

Assignment is below at the bottom

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
import tensorflow as tf
import datetime as dt
import matplotlib.pyplot as plt
plt.rcParams['figure.figsize'] = (16, 16)
plt.rcParams['font.size'] = 14
print("Num GPUs Available: ", len(tf.config.experimental.list_physical_devices('GPU')))

(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
```

Num GPUs Available: 1
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 input is 784

# 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))))
```

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

```
In [4]: from tensorflow import program

log_dir = "C:/Users/gdlev/AppData/Local/Temp/autoencoder/logs/fit/" + dt.datetime.now().strftime("%Y%m%d-%H%M%S")
if __name__ == "__main__":
    tb = program.TensorBoard()
    tb.configure(argv=[None, '--logdir', log_dir])
    url = tb.launch()
    print(f"Tensorflow listening on {url}")

tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_freq=1)
```

Epoch 1/100
235/235 [=====] - 3s 9ms/step - loss: 0.2481 - val_loss: 0.1877
Epoch 2/100
235/235 [=====] - 2s 7ms/step - loss: 0.1799 - val_loss: 0.1735
Epoch 3/100
235/235 [=====] - 2s 7ms/step - loss: 0.1709 - val_loss: 0.1674
Epoch 4/100
235/235 [=====] - 2s 7ms/step - loss: 0.1659 - val_loss: 0.1638
Epoch 5/100
235/235 [=====] - 2s 8ms/step - loss: 0.1620 - val_loss: 0.1606
Epoch 6/100
235/235 [=====] - 2s 7ms/step - loss: 0.1595 - val_loss: 0.1583
Epoch 7/100
235/235 [=====] - 2s 7ms/step - loss: 0.1575 - val_loss: 0.1566
Epoch 8/100
235/235 [=====] - 2s 7ms/step - loss: 0.1559 - val_loss: 0.1554
Epoch 9/100
235/235 [=====] - 2s 7ms/step - loss: 0.1545 - val_loss: 0.1539
Epoch 10/100
235/235 [=====] - 2s 7ms/step - loss: 0.1533 - val_loss: 0.1536
Epoch 11/100
235/235 [=====] - 2s 8ms/step - loss: 0.1522 - val_loss: 0.1524
Epoch 12/100
235/235 [=====] - 2s 7ms/step - loss: 0.1511 - val_loss: 0.1520
Epoch 13/100
235/235 [=====] - 2s 7ms/step - loss: 0.1503 - val_loss: 0.1508
Epoch 14/100
235/235 [=====] - 2s 7ms/step - loss: 0.1494 - val_loss: 0.1499
Epoch 15/100
235/235 [=====] - 2s 8ms/step - loss: 0.1486 - val_loss: 0.1495
Epoch 16/100
235/235 [=====] - 2s 7ms/step - loss: 0.1479 - val_loss: 0.1488
Epoch 17/100
235/235 [=====] - 2s 7ms/step - loss: 0.1473 - val_loss: 0.1485
Epoch 18/100
235/235 [=====] - 2s 7ms/step - loss: 0.1467 - val_loss: 0.1481
Epoch 19/100
235/235 [=====] - 2s 7ms/step - loss: 0.1462 - val_loss: 0.1477
Epoch 20/100
235/235 [=====] - 2s 10ms/step - loss: 0.1457 - val_loss: 0.1475

Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1452 - val_loss: 0.1472
Epoch 22/100
235/235 [=====] - 3s 11ms/step - loss: 0.1447 - val_loss: 0.1464
Epoch 23/100
235/235 [=====] - 3s 12ms/step - loss: 0.1443 - val_loss: 0.1461
Epoch 24/100
235/235 [=====] - 2s 9ms/step - loss: 0.1440 - val_loss: 0.1461
Epoch 25/100
235/235 [=====] - 3s 11ms/step - loss: 0.1436 - val_loss: 0.1459
Epoch 26/100
235/235 [=====] - 2s 8ms/step - loss: 0.1433 - val_loss: 0.1454
Epoch 27/100
235/235 [=====] - 2s 8ms/step - loss: 0.1429 - val_loss: 0.1451
Epoch 28/100
235/235 [=====] - 2s 8ms/step - loss: 0.1426 - val_loss: 0.1451
Epoch 29/100
235/235 [=====] - 2s 8ms/step - loss: 0.1423 - val_loss: 0.1448
Epoch 30/100
235/235 [=====] - 2s 10ms/step - loss: 0.1421 - val_loss: 0.1446
Epoch 31/100
235/235 [=====] - 2s 8ms/step - loss: 0.1417 - val_loss: 0.1445
Epoch 32/100
235/235 [=====] - 2s 8ms/step - loss: 0.1415 - val_loss: 0.1446
Epoch 33/100
235/235 [=====] - 2s 8ms/step - loss: 0.1412 - val_loss: 0.1442
Epoch 34/100
235/235 [=====] - 2s 7ms/step - loss: 0.1410 - val_loss: 0.1440
Epoch 35/100
235/235 [=====] - 2s 7ms/step - loss: 0.1408 - val_loss: 0.1438
Epoch 36/100
235/235 [=====] - 2s 7ms/step - loss: 0.1406 - val_loss: 0.1439
Epoch 37/100
235/235 [=====] - 2s 7ms/step - loss: 0.1403 - val_loss: 0.1436
Epoch 38/100
235/235 [=====] - 2s 7ms/step - loss: 0.1401 - val_loss: 0.1438
Epoch 39/100
235/235 [=====] - 2s 7ms/step - loss: 0.1399 - val_loss: 0.1435
Epoch 40/100
235/235 [=====] - 2s 7ms/step - loss: 0.1397 - val_loss: 0.1437

```
Epoch 41/100
235/235 [=====] - 2s 8ms/step - loss: 0.1395 - val_loss: 0.1
432
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.1393 - val_loss: 0.1
433
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.1392 - val_loss: 0.1
432
Epoch 44/100
235/235 [=====] - 2s 7ms/step - loss: 0.1390 - val_loss: 0.1
430
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.1389 - val_loss: 0.1
429
Epoch 46/100
235/235 [=====] - 2s 7ms/step - loss: 0.1387 - val_loss: 0.1
429
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1386 - val_loss: 0.1
425
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1384 - val_loss: 0.1
428
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.1383 - val_loss: 0.1
424
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.1381 - val_loss: 0.1
426
Epoch 51/100
235/235 [=====] - 2s 7ms/step - loss: 0.1380 - val_loss: 0.1
426
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.1379 - val_loss: 0.1
427
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.1377 - val_loss: 0.1
426
Epoch 54/100
235/235 [=====] - 2s 7ms/step - loss: 0.1376 - val_loss: 0.1
425
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.1375 - val_loss: 0.1
426
Epoch 56/100
235/235 [=====] - 2s 7ms/step - loss: 0.1374 - val_loss: 0.1
426
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.1373 - val_loss: 0.1
423
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.1371 - val_loss: 0.1
422
Epoch 59/100
235/235 [=====] - 2s 8ms/step - loss: 0.1371 - val_loss: 0.1
424
Epoch 60/100
235/235 [=====] - 2s 7ms/step - loss: 0.1370 - val_loss: 0.1
421
```

Epoch 61/100
235/235 [=====] - 2s 7ms/step - loss: 0.1369 - val_loss: 0.1
423
Epoch 62/100
235/235 [=====] - 2s 7ms/step - loss: 0.1367 - val_loss: 0.1
423
Epoch 63/100
235/235 [=====] - 2s 7ms/step - loss: 0.1367 - val_loss: 0.1
421
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.1366 - val_loss: 0.1
420
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.1365 - val_loss: 0.1
420
Epoch 66/100
235/235 [=====] - 2s 8ms/step - loss: 0.1364 - val_loss: 0.1
421
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.1363 - val_loss: 0.1
421
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.1362 - val_loss: 0.1
421
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.1362 - val_loss: 0.1
421
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.1360 - val_loss: 0.1
420
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.1360 - val_loss: 0.1
420
Epoch 72/100
235/235 [=====] - 2s 7ms/step - loss: 0.1359 - val_loss: 0.1
420
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.1358 - val_loss: 0.1
420
Epoch 74/100
235/235 [=====] - 2s 7ms/step - loss: 0.1358 - val_loss: 0.1
417
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.1357 - val_loss: 0.1
419
Epoch 76/100
235/235 [=====] - 2s 8ms/step - loss: 0.1357 - val_loss: 0.1
418
Epoch 77/100
235/235 [=====] - 2s 8ms/step - loss: 0.1356 - val_loss: 0.1
419
Epoch 78/100
235/235 [=====] - 2s 7ms/step - loss: 0.1355 - val_loss: 0.1
419
Epoch 79/100
235/235 [=====] - 2s 8ms/step - loss: 0.1354 - val_loss: 0.1
420
Epoch 80/100
235/235 [=====] - 2s 7ms/step - loss: 0.1353 - val_loss: 0.1
416

Epoch 81/100
235/235 [=====] - 2s 7ms/step - loss: 0.1353 - val_loss: 0.1
418
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.1352 - val_loss: 0.1
419
Epoch 83/100
235/235 [=====] - 2s 7ms/step - loss: 0.1351 - val_loss: 0.1
419
Epoch 84/100
235/235 [=====] - 2s 7ms/step - loss: 0.1351 - val_loss: 0.1
421
Epoch 85/100
235/235 [=====] - 2s 7ms/step - loss: 0.1350 - val_loss: 0.1
417
Epoch 86/100
235/235 [=====] - 2s 7ms/step - loss: 0.1349 - val_loss: 0.1
419
Epoch 87/100
235/235 [=====] - 2s 7ms/step - loss: 0.1349 - val_loss: 0.1
420
Epoch 88/100
235/235 [=====] - 2s 7ms/step - loss: 0.1348 - val_loss: 0.1
418
Epoch 89/100
235/235 [=====] - 2s 7ms/step - loss: 0.1347 - val_loss: 0.1
419
Epoch 90/100
235/235 [=====] - 2s 7ms/step - loss: 0.1347 - val_loss: 0.1
419
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.1346 - val_loss: 0.1
417
Epoch 92/100
235/235 [=====] - 2s 7ms/step - loss: 0.1346 - val_loss: 0.1
417
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.1345 - val_loss: 0.1
420
Epoch 94/100
235/235 [=====] - 2s 8ms/step - loss: 0.1344 - val_loss: 0.1
417
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.1344 - val_loss: 0.1
419
Epoch 96/100
235/235 [=====] - 2s 7ms/step - loss: 0.1344 - val_loss: 0.1
417
Epoch 97/100
235/235 [=====] - 2s 7ms/step - loss: 0.1343 - val_loss: 0.1
420
Epoch 98/100
235/235 [=====] - 2s 7ms/step - loss: 0.1342 - val_loss: 0.1
416
Epoch 99/100
235/235 [=====] - 2s 7ms/step - loss: 0.1342 - val_loss: 0.1
416
Epoch 100/100
235/235 [=====] - 2s 7ms/step - loss: 0.1342 - val_loss: 0.1
417

```
In [121]: encoded_imgs
```

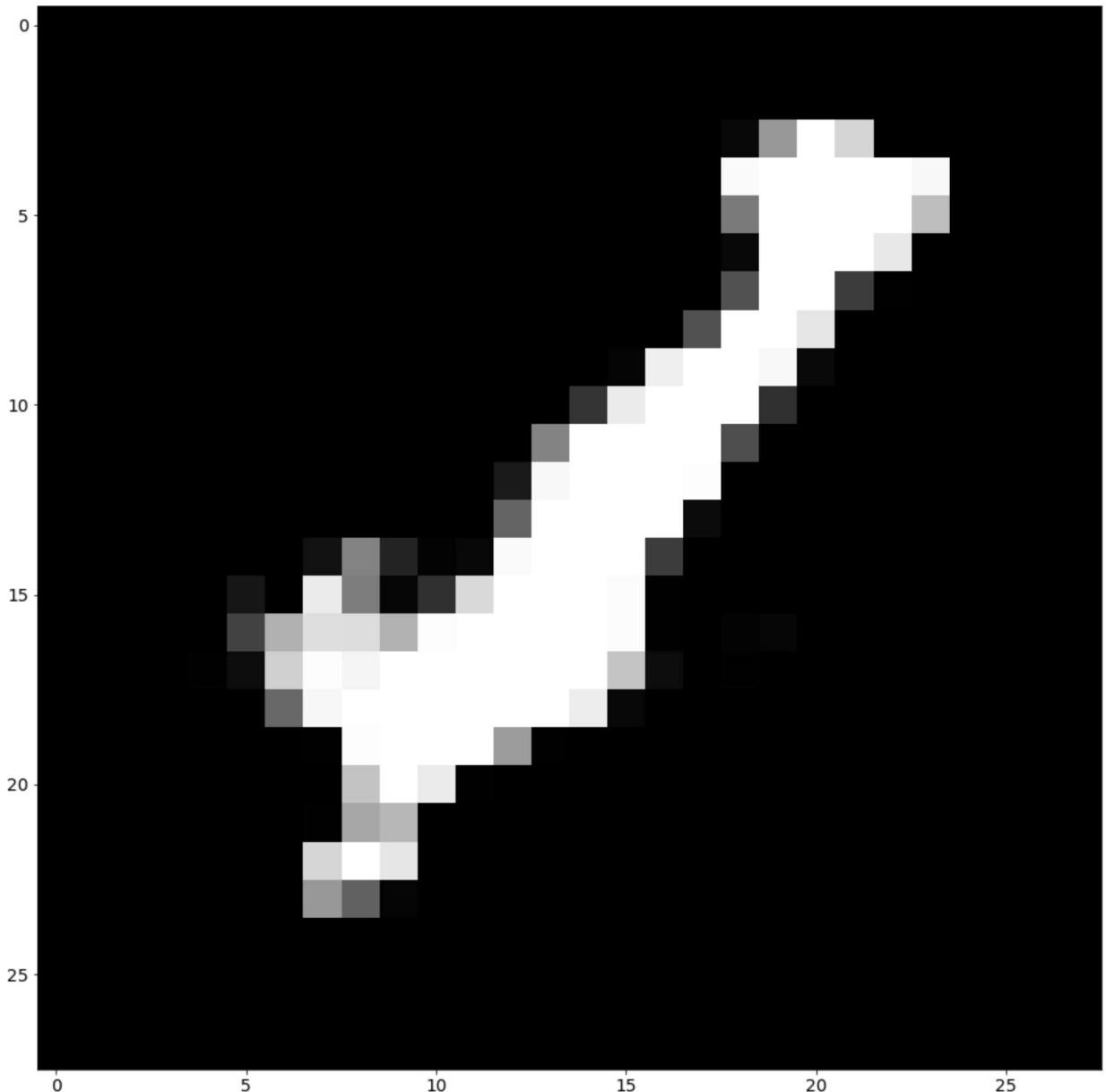
```
Out[121]: array([[ 1.9707481,  0.        ,  0.        , ...,  8.342426 ,  6.2630024,
   11.534848 ],
   [ 5.280365 ,  0.        ,  8.033773 , ...,  2.0426934,  7.878948 ,
   4.3984838],
   [ 3.9974663,  0.        ,  2.2056983, ...,  4.0428467,  8.595585 ,
   2.9682508],
   ...,
   [ 8.609844 ,  0.        ,  9.215833 , ...,  15.954529 ,  14.438898 ,
   23.025545 ],
   [ 4.8199234,  0.        ,  11.494822 , ...,  9.680196 ,  7.003931 ,
   7.4360356],
   [ 7.1014156,  0.        ,  19.093859 , ...,  6.1466084,  6.6854944,
   10.798484 ]], dtype=float32)
```

```
In [94]: noise = np.random.normal(20,4, (4,8))
noise_preds = decoder.predict(noise)
```

```
1/1 [=====] - 0s 443ms/step
```

```
In [95]: plt.imshow(noise_preds[1].reshape(28,28))
```

```
Out[95]: <matplotlib.image.AxesImage at 0x2020d2aa380>
```



```
In [9]: np.max(encoded_imgs)
```

```
NameError: name 'encoded_imgs' is not defined
```

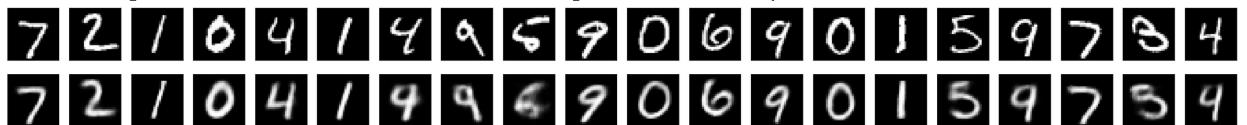
Traceback (most recent call last)
c:\Users\gdlev\portfolio\mlnn\w12\autoencoder_gd1.ipynb Cell 11 in <cell line: 1>()
----> 1 np.max(encoded_imgs)

```
In [10]: 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()
```

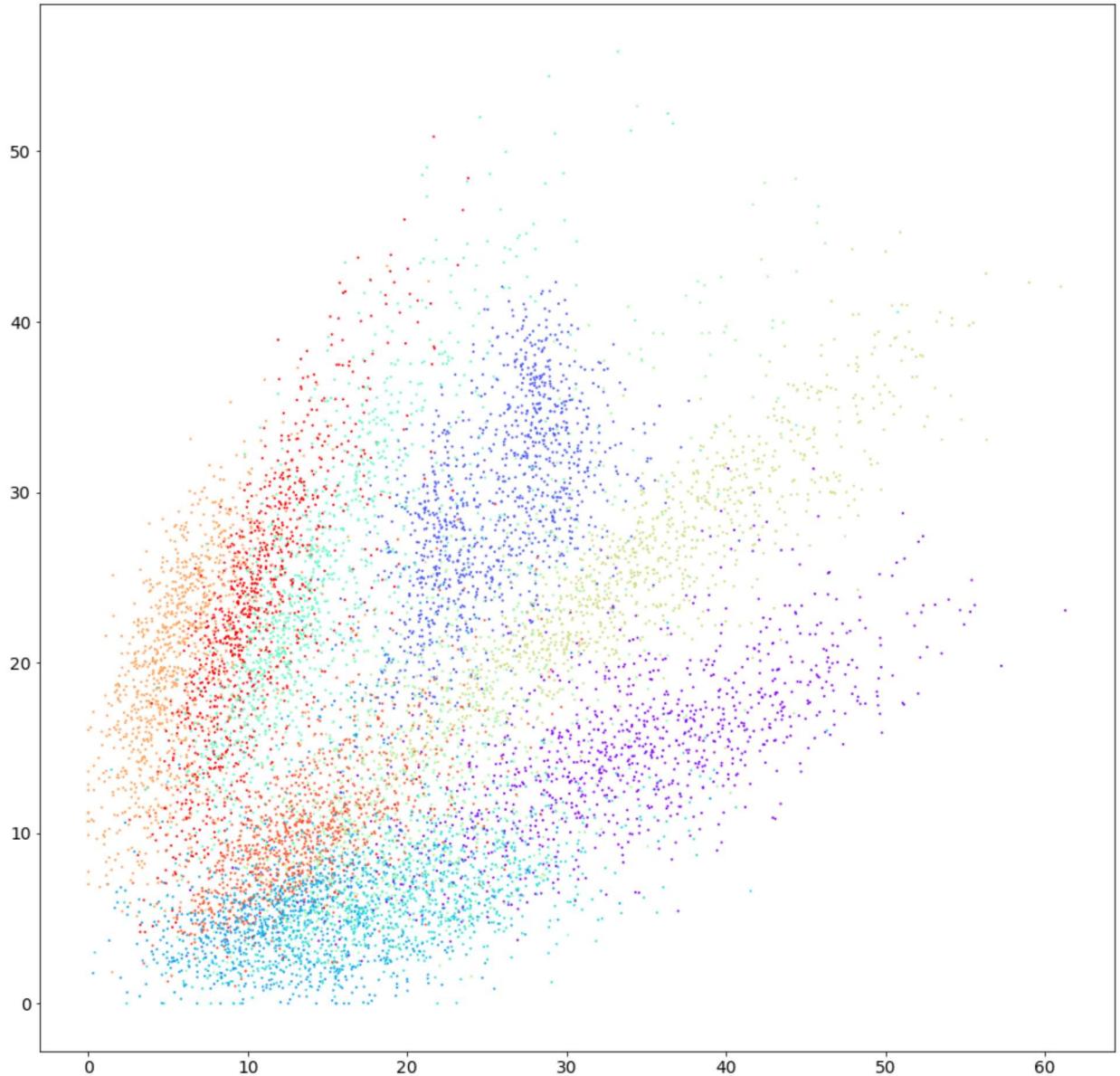
```
313/313 [=====] - 1s 2ms/step
313/313 [=====] - 1s 2ms/step
```



```
In [11]: encoded_imgs
```

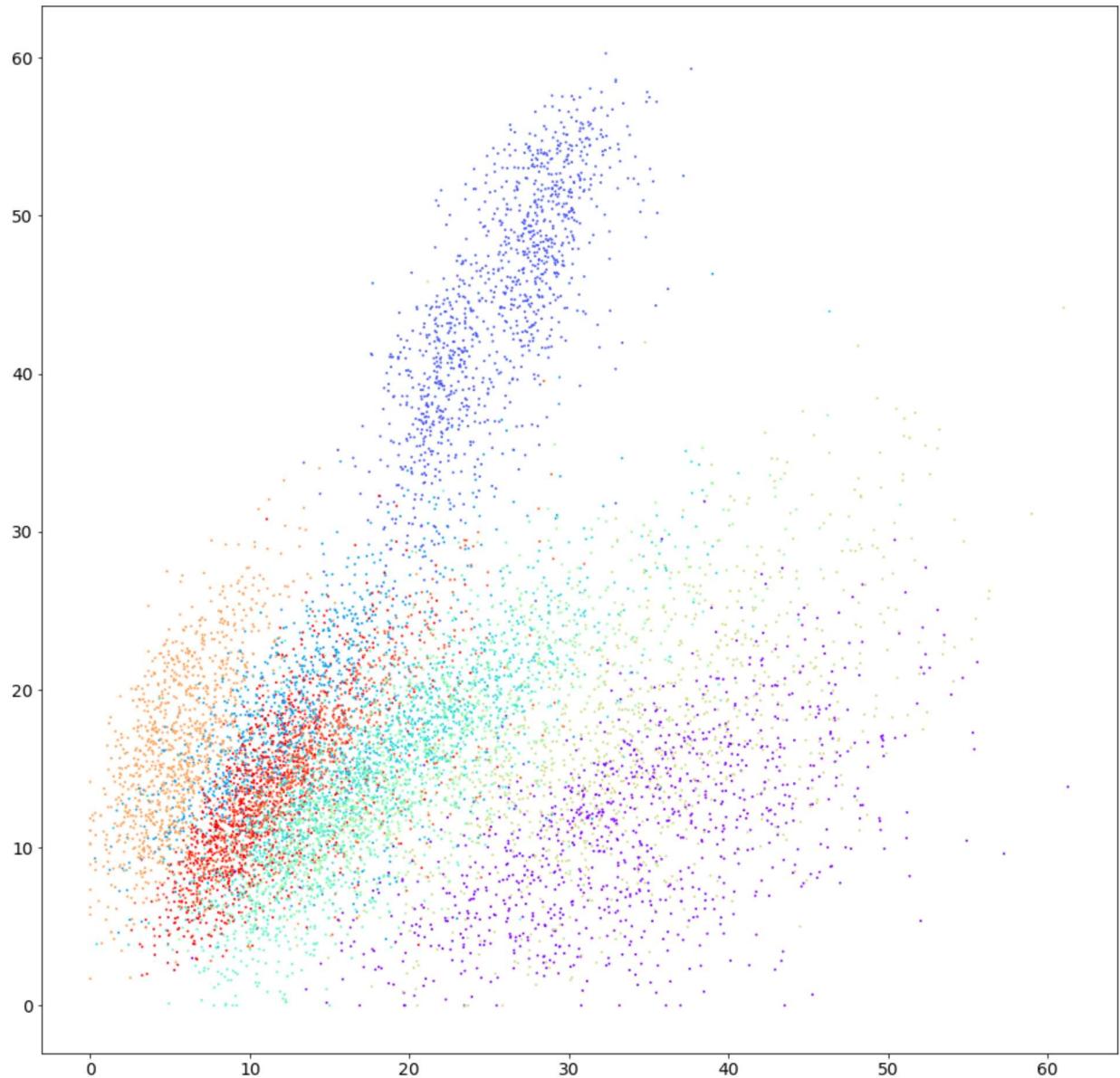
```
Out[11]: array([[22.432108 ,  3.1397989, 14.283261 , 19.346865 ],
   [ 6.250051 , 14.999794 , 13.975002 , 23.353971 ],
   [38.193222 , 27.468084 , 29.033352 , 54.27407 ],
   ...,
   [22.029963 , 11.188628 , 10.827792 , 13.666468 ],
   [22.251219 , 22.680052 ,  3.5536025, 19.580408 ],
   [20.399652 , 26.928648 , 14.511384 , 12.331304 ]], dtype=float32)
```

```
In [12]: plt.scatter(encoded_imgs[:,1], encoded_imgs[:,0], s=1, c=ytest, cmap='rainbow')
plt.show()
```



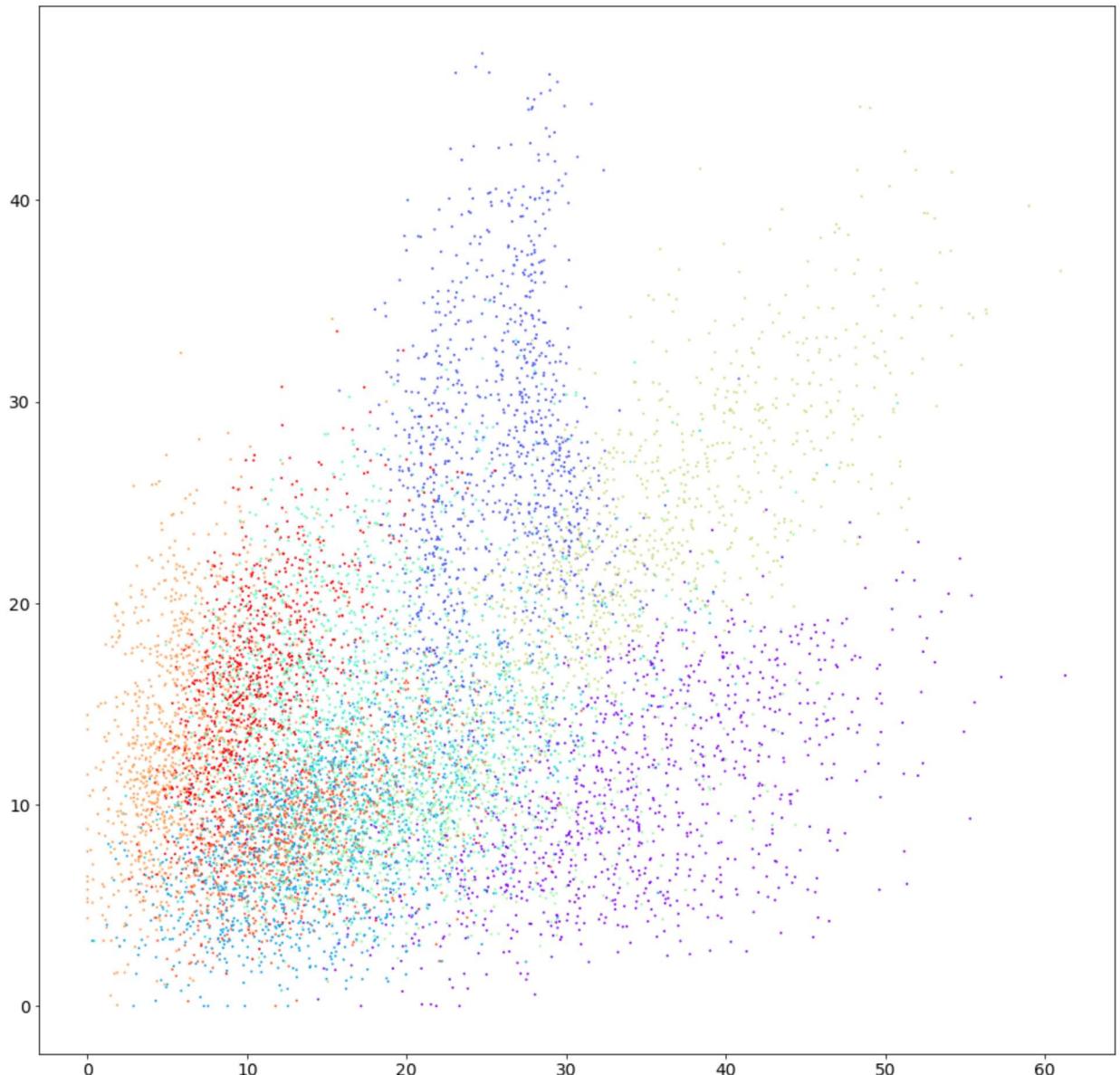
```
In [13]: plt.scatter(encoded_imgs[:,1], encoded_imgs[:,3], s=1, c=ytest, cmap='rainbow')
# plt.show()
```

```
Out[13]: <matplotlib.collections.PathCollection at 0x20202a3a230>
```



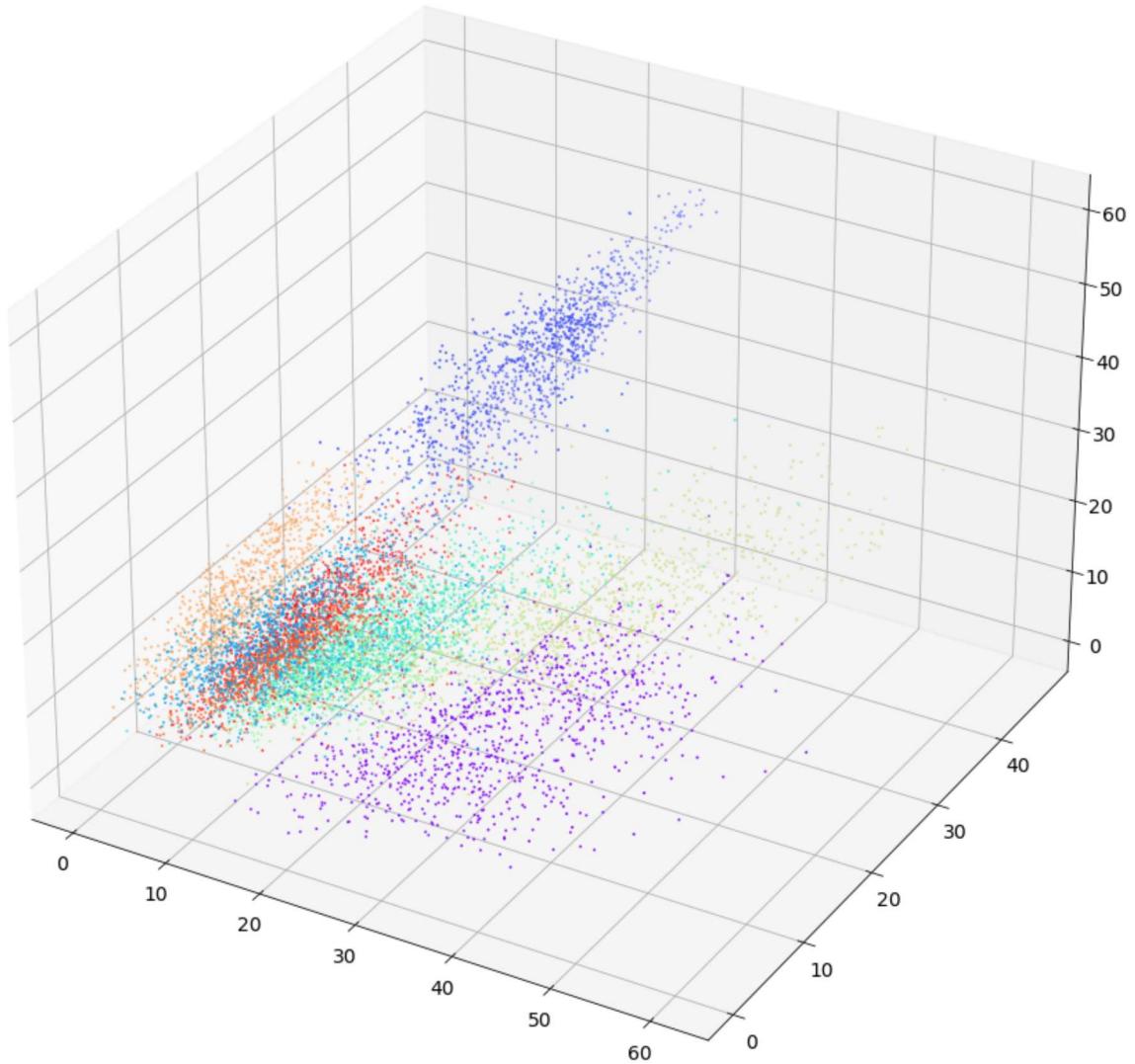
```
In [14]: plt.scatter(encoded_imgs[:,1], encoded_imgs[:,2], s=1, c=ytest, cmap='rainbow')
# plt.show()
```

```
Out[14]: <matplotlib.collections.PathCollection at 0x20202aa8bb0>
```



```
In [15]: 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, cmap='rainbow')
```

```
Out[15]: <mpl_toolkits.mplot3d.art3d.Path3DCollection at 0x20202b0e3e0>
```



Assignment

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 [16]: def train_autoencoder(encoding_dim = 2):

    # encoding_dim = 4 # 32 floats -> compression of factor 24.5, assuming the input

    # this is our input placeholder
    x = 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')

from tensorflow import program

log_dir = "C:/Users/gdlev/AppData/Local/Temp/autoencoder/logs/fit/" + dt.datetime.now().strftime("%Y%m%d-%H%M%S")
if __name__ == "__main__":
    tb = program.TensorBoard()
    tb.configure(argv=[None, '--logdir', log_dir])
    url = tb.launch()
    print(f"Tensorflow listening on {url}")

tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_fi

history = autoencoder.fit(xtrain, xtrain,
                           epochs=100,
                           batch_size=256,
                           shuffle=True,
                           validation_data=(xtest, xtest),
                           callbacks=[tensorboard_callback])
return history

```

In [17]:

```

dimensions = range(2,18,2)
losses = []
for encoding_dim in dimensions:
    print(f"Encoding Dimensions: {encoding_dim}")
    loss = train_autoencoder(encoding_dim=encoding_dim)
    losses.append(loss)

```

```
Encoding Dimensions: 2
Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 3s 9ms/step - loss: 0.2821 - val_loss: 0.2
505
Epoch 2/100
235/235 [=====] - 2s 10ms/step - loss: 0.2458 - val_loss: 0.
2403
Epoch 3/100
235/235 [=====] - 2s 10ms/step - loss: 0.2378 - val_loss: 0.
2332
Epoch 4/100
235/235 [=====] - 2s 8ms/step - loss: 0.2313 - val_loss: 0.2
287
Epoch 5/100
235/235 [=====] - 2s 8ms/step - loss: 0.2278 - val_loss: 0.2
262
Epoch 6/100
235/235 [=====] - 2s 9ms/step - loss: 0.2257 - val_loss: 0.2
241
Epoch 7/100
235/235 [=====] - 2s 9ms/step - loss: 0.2237 - val_loss: 0.2
225
Epoch 8/100
235/235 [=====] - 2s 9ms/step - loss: 0.2219 - val_loss: 0.2
213
Epoch 9/100
235/235 [=====] - 2s 8ms/step - loss: 0.2119 - val_loss: 0.2
014
Epoch 10/100
235/235 [=====] - 2s 7ms/step - loss: 0.1976 - val_loss: 0.1
940
Epoch 11/100
235/235 [=====] - 2s 7ms/step - loss: 0.1928 - val_loss: 0.1
909
Epoch 12/100
235/235 [=====] - 2s 7ms/step - loss: 0.1897 - val_loss: 0.1
878
Epoch 13/100
235/235 [=====] - 2s 7ms/step - loss: 0.1877 - val_loss: 0.1
865
Epoch 14/100
235/235 [=====] - 2s 8ms/step - loss: 0.1859 - val_loss: 0.1
852
Epoch 15/100
235/235 [=====] - 2s 9ms/step - loss: 0.1846 - val_loss: 0.1
840
Epoch 16/100
235/235 [=====] - 2s 8ms/step - loss: 0.1835 - val_loss: 0.1
831
Epoch 17/100
235/235 [=====] - 2s 8ms/step - loss: 0.1826 - val_loss: 0.1
823
Epoch 18/100
235/235 [=====] - 4s 16ms/step - loss: 0.1815 - val_loss: 0.
1815
Epoch 19/100
235/235 [=====] - 4s 16ms/step - loss: 0.1807 - val_loss: 0.
1809
Epoch 20/100
```

235/235 [=====] - 3s 12ms/step - loss: 0.1800 - val_loss: 0.
1804
Epoch 21/100
235/235 [=====] - 2s 10ms/step - loss: 0.1794 - val_loss: 0.
1800
Epoch 22/100
235/235 [=====] - 2s 8ms/step - loss: 0.1787 - val_loss: 0.1
794
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.1782 - val_loss: 0.1
791
Epoch 24/100
235/235 [=====] - 2s 8ms/step - loss: 0.1775 - val_loss: 0.1
788
Epoch 25/100
235/235 [=====] - 2s 8ms/step - loss: 0.1772 - val_loss: 0.1
786
Epoch 26/100
235/235 [=====] - 2s 8ms/step - loss: 0.1767 - val_loss: 0.1
780
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.1763 - val_loss: 0.1
780
Epoch 28/100
235/235 [=====] - 2s 9ms/step - loss: 0.1758 - val_loss: 0.1
772
Epoch 29/100
235/235 [=====] - 2s 8ms/step - loss: 0.1754 - val_loss: 0.1
770
Epoch 30/100
235/235 [=====] - 2s 8ms/step - loss: 0.1752 - val_loss: 0.1
767
Epoch 31/100
235/235 [=====] - 2s 8ms/step - loss: 0.1746 - val_loss: 0.1
763
Epoch 32/100
235/235 [=====] - 2s 7ms/step - loss: 0.1741 - val_loss: 0.1
758
Epoch 33/100
235/235 [=====] - 2s 9ms/step - loss: 0.1736 - val_loss: 0.1
757
Epoch 34/100
235/235 [=====] - 2s 10ms/step - loss: 0.1735 - val_loss: 0.
1756
Epoch 35/100
235/235 [=====] - 2s 10ms/step - loss: 0.1731 - val_loss: 0.
1754
Epoch 36/100
235/235 [=====] - 2s 9ms/step - loss: 0.1725 - val_loss: 0.1
749
Epoch 37/100
235/235 [=====] - 2s 8ms/step - loss: 0.1722 - val_loss: 0.1
750
Epoch 38/100
235/235 [=====] - 2s 8ms/step - loss: 0.1719 - val_loss: 0.1
747
Epoch 39/100
235/235 [=====] - 2s 9ms/step - loss: 0.1716 - val_loss: 0.1
746
Epoch 40/100

235/235 [=====] - 2s 9ms/step - loss: 0.1714 - val_loss: 0.1
746
Epoch 41/100
235/235 [=====] - 2s 9ms/step - loss: 0.1712 - val_loss: 0.1
741
Epoch 42/100
235/235 [=====] - 2s 9ms/step - loss: 0.1707 - val_loss: 0.1
741
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.1705 - val_loss: 0.1
737
Epoch 44/100
235/235 [=====] - 2s 8ms/step - loss: 0.1702 - val_loss: 0.1
739
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.1700 - val_loss: 0.1
737
Epoch 46/100
235/235 [=====] - 2s 9ms/step - loss: 0.1696 - val_loss: 0.1
734
Epoch 47/100
235/235 [=====] - 2s 8ms/step - loss: 0.1696 - val_loss: 0.1
736
Epoch 48/100
235/235 [=====] - 2s 8ms/step - loss: 0.1694 - val_loss: 0.1
731
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.1689 - val_loss: 0.1
726
Epoch 50/100
235/235 [=====] - 2s 8ms/step - loss: 0.1689 - val_loss: 0.1
728
Epoch 51/100
235/235 [=====] - 2s 8ms/step - loss: 0.1685 - val_loss: 0.1
730
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.1686 - val_loss: 0.1
730
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.1682 - val_loss: 0.1
726
Epoch 54/100
235/235 [=====] - 2s 8ms/step - loss: 0.1682 - val_loss: 0.1
724
Epoch 55/100
235/235 [=====] - 2s 8ms/step - loss: 0.1679 - val_loss: 0.1
725
Epoch 56/100
235/235 [=====] - 2s 9ms/step - loss: 0.1679 - val_loss: 0.1
724
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.1677 - val_loss: 0.1
721
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.1675 - val_loss: 0.1
720
Epoch 59/100
235/235 [=====] - 2s 7ms/step - loss: 0.1677 - val_loss: 0.1
720
Epoch 60/100

235/235 [=====] - 2s 8ms/step - loss: 0.1674 - val_loss: 0.1
718
Epoch 61/100
235/235 [=====] - 2s 7ms/step - loss: 0.1670 - val_loss: 0.1
721
Epoch 62/100
235/235 [=====] - 2s 7ms/step - loss: 0.1668 - val_loss: 0.1
721
Epoch 63/100
235/235 [=====] - 2s 8ms/step - loss: 0.1668 - val_loss: 0.1
719
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.1664 - val_loss: 0.1
714
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.1662 - val_loss: 0.1
716
Epoch 66/100
235/235 [=====] - 2s 7ms/step - loss: 0.1663 - val_loss: 0.1
716
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.1665 - val_loss: 0.1
714
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.1660 - val_loss: 0.1
718
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.1658 - val_loss: 0.1
711
Epoch 70/100
235/235 [=====] - 2s 8ms/step - loss: 0.1656 - val_loss: 0.1
714
Epoch 71/100
235/235 [=====] - 2s 10ms/step - loss: 0.1655 - val_loss: 0.
1711
Epoch 72/100
235/235 [=====] - 2s 9ms/step - loss: 0.1654 - val_loss: 0.1
711
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.1655 - val_loss: 0.1
716
Epoch 74/100
235/235 [=====] - 2s 10ms/step - loss: 0.1662 - val_loss: 0.
1715
Epoch 75/100
235/235 [=====] - 3s 11ms/step - loss: 0.1660 - val_loss: 0.
1713
Epoch 76/100
235/235 [=====] - 2s 9ms/step - loss: 0.1657 - val_loss: 0.1
709
Epoch 77/100
235/235 [=====] - 2s 9ms/step - loss: 0.1653 - val_loss: 0.1
710
Epoch 78/100
235/235 [=====] - 2s 9ms/step - loss: 0.1653 - val_loss: 0.1
709
Epoch 79/100
235/235 [=====] - 2s 8ms/step - loss: 0.1649 - val_loss: 0.1
709
Epoch 80/100

235/235 [=====] - 2s 9ms/step - loss: 0.1647 - val_loss: 0.1
710
Epoch 81/100
235/235 [=====] - 2s 9ms/step - loss: 0.1646 - val_loss: 0.1
708
Epoch 82/100
235/235 [=====] - 2s 9ms/step - loss: 0.1643 - val_loss: 0.1
705
Epoch 83/100
235/235 [=====] - 2s 9ms/step - loss: 0.1645 - val_loss: 0.1
708
Epoch 84/100
235/235 [=====] - 2s 8ms/step - loss: 0.1644 - val_loss: 0.1
708
Epoch 85/100
235/235 [=====] - 2s 8ms/step - loss: 0.1642 - val_loss: 0.1
708
Epoch 86/100
235/235 [=====] - 2s 8ms/step - loss: 0.1641 - val_loss: 0.1
707
Epoch 87/100
235/235 [=====] - 2s 9ms/step - loss: 0.1640 - val_loss: 0.1
710
Epoch 88/100
235/235 [=====] - 2s 9ms/step - loss: 0.1640 - val_loss: 0.1
707
Epoch 89/100
235/235 [=====] - 2s 10ms/step - loss: 0.1639 - val_loss: 0.
1707
Epoch 90/100
235/235 [=====] - 2s 8ms/step - loss: 0.1639 - val_loss: 0.1
708
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.1638 - val_loss: 0.1
715
Epoch 92/100
235/235 [=====] - 2s 7ms/step - loss: 0.1637 - val_loss: 0.1
703
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.1635 - val_loss: 0.1
706
Epoch 94/100
235/235 [=====] - 2s 8ms/step - loss: 0.1638 - val_loss: 0.1
704
Epoch 95/100
235/235 [=====] - 2s 9ms/step - loss: 0.1636 - val_loss: 0.1
704
Epoch 96/100
235/235 [=====] - 2s 8ms/step - loss: 0.1635 - val_loss: 0.1
705
Epoch 97/100
235/235 [=====] - 2s 8ms/step - loss: 0.1633 - val_loss: 0.1
706
Epoch 98/100
235/235 [=====] - 2s 7ms/step - loss: 0.1633 - val_loss: 0.1
704
Epoch 99/100
235/235 [=====] - 2s 7ms/step - loss: 0.1632 - val_loss: 0.1
705
Epoch 100/100

```
235/235 [=====] - 2s 10ms/step - loss: 0.1631 - val_loss: 0.  
1706  
Encoding Dimensions: 4  
Tensorflow listening on http://localhost:6006/  
Epoch 1/100  
235/235 [=====] - 2s 8ms/step - loss: 0.2596 - val_loss: 0.2  
040  
Epoch 2/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1953 - val_loss: 0.1  
888  
Epoch 3/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1841 - val_loss: 0.1  
800  
Epoch 4/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1778 - val_loss: 0.1  
755  
Epoch 5/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1739 - val_loss: 0.1  
727  
Epoch 6/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1712 - val_loss: 0.1  
703  
Epoch 7/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1693 - val_loss: 0.1  
692  
Epoch 8/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1676 - val_loss: 0.1  
673  
Epoch 9/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1663 - val_loss: 0.1  
668  
Epoch 10/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1651 - val_loss: 0.1  
654  
Epoch 11/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1640 - val_loss: 0.1  
643  
Epoch 12/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1631 - val_loss: 0.1  
638  
Epoch 13/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1622 - val_loss: 0.1  
628  
Epoch 14/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1614 - val_loss: 0.1  
623  
Epoch 15/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1607 - val_loss: 0.1  
621  
Epoch 16/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1600 - val_loss: 0.1  
612  
Epoch 17/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1595 - val_loss: 0.1  
607  
Epoch 18/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1588 - val_loss: 0.1  
603  
Epoch 19/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1583 - val_loss: 0.1
```

600
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.1578 - val_loss: 0.1595
Epoch 21/100
235/235 [=====] - 2s 7ms/step - loss: 0.1573 - val_loss: 0.1593
Epoch 22/100
235/235 [=====] - 2s 8ms/step - loss: 0.1568 - val_loss: 0.1590
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.1564 - val_loss: 0.1587
Epoch 24/100
235/235 [=====] - 2s 7ms/step - loss: 0.1560 - val_loss: 0.1582
Epoch 25/100
235/235 [=====] - 2s 7ms/step - loss: 0.1557 - val_loss: 0.1583
Epoch 26/100
235/235 [=====] - 2s 7ms/step - loss: 0.1553 - val_loss: 0.1578
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.1549 - val_loss: 0.1578
Epoch 28/100
235/235 [=====] - 2s 7ms/step - loss: 0.1547 - val_loss: 0.1574
Epoch 29/100
235/235 [=====] - 2s 7ms/step - loss: 0.1544 - val_loss: 0.1571
Epoch 30/100
235/235 [=====] - 2s 7ms/step - loss: 0.1541 - val_loss: 0.1571
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.1538 - val_loss: 0.1571
Epoch 32/100
235/235 [=====] - 2s 8ms/step - loss: 0.1536 - val_loss: 0.1567
Epoch 33/100
235/235 [=====] - 2s 8ms/step - loss: 0.1533 - val_loss: 0.1567
Epoch 34/100
235/235 [=====] - 2s 7ms/step - loss: 0.1531 - val_loss: 0.1567
Epoch 35/100
235/235 [=====] - 2s 7ms/step - loss: 0.1529 - val_loss: 0.1563
Epoch 36/100
235/235 [=====] - 2s 8ms/step - loss: 0.1527 - val_loss: 0.1563
Epoch 37/100
235/235 [=====] - 2s 8ms/step - loss: 0.1525 - val_loss: 0.1566
Epoch 38/100
235/235 [=====] - 2s 7ms/step - loss: 0.1523 - val_loss: 0.1564
Epoch 39/100
235/235 [=====] - 2s 8ms/step - loss: 0.1522 - val_loss: 0.1564

562
Epoch 40/100
235/235 [=====] - 2s 7ms/step - loss: 0.1520 - val_loss: 0.1
561
Epoch 41/100
235/235 [=====] - 2s 8ms/step - loss: 0.1519 - val_loss: 0.1
560
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.1517 - val_loss: 0.1
560
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.1515 - val_loss: 0.1
559
Epoch 44/100
235/235 [=====] - 2s 7ms/step - loss: 0.1514 - val_loss: 0.1
559
Epoch 45/100
235/235 [=====] - 2s 8ms/step - loss: 0.1512 - val_loss: 0.1
558
Epoch 46/100
235/235 [=====] - 2s 7ms/step - loss: 0.1511 - val_loss: 0.1
557
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1509 - val_loss: 0.1
556
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1508 - val_loss: 0.1
557
Epoch 49/100
235/235 [=====] - 2s 8ms/step - loss: 0.1507 - val_loss: 0.1
556
Epoch 50/100
235/235 [=====] - 2s 8ms/step - loss: 0.1505 - val_loss: 0.1
557
Epoch 51/100
235/235 [=====] - 2s 9ms/step - loss: 0.1504 - val_loss: 0.1
557
Epoch 52/100
235/235 [=====] - 2s 9ms/step - loss: 0.1503 - val_loss: 0.1
556
Epoch 53/100
235/235 [=====] - 2s 8ms/step - loss: 0.1502 - val_loss: 0.1
553
Epoch 54/100
235/235 [=====] - 2s 8ms/step - loss: 0.1501 - val_loss: 0.1
552
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.1500 - val_loss: 0.1
555
Epoch 56/100
235/235 [=====] - 2s 7ms/step - loss: 0.1500 - val_loss: 0.1
552
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.1498 - val_loss: 0.1
554
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.1496 - val_loss: 0.1
552
Epoch 59/100
235/235 [=====] - 2s 8ms/step - loss: 0.1495 - val_loss: 0.1

554
Epoch 60/100
235/235 [=====] - 2s 7ms/step - loss: 0.1495 - val_loss: 0.1
555
Epoch 61/100
235/235 [=====] - 2s 9ms/step - loss: 0.1494 - val_loss: 0.1
550
Epoch 62/100
235/235 [=====] - 2s 8ms/step - loss: 0.1492 - val_loss: 0.1
552
Epoch 63/100
235/235 [=====] - 2s 7ms/step - loss: 0.1492 - val_loss: 0.1
550
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.1491 - val_loss: 0.1
552
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.1490 - val_loss: 0.1
552
Epoch 66/100
235/235 [=====] - 2s 7ms/step - loss: 0.1489 - val_loss: 0.1
551
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.1488 - val_loss: 0.1
551
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.1488 - val_loss: 0.1
554
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.1487 - val_loss: 0.1
549
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.1486 - val_loss: 0.1
549
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.1485 - val_loss: 0.1
548
Epoch 72/100
235/235 [=====] - 2s 7ms/step - loss: 0.1485 - val_loss: 0.1
550
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.1484 - val_loss: 0.1
547
Epoch 74/100
235/235 [=====] - 2s 7ms/step - loss: 0.1483 - val_loss: 0.1
548
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.1483 - val_loss: 0.1
548
Epoch 76/100
235/235 [=====] - 2s 7ms/step - loss: 0.1482 - val_loss: 0.1
548
Epoch 77/100
235/235 [=====] - 2s 7ms/step - loss: 0.1481 - val_loss: 0.1
552
Epoch 78/100
235/235 [=====] - 2s 7ms/step - loss: 0.1481 - val_loss: 0.1
550
Epoch 79/100
235/235 [=====] - 2s 7ms/step - loss: 0.1479 - val_loss: 0.1

548
Epoch 80/100
235/235 [=====] - 2s 7ms/step - loss: 0.1479 - val_loss: 0.1
550
Epoch 81/100
235/235 [=====] - 2s 7ms/step - loss: 0.1479 - val_loss: 0.1
552
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.1477 - val_loss: 0.1
547
Epoch 83/100
235/235 [=====] - 2s 7ms/step - loss: 0.1477 - val_loss: 0.1
544
Epoch 84/100
235/235 [=====] - 2s 7ms/step - loss: 0.1476 - val_loss: 0.1
547
Epoch 85/100
235/235 [=====] - 2s 7ms/step - loss: 0.1476 - val_loss: 0.1
552
Epoch 86/100
235/235 [=====] - 2s 8ms/step - loss: 0.1475 - val_loss: 0.1
545
Epoch 87/100
235/235 [=====] - 2s 8ms/step - loss: 0.1474 - val_loss: 0.1
545
Epoch 88/100
235/235 [=====] - 2s 7ms/step - loss: 0.1474 - val_loss: 0.1
545
Epoch 89/100
235/235 [=====] - 2s 7ms/step - loss: 0.1473 - val_loss: 0.1
548
Epoch 90/100
235/235 [=====] - 2s 7ms/step - loss: 0.1473 - val_loss: 0.1
544
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.1472 - val_loss: 0.1
546
Epoch 92/100
235/235 [=====] - 2s 8ms/step - loss: 0.1471 - val_loss: 0.1
548
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.1471 - val_loss: 0.1
546
Epoch 94/100
235/235 [=====] - 2s 7ms/step - loss: 0.1470 - val_loss: 0.1
545
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.1470 - val_loss: 0.1
543
Epoch 96/100
235/235 [=====] - 2s 7ms/step - loss: 0.1469 - val_loss: 0.1
543
Epoch 97/100
235/235 [=====] - 2s 7ms/step - loss: 0.1469 - val_loss: 0.1
545
Epoch 98/100
235/235 [=====] - 2s 7ms/step - loss: 0.1469 - val_loss: 0.1
545
Epoch 99/100
235/235 [=====] - 2s 7ms/step - loss: 0.1468 - val_loss: 0.1

545
Epoch 100/100
235/235 [=====] - 2s 7ms/step - loss: 0.1468 - val_loss: 0.1
545
Encoding Dimensions: 6
Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 2s 8ms/step - loss: 0.2641 - val_loss: 0.2
234
Epoch 2/100
235/235 [=====] - 2s 7ms/step - loss: 0.2028 - val_loss: 0.1
920
Epoch 3/100
235/235 [=====] - 2s 7ms/step - loss: 0.1862 - val_loss: 0.1
820
Epoch 4/100
235/235 [=====] - 2s 7ms/step - loss: 0.1787 - val_loss: 0.1
761
Epoch 5/100
235/235 [=====] - 2s 7ms/step - loss: 0.1743 - val_loss: 0.1
730
Epoch 6/100
235/235 [=====] - 2s 7ms/step - loss: 0.1714 - val_loss: 0.1
709
Epoch 7/100
235/235 [=====] - 2s 7ms/step - loss: 0.1696 - val_loss: 0.1
692
Epoch 8/100
235/235 [=====] - 2s 7ms/step - loss: 0.1681 - val_loss: 0.1
680
Epoch 9/100
235/235 [=====] - 2s 7ms/step - loss: 0.1668 - val_loss: 0.1
672
Epoch 10/100
235/235 [=====] - 2s 7ms/step - loss: 0.1657 - val_loss: 0.1
666
Epoch 11/100
235/235 [=====] - 2s 8ms/step - loss: 0.1647 - val_loss: 0.1
654
Epoch 12/100
235/235 [=====] - 2s 7ms/step - loss: 0.1638 - val_loss: 0.1
644
Epoch 13/100
235/235 [=====] - 2s 7ms/step - loss: 0.1630 - val_loss: 0.1
639
Epoch 14/100
235/235 [=====] - 2s 7ms/step - loss: 0.1622 - val_loss: 0.1
633
Epoch 15/100
235/235 [=====] - 2s 7ms/step - loss: 0.1614 - val_loss: 0.1
625
Epoch 16/100
235/235 [=====] - 2s 7ms/step - loss: 0.1608 - val_loss: 0.1
619
Epoch 17/100
235/235 [=====] - 2s 8ms/step - loss: 0.1601 - val_loss: 0.1
613
Epoch 18/100
235/235 [=====] - 2s 9ms/step - loss: 0.1596 - val_loss: 0.1
610

Epoch 19/100
235/235 [=====] - 2s 8ms/step - loss: 0.1590 - val_loss: 0.1603
Epoch 20/100
235/235 [=====] - 2s 8ms/step - loss: 0.1585 - val_loss: 0.1599
Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1581 - val_loss: 0.1600
Epoch 22/100
235/235 [=====] - 2s 10ms/step - loss: 0.1576 - val_loss: 0.1594
Epoch 23/100
235/235 [=====] - 3s 12ms/step - loss: 0.1571 - val_loss: 0.1591
Epoch 24/100
235/235 [=====] - 3s 13ms/step - loss: 0.1567 - val_loss: 0.1587
Epoch 25/100
235/235 [=====] - 2s 9ms/step - loss: 0.1564 - val_loss: 0.1585
Epoch 26/100
235/235 [=====] - 2s 10ms/step - loss: 0.1561 - val_loss: 0.1585
Epoch 27/100
235/235 [=====] - 2s 9ms/step - loss: 0.1558 - val_loss: 0.1581
Epoch 28/100
235/235 [=====] - 2s 9ms/step - loss: 0.1555 - val_loss: 0.1581
Epoch 29/100
235/235 [=====] - 2s 10ms/step - loss: 0.1552 - val_loss: 0.1576
Epoch 30/100
235/235 [=====] - 2s 8ms/step - loss: 0.1548 - val_loss: 0.1576
Epoch 31/100
235/235 [=====] - 2s 9ms/step - loss: 0.1547 - val_loss: 0.1572
Epoch 32/100
235/235 [=====] - 3s 14ms/step - loss: 0.1544 - val_loss: 0.1573
Epoch 33/100
235/235 [=====] - 2s 8ms/step - loss: 0.1542 - val_loss: 0.1572
Epoch 34/100
235/235 [=====] - 2s 8ms/step - loss: 0.1539 - val_loss: 0.1572
Epoch 35/100
235/235 [=====] - 2s 8ms/step - loss: 0.1538 - val_loss: 0.1570
Epoch 36/100
235/235 [=====] - 2s 9ms/step - loss: 0.1535 - val_loss: 0.1568
Epoch 37/100
235/235 [=====] - 3s 11ms/step - loss: 0.1534 - val_loss: 0.1568
Epoch 38/100
235/235 [=====] - 2s 9ms/step - loss: 0.1532 - val_loss: 0.1569

Epoch 39/100
235/235 [=====] - 2s 9ms/step - loss: 0.1531 - val_loss: 0.1563
Epoch 40/100
235/235 [=====] - 2s 8ms/step - loss: 0.1529 - val_loss: 0.1564
Epoch 41/100
235/235 [=====] - 2s 7ms/step - loss: 0.1526 - val_loss: 0.1563
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.1524 - val_loss: 0.1559
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.1523 - val_loss: 0.1560
Epoch 44/100
235/235 [=====] - 2s 8ms/step - loss: 0.1521 - val_loss: 0.1558
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.1520 - val_loss: 0.1562
Epoch 46/100
235/235 [=====] - 2s 8ms/step - loss: 0.1518 - val_loss: 0.1561
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1517 - val_loss: 0.1554
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1516 - val_loss: 0.1557
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.1515 - val_loss: 0.1560
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.1513 - val_loss: 0.1554
Epoch 51/100
235/235 [=====] - 2s 8ms/step - loss: 0.1511 - val_loss: 0.1556
Epoch 52/100
235/235 [=====] - 2s 9ms/step - loss: 0.1510 - val_loss: 0.1553
Epoch 53/100
235/235 [=====] - 2s 10ms/step - loss: 0.1509 - val_loss: 0.1555
Epoch 54/100
235/235 [=====] - 2s 9ms/step - loss: 0.1508 - val_loss: 0.1553
Epoch 55/100
235/235 [=====] - 2s 8ms/step - loss: 0.1507 - val_loss: 0.1558
Epoch 56/100
235/235 [=====] - 2s 8ms/step - loss: 0.1506 - val_loss: 0.1554
Epoch 57/100
235/235 [=====] - 2s 8ms/step - loss: 0.1504 - val_loss: 0.1552
Epoch 58/100
235/235 [=====] - 2s 8ms/step - loss: 0.1503 - val_loss: 0.1550

Epoch 59/100
235/235 [=====] - 2s 9ms/step - loss: 0.1502 - val_loss: 0.1552
Epoch 60/100
235/235 [=====] - 2s 9ms/step - loss: 0.1502 - val_loss: 0.1552
Epoch 61/100
235/235 [=====] - 2s 9ms/step - loss: 0.1500 - val_loss: 0.1553
Epoch 62/100
235/235 [=====] - 2s 8ms/step - loss: 0.1499 - val_loss: 0.1548
Epoch 63/100
235/235 [=====] - 2s 8ms/step - loss: 0.1499 - val_loss: 0.1549
Epoch 64/100
235/235 [=====] - 2s 8ms/step - loss: 0.1498 - val_loss: 0.1550
Epoch 65/100
235/235 [=====] - 2s 8ms/step - loss: 0.1497 - val_loss: 0.1548
Epoch 66/100
235/235 [=====] - 2s 8ms/step - loss: 0.1496 - val_loss: 0.1548
Epoch 67/100
235/235 [=====] - 2s 9ms/step - loss: 0.1495 - val_loss: 0.1549
Epoch 68/100
235/235 [=====] - 2s 9ms/step - loss: 0.1494 - val_loss: 0.1548
Epoch 69/100
235/235 [=====] - 2s 8ms/step - loss: 0.1493 - val_loss: 0.1551
Epoch 70/100
235/235 [=====] - 2s 8ms/step - loss: 0.1493 - val_loss: 0.1548
Epoch 71/100
235/235 [=====] - 2s 8ms/step - loss: 0.1492 - val_loss: 0.1546
Epoch 72/100
235/235 [=====] - 2s 10ms/step - loss: 0.1491 - val_loss: 0.1546
Epoch 73/100
235/235 [=====] - 2s 10ms/step - loss: 0.1491 - val_loss: 0.1549
Epoch 74/100
235/235 [=====] - 2s 9ms/step - loss: 0.1489 - val_loss: 0.1549
Epoch 75/100
235/235 [=====] - 2s 8ms/step - loss: 0.1488 - val_loss: 0.1546
Epoch 76/100
235/235 [=====] - 2s 8ms/step - loss: 0.1488 - val_loss: 0.1550
Epoch 77/100
235/235 [=====] - 2s 7ms/step - loss: 0.1487 - val_loss: 0.1546
Epoch 78/100
235/235 [=====] - 2s 9ms/step - loss: 0.1486 - val_loss: 0.1546

Epoch 79/100
235/235 [=====] - 2s 8ms/step - loss: 0.1486 - val_loss: 0.1547
Epoch 80/100
235/235 [=====] - 2s 8ms/step - loss: 0.1486 - val_loss: 0.1545
Epoch 81/100
235/235 [=====] - 2s 7ms/step - loss: 0.1485 - val_loss: 0.1543
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.1484 - val_loss: 0.1544
Epoch 83/100
235/235 [=====] - 2s 7ms/step - loss: 0.1483 - val_loss: 0.1546
Epoch 84/100
235/235 [=====] - 2s 8ms/step - loss: 0.1483 - val_loss: 0.1544
Epoch 85/100
235/235 [=====] - 2s 7ms/step - loss: 0.1482 - val_loss: 0.1549
Epoch 86/100
235/235 [=====] - 2s 7ms/step - loss: 0.1482 - val_loss: 0.1545
Epoch 87/100
235/235 [=====] - 2s 8ms/step - loss: 0.1481 - val_loss: 0.1542
Epoch 88/100
235/235 [=====] - 2s 8ms/step - loss: 0.1480 - val_loss: 0.1543
Epoch 89/100
235/235 [=====] - 2s 8ms/step - loss: 0.1479 - val_loss: 0.1542
Epoch 90/100
235/235 [=====] - 2s 8ms/step - loss: 0.1478 - val_loss: 0.1548
Epoch 91/100
235/235 [=====] - 2s 8ms/step - loss: 0.1478 - val_loss: 0.1543
Epoch 92/100
235/235 [=====] - 2s 9ms/step - loss: 0.1477 - val_loss: 0.1543
Epoch 93/100
235/235 [=====] - 3s 11ms/step - loss: 0.1477 - val_loss: 0.1545
Epoch 94/100
235/235 [=====] - 2s 10ms/step - loss: 0.1477 - val_loss: 0.1542
Epoch 95/100
235/235 [=====] - 2s 10ms/step - loss: 0.1477 - val_loss: 0.1544
Epoch 96/100
235/235 [=====] - 3s 12ms/step - loss: 0.1476 - val_loss: 0.1543
Epoch 97/100
235/235 [=====] - 2s 10ms/step - loss: 0.1475 - val_loss: 0.1544
Epoch 98/100
235/235 [=====] - 4s 16ms/step - loss: 0.1475 - val_loss: 0.1542

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Epoch 99/100
235/235 [=====] - 2s 10ms/step - loss: 0.1474 - val_loss: 0.
1543
Epoch 100/100
235/235 [=====] - 3s 12ms/step - loss: 0.1474 - val_loss: 0.
1541
Encoding Dimensions: 8
Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 3s 9ms/step - loss: 0.2422 - val_loss: 0.1
701
Epoch 2/100
235/235 [=====] - 2s 8ms/step - loss: 0.1579 - val_loss: 0.1
473
Epoch 3/100
235/235 [=====] - 2s 8ms/step - loss: 0.1448 - val_loss: 0.1
403
Epoch 4/100
235/235 [=====] - 2s 8ms/step - loss: 0.1394 - val_loss: 0.1
365
Epoch 5/100
235/235 [=====] - 3s 12ms/step - loss: 0.1360 - val_loss: 0.
1340
Epoch 6/100
235/235 [=====] - 3s 11ms/step - loss: 0.1336 - val_loss: 0.
1321
Epoch 7/100
235/235 [=====] - 2s 8ms/step - loss: 0.1317 - val_loss: 0.1
305
Epoch 8/100
235/235 [=====] - 2s 8ms/step - loss: 0.1301 - val_loss: 0.1
294
Epoch 9/100
235/235 [=====] - 2s 8ms/step - loss: 0.1288 - val_loss: 0.1
280
Epoch 10/100
235/235 [=====] - 2s 8ms/step - loss: 0.1277 - val_loss: 0.1
267
Epoch 11/100
235/235 [=====] - 2s 8ms/step - loss: 0.1266 - val_loss: 0.1
263
Epoch 12/100
235/235 [=====] - 2s 8ms/step - loss: 0.1256 - val_loss: 0.1
251
Epoch 13/100
235/235 [=====] - 2s 8ms/step - loss: 0.1247 - val_loss: 0.1
243
Epoch 14/100
235/235 [=====] - 2s 8ms/step - loss: 0.1240 - val_loss: 0.1
236
Epoch 15/100
235/235 [=====] - 2s 8ms/step - loss: 0.1233 - val_loss: 0.1
232
Epoch 16/100
235/235 [=====] - 2s 8ms/step - loss: 0.1227 - val_loss: 0.1
228
Epoch 17/100
235/235 [=====] - 3s 11ms/step - loss: 0.1221 - val_loss: 0.
1226
Epoch 18/100
```

235/235 [=====] - 2s 8ms/step - loss: 0.1215 - val_loss: 0.1
219
Epoch 19/100
235/235 [=====] - 2s 9ms/step - loss: 0.1210 - val_loss: 0.1
215
Epoch 20/100
235/235 [=====] - 2s 8ms/step - loss: 0.1206 - val_loss: 0.1
212
Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1202 - val_loss: 0.1
208
Epoch 22/100
235/235 [=====] - 2s 9ms/step - loss: 0.1197 - val_loss: 0.1
209
Epoch 23/100
235/235 [=====] - 2s 9ms/step - loss: 0.1194 - val_loss: 0.1
204
Epoch 24/100
235/235 [=====] - 2s 9ms/step - loss: 0.1191 - val_loss: 0.1
200
Epoch 25/100
235/235 [=====] - 2s 8ms/step - loss: 0.1187 - val_loss: 0.1
199
Epoch 26/100
235/235 [=====] - 2s 10ms/step - loss: 0.1183 - val_loss: 0.
1199
Epoch 27/100
235/235 [=====] - 2s 10ms/step - loss: 0.1181 - val_loss: 0.
1193
Epoch 28/100
235/235 [=====] - 2s 8ms/step - loss: 0.1178 - val_loss: 0.1
191
Epoch 29/100
235/235 [=====] - 2s 8ms/step - loss: 0.1175 - val_loss: 0.1
193
Epoch 30/100
235/235 [=====] - 2s 10ms/step - loss: 0.1173 - val_loss: 0.
1189
Epoch 31/100
235/235 [=====] - 2s 9ms/step - loss: 0.1170 - val_loss: 0.1
185
Epoch 32/100
235/235 [=====] - 2s 9ms/step - loss: 0.1168 - val_loss: 0.1
185
Epoch 33/100
235/235 [=====] - 2s 9ms/step - loss: 0.1166 - val_loss: 0.1
185
Epoch 34/100
235/235 [=====] - 2s 8ms/step - loss: 0.1164 - val_loss: 0.1
184
Epoch 35/100
235/235 [=====] - 2s 8ms/step - loss: 0.1162 - val_loss: 0.1
183
Epoch 36/100
235/235 [=====] - 2s 9ms/step - loss: 0.1160 - val_loss: 0.1
182
Epoch 37/100
235/235 [=====] - 2s 8ms/step - loss: 0.1158 - val_loss: 0.1
180
Epoch 38/100

```
235/235 [=====] - 2s 8ms/step - loss: 0.1156 - val_loss: 0.1  
177  
Epoch 39/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1154 - val_loss: 0.1  
178  
Epoch 40/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1153 - val_loss: 0.1  
176  
Epoch 41/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1151 - val_loss: 0.1  
176  
Epoch 42/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1150 - val_loss: 0.1  
175  
Epoch 43/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1148 - val_loss: 0.1  
172  
Epoch 44/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1147 - val_loss: 0.1  
173  
Epoch 45/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1146 - val_loss: 0.1  
171  
Epoch 46/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1144 - val_loss: 0.1  
171  
Epoch 47/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1142 - val_loss: 0.1  
171  
Epoch 48/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1141 - val_loss: 0.1  
171  
Epoch 49/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1140 - val_loss: 0.1  
168  
Epoch 50/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1139 - val_loss: 0.1  
169  
Epoch 51/100  
235/235 [=====] - 3s 14ms/step - loss: 0.1138 - val_loss: 0.  
1169  
Epoch 52/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1137 - val_loss: 0.1  
167  
Epoch 53/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1136 - val_loss: 0.1  
167  
Epoch 54/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1135 - val_loss: 0.1  
165  
Epoch 55/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1134 - val_loss: 0.1  
165  
Epoch 56/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1132 - val_loss: 0.1  
163  
Epoch 57/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1131 - val_loss: 0.1  
166  
Epoch 58/100
```

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235/235 [=====] - 2s 7ms/step - loss: 0.1131 - val_loss: 0.1  
163  
Epoch 59/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1129 - val_loss: 0.1  
162  
Epoch 60/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1129 - val_loss: 0.1  
162  
Epoch 61/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1128 - val_loss: 0.1  
162  
Epoch 62/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1127 - val_loss: 0.1  
162  
Epoch 63/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1126 - val_loss: 0.1  
162  
Epoch 64/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1125 - val_loss: 0.1  
160  
Epoch 65/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1125 - val_loss: 0.1  
160  
Epoch 66/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1124 - val_loss: 0.1  
160  
Epoch 67/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1123 - val_loss: 0.1  
159  
Epoch 68/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1122 - val_loss: 0.1  
160  
Epoch 69/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1121 - val_loss: 0.1  
159  
Epoch 70/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1120 - val_loss: 0.1  
157  
Epoch 71/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1120 - val_loss: 0.1  
160  
Epoch 72/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1119 - val_loss: 0.1  
161  
Epoch 73/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1118 - val_loss: 0.1  
158  
Epoch 74/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1117 - val_loss: 0.1  
160  
Epoch 75/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1117 - val_loss: 0.1  
156  
Epoch 76/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1116 - val_loss: 0.1  
156  
Epoch 77/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1116 - val_loss: 0.1  
157  
Epoch 78/100
```

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235/235 [=====] - 2s 7ms/step - loss: 0.1115 - val_loss: 0.1  
158  
Epoch 79/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1115 - val_loss: 0.1  
157  
Epoch 80/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1114 - val_loss: 0.1  
155  
Epoch 81/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1113 - val_loss: 0.1  
157  
Epoch 82/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1112 - val_loss: 0.1  
156  
Epoch 83/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1112 - val_loss: 0.1  
157  
Epoch 84/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1111 - val_loss: 0.1  
157  
Epoch 85/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1111 - val_loss: 0.1  
155  
Epoch 86/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1110 - val_loss: 0.1  
156  
Epoch 87/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1110 - val_loss: 0.1  
155  
Epoch 88/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1109 - val_loss: 0.1  
158  
Epoch 89/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1108 - val_loss: 0.1  
155  
Epoch 90/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1108 - val_loss: 0.1  
153  
Epoch 91/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1108 - val_loss: 0.1  
155  
Epoch 92/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1107 - val_loss: 0.1  
154  
Epoch 93/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1107 - val_loss: 0.1  
156  
Epoch 94/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1106 - val_loss: 0.1  
155  
Epoch 95/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1106 - val_loss: 0.1  
155  
Epoch 96/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1105 - val_loss: 0.1  
154  
Epoch 97/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1105 - val_loss: 0.1  
153  
Epoch 98/100
```

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235/235 [=====] - 2s 7ms/step - loss: 0.1104 - val_loss: 0.1  
154  
Epoch 99/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1104 - val_loss: 0.1  
154  
Epoch 100/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1103 - val_loss: 0.1  
154  
Encoding Dimensions: 10  
Tensorflow listening on http://localhost:6006/  
Epoch 1/100  
235/235 [=====] - 2s 8ms/step - loss: 0.2421 - val_loss: 0.1  
660  
Epoch 2/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1507 - val_loss: 0.1  
399  
Epoch 3/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1361 - val_loss: 0.1  
308  
Epoch 4/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1296 - val_loss: 0.1  
263  
Epoch 5/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1261 - val_loss: 0.1  
234  
Epoch 6/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1235 - val_loss: 0.1  
215  
Epoch 7/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1215 - val_loss: 0.1  
199  
Epoch 8/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1199 - val_loss: 0.1  
186  
Epoch 9/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1185 - val_loss: 0.1  
172  
Epoch 10/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1173 - val_loss: 0.1  
161  
Epoch 11/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1162 - val_loss: 0.1  
153  
Epoch 12/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1152 - val_loss: 0.1  
147  
Epoch 13/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1144 - val_loss: 0.1  
139  
Epoch 14/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1136 - val_loss: 0.1  
134  
Epoch 15/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1129 - val_loss: 0.1  
125  
Epoch 16/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1123 - val_loss: 0.1  
123  
Epoch 17/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1117 - val_loss: 0.1
```

115
Epoch 18/100
235/235 [=====] - 2s 7ms/step - loss: 0.1111 - val_loss: 0.114
Epoch 19/100
235/235 [=====] - 2s 7ms/step - loss: 0.1106 - val_loss: 0.1108
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.1102 - val_loss: 0.1107
Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1098 - val_loss: 0.1102
Epoch 22/100
235/235 [=====] - 2s 9ms/step - loss: 0.1094 - val_loss: 0.1100
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.1090 - val_loss: 0.1093
Epoch 24/100
235/235 [=====] - 2s 7ms/step - loss: 0.1086 - val_loss: 0.1092
Epoch 25/100
235/235 [=====] - 2s 7ms/step - loss: 0.1083 - val_loss: 0.1090
Epoch 26/100
235/235 [=====] - 2s 7ms/step - loss: 0.1081 - val_loss: 0.1090
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.1078 - val_loss: 0.1087
Epoch 28/100
235/235 [=====] - 2s 7ms/step - loss: 0.1075 - val_loss: 0.1083
Epoch 29/100
235/235 [=====] - 2s 7ms/step - loss: 0.1072 - val_loss: 0.1084
Epoch 30/100
235/235 [=====] - 2s 7ms/step - loss: 0.1070 - val_loss: 0.1084
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.1068 - val_loss: 0.1080
Epoch 32/100
235/235 [=====] - 2s 8ms/step - loss: 0.1066 - val_loss: 0.1079
Epoch 33/100
235/235 [=====] - 2s 8ms/step - loss: 0.1064 - val_loss: 0.1076
Epoch 34/100
235/235 [=====] - 2s 8ms/step - loss: 0.1061 - val_loss: 0.1073
Epoch 35/100
235/235 [=====] - 2s 8ms/step - loss: 0.1060 - val_loss: 0.1075
Epoch 36/100
235/235 [=====] - 2s 7ms/step - loss: 0.1058 - val_loss: 0.1074
Epoch 37/100
235/235 [=====] - 2s 8ms/step - loss: 0.1056 - val_loss: 0.1074

071
Epoch 38/100
235/235 [=====] - 2s 8ms/step - loss: 0.1054 - val_loss: 0.1070
Epoch 39/100
235/235 [=====] - 2s 8ms/step - loss: 0.1053 - val_loss: 0.1069
Epoch 40/100
235/235 [=====] - 2s 7ms/step - loss: 0.1051 - val_loss: 0.1068
Epoch 41/100
235/235 [=====] - 2s 8ms/step - loss: 0.1050 - val_loss: 0.1068
Epoch 42/100
235/235 [=====] - 2s 10ms/step - loss: 0.1048 - val_loss: 0.1068
Epoch 43/100
235/235 [=====] - 2s 9ms/step - loss: 0.1047 - val_loss: 0.1067
Epoch 44/100
235/235 [=====] - 2s 7ms/step - loss: 0.1045 - val_loss: 0.1063
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.1044 - val_loss: 0.1064
Epoch 46/100
235/235 [=====] - 2s 8ms/step - loss: 0.1043 - val_loss: 0.1062
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1041 - val_loss: 0.1062
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1040 - val_loss: 0.1063
Epoch 49/100
235/235 [=====] - 2s 8ms/step - loss: 0.1040 - val_loss: 0.1059
Epoch 50/100
235/235 [=====] - 2s 10ms/step - loss: 0.1038 - val_loss: 0.1060
Epoch 51/100
235/235 [=====] - 2s 8ms/step - loss: 0.1037 - val_loss: 0.1060
Epoch 52/100
235/235 [=====] - 2s 10ms/step - loss: 0.1036 - val_loss: 0.1061
Epoch 53/100
235/235 [=====] - 3s 11ms/step - loss: 0.1035 - val_loss: 0.1059
Epoch 54/100
235/235 [=====] - 4s 17ms/step - loss: 0.1034 - val_loss: 0.1060
Epoch 55/100
235/235 [=====] - 3s 14ms/step - loss: 0.1033 - val_loss: 0.1059
Epoch 56/100
235/235 [=====] - 3s 11ms/step - loss: 0.1032 - val_loss: 0.1064
Epoch 57/100
235/235 [=====] - 4s 17ms/step - loss: 0.1031 - val_loss: 0.

1058
Epoch 58/100
235/235 [=====] - 3s 14ms/step - loss: 0.1030 - val_loss: 0.
1058
Epoch 59/100
235/235 [=====] - 3s 12ms/step - loss: 0.1029 - val_loss: 0.
1059
Epoch 60/100
235/235 [=====] - 4s 15ms/step - loss: 0.1028 - val_loss: 0.
1055
Epoch 61/100
235/235 [=====] - 4s 15ms/step - loss: 0.1028 - val_loss: 0.
1058
Epoch 62/100
235/235 [=====] - 2s 9ms/step - loss: 0.1027 - val_loss: 0.1
055
Epoch 63/100
235/235 [=====] - 2s 8ms/step - loss: 0.1026 - val_loss: 0.1
055
Epoch 64/100
235/235 [=====] - 2s 10ms/step - loss: 0.1025 - val_loss: 0.
1053
Epoch 65/100
235/235 [=====] - 2s 8ms/step - loss: 0.1024 - val_loss: 0.1
054
Epoch 66/100
235/235 [=====] - 2s 10ms/step - loss: 0.1024 - val_loss: 0.
1058
Epoch 67/100
235/235 [=====] - 2s 9ms/step - loss: 0.1023 - val_loss: 0.1
053
Epoch 68/100
235/235 [=====] - 2s 8ms/step - loss: 0.1022 - val_loss: 0.1
051
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.1022 - val_loss: 0.1
051
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.1021 - val_loss: 0.1
051
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.1020 - val_loss: 0.1
052
Epoch 72/100
235/235 [=====] - 2s 8ms/step - loss: 0.1019 - val_loss: 0.1
053
Epoch 73/100
235/235 [=====] - 2s 8ms/step - loss: 0.1019 - val_loss: 0.1
055
Epoch 74/100
235/235 [=====] - 2s 8ms/step - loss: 0.1018 - val_loss: 0.1
053
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.1018 - val_loss: 0.1
052
Epoch 76/100
235/235 [=====] - 2s 9ms/step - loss: 0.1017 - val_loss: 0.1
053
Epoch 77/100
235/235 [=====] - 3s 11ms/step - loss: 0.1016 - val_loss: 0.

1050
Epoch 78/100
235/235 [=====] - 2s 7ms/step - loss: 0.1016 - val_loss: 0.1051
Epoch 79/100
235/235 [=====] - 2s 8ms/step - loss: 0.1015 - val_loss: 0.1050
Epoch 80/100
235/235 [=====] - 2s 8ms/step - loss: 0.1015 - val_loss: 0.1049
Epoch 81/100
235/235 [=====] - 2s 7ms/step - loss: 0.1014 - val_loss: 0.1049
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.1014 - val_loss: 0.1048
Epoch 83/100
235/235 [=====] - 2s 10ms/step - loss: 0.1013 - val_loss: 0.1049
Epoch 84/100
235/235 [=====] - 2s 7ms/step - loss: 0.1013 - val_loss: 0.1046
Epoch 85/100
235/235 [=====] - 2s 8ms/step - loss: 0.1012 - val_loss: 0.1047
Epoch 86/100
235/235 [=====] - 2s 7ms/step - loss: 0.1011 - val_loss: 0.1050
Epoch 87/100
235/235 [=====] - 2s 9ms/step - loss: 0.1011 - val_loss: 0.1047
Epoch 88/100
235/235 [=====] - 2s 8ms/step - loss: 0.1011 - val_loss: 0.1048
Epoch 89/100
235/235 [=====] - 2s 9ms/step - loss: 0.1010 - val_loss: 0.1047
Epoch 90/100
235/235 [=====] - 2s 8ms/step - loss: 0.1009 - val_loss: 0.1048
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.1009 - val_loss: 0.1047
Epoch 92/100
235/235 [=====] - 2s 7ms/step - loss: 0.1009 - val_loss: 0.1046
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.1008 - val_loss: 0.1048
Epoch 94/100
235/235 [=====] - 2s 7ms/step - loss: 0.1008 - val_loss: 0.1045
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.1007 - val_loss: 0.1045
Epoch 96/100
235/235 [=====] - 2s 7ms/step - loss: 0.1007 - val_loss: 0.1046
Epoch 97/100
235/235 [=====] - 2s 9ms/step - loss: 0.1006 - val_loss: 0.1046

```
045
Epoch 98/100
235/235 [=====] - 2s 8ms/step - loss: 0.1006 - val_loss: 0.1
048
Epoch 99/100
235/235 [=====] - 2s 8ms/step - loss: 0.1006 - val_loss: 0.1
045
Epoch 100/100
235/235 [=====] - 2s 8ms/step - loss: 0.1005 - val_loss: 0.1
048
Encoding Dimensions: 12
Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 3s 9ms/step - loss: 0.2404 - val_loss: 0.1
682
Epoch 2/100
235/235 [=====] - 2s 8ms/step - loss: 0.1485 - val_loss: 0.1
339
Epoch 3/100
235/235 [=====] - 2s 8ms/step - loss: 0.1290 - val_loss: 0.1
243
Epoch 4/100
235/235 [=====] - 2s 8ms/step - loss: 0.1221 - val_loss: 0.1
190
Epoch 5/100
235/235 [=====] - 2s 8ms/step - loss: 0.1182 - val_loss: 0.1
157
Epoch 6/100
235/235 [=====] - 2s 8ms/step - loss: 0.1152 - val_loss: 0.1
133
Epoch 7/100
235/235 [=====] - 2s 7ms/step - loss: 0.1129 - val_loss: 0.1
112
Epoch 8/100
235/235 [=====] - 2s 7ms/step - loss: 0.1111 - val_loss: 0.1
100
Epoch 9/100
235/235 [=====] - 2s 7ms/step - loss: 0.1096 - val_loss: 0.1
080
Epoch 10/100
235/235 [=====] - 2s 7ms/step - loss: 0.1083 - val_loss: 0.1
069
Epoch 11/100
235/235 [=====] - 2s 7ms/step - loss: 0.1072 - val_loss: 0.1
061
Epoch 12/100
235/235 [=====] - 2s 8ms/step - loss: 0.1063 - val_loss: 0.1
052
Epoch 13/100
235/235 [=====] - 2s 8ms/step - loss: 0.1054 - val_loss: 0.1
046
Epoch 14/100
235/235 [=====] - 2s 8ms/step - loss: 0.1046 - val_loss: 0.1
039
Epoch 15/100
235/235 [=====] - 2s 8ms/step - loss: 0.1039 - val_loss: 0.1
033
Epoch 16/100
235/235 [=====] - 2s 8ms/step - loss: 0.1033 - val_loss: 0.1
029
```

Epoch 17/100
235/235 [=====] - 2s 7ms/step - loss: 0.1028 - val_loss: 0.1026
Epoch 18/100
235/235 [=====] - 2s 7ms/step - loss: 0.1023 - val_loss: 0.1024
Epoch 19/100
235/235 [=====] - 2s 7ms/step - loss: 0.1017 - val_loss: 0.1018
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.1013 - val_loss: 0.1010
Epoch 21/100
235/235 [=====] - 2s 7ms/step - loss: 0.1009 - val_loss: 0.1012
Epoch 22/100
235/235 [=====] - 2s 7ms/step - loss: 0.1005 - val_loss: 0.1011
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.1001 - val_loss: 0.1003
Epoch 24/100
235/235 [=====] - 2s 7ms/step - loss: 0.0998 - val_loss: 0.1002
Epoch 25/100
235/235 [=====] - 2s 7ms/step - loss: 0.0995 - val_loss: 0.0999
Epoch 26/100
235/235 [=====] - 2s 7ms/step - loss: 0.0992 - val_loss: 0.0998
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.0989 - val_loss: 0.0995
Epoch 28/100
235/235 [=====] - 2s 7ms/step - loss: 0.0986 - val_loss: 0.0991
Epoch 29/100
235/235 [=====] - 2s 7ms/step - loss: 0.0984 - val_loss: 0.0993
Epoch 30/100
235/235 [=====] - 2s 7ms/step - loss: 0.0982 - val_loss: 0.0989
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.0978 - val_loss: 0.0984
Epoch 32/100
235/235 [=====] - 2s 7ms/step - loss: 0.0977 - val_loss: 0.0983
Epoch 33/100
235/235 [=====] - 2s 7ms/step - loss: 0.0974 - val_loss: 0.0982
Epoch 34/100
235/235 [=====] - 2s 7ms/step - loss: 0.0972 - val_loss: 0.0979
Epoch 35/100
235/235 [=====] - 2s 7ms/step - loss: 0.0970 - val_loss: 0.0980
Epoch 36/100
235/235 [=====] - 2s 10ms/step - loss: 0.0969 - val_loss: 0.0978

Epoch 37/100
235/235 [=====] - 2s 7ms/step - loss: 0.0967 - val_loss: 0.0976
Epoch 38/100
235/235 [=====] - 2s 7ms/step - loss: 0.0965 - val_loss: 0.0974
Epoch 39/100
235/235 [=====] - 2s 9ms/step - loss: 0.0963 - val_loss: 0.0974
Epoch 40/100
235/235 [=====] - 2s 8ms/step - loss: 0.0962 - val_loss: 0.0970
Epoch 41/100
235/235 [=====] - 2s 9ms/step - loss: 0.0960 - val_loss: 0.0970
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.0959 - val_loss: 0.0969
Epoch 43/100
235/235 [=====] - 2s 9ms/step - loss: 0.0957 - val_loss: 0.0968
Epoch 44/100
235/235 [=====] - 3s 11ms/step - loss: 0.0956 - val_loss: 0.0968
Epoch 45/100
235/235 [=====] - 2s 8ms/step - loss: 0.0955 - val_loss: 0.0968
Epoch 46/100
235/235 [=====] - 2s 10ms/step - loss: 0.0953 - val_loss: 0.0965
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.0952 - val_loss: 0.0964
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.0951 - val_loss: 0.0964
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.0950 - val_loss: 0.0963
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.0949 - val_loss: 0.0963
Epoch 51/100
235/235 [=====] - 2s 7ms/step - loss: 0.0947 - val_loss: 0.0964
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.0946 - val_loss: 0.0961
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.0945 - val_loss: 0.0962
Epoch 54/100
235/235 [=====] - 2s 7ms/step - loss: 0.0944 - val_loss: 0.0960
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.0944 - val_loss: 0.0959
Epoch 56/100
235/235 [=====] - 2s 7ms/step - loss: 0.0942 - val_loss: 0.0958

Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.0942 - val_loss: 0.0
958
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.0941 - val_loss: 0.0
958
Epoch 59/100
235/235 [=====] - 2s 7ms/step - loss: 0.0940 - val_loss: 0.0
957
Epoch 60/100
235/235 [=====] - 2s 7ms/step - loss: 0.0939 - val_loss: 0.0
954
Epoch 61/100
235/235 [=====] - 2s 7ms/step - loss: 0.0938 - val_loss: 0.0
955
Epoch 62/100
235/235 [=====] - 2s 7ms/step - loss: 0.0937 - val_loss: 0.0
953
Epoch 63/100
235/235 [=====] - 2s 7ms/step - loss: 0.0937 - val_loss: 0.0
958
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.0936 - val_loss: 0.0
955
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.0935 - val_loss: 0.0
953
Epoch 66/100
235/235 [=====] - 2s 7ms/step - loss: 0.0934 - val_loss: 0.0
955
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.0934 - val_loss: 0.0
953
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.0932 - val_loss: 0.0
955
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.0932 - val_loss: 0.0
951
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.0931 - val_loss: 0.0
955
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.0931 - val_loss: 0.0
951
Epoch 72/100
235/235 [=====] - 2s 7ms/step - loss: 0.0930 - val_loss: 0.0
950
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.0930 - val_loss: 0.0
950
Epoch 74/100
235/235 [=====] - 2s 7ms/step - loss: 0.0929 - val_loss: 0.0
950
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.0928 - val_loss: 0.0
949
Epoch 76/100
235/235 [=====] - 2s 7ms/step - loss: 0.0928 - val_loss: 0.0
948

Epoch 77/100
235/235 [=====] - 2s 7ms/step - loss: 0.0927 - val_loss: 0.0
948
Epoch 78/100
235/235 [=====] - 2s 7ms/step - loss: 0.0927 - val_loss: 0.0
950
Epoch 79/100
235/235 [=====] - 2s 7ms/step - loss: 0.0926 - val_loss: 0.0
948
Epoch 80/100
235/235 [=====] - 2s 7ms/step - loss: 0.0926 - val_loss: 0.0
949
Epoch 81/100
235/235 [=====] - 2s 9ms/step - loss: 0.0924 - val_loss: 0.0
947
Epoch 82/100
235/235 [=====] - 2s 8ms/step - loss: 0.0924 - val_loss: 0.0
948
Epoch 83/100
235/235 [=====] - 2s 7ms/step - loss: 0.0924 - val_loss: 0.0
945
Epoch 84/100
235/235 [=====] - 2s 7ms/step - loss: 0.0923 - val_loss: 0.0
944
Epoch 85/100
235/235 [=====] - 2s 7ms/step - loss: 0.0923 - val_loss: 0.0
948
Epoch 86/100
235/235 [=====] - 2s 7ms/step - loss: 0.0922 - val_loss: 0.0
945
Epoch 87/100
235/235 [=====] - 2s 7ms/step - loss: 0.0921 - val_loss: 0.0
947
Epoch 88/100
235/235 [=====] - 2s 7ms/step - loss: 0.0922 - val_loss: 0.0
944
Epoch 89/100
235/235 [=====] - 2s 7ms/step - loss: 0.0921 - val_loss: 0.0
945
Epoch 90/100
235/235 [=====] - 2s 7ms/step - loss: 0.0920 - val_loss: 0.0
944
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.0920 - val_loss: 0.0
944
Epoch 92/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
945
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
944
Epoch 94/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
943
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.0918 - val_loss: 0.0
942
Epoch 96/100
235/235 [=====] - 2s 7ms/step - loss: 0.0917 - val_loss: 0.0
942

```
Epoch 97/100
235/235 [=====] - 2s 7ms/step - loss: 0.0917 - val_loss: 0.0
941
Epoch 98/100
235/235 [=====] - 2s 7ms/step - loss: 0.0917 - val_loss: 0.0
942
Epoch 99/100
235/235 [=====] - 2s 7ms/step - loss: 0.0916 - val_loss: 0.0
941
Epoch 100/100
235/235 [=====] - 2s 7ms/step - loss: 0.0916 - val_loss: 0.0
944
Encoding Dimensions: 14
Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 3s 8ms/step - loss: 0.2238 - val_loss: 0.1
530
Epoch 2/100
235/235 [=====] - 2s 7ms/step - loss: 0.1405 - val_loss: 0.1
299
Epoch 3/100
235/235 [=====] - 2s 7ms/step - loss: 0.1275 - val_loss: 0.1
230
Epoch 4/100
235/235 [=====] - 2s 7ms/step - loss: 0.1214 - val_loss: 0.1
175
Epoch 5/100
235/235 [=====] - 2s 7ms/step - loss: 0.1164 - val_loss: 0.1
137
Epoch 6/100
235/235 [=====] - 2s 7ms/step - loss: 0.1132 - val_loss: 0.1
110
Epoch 7/100
235/235 [=====] - 2s 7ms/step - loss: 0.1109 - val_loss: 0.1
088
Epoch 8/100
235/235 [=====] - 2s 7ms/step - loss: 0.1091 - val_loss: 0.1
078
Epoch 9/100
235/235 [=====] - 2s 7ms/step - loss: 0.1076 - val_loss: 0.1
058
Epoch 10/100
235/235 [=====] - 2s 7ms/step - loss: 0.1062 - val_loss: 0.1
048
Epoch 11/100
235/235 [=====] - 2s 7ms/step - loss: 0.1050 - val_loss: 0.1
041
Epoch 12/100
235/235 [=====] - 2s 7ms/step - loss: 0.1040 - val_loss: 0.1
032
Epoch 13/100
235/235 [=====] - 2s 7ms/step - loss: 0.1031 - val_loss: 0.1
021
Epoch 14/100
235/235 [=====] - 2s 7ms/step - loss: 0.1023 - val_loss: 0.1
019
Epoch 15/100
235/235 [=====] - 2s 10ms/step - loss: 0.1016 - val_loss: 0.
1010
Epoch 16/100
```

```
235/235 [=====] - 2s 7ms/step - loss: 0.1010 - val_loss: 0.1004
Epoch 17/100
235/235 [=====] - 2s 7ms/step - loss: 0.1004 - val_loss: 0.1000
Epoch 18/100
235/235 [=====] - 2s 7ms/step - loss: 0.0999 - val_loss: 0.0998
Epoch 19/100
235/235 [=====] - 2s 8ms/step - loss: 0.0995 - val_loss: 0.0991
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.0991 - val_loss: 0.0988
Epoch 21/100
235/235 [=====] - 2s 7ms/step - loss: 0.0986 - val_loss: 0.0985
Epoch 22/100
235/235 [=====] - 2s 7ms/step - loss: 0.0983 - val_loss: 0.0983
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.0979 - val_loss: 0.0984
Epoch 24/100
235/235 [=====] - 2s 7ms/step - loss: 0.0976 - val_loss: 0.0976
Epoch 25/100
235/235 [=====] - 2s 7ms/step - loss: 0.0972 - val_loss: 0.0976
Epoch 26/100
235/235 [=====] - 2s 7ms/step - loss: 0.0970 - val_loss: 0.0972
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.0967 - val_loss: 0.0971
Epoch 28/100
235/235 [=====] - 2s 7ms/step - loss: 0.0965 - val_loss: 0.0968
Epoch 29/100
235/235 [=====] - 2s 7ms/step - loss: 0.0962 - val_loss: 0.0964
Epoch 30/100
235/235 [=====] - 2s 7ms/step - loss: 0.0961 - val_loss: 0.0964
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.0958 - val_loss: 0.0964
Epoch 32/100
235/235 [=====] - 2s 7ms/step - loss: 0.0956 - val_loss: 0.0962
Epoch 33/100
235/235 [=====] - 2s 7ms/step - loss: 0.0954 - val_loss: 0.0961
Epoch 34/100
235/235 [=====] - 2s 7ms/step - loss: 0.0953 - val_loss: 0.0962
Epoch 35/100
235/235 [=====] - 2s 7ms/step - loss: 0.0951 - val_loss: 0.0957
Epoch 36/100
```

235/235 [=====] - 2s 7ms/step - loss: 0.0949 - val_loss: 0.0
958
Epoch 37/100
235/235 [=====] - 2s 7ms/step - loss: 0.0947 - val_loss: 0.0
956
Epoch 38/100
235/235 [=====] - 2s 7ms/step - loss: 0.0946 - val_loss: 0.0
953
Epoch 39/100
235/235 [=====] - 2s 7ms/step - loss: 0.0944 - val_loss: 0.0
954
Epoch 40/100
235/235 [=====] - 2s 8ms/step - loss: 0.0942 - val_loss: 0.0
953
Epoch 41/100
235/235 [=====] - 2s 7ms/step - loss: 0.0941 - val_loss: 0.0
951
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.0940 - val_loss: 0.0
950
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.0939 - val_loss: 0.0
947
Epoch 44/100
235/235 [=====] - 2s 7ms/step - loss: 0.0937 - val_loss: 0.0
946
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.0937 - val_loss: 0.0
948
Epoch 46/100
235/235 [=====] - 2s 7ms/step - loss: 0.0935 - val_loss: 0.0
945
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.0934 - val_loss: 0.0
944
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.0933 - val_loss: 0.0
944
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.0932 - val_loss: 0.0
942
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.0931 - val_loss: 0.0
945
Epoch 51/100
235/235 [=====] - 2s 7ms/step - loss: 0.0931 - val_loss: 0.0
942
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.0929 - val_loss: 0.0
941
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.0929 - val_loss: 0.0
942
Epoch 54/100
235/235 [=====] - 2s 7ms/step - loss: 0.0928 - val_loss: 0.0
940
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.0927 - val_loss: 0.0
942
Epoch 56/100

235/235 [=====] - 2s 7ms/step - loss: 0.0926 - val_loss: 0.0
940
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.0925 - val_loss: 0.0
942
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.0924 - val_loss: 0.0
938
Epoch 59/100
235/235 [=====] - 2s 7ms/step - loss: 0.0923 - val_loss: 0.0
936
Epoch 60/100
235/235 [=====] - 2s 7ms/step - loss: 0.0923 - val_loss: 0.0
939
Epoch 61/100
235/235 [=====] - 2s 7ms/step - loss: 0.0922 - val_loss: 0.0
936
Epoch 62/100
235/235 [=====] - 2s 7ms/step - loss: 0.0921 - val_loss: 0.0
936
Epoch 63/100
235/235 [=====] - 2s 7ms/step - loss: 0.0921 - val_loss: 0.0
935
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
935
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
936
Epoch 66/100
235/235 [=====] - 2s 7ms/step - loss: 0.0919 - val_loss: 0.0
938
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.0918 - val_loss: 0.0
935
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.0917 - val_loss: 0.0
933
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.0917 - val_loss: 0.0
935
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.0916 - val_loss: 0.0
931
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.0915 - val_loss: 0.0
933
Epoch 72/100
235/235 [=====] - 2s 7ms/step - loss: 0.0915 - val_loss: 0.0
932
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.0915 - val_loss: 0.0
930
Epoch 74/100
235/235 [=====] - 2s 7ms/step - loss: 0.0914 - val_loss: 0.0
933
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.0913 - val_loss: 0.0
930
Epoch 76/100

```
235/235 [=====] - 2s 7ms/step - loss: 0.0913 - val_loss: 0.0  
930  
Epoch 77/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0912 - val_loss: 0.0  
932  
Epoch 78/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0912 - val_loss: 0.0  
929  
Epoch 79/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0911 - val_loss: 0.0  
933  
Epoch 80/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0910 - val_loss: 0.0  
929  
Epoch 81/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0910 - val_loss: 0.0  
933  
Epoch 82/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0910 - val_loss: 0.0  
929  
Epoch 83/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0909 - val_loss: 0.0  
930  
Epoch 84/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0909 - val_loss: 0.0  
927  
Epoch 85/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0908 - val_loss: 0.0  
929  
Epoch 86/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0908 - val_loss: 0.0  
930  
Epoch 87/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0907 - val_loss: 0.0  
928  
Epoch 88/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0907 - val_loss: 0.0  
926  
Epoch 89/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0906 - val_loss: 0.0  
926  
Epoch 90/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0906 - val_loss: 0.0  
928  
Epoch 91/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0906 - val_loss: 0.0  
926  
Epoch 92/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0905 - val_loss: 0.0  
926  
Epoch 93/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0905 - val_loss: 0.0  
925  
Epoch 94/100  
235/235 [=====] - 2s 8ms/step - loss: 0.0904 - val_loss: 0.0  
926  
Epoch 95/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0904 - val_loss: 0.0  
925  
Epoch 96/100
```

```
235/235 [=====] - 2s 7ms/step - loss: 0.0903 - val_loss: 0.0  
924  
Epoch 97/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0903 - val_loss: 0.0  
925  
Epoch 98/100  
235/235 [=====] - 2s 7ms/step - loss: 0.0902 - val_loss: 0.0  
924  
Epoch 99/100  
235/235 [=====] - 2s 10ms/step - loss: 0.0902 - val_loss: 0.  
0922  
Epoch 100/100  
235/235 [=====] - 2s 8ms/step - loss: 0.0902 - val_loss: 0.0  
924  
Encoding Dimensions: 16  
Tensorflow listening on http://localhost:6006/  
Epoch 1/100  
235/235 [=====] - 3s 9ms/step - loss: 0.2389 - val_loss: 0.1  
653  
Epoch 2/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1517 - val_loss: 0.1  
392  
Epoch 3/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1362 - val_loss: 0.1  
311  
Epoch 4/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1299 - val_loss: 0.1  
267  
Epoch 5/100  
235/235 [=====] - 2s 10ms/step - loss: 0.1261 - val_loss: 0.  
1237  
Epoch 6/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1234 - val_loss: 0.1  
216  
Epoch 7/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1212 - val_loss: 0.1  
197  
Epoch 8/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1195 - val_loss: 0.1  
185  
Epoch 9/100  
235/235 [=====] - 2s 7ms/step - loss: 0.1181 - val_loss: 0.1  
170  
Epoch 10/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1168 - val_loss: 0.1  
158  
Epoch 11/100  
235/235 [=====] - 2s 10ms/step - loss: 0.1156 - val_loss: 0.  
1144  
Epoch 12/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1135 - val_loss: 0.1  
121  
Epoch 13/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1118 - val_loss: 0.1  
107  
Epoch 14/100  
235/235 [=====] - 2s 9ms/step - loss: 0.1107 - val_loss: 0.1  
100  
Epoch 15/100  
235/235 [=====] - 2s 8ms/step - loss: 0.1098 - val_loss: 0.1
```

093
Epoch 16/100
235/235 [=====] - 2s 8ms/step - loss: 0.1090 - val_loss: 0.1085
Epoch 17/100
235/235 [=====] - 2s 8ms/step - loss: 0.1083 - val_loss: 0.1082
Epoch 18/100
235/235 [=====] - 3s 13ms/step - loss: 0.1077 - val_loss: 0.1077
Epoch 19/100
235/235 [=====] - 2s 8ms/step - loss: 0.1072 - val_loss: 0.1073
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.1067 - val_loss: 0.1067
Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1063 - val_loss: 0.1064
Epoch 22/100
235/235 [=====] - 2s 8ms/step - loss: 0.1059 - val_loss: 0.1058
Epoch 23/100
235/235 [=====] - 2s 8ms/step - loss: 0.1054 - val_loss: 0.1057
Epoch 24/100
235/235 [=====] - 2s 10ms/step - loss: 0.1050 - val_loss: 0.1052
Epoch 25/100
235/235 [=====] - 3s 12ms/step - loss: 0.1047 - val_loss: 0.1051
Epoch 26/100
235/235 [=====] - 3s 11ms/step - loss: 0.1044 - val_loss: 0.1049
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.1041 - val_loss: 0.1045
Epoch 28/100
235/235 [=====] - 2s 8ms/step - loss: 0.1038 - val_loss: 0.1044
Epoch 29/100
235/235 [=====] - 2s 8ms/step - loss: 0.1035 - val_loss: 0.1043
Epoch 30/100
235/235 [=====] - 2s 8ms/step - loss: 0.1033 - val_loss: 0.1041
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.1031 - val_loss: 0.1042
Epoch 32/100
235/235 [=====] - 2s 8ms/step - loss: 0.1028 - val_loss: 0.1037
Epoch 33/100
235/235 [=====] - 2s 8ms/step - loss: 0.1026 - val_loss: 0.1037
Epoch 34/100
235/235 [=====] - 2s 8ms/step - loss: 0.1025 - val_loss: 0.1039
Epoch 35/100
235/235 [=====] - 2s 8ms/step - loss: 0.1023 - val_loss: 0.1039

033
Epoch 36/100
235/235 [=====] - 2s 8ms/step - loss: 0.1020 - val_loss: 0.1
031
Epoch 37/100
235/235 [=====] - 2s 8ms/step - loss: 0.1019 - val_loss: 0.1
031
Epoch 38/100
235/235 [=====] - 2s 8ms/step - loss: 0.1017 - val_loss: 0.1
028
Epoch 39/100
235/235 [=====] - 2s 7ms/step - loss: 0.1015 - val_loss: 0.1
029
Epoch 40/100
235/235 [=====] - 2s 8ms/step - loss: 0.1014 - val_loss: 0.1
028
Epoch 41/100
235/235 [=====] - 2s 9ms/step - loss: 0.1012 - val_loss: 0.1
025
Epoch 42/100
235/235 [=====] - 2s 8ms/step - loss: 0.1011 - val_loss: 0.1
023
Epoch 43/100
235/235 [=====] - 2s 9ms/step - loss: 0.1009 - val_loss: 0.1
025
Epoch 44/100
235/235 [=====] - 2s 10ms/step - loss: 0.1008 - val_loss: 0.
1026
Epoch 45/100
235/235 [=====] - 2s 9ms/step - loss: 0.1007 - val_loss: 0.1
022
Epoch 46/100
235/235 [=====] - 2s 8ms/step - loss: 0.1005 - val_loss: 0.1
020
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1004 - val_loss: 0.1
020
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1003 - val_loss: 0.1
018
Epoch 49/100
235/235 [=====] - 3s 11ms/step - loss: 0.1002 - val_loss: 0.
1018
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.1000 - val_loss: 0.1
018
Epoch 51/100
235/235 [=====] - 2s 7ms/step - loss: 0.1000 - val_loss: 0.1
019
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.0999 - val_loss: 0.1
015
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.0997 - val_loss: 0.1
015
Epoch 54/100
235/235 [=====] - 2s 7ms/step - loss: 0.0996 - val_loss: 0.1
017
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.0995 - val_loss: 0.1

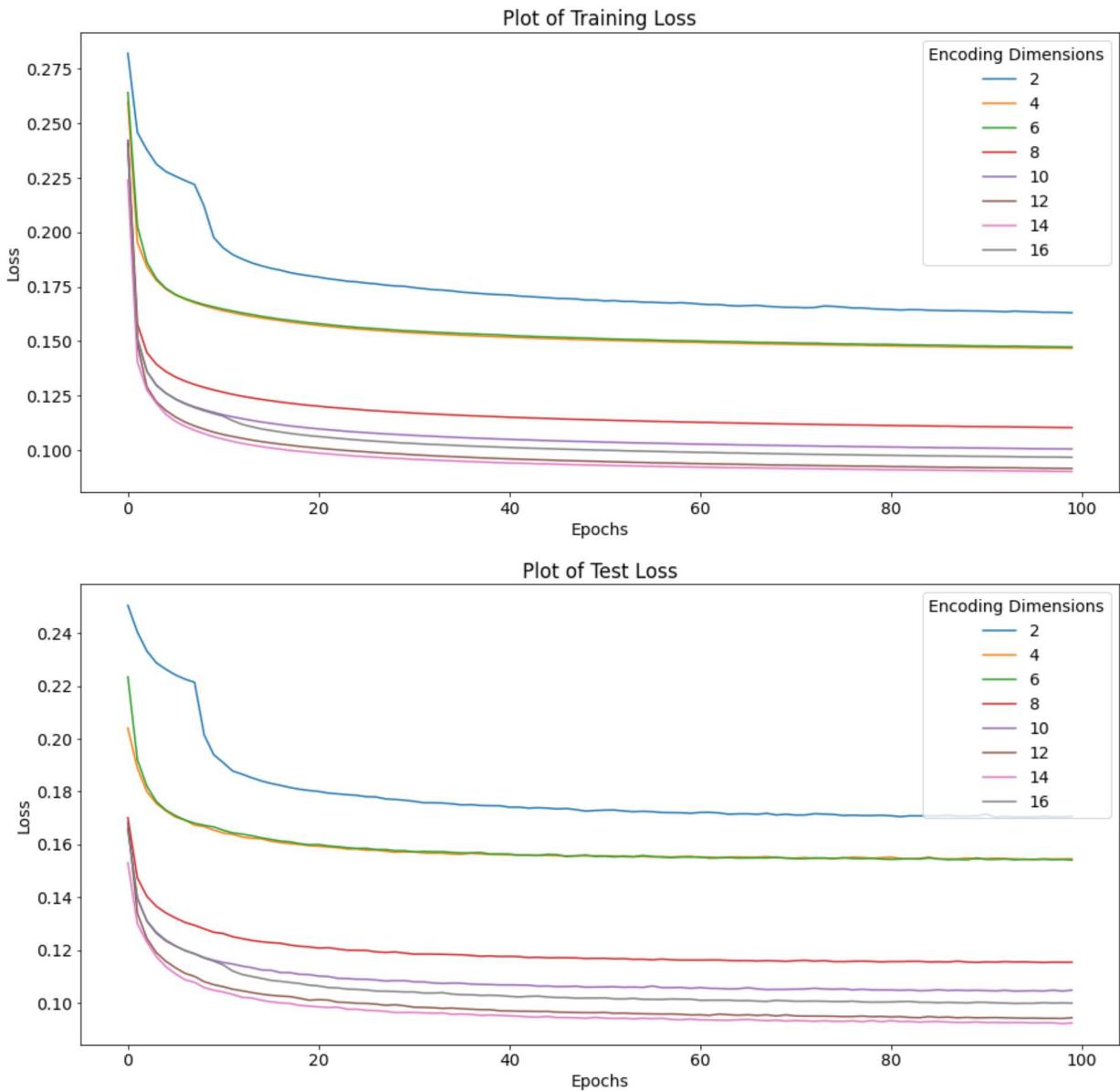
014
Epoch 56/100
235/235 [=====] - 2s 7ms/step - loss: 0.0995 - val_loss: 0.1
014
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.0994 - val_loss: 0.1
013
Epoch 58/100
235/235 [=====] - 2s 7ms/step - loss: 0.0992 - val_loss: 0.1
015
Epoch 59/100
235/235 [=====] - 2s 7ms/step - loss: 0.0992 - val_loss: 0.1
014
Epoch 60/100
235/235 [=====] - 2s 7ms/step - loss: 0.0991 - val_loss: 0.1
014
Epoch 61/100
235/235 [=====] - 2s 8ms/step - loss: 0.0990 - val_loss: 0.1
010
Epoch 62/100
235/235 [=====] - 2s 7ms/step - loss: 0.0989 - val_loss: 0.1
010
Epoch 63/100
235/235 [=====] - 2s 7ms/step - loss: 0.0988 - val_loss: 0.1
010
Epoch 64/100
235/235 [=====] - 2s 7ms/step - loss: 0.0987 - val_loss: 0.1
011
Epoch 65/100
235/235 [=====] - 2s 7ms/step - loss: 0.0987 - val_loss: 0.1
008
Epoch 66/100
235/235 [=====] - 2s 7ms/step - loss: 0.0986 - val_loss: 0.1
009
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.0985 - val_loss: 0.1
007
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.0985 - val_loss: 0.1
006
Epoch 69/100
235/235 [=====] - 2s 7ms/step - loss: 0.0984 - val_loss: 0.1
010
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.0983 - val_loss: 0.1
008
Epoch 71/100
235/235 [=====] - 2s 7ms/step - loss: 0.0982 - val_loss: 0.1
006
Epoch 72/100
235/235 [=====] - 2s 7ms/step - loss: 0.0981 - val_loss: 0.1
007
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.0981 - val_loss: 0.1
007
Epoch 74/100
235/235 [=====] - 2s 7ms/step - loss: 0.0980 - val_loss: 0.1
006
Epoch 75/100
235/235 [=====] - 2s 7ms/step - loss: 0.0980 - val_loss: 0.1

005
Epoch 76/100
235/235 [=====] - 2s 7ms/step - loss: 0.0979 - val_loss: 0.1
005
Epoch 77/100
235/235 [=====] - 2s 7ms/step - loss: 0.0979 - val_loss: 0.1
007
Epoch 78/100
235/235 [=====] - 2s 7ms/step - loss: 0.0978 - val_loss: 0.1
004
Epoch 79/100
235/235 [=====] - 2s 7ms/step - loss: 0.0977 - val_loss: 0.1
003
Epoch 80/100
235/235 [=====] - 2s 8ms/step - loss: 0.0977 - val_loss: 0.1
003
Epoch 81/100
235/235 [=====] - 2s 7ms/step - loss: 0.0976 - val_loss: 0.1
003
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.0976 - val_loss: 0.1
005
Epoch 83/100
235/235 [=====] - 2s 7ms/step - loss: 0.0975 - val_loss: 0.1
006
Epoch 84/100
235/235 [=====] - 2s 7ms/step - loss: 0.0975 - val_loss: 0.1
002
Epoch 85/100
235/235 [=====] - 2s 7ms/step - loss: 0.0974 - val_loss: 0.1
002
Epoch 86/100
235/235 [=====] - 2s 7ms/step - loss: 0.0974 - val_loss: 0.1
001
Epoch 87/100
235/235 [=====] - 2s 7ms/step - loss: 0.0973 - val_loss: 0.1
002
Epoch 88/100
235/235 [=====] - 2s 7ms/step - loss: 0.0973 - val_loss: 0.1
001
Epoch 89/100
235/235 [=====] - 2s 7ms/step - loss: 0.0972 - val_loss: 0.1
000
Epoch 90/100
235/235 [=====] - 2s 7ms/step - loss: 0.0971 - val_loss: 0.1
002
Epoch 91/100
235/235 [=====] - 2s 7ms/step - loss: 0.0971 - val_loss: 0.1
002
Epoch 92/100
235/235 [=====] - 2s 7ms/step - loss: 0.0971 - val_loss: 0.1
000
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.0970 - val_loss: 0.0
999
Epoch 94/100
235/235 [=====] - 2s 7ms/step - loss: 0.0970 - val_loss: 0.0
998
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.0969 - val_loss: 0.0

```
998
Epoch 96/100
235/235 [=====] - 2s 7ms/step - loss: 0.0969 - val_loss: 0.0
998
Epoch 97/100
235/235 [=====] - 2s 7ms/step - loss: 0.0968 - val_loss: 0.1
001
Epoch 98/100
235/235 [=====] - 2s 7ms/step - loss: 0.0968 - val_loss: 0.0
999
Epoch 99/100
235/235 [=====] - 2s 7ms/step - loss: 0.0968 - val_loss: 0.1
000
Epoch 100/100
235/235 [=====] - 2s 7ms/step - loss: 0.0967 - val_loss: 0.0
999
```

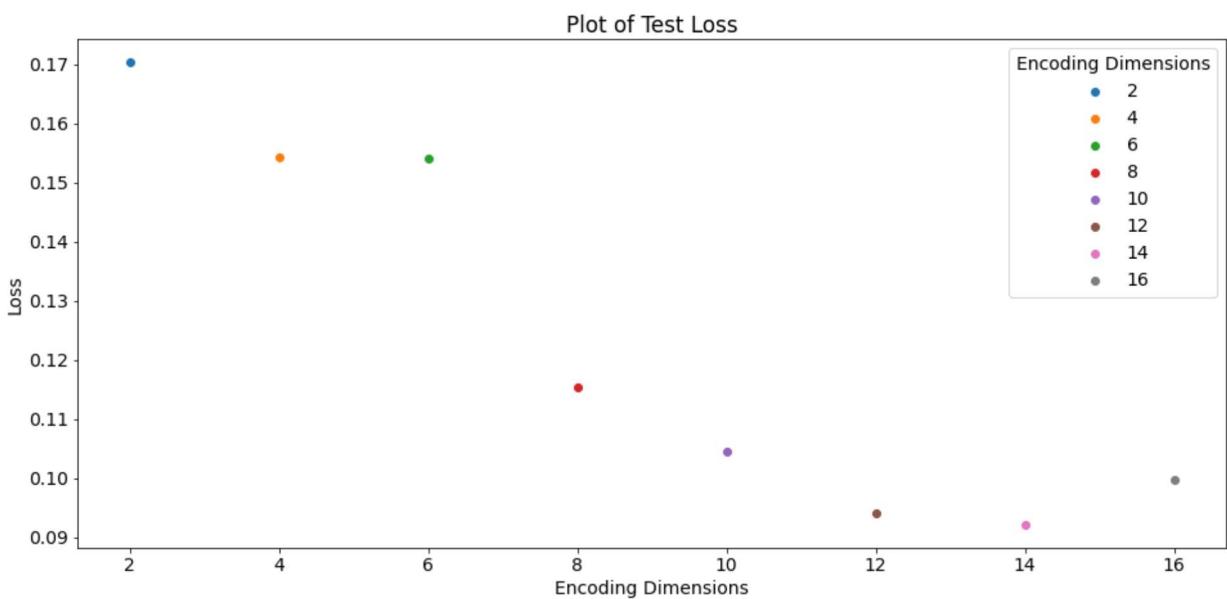
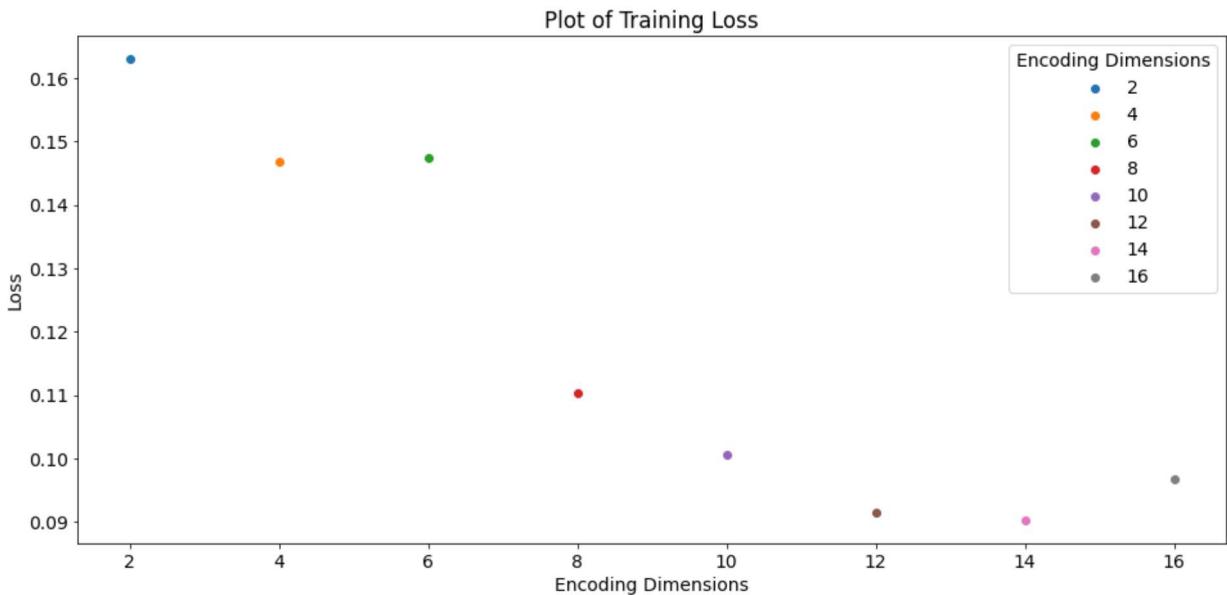
```
In [32]: fig, ax = plt.subplots(2,1)
for i in range(len(dimensions)):
    ax[0].plot(losses[i].history['loss'], label = dimensions[i])
    ax[0].set_xlabel('Epochs')
    ax[0].set_ylabel('Loss')
    ax[0].legend(loc = "upper right", title = "Encoding Dimensions")
    ax[0].set_title("Plot of Training Loss")

    ax[1].plot(losses[i].history['val_loss'], label = dimensions[i])
    ax[1].set_xlabel('Epochs')
    ax[1].set_ylabel('Loss')
    ax[1].legend(loc = "upper right", title = "Encoding Dimensions")
    ax[1].set_title("Plot of Test Loss")
```



```
In [87]: fig, ax = plt.subplots(2,1)
for i in range(len(dimensions)):
    ax[0].scatter(dimensions[i], np.min(losses[i].history['loss']), label = dimensions[i])
    ax[0].set_xlabel('Encoding Dimensions')
    ax[0].set_ylabel('Loss')
    ax[0].legend(loc = "upper right", title = "Encoding Dimensions")
    ax[0].set_title("Plot of Training Loss")

    ax[1].scatter(dimensions[i], np.min(losses[i].history['val_loss']), label = dimensions[i])
    ax[1].set_xlabel('Encoding Dimensions')
    ax[1].set_ylabel('Loss')
    ax[1].legend(loc = "upper right", title = "Encoding Dimensions")
    ax[1].set_title("Plot of Test Loss")
```



1. **After** 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 [84]: encoding_dim = 8

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)
```


Tensorflow listening on http://localhost:6006/
Epoch 1/100
235/235 [=====] - 2s 8ms/step - loss: 0.2656 - val_loss: 0.5695
Epoch 2/100
235/235 [=====] - 2s 7ms/step - loss: 0.2272 - val_loss: 0.4106
Epoch 3/100
235/235 [=====] - 2s 7ms/step - loss: 0.2083 - val_loss: 0.3623
Epoch 4/100
235/235 [=====] - 2s 7ms/step - loss: 0.2006 - val_loss: 0.3287
Epoch 5/100
235/235 [=====] - 2s 7ms/step - loss: 0.1899 - val_loss: 0.3063
Epoch 6/100
235/235 [=====] - 2s 7ms/step - loss: 0.1771 - val_loss: 0.3145
Epoch 7/100
235/235 [=====] - 2s 7ms/step - loss: 0.1727 - val_loss: 0.3158
Epoch 8/100
235/235 [=====] - 2s 7ms/step - loss: 0.1678 - val_loss: 0.3285
Epoch 9/100
235/235 [=====] - 2s 7ms/step - loss: 0.1601 - val_loss: 0.3259
Epoch 10/100
235/235 [=====] - 2s 8ms/step - loss: 0.1572 - val_loss: 0.3132
Epoch 11/100
235/235 [=====] - 2s 10ms/step - loss: 0.1550 - val_loss: 0.33121
Epoch 12/100
235/235 [=====] - 2s 8ms/step - loss: 0.1534 - val_loss: 0.3151
Epoch 13/100
235/235 [=====] - 2s 9ms/step - loss: 0.1521 - val_loss: 0.3101
Epoch 14/100
235/235 [=====] - 2s 8ms/step - loss: 0.1511 - val_loss: 0.3089
Epoch 15/100
235/235 [=====] - 2s 8ms/step - loss: 0.1500 - val_loss: 0.3072
Epoch 16/100
235/235 [=====] - 2s 7ms/step - loss: 0.1492 - val_loss: 0.3080
Epoch 17/100
235/235 [=====] - 2s 7ms/step - loss: 0.1483 - val_loss: 0.3112
Epoch 18/100
235/235 [=====] - 2s 7ms/step - loss: 0.1471 - val_loss: 0.3027
Epoch 19/100
235/235 [=====] - 2s 7ms/step - loss: 0.1446 - val_loss: 0.2960
Epoch 20/100
235/235 [=====] - 2s 7ms/step - loss: 0.1424 - val_loss: 0.2

999
Epoch 21/100
235/235 [=====] - 2s 8ms/step - loss: 0.1411 - val_loss: 0.2
965
Epoch 22/100
235/235 [=====] - 2s 7ms/step - loss: 0.1400 - val_loss: 0.2
981
Epoch 23/100
235/235 [=====] - 2s 7ms/step - loss: 0.1390 - val_loss: 0.2
928
Epoch 24/100
235/235 [=====] - 2s 7ms/step - loss: 0.1384 - val_loss: 0.2
969
Epoch 25/100
235/235 [=====] - 2s 7ms/step - loss: 0.1377 - val_loss: 0.2
927
Epoch 26/100
235/235 [=====] - 2s 7ms/step - loss: 0.1370 - val_loss: 0.2
974
Epoch 27/100
235/235 [=====] - 2s 7ms/step - loss: 0.1364 - val_loss: 0.2
925
Epoch 28/100
235/235 [=====] - 2s 7ms/step - loss: 0.1359 - val_loss: 0.2
904
Epoch 29/100
235/235 [=====] - 2s 7ms/step - loss: 0.1355 - val_loss: 0.2
852
Epoch 30/100
235/235 [=====] - 2s 7ms/step - loss: 0.1350 - val_loss: 0.2
834
Epoch 31/100
235/235 [=====] - 2s 7ms/step - loss: 0.1344 - val_loss: 0.2
879
Epoch 32/100
235/235 [=====] - 2s 7ms/step - loss: 0.1342 - val_loss: 0.2
756
Epoch 33/100
235/235 [=====] - 2s 7ms/step - loss: 0.1336 - val_loss: 0.2
777
Epoch 34/100
235/235 [=====] - 2s 7ms/step - loss: 0.1320 - val_loss: 0.2
782
Epoch 35/100
235/235 [=====] - 2s 8ms/step - loss: 0.1308 - val_loss: 0.2
762
Epoch 36/100
235/235 [=====] - 2s 7ms/step - loss: 0.1299 - val_loss: 0.2
653
Epoch 37/100
235/235 [=====] - 2s 7ms/step - loss: 0.1292 - val_loss: 0.2
667
Epoch 38/100
235/235 [=====] - 2s 7ms/step - loss: 0.1287 - val_loss: 0.2
725
Epoch 39/100
235/235 [=====] - 2s 7ms/step - loss: 0.1281 - val_loss: 0.2
624
Epoch 40/100
235/235 [=====] - 2s 7ms/step - loss: 0.1276 - val_loss: 0.2

681
Epoch 41/100
235/235 [=====] - 2s 7ms/step - loss: 0.1272 - val_loss: 0.2
622
Epoch 42/100
235/235 [=====] - 2s 7ms/step - loss: 0.1268 - val_loss: 0.2
648
Epoch 43/100
235/235 [=====] - 2s 7ms/step - loss: 0.1265 - val_loss: 0.2
627
Epoch 44/100
235/235 [=====] - 2s 7ms/step - loss: 0.1262 - val_loss: 0.2
611
Epoch 45/100
235/235 [=====] - 2s 7ms/step - loss: 0.1257 - val_loss: 0.2
557
Epoch 46/100
235/235 [=====] - 2s 7ms/step - loss: 0.1255 - val_loss: 0.2
569
Epoch 47/100
235/235 [=====] - 2s 7ms/step - loss: 0.1253 - val_loss: 0.2
542
Epoch 48/100
235/235 [=====] - 2s 7ms/step - loss: 0.1249 - val_loss: 0.2
550
Epoch 49/100
235/235 [=====] - 2s 7ms/step - loss: 0.1247 - val_loss: 0.2
545
Epoch 50/100
235/235 [=====] - 2s 7ms/step - loss: 0.1243 - val_loss: 0.2
528
Epoch 51/100
235/235 [=====] - 2s 7ms/step - loss: 0.1242 - val_loss: 0.2
538
Epoch 52/100
235/235 [=====] - 2s 7ms/step - loss: 0.1240 - val_loss: 0.2
508
Epoch 53/100
235/235 [=====] - 2s 7ms/step - loss: 0.1237 - val_loss: 0.2
519
Epoch 54/100
235/235 [=====] - 2s 7ms/step - loss: 0.1236 - val_loss: 0.2
466
Epoch 55/100
235/235 [=====] - 2s 7ms/step - loss: 0.1233 - val_loss: 0.2
454
Epoch 56/100
235/235 [=====] - 2s 7ms/step - loss: 0.1231 - val_loss: 0.2
473
Epoch 57/100
235/235 [=====] - 2s 7ms/step - loss: 0.1229 - val_loss: 0.2
477
Epoch 58/100
235/235 [=====] - 2s 8ms/step - loss: 0.1228 - val_loss: 0.2
481
Epoch 59/100
235/235 [=====] - 2s 10ms/step - loss: 0.1225 - val_loss: 0.
2464
Epoch 60/100
235/235 [=====] - 2s 9ms/step - loss: 0.1224 - val_loss: 0.2

408
Epoch 61/100
235/235 [=====] - 2s 10ms/step - loss: 0.1223 - val_loss: 0.
2421
Epoch 62/100
235/235 [=====] - 2s 9ms/step - loss: 0.1220 - val_loss: 0.2
411
Epoch 63/100
235/235 [=====] - 2s 8ms/step - loss: 0.1220 - val_loss: 0.2
389
Epoch 64/100
235/235 [=====] - 2s 8ms/step - loss: 0.1218 - val_loss: 0.2
371
Epoch 65/100
235/235 [=====] - 2s 8ms/step - loss: 0.1217 - val_loss: 0.2
387
Epoch 66/100
235/235 [=====] - 2s 8ms/step - loss: 0.1215 - val_loss: 0.2
376
Epoch 67/100
235/235 [=====] - 2s 7ms/step - loss: 0.1214 - val_loss: 0.2
343
Epoch 68/100
235/235 [=====] - 2s 7ms/step - loss: 0.1213 - val_loss: 0.2
360
Epoch 69/100
235/235 [=====] - 2s 8ms/step - loss: 0.1210 - val_loss: 0.2
353
Epoch 70/100
235/235 [=====] - 2s 7ms/step - loss: 0.1210 - val_loss: 0.2
414
Epoch 71/100
235/235 [=====] - 2s 8ms/step - loss: 0.1209 - val_loss: 0.2
368
Epoch 72/100
235/235 [=====] - 2s 8ms/step - loss: 0.1207 - val_loss: 0.2
344
Epoch 73/100
235/235 [=====] - 2s 7ms/step - loss: 0.1206 - val_loss: 0.2
352
Epoch 74/100
235/235 [=====] - 2s 8ms/step - loss: 0.1206 - val_loss: 0.2
328
Epoch 75/100
235/235 [=====] - 2s 8ms/step - loss: 0.1203 - val_loss: 0.2
332
Epoch 76/100
235/235 [=====] - 2s 8ms/step - loss: 0.1203 - val_loss: 0.2
361
Epoch 77/100
235/235 [=====] - 2s 7ms/step - loss: 0.1202 - val_loss: 0.2
288
Epoch 78/100
235/235 [=====] - 2s 8ms/step - loss: 0.1201 - val_loss: 0.2
320
Epoch 79/100
235/235 [=====] - 2s 10ms/step - loss: 0.1201 - val_loss: 0.
2362
Epoch 80/100
235/235 [=====] - 2s 9ms/step - loss: 0.1199 - val_loss: 0.2

330
Epoch 81/100
235/235 [=====] - 2s 9ms/step - loss: 0.1199 - val_loss: 0.2
308
Epoch 82/100
235/235 [=====] - 2s 7ms/step - loss: 0.1197 - val_loss: 0.2
308
Epoch 83/100
235/235 [=====] - 3s 11ms/step - loss: 0.1197 - val_loss: 0.
2296
Epoch 84/100
235/235 [=====] - 2s 9ms/step - loss: 0.1194 - val_loss: 0.2
303
Epoch 85/100
235/235 [=====] - 2s 10ms/step - loss: 0.1194 - val_loss: 0.
2283
Epoch 86/100
235/235 [=====] - 2s 9ms/step - loss: 0.1194 - val_loss: 0.2
288
Epoch 87/100
235/235 [=====] - 2s 9ms/step - loss: 0.1193 - val_loss: 0.2
319
Epoch 88/100
235/235 [=====] - 2s 8ms/step - loss: 0.1192 - val_loss: 0.2
314
Epoch 89/100
235/235 [=====] - 2s 8ms/step - loss: 0.1191 - val_loss: 0.2
296
Epoch 90/100
235/235 [=====] - 2s 8ms/step - loss: 0.1190 - val_loss: 0.2
286
Epoch 91/100
235/235 [=====] - 2s 10ms/step - loss: 0.1189 - val_loss: 0.
2301
Epoch 92/100
235/235 [=====] - 2s 9ms/step - loss: 0.1190 - val_loss: 0.2
277
Epoch 93/100
235/235 [=====] - 2s 7ms/step - loss: 0.1189 - val_loss: 0.2
269
Epoch 94/100
235/235 [=====] - 2s 7ms/step - loss: 0.1188 - val_loss: 0.2
313
Epoch 95/100
235/235 [=====] - 2s 7ms/step - loss: 0.1187 - val_loss: 0.2
281
Epoch 96/100
235/235 [=====] - 2s 9ms/step - loss: 0.1186 - val_loss: 0.2
249
Epoch 97/100
235/235 [=====] - 2s 7ms/step - loss: 0.1186 - val_loss: 0.2
279
Epoch 98/100
235/235 [=====] - 2s 8ms/step - loss: 0.1185 - val_loss: 0.2
259
Epoch 99/100
235/235 [=====] - 2s 8ms/step - loss: 0.1184 - val_loss: 0.2
271
Epoch 100/100

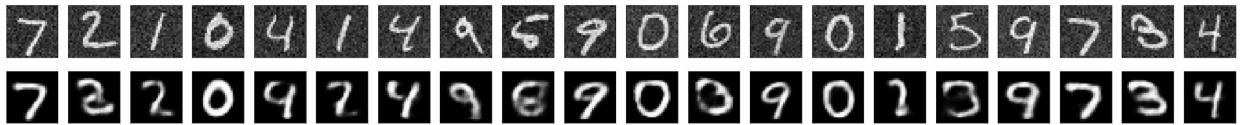
```
235/235 [=====] - 2s 8ms/step - loss: 0.1185 - val_loss: 0.2  
225
```

In [120]:

```
xtest_noise = xtest + np.random.normal(0,0.1, (10000, 784))  
encoded_imgs = encoder.predict(xtest_noise)  
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_noise[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()
```

```
313/313 [=====] - 1s 3ms/step
```

```
313/313 [=====] - 0s 1ms/step
```



In []: