel_initializer='normal'
model.add(Dense(1, kernel_initializer='normal', activation='linear')) #linear
print(model.summary())
```

H:\Anaconda\Lib\site-packages\keras\src\layers\core\dense.py:87: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

```
super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

Model: "sequential\_1"

Layer (type)	Output Shape	Param #
dense_2 (Dense)	(None, 20)	160
dense_3 (Dense)	(None, 1)	21

Total params: 181 (724.00 B)

Trainable params: 181 (724.00 B)

Non-trainable params: 0 (0.00 B)

None

```
[59]: sgd = tf.keras.optimizers.SGD(learning_rate=0.01, decay=0.0, momentum=0.7,
    ↪nesterov=False) ####OK
#adam=tf.keras.optimizers.Adam(learning_rate=0.01, beta_1=0.9, beta_2=0.999,
    ↪epsilon=1e-8)
model.compile(optimizer=sgd, loss='mean_absolute_error')
```

H:\Anaconda\Lib\site-packages\keras\src\optimizers\base\_optimizer.py:86: UserWarning: Argument `decay` is no longer supported and will be ignored.  
warnings.warn(

```
[61]: # fit the keras model on the dataset REAL DATA
history = model.fit(X, y, epochs=100, batch_size=4, verbose=2,
    ↪validation_split=0.20)
```

Epoch 1/100

19/19 - 0s - 20ms/step - loss: 0.0799 - val\_loss: 0.6099

Epoch 2/100

19/19 - 0s - 3ms/step - loss: 0.0818 - val\_loss: 0.6386

Epoch 3/100

19/19 - 0s - 2ms/step - loss: 0.0767 - val\_loss: 0.6215

Epoch 4/100

19/19 - 0s - 2ms/step - loss: 0.0759 - val\_loss: 0.6283

Epoch 5/100  
19/19 - 0s - 2ms/step - loss: 0.0763 - val\_loss: 0.6411  
Epoch 6/100  
19/19 - 0s - 2ms/step - loss: 0.0755 - val\_loss: 0.6225  
Epoch 7/100  
19/19 - 0s - 2ms/step - loss: 0.0737 - val\_loss: 0.6274  
Epoch 8/100  
19/19 - 0s - 2ms/step - loss: 0.0745 - val\_loss: 0.6282  
Epoch 9/100  
19/19 - 0s - 2ms/step - loss: 0.0723 - val\_loss: 0.6129  
Epoch 10/100  
19/19 - 0s - 3ms/step - loss: 0.0732 - val\_loss: 0.5999  
Epoch 11/100  
19/19 - 0s - 2ms/step - loss: 0.0708 - val\_loss: 0.5740  
Epoch 12/100  
19/19 - 0s - 2ms/step - loss: 0.0732 - val\_loss: 0.5894  
Epoch 13/100  
19/19 - 0s - 2ms/step - loss: 0.0706 - val\_loss: 0.5830  
Epoch 14/100  
19/19 - 0s - 2ms/step - loss: 0.0695 - val\_loss: 0.5799  
Epoch 15/100  
19/19 - 0s - 2ms/step - loss: 0.0683 - val\_loss: 0.5396  
Epoch 16/100  
19/19 - 0s - 3ms/step - loss: 0.0679 - val\_loss: 0.5270  
Epoch 17/100  
19/19 - 0s - 3ms/step - loss: 0.0669 - val\_loss: 0.5082  
Epoch 18/100  
19/19 - 0s - 2ms/step - loss: 0.0654 - val\_loss: 0.4925  
Epoch 19/100  
19/19 - 0s - 2ms/step - loss: 0.0651 - val\_loss: 0.5375  
Epoch 20/100  
19/19 - 0s - 2ms/step - loss: 0.0651 - val\_loss: 0.4765  
Epoch 21/100  
19/19 - 0s - 2ms/step - loss: 0.0644 - val\_loss: 0.5097  
Epoch 22/100  
19/19 - 0s - 2ms/step - loss: 0.0597 - val\_loss: 0.4936  
Epoch 23/100  
19/19 - 0s - 2ms/step - loss: 0.0596 - val\_loss: 0.4782  
Epoch 24/100  
19/19 - 0s - 2ms/step - loss: 0.0563 - val\_loss: 0.4749  
Epoch 25/100  
19/19 - 0s - 2ms/step - loss: 0.0559 - val\_loss: 0.4791  
Epoch 26/100  
19/19 - 0s - 2ms/step - loss: 0.0559 - val\_loss: 0.4741  
Epoch 27/100  
19/19 - 0s - 2ms/step - loss: 0.0550 - val\_loss: 0.4787  
Epoch 28/100  
19/19 - 0s - 2ms/step - loss: 0.0541 - val\_loss: 0.4225

Epoch 29/100  
19/19 - 0s - 2ms/step - loss: 0.0487 - val\_loss: 0.4445  
Epoch 30/100  
19/19 - 0s - 2ms/step - loss: 0.0523 - val\_loss: 0.4218  
Epoch 31/100  
19/19 - 0s - 3ms/step - loss: 0.0500 - val\_loss: 0.3700  
Epoch 32/100  
19/19 - 0s - 2ms/step - loss: 0.0487 - val\_loss: 0.3598  
Epoch 33/100  
19/19 - 0s - 3ms/step - loss: 0.0505 - val\_loss: 0.3470  
Epoch 34/100  
19/19 - 0s - 2ms/step - loss: 0.0438 - val\_loss: 0.3736  
Epoch 35/100  
19/19 - 0s - 2ms/step - loss: 0.0417 - val\_loss: 0.3710  
Epoch 36/100  
19/19 - 0s - 2ms/step - loss: 0.0400 - val\_loss: 0.3833  
Epoch 37/100  
19/19 - 0s - 2ms/step - loss: 0.0430 - val\_loss: 0.3523  
Epoch 38/100  
19/19 - 0s - 2ms/step - loss: 0.0396 - val\_loss: 0.3138  
Epoch 39/100  
19/19 - 0s - 2ms/step - loss: 0.0360 - val\_loss: 0.2945  
Epoch 40/100  
19/19 - 0s - 2ms/step - loss: 0.0396 - val\_loss: 0.3301  
Epoch 41/100  
19/19 - 0s - 2ms/step - loss: 0.0369 - val\_loss: 0.2879  
Epoch 42/100  
19/19 - 0s - 2ms/step - loss: 0.0390 - val\_loss: 0.2600  
Epoch 43/100  
19/19 - 0s - 2ms/step - loss: 0.0356 - val\_loss: 0.2937  
Epoch 44/100  
19/19 - 0s - 3ms/step - loss: 0.0438 - val\_loss: 0.2654  
Epoch 45/100  
19/19 - 0s - 2ms/step - loss: 0.0366 - val\_loss: 0.2310  
Epoch 46/100  
19/19 - 0s - 2ms/step - loss: 0.0343 - val\_loss: 0.2513  
Epoch 47/100  
19/19 - 0s - 2ms/step - loss: 0.0313 - val\_loss: 0.2247  
Epoch 48/100  
19/19 - 0s - 2ms/step - loss: 0.0326 - val\_loss: 0.2189  
Epoch 49/100  
19/19 - 0s - 2ms/step - loss: 0.0373 - val\_loss: 0.2259  
Epoch 50/100  
19/19 - 0s - 2ms/step - loss: 0.0275 - val\_loss: 0.2051  
Epoch 51/100  
19/19 - 0s - 2ms/step - loss: 0.0315 - val\_loss: 0.1759  
Epoch 52/100  
19/19 - 0s - 2ms/step - loss: 0.0284 - val\_loss: 0.2303

Epoch 53/100  
19/19 - 0s - 2ms/step - loss: 0.0236 - val\_loss: 0.1821  
Epoch 54/100  
19/19 - 0s - 2ms/step - loss: 0.0304 - val\_loss: 0.1654  
Epoch 55/100  
19/19 - 0s - 2ms/step - loss: 0.0304 - val\_loss: 0.2006  
Epoch 56/100  
19/19 - 0s - 3ms/step - loss: 0.0304 - val\_loss: 0.1112  
Epoch 57/100  
19/19 - 0s - 2ms/step - loss: 0.0223 - val\_loss: 0.1757  
Epoch 58/100  
19/19 - 0s - 2ms/step - loss: 0.0296 - val\_loss: 0.1650  
Epoch 59/100  
19/19 - 0s - 2ms/step - loss: 0.0222 - val\_loss: 0.1407  
Epoch 60/100  
19/19 - 0s - 2ms/step - loss: 0.0260 - val\_loss: 0.1155  
Epoch 61/100  
19/19 - 0s - 2ms/step - loss: 0.0307 - val\_loss: 0.1663  
Epoch 62/100  
19/19 - 0s - 2ms/step - loss: 0.0208 - val\_loss: 0.1370  
Epoch 63/100  
19/19 - 0s - 2ms/step - loss: 0.0236 - val\_loss: 0.1541  
Epoch 64/100  
19/19 - 0s - 2ms/step - loss: 0.0240 - val\_loss: 0.1600  
Epoch 65/100  
19/19 - 0s - 2ms/step - loss: 0.0252 - val\_loss: 0.1653  
Epoch 66/100  
19/19 - 0s - 2ms/step - loss: 0.0218 - val\_loss: 0.1301  
Epoch 67/100  
19/19 - 0s - 2ms/step - loss: 0.0226 - val\_loss: 0.1253  
Epoch 68/100  
19/19 - 0s - 2ms/step - loss: 0.0264 - val\_loss: 0.1286  
Epoch 69/100  
19/19 - 0s - 2ms/step - loss: 0.0220 - val\_loss: 0.0989  
Epoch 70/100  
19/19 - 0s - 2ms/step - loss: 0.0243 - val\_loss: 0.1242  
Epoch 71/100  
19/19 - 0s - 2ms/step - loss: 0.0250 - val\_loss: 0.0655  
Epoch 72/100  
19/19 - 0s - 2ms/step - loss: 0.0217 - val\_loss: 0.1059  
Epoch 73/100  
19/19 - 0s - 2ms/step - loss: 0.0184 - val\_loss: 0.0931  
Epoch 74/100  
19/19 - 0s - 2ms/step - loss: 0.0259 - val\_loss: 0.0893  
Epoch 75/100  
19/19 - 0s - 2ms/step - loss: 0.0262 - val\_loss: 0.0886  
Epoch 76/100  
19/19 - 0s - 2ms/step - loss: 0.0250 - val\_loss: 0.0867



Epoch 77/100  
19/19 - 0s - 2ms/step - loss: 0.0194 - val\_loss: 0.0485  
Epoch 78/100  
19/19 - 0s - 3ms/step - loss: 0.0223 - val\_loss: 0.0924  
Epoch 79/100  
19/19 - 0s - 2ms/step - loss: 0.0203 - val\_loss: 0.0781  
Epoch 80/100  
19/19 - 0s - 2ms/step - loss: 0.0214 - val\_loss: 0.0678  
Epoch 81/100  
19/19 - 0s - 2ms/step - loss: 0.0181 - val\_loss: 0.0349  
Epoch 82/100  
19/19 - 0s - 2ms/step - loss: 0.0242 - val\_loss: 0.0684  
Epoch 83/100  
19/19 - 0s - 2ms/step - loss: 0.0194 - val\_loss: 0.0518  
Epoch 84/100  
19/19 - 0s - 2ms/step - loss: 0.0182 - val\_loss: 0.0671  
Epoch 85/100  
19/19 - 0s - 2ms/step - loss: 0.0205 - val\_loss: 0.1173  
Epoch 86/100  
19/19 - 0s - 2ms/step - loss: 0.0224 - val\_loss: 0.0623  
Epoch 87/100  
19/19 - 0s - 2ms/step - loss: 0.0197 - val\_loss: 0.0809  
Epoch 88/100  
19/19 - 0s - 2ms/step - loss: 0.0195 - val\_loss: 0.0513  
Epoch 89/100  
19/19 - 0s - 2ms/step - loss: 0.0207 - val\_loss: 0.0246  
Epoch 90/100  
19/19 - 0s - 2ms/step - loss: 0.0222 - val\_loss: 0.0585  
Epoch 91/100  
19/19 - 0s - 2ms/step - loss: 0.0180 - val\_loss: 0.0791  
Epoch 92/100  
19/19 - 0s - 2ms/step - loss: 0.0131 - val\_loss: 0.0415  
Epoch 93/100  
19/19 - 0s - 2ms/step - loss: 0.0184 - val\_loss: 0.0640  
Epoch 94/100  
19/19 - 0s - 2ms/step - loss: 0.0153 - val\_loss: 0.0242  
Epoch 95/100  
19/19 - 0s - 2ms/step - loss: 0.0183 - val\_loss: 0.0763  
Epoch 96/100  
19/19 - 0s - 2ms/step - loss: 0.0192 - val\_loss: 0.0582  
Epoch 97/100  
19/19 - 0s - 2ms/step - loss: 0.0165 - val\_loss: 0.0161  
Epoch 98/100  
19/19 - 0s - 2ms/step - loss: 0.0210 - val\_loss: 0.0765  
Epoch 99/100  
19/19 - 0s - 2ms/step - loss: 0.0167 - val\_loss: 0.0688  
Epoch 100/100  
19/19 - 0s - 2ms/step - loss: 0.0191 - val\_loss: 0.0894

```
[62]: # evaluate on test set
      yhat = model.predict(X)
      error = mean_absolute_error(y, yhat)
      print('MAE: %.5f' % error)
```

```
3/3          0s 9ms/step
MAE: 0.04645
```

```
[65]: #print(yhat)
```

```
[67]: #print(y)
```

```
[69]: ###plt.plot(y)
```

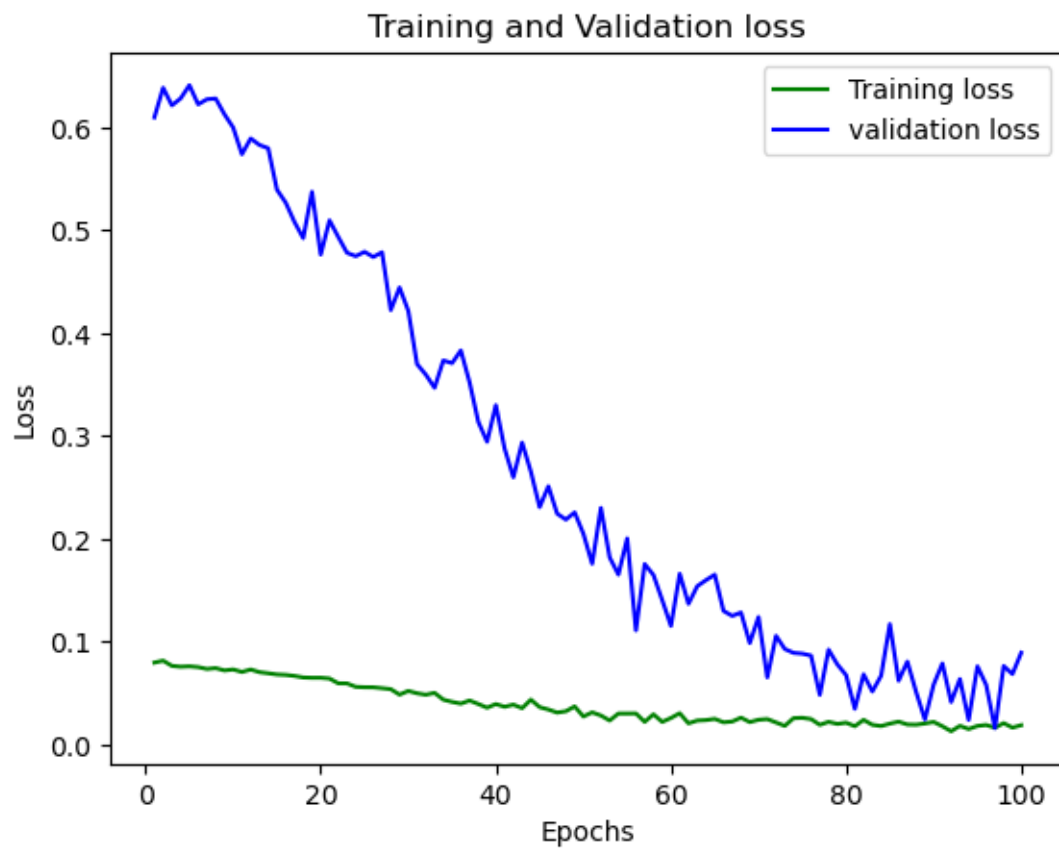
```
[71]: ####plt.plot(yhat)
```

```
[73]: #####print(yhat-y)
```

```
[75]: print(history.history.keys())
```

```
dict_keys(['loss', 'val_loss'])
```

```
[77]: loss_train = history.history['loss']
      loss_val = history.history['val_loss']
      epochs = range(1,101)
      plt.plot(epochs, loss_train, 'g', label='Training loss')
      plt.plot(epochs, loss_val, 'b', label='validation loss')
      plt.title('Training and Validation loss')
      plt.xlabel('Epochs')
      plt.ylabel('Loss')
      plt.legend()
      plt.show()
```



[ ]:

[ ]: