xor_sol

August 3, 2025

1 Deep Learning Practice: XOR

1.1 Jupyter Lab Version

1.2 Full solution: no fair peeking

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[7]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import keras
import os
import time

# This is the keras 3 way of doing things
from keras.layers import Input, Dense
from keras.models import Sequential

# Default plotting parameters
FONTSIZE = 18
plt.rcParams['figure.figsize'] = (10, 6)
plt.rcParams['font.size'] = FONTSIZE
```

[2]:
```
# Shell command to check GPU usage: nvidia-smi
# Execute if you do not want the GPU to be used:
os.environ["CUDA_VISIBLE_DEVICES"] = "-1"
```

[4]:
```
def build_model(n_inputs:int,
                n_hidden:[int],
                n_output:int,
                activation_hidden:str='elu',
                activation_output:str='elu',
                lrate:float=0.001)->Sequential:
    '''
    Build a simple fully connected model

    :param n_inputs: Number of input dimensions
    :param n_hidden: List: number of units in each hidden layer
```

```
    :param n_output: Number of ouptut dimensions
    :param activation_hidden: Activation function to be used for hidden and␣
↪output units
    :param activation_output: Activation function for the output unit(s)
    :param lrate: Learning rate for Adam Optimizer
    '''
    # Simple sequential model
    model = Sequential();

    # Input layer
    model.add(Input(shape=(n_inputs,), name = 'Input'))

    # Hidden layer
    for i,n in enumerate(n_hidden):
        model.add(Dense(n,
                        use_bias=True,
                        activation=activation_hidden,
                        name=f'hidden_{i}',
                       ))


    # Output layer
    model.add(Dense(n_output,
                    use_bias=True,
                    activation=activation_output,
                    name='output',
                   ))

    # My favorite optimizer
    opt = keras.optimizers.Adam(learning_rate=lrate,
                                amsgrad=False)


    # Compile the model.  Mean squared error loss
    model.compile(loss='mse', optimizer=opt)

    # Display the network
    print(model.summary())

    #
    return model
```

[5]:
```
# Create training set: XOR
ins = np.array([[0, 0], [0, 1], [1, 0], [1,1]])
outs = np.array([[0], [1], [1], [0]])
```

[ ]:
```

```

[ ]:

[8]:
```
# Build our XOR network.
# Note: sigmoid is a must for binary functions
model = build_model(ins.shape[1], [10], outs.shape[1],
                    activation_output='sigmoid',
                    lrate=0.01)
```

```
2025-08-03 16:14:30.217599: E
external/local_xla/xla/stream_executor/cuda/cuda_driver.cc:152] failed call to
cuInit: INTERNAL: CUDA error: Failed call to cuInit: CUDA_ERROR_NO_DEVICE: no
CUDA-capable device is detected
```

```
Model: "sequential_1"
```

Layer (type)	Output Shape	Param #
hidden_0 (Dense)	(None, 10)	30
output (Dense)	(None, 1)	11

```
 Total params: 41 (164.00 B)

 Trainable params: 41 (164.00 B)

 Non-trainable params: 0 (0.00 B)
```

```
None
```

[9]:
```
# Training
history = model.fit(x=ins,
                    y=outs,
                    epochs=1000,
                    verbose=True,
                   )
```

```
Epoch 1/1000
1/1             0s 467ms/step - loss:
0.2517
Epoch 2/1000
1/1             0s 29ms/step - loss:
0.2494
Epoch 3/1000
1/1             0s 24ms/step - loss:
```

```
0.2480
Epoch 4/1000
1/1             0s 22ms/step - loss:
0.2472
Epoch 5/1000
1/1             0s 22ms/step - loss:
0.2465
Epoch 6/1000
1/1             0s 25ms/step - loss:
0.2457
Epoch 7/1000
1/1             0s 22ms/step - loss:
0.2448
Epoch 8/1000
1/1             0s 22ms/step - loss:
0.2438
Epoch 9/1000
1/1             0s 24ms/step - loss:
0.2428
Epoch 10/1000
1/1             0s 22ms/step - loss:
0.2419
Epoch 11/1000
1/1             0s 23ms/step - loss:
0.2410
Epoch 12/1000
1/1             0s 23ms/step - loss:
0.2402
Epoch 13/1000
1/1             0s 21ms/step - loss:
0.2394
Epoch 14/1000
1/1             0s 21ms/step - loss:
0.2385
Epoch 15/1000
1/1             0s 21ms/step - loss:
0.2376
Epoch 16/1000
1/1             0s 22ms/step - loss:
0.2367
Epoch 17/1000
1/1             0s 21ms/step - loss:
0.2357
Epoch 18/1000
1/1             0s 22ms/step - loss:
0.2347
Epoch 19/1000
1/1             0s 22ms/step - loss:
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0.2336
Epoch 20/1000
1/1             0s 24ms/step - loss:
0.2325
Epoch 21/1000
1/1             0s 23ms/step - loss:
0.2314
Epoch 22/1000
1/1             0s 23ms/step - loss:
0.2302
Epoch 23/1000
1/1             0s 22ms/step - loss:
0.2290
Epoch 24/1000
1/1             0s 21ms/step - loss:
0.2278
Epoch 25/1000
1/1             0s 25ms/step - loss:
0.2265
Epoch 26/1000
1/1             0s 23ms/step - loss:
0.2251
Epoch 27/1000
1/1             0s 21ms/step - loss:
0.2237
Epoch 28/1000
1/1             0s 23ms/step - loss:
0.2222
Epoch 29/1000
1/1             0s 23ms/step - loss:
0.2207
Epoch 30/1000
1/1             0s 22ms/step - loss:
0.2191
Epoch 31/1000
1/1             0s 24ms/step - loss:
0.2174
Epoch 32/1000
1/1             0s 22ms/step - loss:
0.2156
Epoch 33/1000
1/1             0s 23ms/step - loss:
0.2138
Epoch 34/1000
1/1             0s 34ms/step - loss:
0.2119
Epoch 35/1000
1/1             0s 33ms/step - loss:
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0.2099
Epoch 36/1000
1/1             0s 22ms/step - loss:
0.2078
Epoch 37/1000
1/1             0s 22ms/step - loss:
0.2056
Epoch 38/1000
1/1             0s 24ms/step - loss:
0.2034
Epoch 39/1000
1/1             0s 22ms/step - loss:
0.2011
Epoch 40/1000
1/1             0s 26ms/step - loss:
0.1987
Epoch 41/1000
1/1             0s 23ms/step - loss:
0.1963
Epoch 42/1000
1/1             0s 23ms/step - loss:
0.1939
Epoch 43/1000
1/1             0s 22ms/step - loss:
0.1913
Epoch 44/1000
1/1             0s 22ms/step - loss:
0.1888
Epoch 45/1000
1/1             0s 21ms/step - loss:
0.1861
Epoch 46/1000
1/1             0s 22ms/step - loss:
0.1834
Epoch 47/1000
1/1             0s 24ms/step - loss:
0.1806
Epoch 48/1000
1/1             0s 22ms/step - loss:
0.1778
Epoch 49/1000
1/1             0s 21ms/step - loss:
0.1749
Epoch 50/1000
1/1             0s 23ms/step - loss:
0.1719
Epoch 51/1000
1/1             0s 24ms/step - loss:
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0.1689
Epoch 52/1000
1/1             0s 22ms/step - loss:
0.1658
Epoch 53/1000
1/1             0s 22ms/step - loss:
0.1626
Epoch 54/1000
1/1             0s 23ms/step - loss:
0.1594
Epoch 55/1000
1/1             0s 23ms/step - loss:
0.1561
Epoch 56/1000
1/1             0s 21ms/step - loss:
0.1528
Epoch 57/1000
1/1             0s 22ms/step - loss:
0.1494
Epoch 58/1000
1/1             0s 22ms/step - loss:
0.1459
Epoch 59/1000
1/1             0s 22ms/step - loss:
0.1425
Epoch 60/1000
1/1             0s 22ms/step - loss:
0.1389
Epoch 61/1000
1/1             0s 22ms/step - loss:
0.1354
Epoch 62/1000
1/1             0s 22ms/step - loss:
0.1318
Epoch 63/1000
1/1             0s 25ms/step - loss:
0.1282
Epoch 64/1000
1/1             0s 24ms/step - loss:
0.1246
Epoch 65/1000
1/1             0s 23ms/step - loss:
0.1209
Epoch 66/1000
1/1             0s 23ms/step - loss:
0.1173
Epoch 67/1000
1/1             0s 24ms/step - loss:
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0.1136
Epoch 68/1000
1/1             0s 22ms/step - loss:
0.1099
Epoch 69/1000
1/1             0s 24ms/step - loss:
0.1063
Epoch 70/1000
1/1             0s 25ms/step - loss:
0.1027
Epoch 71/1000
1/1             0s 23ms/step - loss:
0.0991
Epoch 72/1000
1/1             0s 23ms/step - loss:
0.0955
Epoch 73/1000
1/1             0s 22ms/step - loss:
0.0919
Epoch 74/1000
1/1             0s 27ms/step - loss:
0.0884
Epoch 75/1000
1/1             0s 24ms/step - loss:
0.0850
Epoch 76/1000
1/1             0s 21ms/step - loss:
0.0816
Epoch 77/1000
1/1             0s 22ms/step - loss:
0.0783
Epoch 78/1000
1/1             0s 25ms/step - loss:
0.0750
Epoch 79/1000
1/1             0s 22ms/step - loss:
0.0718
Epoch 80/1000
1/1             0s 22ms/step - loss:
0.0687
Epoch 81/1000
1/1             0s 24ms/step - loss:
0.0657
Epoch 82/1000
1/1             0s 24ms/step - loss:
0.0628
Epoch 83/1000
1/1             0s 23ms/step - loss:
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0.0599
Epoch 84/1000
1/1             0s 24ms/step - loss:
0.0572
Epoch 85/1000
1/1             0s 23ms/step - loss:
0.0545
Epoch 86/1000
1/1             0s 26ms/step - loss:
0.0519
Epoch 87/1000
1/1             0s 23ms/step - loss:
0.0495
Epoch 88/1000
1/1             0s 23ms/step - loss:
0.0471
Epoch 89/1000
1/1             0s 25ms/step - loss:
0.0448
Epoch 90/1000
1/1             0s 22ms/step - loss:
0.0426
Epoch 91/1000
1/1             0s 22ms/step - loss:
0.0405
Epoch 92/1000
1/1             0s 22ms/step - loss:
0.0385
Epoch 93/1000
1/1             0s 23ms/step - loss:
0.0366
Epoch 94/1000
1/1             0s 24ms/step - loss:
0.0348
Epoch 95/1000
1/1             0s 21ms/step - loss:
0.0331
Epoch 96/1000
1/1             0s 24ms/step - loss:
0.0315
Epoch 97/1000
1/1             0s 26ms/step - loss:
0.0299
Epoch 98/1000
1/1             0s 22ms/step - loss:
0.0284
Epoch 99/1000
1/1             0s 22ms/step - loss:
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0.0270
Epoch 100/1000
1/1             0s 22ms/step - loss:
0.0257
Epoch 101/1000
1/1             0s 23ms/step - loss:
0.0245
Epoch 102/1000
1/1             0s 23ms/step - loss:
0.0233
Epoch 103/1000
1/1             0s 23ms/step - loss:
0.0222
Epoch 104/1000
1/1             0s 25ms/step - loss:
0.0211
Epoch 105/1000
1/1             0s 23ms/step - loss:
0.0201
Epoch 106/1000
1/1             0s 23ms/step - loss:
0.0192
Epoch 107/1000
1/1             0s 22ms/step - loss:
0.0183
Epoch 108/1000
1/1             0s 22ms/step - loss:
0.0175
Epoch 109/1000
1/1             0s 23ms/step - loss:
0.0167
Epoch 110/1000
1/1             0s 22ms/step - loss:
0.0159
Epoch 111/1000
1/1             0s 23ms/step - loss:
0.0152
Epoch 112/1000
1/1             0s 23ms/step - loss:
0.0146
Epoch 113/1000
1/1             0s 26ms/step - loss:
0.0139
Epoch 114/1000
1/1             0s 22ms/step - loss:
0.0133
Epoch 115/1000
1/1             0s 26ms/step - loss:
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0.0128
Epoch 116/1000
1/1             0s 23ms/step - loss:
0.0123
Epoch 117/1000
1/1             0s 22ms/step - loss:
0.0118
Epoch 118/1000
1/1             0s 22ms/step - loss:
0.0113
Epoch 119/1000
1/1             0s 23ms/step - loss:
0.0109
Epoch 120/1000
1/1             0s 22ms/step - loss:
0.0104
Epoch 121/1000
1/1             0s 27ms/step - loss:
0.0100
Epoch 122/1000
1/1             0s 25ms/step - loss:
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Epoch 123/1000
1/1             0s 28ms/step - loss:
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Epoch 124/1000
1/1             0s 24ms/step - loss:
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Epoch 125/1000
1/1             0s 23ms/step - loss:
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Epoch 126/1000
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Epoch 127/1000
1/1             0s 22ms/step - loss:
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Epoch 128/1000
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Epoch 130/1000
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0.0071
Epoch 132/1000
1/1             0s 29ms/step - loss:
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Epoch 133/1000
1/1             0s 23ms/step - loss:
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Epoch 134/1000
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Epoch 136/1000
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Epoch 137/1000
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Epoch 138/1000
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Epoch 139/1000
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Epoch 142/1000
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Epoch 147/1000
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0.0045
Epoch 148/1000
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Epoch 150/1000
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Epoch 151/1000
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Epoch 152/1000
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Epoch 157/1000
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Epoch 158/1000
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Epoch 159/1000
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Epoch 160/1000
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Epoch 162/1000
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Epoch 163/1000
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0.0032
Epoch 164/1000
1/1             0s 23ms/step - loss:
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Epoch 165/1000
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0.0024
Epoch 179/1000
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0.0024
Epoch 180/1000
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Epoch 212/1000
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1/1             0s 26ms/step - loss:
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1/1             0s 24ms/step - loss:
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Epoch 223/1000
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Epoch 226/1000
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Epoch 227/1000
1/1             0s 23ms/step - loss:
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0.0013
Epoch 228/1000
1/1             0s 24ms/step - loss:
0.0012
Epoch 229/1000
1/1             0s 25ms/step - loss:
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1/1             0s 23ms/step - loss:
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Epoch 233/1000
1/1             0s 22ms/step - loss:
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Epoch 234/1000
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Epoch 237/1000
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Epoch 238/1000
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Epoch 239/1000
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Epoch 240/1000
1/1             0s 23ms/step - loss:
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Epoch 241/1000
1/1             0s 26ms/step - loss:
0.0011
Epoch 242/1000
1/1             0s 24ms/step - loss:
0.0011
Epoch 243/1000
1/1             0s 23ms/step - loss:
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0.0011
Epoch 244/1000
1/1             0s 24ms/step - loss:
0.0010
Epoch 245/1000
1/1             0s 26ms/step - loss:
0.0010
Epoch 246/1000
1/1             0s 23ms/step - loss:
0.0010
Epoch 247/1000
1/1             0s 23ms/step - loss:
0.0010
Epoch 248/1000
1/1             0s 23ms/step - loss:
0.0010
Epoch 249/1000
1/1             0s 23ms/step - loss:
9.9288e-04
Epoch 250/1000
1/1             0s 24ms/step - loss:
9.8307e-04
Epoch 251/1000
1/1             0s 23ms/step - loss:
9.7341e-04
Epoch 252/1000
1/1             0s 24ms/step - loss:
9.6389e-04
Epoch 253/1000
1/1             0s 28ms/step - loss:
9.5451e-04
Epoch 254/1000
1/1             0s 24ms/step - loss:
9.4527e-04
Epoch 255/1000
1/1             0s 22ms/step - loss:
9.3618e-04
Epoch 256/1000
1/1             0s 24ms/step - loss:
9.2721e-04
Epoch 257/1000
1/1             0s 24ms/step - loss:
9.1837e-04
Epoch 258/1000
1/1             0s 23ms/step - loss:
9.0967e-04
Epoch 259/1000
1/1             0s 23ms/step - loss:
```

```
9.0109e-04
Epoch 260/1000
1/1             0s 24ms/step - loss:
8.9263e-04
Epoch 261/1000
1/1             0s 24ms/step - loss:
8.8429e-04
Epoch 262/1000
1/1             0s 26ms/step - loss:
8.7608e-04
Epoch 263/1000
1/1             0s 26ms/step - loss:
8.6798e-04
Epoch 264/1000
1/1             0s 26ms/step - loss:
8.5999e-04
Epoch 265/1000
1/1             0s 23ms/step - loss:
8.5212e-04
Epoch 266/1000
1/1             0s 28ms/step - loss:
8.4435e-04
Epoch 267/1000
1/1             0s 23ms/step - loss:
8.3670e-04
Epoch 268/1000
1/1             0s 22ms/step - loss:
8.2915e-04
Epoch 269/1000
1/1             0s 23ms/step - loss:
8.2170e-04
Epoch 270/1000
1/1             0s 24ms/step - loss:
8.1436e-04
Epoch 271/1000
1/1             0s 22ms/step - loss:
8.0711e-04
Epoch 272/1000
1/1             0s 23ms/step - loss:
7.9997e-04
Epoch 273/1000
1/1             0s 23ms/step - loss:
7.9292e-04
Epoch 274/1000
1/1             0s 23ms/step - loss:
7.8596e-04
Epoch 275/1000
1/1             0s 26ms/step - loss:
```

```
7.7910e-04
Epoch 276/1000
1/1             0s 24ms/step - loss:
7.7233e-04
Epoch 277/1000
1/1             0s 23ms/step - loss:
7.6565e-04
Epoch 278/1000
1/1             0s 26ms/step - loss:
7.5906e-04
Epoch 279/1000
1/1             0s 24ms/step - loss:
7.5255e-04
Epoch 280/1000
1/1             0s 23ms/step - loss:
7.4613e-04
Epoch 281/1000
1/1             0s 24ms/step - loss:
7.3980e-04
Epoch 282/1000
1/1             0s 22ms/step - loss:
7.3355e-04
Epoch 283/1000
1/1             0s 23ms/step - loss:
7.2738e-04
Epoch 284/1000
1/1             0s 25ms/step - loss:
7.2129e-04
Epoch 285/1000
1/1             0s 24ms/step - loss:
7.1528e-04
Epoch 286/1000
1/1             0s 26ms/step - loss:
7.0935e-04
Epoch 287/1000
1/1             0s 24ms/step - loss:
7.0349e-04
Epoch 288/1000
1/1             0s 23ms/step - loss:
6.9771e-04
Epoch 289/1000
1/1             0s 24ms/step - loss:
6.9200e-04
Epoch 290/1000
1/1             0s 23ms/step - loss:
6.8637e-04
Epoch 291/1000
1/1             0s 22ms/step - loss:
```

```
6.8081e-04
Epoch 292/1000
1/1             0s 28ms/step - loss:
6.7531e-04
Epoch 293/1000
1/1             0s 25ms/step - loss:
6.6988e-04
Epoch 294/1000
1/1             0s 23ms/step - loss:
6.6453e-04
Epoch 295/1000
1/1             0s 23ms/step - loss:
6.5923e-04
Epoch 296/1000
1/1             0s 23ms/step - loss:
6.5401e-04
Epoch 297/1000
1/1             0s 23ms/step - loss:
6.4884e-04
Epoch 298/1000
1/1             0s 24ms/step - loss:
6.4375e-04
Epoch 299/1000
1/1             0s 23ms/step - loss:
6.3871e-04
Epoch 300/1000
1/1             0s 28ms/step - loss:
6.3373e-04
Epoch 301/1000
1/1             0s 22ms/step - loss:
6.2881e-04
Epoch 302/1000
1/1             0s 23ms/step - loss:
6.2396e-04
Epoch 303/1000
1/1             0s 23ms/step - loss:
6.1916e-04
Epoch 304/1000
1/1             0s 24ms/step - loss:
6.1441e-04
Epoch 305/1000
1/1             0s 22ms/step - loss:
6.0973e-04
Epoch 306/1000
1/1             0s 24ms/step - loss:
6.0510e-04
Epoch 307/1000
1/1             0s 24ms/step - loss:
```

```
6.0052e-04
Epoch 308/1000
1/1             0s 24ms/step - loss:
5.9600e-04
Epoch 309/1000
1/1             0s 23ms/step - loss:
5.9153e-04
Epoch 310/1000
1/1             0s 23ms/step - loss:
5.8711e-04
Epoch 311/1000
1/1             0s 22ms/step - loss:
5.8274e-04
Epoch 312/1000
1/1             0s 24ms/step - loss:
5.7842e-04
Epoch 313/1000
1/1             0s 24ms/step - loss:
5.7415e-04
Epoch 314/1000
1/1             0s 23ms/step - loss:
5.6993e-04
Epoch 315/1000
1/1             0s 26ms/step - loss:
5.6576e-04
Epoch 316/1000
1/1             0s 22ms/step - loss:
5.6163e-04
Epoch 317/1000
1/1             0s 24ms/step - loss:
5.5755e-04
Epoch 318/1000
1/1             0s 24ms/step - loss:
5.5352e-04
Epoch 319/1000
1/1             0s 23ms/step - loss:
5.4953e-04
Epoch 320/1000
1/1             0s 27ms/step - loss:
5.4559e-04
Epoch 321/1000
1/1             0s 26ms/step - loss:
5.4169e-04
Epoch 322/1000
1/1             0s 26ms/step - loss:
5.3783e-04
Epoch 323/1000
1/1             0s 26ms/step - loss:
```

```
5.3401e-04
Epoch 324/1000
1/1             0s 24ms/step - loss:
5.3024e-04
Epoch 325/1000
1/1             0s 23ms/step - loss:
5.2650e-04
Epoch 326/1000
1/1             0s 22ms/step - loss:
5.2281e-04
Epoch 327/1000
1/1             0s 24ms/step - loss:
5.1916e-04
Epoch 328/1000
1/1             0s 27ms/step - loss:
5.1554e-04
Epoch 329/1000
1/1             0s 25ms/step - loss:
5.1197e-04
Epoch 330/1000
1/1             0s 22ms/step - loss:
5.0843e-04
Epoch 331/1000
1/1             0s 23ms/step - loss:
5.0493e-04
Epoch 332/1000
1/1             0s 24ms/step - loss:
5.0147e-04
Epoch 333/1000
1/1             0s 23ms/step - loss:
4.9804e-04
Epoch 334/1000
1/1             0s 23ms/step - loss:
4.9465e-04
Epoch 335/1000
1/1             0s 23ms/step - loss:
4.9130e-04
Epoch 336/1000
1/1             0s 23ms/step - loss:
4.8797e-04
Epoch 337/1000
1/1             0s 22ms/step - loss:
4.8469e-04
Epoch 338/1000
1/1             0s 23ms/step - loss:
4.8144e-04
Epoch 339/1000
1/1             0s 23ms/step - loss:
```

```
4.7822e-04
Epoch 340/1000
1/1             0s 24ms/step - loss:
4.7503e-04
Epoch 341/1000
1/1             0s 25ms/step - loss:
4.7188e-04
Epoch 342/1000
1/1             0s 23ms/step - loss:
4.6876e-04
Epoch 343/1000
1/1             0s 22ms/step - loss:
4.6567e-04
Epoch 344/1000
1/1             0s 25ms/step - loss:
4.6261e-04
Epoch 345/1000
1/1             0s 22ms/step - loss:
4.5958e-04
Epoch 346/1000
1/1             0s 22ms/step - loss:
4.5658e-04
Epoch 347/1000
1/1             0s 22ms/step - loss:
4.5361e-04
Epoch 348/1000
1/1             0s 23ms/step - loss:
4.5067e-04
Epoch 349/1000
1/1             0s 22ms/step - loss:
4.4776e-04
Epoch 350/1000
1/1             0s 22ms/step - loss:
4.4488e-04
Epoch 351/1000
1/1             0s 24ms/step - loss:
4.4203e-04
Epoch 352/1000
1/1             0s 28ms/step - loss:
4.3921e-04
Epoch 353/1000
1/1             0s 23ms/step - loss:
4.3641e-04
Epoch 354/1000
1/1             0s 23ms/step - loss:
4.3364e-04
Epoch 355/1000
1/1             0s 23ms/step - loss:
```

```
4.3090e-04
Epoch 356/1000
1/1             0s 28ms/step - loss:
4.2818e-04
Epoch 357/1000
1/1             0s 22ms/step - loss:
4.2549e-04
Epoch 358/1000
1/1             0s 25ms/step - loss:
4.2282e-04
Epoch 359/1000
1/1             0s 23ms/step - loss:
4.2018e-04
Epoch 360/1000
1/1             0s 25ms/step - loss:
4.1757e-04
Epoch 361/1000
1/1             0s 25ms/step - loss:
4.1498e-04
Epoch 362/1000
1/1             0s 23ms/step - loss:
4.1242e-04
Epoch 363/1000
1/1             0s 26ms/step - loss:
4.0987e-04
Epoch 364/1000
1/1             0s 24ms/step - loss:
4.0736e-04
Epoch 365/1000
1/1             0s 22ms/step - loss:
4.0486e-04
Epoch 366/1000
1/1             0s 23ms/step - loss:
4.0239e-04
Epoch 367/1000
1/1             0s 23ms/step - loss:
3.9995e-04
Epoch 368/1000
1/1             0s 23ms/step - loss:
3.9752e-04
Epoch 369/1000
1/1             0s 24ms/step - loss:
3.9512e-04
Epoch 370/1000
1/1             0s 22ms/step - loss:
3.9274e-04
Epoch 371/1000
1/1             0s 24ms/step - loss:
```

```
3.9038e-04
Epoch 372/1000
1/1             0s 22ms/step - loss:
3.8804e-04
Epoch 373/1000
1/1             0s 24ms/step - loss:
3.8573e-04
Epoch 374/1000
1/1             0s 25ms/step - loss:
3.8343e-04
Epoch 375/1000
1/1             0s 33ms/step - loss:
3.8116e-04
Epoch 376/1000
1/1             0s 25ms/step - loss:
3.7890e-04
Epoch 377/1000
1/1             0s 25ms/step - loss:
3.7667e-04
Epoch 378/1000
1/1             0s 23ms/step - loss:
3.7446e-04
Epoch 379/1000
1/1             0s 24ms/step - loss:
3.7226e-04
Epoch 380/1000
1/1             0s 25ms/step - loss:
3.7009e-04
Epoch 381/1000
1/1             0s 24ms/step - loss:
3.6793e-04
Epoch 382/1000
1/1             0s 25ms/step - loss:
3.6580e-04
Epoch 383/1000
1/1             0s 25ms/step - loss:
3.6368e-04
Epoch 384/1000
1/1             0s 25ms/step - loss:
3.6158e-04
Epoch 385/1000
1/1             0s 25ms/step - loss:
3.5950e-04
Epoch 386/1000
1/1             0s 25ms/step - loss:
3.5744e-04
Epoch 387/1000
1/1             0s 25ms/step - loss:
```

```
3.5540e-04
Epoch 388/1000
1/1             0s 24ms/step - loss:
3.5337e-04
Epoch 389/1000
1/1             0s 26ms/step - loss:
3.5136e-04
Epoch 390/1000
1/1             0s 23ms/step - loss:
3.4937e-04
Epoch 391/1000
1/1             0s 27ms/step - loss:
3.4739e-04
Epoch 392/1000
1/1             0s 26ms/step - loss:
3.4544e-04
Epoch 393/1000
1/1             0s 26ms/step - loss:
3.4350e-04
Epoch 394/1000
1/1             0s 29ms/step - loss:
3.4157e-04
Epoch 395/1000
1/1             0s 24ms/step - loss:
3.3966e-04
Epoch 396/1000
1/1             0s 25ms/step - loss:
3.3777e-04
Epoch 397/1000
1/1             0s 25ms/step - loss:
3.3590e-04
Epoch 398/1000
1/1             0s 23ms/step - loss:
3.3404e-04
Epoch 399/1000
1/1             0s 29ms/step - loss:
3.3219e-04
Epoch 400/1000
1/1             0s 24ms/step - loss:
3.3036e-04
Epoch 401/1000
1/1             0s 23ms/step - loss:
3.2855e-04
Epoch 402/1000
1/1             0s 23ms/step - loss:
3.2675e-04
Epoch 403/1000
1/1             0s 23ms/step - loss:
```

```
3.2497e-04
Epoch 404/1000
1/1             0s 27ms/step - loss:
3.2320e-04
Epoch 405/1000
1/1             0s 25ms/step - loss:
3.2144e-04
Epoch 406/1000
1/1             0s 23ms/step - loss:
3.1970e-04
Epoch 407/1000
1/1             0s 25ms/step - loss:
3.1797e-04
Epoch 408/1000
1/1             0s 24ms/step - loss:
3.1626e-04
Epoch 409/1000
1/1             0s 23ms/step - loss:
3.1456e-04
Epoch 410/1000
1/1             0s 24ms/step - loss:
3.1288e-04
Epoch 411/1000
1/1             0s 23ms/step - loss:
3.1121e-04
Epoch 412/1000
1/1             0s 23ms/step - loss:
3.0955e-04
Epoch 413/1000
1/1             0s 25ms/step - loss:
3.0791e-04
Epoch 414/1000
1/1             0s 25ms/step - loss:
3.0628e-04
Epoch 415/1000
1/1             0s 24ms/step - loss:
3.0466e-04
Epoch 416/1000
1/1             0s 23ms/step - loss:
3.0306e-04
Epoch 417/1000
1/1             0s 26ms/step - loss:
3.0146e-04
Epoch 418/1000
1/1             0s 30ms/step - loss:
2.9988e-04
Epoch 419/1000
1/1             0s 27ms/step - loss:
```

```
2.9832e-04
Epoch 420/1000
1/1             0s 23ms/step - loss:
2.9676e-04
Epoch 421/1000
1/1             0s 27ms/step - loss:
2.9522e-04
Epoch 422/1000
1/1             0s 23ms/step - loss:
2.9369e-04
Epoch 423/1000
1/1             0s 24ms/step - loss:
2.9217e-04
Epoch 424/1000
1/1             0s 22ms/step - loss:
2.9067e-04
Epoch 425/1000
1/1             0s 23ms/step - loss:
2.8917e-04
Epoch 426/1000
1/1             0s 22ms/step - loss:
2.8769e-04
Epoch 427/1000
1/1             0s 22ms/step - loss:
2.8622e-04
Epoch 428/1000
1/1             0s 25ms/step - loss:
2.8476e-04
Epoch 429/1000
1/1             0s 23ms/step - loss:
2.8331e-04
Epoch 430/1000
1/1             0s 24ms/step - loss:
2.8187e-04
Epoch 431/1000
1/1             0s 22ms/step - loss:
2.8044e-04
Epoch 432/1000
1/1             0s 22ms/step - loss:
2.7903e-04
Epoch 433/1000
1/1             0s 27ms/step - loss:
2.7762e-04
Epoch 434/1000
1/1             0s 23ms/step - loss:
2.7623e-04
Epoch 435/1000
1/1             0s 25ms/step - loss:
```

```
2.7484e-04
Epoch 436/1000
1/1             0s 26ms/step - loss:
2.7347e-04
Epoch 437/1000
1/1             0s 25ms/step - loss:
2.7211e-04
Epoch 438/1000
1/1             0s 25ms/step - loss:
2.7075e-04
Epoch 439/1000
1/1             0s 22ms/step - loss:
2.6941e-04
Epoch 440/1000
1/1             0s 24ms/step - loss:
2.6808e-04
Epoch 441/1000
1/1             0s 23ms/step - loss:
2.6675e-04
Epoch 442/1000
1/1             0s 23ms/step - loss:
2.6544e-04
Epoch 443/1000
1/1             0s 23ms/step - loss:
2.6414e-04
Epoch 444/1000
1/1             0s 24ms/step - loss:
2.6284e-04
Epoch 445/1000
1/1             0s 23ms/step - loss:
2.6156e-04
Epoch 446/1000
1/1             0s 23ms/step - loss:
2.6029e-04
Epoch 447/1000
1/1             0s 23ms/step - loss:
2.5902e-04
Epoch 448/1000
1/1             0s 24ms/step - loss:
2.5776e-04
Epoch 449/1000
1/1             0s 23ms/step - loss:
2.5652e-04
Epoch 450/1000
1/1             0s 24ms/step - loss:
2.5528e-04
Epoch 451/1000
1/1             0s 23ms/step - loss:
```

```
2.5405e-04
Epoch 452/1000
1/1             0s 24ms/step - loss:
2.5283e-04
Epoch 453/1000
1/1             0s 23ms/step - loss:
2.5162e-04
Epoch 454/1000
1/1             0s 24ms/step - loss:
2.5042e-04
Epoch 455/1000
1/1             0s 25ms/step - loss:
2.4922e-04
Epoch 456/1000
1/1             0s 23ms/step - loss:
2.4804e-04
Epoch 457/1000
1/1             0s 24ms/step - loss:
2.4686e-04
Epoch 458/1000
1/1             0s 22ms/step - loss:
2.4569e-04
Epoch 459/1000
1/1             0s 23ms/step - loss:
2.4453e-04
Epoch 460/1000
1/1             0s 23ms/step - loss:
2.4338e-04
Epoch 461/1000
1/1             0s 23ms/step - loss:
2.4223e-04
Epoch 462/1000
1/1             0s 23ms/step - loss:
2.4110e-04
Epoch 463/1000
1/1             0s 24ms/step - loss:
2.3997e-04
Epoch 464/1000
1/1             0s 24ms/step - loss:
2.3885e-04
Epoch 465/1000
1/1             0s 31ms/step - loss:
2.3774e-04
Epoch 466/1000
1/1             0s 22ms/step - loss:
2.3664e-04
Epoch 467/1000
1/1             0s 24ms/step - loss:
```

```
2.3554e-04
Epoch 468/1000
1/1             0s 23ms/step - loss:
2.3445e-04
Epoch 469/1000
1/1             0s 23ms/step - loss:
2.3337e-04
Epoch 470/1000
1/1             0s 23ms/step - loss:
2.3229e-04
Epoch 471/1000
1/1             0s 23ms/step - loss:
2.3123e-04
Epoch 472/1000
1/1             0s 23ms/step - loss:
2.3017e-04
Epoch 473/1000
1/1             0s 24ms/step - loss:
2.2912e-04
Epoch 474/1000
1/1             0s 23ms/step - loss:
2.2807e-04
Epoch 475/1000
1/1             0s 23ms/step - loss:
2.2704e-04
Epoch 476/1000
1/1             0s 25ms/step - loss:
2.2601e-04
Epoch 477/1000
1/1             0s 23ms/step - loss:
2.2498e-04
Epoch 478/1000
1/1             0s 23ms/step - loss:
2.2397e-04
Epoch 479/1000
1/1             0s 23ms/step - loss:
2.2296e-04
Epoch 480/1000
1/1             0s 23ms/step - loss:
2.2195e-04
Epoch 481/1000
1/1             0s 23ms/step - loss:
2.2096e-04
Epoch 482/1000
1/1             0s 24ms/step - loss:
2.1997e-04
Epoch 483/1000
1/1             0s 22ms/step - loss:
```

```
2.1899e-04
Epoch 484/1000
1/1             0s 26ms/step - loss:
2.1801e-04
Epoch 485/1000
1/1             0s 24ms/step - loss:
2.1704e-04
Epoch 486/1000
1/1             0s 22ms/step - loss:
2.1608e-04
Epoch 487/1000
1/1             0s 24ms/step - loss:
2.1512e-04
Epoch 488/1000
1/1             0s 23ms/step - loss:
2.1417e-04
Epoch 489/1000
1/1             0s 23ms/step - loss:
2.1323e-04
Epoch 490/1000
1/1             0s 22ms/step - loss:
2.1229e-04
Epoch 491/1000
1/1             0s 23ms/step - loss:
2.1136e-04
Epoch 492/1000
1/1             0s 25ms/step - loss:
2.1043e-04
Epoch 493/1000
1/1             0s 24ms/step - loss:
2.0951e-04
Epoch 494/1000
1/1             0s 25ms/step - loss:
2.0860e-04
Epoch 495/1000
1/1             0s 23ms/step - loss:
2.0769e-04
Epoch 496/1000
1/1             0s 23ms/step - loss:
2.0679e-04
Epoch 497/1000
1/1             0s 24ms/step - loss:
2.0589e-04
Epoch 498/1000
1/1             0s 24ms/step - loss:
2.0500e-04
Epoch 499/1000
1/1             0s 23ms/step - loss:
```

```
2.0412e-04
Epoch 500/1000
1/1             0s 23ms/step - loss:
2.0324e-04
Epoch 501/1000
1/1             0s 23ms/step - loss:
2.0237e-04
Epoch 502/1000
1/1             0s 22ms/step - loss:
2.0150e-04
Epoch 503/1000
1/1             0s 23ms/step - loss:
2.0064e-04
Epoch 504/1000
1/1             0s 22ms/step - loss:
1.9978e-04
Epoch 505/1000
1/1             0s 22ms/step - loss:
1.9893e-04
Epoch 506/1000
1/1             0s 23ms/step - loss:
1.9809e-04
Epoch 507/1000
1/1             0s 22ms/step - loss:
1.9725e-04
Epoch 508/1000
1/1             0s 24ms/step - loss:
1.9641e-04
Epoch 509/1000
1/1             0s 22ms/step - loss:
1.9558e-04
Epoch 510/1000
1/1             0s 29ms/step - loss:
1.9476e-04
Epoch 511/1000
1/1             0s 27ms/step - loss:
1.9394e-04
Epoch 512/1000
1/1             0s 22ms/step - loss:
1.9313e-04
Epoch 513/1000
1/1             0s 23ms/step - loss:
1.9232e-04
Epoch 514/1000
1/1             0s 28ms/step - loss:
1.9152e-04
Epoch 515/1000
1/1             0s 23ms/step - loss:
```

```
1.9072e-04
Epoch 516/1000
1/1             0s 24ms/step - loss:
1.8992e-04
Epoch 517/1000
1/1             0s 23ms/step - loss:
1.8914e-04
Epoch 518/1000
1/1             0s 23ms/step - loss:
1.8835e-04
Epoch 519/1000
1/1             0s 28ms/step - loss:
1.8757e-04
Epoch 520/1000
1/1             0s 22ms/step - loss:
1.8680e-04
Epoch 521/1000
1/1             0s 25ms/step - loss:
1.8603e-04
Epoch 522/1000
1/1             0s 23ms/step - loss:
1.8527e-04
Epoch 523/1000
1/1             0s 23ms/step - loss:
1.8451e-04
Epoch 524/1000
1/1             0s 25ms/step - loss:
1.8375e-04
Epoch 525/1000
1/1             0s 24ms/step - loss:
1.8300e-04
Epoch 526/1000
1/1             0s 24ms/step - loss:
1.8225e-04
Epoch 527/1000
1/1             0s 27ms/step - loss:
1.8151e-04
Epoch 528/1000
1/1             0s 23ms/step - loss:
1.8078e-04
Epoch 529/1000
1/1             0s 23ms/step - loss:
1.8004e-04
Epoch 530/1000
1/1             0s 23ms/step - loss:
1.7931e-04
Epoch 531/1000
1/1             0s 30ms/step - loss:
```

```
1.7859e-04
Epoch 532/1000
1/1             0s 24ms/step - loss:
1.7787e-04
Epoch 533/1000
1/1             0s 23ms/step - loss:
1.7716e-04
Epoch 534/1000
1/1             0s 23ms/step - loss:
1.7645e-04
Epoch 535/1000
1/1             0s 27ms/step - loss:
1.7574e-04
Epoch 536/1000
1/1             0s 24ms/step - loss:
1.7504e-04
Epoch 537/1000
1/1             0s 23ms/step - loss:
1.7434e-04
Epoch 538/1000
1/1             0s 24ms/step - loss:
1.7365e-04
Epoch 539/1000
1/1             0s 23ms/step - loss:
1.7296e-04
Epoch 540/1000
1/1             0s 24ms/step - loss:
1.7227e-04
Epoch 541/1000
1/1             0s 25ms/step - loss:
1.7159e-04
Epoch 542/1000
1/1             0s 24ms/step - loss:
1.7091e-04
Epoch 543/1000
1/1             0s 25ms/step - loss:
1.7024e-04
Epoch 544/1000
1/1             0s 23ms/step - loss:
1.6957e-04
Epoch 545/1000
1/1             0s 24ms/step - loss:
1.6890e-04
Epoch 546/1000
1/1             0s 23ms/step - loss:
1.6824e-04
Epoch 547/1000
1/1             0s 30ms/step - loss:
```

```
1.6758e-04
Epoch 548/1000
1/1             0s 22ms/step - loss:
1.6693e-04
Epoch 549/1000
1/1             0s 25ms/step - loss:
1.6628e-04
Epoch 550/1000
1/1             0s 23ms/step - loss:
1.6563e-04
Epoch 551/1000
1/1             0s 32ms/step - loss:
1.6499e-04
Epoch 552/1000
1/1             0s 23ms/step - loss:
1.6435e-04
Epoch 553/1000
1/1             0s 25ms/step - loss:
1.6371e-04
Epoch 554/1000
1/1             0s 24ms/step - loss:
1.6308e-04
Epoch 555/1000
1/1             0s 22ms/step - loss:
1.6245e-04
Epoch 556/1000
1/1             0s 23ms/step - loss:
1.6183e-04
Epoch 557/1000
1/1             0s 24ms/step - loss:
1.6121e-04
Epoch 558/1000
1/1             0s 23ms/step - loss:
1.6059e-04
Epoch 559/1000
1/1             0s 23ms/step - loss:
1.5998e-04
Epoch 560/1000
1/1             0s 24ms/step - loss:
1.5937e-04
Epoch 561/1000
1/1             0s 27ms/step - loss:
1.5876e-04
Epoch 562/1000
1/1             0s 24ms/step - loss:
1.5816e-04
Epoch 563/1000
1/1             0s 23ms/step - loss:
```

```
1.5756e-04
Epoch 564/1000
1/1             0s 25ms/step - loss:
1.5696e-04
Epoch 565/1000
1/1             0s 25ms/step - loss:
1.5637e-04
Epoch 566/1000
1/1             0s 24ms/step - loss:
1.5578e-04
Epoch 567/1000
1/1             0s 24ms/step - loss:
1.5519e-04
Epoch 568/1000
1/1             0s 25ms/step - loss:
1.5461e-04
Epoch 569/1000
1/1             0s 23ms/step - loss:
1.5403e-04
Epoch 570/1000
1/1             0s 22ms/step - loss:
1.5345e-04
Epoch 571/1000
1/1             0s 24ms/step - loss:
1.5288e-04
Epoch 572/1000
1/1             0s 28ms/step - loss:
1.5231e-04
Epoch 573/1000
1/1             0s 28ms/step - loss:
1.5174e-04
Epoch 574/1000
1/1             0s 24ms/step - loss:
1.5118e-04
Epoch 575/1000
1/1             0s 24ms/step - loss:
1.5062e-04
Epoch 576/1000
1/1             0s 24ms/step - loss:
1.5006e-04
Epoch 577/1000
1/1             0s 25ms/step - loss:
1.4951e-04
Epoch 578/1000
1/1             0s 23ms/step - loss:
1.4896e-04
Epoch 579/1000
1/1             0s 23ms/step - loss:
```

```
1.4841e-04
Epoch 580/1000
1/1             0s 25ms/step - loss:
1.4786e-04
Epoch 581/1000
1/1             0s 26ms/step - loss:
1.4732e-04
Epoch 582/1000
1/1             0s 25ms/step - loss:
1.4678e-04
Epoch 583/1000
1/1             0s 24ms/step - loss:
1.4625e-04
Epoch 584/1000
1/1             0s 23ms/step - loss:
1.4571e-04
Epoch 585/1000
1/1             0s 24ms/step - loss:
1.4518e-04
Epoch 586/1000
1/1             0s 23ms/step - loss:
1.4466e-04
Epoch 587/1000
1/1             0s 23ms/step - loss:
1.4413e-04
Epoch 588/1000
1/1             0s 23ms/step - loss:
1.4361e-04
Epoch 589/1000
1/1             0s 23ms/step - loss:
1.4309e-04
Epoch 590/1000
1/1             0s 26ms/step - loss:
1.4258e-04
Epoch 591/1000
1/1             0s 23ms/step - loss:
1.4206e-04
Epoch 592/1000
1/1             0s 22ms/step - loss:
1.4155e-04
Epoch 593/1000
1/1             0s 24ms/step - loss:
1.4104e-04
Epoch 594/1000
1/1             0s 22ms/step - loss:
1.4054e-04
Epoch 595/1000
1/1             0s 25ms/step - loss:
```

```
1.4004e-04
Epoch 596/1000
1/1             0s 24ms/step - loss:
1.3954e-04
Epoch 597/1000
1/1             0s 25ms/step - loss:
1.3904e-04
Epoch 598/1000
1/1             0s 22ms/step - loss:
1.3855e-04
Epoch 599/1000
1/1             0s 24ms/step - loss:
1.3806e-04
Epoch 600/1000
1/1             0s 23ms/step - loss:
1.3757e-04
Epoch 601/1000
1/1             0s 22ms/step - loss:
1.3708e-04
Epoch 602/1000
1/1             0s 22ms/step - loss:
1.3660e-04
Epoch 603/1000
1/1             0s 26ms/step - loss:
1.3612e-04
Epoch 604/1000
1/1             0s 22ms/step - loss:
1.3564e-04
Epoch 605/1000
1/1             0s 24ms/step - loss:
1.3516e-04
Epoch 606/1000
1/1             0s 23ms/step - loss:
1.3469e-04
Epoch 607/1000
1/1             0s 23ms/step - loss:
1.3422e-04
Epoch 608/1000
1/1             0s 23ms/step - loss:
1.3375e-04
Epoch 609/1000
1/1             0s 24ms/step - loss:
1.3328e-04
Epoch 610/1000
1/1             0s 24ms/step - loss:
1.3282e-04
Epoch 611/1000
1/1             0s 23ms/step - loss:
```

```
1.3236e-04
Epoch 612/1000
1/1             0s 25ms/step - loss:
1.3190e-04
Epoch 613/1000
1/1             0s 23ms/step - loss:
1.3144e-04
Epoch 614/1000
1/1             0s 26ms/step - loss:
1.3099e-04
Epoch 615/1000
1/1             0s 22ms/step - loss:
1.3054e-04
Epoch 616/1000
1/1             0s 22ms/step - loss:
1.3009e-04
Epoch 617/1000
1/1             0s 22ms/step - loss:
1.2964e-04
Epoch 618/1000
1/1             0s 28ms/step - loss:
1.2919e-04
Epoch 619/1000
1/1             0s 22ms/step - loss:
1.2875e-04
Epoch 620/1000
1/1             0s 25ms/step - loss:
1.2831e-04
Epoch 621/1000
1/1             0s 24ms/step - loss:
1.2787e-04
Epoch 622/1000
1/1             0s 23ms/step - loss:
1.2744e-04
Epoch 623/1000
1/1             0s 24ms/step - loss:
1.2700e-04
Epoch 624/1000
1/1             0s 23ms/step - loss:
1.2657e-04
Epoch 625/1000
1/1             0s 27ms/step - loss:
1.2614e-04
Epoch 626/1000
1/1             0s 25ms/step - loss:
1.2572e-04
Epoch 627/1000
1/1             0s 26ms/step - loss:
```

```
1.2529e-04
Epoch 628/1000
1/1             0s 25ms/step - loss:
1.2487e-04
Epoch 629/1000
1/1             0s 24ms/step - loss:
1.2445e-04
Epoch 630/1000
1/1             0s 25ms/step - loss:
1.2403e-04
Epoch 631/1000
1/1             0s 23ms/step - loss:
1.2361e-04
Epoch 632/1000
1/1             0s 24ms/step - loss:
1.2320e-04
Epoch 633/1000
1/1             0s 26ms/step - loss:
1.2279e-04
Epoch 634/1000
1/1             0s 23ms/step - loss:
1.2238e-04
Epoch 635/1000
1/1             0s 23ms/step - loss:
1.2197e-04
Epoch 636/1000
1/1             0s 26ms/step - loss:
1.2156e-04
Epoch 637/1000
1/1             0s 24ms/step - loss:
1.2116e-04
Epoch 638/1000
1/1             0s 24ms/step - loss:
1.2076e-04
Epoch 639/1000
1/1             0s 24ms/step - loss:
1.2036e-04
Epoch 640/1000
1/1             0s 24ms/step - loss:
1.1996e-04
Epoch 641/1000
1/1             0s 23ms/step - loss:
1.1956e-04
Epoch 642/1000
1/1             0s 24ms/step - loss:
1.1917e-04
Epoch 643/1000
1/1             0s 22ms/step - loss:
```

```
1.1878e-04
Epoch 644/1000
1/1             0s 22ms/step - loss:
1.1839e-04
Epoch 645/1000
1/1             0s 28ms/step - loss:
1.1800e-04
Epoch 646/1000
1/1             0s 24ms/step - loss:
1.1761e-04
Epoch 647/1000
1/1             0s 26ms/step - loss:
1.1723e-04
Epoch 648/1000
1/1             0s 22ms/step - loss:
1.1685e-04
Epoch 649/1000
1/1             0s 26ms/step - loss:
1.1647e-04
Epoch 650/1000
1/1             0s 22ms/step - loss:
1.1609e-04
Epoch 651/1000
1/1             0s 24ms/step - loss:
1.1571e-04
Epoch 652/1000
1/1             0s 22ms/step - loss:
1.1534e-04
Epoch 653/1000
1/1             0s 24ms/step - loss:
1.1496e-04
Epoch 654/1000
1/1             0s 24ms/step - loss:
1.1459e-04
Epoch 655/1000
1/1             0s 23ms/step - loss:
1.1422e-04
Epoch 656/1000
1/1             0s 23ms/step - loss:
1.1385e-04
Epoch 657/1000
1/1             0s 23ms/step - loss:
1.1349e-04
Epoch 658/1000
1/1             0s 22ms/step - loss:
1.1312e-04
Epoch 659/1000
1/1             0s 22ms/step - loss:
```

```
1.1276e-04
Epoch 660/1000
1/1             0s 25ms/step - loss:
1.1240e-04
Epoch 661/1000
1/1             0s 24ms/step - loss:
1.1204e-04
Epoch 662/1000
1/1             0s 22ms/step - loss:
1.1168e-04
Epoch 663/1000
1/1             0s 26ms/step - loss:
1.1133e-04
Epoch 664/1000
1/1             0s 24ms/step - loss:
1.1097e-04
Epoch 665/1000
1/1             0s 26ms/step - loss:
1.1062e-04
Epoch 666/1000
1/1             0s 22ms/step - loss:
1.1027e-04
Epoch 667/1000
1/1             0s 22ms/step - loss:
1.0992e-04
Epoch 668/1000
1/1             0s 23ms/step - loss:
1.0957e-04
Epoch 669/1000
1/1             0s 23ms/step - loss:
1.0923e-04
Epoch 670/1000
1/1             0s 22ms/step - loss:
1.0888e-04
Epoch 671/1000
1/1             0s 27ms/step - loss:
1.0854e-04
Epoch 672/1000
1/1             0s 24ms/step - loss:
1.0820e-04
Epoch 673/1000
1/1             0s 22ms/step - loss:
1.0786e-04
Epoch 674/1000
1/1             0s 23ms/step - loss:
1.0752e-04
Epoch 675/1000
1/1             0s 24ms/step - loss:
```

```
1.0719e-04
Epoch 676/1000
1/1             0s 23ms/step - loss:
1.0685e-04
Epoch 677/1000
1/1             0s 24ms/step - loss:
1.0652e-04
Epoch 678/1000
1/1             0s 24ms/step - loss:
1.0619e-04
Epoch 679/1000
1/1             0s 23ms/step - loss:
1.0586e-04
Epoch 680/1000
1/1             0s 23ms/step - loss:
1.0553e-04
Epoch 681/1000
1/1             0s 26ms/step - loss:
1.0520e-04
Epoch 682/1000
1/1             0s 22ms/step - loss:
1.0488e-04
Epoch 683/1000
1/1             0s 22ms/step - loss:
1.0455e-04
Epoch 684/1000
1/1             0s 23ms/step - loss:
1.0423e-04
Epoch 685/1000
1/1             0s 28ms/step - loss:
1.0391e-04
Epoch 686/1000
1/1             0s 23ms/step - loss:
1.0359e-04
Epoch 687/1000
1/1             0s 23ms/step - loss:
1.0327e-04
Epoch 688/1000
1/1             0s 26ms/step - loss:
1.0296e-04
Epoch 689/1000
1/1             0s 22ms/step - loss:
1.0264e-04
Epoch 690/1000
1/1             0s 23ms/step - loss:
1.0233e-04
Epoch 691/1000
1/1             0s 24ms/step - loss:
```

```
1.0202e-04
Epoch 692/1000
1/1             0s 23ms/step - loss:
1.0170e-04
Epoch 693/1000
1/1             0s 24ms/step - loss:
1.0139e-04
Epoch 694/1000
1/1             0s 30ms/step - loss:
1.0109e-04
Epoch 695/1000
1/1             0s 26ms/step - loss:
1.0078e-04
Epoch 696/1000
1/1             0s 23ms/step - loss:
1.0048e-04
Epoch 697/1000
1/1             0s 23ms/step - loss:
1.0017e-04
Epoch 698/1000
1/1             0s 23ms/step - loss:
9.9869e-05
Epoch 699/1000
1/1             0s 25ms/step - loss:
9.9568e-05
Epoch 700/1000
1/1             0s 24ms/step - loss:
9.9268e-05
Epoch 701/1000
1/1             0s 23ms/step - loss:
9.8970e-05
Epoch 702/1000
1/1             0s 23ms/step - loss:
9.8673e-05
Epoch 703/1000
1/1             0s 23ms/step - loss:
9.8377e-05
Epoch 704/1000
1/1             0s 23ms/step - loss:
9.8083e-05
Epoch 705/1000
1/1             0s 22ms/step - loss:
9.7790e-05
Epoch 706/1000
1/1             0s 23ms/step - loss:
9.7498e-05
Epoch 707/1000
1/1             0s 26ms/step - loss:
```

```
9.7207e-05
Epoch 708/1000
1/1             0s 23ms/step - loss:
9.6918e-05
Epoch 709/1000
1/1             0s 26ms/step - loss:
9.6630e-05
Epoch 710/1000
1/1             0s 25ms/step - loss:
9.6344e-05
Epoch 711/1000
1/1             0s 23ms/step - loss:
9.6059e-05
Epoch 712/1000
1/1             0s 28ms/step - loss:
9.5774e-05
Epoch 713/1000
1/1             0s 24ms/step - loss:
9.5492e-05
Epoch 714/1000
1/1             0s 24ms/step - loss:
9.5210e-05
Epoch 715/1000
1/1             0s 26ms/step - loss:
9.4930e-05
Epoch 716/1000
1/1             0s 26ms/step - loss:
9.4651e-05
Epoch 717/1000
1/1             0s 25ms/step - loss:
9.4372e-05
Epoch 718/1000
1/1             0s 27ms/step - loss:
9.4096e-05
Epoch 719/1000
1/1             0s 25ms/step - loss:
9.3820e-05
Epoch 720/1000
1/1             0s 24ms/step - loss:
9.3546e-05
Epoch 721/1000
1/1             0s 23ms/step - loss:
9.3273e-05
Epoch 722/1000
1/1             0s 24ms/step - loss:
9.3001e-05
Epoch 723/1000
1/1             0s 22ms/step - loss:
```

```
9.2730e-05
Epoch 724/1000
1/1             0s 24ms/step - loss:
9.2461e-05
Epoch 725/1000
1/1             0s 26ms/step - loss:
9.2192e-05
Epoch 726/1000
1/1             0s 24ms/step - loss:
9.1925e-05
Epoch 727/1000
1/1             0s 23ms/step - loss:
9.1659e-05
Epoch 728/1000
1/1             0s 24ms/step - loss:
9.1394e-05
Epoch 729/1000
1/1             0s 23ms/step - loss:
9.1130e-05
Epoch 730/1000
1/1             0s 22ms/step - loss:
9.0868e-05
Epoch 731/1000
1/1             0s 22ms/step - loss:
9.0606e-05
Epoch 732/1000
1/1             0s 25ms/step - loss:
9.0346e-05
Epoch 733/1000
1/1             0s 26ms/step - loss:
9.0086e-05
Epoch 734/1000
1/1             0s 23ms/step - loss:
8.9828e-05
Epoch 735/1000
1/1             0s 23ms/step - loss:
8.9571e-05
Epoch 736/1000
1/1             0s 23ms/step - loss:
8.9315e-05
Epoch 737/1000
1/1             0s 23ms/step - loss:
8.9060e-05
Epoch 738/1000
1/1             0s 26ms/step - loss:
8.8806e-05
Epoch 739/1000
1/1             0s 24ms/step - loss:
```

```
8.8554e-05
Epoch 740/1000
1/1             0s 22ms/step - loss:
8.8302e-05
Epoch 741/1000
1/1             0s 26ms/step - loss:
8.8051e-05
Epoch 742/1000
1/1             0s 23ms/step - loss:
8.7802e-05
Epoch 743/1000
1/1             0s 24ms/step - loss:
8.7553e-05
Epoch 744/1000
1/1             0s 25ms/step - loss:
8.7306e-05
Epoch 745/1000
1/1             0s 23ms/step - loss:
8.7059e-05
Epoch 746/1000
1/1             0s 24ms/step - loss:
8.6814e-05
Epoch 747/1000
1/1             0s 26ms/step - loss:
8.6570e-05
Epoch 748/1000
1/1             0s 23ms/step - loss:
8.6326e-05
Epoch 749/1000
1/1             0s 23ms/step - loss:
8.6084e-05
Epoch 750/1000
1/1             0s 24ms/step - loss:
8.5842e-05
Epoch 751/1000
1/1             0s 23ms/step - loss:
8.5602e-05
Epoch 752/1000
1/1             0s 23ms/step - loss:
8.5363e-05
Epoch 753/1000
1/1             0s 23ms/step - loss:
8.5124e-05
Epoch 754/1000
1/1             0s 23ms/step - loss:
8.4887e-05
Epoch 755/1000
1/1             0s 23ms/step - loss:
```

```
8.4651e-05
Epoch 756/1000
1/1             0s 24ms/step - loss:
8.4415e-05
Epoch 757/1000
1/1             0s 24ms/step - loss:
8.4181e-05
Epoch 758/1000
1/1             0s 23ms/step - loss:
8.3947e-05
Epoch 759/1000
1/1             0s 25ms/step - loss:
8.3715e-05
Epoch 760/1000
1/1             0s 22ms/step - loss:
8.3484e-05
Epoch 761/1000
1/1             0s 24ms/step - loss:
8.3253e-05
Epoch 762/1000
1/1             0s 23ms/step - loss:
8.3023e-05
Epoch 763/1000
1/1             0s 24ms/step - loss:
8.2794e-05
Epoch 764/1000
1/1             0s 27ms/step - loss:
8.2567e-05
Epoch 765/1000
1/1             0s 24ms/step - loss:
8.2340e-05
Epoch 766/1000
1/1             0s 27ms/step - loss:
8.2114e-05
Epoch 767/1000
1/1             0s 23ms/step - loss:
8.1889e-05
Epoch 768/1000
1/1             0s 23ms/step - loss:
8.1665e-05
Epoch 769/1000
1/1             0s 23ms/step - loss:
8.1442e-05
Epoch 770/1000
1/1             0s 22ms/step - loss:
8.1220e-05
Epoch 771/1000
1/1             0s 24ms/step - loss:
```

```
8.0998e-05
Epoch 772/1000
1/1             0s 23ms/step - loss:
8.0778e-05
Epoch 773/1000
1/1             0s 23ms/step - loss:
8.0558e-05
Epoch 774/1000
1/1             0s 24ms/step - loss:
8.0340e-05
Epoch 775/1000
1/1             0s 24ms/step - loss:
8.0122e-05
Epoch 776/1000
1/1             0s 23ms/step - loss:
7.9905e-05
Epoch 777/1000
1/1             0s 23ms/step - loss:
7.9689e-05
Epoch 778/1000
1/1             0s 25ms/step - loss:
7.9473e-05
Epoch 779/1000
1/1             0s 27ms/step - loss:
7.9259e-05
Epoch 780/1000
1/1             0s 24ms/step - loss:
7.9046e-05
Epoch 781/1000
1/1             0s 25ms/step - loss:
7.8833e-05
Epoch 782/1000
1/1             0s 23ms/step - loss:
7.8621e-05
Epoch 783/1000
1/1             0s 23ms/step - loss:
7.8410e-05
Epoch 784/1000
1/1             0s 23ms/step - loss:
7.8200e-05
Epoch 785/1000
1/1             0s 24ms/step - loss:
7.7991e-05
Epoch 786/1000
1/1             0s 26ms/step - loss:
7.7782e-05
Epoch 787/1000
1/1             0s 23ms/step - loss:
```

```
7.7575e-05
Epoch 788/1000
1/1             0s 22ms/step - loss:
7.7368e-05
Epoch 789/1000
1/1             0s 26ms/step - loss:
7.7162e-05
Epoch 790/1000
1/1             0s 24ms/step - loss:
7.6957e-05
Epoch 791/1000
1/1             0s 23ms/step - loss:
7.6753e-05
Epoch 792/1000
1/1             0s 24ms/step - loss:
7.6549e-05
Epoch 793/1000
1/1             0s 24ms/step - loss:
7.6346e-05
Epoch 794/1000
1/1             0s 24ms/step - loss:
7.6144e-05
Epoch 795/1000
1/1             0s 23ms/step - loss:
7.5943e-05
Epoch 796/1000
1/1             0s 31ms/step - loss:
7.5743e-05
Epoch 797/1000
1/1             0s 22ms/step - loss:
7.5543e-05
Epoch 798/1000
1/1             0s 24ms/step - loss:
7.5344e-05
Epoch 799/1000
1/1             0s 24ms/step - loss:
7.5146e-05
Epoch 800/1000
1/1             0s 23ms/step - loss:
7.4949e-05
Epoch 801/1000
1/1             0s 26ms/step - loss:
7.4752e-05
Epoch 802/1000
1/1             0s 23ms/step - loss:
7.4557e-05
Epoch 803/1000
1/1             0s 24ms/step - loss:
```

```
7.4362e-05
Epoch 804/1000
1/1             0s 24ms/step - loss:
7.4167e-05
Epoch 805/1000
1/1             0s 23ms/step - loss:
7.3974e-05
Epoch 806/1000
1/1             0s 23ms/step - loss:
7.3781e-05
Epoch 807/1000
1/1             0s 23ms/step - loss:
7.3589e-05
Epoch 808/1000
1/1             0s 23ms/step - loss:
7.3398e-05
Epoch 809/1000
1/1             0s 24ms/step - loss:
7.3207e-05
Epoch 810/1000
1/1             0s 27ms/step - loss:
7.3018e-05
Epoch 811/1000
1/1             0s 25ms/step - loss:
7.2828e-05
Epoch 812/1000
1/1             0s 28ms/step - loss:
7.2640e-05
Epoch 813/1000
1/1             0s 23ms/step - loss:
7.2453e-05
Epoch 814/1000
1/1             0s 24ms/step - loss:
7.2266e-05
Epoch 815/1000
1/1             0s 24ms/step - loss:
7.2079e-05
Epoch 816/1000
1/1             0s 24ms/step - loss:
7.1894e-05
Epoch 817/1000
1/1             0s 23ms/step - loss:
7.1709e-05
Epoch 818/1000
1/1             0s 23ms/step - loss:
7.1525e-05
Epoch 819/1000
1/1             0s 25ms/step - loss:
```

```
7.1342e-05
Epoch 820/1000
1/1             0s 24ms/step - loss:
7.1159e-05
Epoch 821/1000
1/1             0s 23ms/step - loss:
7.0977e-05
Epoch 822/1000
1/1             0s 23ms/step - loss:
7.0796e-05
Epoch 823/1000
1/1             0s 26ms/step - loss:
7.0615e-05
Epoch 824/1000
1/1             0s 25ms/step - loss:
7.0435e-05
Epoch 825/1000
1/1             0s 24ms/step - loss:
7.0256e-05
Epoch 826/1000
1/1             0s 27ms/step - loss:
7.0077e-05
Epoch 827/1000
1/1             0s 24ms/step - loss:
6.9900e-05
Epoch 828/1000
1/1             0s 24ms/step - loss:
6.9722e-05
Epoch 829/1000
1/1             0s 24ms/step - loss:
6.9546e-05
Epoch 830/1000
1/1             0s 23ms/step - loss:
6.9370e-05
Epoch 831/1000
1/1             0s 24ms/step - loss:
6.9195e-05
Epoch 832/1000
1/1             0s 24ms/step - loss:
6.9020e-05
Epoch 833/1000
1/1             0s 28ms/step - loss:
6.8846e-05
Epoch 834/1000
1/1             0s 22ms/step - loss:
6.8673e-05
Epoch 835/1000
1/1             0s 23ms/step - loss:
```

```
6.8500e-05
Epoch 836/1000
1/1             0s 23ms/step - loss:
6.8328e-05
Epoch 837/1000
1/1             0s 25ms/step - loss:
6.8156e-05
Epoch 838/1000
1/1             0s 23ms/step - loss:
6.7986e-05
Epoch 839/1000
1/1             0s 24ms/step - loss:
6.7816e-05
Epoch 840/1000
1/1             0s 24ms/step - loss:
6.7646e-05
Epoch 841/1000
1/1             0s 29ms/step - loss:
6.7477e-05
Epoch 842/1000
1/1             0s 23ms/step - loss:
6.7309e-05
Epoch 843/1000
1/1             0s 24ms/step - loss:
6.7141e-05
Epoch 844/1000
1/1             0s 24ms/step - loss:
6.6974e-05
Epoch 845/1000
1/1             0s 29ms/step - loss:
6.6808e-05
Epoch 846/1000
1/1             0s 22ms/step - loss:
6.6642e-05
Epoch 847/1000
1/1             0s 24ms/step - loss:
6.6477e-05
Epoch 848/1000
1/1             0s 24ms/step - loss:
6.6312e-05
Epoch 849/1000
1/1             0s 24ms/step - loss:
6.6148e-05
Epoch 850/1000
1/1             0s 24ms/step - loss:
6.5985e-05
Epoch 851/1000
1/1             0s 23ms/step - loss:
```

```
6.5822e-05
Epoch 852/1000
1/1             0s 24ms/step - loss:
6.5660e-05
Epoch 853/1000
1/1             0s 27ms/step - loss:
6.5498e-05
Epoch 854/1000
1/1             0s 26ms/step - loss:
6.5337e-05
Epoch 855/1000
1/1             0s 22ms/step - loss:
6.5177e-05
Epoch 856/1000
1/1             0s 26ms/step - loss:
6.5017e-05
Epoch 857/1000
1/1             0s 26ms/step - loss:
6.4858e-05
Epoch 858/1000
1/1             0s 23ms/step - loss:
6.4699e-05
Epoch 859/1000
1/1             0s 23ms/step - loss:
6.4541e-05
Epoch 860/1000
1/1             0s 23ms/step - loss:
6.4383e-05
Epoch 861/1000
1/1             0s 25ms/step - loss:
6.4226e-05
Epoch 862/1000
1/1             0s 24ms/step - loss:
6.4070e-05
Epoch 863/1000
1/1             0s 25ms/step - loss:
6.3914e-05
Epoch 864/1000
1/1             0s 27ms/step - loss:
6.3759e-05
Epoch 865/1000
1/1             0s 25ms/step - loss:
6.3604e-05
Epoch 866/1000
1/1             0s 23ms/step - loss:
6.3450e-05
Epoch 867/1000
1/1             0s 23ms/step - loss:
```

```
6.3296e-05
Epoch 868/1000
1/1             0s 24ms/step - loss:
6.3143e-05
Epoch 869/1000
1/1             0s 24ms/step - loss:
6.2990e-05
Epoch 870/1000
1/1             0s 24ms/step - loss:
6.2838e-05
Epoch 871/1000
1/1             0s 24ms/step - loss:
6.2687e-05
Epoch 872/1000
1/1             0s 25ms/step - loss:
6.2536e-05
Epoch 873/1000
1/1             0s 23ms/step - loss:
6.2385e-05
Epoch 874/1000
1/1             0s 24ms/step - loss:
6.2236e-05
Epoch 875/1000
1/1             0s 24ms/step - loss:
6.2086e-05
Epoch 876/1000
1/1             0s 24ms/step - loss:
6.1937e-05
Epoch 877/1000
1/1             0s 24ms/step - loss:
6.1789e-05
Epoch 878/1000
1/1             0s 26ms/step - loss:
6.1641e-05
Epoch 879/1000
1/1             0s 23ms/step - loss:
6.1494e-05
Epoch 880/1000
1/1             0s 24ms/step - loss:
6.1347e-05
Epoch 881/1000
1/1             0s 23ms/step - loss:
6.1201e-05
Epoch 882/1000
1/1             0s 24ms/step - loss:
6.1055e-05
Epoch 883/1000
1/1             0s 23ms/step - loss:
```

```
6.0910e-05
Epoch 884/1000
1/1             0s 23ms/step - loss:
6.0765e-05
Epoch 885/1000
1/1             0s 23ms/step - loss:
6.0621e-05
Epoch 886/1000
1/1             0s 23ms/step - loss:
6.0478e-05
Epoch 887/1000
1/1             0s 24ms/step - loss:
6.0334e-05
Epoch 888/1000
1/1             0s 23ms/step - loss:
6.0192e-05
Epoch 889/1000
1/1             0s 23ms/step - loss:
6.0049e-05
Epoch 890/1000
1/1             0s 23ms/step - loss:
5.9908e-05
Epoch 891/1000
1/1             0s 24ms/step - loss:
5.9767e-05
Epoch 892/1000
1/1             0s 23ms/step - loss:
5.9626e-05
Epoch 893/1000
1/1             0s 23ms/step - loss:
5.9486e-05
Epoch 894/1000
1/1             0s 23ms/step - loss:
5.9346e-05
Epoch 895/1000
1/1             0s 25ms/step - loss:
5.9207e-05
Epoch 896/1000
1/1             0s 24ms/step - loss:
5.9068e-05
Epoch 897/1000
1/1             0s 24ms/step - loss:
5.8930e-05
Epoch 898/1000
1/1             0s 24ms/step - loss:
5.8792e-05
Epoch 899/1000
1/1             0s 22ms/step - loss:
```

```
5.8654e-05
Epoch 900/1000
1/1             0s 23ms/step - loss:
5.8518e-05
Epoch 901/1000
1/1             0s 23ms/step - loss:
5.8381e-05
Epoch 902/1000
1/1             0s 22ms/step - loss:
5.8245e-05
Epoch 903/1000
1/1             0s 24ms/step - loss:
5.8110e-05
Epoch 904/1000
1/1             0s 22ms/step - loss:
5.7975e-05
Epoch 905/1000
1/1             0s 23ms/step - loss:
5.7840e-05
Epoch 906/1000
1/1             0s 23ms/step - loss:
5.7706e-05
Epoch 907/1000
1/1             0s 24ms/step - loss:
5.7572e-05
Epoch 908/1000
1/1             0s 23ms/step - loss:
5.7439e-05
Epoch 909/1000
1/1             0s 23ms/step - loss:
5.7307e-05
Epoch 910/1000
1/1             0s 23ms/step - loss:
5.7174e-05
Epoch 911/1000
1/1             0s 23ms/step - loss:
5.7043e-05
Epoch 912/1000
1/1             0s 23ms/step - loss:
5.6911e-05
Epoch 913/1000
1/1             0s 23ms/step - loss:
5.6780e-05
Epoch 914/1000
1/1             0s 24ms/step - loss:
5.6649e-05
Epoch 915/1000
1/1             0s 24ms/step - loss:
```

```
5.6520e-05
Epoch 916/1000
1/1             0s 24ms/step - loss:
5.6390e-05
Epoch 917/1000
1/1             0s 22ms/step - loss:
5.6261e-05
Epoch 918/1000
1/1             0s 24ms/step - loss:
5.6132e-05
Epoch 919/1000
1/1             0s 24ms/step - loss:
5.6004e-05
Epoch 920/1000
1/1             0s 22ms/step - loss:
5.5876e-05
Epoch 921/1000
1/1             0s 23ms/step - loss:
5.5748e-05
Epoch 922/1000
1/1             0s 25ms/step - loss:
5.5621e-05
Epoch 923/1000
1/1             0s 23ms/step - loss:
5.5495e-05
Epoch 924/1000
1/1             0s 24ms/step - loss:
5.5368e-05
Epoch 925/1000
1/1             0s 24ms/step - loss:
5.5243e-05
Epoch 926/1000
1/1             0s 22ms/step - loss:
5.5117e-05
Epoch 927/1000
1/1             0s 23ms/step - loss:
5.4992e-05
Epoch 928/1000
1/1             0s 24ms/step - loss:
5.4868e-05
Epoch 929/1000
1/1             0s 26ms/step - loss:
5.4744e-05
Epoch 930/1000
1/1             0s 24ms/step - loss:
5.4620e-05
Epoch 931/1000
1/1             0s 23ms/step - loss:
```

```
5.4497e-05
Epoch 932/1000
1/1             0s 23ms/step - loss:
5.4374e-05
Epoch 933/1000
1/1             0s 25ms/step - loss:
5.4251e-05
Epoch 934/1000
1/1             0s 24ms/step - loss:
5.4129e-05
Epoch 935/1000
1/1             0s 24ms/step - loss:
5.4008e-05
Epoch 936/1000
1/1             0s 25ms/step - loss:
5.3887e-05
Epoch 937/1000
1/1             0s 24ms/step - loss:
5.3766e-05
Epoch 938/1000
1/1             0s 24ms/step - loss:
5.3645e-05
Epoch 939/1000
1/1             0s 25ms/step - loss:
5.3525e-05
Epoch 940/1000
1/1             0s 25ms/step - loss:
5.3405e-05
Epoch 941/1000
1/1             0s 24ms/step - loss:
5.3286e-05
Epoch 942/1000
1/1             0s 24ms/step - loss:
5.3167e-05
Epoch 943/1000
1/1             0s 24ms/step - loss:
5.3048e-05
Epoch 944/1000
1/1             0s 23ms/step - loss:
5.2930e-05
Epoch 945/1000
1/1             0s 24ms/step - loss:
5.2813e-05
Epoch 946/1000
1/1             0s 23ms/step - loss:
5.2695e-05
Epoch 947/1000
1/1             0s 22ms/step - loss:
```

```
5.2578e-05
Epoch 948/1000
1/1             0s 24ms/step - loss:
5.2462e-05
Epoch 949/1000
1/1             0s 23ms/step - loss:
5.2346e-05
Epoch 950/1000
1/1             0s 25ms/step - loss:
5.2230e-05
Epoch 951/1000
1/1             0s 24ms/step - loss:
5.2114e-05
Epoch 952/1000
1/1             0s 24ms/step - loss:
5.1999e-05
Epoch 953/1000
1/1             0s 26ms/step - loss:
5.1884e-05
Epoch 954/1000
1/1             0s 24ms/step - loss:
5.1770e-05
Epoch 955/1000
1/1             0s 22ms/step - loss:
5.1656e-05
Epoch 956/1000
1/1             0s 23ms/step - loss:
5.1543e-05
Epoch 957/1000
1/1             0s 23ms/step - loss:
5.1429e-05
Epoch 958/1000
1/1             0s 24ms/step - loss:
5.1316e-05
Epoch 959/1000
1/1             0s 24ms/step - loss:
5.1204e-05
Epoch 960/1000
1/1             0s 23ms/step - loss:
5.1092e-05
Epoch 961/1000
1/1             0s 27ms/step - loss:
5.0980e-05
Epoch 962/1000
1/1             0s 23ms/step - loss:
5.0869e-05
Epoch 963/1000
1/1             0s 24ms/step - loss:
```

```
5.0757e-05
Epoch 964/1000
1/1             0s 23ms/step - loss:
5.0647e-05
Epoch 965/1000
1/1             0s 23ms/step - loss:
5.0536e-05
Epoch 966/1000
1/1             0s 24ms/step - loss:
5.0426e-05
Epoch 967/1000
1/1             0s 25ms/step - loss:
5.0316e-05
Epoch 968/1000
1/1             0s 22ms/step - loss:
5.0207e-05
Epoch 969/1000
1/1             0s 24ms/step - loss:
5.0098e-05
Epoch 970/1000
1/1             0s 25ms/step - loss:
4.9990e-05
Epoch 971/1000
1/1             0s 27ms/step - loss:
4.9881e-05
Epoch 972/1000
1/1             0s 28ms/step - loss:
4.9774e-05
Epoch 973/1000
1/1             0s 28ms/step - loss:
4.9666e-05
Epoch 974/1000
1/1             0s 28ms/step - loss:
4.9559e-05
Epoch 975/1000
1/1             0s 28ms/step - loss:
4.9452e-05
Epoch 976/1000
1/1             0s 29ms/step - loss:
4.9345e-05
Epoch 977/1000
1/1             0s 23ms/step - loss:
4.9239e-05
Epoch 978/1000
1/1             0s 22ms/step - loss:
4.9133e-05
Epoch 979/1000
1/1             0s 27ms/step - loss:
```

```
4.9027e-05
Epoch 980/1000
1/1             0s 26ms/step - loss:
4.8922e-05
Epoch 981/1000
1/1             0s 22ms/step - loss:
4.8817e-05
Epoch 982/1000
1/1             0s 23ms/step - loss:
4.8713e-05
Epoch 983/1000
1/1             0s 28ms/step - loss:
4.8608e-05
Epoch 984/1000
1/1             0s 25ms/step - loss:
4.8504e-05
Epoch 985/1000
1/1             0s 26ms/step - loss:
4.8401e-05
Epoch 986/1000
1/1             0s 24ms/step - loss:
4.8297e-05
Epoch 987/1000
1/1             0s 24ms/step - loss:
4.8194e-05
Epoch 988/1000
1/1             0s 28ms/step - loss:
4.8092e-05
Epoch 989/1000
1/1             0s 24ms/step - loss:
4.7989e-05
Epoch 990/1000
1/1             0s 30ms/step - loss:
4.7887e-05
Epoch 991/1000
1/1             0s 27ms/step - loss:
4.7786e-05
Epoch 992/1000
1/1             0s 25ms/step - loss:
4.7684e-05
Epoch 993/1000
1/1             0s 25ms/step - loss:
4.7583e-05
Epoch 994/1000
1/1             0s 27ms/step - loss:
4.7483e-05
Epoch 995/1000
1/1             0s 26ms/step - loss:
```

```
4.7382e-05
Epoch 996/1000
1/1             0s 27ms/step - loss:
4.7282e-05
Epoch 997/1000
1/1             0s 24ms/step - loss:
4.7182e-05
Epoch 998/1000
1/1             0s 26ms/step - loss:
4.7083e-05
Epoch 999/1000
1/1             0s 25ms/step - loss:
4.6983e-05
Epoch 1000/1000
1/1             0s 26ms/step - loss:
4.6884e-05
```

[14]:
```
# What does the trained model do with the inputs?
model.predict(ins)
```

```
1/1             0s 19ms/step
```

[14]:
```
array([[0.007444  ],
       [0.9923087 ],
       [0.9940775 ],
       [0.00612354]], dtype=float32)
```

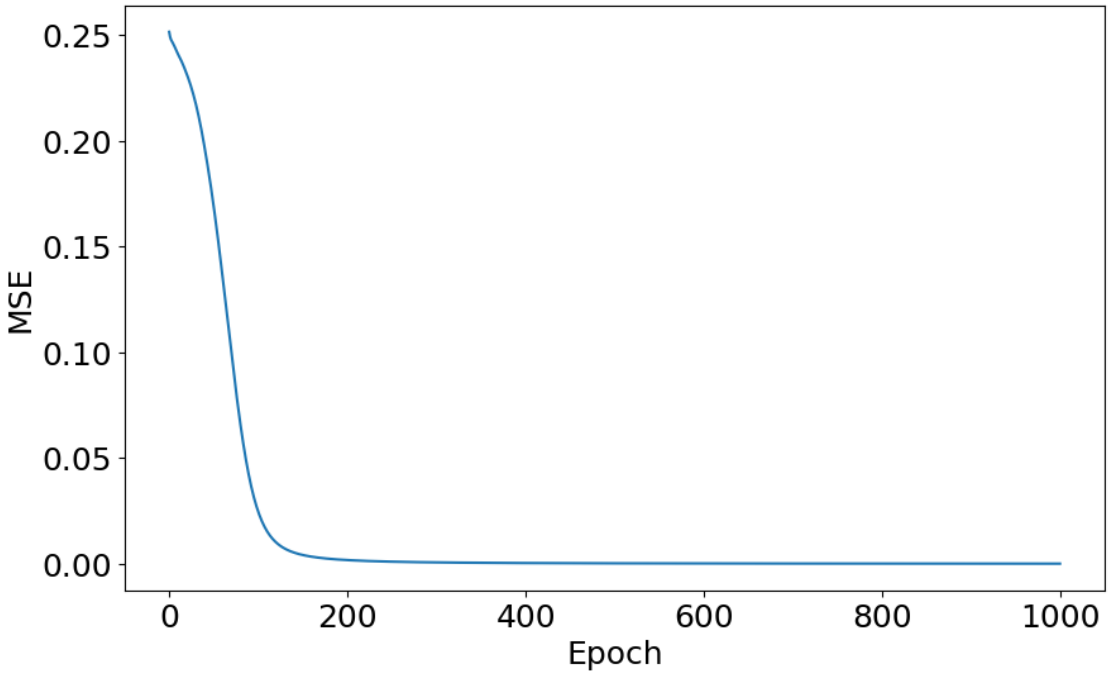
[15]:
```
# What is the performance of the trained model?
#  This shows loss
model.evaluate(ins, outs)
```

```
1/1             0s 20ms/step - loss:
4.6786e-05
```

[15]:
```
4.6785826270934194e-05
```

[12]:
```
# Display learning curve
plt.plot(history.history['loss'])
plt.xlabel('Epoch')
plt.ylabel('MSE')
```

[12]:
```
Text(0, 0.5, 'MSE')
```


0.25
0.20
0.15
0.10
0.05
0.00
MSE
0
200
400
600
800
1000
Epoch

[ ]:

[ ]: