Лабораторная работа 2

Многослойные сети. Алгоритм обратного распространения ошибки.

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Целью работы является исследование свойств многослойной нейронной сети прямого распространения и алгоритмов ее обучения, применение сети в задачах классификации и аппроксимации функции.

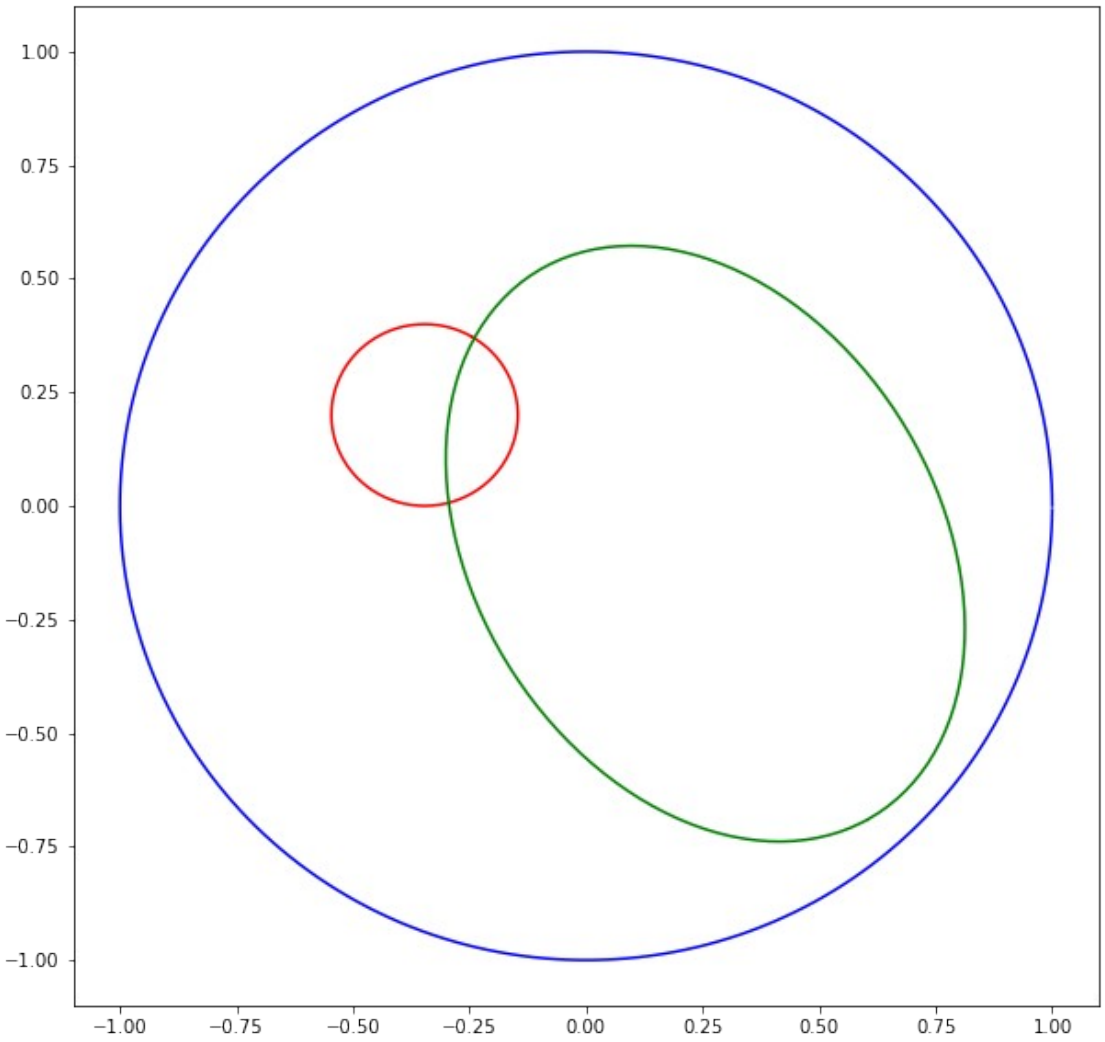
Вариант 12

```
import os
import keras
import tensorflow as tf
from keras.layers import *
import matplotlib.pyplot as plt
import numpy as np
import pylab
```

Задание №1

```
# Уравнение эллипса в параметрическом виде.
def ellipse(t, a, b, x0, y0):
    x = x0 + a * np.cos(t)
    y = y0 + b * np.sin(t)
    return x, y

# Функция вращения фигуры на заданный угол.
def rotate(x, y, alpha):
    xr = x * np.cos(alpha) - y * np.sin(alpha)
    yr = x * np.sin(alpha) + y * np.cos(alpha)
    return xr, yr

# Эллипс
a1 = 0.2
b1 = 0.2
alpha1 = np.pi/3
x01 = 0
y01 = 0.4

# Эллипс
a2 = 0.7
b2 = 0.5
alpha2 = -np.pi/3
x02 = 0.2
y02 = 0.18

# Эллипс
a3 = 1
b3 = 1
```

```
alpha3 = 0
x03 = 0
y03 = 0


t = np.arange(0, 2 * np.pi, 0.025)

fig1x, fig1y = ellipse(t, a1, b1, x01, y01)
fig1x, fig1y = rotate(fig1x, fig1y, alpha1)

fig2x, fig2y = ellipse(t, a2, b2, x02, y02)
fig2x, fig2y = rotate(fig2x, fig2y, alpha2)

fig3x, fig3y = ellipse(t, a3, b3, x03, y03)
fig3x, fig3y = rotate(fig3x, fig3y, alpha3)

figure = plt.figure(figsize = (10, 10))

plt.plot(fig1x, fig1y, c = 'r')
plt.plot(fig2x, fig2y, c = 'g')
plt.plot(fig3x, fig3y, c = 'b')
plt.show()
```




```
datax = np.concatenate((fig1x, fig2x, fig3x), axis=0)
datay = np.concatenate((fig1y, fig2y, fig3y), axis=0)


data = np.array([datax, datay])

l1 = [[1, 0, 0] for _ in range(len(fig1x))]
l2 = [[0, 1, 0] for _ in range(len(fig2x))]
l3 = [[0, 0, 1] for _ in range(len(fig3x))]

labels = np.array(l1 + l2 + l3)

data = data.transpose()

from sklearn.model_selection import train_test_split

train, test, train_labels, test_labels = train_test_split(data,
labels, test_size = 0.2, random_state = 10,shuffle = True)
```

```
model = keras.models.Sequential()

model.add(Dense(10, input_dim = 2,
kernel_initializer=keras.initializers.RandomNormal(stddev=0.01)))
model.add(Dense(20, activation='tanh'))
model.add(Dense(10, activation='tanh'))
model.add(Dense(3, activation='sigmoid'))

model.compile(tf.keras.optimizers.SGD(0.05), 'mse')

hist = model.fit(train, train_labels, batch_size = 1, epochs = 100)
```

```
Epoch 1/100
604/604 [==============================] - 2s 2ms/step - loss: 0.2140
Epoch 2/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1998
Epoch 3/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1943
Epoch 4/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1919
Epoch 5/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1865
Epoch 6/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1817
Epoch 7/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1751
Epoch 8/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1669
Epoch 9/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1579
Epoch 10/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1504
Epoch 11/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1445
Epoch 12/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1419
Epoch 13/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1391
Epoch 14/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1366
Epoch 15/100
604/604 [==============================] - 2s 3ms/step - loss: 0.1343
Epoch 16/100
604/604 [==============================] - 2s 3ms/step - loss: 0.1324
Epoch 17/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1298
Epoch 18/100
604/604 [==============================] - 2s 3ms/step - loss: 0.1273
Epoch 19/100
604/604 [==============================] - 2s 3ms/step - loss: 0.1243
```

```
Epoch 20/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1222
Epoch 21/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1184
Epoch 22/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1167
Epoch 23/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1130
Epoch 24/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1090
Epoch 25/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1061
Epoch 26/100
604/604 [==============================] - 1s 2ms/step - loss: 0.1001
Epoch 27/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0942
Epoch 28/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0876
Epoch 29/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0785
Epoch 30/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0720
Epoch 31/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0683
Epoch 32/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0634
Epoch 33/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0602
Epoch 34/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0580
Epoch 35/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0554
Epoch 36/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0542
Epoch 37/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0526
Epoch 38/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0509
Epoch 39/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0494
Epoch 40/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0468
Epoch 41/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0488
Epoch 42/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0471
Epoch 43/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0444
Epoch 44/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0459
```

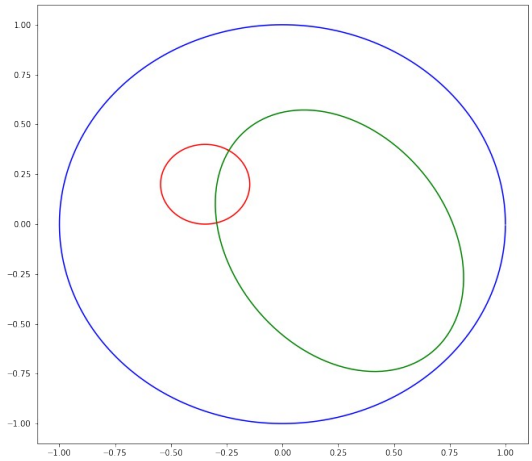
```
Epoch 45/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0470
Epoch 46/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0443
Epoch 47/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0436
Epoch 48/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0435
Epoch 49/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0451
Epoch 50/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0405
Epoch 51/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0405
Epoch 52/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0401
Epoch 53/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0433
Epoch 54/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0406
Epoch 55/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0370
Epoch 56/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0385
Epoch 57/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0385
Epoch 58/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0353
Epoch 59/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0387
Epoch 60/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0372
Epoch 61/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0400
Epoch 62/100
604/604 [==============================] - 2s 3ms/step - loss: 0.0357
Epoch 63/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0369
Epoch 64/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0360
Epoch 65/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0305
Epoch 66/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0288
Epoch 67/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0327
Epoch 68/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0377
Epoch 69/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0339
```

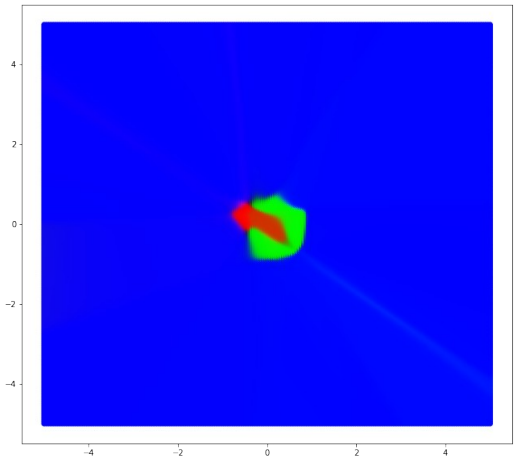
```
Epoch 70/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0324
Epoch 71/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0358
Epoch 72/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0320
Epoch 73/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0272
Epoch 74/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0327
Epoch 75/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0356
Epoch 76/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0258
Epoch 77/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0242
Epoch 78/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0254
Epoch 79/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0250
Epoch 80/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0261
Epoch 81/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0245
Epoch 82/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0245
Epoch 83/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0239
Epoch 84/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0240
Epoch 85/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0235
Epoch 86/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0233
Epoch 87/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0227
Epoch 88/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0236
Epoch 89/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0239
Epoch 90/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0239
Epoch 91/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0242
Epoch 92/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0239
Epoch 93/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0232
Epoch 94/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0237
```

```
Epoch 95/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0230
Epoch 96/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0237
Epoch 97/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0237
Epoch 98/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0221
Epoch 99/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0233
Epoch 100/100
604/604 [==============================] - 1s 2ms/step - loss: 0.0236
```

```
import itertools

x = np.linspace(-5, 5, 200)
y = np.linspace(-5, 5, 200)

figure = plt.figure(figsize = (24, 10))

ax1 = figure.add_subplot(1, 2, 1)
ax2 = figure.add_subplot(1, 2, 2)

ax1.plot(fig1x, fig1y, c = 'r')
ax1.plot(fig2x, fig2y, c = 'g')
ax1.plot(fig3x, fig3y, c = 'b')

data = np.array(list(itertools.product(x, y)))

xy = data.transpose()

pred = model.predict(data)


ax2.scatter(xy[0], xy[1], c = pred)

plt.show()
```

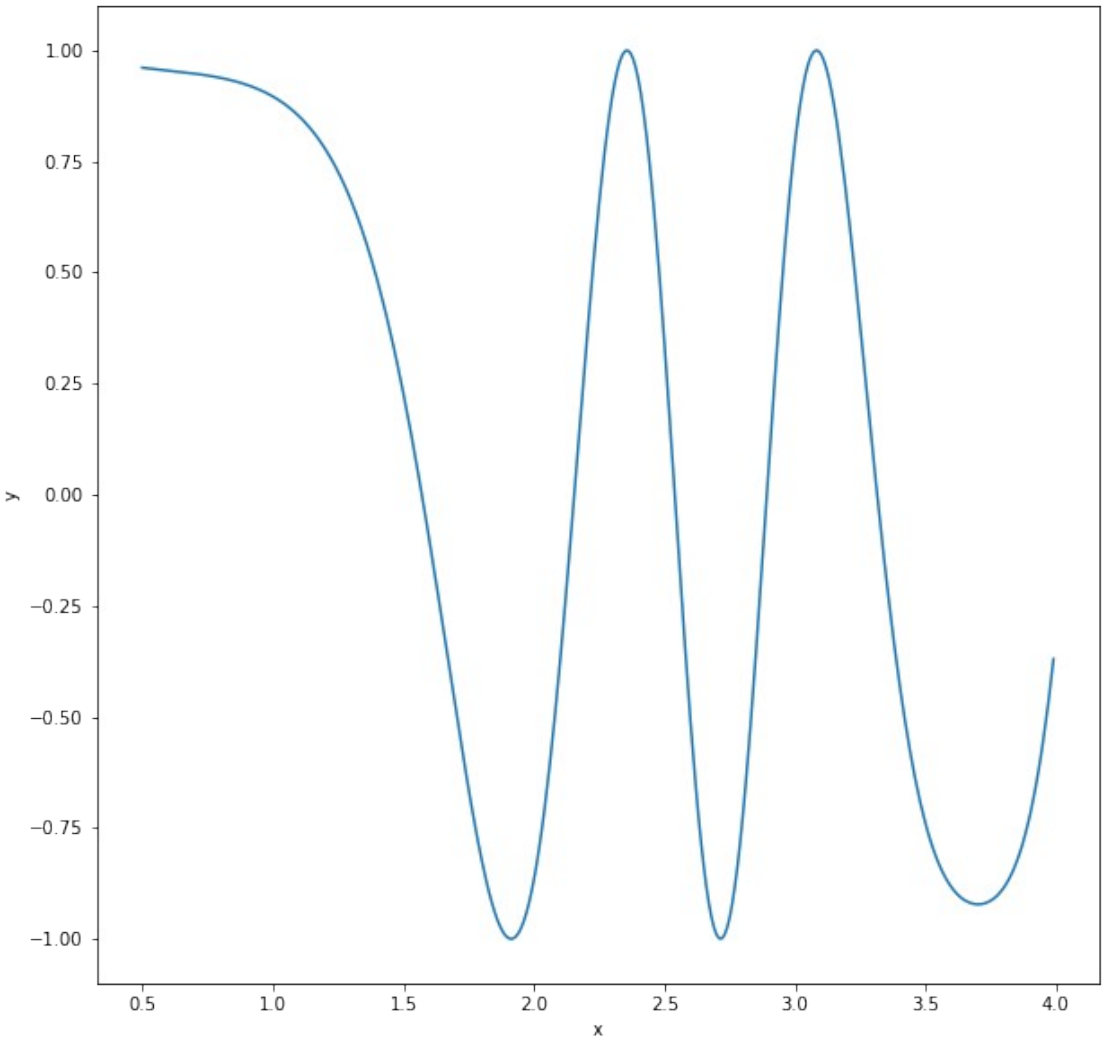
```
1250/1250 [==============================] - 2s 1ms/step
```





Задание №2

```
def x(t):
    return np.cos(-(np.cos(t)) * t**2 + t)

h = 0.01

train_x = np.arange(0.5, 4, h)
train_y = x(train_x)

figure = plt.figure(figsize = (10, 10))
plt.plot(train_x, train_y)
plt.ylabel("y")
plt.xlabel("x")
plt.show()
```




```
model = keras.models.Sequential()

model.add(Dense(20, input_dim = 1, activation = "tanh",
kernel_initializer = keras.initializers.RandomNormal(stddev = 0.01),
bias_initializer = keras.initializers.Zeros()))
model.add(Dense(80, activation = "tanh"))
model.add(Dense(40, activation = "tanh"))
model.add(Dense(1, activation = "linear"))

model.compile(tf.keras.optimizers.SGD(0.01), 'mse')

hist = model.fit(train_x, train_y, batch_size = 1, epochs = 800,
shuffle = True)

Epoch 1/800
350/350 [==============================] - 1s 2ms/step - loss: 0.4598
Epoch 2/800
350/350 [==============================] - 1s 2ms/step - loss: 0.4264
```

```
Epoch 3/800
350/350 [==============================] - 1s 2ms/step - loss: 0.4124
Epoch 4/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3983
Epoch 5/800
350/350 [==============================] - 1s 3ms/step - loss: 0.3895
Epoch 6/800
350/350 [==============================] - 1s 3ms/step - loss: 0.3943
Epoch 7/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3836
Epoch 8/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3853
Epoch 9/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3767
Epoch 10/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3666
Epoch 11/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3731
Epoch 12/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3698
Epoch 13/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3661
Epoch 14/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3678
Epoch 15/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3705
Epoch 16/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3651
Epoch 17/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3577
Epoch 18/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3560
Epoch 19/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3507
Epoch 20/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3518
Epoch 21/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3549
Epoch 22/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3504
Epoch 23/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3524
Epoch 24/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3481
Epoch 25/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3428
Epoch 26/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3416
Epoch 27/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3363
```

```
Epoch 28/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3365
Epoch 29/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3324
Epoch 30/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3296
Epoch 31/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3202
Epoch 32/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3273
Epoch 33/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3236
Epoch 34/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3256
Epoch 35/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3157
Epoch 36/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3237
Epoch 37/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3050
Epoch 38/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3203
Epoch 39/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3174
Epoch 40/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3136
Epoch 41/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3154
Epoch 42/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3039
Epoch 43/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3060
Epoch 44/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3082
Epoch 45/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3079
Epoch 46/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2949
Epoch 47/800
350/350 [==============================] - 1s 3ms/step - loss: 0.3117
Epoch 48/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2874
Epoch 49/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2996
Epoch 50/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3004
Epoch 51/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2835
Epoch 52/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2976
```

```
Epoch 53/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2894
Epoch 54/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2846
Epoch 55/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2872
Epoch 56/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2847
Epoch 57/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2748
Epoch 58/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2823
Epoch 59/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2731
Epoch 60/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2649
Epoch 61/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2680
Epoch 62/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2645
Epoch 63/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2467
Epoch 64/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2567
Epoch 65/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2316
Epoch 66/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2543
Epoch 67/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2424
Epoch 68/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2401
Epoch 69/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2358
Epoch 70/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2315
Epoch 71/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2230
Epoch 72/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2294
Epoch 73/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2295
Epoch 74/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2332
Epoch 75/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2321
Epoch 76/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2266
Epoch 77/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2162
```

```
Epoch 78/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2210
Epoch 79/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2095
Epoch 80/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2169
Epoch 81/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2102
Epoch 82/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2137
Epoch 83/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2152
Epoch 84/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2176
Epoch 85/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2152
Epoch 86/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2126
Epoch 87/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2203
Epoch 88/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2163
Epoch 89/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2134
Epoch 90/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2172
Epoch 91/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2114
Epoch 92/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2132
Epoch 93/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2081
Epoch 94/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2127
Epoch 95/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2121
Epoch 96/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2178
Epoch 97/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2026
Epoch 98/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2130
Epoch 99/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2151
Epoch 100/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2148
Epoch 101/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2086
Epoch 102/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2143
```

```
Epoch 103/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2180
Epoch 104/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2105
Epoch 105/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1929
Epoch 106/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2132
Epoch 107/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2085
Epoch 108/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2077
Epoch 109/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2110
Epoch 110/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2091
Epoch 111/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2051
Epoch 112/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2069
Epoch 113/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2080
Epoch 114/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2043
Epoch 115/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2059
Epoch 116/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2051
Epoch 117/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2011
Epoch 118/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2044
Epoch 119/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2014
Epoch 120/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2050
Epoch 121/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2006
Epoch 122/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1966
Epoch 123/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1910
Epoch 124/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1934
Epoch 125/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1891
Epoch 126/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1880
Epoch 127/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1801
```

```
Epoch 128/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1797
Epoch 129/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1687
Epoch 130/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1722
Epoch 131/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1586
Epoch 132/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1631
Epoch 133/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1542
Epoch 134/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1439
Epoch 135/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1384
Epoch 136/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1269
Epoch 137/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1478
Epoch 138/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1198
Epoch 139/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1510
Epoch 140/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1084
Epoch 141/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1325
Epoch 142/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1150
Epoch 143/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0988
Epoch 144/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1153
Epoch 145/800
350/350 [==============================] - 1s 2ms/step - loss: 0.3349
Epoch 146/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2738
Epoch 147/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2404
Epoch 148/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2408
Epoch 149/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2233
Epoch 150/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2119
Epoch 151/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2010
Epoch 152/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2099
```

```
Epoch 153/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2017
Epoch 154/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2018
Epoch 155/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1728
Epoch 156/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1578
Epoch 157/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1508
Epoch 158/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2347
Epoch 159/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2659
Epoch 160/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2632
Epoch 161/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2573
Epoch 162/800
350/350 [==============================] - 1s 3ms/step - loss: 0.2494
Epoch 163/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2418
Epoch 164/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2486
Epoch 165/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2366
Epoch 166/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2340
Epoch 167/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2562
Epoch 168/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2512
Epoch 169/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2407
Epoch 170/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2372
Epoch 171/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2253
Epoch 172/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2436
Epoch 173/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2246
Epoch 174/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2365
Epoch 175/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2328
Epoch 176/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2239
Epoch 177/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2271
```

```
Epoch 178/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2405
Epoch 179/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2219
Epoch 180/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2200
Epoch 181/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2159
Epoch 182/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2274
Epoch 183/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2222
Epoch 184/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2137
Epoch 185/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2199
Epoch 186/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2144
Epoch 187/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2156
Epoch 188/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1954
Epoch 189/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2037
Epoch 190/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1832
Epoch 191/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1870
Epoch 192/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1731
Epoch 193/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1712
Epoch 194/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1420
Epoch 195/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1342
Epoch 196/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1221
Epoch 197/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1281
Epoch 198/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2673
Epoch 199/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2350
Epoch 200/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2277
Epoch 201/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2263
Epoch 202/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2182
```

```
Epoch 203/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2261
Epoch 204/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2399
Epoch 205/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1870
Epoch 206/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1966
Epoch 207/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1555
Epoch 208/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1239
Epoch 209/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1123
Epoch 210/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0926
Epoch 211/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0781
Epoch 212/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1783
Epoch 213/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2362
Epoch 214/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2311
Epoch 215/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2179
Epoch 216/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2238
Epoch 217/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2222
Epoch 218/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2221
Epoch 219/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2308
Epoch 220/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2284
Epoch 221/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2202
Epoch 222/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2272
Epoch 223/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2232
Epoch 224/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2212
Epoch 225/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2101
Epoch 226/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2125
Epoch 227/800
350/350 [==============================] - 1s 2ms/step - loss: 0.2058
```

```
Epoch 228/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1936
Epoch 229/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1811
Epoch 230/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1821
Epoch 231/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1461
Epoch 232/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1369
Epoch 233/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1059
Epoch 234/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1227
Epoch 235/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0792
Epoch 236/800
350/350 [==============================] - 1s 3ms/step - loss: 0.1251
Epoch 237/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0876
Epoch 238/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0974
Epoch 239/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1083
Epoch 240/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0895
Epoch 241/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0646
Epoch 242/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0512
Epoch 243/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0765
Epoch 244/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0467
Epoch 245/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1296
Epoch 246/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0692
Epoch 247/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0430
Epoch 248/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0685
Epoch 249/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0256
Epoch 250/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0172
Epoch 251/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0580
Epoch 252/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0580
```

```
Epoch 253/800
350/350 [==============================] - 1s 2ms/step - loss: 0.1078
Epoch 254/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0529
Epoch 255/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0305
Epoch 256/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0166
Epoch 257/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0116
Epoch 258/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0159
Epoch 259/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0250
Epoch 260/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0126
Epoch 261/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0622
Epoch 262/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0298
Epoch 263/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0098
Epoch 264/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0266
Epoch 265/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0382
Epoch 266/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0292
Epoch 267/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0191
Epoch 268/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0142
Epoch 269/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0183
Epoch 270/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0067
Epoch 271/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0072
Epoch 272/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0077
Epoch 273/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0109
Epoch 274/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0089
Epoch 275/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0079
Epoch 276/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0081
Epoch 277/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0189
```

```
Epoch 278/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0103
Epoch 279/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0083
Epoch 280/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0085
Epoch 281/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0128
Epoch 282/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0082
Epoch 283/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0100
Epoch 284/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0257
Epoch 285/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0244
Epoch 286/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0101
Epoch 287/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0073
Epoch 288/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0097
Epoch 289/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0068
Epoch 290/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0227
Epoch 291/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0097
Epoch 292/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0095
Epoch 293/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0087
Epoch 294/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0371
Epoch 295/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0082
Epoch 296/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0067
Epoch 297/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0169
Epoch 298/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 299/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0260
Epoch 300/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0084
Epoch 301/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0082
Epoch 302/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0067
```

```
Epoch 303/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0143
Epoch 304/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0279
Epoch 305/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0071
Epoch 306/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0054
Epoch 307/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0187
Epoch 308/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0099
Epoch 309/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0128
Epoch 310/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0076
Epoch 311/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0096
Epoch 312/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0114
Epoch 313/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0106
Epoch 314/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0072
Epoch 315/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0107
Epoch 316/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0070
Epoch 317/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0072
Epoch 318/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0223
Epoch 319/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0109
Epoch 320/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0309
Epoch 321/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0068
Epoch 322/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0108
Epoch 323/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0079
Epoch 324/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 325/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0077
Epoch 326/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 327/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0171
```

```
Epoch 328/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0192
Epoch 329/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 330/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0057
Epoch 331/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0160
Epoch 332/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0096
Epoch 333/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0103
Epoch 334/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0087
Epoch 335/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 336/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0153
Epoch 337/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0122
Epoch 338/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0054
Epoch 339/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0065
Epoch 340/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0102
Epoch 341/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0079
Epoch 342/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0052
Epoch 343/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0091
Epoch 344/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0081
Epoch 345/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0071
Epoch 346/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0099
Epoch 347/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0055
Epoch 348/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0051
Epoch 349/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0058
Epoch 350/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0131
Epoch 351/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 352/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0082
```

```
Epoch 353/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0059
Epoch 354/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0071
Epoch 355/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0068
Epoch 356/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0062
Epoch 357/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0053
Epoch 358/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0123
Epoch 359/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0067
Epoch 360/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0076
Epoch 361/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 362/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0063
Epoch 363/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0073
Epoch 364/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0057
Epoch 365/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0059
Epoch 366/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0103
Epoch 367/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0106
Epoch 368/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 369/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0079
Epoch 370/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0063
Epoch 371/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0059
Epoch 372/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0084
Epoch 373/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0111
Epoch 374/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0059
Epoch 375/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0062
Epoch 376/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0042
Epoch 377/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0220
```

```
Epoch 378/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 379/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 380/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0068
Epoch 381/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0051
Epoch 382/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0075
Epoch 383/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0053
Epoch 384/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 385/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0062
Epoch 386/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0110
Epoch 387/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0059
Epoch 388/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0054
Epoch 389/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 390/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0093
Epoch 391/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0154
Epoch 392/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0045
Epoch 393/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0057
Epoch 394/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0072
Epoch 395/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 396/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
Epoch 397/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 398/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0048
Epoch 399/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 400/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0050
Epoch 401/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0102
Epoch 402/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
```

```
Epoch 403/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0057
Epoch 404/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 405/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 406/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 407/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0065
Epoch 408/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0049
Epoch 409/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
Epoch 410/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0070
Epoch 411/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0076
Epoch 412/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 413/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0045
Epoch 414/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 415/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 416/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0089
Epoch 417/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0035
Epoch 418/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 419/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 420/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0088
Epoch 421/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 422/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0045
Epoch 423/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 424/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 425/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 426/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 427/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0040
```

```
Epoch 428/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0141
Epoch 429/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
Epoch 430/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0060
Epoch 431/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0101
Epoch 432/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 433/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 434/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
Epoch 435/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 436/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 437/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0050
Epoch 438/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0058
Epoch 439/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0083
Epoch 440/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 441/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0045
Epoch 442/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 443/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 444/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0084
Epoch 445/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0051
Epoch 446/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0037
Epoch 447/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 448/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0040
Epoch 449/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0038
Epoch 450/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0047
Epoch 451/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0038
Epoch 452/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0035
```

```
Epoch 453/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 454/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0088
Epoch 455/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0057
Epoch 456/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 457/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0040
Epoch 458/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0033
Epoch 459/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0037
Epoch 460/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0029
Epoch 461/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0035
Epoch 462/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0061
Epoch 463/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0110
Epoch 464/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 465/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0044
Epoch 466/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
Epoch 467/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0029
Epoch 468/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0069
Epoch 469/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0037
Epoch 470/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0058
Epoch 471/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 472/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 473/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0152
Epoch 474/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0077
Epoch 475/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 476/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 477/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
```

```
Epoch 478/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 479/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 480/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 481/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0160
Epoch 482/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0101
Epoch 483/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0099
Epoch 484/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
Epoch 485/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0038
Epoch 486/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0042
Epoch 487/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0037
Epoch 488/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 489/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0043
Epoch 490/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0025
Epoch 491/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
Epoch 492/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0038
Epoch 493/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0029
Epoch 494/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 495/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0031
Epoch 496/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0035
Epoch 497/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0046
Epoch 498/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0037
Epoch 499/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 500/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 501/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 502/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
```

```
Epoch 503/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 504/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0030
Epoch 505/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0049
Epoch 506/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 507/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0024
Epoch 508/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 509/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0026
Epoch 510/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 511/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 512/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0030
Epoch 513/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 514/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 515/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 516/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
Epoch 517/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0063
Epoch 518/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0038
Epoch 519/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 520/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0051
Epoch 521/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 522/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 523/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 524/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0026
Epoch 525/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 526/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0024
Epoch 527/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0026
```

```
Epoch 528/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0044
Epoch 529/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0028
Epoch 530/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0035
Epoch 531/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 532/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 533/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0034
Epoch 534/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 535/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 536/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 537/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 538/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0036
Epoch 539/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 540/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0031
Epoch 541/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 542/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0025
Epoch 543/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0078
Epoch 544/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0029
Epoch 545/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 546/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 547/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0024
Epoch 548/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0030
Epoch 549/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 550/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0056
Epoch 551/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0026
Epoch 552/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
```

```
Epoch 553/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 554/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 555/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 556/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 557/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 558/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 559/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 560/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0024
Epoch 561/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 562/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 563/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 564/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 565/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 566/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 567/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 568/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 569/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0041
Epoch 570/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0024
Epoch 571/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 572/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 573/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 574/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 575/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0039
Epoch 576/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0026
Epoch 577/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
```

```
Epoch 578/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 579/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 580/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0065
Epoch 581/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 582/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 583/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 584/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0025
Epoch 585/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 586/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 587/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 588/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0029
Epoch 589/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 590/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 591/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 592/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 593/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 594/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 595/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 596/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 597/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 598/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0025
Epoch 599/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0023
Epoch 600/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0020
Epoch 601/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0020
Epoch 602/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
```

```
Epoch 603/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 604/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 605/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 606/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 607/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 608/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 609/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 610/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 611/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 612/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 613/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 614/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 615/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0033
Epoch 616/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 617/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 618/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 619/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 620/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 621/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 622/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 623/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0050
Epoch 624/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0013
Epoch 625/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0017
Epoch 626/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0014
Epoch 627/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
```

```
Epoch 628/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 629/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 630/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 631/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0030
Epoch 632/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 633/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 634/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 635/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 636/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0029
Epoch 637/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 638/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 639/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0027
Epoch 640/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0023
Epoch 641/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 642/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 643/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 644/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 645/800
350/350 [==============================] - 1s 2ms/step - loss:
9.3587e-04
Epoch 646/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 647/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 648/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 649/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 650/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 651/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 652/800
```

```
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 653/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 654/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 655/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 656/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 657/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 658/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0017
Epoch 659/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 660/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 661/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 662/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 663/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 664/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 665/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 666/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 667/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 668/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0018
Epoch 669/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0032
Epoch 670/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0014
Epoch 671/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 672/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 673/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 674/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0018
Epoch 675/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 676/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 677/800
```

```
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 678/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 679/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 680/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 681/800
350/350 [==============================] - 1s 2ms/step - loss:
9.3206e-04
Epoch 682/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0028
Epoch 683/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 684/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 685/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 686/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 687/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 688/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 689/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 690/800
350/350 [==============================] - 1s 2ms/step - loss:
9.9719e-04
Epoch 691/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 692/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 693/800
350/350 [==============================] - 1s 2ms/step - loss:
9.6206e-04
Epoch 694/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 695/800
350/350 [==============================] - 1s 2ms/step - loss:
9.3476e-04
Epoch 696/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 697/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 698/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 699/800
350/350 [==============================] - 1s 2ms/step - loss:
7.9381e-04
```

```
Epoch 700/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 701/800
350/350 [==============================] - 1s 2ms/step - loss:
9.5845e-04
Epoch 702/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 703/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 704/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0019
Epoch 705/800
350/350 [==============================] - 1s 2ms/step - loss:
8.3591e-04
Epoch 706/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 707/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 708/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0021
Epoch 709/800
350/350 [==============================] - 1s 2ms/step - loss:
8.6956e-04
Epoch 710/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0025
Epoch 711/800
350/350 [==============================] - 1s 2ms/step - loss:
8.3028e-04
Epoch 712/800
350/350 [==============================] - 1s 2ms/step - loss:
8.0481e-04
Epoch 713/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 714/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 715/800
350/350 [==============================] - 1s 2ms/step - loss:
9.1614e-04
Epoch 716/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 717/800
350/350 [==============================] - 1s 2ms/step - loss:
9.6677e-04
Epoch 718/800
350/350 [==============================] - 1s 2ms/step - loss:
8.1430e-04
Epoch 719/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 720/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
```

```
Epoch 721/800
350/350 [==============================] - 1s 2ms/step - loss:
9.4881e-04
Epoch 722/800
350/350 [==============================] - 1s 2ms/step - loss:
6.9262e-04
Epoch 723/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 724/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 725/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0022
Epoch 726/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 727/800
350/350 [==============================] - 1s 2ms/step - loss:
9.5004e-04
Epoch 728/800
350/350 [==============================] - 1s 2ms/step - loss:
8.8748e-04
Epoch 729/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 730/800
350/350 [==============================] - 1s 2ms/step - loss:
9.8984e-04
Epoch 731/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 732/800
350/350 [==============================] - 1s 2ms/step - loss:
8.7373e-04
Epoch 733/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 734/800
350/350 [==============================] - 1s 2ms/step - loss:
7.8442e-04
Epoch 735/800
350/350 [==============================] - 1s 3ms/step - loss:
7.0813e-04
Epoch 736/800
350/350 [==============================] - 1s 3ms/step - loss:
9.5913e-04
Epoch 737/800
350/350 [==============================] - 1s 3ms/step - loss: 0.0012
Epoch 738/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
Epoch 739/800
350/350 [==============================] - 1s 2ms/step - loss:
9.2120e-04
Epoch 740/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
```

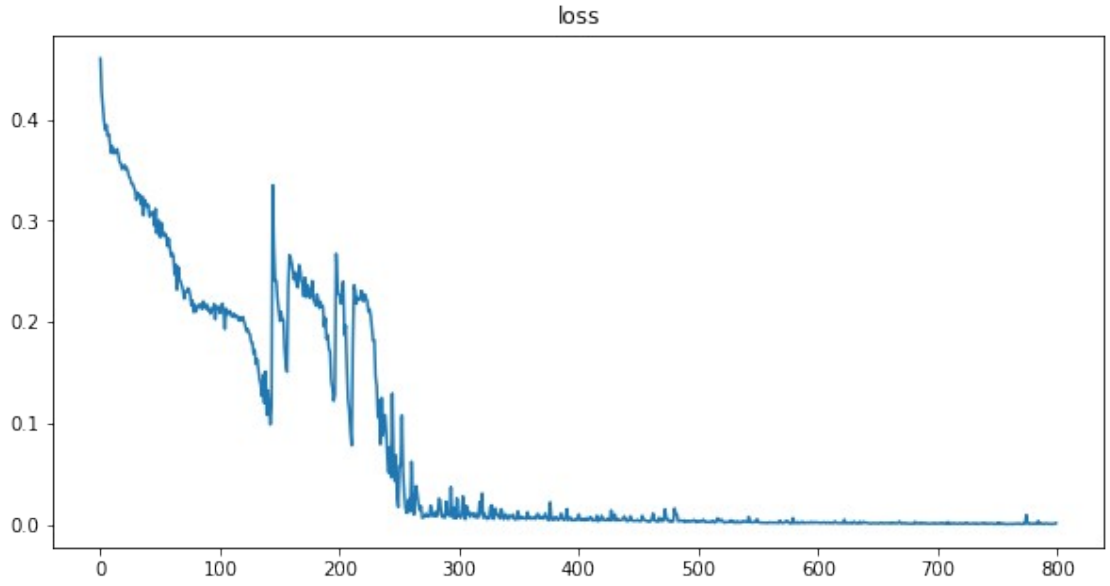
```
Epoch 741/800
350/350 [==============================] - 1s 2ms/step - loss:
8.4516e-04
Epoch 742/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 743/800
350/350 [==============================] - 1s 2ms/step - loss:
7.4660e-04
Epoch 744/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 745/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 746/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 747/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 748/800
350/350 [==============================] - 1s 2ms/step - loss:
7.2634e-04
Epoch 749/800
350/350 [==============================] - 1s 2ms/step - loss:
6.3182e-04
Epoch 750/800
350/350 [==============================] - 1s 2ms/step - loss:
8.9157e-04
Epoch 751/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0018
Epoch 752/800
350/350 [==============================] - 1s 2ms/step - loss:
6.0161e-04
Epoch 753/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0020
Epoch 754/800
350/350 [==============================] - 1s 2ms/step - loss:
8.6108e-04
Epoch 755/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 756/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 757/800
350/350 [==============================] - 1s 2ms/step - loss:
6.9152e-04
Epoch 758/800
350/350 [==============================] - 1s 2ms/step - loss:
5.6172e-04
Epoch 759/800
350/350 [==============================] - 1s 2ms/step - loss:
5.5525e-04
Epoch 760/800
350/350 [==============================] - 1s 2ms/step - loss:
```

```
6.7732e-04
Epoch 761/800
350/350 [==============================] - 1s 2ms/step - loss:
8.4986e-04
Epoch 762/800
350/350 [==============================] - 1s 2ms/step - loss:
7.8464e-04
Epoch 763/800
350/350 [==============================] - 1s 2ms/step - loss:
7.4059e-04
Epoch 764/800
350/350 [==============================] - 1s 2ms/step - loss:
5.6138e-04
Epoch 765/800
350/350 [==============================] - 1s 2ms/step - loss:
8.7897e-04
Epoch 766/800
350/350 [==============================] - 1s 2ms/step - loss:
8.1439e-04
Epoch 767/800
350/350 [==============================] - 1s 2ms/step - loss:
8.9323e-04
Epoch 768/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 769/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 770/800
350/350 [==============================] - 1s 2ms/step - loss:
6.6673e-04
Epoch 771/800
350/350 [==============================] - 1s 2ms/step - loss:
5.5027e-04
Epoch 772/800
350/350 [==============================] - 1s 2ms/step - loss:
6.0599e-04
Epoch 773/800
350/350 [==============================] - 1s 2ms/step - loss:
9.7681e-04
Epoch 774/800
350/350 [==============================] - 1s 2ms/step - loss:
9.3716e-04
Epoch 775/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0096
Epoch 776/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 777/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0015
Epoch 778/800
350/350 [==============================] - 1s 2ms/step - loss:
5.2221e-04
```

```
Epoch 779/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 780/800
350/350 [==============================] - 1s 2ms/step - loss:
9.0880e-04
Epoch 781/800
350/350 [==============================] - 1s 2ms/step - loss:
7.9067e-04
Epoch 782/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0014
Epoch 783/800
350/350 [==============================] - 1s 2ms/step - loss:
5.8098e-04
Epoch 784/800
350/350 [==============================] - 1s 2ms/step - loss:
9.9081e-04
Epoch 785/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0037
Epoch 786/800
350/350 [==============================] - 1s 2ms/step - loss:
8.1819e-04
Epoch 787/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0013
Epoch 788/800
350/350 [==============================] - 1s 2ms/step - loss:
8.7010e-04
Epoch 789/800
350/350 [==============================] - 1s 2ms/step - loss:
9.9239e-04
Epoch 790/800
350/350 [==============================] - 1s 2ms/step - loss:
5.2091e-04
Epoch 791/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0011
Epoch 792/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0012
Epoch 793/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0010
Epoch 794/800
350/350 [==============================] - 1s 2ms/step - loss:
8.0755e-04
Epoch 795/800
350/350 [==============================] - 1s 2ms/step - loss:
6.3493e-04
Epoch 796/800
350/350 [==============================] - 1s 2ms/step - loss:
9.4799e-04
Epoch 797/800
350/350 [==============================] - 1s 2ms/step - loss:
5.7771e-04
```

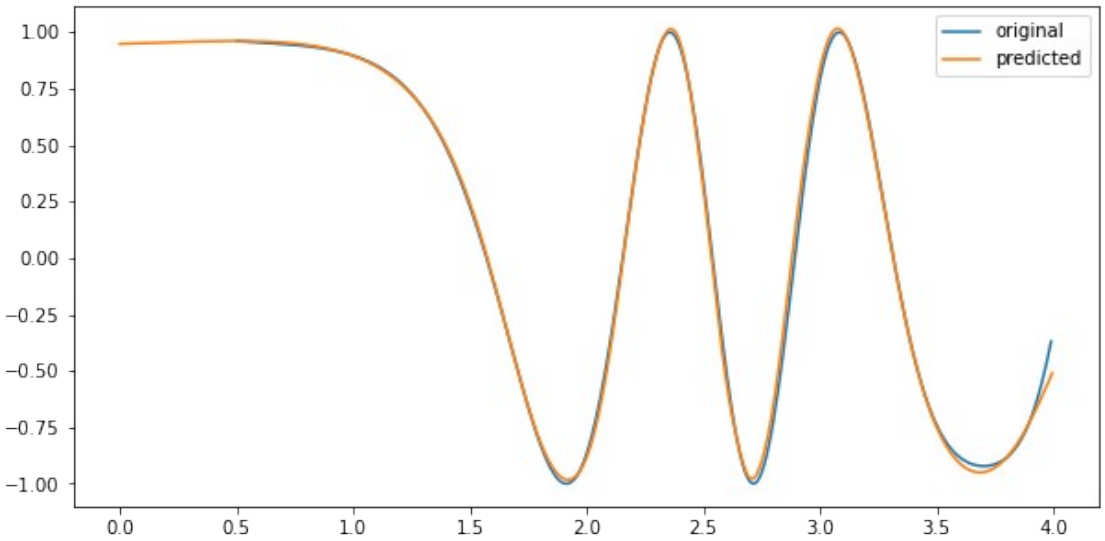
```
Epoch 798/800
350/350 [==============================] - 1s 2ms/step - loss:
8.4552e-04
Epoch 799/800
350/350 [==============================] - 1s 2ms/step - loss:
7.5395e-04
Epoch 800/800
350/350 [==============================] - 1s 2ms/step - loss: 0.0016
```

```
figure = plt.figure(figsize = (10, 5))
histx = []
for i in range(len(hist.history['loss'])):
    histx.append(i)


plt.plot(histx, hist.history['loss'])
plt.title("loss")
plt.show()
```




```
t2 = np.arange(0, 4.0, 0.005)

pred = model.predict(t2)

figure = plt.figure(figsize = (10, 5))


plt.plot(train_x, train_y, label = 'original')
plt.plot(t2, pred, label = 'predicted')
plt.legend()
plt.show()
```

```
25/25 [==============================] - 0s 2ms/step
```



Вывод

Выполнив данную лабораторную работу, я вспомнил, как устроены многослойные сети также я реализовал многослойные нейронные сети для решения задач фильтрации и аппроксимации с помощью фреймворка TensorFlow