Hands_on_Activity_6_2_Training_Neural_Networks_DONE

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Technological Institute of the Philippines	Quezon City - Computer Engineering
Course Code:	CPE 019
Code Title:	Emerging Technologies in CpE 2 - Fundamentals of Computer Vision
2nd Semester	AY 2023-2024

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ACTIVITY NO. | **Hands-on Activity 6.2 - Training Neural Networks Name** | Dela Cruz, Irish **Section** | CPE32S3 **Date Performed**: | 03/27/2024 **Date Submitted**: | 04/01/2024 **Instructor**: | Engr. Roman M. Richard

Objective(s): This activity aims to demonstrate how to train neural networks using keras

Intended Learning Outcomes (ILOs):

- Demonstrate how to build and train neural networks
- Demonstrate how to evaluate and plot the model using training and validation loss

Resources:

- Jupyter Notebook

CI Pima Diabetes Dataset

- pima-indians-diabetes.csv

Procedures Load the necessary libraries

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import confusion_matrix, precision_recall_curve,␣
↪roc_auc_score, roc_curve, accuracy_score
from sklearn.ensemble import RandomForestClassifier
```

```
import seaborn as sns

%matplotlib inline
```

[ ]:
```
## Import Keras objects for Deep Learning

from keras.models  import Sequential
from keras.layers import Input, Dense, Flatten, Dropout, BatchNormalization
from keras.optimizers import Adam, SGD, RMSprop
```

Load the dataset

[ ]:
```
filepath = "/content/pima-indians-diabetes.csv"
names = ["times_pregnant", "glucose_tolerance_test", "blood_pressure",␣
 ↪"skin_thickness", "insulin",
        "bmi", "pedigree_function", "age", "has_diabetes"]
diabetes_df = pd.read_csv(filepath, names=names)
```

Check the top 5 samples of the data

[ ]:
```
print(diabetes_df.shape)
diabetes_df.sample(5)
```

```
(768, 9)
```

[ ]:

	times_pregnant	glucose_tolerance_test	blood_pressure	skin_thickness	\
250	9	106	52	0	
300	0	167	0	0	
763	10	101	76	48	
593	2	82	52	22	
269	2	146	0	0	

	insulin	bmi	pedigree_function	age	has_diabetes
250	0	31.2	0.380	42	0
300	0	32.3	0.839	30	1
763	180	32.9	0.171	63	0
593	115	28.5	1.699	25	0
269	0	27.5	0.240	28	1

[ ]:
```
diabetes_df.dtypes
```

[ ]:
```
times_pregnant              int64
glucose_tolerance_test      int64
blood_pressure              int64
skin_thickness              int64
insulin                     int64
bmi                       float64
pedigree_function         float64
```

```
age                          int64
has_diabetes                 int64
dtype: object
```

[ ]:
```
X = diabetes_df.iloc[:, :-1].values
y = diabetes_df["has_diabetes"].values
```

Split the data to Train, and Test (75%, 25%)

[ ]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25,␣
↪random_state=11111)
```

[ ]:
```
np.mean(y), np.mean(1-y)
```

[ ]:
```
(0.3489583333333333, 0.6510416666666666)
```

Build a single hidden layer neural network using 12 nodes. Use the sequential model with single layer network and input shape to 8.

Normalize the data

[ ]:
```
normalizer = StandardScaler()
X_train_norm = normalizer.fit_transform(X_train)
X_test_norm = normalizer.transform(X_test)
```

Define the model: * Input size is 8-dimensional * 1 hidden layer, 12 hidden nodes, sigmoid activation * Final layer with one node and sigmoid activation (standard for binary classification)

[ ]:
```
model  = Sequential([
    Dense(12, input_shape=(8,), activation="relu"),
    Dense(1, activation="sigmoid")
])
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:88:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When
using Sequential models, prefer using an `Input(shape)` object as the first
layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

View the model summary

[ ]:
```
model.summary()
```

```
Model: "sequential"
```

```
 Layer (type)                Output Shape              ␣
↪Param #
```

```
dense (Dense)                        (None, 12)                  ␣
↪108

dense_1 (Dense)                      (None, 1)                   ␣
↪ 13


Total params: 121 (484.00 B)

Trainable params: 121 (484.00 B)

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

0.0.1 Analysis

Total parameters is 121, which includes the trainable and non-trainable. Trainable patterns is same with total no. of parameters which means that 121 there was learnable during training. There's 0 non-trainable which means that there's no parameters there that can't be updated during the training process.

[ ]:
```
diabetes_df.shape
```

[ ]:
```
(768, 9)
```

Train the model * Compile the model with optimizer, loss function and metrics * Use the fit function to return the run history.

[ ]:
```
model.compile(SGD(learning_rate = .003), "binary_crossentropy",␣
 ↪metrics=["accuracy"])
run_hist_1 = model.fit(X_train_norm, y_train, validation_data=(X_test_norm,␣
 ↪y_test), epochs=200)
```

```
Epoch 1/200
18/18             2s 49ms/step -
accuracy: 0.5903 - loss: 0.7118 - val_accuracy: 0.5938 - val_loss: 0.6988
Epoch 2/200
18/18             1s 14ms/step -
accuracy: 0.6114 - loss: 0.6972 - val_accuracy: 0.5938 - val_loss: 0.6915
Epoch 3/200
18/18             0s 16ms/step -
accuracy: 0.6205 - loss: 0.6800 - val_accuracy: 0.5990 - val_loss: 0.6845
Epoch 4/200
18/18             1s 17ms/step -
accuracy: 0.6519 - loss: 0.6488 - val_accuracy: 0.6042 - val_loss: 0.6778
Epoch 5/200
18/18             0s 12ms/step -
```

```
accuracy: 0.5977 - loss: 0.6927 - val_accuracy: 0.6146 - val_loss: 0.6714
Epoch 6/200
18/18             0s 17ms/step -
accuracy: 0.6937 - loss: 0.6285 - val_accuracy: 0.6198 - val_loss: 0.6652
Epoch 7/200
18/18             0s 7ms/step -
accuracy: 0.6259 - loss: 0.6650 - val_accuracy: 0.6198 - val_loss: 0.6593
Epoch 8/200
18/18             0s 8ms/step -
accuracy: 0.6817 - loss: 0.6248 - val_accuracy: 0.6250 - val_loss: 0.6537
Epoch 9/200
18/18             0s 13ms/step -
accuracy: 0.6735 - loss: 0.6330 - val_accuracy: 0.6302 - val_loss: 0.6482
Epoch 10/200
18/18             0s 10ms/step -
accuracy: 0.6559 - loss: 0.6470 - val_accuracy: 0.6354 - val_loss: 0.6431
Epoch 11/200
18/18             0s 6ms/step -
accuracy: 0.6468 - loss: 0.6346 - val_accuracy: 0.6354 - val_loss: 0.6381
Epoch 12/200
18/18             0s 14ms/step -
accuracy: 0.6954 - loss: 0.5969 - val_accuracy: 0.6354 - val_loss: 0.6333
Epoch 13/200
18/18             0s 3ms/step -
accuracy: 0.6521 - loss: 0.6133 - val_accuracy: 0.6406 - val_loss: 0.6287
Epoch 14/200
18/18             0s 3ms/step -
accuracy: 0.6702 - loss: 0.6167 - val_accuracy: 0.6458 - val_loss: 0.6243
Epoch 15/200
18/18             0s 4ms/step -
accuracy: 0.6892 - loss: 0.5995 - val_accuracy: 0.6510 - val_loss: 0.6201
Epoch 16/200
18/18             0s 4ms/step -
accuracy: 0.6880 - loss: 0.5978 - val_accuracy: 0.6510 - val_loss: 0.6161
Epoch 17/200
18/18             0s 4ms/step -
accuracy: 0.6619 - loss: 0.6031 - val_accuracy: 0.6510 - val_loss: 0.6122
Epoch 18/200
18/18             0s 4ms/step -
accuracy: 0.6603 - loss: 0.6015 - val_accuracy: 0.6510 - val_loss: 0.6085
Epoch 19/200
18/18             0s 4ms/step -
accuracy: 0.6834 - loss: 0.5944 - val_accuracy: 0.6562 - val_loss: 0.6049
Epoch 20/200
18/18             0s 4ms/step -
accuracy: 0.6570 - loss: 0.5981 - val_accuracy: 0.6510 - val_loss: 0.6014
Epoch 21/200
18/18             0s 3ms/step -
```

```
accuracy: 0.6816 - loss: 0.5897 - val_accuracy: 0.6510 - val_loss: 0.5981
Epoch 22/200
18/18             0s 5ms/step -
accuracy: 0.6728 - loss: 0.5873 - val_accuracy: 0.6562 - val_loss: 0.5949
Epoch 23/200
18/18             0s 4ms/step -
accuracy: 0.7177 - loss: 0.5624 - val_accuracy: 0.6667 - val_loss: 0.5918
Epoch 24/200
18/18             0s 4ms/step -
accuracy: 0.7033 - loss: 0.5818 - val_accuracy: 0.6667 - val_loss: 0.5888
Epoch 25/200
18/18             0s 4ms/step -
accuracy: 0.7134 - loss: 0.5636 - val_accuracy: 0.6667 - val_loss: 0.5860
Epoch 26/200
18/18             0s 4ms/step -
accuracy: 0.6788 - loss: 0.5828 - val_accuracy: 0.6667 - val_loss: 0.5832
Epoch 27/200
18/18             0s 3ms/step -
accuracy: 0.6819 - loss: 0.5797 - val_accuracy: 0.6615 - val_loss: 0.5806
Epoch 28/200
18/18             0s 4ms/step -
accuracy: 0.6922 - loss: 0.5767 - val_accuracy: 0.6615 - val_loss: 0.5781
Epoch 29/200
18/18             0s 3ms/step -
accuracy: 0.7126 - loss: 0.5725 - val_accuracy: 0.6771 - val_loss: 0.5756
Epoch 30/200
18/18             0s 3ms/step -
accuracy: 0.7169 - loss: 0.5633 - val_accuracy: 0.6823 - val_loss: 0.5732
Epoch 31/200
18/18             0s 5ms/step -
accuracy: 0.7290 - loss: 0.5543 - val_accuracy: 0.6823 - val_loss: 0.5710
Epoch 32/200
18/18             0s 4ms/step -
accuracy: 0.7292 - loss: 0.5577 - val_accuracy: 0.6771 - val_loss: 0.5687
Epoch 33/200
18/18             0s 4ms/step -
accuracy: 0.7127 - loss: 0.5671 - val_accuracy: 0.6771 - val_loss: 0.5666
Epoch 34/200
18/18             0s 4ms/step -
accuracy: 0.7206 - loss: 0.5523 - val_accuracy: 0.6771 - val_loss: 0.5646
Epoch 35/200
18/18             0s 4ms/step -
accuracy: 0.7488 - loss: 0.5225 - val_accuracy: 0.6979 - val_loss: 0.5626
Epoch 36/200
18/18             0s 4ms/step -
accuracy: 0.7534 - loss: 0.5436 - val_accuracy: 0.7031 - val_loss: 0.5606
Epoch 37/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7234 - loss: 0.5509 - val_accuracy: 0.7031 - val_loss: 0.5588
Epoch 38/200
18/18             0s 4ms/step -
accuracy: 0.7315 - loss: 0.5458 - val_accuracy: 0.7083 - val_loss: 0.5570
Epoch 39/200
18/18             0s 4ms/step -
accuracy: 0.7464 - loss: 0.5418 - val_accuracy: 0.7083 - val_loss: 0.5552
Epoch 40/200
18/18             0s 3ms/step -
accuracy: 0.7130 - loss: 0.5543 - val_accuracy: 0.7135 - val_loss: 0.5535
Epoch 41/200
18/18             0s 4ms/step -
accuracy: 0.7295 - loss: 0.5458 - val_accuracy: 0.7135 - val_loss: 0.5518
Epoch 42/200
18/18             0s 4ms/step -
accuracy: 0.7545 - loss: 0.5256 - val_accuracy: 0.7135 - val_loss: 0.5503
Epoch 43/200
18/18             0s 4ms/step -
accuracy: 0.7585 - loss: 0.5272 - val_accuracy: 0.7135 - val_loss: 0.5487
Epoch 44/200
18/18             0s 3ms/step -
accuracy: 0.7516 - loss: 0.5412 - val_accuracy: 0.7135 - val_loss: 0.5472
Epoch 45/200
18/18             0s 4ms/step -
accuracy: 0.7511 - loss: 0.5380 - val_accuracy: 0.7188 - val_loss: 0.5458
Epoch 46/200
18/18             0s 4ms/step -
accuracy: 0.7437 - loss: 0.5483 - val_accuracy: 0.7188 - val_loss: 0.5444
Epoch 47/200
18/18             0s 4ms/step -
accuracy: 0.7576 - loss: 0.5374 - val_accuracy: 0.7292 - val_loss: 0.5430
Epoch 48/200
18/18             0s 4ms/step -
accuracy: 0.7618 - loss: 0.5130 - val_accuracy: 0.7292 - val_loss: 0.5417
Epoch 49/200
18/18             0s 3ms/step -
accuracy: 0.7601 - loss: 0.5305 - val_accuracy: 0.7292 - val_loss: 0.5404
Epoch 50/200
18/18             0s 4ms/step -
accuracy: 0.7893 - loss: 0.5063 - val_accuracy: 0.7292 - val_loss: 0.5392
Epoch 51/200
18/18             0s 4ms/step -
accuracy: 0.7561 - loss: 0.5319 - val_accuracy: 0.7292 - val_loss: 0.5380
Epoch 52/200
18/18             0s 3ms/step -
accuracy: 0.7667 - loss: 0.5318 - val_accuracy: 0.7292 - val_loss: 0.5369
Epoch 53/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7871 - loss: 0.4993 - val_accuracy: 0.7396 - val_loss: 0.5358
Epoch 54/200
18/18             0s 3ms/step -
accuracy: 0.7709 - loss: 0.5191 - val_accuracy: 0.7396 - val_loss: 0.5347
Epoch 55/200
18/18             0s 4ms/step -
accuracy: 0.7828 - loss: 0.5062 - val_accuracy: 0.7396 - val_loss: 0.5336
Epoch 56/200
18/18             0s 4ms/step -
accuracy: 0.7945 - loss: 0.4956 - val_accuracy: 0.7396 - val_loss: 0.5326
Epoch 57/200
18/18             0s 4ms/step -
accuracy: 0.7779 - loss: 0.5146 - val_accuracy: 0.7396 - val_loss: 0.5316
Epoch 58/200
18/18             0s 4ms/step -
accuracy: 0.7674 - loss: 0.5034 - val_accuracy: 0.7396 - val_loss: 0.5307
Epoch 59/200
18/18             0s 3ms/step -
accuracy: 0.7751 - loss: 0.5164 - val_accuracy: 0.7448 - val_loss: 0.5297
Epoch 60/200
18/18             0s 4ms/step -
accuracy: 0.7538 - loss: 0.5112 - val_accuracy: 0.7448 - val_loss: 0.5289
Epoch 61/200
18/18             0s 4ms/step -
accuracy: 0.7501 - loss: 0.5134 - val_accuracy: 0.7448 - val_loss: 0.5280
Epoch 62/200
18/18             0s 3ms/step -
accuracy: 0.7519 - loss: 0.5176 - val_accuracy: 0.7448 - val_loss: 0.5271
Epoch 63/200
18/18             0s 4ms/step -
accuracy: 0.7596 - loss: 0.5083 - val_accuracy: 0.7448 - val_loss: 0.5263
Epoch 64/200
18/18             0s 4ms/step -
accuracy: 0.7589 - loss: 0.5189 - val_accuracy: 0.7448 - val_loss: 0.5255
Epoch 65/200
18/18             0s 3ms/step -
accuracy: 0.7731 - loss: 0.5105 - val_accuracy: 0.7448 - val_loss: 0.5248
Epoch 66/200
18/18             0s 4ms/step -
accuracy: 0.7417 - loss: 0.5195 - val_accuracy: 0.7448 - val_loss: 0.5240
Epoch 67/200
18/18             0s 4ms/step -
accuracy: 0.7438 - loss: 0.5271 - val_accuracy: 0.7448 - val_loss: 0.5233
Epoch 68/200
18/18             0s 7ms/step -
accuracy: 0.7648 - loss: 0.5041 - val_accuracy: 0.7448 - val_loss: 0.5226
Epoch 69/200
18/18             0s 6ms/step -
```

```
accuracy: 0.7725 - loss: 0.5045 - val_accuracy: 0.7448 - val_loss: 0.5219
Epoch 70/200
18/18             0s 6ms/step -
accuracy: 0.7512 - loss: 0.5107 - val_accuracy: 0.7448 - val_loss: 0.5213
Epoch 71/200
18/18             0s 4ms/step -
accuracy: 0.7709 - loss: 0.5063 - val_accuracy: 0.7448 - val_loss: 0.5206
Epoch 72/200
18/18             0s 5ms/step -
accuracy: 0.7507 - loss: 0.5055 - val_accuracy: 0.7448 - val_loss: 0.5200
Epoch 73/200
18/18             0s 5ms/step -
accuracy: 0.7447 - loss: 0.5089 - val_accuracy: 0.7500 - val_loss: 0.5194
Epoch 74/200
18/18             0s 5ms/step -
accuracy: 0.7767 - loss: 0.4930 - val_accuracy: 0.7500 - val_loss: 0.5188
Epoch 75/200
18/18             0s 6ms/step -
accuracy: 0.7662 - loss: 0.5118 - val_accuracy: 0.7500 - val_loss: 0.5182
Epoch 76/200
18/18             0s 5ms/step -
accuracy: 0.7794 - loss: 0.4917 - val_accuracy: 0.7500 - val_loss: 0.5177
Epoch 77/200
18/18             0s 5ms/step -
accuracy: 0.7547 - loss: 0.5106 - val_accuracy: 0.7552 - val_loss: 0.5171
Epoch 78/200
18/18             0s 5ms/step -
accuracy: 0.7961 - loss: 0.4721 - val_accuracy: 0.7552 - val_loss: 0.5166
Epoch 79/200
18/18             0s 5ms/step -
accuracy: 0.7638 - loss: 0.5016 - val_accuracy: 0.7500 - val_loss: 0.5161
Epoch 80/200
18/18             0s 5ms/step -
accuracy: 0.7814 - loss: 0.4819 - val_accuracy: 0.7552 - val_loss: 0.5156
Epoch 81/200
18/18             0s 5ms/step -
accuracy: 0.7806 - loss: 0.4798 - val_accuracy: 0.7552 - val_loss: 0.5151
Epoch 82/200
18/18             0s 5ms/step -
accuracy: 0.7703 - loss: 0.4859 - val_accuracy: 0.7552 - val_loss: 0.5147
Epoch 83/200
18/18             0s 5ms/step -
accuracy: 0.7652 - loss: 0.5152 - val_accuracy: 0.7552 - val_loss: 0.5142
Epoch 84/200
18/18             0s 5ms/step -
accuracy: 0.7618 - loss: 0.5041 - val_accuracy: 0.7604 - val_loss: 0.5138
Epoch 85/200
18/18             0s 3ms/step -
```

```
accuracy: 0.7622 - loss: 0.5012 - val_accuracy: 0.7656 - val_loss: 0.5133
Epoch 86/200
18/18             0s 4ms/step -
accuracy: 0.7474 - loss: 0.5134 - val_accuracy: 0.7656 - val_loss: 0.5129
Epoch 87/200
18/18             0s 4ms/step -
accuracy: 0.7686 - loss: 0.4902 - val_accuracy: 0.7656 - val_loss: 0.5125
Epoch 88/200
18/18             0s 3ms/step -
accuracy: 0.7592 - loss: 0.4982 - val_accuracy: 0.7604 - val_loss: 0.5121
Epoch 89/200
18/18             0s 3ms/step -
accuracy: 0.7753 - loss: 0.4831 - val_accuracy: 0.7604 - val_loss: 0.5117
Epoch 90/200
18/18             0s 3ms/step -
accuracy: 0.7888 - loss: 0.4766 - val_accuracy: 0.7604 - val_loss: 0.5114
Epoch 91/200
18/18             0s 4ms/step -
accuracy: 0.7859 - loss: 0.4793 - val_accuracy: 0.7656 - val_loss: 0.5110
Epoch 92/200
18/18             0s 3ms/step -
accuracy: 0.7449 - loss: 0.5079 - val_accuracy: 0.7656 - val_loss: 0.5106
Epoch 93/200
18/18             0s 3ms/step -
accuracy: 0.7578 - loss: 0.5009 - val_accuracy: 0.7656 - val_loss: 0.5103
Epoch 94/200
18/18             0s 4ms/step -
accuracy: 0.7511 - loss: 0.5031 - val_accuracy: 0.7656 - val_loss: 0.5100
Epoch 95/200
18/18             0s 4ms/step -
accuracy: 0.7706 - loss: 0.4830 - val_accuracy: 0.7604 - val_loss: 0.5096
Epoch 96/200
18/18             0s 4ms/step -
accuracy: 0.7373 - loss: 0.5105 - val_accuracy: 0.7604 - val_loss: 0.5093
Epoch 97/200
18/18             0s 4ms/step -
accuracy: 0.7763 - loss: 0.4671 - val_accuracy: 0.7604 - val_loss: 0.5090
Epoch 98/200
18/18             0s 3ms/step -
accuracy: 0.7913 - loss: 0.4770 - val_accuracy: 0.7604 - val_loss: 0.5087
Epoch 99/200
18/18             0s 5ms/step -
accuracy: 0.7851 - loss: 0.4640 - val_accuracy: 0.7604 - val_loss: 0.5084
Epoch 100/200
18/18             0s 4ms/step -
accuracy: 0.7751 - loss: 0.4868 - val_accuracy: 0.7604 - val_loss: 0.5081
Epoch 101/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7616 - loss: 0.4961 - val_accuracy: 0.7604 - val_loss: 0.5079
Epoch 102/200
18/18             0s 4ms/step -
accuracy: 0.7609 - loss: 0.5001 - val_accuracy: 0.7604 - val_loss: 0.5076
Epoch 103/200
18/18             0s 4ms/step -
accuracy: 0.7633 - loss: 0.4892 - val_accuracy: 0.7656 - val_loss: 0.5073
Epoch 104/200
18/18             0s 3ms/step -
accuracy: 0.7822 - loss: 0.4828 - val_accuracy: 0.7656 - val_loss: 0.5071
Epoch 105/200
18/18             0s 4ms/step -
accuracy: 0.7606 - loss: 0.5015 - val_accuracy: 0.7656 - val_loss: 0.5068
Epoch 106/200
18/18             0s 4ms/step -
accuracy: 0.7376 - loss: 0.5105 - val_accuracy: 0.7656 - val_loss: 0.5066
Epoch 107/200
18/18             0s 4ms/step -
accuracy: 0.7748 - loss: 0.4863 - val_accuracy: 0.7656 - val_loss: 0.5063
Epoch 108/200
18/18             0s 4ms/step -
accuracy: 0.7721 - loss: 0.4782 - val_accuracy: 0.7656 - val_loss: 0.5061
Epoch 109/200
18/18             0s 3ms/step -
accuracy: 0.7806 - loss: 0.4588 - val_accuracy: 0.7656 - val_loss: 0.5059
Epoch 110/200
18/18             0s 3ms/step -
accuracy: 0.7524 - loss: 0.4846 - val_accuracy: 0.7656 - val_loss: 0.5057
Epoch 111/200
18/18             0s 4ms/step -
accuracy: 0.7276 - loss: 0.5144 - val_accuracy: 0.7656 - val_loss: 0.5055
Epoch 112/200
18/18             0s 4ms/step -
accuracy: 0.7394 - loss: 0.5205 - val_accuracy: 0.7656 - val_loss: 0.5053
Epoch 113/200
18/18             0s 3ms/step -
accuracy: 0.7662 - loss: 0.4708 - val_accuracy: 0.7656 - val_loss: 0.5051
Epoch 114/200
18/18             0s 4ms/step -
accuracy: 0.7806 - loss: 0.4626 - val_accuracy: 0.7708 - val_loss: 0.5049
Epoch 115/200
18/18             0s 5ms/step -
accuracy: 0.7656 - loss: 0.4779 - val_accuracy: 0.7708 - val_loss: 0.5047
Epoch 116/200
18/18             0s 3ms/step -
accuracy: 0.7510 - loss: 0.4785 - val_accuracy: 0.7708 - val_loss: 0.5045
Epoch 117/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7545 - loss: 0.4791 - val_accuracy: 0.7708 - val_loss: 0.5043
Epoch 118/200
18/18             0s 3ms/step -
accuracy: 0.7609 - loss: 0.4983 - val_accuracy: 0.7708 - val_loss: 0.5041
Epoch 119/200
18/18             0s 3ms/step -
accuracy: 0.7559 - loss: 0.4890 - val_accuracy: 0.7760 - val_loss: 0.5040
Epoch 120/200
18/18             0s 3ms/step -
accuracy: 0.7594 - loss: 0.4858 - val_accuracy: 0.7760 - val_loss: 0.5038
Epoch 121/200
18/18             0s 4ms/step -
accuracy: 0.7632 - loss: 0.4725 - val_accuracy: 0.7760 - val_loss: 0.5036
Epoch 122/200
18/18             0s 3ms/step -
accuracy: 0.7570 - loss: 0.4729 - val_accuracy: 0.7760 - val_loss: 0.5035
Epoch 123/200
18/18             0s 4ms/step -
accuracy: 0.7462 - loss: 0.4790 - val_accuracy: 0.7760 - val_loss: 0.5033
Epoch 124/200
18/18             0s 4ms/step -
accuracy: 0.7628 - loss: 0.4807 - val_accuracy: 0.7760 - val_loss: 0.5031
Epoch 125/200
18/18             0s 3ms/step -
accuracy: 0.7563 - loss: 0.4903 - val_accuracy: 0.7760 - val_loss: 0.5030
Epoch 126/200
18/18             0s 3ms/step -
accuracy: 0.7556 - loss: 0.4864 - val_accuracy: 0.7760 - val_loss: 0.5028
Epoch 127/200
18/18             0s 4ms/step -
accuracy: 0.7576 - loss: 0.4794 - val_accuracy: 0.7760 - val_loss: 0.5027
Epoch 128/200
18/18             0s 4ms/step -
accuracy: 0.7529 - loss: 0.4729 - val_accuracy: 0.7760 - val_loss: 0.5026
Epoch 129/200
18/18             0s 4ms/step -
accuracy: 0.7495 - loss: 0.4852 - val_accuracy: 0.7760 - val_loss: 0.5024
Epoch 130/200
18/18             0s 4ms/step -
accuracy: 0.7725 - loss: 0.4880 - val_accuracy: 0.7760 - val_loss: 0.5023
Epoch 131/200
18/18             0s 4ms/step -
accuracy: 0.7648 - loss: 0.4682 - val_accuracy: 0.7760 - val_loss: 0.5021
Epoch 132/200
18/18             0s 3ms/step -
accuracy: 0.7651 - loss: 0.4549 - val_accuracy: 0.7812 - val_loss: 0.5020
Epoch 133/200
18/18             0s 3ms/step -
```

```
accuracy: 0.7785 - loss: 0.4734 - val_accuracy: 0.7812 - val_loss: 0.5019
Epoch 134/200
18/18             0s 3ms/step -
accuracy: 0.7829 - loss: 0.4469 - val_accuracy: 0.7812 - val_loss: 0.5017
Epoch 135/200
18/18             0s 3ms/step -
accuracy: 0.7696 - loss: 0.4642 - val_accuracy: 0.7812 - val_loss: 0.5016
Epoch 136/200
18/18             0s 4ms/step -
accuracy: 0.7780 - loss: 0.4794 - val_accuracy: 0.7812 - val_loss: 0.5015
Epoch 137/200
18/18             0s 3ms/step -
accuracy: 0.7938 - loss: 0.4563 - val_accuracy: 0.7812 - val_loss: 0.5014
Epoch 138/200
18/18             0s 4ms/step -
accuracy: 0.7549 - loss: 0.4900 - val_accuracy: 0.7865 - val_loss: 0.5012
Epoch 139/200
18/18             0s 4ms/step -
accuracy: 0.7499 - loss: 0.4909 - val_accuracy: 0.7865 - val_loss: 0.5011
Epoch 140/200
18/18             0s 3ms/step -
accuracy: 0.7618 - loss: 0.4787 - val_accuracy: 0.7865 - val_loss: 0.5010
Epoch 141/200
18/18             0s 4ms/step -
accuracy: 0.7699 - loss: 0.4596 - val_accuracy: 0.7865 - val_loss: 0.5009
Epoch 142/200
18/18             0s 3ms/step -
accuracy: 0.7968 - loss: 0.4493 - val_accuracy: 0.7865 - val_loss: 0.5008
Epoch 143/200
18/18             0s 4ms/step -
accuracy: 0.8039 - loss: 0.4502 - val_accuracy: 0.7865 - val_loss: 0.5007
Epoch 144/200
18/18             0s 4ms/step -
accuracy: 0.7579 - loss: 0.4960 - val_accuracy: 0.7865 - val_loss: 0.5006
Epoch 145/200
18/18             0s 3ms/step -
accuracy: 0.7957 - loss: 0.4554 - val_accuracy: 0.7865 - val_loss: 0.5005
Epoch 146/200
18/18             0s 3ms/step -
accuracy: 0.7708 - loss: 0.4597 - val_accuracy: 0.7865 - val_loss: 0.5004
Epoch 147/200
18/18             0s 5ms/step -
accuracy: 0.8098 - loss: 0.4455 - val_accuracy: 0.7865 - val_loss: 0.5003
Epoch 148/200
18/18             0s 3ms/step -
accuracy: 0.7841 - loss: 0.4497 - val_accuracy: 0.7865 - val_loss: 0.5002
Epoch 149/200
18/18             0s 3ms/step -
```

```
accuracy: 0.7633 - loss: 0.4834 - val_accuracy: 0.7865 - val_loss: 0.5001
Epoch 150/200
18/18             0s 3ms/step -
accuracy: 0.7538 - loss: 0.4769 - val_accuracy: 0.7865 - val_loss: 0.5000
Epoch 151/200
18/18             0s 4ms/step -
accuracy: 0.7784 - loss: 0.4547 - val_accuracy: 0.7812 - val_loss: 0.4999
Epoch 152/200
18/18             0s 3ms/step -
accuracy: 0.7701 - loss: 0.4608 - val_accuracy: 0.7760 - val_loss: 0.4998
Epoch 153/200
18/18             0s 3ms/step -
accuracy: 0.7636 - loss: 0.4731 - val_accuracy: 0.7760 - val_loss: 0.4997
Epoch 154/200
18/18             0s 3ms/step -
accuracy: 0.7506 - loss: 0.4883 - val_accuracy: 0.7760 - val_loss: 0.4997
Epoch 155/200
18/18             0s 4ms/step -
accuracy: 0.7553 - loss: 0.4886 - val_accuracy: 0.7760 - val_loss: 0.4996
Epoch 156/200
18/18             0s 4ms/step -
accuracy: 0.7840 - loss: 0.4718 - val_accuracy: 0.7708 - val_loss: 0.4995
Epoch 157/200
18/18             0s 3ms/step -
accuracy: 0.7615 - loss: 0.4711 - val_accuracy: 0.7708 - val_loss: 0.4994
Epoch 158/200
18/18             0s 3ms/step -
accuracy: 0.7801 - loss: 0.4663 - val_accuracy: 0.7708 - val_loss: 0.4994
Epoch 159/200
18/18             0s 4ms/step -
accuracy: 0.7659 - loss: 0.4776 - val_accuracy: 0.7708 - val_loss: 0.4993
Epoch 160/200
18/18             0s 4ms/step -
accuracy: 0.7645 - loss: 0.4878 - val_accuracy: 0.7708 - val_loss: 0.4992
Epoch 161/200
18/18             0s 3ms/step -
accuracy: 0.7777 - loss: 0.4668 - val_accuracy: 0.7708 - val_loss: 0.4991
Epoch 162/200
18/18             0s 4ms/step -
accuracy: 0.7800 - loss: 0.4549 - val_accuracy: 0.7760 - val_loss: 0.4991
Epoch 163/200
18/18             0s 3ms/step -
accuracy: 0.7834 - loss: 0.4823 - val_accuracy: 0.7760 - val_loss: 0.4990
Epoch 164/200
18/18             0s 5ms/step -
accuracy: 0.7649 - loss: 0.4654 - val_accuracy: 0.7760 - val_loss: 0.4989
Epoch 165/200
18/18             0s 6ms/step -
```

```
accuracy: 0.7608 - loss: 0.4625 - val_accuracy: 0.7760 - val_loss: 0.4989
Epoch 166/200
18/18             0s 5ms/step -
accuracy: 0.7638 - loss: 0.4805 - val_accuracy: 0.7760 - val_loss: 0.4988
Epoch 167/200
18/18             0s 5ms/step -
accuracy: 0.7970 - loss: 0.4432 - val_accuracy: 0.7760 - val_loss: 0.4988
Epoch 168/200
18/18             0s 5ms/step -
accuracy: 0.7649 - loss: 0.4626 - val_accuracy: 0.7760 - val_loss: 0.4987
Epoch 169/200
18/18             0s 5ms/step -
accuracy: 0.7595 - loss: 0.4720 - val_accuracy: 0.7760 - val_loss: 0.4986
Epoch 170/200
18/18             0s 5ms/step -
accuracy: 0.7621 - loss: 0.4700 - val_accuracy: 0.7760 - val_loss: 0.4986
Epoch 171/200
18/18             0s 5ms/step -
accuracy: 0.7555 - loss: 0.4957 - val_accuracy: 0.7760 - val_loss: 0.4985
Epoch 172/200
18/18             0s 6ms/step -
accuracy: 0.7863 - loss: 0.4619 - val_accuracy: 0.7760 - val_loss: 0.4985
Epoch 173/200
18/18             0s 5ms/step -
accuracy: 0.7785 - loss: 0.4538 - val_accuracy: 0.7760 - val_loss: 0.4984
Epoch 174/200
18/18             0s 5ms/step -
accuracy: 0.7895 - loss: 0.4435 - val_accuracy: 0.7760 - val_loss: 0.4984
Epoch 175/200
18/18             0s 5ms/step -
accuracy: 0.7504 - loss: 0.4993 - val_accuracy: 0.7760 - val_loss: 0.4983
Epoch 176/200
18/18             0s 7ms/step -
accuracy: 0.7664 - loss: 0.4767 - val_accuracy: 0.7760 - val_loss: 0.4983
Epoch 177/200
18/18             0s 4ms/step -
accuracy: 0.7566 - loss: 0.4693 - val_accuracy: 0.7760 - val_loss: 0.4982
Epoch 178/200
18/18             0s 4ms/step -
accuracy: 0.7840 - loss: 0.4335 - val_accuracy: 0.7760 - val_loss: 0.4982
Epoch 179/200
18/18             0s 3ms/step -
accuracy: 0.7519 - loss: 0.4719 - val_accuracy: 0.7760 - val_loss: 0.4981
Epoch 180/200
18/18             0s 4ms/step -
accuracy: 0.7655 - loss: 0.4782 - val_accuracy: 0.7760 - val_loss: 0.4981
Epoch 181/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7542 - loss: 0.4907 - val_accuracy: 0.7760 - val_loss: 0.4980
Epoch 182/200
18/18             0s 3ms/step -
accuracy: 0.7744 - loss: 0.4737 - val_accuracy: 0.7760 - val_loss: 0.4980
Epoch 183/200
18/18             0s 3ms/step -
accuracy: 0.7611 - loss: 0.4648 - val_accuracy: 0.7760 - val_loss: 0.4979
Epoch 184/200
18/18             0s 4ms/step -
accuracy: 0.7938 - loss: 0.4590 - val_accuracy: 0.7760 - val_loss: 0.4979
Epoch 185/200
18/18             0s 4ms/step -
accuracy: 0.7776 - loss: 0.4544 - val_accuracy: 0.7760 - val_loss: 0.4979
Epoch 186/200
18/18             0s 3ms/step -
accuracy: 0.7773 - loss: 0.4623 - val_accuracy: 0.7760 - val_loss: 0.4978
Epoch 187/200
18/18             0s 3ms/step -
accuracy: 0.7672 - loss: 0.4890 - val_accuracy: 0.7760 - val_loss: 0.4978
Epoch 188/200
18/18             0s 4ms/step -
accuracy: 0.7659 - loss: 0.4665 - val_accuracy: 0.7760 - val_loss: 0.4977
Epoch 189/200
18/18             0s 3ms/step -
accuracy: 0.7714 - loss: 0.4611 - val_accuracy: 0.7760 - val_loss: 0.4977
Epoch 190/200
18/18             0s 4ms/step -
accuracy: 0.7687 - loss: 0.4709 - val_accuracy: 0.7760 - val_loss: 0.4976
Epoch 191/200
18/18             0s 4ms/step -
accuracy: 0.7710 - loss: 0.4512 - val_accuracy: 0.7760 - val_loss: 0.4976
Epoch 192/200
18/18             0s 4ms/step -
accuracy: 0.7469 - loss: 0.4837 - val_accuracy: 0.7760 - val_loss: 0.4976
Epoch 193/200
18/18             0s 5ms/step -
accuracy: 0.7572 - loss: 0.4731 - val_accuracy: 0.7760 - val_loss: 0.4975
Epoch 194/200
18/18             0s 4ms/step -
accuracy: 0.7840 - loss: 0.4657 - val_accuracy: 0.7760 - val_loss: 0.4975
Epoch 195/200
18/18             0s 3ms/step -
accuracy: 0.7804 - loss: 0.4773 - val_accuracy: 0.7760 - val_loss: 0.4974
Epoch 196/200
18/18             0s 4ms/step -
accuracy: 0.7678 - loss: 0.4736 - val_accuracy: 0.7760 - val_loss: 0.4974
Epoch 197/200
18/18             0s 4ms/step -
```

```
accuracy: 0.7330 - loss: 0.5111 - val_accuracy: 0.7760 - val_loss: 0.4973
Epoch 198/200
18/18             0s 3ms/step -
accuracy: 0.7712 - loss: 0.4717 - val_accuracy: 0.7760 - val_loss: 0.4973
Epoch 199/200
18/18             0s 4ms/step -
accuracy: 0.7714 - loss: 0.4762 - val_accuracy: 0.7760 - val_loss: 0.4973
Epoch 200/200
18/18             0s 4ms/step -
accuracy: 0.7895 - loss: 0.4390 - val_accuracy: 0.7760 - val_loss: 0.4972
```

[ ]:
```
## Like we did for the Random Forest, we generate two kinds of predictions
#  One is a hard decision, the other is a probabilitistic score.

y_pred_prob_nn_1 = model.predict(X_test_norm)
y_pred_class_nn_1 = np.argmax(y_pred_prob_nn_1, axis=1)
```

```
6/6             0s 3ms/step
```

[ ]:
```
# Let's check out the outputs to get a feel for how keras apis work.
y_pred_class_nn_1[:10]
```

[ ]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

[ ]:
```
y_pred_prob_nn_1[:10]
```

[ ]:
```
array([[0.47451037],
       [0.48907652],
       [0.29743898],
       [0.33617893],
       [0.17411605],
       [0.41381925],
       [0.04458674],
       [0.29017496],
       [0.77602726],
       [0.25912988]], dtype=float32)
```

Create the plot_roc function

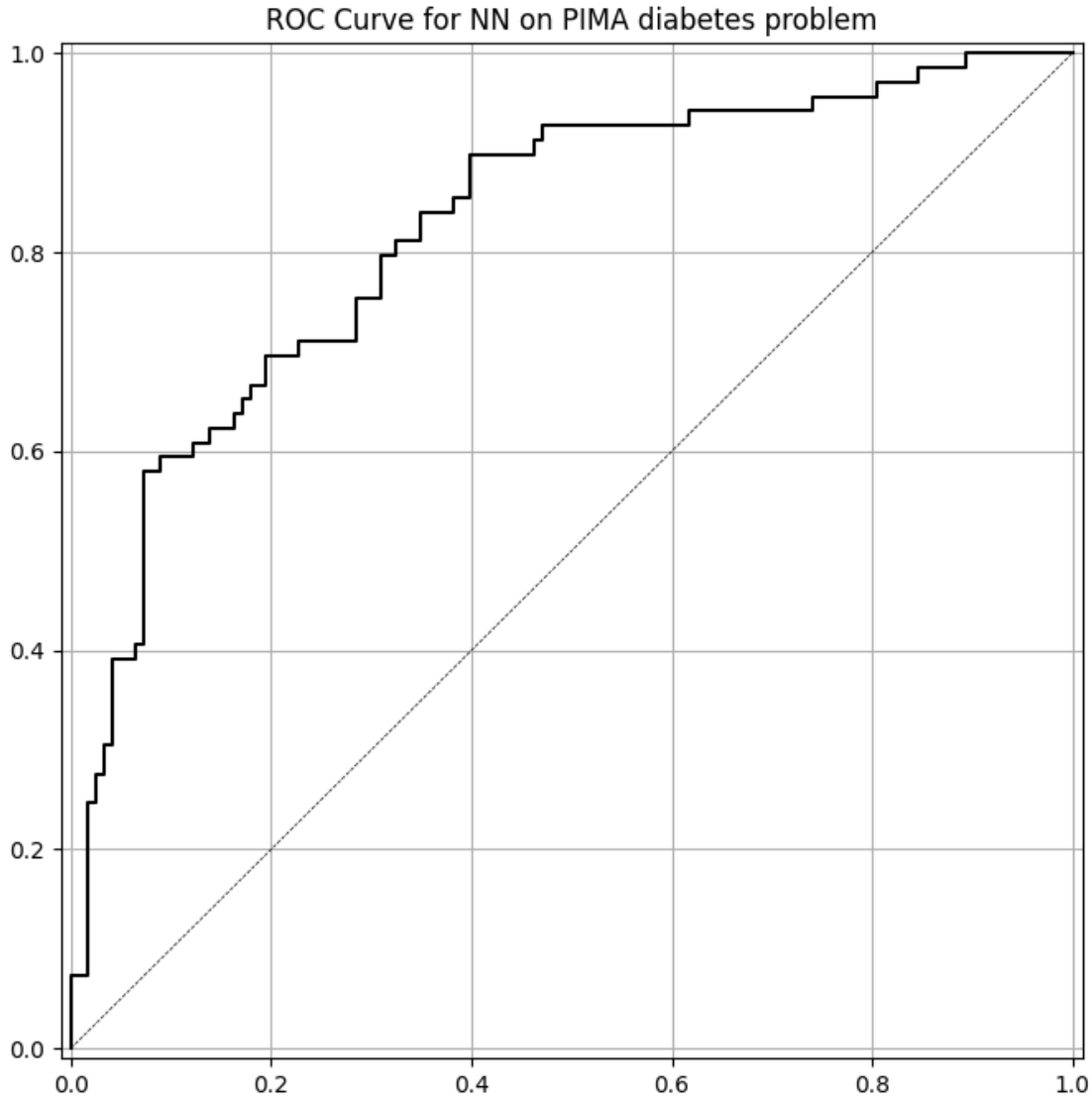
[ ]:
```
def plot_roc(y_test, y_pred, model_name):
    fpr, tpr, thr = roc_curve(y_test, y_pred)
    fig, ax = plt.subplots(figsize=(8, 8))
    ax.plot(fpr, tpr, 'k-')
    ax.plot([0, 1], [0, 1], 'k--', linewidth=.5)  # roc curve for random model
    ax.grid(True)
    ax.set(title='ROC Curve for {} on PIMA diabetes problem'.format(model_name),
           xlim=[-0.01, 1.01], ylim=[-0.01, 1.01])
```

Evaluate the model performance and plot the ROC CURVE

```
[ ]: print('accuracy is {:.3f}'.format(accuracy_score(y_test,y_pred_class_nn_1)))
     print('roc-auc is {:.3f}'.format(roc_auc_score(y_test,y_pred_prob_nn_1)))

     plot_roc(y_test, y_pred_prob_nn_1, 'NN')
```

```
accuracy is 0.641
roc-auc is 0.823
```



0.0.2 Analysis

The accuray was approximately 64.1%, it's not be the best indicator for imbalanced dataset, where one class has significantly more samples than other. While the ROC-AUC is 82.3%, its indicate

high score which means better performance. Since the ROC-AUC was used to distinguised between positive and negative class, with the high score of 82.3% suggessted that the model performs well in distinguishing between the 2 class.

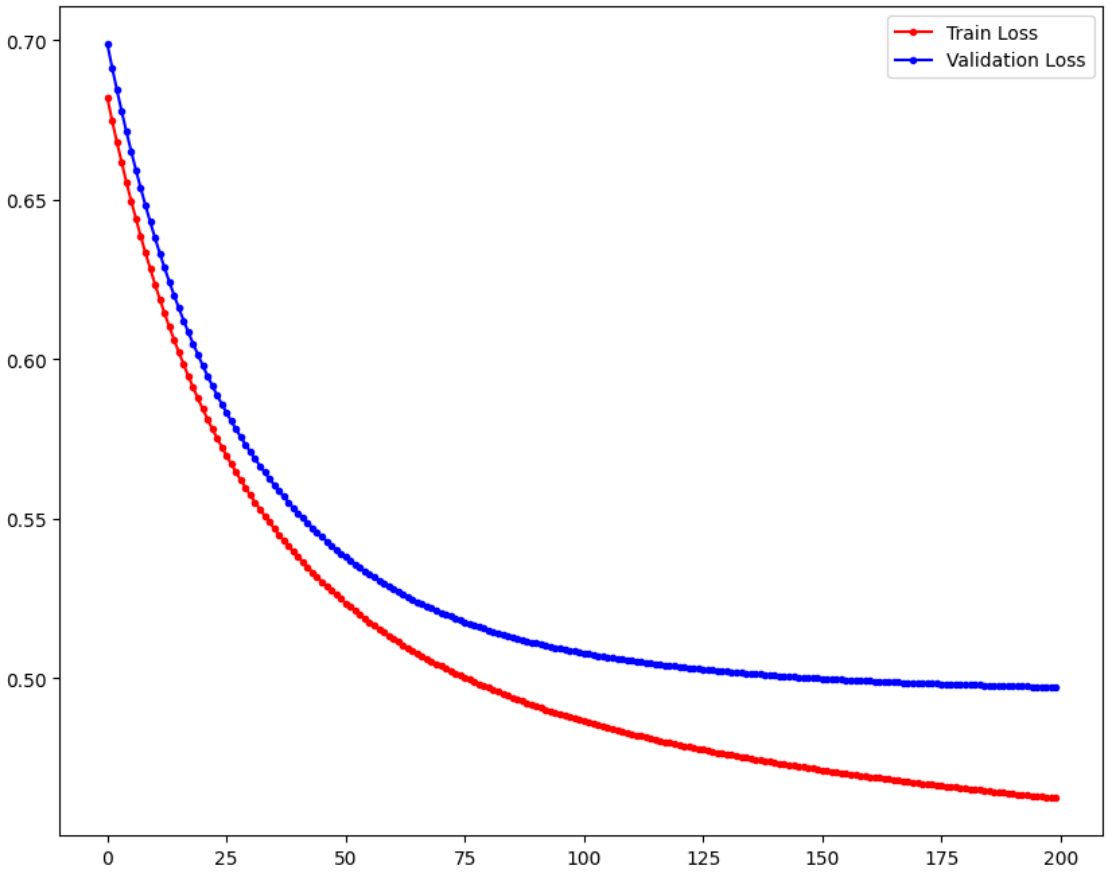
Plot the training loss and the validation loss over the different epochs and see how it looks

[ ]:
```
run_hist_1.history.keys()
```

[ ]:
```
dict_keys(['accuracy', 'loss', 'val_accuracy', 'val_loss'])
```

[ ]:
```
fig, ax = plt.subplots(figsize=(10, 8))
ax.plot(run_hist_1.history["loss"],'r', marker='.', label="Train Loss")
ax.plot(run_hist_1.history["val_loss"],'b', marker='.', label="Validation Loss")
ax.legend()
```

[ ]:
```
<matplotlib.legend.Legend at 0x797396ff0490>
```



What is your interpretation about the result of the train and validation loss?

#type your answer The graph show that when the number of iteration increases (x-axis ranges from 0 - 200) both training and validation loss decreases (y axis represent as loss or error value,

in order to measure whether the model is fitting the training and validation data). The model's performance on training data improves over time.

As you can see the training loss is consistently lower than valitation loss, which means that the model might be overfitting the training data. There's occurence of Overfitting especially when the model learns the training data too well, including the noise and outlier, which negatively impacts its performance on unseen data.

Supplementary Activity

- Build a model with two hidden layers, each with 6 nodes
- Use the "relu" activation function for the hidden layers, and "sigmoid" for the final layer
- Use a learning rate of .003 and train for 1500 epochs
- Graph the trajectory of the loss functions, accuracy on both train and test set
- Plot the roc curve for the predictions
- Use different learning rates, numbers of epochs, and network structures.
- Plot the results of training and validation loss using different learning rates, number of epocgs and network structures
- Interpret your result

Conclusion Overall, this activity gives me an insight on how to build and train neural networks that involves several steps like the no. of layers, no. of neurons in each layer, and activitation functions. Also, the compiling model like what optimizer to be used, loss functions, and metrics during training. Then gives me an insight about the model's performance using the validation data and accuracy or ROC. After I saw my graph I visualized that my model's performance (training and validation loss) helps me to understand whether it actually learned or it's overfitting/underfitting. With the practice and experimentation about this activity I can implement a model to achieve a better performance on real-world datasets.

#type your answer here

[ ]:
```
dataset = pd.read_csv("/content/heart.csv", na_values="?")
dataset.rename(columns={"target": "has_heart_disease"}, inplace=True)
```

[ ]:
```
dataset["has_heart_disease"].replace(inplace=True, value=[1, 1, 1, 1],␣
 ↪to_replace=[1, 2, 3, 4])

np_dataset = dataset.to_numpy()

feature_names = ['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs',
                 'restecg','thalach', 'exang', 'oldpeak', 'slope', 'ca', 'thal']
```

[ ]:
```
dataset.head(20)
```

[ ]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	\
0	63	1	3	145	233	1	0	150	0	2.3	
1	37	1	2	130	250	0	1	187	0	3.5	
2	41	0	1	130	204	0	0	172	0	1.4	
3	56	1	1	120	236	0	1	178	0	0.8	

```
4    57    0   0       120   354    0        1      163      1      0.6
5    57    1   0       140   192    0        1      148      0      0.4
6    56    0   1       140   294    0        0      153      0      1.3
7    44    1   1       120   263    0        1      173      0      0.0
8    52    1   2       172   199    1        1      162      0      0.5
9    57    1   2       150   168    0        1      174      0      1.6
10   54    1   0       140   239    0        1      160      0      1.2
11   48    0   2       130   275    0        1      139      0      0.2
12   49    1   1       130   266    0        1      171      0      0.6
13   64    1   3       110   211    0        0      144      1      1.8
14   58    0   3       150   283    1        0      162      0      1.0
15   50    0   2       120   219    0        1      158      0      1.6
16   58    0   2       120   340    0        1      172      0      0.0
17   66    0   3       150   226    0        1      114      0      2.6
18   43    1   0       150   247    0        1      171      0      1.5
19   69    0   3       140   239    0        1      151      0      1.8

    slope  ca  thal  has_heart_disease
0       0   0     1                  1
1       0   0     2                  1
2       2   0     2                  1
3       2   0     2                  1
4       2   0     2                  1
5       1   0     1                  1
6       1   0     2                  1
7       2   0     3                  1
8       2   0     3                  1
9       2   0     2                  1
10      2   0     2                  1
11      2   0     2                  1
12      2   0     2                  1
13      1   0     2                  1
14      2   0     2                  1
15      1   0     2                  1
16      2   0     2                  1
17      0   0     2                  1
18      2   0     2                  1
19      2   2     2                  1
```

[ ]:
```
dataset.tail(20)
```

[ ]:
```
     age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  \
283   40    1   0       152   223    0        1      181      0      0.0
284   61    1   0       140   207    0        0      138      1      1.9
285   46    1   0       140   311    0        1      120      1      1.8
286   59    1   3       134   204    0        1      162      0      0.8
287   57    1   1       154   232    0        0      164      0      0.0
```

288	57	1	0	110	335	0	1	143	1	3.0
289	55	0	0	128	205	0	2	130	1	2.0
290	61	1	0	148	203	0	1	161	0	0.0
291	58	1	0	114	318	0	2	140	0	4.4
292	58	0	0	170	225	1	0	146	1	2.8
293	67	1	2	152	212	0	0	150	0	0.8
294	44	1	0	120	169	0	1	144	1	2.8
295	63	1	0	140	187	0	0	144	1	4.0
296	63	0	0	124	197	0	1	136	1	0.0
297	59	1	0	164	176	1	0	90	0	1.0
298	57	0	0	140	241	0	1	123	1	0.2
299	45	1	3	110	264	0	1	132	0	1.2
300	68	1	0	144	193	1	1	141	0	3.4
301	57	1	0	130	131	0	1	115	1	1.2
302	57	0	1	130	236	0	0	174	0	0.0

	slope	ca	thal	has_heart_disease
283	2	0	3	0
284	2	1	3	0
285	1	2	3	0
286	2	2	2	0
287	2	1	2	0
288	1	1	3	0
289	1	1	3	0
290	2	1	3	0
291	0	3	1	0
292	1	2	1	0
293	1	0	3	0
294	0	0	1	0
295	2	2	3	0
296	1	0	2	0
297	1	2	1	0
298	1	0	3	0
299	1	0	3	0
300	1	2	3	0
301	1	1	3	0
302	1	1	2	0

[ ]:
```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   age                 303 non-null    int64
 1   sex                 303 non-null    int64
```

```
 2   cp                303 non-null    int64
 3   trestbps          303 non-null    int64
 4   chol              303 non-null    int64
 5   fbs               303 non-null    int64
 6   restecg           303 non-null    int64
 7   thalach           303 non-null    int64
 8   exang             303 non-null    int64
 9   oldpeak           303 non-null    float64
 10  slope             303 non-null    int64
 11  ca                303 non-null    int64
 12  thal              303 non-null    int64
 13  has_heart_disease 303 non-null    int64
dtypes: float64(1), int64(13)
memory usage: 33.3 KB
```

[ ]:
```
dataset.isnull().sum()
```

[ ]:
```
age                 0
sex                 0
cp                  0
trestbps            0
chol                0
fbs                 0
restecg             0
thalach             0
exang               0
oldpeak             0
slope               0
ca                  0
thal                0
has_heart_disease   0
dtype: int64
```

[ ]:
```
dataset.dtypes
dataset['has_heart_disease'].astype(int)
dataset['has_heart_disease'].value_counts()
```

[ ]:
```
1    165
0    138
Name: has_heart_disease, dtype: int64
```

[ ]:
```
Zero = dataset[dataset.has_heart_disease == 0] # absence
One = dataset[dataset.has_heart_disease == 1]  # presence
```

[ ]:
```
ZeroDS = Zero.sample(len(One), replace = True, random_state=100)
OneDB = pd.concat([ZeroDS, One])
```

[ ]:
```
count = OneDB['has_heart_disease'].value_counts()
print(count)
```

```
0    165
1    165
Name: has_heart_disease, dtype: int64
```

[ ]:
```
X = dataset.iloc[:, :-1].values
y = dataset["has_heart_disease"].values
```

[ ]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.5,␣
↪random_state=100)
```

[ ]:
```
normalizer = StandardScaler()
X_train_norm = normalizer.fit_transform(X_train)
X_test_norm = normalizer.transform(X_test)
```

Define the model: * Input size is 13-dimensional * 2 hidden layer, each with 6 nodes using relu activation * Final layer with one node and sigmoid activation (standard for binary classification) * Use a learning rate of .003 and train for 1500 epochs

[ ]:
```
model  = Sequential([
    Dense(6, input_shape=(13,), activation="relu"),
    Dense(6, input_shape=(13,), activation="relu"),
    Dense(1, activation="sigmoid")
])
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:88:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When
using Sequential models, prefer using an `Input(shape)` object as the first
layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

[ ]:
```
dataset.shape
```

[ ]:
```
(303, 14)
```

[ ]:
```
model.summary()
```

```
Model: "sequential_9"
```

Layer (type)	Output Shape	Param #
dense_26 (Dense)	(None, 6)	84

```
dense_27 (Dense)                        (None, 6)                       ␣
↪ 42

dense_28 (Dense)                        (None, 1)                       ␣
↪  7


Total params: 133 (532.00 B)

Trainable params: 133 (532.00 B)

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

[ ]:
```
!pip install --upgrade keras
```

```
Requirement already satisfied: keras in /usr/local/lib/python3.10/dist-packages
(3.1.1)
Requirement already satisfied: absl-py in /usr/local/lib/python3.10/dist-
packages (from keras) (1.4.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages
(from keras) (1.25.2)
Requirement already satisfied: rich in /usr/local/lib/python3.10/dist-packages
(from keras) (13.7.1)
Requirement already satisfied: namex in /usr/local/lib/python3.10/dist-packages
(from keras) (0.0.7)
Requirement already satisfied: h5py in /usr/local/lib/python3.10/dist-packages
(from keras) (3.9.0)
Requirement already satisfied: optree in /usr/local/lib/python3.10/dist-packages
(from keras) (0.11.0)
Requirement already satisfied: ml-dtypes in /usr/local/lib/python3.10/dist-
packages (from keras) (0.2.0)
Requirement already satisfied: typing-extensions>=4.0.0 in
/usr/local/lib/python3.10/dist-packages (from optree->keras) (4.10.0)
Requirement already satisfied: markdown-it-py>=2.2.0 in
/usr/local/lib/python3.10/dist-packages (from rich->keras) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in
/usr/local/lib/python3.10/dist-packages (from rich->keras) (2.16.1)
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.10/dist-
packages (from markdown-it-py>=2.2.0->rich->keras) (0.1.2)
```

[175]:
```
model.compile(SGD(learning_rate = .003), "binary_crossentropy",␣
↪metrics=["accuracy"])
run_hist_1 = model.fit(X_train_norm, y_train, validation_data=(X_test_norm,␣
↪y_test), epochs=1500)
```

```
Epoch 1/1500
5/5            3s 245ms/step -
accuracy: 0.6607 - loss: 0.6418 - val_accuracy: 0.5987 - val_loss: 0.6684
Epoch 2/1500
5/5            0s 31ms/step -
accuracy: 0.6077 - loss: 0.6548 - val_accuracy: 0.5987 - val_loss: 0.6681
Epoch 3/1500
5/5            0s 41ms/step -
accuracy: 0.6242 - loss: 0.6456 - val_accuracy: 0.6053 - val_loss: 0.6679
Epoch 4/1500
5/5            0s 55ms/step -
accuracy: 0.6590 - loss: 0.6455 - val_accuracy: 0.6118 - val_loss: 0.6676
Epoch 5/1500
5/5            0s 39ms/step -
accuracy: 0.6208 - loss: 0.6407 - val_accuracy: 0.6184 - val_loss: 0.6674
Epoch 6/1500
5/5            0s 37ms/step -
accuracy: 0.6364 - loss: 0.6433 - val_accuracy: 0.6184 - val_loss: 0.6671
Epoch 7/1500
5/5            0s 39ms/step -
accuracy: 0.6222 - loss: 0.6484 - val_accuracy: 0.6184 - val_loss: 0.6669
Epoch 8/1500
5/5            0s 36ms/step -
accuracy: 0.6529 - loss: 0.6448 - val_accuracy: 0.6184 - val_loss: 0.6667
Epoch 9/1500
5/5            0s 49ms/step -
accuracy: 0.5770 - loss: 0.6520 - val_accuracy: 0.6184 - val_loss: 0.6664
Epoch 10/1500
5/5            0s 67ms/step -
accuracy: 0.6442 - loss: 0.6371 - val_accuracy: 0.6184 - val_loss: 0.6662
Epoch 11/1500
5/5            0s 36ms/step -
accuracy: 0.6607 - loss: 0.6452 - val_accuracy: 0.6184 - val_loss: 0.6659
Epoch 12/1500
5/5            0s 33ms/step -
accuracy: 0.6421 - loss: 0.6386 - val_accuracy: 0.6184 - val_loss: 0.6657
Epoch 13/1500
5/5            0s 50ms/step -
accuracy: 0.6412 - loss: 0.6415 - val_accuracy: 0.6184 - val_loss: 0.6655
Epoch 14/1500
5/5            1s 36ms/step -
accuracy: 0.6673 - loss: 0.6329 - val_accuracy: 0.6184 - val_loss: 0.6652
Epoch 15/1500
5/5            0s 35ms/step -
accuracy: 0.6321 - loss: 0.6502 - val_accuracy: 0.6184 - val_loss: 0.6650
Epoch 16/1500
5/5            0s 64ms/step -
accuracy: 0.6729 - loss: 0.6424 - val_accuracy: 0.6184 - val_loss: 0.6647
```

```
Epoch 17/1500
5/5            0s 45ms/step -
accuracy: 0.6165 - loss: 0.6484 - val_accuracy: 0.6184 - val_loss: 0.6645
Epoch 18/1500
5/5            1s 52ms/step -
accuracy: 0.6321 - loss: 0.6471 - val_accuracy: 0.6184 - val_loss: 0.6642
Epoch 19/1500
5/5            1s 85ms/step -
accuracy: 0.6395 - loss: 0.6397 - val_accuracy: 0.6250 - val_loss: 0.6640
Epoch 20/1500
5/5            0s 64ms/step -
accuracy: 0.6686 - loss: 0.6370 - val_accuracy: 0.6250 - val_loss: 0.6638
Epoch 21/1500
5/5            1s 64ms/step -
accuracy: 0.6646 - loss: 0.6228 - val_accuracy: 0.6250 - val_loss: 0.6635
Epoch 22/1500
5/5            0s 48ms/step -
accuracy: 0.6612 - loss: 0.6435 - val_accuracy: 0.6250 - val_loss: 0.6633
Epoch 23/1500
5/5            1s 70ms/step -
accuracy: 0.6525 - loss: 0.6420 - val_accuracy: 0.6184 - val_loss: 0.6630
Epoch 24/1500
5/5            0s 53ms/step -
accuracy: 0.6265 - loss: 0.6341 - val_accuracy: 0.6184 - val_loss: 0.6628
Epoch 25/1500
5/5            0s 45ms/step -
accuracy: 0.6386 - loss: 0.6392 - val_accuracy: 0.6184 - val_loss: 0.6625
Epoch 26/1500
5/5            0s 38ms/step -
accuracy: 0.6343 - loss: 0.6452 - val_accuracy: 0.6184 - val_loss: 0.6623
Epoch 27/1500
5/5            0s 29ms/step -
accuracy: 0.6469 - loss: 0.6358 - val_accuracy: 0.6184 - val_loss: 0.6620
Epoch 28/1500
5/5            0s 58ms/step -
accuracy: 0.6248 - loss: 0.6525 - val_accuracy: 0.6184 - val_loss: 0.6617
Epoch 29/1500
5/5            1s 36ms/step -
accuracy: 0.6182 - loss: 0.6322 - val_accuracy: 0.6184 - val_loss: 0.6615
Epoch 30/1500
5/5            0s 42ms/step -
accuracy: 0.6599 - loss: 0.6390 - val_accuracy: 0.6184 - val_loss: 0.6612
Epoch 31/1500
5/5            1s 58ms/step -
accuracy: 0.6968 - loss: 0.6241 - val_accuracy: 0.6184 - val_loss: 0.6609
Epoch 32/1500
5/5            0s 46ms/step -
accuracy: 0.6387 - loss: 0.6443 - val_accuracy: 0.6250 - val_loss: 0.6607
```

```
Epoch 33/1500
5/5            0s 40ms/step -
accuracy: 0.6712 - loss: 0.6293 - val_accuracy: 0.6250 - val_loss: 0.6604
Epoch 34/1500
5/5            0s 40ms/step -
accuracy: 0.6392 - loss: 0.6340 - val_accuracy: 0.6250 - val_loss: 0.6601
Epoch 35/1500
5/5            1s 49ms/step -
accuracy: 0.6661 - loss: 0.6318 - val_accuracy: 0.6250 - val_loss: 0.6598
Epoch 36/1500
5/5            1s 56ms/step -
accuracy: 0.7043 - loss: 0.6309 - val_accuracy: 0.6316 - val_loss: 0.6595
Epoch 37/1500
5/5            1s 48ms/step -
accuracy: 0.6695 - loss: 0.6306 - val_accuracy: 0.6316 - val_loss: 0.6593
Epoch 38/1500
5/5            0s 40ms/step -
accuracy: 0.6127 - loss: 0.6404 - val_accuracy: 0.6250 - val_loss: 0.6590
Epoch 39/1500
5/5            0s 40ms/step -
accuracy: 0.6848 - loss: 0.6240 - val_accuracy: 0.6316 - val_loss: 0.6587
Epoch 40/1500
5/5            0s 31ms/step -
accuracy: 0.6292 - loss: 0.6291 - val_accuracy: 0.6382 - val_loss: 0.6584
Epoch 41/1500
5/5            0s 22ms/step -
accuracy: 0.6309 - loss: 0.6308 - val_accuracy: 0.6316 - val_loss: 0.6581
Epoch 42/1500
5/5            0s 28ms/step -
accuracy: 0.6699 - loss: 0.6403 - val_accuracy: 0.6382 - val_loss: 0.6578
Epoch 43/1500
5/5            0s 26ms/step -
accuracy: 0.6608 - loss: 0.6343 - val_accuracy: 0.6447 - val_loss: 0.6576
Epoch 44/1500
5/5            0s 19ms/step -
accuracy: 0.6734 - loss: 0.6332 - val_accuracy: 0.6447 - val_loss: 0.6573
Epoch 45/1500
5/5            0s 16ms/step -
accuracy: 0.6534 - loss: 0.6363 - val_accuracy: 0.6447 - val_loss: 0.6570
Epoch 46/1500
5/5            0s 28ms/step -
accuracy: 0.6265 - loss: 0.6421 - val_accuracy: 0.6447 - val_loss: 0.6567
Epoch 47/1500
5/5            0s 17ms/step -
accuracy: 0.6873 - loss: 0.6181 - val_accuracy: 0.6447 - val_loss: 0.6564
Epoch 48/1500
5/5            0s 24ms/step -
accuracy: 0.6899 - loss: 0.6324 - val_accuracy: 0.6447 - val_loss: 0.6562
```

```
Epoch 49/1500
5/5             0s 41ms/step -
accuracy: 0.6613 - loss: 0.6390 - val_accuracy: 0.6447 - val_loss: 0.6559
Epoch 50/1500
5/5             0s 19ms/step -
accuracy: 0.6165 - loss: 0.6441 - val_accuracy: 0.6447 - val_loss: 0.6556
Epoch 51/1500
5/5             0s 18ms/step -
accuracy: 0.7003 - loss: 0.6210 - val_accuracy: 0.6382 - val_loss: 0.6553
Epoch 52/1500
5/5             0s 26ms/step -
accuracy: 0.6582 - loss: 0.6299 - val_accuracy: 0.6382 - val_loss: 0.6550
Epoch 53/1500
5/5             0s 39ms/step -
accuracy: 0.6747 - loss: 0.6259 - val_accuracy: 0.6382 - val_loss: 0.6548
Epoch 54/1500
5/5             0s 33ms/step -
accuracy: 0.6583 - loss: 0.6176 - val_accuracy: 0.6316 - val_loss: 0.6545
Epoch 55/1500
5/5             0s 32ms/step -
accuracy: 0.6734 - loss: 0.6192 - val_accuracy: 0.6316 - val_loss: 0.6542
Epoch 56/1500
5/5             0s 22ms/step -
accuracy: 0.6626 - loss: 0.6215 - val_accuracy: 0.6316 - val_loss: 0.6539
Epoch 57/1500
5/5             0s 26ms/step -
accuracy: 0.6561 - loss: 0.6258 - val_accuracy: 0.6316 - val_loss: 0.6536
Epoch 58/1500
5/5             0s 29ms/step -
accuracy: 0.6509 - loss: 0.6162 - val_accuracy: 0.6316 - val_loss: 0.6533
Epoch 59/1500
5/5             0s 37ms/step -
accuracy: 0.6687 - loss: 0.6217 - val_accuracy: 0.6316 - val_loss: 0.6531
Epoch 60/1500
5/5             0s 37ms/step -
accuracy: 0.6552 - loss: 0.6299 - val_accuracy: 0.6316 - val_loss: 0.6528
Epoch 61/1500
5/5             0s 25ms/step -
accuracy: 0.6466 - loss: 0.6215 - val_accuracy: 0.6316 - val_loss: 0.6525
Epoch 62/1500
5/5             0s 19ms/step -
accuracy: 0.6900 - loss: 0.6225 - val_accuracy: 0.6316 - val_loss: 0.6522
Epoch 63/1500
5/5             0s 19ms/step -
accuracy: 0.6418 - loss: 0.6220 - val_accuracy: 0.6250 - val_loss: 0.6520
Epoch 64/1500
5/5             0s 33ms/step -
accuracy: 0.6913 - loss: 0.6119 - val_accuracy: 0.6316 - val_loss: 0.6517
```

```
Epoch 65/1500
5/5            0s 34ms/step -
accuracy: 0.6839 - loss: 0.6222 - val_accuracy: 0.6316 - val_loss: 0.6514
Epoch 66/1500
5/5            0s 24ms/step -
accuracy: 0.6487 - loss: 0.6363 - val_accuracy: 0.6316 - val_loss: 0.6511
Epoch 67/1500
5/5            0s 19ms/step -
accuracy: 0.6934 - loss: 0.6172 - val_accuracy: 0.6316 - val_loss: 0.6508
Epoch 68/1500
5/5            0s 32ms/step -
accuracy: 0.6930 - loss: 0.6258 - val_accuracy: 0.6316 - val_loss: 0.6506
Epoch 69/1500
5/5            0s 31ms/step -
accuracy: 0.6917 - loss: 0.6170 - val_accuracy: 0.6382 - val_loss: 0.6503
Epoch 70/1500
5/5            0s 21ms/step -
accuracy: 0.6995 - loss: 0.6058 - val_accuracy: 0.6382 - val_loss: 0.6500
Epoch 71/1500
5/5            0s 22ms/step -
accuracy: 0.6453 - loss: 0.6289 - val_accuracy: 0.6382 - val_loss: 0.6497
Epoch 72/1500
5/5            0s 19ms/step -
accuracy: 0.6631 - loss: 0.6257 - val_accuracy: 0.6382 - val_loss: 0.6495
Epoch 73/1500
5/5            0s 16ms/step -
accuracy: 0.6227 - loss: 0.6357 - val_accuracy: 0.6382 - val_loss: 0.6492
Epoch 74/1500
5/5            0s 20ms/step -
accuracy: 0.6840 - loss: 0.6195 - val_accuracy: 0.6447 - val_loss: 0.6489
Epoch 75/1500
5/5            0s 26ms/step -
accuracy: 0.6775 - loss: 0.6203 - val_accuracy: 0.6447 - val_loss: 0.6487
Epoch 76/1500
5/5            0s 27ms/step -
accuracy: 0.6728 - loss: 0.6380 - val_accuracy: 0.6447 - val_loss: 0.6484
Epoch 77/1500
5/5            0s 41ms/step -
accuracy: 0.6728 - loss: 0.6240 - val_accuracy: 0.6447 - val_loss: 0.6481
Epoch 78/1500
5/5            0s 23ms/step -
accuracy: 0.7014 - loss: 0.6115 - val_accuracy: 0.6447 - val_loss: 0.6478
Epoch 79/1500
5/5            0s 24ms/step -
accuracy: 0.6884 - loss: 0.6289 - val_accuracy: 0.6447 - val_loss: 0.6476
Epoch 80/1500
5/5            0s 36ms/step -
accuracy: 0.7114 - loss: 0.6158 - val_accuracy: 0.6513 - val_loss: 0.6473
```

```
Epoch 81/1500
5/5            0s 29ms/step -
accuracy: 0.6745 - loss: 0.6157 - val_accuracy: 0.6579 - val_loss: 0.6470
Epoch 82/1500
5/5            0s 32ms/step -
accuracy: 0.6736 - loss: 0.6189 - val_accuracy: 0.6579 - val_loss: 0.6467
Epoch 83/1500
5/5            0s 39ms/step -
accuracy: 0.6840 - loss: 0.6206 - val_accuracy: 0.6579 - val_loss: 0.6464
Epoch 84/1500
5/5            0s 27ms/step -
accuracy: 0.7074 - loss: 0.6064 - val_accuracy: 0.6711 - val_loss: 0.6462
Epoch 85/1500
5/5            0s 42ms/step -
accuracy: 0.6962 - loss: 0.6154 - val_accuracy: 0.6711 - val_loss: 0.6459
Epoch 86/1500
5/5            0s 22ms/step -
accuracy: 0.6780 - loss: 0.6175 - val_accuracy: 0.6711 - val_loss: 0.6456
Epoch 87/1500
5/5            0s 27ms/step -
accuracy: 0.6736 - loss: 0.6214 - val_accuracy: 0.6711 - val_loss: 0.6453
Epoch 88/1500
5/5            0s 20ms/step -
accuracy: 0.6857 - loss: 0.6244 - val_accuracy: 0.6711 - val_loss: 0.6450
Epoch 89/1500
5/5            0s 16ms/step -
accuracy: 0.6884 - loss: 0.6154 - val_accuracy: 0.6711 - val_loss: 0.6448
Epoch 90/1500
5/5            0s 19ms/step -
accuracy: 0.6993 - loss: 0.6090 - val_accuracy: 0.6711 - val_loss: 0.6445
Epoch 91/1500
5/5            0s 41ms/step -
accuracy: 0.6646 - loss: 0.6214 - val_accuracy: 0.6711 - val_loss: 0.6442
Epoch 92/1500
5/5            0s 15ms/step -
accuracy: 0.6728 - loss: 0.6207 - val_accuracy: 0.6711 - val_loss: 0.6440
Epoch 93/1500
5/5            0s 27ms/step -
accuracy: 0.7032 - loss: 0.6189 - val_accuracy: 0.6711 - val_loss: 0.6437
Epoch 94/1500
5/5            0s 40ms/step -
accuracy: 0.6737 - loss: 0.6177 - val_accuracy: 0.6711 - val_loss: 0.6434
Epoch 95/1500
5/5            0s 24ms/step -
accuracy: 0.6906 - loss: 0.6093 - val_accuracy: 0.6711 - val_loss: 0.6431
Epoch 96/1500
5/5            0s 40ms/step -
accuracy: 0.7114 - loss: 0.6085 - val_accuracy: 0.6776 - val_loss: 0.6429
```

```
Epoch 97/1500
5/5             0s 27ms/step -
accuracy: 0.7405 - loss: 0.5920 - val_accuracy: 0.6842 - val_loss: 0.6426
Epoch 98/1500
5/5             0s 18ms/step -
accuracy: 0.7272 - loss: 0.6148 - val_accuracy: 0.6842 - val_loss: 0.6423
Epoch 99/1500
5/5             0s 30ms/step -
accuracy: 0.7267 - loss: 0.6157 - val_accuracy: 0.6908 - val_loss: 0.6421
Epoch 100/1500
5/5             0s 32ms/step -
accuracy: 0.7289 - loss: 0.6192 - val_accuracy: 0.6908 - val_loss: 0.6418
Epoch 101/1500
5/5             0s 30ms/step -
accuracy: 0.7198 - loss: 0.6087 - val_accuracy: 0.6908 - val_loss: 0.6416
Epoch 102/1500
5/5             0s 19ms/step -
accuracy: 0.7415 - loss: 0.6172 - val_accuracy: 0.6974 - val_loss: 0.6413
Epoch 103/1500
5/5             0s 54ms/step -
accuracy: 0.6999 - loss: 0.6112 - val_accuracy: 0.6974 - val_loss: 0.6411
Epoch 104/1500
5/5             0s 25ms/step -
accuracy: 0.7207 - loss: 0.6252 - val_accuracy: 0.6974 - val_loss: 0.6408
Epoch 105/1500
5/5             0s 42ms/step -
accuracy: 0.6994 - loss: 0.6290 - val_accuracy: 0.6974 - val_loss: 0.6406
Epoch 106/1500
5/5             0s 28ms/step -
accuracy: 0.7242 - loss: 0.6119 - val_accuracy: 0.6974 - val_loss: 0.6403
Epoch 107/1500
5/5             0s 52ms/step -
accuracy: 0.7428 - loss: 0.5997 - val_accuracy: 0.6974 - val_loss: 0.6401
Epoch 108/1500
5/5             1s 35ms/step -
accuracy: 0.7576 - loss: 0.6008 - val_accuracy: 0.6974 - val_loss: 0.6398
Epoch 109/1500
5/5             0s 47ms/step -
accuracy: 0.6925 - loss: 0.6185 - val_accuracy: 0.6974 - val_loss: 0.6396
Epoch 110/1500
5/5             0s 29ms/step -
accuracy: 0.7177 - loss: 0.6027 - val_accuracy: 0.6974 - val_loss: 0.6393
Epoch 111/1500
5/5             0s 28ms/step -
accuracy: 0.6916 - loss: 0.6154 - val_accuracy: 0.6974 - val_loss: 0.6391
Epoch 112/1500
5/5             0s 23ms/step -
accuracy: 0.7211 - loss: 0.6074 - val_accuracy: 0.6974 - val_loss: 0.6388
```

```
Epoch 113/1500
5/5             0s 35ms/step -
accuracy: 0.6942 - loss: 0.6257 - val_accuracy: 0.6974 - val_loss: 0.6386
Epoch 114/1500
5/5             0s 28ms/step -
accuracy: 0.7576 - loss: 0.6081 - val_accuracy: 0.6974 - val_loss: 0.6383
Epoch 115/1500
5/5             0s 29ms/step -
accuracy: 0.7354 - loss: 0.5989 - val_accuracy: 0.6974 - val_loss: 0.6381
Epoch 116/1500
5/5             0s 36ms/step -
accuracy: 0.7276 - loss: 0.6081 - val_accuracy: 0.6974 - val_loss: 0.6378
Epoch 117/1500
5/5             0s 28ms/step -
accuracy: 0.7129 - loss: 0.6168 - val_accuracy: 0.6974 - val_loss: 0.6376
Epoch 118/1500
5/5             0s 21ms/step -
accuracy: 0.7606 - loss: 0.5936 - val_accuracy: 0.6974 - val_loss: 0.6374
Epoch 119/1500
5/5             0s 40ms/step -
accuracy: 0.6981 - loss: 0.6115 - val_accuracy: 0.6974 - val_loss: 0.6371
Epoch 120/1500
5/5             0s 30ms/step -
accuracy: 0.6973 - loss: 0.6150 - val_accuracy: 0.6974 - val_loss: 0.6369
Epoch 121/1500
5/5             0s 32ms/step -
accuracy: 0.7437 - loss: 0.6048 - val_accuracy: 0.6974 - val_loss: 0.6366
Epoch 122/1500
5/5             0s 24ms/step -
accuracy: 0.7702 - loss: 0.6014 - val_accuracy: 0.6974 - val_loss: 0.6364
Epoch 123/1500
5/5             0s 31ms/step -
accuracy: 0.6877 - loss: 0.6155 - val_accuracy: 0.6974 - val_loss: 0.6362
Epoch 124/1500
5/5             0s 20ms/step -
accuracy: 0.7242 - loss: 0.6109 - val_accuracy: 0.6974 - val_loss: 0.6359
Epoch 125/1500
5/5             0s 20ms/step -
accuracy: 0.7194 - loss: 0.5854 - val_accuracy: 0.6974 - val_loss: 0.6356
Epoch 126/1500
5/5             0s 19ms/step -
accuracy: 0.7563 - loss: 0.6025 - val_accuracy: 0.6974 - val_loss: 0.6354
Epoch 127/1500
5/5             0s 24ms/step -
accuracy: 0.7142 - loss: 0.5923 - val_accuracy: 0.6974 - val_loss: 0.6351
Epoch 128/1500
5/5             0s 33ms/step -
accuracy: 0.7441 - loss: 0.5934 - val_accuracy: 0.6974 - val_loss: 0.6349
```

```
Epoch 129/1500
5/5             0s 19ms/step -
accuracy: 0.7090 - loss: 0.6065 - val_accuracy: 0.6974 - val_loss: 0.6347
Epoch 130/1500
5/5             0s 22ms/step -
accuracy: 0.7281 - loss: 0.6106 - val_accuracy: 0.6974 - val_loss: 0.6344
Epoch 131/1500
5/5             0s 20ms/step -
accuracy: 0.7350 - loss: 0.5947 - val_accuracy: 0.6974 - val_loss: 0.6342
Epoch 132/1500
5/5             0s 20ms/step -
accuracy: 0.7103 - loss: 0.6049 - val_accuracy: 0.7039 - val_loss: 0.6339
Epoch 133/1500
5/5             0s 21ms/step -
accuracy: 0.7337 - loss: 0.6083 - val_accuracy: 0.7039 - val_loss: 0.6337
Epoch 134/1500
5/5             0s 26ms/step -
accuracy: 0.7354 - loss: 0.5975 - val_accuracy: 0.7105 - val_loss: 0.6334
Epoch 135/1500
5/5             0s 17ms/step -
accuracy: 0.7090 - loss: 0.6104 - val_accuracy: 0.7105 - val_loss: 0.6332
Epoch 136/1500
5/5             0s 18ms/step -
accuracy: 0.7619 - loss: 0.5902 - val_accuracy: 0.7105 - val_loss: 0.6329
Epoch 137/1500
5/5             0s 19ms/step -
accuracy: 0.7354 - loss: 0.5934 - val_accuracy: 0.7105 - val_loss: 0.6327
Epoch 138/1500
5/5             0s 38ms/step -
accuracy: 0.7229 - loss: 0.6026 - val_accuracy: 0.7105 - val_loss: 0.6324
Epoch 139/1500
5/5             0s 18ms/step -
accuracy: 0.7350 - loss: 0.6083 - val_accuracy: 0.7105 - val_loss: 0.6322
Epoch 140/1500
5/5             0s 18ms/step -
accuracy: 0.7658 - loss: 0.5906 - val_accuracy: 0.7105 - val_loss: 0.6319
Epoch 141/1500
5/5             0s 18ms/step -
accuracy: 0.7398 - loss: 0.5928 - val_accuracy: 0.7105 - val_loss: 0.6317
Epoch 142/1500
5/5             0s 24ms/step -
accuracy: 0.7194 - loss: 0.6064 - val_accuracy: 0.7105 - val_loss: 0.6314
Epoch 143/1500
5/5             0s 19ms/step -
accuracy: 0.7320 - loss: 0.5955 - val_accuracy: 0.7171 - val_loss: 0.6312
Epoch 144/1500
5/5             0s 19ms/step -
accuracy: 0.7181 - loss: 0.5940 - val_accuracy: 0.7237 - val_loss: 0.6309
```

```
Epoch 145/1500
5/5             0s 19ms/step -
accuracy: 0.7472 - loss: 0.5825 - val_accuracy: 0.7237 - val_loss: 0.6307
Epoch 146/1500
5/5             0s 18ms/step -
accuracy: 0.7042 - loss: 0.6048 - val_accuracy: 0.7237 - val_loss: 0.6304
Epoch 147/1500
5/5             0s 21ms/step -
accuracy: 0.7320 - loss: 0.5998 - val_accuracy: 0.7237 - val_loss: 0.6302
Epoch 148/1500
5/5             0s 21ms/step -
accuracy: 0.7116 - loss: 0.6049 - val_accuracy: 0.7237 - val_loss: 0.6300
Epoch 149/1500
5/5             0s 21ms/step -
accuracy: 0.7107 - loss: 0.6092 - val_accuracy: 0.7237 - val_loss: 0.6297
Epoch 150/1500
5/5             0s 19ms/step -
accuracy: 0.7363 - loss: 0.5989 - val_accuracy: 0.7237 - val_loss: 0.6294
Epoch 151/1500
5/5             0s 21ms/step -
accuracy: 0.6946 - loss: 0.6032 - val_accuracy: 0.7237 - val_loss: 0.6292
Epoch 152/1500
5/5             0s 21ms/step -
accuracy: 0.7272 - loss: 0.5947 - val_accuracy: 0.7237 - val_loss: 0.6289
Epoch 153/1500
5/5             0s 20ms/step -
accuracy: 0.7298 - loss: 0.6012 - val_accuracy: 0.7237 - val_loss: 0.6287
Epoch 154/1500
5/5             0s 16ms/step -
accuracy: 0.7459 - loss: 0.5843 - val_accuracy: 0.7237 - val_loss: 0.6284
Epoch 155/1500
5/5             0s 16ms/step -
accuracy: 0.7246 - loss: 0.6077 - val_accuracy: 0.7237 - val_loss: 0.6281
Epoch 156/1500
5/5             0s 32ms/step -
accuracy: 0.7342 - loss: 0.5875 - val_accuracy: 0.7237 - val_loss: 0.6279
Epoch 157/1500
5/5             0s 26ms/step -
accuracy: 0.7355 - loss: 0.5967 - val_accuracy: 0.7237 - val_loss: 0.6276
Epoch 158/1500
5/5             0s 19ms/step -
accuracy: 0.7259 - loss: 0.5945 - val_accuracy: 0.7237 - val_loss: 0.6274
Epoch 159/1500
5/5             0s 20ms/step -
accuracy: 0.7472 - loss: 0.5870 - val_accuracy: 0.7237 - val_loss: 0.6271
Epoch 160/1500
5/5             0s 28ms/step -
accuracy: 0.7129 - loss: 0.6076 - val_accuracy: 0.7237 - val_loss: 0.6269
```

```
Epoch 161/1500
5/5             0s 30ms/step -
accuracy: 0.7450 - loss: 0.5895 - val_accuracy: 0.7237 - val_loss: 0.6266
Epoch 162/1500
5/5             0s 20ms/step -
accuracy: 0.7255 - loss: 0.6021 - val_accuracy: 0.7237 - val_loss: 0.6263
Epoch 163/1500
5/5             0s 20ms/step -
accuracy: 0.7177 - loss: 0.6016 - val_accuracy: 0.7237 - val_loss: 0.6260
Epoch 164/1500
5/5             0s 21ms/step -
accuracy: 0.7503 - loss: 0.5933 - val_accuracy: 0.7237 - val_loss: 0.6258
Epoch 165/1500
5/5             0s 23ms/step -
accuracy: 0.7034 - loss: 0.6165 - val_accuracy: 0.7237 - val_loss: 0.6255
Epoch 166/1500
5/5             0s 17ms/step -
accuracy: 0.7807 - loss: 0.5807 - val_accuracy: 0.7303 - val_loss: 0.6252
Epoch 167/1500
5/5             0s 18ms/step -
accuracy: 0.7581 - loss: 0.6061 - val_accuracy: 0.7303 - val_loss: 0.6249
Epoch 168/1500
5/5             0s 20ms/step -
accuracy: 0.7412 - loss: 0.5886 - val_accuracy: 0.7303 - val_loss: 0.6247
Epoch 169/1500
5/5             0s 16ms/step -
accuracy: 0.7377 - loss: 0.5912 - val_accuracy: 0.7303 - val_loss: 0.6244
Epoch 170/1500
5/5             0s 26ms/step -
accuracy: 0.7342 - loss: 0.5935 - val_accuracy: 0.7303 - val_loss: 0.6241
Epoch 171/1500
5/5             0s 38ms/step -
accuracy: 0.7529 - loss: 0.5987 - val_accuracy: 0.7303 - val_loss: 0.6238
Epoch 172/1500
5/5             0s 47ms/step -
accuracy: 0.7624 - loss: 0.5794 - val_accuracy: 0.7303 - val_loss: 0.6236
Epoch 173/1500
5/5             0s 44ms/step -
accuracy: 0.7620 - loss: 0.5816 - val_accuracy: 0.7303 - val_loss: 0.6233
Epoch 174/1500
5/5             0s 26ms/step -
accuracy: 0.7299 - loss: 0.5863 - val_accuracy: 0.7303 - val_loss: 0.6230
Epoch 175/1500
5/5             0s 29ms/step -
accuracy: 0.7533 - loss: 0.5861 - val_accuracy: 0.7303 - val_loss: 0.6227
Epoch 176/1500
5/5             0s 31ms/step -
accuracy: 0.7768 - loss: 0.5867 - val_accuracy: 0.7303 - val_loss: 0.6225
```

```
Epoch 177/1500
5/5             0s 23ms/step -
accuracy: 0.7503 - loss: 0.5855 - val_accuracy: 0.7303 - val_loss: 0.6222
Epoch 178/1500
5/5             0s 32ms/step -
accuracy: 0.7524 - loss: 0.5814 - val_accuracy: 0.7303 - val_loss: 0.6219
Epoch 179/1500
5/5             0s 25ms/step -
accuracy: 0.7516 - loss: 0.5897 - val_accuracy: 0.7303 - val_loss: 0.6216
Epoch 180/1500
5/5             0s 42ms/step -
accuracy: 0.7095 - loss: 0.6030 - val_accuracy: 0.7303 - val_loss: 0.6213
Epoch 181/1500
5/5             0s 28ms/step -
accuracy: 0.7177 - loss: 0.5941 - val_accuracy: 0.7303 - val_loss: 0.6211
Epoch 182/1500
5/5             0s 21ms/step -
accuracy: 0.7577 - loss: 0.5930 - val_accuracy: 0.7303 - val_loss: 0.6208
Epoch 183/1500
5/5             0s 21ms/step -
accuracy: 0.7759 - loss: 0.5784 - val_accuracy: 0.7303 - val_loss: 0.6206
Epoch 184/1500
5/5             0s 20ms/step -
accuracy: 0.7638 - loss: 0.5735 - val_accuracy: 0.7303 - val_loss: 0.6203
Epoch 185/1500
5/5             0s 19ms/step -
accuracy: 0.7733 - loss: 0.5719 - val_accuracy: 0.7303 - val_loss: 0.6200
Epoch 186/1500
5/5             0s 27ms/step -
accuracy: 0.7460 - loss: 0.5969 - val_accuracy: 0.7368 - val_loss: 0.6197
Epoch 187/1500
5/5             0s 19ms/step -
accuracy: 0.7503 - loss: 0.5843 - val_accuracy: 0.7368 - val_loss: 0.6195
Epoch 188/1500
5/5             0s 46ms/step -
accuracy: 0.7529 - loss: 0.5786 - val_accuracy: 0.7368 - val_loss: 0.6192
Epoch 189/1500
5/5             0s 21ms/step -
accuracy: 0.7317 - loss: 0.5835 - val_accuracy: 0.7368 - val_loss: 0.6189
Epoch 190/1500
5/5             0s 24ms/step -
accuracy: 0.7590 - loss: 0.5753 - val_accuracy: 0.7368 - val_loss: 0.6187
Epoch 191/1500
5/5             0s 23ms/step -
accuracy: 0.7351 - loss: 0.5861 - val_accuracy: 0.7368 - val_loss: 0.6184
Epoch 192/1500
5/5             0s 51ms/step -
accuracy: 0.7225 - loss: 0.5871 - val_accuracy: 0.7368 - val_loss: 0.6181
```

```
Epoch 193/1500
5/5             0s 19ms/step -
accuracy: 0.7334 - loss: 0.5883 - val_accuracy: 0.7368 - val_loss: 0.6179
Epoch 194/1500
5/5             0s 21ms/step -
accuracy: 0.7529 - loss: 0.5711 - val_accuracy: 0.7368 - val_loss: 0.6176
Epoch 195/1500
5/5             0s 19ms/step -
accuracy: 0.7711 - loss: 0.5771 - val_accuracy: 0.7368 - val_loss: 0.6173
Epoch 196/1500
5/5             0s 32ms/step -
accuracy: 0.7434 - loss: 0.5832 - val_accuracy: 0.7368 - val_loss: 0.6171
Epoch 197/1500
5/5             0s 20ms/step -
accuracy: 0.7786 - loss: 0.5771 - val_accuracy: 0.7368 - val_loss: 0.6168
Epoch 198/1500
5/5             0s 37ms/step -
accuracy: 0.7816 - loss: 0.5679 - val_accuracy: 0.7368 - val_loss: 0.6165
Epoch 199/1500
5/5             0s 29ms/step -
accuracy: 0.7734 - loss: 0.5685 - val_accuracy: 0.7368 - val_loss: 0.6162
Epoch 200/1500
5/5             0s 33ms/step -
accuracy: 0.7838 - loss: 0.5667 - val_accuracy: 0.7368 - val_loss: 0.6160
Epoch 201/1500
5/5             0s 40ms/step -
accuracy: 0.7234 - loss: 0.5900 - val_accuracy: 0.7368 - val_loss: 0.6157
Epoch 202/1500
5/5             0s 19ms/step -
accuracy: 0.7903 - loss: 0.5554 - val_accuracy: 0.7368 - val_loss: 0.6154
Epoch 203/1500
5/5             0s 20ms/step -
accuracy: 0.7564 - loss: 0.5856 - val_accuracy: 0.7368 - val_loss: 0.6151
Epoch 204/1500
5/5             0s 19ms/step -
accuracy: 0.7326 - loss: 0.5933 - val_accuracy: 0.7368 - val_loss: 0.6148
Epoch 205/1500
5/5             0s 19ms/step -
accuracy: 0.7356 - loss: 0.5779 - val_accuracy: 0.7368 - val_loss: 0.6145
Epoch 206/1500
5/5             0s 22ms/step -
accuracy: 0.7543 - loss: 0.5699 - val_accuracy: 0.7368 - val_loss: 0.6142
Epoch 207/1500
5/5             0s 21ms/step -
accuracy: 0.7816 - loss: 0.5738 - val_accuracy: 0.7368 - val_loss: 0.6139
Epoch 208/1500
5/5             0s 20ms/step -
accuracy: 0.7699 - loss: 0.5675 - val_accuracy: 0.7368 - val_loss: 0.6137
```

```
Epoch 209/1500
5/5             0s 24ms/step -
accuracy: 0.7829 - loss: 0.5700 - val_accuracy: 0.7368 - val_loss: 0.6134
Epoch 210/1500
5/5             0s 49ms/step -
accuracy: 0.7274 - loss: 0.5922 - val_accuracy: 0.7368 - val_loss: 0.6131
Epoch 211/1500
5/5             0s 21ms/step -
accuracy: 0.7630 - loss: 0.5712 - val_accuracy: 0.7368 - val_loss: 0.6128
Epoch 212/1500
5/5             0s 18ms/step -
accuracy: 0.7560 - loss: 0.5736 - val_accuracy: 0.7368 - val_loss: 0.6125
Epoch 213/1500
5/5             0s 25ms/step -
accuracy: 0.7834 - loss: 0.5616 - val_accuracy: 0.7368 - val_loss: 0.6122
Epoch 214/1500
5/5             0s 31ms/step -
accuracy: 0.7521 - loss: 0.5766 - val_accuracy: 0.7368 - val_loss: 0.6119
Epoch 215/1500
5/5             0s 51ms/step -
accuracy: 0.7886 - loss: 0.5679 - val_accuracy: 0.7368 - val_loss: 0.6116
Epoch 216/1500
5/5             0s 33ms/step -
accuracy: 0.7721 - loss: 0.5641 - val_accuracy: 0.7368 - val_loss: 0.6114
Epoch 217/1500
5/5             0s 16ms/step -
accuracy: 0.7704 - loss: 0.5729 - val_accuracy: 0.7368 - val_loss: 0.6111
Epoch 218/1500
5/5             0s 11ms/step -
accuracy: 0.7717 - loss: 0.5716 - val_accuracy: 0.7368 - val_loss: 0.6108
Epoch 219/1500
5/5             0s 14ms/step -
accuracy: 0.7825 - loss: 0.5603 - val_accuracy: 0.7368 - val_loss: 0.6105
Epoch 220/1500
5/5             0s 11ms/step -
accuracy: 0.7444 - loss: 0.5729 - val_accuracy: 0.7368 - val_loss: 0.6102
Epoch 221/1500
5/5             0s 11ms/step -
accuracy: 0.7192 - loss: 0.5902 - val_accuracy: 0.7368 - val_loss: 0.6099
Epoch 222/1500
5/5             0s 12ms/step -
accuracy: 0.7791 - loss: 0.5652 - val_accuracy: 0.7368 - val_loss: 0.6096
Epoch 223/1500
5/5             0s 14ms/step -
accuracy: 0.7752 - loss: 0.5786 - val_accuracy: 0.7434 - val_loss: 0.6093
Epoch 224/1500
5/5             0s 15ms/step -
accuracy: 0.7921 - loss: 0.5524 - val_accuracy: 0.7434 - val_loss: 0.6090
```

```
Epoch 225/1500
5/5             0s 11ms/step -
accuracy: 0.7574 - loss: 0.5718 - val_accuracy: 0.7434 - val_loss: 0.6088
Epoch 226/1500
5/5             0s 15ms/step -
accuracy: 0.8077 - loss: 0.5468 - val_accuracy: 0.7434 - val_loss: 0.6085
Epoch 227/1500
5/5             0s 10ms/step -
accuracy: 0.7626 - loss: 0.5631 - val_accuracy: 0.7434 - val_loss: 0.6082
Epoch 228/1500
5/5             0s 15ms/step -
accuracy: 0.7661 - loss: 0.5776 - val_accuracy: 0.7434 - val_loss: 0.6079
Epoch 229/1500
5/5             0s 12ms/step -
accuracy: 0.7721 - loss: 0.5702 - val_accuracy: 0.7434 - val_loss: 0.6076
Epoch 230/1500
5/5             0s 14ms/step -
accuracy: 0.7891 - loss: 0.5516 - val_accuracy: 0.7434 - val_loss: 0.6073
Epoch 231/1500
5/5             0s 10ms/step -
accuracy: 0.7643 - loss: 0.5628 - val_accuracy: 0.7434 - val_loss: 0.6070
Epoch 232/1500
5/5             0s 13ms/step -
accuracy: 0.7548 - loss: 0.5910 - val_accuracy: 0.7434 - val_loss: 0.6068
Epoch 233/1500
5/5             0s 23ms/step -
accuracy: 0.7630 - loss: 0.5621 - val_accuracy: 0.7434 - val_loss: 0.6065
Epoch 234/1500
5/5             0s 18ms/step -
accuracy: 0.7396 - loss: 0.5785 - val_accuracy: 0.7434 - val_loss: 0.6062
Epoch 235/1500
5/5             0s 17ms/step -
accuracy: 0.7821 - loss: 0.5644 - val_accuracy: 0.7500 - val_loss: 0.6059
Epoch 236/1500
5/5             0s 17ms/step -
accuracy: 0.7734 - loss: 0.5633 - val_accuracy: 0.7500 - val_loss: 0.6056
Epoch 237/1500
5/5             0s 21ms/step -
accuracy: 0.7986 - loss: 0.5380 - val_accuracy: 0.7500 - val_loss: 0.6053
Epoch 238/1500
5/5             0s 17ms/step -
accuracy: 0.7591 - loss: 0.5748 - val_accuracy: 0.7500 - val_loss: 0.6050
Epoch 239/1500
5/5             0s 16ms/step -
accuracy: 0.7951 - loss: 0.5487 - val_accuracy: 0.7500 - val_loss: 0.6048
Epoch 240/1500
5/5             0s 18ms/step -
accuracy: 0.7695 - loss: 0.5670 - val_accuracy: 0.7500 - val_loss: 0.6045
```

```
Epoch 241/1500
5/5             0s 16ms/step -
accuracy: 0.7478 - loss: 0.5702 - val_accuracy: 0.7500 - val_loss: 0.6042
Epoch 242/1500
5/5             0s 18ms/step -
accuracy: 0.7457 - loss: 0.5518 - val_accuracy: 0.7500 - val_loss: 0.6039
Epoch 243/1500
5/5             0s 19ms/step -
accuracy: 0.7817 - loss: 0.5736 - val_accuracy: 0.7500 - val_loss: 0.6036
Epoch 244/1500
5/5             0s 18ms/step -
accuracy: 0.7626 - loss: 0.5699 - val_accuracy: 0.7500 - val_loss: 0.6033
Epoch 245/1500
5/5             0s 14ms/step -
accuracy: 0.7665 - loss: 0.5564 - val_accuracy: 0.7500 - val_loss: 0.6031
Epoch 246/1500
5/5             0s 20ms/step -
accuracy: 0.7487 - loss: 0.5767 - val_accuracy: 0.7566 - val_loss: 0.6028
Epoch 247/1500
5/5             0s 18ms/step -
accuracy: 0.8242 - loss: 0.5454 - val_accuracy: 0.7632 - val_loss: 0.6025
Epoch 248/1500
5/5             0s 17ms/step -
accuracy: 0.7825 - loss: 0.5565 - val_accuracy: 0.7632 - val_loss: 0.6022
Epoch 249/1500
5/5             0s 14ms/step -
accuracy: 0.7691 - loss: 0.5584 - val_accuracy: 0.7632 - val_loss: 0.6019
Epoch 250/1500
5/5             0s 14ms/step -
accuracy: 0.7943 - loss: 0.5577 - val_accuracy: 0.7632 - val_loss: 0.6016
Epoch 251/1500
5/5             0s 12ms/step -
accuracy: 0.7748 - loss: 0.5641 - val_accuracy: 0.7632 - val_loss: 0.6014
Epoch 252/1500
5/5             0s 14ms/step -
accuracy: 0.8078 - loss: 0.5465 - val_accuracy: 0.7632 - val_loss: 0.6011
Epoch 253/1500
5/5             0s 13ms/step -
accuracy: 0.7704 - loss: 0.5585 - val_accuracy: 0.7632 - val_loss: 0.6008
Epoch 254/1500
5/5             0s 15ms/step -
accuracy: 0.7509 - loss: 0.5624 - val_accuracy: 0.7697 - val_loss: 0.6005
Epoch 255/1500
5/5             0s 16ms/step -
accuracy: 0.7821 - loss: 0.5532 - val_accuracy: 0.7697 - val_loss: 0.6002
Epoch 256/1500
5/5             0s 11ms/step -
accuracy: 0.7756 - loss: 0.5646 - val_accuracy: 0.7697 - val_loss: 0.6000
```

```
Epoch 257/1500
5/5             0s 11ms/step -
accuracy: 0.7913 - loss: 0.5545 - val_accuracy: 0.7697 - val_loss: 0.5997
Epoch 258/1500
5/5             0s 15ms/step -
accuracy: 0.7570 - loss: 0.5729 - val_accuracy: 0.7697 - val_loss: 0.5994
Epoch 259/1500
5/5             0s 15ms/step -
accuracy: 0.8025 - loss: 0.5361 - val_accuracy: 0.7697 - val_loss: 0.5991
Epoch 260/1500
5/5             0s 16ms/step -
accuracy: 0.7986 - loss: 0.5411 - val_accuracy: 0.7697 - val_loss: 0.5988
Epoch 261/1500
5/5             0s 11ms/step -
accuracy: 0.7617 - loss: 0.5694 - val_accuracy: 0.7697 - val_loss: 0.5985
Epoch 262/1500
5/5             0s 13ms/step -
accuracy: 0.7405 - loss: 0.5614 - val_accuracy: 0.7697 - val_loss: 0.5982
Epoch 263/1500
5/5             0s 15ms/step -
accuracy: 0.7791 - loss: 0.5498 - val_accuracy: 0.7697 - val_loss: 0.5980
Epoch 264/1500
5/5             0s 15ms/step -
accuracy: 0.7930 - loss: 0.5357 - val_accuracy: 0.7697 - val_loss: 0.5977
Epoch 265/1500
5/5             0s 14ms/step -
accuracy: 0.7882 - loss: 0.5470 - val_accuracy: 0.7697 - val_loss: 0.5974
Epoch 266/1500
5/5             0s 15ms/step -
accuracy: 0.7496 - loss: 0.5629 - val_accuracy: 0.7697 - val_loss: 0.5971
Epoch 267/1500
5/5             0s 15ms/step -
accuracy: 0.7648 - loss: 0.5515 - val_accuracy: 0.7697 - val_loss: 0.5968
Epoch 268/1500
5/5             0s 12ms/step -
accuracy: 0.7661 - loss: 0.5614 - val_accuracy: 0.7697 - val_loss: 0.5965
Epoch 269/1500
5/5             0s 14ms/step -
accuracy: 0.7813 - loss: 0.5484 - val_accuracy: 0.7697 - val_loss: 0.5963
Epoch 270/1500
5/5             0s 11ms/step -
accuracy: 0.8078 - loss: 0.5396 - val_accuracy: 0.7697 - val_loss: 0.5960
Epoch 271/1500
5/5             0s 15ms/step -
accuracy: 0.7865 - loss: 0.5531 - val_accuracy: 0.7697 - val_loss: 0.5957
Epoch 272/1500
5/5             0s 14ms/step -
accuracy: 0.7518 - loss: 0.5686 - val_accuracy: 0.7697 - val_loss: 0.5954
```

```
Epoch 273/1500
5/5             0s 12ms/step -
accuracy: 0.7874 - loss: 0.5527 - val_accuracy: 0.7697 - val_loss: 0.5951
Epoch 274/1500
5/5             0s 14ms/step -
accuracy: 0.7870 - loss: 0.5552 - val_accuracy: 0.7697 - val_loss: 0.5949
Epoch 275/1500
5/5             0s 15ms/step -
accuracy: 0.7631 - loss: 0.5610 - val_accuracy: 0.7697 - val_loss: 0.5946
Epoch 276/1500
5/5             0s 11ms/step -
accuracy: 0.7852 - loss: 0.5617 - val_accuracy: 0.7697 - val_loss: 0.5943
Epoch 277/1500
5/5             0s 15ms/step -
accuracy: 0.8035 - loss: 0.5339 - val_accuracy: 0.7697 - val_loss: 0.5940
Epoch 278/1500
5/5             0s 13ms/step -
accuracy: 0.7505 - loss: 0.5752 - val_accuracy: 0.7697 - val_loss: 0.5937
Epoch 279/1500
5/5             0s 14ms/step -
accuracy: 0.7635 - loss: 0.5723 - val_accuracy: 0.7697 - val_loss: 0.5934
Epoch 280/1500
5/5             0s 11ms/step -
accuracy: 0.7670 - loss: 0.5543 - val_accuracy: 0.7697 - val_loss: 0.5932
Epoch 281/1500
5/5             0s 11ms/step -
accuracy: 0.7861 - loss: 0.5364 - val_accuracy: 0.7697 - val_loss: 0.5929
Epoch 282/1500
5/5             0s 12ms/step -
accuracy: 0.7562 - loss: 0.5606 - val_accuracy: 0.7697 - val_loss: 0.5926
Epoch 283/1500
5/5             0s 15ms/step -
accuracy: 0.7775 - loss: 0.5443 - val_accuracy: 0.7697 - val_loss: 0.5923
Epoch 284/1500
5/5             0s 12ms/step -
accuracy: 0.7792 - loss: 0.5452 - val_accuracy: 0.7697 - val_loss: 0.5920
Epoch 285/1500
5/5             0s 14ms/step -
accuracy: 0.8191 - loss: 0.5358 - val_accuracy: 0.7697 - val_loss: 0.5917
Epoch 286/1500
5/5             0s 15ms/step -
accuracy: 0.8191 - loss: 0.5347 - val_accuracy: 0.7697 - val_loss: 0.5914
Epoch 287/1500
5/5             0s 14ms/step -
accuracy: 0.7562 - loss: 0.5720 - val_accuracy: 0.7697 - val_loss: 0.5912
Epoch 288/1500
5/5             0s 17ms/step -
accuracy: 0.7497 - loss: 0.5801 - val_accuracy: 0.7697 - val_loss: 0.5909
```

```
Epoch 289/1500
5/5             0s 15ms/step -
accuracy: 0.7918 - loss: 0.5195 - val_accuracy: 0.7697 - val_loss: 0.5906
Epoch 290/1500
5/5             0s 15ms/step -
accuracy: 0.7636 - loss: 0.5703 - val_accuracy: 0.7697 - val_loss: 0.5903
Epoch 291/1500
5/5             0s 12ms/step -
accuracy: 0.7801 - loss: 0.5528 - val_accuracy: 0.7697 - val_loss: 0.5900
Epoch 292/1500
5/5             0s 15ms/step -
accuracy: 0.7675 - loss: 0.5776 - val_accuracy: 0.7697 - val_loss: 0.5897
Epoch 293/1500
5/5             0s 12ms/step -
accuracy: 0.8018 - loss: 0.5311 - val_accuracy: 0.7697 - val_loss: 0.5894
Epoch 294/1500
5/5             0s 15ms/step -
accuracy: 0.8100 - loss: 0.5267 - val_accuracy: 0.7697 - val_loss: 0.5891
Epoch 295/1500
5/5             0s 12ms/step -
accuracy: 0.7827 - loss: 0.5446 - val_accuracy: 0.7697 - val_loss: 0.5888
Epoch 296/1500
5/5             0s 12ms/step -
accuracy: 0.7926 - loss: 0.5469 - val_accuracy: 0.7697 - val_loss: 0.5885
Epoch 297/1500
5/5             0s 15ms/step -
accuracy: 0.7883 - loss: 0.5509 - val_accuracy: 0.7697 - val_loss: 0.5882
Epoch 298/1500
5/5             0s 16ms/step -
accuracy: 0.7913 - loss: 0.5551 - val_accuracy: 0.7697 - val_loss: 0.5879
Epoch 299/1500
5/5             0s 12ms/step -
accuracy: 0.7861 - loss: 0.5339 - val_accuracy: 0.7697 - val_loss: 0.5877
Epoch 300/1500
5/5             0s 15ms/step -
accuracy: 0.7788 - loss: 0.5528 - val_accuracy: 0.7697 - val_loss: 0.5873
Epoch 301/1500
5/5             0s 11ms/step -
accuracy: 0.7788 - loss: 0.5485 - val_accuracy: 0.7697 - val_loss: 0.5870
Epoch 302/1500
5/5             0s 11ms/step -
accuracy: 0.7770 - loss: 0.5510 - val_accuracy: 0.7697 - val_loss: 0.5867
Epoch 303/1500
5/5             0s 14ms/step -
accuracy: 0.7861 - loss: 0.5399 - val_accuracy: 0.7697 - val_loss: 0.5864
Epoch 304/1500
5/5             0s 15ms/step -
accuracy: 0.8022 - loss: 0.5294 - val_accuracy: 0.7697 - val_loss: 0.5862
```

```
Epoch 305/1500
5/5             0s 11ms/step -
accuracy: 0.8083 - loss: 0.5189 - val_accuracy: 0.7697 - val_loss: 0.5858
Epoch 306/1500
5/5             0s 11ms/step -
accuracy: 0.7939 - loss: 0.5552 - val_accuracy: 0.7697 - val_loss: 0.5856
Epoch 307/1500
5/5             0s 11ms/step -
accuracy: 0.7939 - loss: 0.5410 - val_accuracy: 0.7697 - val_loss: 0.5853
Epoch 308/1500
5/5             0s 11ms/step -
accuracy: 0.7701 - loss: 0.5293 - val_accuracy: 0.7697 - val_loss: 0.5850
Epoch 309/1500
5/5             0s 14ms/step -
accuracy: 0.8083 - loss: 0.5434 - val_accuracy: 0.7697 - val_loss: 0.5847
Epoch 310/1500
5/5             0s 15ms/step -
accuracy: 0.8026 - loss: 0.5232 - val_accuracy: 0.7697 - val_loss: 0.5844
Epoch 311/1500
5/5             0s 15ms/step -
accuracy: 0.8013 - loss: 0.5334 - val_accuracy: 0.7697 - val_loss: 0.5841
Epoch 312/1500
5/5             0s 12ms/step -
accuracy: 0.8187 - loss: 0.5169 - val_accuracy: 0.7697 - val_loss: 0.5838
Epoch 313/1500
5/5             0s 11ms/step -
accuracy: 0.7887 - loss: 0.5453 - val_accuracy: 0.7697 - val_loss: 0.5835
Epoch 314/1500
5/5             0s 13ms/step -
accuracy: 0.7952 - loss: 0.5231 - val_accuracy: 0.7697 - val_loss: 0.5832
Epoch 315/1500
5/5             0s 11ms/step -
accuracy: 0.8091 - loss: 0.5352 - val_accuracy: 0.7697 - val_loss: 0.5829
Epoch 316/1500
5/5             0s 15ms/step -
accuracy: 0.7901 - loss: 0.5314 - val_accuracy: 0.7697 - val_loss: 0.5826
Epoch 317/1500
5/5             0s 15ms/step -
accuracy: 0.7992 - loss: 0.5406 - val_accuracy: 0.7697 - val_loss: 0.5823
Epoch 318/1500
5/5             0s 15ms/step -
accuracy: 0.7931 - loss: 0.5225 - val_accuracy: 0.7697 - val_loss: 0.5820
Epoch 319/1500
5/5             0s 12ms/step -
accuracy: 0.8144 - loss: 0.5354 - val_accuracy: 0.7697 - val_loss: 0.5818
Epoch 320/1500
5/5             0s 13ms/step -
accuracy: 0.8222 - loss: 0.5310 - val_accuracy: 0.7697 - val_loss: 0.5815
```

```
Epoch 321/1500
5/5             0s 15ms/step -
accuracy: 0.7775 - loss: 0.5501 - val_accuracy: 0.7697 - val_loss: 0.5812
Epoch 322/1500
5/5             0s 18ms/step -
accuracy: 0.7970 - loss: 0.5341 - val_accuracy: 0.7697 - val_loss: 0.5809
Epoch 323/1500
5/5             0s 13ms/step -
accuracy: 0.8083 - loss: 0.5414 - val_accuracy: 0.7697 - val_loss: 0.5806
Epoch 324/1500
5/5             0s 15ms/step -
accuracy: 0.7962 - loss: 0.5241 - val_accuracy: 0.7697 - val_loss: 0.5804
Epoch 325/1500
5/5             0s 12ms/step -
accuracy: 0.8014 - loss: 0.5340 - val_accuracy: 0.7697 - val_loss: 0.5801
Epoch 326/1500
5/5             0s 14ms/step -
accuracy: 0.7831 - loss: 0.5417 - val_accuracy: 0.7697 - val_loss: 0.5798
Epoch 327/1500
5/5             0s 16ms/step -
accuracy: 0.7857 - loss: 0.5415 - val_accuracy: 0.7697 - val_loss: 0.5795
Epoch 328/1500
5/5             0s 15ms/step -
accuracy: 0.7762 - loss: 0.5338 - val_accuracy: 0.7697 - val_loss: 0.5792
Epoch 329/1500
5/5             0s 13ms/step -
accuracy: 0.7727 - loss: 0.5404 - val_accuracy: 0.7697 - val_loss: 0.5789
Epoch 330/1500
5/5             0s 12ms/step -
accuracy: 0.7992 - loss: 0.5399 - val_accuracy: 0.7697 - val_loss: 0.5786
Epoch 331/1500
5/5             0s 12ms/step -
accuracy: 0.7945 - loss: 0.5337 - val_accuracy: 0.7697 - val_loss: 0.5783
Epoch 332/1500
5/5             0s 11ms/step -
accuracy: 0.8101 - loss: 0.5051 - val_accuracy: 0.7697 - val_loss: 0.5780
Epoch 333/1500
5/5             0s 11ms/step -
accuracy: 0.8053 - loss: 0.5247 - val_accuracy: 0.7697 - val_loss: 0.5777
Epoch 334/1500
5/5             0s 11ms/step -
accuracy: 0.7966 - loss: 0.5238 - val_accuracy: 0.7697 - val_loss: 0.5774
Epoch 335/1500
5/5             0s 18ms/step -
accuracy: 0.8144 - loss: 0.5232 - val_accuracy: 0.7697 - val_loss: 0.5771
Epoch 336/1500
5/5             0s 16ms/step -
accuracy: 0.8140 - loss: 0.5104 - val_accuracy: 0.7697 - val_loss: 0.5768
```

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Epoch 337/1500
5/5             0s 17ms/step -
accuracy: 0.7871 - loss: 0.5459 - val_accuracy: 0.7697 - val_loss: 0.5765
Epoch 338/1500
5/5             0s 24ms/step -
accuracy: 0.7905 - loss: 0.5439 - val_accuracy: 0.7697 - val_loss: 0.5762
Epoch 339/1500
5/5             0s 23ms/step -
accuracy: 0.8196 - loss: 0.5279 - val_accuracy: 0.7697 - val_loss: 0.5759
Epoch 340/1500
5/5             0s 14ms/step -
accuracy: 0.7914 - loss: 0.5499 - val_accuracy: 0.7697 - val_loss: 0.5756
Epoch 341/1500
5/5             0s 15ms/step -
accuracy: 0.7931 - loss: 0.5322 - val_accuracy: 0.7697 - val_loss: 0.5753
Epoch 342/1500
5/5             0s 16ms/step -
accuracy: 0.8222 - loss: 0.5147 - val_accuracy: 0.7697 - val_loss: 0.5750
Epoch 343/1500
5/5             0s 18ms/step -
accuracy: 0.8218 - loss: 0.5185 - val_accuracy: 0.7697 - val_loss: 0.5747
Epoch 344/1500
5/5             0s 19ms/step -
accuracy: 0.7845 - loss: 0.5251 - val_accuracy: 0.7697 - val_loss: 0.5744
Epoch 345/1500
5/5             0s 20ms/step -
accuracy: 0.8166 - loss: 0.5170 - val_accuracy: 0.7697 - val_loss: 0.5741
Epoch 346/1500
5/5             0s 17ms/step -
accuracy: 0.7632 - loss: 0.5549 - val_accuracy: 0.7697 - val_loss: 0.5739
Epoch 347/1500
5/5             0s 14ms/step -
accuracy: 0.7905 - loss: 0.5308 - val_accuracy: 0.7697 - val_loss: 0.5736
Epoch 348/1500
5/5             0s 18ms/step -
accuracy: 0.7984 - loss: 0.5073 - val_accuracy: 0.7697 - val_loss: 0.5733
Epoch 349/1500
5/5             0s 23ms/step -
accuracy: 0.7858 - loss: 0.5262 - val_accuracy: 0.7697 - val_loss: 0.5730
Epoch 350/1500
5/5             0s 15ms/step -
accuracy: 0.8092 - loss: 0.5310 - val_accuracy: 0.7697 - val_loss: 0.5727
Epoch 351/1500
5/5             0s 15ms/step -
accuracy: 0.8084 - loss: 0.5324 - val_accuracy: 0.7697 - val_loss: 0.5724
Epoch 352/1500
5/5             0s 18ms/step -
accuracy: 0.8283 - loss: 0.5178 - val_accuracy: 0.7697 - val_loss: 0.5722
```

```
Epoch 353/1500
5/5             0s 12ms/step -
accuracy: 0.7958 - loss: 0.5243 - val_accuracy: 0.7697 - val_loss: 0.5719
Epoch 354/1500
5/5             0s 15ms/step -
accuracy: 0.8166 - loss: 0.5241 - val_accuracy: 0.7697 - val_loss: 0.5716
Epoch 355/1500
5/5             0s 15ms/step -
accuracy: 0.8171 - loss: 0.5303 - val_accuracy: 0.7697 - val_loss: 0.5713
Epoch 356/1500
5/5             0s 14ms/step -
accuracy: 0.8045 - loss: 0.5124 - val_accuracy: 0.7632 - val_loss: 0.5710
Epoch 357/1500
5/5             0s 14ms/step -
accuracy: 0.7971 - loss: 0.5359 - val_accuracy: 0.7632 - val_loss: 0.5707
Epoch 358/1500
5/5             0s 13ms/step -
accuracy: 0.7954 - loss: 0.5173 - val_accuracy: 0.7566 - val_loss: 0.5704
Epoch 359/1500
5/5             0s 13ms/step -
accuracy: 0.7893 - loss: 0.5509 - val_accuracy: 0.7566 - val_loss: 0.5701
Epoch 360/1500
5/5             0s 15ms/step -
accuracy: 0.8119 - loss: 0.5106 - val_accuracy: 0.7566 - val_loss: 0.5699
Epoch 361/1500
5/5             0s 15ms/step -
accuracy: 0.8227 - loss: 0.5089 - val_accuracy: 0.7566 - val_loss: 0.5696
Epoch 362/1500
5/5             0s 15ms/step -
accuracy: 0.7741 - loss: 0.5319 - val_accuracy: 0.7566 - val_loss: 0.5693
Epoch 363/1500
5/5             0s 15ms/step -
accuracy: 0.8184 - loss: 0.5081 - val_accuracy: 0.7566 - val_loss: 0.5690
Epoch 364/1500
5/5             0s 17ms/step -
accuracy: 0.8136 - loss: 0.5030 - val_accuracy: 0.7566 - val_loss: 0.5687
Epoch 365/1500
5/5             0s 13ms/step -
accuracy: 0.8014 - loss: 0.5217 - val_accuracy: 0.7566 - val_loss: 0.5684
Epoch 366/1500
5/5             0s 14ms/step -
accuracy: 0.7880 - loss: 0.5227 - val_accuracy: 0.7566 - val_loss: 0.5682
Epoch 367/1500
5/5             0s 12ms/step -
accuracy: 0.8201 - loss: 0.5127 - val_accuracy: 0.7566 - val_loss: 0.5679
Epoch 368/1500
5/5             0s 12ms/step -
accuracy: 0.8105 - loss: 0.5110 - val_accuracy: 0.7566 - val_loss: 0.5676
```

```
Epoch 369/1500
5/5             0s 14ms/step -
accuracy: 0.8019 - loss: 0.5223 - val_accuracy: 0.7566 - val_loss: 0.5673
Epoch 370/1500
5/5             0s 11ms/step -
accuracy: 0.7988 - loss: 0.5246 - val_accuracy: 0.7566 - val_loss: 0.5670
Epoch 371/1500
5/5             0s 15ms/step -
accuracy: 0.8101 - loss: 0.5234 - val_accuracy: 0.7566 - val_loss: 0.5667
Epoch 372/1500
5/5             0s 13ms/step -
accuracy: 0.8023 - loss: 0.5164 - val_accuracy: 0.7566 - val_loss: 0.5665
Epoch 373/1500
5/5             0s 12ms/step -
accuracy: 0.8014 - loss: 0.5080 - val_accuracy: 0.7566 - val_loss: 0.5662
Epoch 374/1500
5/5             0s 12ms/step -
accuracy: 0.8101 - loss: 0.5229 - val_accuracy: 0.7566 - val_loss: 0.5659
Epoch 375/1500
5/5             0s 16ms/step -
accuracy: 0.8175 - loss: 0.5153 - val_accuracy: 0.7566 - val_loss: 0.5656
Epoch 376/1500
5/5             0s 11ms/step -
accuracy: 0.8079 - loss: 0.4979 - val_accuracy: 0.7566 - val_loss: 0.5653
Epoch 377/1500
5/5             0s 12ms/step -
accuracy: 0.8079 - loss: 0.5151 - val_accuracy: 0.7566 - val_loss: 0.5650
Epoch 378/1500
5/5             0s 15ms/step -
accuracy: 0.8149 - loss: 0.5077 - val_accuracy: 0.7566 - val_loss: 0.5648
Epoch 379/1500
5/5             0s 11ms/step -
accuracy: 0.8149 - loss: 0.5086 - val_accuracy: 0.7566 - val_loss: 0.5645
Epoch 380/1500
5/5             0s 11ms/step -
accuracy: 0.7754 - loss: 0.5233 - val_accuracy: 0.7566 - val_loss: 0.5642
Epoch 381/1500
5/5             0s 14ms/step -
accuracy: 0.8340 - loss: 0.4848 - val_accuracy: 0.7566 - val_loss: 0.5639
Epoch 382/1500
5/5             0s 12ms/step -
accuracy: 0.8105 - loss: 0.5190 - val_accuracy: 0.7566 - val_loss: 0.5636
Epoch 383/1500
5/5             0s 15ms/step -
accuracy: 0.8166 - loss: 0.5007 - val_accuracy: 0.7566 - val_loss: 0.5633
Epoch 384/1500
5/5             0s 16ms/step -
accuracy: 0.8127 - loss: 0.5160 - val_accuracy: 0.7566 - val_loss: 0.5631
```

```
Epoch 385/1500
5/5             0s 12ms/step -
accuracy: 0.8288 - loss: 0.4973 - val_accuracy: 0.7566 - val_loss: 0.5628
Epoch 386/1500
5/5             0s 14ms/step -
accuracy: 0.8392 - loss: 0.4920 - val_accuracy: 0.7566 - val_loss: 0.5625
Epoch 387/1500
5/5             0s 13ms/step -
accuracy: 0.8366 - loss: 0.4889 - val_accuracy: 0.7566 - val_loss: 0.5622
Epoch 388/1500
5/5             0s 15ms/step -
accuracy: 0.7810 - loss: 0.5331 - val_accuracy: 0.7566 - val_loss: 0.5619
Epoch 389/1500
5/5             0s 16ms/step -
accuracy: 0.8027 - loss: 0.5167 - val_accuracy: 0.7566 - val_loss: 0.5617
Epoch 390/1500
5/5             0s 12ms/step -
accuracy: 0.8288 - loss: 0.5140 - val_accuracy: 0.7566 - val_loss: 0.5614
Epoch 391/1500
5/5             0s 13ms/step -
accuracy: 0.8188 - loss: 0.5227 - val_accuracy: 0.7566 - val_loss: 0.5611
Epoch 392/1500
5/5             0s 15ms/step -
accuracy: 0.8088 - loss: 0.5160 - val_accuracy: 0.7566 - val_loss: 0.5608
Epoch 393/1500
5/5             0s 13ms/step -
accuracy: 0.8110 - loss: 0.5095 - val_accuracy: 0.7566 - val_loss: 0.5605
Epoch 394/1500
5/5             0s 12ms/step -
accuracy: 0.8249 - loss: 0.4931 - val_accuracy: 0.7566 - val_loss: 0.5602
Epoch 395/1500
5/5             0s 19ms/step -
accuracy: 0.8306 - loss: 0.4910 - val_accuracy: 0.7566 - val_loss: 0.5600
Epoch 396/1500
5/5             0s 12ms/step -
accuracy: 0.8371 - loss: 0.4799 - val_accuracy: 0.7566 - val_loss: 0.5597
Epoch 397/1500
5/5             0s 15ms/step -
accuracy: 0.8266 - loss: 0.4938 - val_accuracy: 0.7566 - val_loss: 0.5594
Epoch 398/1500
5/5             0s 16ms/step -
accuracy: 0.8197 - loss: 0.5268 - val_accuracy: 0.7566 - val_loss: 0.5591
Epoch 399/1500
5/5             0s 16ms/step -
accuracy: 0.7772 - loss: 0.5379 - val_accuracy: 0.7566 - val_loss: 0.5588
Epoch 400/1500
5/5             0s 12ms/step -
accuracy: 0.7937 - loss: 0.5315 - val_accuracy: 0.7566 - val_loss: 0.5585
```

```
Epoch 401/1500
5/5             0s 14ms/step -
accuracy: 0.8253 - loss: 0.5029 - val_accuracy: 0.7566 - val_loss: 0.5582
Epoch 402/1500
5/5             0s 11ms/step -
accuracy: 0.7772 - loss: 0.5392 - val_accuracy: 0.7566 - val_loss: 0.5579
Epoch 403/1500
5/5             0s 12ms/step -
accuracy: 0.8223 - loss: 0.4958 - val_accuracy: 0.7566 - val_loss: 0.5576
Epoch 404/1500
5/5             0s 11ms/step -
accuracy: 0.8128 - loss: 0.4868 - val_accuracy: 0.7566 - val_loss: 0.5573
Epoch 405/1500
5/5             0s 14ms/step -
accuracy: 0.8366 - loss: 0.4881 - val_accuracy: 0.7566 - val_loss: 0.5571
Epoch 406/1500
5/5             0s 14ms/step -
accuracy: 0.7880 - loss: 0.5071 - val_accuracy: 0.7566 - val_loss: 0.5568
Epoch 407/1500
5/5             0s 15ms/step -
accuracy: 0.8336 - loss: 0.4985 - val_accuracy: 0.7566 - val_loss: 0.5565
Epoch 408/1500
5/5             0s 11ms/step -
accuracy: 0.8271 - loss: 0.5091 - val_accuracy: 0.7566 - val_loss: 0.5562
Epoch 409/1500
5/5             0s 16ms/step -
accuracy: 0.8141 - loss: 0.5081 - val_accuracy: 0.7566 - val_loss: 0.5559
Epoch 410/1500
5/5             0s 12ms/step -
accuracy: 0.8175 - loss: 0.5036 - val_accuracy: 0.7566 - val_loss: 0.5556
Epoch 411/1500
5/5             0s 15ms/step -
accuracy: 0.7819 - loss: 0.5406 - val_accuracy: 0.7566 - val_loss: 0.5553
Epoch 412/1500
5/5             0s 12ms/step -
accuracy: 0.8102 - loss: 0.5043 - val_accuracy: 0.7566 - val_loss: 0.5550
Epoch 413/1500
5/5             0s 12ms/step -
accuracy: 0.8154 - loss: 0.4971 - val_accuracy: 0.7566 - val_loss: 0.5547
Epoch 414/1500
5/5             0s 12ms/step -
accuracy: 0.8358 - loss: 0.5002 - val_accuracy: 0.7566 - val_loss: 0.5544
Epoch 415/1500
5/5             0s 15ms/step -
accuracy: 0.7650 - loss: 0.5307 - val_accuracy: 0.7566 - val_loss: 0.5541
Epoch 416/1500
5/5             0s 15ms/step -
accuracy: 0.8071 - loss: 0.4929 - val_accuracy: 0.7566 - val_loss: 0.5539
```

```
Epoch 417/1500
5/5             0s 15ms/step -
accuracy: 0.8188 - loss: 0.5056 - val_accuracy: 0.7566 - val_loss: 0.5536
Epoch 418/1500
5/5             0s 12ms/step -
accuracy: 0.8319 - loss: 0.4903 - val_accuracy: 0.7566 - val_loss: 0.5533
Epoch 419/1500
5/5             0s 12ms/step -
accuracy: 0.8158 - loss: 0.5143 - val_accuracy: 0.7566 - val_loss: 0.5530
Epoch 420/1500
5/5             0s 17ms/step -
accuracy: 0.7962 - loss: 0.5107 - val_accuracy: 0.7566 - val_loss: 0.5527
Epoch 421/1500
5/5             0s 13ms/step -
accuracy: 0.8045 - loss: 0.5050 - val_accuracy: 0.7566 - val_loss: 0.5524
Epoch 422/1500
5/5             0s 11ms/step -
accuracy: 0.7789 - loss: 0.5112 - val_accuracy: 0.7566 - val_loss: 0.5521
Epoch 423/1500
5/5             0s 15ms/step -
accuracy: 0.8479 - loss: 0.4708 - val_accuracy: 0.7566 - val_loss: 0.5518
Epoch 424/1500
5/5             0s 15ms/step -
accuracy: 0.8284 - loss: 0.5006 - val_accuracy: 0.7566 - val_loss: 0.5514
Epoch 425/1500
5/5             0s 15ms/step -
accuracy: 0.8497 - loss: 0.4711 - val_accuracy: 0.7500 - val_loss: 0.5511
Epoch 426/1500
5/5             0s 15ms/step -
accuracy: 0.8067 - loss: 0.5011 - val_accuracy: 0.7500 - val_loss: 0.5508
Epoch 427/1500
5/5             0s 13ms/step -
accuracy: 0.8271 - loss: 0.4799 - val_accuracy: 0.7500 - val_loss: 0.5505
Epoch 428/1500
5/5             0s 16ms/step -
accuracy: 0.8115 - loss: 0.5000 - val_accuracy: 0.7500 - val_loss: 0.5502
Epoch 429/1500
5/5             0s 12ms/step -
accuracy: 0.8184 - loss: 0.5001 - val_accuracy: 0.7500 - val_loss: 0.5499
Epoch 430/1500
5/5             0s 16ms/step -
accuracy: 0.8119 - loss: 0.4948 - val_accuracy: 0.7500 - val_loss: 0.5496
Epoch 431/1500
5/5             0s 17ms/step -
accuracy: 0.8367 - loss: 0.4883 - val_accuracy: 0.7500 - val_loss: 0.5493
Epoch 432/1500
5/5             0s 20ms/step -
accuracy: 0.8310 - loss: 0.5025 - val_accuracy: 0.7500 - val_loss: 0.5490
```

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Epoch 433/1500
5/5             0s 15ms/step -
accuracy: 0.8415 - loss: 0.4860 - val_accuracy: 0.7500 - val_loss: 0.5486
Epoch 434/1500
5/5             0s 20ms/step -
accuracy: 0.8476 - loss: 0.4782 - val_accuracy: 0.7500 - val_loss: 0.5483
Epoch 435/1500
5/5             0s 18ms/step -
accuracy: 0.8523 - loss: 0.4616 - val_accuracy: 0.7500 - val_loss: 0.5480
Epoch 436/1500
5/5             0s 16ms/step -
accuracy: 0.8337 - loss: 0.5036 - val_accuracy: 0.7500 - val_loss: 0.5477
Epoch 437/1500
5/5             0s 18ms/step -
accuracy: 0.7903 - loss: 0.5163 - val_accuracy: 0.7500 - val_loss: 0.5474
Epoch 438/1500
5/5             0s 21ms/step -
accuracy: 0.7933 - loss: 0.5092 - val_accuracy: 0.7500 - val_loss: 0.5471
Epoch 439/1500
5/5             0s 18ms/step -
accuracy: 0.8324 - loss: 0.4878 - val_accuracy: 0.7500 - val_loss: 0.5468
Epoch 440/1500
5/5             0s 15ms/step -
accuracy: 0.8402 - loss: 0.4937 - val_accuracy: 0.7500 - val_loss: 0.5465
Epoch 441/1500
5/5             0s 15ms/step -
accuracy: 0.8385 - loss: 0.4677 - val_accuracy: 0.7500 - val_loss: 0.5462
Epoch 442/1500
5/5             0s 18ms/step -
accuracy: 0.8454 - loss: 0.4853 - val_accuracy: 0.7500 - val_loss: 0.5459
Epoch 443/1500
5/5             0s 20ms/step -
accuracy: 0.8406 - loss: 0.4831 - val_accuracy: 0.7500 - val_loss: 0.5456
Epoch 444/1500
5/5             0s 17ms/step -
accuracy: 0.8415 - loss: 0.5101 - val_accuracy: 0.7500 - val_loss: 0.5453
Epoch 445/1500
5/5             0s 20ms/step -
accuracy: 0.8272 - loss: 0.4996 - val_accuracy: 0.7500 - val_loss: 0.5450
Epoch 446/1500
5/5             0s 17ms/step -
accuracy: 0.8524 - loss: 0.4831 - val_accuracy: 0.7500 - val_loss: 0.5447
Epoch 447/1500
5/5             0s 16ms/step -
accuracy: 0.8263 - loss: 0.4854 - val_accuracy: 0.7500 - val_loss: 0.5444
Epoch 448/1500
5/5             0s 15ms/step -
accuracy: 0.8090 - loss: 0.5232 - val_accuracy: 0.7500 - val_loss: 0.5441
```

```
Epoch 449/1500
5/5             0s 12ms/step -
accuracy: 0.8103 - loss: 0.5079 - val_accuracy: 0.7500 - val_loss: 0.5438
Epoch 450/1500
5/5             0s 13ms/step -
accuracy: 0.8489 - loss: 0.4633 - val_accuracy: 0.7500 - val_loss: 0.5435
Epoch 451/1500
5/5             0s 15ms/step -
accuracy: 0.8506 - loss: 0.4795 - val_accuracy: 0.7566 - val_loss: 0.5432
Epoch 452/1500
5/5             0s 15ms/step -
accuracy: 0.8211 - loss: 0.4978 - val_accuracy: 0.7566 - val_loss: 0.5429
Epoch 453/1500
5/5             0s 14ms/step -
accuracy: 0.8302 - loss: 0.4936 - val_accuracy: 0.7566 - val_loss: 0.5426
Epoch 454/1500
5/5             0s 15ms/step -
accuracy: 0.8098 - loss: 0.5180 - val_accuracy: 0.7566 - val_loss: 0.5424
Epoch 455/1500
5/5             0s 11ms/step -
accuracy: 0.8350 - loss: 0.4878 - val_accuracy: 0.7566 - val_loss: 0.5420
Epoch 456/1500
5/5             0s 15ms/step -
accuracy: 0.8320 - loss: 0.4839 - val_accuracy: 0.7566 - val_loss: 0.5418
Epoch 457/1500
5/5             0s 15ms/step -
accuracy: 0.8372 - loss: 0.4826 - val_accuracy: 0.7566 - val_loss: 0.5415
Epoch 458/1500
5/5             0s 12ms/step -
accuracy: 0.8684 - loss: 0.4715 - val_accuracy: 0.7566 - val_loss: 0.5412
Epoch 459/1500
5/5             0s 15ms/step -
accuracy: 0.8146 - loss: 0.5100 - val_accuracy: 0.7566 - val_loss: 0.5409
Epoch 460/1500
5/5             0s 16ms/step -
accuracy: 0.8563 - loss: 0.4762 - val_accuracy: 0.7566 - val_loss: 0.5406
Epoch 461/1500
5/5             0s 14ms/step -
accuracy: 0.8051 - loss: 0.5011 - val_accuracy: 0.7566 - val_loss: 0.5403
Epoch 462/1500
5/5             0s 15ms/step -
accuracy: 0.8419 - loss: 0.4744 - val_accuracy: 0.7566 - val_loss: 0.5401
Epoch 463/1500
5/5             0s 14ms/step -
accuracy: 0.8424 - loss: 0.5019 - val_accuracy: 0.7566 - val_loss: 0.5398
Epoch 464/1500
5/5             0s 11ms/step -
accuracy: 0.8450 - loss: 0.4880 - val_accuracy: 0.7566 - val_loss: 0.5395
```

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Epoch 465/1500
5/5             0s 14ms/step -
accuracy: 0.8480 - loss: 0.4903 - val_accuracy: 0.7632 - val_loss: 0.5392
Epoch 466/1500
5/5             0s 15ms/step -
accuracy: 0.8242 - loss: 0.4870 - val_accuracy: 0.7632 - val_loss: 0.5389
Epoch 467/1500
5/5             0s 15ms/step -
accuracy: 0.8580 - loss: 0.4626 - val_accuracy: 0.7632 - val_loss: 0.5386
Epoch 468/1500
5/5             0s 11ms/step -
accuracy: 0.8515 - loss: 0.4735 - val_accuracy: 0.7697 - val_loss: 0.5383
Epoch 469/1500
5/5             0s 12ms/step -
accuracy: 0.8242 - loss: 0.4936 - val_accuracy: 0.7697 - val_loss: 0.5380
Epoch 470/1500
5/5             0s 15ms/step -
accuracy: 0.8589 - loss: 0.4757 - val_accuracy: 0.7697 - val_loss: 0.5377
Epoch 471/1500
5/5             0s 13ms/step -
accuracy: 0.8420 - loss: 0.4827 - val_accuracy: 0.7697 - val_loss: 0.5374
Epoch 472/1500
5/5             0s 11ms/step -
accuracy: 0.8185 - loss: 0.4967 - val_accuracy: 0.7697 - val_loss: 0.5372
Epoch 473/1500
5/5             0s 16ms/step -
accuracy: 0.8003 - loss: 0.5077 - val_accuracy: 0.7697 - val_loss: 0.5369
Epoch 474/1500
5/5             0s 15ms/step -
accuracy: 0.8407 - loss: 0.4734 - val_accuracy: 0.7697 - val_loss: 0.5366
Epoch 475/1500
5/5             0s 11ms/step -
accuracy: 0.8524 - loss: 0.4697 - val_accuracy: 0.7697 - val_loss: 0.5363
Epoch 476/1500
5/5             0s 13ms/step -
accuracy: 0.8520 - loss: 0.4778 - val_accuracy: 0.7697 - val_loss: 0.5360
Epoch 477/1500
5/5             0s 16ms/step -
accuracy: 0.8507 - loss: 0.4671 - val_accuracy: 0.7697 - val_loss: 0.5357
Epoch 478/1500
5/5             0s 15ms/step -
accuracy: 0.8272 - loss: 0.4816 - val_accuracy: 0.7763 - val_loss: 0.5355
Epoch 479/1500
5/5             0s 12ms/step -
accuracy: 0.8133 - loss: 0.4936 - val_accuracy: 0.7763 - val_loss: 0.5352
Epoch 480/1500
5/5             0s 15ms/step -
accuracy: 0.8758 - loss: 0.4688 - val_accuracy: 0.7763 - val_loss: 0.5349
```

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Epoch 481/1500
5/5             0s 14ms/step -
accuracy: 0.8389 - loss: 0.4740 - val_accuracy: 0.7763 - val_loss: 0.5345
Epoch 482/1500
5/5             0s 15ms/step -
accuracy: 0.8411 - loss: 0.4730 - val_accuracy: 0.7763 - val_loss: 0.5343
Epoch 483/1500
5/5             0s 11ms/step -
accuracy: 0.8402 - loss: 0.4735 - val_accuracy: 0.7763 - val_loss: 0.5340
Epoch 484/1500
5/5             0s 15ms/step -
accuracy: 0.8242 - loss: 0.4917 - val_accuracy: 0.7763 - val_loss: 0.5337
Epoch 485/1500
5/5             0s 11ms/step -
accuracy: 0.8151 - loss: 0.4796 - val_accuracy: 0.7763 - val_loss: 0.5334
Epoch 486/1500
5/5             0s 11ms/step -
accuracy: 0.8559 - loss: 0.4739 - val_accuracy: 0.7763 - val_loss: 0.5332
Epoch 487/1500
5/5             0s 13ms/step -
accuracy: 0.8290 - loss: 0.4945 - val_accuracy: 0.7763 - val_loss: 0.5329
Epoch 488/1500
5/5             0s 15ms/step -
accuracy: 0.8355 - loss: 0.4840 - val_accuracy: 0.7763 - val_loss: 0.5326
Epoch 489/1500
5/5             0s 13ms/step -
accuracy: 0.8719 - loss: 0.4422 - val_accuracy: 0.7763 - val_loss: 0.5323
Epoch 490/1500
5/5             0s 11ms/step -
accuracy: 0.8528 - loss: 0.4659 - val_accuracy: 0.7763 - val_loss: 0.5321
Epoch 491/1500
5/5             0s 12ms/step -
accuracy: 0.8303 - loss: 0.4831 - val_accuracy: 0.7763 - val_loss: 0.5318
Epoch 492/1500
5/5             0s 15ms/step -
accuracy: 0.8672 - loss: 0.4486 - val_accuracy: 0.7763 - val_loss: 0.5315
Epoch 493/1500
5/5             0s 11ms/step -
accuracy: 0.8537 - loss: 0.4516 - val_accuracy: 0.7763 - val_loss: 0.5312
Epoch 494/1500
5/5             0s 12ms/step -
accuracy: 0.8554 - loss: 0.4745 - val_accuracy: 0.7763 - val_loss: 0.5309
Epoch 495/1500
5/5             0s 13ms/step -
accuracy: 0.7986 - loss: 0.4994 - val_accuracy: 0.7763 - val_loss: 0.5306
Epoch 496/1500
5/5             0s 15ms/step -
accuracy: 0.8576 - loss: 0.4696 - val_accuracy: 0.7763 - val_loss: 0.5303
```

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Epoch 497/1500
5/5             0s 11ms/step -
accuracy: 0.8537 - loss: 0.4666 - val_accuracy: 0.7763 - val_loss: 0.5300
Epoch 498/1500
5/5             0s 14ms/step -
accuracy: 0.8424 - loss: 0.4740 - val_accuracy: 0.7763 - val_loss: 0.5297
Epoch 499/1500
5/5             0s 15ms/step -
accuracy: 0.8190 - loss: 0.4932 - val_accuracy: 0.7763 - val_loss: 0.5294
Epoch 500/1500
5/5             0s 11ms/step -
accuracy: 0.8533 - loss: 0.4599 - val_accuracy: 0.7763 - val_loss: 0.5292
Epoch 501/1500
5/5             0s 14ms/step -
accuracy: 0.8411 - loss: 0.4520 - val_accuracy: 0.7763 - val_loss: 0.5289
Epoch 502/1500
5/5             0s 16ms/step -
accuracy: 0.8298 - loss: 0.4785 - val_accuracy: 0.7763 - val_loss: 0.5286
Epoch 503/1500
5/5             0s 16ms/step -
accuracy: 0.8055 - loss: 0.5064 - val_accuracy: 0.7763 - val_loss: 0.5283
Epoch 504/1500
5/5             0s 15ms/step -
accuracy: 0.8520 - loss: 0.4613 - val_accuracy: 0.7763 - val_loss: 0.5281
Epoch 505/1500
5/5             0s 15ms/step -
accuracy: 0.8546 - loss: 0.4602 - val_accuracy: 0.7763 - val_loss: 0.5278
Epoch 506/1500
5/5             0s 12ms/step -
accuracy: 0.8593 - loss: 0.4646 - val_accuracy: 0.7763 - val_loss: 0.5275
Epoch 507/1500
5/5             0s 15ms/step -
accuracy: 0.8125 - loss: 0.5023 - val_accuracy: 0.7763 - val_loss: 0.5272
Epoch 508/1500
5/5             0s 11ms/step -
accuracy: 0.8294 - loss: 0.4554 - val_accuracy: 0.7697 - val_loss: 0.5269
Epoch 509/1500
5/5             0s 15ms/step -
accuracy: 0.8602 - loss: 0.4626 - val_accuracy: 0.7697 - val_loss: 0.5267
Epoch 510/1500
5/5             0s 12ms/step -
accuracy: 0.8793 - loss: 0.4468 - val_accuracy: 0.7697 - val_loss: 0.5264
Epoch 511/1500
5/5             0s 15ms/step -
accuracy: 0.8580 - loss: 0.4702 - val_accuracy: 0.7697 - val_loss: 0.5261
Epoch 512/1500
5/5             0s 13ms/step -
accuracy: 0.8346 - loss: 0.4632 - val_accuracy: 0.7697 - val_loss: 0.5258
```

```
Epoch 513/1500
5/5             0s 11ms/step -
accuracy: 0.8376 - loss: 0.4776 - val_accuracy: 0.7697 - val_loss: 0.5255
Epoch 514/1500
5/5             0s 13ms/step -
accuracy: 0.8368 - loss: 0.4648 - val_accuracy: 0.7697 - val_loss: 0.5252
Epoch 515/1500
5/5             0s 14ms/step -
accuracy: 0.8380 - loss: 0.4629 - val_accuracy: 0.7697 - val_loss: 0.5249
Epoch 516/1500
5/5             0s 16ms/step -
accuracy: 0.8415 - loss: 0.4606 - val_accuracy: 0.7697 - val_loss: 0.5246
Epoch 517/1500
5/5             0s 16ms/step -
accuracy: 0.8285 - loss: 0.4723 - val_accuracy: 0.7697 - val_loss: 0.5243
Epoch 518/1500
5/5             0s 11ms/step -
accuracy: 0.7977 - loss: 0.4887 - val_accuracy: 0.7697 - val_loss: 0.5240
Epoch 519/1500
5/5             0s 12ms/step -
accuracy: 0.8515 - loss: 0.4690 - val_accuracy: 0.7697 - val_loss: 0.5237
Epoch 520/1500
5/5             0s 16ms/step -
accuracy: 0.8376 - loss: 0.4732 - val_accuracy: 0.7697 - val_loss: 0.5234
Epoch 521/1500
5/5             0s 11ms/step -
accuracy: 0.8215 - loss: 0.4730 - val_accuracy: 0.7697 - val_loss: 0.5232
Epoch 522/1500
5/5             0s 12ms/step -
accuracy: 0.8467 - loss: 0.4616 - val_accuracy: 0.7697 - val_loss: 0.5229
Epoch 523/1500
5/5             0s 12ms/step -
accuracy: 0.8498 - loss: 0.4561 - val_accuracy: 0.7697 - val_loss: 0.5226
Epoch 524/1500
5/5             0s 13ms/step -
accuracy: 0.8663 - loss: 0.4559 - val_accuracy: 0.7697 - val_loss: 0.5223
Epoch 525/1500
5/5             0s 15ms/step -
accuracy: 0.8393 - loss: 0.4456 - val_accuracy: 0.7697 - val_loss: 0.5220
Epoch 526/1500
5/5             0s 15ms/step -
accuracy: 0.8315 - loss: 0.4707 - val_accuracy: 0.7697 - val_loss: 0.5217
Epoch 527/1500
5/5             0s 14ms/step -
accuracy: 0.8111 - loss: 0.4875 - val_accuracy: 0.7697 - val_loss: 0.5215
Epoch 528/1500
5/5             0s 16ms/step -
accuracy: 0.8185 - loss: 0.4651 - val_accuracy: 0.7697 - val_loss: 0.5212
```

```
Epoch 529/1500
5/5             0s 12ms/step -
accuracy: 0.8341 - loss: 0.4505 - val_accuracy: 0.7697 - val_loss: 0.5209
Epoch 530/1500
5/5             0s 12ms/step -
accuracy: 0.8215 - loss: 0.4772 - val_accuracy: 0.7697 - val_loss: 0.5206
Epoch 531/1500
5/5             0s 17ms/step -
accuracy: 0.8415 - loss: 0.4604 - val_accuracy: 0.7697 - val_loss: 0.5203
Epoch 532/1500
5/5             0s 19ms/step -
accuracy: 0.8307 - loss: 0.4642 - val_accuracy: 0.7697 - val_loss: 0.5200
Epoch 533/1500
5/5             0s 21ms/step -
accuracy: 0.8302 - loss: 0.4676 - val_accuracy: 0.7632 - val_loss: 0.5198
Epoch 534/1500
5/5             0s 14ms/step -
accuracy: 0.8406 - loss: 0.4391 - val_accuracy: 0.7697 - val_loss: 0.5195
Epoch 535/1500
5/5             0s 21ms/step -
accuracy: 0.8502 - loss: 0.4516 - val_accuracy: 0.7697 - val_loss: 0.5192
Epoch 536/1500
5/5             0s 22ms/step -
accuracy: 0.8446 - loss: 0.4512 - val_accuracy: 0.7697 - val_loss: 0.5189
Epoch 537/1500
5/5             0s 27ms/step -
accuracy: 0.8476 - loss: 0.4533 - val_accuracy: 0.7697 - val_loss: 0.5186
Epoch 538/1500
5/5             0s 22ms/step -
accuracy: 0.8229 - loss: 0.4819 - val_accuracy: 0.7697 - val_loss: 0.5183
Epoch 539/1500
5/5             0s 17ms/step -
accuracy: 0.8446 - loss: 0.4507 - val_accuracy: 0.7697 - val_loss: 0.5180
Epoch 540/1500
5/5             0s 19ms/step -
accuracy: 0.8576 - loss: 0.4407 - val_accuracy: 0.7697 - val_loss: 0.5177
Epoch 541/1500
5/5             0s 21ms/step -
accuracy: 0.8168 - loss: 0.4743 - val_accuracy: 0.7697 - val_loss: 0.5174
Epoch 542/1500
5/5             0s 23ms/step -
accuracy: 0.8098 - loss: 0.4642 - val_accuracy: 0.7697 - val_loss: 0.5172
Epoch 543/1500
5/5             0s 20ms/step -
accuracy: 0.8124 - loss: 0.4781 - val_accuracy: 0.7697 - val_loss: 0.5169
Epoch 544/1500
5/5             0s 17ms/step -
accuracy: 0.8380 - loss: 0.4640 - val_accuracy: 0.7697 - val_loss: 0.5166
```

```
Epoch 545/1500
5/5             0s 16ms/step -
accuracy: 0.7981 - loss: 0.4804 - val_accuracy: 0.7697 - val_loss: 0.5163
Epoch 546/1500
5/5             0s 18ms/step -
accuracy: 0.8398 - loss: 0.4703 - val_accuracy: 0.7697 - val_loss: 0.5160
Epoch 547/1500
5/5             0s 18ms/step -
accuracy: 0.8359 - loss: 0.4742 - val_accuracy: 0.7697 - val_loss: 0.5157
Epoch 548/1500
5/5             0s 15ms/step -
accuracy: 0.8450 - loss: 0.4485 - val_accuracy: 0.7697 - val_loss: 0.5155
Epoch 549/1500
5/5             0s 11ms/step -
accuracy: 0.8415 - loss: 0.4617 - val_accuracy: 0.7697 - val_loss: 0.5152
Epoch 550/1500
5/5             0s 15ms/step -
accuracy: 0.8116 - loss: 0.4813 - val_accuracy: 0.7697 - val_loss: 0.5149
Epoch 551/1500
5/5             0s 12ms/step -
accuracy: 0.8463 - loss: 0.4605 - val_accuracy: 0.7697 - val_loss: 0.5147
Epoch 552/1500
5/5             0s 12ms/step -
accuracy: 0.8333 - loss: 0.4462 - val_accuracy: 0.7697 - val_loss: 0.5144
Epoch 553/1500
5/5             0s 11ms/step -
accuracy: 0.8311 - loss: 0.4679 - val_accuracy: 0.7697 - val_loss: 0.5141
Epoch 554/1500
5/5             0s 12ms/step -
accuracy: 0.8129 - loss: 0.4618 - val_accuracy: 0.7697 - val_loss: 0.5138
Epoch 555/1500
5/5             0s 17ms/step -
accuracy: 0.8398 - loss: 0.4435 - val_accuracy: 0.7697 - val_loss: 0.5135
Epoch 556/1500
5/5             0s 12ms/step -
accuracy: 0.8372 - loss: 0.4464 - val_accuracy: 0.7632 - val_loss: 0.5133
Epoch 557/1500
5/5             0s 18ms/step -
accuracy: 0.8367 - loss: 0.4666 - val_accuracy: 0.7632 - val_loss: 0.5130
Epoch 558/1500
5/5             0s 12ms/step -
accuracy: 0.8202 - loss: 0.4635 - val_accuracy: 0.7632 - val_loss: 0.5127
Epoch 559/1500
5/5             0s 13ms/step -
accuracy: 0.8550 - loss: 0.4390 - val_accuracy: 0.7632 - val_loss: 0.5124
Epoch 560/1500
5/5             0s 14ms/step -
accuracy: 0.8376 - loss: 0.4538 - val_accuracy: 0.7632 - val_loss: 0.5122
```

```
Epoch 561/1500
5/5             0s 14ms/step -
accuracy: 0.7912 - loss: 0.4942 - val_accuracy: 0.7632 - val_loss: 0.5119
Epoch 562/1500
5/5             0s 13ms/step -
accuracy: 0.8741 - loss: 0.4030 - val_accuracy: 0.7697 - val_loss: 0.5117
Epoch 563/1500
5/5             0s 12ms/step -
accuracy: 0.8572 - loss: 0.4522 - val_accuracy: 0.7697 - val_loss: 0.5114
Epoch 564/1500
5/5             0s 16ms/step -
accuracy: 0.8732 - loss: 0.4180 - val_accuracy: 0.7697 - val_loss: 0.5111
Epoch 565/1500
5/5             0s 14ms/step -
accuracy: 0.8416 - loss: 0.4418 - val_accuracy: 0.7697 - val_loss: 0.5108
Epoch 566/1500
5/5             0s 16ms/step -
accuracy: 0.8346 - loss: 0.4474 - val_accuracy: 0.7697 - val_loss: 0.5105
Epoch 567/1500
5/5             0s 13ms/step -
accuracy: 0.8337 - loss: 0.4548 - val_accuracy: 0.7697 - val_loss: 0.5103
Epoch 568/1500
5/5             0s 17ms/step -
accuracy: 0.8515 - loss: 0.4344 - val_accuracy: 0.7697 - val_loss: 0.5100
Epoch 569/1500
5/5             0s 16ms/step -
accuracy: 0.8429 - loss: 0.4443 - val_accuracy: 0.7697 - val_loss: 0.5097
Epoch 570/1500
5/5             0s 12ms/step -
accuracy: 0.8515 - loss: 0.4288 - val_accuracy: 0.7697 - val_loss: 0.5094
Epoch 571/1500
5/5             0s 12ms/step -
accuracy: 0.8203 - loss: 0.4724 - val_accuracy: 0.7697 - val_loss: 0.5092
Epoch 572/1500
5/5             0s 12ms/step -
accuracy: 0.8376 - loss: 0.4485 - val_accuracy: 0.7697 - val_loss: 0.5089
Epoch 573/1500
5/5             0s 15ms/step -
accuracy: 0.8307 - loss: 0.4627 - val_accuracy: 0.7697 - val_loss: 0.5086
Epoch 574/1500
5/5             0s 13ms/step -
accuracy: 0.8585 - loss: 0.4337 - val_accuracy: 0.7632 - val_loss: 0.5083
Epoch 575/1500
5/5             0s 16ms/step -
accuracy: 0.8125 - loss: 0.4760 - val_accuracy: 0.7632 - val_loss: 0.5080
Epoch 576/1500
5/5             0s 15ms/step -
accuracy: 0.8324 - loss: 0.4684 - val_accuracy: 0.7632 - val_loss: 0.5078
```

```
Epoch 577/1500
5/5             0s 15ms/step -
accuracy: 0.8481 - loss: 0.4580 - val_accuracy: 0.7632 - val_loss: 0.5075
Epoch 578/1500
5/5             0s 12ms/step -
accuracy: 0.8437 - loss: 0.4186 - val_accuracy: 0.7632 - val_loss: 0.5072
Epoch 579/1500
5/5             0s 16ms/step -
accuracy: 0.8442 - loss: 0.4480 - val_accuracy: 0.7632 - val_loss: 0.5070
Epoch 580/1500
5/5             0s 13ms/step -
accuracy: 0.8533 - loss: 0.4284 - val_accuracy: 0.7632 - val_loss: 0.5067
Epoch 581/1500
5/5             0s 17ms/step -
accuracy: 0.8246 - loss: 0.4491 - val_accuracy: 0.7632 - val_loss: 0.5064
Epoch 582/1500
5/5             0s 17ms/step -
accuracy: 0.8620 - loss: 0.4365 - val_accuracy: 0.7632 - val_loss: 0.5062
Epoch 583/1500
5/5             0s 16ms/step -
accuracy: 0.8593 - loss: 0.4256 - val_accuracy: 0.7632 - val_loss: 0.5059
Epoch 584/1500
5/5             0s 16ms/step -
accuracy: 0.8485 - loss: 0.4435 - val_accuracy: 0.7632 - val_loss: 0.5056
Epoch 585/1500
5/5             0s 12ms/step -
accuracy: 0.8182 - loss: 0.4490 - val_accuracy: 0.7632 - val_loss: 0.5054
Epoch 586/1500
5/5             0s 13ms/step -
accuracy: 0.8477 - loss: 0.4262 - val_accuracy: 0.7632 - val_loss: 0.5051
Epoch 587/1500
5/5             0s 11ms/step -
accuracy: 0.8425 - loss: 0.4498 - val_accuracy: 0.7632 - val_loss: 0.5048
Epoch 588/1500
5/5             0s 16ms/step -
accuracy: 0.8407 - loss: 0.4603 - val_accuracy: 0.7632 - val_loss: 0.5045
Epoch 589/1500
5/5             0s 15ms/step -
accuracy: 0.8446 - loss: 0.4365 - val_accuracy: 0.7632 - val_loss: 0.5043
Epoch 590/1500
5/5             0s 16ms/step -
accuracy: 0.8563 - loss: 0.4366 - val_accuracy: 0.7632 - val_loss: 0.5040
Epoch 591/1500
5/5             0s 11ms/step -
accuracy: 0.8815 - loss: 0.4003 - val_accuracy: 0.7632 - val_loss: 0.5037
Epoch 592/1500
5/5             0s 12ms/step -
accuracy: 0.8529 - loss: 0.4412 - val_accuracy: 0.7632 - val_loss: 0.5034
```

```
Epoch 593/1500
5/5             0s 15ms/step -
accuracy: 0.8581 - loss: 0.4415 - val_accuracy: 0.7632 - val_loss: 0.5032
Epoch 594/1500
5/5             0s 15ms/step -
accuracy: 0.8529 - loss: 0.4233 - val_accuracy: 0.7632 - val_loss: 0.5029
Epoch 595/1500
5/5             0s 13ms/step -
accuracy: 0.8156 - loss: 0.4708 - val_accuracy: 0.7632 - val_loss: 0.5027
Epoch 596/1500
5/5             0s 15ms/step -
accuracy: 0.8668 - loss: 0.4104 - val_accuracy: 0.7632 - val_loss: 0.5024
Epoch 597/1500
5/5             0s 18ms/step -
accuracy: 0.8477 - loss: 0.4407 - val_accuracy: 0.7632 - val_loss: 0.5022
Epoch 598/1500
5/5             0s 13ms/step -
accuracy: 0.8798 - loss: 0.4199 - val_accuracy: 0.7632 - val_loss: 0.5019
Epoch 599/1500
5/5             0s 11ms/step -
accuracy: 0.8538 - loss: 0.4360 - val_accuracy: 0.7632 - val_loss: 0.5016
Epoch 600/1500
5/5             0s 12ms/step -
accuracy: 0.8742 - loss: 0.4343 - val_accuracy: 0.7632 - val_loss: 0.5014
Epoch 601/1500
5/5             0s 12ms/step -
accuracy: 0.8638 - loss: 0.4235 - val_accuracy: 0.7632 - val_loss: 0.5011
Epoch 602/1500
5/5             0s 16ms/step -
accuracy: 0.8199 - loss: 0.4636 - val_accuracy: 0.7632 - val_loss: 0.5008
Epoch 603/1500
5/5             0s 11ms/step -
accuracy: 0.8590 - loss: 0.4447 - val_accuracy: 0.7632 - val_loss: 0.5006
Epoch 604/1500
5/5             0s 12ms/step -
accuracy: 0.8369 - loss: 0.4378 - val_accuracy: 0.7632 - val_loss: 0.5003
Epoch 605/1500
5/5             0s 18ms/step -
accuracy: 0.8577 - loss: 0.4109 - val_accuracy: 0.7632 - val_loss: 0.5001
Epoch 606/1500
5/5             0s 16ms/step -
accuracy: 0.8529 - loss: 0.4461 - val_accuracy: 0.7632 - val_loss: 0.4998
Epoch 607/1500
5/5             0s 11ms/step -
accuracy: 0.8516 - loss: 0.4406 - val_accuracy: 0.7632 - val_loss: 0.4996
Epoch 608/1500
5/5             0s 15ms/step -
accuracy: 0.8573 - loss: 0.4236 - val_accuracy: 0.7632 - val_loss: 0.4993
```

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Epoch 609/1500
5/5             0s 15ms/step -
accuracy: 0.8429 - loss: 0.4380 - val_accuracy: 0.7632 - val_loss: 0.4991
Epoch 610/1500
5/5             0s 12ms/step -
accuracy: 0.8538 - loss: 0.4435 - val_accuracy: 0.7566 - val_loss: 0.4988
Epoch 611/1500
5/5             0s 15ms/step -
accuracy: 0.8299 - loss: 0.4484 - val_accuracy: 0.7566 - val_loss: 0.4986
Epoch 612/1500
5/5             0s 15ms/step -
accuracy: 0.8759 - loss: 0.4214 - val_accuracy: 0.7566 - val_loss: 0.4983
Epoch 613/1500
5/5             0s 14ms/step -
accuracy: 0.8217 - loss: 0.4398 - val_accuracy: 0.7566 - val_loss: 0.4981
Epoch 614/1500
5/5             0s 15ms/step -
accuracy: 0.8599 - loss: 0.4203 - val_accuracy: 0.7566 - val_loss: 0.4978
Epoch 615/1500
5/5             0s 11ms/step -
accuracy: 0.8546 - loss: 0.4350 - val_accuracy: 0.7566 - val_loss: 0.4975
Epoch 616/1500
5/5             0s 15ms/step -
accuracy: 0.8490 - loss: 0.4350 - val_accuracy: 0.7566 - val_loss: 0.4973
Epoch 617/1500
5/5             0s 13ms/step -
accuracy: 0.8434 - loss: 0.4474 - val_accuracy: 0.7566 - val_loss: 0.4970
Epoch 618/1500
5/5             0s 13ms/step -
accuracy: 0.8629 - loss: 0.4205 - val_accuracy: 0.7566 - val_loss: 0.4967
Epoch 619/1500
5/5             0s 13ms/step -
accuracy: 0.8694 - loss: 0.4182 - val_accuracy: 0.7566 - val_loss: 0.4965
Epoch 620/1500
5/5             0s 15ms/step -
accuracy: 0.8855 - loss: 0.4003 - val_accuracy: 0.7566 - val_loss: 0.4962
Epoch 621/1500
5/5             0s 12ms/step -
accuracy: 0.8512 - loss: 0.4310 - val_accuracy: 0.7566 - val_loss: 0.4959
Epoch 622/1500
5/5             0s 15ms/step -
accuracy: 0.8546 - loss: 0.4260 - val_accuracy: 0.7566 - val_loss: 0.4957
Epoch 623/1500
5/5             0s 15ms/step -
accuracy: 0.8659 - loss: 0.4122 - val_accuracy: 0.7566 - val_loss: 0.4954
Epoch 624/1500
5/5             0s 12ms/step -
accuracy: 0.8829 - loss: 0.4080 - val_accuracy: 0.7566 - val_loss: 0.4952
```

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Epoch 625/1500
5/5             0s 12ms/step -
accuracy: 0.8655 - loss: 0.4115 - val_accuracy: 0.7566 - val_loss: 0.4949
Epoch 626/1500
5/5             0s 16ms/step -
accuracy: 0.8416 - loss: 0.4503 - val_accuracy: 0.7566 - val_loss: 0.4947
Epoch 627/1500
5/5             0s 13ms/step -
accuracy: 0.8338 - loss: 0.4532 - val_accuracy: 0.7566 - val_loss: 0.4944
Epoch 628/1500
5/5             0s 19ms/step -
accuracy: 0.8533 - loss: 0.4388 - val_accuracy: 0.7566 - val_loss: 0.4942
Epoch 629/1500
5/5             0s 17ms/step -
accuracy: 0.8533 - loss: 0.4165 - val_accuracy: 0.7697 - val_loss: 0.4939
Epoch 630/1500
5/5             0s 24ms/step -
accuracy: 0.8464 - loss: 0.4482 - val_accuracy: 0.7697 - val_loss: 0.4936
Epoch 631/1500
5/5             0s 18ms/step -
accuracy: 0.8681 - loss: 0.4136 - val_accuracy: 0.7697 - val_loss: 0.4934
Epoch 632/1500
5/5             0s 21ms/step -
accuracy: 0.8603 - loss: 0.4185 - val_accuracy: 0.7697 - val_loss: 0.4932
Epoch 633/1500
5/5             0s 18ms/step -
accuracy: 0.8573 - loss: 0.4178 - val_accuracy: 0.7697 - val_loss: 0.4929
Epoch 634/1500
5/5             0s 22ms/step -
accuracy: 0.8863 - loss: 0.3952 - val_accuracy: 0.7697 - val_loss: 0.4927
Epoch 635/1500
5/5             0s 18ms/step -
accuracy: 0.8473 - loss: 0.4258 - val_accuracy: 0.7697 - val_loss: 0.4924
Epoch 636/1500
5/5             0s 20ms/step -
accuracy: 0.8373 - loss: 0.4559 - val_accuracy: 0.7697 - val_loss: 0.4921
Epoch 637/1500
5/5             0s 21ms/step -
accuracy: 0.8625 - loss: 0.4237 - val_accuracy: 0.7697 - val_loss: 0.4919
Epoch 638/1500
5/5             0s 19ms/step -
accuracy: 0.8594 - loss: 0.4227 - val_accuracy: 0.7697 - val_loss: 0.4917
Epoch 639/1500
5/5             0s 19ms/step -
accuracy: 0.8468 - loss: 0.4219 - val_accuracy: 0.7697 - val_loss: 0.4914
Epoch 640/1500
5/5             0s 18ms/step -
accuracy: 0.8772 - loss: 0.3951 - val_accuracy: 0.7697 - val_loss: 0.4911
```

```
Epoch 641/1500
5/5             0s 18ms/step -
accuracy: 0.8559 - loss: 0.4179 - val_accuracy: 0.7697 - val_loss: 0.4909
Epoch 642/1500
5/5             0s 18ms/step -
accuracy: 0.8733 - loss: 0.4114 - val_accuracy: 0.7697 - val_loss: 0.4907
Epoch 643/1500
5/5             0s 18ms/step -
accuracy: 0.8373 - loss: 0.4511 - val_accuracy: 0.7697 - val_loss: 0.4904
Epoch 644/1500
5/5             0s 24ms/step -
accuracy: 0.8477 - loss: 0.4170 - val_accuracy: 0.7697 - val_loss: 0.4902
Epoch 645/1500
5/5             0s 20ms/step -
accuracy: 0.8651 - loss: 0.4080 - val_accuracy: 0.7697 - val_loss: 0.4899
Epoch 646/1500
5/5             0s 12ms/step -
accuracy: 0.8317 - loss: 0.4478 - val_accuracy: 0.7697 - val_loss: 0.4897
Epoch 647/1500
5/5             0s 16ms/step -
accuracy: 0.8573 - loss: 0.4140 - val_accuracy: 0.7697 - val_loss: 0.4894
Epoch 648/1500
5/5             0s 15ms/step -
accuracy: 0.8625 - loss: 0.4261 - val_accuracy: 0.7697 - val_loss: 0.4892
Epoch 649/1500
5/5             0s 13ms/step -
accuracy: 0.8286 - loss: 0.4621 - val_accuracy: 0.7697 - val_loss: 0.4890
Epoch 650/1500
5/5             0s 13ms/step -
accuracy: 0.8760 - loss: 0.4020 - val_accuracy: 0.7697 - val_loss: 0.4888
Epoch 651/1500
5/5             0s 12ms/step -
accuracy: 0.8760 - loss: 0.4170 - val_accuracy: 0.7697 - val_loss: 0.4885
Epoch 652/1500
5/5             0s 14ms/step -
accuracy: 0.8898 - loss: 0.3741 - val_accuracy: 0.7697 - val_loss: 0.4883
Epoch 653/1500
5/5             0s 16ms/step -
accuracy: 0.8486 - loss: 0.4234 - val_accuracy: 0.7697 - val_loss: 0.4880
Epoch 654/1500
5/5             0s 13ms/step -
accuracy: 0.8647 - loss: 0.4152 - val_accuracy: 0.7697 - val_loss: 0.4878
Epoch 655/1500
5/5             0s 13ms/step -
accuracy: 0.8846 - loss: 0.4036 - val_accuracy: 0.7697 - val_loss: 0.4875
Epoch 656/1500
5/5             0s 12ms/step -
accuracy: 0.8321 - loss: 0.4406 - val_accuracy: 0.7697 - val_loss: 0.4873
```

```
Epoch 657/1500
5/5             0s 16ms/step -
accuracy: 0.8373 - loss: 0.4346 - val_accuracy: 0.7697 - val_loss: 0.4870
Epoch 658/1500
5/5             0s 13ms/step -
accuracy: 0.8820 - loss: 0.4034 - val_accuracy: 0.7697 - val_loss: 0.4868
Epoch 659/1500
5/5             0s 12ms/step -
accuracy: 0.8334 - loss: 0.4359 - val_accuracy: 0.7697 - val_loss: 0.4866
Epoch 660/1500
5/5             0s 15ms/step -
accuracy: 0.8694 - loss: 0.4130 - val_accuracy: 0.7697 - val_loss: 0.4863
Epoch 661/1500
5/5             0s 13ms/step -
accuracy: 0.8560 - loss: 0.4133 - val_accuracy: 0.7697 - val_loss: 0.4861
Epoch 662/1500
5/5             0s 19ms/step -
accuracy: 0.8508 - loss: 0.4355 - val_accuracy: 0.7697 - val_loss: 0.4859
Epoch 663/1500
5/5             0s 15ms/step -
accuracy: 0.8703 - loss: 0.4122 - val_accuracy: 0.7697 - val_loss: 0.4856
Epoch 664/1500
5/5             0s 12ms/step -
accuracy: 0.8825 - loss: 0.3922 - val_accuracy: 0.7697 - val_loss: 0.4854
Epoch 665/1500
5/5             0s 51ms/step -
accuracy: 0.8756 - loss: 0.4064 - val_accuracy: 0.7697 - val_loss: 0.4852
Epoch 666/1500
5/5             0s 16ms/step -
accuracy: 0.8625 - loss: 0.4232 - val_accuracy: 0.7697 - val_loss: 0.4849
Epoch 667/1500
5/5             0s 13ms/step -
accuracy: 0.8456 - loss: 0.4373 - val_accuracy: 0.7697 - val_loss: 0.4847
Epoch 668/1500
5/5             0s 14ms/step -
accuracy: 0.8582 - loss: 0.4069 - val_accuracy: 0.7697 - val_loss: 0.4845
Epoch 669/1500
5/5             0s 17ms/step -
accuracy: 0.8582 - loss: 0.4200 - val_accuracy: 0.7697 - val_loss: 0.4842
Epoch 670/1500
5/5             0s 13ms/step -
accuracy: 0.8781 - loss: 0.4003 - val_accuracy: 0.7697 - val_loss: 0.4840
Epoch 671/1500
5/5             0s 16ms/step -
accuracy: 0.8495 - loss: 0.4283 - val_accuracy: 0.7697 - val_loss: 0.4838
Epoch 672/1500
5/5             0s 12ms/step -
accuracy: 0.8803 - loss: 0.4022 - val_accuracy: 0.7697 - val_loss: 0.4835
```

```
Epoch 673/1500
5/5             0s 12ms/step -
accuracy: 0.8725 - loss: 0.4036 - val_accuracy: 0.7697 - val_loss: 0.4833
Epoch 674/1500
5/5             0s 16ms/step -
accuracy: 0.8161 - loss: 0.4341 - val_accuracy: 0.7697 - val_loss: 0.4831
Epoch 675/1500
5/5             0s 13ms/step -
accuracy: 0.8638 - loss: 0.4168 - val_accuracy: 0.7697 - val_loss: 0.4828
Epoch 676/1500
5/5             0s 13ms/step -
accuracy: 0.8729 - loss: 0.3959 - val_accuracy: 0.7697 - val_loss: 0.4826
Epoch 677/1500
5/5             0s 16ms/step -
accuracy: 0.8820 - loss: 0.3827 - val_accuracy: 0.7697 - val_loss: 0.4823
Epoch 678/1500
5/5             0s 14ms/step -
accuracy: 0.8417 - loss: 0.4269 - val_accuracy: 0.7697 - val_loss: 0.4821
Epoch 679/1500
5/5             0s 13ms/step -
accuracy: 0.8694 - loss: 0.3997 - val_accuracy: 0.7697 - val_loss: 0.4819
Epoch 680/1500
5/5             0s 13ms/step -
accuracy: 0.8512 - loss: 0.3944 - val_accuracy: 0.7697 - val_loss: 0.4816
Epoch 681/1500
5/5             0s 16ms/step -
accuracy: 0.8295 - loss: 0.4375 - val_accuracy: 0.7697 - val_loss: 0.4814
Epoch 682/1500
5/5             0s 13ms/step -
accuracy: 0.8595 - loss: 0.4046 - val_accuracy: 0.7697 - val_loss: 0.4812
Epoch 683/1500
5/5             0s 15ms/step -
accuracy: 0.8816 - loss: 0.4033 - val_accuracy: 0.7697 - val_loss: 0.4810
Epoch 684/1500
5/5             0s 17ms/step -
accuracy: 0.8608 - loss: 0.4001 - val_accuracy: 0.7697 - val_loss: 0.4808
Epoch 685/1500
5/5             0s 13ms/step -
accuracy: 0.8733 - loss: 0.3897 - val_accuracy: 0.7697 - val_loss: 0.4806
Epoch 686/1500
5/5             0s 13ms/step -
accuracy: 0.8438 - loss: 0.4075 - val_accuracy: 0.7697 - val_loss: 0.4803
Epoch 687/1500
5/5             0s 12ms/step -
accuracy: 0.8612 - loss: 0.4142 - val_accuracy: 0.7697 - val_loss: 0.4801
Epoch 688/1500
5/5             0s 15ms/step -
accuracy: 0.8590 - loss: 0.4158 - val_accuracy: 0.7697 - val_loss: 0.4799
```

```
Epoch 689/1500
5/5             0s 11ms/step -
accuracy: 0.8733 - loss: 0.4033 - val_accuracy: 0.7697 - val_loss: 0.4796
Epoch 690/1500
5/5             0s 13ms/step -
accuracy: 0.8621 - loss: 0.4084 - val_accuracy: 0.7697 - val_loss: 0.4794
Epoch 691/1500
5/5             0s 15ms/step -
accuracy: 0.8573 - loss: 0.4079 - val_accuracy: 0.7697 - val_loss: 0.4792
Epoch 692/1500
5/5             0s 13ms/step -
accuracy: 0.8699 - loss: 0.3910 - val_accuracy: 0.7697 - val_loss: 0.4790
Epoch 693/1500
5/5             0s 13ms/step -
accuracy: 0.8534 - loss: 0.4165 - val_accuracy: 0.7697 - val_loss: 0.4788
Epoch 694/1500
5/5             0s 16ms/step -
accuracy: 0.8820 - loss: 0.3706 - val_accuracy: 0.7697 - val_loss: 0.4785
Epoch 695/1500
5/5             0s 12ms/step -
accuracy: 0.8412 - loss: 0.4112 - val_accuracy: 0.7697 - val_loss: 0.4783
Epoch 696/1500
5/5             0s 12ms/step -
accuracy: 0.8386 - loss: 0.4437 - val_accuracy: 0.7697 - val_loss: 0.4781
Epoch 697/1500
5/5             0s 16ms/step -
accuracy: 0.8590 - loss: 0.4000 - val_accuracy: 0.7697 - val_loss: 0.4779
Epoch 698/1500
5/5             0s 14ms/step -
accuracy: 0.8430 - loss: 0.4166 - val_accuracy: 0.7697 - val_loss: 0.4777
Epoch 699/1500
5/5             0s 12ms/step -
accuracy: 0.8608 - loss: 0.3896 - val_accuracy: 0.7697 - val_loss: 0.4775
Epoch 700/1500
5/5             0s 43ms/step -
accuracy: 0.8655 - loss: 0.3913 - val_accuracy: 0.7697 - val_loss: 0.4773
Epoch 701/1500
5/5             0s 44ms/step -
accuracy: 0.8833 - loss: 0.4047 - val_accuracy: 0.7697 - val_loss: 0.4771
Epoch 702/1500
5/5             0s 13ms/step -
accuracy: 0.8412 - loss: 0.4425 - val_accuracy: 0.7697 - val_loss: 0.4769
Epoch 703/1500
5/5             0s 13ms/step -
accuracy: 0.8564 - loss: 0.4013 - val_accuracy: 0.7763 - val_loss: 0.4767
Epoch 704/1500
5/5             0s 16ms/step -
accuracy: 0.8534 - loss: 0.4191 - val_accuracy: 0.7763 - val_loss: 0.4765
```

```
Epoch 705/1500
5/5             0s 14ms/step -
accuracy: 0.8608 - loss: 0.4142 - val_accuracy: 0.7763 - val_loss: 0.4763
Epoch 706/1500
5/5             0s 14ms/step -
accuracy: 0.8842 - loss: 0.3820 - val_accuracy: 0.7763 - val_loss: 0.4761
Epoch 707/1500
5/5             0s 13ms/step -
accuracy: 0.8755 - loss: 0.3856 - val_accuracy: 0.7763 - val_loss: 0.4759
Epoch 708/1500
5/5             0s 12ms/step -
accuracy: 0.8868 - loss: 0.3721 - val_accuracy: 0.7763 - val_loss: 0.4758
Epoch 709/1500
5/5             0s 13ms/step -
accuracy: 0.8634 - loss: 0.4113 - val_accuracy: 0.7763 - val_loss: 0.4756
Epoch 710/1500
5/5             0s 12ms/step -
accuracy: 0.8725 - loss: 0.4004 - val_accuracy: 0.7763 - val_loss: 0.4753
Epoch 711/1500
5/5             0s 12ms/step -
accuracy: 0.8490 - loss: 0.4136 - val_accuracy: 0.7763 - val_loss: 0.4752
Epoch 712/1500
5/5             0s 12ms/step -
accuracy: 0.8760 - loss: 0.3920 - val_accuracy: 0.7763 - val_loss: 0.4750
Epoch 713/1500
5/5             0s 16ms/step -
accuracy: 0.8551 - loss: 0.4199 - val_accuracy: 0.7763 - val_loss: 0.4748
Epoch 714/1500
5/5             0s 12ms/step -
accuracy: 0.8616 - loss: 0.3953 - val_accuracy: 0.7763 - val_loss: 0.4746
Epoch 715/1500
5/5             0s 22ms/step -
accuracy: 0.8803 - loss: 0.3736 - val_accuracy: 0.7763 - val_loss: 0.4744
Epoch 716/1500
5/5             0s 16ms/step -
accuracy: 0.8482 - loss: 0.4166 - val_accuracy: 0.7763 - val_loss: 0.4742
Epoch 717/1500
5/5             0s 16ms/step -
accuracy: 0.8612 - loss: 0.3977 - val_accuracy: 0.7763 - val_loss: 0.4739
Epoch 718/1500
5/5             0s 17ms/step -
accuracy: 0.8399 - loss: 0.4079 - val_accuracy: 0.7763 - val_loss: 0.4738
Epoch 719/1500
5/5             0s 15ms/step -
accuracy: 0.8612 - loss: 0.3994 - val_accuracy: 0.7763 - val_loss: 0.4736
Epoch 720/1500
5/5             0s 16ms/step -
accuracy: 0.8286 - loss: 0.4285 - val_accuracy: 0.7763 - val_loss: 0.4734
```

```
Epoch 721/1500
5/5             0s 23ms/step -
accuracy: 0.8317 - loss: 0.4291 - val_accuracy: 0.7763 - val_loss: 0.4733
Epoch 722/1500
5/5             0s 16ms/step -
accuracy: 0.8634 - loss: 0.3861 - val_accuracy: 0.7763 - val_loss: 0.4731
Epoch 723/1500
5/5             0s 19ms/step -
accuracy: 0.8473 - loss: 0.4128 - val_accuracy: 0.7763 - val_loss: 0.4729
Epoch 724/1500
5/5             0s 21ms/step -
accuracy: 0.8812 - loss: 0.3621 - val_accuracy: 0.7763 - val_loss: 0.4727
Epoch 725/1500
5/5             0s 20ms/step -
accuracy: 0.8616 - loss: 0.3733 - val_accuracy: 0.7763 - val_loss: 0.4726
Epoch 726/1500
5/5             0s 17ms/step -
accuracy: 0.8668 - loss: 0.3767 - val_accuracy: 0.7763 - val_loss: 0.4724
Epoch 727/1500
5/5             0s 25ms/step -
accuracy: 0.8846 - loss: 0.3607 - val_accuracy: 0.7763 - val_loss: 0.4722
Epoch 728/1500
5/5             0s 20ms/step -
accuracy: 0.8833 - loss: 0.3724 - val_accuracy: 0.7829 - val_loss: 0.4720
Epoch 729/1500
5/5             0s 20ms/step -
accuracy: 0.8525 - loss: 0.3985 - val_accuracy: 0.7829 - val_loss: 0.4719
Epoch 730/1500
5/5             0s 16ms/step -
accuracy: 0.8616 - loss: 0.4024 - val_accuracy: 0.7829 - val_loss: 0.4717
Epoch 731/1500
5/5             0s 13ms/step -
accuracy: 0.8421 - loss: 0.4233 - val_accuracy: 0.7829 - val_loss: 0.4715
Epoch 732/1500
5/5             0s 12ms/step -
accuracy: 0.8638 - loss: 0.4032 - val_accuracy: 0.7829 - val_loss: 0.4714
Epoch 733/1500
5/5             0s 16ms/step -
accuracy: 0.8325 - loss: 0.4336 - val_accuracy: 0.7829 - val_loss: 0.4712
Epoch 734/1500
5/5             0s 16ms/step -
accuracy: 0.8538 - loss: 0.3902 - val_accuracy: 0.7829 - val_loss: 0.4710
Epoch 735/1500
5/5             0s 15ms/step -
accuracy: 0.8820 - loss: 0.3792 - val_accuracy: 0.7829 - val_loss: 0.4709
Epoch 736/1500
5/5             0s 16ms/step -
accuracy: 0.8742 - loss: 0.3789 - val_accuracy: 0.7829 - val_loss: 0.4707
```

```
Epoch 737/1500
5/5             0s 13ms/step -
accuracy: 0.8525 - loss: 0.3816 - val_accuracy: 0.7829 - val_loss: 0.4705
Epoch 738/1500
5/5             0s 16ms/step -
accuracy: 0.8569 - loss: 0.3884 - val_accuracy: 0.7829 - val_loss: 0.4703
Epoch 739/1500
5/5             0s 13ms/step -
accuracy: 0.8786 - loss: 0.3698 - val_accuracy: 0.7829 - val_loss: 0.4701
Epoch 740/1500
5/5             0s 18ms/step -
accuracy: 0.8647 - loss: 0.3846 - val_accuracy: 0.7829 - val_loss: 0.4700
Epoch 741/1500
5/5             0s 14ms/step -
accuracy: 0.8603 - loss: 0.3996 - val_accuracy: 0.7829 - val_loss: 0.4698
Epoch 742/1500
5/5             0s 12ms/step -
accuracy: 0.8733 - loss: 0.3739 - val_accuracy: 0.7829 - val_loss: 0.4696
Epoch 743/1500
5/5             0s 12ms/step -
accuracy: 0.8742 - loss: 0.3727 - val_accuracy: 0.7829 - val_loss: 0.4695
Epoch 744/1500
5/5             0s 13ms/step -
accuracy: 0.8556 - loss: 0.3941 - val_accuracy: 0.7829 - val_loss: 0.4693
Epoch 745/1500
5/5             0s 12ms/step -
accuracy: 0.8551 - loss: 0.3858 - val_accuracy: 0.7829 - val_loss: 0.4692
Epoch 746/1500
5/5             0s 17ms/step -
accuracy: 0.8447 - loss: 0.4086 - val_accuracy: 0.7829 - val_loss: 0.4690
Epoch 747/1500
5/5             0s 12ms/step -
accuracy: 0.8473 - loss: 0.3926 - val_accuracy: 0.7829 - val_loss: 0.4689
Epoch 748/1500
5/5             0s 12ms/step -
accuracy: 0.8690 - loss: 0.3713 - val_accuracy: 0.7829 - val_loss: 0.4687
Epoch 749/1500
5/5             0s 16ms/step -
accuracy: 0.8130 - loss: 0.4353 - val_accuracy: 0.7829 - val_loss: 0.4685
Epoch 750/1500
5/5             0s 13ms/step -
accuracy: 0.8820 - loss: 0.3640 - val_accuracy: 0.7829 - val_loss: 0.4683
Epoch 751/1500
5/5             0s 12ms/step -
accuracy: 0.8191 - loss: 0.4044 - val_accuracy: 0.7829 - val_loss: 0.4682
Epoch 752/1500
5/5             0s 15ms/step -
accuracy: 0.8699 - loss: 0.3717 - val_accuracy: 0.7829 - val_loss: 0.4680
```

```
Epoch 753/1500
5/5             0s 14ms/step -
accuracy: 0.8790 - loss: 0.3745 - val_accuracy: 0.7829 - val_loss: 0.4679
Epoch 754/1500
5/5             0s 12ms/step -
accuracy: 0.8629 - loss: 0.3862 - val_accuracy: 0.7829 - val_loss: 0.4677
Epoch 755/1500
5/5             0s 12ms/step -
accuracy: 0.8725 - loss: 0.3928 - val_accuracy: 0.7829 - val_loss: 0.4675
Epoch 756/1500
5/5             0s 12ms/step -
accuracy: 0.8582 - loss: 0.3937 - val_accuracy: 0.7829 - val_loss: 0.4673
Epoch 757/1500
5/5             0s 13ms/step -
accuracy: 0.8968 - loss: 0.3475 - val_accuracy: 0.7829 - val_loss: 0.4672
Epoch 758/1500
5/5             0s 15ms/step -
accuracy: 0.8686 - loss: 0.3698 - val_accuracy: 0.7895 - val_loss: 0.4670
Epoch 759/1500
5/5             0s 12ms/step -
accuracy: 0.8755 - loss: 0.3699 - val_accuracy: 0.7895 - val_loss: 0.4669
Epoch 760/1500
5/5             0s 12ms/step -
accuracy: 0.8634 - loss: 0.3654 - val_accuracy: 0.7895 - val_loss: 0.4667
Epoch 761/1500
5/5             0s 12ms/step -
accuracy: 0.8564 - loss: 0.3991 - val_accuracy: 0.7895 - val_loss: 0.4666
Epoch 762/1500
5/5             0s 12ms/step -
accuracy: 0.8538 - loss: 0.4047 - val_accuracy: 0.7895 - val_loss: 0.4664
Epoch 763/1500
5/5             0s 12ms/step -
accuracy: 0.8751 - loss: 0.3888 - val_accuracy: 0.7895 - val_loss: 0.4662
Epoch 764/1500
5/5             0s 13ms/step -
accuracy: 0.8677 - loss: 0.3808 - val_accuracy: 0.7895 - val_loss: 0.4661
Epoch 765/1500
5/5             0s 17ms/step -
accuracy: 0.8586 - loss: 0.3652 - val_accuracy: 0.7895 - val_loss: 0.4659
Epoch 766/1500
5/5             0s 14ms/step -
accuracy: 0.8686 - loss: 0.3819 - val_accuracy: 0.7895 - val_loss: 0.4657
Epoch 767/1500
5/5             0s 13ms/step -
accuracy: 0.8838 - loss: 0.3692 - val_accuracy: 0.7895 - val_loss: 0.4656
Epoch 768/1500
5/5             0s 12ms/step -
accuracy: 0.8681 - loss: 0.3839 - val_accuracy: 0.7895 - val_loss: 0.4654
```

```
Epoch 769/1500
5/5             0s 16ms/step -
accuracy: 0.8686 - loss: 0.3667 - val_accuracy: 0.7895 - val_loss: 0.4652
Epoch 770/1500
5/5             0s 12ms/step -
accuracy: 0.8655 - loss: 0.3785 - val_accuracy: 0.7895 - val_loss: 0.4651
Epoch 771/1500
5/5             0s 16ms/step -
accuracy: 0.8738 - loss: 0.3747 - val_accuracy: 0.7895 - val_loss: 0.4649
Epoch 772/1500
5/5             0s 14ms/step -
accuracy: 0.8716 - loss: 0.3698 - val_accuracy: 0.7895 - val_loss: 0.4648
Epoch 773/1500
5/5             0s 17ms/step -
accuracy: 0.8712 - loss: 0.3808 - val_accuracy: 0.7895 - val_loss: 0.4646
Epoch 774/1500
5/5             0s 19ms/step -
accuracy: 0.8690 - loss: 0.3756 - val_accuracy: 0.7895 - val_loss: 0.4645
Epoch 775/1500
5/5             0s 13ms/step -
accuracy: 0.8803 - loss: 0.3659 - val_accuracy: 0.7895 - val_loss: 0.4644
Epoch 776/1500
5/5             0s 14ms/step -
accuracy: 0.8751 - loss: 0.3608 - val_accuracy: 0.7895 - val_loss: 0.4642
Epoch 777/1500
5/5             0s 15ms/step -
accuracy: 0.8647 - loss: 0.3887 - val_accuracy: 0.7895 - val_loss: 0.4640
Epoch 778/1500
5/5             0s 13ms/step -
accuracy: 0.8526 - loss: 0.4033 - val_accuracy: 0.7895 - val_loss: 0.4639
Epoch 779/1500
5/5             0s 15ms/step -
accuracy: 0.8881 - loss: 0.3905 - val_accuracy: 0.7895 - val_loss: 0.4637
Epoch 780/1500
5/5             0s 13ms/step -
accuracy: 0.8708 - loss: 0.3857 - val_accuracy: 0.7895 - val_loss: 0.4636
Epoch 781/1500
5/5             0s 17ms/step -
accuracy: 0.8660 - loss: 0.3816 - val_accuracy: 0.7895 - val_loss: 0.4634
Epoch 782/1500
5/5             0s 16ms/step -
accuracy: 0.8638 - loss: 0.3953 - val_accuracy: 0.7895 - val_loss: 0.4633
Epoch 783/1500
5/5             0s 13ms/step -
accuracy: 0.8539 - loss: 0.3928 - val_accuracy: 0.7895 - val_loss: 0.4631
Epoch 784/1500
5/5             0s 14ms/step -
accuracy: 0.8716 - loss: 0.3621 - val_accuracy: 0.7961 - val_loss: 0.4630
```

```
Epoch 785/1500
5/5             0s 16ms/step -
accuracy: 0.8677 - loss: 0.3846 - val_accuracy: 0.7961 - val_loss: 0.4629
Epoch 786/1500
5/5             0s 12ms/step -
accuracy: 0.8725 - loss: 0.3862 - val_accuracy: 0.7961 - val_loss: 0.4627
Epoch 787/1500
5/5             0s 17ms/step -
accuracy: 0.8643 - loss: 0.3800 - val_accuracy: 0.7961 - val_loss: 0.4626
Epoch 788/1500
5/5             0s 16ms/step -
accuracy: 0.8812 - loss: 0.3724 - val_accuracy: 0.7961 - val_loss: 0.4624
Epoch 789/1500
5/5             0s 17ms/step -
accuracy: 0.8660 - loss: 0.3947 - val_accuracy: 0.8026 - val_loss: 0.4623
Epoch 790/1500
5/5             0s 17ms/step -
accuracy: 0.8730 - loss: 0.3866 - val_accuracy: 0.8026 - val_loss: 0.4622
Epoch 791/1500
5/5             0s 12ms/step -
accuracy: 0.8860 - loss: 0.3465 - val_accuracy: 0.8026 - val_loss: 0.4620
Epoch 792/1500
5/5             0s 14ms/step -
accuracy: 0.8717 - loss: 0.3874 - val_accuracy: 0.8026 - val_loss: 0.4619
Epoch 793/1500
5/5             0s 12ms/step -
accuracy: 0.8682 - loss: 0.3875 - val_accuracy: 0.8026 - val_loss: 0.4617
Epoch 794/1500
5/5             0s 13ms/step -
accuracy: 0.8665 - loss: 0.3771 - val_accuracy: 0.8026 - val_loss: 0.4616
Epoch 795/1500
5/5             0s 15ms/step -
accuracy: 0.8691 - loss: 0.3821 - val_accuracy: 0.8026 - val_loss: 0.4614
Epoch 796/1500
5/5             0s 16ms/step -
accuracy: 0.8496 - loss: 0.3929 - val_accuracy: 0.8026 - val_loss: 0.4613
Epoch 797/1500
5/5             0s 13ms/step -
accuracy: 0.8374 - loss: 0.4097 - val_accuracy: 0.8026 - val_loss: 0.4612
Epoch 798/1500
5/5             0s 13ms/step -
accuracy: 0.8769 - loss: 0.3625 - val_accuracy: 0.8026 - val_loss: 0.4610
Epoch 799/1500
5/5             0s 14ms/step -
accuracy: 0.8608 - loss: 0.3901 - val_accuracy: 0.8026 - val_loss: 0.4609
Epoch 800/1500
5/5             0s 12ms/step -
accuracy: 0.8630 - loss: 0.3894 - val_accuracy: 0.8026 - val_loss: 0.4607
```

```
Epoch 801/1500
5/5             0s 15ms/step -
accuracy: 0.8743 - loss: 0.3789 - val_accuracy: 0.8026 - val_loss: 0.4606
Epoch 802/1500
5/5             0s 16ms/step -
accuracy: 0.8756 - loss: 0.3922 - val_accuracy: 0.8026 - val_loss: 0.4605
Epoch 803/1500
5/5             0s 16ms/step -
accuracy: 0.8443 - loss: 0.4003 - val_accuracy: 0.8026 - val_loss: 0.4604
Epoch 804/1500
5/5             0s 15ms/step -
accuracy: 0.8682 - loss: 0.3767 - val_accuracy: 0.8026 - val_loss: 0.4603
Epoch 805/1500
5/5             0s 13ms/step -
accuracy: 0.8843 - loss: 0.3533 - val_accuracy: 0.8026 - val_loss: 0.4601
Epoch 806/1500
5/5             0s 12ms/step -
accuracy: 0.8799 - loss: 0.3686 - val_accuracy: 0.8026 - val_loss: 0.4600
Epoch 807/1500
5/5             0s 18ms/step -
accuracy: 0.9090 - loss: 0.3437 - val_accuracy: 0.8026 - val_loss: 0.4599
Epoch 808/1500
5/5             0s 20ms/step -
accuracy: 0.8851 - loss: 0.3590 - val_accuracy: 0.8026 - val_loss: 0.4598
Epoch 809/1500
5/5             0s 18ms/step -
accuracy: 0.8752 - loss: 0.3648 - val_accuracy: 0.8026 - val_loss: 0.4597
Epoch 810/1500
5/5             0s 22ms/step -
accuracy: 0.8621 - loss: 0.3966 - val_accuracy: 0.8026 - val_loss: 0.4596
Epoch 811/1500
5/5             0s 21ms/step -
accuracy: 0.8756 - loss: 0.3618 - val_accuracy: 0.8026 - val_loss: 0.4594
Epoch 812/1500
5/5             0s 22ms/step -
accuracy: 0.8548 - loss: 0.3901 - val_accuracy: 0.8026 - val_loss: 0.4593
Epoch 813/1500
5/5             0s 23ms/step -
accuracy: 0.8595 - loss: 0.3915 - val_accuracy: 0.8026 - val_loss: 0.4592
Epoch 814/1500
5/5             0s 21ms/step -
accuracy: 0.8656 - loss: 0.3819 - val_accuracy: 0.8026 - val_loss: 0.4591
Epoch 815/1500
5/5             0s 17ms/step -
accuracy: 0.8656 - loss: 0.3740 - val_accuracy: 0.8026 - val_loss: 0.4590
Epoch 816/1500
5/5             0s 21ms/step -
accuracy: 0.8482 - loss: 0.4073 - val_accuracy: 0.8026 - val_loss: 0.4589
```

```
Epoch 817/1500
5/5             0s 27ms/step -
accuracy: 0.8730 - loss: 0.3757 - val_accuracy: 0.8026 - val_loss: 0.4588
Epoch 818/1500
5/5             0s 22ms/step -
accuracy: 0.8708 - loss: 0.3618 - val_accuracy: 0.8026 - val_loss: 0.4587
Epoch 819/1500
5/5             0s 22ms/step -
accuracy: 0.8652 - loss: 0.3680 - val_accuracy: 0.8026 - val_loss: 0.4586
Epoch 820/1500
5/5             0s 22ms/step -
accuracy: 0.8760 - loss: 0.3511 - val_accuracy: 0.8026 - val_loss: 0.4585
Epoch 821/1500
5/5             0s 19ms/step -
accuracy: 0.8869 - loss: 0.3649 - val_accuracy: 0.8026 - val_loss: 0.4584
Epoch 822/1500
5/5             0s 16ms/step -
accuracy: 0.8660 - loss: 0.3819 - val_accuracy: 0.8026 - val_loss: 0.4582
Epoch 823/1500
5/5             0s 16ms/step -
accuracy: 0.8656 - loss: 0.3682 - val_accuracy: 0.8026 - val_loss: 0.4581
Epoch 824/1500
5/5             0s 13ms/step -
accuracy: 0.8808 - loss: 0.3682 - val_accuracy: 0.8026 - val_loss: 0.4580
Epoch 825/1500
5/5             0s 15ms/step -
accuracy: 0.8773 - loss: 0.3781 - val_accuracy: 0.8026 - val_loss: 0.4579
Epoch 826/1500
5/5             0s 13ms/step -
accuracy: 0.8786 - loss: 0.3798 - val_accuracy: 0.8026 - val_loss: 0.4578
Epoch 827/1500
5/5             0s 17ms/step -
accuracy: 0.8686 - loss: 0.3794 - val_accuracy: 0.7961 - val_loss: 0.4577
Epoch 828/1500
5/5             0s 13ms/step -
accuracy: 0.8678 - loss: 0.3669 - val_accuracy: 0.7961 - val_loss: 0.4576
Epoch 829/1500
5/5             0s 12ms/step -
accuracy: 0.8673 - loss: 0.3753 - val_accuracy: 0.7961 - val_loss: 0.4575
Epoch 830/1500
5/5             0s 13ms/step -
accuracy: 0.8739 - loss: 0.3568 - val_accuracy: 0.7961 - val_loss: 0.4574
Epoch 831/1500
5/5             0s 16ms/step -
accuracy: 0.8526 - loss: 0.3700 - val_accuracy: 0.7961 - val_loss: 0.4573
Epoch 832/1500
5/5             0s 16ms/step -
accuracy: 0.9246 - loss: 0.3163 - val_accuracy: 0.7961 - val_loss: 0.4572
```

```
Epoch 833/1500
5/5             0s 16ms/step -
accuracy: 0.8682 - loss: 0.3683 - val_accuracy: 0.7961 - val_loss: 0.4571
Epoch 834/1500
5/5             0s 13ms/step -
accuracy: 0.8613 - loss: 0.3988 - val_accuracy: 0.7961 - val_loss: 0.4570
Epoch 835/1500
5/5             0s 13ms/step -
accuracy: 0.8912 - loss: 0.3423 - val_accuracy: 0.7961 - val_loss: 0.4569
Epoch 836/1500
5/5             0s 12ms/step -
accuracy: 0.8699 - loss: 0.3567 - val_accuracy: 0.7961 - val_loss: 0.4568
Epoch 837/1500
5/5             0s 13ms/step -
accuracy: 0.8752 - loss: 0.3607 - val_accuracy: 0.7961 - val_loss: 0.4567
Epoch 838/1500
5/5             0s 13ms/step -
accuracy: 0.8843 - loss: 0.3400 - val_accuracy: 0.7961 - val_loss: 0.4566
Epoch 839/1500
5/5             0s 12ms/step -
accuracy: 0.8548 - loss: 0.4017 - val_accuracy: 0.7961 - val_loss: 0.4566
Epoch 840/1500
5/5             0s 16ms/step -
accuracy: 0.8595 - loss: 0.3773 - val_accuracy: 0.7961 - val_loss: 0.4565
Epoch 841/1500
5/5             0s 16ms/step -
accuracy: 0.8882 - loss: 0.3714 - val_accuracy: 0.7961 - val_loss: 0.4564
Epoch 842/1500
5/5             0s 16ms/step -
accuracy: 0.8613 - loss: 0.3756 - val_accuracy: 0.7961 - val_loss: 0.4563
Epoch 843/1500
5/5             0s 13ms/step -
accuracy: 0.9116 - loss: 0.3433 - val_accuracy: 0.7961 - val_loss: 0.4562
Epoch 844/1500
5/5             0s 16ms/step -
accuracy: 0.8851 - loss: 0.3460 - val_accuracy: 0.7961 - val_loss: 0.4561
Epoch 845/1500
5/5             0s 15ms/step -
accuracy: 0.8613 - loss: 0.3783 - val_accuracy: 0.7961 - val_loss: 0.4560
Epoch 846/1500
5/5             0s 14ms/step -
accuracy: 0.8825 - loss: 0.3613 - val_accuracy: 0.7961 - val_loss: 0.4559
Epoch 847/1500
5/5             0s 12ms/step -
accuracy: 0.8582 - loss: 0.3891 - val_accuracy: 0.7961 - val_loss: 0.4559
Epoch 848/1500
5/5             0s 16ms/step -
accuracy: 0.8652 - loss: 0.3685 - val_accuracy: 0.7961 - val_loss: 0.4558
```

```
Epoch 849/1500
5/5             0s 16ms/step -
accuracy: 0.8786 - loss: 0.3673 - val_accuracy: 0.7961 - val_loss: 0.4557
Epoch 850/1500
5/5             0s 16ms/step -
accuracy: 0.8756 - loss: 0.3675 - val_accuracy: 0.7961 - val_loss: 0.4555
Epoch 851/1500
5/5             0s 15ms/step -
accuracy: 0.8660 - loss: 0.3844 - val_accuracy: 0.7961 - val_loss: 0.4554
Epoch 852/1500
5/5             0s 16ms/step -
accuracy: 0.8552 - loss: 0.3941 - val_accuracy: 0.7961 - val_loss: 0.4553
Epoch 853/1500
5/5             0s 14ms/step -
accuracy: 0.8669 - loss: 0.3729 - val_accuracy: 0.7961 - val_loss: 0.4553
Epoch 854/1500
5/5             0s 15ms/step -
accuracy: 0.8634 - loss: 0.3565 - val_accuracy: 0.7961 - val_loss: 0.4552
Epoch 855/1500
5/5             0s 13ms/step -
accuracy: 0.8947 - loss: 0.3409 - val_accuracy: 0.7961 - val_loss: 0.4551
Epoch 856/1500
5/5             0s 13ms/step -
accuracy: 0.8903 - loss: 0.3397 - val_accuracy: 0.7961 - val_loss: 0.4550
Epoch 857/1500
5/5             0s 16ms/step -
accuracy: 0.8734 - loss: 0.3592 - val_accuracy: 0.7961 - val_loss: 0.4549
Epoch 858/1500
5/5             0s 14ms/step -
accuracy: 0.8465 - loss: 0.3975 - val_accuracy: 0.7961 - val_loss: 0.4548
Epoch 859/1500
5/5             0s 14ms/step -
accuracy: 0.9042 - loss: 0.3312 - val_accuracy: 0.7961 - val_loss: 0.4547
Epoch 860/1500
5/5             0s 18ms/step -
accuracy: 0.8908 - loss: 0.3386 - val_accuracy: 0.7961 - val_loss: 0.4546
Epoch 861/1500
5/5             0s 12ms/step -
accuracy: 0.8708 - loss: 0.3466 - val_accuracy: 0.7961 - val_loss: 0.4545
Epoch 862/1500
5/5             0s 13ms/step -
accuracy: 0.8526 - loss: 0.3731 - val_accuracy: 0.7961 - val_loss: 0.4544
Epoch 863/1500
5/5             0s 16ms/step -
accuracy: 0.8717 - loss: 0.3578 - val_accuracy: 0.7961 - val_loss: 0.4543
Epoch 864/1500
5/5             0s 17ms/step -
accuracy: 0.8695 - loss: 0.3629 - val_accuracy: 0.7961 - val_loss: 0.4542
```

```
Epoch 865/1500
5/5             0s 12ms/step -
accuracy: 0.8773 - loss: 0.3558 - val_accuracy: 0.7961 - val_loss: 0.4541
Epoch 866/1500
5/5             0s 16ms/step -
accuracy: 0.8890 - loss: 0.3320 - val_accuracy: 0.7961 - val_loss: 0.4540
Epoch 867/1500
5/5             0s 13ms/step -
accuracy: 0.8804 - loss: 0.3435 - val_accuracy: 0.7961 - val_loss: 0.4539
Epoch 868/1500
5/5             0s 13ms/step -
accuracy: 0.8765 - loss: 0.3682 - val_accuracy: 0.7961 - val_loss: 0.4538
Epoch 869/1500
5/5             0s 18ms/step -
accuracy: 0.8543 - loss: 0.3638 - val_accuracy: 0.7961 - val_loss: 0.4537
Epoch 870/1500
5/5             0s 15ms/step -
accuracy: 0.8617 - loss: 0.3817 - val_accuracy: 0.7961 - val_loss: 0.4535
Epoch 871/1500
5/5             0s 16ms/step -
accuracy: 0.8430 - loss: 0.3959 - val_accuracy: 0.7961 - val_loss: 0.4534
Epoch 872/1500
5/5             0s 14ms/step -
accuracy: 0.9029 - loss: 0.3143 - val_accuracy: 0.7961 - val_loss: 0.4534
Epoch 873/1500
5/5             0s 16ms/step -
accuracy: 0.8834 - loss: 0.3537 - val_accuracy: 0.7961 - val_loss: 0.4533
Epoch 874/1500
5/5             0s 16ms/step -
accuracy: 0.8613 - loss: 0.3787 - val_accuracy: 0.7961 - val_loss: 0.4532
Epoch 875/1500
5/5             0s 13ms/step -
accuracy: 0.8509 - loss: 0.3539 - val_accuracy: 0.7961 - val_loss: 0.4531
Epoch 876/1500
5/5             0s 17ms/step -
accuracy: 0.9025 - loss: 0.3286 - val_accuracy: 0.7961 - val_loss: 0.4530
Epoch 877/1500
5/5             0s 18ms/step -
accuracy: 0.8886 - loss: 0.3204 - val_accuracy: 0.7961 - val_loss: 0.4529
Epoch 878/1500
5/5             0s 16ms/step -
accuracy: 0.8699 - loss: 0.3689 - val_accuracy: 0.7961 - val_loss: 0.4528
Epoch 879/1500
5/5             0s 16ms/step -
accuracy: 0.8734 - loss: 0.3696 - val_accuracy: 0.7961 - val_loss: 0.4527
Epoch 880/1500
5/5             0s 19ms/step -
accuracy: 0.8990 - loss: 0.3254 - val_accuracy: 0.7961 - val_loss: 0.4526
```

```
Epoch 881/1500
5/5             0s 17ms/step -
accuracy: 0.8561 - loss: 0.4016 - val_accuracy: 0.7961 - val_loss: 0.4525
Epoch 882/1500
5/5             0s 12ms/step -
accuracy: 0.8686 - loss: 0.3620 - val_accuracy: 0.7961 - val_loss: 0.4524
Epoch 883/1500
5/5             0s 13ms/step -
accuracy: 0.8713 - loss: 0.3538 - val_accuracy: 0.7961 - val_loss: 0.4523
Epoch 884/1500
5/5             0s 13ms/step -
accuracy: 0.8509 - loss: 0.3874 - val_accuracy: 0.7961 - val_loss: 0.4522
Epoch 885/1500
5/5             0s 15ms/step -
accuracy: 0.8491 - loss: 0.3922 - val_accuracy: 0.7961 - val_loss: 0.4521
Epoch 886/1500
5/5             0s 17ms/step -
accuracy: 0.8869 - loss: 0.3515 - val_accuracy: 0.7961 - val_loss: 0.4520
Epoch 887/1500
5/5             0s 18ms/step -
accuracy: 0.8799 - loss: 0.3508 - val_accuracy: 0.7961 - val_loss: 0.4519
Epoch 888/1500
5/5             0s 17ms/step -
accuracy: 0.8821 - loss: 0.3539 - val_accuracy: 0.7961 - val_loss: 0.4518
Epoch 889/1500
5/5             0s 16ms/step -
accuracy: 0.8882 - loss: 0.3350 - val_accuracy: 0.7961 - val_loss: 0.4517
Epoch 890/1500
5/5             0s 13ms/step -
accuracy: 0.8890 - loss: 0.3316 - val_accuracy: 0.7961 - val_loss: 0.4517
Epoch 891/1500
5/5             0s 16ms/step -
accuracy: 0.8869 - loss: 0.3321 - val_accuracy: 0.7961 - val_loss: 0.4516
Epoch 892/1500
5/5             0s 12ms/step -
accuracy: 0.8799 - loss: 0.3382 - val_accuracy: 0.7961 - val_loss: 0.4515
Epoch 893/1500
5/5             0s 12ms/step -
accuracy: 0.8956 - loss: 0.3336 - val_accuracy: 0.7961 - val_loss: 0.4514
Epoch 894/1500
5/5             0s 13ms/step -
accuracy: 0.8799 - loss: 0.3437 - val_accuracy: 0.7961 - val_loss: 0.4513
Epoch 895/1500
5/5             0s 14ms/step -
accuracy: 0.9025 - loss: 0.3191 - val_accuracy: 0.7961 - val_loss: 0.4512
Epoch 896/1500
5/5             0s 13ms/step -
accuracy: 0.8717 - loss: 0.3687 - val_accuracy: 0.7961 - val_loss: 0.4511
```

```
Epoch 897/1500
5/5             0s 14ms/step -
accuracy: 0.8791 - loss: 0.3443 - val_accuracy: 0.7961 - val_loss: 0.4510
Epoch 898/1500
5/5             0s 16ms/step -
accuracy: 0.8500 - loss: 0.3621 - val_accuracy: 0.7961 - val_loss: 0.4510
Epoch 899/1500
5/5             0s 13ms/step -
accuracy: 0.8600 - loss: 0.3546 - val_accuracy: 0.7961 - val_loss: 0.4509
Epoch 900/1500
5/5             0s 16ms/step -
accuracy: 0.8921 - loss: 0.3429 - val_accuracy: 0.7961 - val_loss: 0.4508
Epoch 901/1500
5/5             0s 14ms/step -
accuracy: 0.8699 - loss: 0.3584 - val_accuracy: 0.7961 - val_loss: 0.4507
Epoch 902/1500
5/5             0s 15ms/step -
accuracy: 0.8834 - loss: 0.3494 - val_accuracy: 0.7961 - val_loss: 0.4506
Epoch 903/1500
5/5             0s 14ms/step -
accuracy: 0.8791 - loss: 0.3349 - val_accuracy: 0.7961 - val_loss: 0.4505
Epoch 904/1500
5/5             0s 22ms/step -
accuracy: 0.8860 - loss: 0.3375 - val_accuracy: 0.7961 - val_loss: 0.4504
Epoch 905/1500
5/5             0s 17ms/step -
accuracy: 0.8691 - loss: 0.3448 - val_accuracy: 0.7961 - val_loss: 0.4503
Epoch 906/1500
5/5             0s 16ms/step -
accuracy: 0.8747 - loss: 0.3440 - val_accuracy: 0.7961 - val_loss: 0.4502
Epoch 907/1500
5/5             0s 21ms/step -
accuracy: 0.8413 - loss: 0.3873 - val_accuracy: 0.7961 - val_loss: 0.4502
Epoch 908/1500
5/5             0s 21ms/step -
accuracy: 0.8717 - loss: 0.3296 - val_accuracy: 0.7961 - val_loss: 0.4500
Epoch 909/1500
5/5             0s 17ms/step -
accuracy: 0.8869 - loss: 0.3309 - val_accuracy: 0.7961 - val_loss: 0.4499
Epoch 910/1500
5/5             0s 17ms/step -
accuracy: 0.8904 - loss: 0.3451 - val_accuracy: 0.7961 - val_loss: 0.4499
Epoch 911/1500
5/5             0s 25ms/step -
accuracy: 0.8756 - loss: 0.3482 - val_accuracy: 0.7961 - val_loss: 0.4498
Epoch 912/1500
5/5             0s 22ms/step -
accuracy: 0.8778 - loss: 0.3548 - val_accuracy: 0.7961 - val_loss: 0.4497
```

```
Epoch 913/1500
5/5             0s 19ms/step -
accuracy: 0.8704 - loss: 0.3461 - val_accuracy: 0.7961 - val_loss: 0.4497
Epoch 914/1500
5/5             0s 22ms/step -
accuracy: 0.8826 - loss: 0.3458 - val_accuracy: 0.7961 - val_loss: 0.4496
Epoch 915/1500
5/5             0s 20ms/step -
accuracy: 0.8526 - loss: 0.3894 - val_accuracy: 0.7961 - val_loss: 0.4495
Epoch 916/1500
5/5             0s 16ms/step -
accuracy: 0.8852 - loss: 0.3410 - val_accuracy: 0.7961 - val_loss: 0.4494
Epoch 917/1500
5/5             0s 17ms/step -
accuracy: 0.8561 - loss: 0.3967 - val_accuracy: 0.7961 - val_loss: 0.4493
Epoch 918/1500
5/5             0s 26ms/step -
accuracy: 0.8656 - loss: 0.3854 - val_accuracy: 0.7961 - val_loss: 0.4492
Epoch 919/1500
5/5             0s 16ms/step -
accuracy: 0.8895 - loss: 0.3422 - val_accuracy: 0.7961 - val_loss: 0.4491
Epoch 920/1500
5/5             0s 17ms/step -
accuracy: 0.8739 - loss: 0.3352 - val_accuracy: 0.7961 - val_loss: 0.4491
Epoch 921/1500
5/5             0s 13ms/step -
accuracy: 0.8813 - loss: 0.3535 - val_accuracy: 0.7961 - val_loss: 0.4490
Epoch 922/1500
5/5             0s 13ms/step -
accuracy: 0.9030 - loss: 0.3252 - val_accuracy: 0.7961 - val_loss: 0.4489
Epoch 923/1500
5/5             0s 16ms/step -
accuracy: 0.8860 - loss: 0.3337 - val_accuracy: 0.7961 - val_loss: 0.4488
Epoch 924/1500
5/5             0s 12ms/step -
accuracy: 0.8856 - loss: 0.3360 - val_accuracy: 0.7961 - val_loss: 0.4487
Epoch 925/1500
5/5             0s 14ms/step -
accuracy: 0.8921 - loss: 0.3205 - val_accuracy: 0.7961 - val_loss: 0.4487
Epoch 926/1500
5/5             0s 12ms/step -
accuracy: 0.8977 - loss: 0.3383 - val_accuracy: 0.7961 - val_loss: 0.4486
Epoch 927/1500
5/5             0s 16ms/step -
accuracy: 0.8773 - loss: 0.3507 - val_accuracy: 0.7961 - val_loss: 0.4485
Epoch 928/1500
5/5             0s 18ms/step -
accuracy: 0.8713 - loss: 0.3469 - val_accuracy: 0.7961 - val_loss: 0.4485
```

```
Epoch 929/1500
5/5             0s 17ms/step -
accuracy: 0.8951 - loss: 0.3230 - val_accuracy: 0.7961 - val_loss: 0.4484
Epoch 930/1500
5/5             0s 13ms/step -
accuracy: 0.8474 - loss: 0.3565 - val_accuracy: 0.7961 - val_loss: 0.4483
Epoch 931/1500
5/5             0s 17ms/step -
accuracy: 0.8934 - loss: 0.3229 - val_accuracy: 0.7961 - val_loss: 0.4482
Epoch 932/1500
5/5             0s 14ms/step -
accuracy: 0.8717 - loss: 0.3611 - val_accuracy: 0.7961 - val_loss: 0.4481
Epoch 933/1500
5/5             0s 16ms/step -
accuracy: 0.8691 - loss: 0.3434 - val_accuracy: 0.7961 - val_loss: 0.4481
Epoch 934/1500
5/5             0s 14ms/step -
accuracy: 0.8778 - loss: 0.3619 - val_accuracy: 0.7961 - val_loss: 0.4480
Epoch 935/1500
5/5             0s 14ms/step -
accuracy: 0.8804 - loss: 0.3589 - val_accuracy: 0.7961 - val_loss: 0.4480
Epoch 936/1500
5/5             0s 15ms/step -
accuracy: 0.8799 - loss: 0.3468 - val_accuracy: 0.7961 - val_loss: 0.4479
Epoch 937/1500
5/5             0s 16ms/step -
accuracy: 0.8943 - loss: 0.3285 - val_accuracy: 0.7961 - val_loss: 0.4478
Epoch 938/1500
5/5             0s 17ms/step -
accuracy: 0.8526 - loss: 0.3888 - val_accuracy: 0.7961 - val_loss: 0.4478
Epoch 939/1500
5/5             0s 16ms/step -
accuracy: 0.8608 - loss: 0.3591 - val_accuracy: 0.7961 - val_loss: 0.4477
Epoch 940/1500
5/5             0s 14ms/step -
accuracy: 0.8448 - loss: 0.3705 - val_accuracy: 0.7961 - val_loss: 0.4477
Epoch 941/1500
5/5             0s 13ms/step -
accuracy: 0.8556 - loss: 0.3694 - val_accuracy: 0.7961 - val_loss: 0.4476
Epoch 942/1500
5/5             0s 16ms/step -
accuracy: 0.8704 - loss: 0.3397 - val_accuracy: 0.7961 - val_loss: 0.4475
Epoch 943/1500
5/5             0s 16ms/step -
accuracy: 0.8765 - loss: 0.3433 - val_accuracy: 0.7961 - val_loss: 0.4474
Epoch 944/1500
5/5             0s 16ms/step -
accuracy: 0.9068 - loss: 0.3040 - val_accuracy: 0.7961 - val_loss: 0.4474
```

```
Epoch 945/1500
5/5             0s 17ms/step -
accuracy: 0.8626 - loss: 0.3597 - val_accuracy: 0.7961 - val_loss: 0.4473
Epoch 946/1500
5/5             0s 17ms/step -
accuracy: 0.8739 - loss: 0.3202 - val_accuracy: 0.7961 - val_loss: 0.4472
Epoch 947/1500
5/5             0s 13ms/step -
accuracy: 0.8869 - loss: 0.3330 - val_accuracy: 0.7961 - val_loss: 0.4472
Epoch 948/1500
5/5             0s 17ms/step -
accuracy: 0.8886 - loss: 0.3233 - val_accuracy: 0.7961 - val_loss: 0.4471
Epoch 949/1500
5/5             0s 14ms/step -
accuracy: 0.8943 - loss: 0.3148 - val_accuracy: 0.7961 - val_loss: 0.4470
Epoch 950/1500
5/5             0s 16ms/step -
accuracy: 0.8899 - loss: 0.3390 - val_accuracy: 0.7961 - val_loss: 0.4470
Epoch 951/1500
5/5             0s 14ms/step -
accuracy: 0.9094 - loss: 0.3120 - val_accuracy: 0.7961 - val_loss: 0.4469
Epoch 952/1500
5/5             0s 17ms/step -
accuracy: 0.8808 - loss: 0.3306 - val_accuracy: 0.7961 - val_loss: 0.4469
Epoch 953/1500
5/5             0s 16ms/step -
accuracy: 0.8578 - loss: 0.3804 - val_accuracy: 0.7961 - val_loss: 0.4468
Epoch 954/1500
5/5             0s 14ms/step -
accuracy: 0.8778 - loss: 0.3474 - val_accuracy: 0.7961 - val_loss: 0.4468
Epoch 955/1500
5/5             0s 17ms/step -
accuracy: 0.8682 - loss: 0.3553 - val_accuracy: 0.7961 - val_loss: 0.4467
Epoch 956/1500
5/5             0s 13ms/step -
accuracy: 0.8999 - loss: 0.3121 - val_accuracy: 0.7961 - val_loss: 0.4467
Epoch 957/1500
5/5             0s 13ms/step -
accuracy: 0.8747 - loss: 0.3330 - val_accuracy: 0.7961 - val_loss: 0.4466
Epoch 958/1500
5/5             0s 14ms/step -
accuracy: 0.8461 - loss: 0.3874 - val_accuracy: 0.7961 - val_loss: 0.4465
Epoch 959/1500
5/5             0s 14ms/step -
accuracy: 0.8665 - loss: 0.3484 - val_accuracy: 0.7961 - val_loss: 0.4465
Epoch 960/1500
5/5             0s 17ms/step -
accuracy: 0.8717 - loss: 0.3519 - val_accuracy: 0.7961 - val_loss: 0.4464
```

```
Epoch 961/1500
5/5            0s 17ms/step -
accuracy: 0.9108 - loss: 0.2955 - val_accuracy: 0.7961 - val_loss: 0.4464
Epoch 962/1500
5/5            0s 12ms/step -
accuracy: 0.8878 - loss: 0.3306 - val_accuracy: 0.7961 - val_loss: 0.4463
Epoch 963/1500
5/5            0s 16ms/step -
accuracy: 0.8782 - loss: 0.3179 - val_accuracy: 0.7961 - val_loss: 0.4462
Epoch 964/1500
5/5            0s 16ms/step -
accuracy: 0.8578 - loss: 0.3587 - val_accuracy: 0.7961 - val_loss: 0.4462
Epoch 965/1500
5/5            0s 16ms/step -
accuracy: 0.9156 - loss: 0.3123 - val_accuracy: 0.7961 - val_loss: 0.4461
Epoch 966/1500
5/5            0s 13ms/step -
accuracy: 0.8700 - loss: 0.3638 - val_accuracy: 0.7961 - val_loss: 0.4460
Epoch 967/1500
5/5            0s 17ms/step -
accuracy: 0.8661 - loss: 0.3446 - val_accuracy: 0.7961 - val_loss: 0.4460
Epoch 968/1500
5/5            0s 20ms/step -
accuracy: 0.8821 - loss: 0.3261 - val_accuracy: 0.7961 - val_loss: 0.4460
Epoch 969/1500
5/5            0s 17ms/step -
accuracy: 0.8887 - loss: 0.3489 - val_accuracy: 0.7961 - val_loss: 0.4459
Epoch 970/1500
5/5            0s 13ms/step -
accuracy: 0.8808 - loss: 0.3413 - val_accuracy: 0.7961 - val_loss: 0.4458
Epoch 971/1500
5/5            0s 13ms/step -
accuracy: 0.9017 - loss: 0.3010 - val_accuracy: 0.7961 - val_loss: 0.4458
Epoch 972/1500
5/5            0s 13ms/step -
accuracy: 0.8652 - loss: 0.3792 - val_accuracy: 0.7961 - val_loss: 0.4457
Epoch 973/1500
5/5            0s 17ms/step -
accuracy: 0.9104 - loss: 0.2961 - val_accuracy: 0.7961 - val_loss: 0.4457
Epoch 974/1500
5/5            0s 16ms/step -
accuracy: 0.8765 - loss: 0.3491 - val_accuracy: 0.8026 - val_loss: 0.4456
Epoch 975/1500
5/5            0s 13ms/step -
accuracy: 0.8557 - loss: 0.3669 - val_accuracy: 0.8026 - val_loss: 0.4456
Epoch 976/1500
5/5            0s 13ms/step -
accuracy: 0.8622 - loss: 0.3552 - val_accuracy: 0.8026 - val_loss: 0.4456
```

```
Epoch 977/1500
5/5             0s 14ms/step -
accuracy: 0.8635 - loss: 0.3611 - val_accuracy: 0.8026 - val_loss: 0.4455
Epoch 978/1500
5/5             0s 16ms/step -
accuracy: 0.8813 - loss: 0.3177 - val_accuracy: 0.8026 - val_loss: 0.4454
Epoch 979/1500
5/5             0s 17ms/step -
accuracy: 0.8995 - loss: 0.3102 - val_accuracy: 0.8026 - val_loss: 0.4454
Epoch 980/1500
5/5             0s 17ms/step -
accuracy: 0.8887 - loss: 0.3258 - val_accuracy: 0.8026 - val_loss: 0.4453
Epoch 981/1500
5/5             0s 15ms/step -
accuracy: 0.8752 - loss: 0.3399 - val_accuracy: 0.8026 - val_loss: 0.4453
Epoch 982/1500
5/5             0s 14ms/step -
accuracy: 0.8947 - loss: 0.3210 - val_accuracy: 0.8026 - val_loss: 0.4452
Epoch 983/1500
5/5             0s 17ms/step -
accuracy: 0.8808 - loss: 0.3294 - val_accuracy: 0.8026 - val_loss: 0.4452
Epoch 984/1500
5/5             0s 15ms/step -
accuracy: 0.8852 - loss: 0.3072 - val_accuracy: 0.8026 - val_loss: 0.4451
Epoch 985/1500
5/5             0s 17ms/step -
accuracy: 0.8865 - loss: 0.2979 - val_accuracy: 0.8026 - val_loss: 0.4451
Epoch 986/1500
5/5             0s 13ms/step -
accuracy: 0.8717 - loss: 0.3308 - val_accuracy: 0.8026 - val_loss: 0.4451
Epoch 987/1500
5/5             0s 12ms/step -
accuracy: 0.8774 - loss: 0.3430 - val_accuracy: 0.8026 - val_loss: 0.4450
Epoch 988/1500
5/5             0s 13ms/step -
accuracy: 0.8635 - loss: 0.3609 - val_accuracy: 0.8026 - val_loss: 0.4450
Epoch 989/1500
5/5             0s 12ms/step -
accuracy: 0.8873 - loss: 0.3342 - val_accuracy: 0.8026 - val_loss: 0.4449
Epoch 990/1500
5/5             0s 14ms/step -
accuracy: 0.8939 - loss: 0.3107 - val_accuracy: 0.8026 - val_loss: 0.4449
Epoch 991/1500
5/5             0s 13ms/step -
accuracy: 0.8761 - loss: 0.3431 - val_accuracy: 0.8026 - val_loss: 0.4449
Epoch 992/1500
5/5             0s 18ms/step -
accuracy: 0.9008 - loss: 0.3025 - val_accuracy: 0.8026 - val_loss: 0.4448
```

```
Epoch 993/1500
5/5             0s 13ms/step -
accuracy: 0.8830 - loss: 0.3099 - val_accuracy: 0.8026 - val_loss: 0.4448
Epoch 994/1500
5/5             0s 14ms/step -
accuracy: 0.8926 - loss: 0.3185 - val_accuracy: 0.8026 - val_loss: 0.4447
Epoch 995/1500
5/5             0s 19ms/step -
accuracy: 0.8626 - loss: 0.3439 - val_accuracy: 0.8026 - val_loss: 0.4447
Epoch 996/1500
5/5             0s 28ms/step -
accuracy: 0.8557 - loss: 0.3728 - val_accuracy: 0.8026 - val_loss: 0.4447
Epoch 997/1500
5/5             0s 26ms/step -
accuracy: 0.8856 - loss: 0.3210 - val_accuracy: 0.8026 - val_loss: 0.4446
Epoch 998/1500
5/5             0s 24ms/step -
accuracy: 0.8878 - loss: 0.3308 - val_accuracy: 0.8026 - val_loss: 0.4446
Epoch 999/1500
5/5             0s 17ms/step -
accuracy: 0.9060 - loss: 0.3059 - val_accuracy: 0.8026 - val_loss: 0.4445
Epoch 1000/1500
5/5             0s 23ms/step -
accuracy: 0.8443 - loss: 0.3557 - val_accuracy: 0.8026 - val_loss: 0.4445
Epoch 1001/1500
5/5             0s 30ms/step -
accuracy: 0.8847 - loss: 0.3335 - val_accuracy: 0.8026 - val_loss: 0.4445
Epoch 1002/1500
5/5             0s 25ms/step -
accuracy: 0.8800 - loss: 0.3359 - val_accuracy: 0.8026 - val_loss: 0.4444
Epoch 1003/1500
5/5             0s 22ms/step -
accuracy: 0.9017 - loss: 0.2947 - val_accuracy: 0.8026 - val_loss: 0.4444
Epoch 1004/1500
5/5             0s 19ms/step -
accuracy: 0.8787 - loss: 0.3358 - val_accuracy: 0.8026 - val_loss: 0.4443
Epoch 1005/1500
5/5             0s 19ms/step -
accuracy: 0.8609 - loss: 0.3471 - val_accuracy: 0.8026 - val_loss: 0.4443
Epoch 1006/1500
5/5             0s 22ms/step -
accuracy: 0.8926 - loss: 0.3140 - val_accuracy: 0.8026 - val_loss: 0.4443
Epoch 1007/1500
5/5             0s 17ms/step -
accuracy: 0.8426 - loss: 0.3614 - val_accuracy: 0.8026 - val_loss: 0.4442
Epoch 1008/1500
5/5             0s 14ms/step -
accuracy: 0.9121 - loss: 0.2979 - val_accuracy: 0.8026 - val_loss: 0.4442
```

```
Epoch 1009/1500
5/5             0s 20ms/step -
accuracy: 0.9004 - loss: 0.3052 - val_accuracy: 0.8026 - val_loss: 0.4442
Epoch 1010/1500
5/5             0s 13ms/step -
accuracy: 0.8787 - loss: 0.3208 - val_accuracy: 0.8026 - val_loss: 0.4442
Epoch 1011/1500
5/5             0s 13ms/step -
accuracy: 0.9125 - loss: 0.2750 - val_accuracy: 0.8026 - val_loss: 0.4441
Epoch 1012/1500
5/5             0s 16ms/step -
accuracy: 0.8960 - loss: 0.3172 - val_accuracy: 0.8026 - val_loss: 0.4441
Epoch 1013/1500
5/5             0s 17ms/step -
accuracy: 0.8761 - loss: 0.3367 - val_accuracy: 0.8026 - val_loss: 0.4441
Epoch 1014/1500
5/5             0s 14ms/step -
accuracy: 0.8778 - loss: 0.3441 - val_accuracy: 0.8026 - val_loss: 0.4440
Epoch 1015/1500
5/5             0s 13ms/step -
accuracy: 0.8791 - loss: 0.3377 - val_accuracy: 0.8026 - val_loss: 0.4440
Epoch 1016/1500
5/5             0s 16ms/step -
accuracy: 0.9099 - loss: 0.3047 - val_accuracy: 0.8026 - val_loss: 0.4440
Epoch 1017/1500
5/5             0s 15ms/step -
accuracy: 0.8947 - loss: 0.3127 - val_accuracy: 0.7961 - val_loss: 0.4439
Epoch 1018/1500
5/5             0s 17ms/step -
accuracy: 0.8648 - loss: 0.3454 - val_accuracy: 0.8026 - val_loss: 0.4439
Epoch 1019/1500
5/5             0s 13ms/step -
accuracy: 0.8817 - loss: 0.3241 - val_accuracy: 0.8026 - val_loss: 0.4439
Epoch 1020/1500
5/5             0s 12ms/step -
accuracy: 0.8874 - loss: 0.3222 - val_accuracy: 0.8026 - val_loss: 0.4439
Epoch 1021/1500
5/5             0s 16ms/step -
accuracy: 0.8609 - loss: 0.3718 - val_accuracy: 0.8026 - val_loss: 0.4439
Epoch 1022/1500
5/5             0s 13ms/step -
accuracy: 0.8570 - loss: 0.3402 - val_accuracy: 0.8026 - val_loss: 0.4439
Epoch 1023/1500
5/5             0s 17ms/step -
accuracy: 0.8739 - loss: 0.3199 - val_accuracy: 0.8026 - val_loss: 0.4438
Epoch 1024/1500
5/5             0s 15ms/step -
accuracy: 0.8939 - loss: 0.3217 - val_accuracy: 0.8026 - val_loss: 0.4438
```

```
Epoch 1025/1500
5/5             0s 19ms/step -
accuracy: 0.9008 - loss: 0.2995 - val_accuracy: 0.8026 - val_loss: 0.4438
Epoch 1026/1500
5/5             0s 13ms/step -
accuracy: 0.8856 - loss: 0.3407 - val_accuracy: 0.8026 - val_loss: 0.4437
Epoch 1027/1500
5/5             0s 13ms/step -
accuracy: 0.8961 - loss: 0.3063 - val_accuracy: 0.8026 - val_loss: 0.4437
Epoch 1028/1500
5/5             0s 17ms/step -
accuracy: 0.8843 - loss: 0.3317 - val_accuracy: 0.8026 - val_loss: 0.4437
Epoch 1029/1500
5/5             0s 13ms/step -
accuracy: 0.8890 - loss: 0.3143 - val_accuracy: 0.8026 - val_loss: 0.4437
Epoch 1030/1500
5/5             0s 16ms/step -
accuracy: 0.8660 - loss: 0.3570 - val_accuracy: 0.8026 - val_loss: 0.4436
Epoch 1031/1500
5/5             0s 17ms/step -
accuracy: 0.8908 - loss: 0.3118 - val_accuracy: 0.8026 - val_loss: 0.4436
Epoch 1032/1500
5/5             0s 16ms/step -
accuracy: 0.8769 - loss: 0.3084 - val_accuracy: 0.8026 - val_loss: 0.4436
Epoch 1033/1500
5/5             0s 15ms/step -
accuracy: 0.8778 - loss: 0.3124 - val_accuracy: 0.8026 - val_loss: 0.4435
Epoch 1034/1500
5/5             0s 17ms/step -
accuracy: 0.8977 - loss: 0.2962 - val_accuracy: 0.8026 - val_loss: 0.4436
Epoch 1035/1500
5/5             0s 17ms/step -
accuracy: 0.8639 - loss: 0.3169 - val_accuracy: 0.8026 - val_loss: 0.4435
Epoch 1036/1500
5/5             0s 13ms/step -
accuracy: 0.8413 - loss: 0.3821 - val_accuracy: 0.8026 - val_loss: 0.4435
Epoch 1037/1500
5/5             0s 14ms/step -
accuracy: 0.8921 - loss: 0.3246 - val_accuracy: 0.8026 - val_loss: 0.4435
Epoch 1038/1500
5/5             0s 19ms/step -
accuracy: 0.8747 - loss: 0.3445 - val_accuracy: 0.8026 - val_loss: 0.4435
Epoch 1039/1500
5/5             0s 17ms/step -
accuracy: 0.8977 - loss: 0.3026 - val_accuracy: 0.8026 - val_loss: 0.4434
Epoch 1040/1500
5/5             0s 13ms/step -
accuracy: 0.8995 - loss: 0.3168 - val_accuracy: 0.8026 - val_loss: 0.4434
```

```
Epoch 1041/1500
5/5             0s 17ms/step -
accuracy: 0.8660 - loss: 0.3326 - val_accuracy: 0.8026 - val_loss: 0.4434
Epoch 1042/1500
5/5             0s 16ms/step -
accuracy: 0.8838 - loss: 0.3021 - val_accuracy: 0.8026 - val_loss: 0.4434
Epoch 1043/1500
5/5             0s 14ms/step -
accuracy: 0.8886 - loss: 0.3172 - val_accuracy: 0.8026 - val_loss: 0.4434
Epoch 1044/1500
5/5             0s 14ms/step -
accuracy: 0.8713 - loss: 0.3326 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1045/1500
5/5             0s 16ms/step -
accuracy: 0.8925 - loss: 0.3114 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1046/1500
5/5             0s 17ms/step -
accuracy: 0.8465 - loss: 0.3650 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1047/1500
5/5             0s 17ms/step -
accuracy: 0.8812 - loss: 0.3233 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1048/1500
5/5             0s 13ms/step -
accuracy: 0.8578 - loss: 0.3508 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1049/1500
5/5             0s 14ms/step -
accuracy: 0.8691 - loss: 0.3315 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1050/1500
5/5             0s 13ms/step -
accuracy: 0.8808 - loss: 0.3187 - val_accuracy: 0.7961 - val_loss: 0.4433
Epoch 1051/1500
5/5             0s 12ms/step -
accuracy: 0.8799 - loss: 0.3231 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1052/1500
5/5             0s 17ms/step -
accuracy: 0.8721 - loss: 0.3502 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1053/1500
5/5             0s 13ms/step -
accuracy: 0.8539 - loss: 0.3352 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1054/1500
5/5             0s 18ms/step -
accuracy: 0.8704 - loss: 0.3290 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1055/1500
5/5             0s 15ms/step -
accuracy: 0.8860 - loss: 0.3101 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1056/1500
5/5             0s 18ms/step -
accuracy: 0.8591 - loss: 0.3254 - val_accuracy: 0.7961 - val_loss: 0.4432
```

```
Epoch 1057/1500
5/5             0s 14ms/step -
accuracy: 0.8543 - loss: 0.3478 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1058/1500
5/5             0s 13ms/step -
accuracy: 0.8812 - loss: 0.3090 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1059/1500
5/5             0s 16ms/step -
accuracy: 0.8895 - loss: 0.2984 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1060/1500
5/5             0s 13ms/step -
accuracy: 0.8743 - loss: 0.3220 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1061/1500
5/5             0s 17ms/step -
accuracy: 0.8656 - loss: 0.3409 - val_accuracy: 0.7961 - val_loss: 0.4432
Epoch 1062/1500
5/5             0s 13ms/step -
accuracy: 0.8665 - loss: 0.3237 - val_accuracy: 0.7961 - val_loss: 0.4431
Epoch 1063/1500
5/5             0s 13ms/step -
accuracy: 0.8882 - loss: 0.3183 - val_accuracy: 0.7961 - val_loss: 0.4431
Epoch 1064/1500
5/5             0s 16ms/step -
accuracy: 0.8930 - loss: 0.2999 - val_accuracy: 0.7961 - val_loss: 0.4431
Epoch 1065/1500
5/5             0s 13ms/step -
accuracy: 0.8747 - loss: 0.3065 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1066/1500
5/5             0s 17ms/step -
accuracy: 0.8982 - loss: 0.2834 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1067/1500
5/5             0s 16ms/step -
accuracy: 0.9121 - loss: 0.2773 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1068/1500
5/5             0s 16ms/step -
accuracy: 0.8930 - loss: 0.2987 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1069/1500
5/5             0s 17ms/step -
accuracy: 0.8543 - loss: 0.3459 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1070/1500
5/5             0s 16ms/step -
accuracy: 0.8760 - loss: 0.3254 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1071/1500
5/5             0s 13ms/step -
accuracy: 0.8600 - loss: 0.3464 - val_accuracy: 0.7961 - val_loss: 0.4430
Epoch 1072/1500
5/5             0s 13ms/step -
accuracy: 0.8890 - loss: 0.3022 - val_accuracy: 0.7961 - val_loss: 0.4429
```

```
Epoch 1073/1500
5/5             0s 12ms/step -
accuracy: 0.8630 - loss: 0.3678 - val_accuracy: 0.7961 - val_loss: 0.4429
Epoch 1074/1500
5/5             0s 13ms/step -
accuracy: 0.8726 - loss: 0.2957 - val_accuracy: 0.7961 - val_loss: 0.4429
Epoch 1075/1500
5/5             0s 13ms/step -
accuracy: 0.8695 - loss: 0.3307 - val_accuracy: 0.8026 - val_loss: 0.4429
Epoch 1076/1500
5/5             0s 17ms/step -
accuracy: 0.8843 - loss: 0.3225 - val_accuracy: 0.8026 - val_loss: 0.4428
Epoch 1077/1500
5/5             0s 14ms/step -
accuracy: 0.8595 - loss: 0.3532 - val_accuracy: 0.8026 - val_loss: 0.4428
Epoch 1078/1500
5/5             0s 17ms/step -
accuracy: 0.8938 - loss: 0.2834 - val_accuracy: 0.8026 - val_loss: 0.4428
Epoch 1079/1500
5/5             0s 17ms/step -
accuracy: 0.8782 - loss: 0.3373 - val_accuracy: 0.8026 - val_loss: 0.4428
Epoch 1080/1500
5/5             0s 16ms/step -
accuracy: 0.8795 - loss: 0.3170 - val_accuracy: 0.8026 - val_loss: 0.4427
Epoch 1081/1500
5/5             0s 13ms/step -
accuracy: 0.8686 - loss: 0.3418 - val_accuracy: 0.8026 - val_loss: 0.4427
Epoch 1082/1500
5/5             0s 16ms/step -
accuracy: 0.8843 - loss: 0.3110 - val_accuracy: 0.8026 - val_loss: 0.4427
Epoch 1083/1500
5/5             0s 17ms/step -
accuracy: 0.8743 - loss: 0.3222 - val_accuracy: 0.7961 - val_loss: 0.4427
Epoch 1084/1500
5/5             0s 16ms/step -
accuracy: 0.8778 - loss: 0.3105 - val_accuracy: 0.8026 - val_loss: 0.4426
Epoch 1085/1500
5/5             0s 20ms/step -
accuracy: 0.8730 - loss: 0.3118 - val_accuracy: 0.8026 - val_loss: 0.4426
Epoch 1086/1500
5/5             0s 23ms/step -
accuracy: 0.8565 - loss: 0.3362 - val_accuracy: 0.8026 - val_loss: 0.4425
Epoch 1087/1500
5/5             0s 24ms/step -
accuracy: 0.8677 - loss: 0.3181 - val_accuracy: 0.8026 - val_loss: 0.4425
Epoch 1088/1500
5/5             0s 23ms/step -
accuracy: 0.8786 - loss: 0.3260 - val_accuracy: 0.8026 - val_loss: 0.4425
```

```
Epoch 1089/1500
5/5             0s 21ms/step -
accuracy: 0.8608 - loss: 0.3398 - val_accuracy: 0.8026 - val_loss: 0.4425
Epoch 1090/1500
5/5             0s 24ms/step -
accuracy: 0.8903 - loss: 0.3010 - val_accuracy: 0.8026 - val_loss: 0.4425
Epoch 1091/1500
5/5             0s 22ms/step -
accuracy: 0.8782 - loss: 0.3064 - val_accuracy: 0.8026 - val_loss: 0.4424
Epoch 1092/1500
5/5             0s 28ms/step -
accuracy: 0.8838 - loss: 0.3162 - val_accuracy: 0.8026 - val_loss: 0.4424
Epoch 1093/1500
5/5             0s 20ms/step -
accuracy: 0.8760 - loss: 0.3197 - val_accuracy: 0.8026 - val_loss: 0.4424
Epoch 1094/1500
5/5             0s 22ms/step -
accuracy: 0.8482 - loss: 0.3446 - val_accuracy: 0.8026 - val_loss: 0.4424
Epoch 1095/1500
5/5             0s 26ms/step -
accuracy: 0.8873 - loss: 0.3183 - val_accuracy: 0.8026 - val_loss: 0.4424
Epoch 1096/1500
5/5             0s 24ms/step -
accuracy: 0.8825 - loss: 0.3157 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1097/1500
5/5             0s 21ms/step -
accuracy: 0.8634 - loss: 0.3117 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1098/1500
5/5             0s 21ms/step -
accuracy: 0.8812 - loss: 0.3100 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1099/1500
5/5             0s 15ms/step -
accuracy: 0.8778 - loss: 0.3158 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1100/1500
5/5             0s 17ms/step -
accuracy: 0.8838 - loss: 0.3041 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1101/1500
5/5             0s 18ms/step -
accuracy: 0.8943 - loss: 0.3085 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1102/1500
5/5             0s 13ms/step -
accuracy: 0.8825 - loss: 0.3125 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1103/1500
5/5             0s 14ms/step -
accuracy: 0.8456 - loss: 0.3457 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1104/1500
5/5             0s 18ms/step -
accuracy: 0.8812 - loss: 0.3052 - val_accuracy: 0.8026 - val_loss: 0.4423
```

```
Epoch 1105/1500
5/5             0s 17ms/step -
accuracy: 0.8569 - loss: 0.3375 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1106/1500
5/5             0s 13ms/step -
accuracy: 0.8799 - loss: 0.3004 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1107/1500
5/5             0s 18ms/step -
accuracy: 0.8756 - loss: 0.2912 - val_accuracy: 0.8026 - val_loss: 0.4423
Epoch 1108/1500
5/5             0s 18ms/step -
accuracy: 0.8903 - loss: 0.3021 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1109/1500
5/5             0s 18ms/step -
accuracy: 0.8808 - loss: 0.3083 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1110/1500
5/5             0s 16ms/step -
accuracy: 0.8925 - loss: 0.3209 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1111/1500
5/5             0s 17ms/step -
accuracy: 0.8782 - loss: 0.3249 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1112/1500
5/5             0s 18ms/step -
accuracy: 0.8782 - loss: 0.3065 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1113/1500
5/5             0s 17ms/step -
accuracy: 0.8938 - loss: 0.2854 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1114/1500
5/5             0s 14ms/step -
accuracy: 0.8673 - loss: 0.3152 - val_accuracy: 0.8026 - val_loss: 0.4422
Epoch 1115/1500
5/5             0s 15ms/step -
accuracy: 0.8760 - loss: 0.3082 - val_accuracy: 0.8026 - val_loss: 0.4421
Epoch 1116/1500
5/5             0s 13ms/step -
accuracy: 0.8743 - loss: 0.2964 - val_accuracy: 0.8026 - val_loss: 0.4421
Epoch 1117/1500
5/5             0s 15ms/step -
accuracy: 0.8561 - loss: 0.3544 - val_accuracy: 0.8026 - val_loss: 0.4421
Epoch 1118/1500
5/5             0s 14ms/step -
accuracy: 0.8869 - loss: 0.2920 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1119/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.2951 - val_accuracy: 0.8026 - val_loss: 0.4421
Epoch 1120/1500
5/5             0s 14ms/step -
accuracy: 0.8921 - loss: 0.2842 - val_accuracy: 0.8026 - val_loss: 0.4421
```

```
Epoch 1121/1500
5/5             0s 16ms/step -
accuracy: 0.8903 - loss: 0.2938 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1122/1500
5/5             0s 13ms/step -
accuracy: 0.8834 - loss: 0.3161 - val_accuracy: 0.8026 - val_loss: 0.4421
Epoch 1123/1500
5/5             0s 13ms/step -
accuracy: 0.8695 - loss: 0.3259 - val_accuracy: 0.8026 - val_loss: 0.4420
Epoch 1124/1500
5/5             0s 18ms/step -
accuracy: 0.8634 - loss: 0.3319 - val_accuracy: 0.8026 - val_loss: 0.4420
Epoch 1125/1500
5/5             0s 14ms/step -
accuracy: 0.8586 - loss: 0.3090 - val_accuracy: 0.8026 - val_loss: 0.4420
Epoch 1126/1500
5/5             0s 16ms/step -
accuracy: 0.8721 - loss: 0.3243 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1127/1500
5/5             0s 14ms/step -
accuracy: 0.8278 - loss: 0.3690 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1128/1500
5/5             0s 17ms/step -
accuracy: 0.8721 - loss: 0.3118 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1129/1500
5/5             0s 14ms/step -
accuracy: 0.8773 - loss: 0.3296 - val_accuracy: 0.8092 - val_loss: 0.4419
Epoch 1130/1500
5/5             0s 13ms/step -
accuracy: 0.8799 - loss: 0.2913 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1131/1500
5/5             0s 19ms/step -
accuracy: 0.8786 - loss: 0.3224 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1132/1500
5/5             0s 17ms/step -
accuracy: 0.8691 - loss: 0.3173 - val_accuracy: 0.8092 - val_loss: 0.4419
Epoch 1133/1500
5/5             0s 17ms/step -
accuracy: 0.8708 - loss: 0.3244 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1134/1500
5/5             0s 14ms/step -
accuracy: 0.8934 - loss: 0.2946 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1135/1500
5/5             0s 15ms/step -
accuracy: 0.8600 - loss: 0.3076 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1136/1500
5/5             0s 16ms/step -
accuracy: 0.8895 - loss: 0.3009 - val_accuracy: 0.8092 - val_loss: 0.4420
```

```
Epoch 1137/1500
5/5             0s 16ms/step -
accuracy: 0.8682 - loss: 0.3299 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1138/1500
5/5             0s 16ms/step -
accuracy: 0.8656 - loss: 0.3092 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1139/1500
5/5             0s 17ms/step -
accuracy: 0.8600 - loss: 0.3340 - val_accuracy: 0.8092 - val_loss: 0.4420
Epoch 1140/1500
5/5             0s 18ms/step -
accuracy: 0.8569 - loss: 0.3511 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1141/1500
5/5             0s 18ms/step -
accuracy: 0.8877 - loss: 0.3146 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1142/1500
5/5             0s 15ms/step -
accuracy: 0.8778 - loss: 0.3078 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1143/1500
5/5             0s 14ms/step -
accuracy: 0.8643 - loss: 0.3136 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1144/1500
5/5             0s 17ms/step -
accuracy: 0.8643 - loss: 0.3203 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1145/1500
5/5             0s 16ms/step -
accuracy: 0.8682 - loss: 0.3107 - val_accuracy: 0.8092 - val_loss: 0.4421
Epoch 1146/1500
5/5             0s 18ms/step -
accuracy: 0.8960 - loss: 0.2892 - val_accuracy: 0.8092 - val_loss: 0.4422
Epoch 1147/1500
5/5             0s 18ms/step -
accuracy: 0.8917 - loss: 0.3192 - val_accuracy: 0.8092 - val_loss: 0.4422
Epoch 1148/1500
5/5             0s 15ms/step -
accuracy: 0.8791 - loss: 0.3015 - val_accuracy: 0.8092 - val_loss: 0.4422
Epoch 1149/1500
5/5             0s 18ms/step -
accuracy: 0.8890 - loss: 0.2780 - val_accuracy: 0.8092 - val_loss: 0.4422
Epoch 1150/1500
5/5             0s 18ms/step -
accuracy: 0.8999 - loss: 0.2872 - val_accuracy: 0.8092 - val_loss: 0.4423
Epoch 1151/1500
5/5             0s 15ms/step -
accuracy: 0.8574 - loss: 0.3318 - val_accuracy: 0.8092 - val_loss: 0.4423
Epoch 1152/1500
5/5             0s 14ms/step -
accuracy: 0.8747 - loss: 0.3190 - val_accuracy: 0.8092 - val_loss: 0.4423
```

```
Epoch 1153/1500
5/5             0s 14ms/step -
accuracy: 0.8860 - loss: 0.2853 - val_accuracy: 0.8092 - val_loss: 0.4423
Epoch 1154/1500
5/5             0s 17ms/step -
accuracy: 0.8834 - loss: 0.3170 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1155/1500
5/5             0s 18ms/step -
accuracy: 0.8565 - loss: 0.3263 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1156/1500
5/5             0s 17ms/step -
accuracy: 0.8903 - loss: 0.3026 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1157/1500
5/5             0s 14ms/step -
accuracy: 0.8817 - loss: 0.3092 - val_accuracy: 0.8092 - val_loss: 0.4423
Epoch 1158/1500
5/5             0s 14ms/step -
accuracy: 0.8843 - loss: 0.3048 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1159/1500
5/5             0s 14ms/step -
accuracy: 0.8791 - loss: 0.2846 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1160/1500
5/5             0s 13ms/step -
accuracy: 0.8713 - loss: 0.3319 - val_accuracy: 0.8092 - val_loss: 0.4424
Epoch 1161/1500
5/5             0s 16ms/step -
accuracy: 0.8990 - loss: 0.2744 - val_accuracy: 0.8092 - val_loss: 0.4425
Epoch 1162/1500
5/5             0s 18ms/step -
accuracy: 0.8652 - loss: 0.3191 - val_accuracy: 0.8092 - val_loss: 0.4425
Epoch 1163/1500
5/5             0s 14ms/step -
accuracy: 0.9021 - loss: 0.2695 - val_accuracy: 0.8092 - val_loss: 0.4425
Epoch 1164/1500
5/5             0s 16ms/step -
accuracy: 0.8877 - loss: 0.2802 - val_accuracy: 0.8092 - val_loss: 0.4425
Epoch 1165/1500
5/5             0s 14ms/step -
accuracy: 0.8752 - loss: 0.3147 - val_accuracy: 0.8092 - val_loss: 0.4425
Epoch 1166/1500
5/5             0s 17ms/step -
accuracy: 0.8578 - loss: 0.3213 - val_accuracy: 0.8092 - val_loss: 0.4426
Epoch 1167/1500
5/5             0s 17ms/step -
accuracy: 0.8778 - loss: 0.3124 - val_accuracy: 0.8092 - val_loss: 0.4426
Epoch 1168/1500
5/5             0s 17ms/step -
accuracy: 0.8752 - loss: 0.3073 - val_accuracy: 0.8092 - val_loss: 0.4426
```

```
Epoch 1169/1500
5/5             0s 14ms/step -
accuracy: 0.8673 - loss: 0.3011 - val_accuracy: 0.8092 - val_loss: 0.4426
Epoch 1170/1500
5/5             0s 18ms/step -
accuracy: 0.8999 - loss: 0.2706 - val_accuracy: 0.8092 - val_loss: 0.4426
Epoch 1171/1500
5/5             0s 16ms/step -
accuracy: 0.8647 - loss: 0.3267 - val_accuracy: 0.8092 - val_loss: 0.4427
Epoch 1172/1500
5/5             0s 17ms/step -
accuracy: 0.8739 - loss: 0.3195 - val_accuracy: 0.8092 - val_loss: 0.4427
Epoch 1173/1500
5/5             0s 17ms/step -
accuracy: 0.8660 - loss: 0.2961 - val_accuracy: 0.8092 - val_loss: 0.4427
Epoch 1174/1500
5/5             0s 19ms/step -
accuracy: 0.8986 - loss: 0.2725 - val_accuracy: 0.8092 - val_loss: 0.4427
Epoch 1175/1500
5/5             0s 23ms/step -
accuracy: 0.8695 - loss: 0.3384 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1176/1500
5/5             0s 18ms/step -
accuracy: 0.8617 - loss: 0.3130 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1177/1500
5/5             0s 23ms/step -
accuracy: 0.8903 - loss: 0.2942 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1178/1500
5/5             0s 23ms/step -
accuracy: 0.8817 - loss: 0.2859 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1179/1500
5/5             0s 18ms/step -
accuracy: 0.8669 - loss: 0.3178 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1180/1500
5/5             0s 25ms/step -
accuracy: 0.8838 - loss: 0.2845 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1181/1500
5/5             0s 25ms/step -
accuracy: 0.8708 - loss: 0.3179 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1182/1500
5/5             0s 23ms/step -
accuracy: 0.8917 - loss: 0.2845 - val_accuracy: 0.8092 - val_loss: 0.4428
Epoch 1183/1500
5/5             0s 24ms/step -
accuracy: 0.8960 - loss: 0.2838 - val_accuracy: 0.8092 - val_loss: 0.4429
Epoch 1184/1500
5/5             0s 23ms/step -
accuracy: 0.8556 - loss: 0.3248 - val_accuracy: 0.8092 - val_loss: 0.4429
```

```
Epoch 1185/1500
5/5             0s 25ms/step -
accuracy: 0.8530 - loss: 0.3180 - val_accuracy: 0.8092 - val_loss: 0.4430
Epoch 1186/1500
5/5             0s 22ms/step -
accuracy: 0.8882 - loss: 0.3053 - val_accuracy: 0.8092 - val_loss: 0.4430
Epoch 1187/1500
5/5             0s 18ms/step -
accuracy: 0.8912 - loss: 0.2900 - val_accuracy: 0.8092 - val_loss: 0.4429
Epoch 1188/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.3251 - val_accuracy: 0.8092 - val_loss: 0.4429
Epoch 1189/1500
5/5             0s 15ms/step -
accuracy: 0.8912 - loss: 0.2852 - val_accuracy: 0.8158 - val_loss: 0.4430
Epoch 1190/1500
5/5             0s 13ms/step -
accuracy: 0.9021 - loss: 0.2855 - val_accuracy: 0.8158 - val_loss: 0.4429
Epoch 1191/1500
5/5             0s 15ms/step -
accuracy: 0.8699 - loss: 0.3172 - val_accuracy: 0.8158 - val_loss: 0.4430
Epoch 1192/1500
5/5             0s 17ms/step -
accuracy: 0.8821 - loss: 0.2853 - val_accuracy: 0.8158 - val_loss: 0.4430
Epoch 1193/1500
5/5             0s 13ms/step -
accuracy: 0.8587 - loss: 0.3205 - val_accuracy: 0.8158 - val_loss: 0.4431
Epoch 1194/1500
5/5             0s 14ms/step -
accuracy: 0.8639 - loss: 0.2994 - val_accuracy: 0.8158 - val_loss: 0.4431
Epoch 1195/1500
5/5             0s 20ms/step -
accuracy: 0.8799 - loss: 0.3057 - val_accuracy: 0.8158 - val_loss: 0.4431
Epoch 1196/1500
5/5             0s 14ms/step -
accuracy: 0.8734 - loss: 0.2850 - val_accuracy: 0.8158 - val_loss: 0.4432
Epoch 1197/1500
5/5             0s 13ms/step -
accuracy: 0.8565 - loss: 0.3497 - val_accuracy: 0.8158 - val_loss: 0.4432
Epoch 1198/1500
5/5             0s 14ms/step -
accuracy: 0.8630 - loss: 0.3110 - val_accuracy: 0.8158 - val_loss: 0.4432
Epoch 1199/1500
5/5             0s 14ms/step -
accuracy: 0.8600 - loss: 0.3348 - val_accuracy: 0.8158 - val_loss: 0.4433
Epoch 1200/1500
5/5             0s 13ms/step -
accuracy: 0.8843 - loss: 0.3045 - val_accuracy: 0.8158 - val_loss: 0.4434
```

```
Epoch 1201/1500
5/5             0s 17ms/step -
accuracy: 0.8595 - loss: 0.3225 - val_accuracy: 0.8158 - val_loss: 0.4434
Epoch 1202/1500
5/5             0s 14ms/step -
accuracy: 0.8595 - loss: 0.3269 - val_accuracy: 0.8158 - val_loss: 0.4434
Epoch 1203/1500
5/5             0s 17ms/step -
accuracy: 0.8903 - loss: 0.2902 - val_accuracy: 0.8158 - val_loss: 0.4435
Epoch 1204/1500
5/5             0s 16ms/step -
accuracy: 0.8725 - loss: 0.2959 - val_accuracy: 0.8158 - val_loss: 0.4435
Epoch 1205/1500
5/5             0s 14ms/step -
accuracy: 0.8391 - loss: 0.3714 - val_accuracy: 0.8158 - val_loss: 0.4435
Epoch 1206/1500
5/5             0s 17ms/step -
accuracy: 0.8882 - loss: 0.2966 - val_accuracy: 0.8158 - val_loss: 0.4435
Epoch 1207/1500
5/5             0s 18ms/step -
accuracy: 0.8778 - loss: 0.3142 - val_accuracy: 0.8158 - val_loss: 0.4436
Epoch 1208/1500
5/5             0s 19ms/step -
accuracy: 0.8938 - loss: 0.2809 - val_accuracy: 0.8158 - val_loss: 0.4436
Epoch 1209/1500
5/5             0s 18ms/step -
accuracy: 0.8743 - loss: 0.2981 - val_accuracy: 0.8158 - val_loss: 0.4436
Epoch 1210/1500
5/5             0s 15ms/step -
accuracy: 0.8608 - loss: 0.3073 - val_accuracy: 0.8158 - val_loss: 0.4437
Epoch 1211/1500
5/5             0s 15ms/step -
accuracy: 0.8504 - loss: 0.3342 - val_accuracy: 0.8158 - val_loss: 0.4437
Epoch 1212/1500
5/5             0s 17ms/step -
accuracy: 0.8535 - loss: 0.3282 - val_accuracy: 0.8158 - val_loss: 0.4437
Epoch 1213/1500
5/5             0s 14ms/step -
accuracy: 0.8782 - loss: 0.3032 - val_accuracy: 0.8158 - val_loss: 0.4438
Epoch 1214/1500
5/5             0s 17ms/step -
accuracy: 0.8704 - loss: 0.3344 - val_accuracy: 0.8158 - val_loss: 0.4438
Epoch 1215/1500
5/5             0s 15ms/step -
accuracy: 0.8630 - loss: 0.3074 - val_accuracy: 0.8158 - val_loss: 0.4438
Epoch 1216/1500
5/5             0s 16ms/step -
accuracy: 0.8774 - loss: 0.3151 - val_accuracy: 0.8158 - val_loss: 0.4439
```

```
Epoch 1217/1500
5/5             0s 14ms/step -
accuracy: 0.8856 - loss: 0.3035 - val_accuracy: 0.8158 - val_loss: 0.4439
Epoch 1218/1500
5/5             0s 17ms/step -
accuracy: 0.8683 - loss: 0.3191 - val_accuracy: 0.8158 - val_loss: 0.4439
Epoch 1219/1500
5/5             0s 23ms/step -
accuracy: 0.8900 - loss: 0.2863 - val_accuracy: 0.8158 - val_loss: 0.4439
Epoch 1220/1500
5/5             0s 18ms/step -
accuracy: 0.8830 - loss: 0.2912 - val_accuracy: 0.8158 - val_loss: 0.4439
Epoch 1221/1500
5/5             0s 13ms/step -
accuracy: 0.8535 - loss: 0.3339 - val_accuracy: 0.8158 - val_loss: 0.4440
Epoch 1222/1500
5/5             0s 18ms/step -
accuracy: 0.8939 - loss: 0.2844 - val_accuracy: 0.8158 - val_loss: 0.4440
Epoch 1223/1500
5/5             0s 17ms/step -
accuracy: 0.8830 - loss: 0.3112 - val_accuracy: 0.8158 - val_loss: 0.4441
Epoch 1224/1500
5/5             0s 13ms/step -
accuracy: 0.8926 - loss: 0.2956 - val_accuracy: 0.8158 - val_loss: 0.4441
Epoch 1225/1500
5/5             0s 14ms/step -
accuracy: 0.9008 - loss: 0.2897 - val_accuracy: 0.8158 - val_loss: 0.4441
Epoch 1226/1500
5/5             0s 17ms/step -
accuracy: 0.8639 - loss: 0.3062 - val_accuracy: 0.8158 - val_loss: 0.4442
Epoch 1227/1500
5/5             0s 21ms/step -
accuracy: 0.8947 - loss: 0.2925 - val_accuracy: 0.8158 - val_loss: 0.4442
Epoch 1228/1500
5/5             0s 16ms/step -
accuracy: 0.8782 - loss: 0.3101 - val_accuracy: 0.8158 - val_loss: 0.4442
Epoch 1229/1500
5/5             0s 14ms/step -
accuracy: 0.8800 - loss: 0.2951 - val_accuracy: 0.8158 - val_loss: 0.4443
Epoch 1230/1500
5/5             0s 14ms/step -
accuracy: 0.8726 - loss: 0.3164 - val_accuracy: 0.8158 - val_loss: 0.4443
Epoch 1231/1500
5/5             0s 17ms/step -
accuracy: 0.8856 - loss: 0.3108 - val_accuracy: 0.8158 - val_loss: 0.4444
Epoch 1232/1500
5/5             0s 17ms/step -
accuracy: 0.8999 - loss: 0.2887 - val_accuracy: 0.8158 - val_loss: 0.4444
```

```
Epoch 1233/1500
5/5             0s 16ms/step -
accuracy: 0.8739 - loss: 0.3071 - val_accuracy: 0.8158 - val_loss: 0.4444
Epoch 1234/1500
5/5             0s 16ms/step -
accuracy: 0.8778 - loss: 0.3113 - val_accuracy: 0.8158 - val_loss: 0.4445
Epoch 1235/1500
5/5             0s 17ms/step -
accuracy: 0.8834 - loss: 0.3347 - val_accuracy: 0.8158 - val_loss: 0.4445
Epoch 1236/1500
5/5             0s 16ms/step -
accuracy: 0.8813 - loss: 0.2844 - val_accuracy: 0.8158 - val_loss: 0.4445
Epoch 1237/1500
5/5             0s 13ms/step -
accuracy: 0.9069 - loss: 0.2464 - val_accuracy: 0.8158 - val_loss: 0.4446
Epoch 1238/1500
5/5             0s 16ms/step -
accuracy: 0.8418 - loss: 0.3343 - val_accuracy: 0.8158 - val_loss: 0.4446
Epoch 1239/1500
5/5             0s 13ms/step -
accuracy: 0.8713 - loss: 0.2996 - val_accuracy: 0.8158 - val_loss: 0.4446
Epoch 1240/1500
5/5             0s 13ms/step -
accuracy: 0.8852 - loss: 0.2899 - val_accuracy: 0.8158 - val_loss: 0.4446
Epoch 1241/1500
5/5             0s 17ms/step -
accuracy: 0.8730 - loss: 0.3076 - val_accuracy: 0.8158 - val_loss: 0.4447
Epoch 1242/1500
5/5             0s 17ms/step -
accuracy: 0.8869 - loss: 0.3178 - val_accuracy: 0.8158 - val_loss: 0.4447
Epoch 1243/1500
5/5             0s 18ms/step -
accuracy: 0.9017 - loss: 0.2580 - val_accuracy: 0.8158 - val_loss: 0.4447
Epoch 1244/1500
5/5             0s 13ms/step -
accuracy: 0.8717 - loss: 0.3240 - val_accuracy: 0.8158 - val_loss: 0.4448
Epoch 1245/1500
5/5             0s 13ms/step -
accuracy: 0.8557 - loss: 0.3462 - val_accuracy: 0.8158 - val_loss: 0.4448
Epoch 1246/1500
5/5             0s 16ms/step -
accuracy: 0.8765 - loss: 0.3056 - val_accuracy: 0.8158 - val_loss: 0.4448
Epoch 1247/1500
5/5             0s 13ms/step -
accuracy: 0.8926 - loss: 0.2948 - val_accuracy: 0.8158 - val_loss: 0.4448
Epoch 1248/1500
5/5             0s 13ms/step -
accuracy: 0.8878 - loss: 0.3027 - val_accuracy: 0.8158 - val_loss: 0.4449
```

```
Epoch 1249/1500
5/5             0s 16ms/step -
accuracy: 0.8730 - loss: 0.3242 - val_accuracy: 0.8158 - val_loss: 0.4449
Epoch 1250/1500
5/5             0s 17ms/step -
accuracy: 0.8439 - loss: 0.3271 - val_accuracy: 0.8158 - val_loss: 0.4450
Epoch 1251/1500
5/5             0s 18ms/step -
accuracy: 0.8839 - loss: 0.2980 - val_accuracy: 0.8158 - val_loss: 0.4450
Epoch 1252/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.2998 - val_accuracy: 0.8158 - val_loss: 0.4450
Epoch 1253/1500
5/5             0s 13ms/step -
accuracy: 0.8839 - loss: 0.2796 - val_accuracy: 0.8158 - val_loss: 0.4451
Epoch 1254/1500
5/5             0s 17ms/step -
accuracy: 0.8617 - loss: 0.3214 - val_accuracy: 0.8158 - val_loss: 0.4451
Epoch 1255/1500
5/5             0s 17ms/step -
accuracy: 0.8722 - loss: 0.3346 - val_accuracy: 0.8158 - val_loss: 0.4451
Epoch 1256/1500
5/5             0s 17ms/step -
accuracy: 0.8882 - loss: 0.2970 - val_accuracy: 0.8158 - val_loss: 0.4452
Epoch 1257/1500
5/5             0s 14ms/step -
accuracy: 0.8700 - loss: 0.3163 - val_accuracy: 0.8158 - val_loss: 0.4452
Epoch 1258/1500
5/5             0s 14ms/step -
accuracy: 0.8852 - loss: 0.3110 - val_accuracy: 0.8158 - val_loss: 0.4453
Epoch 1259/1500
5/5             0s 18ms/step -
accuracy: 0.8665 - loss: 0.3159 - val_accuracy: 0.8158 - val_loss: 0.4453
Epoch 1260/1500
5/5             0s 14ms/step -
accuracy: 0.8882 - loss: 0.3010 - val_accuracy: 0.8158 - val_loss: 0.4454
Epoch 1261/1500
5/5             0s 13ms/step -
accuracy: 0.8817 - loss: 0.3040 - val_accuracy: 0.8158 - val_loss: 0.4454
Epoch 1262/1500
5/5             0s 17ms/step -
accuracy: 0.9151 - loss: 0.2515 - val_accuracy: 0.8158 - val_loss: 0.4454
Epoch 1263/1500
5/5             0s 13ms/step -
accuracy: 0.8630 - loss: 0.3126 - val_accuracy: 0.8158 - val_loss: 0.4454
Epoch 1264/1500
5/5             0s 19ms/step -
accuracy: 0.8999 - loss: 0.2744 - val_accuracy: 0.8158 - val_loss: 0.4454
```

```
Epoch 1265/1500
5/5             0s 18ms/step -
accuracy: 0.8704 - loss: 0.2982 - val_accuracy: 0.8158 - val_loss: 0.4455
Epoch 1266/1500
5/5             0s 22ms/step -
accuracy: 0.8817 - loss: 0.3049 - val_accuracy: 0.8158 - val_loss: 0.4455
Epoch 1267/1500
5/5             0s 18ms/step -
accuracy: 0.8791 - loss: 0.3091 - val_accuracy: 0.8158 - val_loss: 0.4455
Epoch 1268/1500
5/5             0s 34ms/step -
accuracy: 0.8891 - loss: 0.3068 - val_accuracy: 0.8158 - val_loss: 0.4456
Epoch 1269/1500
5/5             0s 26ms/step -
accuracy: 0.8909 - loss: 0.3015 - val_accuracy: 0.8158 - val_loss: 0.4457
Epoch 1270/1500
5/5             0s 18ms/step -
accuracy: 0.9182 - loss: 0.2605 - val_accuracy: 0.8158 - val_loss: 0.4456
Epoch 1271/1500
5/5             0s 17ms/step -
accuracy: 0.8883 - loss: 0.2944 - val_accuracy: 0.8158 - val_loss: 0.4457
Epoch 1272/1500
5/5             0s 22ms/step -
accuracy: 0.9074 - loss: 0.2693 - val_accuracy: 0.8158 - val_loss: 0.4457
Epoch 1273/1500
5/5             0s 21ms/step -
accuracy: 0.8995 - loss: 0.2810 - val_accuracy: 0.8158 - val_loss: 0.4457
Epoch 1274/1500
5/5             0s 22ms/step -
accuracy: 0.8843 - loss: 0.3045 - val_accuracy: 0.8158 - val_loss: 0.4458
Epoch 1275/1500
5/5             0s 19ms/step -
accuracy: 0.8861 - loss: 0.2823 - val_accuracy: 0.8158 - val_loss: 0.4458
Epoch 1276/1500
5/5             0s 30ms/step -
accuracy: 0.8744 - loss: 0.3053 - val_accuracy: 0.8158 - val_loss: 0.4459
Epoch 1277/1500
5/5             0s 17ms/step -
accuracy: 0.8943 - loss: 0.2840 - val_accuracy: 0.8158 - val_loss: 0.4459
Epoch 1278/1500
5/5             0s 16ms/step -
accuracy: 0.8904 - loss: 0.2832 - val_accuracy: 0.8158 - val_loss: 0.4460
Epoch 1279/1500
5/5             0s 17ms/step -
accuracy: 0.8943 - loss: 0.3083 - val_accuracy: 0.8158 - val_loss: 0.4460
Epoch 1280/1500
5/5             0s 15ms/step -
accuracy: 0.9004 - loss: 0.2895 - val_accuracy: 0.8158 - val_loss: 0.4460
```

```
Epoch 1281/1500
5/5             0s 17ms/step -
accuracy: 0.8861 - loss: 0.3068 - val_accuracy: 0.8158 - val_loss: 0.4461
Epoch 1282/1500
5/5             0s 18ms/step -
accuracy: 0.8891 - loss: 0.2977 - val_accuracy: 0.8158 - val_loss: 0.4461
Epoch 1283/1500
5/5             0s 14ms/step -
accuracy: 0.8978 - loss: 0.2989 - val_accuracy: 0.8158 - val_loss: 0.4461
Epoch 1284/1500
5/5             0s 18ms/step -
accuracy: 0.8540 - loss: 0.3295 - val_accuracy: 0.8158 - val_loss: 0.4462
Epoch 1285/1500
5/5             0s 14ms/step -
accuracy: 0.8883 - loss: 0.3070 - val_accuracy: 0.8158 - val_loss: 0.4463
Epoch 1286/1500
5/5             0s 17ms/step -
accuracy: 0.9047 - loss: 0.2815 - val_accuracy: 0.8158 - val_loss: 0.4463
Epoch 1287/1500
5/5             0s 18ms/step -
accuracy: 0.8926 - loss: 0.3062 - val_accuracy: 0.8158 - val_loss: 0.4463
Epoch 1288/1500
5/5             0s 17ms/step -
accuracy: 0.8861 - loss: 0.2982 - val_accuracy: 0.8158 - val_loss: 0.4464
Epoch 1289/1500
5/5             0s 17ms/step -
accuracy: 0.8744 - loss: 0.3367 - val_accuracy: 0.8158 - val_loss: 0.4464
Epoch 1290/1500
5/5             0s 17ms/step -
accuracy: 0.8735 - loss: 0.3101 - val_accuracy: 0.8158 - val_loss: 0.4465
Epoch 1291/1500
5/5             0s 13ms/step -
accuracy: 0.8891 - loss: 0.2864 - val_accuracy: 0.8158 - val_loss: 0.4465
Epoch 1292/1500
5/5             0s 14ms/step -
accuracy: 0.9087 - loss: 0.2681 - val_accuracy: 0.8158 - val_loss: 0.4466
Epoch 1293/1500
5/5             0s 14ms/step -
accuracy: 0.8870 - loss: 0.2913 - val_accuracy: 0.8158 - val_loss: 0.4466
Epoch 1294/1500
5/5             0s 18ms/step -
accuracy: 0.8679 - loss: 0.3395 - val_accuracy: 0.8158 - val_loss: 0.4466
Epoch 1295/1500
5/5             0s 13ms/step -
accuracy: 0.9130 - loss: 0.2799 - val_accuracy: 0.8158 - val_loss: 0.4467
Epoch 1296/1500
5/5             0s 15ms/step -
accuracy: 0.8969 - loss: 0.3147 - val_accuracy: 0.8158 - val_loss: 0.4467
```

```
Epoch 1297/1500
5/5             0s 17ms/step -
accuracy: 0.8787 - loss: 0.2876 - val_accuracy: 0.8158 - val_loss: 0.4468
Epoch 1298/1500
5/5             0s 14ms/step -
accuracy: 0.8783 - loss: 0.2980 - val_accuracy: 0.8158 - val_loss: 0.4468
Epoch 1299/1500
5/5             0s 14ms/step -
accuracy: 0.8956 - loss: 0.2663 - val_accuracy: 0.8158 - val_loss: 0.4469
Epoch 1300/1500
5/5             0s 16ms/step -
accuracy: 0.8757 - loss: 0.3281 - val_accuracy: 0.8158 - val_loss: 0.4469
Epoch 1301/1500
5/5             0s 17ms/step -
accuracy: 0.9008 - loss: 0.2725 - val_accuracy: 0.8158 - val_loss: 0.4470
Epoch 1302/1500
5/5             0s 14ms/step -
accuracy: 0.8648 - loss: 0.3068 - val_accuracy: 0.8158 - val_loss: 0.4470
Epoch 1303/1500
5/5             0s 18ms/step -
accuracy: 0.8605 - loss: 0.3541 - val_accuracy: 0.8158 - val_loss: 0.4471
Epoch 1304/1500
5/5             0s 15ms/step -
accuracy: 0.8817 - loss: 0.2957 - val_accuracy: 0.8158 - val_loss: 0.4471
Epoch 1305/1500
5/5             0s 15ms/step -
accuracy: 0.9030 - loss: 0.2661 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1306/1500
5/5             0s 15ms/step -
accuracy: 0.8991 - loss: 0.3014 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1307/1500
5/5             0s 17ms/step -
accuracy: 0.8800 - loss: 0.2843 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1308/1500
5/5             0s 14ms/step -
accuracy: 0.9078 - loss: 0.2838 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1309/1500
5/5             0s 18ms/step -
accuracy: 0.9134 - loss: 0.2592 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1310/1500
5/5             0s 15ms/step -
accuracy: 0.9021 - loss: 0.2759 - val_accuracy: 0.8158 - val_loss: 0.4472
Epoch 1311/1500
5/5             0s 17ms/step -
accuracy: 0.8878 - loss: 0.2996 - val_accuracy: 0.8158 - val_loss: 0.4473
Epoch 1312/1500
5/5             0s 14ms/step -
accuracy: 0.8683 - loss: 0.3347 - val_accuracy: 0.8158 - val_loss: 0.4473
```

```
Epoch 1313/1500
5/5             0s 14ms/step -
accuracy: 0.9013 - loss: 0.2859 - val_accuracy: 0.8158 - val_loss: 0.4474
Epoch 1314/1500
5/5             0s 14ms/step -
accuracy: 0.8661 - loss: 0.2977 - val_accuracy: 0.8092 - val_loss: 0.4474
Epoch 1315/1500
5/5             0s 14ms/step -
accuracy: 0.8965 - loss: 0.3070 - val_accuracy: 0.8092 - val_loss: 0.4474
Epoch 1316/1500
5/5             0s 14ms/step -
accuracy: 0.8878 - loss: 0.2839 - val_accuracy: 0.8092 - val_loss: 0.4475
Epoch 1317/1500
5/5             0s 15ms/step -
accuracy: 0.8965 - loss: 0.2870 - val_accuracy: 0.8092 - val_loss: 0.4475
Epoch 1318/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.3065 - val_accuracy: 0.8092 - val_loss: 0.4476
Epoch 1319/1500
5/5             0s 17ms/step -
accuracy: 0.8956 - loss: 0.2655 - val_accuracy: 0.8092 - val_loss: 0.4476
Epoch 1320/1500
5/5             0s 17ms/step -
accuracy: 0.8822 - loss: 0.2995 - val_accuracy: 0.8092 - val_loss: 0.4476
Epoch 1321/1500
5/5             0s 17ms/step -
accuracy: 0.8800 - loss: 0.2868 - val_accuracy: 0.8092 - val_loss: 0.4476
Epoch 1322/1500
5/5             0s 14ms/step -
accuracy: 0.8609 - loss: 0.3297 - val_accuracy: 0.8092 - val_loss: 0.4476
Epoch 1323/1500
5/5             0s 15ms/step -
accuracy: 0.8856 - loss: 0.2842 - val_accuracy: 0.8092 - val_loss: 0.4477
Epoch 1324/1500
5/5             0s 18ms/step -
accuracy: 0.8770 - loss: 0.3039 - val_accuracy: 0.8092 - val_loss: 0.4477
Epoch 1325/1500
5/5             0s 21ms/step -
accuracy: 0.9069 - loss: 0.2905 - val_accuracy: 0.8092 - val_loss: 0.4477
Epoch 1326/1500
5/5             0s 15ms/step -
accuracy: 0.9069 - loss: 0.2645 - val_accuracy: 0.8092 - val_loss: 0.4477
Epoch 1327/1500
5/5             0s 14ms/step -
accuracy: 0.8878 - loss: 0.2799 - val_accuracy: 0.8092 - val_loss: 0.4477
Epoch 1328/1500
5/5             0s 13ms/step -
accuracy: 0.8514 - loss: 0.3396 - val_accuracy: 0.8092 - val_loss: 0.4477
```

```
Epoch 1329/1500
5/5             0s 14ms/step -
accuracy: 0.8661 - loss: 0.3146 - val_accuracy: 0.8092 - val_loss: 0.4478
Epoch 1330/1500
5/5             0s 18ms/step -
accuracy: 0.8813 - loss: 0.3001 - val_accuracy: 0.8092 - val_loss: 0.4478
Epoch 1331/1500
5/5             0s 17ms/step -
accuracy: 0.8791 - loss: 0.3202 - val_accuracy: 0.8092 - val_loss: 0.4478
Epoch 1332/1500
5/5             0s 15ms/step -
accuracy: 0.8852 - loss: 0.2857 - val_accuracy: 0.8092 - val_loss: 0.4478
Epoch 1333/1500
5/5             0s 17ms/step -
accuracy: 0.8796 - loss: 0.3075 - val_accuracy: 0.8092 - val_loss: 0.4479
Epoch 1334/1500
5/5             0s 15ms/step -
accuracy: 0.8752 - loss: 0.3315 - val_accuracy: 0.8092 - val_loss: 0.4479
Epoch 1335/1500
5/5             0s 15ms/step -
accuracy: 0.8622 - loss: 0.3633 - val_accuracy: 0.8092 - val_loss: 0.4479
Epoch 1336/1500
5/5             0s 17ms/step -
accuracy: 0.8913 - loss: 0.2773 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1337/1500
5/5             0s 14ms/step -
accuracy: 0.8952 - loss: 0.2814 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1338/1500
5/5             0s 15ms/step -
accuracy: 0.8822 - loss: 0.3091 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1339/1500
5/5             0s 15ms/step -
accuracy: 0.8943 - loss: 0.2797 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1340/1500
5/5             0s 15ms/step -
accuracy: 0.8722 - loss: 0.3083 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1341/1500
5/5             0s 14ms/step -
accuracy: 0.8735 - loss: 0.3062 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1342/1500
5/5             0s 20ms/step -
accuracy: 0.8744 - loss: 0.3367 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1343/1500
5/5             0s 20ms/step -
accuracy: 0.8726 - loss: 0.3283 - val_accuracy: 0.8092 - val_loss: 0.4480
Epoch 1344/1500
5/5             0s 14ms/step -
accuracy: 0.8770 - loss: 0.3340 - val_accuracy: 0.8092 - val_loss: 0.4480
```

```
Epoch 1345/1500
5/5             0s 14ms/step -
accuracy: 0.8874 - loss: 0.2988 - val_accuracy: 0.8092 - val_loss: 0.4481
Epoch 1346/1500
5/5             0s 18ms/step -
accuracy: 0.8883 - loss: 0.3116 - val_accuracy: 0.8092 - val_loss: 0.4481
Epoch 1347/1500
5/5             0s 14ms/step -
accuracy: 0.9047 - loss: 0.2781 - val_accuracy: 0.8092 - val_loss: 0.4481
Epoch 1348/1500
5/5             0s 17ms/step -
accuracy: 0.9017 - loss: 0.2660 - val_accuracy: 0.8092 - val_loss: 0.4481
Epoch 1349/1500
5/5             0s 17ms/step -
accuracy: 0.8579 - loss: 0.3351 - val_accuracy: 0.8092 - val_loss: 0.4482
Epoch 1350/1500
5/5             0s 21ms/step -
accuracy: 0.8887 - loss: 0.2840 - val_accuracy: 0.8092 - val_loss: 0.4482
Epoch 1351/1500
5/5             0s 15ms/step -
accuracy: 0.8709 - loss: 0.3238 - val_accuracy: 0.8092 - val_loss: 0.4482
Epoch 1352/1500
5/5             0s 15ms/step -
accuracy: 0.8930 - loss: 0.2849 - val_accuracy: 0.8092 - val_loss: 0.4482
Epoch 1353/1500
5/5             0s 17ms/step -
accuracy: 0.8770 - loss: 0.3102 - val_accuracy: 0.8092 - val_loss: 0.4482
Epoch 1354/1500
5/5             0s 17ms/step -
accuracy: 0.8735 - loss: 0.3097 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1355/1500
5/5             0s 14ms/step -
accuracy: 0.8922 - loss: 0.2749 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1356/1500
5/5             0s 24ms/step -
accuracy: 0.8856 - loss: 0.2946 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1357/1500
5/5             0s 20ms/step -
accuracy: 0.8661 - loss: 0.3135 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1358/1500
5/5             0s 18ms/step -
accuracy: 0.8692 - loss: 0.2738 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1359/1500
5/5             0s 27ms/step -
accuracy: 0.9147 - loss: 0.2486 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1360/1500
5/5             0s 20ms/step -
accuracy: 0.8865 - loss: 0.2880 - val_accuracy: 0.8092 - val_loss: 0.4483
```

```
Epoch 1361/1500
5/5             0s 25ms/step -
accuracy: 0.9017 - loss: 0.2681 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1362/1500
5/5             0s 21ms/step -
accuracy: 0.8631 - loss: 0.3292 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1363/1500
5/5             0s 32ms/step -
accuracy: 0.9056 - loss: 0.2618 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1364/1500
5/5             0s 23ms/step -
accuracy: 0.8783 - loss: 0.3033 - val_accuracy: 0.8092 - val_loss: 0.4483
Epoch 1365/1500
5/5             0s 23ms/step -
accuracy: 0.8974 - loss: 0.2870 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1366/1500
5/5             0s 21ms/step -
accuracy: 0.9078 - loss: 0.2462 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1367/1500
5/5             0s 24ms/step -
accuracy: 0.8787 - loss: 0.3059 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1368/1500
5/5             0s 17ms/step -
accuracy: 0.8870 - loss: 0.2818 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1369/1500
5/5             0s 14ms/step -
accuracy: 0.8770 - loss: 0.3173 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1370/1500
5/5             0s 14ms/step -
accuracy: 0.9013 - loss: 0.2746 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1371/1500
5/5             0s 14ms/step -
accuracy: 0.8635 - loss: 0.3240 - val_accuracy: 0.8092 - val_loss: 0.4484
Epoch 1372/1500
5/5             0s 18ms/step -
accuracy: 0.8883 - loss: 0.2810 - val_accuracy: 0.8092 - val_loss: 0.4485
Epoch 1373/1500
5/5             0s 15ms/step -
accuracy: 0.8713 - loss: 0.2949 - val_accuracy: 0.8092 - val_loss: 0.4485
Epoch 1374/1500
5/5             0s 17ms/step -
accuracy: 0.8657 - loss: 0.3294 - val_accuracy: 0.8092 - val_loss: 0.4485
Epoch 1375/1500
5/5             0s 15ms/step -
accuracy: 0.8848 - loss: 0.3040 - val_accuracy: 0.8092 - val_loss: 0.4485
Epoch 1376/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.2984 - val_accuracy: 0.8092 - val_loss: 0.4486
```

```
Epoch 1377/1500
5/5             0s 13ms/step -
accuracy: 0.8813 - loss: 0.2875 - val_accuracy: 0.8092 - val_loss: 0.4486
Epoch 1378/1500
5/5             0s 19ms/step -
accuracy: 0.8900 - loss: 0.2734 - val_accuracy: 0.8092 - val_loss: 0.4486
Epoch 1379/1500
5/5             0s 15ms/step -
accuracy: 0.9173 - loss: 0.2628 - val_accuracy: 0.8092 - val_loss: 0.4487
Epoch 1380/1500
5/5             0s 18ms/step -
accuracy: 0.8626 - loss: 0.3397 - val_accuracy: 0.8092 - val_loss: 0.4487
Epoch 1381/1500
5/5             0s 18ms/step -
accuracy: 0.8804 - loss: 0.2828 - val_accuracy: 0.8092 - val_loss: 0.4487
Epoch 1382/1500
5/5             0s 18ms/step -
accuracy: 0.9013 - loss: 0.2765 - val_accuracy: 0.8092 - val_loss: 0.4487
Epoch 1383/1500
5/5             0s 14ms/step -
accuracy: 0.8648 - loss: 0.3225 - val_accuracy: 0.8092 - val_loss: 0.4488
Epoch 1384/1500
5/5             0s 19ms/step -
accuracy: 0.8787 - loss: 0.3135 - val_accuracy: 0.8092 - val_loss: 0.4488
Epoch 1385/1500
5/5             0s 18ms/step -
accuracy: 0.8509 - loss: 0.3098 - val_accuracy: 0.8092 - val_loss: 0.4488
Epoch 1386/1500
5/5             0s 17ms/step -
accuracy: 0.9039 - loss: 0.2779 - val_accuracy: 0.8092 - val_loss: 0.4488
Epoch 1387/1500
5/5             0s 14ms/step -
accuracy: 0.8783 - loss: 0.2740 - val_accuracy: 0.8092 - val_loss: 0.4488
Epoch 1388/1500
5/5             0s 17ms/step -
accuracy: 0.9013 - loss: 0.2672 - val_accuracy: 0.8092 - val_loss: 0.4489
Epoch 1389/1500
5/5             0s 17ms/step -
accuracy: 0.8744 - loss: 0.3071 - val_accuracy: 0.8092 - val_loss: 0.4489
Epoch 1390/1500
5/5             0s 16ms/step -
accuracy: 0.9095 - loss: 0.2548 - val_accuracy: 0.8092 - val_loss: 0.4489
Epoch 1391/1500
5/5             0s 19ms/step -
accuracy: 0.9065 - loss: 0.2862 - val_accuracy: 0.8092 - val_loss: 0.4490
Epoch 1392/1500
5/5             0s 13ms/step -
accuracy: 0.8613 - loss: 0.3103 - val_accuracy: 0.8092 - val_loss: 0.4490
```

```
Epoch 1393/1500
5/5             0s 17ms/step -
accuracy: 0.8709 - loss: 0.2996 - val_accuracy: 0.8092 - val_loss: 0.4490
Epoch 1394/1500
5/5             0s 14ms/step -
accuracy: 0.8887 - loss: 0.2949 - val_accuracy: 0.8092 - val_loss: 0.4490
Epoch 1395/1500
5/5             0s 19ms/step -
accuracy: 0.8796 - loss: 0.3115 - val_accuracy: 0.8092 - val_loss: 0.4490
Epoch 1396/1500
5/5             0s 18ms/step -
accuracy: 0.8930 - loss: 0.2821 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1397/1500
5/5             0s 14ms/step -
accuracy: 0.9026 - loss: 0.2560 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1398/1500
5/5             0s 16ms/step -
accuracy: 0.8961 - loss: 0.2612 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1399/1500
5/5             0s 17ms/step -
accuracy: 0.8726 - loss: 0.3130 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1400/1500
5/5             0s 20ms/step -
accuracy: 0.8982 - loss: 0.2567 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1401/1500
5/5             0s 15ms/step -
accuracy: 0.8952 - loss: 0.2766 - val_accuracy: 0.8092 - val_loss: 0.4491
Epoch 1402/1500
5/5             0s 18ms/step -
accuracy: 0.9056 - loss: 0.2648 - val_accuracy: 0.8092 - val_loss: 0.4492
Epoch 1403/1500
5/5             0s 14ms/step -
accuracy: 0.8674 - loss: 0.3070 - val_accuracy: 0.8092 - val_loss: 0.4492
Epoch 1404/1500
5/5             0s 15ms/step -
accuracy: 0.8796 - loss: 0.2950 - val_accuracy: 0.8092 - val_loss: 0.4492
Epoch 1405/1500
5/5             0s 15ms/step -
accuracy: 0.8514 - loss: 0.3454 - val_accuracy: 0.8092 - val_loss: 0.4492
Epoch 1406/1500
5/5             0s 17ms/step -
accuracy: 0.8961 - loss: 0.2798 - val_accuracy: 0.8092 - val_loss: 0.4493
Epoch 1407/1500
5/5             0s 16ms/step -
accuracy: 0.9060 - loss: 0.2860 - val_accuracy: 0.8092 - val_loss: 0.4493
Epoch 1408/1500
5/5             0s 49ms/step -
accuracy: 0.8982 - loss: 0.2678 - val_accuracy: 0.8092 - val_loss: 0.4493
```

```
Epoch 1409/1500
5/5             0s 27ms/step -
accuracy: 0.8883 - loss: 0.2813 - val_accuracy: 0.8092 - val_loss: 0.4493
Epoch 1410/1500
5/5             0s 21ms/step -
accuracy: 0.8861 - loss: 0.3116 - val_accuracy: 0.8092 - val_loss: 0.4493
Epoch 1411/1500
5/5             0s 17ms/step -
accuracy: 0.8839 - loss: 0.2921 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1412/1500
5/5             0s 21ms/step -
accuracy: 0.8865 - loss: 0.2719 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1413/1500
5/5             0s 17ms/step -
accuracy: 0.8917 - loss: 0.2692 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1414/1500
5/5             0s 46ms/step -
accuracy: 0.8861 - loss: 0.3080 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1415/1500
5/5             0s 19ms/step -
accuracy: 0.8830 - loss: 0.2826 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1416/1500
5/5             0s 18ms/step -
accuracy: 0.8796 - loss: 0.3172 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1417/1500
5/5             0s 21ms/step -
accuracy: 0.8987 - loss: 0.2528 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1418/1500
5/5             0s 18ms/step -
accuracy: 0.8870 - loss: 0.2950 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1419/1500
5/5             0s 14ms/step -
accuracy: 0.8930 - loss: 0.2711 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1420/1500
5/5             0s 13ms/step -
accuracy: 0.8848 - loss: 0.2705 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1421/1500
5/5             0s 18ms/step -
accuracy: 0.8874 - loss: 0.2864 - val_accuracy: 0.8092 - val_loss: 0.4494
Epoch 1422/1500
5/5             0s 17ms/step -
accuracy: 0.8809 - loss: 0.2873 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1423/1500
5/5             0s 17ms/step -
accuracy: 0.9121 - loss: 0.2467 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1424/1500
5/5             0s 16ms/step -
accuracy: 0.8783 - loss: 0.3259 - val_accuracy: 0.8092 - val_loss: 0.4495
```

```
Epoch 1425/1500
5/5             0s 15ms/step -
accuracy: 0.8722 - loss: 0.2910 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1426/1500
5/5             0s 15ms/step -
accuracy: 0.8974 - loss: 0.2651 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1427/1500
5/5             0s 17ms/step -
accuracy: 0.8982 - loss: 0.2802 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1428/1500
5/5             0s 48ms/step -
accuracy: 0.8718 - loss: 0.2869 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1429/1500
5/5             0s 29ms/step -
accuracy: 0.9108 - loss: 0.2414 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1430/1500
5/5             0s 14ms/step -
accuracy: 0.8705 - loss: 0.2984 - val_accuracy: 0.8092 - val_loss: 0.4495
Epoch 1431/1500
5/5             0s 16ms/step -
accuracy: 0.8856 - loss: 0.2962 - val_accuracy: 0.8092 - val_loss: 0.4496
Epoch 1432/1500
5/5             0s 15ms/step -
accuracy: 0.8648 - loss: 0.3179 - val_accuracy: 0.8092 - val_loss: 0.4496
Epoch 1433/1500
5/5             0s 18ms/step -
accuracy: 0.9047 - loss: 0.2878 - val_accuracy: 0.8092 - val_loss: 0.4496
Epoch 1434/1500
5/5             0s 15ms/step -
accuracy: 0.8791 - loss: 0.3034 - val_accuracy: 0.8092 - val_loss: 0.4496
Epoch 1435/1500
5/5             0s 28ms/step -
accuracy: 0.8548 - loss: 0.3336 - val_accuracy: 0.8092 - val_loss: 0.4497
Epoch 1436/1500
5/5             0s 18ms/step -
accuracy: 0.8843 - loss: 0.2763 - val_accuracy: 0.8092 - val_loss: 0.4497
Epoch 1437/1500
5/5             0s 21ms/step -
accuracy: 0.9091 - loss: 0.2536 - val_accuracy: 0.8092 - val_loss: 0.4498
Epoch 1438/1500
5/5             0s 20ms/step -
accuracy: 0.9126 - loss: 0.2456 - val_accuracy: 0.8092 - val_loss: 0.4498
Epoch 1439/1500
5/5             0s 29ms/step -
accuracy: 0.8783 - loss: 0.2816 - val_accuracy: 0.8092 - val_loss: 0.4498
Epoch 1440/1500
5/5             0s 18ms/step -
accuracy: 0.8774 - loss: 0.3019 - val_accuracy: 0.8092 - val_loss: 0.4498
```

```
Epoch 1441/1500
5/5             0s 23ms/step -
accuracy: 0.9113 - loss: 0.2455 - val_accuracy: 0.8092 - val_loss: 0.4498
Epoch 1442/1500
5/5             0s 22ms/step -
accuracy: 0.8843 - loss: 0.3051 - val_accuracy: 0.8092 - val_loss: 0.4498
Epoch 1443/1500
5/5             0s 22ms/step -
accuracy: 0.8896 - loss: 0.2759 - val_accuracy: 0.8092 - val_loss: 0.4499
Epoch 1444/1500
5/5             0s 24ms/step -
accuracy: 0.9217 - loss: 0.2276 - val_accuracy: 0.8092 - val_loss: 0.4499
Epoch 1445/1500
5/5             0s 21ms/step -
accuracy: 0.8965 - loss: 0.2784 - val_accuracy: 0.8092 - val_loss: 0.4499
Epoch 1446/1500
5/5             0s 25ms/step -
accuracy: 0.8852 - loss: 0.2944 - val_accuracy: 0.8092 - val_loss: 0.4500
Epoch 1447/1500
5/5             0s 18ms/step -
accuracy: 0.9126 - loss: 0.2604 - val_accuracy: 0.8092 - val_loss: 0.4500
Epoch 1448/1500
5/5             0s 15ms/step -
accuracy: 0.8653 - loss: 0.3147 - val_accuracy: 0.8092 - val_loss: 0.4500
Epoch 1449/1500
5/5             0s 15ms/step -
accuracy: 0.8852 - loss: 0.2773 - val_accuracy: 0.8092 - val_loss: 0.4500
Epoch 1450/1500
5/5             0s 16ms/step -
accuracy: 0.8904 - loss: 0.2796 - val_accuracy: 0.8092 - val_loss: 0.4500
Epoch 1451/1500
5/5             0s 17ms/step -
accuracy: 0.8843 - loss: 0.3044 - val_accuracy: 0.8092 - val_loss: 0.4501
Epoch 1452/1500
5/5             0s 18ms/step -
accuracy: 0.8648 - loss: 0.2975 - val_accuracy: 0.8092 - val_loss: 0.4501
Epoch 1453/1500
5/5             0s 17ms/step -
accuracy: 0.8744 - loss: 0.3238 - val_accuracy: 0.8092 - val_loss: 0.4501
Epoch 1454/1500
5/5             0s 15ms/step -
accuracy: 0.8804 - loss: 0.2922 - val_accuracy: 0.8092 - val_loss: 0.4501
Epoch 1455/1500
5/5             0s 19ms/step -
accuracy: 0.9087 - loss: 0.2267 - val_accuracy: 0.8092 - val_loss: 0.4502
Epoch 1456/1500
5/5             0s 15ms/step -
accuracy: 0.8978 - loss: 0.2657 - val_accuracy: 0.8092 - val_loss: 0.4502
```

```
Epoch 1457/1500
5/5             0s 14ms/step -
accuracy: 0.8974 - loss: 0.2562 - val_accuracy: 0.8092 - val_loss: 0.4502
Epoch 1458/1500
5/5             0s 18ms/step -
accuracy: 0.8752 - loss: 0.3237 - val_accuracy: 0.8092 - val_loss: 0.4502
Epoch 1459/1500
5/5             0s 17ms/step -
accuracy: 0.8835 - loss: 0.2792 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1460/1500
5/5             0s 15ms/step -
accuracy: 0.9082 - loss: 0.2705 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1461/1500
5/5             0s 17ms/step -
accuracy: 0.8731 - loss: 0.3052 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1462/1500
5/5             0s 17ms/step -
accuracy: 0.8852 - loss: 0.2659 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1463/1500
5/5             0s 18ms/step -
accuracy: 0.8709 - loss: 0.2957 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1464/1500
5/5             0s 16ms/step -
accuracy: 0.8587 - loss: 0.3200 - val_accuracy: 0.8092 - val_loss: 0.4503
Epoch 1465/1500
5/5             0s 14ms/step -
accuracy: 0.8783 - loss: 0.2959 - val_accuracy: 0.8092 - val_loss: 0.4504
Epoch 1466/1500
5/5             0s 17ms/step -
accuracy: 0.8874 - loss: 0.2675 - val_accuracy: 0.8092 - val_loss: 0.4504
Epoch 1467/1500
5/5             0s 17ms/step -
accuracy: 0.8839 - loss: 0.2937 - val_accuracy: 0.8092 - val_loss: 0.4505
Epoch 1468/1500
5/5             0s 14ms/step -
accuracy: 0.8709 - loss: 0.3192 - val_accuracy: 0.8092 - val_loss: 0.4505
Epoch 1469/1500
5/5             0s 18ms/step -
accuracy: 0.8800 - loss: 0.3000 - val_accuracy: 0.8092 - val_loss: 0.4505
Epoch 1470/1500
5/5             0s 15ms/step -
accuracy: 0.8544 - loss: 0.3204 - val_accuracy: 0.8092 - val_loss: 0.4505
Epoch 1471/1500
5/5             0s 14ms/step -
accuracy: 0.8891 - loss: 0.2578 - val_accuracy: 0.8092 - val_loss: 0.4505
Epoch 1472/1500
5/5             0s 14ms/step -
accuracy: 0.9013 - loss: 0.2790 - val_accuracy: 0.8092 - val_loss: 0.4505
```

```
Epoch 1473/1500
5/5             0s 18ms/step -
accuracy: 0.8609 - loss: 0.2929 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1474/1500
5/5             0s 17ms/step -
accuracy: 0.8883 - loss: 0.2892 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1475/1500
5/5             0s 18ms/step -
accuracy: 0.8948 - loss: 0.2456 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1476/1500
5/5             0s 14ms/step -
accuracy: 0.9039 - loss: 0.2632 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1477/1500
5/5             0s 14ms/step -
accuracy: 0.8904 - loss: 0.2732 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1478/1500
5/5             0s 18ms/step -
accuracy: 0.8726 - loss: 0.3064 - val_accuracy: 0.8092 - val_loss: 0.4506
Epoch 1479/1500
5/5             0s 18ms/step -
accuracy: 0.8861 - loss: 0.2649 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1480/1500
5/5             0s 14ms/step -
accuracy: 0.8592 - loss: 0.3153 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1481/1500
5/5             0s 14ms/step -
accuracy: 0.8969 - loss: 0.2609 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1482/1500
5/5             0s 14ms/step -
accuracy: 0.8930 - loss: 0.2960 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1483/1500
5/5             0s 14ms/step -
accuracy: 0.8848 - loss: 0.2871 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1484/1500
5/5             0s 17ms/step -
accuracy: 0.8713 - loss: 0.2918 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1485/1500
5/5             0s 17ms/step -
accuracy: 0.8843 - loss: 0.2771 - val_accuracy: 0.8092 - val_loss: 0.4507
Epoch 1486/1500
5/5             0s 17ms/step -
accuracy: 0.9034 - loss: 0.2880 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1487/1500
5/5             0s 14ms/step -
accuracy: 0.8961 - loss: 0.2794 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1488/1500
5/5             0s 14ms/step -
accuracy: 0.9060 - loss: 0.2537 - val_accuracy: 0.8092 - val_loss: 0.4508
```

```
Epoch 1489/1500
5/5             0s 17ms/step -
accuracy: 0.8917 - loss: 0.2807 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1490/1500
5/5             0s 13ms/step -
accuracy: 0.9100 - loss: 0.2475 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1491/1500
5/5             0s 15ms/step -
accuracy: 0.8531 - loss: 0.3296 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1492/1500
5/5             0s 14ms/step -
accuracy: 0.8787 - loss: 0.3041 - val_accuracy: 0.8092 - val_loss: 0.4508
Epoch 1493/1500
5/5             0s 17ms/step -
accuracy: 0.8744 - loss: 0.2840 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1494/1500
5/5             0s 18ms/step -
accuracy: 0.8856 - loss: 0.2738 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1495/1500
5/5             0s 16ms/step -
accuracy: 0.9026 - loss: 0.2728 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1496/1500
5/5             0s 19ms/step -
accuracy: 0.8692 - loss: 0.3076 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1497/1500
5/5             0s 17ms/step -
accuracy: 0.8648 - loss: 0.3270 - val_accuracy: 0.8092 - val_loss: 0.4510
Epoch 1498/1500
5/5             0s 15ms/step -
accuracy: 0.9204 - loss: 0.2442 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1499/1500
5/5             0s 18ms/step -
accuracy: 0.9047 - loss: 0.2522 - val_accuracy: 0.8092 - val_loss: 0.4509
Epoch 1500/1500
5/5             0s 20ms/step -
accuracy: 0.8878 - loss: 0.2660 - val_accuracy: 0.8092 - val_loss: 0.4509
```

[176]:
```
y_pred_prob_nn_1 = model.predict(X_test_norm)
y_pred_class_nn_1 = np.argmax(y_pred_prob_nn_1, axis=1)
```

```
5/5             0s 11ms/step
```

[177]:
```
y_pred_class_nn_1[:10]
```

[177]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

[178]:
```
y_pred_prob_nn_1[:10]
```

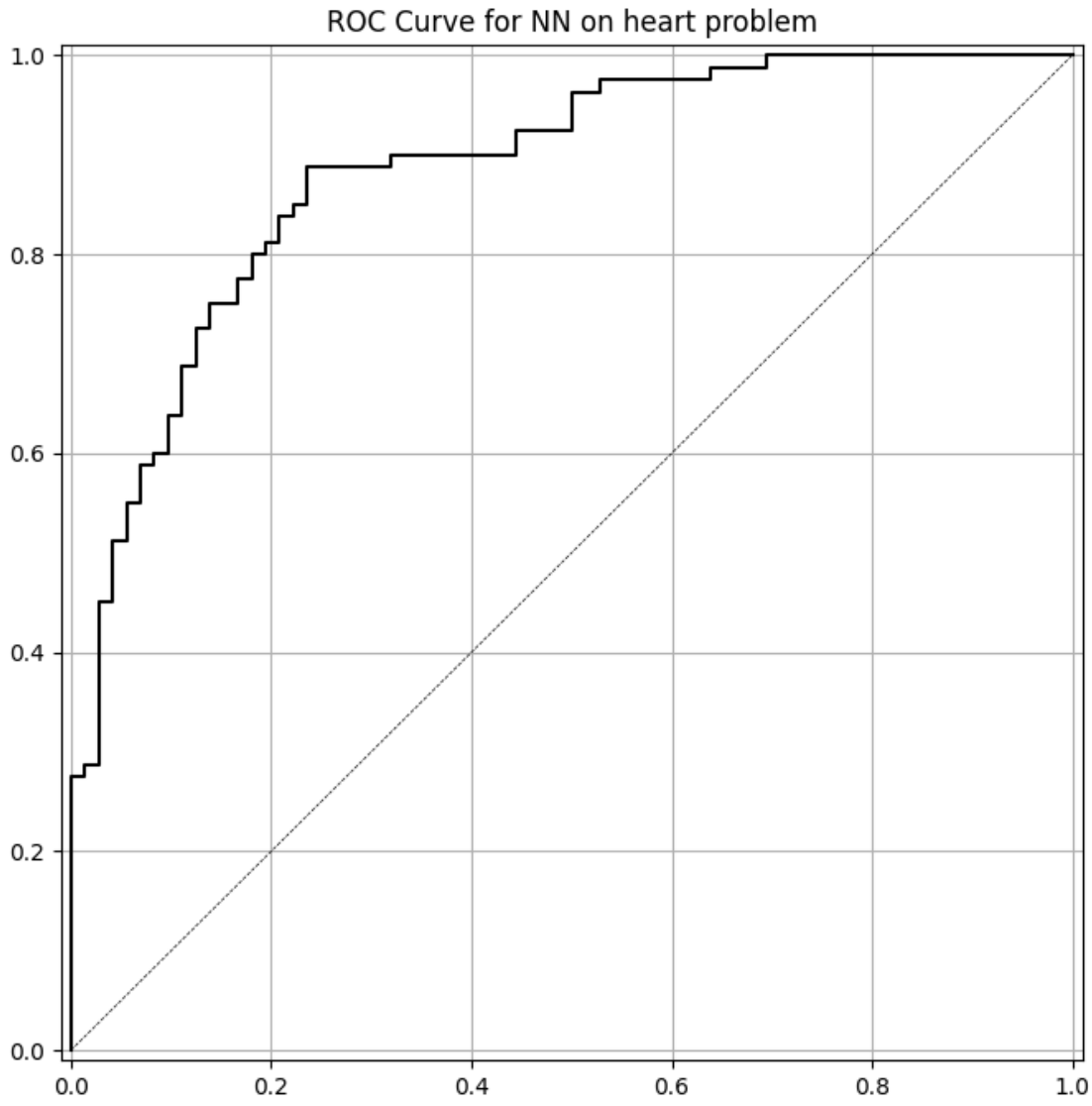
[178]:
```
array([[0.9702111 ],
       [0.00788167],
       [0.00885313],
       [0.98619574],
       [0.7185315 ],
       [0.03045651],
       [0.04497855],
       [0.10267232],
       [0.7419374 ],
       [0.73928463]], dtype=float32)
```

[179]:
```
def plot_roc(y_test, y_pred, model_name):
    fpr, tpr, thr = roc_curve(y_test, y_pred)
    fig, ax = plt.subplots(figsize=(8, 8))
    ax.plot(fpr, tpr, 'k-')
    ax.plot([0, 1], [0, 1], 'k--', linewidth=.5)  # roc curve for random model
    ax.grid(True)
    ax.set(title='ROC Curve for {} on heart problem'.format(model_name),
           xlim=[-0.01, 1.01], ylim=[-0.01, 1.01])
```

[180]:
```
print('accuracy is {:.3f}'.format(accuracy_score(y_test,y_pred_class_nn_1)))
print('roc-auc is {:.3f}'.format(roc_auc_score(y_test,y_pred_prob_nn_1)))

plot_roc(y_test, y_pred_prob_nn_1, 'NN')
```

```
accuracy is 0.474
roc-auc is 0.885
```



0.0.3 Analysis

The accuracy is only 47.4% and the ROC-AUC is 84.4% which indicates that the model's performance is relativelt low in terms of accuracy, but does well in distinguishing between the two classes. The ROC curve demonstrate the model's performance at different thresholds.

The x-axis there in the graph represent as the False Positive Rate and the y- axis represent as True Positive Rate. The curve diagonal line there is represent a random classifier. As you can see above the points (0.0) and (0.1) are missing, which makes the curve as straight line. The curve is above from diagonal line which indicates a better performance.

[181]:
```
from sklearn import metrics
```

```python
print('Neural Network:\n {}\n'.format(
    metrics.classification_report(y_pred_class_nn_1, y_test)))

nn_conf_matrix1 = metrics.confusion_matrix(y_pred_class_nn_1, y_test)
conf_mat_nn1 = pd.DataFrame(
    nn_conf_matrix1,
    columns=["Predicted NO", "Predicted YES"],
    index=["Actual NO", "Actual YES"])

print(conf_mat_nn1)
```

```
Neural Network:
               precision    recall  f1-score   support

           0       1.00      0.47      0.64       152
           1       0.00      0.00      0.00         0

    accuracy                           0.47       152
   macro avg       0.50      0.24      0.32       152
weighted avg       1.00      0.47      0.64       152


            Predicted NO  Predicted YES
Actual NO             72             80
Actual YES             0              0
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Recall and F-score are ill-defined and being set to 0.0
in labels with no true samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Recall and F-score are ill-defined and being set to 0.0
in labels with no true samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Recall and F-score are ill-defined and being set to 0.0
in labels with no true samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

0.0.4 Analysis

TN (1st left cell - both actual & predicted was negative (no heart disease at all) FP (1st righ cell) - Actual is positive (no heart disease) and predicted is positive (can have) FN (second left cell) - Actual value (has heart disease) but predicted as negative value (predicted as no heart disease) TP (second right cell) - both is positive (has heart disease)

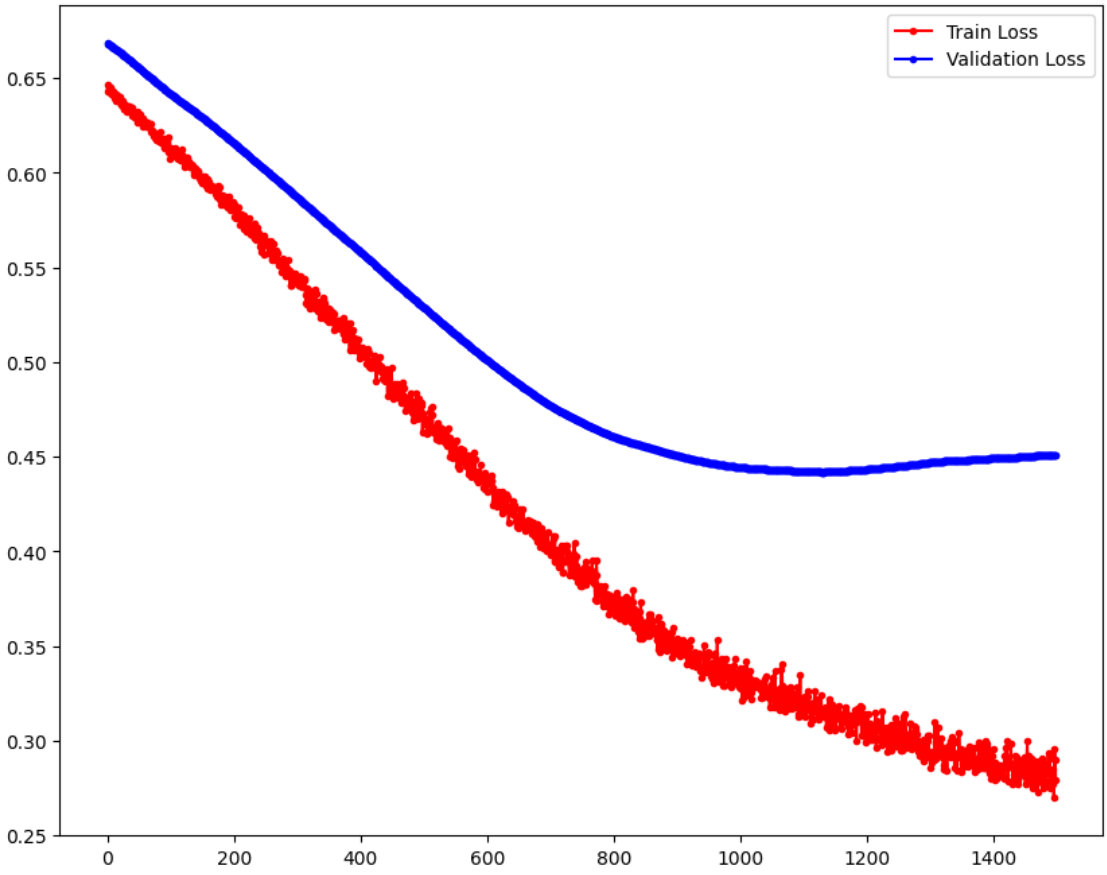
The total of True Negative here is 72 which means there's no heart disease among the patients. While there's also saying that 80 among 303 patients - the actual value says no heart disease but the predicted value says they can also have heart disease.

[182]:
```
run_hist_1.history.keys()
```

[182]:
```
dict_keys(['accuracy', 'loss', 'val_accuracy', 'val_loss'])
```

[183]:
```
fig, ax = plt.subplots(figsize=(10, 8))

ax.plot(run_hist_1.history["loss"], 'r', marker='.', label="Train Loss")
ax.plot(run_hist_1.history["val_loss"], 'b', marker='.', label="Validation␣
↪Loss")
ax.legend()
plt.show()
```



0.0.5 Analysis

It starts with 0.65 (both train and validation loss). As the training progresses, the train loss decreases steadily reaching to 0.25 after 1400 iterations. Which indicates that the model is becoming

more accurate predicting the output for the training data.

The validation loss decreases (measures on unseen data of models performance), but it doesn't decrease rapidly as the train loss. Also, the gap between the 2 lines there's overfitting to the training data, the training data learns too well but performs poorly on new data.

1 Use different learning rates, numbers of epochs, and network structures.

[ ]:
```
X_train2, X_test2, y_train2, y_test2 = train_test_split(X, y, test_size=0.5,␣
↪random_state=100)
```

[ ]:
```
import tensorflow as tf
from tensorflow import keras

model = keras.models.Sequential([
    keras.layers.Dense(6, activation='relu', input_shape=input_shape),
    keras.layers.Dense(6, activation='relu'),
    keras.layers.Dropout(0.5),
    keras.layers.Dense(1, activation='sigmoid')
])
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:88:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When
using Sequential models, prefer using an `Input(shape)` object as the first
layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

[ ]:
```
model.compile(optimizer='adam', loss='binary_crossentropy',␣
↪metrics=['accuracy'])
```

[ ]:
```
model.summary()
```

```
Model: "sequential_8"
```

Layer (type)	Output Shape	Param #
dense_23 (Dense)	(None, 6)	84
dense_24 (Dense)	(None, 6)	42
dropout_5 (Dropout)	(None, 6)	0

```
 dense_25 (Dense)                        (None, 1)                          ␣
↪  7
```

Total params: 133 (532.00 B)

Trainable params: 133 (532.00 B)

Non-trainable params: 0 (0.00 B)

[ ]:
```
model.compile(SGD(learning_rate = 0.7), "binary_crossentropy",␣
↪metrics=["accuracy"])
run_hist_2 = model.fit(X_train_norm, y_train, validation_data=(X_test_norm,␣
↪y_test), epochs=100)
```

```
Epoch 1/100
5/5              1s 63ms/step -
accuracy: 0.5256 - loss: 0.8555 - val_accuracy: 0.6711 - val_loss: 0.6061
Epoch 2/100
5/5              0s 12ms/step -
accuracy: 0.6241 - loss: 0.6441 - val_accuracy: 0.7368 - val_loss: 0.5538
Epoch 3/100
5/5              0s 14ms/step -
accuracy: 0.6735 - loss: 0.5912 - val_accuracy: 0.7632 - val_loss: 0.5057
Epoch 4/100
5/5              0s 14ms/step -
accuracy: 0.6910 - loss: 0.5238 - val_accuracy: 0.7697 - val_loss: 0.4617
Epoch 5/100
5/5              0s 13ms/step -
accuracy: 0.7081 - loss: 0.5316 - val_accuracy: 0.7961 - val_loss: 0.4710
Epoch 6/100
5/5              0s 16ms/step -
accuracy: 0.7017 - loss: 0.5117 - val_accuracy: 0.8026 - val_loss: 0.4325
Epoch 7/100
5/5              0s 11ms/step -
accuracy: 0.7073 - loss: 0.4760 - val_accuracy: 0.8026 - val_loss: 0.4262
Epoch 8/100
5/5              0s 14ms/step -
accuracy: 0.7945 - loss: 0.4947 - val_accuracy: 0.7961 - val_loss: 0.4175
Epoch 9/100
5/5              0s 12ms/step -
accuracy: 0.7958 - loss: 0.4493 - val_accuracy: 0.8026 - val_loss: 0.4349
Epoch 10/100
5/5              0s 11ms/step -
```

```
accuracy: 0.8624 - loss: 0.4439 - val_accuracy: 0.8026 - val_loss: 0.4261
Epoch 11/100
5/5             0s 13ms/step -
accuracy: 0.8317 - loss: 0.4279 - val_accuracy: 0.8092 - val_loss: 0.4341
Epoch 12/100
5/5             0s 11ms/step -
accuracy: 0.8198 - loss: 0.3969 - val_accuracy: 0.7895 - val_loss: 0.4511
Epoch 13/100
5/5             0s 12ms/step -
accuracy: 0.8764 - loss: 0.3389 - val_accuracy: 0.8158 - val_loss: 0.4373
Epoch 14/100
5/5             0s 12ms/step -
accuracy: 0.8680 - loss: 0.4161 - val_accuracy: 0.7895 - val_loss: 0.4594
Epoch 15/100
5/5             0s 14ms/step -
accuracy: 0.8511 - loss: 0.3779 - val_accuracy: 0.7632 - val_loss: 0.5015
Epoch 16/100
5/5             0s 14ms/step -
accuracy: 0.8080 - loss: 0.4327 - val_accuracy: 0.7829 - val_loss: 0.4650
Epoch 17/100
5/5             0s 11ms/step -
accuracy: 0.8468 - loss: 0.3843 - val_accuracy: 0.7895 - val_loss: 0.4948
Epoch 18/100
5/5             0s 15ms/step -
accuracy: 0.8690 - loss: 0.3717 - val_accuracy: 0.7895 - val_loss: 0.4688
Epoch 19/100
5/5             0s 14ms/step -
accuracy: 0.8434 - loss: 0.3377 - val_accuracy: 0.7895 - val_loss: 0.5085
Epoch 20/100
5/5             0s 11ms/step -
accuracy: 0.8503 - loss: 0.3268 - val_accuracy: 0.7829 - val_loss: 0.5090
Epoch 21/100
5/5             0s 14ms/step -
accuracy: 0.8991 - loss: 0.3013 - val_accuracy: 0.7895 - val_loss: 0.5484
Epoch 22/100
5/5             0s 14ms/step -
accuracy: 0.8682 - loss: 0.3123 - val_accuracy: 0.8092 - val_loss: 0.5170
Epoch 23/100
5/5             0s 10ms/step -
accuracy: 0.8016 - loss: 0.3544 - val_accuracy: 0.8092 - val_loss: 0.5366
Epoch 24/100
5/5             0s 14ms/step -
accuracy: 0.8879 - loss: 0.3097 - val_accuracy: 0.8092 - val_loss: 0.6056
Epoch 25/100
5/5             0s 13ms/step -
accuracy: 0.8786 - loss: 0.2705 - val_accuracy: 0.7895 - val_loss: 0.6068
Epoch 26/100
5/5             0s 14ms/step -
```

```
accuracy: 0.8726 - loss: 0.3114 - val_accuracy: 0.8092 - val_loss: 0.5700
Epoch 27/100
5/5             0s 11ms/step -
accuracy: 0.9235 - loss: 0.2723 - val_accuracy: 0.7829 - val_loss: 0.6067
Epoch 28/100
5/5             0s 14ms/step -
accuracy: 0.8921 - loss: 0.3003 - val_accuracy: 0.8092 - val_loss: 0.6028
Epoch 29/100
5/5             0s 14ms/step -
accuracy: 0.8611 - loss: 0.2788 - val_accuracy: 0.8026 - val_loss: 0.6722
Epoch 30/100
5/5             0s 14ms/step -
accuracy: 0.8573 - loss: 0.3420 - val_accuracy: 0.8158 - val_loss: 0.6633
Epoch 31/100
5/5             0s 14ms/step -
accuracy: 0.8956 - loss: 0.2523 - val_accuracy: 0.8092 - val_loss: 0.6981
Epoch 32/100
5/5             0s 11ms/step -
accuracy: 0.9379 - loss: 0.2410 - val_accuracy: 0.8092 - val_loss: 0.6746
Epoch 33/100
5/5             0s 14ms/step -
accuracy: 0.8826 - loss: 0.2876 - val_accuracy: 0.7895 - val_loss: 0.6565
Epoch 34/100
5/5             0s 11ms/step -
accuracy: 0.8386 - loss: 0.2994 - val_accuracy: 0.8026 - val_loss: 0.7660
Epoch 35/100
5/5             0s 12ms/step -
accuracy: 0.9040 - loss: 0.2151 - val_accuracy: 0.8224 - val_loss: 0.7749
Epoch 36/100
5/5             0s 11ms/step -
accuracy: 0.9025 - loss: 0.2527 - val_accuracy: 0.8224 - val_loss: 0.7245
Epoch 37/100
5/5             0s 15ms/step -
accuracy: 0.9040 - loss: 0.2180 - val_accuracy: 0.8092 - val_loss: 0.8117
Epoch 38/100
5/5             0s 10ms/step -
accuracy: 0.9019 - loss: 0.2326 - val_accuracy: 0.8224 - val_loss: 0.8314
Epoch 39/100
5/5             0s 10ms/step -
accuracy: 0.9484 - loss: 0.1957 - val_accuracy: 0.7500 - val_loss: 0.8341
Epoch 40/100
5/5             0s 12ms/step -
accuracy: 0.9210 - loss: 0.2039 - val_accuracy: 0.7961 - val_loss: 0.8707
Epoch 41/100
5/5             0s 15ms/step -
accuracy: 0.8982 - loss: 0.2341 - val_accuracy: 0.8158 - val_loss: 0.8270
Epoch 42/100
5/5             0s 14ms/step -
```

```
accuracy: 0.9089 - loss: 0.2082 - val_accuracy: 0.8092 - val_loss: 0.8645
Epoch 43/100
5/5             0s 17ms/step -
accuracy: 0.8926 - loss: 0.2253 - val_accuracy: 0.8355 - val_loss: 0.8444
Epoch 44/100
5/5             0s 14ms/step -
accuracy: 0.8910 - loss: 0.2759 - val_accuracy: 0.8092 - val_loss: 1.0509
Epoch 45/100
5/5             0s 11ms/step -
accuracy: 0.9260 - loss: 0.1893 - val_accuracy: 0.8487 - val_loss: 0.8030
Epoch 46/100
5/5             0s 10ms/step -
accuracy: 0.8679 - loss: 0.2887 - val_accuracy: 0.7434 - val_loss: 0.8829
Epoch 47/100
5/5             0s 11ms/step -
accuracy: 0.8508 - loss: 0.3121 - val_accuracy: 0.8158 - val_loss: 0.8861
Epoch 48/100
5/5             0s 11ms/step -
accuracy: 0.9119 - loss: 0.2352 - val_accuracy: 0.8158 - val_loss: 0.9476
Epoch 49/100
5/5             0s 15ms/step -
accuracy: 0.9497 - loss: 0.2042 - val_accuracy: 0.7697 - val_loss: 0.9940
Epoch 50/100
5/5             0s 11ms/step -
accuracy: 0.9170 - loss: 0.2207 - val_accuracy: 0.8289 - val_loss: 0.8397
Epoch 51/100
5/5             0s 14ms/step -
accuracy: 0.9241 - loss: 0.1974 - val_accuracy: 0.8158 - val_loss: 1.0504
Epoch 52/100
5/5             0s 13ms/step -
accuracy: 0.9008 - loss: 0.3130 - val_accuracy: 0.8092 - val_loss: 0.9966
Epoch 53/100
5/5             0s 14ms/step -
accuracy: 0.9258 - loss: 0.2019 - val_accuracy: 0.7961 - val_loss: 1.1646
Epoch 54/100
5/5             0s 11ms/step -
accuracy: 0.9560 - loss: 0.1467 - val_accuracy: 0.8224 - val_loss: 1.1992
Epoch 55/100
5/5             0s 14ms/step -
accuracy: 0.9511 - loss: 0.1473 - val_accuracy: 0.8158 - val_loss: 1.2467
Epoch 56/100
5/5             0s 10ms/step -
accuracy: 0.9558 - loss: 0.1654 - val_accuracy: 0.8026 - val_loss: 1.2387
Epoch 57/100
5/5             0s 11ms/step -
accuracy: 0.9301 - loss: 0.1880 - val_accuracy: 0.7961 - val_loss: 1.3808
Epoch 58/100
5/5             0s 14ms/step -
```

```
accuracy: 0.9429 - loss: 0.1645 - val_accuracy: 0.8092 - val_loss: 1.4594
Epoch 59/100
5/5             0s 14ms/step -
accuracy: 0.9424 - loss: 0.1513 - val_accuracy: 0.8026 - val_loss: 1.4047
Epoch 60/100
5/5             0s 15ms/step -
accuracy: 0.9699 - loss: 0.1176 - val_accuracy: 0.7961 - val_loss: 1.4079
Epoch 61/100
5/5             0s 11ms/step -
accuracy: 0.9511 - loss: 0.1674 - val_accuracy: 0.8158 - val_loss: 1.4948
Epoch 62/100
5/5             0s 11ms/step -
accuracy: 0.9494 - loss: 0.1423 - val_accuracy: 0.8026 - val_loss: 1.5387
Epoch 63/100
5/5             0s 11ms/step -
accuracy: 0.9760 - loss: 0.1027 - val_accuracy: 0.8158 - val_loss: 1.6469
Epoch 64/100
5/5             0s 11ms/step -
accuracy: 0.9294 - loss: 0.1691 - val_accuracy: 0.8026 - val_loss: 1.6219
Epoch 65/100
5/5             0s 12ms/step -
accuracy: 0.9547 - loss: 0.1351 - val_accuracy: 0.8092 - val_loss: 1.5137
Epoch 66/100
5/5             0s 11ms/step -
accuracy: 0.9763 - loss: 0.1090 - val_accuracy: 0.7961 - val_loss: 1.5820
Epoch 67/100
5/5             0s 15ms/step -
accuracy: 0.9668 - loss: 0.1244 - val_accuracy: 0.8026 - val_loss: 1.6320
Epoch 68/100
5/5             0s 11ms/step -
accuracy: 0.9760 - loss: 0.0977 - val_accuracy: 0.8026 - val_loss: 1.5741
Epoch 69/100
5/5             0s 15ms/step -
accuracy: 0.9668 - loss: 0.1158 - val_accuracy: 0.8026 - val_loss: 1.7020
Epoch 70/100
5/5             0s 16ms/step -
accuracy: 0.9333 - loss: 0.1720 - val_accuracy: 0.8092 - val_loss: 1.7230
Epoch 71/100
5/5             0s 12ms/step -
accuracy: 0.9834 - loss: 0.0749 - val_accuracy: 0.8026 - val_loss: 1.7702
Epoch 72/100
5/5             0s 12ms/step -
accuracy: 0.9738 - loss: 0.1053 - val_accuracy: 0.8026 - val_loss: 1.8275
Epoch 73/100
5/5             0s 14ms/step -
accuracy: 0.9912 - loss: 0.0668 - val_accuracy: 0.8026 - val_loss: 1.8854
Epoch 74/100
5/5             0s 15ms/step -
```

```
accuracy: 0.9729 - loss: 0.0998 - val_accuracy: 0.8026 - val_loss: 1.9452
Epoch 75/100
5/5             0s 11ms/step -
accuracy: 0.9560 - loss: 0.1326 - val_accuracy: 0.8026 - val_loss: 1.8939
Epoch 76/100
5/5             0s 11ms/step -
accuracy: 0.9795 - loss: 0.0979 - val_accuracy: 0.8092 - val_loss: 1.7537
Epoch 77/100
5/5             0s 15ms/step -
accuracy: 0.9596 - loss: 0.1278 - val_accuracy: 0.8224 - val_loss: 2.0649
Epoch 78/100
5/5             0s 13ms/step -
accuracy: 0.9363 - loss: 0.1740 - val_accuracy: 0.7434 - val_loss: 1.6508
Epoch 79/100
5/5             0s 18ms/step -
accuracy: 0.9144 - loss: 0.2165 - val_accuracy: 0.7961 - val_loss: 1.7242
Epoch 80/100
5/5             0s 15ms/step -
accuracy: 0.9537 - loss: 0.1354 - val_accuracy: 0.8026 - val_loss: 1.3282
Epoch 81/100
5/5             0s 16ms/step -
accuracy: 0.9355 - loss: 0.1989 - val_accuracy: 0.7961 - val_loss: 1.3256
Epoch 82/100
5/5             0s 15ms/step -
accuracy: 0.9533 - loss: 0.1520 - val_accuracy: 0.8092 - val_loss: 1.4364
Epoch 83/100
5/5             0s 20ms/step -
accuracy: 0.9812 - loss: 0.0957 - val_accuracy: 0.7697 - val_loss: 1.8962
Epoch 84/100
5/5             0s 16ms/step -
accuracy: 0.9406 - loss: 0.1835 - val_accuracy: 0.8158 - val_loss: 1.3571
Epoch 85/100
5/5             0s 15ms/step -
accuracy: 0.9547 - loss: 0.1213 - val_accuracy: 0.8158 - val_loss: 1.5568
Epoch 86/100
5/5             0s 19ms/step -
accuracy: 0.9681 - loss: 0.1098 - val_accuracy: 0.8092 - val_loss: 1.6068
Epoch 87/100
5/5             0s 15ms/step -
accuracy: 0.9895 - loss: 0.0677 - val_accuracy: 0.8092 - val_loss: 1.6531
Epoch 88/100
5/5             0s 15ms/step -
accuracy: 0.9756 - loss: 0.0991 - val_accuracy: 0.8026 - val_loss: 1.6513
Epoch 89/100
5/5             0s 18ms/step -
accuracy: 0.9860 - loss: 0.0737 - val_accuracy: 0.8158 - val_loss: 1.6967
Epoch 90/100
5/5             0s 20ms/step -
```

```
accuracy: 0.9781 - loss: 0.0821 - val_accuracy: 0.8158 - val_loss: 1.7627
Epoch 91/100
5/5             0s 15ms/step -
accuracy: 0.9742 - loss: 0.1001 - val_accuracy: 0.8092 - val_loss: 1.8536
Epoch 92/100
5/5             0s 17ms/step -
accuracy: 0.9829 - loss: 0.0834 - val_accuracy: 0.8092 - val_loss: 1.8741
Epoch 93/100
5/5             0s 17ms/step -
accuracy: 0.9729 - loss: 0.0896 - val_accuracy: 0.8092 - val_loss: 1.9088
Epoch 94/100
5/5             0s 19ms/step -
accuracy: 0.9581 - loss: 0.1187 - val_accuracy: 0.8092 - val_loss: 1.9044
Epoch 95/100
5/5             0s 16ms/step -
accuracy: 0.9895 - loss: 0.0642 - val_accuracy: 0.8092 - val_loss: 1.9463
Epoch 96/100
5/5             0s 20ms/step -
accuracy: 0.9568 - loss: 0.1308 - val_accuracy: 0.8092 - val_loss: 2.0275
Epoch 97/100
5/5             0s 18ms/step -
accuracy: 0.9943 - loss: 0.0462 - val_accuracy: 0.8092 - val_loss: 2.0780
Epoch 98/100
5/5             0s 15ms/step -
accuracy: 0.9943 - loss: 0.0511 - val_accuracy: 0.8158 - val_loss: 2.0634
Epoch 99/100
5/5             0s 15ms/step -
accuracy: 0.9669 - loss: 0.0938 - val_accuracy: 0.8158 - val_loss: 2.0922
Epoch 100/100
5/5             0s 11ms/step -
accuracy: 0.9529 - loss: 0.1332 - val_accuracy: 0.8158 - val_loss: 2.0935
```

[ ]:
```
y_pred_prob_nn_2 = model.predict(X_test_norm)
y_pred_class_nn_2 = np.argmax(y_pred_prob_nn_1, axis=1)
```

```
5/5             0s 14ms/step
```

[ ]:
```
y_pred_class_nn_2[:10]
```

[ ]:
```
array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

[ ]:
```
y_pred_prob_nn_2[:10]
```

[ ]:
```
array([[9.9995345e-01],
       [3.2136320e-06],
       [7.7949046e-08],
       [1.0000000e+00],
       [9.7773604e-02],
```

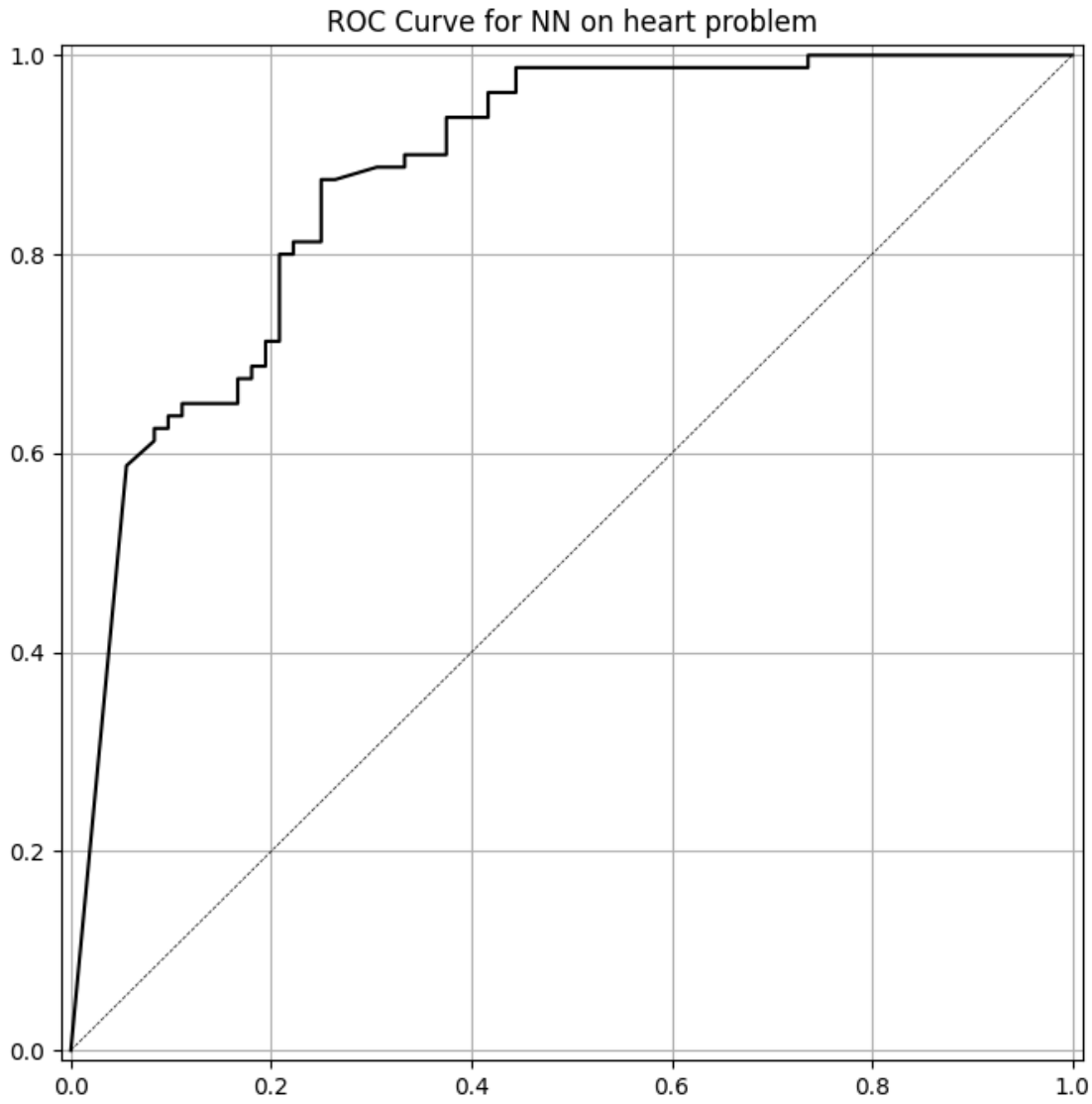
```
       [7.3394142e-07],
       [9.9829006e-01],
       [2.9021932e-03],
       [1.0000000e+00],
       [9.9999905e-01]], dtype=float32)
```

[ ]:
```
def plot_roc(y_test, y_pred, model_name):
    fpr, tpr, thr = roc_curve(y_test, y_pred)
    fig, ax = plt.subplots(figsize=(8, 8))
    ax.plot(fpr, tpr, 'k-')
    ax.plot([0, 1], [0, 1], 'k--', linewidth=.5)  # roc curve for random model
    ax.grid(True)
    ax.set(title='ROC Curve for {} on heart problem'.format(model_name),
           xlim=[-0.01, 1.01], ylim=[-0.01, 1.01])
```

[ ]:
```
print('accuracy is {:.3f}'.format(accuracy_score(y_test, y_pred_class_nn_2)))
print('roc-auc is {:.3f}'.format(roc_auc_score(y_test, y_pred_prob_nn_2)))

plot_roc(y_test, y_pred_prob_nn_2, 'NN')
```

```
accuracy is 0.474
roc-auc is 0.878
```



1.0.1 Analysis

The Accuracy is reported as 47.4% and ROC-AUC score is 87.8%. The curve indicates that the model performs well to distinguish the positive and negative classes. However the accuracy score is very low which suggest that the model could improved for specific task

[185]:
```
from sklearn import metrics

print('Neural Network:\n {}\n'.format(
    metrics.classification_report(y_test, y_pred_class_nn_2)))

nn_conf_matrix2 = metrics.confusion_matrix(y_test, y_pred_class_nn_2)
conf_mat_nn2 = pd.DataFrame(
```

```python
    nn_conf_matrix2,
    columns=["Predicted NO", "Predicted YES"],
    index=["Actual NO", "Actual YES"])

print(conf_mat_nn2)
```

```
Neural Network:
               precision    recall  f1-score   support

           0       0.47      1.00      0.64        72
           1       0.00      0.00      0.00        80

    accuracy                           0.47       152
   macro avg       0.24      0.50      0.32       152
weighted avg       0.22      0.47      0.30       152


            Predicted NO  Predicted YES
Actual NO             72              0
Actual YES            80              0
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

1.0.2 Analysis

TN (1st left cell - both actual & predicted was negative (no heart disease at all)

FP (1st righ cell) - Actual is positive (no heart disease) and predicted is positive (can have)

FN (second left cell) - Actual value (has heart disease) but predicted as negative value (predicted as no heart disease)

TP (second right cell) - both is positive (has heart disease)

Total of 72 correct predictions for negative class (no heart disease at all) and 80 incorrect predictions for positive class which means the there's 80 patients among 303 has heart disease but predicted as

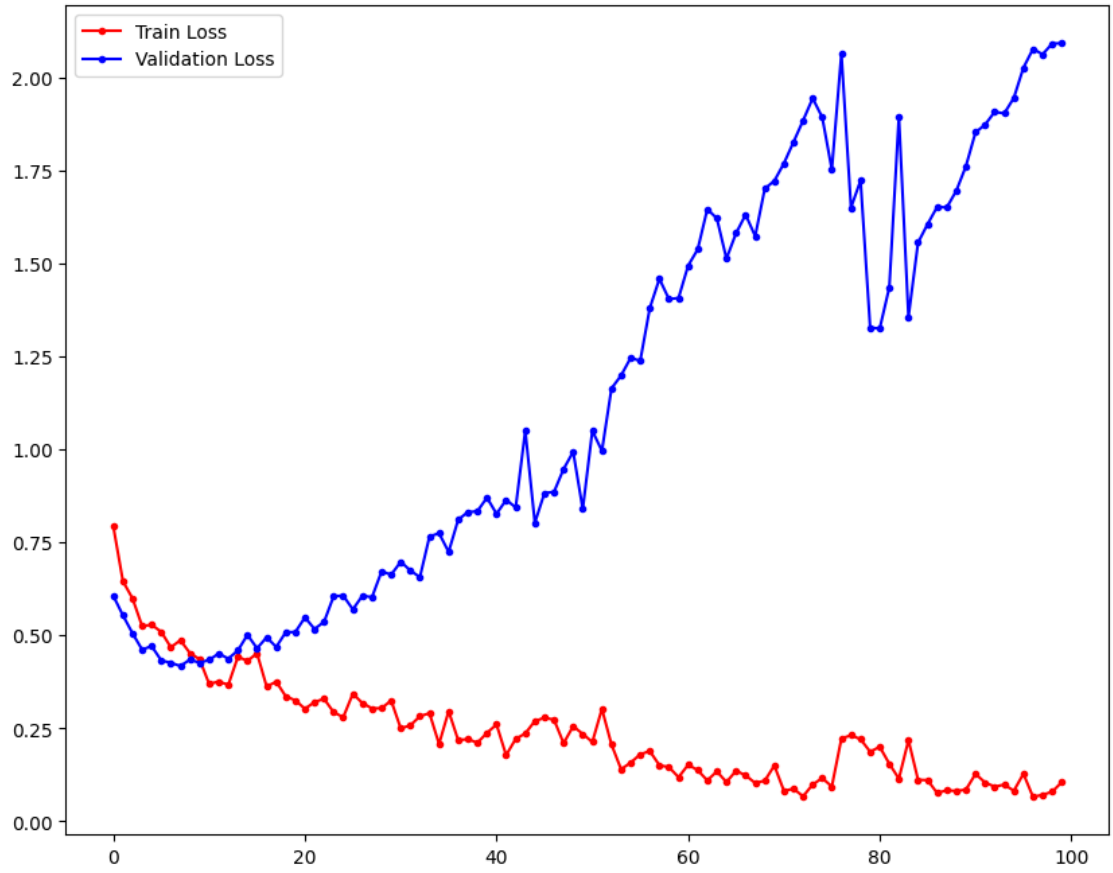
no heart disease. The model's performance need further analysis and adjustment to address this kind of problem.

[ ]:
```
run_hist_2.history.keys()
```

[ ]:
```
dict_keys(['accuracy', 'loss', 'val_accuracy', 'val_loss'])
```

[ ]:
```
fig, ax = plt.subplots(figsize=(10, 8))

ax.plot(run_hist_2.history["loss"], 'r', marker='.', label="Train Loss")
ax.plot(run_hist_2.history["val_loss"], 'b', marker='.', label="Validation␣
 ↪Loss")
ax.legend()
plt.show()
```



1.0.3 Analysis

At the start the training process, the training loss is in the range of 0.75 - 1 and the validation loss is in tha range of 0.5 - 0.75. When the training loss decreases, reaching a minimum of 0.126 at iteration 10. However, the validation loss decreases initially but starts to increase after 5 iterations

which indicate that the model may be overfitting to the training data.