ann-classification

July 20, 2023

Welcome to Colab!

If you're already familiar with Colab, check out this video to learn about interactive tables, the executed code history view, and the command palette.

What is Colab?

Colab, or "Colaboratory", allows you to write and execute Python in your browser, with - Zero configuration required - Access to GPUs free of charge - Easy sharing

Whether you're a **student**, a **data scientist** or an **AI researcher**, Colab can make your work easier. Watch Introduction to Colab to learn more, or just get started below!

0.1 Getting started

The document you are reading is not a static web page, but an interactive environment called a **Colab notebook** that lets you write and execute code.

For example, here is a **code cell** with a short Python script that computes a value, stores it in a variable, and prints the result:

[ ]:
```
seconds_in_a_day = 24 * 60 * 60
seconds_in_a_day
```

[ ]:
```
86400
```

To execute the code in the above cell, select it with a click and then either press the play button to the left of the code, or use the keyboard shortcut "Command/Ctrl+Enter". To edit the code, just click the cell and start editing.

Variables that you define in one cell can later be used in other cells:

[ ]:
```
seconds_in_a_week = 7 * seconds_in_a_day
seconds_in_a_week
```

[ ]:
```
604800
```

Colab notebooks allow you to combine **executable code** and **rich text** in a single document, along with **images**, **HTML**, **LaTeX** and more. When you create your own Colab notebooks, they are stored in your Google Drive account. You can easily share your Colab notebooks with co-workers or friends, allowing them to comment on your notebooks or even edit them. To learn more, see Overview of Colab. To create a new Colab notebook you can use the File menu above, or use the following link: create a new Colab notebook.

Colab notebooks are Jupyter notebooks that are hosted by Colab. To learn more about the Jupyter project, see jupyter.org.

0.2 Data science

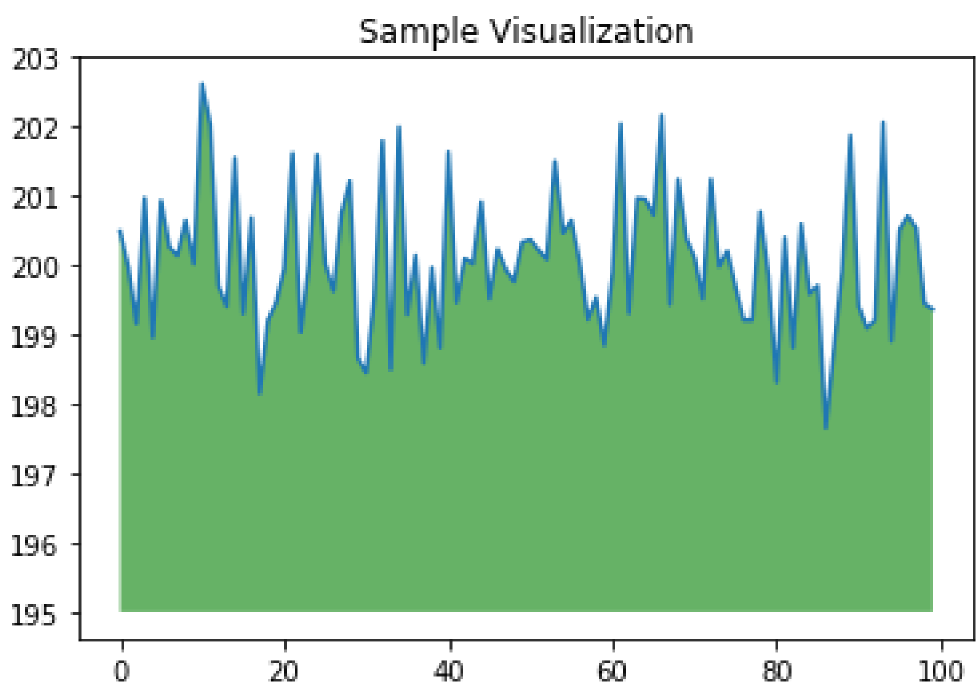
With Colab you can harness the full power of popular Python libraries to analyze and visualize data. The code cell below uses **numpy** to generate some random data, and uses **matplotlib** to visualize it. To edit the code, just click the cell and start editing.

[ ]:
```
import numpy as np
from matplotlib import pyplot as plt

ys = 200 + np.random.randn(100)
x = [x for x in range(len(ys))]

plt.plot(x, ys, '-')
plt.fill_between(x, ys, 195, where=(ys > 195), facecolor='g', alpha=0.6)

plt.title("Sample Visualization")
plt.show()
```



You can import your own data into Colab notebooks from your Google Drive account, including from spreadsheets, as well as from Github and many other sources. To learn more about importing data, and how Colab can be used for data science, see the links below under Working with Data.

0.3 Machine learning

With Colab you can import an image dataset, train an image classifier on it, and evaluate the model, all in just a few lines of code. Colab notebooks execute code on Google's cloud servers, meaning you can leverage the power of Google hardware, including GPUs and TPUs, regardless of the power of your machine. All you need is a browser.

Colab is used extensively in the machine learning community with applications including: - Getting started with TensorFlow - Developing and training neural networks - Experimenting with TPUs - Disseminating AI research - Creating tutorials

To see sample Colab notebooks that demonstrate machine learning applications, see the machine learning examples below.

0.4 More Resources

0.4.1 Working with Notebooks in Colab

- Overview of Colaboratory
- Guide to Markdown
- Importing libraries and installing dependencies
- Saving and loading notebooks in GitHub
- Interactive forms
- Interactive widgets
-

Working with Data

- Loading data: Drive, Sheets, and Google Cloud Storage
- Charts: visualizing data
- Getting started with BigQuery

0.4.2 Machine Learning Crash Course

These are a few of the notebooks from Google's online Machine Learning course. See the full course website for more. - Intro to Pandas DataFrame - Linear regression with tf.keras using synthetic data

Using Accelerated Hardware

- TensorFlow with GPUs
- TensorFlow with TPUs

0.4.3 Featured examples

- NeMo Voice Swap: Use Nvidia's NeMo conversational AI Toolkit to swap a voice in an audio fragment with a computer generated one.

- Retraining an Image Classifier: Build a Keras model on top of a pre-trained image classifier to distinguish flowers.

- Text Classification: Classify IMDB movie reviews as either *positive* or *negative*.
- Style Transfer: Use deep learning to transfer style between images.
- Multilingual Universal Sentence Encoder Q&A: Use a machine learning model to answer questions from the SQuAD dataset.
- Video Interpolation: Predict what happened in a video between the first and the last frame.

[3]:
```
import tensorflow as tf
import pandas as pd
import numpy as np


df=pd.read_csv('/content/Churn_Modelling.csv')
df.head()
```

[3]:
```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age  \
0          1    15634602  Hargrave          619    France  Female   42
1          2    15647311      Hill          608     Spain  Female   41
2          3    15619304      Onio          502    France  Female   42
3          4    15701354      Boni          699    France  Female   39
4          5    15737888  Mitchell          850     Spain  Female   43

   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
```

[31]:
```
df['Geography'].value_counts()
```

[31]:
```
France     5014
Germany    2509
Spain      2477
Name: Geography, dtype: int64
```

[4]:
```
tf.__version__
```

[4]:
```
'2.12.0'
```

[9]:
```
X=df.iloc[:,3:-1].values
Y=df.iloc[:,-1].values
```

[10]:
```
print(X)
```

```
[[619 'France' 'Female' … 1 1 101348.88]
 [608 'Spain' 'Female' … 0 1 112542.58]
 [502 'France' 'Female' … 1 0 113931.57]
 …
 [709 'France' 'Female' … 0 1 42085.58]
 [772 'Germany' 'Male' … 1 0 92888.52]
 [792 'France' 'Female' … 1 0 38190.78]]
```

[11]:
```
print(Y)
```

```
[1 0 1 … 1 1 0]
```

[12]:
```
from sklearn.preprocessing import LabelEncoder

le=LabelEncoder()

X[:,2]=le.fit_transform(X[:,2])
```

[13]:
```
print(X)
```

```
[[619 'France' 0 … 1 1 101348.88]
 [608 'Spain' 0 … 0 1 112542.58]
 [502 'France' 0 … 1 0 113931.57]
 …
 [709 'France' 0 … 0 1 42085.58]
 [772 'Germany' 1 … 1 0 92888.52]
 [792 'France' 0 … 1 0 38190.78]]
```

[14]:
```
from sklearn.compose import ColumnTransformer
from sklearn.preprocessing import OneHotEncoder

ct=ColumnTransformer(transformers=[('encoder',OneHotEncoder(),[1])],remainder='passthrough')
X=np.array(ct.fit_transform(X))
print(X)
```

```
[[1.0 0.0 0.0 … 1 1 101348.88]
 [0.0 0.0 1.0 … 0 1 112542.58]
 [1.0 0.0 0.0 … 1 0 113931.57]
 …
 [1.0 0.0 0.0 … 0 1 42085.58]
 [0.0 1.0 0.0 … 1 0 92888.52]
 [1.0 0.0 0.0 … 1 0 38190.78]]
```

[16]:
```python
from sklearn.model_selection import train_test_split

X_train,X_test,Y_train,Y_test=train_test_split(X,Y,test_size=0.20)
```

[17]:
```python
print(X_train)
```

```
[[0.0 0.0 1.0 … 0 0 197602.29]
 [0.0 0.0 1.0 … 1 0 109659.12]
 [1.0 0.0 0.0 … 0 0 30781.77]
 …
 [1.0 0.0 0.0 … 0 1 88815.25]
 [1.0 0.0 0.0 … 1 1 65998.26]
 [1.0 0.0 0.0 … 0 1 91981.85]]
```

[18]:
```python
print(X_test)
```

```
[[0.0 1.0 0.0 … 0 0 127095.14]
 [1.0 0.0 0.0 … 1 0 158049.9]
 [0.0 0.0 1.0 … 1 1 186841.71]
 …
 [1.0 0.0 0.0 … 1 1 159044.1]
 [0.0 1.0 0.0 … 0 0 27345.18]
 [1.0 0.0 0.0 … 1 1 169915.02]]
```

[19]:
```python
print(Y_train)
```

```
[0 0 0 … 0 0 1]
```

[20]:
```python
print(Y_test)
```

```
[0 0 0 … 0 1 0]
```

[21]:
```python
from sklearn.preprocessing import StandardScaler
sc=StandardScaler()

X_train=sc.fit_transform(X_train)
X_test=sc.transform(X_test)
```

[22]:
```python
X_train
```

[22]:
```
array([[-0.99700449, -0.57965968,  1.73205081, …, -1.5547807 ,
        -1.02148066,  1.68810678],
       [-0.99700449, -0.57965968,  1.73205081, …,  0.64317752,
        -1.02148066,  0.16015636],
       [ 1.00300451, -0.57965968, -0.57735027, …, -1.5547807 ,
        -1.02148066, -1.21028185],
       …,
       [ 1.00300451, -0.57965968, -0.57735027, …, -1.5547807 ,
```

```
          0.97897106, -0.20199115],
        [ 1.00300451, -0.57965968, -0.57735027, …,  0.64317752,
          0.97897106, -0.59842022],
        [ 1.00300451, -0.57965968, -0.57735027, …, -1.5547807 ,
          0.97897106, -0.14697371]])
```

[23]:
```
X_test
```

[23]:
```
array([[-0.99700449,  1.72515018, -0.57735027, …, -1.5547807 ,
         -1.02148066,  0.46309488],
        [ 1.00300451, -0.57965968, -0.57735027, …,  0.64317752,
         -1.02148066,  1.00091196],
        [-0.99700449, -0.57965968,  1.73205081, …,  0.64317752,
          0.97897106,  1.50114931],
        …,
        [ 1.00300451, -0.57965968, -0.57735027, …,  0.64317752,
          0.97897106,  1.01818548],
        [-0.99700449,  1.72515018, -0.57735027, …, -1.5547807 ,
         -1.02148066, -1.26999017],
        [ 1.00300451, -0.57965968, -0.57735027, …,  0.64317752,
          0.97897106,  1.20706003]])
```

[24]:
```
#Building the ANN


ann=tf.keras.models.Sequential()
```

[25]:
```
#Adding the input layer and the first hidden layer

ann.add(tf.keras.layers.Dense(units=6,activation='relu'))
```

[27]:
```
#Adding the second hidden layer
ann.add(tf.keras.layers.Dense(units=6,activation='relu'))
```

[28]:
```
#Adding the output layer
ann.add(tf.keras.layers.Dense(units=1,activation='sigmoid'))
```

[29]:
```
#Trainig the ann
ann.compile(optimizer='adam',loss='binary_crossentropy',metrics=['accuracy'])
```

[40]:
```
#Compliling the ann

ann.fit(X_train,Y_train,batch_size=32,epochs=500)
```

```
Epoch 1/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3307 -
accuracy: 0.8644
```

```
Epoch 2/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3308 -
accuracy: 0.8625
Epoch 3/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3304 -
accuracy: 0.8610
Epoch 4/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3305 -
accuracy: 0.8641
Epoch 5/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3295 -
accuracy: 0.8641
Epoch 6/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3312 -
accuracy: 0.8635
Epoch 7/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3302 -
accuracy: 0.8641
Epoch 8/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3308 -
accuracy: 0.8636
Epoch 9/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3299 -
accuracy: 0.8646
Epoch 10/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3298 -
accuracy: 0.8648
Epoch 11/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3305 -
accuracy: 0.8635
Epoch 12/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3303 -
accuracy: 0.8644
Epoch 13/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3303 -
accuracy: 0.8626
Epoch 14/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3300 -
accuracy: 0.8644
Epoch 15/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3296 -
accuracy: 0.8635
Epoch 16/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3300 -
accuracy: 0.8627
Epoch 17/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3302 -
accuracy: 0.8626
```

```
Epoch 18/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3301 -
accuracy: 0.8643
Epoch 19/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3304 -
accuracy: 0.8640
Epoch 20/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3296 -
accuracy: 0.8634
Epoch 21/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3296 -
accuracy: 0.8639
Epoch 22/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3296 -
accuracy: 0.8637
Epoch 23/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3290 -
accuracy: 0.8656
Epoch 24/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3292 -
accuracy: 0.8625
Epoch 25/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3288 -
accuracy: 0.8631
Epoch 26/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3294 -
accuracy: 0.8636
Epoch 27/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3298 -
accuracy: 0.8640
Epoch 28/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3297 -
accuracy: 0.8619
Epoch 29/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3286 -
accuracy: 0.8651
Epoch 30/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3286 -
accuracy: 0.8645
Epoch 31/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3288 -
accuracy: 0.8635
Epoch 32/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3290 -
accuracy: 0.8639
Epoch 33/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3291 -
accuracy: 0.8627
```

```
Epoch 34/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3291 -
accuracy: 0.8633
Epoch 35/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3287 -
accuracy: 0.8648
Epoch 36/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3288 -
accuracy: 0.8624
Epoch 37/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3288 -
accuracy: 0.8656
Epoch 38/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3284 -
accuracy: 0.8640
Epoch 39/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3288 -
accuracy: 0.8645
Epoch 40/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3281 -
accuracy: 0.8645
Epoch 41/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3289 -
accuracy: 0.8627
Epoch 42/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3283 -
accuracy: 0.8615
Epoch 43/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3286 -
accuracy: 0.8641
Epoch 44/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3280 -
accuracy: 0.8629
Epoch 45/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3287 -
accuracy: 0.8650
Epoch 46/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3279 -
accuracy: 0.8654
Epoch 47/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3277 -
accuracy: 0.8650
Epoch 48/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3286 -
accuracy: 0.8645
Epoch 49/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3278 -
accuracy: 0.8650
```

```
Epoch 50/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3280 -
accuracy: 0.8626
Epoch 51/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3288 -
accuracy: 0.8627
Epoch 52/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3280 -
accuracy: 0.8654
Epoch 53/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3278 -
accuracy: 0.8652
Epoch 54/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3279 -
accuracy: 0.8635
Epoch 55/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3276 -
accuracy: 0.8646
Epoch 56/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3281 -
accuracy: 0.8649
Epoch 57/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3282 -
accuracy: 0.8654
Epoch 58/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3277 -
accuracy: 0.8629
Epoch 59/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3270 -
accuracy: 0.8645
Epoch 60/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3269 -
accuracy: 0.8630
Epoch 61/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3280 -
accuracy: 0.8641
Epoch 62/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3277 -
accuracy: 0.8646
Epoch 63/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3273 -
accuracy: 0.8639
Epoch 64/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3277 -
accuracy: 0.8648
Epoch 65/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3273 -
accuracy: 0.8656
```

```
Epoch 66/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3273 -
accuracy: 0.8670
Epoch 67/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3271 -
accuracy: 0.8640
Epoch 68/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3278 -
accuracy: 0.8668
Epoch 69/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3270 -
accuracy: 0.8646
Epoch 70/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3272 -
accuracy: 0.8654
Epoch 71/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3277 -
accuracy: 0.8648
Epoch 72/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3269 -
accuracy: 0.8651
Epoch 73/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3275 -
accuracy: 0.8648
Epoch 74/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3265 -
accuracy: 0.8673
Epoch 75/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3266 -
accuracy: 0.8660
Epoch 76/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3277 -
accuracy: 0.8641
Epoch 77/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3273 -
accuracy: 0.8634
Epoch 78/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3276 -
accuracy: 0.8625
Epoch 79/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3278 -
accuracy: 0.8626
Epoch 80/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3271 -
accuracy: 0.8641
Epoch 81/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3267 -
accuracy: 0.8652
```

```
Epoch 82/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3270 -
accuracy: 0.8645
Epoch 83/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3269 -
accuracy: 0.8664
Epoch 84/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3273 -
accuracy: 0.8630
Epoch 85/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3262 -
accuracy: 0.8661
Epoch 86/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3273 -
accuracy: 0.8646
Epoch 87/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3273 -
accuracy: 0.8633
Epoch 88/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3261 -
accuracy: 0.8662
Epoch 89/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3271 -
accuracy: 0.8620
Epoch 90/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3265 -
accuracy: 0.8677
Epoch 91/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3264 -
accuracy: 0.8652
Epoch 92/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3261 -
accuracy: 0.8660
Epoch 93/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3269 -
accuracy: 0.8650
Epoch 94/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3265 -
accuracy: 0.8654
Epoch 95/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3265 -
accuracy: 0.8641
Epoch 96/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3268 -
accuracy: 0.8656
Epoch 97/500
250/250 [==============================] - 2s 6ms/step - loss: 0.3262 -
accuracy: 0.8681
```

```
Epoch 98/500
250/250 [==============================] - 1s 5ms/step - loss: 0.3268 -
accuracy: 0.8644
Epoch 99/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3266 -
accuracy: 0.8658
Epoch 100/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3262 -
accuracy: 0.8658
Epoch 101/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3262 -
accuracy: 0.8671
Epoch 102/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3259 -
accuracy: 0.8666
Epoch 103/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3261 -
accuracy: 0.8660
Epoch 104/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3260 -
accuracy: 0.8659
Epoch 105/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3264 -
accuracy: 0.8664
Epoch 106/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3265 -
accuracy: 0.8654
Epoch 107/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3265 -
accuracy: 0.8645
Epoch 108/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3265 -
accuracy: 0.8643
Epoch 109/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3262 -
accuracy: 0.8665
Epoch 110/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3265 -
accuracy: 0.8670
Epoch 111/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3261 -
accuracy: 0.8652
Epoch 112/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3259 -
accuracy: 0.8648
Epoch 113/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3258 -
accuracy: 0.8669
```

```
Epoch 114/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3261 -
accuracy: 0.8649
Epoch 115/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3263 -
accuracy: 0.8666
Epoch 116/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3254 -
accuracy: 0.8677
Epoch 117/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3267 -
accuracy: 0.8644
Epoch 118/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3255 -
accuracy: 0.8690
Epoch 119/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3267 -
accuracy: 0.8665
Epoch 120/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3258 -
accuracy: 0.8655
Epoch 121/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3252 -
accuracy: 0.8669
Epoch 122/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3259 -
accuracy: 0.8662
Epoch 123/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3253 -
accuracy: 0.8648
Epoch 124/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3257 -
accuracy: 0.8651
Epoch 125/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3258 -
accuracy: 0.8660
Epoch 126/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3258 -
accuracy: 0.8659
Epoch 127/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3259 -
accuracy: 0.8640
Epoch 128/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3250 -
accuracy: 0.8685
Epoch 129/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3254 -
accuracy: 0.8655
```

```
Epoch 130/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3254 -
accuracy: 0.8661
Epoch 131/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3258 -
accuracy: 0.8652
Epoch 132/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3257 -
accuracy: 0.8668
Epoch 133/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3256 -
accuracy: 0.8662
Epoch 134/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3255 -
accuracy: 0.8669
Epoch 135/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3249 -
accuracy: 0.8654
Epoch 136/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3257 -
accuracy: 0.8661
Epoch 137/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3249 -
accuracy: 0.8650
Epoch 138/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3252 -
accuracy: 0.8666
Epoch 139/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3251 -
accuracy: 0.8665
Epoch 140/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3261 -
accuracy: 0.8659
Epoch 141/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3256 -
accuracy: 0.8652
Epoch 142/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3256 -
accuracy: 0.8669
Epoch 143/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3255 -
accuracy: 0.8660
Epoch 144/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3253 -
accuracy: 0.8677
Epoch 145/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3251 -
accuracy: 0.8670
```

```
Epoch 146/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3250 -
accuracy: 0.8673
Epoch 147/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3252 -
accuracy: 0.8676
Epoch 148/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3260 -
accuracy: 0.8670
Epoch 149/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3245 -
accuracy: 0.8684
Epoch 150/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3241 -
accuracy: 0.8677
Epoch 151/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8686
Epoch 152/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3248 -
accuracy: 0.8675
Epoch 153/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3253 -
accuracy: 0.8652
Epoch 154/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3253 -
accuracy: 0.8669
Epoch 155/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3255 -
accuracy: 0.8666
Epoch 156/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3245 -
accuracy: 0.8662
Epoch 157/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3254 -
accuracy: 0.8670
Epoch 158/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3246 -
accuracy: 0.8681
Epoch 159/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3251 -
accuracy: 0.8656
Epoch 160/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3244 -
accuracy: 0.8668
Epoch 161/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3252 -
accuracy: 0.8684
```

```
Epoch 162/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8675
Epoch 163/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3252 -
accuracy: 0.8662
Epoch 164/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8650
Epoch 165/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3251 -
accuracy: 0.8671
Epoch 166/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3247 -
accuracy: 0.8661
Epoch 167/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3251 -
accuracy: 0.8670
Epoch 168/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3246 -
accuracy: 0.8669
Epoch 169/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3250 -
accuracy: 0.8671
Epoch 170/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3238 -
accuracy: 0.8685
Epoch 171/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3254 -
accuracy: 0.8668
Epoch 172/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8673
Epoch 173/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3249 -
accuracy: 0.8669
Epoch 174/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3246 -
accuracy: 0.8691
Epoch 175/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8659
Epoch 176/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3247 -
accuracy: 0.8662
Epoch 177/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3245 -
accuracy: 0.8675
```

```
Epoch 178/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8684
Epoch 179/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3239 -
accuracy: 0.8655
Epoch 180/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3248 -
accuracy: 0.8684
Epoch 181/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3247 -
accuracy: 0.8668
Epoch 182/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3242 -
accuracy: 0.8666
Epoch 183/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3244 -
accuracy: 0.8654
Epoch 184/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3235 -
accuracy: 0.8664
Epoch 185/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8679
Epoch 186/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3251 -
accuracy: 0.8662
Epoch 187/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3245 -
accuracy: 0.8670
Epoch 188/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8686
Epoch 189/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3245 -
accuracy: 0.8686
Epoch 190/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3250 -
accuracy: 0.8686
Epoch 191/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3242 -
accuracy: 0.8666
Epoch 192/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3245 -
accuracy: 0.8686
Epoch 193/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3249 -
accuracy: 0.8671
```

```
Epoch 194/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8676
Epoch 195/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8687
Epoch 196/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3248 -
accuracy: 0.8673
Epoch 197/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8664
Epoch 198/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8670
Epoch 199/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3242 -
accuracy: 0.8665
Epoch 200/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3241 -
accuracy: 0.8662
Epoch 201/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8664
Epoch 202/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8665
Epoch 203/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3244 -
accuracy: 0.8676
Epoch 204/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3239 -
accuracy: 0.8676
Epoch 205/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3240 -
accuracy: 0.8680
Epoch 206/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3244 -
accuracy: 0.8662
Epoch 207/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3243 -
accuracy: 0.8692
Epoch 208/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3246 -
accuracy: 0.8685
Epoch 209/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8702
```

```
Epoch 210/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8675
Epoch 211/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3244 -
accuracy: 0.8690
Epoch 212/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3242 -
accuracy: 0.8675
Epoch 213/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3246 -
accuracy: 0.8686
Epoch 214/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3242 -
accuracy: 0.8679
Epoch 215/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8675
Epoch 216/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8676
Epoch 217/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8664
Epoch 218/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8681
Epoch 219/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3231 -
accuracy: 0.8676
Epoch 220/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3248 -
accuracy: 0.8668
Epoch 221/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8676
Epoch 222/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8666
Epoch 223/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8671
Epoch 224/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8692
Epoch 225/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3242 -
accuracy: 0.8671
```

```
Epoch 226/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8664
Epoch 227/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8669
Epoch 228/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3238 -
accuracy: 0.8674
Epoch 229/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3237 -
accuracy: 0.8679
Epoch 230/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3238 -
accuracy: 0.8690
Epoch 231/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3237 -
accuracy: 0.8665
Epoch 232/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3239 -
accuracy: 0.8673
Epoch 233/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8679
Epoch 234/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8662
Epoch 235/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8677
Epoch 236/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8665
Epoch 237/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8690
Epoch 238/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8691
Epoch 239/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8674
Epoch 240/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8665
Epoch 241/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8680
```

```
Epoch 242/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3240 -
accuracy: 0.8689
Epoch 243/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8683
Epoch 244/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3241 -
accuracy: 0.8664
Epoch 245/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8691
Epoch 246/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8674
Epoch 247/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8689
Epoch 248/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3236 -
accuracy: 0.8668
Epoch 249/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8691
Epoch 250/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8674
Epoch 251/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3244 -
accuracy: 0.8677
Epoch 252/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3230 -
accuracy: 0.8677
Epoch 253/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3239 -
accuracy: 0.8665
Epoch 254/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3240 -
accuracy: 0.8669
Epoch 255/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3239 -
accuracy: 0.8671
Epoch 256/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8671
Epoch 257/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3241 -
accuracy: 0.8695
```

```
Epoch 258/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3238 -
accuracy: 0.8669
Epoch 259/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8679
Epoch 260/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8686
Epoch 261/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8683
Epoch 262/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3238 -
accuracy: 0.8673
Epoch 263/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8668
Epoch 264/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8676
Epoch 265/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3234 -
accuracy: 0.8668
Epoch 266/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8671
Epoch 267/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3230 -
accuracy: 0.8668
Epoch 268/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3240 -
accuracy: 0.8661
Epoch 269/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3234 -
accuracy: 0.8665
Epoch 270/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8680
Epoch 271/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8679
Epoch 272/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3234 -
accuracy: 0.8684
Epoch 273/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3246 -
accuracy: 0.8652
```

```
Epoch 274/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3237 -
accuracy: 0.8694
Epoch 275/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3236 -
accuracy: 0.8666
Epoch 276/500
250/250 [==============================] - 1s 5ms/step - loss: 0.3237 -
accuracy: 0.8679
Epoch 277/500
250/250 [==============================] - 3s 11ms/step - loss: 0.3238 -
accuracy: 0.8692
Epoch 278/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3233 -
accuracy: 0.8683
Epoch 279/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8673
Epoch 280/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3238 -
accuracy: 0.8675
Epoch 281/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8685
Epoch 282/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3237 -
accuracy: 0.8669
Epoch 283/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8671
Epoch 284/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8679
Epoch 285/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3237 -
accuracy: 0.8679
Epoch 286/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8671
Epoch 287/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8683
Epoch 288/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3247 -
accuracy: 0.8671
Epoch 289/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8674
```

```
Epoch 290/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3234 -
accuracy: 0.8675
Epoch 291/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3238 -
accuracy: 0.8674
Epoch 292/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3227 -
accuracy: 0.8665
Epoch 293/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3236 -
accuracy: 0.8680
Epoch 294/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8665
Epoch 295/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3239 -
accuracy: 0.8690
Epoch 296/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3248 -
accuracy: 0.8675
Epoch 297/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3237 -
accuracy: 0.8683
Epoch 298/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8686
Epoch 299/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3235 -
accuracy: 0.8658
Epoch 300/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3241 -
accuracy: 0.8674
Epoch 301/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8676
Epoch 302/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8675
Epoch 303/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8685
Epoch 304/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8668
Epoch 305/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3227 -
accuracy: 0.8671
```

```
Epoch 306/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8689
Epoch 307/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8677
Epoch 308/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8676
Epoch 309/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8679
Epoch 310/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3237 -
accuracy: 0.8679
Epoch 311/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3235 -
accuracy: 0.8680
Epoch 312/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3231 -
accuracy: 0.8676
Epoch 313/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3242 -
accuracy: 0.8671
Epoch 314/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3230 -
accuracy: 0.8687
Epoch 315/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8689
Epoch 316/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8686
Epoch 317/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8677
Epoch 318/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8673
Epoch 319/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3233 -
accuracy: 0.8680
Epoch 320/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3239 -
accuracy: 0.8679
Epoch 321/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3231 -
accuracy: 0.8676
```

```
Epoch 322/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3236 -
accuracy: 0.8690
Epoch 323/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8705
Epoch 324/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3241 -
accuracy: 0.8681
Epoch 325/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8677
Epoch 326/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8673
Epoch 327/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8692
Epoch 328/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8702
Epoch 329/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8687
Epoch 330/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8681
Epoch 331/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8689
Epoch 332/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8670
Epoch 333/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3240 -
accuracy: 0.8661
Epoch 334/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8665
Epoch 335/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8676
Epoch 336/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8675
Epoch 337/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3235 -
accuracy: 0.8696
```

```
Epoch 338/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8674
Epoch 339/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8673
Epoch 340/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8677
Epoch 341/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3228 -
accuracy: 0.8670
Epoch 342/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3230 -
accuracy: 0.8687
Epoch 343/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3236 -
accuracy: 0.8666
Epoch 344/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3235 -
accuracy: 0.8674
Epoch 345/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3230 -
accuracy: 0.8679
Epoch 346/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8666
Epoch 347/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8656
Epoch 348/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8691
Epoch 349/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8677
Epoch 350/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8684
Epoch 351/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3236 -
accuracy: 0.8685
Epoch 352/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3230 -
accuracy: 0.8684
Epoch 353/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3229 -
accuracy: 0.8679
```

```
Epoch 354/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8674
Epoch 355/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8671
Epoch 356/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3240 -
accuracy: 0.8671
Epoch 357/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8660
Epoch 358/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8656
Epoch 359/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8665
Epoch 360/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8677
Epoch 361/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8687
Epoch 362/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3224 -
accuracy: 0.8669
Epoch 363/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3243 -
accuracy: 0.8686
Epoch 364/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8676
Epoch 365/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3235 -
accuracy: 0.8674
Epoch 366/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3238 -
accuracy: 0.8664
Epoch 367/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3233 -
accuracy: 0.8669
Epoch 368/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3234 -
accuracy: 0.8684
Epoch 369/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8690
```

```
Epoch 370/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3241 -
accuracy: 0.8652
Epoch 371/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3231 -
accuracy: 0.8676
Epoch 372/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3228 -
accuracy: 0.8698
Epoch 373/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8684
Epoch 374/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3231 -
accuracy: 0.8669
Epoch 375/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3229 -
accuracy: 0.8649
Epoch 376/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8686
Epoch 377/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3234 -
accuracy: 0.8680
Epoch 378/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8686
Epoch 379/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8692
Epoch 380/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8675
Epoch 381/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3236 -
accuracy: 0.8690
Epoch 382/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8676
Epoch 383/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3236 -
accuracy: 0.8674
Epoch 384/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8666
Epoch 385/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8673
```

```
Epoch 386/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8695
Epoch 387/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8699
Epoch 388/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8687
Epoch 389/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3233 -
accuracy: 0.8677
Epoch 390/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3235 -
accuracy: 0.8686
Epoch 391/500
250/250 [==============================] - 1s 4ms/step - loss: 0.3225 -
accuracy: 0.8687
Epoch 392/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3235 -
accuracy: 0.8675
Epoch 393/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8689
Epoch 394/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8687
Epoch 395/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8681
Epoch 396/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8700
Epoch 397/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3222 -
accuracy: 0.8692
Epoch 398/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8661
Epoch 399/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8690
Epoch 400/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3237 -
accuracy: 0.8684
Epoch 401/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8685
```

```
Epoch 402/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3235 -
accuracy: 0.8676
Epoch 403/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3222 -
accuracy: 0.8680
Epoch 404/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3229 -
accuracy: 0.8685
Epoch 405/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8661
Epoch 406/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3227 -
accuracy: 0.8675
Epoch 407/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3235 -
accuracy: 0.8671
Epoch 408/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3233 -
accuracy: 0.8686
Epoch 409/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8681
Epoch 410/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8668
Epoch 411/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3236 -
accuracy: 0.8660
Epoch 412/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3226 -
accuracy: 0.8686
Epoch 413/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8698
Epoch 414/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3225 -
accuracy: 0.8677
Epoch 415/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3224 -
accuracy: 0.8680
Epoch 416/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3240 -
accuracy: 0.8679
Epoch 417/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8676
```

```
Epoch 418/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8668
Epoch 419/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3228 -
accuracy: 0.8700
Epoch 420/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8692
Epoch 421/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8681
Epoch 422/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8673
Epoch 423/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3233 -
accuracy: 0.8681
Epoch 424/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8679
Epoch 425/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3238 -
accuracy: 0.8669
Epoch 426/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8696
Epoch 427/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3243 -
accuracy: 0.8669
Epoch 428/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3225 -
accuracy: 0.8679
Epoch 429/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8673
Epoch 430/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8695
Epoch 431/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8673
Epoch 432/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3224 -
accuracy: 0.8681
Epoch 433/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3226 -
accuracy: 0.8680
```

```
Epoch 434/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8666
Epoch 435/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3218 -
accuracy: 0.8685
Epoch 436/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3237 -
accuracy: 0.8687
Epoch 437/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3232 -
accuracy: 0.8679
Epoch 438/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8686
Epoch 439/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8700
Epoch 440/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8676
Epoch 441/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8662
Epoch 442/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8674
Epoch 443/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8686
Epoch 444/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8696
Epoch 445/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3224 -
accuracy: 0.8674
Epoch 446/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3239 -
accuracy: 0.8666
Epoch 447/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3227 -
accuracy: 0.8666
Epoch 448/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3221 -
accuracy: 0.8671
Epoch 449/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8683
```

```
Epoch 450/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3225 -
accuracy: 0.8692
Epoch 451/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8680
Epoch 452/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3225 -
accuracy: 0.8681
Epoch 453/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8675
Epoch 454/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3225 -
accuracy: 0.8683
Epoch 455/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3227 -
accuracy: 0.8676
Epoch 456/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3237 -
accuracy: 0.8677
Epoch 457/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8679
Epoch 458/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3229 -
accuracy: 0.8658
Epoch 459/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3230 -
accuracy: 0.8687
Epoch 460/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3223 -
accuracy: 0.8691
Epoch 461/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8680
Epoch 462/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8689
Epoch 463/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8683
Epoch 464/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8664
Epoch 465/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8685
```

```
Epoch 466/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8679
Epoch 467/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3223 -
accuracy: 0.8670
Epoch 468/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8680
Epoch 469/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3224 -
accuracy: 0.8675
Epoch 470/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8669
Epoch 471/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3225 -
accuracy: 0.8684
Epoch 472/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3228 -
accuracy: 0.8687
Epoch 473/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8684
Epoch 474/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8676
Epoch 475/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3225 -
accuracy: 0.8669
Epoch 476/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3224 -
accuracy: 0.8675
Epoch 477/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3224 -
accuracy: 0.8668
Epoch 478/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3234 -
accuracy: 0.8694
Epoch 479/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3232 -
accuracy: 0.8687
Epoch 480/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3230 -
accuracy: 0.8681
Epoch 481/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3234 -
accuracy: 0.8676
```

```
Epoch 482/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3233 -
accuracy: 0.8686
Epoch 483/500
250/250 [==============================] - 1s 3ms/step - loss: 0.3227 -
accuracy: 0.8683
Epoch 484/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3227 -
accuracy: 0.8687
Epoch 485/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3224 -
accuracy: 0.8679
Epoch 486/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3219 -
accuracy: 0.8686
Epoch 487/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3229 -
accuracy: 0.8664
Epoch 488/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3230 -
accuracy: 0.8685
Epoch 489/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8686
Epoch 490/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3231 -
accuracy: 0.8685
Epoch 491/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3229 -
accuracy: 0.8674
Epoch 492/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3226 -
accuracy: 0.8671
Epoch 493/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3232 -
accuracy: 0.8665
Epoch 494/500
250/250 [==============================] - 0s 2ms/step - loss: 0.3225 -
accuracy: 0.8679
Epoch 495/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8690
Epoch 496/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3221 -
accuracy: 0.8675
Epoch 497/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3232 -
accuracy: 0.8671
```

```
Epoch 498/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3224 -
accuracy: 0.8679
Epoch 499/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3222 -
accuracy: 0.8690
Epoch 500/500
250/250 [==============================] - 1s 2ms/step - loss: 0.3223 -
accuracy: 0.8681
```

[40]:
```
<keras.callbacks.History at 0x7e24ec2819c0>
```

[41]:
```
print(ann.predict(sc.transform([[1,0,0,600,1,40,3,60000,2,1,1,50000]]))>0.5)
```

```
1/1 [==============================] - 0s 23ms/step
[[False]]
```

[44]:
```
y_pred=ann.predict(X_test)
y_pred=(y_pred>0.5)

print(np.concatenate((y_pred.reshape(len(y_pred),1), Y_test.
↪reshape(len(Y_test),1)),1))
```

```
63/63 [==============================] - 0s 1ms/step
[[0 0]
 [0 0]
 [0 0]
 …
 [0 0]
 [0 1]
 [0 0]]
```

[45]:
```
from sklearn.metrics import confusion_matrix,accuracy_score

cm=confusion_matrix(Y_test,y_pred)
print(cm)
accuracy_score(Y_test,y_pred)
```

```
[[1540   49]
 [ 230  181]]
```

[45]:
```
0.8605
```

[ ]:
```
```