MLP (Multi Layer Perceptron)

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In [ ]:

```
#Libraries
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import random
```

In [ ]:

```
#Inicializar numeros aleatorios con semilla 10
random.seed(10)
```

In [ ]:

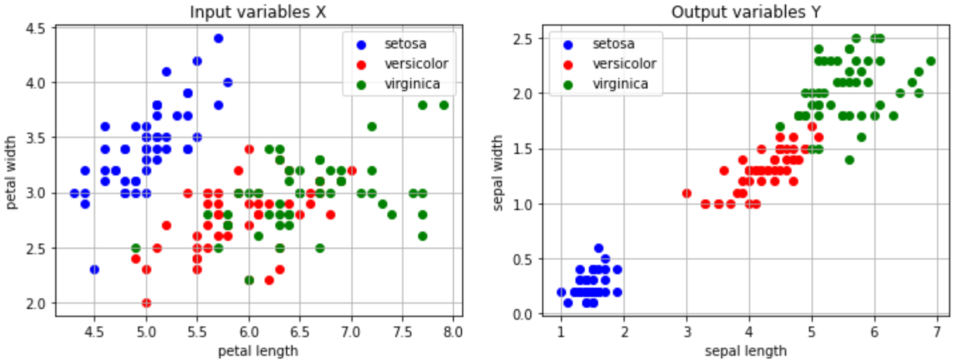
```
# Load and split data
from sklearn.datasets import load_iris
iris = load_iris()

# We will use length and width of petals as X to predict length and width of sepals as Y
# We also keep the labels in a vector L
X = iris.data[:, :2]
Y = iris.data[:, 2:]
L = iris.target

print("X data:", X.shape)
print("Y data:", Y.shape)
print("L data:", L.shape)

# Plot it
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.scatter(X[L==0, 0], X[L==0, 1], c='b', label='setosa')
plt.scatter(X[L==1, 0], X[L==1, 1], c='r', label='versicolor')
plt.scatter(X[L==2, 0], X[L==2, 1], c='g', label='virginica')
plt.legend()
plt.grid(True)
plt.xlabel('petal length')
plt.ylabel('petal width')
plt.title('Input variables X')
plt.subplot(1, 2, 2)
plt.scatter(Y[L==0, 0], Y[L==0, 1], c='b', label='setosa')
plt.scatter(Y[L==1, 0], Y[L==1, 1], c='r', label='versicolor')
plt.scatter(Y[L==2, 0], Y[L==2, 1], c='g', label='virginica')
plt.legend()
plt.grid(True)
plt.xlabel('sepal length')
plt.ylabel('sepal width')
plt.title('Output variables Y')
plt.show()
```

```
X data: (150, 2)
Y data: (150, 2)
L data: (150,)
```



In [ ]:

```
# Split it into training and test sets
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test, l_train, l_test = train_test_split(X, Y, L, test_size=0.2)

print("Training + validation inputs X:", x_train.shape)
print("Test inputs X:", x_test.shape)
print("Training + validation outputs Y:", y_train.shape)
print("Test outputs Y:", y_test.shape)
print("Training + validation labels l:", l_train.shape)
print("Test labels l:", l_test.shape)
```

```
Training + validation inputs X: (120, 2)
Test inputs X: (30, 2)
Training + validation outputs Y: (120, 2)
Test outputs Y: (30, 2)
Training + validation labels l: (120,)
Test labels l: (30,)
```

In [ ]:

```
# import tensorflow an the classes Model, Input (place-holder layer), and Dense (fully connected layer)
import tensorflow as tf
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Dense
import tensorflow.keras.backend as K
```

Reto

Usando como base el código python proporcionado en notebook de jupyter (“DL_02_MLP.ipynb”),construir un modelo MLP que mejore el desempeño (minimize la pérdida) para el problema de regresión propuesto.

Sugerencias

- Prueba con varias arquitecturas de entre 2 y 5 capas.
- Prueba con varios número de neuronas en cada capa.
- Prueba diferentes tamaños de lote.
- Prueba diferentes números de épocas.
- Por ahora, manten SGD y MSE como optimizador y pérdida, respectivamente.

In [ ]:

```
def MLP_arquitectures(hiden_layers, batch_size, nepocs):

  if hiden_layers == 2:
    # 2 Layers with 6,10 neurons per layer
    # Create an MLP of two inputs x=[x1, x2], and two outputs y=[y1, y2]
    i = Input(shape=(2), name='input')
    h = Dense(units=6, activation='relu', name='hidden1')(i)
    h = Dense(units=10, activation='relu', name='hidden2')(h)
    o = Dense(units=2, activation=None, name='output')(h)
  elif hiden_layers == 3:
    # 3 Layers with 6,10,12 neurons per layer
    i = Input(shape=(2), name='input')
    h = Dense(units=6, activation='relu', name='hidden1')(i)
    h = Dense(units=10, activation='relu', name='hidden2')(h)
    h = Dense(units=12, activation='relu', name='hidden3')(h)
    o = Dense(units=2, activation=None, name='output')(h)
  elif hiden_layers == 4:
    # 4 Layers with 6,10,12,15 neurons per layer
    i = Input(shape=(2), name='input')
    h = Dense(units=6, activation='relu', name='hidden1')(i)
    h = Dense(units=10, activation='relu', name='hidden2')(h)
    h = Dense(units=12, activation='relu', name='hidden3')(h)
    h = Dense(units=15, activation='relu', name='hidden4')(h)
    o = Dense(units=2, activation=None, name='output')(h)
  else:
    # 5 Layers with 6,10,12,15 neurons per layer
    i = Input(shape=(2), name='input')
    h = Dense(units=6, activation='relu', name='hidden1')(i)
    h = Dense(units=10, activation='relu', name='hidden2')(h)
    h = Dense(units=12, activation='relu', name='hidden3')(h)
    h = Dense(units=15, activation='relu', name='hidden4')(h)
    h = Dense(units=10, activation='relu', name='hidden5')(h)
    o = Dense(units=2, activation=None, name='output')(h)

  MLP = Model(inputs=i, outputs=o)

  # Compile
  MLP.compile(optimizer='sgd', loss='mse')

  # Training
  MLP.fit(x=x_train, y=y_train, batch_size=batch_size, epochs=nepocs, verbose=1, validation_split=0.2)
  return MLP
```

Obs.

De acuerdo a lo visto durante clase y en la documentación, la activación sugerida para capas ocultas es la Relu así como la activación lineal para output de regresión. De hecho, hicimos el ejercicio de considerar las activaciones de las capas ocultas y de output como Relu y el desempeño fue peor que los modelos que veremos a continuación (Error de test mayor).

In [ ]:

```
def models_eval(hiden_layers, batch_size, epocs):
  layers=[]
  nunits=[]
  nbatch=[]
  nepocs=[]
  av_loss_train = []
  av_loss_validation = []
  av_loss_test = []

  for hl, bz, ep in zip(hiden_layers, batch_size, epocs):
    model = MLP_arquitectures(hl, bz, ep)
    layers.append(hl)
    nbatch.append(bz)
    nepocs.append(ep)
    av_loss_validation.append(model.history.history['val_loss'][-1])

    if hl == 2:
      nunits.append(110)
    elif hl == 3:
      nunits.append(246)
    elif hl == 4:
      nunits.append(447)
    else:
      nunits.append(597)

    # Testing the model
    train = model.evaluate(x=x_train, y=y_train, verbose=False)
    test = model.evaluate(x=x_test, y=y_test, verbose=False)
    av_loss_train.append(train)
    av_loss_test.append(test)
    # Reset session
    tf.keras.backend.clear_session()

  table={'hidden_layers':layers, 'batch_size':nbatch,'epocs':nepocs,'Trainable params':nunits,'average_loss_train':av_loss_train,'aver
  results=pd.DataFrame(table)

  return results
```

In [ ]:

```
# Define inputs params
hiden_layers= [2,3,4,5,3,3]
batch_size= [1,1,2,2,2,1]
epocs=[50,70,100,150,150,100]
```

In [ ]:

```
#Inicializar numeros aleatorios con semilla 10 para seleccion de modelo
random.seed(10)
```

In [ ]:

```
test = models_eval(hiden_layers, batch_size, epocs)
```

```
Epoch 1/50
96/96 [==============================] - 1s 8ms/step - loss: 1.7606 - val_loss: 0.6843
Epoch 2/50
96/96 [==============================] - 0s 2ms/step - loss: 0.8943 - val_loss: 1.0362
Epoch 3/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5530 - val_loss: 0.8184
Epoch 4/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5076 - val_loss: 0.6138
Epoch 5/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5487 - val_loss: 0.4211
Epoch 6/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5179 - val_loss: 0.4735
Epoch 7/50
96/96 [==============================] - 0s 2ms/step - loss: 0.4721 - val_loss: 0.9659
Epoch 8/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5423 - val_loss: 0.3562
Epoch 9/50
96/96 [==============================] - 0s 2ms/step - loss: 0.4053 - val_loss: 0.5330
Epoch 10/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5045 - val_loss: 0.4084
Epoch 11/50
96/96 [==============================] - 0s 2ms/step - loss: 0.5066 - val_loss: 0.4610
Epoch 12/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3129 - val_loss: 0.3527
Epoch 13/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3212 - val_loss: 0.4359
Epoch 14/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2877 - val_loss: 0.4707
Epoch 15/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3530 - val_loss: 0.4546
Epoch 16/50
```

```
96/96 [==============================] - 0s 2ms/step - loss: 0.4785 - val_loss: 0.8026
Epoch 17/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2942 - val_loss: 0.4103
Epoch 18/50
96/96 [==============================] - 0s 3ms/step - loss: 0.3361 - val_loss: 0.5136
Epoch 19/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3342 - val_loss: 0.4253
Epoch 20/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2709 - val_loss: 0.5578
Epoch 21/50
96/96 [==============================] - 0s 2ms/step - loss: 0.4105 - val_loss: 0.5326
Epoch 22/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3889 - val_loss: 0.5975
Epoch 23/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2659 - val_loss: 0.9092
Epoch 24/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3795 - val_loss: 0.4057
Epoch 25/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3176 - val_loss: 0.4423
Epoch 26/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3522 - val_loss: 0.4224
Epoch 27/50
96/96 [==============================] - 0s 2ms/step - loss: 0.4327 - val_loss: 0.3872
Epoch 28/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2769 - val_loss: 0.3201
Epoch 29/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3314 - val_loss: 0.5076
Epoch 30/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2910 - val_loss: 0.3851
Epoch 31/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3235 - val_loss: 0.4490
Epoch 32/50
96/96 [==============================] - 0s 3ms/step - loss: 0.3522 - val_loss: 0.6737
Epoch 33/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3735 - val_loss: 0.4276
Epoch 34/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2760 - val_loss: 0.4559
Epoch 35/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3367 - val_loss: 0.4915
Epoch 36/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2498 - val_loss: 0.4245
Epoch 37/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2985 - val_loss: 0.5234
Epoch 38/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2084 - val_loss: 0.3460
Epoch 39/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2851 - val_loss: 0.4022
Epoch 40/50
96/96 [==============================] - 0s 2ms/step - loss: 0.4312 - val_loss: 0.7679
Epoch 41/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3115 - val_loss: 0.3262
Epoch 42/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2393 - val_loss: 0.3555
Epoch 43/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2001 - val_loss: 0.5133
Epoch 44/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2582 - val_loss: 0.6300
Epoch 45/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2830 - val_loss: 0.3035
Epoch 46/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3160 - val_loss: 0.3827
Epoch 47/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2842 - val_loss: 0.2996
Epoch 48/50
96/96 [==============================] - 0s 2ms/step - loss: 0.2788 - val_loss: 0.5805
Epoch 49/50
96/96 [==============================] - 0s 3ms/step - loss: 0.2459 - val_loss: 0.4556
Epoch 50/50
96/96 [==============================] - 0s 2ms/step - loss: 0.3133 - val_loss: 0.4605
Epoch 1/70
96/96 [==============================] - 1s 3ms/step - loss: 4.2456 - val_loss: 2.8548
Epoch 2/70
96/96 [==============================] - 0s 2ms/step - loss: 1.4863 - val_loss: 0.6922
Epoch 3/70
96/96 [==============================] - 0s 2ms/step - loss: 1.0861 - val_loss: 0.4899
Epoch 4/70
96/96 [==============================] - 0s 2ms/step - loss: 0.5088 - val_loss: 0.6675
Epoch 5/70
96/96 [==============================] - 0s 2ms/step - loss: 0.6368 - val_loss: 0.6229
Epoch 6/70
96/96 [==============================] - 0s 2ms/step - loss: 0.6630 - val_loss: 0.7946
Epoch 7/70
96/96 [==============================] - 0s 2ms/step - loss: 0.5803 - val_loss: 0.5728
Epoch 8/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4669 - val_loss: 0.5301
Epoch 9/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4298 - val_loss: 0.4508
Epoch 10/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3839 - val_loss: 0.4211
Epoch 11/70
96/96 [==============================] - 0s 3ms/step - loss: 0.5900 - val_loss: 0.3887
```

```
Epoch 12/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4423 - val_loss: 0.4544
Epoch 13/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4157 - val_loss: 0.6459
Epoch 14/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4680 - val_loss: 0.5388
Epoch 15/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3699 - val_loss: 0.5835
Epoch 16/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3828 - val_loss: 0.4046
Epoch 17/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3902 - val_loss: 0.6238
Epoch 18/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3603 - val_loss: 0.5037
Epoch 19/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3707 - val_loss: 0.3943
Epoch 20/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2650 - val_loss: 0.4409
Epoch 21/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2573 - val_loss: 0.4401
Epoch 22/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3528 - val_loss: 0.4368
Epoch 23/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2993 - val_loss: 0.7890
Epoch 24/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4812 - val_loss: 0.6133
Epoch 25/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3686 - val_loss: 0.7162
Epoch 26/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3829 - val_loss: 0.4072
Epoch 27/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3253 - val_loss: 0.5016
Epoch 28/70
96/96 [==============================] - 0s 3ms/step - loss: 0.3093 - val_loss: 0.5944
Epoch 29/70
96/96 [==============================] - 0s 2ms/step - loss: 0.6627 - val_loss: 0.5432
Epoch 30/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3007 - val_loss: 0.3500
Epoch 31/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4828 - val_loss: 0.6651
Epoch 32/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4535 - val_loss: 0.3572
Epoch 33/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3363 - val_loss: 0.3979
Epoch 34/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2483 - val_loss: 0.5652
Epoch 35/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3774 - val_loss: 0.3880
Epoch 36/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3386 - val_loss: 0.3609
Epoch 37/70
96/96 [==============================] - 0s 2ms/step - loss: 0.6104 - val_loss: 0.3697
Epoch 38/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2375 - val_loss: 0.3437
Epoch 39/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3343 - val_loss: 0.4940
Epoch 40/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2363 - val_loss: 0.5480
Epoch 41/70
96/96 [==============================] - 0s 2ms/step - loss: 0.4166 - val_loss: 0.3786
Epoch 42/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2597 - val_loss: 0.3333
Epoch 43/70
96/96 [==============================] - 0s 3ms/step - loss: 0.2083 - val_loss: 0.8020
Epoch 44/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3550 - val_loss: 0.3679
Epoch 45/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2305 - val_loss: 0.4382
Epoch 46/70
96/96 [==============================] - 0s 2ms/step - loss: 0.7007 - val_loss: 0.4754
Epoch 47/70
96/96 [==============================] - 0s 2ms/step - loss: 0.5266 - val_loss: 0.3660
Epoch 48/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2630 - val_loss: 0.3472
Epoch 49/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2959 - val_loss: 0.3811
Epoch 50/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2522 - val_loss: 0.3633
Epoch 51/70
96/96 [==============================] - 0s 2ms/step - loss: 0.1741 - val_loss: 0.6781
Epoch 52/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3580 - val_loss: 0.3303
Epoch 53/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2758 - val_loss: 0.3830
Epoch 54/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3312 - val_loss: 0.5333
Epoch 55/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2970 - val_loss: 0.4341
Epoch 56/70
96/96 [==============================] - 0s 2ms/step - loss: 0.1768 - val_loss: 0.3185
Epoch 57/70
```

```
96/96 [==============================] - 0s 2ms/step - loss: 0.4318 - val_loss: 0.3252
Epoch 58/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2170 - val_loss: 0.3739
Epoch 59/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2311 - val_loss: 0.3722
Epoch 60/70
96/96 [==============================] - 0s 3ms/step - loss: 0.3691 - val_loss: 0.5041
Epoch 61/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2981 - val_loss: 0.3619
Epoch 62/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2243 - val_loss: 0.3354
Epoch 63/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3940 - val_loss: 0.3634
Epoch 64/70
96/96 [==============================] - 0s 2ms/step - loss: 0.1971 - val_loss: 0.6456
Epoch 65/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3383 - val_loss: 0.3267
Epoch 66/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2321 - val_loss: 0.3856
Epoch 67/70
96/96 [==============================] - 0s 2ms/step - loss: 0.2736 - val_loss: 0.3318
Epoch 68/70
96/96 [==============================] - 0s 2ms/step - loss: 0.3190 - val_loss: 0.7120
Epoch 69/70
96/96 [==============================] - 0s 2ms/step - loss: 0.5025 - val_loss: 0.6468
Epoch 70/70
96/96 [==============================] - 0s 2ms/step - loss: 0.5190 - val_loss: 0.4503
Epoch 1/100
48/48 [==============================] - 1s 6ms/step - loss: 5.5118 - val_loss: 1.9097
Epoch 2/100
48/48 [==============================] - 0s 3ms/step - loss: 1.8636 - val_loss: 1.7679
Epoch 3/100
48/48 [==============================] - 0s 3ms/step - loss: 1.7603 - val_loss: 1.0180
Epoch 4/100
48/48 [==============================] - 0s 6ms/step - loss: 1.1826 - val_loss: 0.6575
Epoch 5/100
48/48 [==============================] - 0s 3ms/step - loss: 0.5308 - val_loss: 1.1839
Epoch 6/100
48/48 [==============================] - 0s 3ms/step - loss: 0.7372 - val_loss: 0.4948
Epoch 7/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3391 - val_loss: 0.4309
Epoch 8/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4522 - val_loss: 0.4247
Epoch 9/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4706 - val_loss: 0.6597
Epoch 10/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4877 - val_loss: 0.4533
Epoch 11/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4461 - val_loss: 0.3858
Epoch 12/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3421 - val_loss: 0.4004
Epoch 13/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4914 - val_loss: 0.6923
Epoch 14/100
48/48 [==============================] - 0s 3ms/step - loss: 0.5820 - val_loss: 0.5094
Epoch 15/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3565 - val_loss: 0.3818
Epoch 16/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4137 - val_loss: 0.3899
Epoch 17/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3302 - val_loss: 1.1023
Epoch 18/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4181 - val_loss: 0.8827
Epoch 19/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4572 - val_loss: 0.4635
Epoch 20/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4375 - val_loss: 0.5022
Epoch 21/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4301 - val_loss: 0.9180
Epoch 22/100
48/48 [==============================] - 0s 5ms/step - loss: 0.3351 - val_loss: 0.6207
Epoch 23/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3455 - val_loss: 0.7064
Epoch 24/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4022 - val_loss: 0.4045
Epoch 25/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3716 - val_loss: 0.3315
Epoch 26/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2699 - val_loss: 0.5610
Epoch 27/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4305 - val_loss: 0.5272
Epoch 28/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3519 - val_loss: 0.4043
Epoch 29/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2234 - val_loss: 0.3706
Epoch 30/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3300 - val_loss: 0.3256
Epoch 31/100
48/48 [==============================] - 0s 3ms/step - loss: 0.4493 - val_loss: 0.3666
Epoch 32/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2500 - val_loss: 0.4050
```

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Epoch 33/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3464 - val_loss: 0.4350
Epoch 34/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2694 - val_loss: 0.3984
Epoch 35/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3987 - val_loss: 0.3419
Epoch 36/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2674 - val_loss: 0.3933
Epoch 37/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2402 - val_loss: 0.5788
Epoch 38/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3072 - val_loss: 0.3394
Epoch 39/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3541 - val_loss: 0.3563
Epoch 40/100
48/48 [==============================] - 0s 5ms/step - loss: 0.1871 - val_loss: 0.3668
Epoch 41/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2743 - val_loss: 0.4797
Epoch 42/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3027 - val_loss: 0.4020
Epoch 43/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2776 - val_loss: 0.4460
Epoch 44/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3129 - val_loss: 0.3686
Epoch 45/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2877 - val_loss: 0.4780
Epoch 46/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3257 - val_loss: 0.4673
Epoch 47/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3045 - val_loss: 0.3772
Epoch 48/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3077 - val_loss: 0.3964
Epoch 49/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3781 - val_loss: 0.3584
Epoch 50/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2863 - val_loss: 0.3372
Epoch 51/100
48/48 [==============================] - 0s 3ms/step - loss: 0.1788 - val_loss: 0.7377
Epoch 52/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3481 - val_loss: 0.5297
Epoch 53/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2167 - val_loss: 0.5906
Epoch 54/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3449 - val_loss: 0.4280
Epoch 55/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2942 - val_loss: 0.3215
Epoch 56/100
48/48 [==============================] - 0s 2ms/step - loss: 0.2345 - val_loss: 0.3598
Epoch 57/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3249 - val_loss: 0.3951
Epoch 58/100
48/48 [==============================] - 0s 5ms/step - loss: 0.2391 - val_loss: 0.4619
Epoch 59/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2490 - val_loss: 0.6539
Epoch 60/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2516 - val_loss: 0.4194
Epoch 61/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2047 - val_loss: 0.3201
Epoch 62/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3201 - val_loss: 0.4149
Epoch 63/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2822 - val_loss: 0.5717
Epoch 64/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3044 - val_loss: 0.4019
Epoch 65/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2799 - val_loss: 0.3562
Epoch 66/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2187 - val_loss: 0.3420
Epoch 67/100
48/48 [==============================] - 0s 3ms/step - loss: 0.1796 - val_loss: 0.5013
Epoch 68/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2768 - val_loss: 0.3516
Epoch 69/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2770 - val_loss: 0.3341
Epoch 70/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3006 - val_loss: 0.3057
Epoch 71/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2980 - val_loss: 0.3362
Epoch 72/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2636 - val_loss: 0.2999
Epoch 73/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2277 - val_loss: 0.8802
Epoch 74/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3664 - val_loss: 0.4031
Epoch 75/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2911 - val_loss: 0.3603
Epoch 76/100
48/48 [==============================] - 0s 6ms/step - loss: 0.2541 - val_loss: 0.3233
Epoch 77/100
48/48 [==============================] - 0s 3ms/step - loss: 0.1974 - val_loss: 0.4433
Epoch 78/100
```

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48/48 [==============================] - 0s 3ms/step - loss: 0.1841 - val_loss: 0.4538
Epoch 79/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2002 - val_loss: 0.6527
Epoch 80/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2579 - val_loss: 0.3473
Epoch 81/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2529 - val_loss: 0.5485
Epoch 82/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2817 - val_loss: 0.4022
Epoch 83/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2422 - val_loss: 0.3834
Epoch 84/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3119 - val_loss: 0.4021
Epoch 85/100
48/48 [==============================] - 0s 3ms/step - loss: 0.1783 - val_loss: 0.3229
Epoch 86/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3081 - val_loss: 0.3089
Epoch 87/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2250 - val_loss: 0.3044
Epoch 88/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2095 - val_loss: 0.3619
Epoch 89/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2603 - val_loss: 0.3200
Epoch 90/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2048 - val_loss: 0.2886
Epoch 91/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2119 - val_loss: 0.3531
Epoch 92/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2565 - val_loss: 0.3107
Epoch 93/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2337 - val_loss: 0.4292
Epoch 94/100
48/48 [==============================] - 0s 6ms/step - loss: 0.2457 - val_loss: 0.6836
Epoch 95/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2110 - val_loss: 0.2899
Epoch 96/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2188 - val_loss: 0.5437
Epoch 97/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3130 - val_loss: 0.2964
Epoch 98/100
48/48 [==============================] - 0s 3ms/step - loss: 0.1773 - val_loss: 0.4712
Epoch 99/100
48/48 [==============================] - 0s 3ms/step - loss: 0.3068 - val_loss: 0.3093
Epoch 100/100
48/48 [==============================] - 0s 3ms/step - loss: 0.2628 - val_loss: 0.3176
Epoch 1/150
48/48 [==============================] - 1s 6ms/step - loss: 5.1840 - val_loss: 1.7806
Epoch 2/150
48/48 [==============================] - 0s 3ms/step - loss: 1.8106 - val_loss: 1.7077
Epoch 3/150
48/48 [==============================] - 0s 3ms/step - loss: 1.4294 - val_loss: 2.0367
Epoch 4/150
48/48 [==============================] - 0s 3ms/step - loss: 1.6706 - val_loss: 2.5434
Epoch 5/150
48/48 [==============================] - 0s 3ms/step - loss: 1.8297 - val_loss: 1.6291
Epoch 6/150
48/48 [==============================] - 0s 3ms/step - loss: 1.6224 - val_loss: 1.3783
Epoch 7/150
48/48 [==============================] - 0s 3ms/step - loss: 1.1733 - val_loss: 0.6770
Epoch 8/150
48/48 [==============================] - 0s 6ms/step - loss: 1.4068 - val_loss: 0.6068
Epoch 9/150
48/48 [==============================] - 0s 3ms/step - loss: 1.0298 - val_loss: 1.5018
Epoch 10/150
48/48 [==============================] - 0s 3ms/step - loss: 1.0934 - val_loss: 0.4218
Epoch 11/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5542 - val_loss: 0.9055
Epoch 12/150
48/48 [==============================] - 0s 3ms/step - loss: 0.6469 - val_loss: 0.5213
Epoch 13/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4126 - val_loss: 1.3156
Epoch 14/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5365 - val_loss: 0.4330
Epoch 15/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4738 - val_loss: 0.4806
Epoch 16/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3939 - val_loss: 1.2456
Epoch 17/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4748 - val_loss: 0.3817
Epoch 18/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3351 - val_loss: 0.3825
Epoch 19/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3909 - val_loss: 0.3842
Epoch 20/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4120 - val_loss: 0.4570
Epoch 21/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5267 - val_loss: 0.4966
Epoch 22/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3111 - val_loss: 0.5224
Epoch 23/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4035 - val_loss: 0.4419
```

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Epoch 24/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2393 - val_loss: 0.5121
Epoch 25/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3656 - val_loss: 0.4572
Epoch 26/150
48/48 [==============================] - 0s 6ms/step - loss: 0.3188 - val_loss: 0.4631
Epoch 27/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2358 - val_loss: 0.5275
Epoch 28/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2548 - val_loss: 0.4844
Epoch 29/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3431 - val_loss: 0.4117
Epoch 30/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3070 - val_loss: 0.3741
Epoch 31/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4136 - val_loss: 0.3520
Epoch 32/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2489 - val_loss: 0.9964
Epoch 33/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3879 - val_loss: 0.5318
Epoch 34/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3427 - val_loss: 0.3595
Epoch 35/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4810 - val_loss: 0.3445
Epoch 36/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3206 - val_loss: 1.1056
Epoch 37/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3457 - val_loss: 0.3545
Epoch 38/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5696 - val_loss: 0.3849
Epoch 39/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2751 - val_loss: 0.4668
Epoch 40/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3402 - val_loss: 0.4152
Epoch 41/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2891 - val_loss: 0.8259
Epoch 42/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2998 - val_loss: 0.4072
Epoch 43/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1982 - val_loss: 0.4486
Epoch 44/150
48/48 [==============================] - 0s 6ms/step - loss: 0.2611 - val_loss: 0.3575
Epoch 45/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1965 - val_loss: 0.3458
Epoch 46/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2490 - val_loss: 0.4245
Epoch 47/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2173 - val_loss: 0.4352
Epoch 48/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2810 - val_loss: 0.3524
Epoch 49/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3099 - val_loss: 0.3459
Epoch 50/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2335 - val_loss: 0.3302
Epoch 51/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2833 - val_loss: 0.3955
Epoch 52/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2537 - val_loss: 0.3372
Epoch 53/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3471 - val_loss: 0.3583
Epoch 54/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2152 - val_loss: 0.3407
Epoch 55/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2700 - val_loss: 0.3615
Epoch 56/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1636 - val_loss: 0.7437
Epoch 57/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1749 - val_loss: 0.3410
Epoch 58/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1872 - val_loss: 0.3731
Epoch 59/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2520 - val_loss: 0.3421
Epoch 60/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2215 - val_loss: 0.4216
Epoch 61/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2154 - val_loss: 0.4057
Epoch 62/150
48/48 [==============================] - 0s 5ms/step - loss: 0.1884 - val_loss: 0.3553
Epoch 63/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1736 - val_loss: 0.3322
Epoch 64/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3498 - val_loss: 0.4219
Epoch 65/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1763 - val_loss: 0.3696
Epoch 66/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3184 - val_loss: 0.3350
Epoch 67/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2334 - val_loss: 0.3217
Epoch 68/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3383 - val_loss: 0.3380
Epoch 69/150
```

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48/48 [==============================] - 0s 3ms/step - loss: 0.1923 - val_loss: 0.5533
Epoch 70/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2783 - val_loss: 0.3274
Epoch 71/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2079 - val_loss: 0.5003
Epoch 72/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2607 - val_loss: 0.4364
Epoch 73/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2841 - val_loss: 0.2802
Epoch 74/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5022 - val_loss: 0.3415
Epoch 75/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2298 - val_loss: 0.3659
Epoch 76/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2678 - val_loss: 0.3430
Epoch 77/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2060 - val_loss: 0.4043
Epoch 78/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2369 - val_loss: 0.4512
Epoch 79/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1750 - val_loss: 0.3446
Epoch 80/150
48/48 [==============================] - 0s 6ms/step - loss: 0.1715 - val_loss: 0.3067
Epoch 81/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1775 - val_loss: 0.4460
Epoch 82/150
48/48 [==============================] - 0s 4ms/step - loss: 0.2197 - val_loss: 0.4001
Epoch 83/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2113 - val_loss: 0.3238
Epoch 84/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1873 - val_loss: 0.3241
Epoch 85/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2467 - val_loss: 0.3428
Epoch 86/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2040 - val_loss: 0.3323
Epoch 87/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4354 - val_loss: 0.4161
Epoch 88/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2586 - val_loss: 0.4347
Epoch 89/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2862 - val_loss: 0.3454
Epoch 90/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2591 - val_loss: 0.3189
Epoch 91/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2328 - val_loss: 0.4441
Epoch 92/150
48/48 [==============================] - 0s 4ms/step - loss: 0.2862 - val_loss: 0.3313
Epoch 93/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1869 - val_loss: 0.4739
Epoch 94/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2454 - val_loss: 0.3802
Epoch 95/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1991 - val_loss: 0.2685
Epoch 96/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2518 - val_loss: 0.3407
Epoch 97/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1711 - val_loss: 0.3255
Epoch 98/150
48/48 [==============================] - 0s 6ms/step - loss: 0.1586 - val_loss: 0.3716
Epoch 99/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2291 - val_loss: 0.3167
Epoch 100/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1729 - val_loss: 0.3752
Epoch 101/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2286 - val_loss: 0.3862
Epoch 102/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2069 - val_loss: 0.3125
Epoch 103/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1830 - val_loss: 0.3089
Epoch 104/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2198 - val_loss: 0.3380
Epoch 105/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2718 - val_loss: 0.3886
Epoch 106/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1961 - val_loss: 0.5141
Epoch 107/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2286 - val_loss: 0.3114
Epoch 108/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1714 - val_loss: 0.3856
Epoch 109/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1954 - val_loss: 0.3130
Epoch 110/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1630 - val_loss: 0.3209
Epoch 111/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2318 - val_loss: 0.3317
Epoch 112/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1788 - val_loss: 0.3180
Epoch 113/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2640 - val_loss: 0.3500
Epoch 114/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2385 - val_loss: 0.3615
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Epoch 115/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3220 - val_loss: 0.3425
Epoch 116/150
48/48 [==============================] - 0s 6ms/step - loss: 0.2521 - val_loss: 0.2996
Epoch 117/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1877 - val_loss: 0.3178
Epoch 118/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1859 - val_loss: 0.3264
Epoch 119/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2233 - val_loss: 0.3391
Epoch 120/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2033 - val_loss: 0.3058
Epoch 121/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2096 - val_loss: 0.3125
Epoch 122/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1908 - val_loss: 0.3357
Epoch 123/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1794 - val_loss: 0.3387
Epoch 124/150
48/48 [==============================] - 0s 4ms/step - loss: 0.1869 - val_loss: 0.3114
Epoch 125/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2299 - val_loss: 0.3544
Epoch 126/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2670 - val_loss: 0.3762
Epoch 127/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1743 - val_loss: 0.2868
Epoch 128/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2837 - val_loss: 0.3343
Epoch 129/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1975 - val_loss: 0.2916
Epoch 130/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1721 - val_loss: 0.3611
Epoch 131/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1814 - val_loss: 0.4001
Epoch 132/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2184 - val_loss: 0.3148
Epoch 133/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1510 - val_loss: 0.6008
Epoch 134/150
48/48 [==============================] - 0s 5ms/step - loss: 0.8617 - val_loss: 0.3792
Epoch 135/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1691 - val_loss: 0.3026
Epoch 136/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2723 - val_loss: 0.4324
Epoch 137/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1803 - val_loss: 0.2774
Epoch 138/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2363 - val_loss: 0.3296
Epoch 139/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2330 - val_loss: 0.3027
Epoch 140/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2305 - val_loss: 0.3996
Epoch 141/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2122 - val_loss: 0.2927
Epoch 142/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1803 - val_loss: 0.3040
Epoch 143/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1583 - val_loss: 0.3594
Epoch 144/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2332 - val_loss: 0.2919
Epoch 145/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2381 - val_loss: 0.2798
Epoch 146/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1753 - val_loss: 0.3224
Epoch 147/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1605 - val_loss: 0.3198
Epoch 148/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2050 - val_loss: 0.4335
Epoch 149/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2049 - val_loss: 0.2719
Epoch 150/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1763 - val_loss: 0.2741
Epoch 1/150
48/48 [==============================] - 1s 9ms/step - loss: 3.0217 - val_loss: 1.4406
Epoch 2/150
48/48 [==============================] - 0s 3ms/step - loss: 1.1307 - val_loss: 1.3703
Epoch 3/150
48/48 [==============================] - 0s 3ms/step - loss: 1.4501 - val_loss: 0.9024
Epoch 4/150
48/48 [==============================] - 0s 3ms/step - loss: 0.7153 - val_loss: 1.1401
Epoch 5/150
48/48 [==============================] - 0s 3ms/step - loss: 0.6154 - val_loss: 1.0276
Epoch 6/150
48/48 [==============================] - 0s 3ms/step - loss: 0.6430 - val_loss: 0.4179
Epoch 7/150
48/48 [==============================] - 0s 3ms/step - loss: 0.6020 - val_loss: 0.8654
Epoch 8/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4518 - val_loss: 1.0089
Epoch 9/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5658 - val_loss: 0.6665
Epoch 10/150
```

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48/48 [==============================] - 0s 3ms/step - loss: 0.4351 - val_loss: 0.4336
Epoch 11/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4759 - val_loss: 0.3874
Epoch 12/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3024 - val_loss: 0.4360
Epoch 13/150
48/48 [==============================] - 0s 3ms/step - loss: 0.7132 - val_loss: 0.3847
Epoch 14/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4650 - val_loss: 0.4111
Epoch 15/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3644 - val_loss: 0.3704
Epoch 16/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3112 - val_loss: 0.4531
Epoch 17/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3456 - val_loss: 0.3835
Epoch 18/150
48/48 [==============================] - 0s 6ms/step - loss: 0.3548 - val_loss: 0.4009
Epoch 19/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3788 - val_loss: 0.5380
Epoch 20/150
48/48 [==============================] - 0s 3ms/step - loss: 0.5138 - val_loss: 0.4915
Epoch 21/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3191 - val_loss: 0.6526
Epoch 22/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3589 - val_loss: 0.3438
Epoch 23/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2776 - val_loss: 0.3925
Epoch 24/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3136 - val_loss: 0.3341
Epoch 25/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2435 - val_loss: 0.7697
Epoch 26/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3545 - val_loss: 0.3755
Epoch 27/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3082 - val_loss: 0.3875
Epoch 28/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2878 - val_loss: 0.3424
Epoch 29/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2915 - val_loss: 0.3379
Epoch 30/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2983 - val_loss: 0.3348
Epoch 31/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2731 - val_loss: 0.5275
Epoch 32/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2630 - val_loss: 0.3551
Epoch 33/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2129 - val_loss: 0.6296
Epoch 34/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3504 - val_loss: 0.3159
Epoch 35/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2242 - val_loss: 0.6099
Epoch 36/150
48/48 [==============================] - 0s 6ms/step - loss: 0.3869 - val_loss: 0.3657
Epoch 37/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2294 - val_loss: 0.3574
Epoch 38/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3024 - val_loss: 0.3855
Epoch 39/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2589 - val_loss: 0.3511
Epoch 40/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3151 - val_loss: 0.4933
Epoch 41/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2287 - val_loss: 0.3512
Epoch 42/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2908 - val_loss: 0.3320
Epoch 43/150
48/48 [==============================] - 0s 4ms/step - loss: 0.3304 - val_loss: 0.6005
Epoch 44/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2810 - val_loss: 0.4704
Epoch 45/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2866 - val_loss: 0.3195
Epoch 46/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2411 - val_loss: 0.5045
Epoch 47/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2934 - val_loss: 0.3598
Epoch 48/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2355 - val_loss: 0.4432
Epoch 49/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2503 - val_loss: 0.5553
Epoch 50/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3462 - val_loss: 0.2846
Epoch 51/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2119 - val_loss: 0.3054
Epoch 52/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2402 - val_loss: 0.3373
Epoch 53/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2106 - val_loss: 0.4464
Epoch 54/150
48/48 [==============================] - 0s 5ms/step - loss: 0.2433 - val_loss: 1.1149
Epoch 55/150
48/48 [==============================] - 0s 3ms/step - loss: 0.6429 - val_loss: 0.4150
```

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Epoch 56/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3096 - val_loss: 0.3100
Epoch 57/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2466 - val_loss: 0.3705
Epoch 58/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2929 - val_loss: 0.3286
Epoch 59/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2074 - val_loss: 0.3744
Epoch 60/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1617 - val_loss: 0.4682
Epoch 61/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3561 - val_loss: 0.3036
Epoch 62/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2011 - val_loss: 0.2997
Epoch 63/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2186 - val_loss: 0.3424
Epoch 64/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1751 - val_loss: 0.3649
Epoch 65/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1574 - val_loss: 0.4229
Epoch 66/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2158 - val_loss: 0.2766
Epoch 67/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2549 - val_loss: 0.2979
Epoch 68/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2378 - val_loss: 0.4401
Epoch 69/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2931 - val_loss: 0.3213
Epoch 70/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1751 - val_loss: 0.3700
Epoch 71/150
48/48 [==============================] - 0s 4ms/step - loss: 0.2541 - val_loss: 0.2713
Epoch 72/150
48/48 [==============================] - 0s 6ms/step - loss: 0.1600 - val_loss: 0.3690
Epoch 73/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3009 - val_loss: 0.3168
Epoch 74/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2308 - val_loss: 0.2819
Epoch 75/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1510 - val_loss: 0.2950
Epoch 76/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2327 - val_loss: 0.2798
Epoch 77/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1855 - val_loss: 0.3840
Epoch 78/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1988 - val_loss: 0.3121
Epoch 79/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2252 - val_loss: 0.4145
Epoch 80/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2428 - val_loss: 0.3347
Epoch 81/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2617 - val_loss: 0.2708
Epoch 82/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1889 - val_loss: 0.2867
Epoch 83/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2335 - val_loss: 0.4156
Epoch 84/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1961 - val_loss: 0.5162
Epoch 85/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3210 - val_loss: 0.4265
Epoch 86/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2114 - val_loss: 0.2800
Epoch 87/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1962 - val_loss: 0.2941
Epoch 88/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1554 - val_loss: 0.3101
Epoch 89/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1555 - val_loss: 0.3921
Epoch 90/150
48/48 [==============================] - 0s 6ms/step - loss: 0.2425 - val_loss: 0.3141
Epoch 91/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2731 - val_loss: 0.2661
Epoch 92/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2654 - val_loss: 0.2664
Epoch 93/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1653 - val_loss: 0.3141
Epoch 94/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2520 - val_loss: 0.2626
Epoch 95/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1903 - val_loss: 0.2720
Epoch 96/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2592 - val_loss: 0.6146
Epoch 97/150
48/48 [==============================] - 0s 3ms/step - loss: 0.4911 - val_loss: 0.4938
Epoch 98/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1795 - val_loss: 0.3005
Epoch 99/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1870 - val_loss: 0.3823
Epoch 100/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2675 - val_loss: 0.2635
Epoch 101/150
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48/48 [==============================] - 0s 3ms/step - loss: 0.2124 - val_loss: 0.2820
Epoch 102/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2172 - val_loss: 0.2654
Epoch 103/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1554 - val_loss: 0.3874
Epoch 104/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2592 - val_loss: 0.2926
Epoch 105/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2127 - val_loss: 0.3827
Epoch 106/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1761 - val_loss: 0.2629
Epoch 107/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1744 - val_loss: 0.3675
Epoch 108/150
48/48 [==============================] - 0s 6ms/step - loss: 0.3103 - val_loss: 0.3155
Epoch 109/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1688 - val_loss: 0.3881
Epoch 110/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1772 - val_loss: 0.3075
Epoch 111/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1665 - val_loss: 0.3620
Epoch 112/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2227 - val_loss: 0.2952
Epoch 113/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2299 - val_loss: 0.2672
Epoch 114/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1906 - val_loss: 0.2657
Epoch 115/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2415 - val_loss: 0.3447
Epoch 116/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2358 - val_loss: 0.3425
Epoch 117/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2083 - val_loss: 0.2703
Epoch 118/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1883 - val_loss: 0.3794
Epoch 119/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2595 - val_loss: 0.3668
Epoch 120/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1586 - val_loss: 0.3717
Epoch 121/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1883 - val_loss: 0.4700
Epoch 122/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1569 - val_loss: 0.2811
Epoch 123/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2764 - val_loss: 0.3225
Epoch 124/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2660 - val_loss: 0.2868
Epoch 125/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1719 - val_loss: 0.2656
Epoch 126/150
48/48 [==============================] - 0s 6ms/step - loss: 0.1499 - val_loss: 0.2743
Epoch 127/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1786 - val_loss: 0.2652
Epoch 128/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1520 - val_loss: 0.8749
Epoch 129/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2750 - val_loss: 0.2519
Epoch 130/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2159 - val_loss: 0.3026
Epoch 131/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2165 - val_loss: 0.2764
Epoch 132/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1955 - val_loss: 0.2907
Epoch 133/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1927 - val_loss: 0.2845
Epoch 134/150
48/48 [==============================] - 0s 3ms/step - loss: 0.3318 - val_loss: 0.3279
Epoch 135/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1547 - val_loss: 0.3232
Epoch 136/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2288 - val_loss: 0.2880
Epoch 137/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2257 - val_loss: 0.2535
Epoch 138/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1742 - val_loss: 0.4084
Epoch 139/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1646 - val_loss: 0.2750
Epoch 140/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2269 - val_loss: 0.2613
Epoch 141/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1894 - val_loss: 0.3628
Epoch 142/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1597 - val_loss: 0.2663
Epoch 143/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1514 - val_loss: 0.3353
Epoch 144/150
48/48 [==============================] - 0s 5ms/step - loss: 0.2237 - val_loss: 0.2601
Epoch 145/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1834 - val_loss: 0.3047
Epoch 146/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1493 - val_loss: 0.3031
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Epoch 147/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2026 - val_loss: 0.3237
Epoch 148/150
48/48 [==============================] - 0s 3ms/step - loss: 0.2319 - val_loss: 0.2768
Epoch 149/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1850 - val_loss: 0.2548
Epoch 150/150
48/48 [==============================] - 0s 3ms/step - loss: 0.1807 - val_loss: 0.5251
Epoch 1/100
96/96 [==============================] - 1s 4ms/step - loss: 2.3399 - val_loss: 2.7414
Epoch 2/100
96/96 [==============================] - 0s 2ms/step - loss: 1.1301 - val_loss: 0.4556
Epoch 3/100
96/96 [==============================] - 0s 2ms/step - loss: 0.7908 - val_loss: 0.6312
Epoch 4/100
96/96 [==============================] - 0s 2ms/step - loss: 1.0010 - val_loss: 0.4598
Epoch 5/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3127 - val_loss: 1.0840
Epoch 6/100
96/96 [==============================] - 0s 2ms/step - loss: 0.6439 - val_loss: 1.6998
Epoch 7/100
96/96 [==============================] - 0s 2ms/step - loss: 0.5385 - val_loss: 0.7240
Epoch 8/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3380 - val_loss: 0.7841
Epoch 9/100
96/96 [==============================] - 0s 4ms/step - loss: 0.3171 - val_loss: 0.3497
Epoch 10/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4974 - val_loss: 0.4585
Epoch 11/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4050 - val_loss: 0.5624
Epoch 12/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3516 - val_loss: 0.7787
Epoch 13/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4033 - val_loss: 0.4179
Epoch 14/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3088 - val_loss: 0.3725
Epoch 15/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3304 - val_loss: 0.5080
Epoch 16/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3362 - val_loss: 0.3289
Epoch 17/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2837 - val_loss: 0.3940
Epoch 18/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3388 - val_loss: 1.0153
Epoch 19/100
96/96 [==============================] - 0s 2ms/step - loss: 0.5112 - val_loss: 0.4909
Epoch 20/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3924 - val_loss: 0.4803
Epoch 21/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3439 - val_loss: 0.3932
Epoch 22/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2867 - val_loss: 0.4534
Epoch 23/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3764 - val_loss: 0.4016
Epoch 24/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2960 - val_loss: 0.3480
Epoch 25/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3616 - val_loss: 0.7867
Epoch 26/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2803 - val_loss: 0.7643
Epoch 27/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3371 - val_loss: 0.3368
Epoch 28/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2595 - val_loss: 0.3618
Epoch 29/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2401 - val_loss: 0.4506
Epoch 30/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2298 - val_loss: 0.4182
Epoch 31/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3489 - val_loss: 0.5594
Epoch 32/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2806 - val_loss: 0.3451
Epoch 33/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2550 - val_loss: 0.4521
Epoch 34/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2921 - val_loss: 0.3554
Epoch 35/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2902 - val_loss: 0.8090
Epoch 36/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3334 - val_loss: 0.3393
Epoch 37/100
96/96 [==============================] - 0s 2ms/step - loss: 0.1863 - val_loss: 0.3153
Epoch 38/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2893 - val_loss: 0.5717
Epoch 39/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2209 - val_loss: 0.3552
Epoch 40/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2446 - val_loss: 0.3631
Epoch 41/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2756 - val_loss: 0.3072
Epoch 42/100
```

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96/96 [==============================] - 0s 2ms/step - loss: 0.2122 - val_loss: 0.5429
Epoch 43/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3281 - val_loss: 0.3333
Epoch 44/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2438 - val_loss: 0.3298
Epoch 45/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3112 - val_loss: 0.3153
Epoch 46/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3106 - val_loss: 0.7601
Epoch 47/100
96/96 [==============================] - 0s 2ms/step - loss: 0.5824 - val_loss: 0.3106
Epoch 48/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4297 - val_loss: 0.3549
Epoch 49/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2426 - val_loss: 0.5802
Epoch 50/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3327 - val_loss: 0.6901
Epoch 51/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2820 - val_loss: 0.4804
Epoch 52/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2589 - val_loss: 0.4658
Epoch 53/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3236 - val_loss: 0.5151
Epoch 54/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2908 - val_loss: 0.4737
Epoch 55/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2664 - val_loss: 0.3139
Epoch 56/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2546 - val_loss: 0.4683
Epoch 57/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2800 - val_loss: 0.3051
Epoch 58/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2305 - val_loss: 0.5187
Epoch 59/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3282 - val_loss: 0.3619
Epoch 60/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2021 - val_loss: 0.4531
Epoch 61/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3181 - val_loss: 0.3253
Epoch 62/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3180 - val_loss: 0.4766
Epoch 63/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2673 - val_loss: 0.4814
Epoch 64/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3312 - val_loss: 0.4604
Epoch 65/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2793 - val_loss: 0.3077
Epoch 66/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2239 - val_loss: 0.4032
Epoch 67/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2161 - val_loss: 0.3083
Epoch 68/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2449 - val_loss: 0.3393
Epoch 69/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2567 - val_loss: 0.3477
Epoch 70/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2491 - val_loss: 0.3043
Epoch 71/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3259 - val_loss: 0.3729
Epoch 72/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2747 - val_loss: 0.3134
Epoch 73/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2134 - val_loss: 0.3205
Epoch 74/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3264 - val_loss: 0.3931
Epoch 75/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2259 - val_loss: 0.3513
Epoch 76/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3592 - val_loss: 0.4405
Epoch 77/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2413 - val_loss: 0.3007
Epoch 78/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2725 - val_loss: 0.3028
Epoch 79/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2628 - val_loss: 0.5140
Epoch 80/100
96/96 [==============================] - 0s 2ms/step - loss: 0.1949 - val_loss: 0.4020
Epoch 81/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3790 - val_loss: 0.5478
Epoch 82/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2740 - val_loss: 0.3530
Epoch 83/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2879 - val_loss: 0.6789
Epoch 84/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2221 - val_loss: 0.4116
Epoch 85/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2654 - val_loss: 0.3661
Epoch 86/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2400 - val_loss: 0.2974
Epoch 87/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2042 - val_loss: 0.2979
```

```
Epoch 88/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2062 - val_loss: 0.4651
Epoch 89/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2670 - val_loss: 0.3140
Epoch 90/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2133 - val_loss: 0.3429
Epoch 91/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2000 - val_loss: 0.4538
Epoch 92/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2466 - val_loss: 0.3583
Epoch 93/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2367 - val_loss: 0.3715
Epoch 94/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2616 - val_loss: 0.3814
Epoch 95/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2555 - val_loss: 0.4636
Epoch 96/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2942 - val_loss: 0.3499
Epoch 97/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2635 - val_loss: 0.3558
Epoch 98/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2019 - val_loss: 0.3499
Epoch 99/100
96/96 [==============================] - 0s 2ms/step - loss: 0.1913 - val_loss: 0.3112
Epoch 100/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2344 - val_loss: 0.5107
```

Reporta

1.Una tabla con tus 5 mejores modelos, comparando:

- 1) número de neuronas por capa;
- 2) numéro total de parámetros;
- 3) tamaño del lote;
- 4) número de épocas;
- 5) pérdida en los tres sets(entrenamiento, validación y prueba)

In [ ]:

```
test
```

Out[ ]:

	hidden_layers	batch_size	epocs	Trainable params	average_loss_train	average_loss_validation	average_loss_test
0	2	1	50	110	0.309713	0.460478	0.314077
1	3	1	70	246	0.296468	0.450276	0.255061
2	4	2	100	447	0.196228	0.317596	0.146830
3	5	2	150	597	0.177973	0.274121	0.129368
4	3	2	150	246	0.449309	0.525098	0.378024
5	3	1	100	246	0.403786	0.510722	0.486067

2.Identifica tu mejor modelo, y justifica por qué es el mejor

De acuerdo a las pruebas se obtiene que la arquitectura que mejor funciona es la que tiene 5 capas ocultas (con 6, 10, 12, 15, 10 redes en cada capa), realiza la optimización con 2 minilotes y con 150 épocas.

Lo consideramos el mejor modelo ya que tiene una perdida menor que las demás arquitecturas; es decir, es el que más generaliza.

In [ ]:

```
# Final Model
# 3 Hidden layers with 6,10,12 neurons per layer
# Create an MLP of two inputs x=[x1, x2], and two outputs y=[y1, y2]
i = Input(shape=(2), name='input')
h = Dense(units=6, activation="relu", name='hidden1')(i)
h = Dense(units=10, activation="relu", name='hidden2')(h)
h = Dense(units=12, activation="relu", name='hidden3')(h)
h = Dense(units=15, activation="relu", name='hidden4')(h)
h = Dense(units=10, activation="relu", name='hidden5')(h)
o = Dense(units=2, activation=None, name='output')(h)

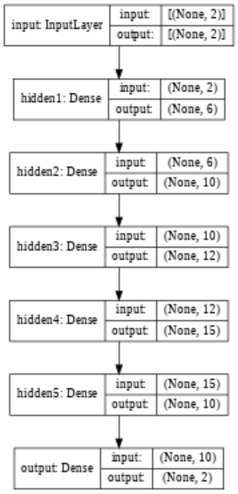
MLP = Model(inputs=i, outputs=o)
MLP.summary()
```

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
input (InputLayer)           [(None, 2)]               0         
_________________________________________________________________
hidden1 (Dense)              (None, 6)                 18        
_________________________________________________________________
hidden2 (Dense)              (None, 10)                70        
_________________________________________________________________
hidden3 (Dense)              (None, 12)                132       
_________________________________________________________________
hidden4 (Dense)              (None, 15)                195       
_________________________________________________________________
hidden5 (Dense)              (None, 10)                160       
_________________________________________________________________
output (Dense)               (None, 2)                 22        
=================================================================
Total params: 597
Trainable params: 597
Non-trainable params: 0
_________________________________________________________________
```

In [ ]:

```
# Plot a diagram of the MLP model
from tensorflow.keras.utils import plot_model
plot_model(MLP, to_file='MLP.png', show_shapes=True, show_layer_names=True, rankdir='TB', expand_nested=True, dpi=48)
```

Out[ ]:



In [ ]:

```
#Compile
MLP.compile(optimizer='sgd', loss='mse')

# Training
MLP.fit(x=x_train, y=y_train, batch_size=1, epochs=100, verbose=1, validation_split=0.2)
```

```
Epoch 1/100
96/96 [==============================] - 1s 3ms/step - loss: 5.6994 - val_loss: 2.0591
Epoch 2/100
96/96 [==============================] - 0s 1ms/step - loss: 1.8086 - val_loss: 2.6628
Epoch 3/100
96/96 [==============================] - 0s 2ms/step - loss: 1.6277 - val_loss: 1.8692
Epoch 4/100
96/96 [==============================] - 0s 2ms/step - loss: 1.1543 - val_loss: 0.8794
Epoch 5/100
96/96 [==============================] - 0s 1ms/step - loss: 0.9746 - val_loss: 0.5366
Epoch 6/100
96/96 [==============================] - 0s 1ms/step - loss: 0.8187 - val_loss: 0.5040
Epoch 7/100
96/96 [==============================] - 0s 2ms/step - loss: 0.6586 - val_loss: 0.5738
Epoch 8/100
96/96 [==============================] - 0s 2ms/step - loss: 0.8206 - val_loss: 0.5623
Epoch 9/100
96/96 [==============================] - 0s 3ms/step - loss: 1.0449 - val_loss: 2.5446
Epoch 10/100
96/96 [==============================] - 0s 1ms/step - loss: 0.6002 - val_loss: 0.6136
Epoch 11/100
96/96 [==============================] - 0s 1ms/step - loss: 0.4668 - val_loss: 0.4454
Epoch 12/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3758 - val_loss: 0.4359
Epoch 13/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3872 - val_loss: 0.5813
Epoch 14/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4782 - val_loss: 0.5049
Epoch 15/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2765 - val_loss: 0.4753
Epoch 16/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3119 - val_loss: 0.4253
```

```
Epoch 17/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3685 - val_loss: 0.4461
Epoch 18/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3504 - val_loss: 0.4428
Epoch 19/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3228 - val_loss: 0.4188
Epoch 20/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3496 - val_loss: 0.7760
Epoch 21/100
96/96 [==============================] - 0s 1ms/step - loss: 0.5247 - val_loss: 1.0522
Epoch 22/100
96/96 [==============================] - 0s 2ms/step - loss: 0.5981 - val_loss: 0.4119
Epoch 23/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2893 - val_loss: 0.4265
Epoch 24/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3787 - val_loss: 1.1208
Epoch 25/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4404 - val_loss: 0.4244
Epoch 26/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3439 - val_loss: 0.5056
Epoch 27/100
96/96 [==============================] - 0s 1ms/step - loss: 0.5082 - val_loss: 0.4349
Epoch 28/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3058 - val_loss: 0.4701
Epoch 29/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3605 - val_loss: 0.4333
Epoch 30/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3495 - val_loss: 0.4485
Epoch 31/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3067 - val_loss: 0.3699
Epoch 32/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3482 - val_loss: 0.4036
Epoch 33/100
96/96 [==============================] - 0s 2ms/step - loss: 0.4177 - val_loss: 0.4624
Epoch 34/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2802 - val_loss: 0.4370
Epoch 35/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2570 - val_loss: 0.4423
Epoch 36/100
96/96 [==============================] - 0s 1ms/step - loss: 0.1881 - val_loss: 0.4365
Epoch 37/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2960 - val_loss: 0.8365
Epoch 38/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2918 - val_loss: 0.4677
Epoch 39/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2377 - val_loss: 0.4095
Epoch 40/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3642 - val_loss: 0.4461
Epoch 41/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2205 - val_loss: 0.4312
Epoch 42/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2767 - val_loss: 0.5369
Epoch 43/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3239 - val_loss: 2.5418
Epoch 44/100
96/96 [==============================] - 0s 1ms/step - loss: 0.6070 - val_loss: 0.4408
Epoch 45/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2565 - val_loss: 0.4320
Epoch 46/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2399 - val_loss: 0.4691
Epoch 47/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3137 - val_loss: 0.4756
Epoch 48/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2545 - val_loss: 0.4256
Epoch 49/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3164 - val_loss: 0.3884
Epoch 50/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2769 - val_loss: 0.4511
Epoch 51/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2791 - val_loss: 0.4275
Epoch 52/100
96/96 [==============================] - 0s 3ms/step - loss: 0.3024 - val_loss: 0.4402
Epoch 53/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3406 - val_loss: 0.4810
Epoch 54/100
96/96 [==============================] - 0s 1ms/step - loss: 0.1956 - val_loss: 0.3873
Epoch 55/100
96/96 [==============================] - 0s 2ms/step - loss: 0.1950 - val_loss: 0.3861
Epoch 56/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2948 - val_loss: 0.4553
Epoch 57/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2902 - val_loss: 0.3406
Epoch 58/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3282 - val_loss: 0.7584
Epoch 59/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2980 - val_loss: 0.4001
Epoch 60/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2831 - val_loss: 0.4256
Epoch 61/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2812 - val_loss: 0.4144
Epoch 62/100
```

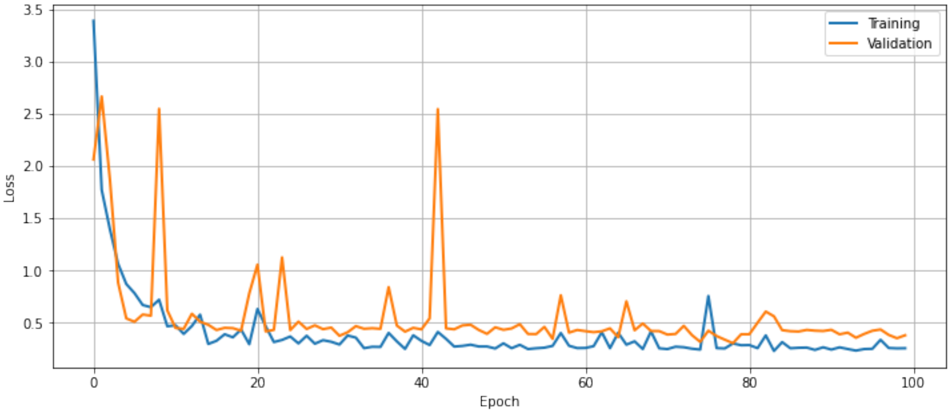
```
96/96 [==============================] - 0s 1ms/step - loss: 0.3786 - val_loss: 0.4046
Epoch 63/100
96/96 [==============================] - 0s 1ms/step - loss: 0.5961 - val_loss: 0.4129
Epoch 64/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2110 - val_loss: 0.4411
Epoch 65/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3697 - val_loss: 0.3565
Epoch 66/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2513 - val_loss: 0.7004
Epoch 67/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3652 - val_loss: 0.4228
Epoch 68/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2668 - val_loss: 0.4876
Epoch 69/100
96/96 [==============================] - 0s 1ms/step - loss: 0.4204 - val_loss: 0.4159
Epoch 70/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2652 - val_loss: 0.4148
Epoch 71/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2053 - val_loss: 0.3816
Epoch 72/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2850 - val_loss: 0.3875
Epoch 73/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2122 - val_loss: 0.4652
Epoch 74/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2227 - val_loss: 0.3761
Epoch 75/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2330 - val_loss: 0.3118
Epoch 76/100
96/96 [==============================] - 0s 1ms/step - loss: 1.2862 - val_loss: 0.4188
Epoch 77/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2674 - val_loss: 0.3675
Epoch 78/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2832 - val_loss: 0.3326
Epoch 79/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2906 - val_loss: 0.2990
Epoch 80/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2825 - val_loss: 0.3846
Epoch 81/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3203 - val_loss: 0.3846
Epoch 82/100
96/96 [==============================] - 0s 1ms/step - loss: 0.1956 - val_loss: 0.4953
Epoch 83/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2957 - val_loss: 0.6021
Epoch 84/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2527 - val_loss: 0.5564
Epoch 85/100
96/96 [==============================] - 0s 2ms/step - loss: 0.3078 - val_loss: 0.4238
Epoch 86/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2539 - val_loss: 0.4140
Epoch 87/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2451 - val_loss: 0.4107
Epoch 88/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2684 - val_loss: 0.4264
Epoch 89/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2486 - val_loss: 0.4190
Epoch 90/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2758 - val_loss: 0.4158
Epoch 91/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2105 - val_loss: 0.4273
Epoch 92/100
96/96 [==============================] - 0s 2ms/step - loss: 0.2187 - val_loss: 0.3842
Epoch 93/100
96/96 [==============================] - 0s 3ms/step - loss: 0.2293 - val_loss: 0.4003
Epoch 94/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2515 - val_loss: 0.3511
Epoch 95/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2754 - val_loss: 0.3876
Epoch 96/100
96/96 [==============================] - 0s 2ms/step - loss: 0.1968 - val_loss: 0.4180
Epoch 97/100
96/96 [==============================] - 0s 1ms/step - loss: 0.3296 - val_loss: 0.4305
Epoch 98/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2201 - val_loss: 0.3782
Epoch 99/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2234 - val_loss: 0.3466
Epoch 100/100
96/96 [==============================] - 0s 1ms/step - loss: 0.2511 - val_loss: 0.3747
```

```
Out[ ]: <tensorflow.python.keras.callbacks.History at 0x7f87a06be5c0>
```

3.Grafica las curvas de desempeño vs época para el mejor modelo

In [ ]:

```
# Plot loss (The object MLP keeps track of the training and validation performance)
plt.figure(figsize=(12, 5))
plt.plot(MLP.history.history['loss'], label='Training', linewidth=2)
plt.plot(MLP.history.history['val_loss'], label='Validation', linewidth=2)
plt.legend()
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.grid(True)
plt.show()
```



4.De acuerdo con las curvas de desempeño del mejor modelo, ¿el modelo parece estable, o su buen desempeño parece más resultado del azar?

A pesar de que esta arquitectura mejora el desempeño del modelo, podemos observar que la pérdida no es estable en el transcurso de las épocas, tiene mucho ruido aunque es uno de los mejores escenarios, generalmente se llega a una pérdida de aproximadamente 18%. No es un resultado al azar, pero si es un resultado que varía apesar de que indicamos una semilla y de que realizamos el reseteo de la sesión de keras para que el modelo no fuera sesgado. Esta variante puede ser porque la evolución de las neuronas, por ejemplo en la siguiente liga de tensor flow : https://playground.tensorflow.org/ se puede jugar con varios parámetros y problemas, de igual manera no siempre se llega a resultados exactamente iguales.

In [ ]:

```
# Use the trained model to compute the average test loss
MLP.evaluate(x=x_test, y=y_test, verbose=False)
```

Out[ ]:

```
0.19144023954868317
```

In [ ]:

```
tf.keras.backend.clear_session()
```

5.Incluye una explicación sobre el efecto que hayan notado en el cambio de los distintos hiperparámetros explorados.

Se observó que el número de epocas es uno de los parámetros que más influyen en el problema, porque justo es el número de veces que recorre los datos y conforme se aumenta este parámetro se hace de alguna manera más experto y converge. De igual manera, el número de lotes para hacer la optimización parece que influye en que tan rapido se optimiza, nuestro modelo final sugiere 2 minilotes.

6.Comenta tus conclusiones.

Este problema de regresión si pudo ser aplicado en un algoritmo de redes neuronales, pero la pérdida mínima que obtuvimos en el conjunto de *prueba(test)* fue de .129, es un modelo bastante ruidoso y esperabamos poder reducir más el error, sin embargo con todas las arquitecturas probadas no se logró minimizar más. Es importante mencionar que sigue siendo un buen modelo, porque únicamente tenemos 2 x (input): *petal length* y *petal width*, si tuvieramos más características que nos ayuden a predecir probablemente podríamos minimizar aún más la pérdida.

In [ ]: