In [36]:

```python
from __future__ import print_function
import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import InputLayer, Conv2D, MaxPooling2D
from keras import backend as K
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
DF = pd.read_csv("data_final.csv",header=None)
X=DF.iloc[:,0:2]
Y=DF.iloc[:,2]
```

In [37]:

```python
from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.2, random_state=42)
print(X_train.shape)
np.random.random((1000,20)).shape
```

(1600, 2)

Out[37]:

(1000, 20)

In [38]:

```python
model=Sequential()
model.add(Dense(40, input_dim=2, activation='relu'))
model.add(Dense(30, activation='sigmoid'))
model.add(Dense(25, activation='relu'))
model.add(Dense(20, activation='softmax'))
model.compile(loss='sparse_categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
#Y_train1= keras.utils.to_categorical(Y_train)
model.fit(X_train, Y_train, epochs=350, batch_size=10)
```

```
Epoch 1/350
1600/1600 [==============================] - 0s 266us/step - loss: 2.8549 - accuracy: 0.1412
Epoch 2/350
1600/1600 [==============================] - 0s 193us/step - loss: 2.4489 - accuracy: 0.2344
Epoch 3/350
1600/1600 [==============================] - 0s 179us/step - loss: 2.1638 - accuracy: 0.2856
Epoch 4/350
1600/1600 [==============================] - 0s 187us/step - loss: 1.9258 - accuracy: 0.3250
Epoch 5/350
1600/1600 [==============================] - 0s 182us/step - loss: 1.7597 - accuracy: 0.3600
Epoch 6/350
1600/1600 [==============================] - 0s 179us/step - loss: 1.6004 - accuracy: 0.3881
Epoch 7/350
1600/1600 [==============================] - 0s 185us/step - loss: 1.4951 - accuracy: 0.3869
Epoch 8/350
1600/1600 [==============================] - 0s 183us/step - loss: 1.4406 - accuracy: 0.3981
Epoch 9/350
1600/1600 [==============================] - 0s 184us/step - loss: 1.3840 - accuracy: 0.4387
Epoch 10/350
1600/1600 [==============================] - 0s 185us/step - loss: 1.3667 - accuracy: 0.4194
Epoch 11/350
1600/1600 [==============================] - 0s 189us/step - loss: 1.3171 - accuracy: 0.4231
Epoch 12/350
1600/1600 [==============================] - 0s 183us/step - loss: 1.3040 - accuracy: 0.4512
Epoch 13/350
1600/1600 [==============================] - 0s 178us/step - loss: 1.2895 - accuracy: 0.4600
Epoch 14/350
1600/1600 [==============================] - 0s 169us/step - loss: 1.2687 - accuracy: 0.4406
Epoch 15/350
1600/1600 [==============================] - 0s 173us/step - loss: 1.2714 - accuracy: 0.4606
Epoch 16/350
```

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Epoch 16/350
1600/1600 [==============================] - 0s 183us/step - loss: 1.2438 - accuracy: 0.4837
Epoch 17/350
1600/1600 [==============================] - 0s 181us/step - loss: 1.2585 - accuracy: 0.4675
Epoch 18/350
1600/1600 [==============================] - 0s 182us/step - loss: 1.2178 - accuracy: 0.5013
Epoch 19/350
1600/1600 [==============================] - 0s 183us/step - loss: 1.2184 - accuracy: 0.4800
Epoch 20/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.1844 - accuracy: 0.4994
Epoch 21/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.1640 - accuracy: 0.4994
Epoch 22/350
1600/1600 [==============================] - 0s 202us/step - loss: 1.1997 - accuracy: 0.4831
Epoch 23/350
1600/1600 [==============================] - 0s 183us/step - loss: 1.1844 - accuracy: 0.4888
Epoch 24/350
1600/1600 [==============================] - 0s 187us/step - loss: 1.1437 - accuracy: 0.5025
Epoch 25/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.1316 - accuracy: 0.4956
Epoch 26/350
1600/1600 [==============================] - 0s 189us/step - loss: 1.1795 - accuracy: 0.5025
Epoch 27/350
1600/1600 [==============================] - 0s 176us/step - loss: 1.1179 - accuracy: 0.5369
Epoch 28/350
1600/1600 [==============================] - 0s 191us/step - loss: 1.1088 - accuracy: 0.5188
Epoch 29/350
1600/1600 [==============================] - 0s 188us/step - loss: 1.1037 - accuracy: 0.5125
Epoch 30/350
1600/1600 [==============================] - 0s 171us/step - loss: 1.1018 - accuracy: 0.5238
Epoch 31/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.0838 - accuracy: 0.5250
Epoch 32/350
1600/1600 [==============================] - 0s 187us/step - loss: 1.0762 - accuracy: 0.5319
Epoch 33/350
1600/1600 [==============================] - 0s 180us/step - loss: 1.0767 - accuracy: 0.5219
Epoch 34/350
1600/1600 [==============================] - 0s 185us/step - loss: 1.0680 - accuracy: 0.5369
Epoch 35/350
1600/1600 [==============================] - 0s 184us/step - loss: 1.0343 - accuracy: 0.5444
Epoch 36/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.0944 - accuracy: 0.5175
Epoch 37/350
1600/1600 [==============================] - 0s 181us/step - loss: 1.1335 - accuracy: 0.5119
Epoch 38/350
1600/1600 [==============================] - 0s 188us/step - loss: 1.1172 - accuracy: 0.5381
Epoch 39/350
1600/1600 [==============================] - 0s 184us/step - loss: 1.0584 - accuracy: 0.5387
Epoch 40/350
1600/1600 [==============================] - 0s 191us/step - loss: 1.1164 - accuracy: 0.5125
Epoch 41/350
1600/1600 [==============================] - 0s 185us/step - loss: 1.0881 - accuracy: 0.5344
Epoch 42/350
1600/1600 [==============================] - 0s 178us/step - loss: 1.0897 - accuracy: 0.5100
Epoch 43/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.0899 - accuracy: 0.5350
Epoch 44/350
1600/1600 [==============================] - 0s 171us/step - loss: 1.0396 - accuracy: 0.5487
Epoch 45/350
1600/1600 [==============================] - 0s 171us/step - loss: 1.0427 - accuracy: 0.5387
Epoch 46/350
1600/1600 [==============================] - 0s 187us/step - loss: 1.0131 - accuracy: 0.5544
Epoch 47/350
1600/1600 [==============================] - 0s 184us/step - loss: 1.0531 - accuracy: 0.5325
Epoch 48/350
1600/1600 [==============================] - 0s 180us/step - loss: 1.0147 - accuracy: 0.5487
Epoch 49/350
1600/1600 [==============================] - 0s 186us/step - loss: 1.0002 - accuracy: 0.5606
Epoch 50/350
1600/1600 [==============================] - 0s 187us/step - loss: 1.0065 - accuracy: 0.5719
Epoch 51/350
1600/1600 [==============================] - 0s 173us/step - loss: 0.9773 - accuracy: 0.5694
Epoch 52/350
1600/1600 [==============================] - 0s 190us/step - loss: 1.0040 - accuracy: 0.5619
Epoch 53/350
1600/1600 [==============================] - 0s 181us/step - loss: 1.0016 - accuracy: 0.5600
Epoch 54/350
1600/1600 [==============================] - 0s 178us/step - loss: 1.0510 - accuracy: 0.5562
```

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1600/1600 [==============================] - 0s 178us/step - loss: 1.0310 - accuracy: 0.5562
Epoch 55/350
1600/1600 [==============================] - 0s 178us/step - loss: 1.0307 - accuracy: 0.5719
Epoch 56/350
1600/1600 [==============================] - 0s 170us/step - loss: 0.9626 - accuracy: 0.5906
Epoch 57/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.9636 - accuracy: 0.5731
Epoch 58/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.9700 - accuracy: 0.5906
Epoch 59/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.9748 - accuracy: 0.5794
Epoch 60/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.9785 - accuracy: 0.6069
Epoch 61/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.9583 - accuracy: 0.5931
Epoch 62/350
1600/1600 [==============================] - 0s 189us/step - loss: 0.9281 - accuracy: 0.5994
Epoch 63/350
1600/1600 [==============================] - 0s 175us/step - loss: 1.0144 - accuracy: 0.5756
Epoch 64/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.9083 - accuracy: 0.6275
Epoch 65/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.9492 - accuracy: 0.6044
Epoch 66/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.9543 - accuracy: 0.5931
Epoch 67/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.9165 - accuracy: 0.6075
Epoch 68/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.8999 - accuracy: 0.6244
Epoch 69/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.9118 - accuracy: 0.5994
Epoch 70/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.8509 - accuracy: 0.6219
Epoch 71/350
1600/1600 [==============================] - 0s 153us/step - loss: 0.8840 - accuracy: 0.6269
Epoch 72/350
1600/1600 [==============================] - 0s 149us/step - loss: 0.8450 - accuracy: 0.6406
Epoch 73/350
1600/1600 [==============================] - 0s 142us/step - loss: 0.8481 - accuracy: 0.6456
Epoch 74/350
1600/1600 [==============================] - 0s 159us/step - loss: 0.8429 - accuracy: 0.6300
Epoch 75/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.9160 - accuracy: 0.6306
Epoch 76/350
1600/1600 [==============================] - 0s 154us/step - loss: 0.8618 - accuracy: 0.6319
Epoch 77/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.8481 - accuracy: 0.6369
Epoch 78/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.8203 - accuracy: 0.6519
Epoch 79/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.8199 - accuracy: 0.6475
Epoch 80/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.8167 - accuracy: 0.6525
Epoch 81/350
1600/1600 [==============================] - 0s 169us/step - loss: 0.8594 - accuracy: 0.6481
Epoch 82/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.8035 - accuracy: 0.6506
Epoch 83/350
1600/1600 [==============================] - 0s 174us/step - loss: 0.8161 - accuracy: 0.6594
Epoch 84/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.8273 - accuracy: 0.6531
Epoch 85/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.8360 - accuracy: 0.6294
Epoch 86/350
1600/1600 [==============================] - 0s 163us/step - loss: 0.8193 - accuracy: 0.6456
Epoch 87/350
1600/1600 [==============================] - 0s 141us/step - loss: 0.7772 - accuracy: 0.6625
Epoch 88/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.7989 - accuracy: 0.6606
Epoch 89/350
1600/1600 [==============================] - 0s 171us/step - loss: 0.7800 - accuracy: 0.6631
Epoch 90/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.7556 - accuracy: 0.6862
Epoch 91/350
1600/1600 [==============================] - 0s 124us/step - loss: 0.7402 - accuracy: 0.6694
Epoch 92/350
1600/1600 [==============================] - 0s 113us/step - loss: 0.7597 - accuracy: 0.6737
Epoch 93/350
```

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Epoch 93/350
1600/1600 [==============================] - 0s 119us/step - loss: 0.7613 - accuracy: 0.6806
Epoch 94/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.7374 - accuracy: 0.6900
Epoch 95/350
1600/1600 [==============================] - 0s 157us/step - loss: 0.7618 - accuracy: 0.6856
Epoch 96/350
1600/1600 [==============================] - 0s 159us/step - loss: 0.7254 - accuracy: 0.6800
Epoch 97/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.7372 - accuracy: 0.6819
Epoch 98/350
1600/1600 [==============================] - 0s 177us/step - loss: 0.7766 - accuracy: 0.6769
Epoch 99/350
1600/1600 [==============================] - 0s 169us/step - loss: 0.7129 - accuracy: 0.6881
Epoch 100/350
1600/1600 [==============================] - 0s 150us/step - loss: 0.7256 - accuracy: 0.6844
Epoch 101/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.7696 - accuracy: 0.6687
Epoch 102/350
1600/1600 [==============================] - 0s 171us/step - loss: 0.7055 - accuracy: 0.7119
Epoch 103/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.6788 - accuracy: 0.6875
Epoch 104/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.6717 - accuracy: 0.7144
Epoch 105/350
1600/1600 [==============================] - 0s 169us/step - loss: 0.6597 - accuracy: 0.7269
Epoch 106/350
1600/1600 [==============================] - 0s 172us/step - loss: 0.6673 - accuracy: 0.7181
Epoch 107/350
1600/1600 [==============================] - 0s 157us/step - loss: 0.6991 - accuracy: 0.6675
Epoch 108/350
1600/1600 [==============================] - 0s 126us/step - loss: 0.7419 - accuracy: 0.7031
Epoch 109/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.6791 - accuracy: 0.7188
Epoch 110/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.6595 - accuracy: 0.7362
Epoch 111/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.6963 - accuracy: 0.7069
Epoch 112/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.6816 - accuracy: 0.7131
Epoch 113/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.6999 - accuracy: 0.6825
Epoch 114/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.7145 - accuracy: 0.7031
Epoch 115/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.6666 - accuracy: 0.7113
Epoch 116/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.6425 - accuracy: 0.7275
Epoch 117/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.6735 - accuracy: 0.7387
Epoch 118/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.6760 - accuracy: 0.7250
Epoch 119/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.6292 - accuracy: 0.7269
Epoch 120/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.6952 - accuracy: 0.6963
Epoch 121/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.6569 - accuracy: 0.7063
Epoch 122/350
1600/1600 [==============================] - 0s 176us/step - loss: 0.6597 - accuracy: 0.7131
Epoch 123/350
1600/1600 [==============================] - 0s 137us/step - loss: 0.6095 - accuracy: 0.7294
Epoch 124/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.6182 - accuracy: 0.7262
Epoch 125/350
1600/1600 [==============================] - 0s 177us/step - loss: 0.6471 - accuracy: 0.7244
Epoch 126/350
1600/1600 [==============================] - 0s 161us/step - loss: 0.6223 - accuracy: 0.7306
Epoch 127/350
1600/1600 [==============================] - 0s 168us/step - loss: 0.6046 - accuracy: 0.7406
Epoch 128/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.6139 - accuracy: 0.7381
Epoch 129/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.5870 - accuracy: 0.7600
Epoch 130/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.6165 - accuracy: 0.7381
Epoch 131/350
1600/1600 [                              ] - 0s 171us/step - loss: 0.5687 - accuracy: 0.7606
```

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1600/1600 [==============================] - 0s 171us/step - loss: 0.5697 - accuracy: 0.7606
Epoch 132/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.5667 - accuracy: 0.7650
Epoch 133/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.5870 - accuracy: 0.7663
Epoch 134/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.6261 - accuracy: 0.7469
Epoch 135/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.6196 - accuracy: 0.7325
Epoch 136/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.6343 - accuracy: 0.7331
Epoch 137/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.5851 - accuracy: 0.7550
Epoch 138/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.6290 - accuracy: 0.7556
Epoch 139/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.6083 - accuracy: 0.7362
Epoch 140/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.5901 - accuracy: 0.7600
Epoch 141/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.6078 - accuracy: 0.7325
Epoch 142/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.5897 - accuracy: 0.7425
Epoch 143/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.6326 - accuracy: 0.7444
Epoch 144/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.6262 - accuracy: 0.7450
Epoch 145/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.5688 - accuracy: 0.7538
Epoch 146/350
1600/1600 [==============================] - 0s 200us/step - loss: 0.5647 - accuracy: 0.7625
Epoch 147/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.5622 - accuracy: 0.7581
Epoch 148/350
1600/1600 [==============================] - 0s 153us/step - loss: 0.5724 - accuracy: 0.7594
Epoch 149/350
1600/1600 [==============================] - 0s 146us/step - loss: 0.5449 - accuracy: 0.7638
Epoch 150/350
1600/1600 [==============================] - 0s 161us/step - loss: 0.5775 - accuracy: 0.7669
Epoch 151/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.5525 - accuracy: 0.7669
Epoch 152/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.5350 - accuracy: 0.7713
Epoch 153/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.5668 - accuracy: 0.7744
Epoch 154/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.6144 - accuracy: 0.7394
Epoch 155/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.5381 - accuracy: 0.7750
Epoch 156/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.5630 - accuracy: 0.7681
Epoch 157/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.5294 - accuracy: 0.7631
Epoch 158/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.5504 - accuracy: 0.7706
Epoch 159/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.5312 - accuracy: 0.7738
Epoch 160/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.5323 - accuracy: 0.7875
Epoch 161/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.5612 - accuracy: 0.7606
Epoch 162/350
1600/1600 [==============================] - 0s 174us/step - loss: 0.5482 - accuracy: 0.7700
Epoch 163/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.5479 - accuracy: 0.7700
Epoch 164/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.5580 - accuracy: 0.7656
Epoch 165/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.5457 - accuracy: 0.7825
Epoch 166/350
1600/1600 [==============================] - 0s 146us/step - loss: 0.5226 - accuracy: 0.7825
Epoch 167/350
1600/1600 [==============================] - 0s 141us/step - loss: 0.5522 - accuracy: 0.7638
Epoch 168/350
1600/1600 [==============================] - 0s 152us/step - loss: 0.5488 - accuracy: 0.7763
Epoch 169/350
1600/1600 [==============================] - 0s 158us/step - loss: 0.5235 - accuracy: 0.7719
```

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Epoch 170/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.5350 - accuracy: 0.7663
Epoch 171/350
1600/1600 [==============================] - 0s 174us/step - loss: 0.5154 - accuracy: 0.7894
Epoch 172/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.4839 - accuracy: 0.7962
Epoch 173/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.5943 - accuracy: 0.7744
Epoch 174/350
1600/1600 [==============================] - 0s 174us/step - loss: 0.5031 - accuracy: 0.8006
Epoch 175/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.5107 - accuracy: 0.7825
Epoch 176/350
1600/1600 [==============================] - 0s 174us/step - loss: 0.5231 - accuracy: 0.7869
Epoch 177/350
1600/1600 [==============================] - 0s 169us/step - loss: 0.5232 - accuracy: 0.7744
Epoch 178/350
1600/1600 [==============================] - 0s 165us/step - loss: 0.5143 - accuracy: 0.7738
Epoch 179/350
1600/1600 [==============================] - 0s 149us/step - loss: 0.5150 - accuracy: 0.7881
Epoch 180/350
1600/1600 [==============================] - 0s 168us/step - loss: 0.5115 - accuracy: 0.7788
Epoch 181/350
1600/1600 [==============================] - 0s 176us/step - loss: 0.5071 - accuracy: 0.7850
Epoch 182/350
1600/1600 [==============================] - 0s 117us/step - loss: 0.5329 - accuracy: 0.7600
Epoch 183/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.4918 - accuracy: 0.7906
Epoch 184/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.5173 - accuracy: 0.7869
Epoch 185/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.5148 - accuracy: 0.7819
Epoch 186/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.5267 - accuracy: 0.7887
Epoch 187/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.5110 - accuracy: 0.7950
Epoch 188/350
1600/1600 [==============================] - 0s 176us/step - loss: 0.5283 - accuracy: 0.7763
Epoch 189/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4878 - accuracy: 0.7937
Epoch 190/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.5120 - accuracy: 0.7831
Epoch 191/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4858 - accuracy: 0.7944
Epoch 192/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.5150 - accuracy: 0.7850
Epoch 193/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.5395 - accuracy: 0.7750
Epoch 194/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4840 - accuracy: 0.7875
Epoch 195/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4898 - accuracy: 0.7962
Epoch 196/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4724 - accuracy: 0.7837
Epoch 197/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4738 - accuracy: 0.7944
Epoch 198/350
1600/1600 [==============================] - 0s 165us/step - loss: 0.4953 - accuracy: 0.7900
Epoch 199/350
1600/1600 [==============================] - 0s 171us/step - loss: 0.4941 - accuracy: 0.7956
Epoch 200/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4701 - accuracy: 0.8188
Epoch 201/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4850 - accuracy: 0.8044
Epoch 202/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.5232 - accuracy: 0.7694
Epoch 203/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4917 - accuracy: 0.7800
Epoch 204/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.4805 - accuracy: 0.8006
Epoch 205/350
1600/1600 [==============================] - 0s 193us/step - loss: 0.4949 - accuracy: 0.7956
Epoch 206/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.4504 - accuracy: 0.8188
Epoch 207/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4886 - accuracy: 0.8125
Epoch 208/350
```

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1600/1600 [==============================] - 0s 185us/step - loss: 0.4844 - accuracy: 0.8087
Epoch 209/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4953 - accuracy: 0.8075
Epoch 210/350
1600/1600 [==============================] - 0s 171us/step - loss: 0.4860 - accuracy: 0.7975
Epoch 211/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4874 - accuracy: 0.7975
Epoch 212/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4849 - accuracy: 0.8156
Epoch 213/350
1600/1600 [==============================] - 0s 206us/step - loss: 0.4718 - accuracy: 0.8056
Epoch 214/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4909 - accuracy: 0.8019
Epoch 215/350
1600/1600 [==============================] - 0s 200us/step - loss: 0.4523 - accuracy: 0.8106
Epoch 216/350
1600/1600 [==============================] - 0s 213us/step - loss: 0.4909 - accuracy: 0.7944
Epoch 217/350
1600/1600 [==============================] - 0s 221us/step - loss: 0.4924 - accuracy: 0.8012
Epoch 218/350
1600/1600 [==============================] - 0s 212us/step - loss: 0.4459 - accuracy: 0.8181
Epoch 219/350
1600/1600 [==============================] - 0s 216us/step - loss: 0.4689 - accuracy: 0.7912
Epoch 220/350
1600/1600 [==============================] - 0s 211us/step - loss: 0.4582 - accuracy: 0.7981
Epoch 221/350
1600/1600 [==============================] - 0s 196us/step - loss: 0.4534 - accuracy: 0.8100
Epoch 222/350
1600/1600 [==============================] - 0s 210us/step - loss: 0.5018 - accuracy: 0.8094
Epoch 223/350
1600/1600 [==============================] - 0s 217us/step - loss: 0.4652 - accuracy: 0.8188
Epoch 224/350
1600/1600 [==============================] - 0s 193us/step - loss: 0.4925 - accuracy: 0.8094
Epoch 225/350
1600/1600 [==============================] - 0s 202us/step - loss: 0.4614 - accuracy: 0.8169
Epoch 226/350
1600/1600 [==============================] - 0s 210us/step - loss: 0.4702 - accuracy: 0.8125
Epoch 227/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.4451 - accuracy: 0.8100
Epoch 228/350
1600/1600 [==============================] - 0s 205us/step - loss: 0.4957 - accuracy: 0.8069
Epoch 229/350
1600/1600 [==============================] - 0s 220us/step - loss: 0.4523 - accuracy: 0.8175
Epoch 230/350
1600/1600 [==============================] - 0s 201us/step - loss: 0.4687 - accuracy: 0.8037
Epoch 231/350
1600/1600 [==============================] - 0s 202us/step - loss: 0.4597 - accuracy: 0.8037
Epoch 232/350
1600/1600 [==============================] - 0s 209us/step - loss: 0.4369 - accuracy: 0.8131
Epoch 233/350
1600/1600 [==============================] - 0s 201us/step - loss: 0.4664 - accuracy: 0.8056
Epoch 234/350
1600/1600 [==============================] - 0s 209us/step - loss: 0.4668 - accuracy: 0.8188
Epoch 235/350
1600/1600 [==============================] - 0s 200us/step - loss: 0.4353 - accuracy: 0.8225
Epoch 236/350
1600/1600 [==============================] - 0s 210us/step - loss: 0.4616 - accuracy: 0.8188
Epoch 237/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4519 - accuracy: 0.8163
Epoch 238/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4582 - accuracy: 0.8188
Epoch 239/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4595 - accuracy: 0.8225
Epoch 240/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4935 - accuracy: 0.7981
Epoch 241/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.4605 - accuracy: 0.8144
Epoch 242/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4615 - accuracy: 0.8081
Epoch 243/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4599 - accuracy: 0.8163
Epoch 244/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4717 - accuracy: 0.8119
Epoch 245/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4563 - accuracy: 0.8213
Epoch 246/350
1600/1600 [==============================] - 0s 194us/step - loss: 0.4588 - accuracy: 0.8163
```

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Epoch 247/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4559 - accuracy: 0.8219
Epoch 248/350
1600/1600 [==============================] - 0s 202us/step - loss: 0.4758 - accuracy: 0.8025
Epoch 249/350
1600/1600 [==============================] - 0s 197us/step - loss: 0.4455 - accuracy: 0.8281
Epoch 250/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4618 - accuracy: 0.8006
Epoch 251/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4656 - accuracy: 0.8081
Epoch 252/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4433 - accuracy: 0.8225
Epoch 253/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4546 - accuracy: 0.8050
Epoch 254/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4421 - accuracy: 0.8119
Epoch 255/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.5066 - accuracy: 0.8075
Epoch 256/350
1600/1600 [==============================] - 0s 193us/step - loss: 0.4598 - accuracy: 0.8112
Epoch 257/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.4547 - accuracy: 0.8175
Epoch 258/350
1600/1600 [==============================] - 0s 209us/step - loss: 0.4828 - accuracy: 0.8144
Epoch 259/350
1600/1600 [==============================] - 0s 202us/step - loss: 0.4357 - accuracy: 0.8244
Epoch 260/350
1600/1600 [==============================] - 0s 194us/step - loss: 0.4253 - accuracy: 0.8225
Epoch 261/350
1600/1600 [==============================] - 0s 172us/step - loss: 0.4329 - accuracy: 0.8256
Epoch 262/350
1600/1600 [==============================] - 0s 162us/step - loss: 0.4392 - accuracy: 0.8156
Epoch 263/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4477 - accuracy: 0.8081
Epoch 264/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4210 - accuracy: 0.8194
Epoch 265/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.4536 - accuracy: 0.7987
Epoch 266/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4444 - accuracy: 0.8200
Epoch 267/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4394 - accuracy: 0.8188
Epoch 268/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4547 - accuracy: 0.8012
Epoch 269/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4873 - accuracy: 0.8025
Epoch 270/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4732 - accuracy: 0.8100
Epoch 271/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.4912 - accuracy: 0.8031
Epoch 272/350
1600/1600 [==============================] - 0s 207us/step - loss: 0.4564 - accuracy: 0.8181
Epoch 273/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4324 - accuracy: 0.8263
Epoch 274/350
1600/1600 [==============================] - 0s 199us/step - loss: 0.4943 - accuracy: 0.8062
Epoch 275/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4473 - accuracy: 0.8231
Epoch 276/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.4207 - accuracy: 0.8325
Epoch 277/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4974 - accuracy: 0.8069
Epoch 278/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.4344 - accuracy: 0.8250
Epoch 279/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.4442 - accuracy: 0.8106
Epoch 280/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4367 - accuracy: 0.8319
Epoch 281/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4295 - accuracy: 0.8188
Epoch 282/350
1600/1600 [==============================] - 0s 200us/step - loss: 0.4343 - accuracy: 0.8181
Epoch 283/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4725 - accuracy: 0.8094
Epoch 284/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4412 - accuracy: 0.8163
Epoch 285/350
```

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1600/1600 [==============================] - 0s 190us/step - loss: 0.4344 - accuracy: 0.8188
Epoch 286/350
1600/1600 [==============================] - 0s 159us/step - loss: 0.4286 - accuracy: 0.8288
Epoch 287/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4355 - accuracy: 0.8325
Epoch 288/350
1600/1600 [==============================] - 0s 169us/step - loss: 0.4483 - accuracy: 0.8219
Epoch 289/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4424 - accuracy: 0.8131
Epoch 290/350
1600/1600 [==============================] - 0s 198us/step - loss: 0.4743 - accuracy: 0.8056
Epoch 291/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.4310 - accuracy: 0.8375
Epoch 292/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4221 - accuracy: 0.8250
Epoch 293/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4180 - accuracy: 0.8156
Epoch 294/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4670 - accuracy: 0.8225
Epoch 295/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.4101 - accuracy: 0.8244
Epoch 296/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.4707 - accuracy: 0.8106
Epoch 297/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4854 - accuracy: 0.8263
Epoch 298/350
1600/1600 [==============================] - 0s 166us/step - loss: 0.4437 - accuracy: 0.8037
Epoch 299/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4259 - accuracy: 0.8225
Epoch 300/350
1600/1600 [==============================] - 0s 179us/step - loss: 0.4203 - accuracy: 0.8175
Epoch 301/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4213 - accuracy: 0.8206
Epoch 302/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4178 - accuracy: 0.8275
Epoch 303/350
1600/1600 [==============================] - 0s 149us/step - loss: 0.4256 - accuracy: 0.8331
Epoch 304/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4264 - accuracy: 0.8256
Epoch 305/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4357 - accuracy: 0.8263
Epoch 306/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4073 - accuracy: 0.8388
Epoch 307/350
1600/1600 [==============================] - 0s 189us/step - loss: 0.4267 - accuracy: 0.8306
Epoch 308/350
1600/1600 [==============================] - 0s 188us/step - loss: 0.4183 - accuracy: 0.8138
Epoch 309/350
1600/1600 [==============================] - 0s 194us/step - loss: 0.4037 - accuracy: 0.8331
Epoch 310/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4414 - accuracy: 0.8231
Epoch 311/350
1600/1600 [==============================] - 0s 195us/step - loss: 0.4086 - accuracy: 0.8300
Epoch 312/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4577 - accuracy: 0.8206
Epoch 313/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4871 - accuracy: 0.8256
Epoch 314/350
1600/1600 [==============================] - 0s 189us/step - loss: 0.3961 - accuracy: 0.8331
Epoch 315/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4203 - accuracy: 0.8363
Epoch 316/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4323 - accuracy: 0.8300
Epoch 317/350
1600/1600 [==============================] - 0s 175us/step - loss: 0.4453 - accuracy: 0.8206
Epoch 318/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.4403 - accuracy: 0.8219
Epoch 319/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4824 - accuracy: 0.8075
Epoch 320/350
1600/1600 [==============================] - 0s 149us/step - loss: 0.4432 - accuracy: 0.8250
Epoch 321/350
1600/1600 [==============================] - 0s 148us/step - loss: 0.4518 - accuracy: 0.8263
Epoch 322/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4425 - accuracy: 0.8213
Epoch 323/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4242 - accuracy: 0.8250
```

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Epoch 324/350
1600/1600 [==============================] - 0s 182us/step - loss: 0.4672 - accuracy: 0.8238
Epoch 325/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4541 - accuracy: 0.8231
Epoch 326/350
1600/1600 [==============================] - 0s 186us/step - loss: 0.4704 - accuracy: 0.8106
Epoch 327/350
1600/1600 [==============================] - 0s 180us/step - loss: 0.4414 - accuracy: 0.8225
Epoch 328/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4310 - accuracy: 0.8200
Epoch 329/350
1600/1600 [==============================] - 0s 190us/step - loss: 0.4325 - accuracy: 0.8219
Epoch 330/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.3982 - accuracy: 0.8313
Epoch 331/350
1600/1600 [==============================] - 0s 181us/step - loss: 0.4529 - accuracy: 0.8213
Epoch 332/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4140 - accuracy: 0.8238
Epoch 333/350
1600/1600 [==============================] - 0s 187us/step - loss: 0.4301 - accuracy: 0.8300
Epoch 334/350
1600/1600 [==============================] - 0s 189us/step - loss: 0.4195 - accuracy: 0.8331
Epoch 335/350
1600/1600 [==============================] - 0s 183us/step - loss: 0.4301 - accuracy: 0.8181
Epoch 336/350
1600/1600 [==============================] - 0s 178us/step - loss: 0.4139 - accuracy: 0.8344
Epoch 337/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4282 - accuracy: 0.8331
Epoch 338/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.3993 - accuracy: 0.8413
Epoch 339/350
1600/1600 [==============================] - 0s 184us/step - loss: 0.4295 - accuracy: 0.8356
Epoch 340/350
1600/1600 [==============================] - 0s 185us/step - loss: 0.4545 - accuracy: 0.8119
Epoch 341/350
1600/1600 [==============================] - 0s 191us/step - loss: 0.4053 - accuracy: 0.8331
Epoch 342/350
1600/1600 [==============================] - 0s 192us/step - loss: 0.4181 - accuracy: 0.8344
Epoch 343/350
1600/1600 [==============================] - 0s 200us/step - loss: 0.4062 - accuracy: 0.8419
Epoch 344/350
1600/1600 [==============================] - 0s 212us/step - loss: 0.3954 - accuracy: 0.8338
Epoch 345/350
1600/1600 [==============================] - 0s 199us/step - loss: 0.4875 - accuracy: 0.8094
Epoch 346/350
1600/1600 [==============================] - 0s 210us/step - loss: 0.4115 - accuracy: 0.8325
Epoch 347/350
1600/1600 [==============================] - 0s 216us/step - loss: 0.3903 - accuracy: 0.8363
Epoch 348/350
1600/1600 [==============================] - 0s 189us/step - loss: 0.4401 - accuracy: 0.8194
Epoch 349/350
1600/1600 [==============================] - 0s 201us/step - loss: 0.4155 - accuracy: 0.8281
Epoch 350/350
1600/1600 [==============================] - 0s 203us/step - loss: 0.4096 - accuracy: 0.8294
```

Out[38]:

```
<keras.callbacks.callbacks.History at 0x20b398d6848>
```

In [39]:

```python
accuracy = model.evaluate(X_train, Y_train)
print('Accuracy: %.2f' % (accuracy[1]*100))
```

```
1600/1600 [==============================] - 0s 58us/step
Accuracy: 87.00
```

In [40]:

```python
print(model.summary())
```

```
Model: "sequential_5"
_____
Layer (type)                 Output Shape              Param #
```

```
Layer (type)                Output Shape            Param #
=================================================================
dense_17 (Dense)            (None, 40)              120
_____
dense_18 (Dense)            (None, 30)              1230
_____
dense_19 (Dense)            (None, 25)              775
_____
dense_20 (Dense)            (None, 20)              520
=================================================================
Total params: 2,645
Trainable params: 2,645
Non-trainable params: 0
_____
None
```

In [41]:

```python
accuracy = model.evaluate(X_test, Y_test)
print('Accuracy: %.2f' % (accuracy[1]*100))
```

```
400/400 [==============================] - 0s 33us/step
Accuracy: 86.50
```

In [ ]:

In [ ]:

In [ ]: