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Video 13.1 https://www.youtube.com/watch?v=kIGHE7Cfe1s

Video 13.2 https://www.youtube.com/watch?v=Rm9bJcDd1KU

Video 13.3 https://youtu.be/6HjZk-3LsjE

```
In [1]:  from keras.callbacks import TensorBoard
         from keras.layers import Input, Dense
         from keras.models import Model
         from keras.datasets import mnist
         import numpy as np

         (xtrain, ytrain), (xtest, ytest) = mnist.load_data()

         xtrain = xtrain.astype('float32') / 255.
         xtest = xtest.astype('float32') / 255.
         xtrain = xtrain.reshape((len(xtrain), np.prod(xtrain.shape[1:])))
         xtest = xtest.reshape((len(xtest), np.prod(xtest.shape[1:])))
         xtrain.shape, xtest.shape
```

```
Out[1]:  ((60000, 784), (10000, 784))
```

```
In [2]:  # this is the size of our encoded representations
         encoding_dim = 4  # 32 floats -> compression of factor 24.5, assuming the ir

         # this is our input placeholder
         x = input_img = Input(shape=(784,))
         # "encoded" is the encoded representation of the input
         x = Dense(256, activation='relu')(x)
         x = Dense(128, activation='relu')(x)
         encoded = Dense(encoding_dim, activation='relu')(x)


         # "decoded" is the lossy reconstruction of the input
         x = Dense(128, activation='relu')(encoded)
         x = Dense(256, activation='relu')(x)
         decoded = Dense(784, activation='sigmoid')(x)

         # this model maps an input to its reconstruction
         autoencoder = Model(input_img, decoded)

         encoder = Model(input_img, encoded)

         # create a placeholder for an encoded (32-dimensional) input
         encoded_input = Input(shape=(encoding_dim,))
         # retrieve the last layer of the autoencoder model
         dcd1 = autoencoder.layers[-1]
         dcd2 = autoencoder.layers[-2]
         dcd3 = autoencoder.layers[-3]

         # create the decoder model
         decoder = Model(encoded_input, dcd1(dcd2(dcd3(encoded_input))))
```

```
2023-04-24 00:09:05.497769: I tensorflow/core/platform/cpu_feature_guard.c
c:142] This TensorFlow binary is optimized with oneAPI Deep Neural Network
Library (oneDNN) to use the following CPU instructions in performance-criti
cal operations:  AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate
compiler flags.
```

In [18]:
```
#autoencoder.compile(optimizer='adadelta', loss='binary_crossentropy')
```

In [3]:
```
autoencoder.compile(optimizer='adam', loss='binary_crossentropy')
```

In [4]:
```
autoencoder.fit(xtrain, xtrain,
                epochs=100,
                batch_size=256,
                shuffle=True,
                validation_data=(xtest, xtest))
                #callbacks=[TensorBoard(log_dir='/tmp/autoencoder')])
```

```
2023-04-24 00:09:20.130155: I tensorflow/compiler/mlir/mlir_graph_optimizat
ion_pass.cc:185] None of the MLIR Optimization Passes are enabled (register
ed 2)
```

```
Epoch 1/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2508 – val
_loss: 0.1879
Epoch 2/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1791 – val
_loss: 0.1721
Epoch 3/100
235/235 [==============================] – 2s 6ms/step – loss: 0.1696 – val
_loss: 0.1660
Epoch 4/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1643 – val
_loss: 0.1620
Epoch 5/100
235/235 [==============================] – 2s 6ms/step – loss: 0.1609 – val
_loss: 0.1600
Epoch 6/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1586 – val
_loss: 0.1576
Epoch 7/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1568 – val
_loss: 0.1561
Epoch 8/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1552 – val
_loss: 0.1544
Epoch 9/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1538 – val
_loss: 0.1533
Epoch 10/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1526 – val
_loss: 0.1523
Epoch 11/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1515 – val
_loss: 0.1516
Epoch 12/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1505 – val
_loss: 0.1507
Epoch 13/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1497 – val
_loss: 0.1501
Epoch 14/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1489 – val
_loss: 0.1494
Epoch 15/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1481 – val
_loss: 0.1487
Epoch 16/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1474 – val
_loss: 0.1481
Epoch 17/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1468 – val
_loss: 0.1478
Epoch 18/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1462 – val
_loss: 0.1470
Epoch 19/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1457 – val
_loss: 0.1466
Epoch 20/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1452 – val
```

```
_loss: 0.1464
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1447 - val
_loss: 0.1462
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1443 - val
_loss: 0.1458
Epoch 23/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1438 - val
_loss: 0.1452
Epoch 24/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1434 - val
_loss: 0.1451
Epoch 25/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1430 - val
_loss: 0.1449
Epoch 26/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1427 - val
_loss: 0.1446
Epoch 27/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1424 - val
_loss: 0.1444
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1420 - val
_loss: 0.1444
Epoch 29/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1418 - val
_loss: 0.1439
Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1415 - val
_loss: 0.1437
Epoch 31/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1412 - val
_loss: 0.1436
Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1409 - val
_loss: 0.1436
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1407 - val
_loss: 0.1432
Epoch 34/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1404 - val
_loss: 0.1431
Epoch 35/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1402 - val
_loss: 0.1431
Epoch 36/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1400 - val
_loss: 0.1429
Epoch 37/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1397 - val
_loss: 0.1426
Epoch 38/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1395 - val
_loss: 0.1426
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1393 - val
_loss: 0.1427
Epoch 40/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1391 - val
_loss: 0.1423
Epoch 41/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1390 - val
_loss: 0.1423
Epoch 42/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1388 - val
_loss: 0.1424
Epoch 43/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1387 - val
_loss: 0.1423
Epoch 44/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1384 - val
_loss: 0.1424
Epoch 45/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1383 - val
_loss: 0.1421
Epoch 46/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1381 - val
_loss: 0.1421
Epoch 47/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1380 - val
_loss: 0.1422
Epoch 48/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1379 - val
_loss: 0.1422
Epoch 49/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1377 - val
_loss: 0.1418
Epoch 50/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1376 - val
_loss: 0.1419
Epoch 51/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1374 - val
_loss: 0.1420
Epoch 52/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1373 - val
_loss: 0.1417
Epoch 53/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1372 - val
_loss: 0.1415
Epoch 54/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1371 - val
_loss: 0.1416
Epoch 55/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1370 - val
_loss: 0.1417
Epoch 56/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1369 - val
_loss: 0.1414
Epoch 57/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1367 - val
_loss: 0.1413
Epoch 58/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1366 - val
_loss: 0.1413
Epoch 59/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1365 - val
_loss: 0.1413
```

```
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1365 - val
_loss: 0.1414
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1363 - val
_loss: 0.1414
Epoch 62/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1363 - val
_loss: 0.1412
Epoch 63/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1362 - val
_loss: 0.1413
Epoch 64/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1361 - val
_loss: 0.1412
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1360 - val
_loss: 0.1414
Epoch 66/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1359 - val
_loss: 0.1414
Epoch 67/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1358 - val
_loss: 0.1410
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1357 - val
_loss: 0.1412
Epoch 69/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1356 - val
_loss: 0.1409
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1356 - val
_loss: 0.1413
Epoch 71/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1355 - val
_loss: 0.1412
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1354 - val
_loss: 0.1413
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1354 - val
_loss: 0.1408
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1353 - val
_loss: 0.1410
Epoch 75/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1352 - val
_loss: 0.1410
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1352 - val
_loss: 0.1413
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1351 - val
_loss: 0.1409
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1350 - val
_loss: 0.1409
Epoch 79/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1350 - val
```

```
_loss: 0.1409
Epoch 80/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1349 - val
_loss: 0.1408
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1348 - val
_loss: 0.1412
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1347 - val
_loss: 0.1410
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1348 - val
_loss: 0.1407
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1346 - val
_loss: 0.1411
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1345 - val
_loss: 0.1410
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1345 - val
_loss: 0.1410
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1345 - val
_loss: 0.1409
Epoch 88/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1344 - val
_loss: 0.1412
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1343 - val
_loss: 0.1409
Epoch 90/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1343 - val
_loss: 0.1411
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1342 - val
_loss: 0.1411
Epoch 92/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1342 - val
_loss: 0.1410
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1342 - val
_loss: 0.1408
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1341 - val
_loss: 0.1408
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1340 - val
_loss: 0.1411
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1340 - val
_loss: 0.1408
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1339 - val
_loss: 0.1411
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1339 - val
_loss: 0.1409
Epoch 99/100
```

```
235/235 [==============================] – 2s 8ms/step – loss: 0.1339 – val
_loss: 0.1411
Epoch 100/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1338 – val
_loss: 0.1411
```

Out[4]: `<keras.callbacks.History at 0x16fc7d2b0>`

In [5]:
```python
autoencoder.evaluate(xtest, xtest, verbose = 0)
```

Out[5]: 0.14108693599700928

In [6]:
```python
encoded_imgs = encoder.predict(xtest)
decoded_imgs = decoder.predict(encoded_imgs)
import matplotlib.pyplot as plt

n = 20  # how many digits we will display
plt.figure(figsize=(40, 4))
for i in range(n):
    # display original
    ax = plt.subplot(2, n, i + 1)
    plt.imshow(xtest[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

    # display reconstruction
    ax = plt.subplot(2, n, i + 1 + n)
    plt.imshow(decoded_imgs[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)
plt.show()
```


In [7]:
```python
encoded_imgs
```

Out[7]:
```
array([[ 8.121867 , 41.15789  , 16.332258 ,  7.376401 ],
       [24.201841 , 21.127634 , 16.845016 ,  6.0990424],
       [36.83489  , 51.335476 , 28.910124 , 18.496061 ],
       ...,
       [12.324904 , 30.052652 ,  9.990883 , 21.742424 ],
       [17.130564 , 16.039772 ,  4.0078583, 14.629419 ],
       [15.10408  , 16.662783 , 11.55282  , 26.731108 ]], dtype=float32)
```

In [8]:
```python
np.max(encoded_imgs)
```

Out[8]: 66.474236

In [9]:
```python
noise = np.random.normal(20,4, (4,4))
noise_preds = decoder.predict(noise)
```

In [10]:
```python
noise
```

Out[10]:
```
array([[20.07561402, 21.32106027, 21.23946429, 21.70652002],
       [23.88273129, 17.89626404, 22.62913063, 20.43102977],
       [18.65630753, 24.97829953, 23.56176308, 19.2978824 ],
       [21.30138864, 26.72723809, 22.82092237, 25.98322885]])
```

In [11]:
```python
plt.imshow(noise_preds[1].reshape(28,28))
```

Out[11]:   <matplotlib.image.AxesImage at 0x16de97d30>
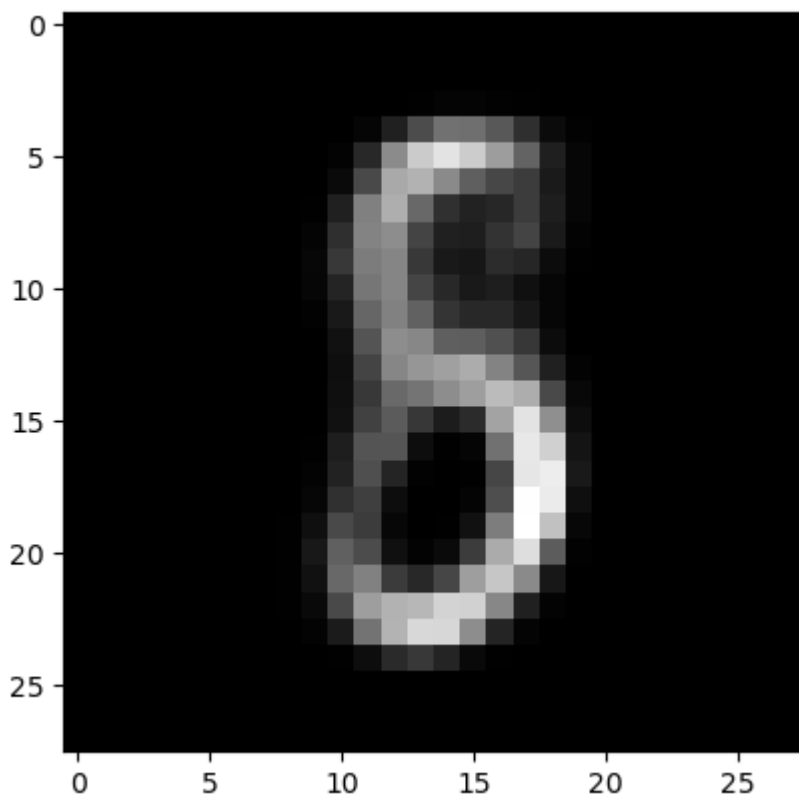
In [12]:
```python
%matplotlib inline
```

In [13]:
```python
plt.scatter(encoded_imgs[:,1], encoded_imgs[:,0], s=1, c=ytest, cmap='rainbo
# plt.show()
```

Out[13]:   <matplotlib.collections.PathCollection at 0x16dc95fd0>
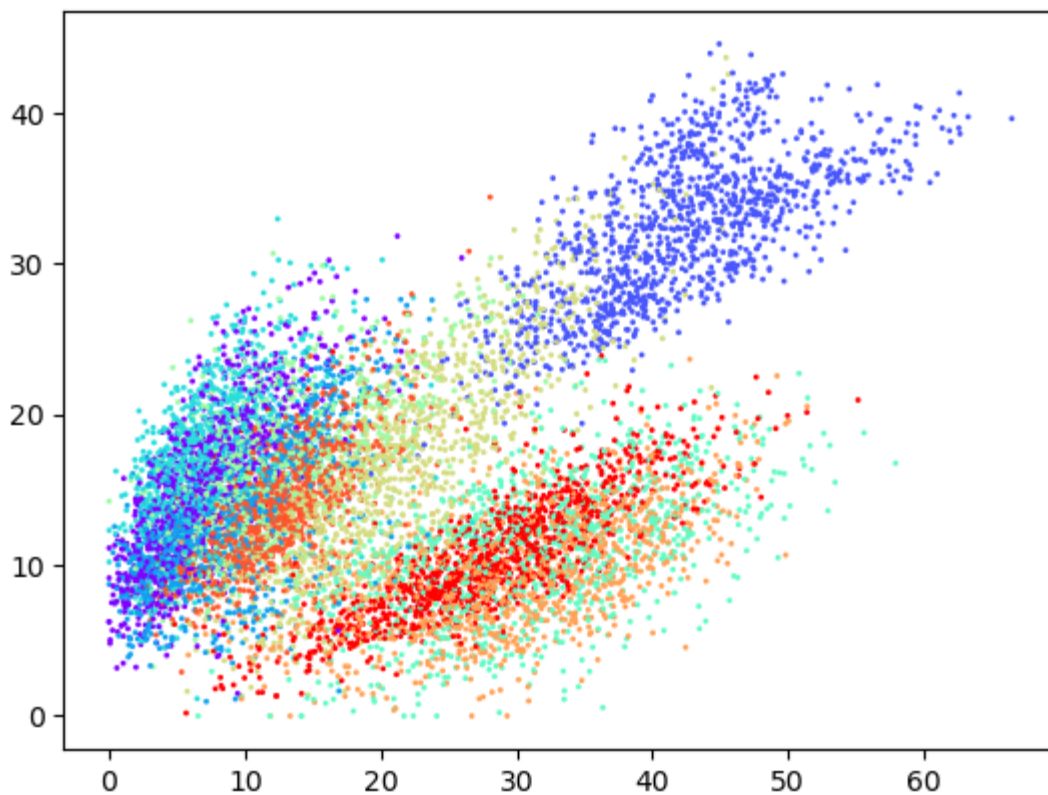
```
In [14]:  plt.scatter(encoded_imgs[:,1], encoded_imgs[:,3], s=1, c=ytest, cmap='rainbo
          # plt.show()
```

Out[14]: <matplotlib.collections.PathCollection at 0x17062cb50>
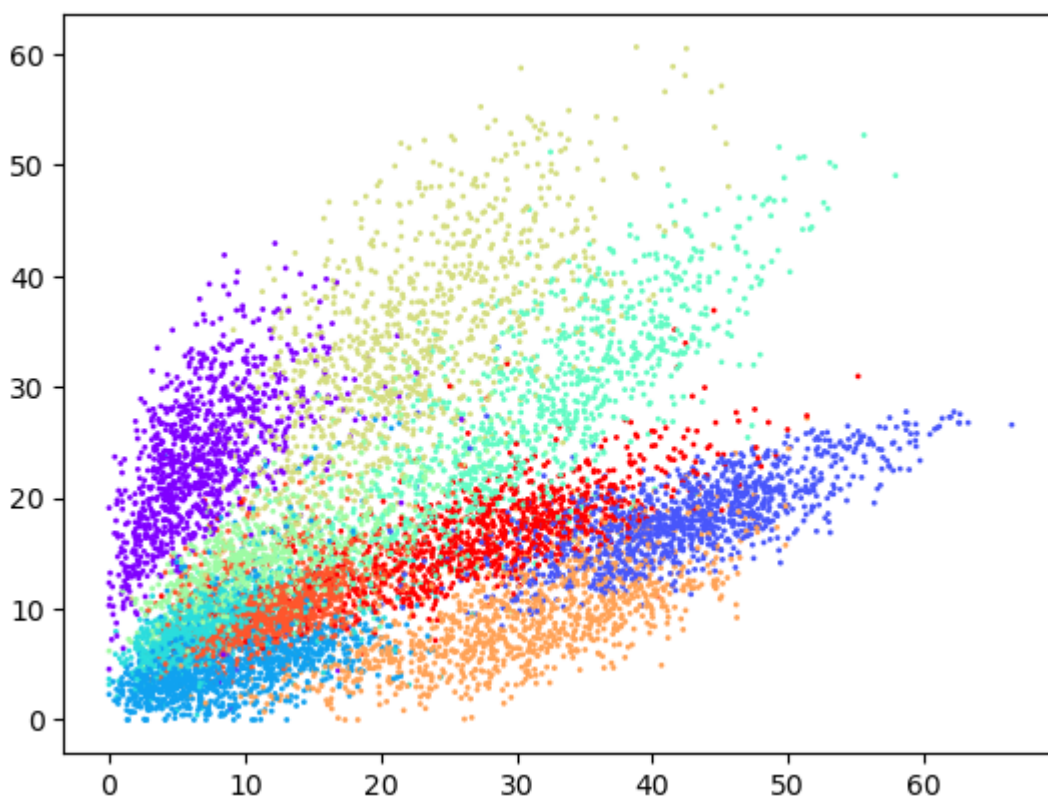
In [15]:
```python
plt.scatter(encoded_imgs[:,1], encoded_imgs[:,2], s=1, c=ytest, cmap='rainbo
# plt.show()
```

Out[15]: <matplotlib.collections.PathCollection at 0x1768f3970>
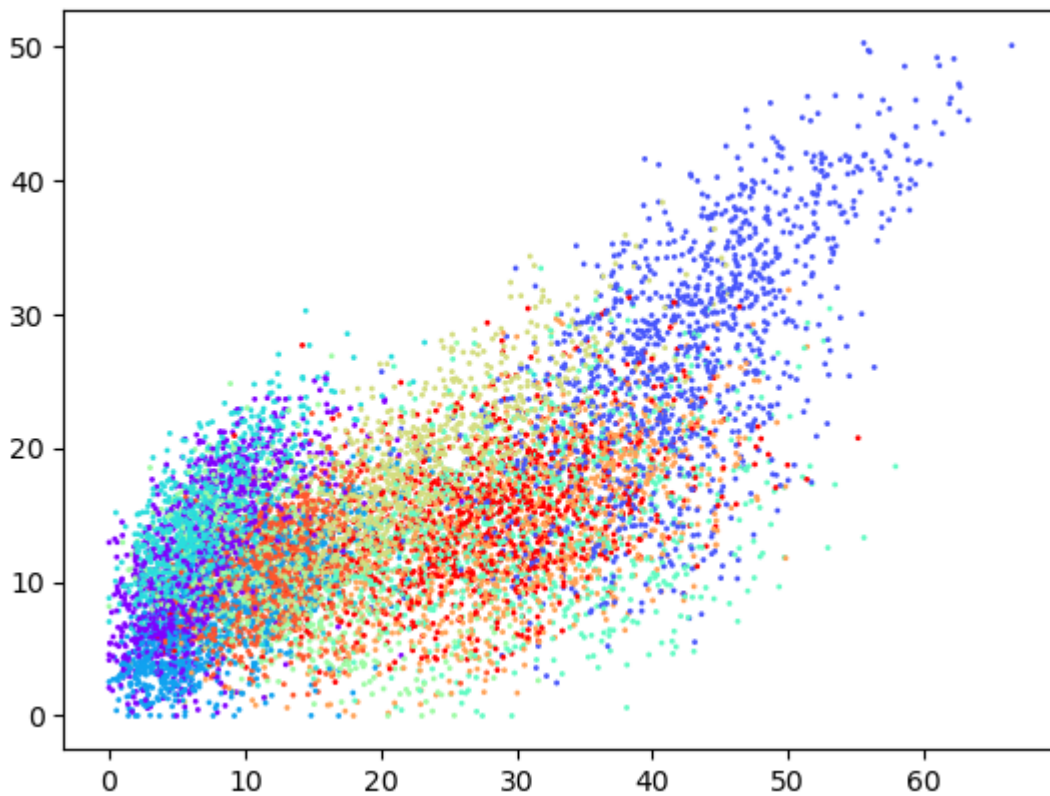
In [16]:
```python
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(encoded_imgs[:,1], encoded_imgs[:,2], encoded_imgs[:,3], c=ytest,
```

Out[16]: <mpl_toolkits.mplot3d.art3d.Path3DCollection at 0x171cd7880>
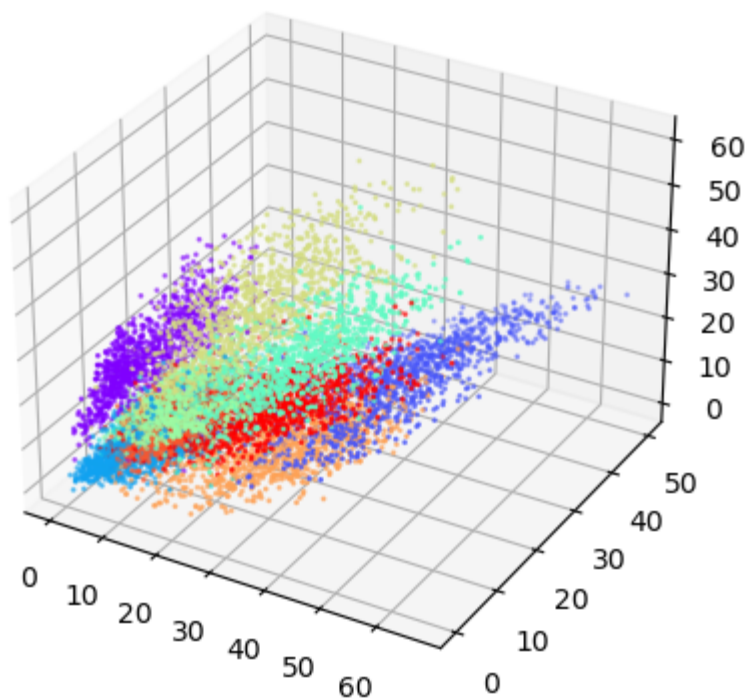
1. change the `encoding_dim` through various values (`range(2,18,2)` and store or keep track of the best loss you can get. Plot the 8 pairs of dimensions vs loss on a scatter plot

```
In [17]: losses = []
         dimensions = range(2,18,2)

         for encoding_dim in dimensions:

             print(encoding_dim)

             # this is our input placeholder
             x = input_img = Input(shape=(784,))
             # "encoded" is the encoded representation of the input
             x = Dense(256, activation='relu')(x)
             x = Dense(128, activation='relu')(x)
             encoded = Dense(encoding_dim, activation='relu')(x)
             # "decoded" is the lossy reconstruction of the input
             x = Dense(128, activation='relu')(encoded)
             x = Dense(256, activation='relu')(x)
             decoded = Dense(784, activation='sigmoid')(x)

             # this model maps an input to its reconstruction
             autoencoder = Model(input_img, decoded)
             encoder = Model(input_img, encoded)

             # create a placeholder for an encoded (32-dimensional) input
             encoded_input = Input(shape=(encoding_dim,))
             # retrieve the last layer of the autoencoder model
             dcd1 = autoencoder.layers[-1]
             dcd2 = autoencoder.layers[-2]
             dcd3 = autoencoder.layers[-3]

             # create the decoder model
             decoder = Model(encoded_input, dcd1(dcd2(dcd3(encoded_input))))

             autoencoder.compile(optimizer='adam', loss='binary_crossentropy')

             autoencoder.fit(xtrain, xtrain,
                         epochs=100,
                         batch_size=256,
                         shuffle=True,
                         validation_data=(xtest, xtest))

             loss = autoencoder.evaluate(xtest, xtest, verbose=0)
             losses.append(loss)
```

```
2
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2755 - val
_loss: 0.2494
Epoch 2/100
235/235 [==============================] - 2s 6ms/step - loss: 0.2450 - val
_loss: 0.2387
Epoch 3/100
235/235 [==============================] - 2s 6ms/step - loss: 0.2356 - val
_loss: 0.2315
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2299 - val
_loss: 0.2275
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2272 - val
_loss: 0.2259
Epoch 6/100
235/235 [==============================] - 2s 6ms/step - loss: 0.2251 - val
_loss: 0.2238
Epoch 7/100
235/235 [==============================] - 2s 6ms/step - loss: 0.2224 - val
_loss: 0.2209
Epoch 8/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2194 - val
_loss: 0.2181
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2170 - val
_loss: 0.2160
Epoch 10/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2152 - val
_loss: 0.2142
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2137 - val
_loss: 0.2127
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2124 - val
_loss: 0.2116
Epoch 13/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2117 - val
_loss: 0.2110
Epoch 14/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2105 - val
_loss: 0.2110
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2100 - val
_loss: 0.2086
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2090 - val
_loss: 0.2080
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2082 - val
_loss: 0.2074
Epoch 18/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2078 - val
_loss: 0.2081
Epoch 19/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2074 - val
_loss: 0.2067
Epoch 20/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.2067 - val
_loss: 0.2058
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2063 - val
_loss: 0.2057
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2057 - val
_loss: 0.2054
Epoch 23/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2054 - val
_loss: 0.2054
Epoch 24/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2053 - val
_loss: 0.2046
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2046 - val
_loss: 0.2039
Epoch 26/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2044 - val
_loss: 0.2033
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2043 - val
_loss: 0.2029
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2038 - val
_loss: 0.2031
Epoch 29/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2036 - val
_loss: 0.2025
Epoch 30/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2032 - val
_loss: 0.2022
Epoch 31/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2030 - val
_loss: 0.2020
Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2032 - val
_loss: 0.2027
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2028 - val
_loss: 0.2027
Epoch 34/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2031 - val
_loss: 0.2033
Epoch 35/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2021 - val
_loss: 0.2014
Epoch 36/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2022 - val
_loss: 0.2014
Epoch 37/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2018 - val
_loss: 0.2013
Epoch 38/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2015 - val
_loss: 0.2016
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2010 - val
_loss: 0.2004
```

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Epoch 40/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2009 – val
_loss: 0.2006
Epoch 41/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2015 – val
_loss: 0.2011
Epoch 42/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2020 – val
_loss: 0.2001
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2005 – val
_loss: 0.1991
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2002 – val
_loss: 0.1994
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2007 – val
_loss: 0.1993
Epoch 46/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1996 – val
_loss: 0.1987
Epoch 47/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1998 – val
_loss: 0.1993
Epoch 48/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1997 – val
_loss: 0.1992
Epoch 49/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1994 – val
_loss: 0.1991
Epoch 50/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1993 – val
_loss: 0.1986
Epoch 51/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1990 – val
_loss: 0.1983
Epoch 52/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1985 – val
_loss: 0.1984
Epoch 53/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1994 – val
_loss: 0.1991
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2003 – val
_loss: 0.2004
Epoch 55/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1995 – val
_loss: 0.1986
Epoch 56/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1982 – val
_loss: 0.1982
Epoch 57/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1979 – val
_loss: 0.1976
Epoch 58/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1978 – val
_loss: 0.1980
Epoch 59/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1987 – val
```

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                    _loss: 0.1974
                    Epoch 60/100
                    235/235 [==============================] - 2s 8ms/step - loss: 0.1976 - val
                    _loss: 0.1970
                    Epoch 61/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1977 - val
                    _loss: 0.1980
                    Epoch 62/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1974 - val
                    _loss: 0.1965
                    Epoch 63/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1970 - val
                    _loss: 0.1968
                    Epoch 64/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1974 - val
                    _loss: 0.1969
                    Epoch 65/100
                    235/235 [==============================] - 2s 8ms/step - loss: 0.1969 - val
                    _loss: 0.1961
                    Epoch 66/100
                    235/235 [==============================] - 2s 8ms/step - loss: 0.1968 - val
                    _loss: 0.1964
                    Epoch 67/100
                    235/235 [==============================] - 2s 8ms/step - loss: 0.1966 - val
                    _loss: 0.1966
                    Epoch 68/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1964 - val
                    _loss: 0.1969
                    Epoch 69/100
                    235/235 [==============================] - 2s 8ms/step - loss: 0.1964 - val
                    _loss: 0.1968
                    Epoch 70/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1979 - val
                    _loss: 0.1965
                    Epoch 71/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1965 - val
                    _loss: 0.1957
                    Epoch 72/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1962 - val
                    _loss: 0.1958
                    Epoch 73/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1960 - val
                    _loss: 0.1957
                    Epoch 74/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1980 - val
                    _loss: 0.1987
                    Epoch 75/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1975 - val
                    _loss: 0.1962
                    Epoch 76/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1964 - val
                    _loss: 0.1970
                    Epoch 77/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1962 - val
                    _loss: 0.1953
                    Epoch 78/100
                    235/235 [==============================] - 2s 7ms/step - loss: 0.1953 - val
                    _loss: 0.1955
                    Epoch 79/100
```

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235/235 [==============================] - 2s 7ms/step - loss: 0.1952 - val
_loss: 0.1952
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1951 - val
_loss: 0.1950
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1951 - val
_loss: 0.1956
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1954 - val
_loss: 0.1955
Epoch 83/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1957 - val
_loss: 0.1948
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1950 - val
_loss: 0.1948
Epoch 85/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1945 - val
_loss: 0.1941
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1944 - val
_loss: 0.1940
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1946 - val
_loss: 0.1940
Epoch 88/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1948 - val
_loss: 0.1944
Epoch 89/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1950 - val
_loss: 0.1939
Epoch 90/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1940 - val
_loss: 0.1949
Epoch 91/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1944 - val
_loss: 0.1947
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1939 - val
_loss: 0.1947
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1939 - val
_loss: 0.1940
Epoch 94/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1939 - val
_loss: 0.1940
Epoch 95/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1939 - val
_loss: 0.1950
Epoch 96/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1936 - val
_loss: 0.1930
Epoch 97/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1934 - val
_loss: 0.1944
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1943 - val
_loss: 0.1937
```

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Epoch 99/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1934 - val
_loss: 0.1932
Epoch 100/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1930 - val
_loss: 0.1931
4
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2573 - val
_loss: 0.1910
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1806 - val
_loss: 0.1725
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1692 - val
_loss: 0.1652
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1638 - val
_loss: 0.1614
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1604 - val
_loss: 0.1587
Epoch 6/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1580 - val
_loss: 0.1566
Epoch 7/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1561 - val
_loss: 0.1551
Epoch 8/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1546 - val
_loss: 0.1540
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1532 - val
_loss: 0.1529
Epoch 10/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1521 - val
_loss: 0.1520
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1510 - val
_loss: 0.1508
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1500 - val
_loss: 0.1501
Epoch 13/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1491 - val
_loss: 0.1494
Epoch 14/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1483 - val
_loss: 0.1488
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1476 - val
_loss: 0.1481
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1470 - val
_loss: 0.1474
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1463 - val
_loss: 0.1472
Epoch 18/100
```

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235/235 [==============================] - 2s 7ms/step - loss: 0.1457 - val
_loss: 0.1466
Epoch 19/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1452 - val
_loss: 0.1464
Epoch 20/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1447 - val
_loss: 0.1463
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1443 - val
_loss: 0.1454
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1439 - val
_loss: 0.1451
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1434 - val
_loss: 0.1450
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1430 - val
_loss: 0.1448
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1426 - val
_loss: 0.1447
Epoch 26/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1423 - val
_loss: 0.1444
Epoch 27/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1419 - val
_loss: 0.1440
Epoch 28/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1416 - val
_loss: 0.1440
Epoch 29/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1413 - val
_loss: 0.1436
Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1411 - val
_loss: 0.1435
Epoch 31/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1408 - val
_loss: 0.1435
Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1405 - val
_loss: 0.1431
Epoch 33/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1402 - val
_loss: 0.1432
Epoch 34/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1401 - val
_loss: 0.1426
Epoch 35/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1398 - val
_loss: 0.1431
Epoch 36/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1395 - val
_loss: 0.1425
Epoch 37/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1394 - val
_loss: 0.1427
```

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Epoch 38/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1392 – val
_loss: 0.1423
Epoch 39/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1389 – val
_loss: 0.1424
Epoch 40/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1387 – val
_loss: 0.1425
Epoch 41/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1386 – val
_loss: 0.1422
Epoch 42/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1385 – val
_loss: 0.1423
Epoch 43/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1383 – val
_loss: 0.1419
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1381 – val
_loss: 0.1425
Epoch 45/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1380 – val
_loss: 0.1419
Epoch 46/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1378 – val
_loss: 0.1421
Epoch 47/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1377 – val
_loss: 0.1416
Epoch 48/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1375 – val
_loss: 0.1417
Epoch 49/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1374 – val
_loss: 0.1417
Epoch 50/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1373 – val
_loss: 0.1415
Epoch 51/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1371 – val
_loss: 0.1416
Epoch 52/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1370 – val
_loss: 0.1414
Epoch 53/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1369 – val
_loss: 0.1416
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1368 – val
_loss: 0.1416
Epoch 55/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1367 – val
_loss: 0.1415
Epoch 56/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1366 – val
_loss: 0.1416
Epoch 57/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1365 – val
```

```
_loss: 0.1414
Epoch 58/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1363 - val
_loss: 0.1412
Epoch 59/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1363 - val
_loss: 0.1411
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1361 - val
_loss: 0.1413
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1360 - val
_loss: 0.1412
Epoch 62/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1359 - val
_loss: 0.1411
Epoch 63/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1358 - val
_loss: 0.1411
Epoch 64/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1358 - val
_loss: 0.1413
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1356 - val
_loss: 0.1412
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1356 - val
_loss: 0.1412
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1355 - val
_loss: 0.1409
Epoch 68/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1354 - val
_loss: 0.1411
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1354 - val
_loss: 0.1409
Epoch 70/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1353 - val
_loss: 0.1409
Epoch 71/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1351 - val
_loss: 0.1411
Epoch 72/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1351 - val
_loss: 0.1409
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1351 - val
_loss: 0.1409
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1349 - val
_loss: 0.1408
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1349 - val
_loss: 0.1408
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1348 - val
_loss: 0.1410
Epoch 77/100
```

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235/235 [==============================] - 2s 7ms/step - loss: 0.1347 - val
_loss: 0.1412
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1346 - val
_loss: 0.1407
Epoch 79/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1346 - val
_loss: 0.1412
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1345 - val
_loss: 0.1408
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1345 - val
_loss: 0.1409
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1344 - val
_loss: 0.1407
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1343 - val
_loss: 0.1409
Epoch 84/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1343 - val
_loss: 0.1409
Epoch 85/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1342 - val
_loss: 0.1411
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1342 - val
_loss: 0.1409
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1341 - val
_loss: 0.1409
Epoch 88/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1341 - val
_loss: 0.1409
Epoch 89/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1339 - val
_loss: 0.1406
Epoch 90/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1340 - val
_loss: 0.1408
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1338 - val
_loss: 0.1409
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1338 - val
_loss: 0.1409
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1338 - val
_loss: 0.1409
Epoch 94/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1337 - val
_loss: 0.1408
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1336 - val
_loss: 0.1405
Epoch 96/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1336 - val
_loss: 0.1409
```

```
Epoch 97/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1336 - val
_loss: 0.1408
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1335 - val
_loss: 0.1413
Epoch 99/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1334 - val
_loss: 0.1408
Epoch 100/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1334 - val
_loss: 0.1406
6
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2501 - val
_loss: 0.1875
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1723 - val
_loss: 0.1627
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1588 - val
_loss: 0.1554
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1537 - val
_loss: 0.1520
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1506 - val
_loss: 0.1495
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1484 - val
_loss: 0.1475
Epoch 7/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1466 - val
_loss: 0.1458
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1452 - val
_loss: 0.1444
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1439 - val
_loss: 0.1434
Epoch 10/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1428 - val
_loss: 0.1426
Epoch 11/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1419 - val
_loss: 0.1420
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1410 - val
_loss: 0.1408
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1402 - val
_loss: 0.1403
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1396 - val
_loss: 0.1398
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1389 - val
_loss: 0.1395
Epoch 16/100
```

```
235/235 [==============================] – 2s 8ms/step – loss: 0.1383 – val
_loss: 0.1392
Epoch 17/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1378 – val
_loss: 0.1386
Epoch 18/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1372 – val
_loss: 0.1380
Epoch 19/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1368 – val
_loss: 0.1379
Epoch 20/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1363 – val
_loss: 0.1372
Epoch 21/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1358 – val
_loss: 0.1369
Epoch 22/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1353 – val
_loss: 0.1365
Epoch 23/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1349 – val
_loss: 0.1362
Epoch 24/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1344 – val
_loss: 0.1360
Epoch 25/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1341 – val
_loss: 0.1359
Epoch 26/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1338 – val
_loss: 0.1355
Epoch 27/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1334 – val
_loss: 0.1353
Epoch 28/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1331 – val
_loss: 0.1351
Epoch 29/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1328 – val
_loss: 0.1349
Epoch 30/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1324 – val
_loss: 0.1346
Epoch 31/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1322 – val
_loss: 0.1342
Epoch 32/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1319 – val
_loss: 0.1341
Epoch 33/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1317 – val
_loss: 0.1338
Epoch 34/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1314 – val
_loss: 0.1339
Epoch 35/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1312 – val
_loss: 0.1337
```

```
Epoch 36/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1309 – val
_loss: 0.1336
Epoch 37/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1308 – val
_loss: 0.1334
Epoch 38/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1305 – val
_loss: 0.1335
Epoch 39/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1303 – val
_loss: 0.1332
Epoch 40/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1301 – val
_loss: 0.1333
Epoch 41/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1300 – val
_loss: 0.1329
Epoch 42/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1297 – val
_loss: 0.1330
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1295 – val
_loss: 0.1330
Epoch 44/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1294 – val
_loss: 0.1329
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1292 – val
_loss: 0.1325
Epoch 46/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1290 – val
_loss: 0.1326
Epoch 47/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1289 – val
_loss: 0.1324
Epoch 48/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1288 – val
_loss: 0.1322
Epoch 49/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1286 – val
_loss: 0.1322
Epoch 50/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1285 – val
_loss: 0.1321
Epoch 51/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1283 – val
_loss: 0.1320
Epoch 52/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1281 – val
_loss: 0.1321
Epoch 53/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1280 – val
_loss: 0.1322
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1279 – val
_loss: 0.1321
Epoch 55/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1278 – val
```

```
_loss: 0.1317
Epoch 56/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1277 - val
_loss: 0.1315
Epoch 57/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1276 - val
_loss: 0.1318
Epoch 58/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1274 - val
_loss: 0.1321
Epoch 59/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1273 - val
_loss: 0.1317
Epoch 60/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1272 - val
_loss: 0.1317
Epoch 61/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1271 - val
_loss: 0.1316
Epoch 62/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1270 - val
_loss: 0.1317
Epoch 63/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1269 - val
_loss: 0.1315
Epoch 64/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1268 - val
_loss: 0.1319
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1268 - val
_loss: 0.1314
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1266 - val
_loss: 0.1314
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1265 - val
_loss: 0.1315
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1264 - val
_loss: 0.1311
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1263 - val
_loss: 0.1314
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1263 - val
_loss: 0.1314
Epoch 71/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1261 - val
_loss: 0.1312
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1261 - val
_loss: 0.1312
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1260 - val
_loss: 0.1312
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1260 - val
_loss: 0.1312
Epoch 75/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1258 - val
_loss: 0.1309
Epoch 76/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1258 - val
_loss: 0.1310
Epoch 77/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1257 - val
_loss: 0.1309
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1256 - val
_loss: 0.1314
Epoch 79/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1255 - val
_loss: 0.1307
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1249 - val
_loss: 0.1301
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1240 - val
_loss: 0.1290
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1233 - val
_loss: 0.1289
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1228 - val
_loss: 0.1278
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1224 - val
_loss: 0.1276
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1222 - val
_loss: 0.1273
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1218 - val
_loss: 0.1272
Epoch 87/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1216 - val
_loss: 0.1268
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1214 - val
_loss: 0.1268
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1212 - val
_loss: 0.1265
Epoch 90/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1210 - val
_loss: 0.1266
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1208 - val
_loss: 0.1262
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1207 - val
_loss: 0.1264
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1204 - val
_loss: 0.1262
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1203 - val
_loss: 0.1259
```

```
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1202 - val
_loss: 0.1257
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1200 - val
_loss: 0.1259
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1199 - val
_loss: 0.1260
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1198 - val
_loss: 0.1256
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1197 - val
_loss: 0.1257
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1196 - val
_loss: 0.1257
8
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2532 - val
_loss: 0.1855
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1598 - val
_loss: 0.1459
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1429 - val
_loss: 0.1385
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1375 - val
_loss: 0.1350
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1346 - val
_loss: 0.1328
Epoch 6/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1324 - val
_loss: 0.1307
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1307 - val
_loss: 0.1292
Epoch 8/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1292 - val
_loss: 0.1280
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1280 - val
_loss: 0.1272
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1269 - val
_loss: 0.1264
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1260 - val
_loss: 0.1255
Epoch 12/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1252 - val
_loss: 0.1249
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1244 - val
_loss: 0.1242
Epoch 14/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1237 - val
_loss: 0.1234
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1230 - val
_loss: 0.1232
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1225 - val
_loss: 0.1227
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1219 - val
_loss: 0.1225
Epoch 18/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1214 - val
_loss: 0.1217
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1210 - val
_loss: 0.1212
Epoch 20/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1205 - val
_loss: 0.1210
Epoch 21/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1201 - val
_loss: 0.1208
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1197 - val
_loss: 0.1206
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1194 - val
_loss: 0.1202
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1190 - val
_loss: 0.1199
Epoch 25/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1187 - val
_loss: 0.1195
Epoch 26/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1183 - val
_loss: 0.1196
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1180 - val
_loss: 0.1194
Epoch 28/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1178 - val
_loss: 0.1191
Epoch 29/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1175 - val
_loss: 0.1190
Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1172 - val
_loss: 0.1186
Epoch 31/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1170 - val
_loss: 0.1188
Epoch 32/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1168 - val
_loss: 0.1185
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1165 - val
_loss: 0.1183
```

```
Epoch 34/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1162 – val
_loss: 0.1178
Epoch 35/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1161 – val
_loss: 0.1178
Epoch 36/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1159 – val
_loss: 0.1179
Epoch 37/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1157 – val
_loss: 0.1177
Epoch 38/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1155 – val
_loss: 0.1177
Epoch 39/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1153 – val
_loss: 0.1173
Epoch 40/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1151 – val
_loss: 0.1173
Epoch 41/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1149 – val
_loss: 0.1171
Epoch 42/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1148 – val
_loss: 0.1169
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1146 – val
_loss: 0.1169
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1144 – val
_loss: 0.1167
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1142 – val
_loss: 0.1167
Epoch 46/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1141 – val
_loss: 0.1165
Epoch 47/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1140 – val
_loss: 0.1165
Epoch 48/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1138 – val
_loss: 0.1164
Epoch 49/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1137 – val
_loss: 0.1163
Epoch 50/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1136 – val
_loss: 0.1161
Epoch 51/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1134 – val
_loss: 0.1163
Epoch 52/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1133 – val
_loss: 0.1161
Epoch 53/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1132 – val
```

```
_loss: 0.1159
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1130 – val
_loss: 0.1159
Epoch 55/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1129 – val
_loss: 0.1160
Epoch 56/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1128 – val
_loss: 0.1159
Epoch 57/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1127 – val
_loss: 0.1159
Epoch 58/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1126 – val
_loss: 0.1156
Epoch 59/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1125 – val
_loss: 0.1157
Epoch 60/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1124 – val
_loss: 0.1158
Epoch 61/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1123 – val
_loss: 0.1154
Epoch 62/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1122 – val
_loss: 0.1156
Epoch 63/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1121 – val
_loss: 0.1155
Epoch 64/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1120 – val
_loss: 0.1156
Epoch 65/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1119 – val
_loss: 0.1155
Epoch 66/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1118 – val
_loss: 0.1152
Epoch 67/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1117 – val
_loss: 0.1154
Epoch 68/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1116 – val
_loss: 0.1152
Epoch 69/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1115 – val
_loss: 0.1152
Epoch 70/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1115 – val
_loss: 0.1152
Epoch 71/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1114 – val
_loss: 0.1153
Epoch 72/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1113 – val
_loss: 0.1151
Epoch 73/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1113 - val
_loss: 0.1153
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1112 - val
_loss: 0.1149
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1111 - val
_loss: 0.1150
Epoch 76/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1110 - val
_loss: 0.1150
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1110 - val
_loss: 0.1151
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1109 - val
_loss: 0.1150
Epoch 79/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1108 - val
_loss: 0.1149
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1108 - val
_loss: 0.1149
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1107 - val
_loss: 0.1148
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1106 - val
_loss: 0.1148
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1106 - val
_loss: 0.1148
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1105 - val
_loss: 0.1147
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1105 - val
_loss: 0.1147
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1104 - val
_loss: 0.1147
Epoch 87/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1103 - val
_loss: 0.1146
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1102 - val
_loss: 0.1147
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1102 - val
_loss: 0.1147
Epoch 90/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1102 - val
_loss: 0.1147
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1101 - val
_loss: 0.1148
Epoch 92/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1100 - val
_loss: 0.1146
```

```
Epoch 93/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1100 - val
_loss: 0.1145
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1100 - val
_loss: 0.1149
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1099 - val
_loss: 0.1144
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1099 - val
_loss: 0.1145
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1098 - val
_loss: 0.1147
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1097 - val
_loss: 0.1147
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1097 - val
_loss: 0.1145
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1097 - val
_loss: 0.1144
10
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2492 - val
_loss: 0.1737
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1545 - val
_loss: 0.1419
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1388 - val
_loss: 0.1338
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1314 - val
_loss: 0.1278
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1268 - val
_loss: 0.1239
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1235 - val
_loss: 0.1207
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1198 - val
_loss: 0.1176
Epoch 8/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1172 - val
_loss: 0.1153
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1154 - val
_loss: 0.1143
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1139 - val
_loss: 0.1126
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1127 - val
_loss: 0.1120
Epoch 12/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1116 - val
_loss: 0.1109
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1108 - val
_loss: 0.1100
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1100 - val
_loss: 0.1096
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1092 - val
_loss: 0.1090
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1086 - val
_loss: 0.1084
Epoch 17/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1081 - val
_loss: 0.1083
Epoch 18/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1075 - val
_loss: 0.1075
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1070 - val
_loss: 0.1071
Epoch 20/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1066 - val
_loss: 0.1068
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1061 - val
_loss: 0.1070
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1059 - val
_loss: 0.1061
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1055 - val
_loss: 0.1058
Epoch 24/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1051 - val
_loss: 0.1055
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1048 - val
_loss: 0.1054
Epoch 26/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1045 - val
_loss: 0.1054
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1042 - val
_loss: 0.1049
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1039 - val
_loss: 0.1047
Epoch 29/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1037 - val
_loss: 0.1047
Epoch 30/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1035 - val
_loss: 0.1045
Epoch 31/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1033 - val
_loss: 0.1043
```

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Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1030 - val
_loss: 0.1043
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1029 - val
_loss: 0.1041
Epoch 34/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1026 - val
_loss: 0.1038
Epoch 35/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1024 - val
_loss: 0.1037
Epoch 36/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1023 - val
_loss: 0.1036
Epoch 37/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1021 - val
_loss: 0.1035
Epoch 38/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1020 - val
_loss: 0.1036
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1018 - val
_loss: 0.1033
Epoch 40/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1017 - val
_loss: 0.1032
Epoch 41/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1015 - val
_loss: 0.1031
Epoch 42/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1013 - val
_loss: 0.1030
Epoch 43/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1011 - val
_loss: 0.1027
Epoch 44/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1010 - val
_loss: 0.1027
Epoch 45/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1009 - val
_loss: 0.1029
Epoch 46/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1008 - val
_loss: 0.1031
Epoch 47/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1007 - val
_loss: 0.1027
Epoch 48/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1006 - val
_loss: 0.1024
Epoch 49/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1005 - val
_loss: 0.1022
Epoch 50/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1003 - val
_loss: 0.1024
Epoch 51/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1003 - val
```

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_loss: 0.1021
Epoch 52/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1001 - val
_loss: 0.1023
Epoch 53/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1000 - val
_loss: 0.1022
Epoch 54/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1000 - val
_loss: 0.1020
Epoch 55/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0998 - val
_loss: 0.1020
Epoch 56/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0998 - val
_loss: 0.1020
Epoch 57/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0997 - val
_loss: 0.1018
Epoch 58/100
235/235 [==============================] - 2s 10ms/step - loss: 0.0995 - va
l_loss: 0.1018
Epoch 59/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0995 - val
_loss: 0.1020
Epoch 60/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0994 - val
_loss: 0.1022
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0993 - val
_loss: 0.1018
Epoch 62/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0992 - val
_loss: 0.1016
Epoch 63/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0991 - val
_loss: 0.1016
Epoch 64/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0991 - val
_loss: 0.1016
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0990 - val
_loss: 0.1016
Epoch 66/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0990 - val
_loss: 0.1013
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0988 - val
_loss: 0.1015
Epoch 68/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0988 - val
_loss: 0.1013
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0987 - val
_loss: 0.1015
Epoch 70/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0987 - val
_loss: 0.1013
Epoch 71/100
```

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235/235 [==============================] - 2s 8ms/step - loss: 0.0986 - val
_loss: 0.1012
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0985 - val
_loss: 0.1013
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0984 - val
_loss: 0.1012
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0984 - val
_loss: 0.1012
Epoch 75/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0984 - val
_loss: 0.1010
Epoch 76/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0983 - val
_loss: 0.1010
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0982 - val
_loss: 0.1010
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0981 - val
_loss: 0.1009
Epoch 79/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0981 - val
_loss: 0.1010
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0980 - val
_loss: 0.1010
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0980 - val
_loss: 0.1010
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0979 - val
_loss: 0.1011
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0978 - val
_loss: 0.1007
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0978 - val
_loss: 0.1009
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0978 - val
_loss: 0.1010
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0977 - val
_loss: 0.1008
Epoch 87/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0977 - val
_loss: 0.1009
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0976 - val
_loss: 0.1006
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0976 - val
_loss: 0.1008
Epoch 90/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0975 - val
_loss: 0.1008
```

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Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0975 - val
_loss: 0.1007
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0974 - val
_loss: 0.1006
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0974 - val
_loss: 0.1006
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0973 - val
_loss: 0.1007
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0973 - val
_loss: 0.1007
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0972 - val
_loss: 0.1005
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0972 - val
_loss: 0.1009
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0972 - val
_loss: 0.1002
Epoch 99/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0971 - val
_loss: 0.1004
Epoch 100/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0971 - val
_loss: 0.1006
12
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2336 - val
_loss: 0.1612
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1476 - val
_loss: 0.1375
Epoch 3/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1354 - val
_loss: 0.1310
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1300 - val
_loss: 0.1268
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1265 - val
_loss: 0.1238
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1239 - val
_loss: 0.1218
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1219 - val
_loss: 0.1203
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1203 - val
_loss: 0.1189
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1190 - val
_loss: 0.1178
Epoch 10/100
```

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235/235 [==============================] - 2s 9ms/step - loss: 0.1178 - val
_loss: 0.1167
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1169 - val
_loss: 0.1159
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1159 - val
_loss: 0.1150
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1152 - val
_loss: 0.1143
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1144 - val
_loss: 0.1139
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1137 - val
_loss: 0.1133
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1132 - val
_loss: 0.1129
Epoch 17/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1126 - val
_loss: 0.1123
Epoch 18/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1121 - val
_loss: 0.1122
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1116 - val
_loss: 0.1116
Epoch 20/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1112 - val
_loss: 0.1114
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1108 - val
_loss: 0.1109
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1103 - val
_loss: 0.1107
Epoch 23/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1100 - val
_loss: 0.1102
Epoch 24/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1096 - val
_loss: 0.1099
Epoch 25/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1093 - val
_loss: 0.1099
Epoch 26/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1090 - val
_loss: 0.1096
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1087 - val
_loss: 0.1095
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1084 - val
_loss: 0.1090
Epoch 29/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1081 - val
_loss: 0.1089
```

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Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1079 - val
_loss: 0.1088
Epoch 31/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1077 - val
_loss: 0.1086
Epoch 32/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1074 - val
_loss: 0.1083
Epoch 33/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1072 - val
_loss: 0.1082
Epoch 34/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1070 - val
_loss: 0.1085
Epoch 35/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1068 - val
_loss: 0.1078
Epoch 36/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1066 - val
_loss: 0.1077
Epoch 37/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1064 - val
_loss: 0.1076
Epoch 38/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1062 - val
_loss: 0.1077
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1060 - val
_loss: 0.1076
Epoch 40/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1059 - val
_loss: 0.1071
Epoch 41/100
235/235 [==============================] - 2s 11ms/step - loss: 0.1057 - va
l_loss: 0.1072
Epoch 42/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1055 - val
_loss: 0.1072
Epoch 43/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1054 - val
_loss: 0.1072
Epoch 44/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1052 - val
_loss: 0.1068
Epoch 45/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1051 - val
_loss: 0.1067
Epoch 46/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1049 - val
_loss: 0.1069
Epoch 47/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1048 - val
_loss: 0.1065
Epoch 48/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1047 - val
_loss: 0.1068
Epoch 49/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1046 - val
```

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_loss: 0.1063
Epoch 50/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1044 – val
_loss: 0.1065
Epoch 51/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1043 – val
_loss: 0.1064
Epoch 52/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1042 – val
_loss: 0.1066
Epoch 53/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1041 – val
_loss: 0.1061
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1040 – val
_loss: 0.1059
Epoch 55/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1038 – val
_loss: 0.1059
Epoch 56/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1038 – val
_loss: 0.1061
Epoch 57/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1036 – val
_loss: 0.1062
Epoch 58/100
235/235 [==============================] – 2s 10ms/step – loss: 0.1035 – va
l_loss: 0.1059
Epoch 59/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1035 – val
_loss: 0.1056
Epoch 60/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1033 – val
_loss: 0.1057
Epoch 61/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1033 – val
_loss: 0.1057
Epoch 62/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1032 – val
_loss: 0.1055
Epoch 63/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1031 – val
_loss: 0.1057
Epoch 64/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1030 – val
_loss: 0.1056
Epoch 65/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1029 – val
_loss: 0.1056
Epoch 66/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1028 – val
_loss: 0.1057
Epoch 67/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1028 – val
_loss: 0.1056
Epoch 68/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1026 – val
_loss: 0.1053
Epoch 69/100
```

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235/235 [==============================] - 2s 8ms/step - loss: 0.1026 - val
_loss: 0.1052
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1025 - val
_loss: 0.1053
Epoch 71/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1024 - val
_loss: 0.1055
Epoch 72/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1023 - val
_loss: 0.1051
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1023 - val
_loss: 0.1052
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1022 - val
_loss: 0.1052
Epoch 75/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1021 - val
_loss: 0.1053
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1021 - val
_loss: 0.1050
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1020 - val
_loss: 0.1049
Epoch 78/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1019 - val
_loss: 0.1049
Epoch 79/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1019 - val
_loss: 0.1050
Epoch 80/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1018 - val
_loss: 0.1050
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1018 - val
_loss: 0.1050
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1017 - val
_loss: 0.1048
Epoch 83/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1016 - val
_loss: 0.1050
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1016 - val
_loss: 0.1050
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1015 - val
_loss: 0.1047
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1015 - val
_loss: 0.1049
Epoch 87/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1014 - val
_loss: 0.1047
Epoch 88/100
235/235 [==============================] - 2s 10ms/step - loss: 0.1013 - va
l_loss: 0.1045
```

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Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1013 - val
_loss: 0.1047
Epoch 90/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1012 - val
_loss: 0.1047
Epoch 91/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1012 - val
_loss: 0.1045
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1011 - val
_loss: 0.1047
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1011 - val
_loss: 0.1047
Epoch 94/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1010 - val
_loss: 0.1045
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1010 - val
_loss: 0.1043
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1009 - val
_loss: 0.1049
Epoch 97/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1009 - val
_loss: 0.1044
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1008 - val
_loss: 0.1044
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1008 - val
_loss: 0.1044
Epoch 100/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1007 - val
_loss: 0.1044
14
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2254 - val
_loss: 0.1545
Epoch 2/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1384 - val
_loss: 0.1265
Epoch 3/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1230 - val
_loss: 0.1178
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1169 - val
_loss: 0.1137
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1132 - val
_loss: 0.1106
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1107 - val
_loss: 0.1088
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1085 - val
_loss: 0.1066
Epoch 8/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1068 - val
_loss: 0.1051
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1054 - val
_loss: 0.1039
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1041 - val
_loss: 0.1029
Epoch 11/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1032 - val
_loss: 0.1024
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1022 - val
_loss: 0.1013
Epoch 13/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1014 - val
_loss: 0.1009
Epoch 14/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1008 - val
_loss: 0.1002
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1001 - val
_loss: 0.0996
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0995 - val
_loss: 0.0993
Epoch 17/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0990 - val
_loss: 0.0987
Epoch 18/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0985 - val
_loss: 0.0983
Epoch 19/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0981 - val
_loss: 0.0980
Epoch 20/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0977 - val
_loss: 0.0975
Epoch 21/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0973 - val
_loss: 0.0970
Epoch 22/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0969 - val
_loss: 0.0969
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0965 - val
_loss: 0.0964
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0962 - val
_loss: 0.0964
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0960 - val
_loss: 0.0961
Epoch 26/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0957 - val
_loss: 0.0959
Epoch 27/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0954 - val
_loss: 0.0956
```

```
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0952 - val
_loss: 0.0953
Epoch 29/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0950 - val
_loss: 0.0958
Epoch 30/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0947 - val
_loss: 0.0954
Epoch 31/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0945 - val
_loss: 0.0950
Epoch 32/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0943 - val
_loss: 0.0951
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0942 - val
_loss: 0.0947
Epoch 34/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0939 - val
_loss: 0.0944
Epoch 35/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0938 - val
_loss: 0.0944
Epoch 36/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0936 - val
_loss: 0.0945
Epoch 37/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0934 - val
_loss: 0.0942
Epoch 38/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0933 - val
_loss: 0.0944
Epoch 39/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0932 - val
_loss: 0.0940
Epoch 40/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0930 - val
_loss: 0.0937
Epoch 41/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0929 - val
_loss: 0.0937
Epoch 42/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0927 - val
_loss: 0.0935
Epoch 43/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0926 - val
_loss: 0.0933
Epoch 44/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0924 - val
_loss: 0.0933
Epoch 45/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0923 - val
_loss: 0.0933
Epoch 46/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0922 - val
_loss: 0.0931
Epoch 47/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0920 - val
```

```
_loss: 0.0932
Epoch 48/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0920 - val
_loss: 0.0932
Epoch 49/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0918 - val
_loss: 0.0930
Epoch 50/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0918 - val
_loss: 0.0933
Epoch 51/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0917 - val
_loss: 0.0926
Epoch 52/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0915 - val
_loss: 0.0929
Epoch 53/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0915 - val
_loss: 0.0930
Epoch 54/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0914 - val
_loss: 0.0925
Epoch 55/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0912 - val
_loss: 0.0925
Epoch 56/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0912 - val
_loss: 0.0926
Epoch 57/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0911 - val
_loss: 0.0926
Epoch 58/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0910 - val
_loss: 0.0925
Epoch 59/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0909 - val
_loss: 0.0924
Epoch 60/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0908 - val
_loss: 0.0924
Epoch 61/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0908 - val
_loss: 0.0923
Epoch 62/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0907 - val
_loss: 0.0922
Epoch 63/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0906 - val
_loss: 0.0921
Epoch 64/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0905 - val
_loss: 0.0920
Epoch 65/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0904 - val
_loss: 0.0920
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0904 - val
_loss: 0.0918
Epoch 67/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.0903 - val
_loss: 0.0919
Epoch 68/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0903 - val
_loss: 0.0919
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0902 - val
_loss: 0.0918
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0901 - val
_loss: 0.0918
Epoch 71/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0901 - val
_loss: 0.0917
Epoch 72/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0900 - val
_loss: 0.0919
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0900 - val
_loss: 0.0918
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0899 - val
_loss: 0.0919
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0899 - val
_loss: 0.0917
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0898 - val
_loss: 0.0915
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0897 - val
_loss: 0.0913
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0896 - val
_loss: 0.0915
Epoch 79/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0896 - val
_loss: 0.0914
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0896 - val
_loss: 0.0914
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0895 - val
_loss: 0.0911
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0894 - val
_loss: 0.0914
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0894 - val
_loss: 0.0914
Epoch 84/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0894 - val
_loss: 0.0912
Epoch 85/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0893 - val
_loss: 0.0913
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0893 - val
_loss: 0.0914
```

```
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0892 - val
_loss: 0.0912
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0892 - val
_loss: 0.0911
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0891 - val
_loss: 0.0910
Epoch 90/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0891 - val
_loss: 0.0911
Epoch 91/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0890 - val
_loss: 0.0912
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0890 - val
_loss: 0.0912
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0890 - val
_loss: 0.0910
Epoch 94/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0889 - val
_loss: 0.0912
Epoch 95/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0889 - val
_loss: 0.0909
Epoch 96/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0888 - val
_loss: 0.0912
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0888 - val
_loss: 0.0912
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0888 - val
_loss: 0.0909
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0887 - val
_loss: 0.0908
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0887 - val
_loss: 0.0913
16
Epoch 1/100
235/235 [==============================] - 3s 9ms/step - loss: 0.2274 - val
_loss: 0.1533
Epoch 2/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1376 - val
_loss: 0.1263
Epoch 3/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1229 - val
_loss: 0.1179
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1172 - val
_loss: 0.1139
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1137 - val
_loss: 0.1111
Epoch 6/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1111 - val
_loss: 0.1088
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1090 - val
_loss: 0.1069
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1073 - val
_loss: 0.1052
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1057 - val
_loss: 0.1042
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1045 - val
_loss: 0.1030
Epoch 11/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1035 - val
_loss: 0.1023
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1024 - val
_loss: 0.1015
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1017 - val
_loss: 0.1008
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1009 - val
_loss: 0.1005
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1003 - val
_loss: 0.0998
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0996 - val
_loss: 0.0991
Epoch 17/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0991 - val
_loss: 0.0985
Epoch 18/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0985 - val
_loss: 0.0980
Epoch 19/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0981 - val
_loss: 0.0975
Epoch 20/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0977 - val
_loss: 0.0975
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0973 - val
_loss: 0.0973
Epoch 22/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0969 - val
_loss: 0.0968
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0966 - val
_loss: 0.0966
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0962 - val
_loss: 0.0963
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0960 - val
_loss: 0.0959
```

```
Epoch 26/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0957 – val
_loss: 0.0959
Epoch 27/100
235/235 [==============================] – 2s 10ms/step – loss: 0.0954 – va
l_loss: 0.0955
Epoch 28/100
235/235 [==============================] – 2s 9ms/step – loss: 0.0952 – val
_loss: 0.0954
Epoch 29/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0950 – val
_loss: 0.0952
Epoch 30/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0947 – val
_loss: 0.0950
Epoch 31/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0945 – val
_loss: 0.0947
Epoch 32/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0943 – val
_loss: 0.0949
Epoch 33/100
235/235 [==============================] – 2s 9ms/step – loss: 0.0941 – val
_loss: 0.0947
Epoch 34/100
235/235 [==============================] – 2s 9ms/step – loss: 0.0939 – val
_loss: 0.0945
Epoch 35/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0938 – val
_loss: 0.0944
Epoch 36/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0936 – val
_loss: 0.0940
Epoch 37/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0934 – val
_loss: 0.0941
Epoch 38/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0933 – val
_loss: 0.0939
Epoch 39/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0932 – val
_loss: 0.0938
Epoch 40/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0930 – val
_loss: 0.0940
Epoch 41/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0928 – val
_loss: 0.0937
Epoch 42/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0927 – val
_loss: 0.0936
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0927 – val
_loss: 0.0933
Epoch 44/100
235/235 [==============================] – 2s 8ms/step – loss: 0.0925 – val
_loss: 0.0933
Epoch 45/100
235/235 [==============================] – 2s 7ms/step – loss: 0.0924 – val
```

```
_loss: 0.0932
Epoch 46/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0923 - val
_loss: 0.0932
Epoch 47/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0921 - val
_loss: 0.0933
Epoch 48/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0920 - val
_loss: 0.0931
Epoch 49/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0919 - val
_loss: 0.0931
Epoch 50/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0918 - val
_loss: 0.0930
Epoch 51/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0917 - val
_loss: 0.0929
Epoch 52/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0916 - val
_loss: 0.0928
Epoch 53/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0915 - val
_loss: 0.0928
Epoch 54/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0914 - val
_loss: 0.0926
Epoch 55/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0914 - val
_loss: 0.0926
Epoch 56/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0913 - val
_loss: 0.0927
Epoch 57/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0912 - val
_loss: 0.0925
Epoch 58/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0911 - val
_loss: 0.0926
Epoch 59/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0910 - val
_loss: 0.0921
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0909 - val
_loss: 0.0924
Epoch 61/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0909 - val
_loss: 0.0922
Epoch 62/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0908 - val
_loss: 0.0922
Epoch 63/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0907 - val
_loss: 0.0922
Epoch 64/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0906 - val
_loss: 0.0919
Epoch 65/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.0906 - val
_loss: 0.0920
Epoch 66/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0905 - val
_loss: 0.0920
Epoch 67/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0905 - val
_loss: 0.0920
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0904 - val
_loss: 0.0918
Epoch 69/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0903 - val
_loss: 0.0917
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0903 - val
_loss: 0.0917
Epoch 71/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0902 - val
_loss: 0.0920
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0902 - val
_loss: 0.0917
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0901 - val
_loss: 0.0919
Epoch 74/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0900 - val
_loss: 0.0916
Epoch 75/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0899 - val
_loss: 0.0914
Epoch 76/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0899 - val
_loss: 0.0915
Epoch 77/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0898 - val
_loss: 0.0914
Epoch 78/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0898 - val
_loss: 0.0918
Epoch 79/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0897 - val
_loss: 0.0914
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0897 - val
_loss: 0.0916
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0896 - val
_loss: 0.0913
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0896 - val
_loss: 0.0911
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0895 - val
_loss: 0.0913
Epoch 84/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0895 - val
_loss: 0.0913
```

```
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0894 - val
_loss: 0.0913
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0894 - val
_loss: 0.0911
Epoch 87/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0894 - val
_loss: 0.0911
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0893 - val
_loss: 0.0910
Epoch 89/100
235/235 [==============================] - 2s 9ms/step - loss: 0.0893 - val
_loss: 0.0915
Epoch 90/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0893 - val
_loss: 0.0913
Epoch 91/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0892 - val
_loss: 0.0910
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0891 - val
_loss: 0.0910
Epoch 93/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0891 - val
_loss: 0.0910
Epoch 94/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0891 - val
_loss: 0.0910
Epoch 95/100
235/235 [==============================] - 2s 7ms/step - loss: 0.0890 - val
_loss: 0.0912
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0890 - val
_loss: 0.0908
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0890 - val
_loss: 0.0907
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0889 - val
_loss: 0.0912
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0889 - val
_loss: 0.0912
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.0888 - val
_loss: 0.0908
```

In [18]:
```python
# example with encoding dim at 16 after previous block is run
encoded_imgs = encoder.predict(xtest)
decoded_imgs = decoder.predict(encoded_imgs)
import matplotlib.pyplot as plt

n = 20  # how many digits we will display
plt.figure(figsize=(40, 4))
for i in range(n):
    # display original
    ax = plt.subplot(2, n, i + 1)
    plt.imshow(xtest[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

    # display reconstruction
    ax = plt.subplot(2, n, i + 1 + n)
    plt.imshow(decoded_imgs[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)
plt.show()
```
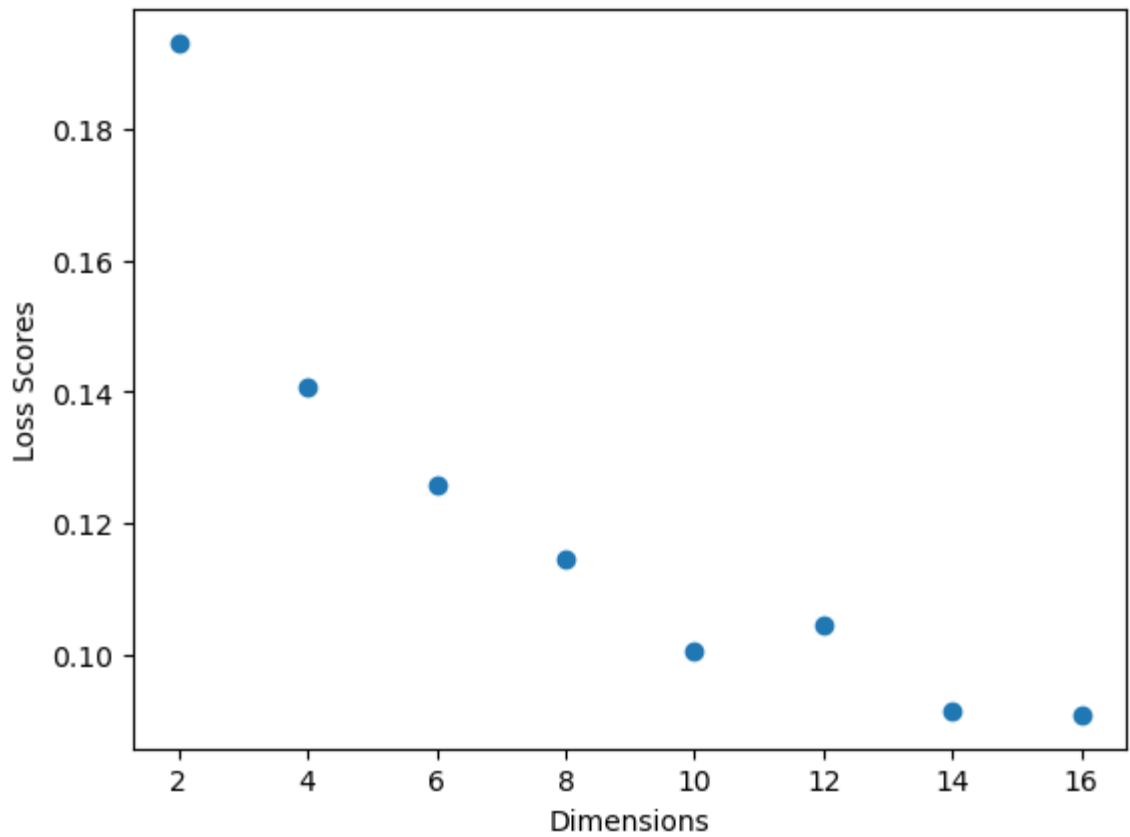

In [19]:
```python
losses
```

Out[19]:
```
[0.1930532604455948,
 0.1406082808971405,
 0.12566663324832916,
 0.11441220343112946,
 0.10058099031448364,
 0.10441082715988159,
 0.09129456430673599,
 0.0907890573143959]
```

In [20]:
```python
plt.figure()
plt.scatter(dimensions, losses)
plt.xlabel("Dimensions")
plt.ylabel("Loss Scores")
```

Out[20]:
```
Text(0, 0.5, 'Loss Scores')
```

1. ▯▯▯ training an autoencoder with `encoding_dim=8`, apply noise (like the previous assignment) to *only* the input of the trained autoencoder (not the output). The output images should be without noise.

Print a few noisy images along with the output images to show they don't have noise.

```
In [21]: losses = []
         encoding_dim = 8
         scales = [.1, .5, 1.0, 2.0, 4.0]

         # this is our input placeholder
         x = input_img = Input(shape=(784,))
         # "encoded" is the encoded representation of the input
         x = Dense(256, activation='relu')(x)
         x = Dense(128, activation='relu')(x)
         encoded = Dense(encoding_dim, activation='relu')(x)
         # "decoded" is the lossy reconstruction of the input
         x = Dense(128, activation='relu')(encoded)
         x = Dense(256, activation='relu')(x)
         decoded = Dense(784, activation='sigmoid')(x)

         # this model maps an input to its reconstruction
         autoencoder = Model(input_img, decoded)
         encoder = Model(input_img, encoded)

         # create a placeholder for an encoded (32-dimensional) input
         encoded_input = Input(shape=(encoding_dim,))
         # retrieve the last layer of the autoencoder model
         dcd1 = autoencoder.layers[-1]
         dcd2 = autoencoder.layers[-2]
         dcd3 = autoencoder.layers[-3]

         # create the decoder model
         decoder = Model(encoded_input, dcd1(dcd2(dcd3(encoded_input))))

         autoencoder.compile(optimizer='adam', loss='binary_crossentropy')

         for scale in scales:
             print(scale)

             noise = np.random.normal(loc=1, scale=scale, size=xtrain.shape)
             xtrain_noisy = xtrain + noise

             noise = np.random.normal(loc=1, scale=scale, size=xtest.shape)
             xtest_noisy = xtest + noise

             autoencoder.fit(xtrain_noisy, xtrain,
                             epochs=100,
                             batch_size=256,
                             shuffle=True,
                             validation_data=(xtest_noisy, xtest))

             loss = autoencoder.evaluate(xtest_noisy, xtest, verbose=0)
             losses.append(loss)

             encoded_imgs = encoder.predict(xtest_noisy)
             decoded_imgs = decoder.predict(encoded_imgs)

             n = 5  # how many digits we will display
             plt.figure(figsize=(40, 4))
             for i in range(n):
                 # display original
                 ax = plt.subplot(2, n, i + 1)
                 plt.imshow(xtest_noisy[i].reshape(28, 28))
                 plt.gray()
```

```python
            plt.gray()
            ax.get_xaxis().set_visible(False)
            ax.get_yaxis().set_visible(False)

            # display reconstruction
            ax = plt.subplot(2, n, i + 1 + n)
            plt.imshow(decoded_imgs[i].reshape(28, 28))
            plt.gray()
            ax.get_xaxis().set_visible(False)
            ax.get_yaxis().set_visible(False)
    plt.show()
```

```
0.1
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2653 - val
_loss: 0.2331
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2193 - val
_loss: 0.2111
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2020 - val
_loss: 0.1928
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1870 - val
_loss: 0.1816
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1777 - val
_loss: 0.1734
Epoch 6/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1673 - val
_loss: 0.1618
Epoch 7/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1598 - val
_loss: 0.1545
Epoch 8/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1525 - val
_loss: 0.1492
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1489 - val
_loss: 0.1465
Epoch 10/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1464 - val
_loss: 0.1448
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1445 - val
_loss: 0.1462
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1431 - val
_loss: 0.1427
Epoch 13/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1420 - val
_loss: 0.1410
Epoch 14/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1409 - val
_loss: 0.1407
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1402 - val
_loss: 0.1390
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1392 - val
```

```
_loss: 0.1383
Epoch 17/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1384 – val
_loss: 0.1377
Epoch 18/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1377 – val
_loss: 0.1372
Epoch 19/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1371 – val
_loss: 0.1369
Epoch 20/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1366 – val
_loss: 0.1365
Epoch 21/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1360 – val
_loss: 0.1357
Epoch 22/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1356 – val
_loss: 0.1352
Epoch 23/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1350 – val
_loss: 0.1351
Epoch 24/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1346 – val
_loss: 0.1343
Epoch 25/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1341 – val
_loss: 0.1339
Epoch 26/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1335 – val
_loss: 0.1339
Epoch 27/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1332 – val
_loss: 0.1328
Epoch 28/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1328 – val
_loss: 0.1336
Epoch 29/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1324 – val
_loss: 0.1327
Epoch 30/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1322 – val
_loss: 0.1319
Epoch 31/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1319 – val
_loss: 0.1319
Epoch 32/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1315 – val
_loss: 0.1314
Epoch 33/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1313 – val
_loss: 0.1313
Epoch 34/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1308 – val
_loss: 0.1317
Epoch 35/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1308 – val
_loss: 0.1318
Epoch 36/100
```

```
235/235 [==============================] – 2s 7ms/step – loss: 0.1304 – val
_loss: 0.1308
Epoch 37/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1300 – val
_loss: 0.1311
Epoch 38/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1299 – val
_loss: 0.1314
Epoch 39/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1298 – val
_loss: 0.1303
Epoch 40/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1296 – val
_loss: 0.1314
Epoch 41/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1292 – val
_loss: 0.1304
Epoch 42/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1290 – val
_loss: 0.1299
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1288 – val
_loss: 0.1294
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1286 – val
_loss: 0.1296
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1285 – val
_loss: 0.1295
Epoch 46/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1284 – val
_loss: 0.1295
Epoch 47/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1282 – val
_loss: 0.1294
Epoch 48/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1280 – val
_loss: 0.1291
Epoch 49/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1279 – val
_loss: 0.1289
Epoch 50/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1277 – val
_loss: 0.1290
Epoch 51/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1276 – val
_loss: 0.1288
Epoch 52/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1274 – val
_loss: 0.1288
Epoch 53/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1273 – val
_loss: 0.1298
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1273 – val
_loss: 0.1282
Epoch 55/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1270 – val
_loss: 0.1283
```

```
Epoch 56/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1269 - val
_loss: 0.1281
Epoch 57/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1268 - val
_loss: 0.1280
Epoch 58/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1267 - val
_loss: 0.1280
Epoch 59/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1265 - val
_loss: 0.1280
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1264 - val
_loss: 0.1279
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1264 - val
_loss: 0.1278
Epoch 62/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1264 - val
_loss: 0.1274
Epoch 63/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1261 - val
_loss: 0.1277
Epoch 64/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1259 - val
_loss: 0.1282
Epoch 65/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1260 - val
_loss: 0.1274
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1259 - val
_loss: 0.1279
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1256 - val
_loss: 0.1271
Epoch 68/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1257 - val
_loss: 0.1279
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1255 - val
_loss: 0.1279
Epoch 70/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1255 - val
_loss: 0.1271
Epoch 71/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1254 - val
_loss: 0.1283
Epoch 72/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1254 - val
_loss: 0.1270
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1251 - val
_loss: 0.1269
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1252 - val
_loss: 0.1270
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1251 - val
```

```
_loss: 0.1267
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1249 - val
_loss: 0.1267
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1249 - val
_loss: 0.1269
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1247 - val
_loss: 0.1265
Epoch 79/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1247 - val
_loss: 0.1268
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1247 - val
_loss: 0.1262
Epoch 81/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1245 - val
_loss: 0.1262
Epoch 82/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1246 - val
_loss: 0.1263
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1244 - val
_loss: 0.1266
Epoch 84/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1244 - val
_loss: 0.1264
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1243 - val
_loss: 0.1262
Epoch 86/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1242 - val
_loss: 0.1264
Epoch 87/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1242 - val
_loss: 0.1265
Epoch 88/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1241 - val
_loss: 0.1269
Epoch 89/100
235/235 [==============================] - 2s 10ms/step - loss: 0.1240 - va
l_loss: 0.1269
Epoch 90/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1240 - val
_loss: 0.1263
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1240 - val
_loss: 0.1259
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1238 - val
_loss: 0.1259
Epoch 93/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1237 - val
_loss: 0.1264
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1239 - val
_loss: 0.1260
Epoch 95/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1237 - val
_loss: 0.1262
Epoch 96/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1236 - val
_loss: 0.1255
Epoch 97/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1236 - val
_loss: 0.1259
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1235 - val
_loss: 0.1256
Epoch 99/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1235 - val
_loss: 0.1256
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1233 - val
_loss: 0.1256
```

```
0.5
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1487 - val
_loss: 0.1462
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1442 - val
_loss: 0.1452
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1423 - val
_loss: 0.1434
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1410 - val
_loss: 0.1431
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1401 - val
_loss: 0.1429
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1395 - val
_loss: 0.1419
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1389 - val
_loss: 0.1418
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1385 - val
_loss: 0.1417
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1380 - val
_loss: 0.1413
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1377 - val
_loss: 0.1414
Epoch 11/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1374 - val
_loss: 0.1414
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1371 - val
_loss: 0.1411
Epoch 13/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1368 - val
_loss: 0.1412
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1365 - val
_loss: 0.1412
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1361 - val
_loss: 0.1413
Epoch 16/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1361 - val
_loss: 0.1412
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1358 - val
_loss: 0.1409
Epoch 18/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1356 - val
_loss: 0.1406
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1355 - val
_loss: 0.1412
Epoch 20/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1353 - val
_loss: 0.1419
Epoch 21/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1352 - val
_loss: 0.1409
Epoch 22/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1350 - val
_loss: 0.1414
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1350 - val
_loss: 0.1421
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1346 - val
_loss: 0.1409
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1346 - val
_loss: 0.1406
Epoch 26/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1345 - val
_loss: 0.1408
Epoch 27/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1343 - val
_loss: 0.1405
Epoch 28/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1342 - val
_loss: 0.1408
Epoch 29/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1340 - val
_loss: 0.1405
Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1340 - val
_loss: 0.1408
Epoch 31/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1339 - val
_loss: 0.1406
Epoch 32/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1338 - val
_loss: 0.1406
Epoch 33/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1337 - val
_loss: 0.1408
Epoch 34/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1336 - val
_loss: 0.1407
Epoch 35/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1335 - val
_loss: 0.1406
Epoch 36/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1333 - val
_loss: 0.1407
Epoch 37/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1333 - val
_loss: 0.1411
Epoch 38/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1331 - val
_loss: 0.1409
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1332 - val
_loss: 0.1408
```

```
Epoch 40/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1330 – val
_loss: 0.1409
Epoch 41/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1328 – val
_loss: 0.1409
Epoch 42/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1328 – val
_loss: 0.1408
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1327 – val
_loss: 0.1412
Epoch 44/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1329 – val
_loss: 0.1405
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1326 – val
_loss: 0.1408
Epoch 46/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1326 – val
_loss: 0.1404
Epoch 47/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1325 – val
_loss: 0.1406
Epoch 48/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1326 – val
_loss: 0.1408
Epoch 49/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1325 – val
_loss: 0.1411
Epoch 50/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1324 – val
_loss: 0.1408
Epoch 51/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1323 – val
_loss: 0.1413
Epoch 52/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1321 – val
_loss: 0.1411
Epoch 53/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1321 – val
_loss: 0.1408
Epoch 54/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1322 – val
_loss: 0.1414
Epoch 55/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1320 – val
_loss: 0.1406
Epoch 56/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1318 – val
_loss: 0.1406
Epoch 57/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1320 – val
_loss: 0.1408
Epoch 58/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1319 – val
_loss: 0.1411
Epoch 59/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1318 – val
```

```
_loss: 0.1416
Epoch 60/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1318 - val
_loss: 0.1407
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1317 - val
_loss: 0.1415
Epoch 62/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1317 - val
_loss: 0.1417
Epoch 63/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1315 - val
_loss: 0.1409
Epoch 64/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1315 - val
_loss: 0.1411
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1315 - val
_loss: 0.1410
Epoch 66/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1315 - val
_loss: 0.1414
Epoch 67/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1314 - val
_loss: 0.1408
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1315 - val
_loss: 0.1408
Epoch 69/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1313 - val
_loss: 0.1410
Epoch 70/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1312 - val
_loss: 0.1414
Epoch 71/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1312 - val
_loss: 0.1409
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1312 - val
_loss: 0.1414
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1311 - val
_loss: 0.1414
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1312 - val
_loss: 0.1414
Epoch 75/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1311 - val
_loss: 0.1409
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1310 - val
_loss: 0.1411
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1310 - val
_loss: 0.1408
Epoch 78/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1309 - val
_loss: 0.1411
Epoch 79/100
```

```
235/235 [==============================] - 2s 8ms/step - loss: 0.1308 - val
_loss: 0.1413
Epoch 80/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1310 - val
_loss: 0.1413
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1309 - val
_loss: 0.1417
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1309 - val
_loss: 0.1419
Epoch 83/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1307 - val
_loss: 0.1418
Epoch 84/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1307 - val
_loss: 0.1417
Epoch 85/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1307 - val
_loss: 0.1417
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1308 - val
_loss: 0.1411
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1306 - val
_loss: 0.1414
Epoch 88/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1306 - val
_loss: 0.1417
Epoch 89/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1305 - val
_loss: 0.1418
Epoch 90/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1305 - val
_loss: 0.1416
Epoch 91/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1305 - val
_loss: 0.1413
Epoch 92/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1305 - val
_loss: 0.1415
Epoch 93/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1305 - val
_loss: 0.1419
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1304 - val
_loss: 0.1412
Epoch 95/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1303 - val
_loss: 0.1411
Epoch 96/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1303 - val
_loss: 0.1413
Epoch 97/100
235/235 [==============================] - 3s 11ms/step - loss: 0.1303 - va
l_loss: 0.1414
Epoch 98/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1303 - val
_loss: 0.1410
```

```
Epoch 99/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1303 – val
_loss: 0.1415
Epoch 100/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1302 – val
_loss: 0.1416
```

```
1.0
Epoch 1/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1790 - val
_loss: 0.1731
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1704 - val
_loss: 0.1707
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1670 - val
_loss: 0.1692
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1649 - val
_loss: 0.1684
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1632 - val
_loss: 0.1687
Epoch 6/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1621 - val
_loss: 0.1683
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1610 - val
_loss: 0.1682
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1602 - val
_loss: 0.1679
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1595 - val
_loss: 0.1678
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1588 - val
_loss: 0.1679
Epoch 11/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1583 - val
_loss: 0.1677
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1578 - val
_loss: 0.1684
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1573 - val
_loss: 0.1681
Epoch 14/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1569 - val
_loss: 0.1694
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1565 - val
_loss: 0.1684
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1561 - val
_loss: 0.1688
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1559 - val
_loss: 0.1698
Epoch 18/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1556 - val
_loss: 0.1693
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1552 - val
_loss: 0.1689
Epoch 20/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1550 - val
_loss: 0.1691
Epoch 21/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1548 - val
_loss: 0.1695
Epoch 22/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1545 - val
_loss: 0.1697
Epoch 23/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1542 - val
_loss: 0.1696
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1542 - val
_loss: 0.1703
Epoch 25/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1538 - val
_loss: 0.1702
Epoch 26/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1538 - val
_loss: 0.1701
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1535 - val
_loss: 0.1702
Epoch 28/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1533 - val
_loss: 0.1705
Epoch 29/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1533 - val
_loss: 0.1706
Epoch 30/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1532 - val
_loss: 0.1709
Epoch 31/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1530 - val
_loss: 0.1709
Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1527 - val
_loss: 0.1707
Epoch 33/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1527 - val
_loss: 0.1710
Epoch 34/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1526 - val
_loss: 0.1710
Epoch 35/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1523 - val
_loss: 0.1719
Epoch 36/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1521 - val
_loss: 0.1715
Epoch 37/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1522 - val
_loss: 0.1720
Epoch 38/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1521 - val
_loss: 0.1716
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1519 - val
_loss: 0.1720
```

```
Epoch 40/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1519 – val
_loss: 0.1718
Epoch 41/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1517 – val
_loss: 0.1721
Epoch 42/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1516 – val
_loss: 0.1724
Epoch 43/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1516 – val
_loss: 0.1731
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1515 – val
_loss: 0.1722
Epoch 45/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1513 – val
_loss: 0.1725
Epoch 46/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1513 – val
_loss: 0.1731
Epoch 47/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1512 – val
_loss: 0.1734
Epoch 48/100
235/235 [==============================] – 2s 10ms/step – loss: 0.1511 – va
l_loss: 0.1727
Epoch 49/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1510 – val
_loss: 0.1734
Epoch 50/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1510 – val
_loss: 0.1731
Epoch 51/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1510 – val
_loss: 0.1733
Epoch 52/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1508 – val
_loss: 0.1730
Epoch 53/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1506 – val
_loss: 0.1741
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1506 – val
_loss: 0.1739
Epoch 55/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1504 – val
_loss: 0.1736
Epoch 56/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1505 – val
_loss: 0.1738
Epoch 57/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1506 – val
_loss: 0.1737
Epoch 58/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1505 – val
_loss: 0.1732
Epoch 59/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1504 – val
```

```
_loss: 0.1737
Epoch 60/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1502 - val
_loss: 0.1737
Epoch 61/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1502 - val
_loss: 0.1735
Epoch 62/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1501 - val
_loss: 0.1736
Epoch 63/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1500 - val
_loss: 0.1744
Epoch 64/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1501 - val
_loss: 0.1742
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1501 - val
_loss: 0.1739
Epoch 66/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1500 - val
_loss: 0.1741
Epoch 67/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1499 - val
_loss: 0.1740
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1499 - val
_loss: 0.1742
Epoch 69/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1497 - val
_loss: 0.1747
Epoch 70/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1497 - val
_loss: 0.1754
Epoch 71/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1498 - val
_loss: 0.1754
Epoch 72/100
235/235 [==============================] - 2s 10ms/step - loss: 0.1496 - va
l_loss: 0.1747
Epoch 73/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1496 - val
_loss: 0.1755
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1496 - val
_loss: 0.1750
Epoch 75/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1496 - val
_loss: 0.1744
Epoch 76/100
235/235 [==============================] - 2s 10ms/step - loss: 0.1495 - va
l_loss: 0.1745
Epoch 77/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1494 - val
_loss: 0.1753
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1494 - val
_loss: 0.1758
Epoch 79/100
```

```
235/235 [==============================] – 2s 7ms/step – loss: 0.1494 – val
_loss: 0.1753
Epoch 80/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1491 – val
_loss: 0.1751
Epoch 81/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1492 – val
_loss: 0.1749
Epoch 82/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1493 – val
_loss: 0.1753
Epoch 83/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1492 – val
_loss: 0.1755
Epoch 84/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1491 – val
_loss: 0.1755
Epoch 85/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1492 – val
_loss: 0.1758
Epoch 86/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1490 – val
_loss: 0.1755
Epoch 87/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1490 – val
_loss: 0.1770
Epoch 88/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1489 – val
_loss: 0.1760
Epoch 89/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1491 – val
_loss: 0.1764
Epoch 90/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1488 – val
_loss: 0.1761
Epoch 91/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1488 – val
_loss: 0.1758
Epoch 92/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1489 – val
_loss: 0.1765
Epoch 93/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1488 – val
_loss: 0.1764
Epoch 94/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1488 – val
_loss: 0.1766
Epoch 95/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1487 – val
_loss: 0.1762
Epoch 96/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1486 – val
_loss: 0.1761
Epoch 97/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1487 – val
_loss: 0.1766
Epoch 98/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1488 – val
_loss: 0.1765
```

```
Epoch 99/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1486 – val
_loss: 0.1763
Epoch 100/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1486 – val
_loss: 0.1768
```

```
2.0
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2289 - val
_loss: 0.2238
Epoch 2/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2194 - val
_loss: 0.2212
Epoch 3/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2156 - val
_loss: 0.2199
Epoch 4/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2130 - val
_loss: 0.2192
Epoch 5/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2109 - val
_loss: 0.2196
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2091 - val
_loss: 0.2198
Epoch 7/100
235/235 [==============================] - 2s 9ms/step - loss: 0.2074 - val
_loss: 0.2198
Epoch 8/100
235/235 [==============================] - 2s 10ms/step - loss: 0.2059 - va
l_loss: 0.2208
Epoch 9/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2047 - val
_loss: 0.2211
Epoch 10/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2035 - val
_loss: 0.2216
Epoch 11/100
235/235 [==============================] - 2s 9ms/step - loss: 0.2024 - val
_loss: 0.2221
Epoch 12/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2012 - val
_loss: 0.2233
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2001 - val
_loss: 0.2245
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1992 - val
_loss: 0.2250
Epoch 15/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1984 - val
_loss: 0.2260
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1975 - val
_loss: 0.2260
Epoch 17/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1968 - val
_loss: 0.2266
Epoch 18/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1960 - val
_loss: 0.2281
Epoch 19/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1954 - val
_loss: 0.2280
Epoch 20/100
```

```
235/235 [==============================] - 2s 9ms/step - loss: 0.1948 - val
_loss: 0.2288
Epoch 21/100
235/235 [==============================] - 2s 10ms/step - loss: 0.1942 - va
l_loss: 0.2303
Epoch 22/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1935 - val
_loss: 0.2302
Epoch 23/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1930 - val
_loss: 0.2311
Epoch 24/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1925 - val
_loss: 0.2316
Epoch 25/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1920 - val
_loss: 0.2318
Epoch 26/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1915 - val
_loss: 0.2340
Epoch 27/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1910 - val
_loss: 0.2334
Epoch 28/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1908 - val
_loss: 0.2345
Epoch 29/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1903 - val
_loss: 0.2344
Epoch 30/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1898 - val
_loss: 0.2363
Epoch 31/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1895 - val
_loss: 0.2363
Epoch 32/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1891 - val
_loss: 0.2360
Epoch 33/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1888 - val
_loss: 0.2362
Epoch 34/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1885 - val
_loss: 0.2376
Epoch 35/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1881 - val
_loss: 0.2375
Epoch 36/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1878 - val
_loss: 0.2384
Epoch 37/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1876 - val
_loss: 0.2405
Epoch 38/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1874 - val
_loss: 0.2398
Epoch 39/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1871 - val
_loss: 0.2402
```

```
Epoch 40/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1870 - val
_loss: 0.2411
Epoch 41/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1866 - val
_loss: 0.2430
Epoch 42/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1863 - val
_loss: 0.2421
Epoch 43/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1861 - val
_loss: 0.2423
Epoch 44/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1859 - val
_loss: 0.2423
Epoch 45/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1856 - val
_loss: 0.2422
Epoch 46/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1855 - val
_loss: 0.2437
Epoch 47/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1852 - val
_loss: 0.2436
Epoch 48/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1851 - val
_loss: 0.2428
Epoch 49/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1849 - val
_loss: 0.2436
Epoch 50/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1848 - val
_loss: 0.2451
Epoch 51/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1845 - val
_loss: 0.2455
Epoch 52/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1845 - val
_loss: 0.2481
Epoch 53/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1843 - val
_loss: 0.2467
Epoch 54/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1840 - val
_loss: 0.2478
Epoch 55/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1839 - val
_loss: 0.2471
Epoch 56/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1837 - val
_loss: 0.2478
Epoch 57/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1836 - val
_loss: 0.2473
Epoch 58/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1835 - val
_loss: 0.2490
Epoch 59/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1834 - val
```

```
_loss: 0.2492
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1833 - val
_loss: 0.2490
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1830 - val
_loss: 0.2500
Epoch 62/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1828 - val
_loss: 0.2492
Epoch 63/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1827 - val
_loss: 0.2504
Epoch 64/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1826 - val
_loss: 0.2493
Epoch 65/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1826 - val
_loss: 0.2493
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1824 - val
_loss: 0.2511
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1823 - val
_loss: 0.2518
Epoch 68/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1821 - val
_loss: 0.2489
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1822 - val
_loss: 0.2505
Epoch 70/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1819 - val
_loss: 0.2512
Epoch 71/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1818 - val
_loss: 0.2505
Epoch 72/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1817 - val
_loss: 0.2537
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1815 - val
_loss: 0.2521
Epoch 74/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1815 - val
_loss: 0.2535
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1815 - val
_loss: 0.2545
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1813 - val
_loss: 0.2533
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1813 - val
_loss: 0.2530
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1812 - val
_loss: 0.2543
Epoch 79/100
```

```
235/235 [==============================] – 2s 8ms/step – loss: 0.1811 – val
_loss: 0.2546
Epoch 80/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1808 – val
_loss: 0.2555
Epoch 81/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1808 – val
_loss: 0.2543
Epoch 82/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1805 – val
_loss: 0.2551
Epoch 83/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1806 – val
_loss: 0.2533
Epoch 84/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1806 – val
_loss: 0.2544
Epoch 85/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1806 – val
_loss: 0.2552
Epoch 86/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1804 – val
_loss: 0.2544
Epoch 87/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1802 – val
_loss: 0.2569
Epoch 88/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1804 – val
_loss: 0.2560
Epoch 89/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1802 – val
_loss: 0.2570
Epoch 90/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1801 – val
_loss: 0.2556
Epoch 91/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1800 – val
_loss: 0.2569
Epoch 92/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1799 – val
_loss: 0.2585
Epoch 93/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1799 – val
_loss: 0.2567
Epoch 94/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1798 – val
_loss: 0.2579
Epoch 95/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1798 – val
_loss: 0.2588
Epoch 96/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1797 – val
_loss: 0.2563
Epoch 97/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1797 – val
_loss: 0.2579
Epoch 98/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1796 – val
_loss: 0.2586
```

```
Epoch 99/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1794 - val
_loss: 0.2581
Epoch 100/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1794 - val
_loss: 0.2561
```

```
4.0
Epoch 1/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2612 - val
_loss: 0.2542
Epoch 2/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2527 - val
_loss: 0.2525
Epoch 3/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2499 - val
_loss: 0.2519
Epoch 4/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2471 - val
_loss: 0.2529
Epoch 5/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2439 - val
_loss: 0.2541
Epoch 6/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2406 - val
_loss: 0.2552
Epoch 7/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2374 - val
_loss: 0.2579
Epoch 8/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2343 - val
_loss: 0.2610
Epoch 9/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2316 - val
_loss: 0.2628
Epoch 10/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2289 - val
_loss: 0.2656
Epoch 11/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2267 - val
_loss: 0.2680
Epoch 12/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2245 - val
_loss: 0.2718
Epoch 13/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2226 - val
_loss: 0.2735
Epoch 14/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2207 - val
_loss: 0.2775
Epoch 15/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2190 - val
_loss: 0.2812
Epoch 16/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2174 - val
_loss: 0.2824
Epoch 17/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2160 - val
_loss: 0.2855
Epoch 18/100
235/235 [==============================] - 2s 8ms/step - loss: 0.2146 - val
_loss: 0.2869
Epoch 19/100
235/235 [==============================] - 2s 7ms/step - loss: 0.2133 - val
_loss: 0.2926
Epoch 20/100
```

```
235/235 [==============================] – 2s 7ms/step – loss: 0.2121 – val
_loss: 0.2936
Epoch 21/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2109 – val
_loss: 0.2943
Epoch 22/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2099 – val
_loss: 0.2964
Epoch 23/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2090 – val
_loss: 0.2976
Epoch 24/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2080 – val
_loss: 0.2991
Epoch 25/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2071 – val
_loss: 0.3027
Epoch 26/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2063 – val
_loss: 0.3058
Epoch 27/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2054 – val
_loss: 0.3039
Epoch 28/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2048 – val
_loss: 0.3066
Epoch 29/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2040 – val
_loss: 0.3073
Epoch 30/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2033 – val
_loss: 0.3074
Epoch 31/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2028 – val
_loss: 0.3121
Epoch 32/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2021 – val
_loss: 0.3144
Epoch 33/100
235/235 [==============================] – 2s 7ms/step – loss: 0.2016 – val
_loss: 0.3136
Epoch 34/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2010 – val
_loss: 0.3172
Epoch 35/100
235/235 [==============================] – 2s 8ms/step – loss: 0.2005 – val
_loss: 0.3181
Epoch 36/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1998 – val
_loss: 0.3188
Epoch 37/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1994 – val
_loss: 0.3196
Epoch 38/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1989 – val
_loss: 0.3195
Epoch 39/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1986 – val
_loss: 0.3209
```

```
Epoch 40/100
235/235 [==============================] – 2s 9ms/step – loss: 0.1981 – val
_loss: 0.3216
Epoch 41/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1977 – val
_loss: 0.3230
Epoch 42/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1974 – val
_loss: 0.3247
Epoch 43/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1969 – val
_loss: 0.3263
Epoch 44/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1965 – val
_loss: 0.3261
Epoch 45/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1960 – val
_loss: 0.3279
Epoch 46/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1956 – val
_loss: 0.3260
Epoch 47/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1952 – val
_loss: 0.3273
Epoch 48/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1949 – val
_loss: 0.3276
Epoch 49/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1947 – val
_loss: 0.3303
Epoch 50/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1945 – val
_loss: 0.3316
Epoch 51/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1942 – val
_loss: 0.3302
Epoch 52/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1938 – val
_loss: 0.3332
Epoch 53/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1933 – val
_loss: 0.3331
Epoch 54/100
235/235 [==============================] – 2s 8ms/step – loss: 0.1932 – val
_loss: 0.3330
Epoch 55/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1931 – val
_loss: 0.3345
Epoch 56/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1929 – val
_loss: 0.3354
Epoch 57/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1924 – val
_loss: 0.3341
Epoch 58/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1920 – val
_loss: 0.3381
Epoch 59/100
235/235 [==============================] – 2s 7ms/step – loss: 0.1918 – val
```

```
_loss: 0.3405
Epoch 60/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1918 - val
_loss: 0.3395
Epoch 61/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1914 - val
_loss: 0.3387
Epoch 62/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1910 - val
_loss: 0.3427
Epoch 63/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1907 - val
_loss: 0.3403
Epoch 64/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1905 - val
_loss: 0.3434
Epoch 65/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1906 - val
_loss: 0.3412
Epoch 66/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1904 - val
_loss: 0.3412
Epoch 67/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1900 - val
_loss: 0.3439
Epoch 68/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1895 - val
_loss: 0.3452
Epoch 69/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1896 - val
_loss: 0.3430
Epoch 70/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1895 - val
_loss: 0.3450
Epoch 71/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1895 - val
_loss: 0.3437
Epoch 72/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1893 - val
_loss: 0.3475
Epoch 73/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1888 - val
_loss: 0.3466
Epoch 74/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1886 - val
_loss: 0.3495
Epoch 75/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1882 - val
_loss: 0.3462
Epoch 76/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1880 - val
_loss: 0.3450
Epoch 77/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1879 - val
_loss: 0.3463
Epoch 78/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1877 - val
_loss: 0.3451
Epoch 79/100
```

```
235/235 [==============================] - 2s 7ms/step - loss: 0.1878 - val
_loss: 0.3472
Epoch 80/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1877 - val
_loss: 0.3494
Epoch 81/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1875 - val
_loss: 0.3470
Epoch 82/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1873 - val
_loss: 0.3495
Epoch 83/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1870 - val
_loss: 0.3523
Epoch 84/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1869 - val
_loss: 0.3495
Epoch 85/100
235/235 [==============================] - 2s 9ms/step - loss: 0.1867 - val
_loss: 0.3516
Epoch 86/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1866 - val
_loss: 0.3532
Epoch 87/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1865 - val
_loss: 0.3521
Epoch 88/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1862 - val
_loss: 0.3541
Epoch 89/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1861 - val
_loss: 0.3509
Epoch 90/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1859 - val
_loss: 0.3537
Epoch 91/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1859 - val
_loss: 0.3503
Epoch 92/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1858 - val
_loss: 0.3530
Epoch 93/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1856 - val
_loss: 0.3544
Epoch 94/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1855 - val
_loss: 0.3548
Epoch 95/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1853 - val
_loss: 0.3560
Epoch 96/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1853 - val
_loss: 0.3575
Epoch 97/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1851 - val
_loss: 0.3548
Epoch 98/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1850 - val
_loss: 0.3540
```

```
Epoch 99/100
235/235 [==============================] - 2s 7ms/step - loss: 0.1847 - val
_loss: 0.3582
Epoch 100/100
235/235 [==============================] - 2s 8ms/step - loss: 0.1846 - val
_loss: 0.3596
```
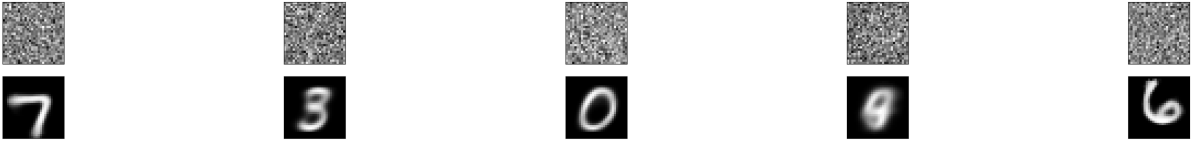

In [22]:
```python
# example with the noise scale at 4.0 after the previous block is run
encoded_imgs = encoder.predict(xtest_noisy)
decoded_imgs = decoder.predict(encoded_imgs)

n = 20  # how many digits we will display
plt.figure(figsize=(40, 4))
for i in range(n):
    # display original
    ax = plt.subplot(2, n, i + 1)
    plt.imshow(xtest_noisy[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)

    # display reconstruction
    ax = plt.subplot(2, n, i + 1 + n)
    plt.imshow(decoded_imgs[i].reshape(28, 28))
    plt.gray()
    ax.get_xaxis().set_visible(False)
    ax.get_yaxis().set_visible(False)
plt.show()
```
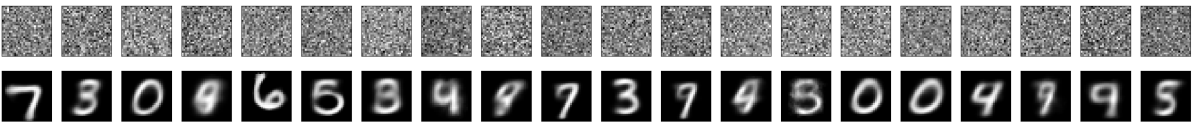

In [23]:
```python
losses
```

Out[23]:
```
[0.1256238967180252,
 0.14162208139896393,
 0.17681051790714264,
 0.25611573457717896,
 0.35957613587379456]
```

In [24]:
```python
plt.figure()
plt.scatter(scales, losses)
plt.xlabel("Noise Scales")
plt.ylabel("Loss Scores")
```

Out[24]:
```
Text(0, 0.5, 'Loss Scores')
```