

iction-using-ann-neural-network-1

January 22, 2024

1 #IMPORTING IMPORTANT LIBRARIES

```
[50]: #THIS CHURN PREDICTION IS MOSTLY DONE BY PLAIN PYTHON NOT USED MOST LIBRARIES_
      ↪ TO LABEL ENCODE AND OTHER STUFF.
      #CODE IS ALSO VERY EASY TO UNDERSTAND
```

```
[1]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

```
[2]: data=pd.read_csv('churn.csv')
data.head()
```

```
[2]:      Sex Marital_Status  Term Phone_service International_plan \
0  Female      Married    16          Yes                Yes
1   Male      Married    70          Yes                No
2  Female      Married    36          Yes                No
3  Female      Married    72          Yes                No
4  Female      Married    40          Yes                Yes
```

```
      Voice_mail_plan Multiple_line Internet_service Technical_support \
0              Yes          No          Cable          Yes
1              Yes          No          Cable          Yes
2              Yes          No          Cable          Yes
3              No          Yes          Cable          Yes
4              No          Yes          Cable          No
```

```
      Streaming_Videos  Agreement_period  Monthly_Charges  Total_Charges  Churn
0              No  Monthly contract          98.05          1410.25  Yes
1              Yes  One year contract          75.25          5023.00  No
2              Yes  Monthly contract          73.35          2379.10  No
3              Yes  One year contract         112.60          7882.25  No
4              Yes  Monthly contract          95.05          3646.80  No
```

```
[3]: data.shape
```

```
[3]: (1000, 14)
```

```
[4]: for column in data:
      if data[column].dtype=='object':
          print(f'{column} : {data[column].unique()}')
```

```
Sex : ['Female' 'Male']
Marital_Status : ['Married' 'Single']
Phone_service : ['Yes' 'No']
International_plan : ['Yes' 'No' 'yes']
Voice_mail_plan : ['Yes' 'No']
Multiple_line : ['No' 'Yes' 'No phone ']
Internet_service : ['Cable' 'No Internet' 'DSL' 'Fiber optic']
Technical_support : ['Yes' 'No' 'No internet ']
Streaming_Videos : ['No' 'Yes' 'No internet ']
Agreement_period : ['Monthly contract' 'One year contract' 'Two year contract']
Churn : ['Yes' 'No']
```

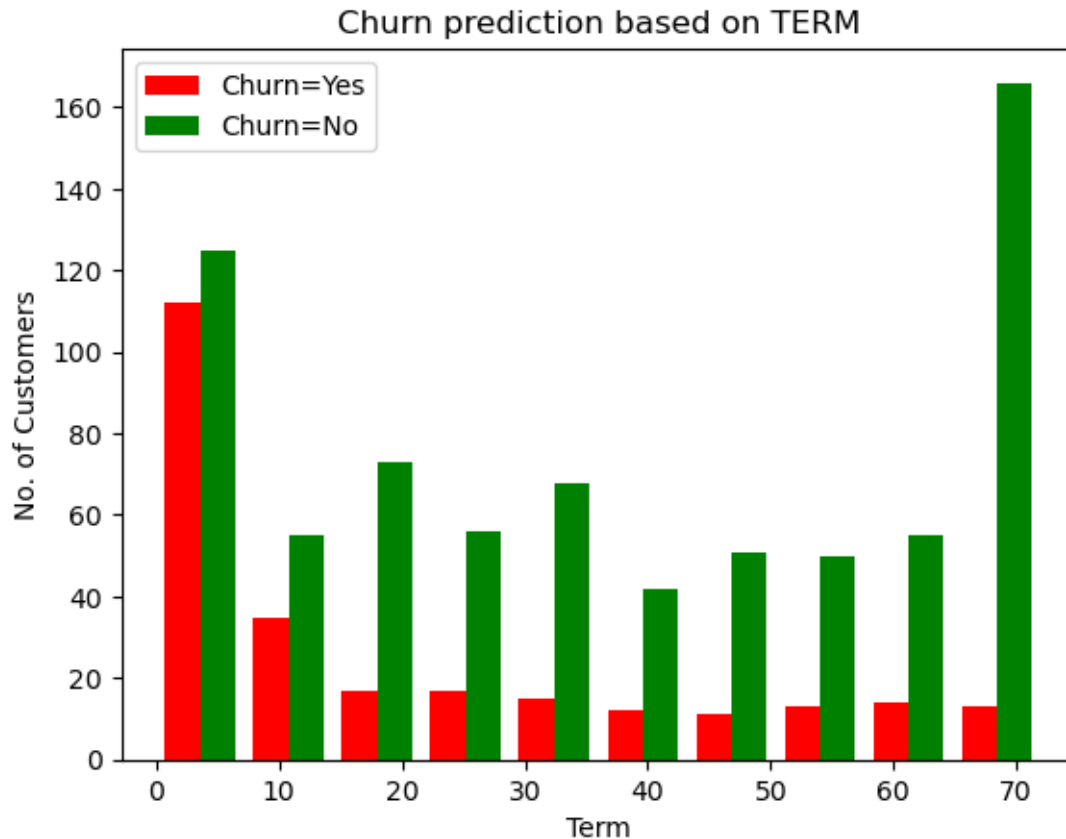
```
[5]: data.Churn.value_counts()
```

```
[5]: No      741
     Yes      259
     Name: Churn, dtype: int64
```

```
[6]: leaving=data[data.Churn=='Yes'].Term
     not_leaving=data[data.Churn=='No'].Term
```

```
[7]: plt.hist([leaving, not_leaving], color=['red','green'],
             ↪label=['Churn=Yes', 'Churn=No'])
     plt.xlabel('Term')
     plt.ylabel('No. of Customers')
     plt.title('Churn prediction based on TERM')
     plt.legend()
```

```
[7]: <matplotlib.legend.Legend at 0x205613f9e10>
```



```
[8]: def unique_columns(column):
      for column in data:
          if data[column].dtype=='object':
              print(f'{column} : {data[column].unique()}')
```

```
[9]: data.replace('No phone ', 'No', inplace=True)
      data.replace('No internet ', 'No', inplace=True)
      data.replace('yes', 'Yes', inplace=True)
```

```
[10]: unique_columns(column)
```

```
Sex : ['Female' 'Male']
Marital_Status : ['Married' 'Single']
Phone_service : ['Yes' 'No']
International_plan : ['Yes' 'No']
Voice_mail_plan : ['Yes' 'No']
Multiple_line : ['No' 'Yes']
Internet_service : ['Cable' 'No Internet' 'DSL' 'Fiber optic']
Technical_support : ['Yes' 'No']
Streaming_Videos : ['No' 'Yes']
```

```
Agreement_period : ['Monthly contract' 'One year contract' 'Two year contract']
Churn : ['Yes' 'No']
```

```
[11]: yes_no_cols=['Phone_service','International_plan','Voice_mail_plan','Multiple_line','Technical_support']
```

```
[12]: for col in yes_no_cols:
      data[col].replace({'Yes':1,'No':0},inplace=True)
```

```
[13]: unique_columns(column)
```

```
Sex : ['Female' 'Male']
Marital_Status : ['Married' 'Single']
Internet_service : ['Cable' 'No Internet' 'DSL' 'Fiber optic']
Agreement_period : ['Monthly contract' 'One year contract' 'Two year contract']
```

```
[14]: data['Sex'].replace({'Female':0,'Male':1},inplace=True)
      data['Marital_Status'].replace({'Married':1,'Single':0},inplace=True)
```

```
[15]: unique_columns(column)
```

```
Internet_service : ['Cable' 'No Internet' 'DSL' 'Fiber optic']
Agreement_period : ['Monthly contract' 'One year contract' 'Two year contract']
```

```
[16]: data=pd.get_dummies(data=data,columns=['Internet_service','Agreement_period'])
```

```
[17]: data.head()
```

```
[17]:
```

	Sex	Marital_Status	Term	Phone_service	International_plan	\
0	0	1	16	1	1	
1	1	1	70	1	0	
2	0	1	36	1	0	
3	0	1	72	1	0	
4	0	1	40	1	1	

	Voice_mail_plan	Multiple_line	Technical_support	Streaming_Videos	\
0	1	0	1	0	
1	1	0	1	1	
2	1	0	1	1	
3	0	1	1	1	
4	0	1	0	1	

	Monthly_Charges	Total_Charges	Churn	Internet_service_Cable	\
0	98.05	1410.25	1	1	
1	75.25	5023.00	0	1	
2	73.35	2379.10	0	1	
3	112.60	7882.25	0	1	
4	95.05	3646.80	0	1	

	Internet_service_DSL	Internet_service_Fiber optic \
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0

	Internet_service_No Internet	Agreement_period_Monthly contract \
0	0	1
1	0	0
2	0	1
3	0	0
4	0	1

	Agreement_period_One year contract	Agreement_period_Two year contract
0	0	0
1	1	0
2	0	0
3	1	0
4	0	0

```
[18]: data.shape
```

```
[18]: (1000, 19)
```

```
[19]: unique_columns(column)
```

```
[20]: data.columns
```

```
[20]: Index(['Sex', 'Marital_Status', 'Term', 'Phone_service', 'International_plan',
        'Voice_mail_plan', 'Multiple_line', 'Technical_support',
        'Streaming_Videos', 'Monthly_Charges', 'Total_Charges', 'Churn',
        'Internet_service_Cable', 'Internet_service_DSL',
        'Internet_service_Fiber optic', 'Internet_service_No Internet',
        'Agreement_period_Monthly contract',
        'Agreement_period_One year contract',
        'Agreement_period_Two year contract'],
        dtype='object')
```

```
[21]: data.dtypes
```

```
[21]: Sex                                int64
      Marital_Status                    int64
      Term                              int64
      Phone_service                     int64
      International_plan                int64
      Voice_mail_plan                   int64
```

```

Multiple_line                int64
Technical_support             int64
Streaming_Videos             int64
Monthly_Charges              float64
Total_Charges                float64
Churn                        int64
Internet_service_Cable       uint8
Internet_service_DSL         uint8
Internet_service_Fiber optic uint8
Internet_service_No Internet uint8
Agreement_period_Monthly contract uint8
Agreement_period_One year contract uint8
Agreement_period_Two year contract uint8
dtype: object

```

```
[22]: data.head()
```

```

[22]:   Sex  Marital_Status  Term  Phone_service  International_plan  \
0     0                1    16                1                  1
1     1                1    70                1                  0
2     0                1    36                1                  0
3     0                1    72                1                  0
4     0                1    40                1                  1

      Voice_mail_plan  Multiple_line  Technical_support  Streaming_Videos  \
0                   1              0                  1                  0
1                   1              0                  1                  1
2                   1              0                  1                  1
3                   0              1                  1                  1
4                   0              1                  0                  1

      Monthly_Charges  Total_Charges  Churn  Internet_service_Cable  \
0                98.05        1410.25     1                  1
1                75.25        5023.00     0                  1
2                73.35        2379.10     0                  1
3               112.60        7882.25     0                  1
4                95.05        3646.80     0                  1

      Internet_service_DSL  Internet_service_Fiber optic  \
0                        0                          0
1                        0                          0
2                        0                          0
3                        0                          0
4                        0                          0

      Internet_service_No Internet  Agreement_period_Monthly contract  \
0                                0                                1

```

1	0	0
2	0	1
3	0	0
4	0	1

	Agreement_period_One year contract	Agreement_period_Two year contract
0	0	0
1	1	0
2	0	0
3	1	0
4	0	0

```
[23]: col_to_scale=['Term','Monthly_Charges','Total_Charges']
```

```
[24]: from sklearn.preprocessing import MinMaxScaler
```

```
[25]: scaler=MinMaxScaler()
```

```
[26]: data[col_to_scale]=scaler.fit_transform(data[col_to_scale])
```

```
[27]: data.head()
```

```
[27]:
```

	Sex	Marital_Status	Term	Phone_service	International_plan	\
0	0	1	0.222222	1	1	
1	1	1	0.972222	1	0	
2	0	1	0.500000	1	0	
3	0	1	1.000000	1	0	
4	0	1	0.555556	1	1	

	Voice_mail_plan	Multiple_line	Technical_support	Streaming_Videos	\
0	1	0	1	0	
1	1	0	1	1	
2	1	0	1	1	
3	0	1	1	1	
4	0	1	0	1	

	Monthly_Charges	Total_Charges	Churn	Internet_service_Cable	\
0	0.812950	0.165880	1	1	
1	0.578623	0.592339	0	1	
2	0.559096	0.280246	0	1	
3	0.962487	0.929853	0	1	
4	0.782117	0.429888	0	1	

	Internet_service_DSL	Internet_service_Fiber optic	\
0	0	0	
1	0	0	
2	0	0	

3	0	0
4	0	0

	Internet_service_No Internet	Agreement_period_Monthly contract \
0	0	1
1	0	0
2	0	1
3	0	0
4	0	1

	Agreement_period_One year contract	Agreement_period_Two year contract
0	0	0
1	1	0
2	0	0
3	1	0
4	0	0

```
[28]: x=data.drop(['Churn'],axis=1)
      y=data[['Churn']]
```

```
[29]: x.shape
```

```
[29]: (1000, 18)
```

```
[30]: y.shape
```

```
[30]: (1000, 1)
```

```
[31]: from sklearn.model_selection import train_test_split
```

```
[32]: x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.
      ↪2,random_state=42)
```

```
[33]: ##By using the KERAS AND TENSORFLOW Model
      import tensorflow as tf
      from tensorflow import keras
```

WARNING:tensorflow:From C:\Users\karti\anaconda3\Lib\site-packages\keras\src\losses.py:2976: The name tf.losses.sparse_softmax_cross_entropy is deprecated. Please use tf.compat.v1.losses.sparse_softmax_cross_entropy instead.

```
[34]: model=keras.Sequential([
      keras.layers.Dense(26,input_shape=(18,),activation='relu'),
      keras.layers.
      ↪Dense(1,activation='sigmoid',bias_initializer='zeros',kernel_initializer='ones')
```



```
] )
```

```
WARNING:tensorflow:From C:\Users\karti\anaconda3\Lib\site-packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.
```

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

```
WARNING:tensorflow:From C:\Users\karti\anaconda3\Lib\site-packages\keras\src\optimizers\__init__.py:309: The name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.
```

```
[36]: model.fit(x_train,y_train,epochs=500)
```

```
Epoch 1/500
```

```
WARNING:tensorflow:From C:\Users\karti\anaconda3\Lib\site-packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.
```

```
WARNING:tensorflow:From C:\Users\karti\anaconda3\Lib\site-packages\keras\src\engine\base_layer_utils.py:384: The name tf.executing_eagerly_outside_functions is deprecated. Please use tf.compat.v1.executing_eagerly_outside_functions instead.
```

```
25/25 [=====] - 1s 2ms/step - loss: 3.1075 - accuracy: 0.2600
```

```
Epoch 2/500
```

```
25/25 [=====] - 0s 3ms/step - loss: 1.8574 - accuracy: 0.2600
```

```
Epoch 3/500
```

```
25/25 [=====] - 0s 2ms/step - loss: 1.2672 - accuracy: 0.2600
```

```
Epoch 4/500
```

```
25/25 [=====] - 0s 2ms/step - loss: 1.0106 - accuracy: 0.2700
```

```
Epoch 5/500
```

```
25/25 [=====] - 0s 3ms/step - loss: 0.8876 - accuracy: 0.2775
```

```
Epoch 6/500
```

```
25/25 [=====] - 0s 3ms/step - loss: 0.8167 - accuracy: 0.3325
```

```
Epoch 7/500
```

```
25/25 [=====] - 0s 2ms/step - loss: 0.7718 - accuracy: 0.3900
```

Epoch 8/500
25/25 [=====] - 0s 2ms/step - loss: 0.7410 - accuracy: 0.4350

Epoch 9/500
25/25 [=====] - 0s 2ms/step - loss: 0.7184 - accuracy: 0.4863

Epoch 10/500
25/25 [=====] - 0s 2ms/step - loss: 0.7016 - accuracy: 0.5562

Epoch 11/500
25/25 [=====] - 0s 2ms/step - loss: 0.6882 - accuracy: 0.6137

Epoch 12/500
25/25 [=====] - 0s 2ms/step - loss: 0.6778 - accuracy: 0.6300

Epoch 13/500
25/25 [=====] - 0s 2ms/step - loss: 0.6695 - accuracy: 0.6513

Epoch 14/500
25/25 [=====] - 0s 2ms/step - loss: 0.6624 - accuracy: 0.6750

Epoch 15/500
25/25 [=====] - 0s 2ms/step - loss: 0.6563 - accuracy: 0.7000

Epoch 16/500
25/25 [=====] - 0s 2ms/step - loss: 0.6513 - accuracy: 0.7113

Epoch 17/500
25/25 [=====] - 0s 3ms/step - loss: 0.6463 - accuracy: 0.7200

Epoch 18/500
25/25 [=====] - 0s 4ms/step - loss: 0.6419 - accuracy: 0.7225

Epoch 19/500
25/25 [=====] - 0s 5ms/step - loss: 0.6379 - accuracy: 0.7262

Epoch 20/500
25/25 [=====] - 0s 4ms/step - loss: 0.6339 - accuracy: 0.7287

Epoch 21/500
25/25 [=====] - 0s 4ms/step - loss: 0.6303 - accuracy: 0.7350

Epoch 22/500
25/25 [=====] - 0s 2ms/step - loss: 0.6267 - accuracy: 0.7437

Epoch 23/500
25/25 [=====] - 0s 2ms/step - loss: 0.6233 - accuracy: 0.7462

Epoch 24/500
25/25 [=====] - 0s 2ms/step - loss: 0.6199 - accuracy: 0.7462

Epoch 25/500
25/25 [=====] - 0s 2ms/step - loss: 0.6166 - accuracy: 0.7500

Epoch 26/500
25/25 [=====] - 0s 2ms/step - loss: 0.6133 - accuracy: 0.7550

Epoch 27/500
25/25 [=====] - 0s 2ms/step - loss: 0.6099 - accuracy: 0.7600

Epoch 28/500
25/25 [=====] - 0s 2ms/step - loss: 0.6067 - accuracy: 0.7650

Epoch 29/500
25/25 [=====] - 0s 2ms/step - loss: 0.6032 - accuracy: 0.7675

Epoch 30/500
25/25 [=====] - 0s 2ms/step - loss: 0.6000 - accuracy: 0.7700

Epoch 31/500
25/25 [=====] - 0s 2ms/step - loss: 0.5967 - accuracy: 0.7713

Epoch 32/500
25/25 [=====] - 0s 2ms/step - loss: 0.5936 - accuracy: 0.7750

Epoch 33/500
25/25 [=====] - 0s 2ms/step - loss: 0.5904 - accuracy: 0.7775

Epoch 34/500
25/25 [=====] - 0s 1ms/step - loss: 0.5876 - accuracy: 0.7725

Epoch 35/500
25/25 [=====] - 0s 2ms/step - loss: 0.5847 - accuracy: 0.7700

Epoch 36/500
25/25 [=====] - 0s 2ms/step - loss: 0.5819 - accuracy: 0.7750

Epoch 37/500
25/25 [=====] - 0s 2ms/step - loss: 0.5790 - accuracy: 0.7812

Epoch 38/500
25/25 [=====] - 0s 2ms/step - loss: 0.5763 - accuracy: 0.7825

Epoch 39/500
25/25 [=====] - 0s 2ms/step - loss: 0.5736 - accuracy: 0.7825

Epoch 40/500
25/25 [=====] - 0s 2ms/step - loss: 0.5709 - accuracy:
0.7825
Epoch 41/500
25/25 [=====] - 0s 2ms/step - loss: 0.5683 - accuracy:
0.7850
Epoch 42/500
25/25 [=====] - 0s 2ms/step - loss: 0.5657 - accuracy:
0.7775
Epoch 43/500
25/25 [=====] - 0s 2ms/step - loss: 0.5631 - accuracy:
0.7775
Epoch 44/500
25/25 [=====] - 0s 2ms/step - loss: 0.5606 - accuracy:
0.7775
Epoch 45/500
25/25 [=====] - 0s 2ms/step - loss: 0.5582 - accuracy:
0.7788
Epoch 46/500
25/25 [=====] - 0s 2ms/step - loss: 0.5559 - accuracy:
0.7775
Epoch 47/500
25/25 [=====] - 0s 2ms/step - loss: 0.5536 - accuracy:
0.7788
Epoch 48/500
25/25 [=====] - 0s 2ms/step - loss: 0.5510 - accuracy:
0.7788
Epoch 49/500
25/25 [=====] - 0s 2ms/step - loss: 0.5486 - accuracy:
0.7788
Epoch 50/500
25/25 [=====] - 0s 2ms/step - loss: 0.5464 - accuracy:
0.7750
Epoch 51/500
25/25 [=====] - 0s 2ms/step - loss: 0.5439 - accuracy:
0.7763
Epoch 52/500
25/25 [=====] - 0s 2ms/step - loss: 0.5416 - accuracy:
0.7788
Epoch 53/500
25/25 [=====] - 0s 1ms/step - loss: 0.5396 - accuracy:
0.7725
Epoch 54/500
25/25 [=====] - 0s 2ms/step - loss: 0.5369 - accuracy:
0.7775
Epoch 55/500
25/25 [=====] - 0s 2ms/step - loss: 0.5346 - accuracy:
0.7750

Epoch 56/500
25/25 [=====] - 0s 1ms/step - loss: 0.5321 - accuracy: 0.7713

Epoch 57/500
25/25 [=====] - 0s 1ms/step - loss: 0.5298 - accuracy: 0.7738

Epoch 58/500
25/25 [=====] - 0s 2ms/step - loss: 0.5276 - accuracy: 0.7700

Epoch 59/500
25/25 [=====] - 0s 1ms/step - loss: 0.5251 - accuracy: 0.7713

Epoch 60/500
25/25 [=====] - 0s 1ms/step - loss: 0.5229 - accuracy: 0.7688

Epoch 61/500
25/25 [=====] - 0s 2ms/step - loss: 0.5207 - accuracy: 0.7663

Epoch 62/500
25/25 [=====] - 0s 2ms/step - loss: 0.5183 - accuracy: 0.7725

Epoch 63/500
25/25 [=====] - 0s 2ms/step - loss: 0.5162 - accuracy: 0.7713

Epoch 64/500
25/25 [=====] - 0s 1ms/step - loss: 0.5139 - accuracy: 0.7713

Epoch 65/500
25/25 [=====] - 0s 2ms/step - loss: 0.5121 - accuracy: 0.7725

Epoch 66/500
25/25 [=====] - 0s 2ms/step - loss: 0.5100 - accuracy: 0.7738

Epoch 67/500
25/25 [=====] - 0s 2ms/step - loss: 0.5077 - accuracy: 0.7750

Epoch 68/500
25/25 [=====] - 0s 2ms/step - loss: 0.5060 - accuracy: 0.7750

Epoch 69/500
25/25 [=====] - 0s 2ms/step - loss: 0.5034 - accuracy: 0.7788

Epoch 70/500
25/25 [=====] - 0s 2ms/step - loss: 0.5017 - accuracy: 0.7738

Epoch 71/500
25/25 [=====] - 0s 2ms/step - loss: 0.4992 - accuracy: 0.7763

Epoch 72/500
25/25 [=====] - 0s 2ms/step - loss: 0.4970 - accuracy: 0.7812

Epoch 73/500
25/25 [=====] - 0s 2ms/step - loss: 0.4954 - accuracy: 0.7763

Epoch 74/500
25/25 [=====] - 0s 2ms/step - loss: 0.4936 - accuracy: 0.7738

Epoch 75/500
25/25 [=====] - 0s 2ms/step - loss: 0.4916 - accuracy: 0.7837

Epoch 76/500
25/25 [=====] - 0s 2ms/step - loss: 0.4893 - accuracy: 0.7800

Epoch 77/500
25/25 [=====] - 0s 2ms/step - loss: 0.4876 - accuracy: 0.7862

Epoch 78/500
25/25 [=====] - 0s 2ms/step - loss: 0.4857 - accuracy: 0.7900

Epoch 79/500
25/25 [=====] - 0s 2ms/step - loss: 0.4836 - accuracy: 0.7900

Epoch 80/500
25/25 [=====] - 0s 2ms/step - loss: 0.4815 - accuracy: 0.7925

Epoch 81/500
25/25 [=====] - 0s 2ms/step - loss: 0.4801 - accuracy: 0.7900

Epoch 82/500
25/25 [=====] - 0s 2ms/step - loss: 0.4782 - accuracy: 0.7950

Epoch 83/500
25/25 [=====] - 0s 2ms/step - loss: 0.4766 - accuracy: 0.7925

Epoch 84/500
25/25 [=====] - 0s 2ms/step - loss: 0.4746 - accuracy: 0.7962

Epoch 85/500
25/25 [=====] - 0s 3ms/step - loss: 0.4730 - accuracy: 0.7937

Epoch 86/500
25/25 [=====] - 0s 2ms/step - loss: 0.4720 - accuracy: 0.7950

Epoch 87/500
25/25 [=====] - 0s 2ms/step - loss: 0.4705 - accuracy: 0.7937

Epoch 88/500
25/25 [=====] - 0s 3ms/step - loss: 0.4690 - accuracy:
0.7975
Epoch 89/500
25/25 [=====] - 0s 3ms/step - loss: 0.4678 - accuracy:
0.7962
Epoch 90/500
25/25 [=====] - 0s 2ms/step - loss: 0.4664 - accuracy:
0.7937
Epoch 91/500
25/25 [=====] - 0s 2ms/step - loss: 0.4644 - accuracy:
0.7987
Epoch 92/500
25/25 [=====] - 0s 2ms/step - loss: 0.4628 - accuracy:
0.8000
Epoch 93/500
25/25 [=====] - 0s 2ms/step - loss: 0.4613 - accuracy:
0.7987
Epoch 94/500
25/25 [=====] - 0s 2ms/step - loss: 0.4610 - accuracy:
0.7925
Epoch 95/500
25/25 [=====] - 0s 2ms/step - loss: 0.4592 - accuracy:
0.7962
Epoch 96/500
25/25 [=====] - 0s 2ms/step - loss: 0.4575 - accuracy:
0.7975
Epoch 97/500
25/25 [=====] - 0s 2ms/step - loss: 0.4564 - accuracy:
0.7975
Epoch 98/500
25/25 [=====] - 0s 2ms/step - loss: 0.4557 - accuracy:
0.7987
Epoch 99/500
25/25 [=====] - 0s 2ms/step - loss: 0.4544 - accuracy:
0.7962
Epoch 100/500
25/25 [=====] - 0s 2ms/step - loss: 0.4532 - accuracy:
0.7987
Epoch 101/500
25/25 [=====] - 0s 2ms/step - loss: 0.4516 - accuracy:
0.7962
Epoch 102/500
25/25 [=====] - 0s 3ms/step - loss: 0.4503 - accuracy:
0.7987
Epoch 103/500
25/25 [=====] - 0s 2ms/step - loss: 0.4493 - accuracy:
0.8000

Epoch 104/500
25/25 [=====] - 0s 2ms/step - loss: 0.4479 - accuracy:
0.8012
Epoch 105/500
25/25 [=====] - 0s 2ms/step - loss: 0.4468 - accuracy:
0.7987
Epoch 106/500
25/25 [=====] - 0s 2ms/step - loss: 0.4458 - accuracy:
0.8025
Epoch 107/500
25/25 [=====] - 0s 2ms/step - loss: 0.4448 - accuracy:
0.8000
Epoch 108/500
25/25 [=====] - 0s 2ms/step - loss: 0.4442 - accuracy:
0.7987
Epoch 109/500
25/25 [=====] - 0s 2ms/step - loss: 0.4425 - accuracy:
0.7950
Epoch 110/500
25/25 [=====] - 0s 2ms/step - loss: 0.4415 - accuracy:
0.8000
Epoch 111/500
25/25 [=====] - 0s 2ms/step - loss: 0.4406 - accuracy:
0.8037
Epoch 112/500
25/25 [=====] - 0s 2ms/step - loss: 0.4399 - accuracy:
0.8000
Epoch 113/500
25/25 [=====] - 0s 2ms/step - loss: 0.4387 - accuracy:
0.8037
Epoch 114/500
25/25 [=====] - 0s 2ms/step - loss: 0.4380 - accuracy:
0.8037
Epoch 115/500
25/25 [=====] - 0s 2ms/step - loss: 0.4370 - accuracy:
0.8012
Epoch 116/500
25/25 [=====] - 0s 2ms/step - loss: 0.4359 - accuracy:
0.8050
Epoch 117/500
25/25 [=====] - 0s 2ms/step - loss: 0.4354 - accuracy:
0.8012
Epoch 118/500
25/25 [=====] - 0s 2ms/step - loss: 0.4343 - accuracy:
0.8025
Epoch 119/500
25/25 [=====] - 0s 2ms/step - loss: 0.4349 - accuracy:
0.8025

Epoch 120/500
25/25 [=====] - 0s 2ms/step - loss: 0.4331 - accuracy:
0.8075
Epoch 121/500
25/25 [=====] - 0s 2ms/step - loss: 0.4332 - accuracy:
0.8037
Epoch 122/500
25/25 [=====] - 0s 2ms/step - loss: 0.4307 - accuracy:
0.8062
Epoch 123/500
25/25 [=====] - 0s 2ms/step - loss: 0.4302 - accuracy:
0.8050
Epoch 124/500
25/25 [=====] - 0s 2ms/step - loss: 0.4296 - accuracy:
0.8050
Epoch 125/500
25/25 [=====] - 0s 2ms/step - loss: 0.4290 - accuracy:
0.8075
Epoch 126/500
25/25 [=====] - 0s 2ms/step - loss: 0.4275 - accuracy:
0.8087
Epoch 127/500
25/25 [=====] - 0s 3ms/step - loss: 0.4269 - accuracy:
0.8025
Epoch 128/500
25/25 [=====] - 0s 2ms/step - loss: 0.4268 - accuracy:
0.8050
Epoch 129/500
25/25 [=====] - 0s 2ms/step - loss: 0.4255 - accuracy:
0.8050
Epoch 130/500
25/25 [=====] - 0s 2ms/step - loss: 0.4256 - accuracy:
0.8012
Epoch 131/500
25/25 [=====] - 0s 2ms/step - loss: 0.4245 - accuracy:
0.8100
Epoch 132/500
25/25 [=====] - 0s 2ms/step - loss: 0.4237 - accuracy:
0.8037
Epoch 133/500
25/25 [=====] - 0s 2ms/step - loss: 0.4229 - accuracy:
0.8062
Epoch 134/500
25/25 [=====] - 0s 2ms/step - loss: 0.4223 - accuracy:
0.8062
Epoch 135/500
25/25 [=====] - 0s 2ms/step - loss: 0.4221 - accuracy:
0.8075

Epoch 136/500
25/25 [=====] - 0s 2ms/step - loss: 0.4213 - accuracy:
0.8012
Epoch 137/500
25/25 [=====] - 0s 2ms/step - loss: 0.4206 - accuracy:
0.8062
Epoch 138/500
25/25 [=====] - 0s 2ms/step - loss: 0.4198 - accuracy:
0.8087
Epoch 139/500
25/25 [=====] - 0s 2ms/step - loss: 0.4191 - accuracy:
0.8000
Epoch 140/500
25/25 [=====] - 0s 2ms/step - loss: 0.4186 - accuracy:
0.8012
Epoch 141/500
25/25 [=====] - 0s 2ms/step - loss: 0.4178 - accuracy:
0.8050
Epoch 142/500
25/25 [=====] - 0s 2ms/step - loss: 0.4179 - accuracy:
0.8050
Epoch 143/500
25/25 [=====] - 0s 2ms/step - loss: 0.4164 - accuracy:
0.8100
Epoch 144/500
25/25 [=====] - 0s 2ms/step - loss: 0.4163 - accuracy:
0.8037
Epoch 145/500
25/25 [=====] - 0s 2ms/step - loss: 0.4163 - accuracy:
0.8012
Epoch 146/500
25/25 [=====] - 0s 2ms/step - loss: 0.4147 - accuracy:
0.8050
Epoch 147/500
25/25 [=====] - 0s 2ms/step - loss: 0.4145 - accuracy:
0.8062
Epoch 148/500
25/25 [=====] - 0s 2ms/step - loss: 0.4139 - accuracy:
0.8100
Epoch 149/500
25/25 [=====] - 0s 2ms/step - loss: 0.4135 - accuracy:
0.8050
Epoch 150/500
25/25 [=====] - 0s 2ms/step - loss: 0.4127 - accuracy:
0.8062
Epoch 151/500
25/25 [=====] - 0s 2ms/step - loss: 0.4122 - accuracy:
0.8037

Epoch 152/500
25/25 [=====] - 0s 2ms/step - loss: 0.4118 - accuracy: 0.8050

Epoch 153/500
25/25 [=====] - 0s 2ms/step - loss: 0.4118 - accuracy: 0.8087

Epoch 154/500
25/25 [=====] - 0s 2ms/step - loss: 0.4108 - accuracy: 0.8087

Epoch 155/500
25/25 [=====] - 0s 2ms/step - loss: 0.4104 - accuracy: 0.8087

Epoch 156/500
25/25 [=====] - 0s 2ms/step - loss: 0.4096 - accuracy: 0.8125

Epoch 157/500
25/25 [=====] - 0s 2ms/step - loss: 0.4091 - accuracy: 0.8062

Epoch 158/500
25/25 [=====] - 0s 2ms/step - loss: 0.4088 - accuracy: 0.8125

Epoch 159/500
25/25 [=====] - 0s 2ms/step - loss: 0.4080 - accuracy: 0.8125

Epoch 160/500
25/25 [=====] - 0s 2ms/step - loss: 0.4077 - accuracy: 0.8150

Epoch 161/500
25/25 [=====] - 0s 2ms/step - loss: 0.4073 - accuracy: 0.8188

Epoch 162/500
25/25 [=====] - 0s 2ms/step - loss: 0.4065 - accuracy: 0.8138

Epoch 163/500
25/25 [=====] - 0s 2ms/step - loss: 0.4061 - accuracy: 0.8125

Epoch 164/500
25/25 [=====] - 0s 2ms/step - loss: 0.4057 - accuracy: 0.8100

Epoch 165/500
25/25 [=====] - 0s 2ms/step - loss: 0.4054 - accuracy: 0.8125

Epoch 166/500
25/25 [=====] - 0s 2ms/step - loss: 0.4049 - accuracy: 0.8125

Epoch 167/500
25/25 [=====] - 0s 2ms/step - loss: 0.4045 - accuracy: 0.8125

Epoch 168/500
25/25 [=====] - 0s 2ms/step - loss: 0.4037 - accuracy: 0.8163

Epoch 169/500
25/25 [=====] - 0s 2ms/step - loss: 0.4029 - accuracy: 0.8188

Epoch 170/500
25/25 [=====] - 0s 2ms/step - loss: 0.4023 - accuracy: 0.8163

Epoch 171/500
25/25 [=====] - 0s 2ms/step - loss: 0.4023 - accuracy: 0.8175

Epoch 172/500
25/25 [=====] - 0s 2ms/step - loss: 0.4028 - accuracy: 0.8125

Epoch 173/500
25/25 [=====] - 0s 2ms/step - loss: 0.4016 - accuracy: 0.8163

Epoch 174/500
25/25 [=====] - 0s 2ms/step - loss: 0.4008 - accuracy: 0.8125

Epoch 175/500
25/25 [=====] - 0s 2ms/step - loss: 0.4004 - accuracy: 0.8175

Epoch 176/500
25/25 [=====] - 0s 2ms/step - loss: 0.4000 - accuracy: 0.8163

Epoch 177/500
25/25 [=====] - 0s 2ms/step - loss: 0.4000 - accuracy: 0.8200

Epoch 178/500
25/25 [=====] - 0s 2ms/step - loss: 0.3998 - accuracy: 0.8163

Epoch 179/500
25/25 [=====] - 0s 2ms/step - loss: 0.3990 - accuracy: 0.8175

Epoch 180/500
25/25 [=====] - 0s 2ms/step - loss: 0.3985 - accuracy: 0.8200

Epoch 181/500
25/25 [=====] - 0s 2ms/step - loss: 0.3983 - accuracy: 0.8175

Epoch 182/500
25/25 [=====] - 0s 2ms/step - loss: 0.3976 - accuracy: 0.8163

Epoch 183/500
25/25 [=====] - 0s 2ms/step - loss: 0.3975 - accuracy: 0.8200

Epoch 184/500
25/25 [=====] - 0s 2ms/step - loss: 0.3971 - accuracy: 0.8175

Epoch 185/500
25/25 [=====] - 0s 2ms/step - loss: 0.3970 - accuracy: 0.8188

Epoch 186/500
25/25 [=====] - 0s 2ms/step - loss: 0.3967 - accuracy: 0.8150

Epoch 187/500
25/25 [=====] - 0s 2ms/step - loss: 0.3962 - accuracy: 0.8200

Epoch 188/500
25/25 [=====] - 0s 2ms/step - loss: 0.3954 - accuracy: 0.8163

Epoch 189/500
25/25 [=====] - 0s 2ms/step - loss: 0.3954 - accuracy: 0.8213

Epoch 190/500
25/25 [=====] - 0s 2ms/step - loss: 0.3948 - accuracy: 0.8213

Epoch 191/500
25/25 [=====] - 0s 2ms/step - loss: 0.3947 - accuracy: 0.8188

Epoch 192/500
25/25 [=====] - 0s 2ms/step - loss: 0.3943 - accuracy: 0.8213

Epoch 193/500
25/25 [=====] - 0s 2ms/step - loss: 0.3938 - accuracy: 0.8188

Epoch 194/500
25/25 [=====] - 0s 2ms/step - loss: 0.3935 - accuracy: 0.8200

Epoch 195/500
25/25 [=====] - 0s 2ms/step - loss: 0.3935 - accuracy: 0.8175

Epoch 196/500
25/25 [=====] - 0s 2ms/step - loss: 0.3935 - accuracy: 0.8200

Epoch 197/500
25/25 [=====] - 0s 2ms/step - loss: 0.3923 - accuracy: 0.8188

Epoch 198/500
25/25 [=====] - 0s 2ms/step - loss: 0.3928 - accuracy: 0.8213

Epoch 199/500
25/25 [=====] - 0s 2ms/step - loss: 0.3917 - accuracy: 0.8213

Epoch 200/500
25/25 [=====] - 0s 2ms/step - loss: 0.3911 - accuracy:
0.8213
Epoch 201/500
25/25 [=====] - 0s 2ms/step - loss: 0.3919 - accuracy:
0.8200
Epoch 202/500
25/25 [=====] - 0s 2ms/step - loss: 0.3915 - accuracy:
0.8238
Epoch 203/500
25/25 [=====] - 0s 2ms/step - loss: 0.3908 - accuracy:
0.8225
Epoch 204/500
25/25 [=====] - 0s 2ms/step - loss: 0.3903 - accuracy:
0.8213
Epoch 205/500
25/25 [=====] - 0s 2ms/step - loss: 0.3897 - accuracy:
0.8213
Epoch 206/500
25/25 [=====] - 0s 2ms/step - loss: 0.3890 - accuracy:
0.8200
Epoch 207/500
25/25 [=====] - 0s 2ms/step - loss: 0.3895 - accuracy:
0.8175
Epoch 208/500
25/25 [=====] - 0s 2ms/step - loss: 0.3891 - accuracy:
0.8200
Epoch 209/500
25/25 [=====] - 0s 2ms/step - loss: 0.3887 - accuracy:
0.8188
Epoch 210/500
25/25 [=====] - 0s 2ms/step - loss: 0.3879 - accuracy:
0.8188
Epoch 211/500
25/25 [=====] - 0s 2ms/step - loss: 0.3876 - accuracy:
0.8188
Epoch 212/500
25/25 [=====] - 0s 2ms/step - loss: 0.3869 - accuracy:
0.8213
Epoch 213/500
25/25 [=====] - 0s 2ms/step - loss: 0.3868 - accuracy:
0.8200
Epoch 214/500
25/25 [=====] - 0s 2ms/step - loss: 0.3855 - accuracy:
0.8225
Epoch 215/500
25/25 [=====] - 0s 2ms/step - loss: 0.3870 - accuracy:
0.8225

Epoch 216/500
25/25 [=====] - 0s 2ms/step - loss: 0.3854 - accuracy:
0.8150
Epoch 217/500
25/25 [=====] - 0s 2ms/step - loss: 0.3847 - accuracy:
0.8225
Epoch 218/500
25/25 [=====] - 0s 2ms/step - loss: 0.3840 - accuracy:
0.8163
Epoch 219/500
25/25 [=====] - 0s 2ms/step - loss: 0.3839 - accuracy:
0.8200
Epoch 220/500
25/25 [=====] - 0s 2ms/step - loss: 0.3839 - accuracy:
0.8225
Epoch 221/500
25/25 [=====] - 0s 2ms/step - loss: 0.3825 - accuracy:
0.8250
Epoch 222/500
25/25 [=====] - 0s 2ms/step - loss: 0.3827 - accuracy:
0.8250
Epoch 223/500
25/25 [=====] - 0s 2ms/step - loss: 0.3825 - accuracy:
0.8138
Epoch 224/500
25/25 [=====] - 0s 2ms/step - loss: 0.3818 - accuracy:
0.8213
Epoch 225/500
25/25 [=====] - 0s 2ms/step - loss: 0.3817 - accuracy:
0.8213
Epoch 226/500
25/25 [=====] - 0s 2ms/step - loss: 0.3811 - accuracy:
0.8238
Epoch 227/500
25/25 [=====] - 0s 2ms/step - loss: 0.3806 - accuracy:
0.8213
Epoch 228/500
25/25 [=====] - 0s 2ms/step - loss: 0.3806 - accuracy:
0.8225
Epoch 229/500
25/25 [=====] - 0s 2ms/step - loss: 0.3800 - accuracy:
0.8200
Epoch 230/500
25/25 [=====] - 0s 2ms/step - loss: 0.3796 - accuracy:
0.8225
Epoch 231/500
25/25 [=====] - 0s 2ms/step - loss: 0.3796 - accuracy:
0.8250

Epoch 232/500
25/25 [=====] - 0s 2ms/step - loss: 0.3790 - accuracy:
0.8213
Epoch 233/500
25/25 [=====] - 0s 2ms/step - loss: 0.3795 - accuracy:
0.8200
Epoch 234/500
25/25 [=====] - 0s 2ms/step - loss: 0.3784 - accuracy:
0.8238
Epoch 235/500
25/25 [=====] - 0s 2ms/step - loss: 0.3785 - accuracy:
0.8238
Epoch 236/500
25/25 [=====] - 0s 2ms/step - loss: 0.3778 - accuracy:
0.8200
Epoch 237/500
25/25 [=====] - 0s 2ms/step - loss: 0.3780 - accuracy:
0.8275
Epoch 238/500
25/25 [=====] - 0s 2ms/step - loss: 0.3769 - accuracy:
0.8250
Epoch 239/500
25/25 [=====] - 0s 3ms/step - loss: 0.3765 - accuracy:
0.8200
Epoch 240/500
25/25 [=====] - 0s 2ms/step - loss: 0.3761 - accuracy:
0.8225
Epoch 241/500
25/25 [=====] - 0s 2ms/step - loss: 0.3762 - accuracy:
0.8238
Epoch 242/500
25/25 [=====] - 0s 2ms/step - loss: 0.3750 - accuracy:
0.8225
Epoch 243/500
25/25 [=====] - 0s 2ms/step - loss: 0.3759 - accuracy:
0.8263
Epoch 244/500
25/25 [=====] - 0s 2ms/step - loss: 0.3742 - accuracy:
0.8263
Epoch 245/500
25/25 [=====] - 0s 2ms/step - loss: 0.3740 - accuracy:
0.8225
Epoch 246/500
25/25 [=====] - 0s 2ms/step - loss: 0.3754 - accuracy:
0.8188
Epoch 247/500
25/25 [=====] - 0s 2ms/step - loss: 0.3748 - accuracy:
0.8263

Epoch 248/500
25/25 [=====] - 0s 2ms/step - loss: 0.3737 - accuracy:
0.8213
Epoch 249/500
25/25 [=====] - 0s 2ms/step - loss: 0.3730 - accuracy:
0.8213
Epoch 250/500
25/25 [=====] - 0s 2ms/step - loss: 0.3728 - accuracy:
0.8263
Epoch 251/500
25/25 [=====] - 0s 2ms/step - loss: 0.3727 - accuracy:
0.8225
Epoch 252/500
25/25 [=====] - 0s 2ms/step - loss: 0.3725 - accuracy:
0.8238
Epoch 253/500
25/25 [=====] - 0s 2ms/step - loss: 0.3731 - accuracy:
0.8150
Epoch 254/500
25/25 [=====] - 0s 2ms/step - loss: 0.3716 - accuracy:
0.8250
Epoch 255/500
25/25 [=====] - 0s 2ms/step - loss: 0.3717 - accuracy:
0.8200
Epoch 256/500
25/25 [=====] - 0s 2ms/step - loss: 0.3718 - accuracy:
0.8288
Epoch 257/500
25/25 [=====] - 0s 2ms/step - loss: 0.3705 - accuracy:
0.8263
Epoch 258/500
25/25 [=====] - 0s 2ms/step - loss: 0.3709 - accuracy:
0.8263
Epoch 259/500
25/25 [=====] - 0s 2ms/step - loss: 0.3700 - accuracy:
0.8275
Epoch 260/500
25/25 [=====] - 0s 2ms/step - loss: 0.3698 - accuracy:
0.8238
Epoch 261/500
25/25 [=====] - 0s 2ms/step - loss: 0.3694 - accuracy:
0.8213
Epoch 262/500
25/25 [=====] - 0s 2ms/step - loss: 0.3698 - accuracy:
0.8275
Epoch 263/500
25/25 [=====] - 0s 2ms/step - loss: 0.3696 - accuracy:
0.8250

Epoch 264/500
25/25 [=====] - 0s 2ms/step - loss: 0.3685 - accuracy:
0.8275
Epoch 265/500
25/25 [=====] - 0s 2ms/step - loss: 0.3695 - accuracy:
0.8225
Epoch 266/500
25/25 [=====] - 0s 2ms/step - loss: 0.3682 - accuracy:
0.8288
Epoch 267/500
25/25 [=====] - 0s 2ms/step - loss: 0.3680 - accuracy:
0.8288
Epoch 268/500
25/25 [=====] - 0s 2ms/step - loss: 0.3684 - accuracy:
0.8225
Epoch 269/500
25/25 [=====] - 0s 2ms/step - loss: 0.3673 - accuracy:
0.8263
Epoch 270/500
25/25 [=====] - 0s 2ms/step - loss: 0.3671 - accuracy:
0.8275
Epoch 271/500
25/25 [=====] - 0s 2ms/step - loss: 0.3685 - accuracy:
0.8188
Epoch 272/500
25/25 [=====] - 0s 2ms/step - loss: 0.3676 - accuracy:
0.8263
Epoch 273/500
25/25 [=====] - 0s 2ms/step - loss: 0.3667 - accuracy:
0.8313
Epoch 274/500
25/25 [=====] - 0s 2ms/step - loss: 0.3656 - accuracy:
0.8275
Epoch 275/500
25/25 [=====] - 0s 2ms/step - loss: 0.3660 - accuracy:
0.8263
Epoch 276/500
25/25 [=====] - 0s 2ms/step - loss: 0.3667 - accuracy:
0.8263
Epoch 277/500
25/25 [=====] - 0s 2ms/step - loss: 0.3656 - accuracy:
0.8225
Epoch 278/500
25/25 [=====] - 0s 2ms/step - loss: 0.3650 - accuracy:
0.8263
Epoch 279/500
25/25 [=====] - 0s 2ms/step - loss: 0.3658 - accuracy:
0.8213

Epoch 280/500
25/25 [=====] - 0s 2ms/step - loss: 0.3644 - accuracy: 0.8275

Epoch 281/500
25/25 [=====] - 0s 2ms/step - loss: 0.3641 - accuracy: 0.8275

Epoch 282/500
25/25 [=====] - 0s 2ms/step - loss: 0.3639 - accuracy: 0.8288

Epoch 283/500
25/25 [=====] - 0s 2ms/step - loss: 0.3640 - accuracy: 0.8325

Epoch 284/500
25/25 [=====] - 0s 2ms/step - loss: 0.3634 - accuracy: 0.8250

Epoch 285/500
25/25 [=====] - 0s 2ms/step - loss: 0.3636 - accuracy: 0.8300

Epoch 286/500
25/25 [=====] - 0s 2ms/step - loss: 0.3631 - accuracy: 0.8325

Epoch 287/500
25/25 [=====] - 0s 2ms/step - loss: 0.3630 - accuracy: 0.8313

Epoch 288/500
25/25 [=====] - 0s 3ms/step - loss: 0.3621 - accuracy: 0.8338

Epoch 289/500
25/25 [=====] - 0s 2ms/step - loss: 0.3625 - accuracy: 0.8325

Epoch 290/500
25/25 [=====] - 0s 2ms/step - loss: 0.3634 - accuracy: 0.8250

Epoch 291/500
25/25 [=====] - 0s 3ms/step - loss: 0.3633 - accuracy: 0.8325

Epoch 292/500
25/25 [=====] - 0s 2ms/step - loss: 0.3626 - accuracy: 0.8300

Epoch 293/500
25/25 [=====] - 0s 2ms/step - loss: 0.3610 - accuracy: 0.8325

Epoch 294/500
25/25 [=====] - 0s 2ms/step - loss: 0.3615 - accuracy: 0.8350

Epoch 295/500
25/25 [=====] - 0s 2ms/step - loss: 0.3603 - accuracy: 0.8325

Epoch 296/500
25/25 [=====] - 0s 3ms/step - loss: 0.3603 - accuracy:
0.8313
Epoch 297/500
25/25 [=====] - 0s 2ms/step - loss: 0.3599 - accuracy:
0.8363
Epoch 298/500
25/25 [=====] - 0s 2ms/step - loss: 0.3598 - accuracy:
0.8313
Epoch 299/500
25/25 [=====] - 0s 2ms/step - loss: 0.3602 - accuracy:
0.8300
Epoch 300/500
25/25 [=====] - 0s 2ms/step - loss: 0.3596 - accuracy:
0.8313
Epoch 301/500
25/25 [=====] - 0s 2ms/step - loss: 0.3593 - accuracy:
0.8338
Epoch 302/500
25/25 [=====] - 0s 2ms/step - loss: 0.3590 - accuracy:
0.8350
Epoch 303/500
25/25 [=====] - 0s 2ms/step - loss: 0.3596 - accuracy:
0.8350
Epoch 304/500
25/25 [=====] - 0s 2ms/step - loss: 0.3600 - accuracy:
0.8263
Epoch 305/500
25/25 [=====] - 0s 2ms/step - loss: 0.3585 - accuracy:
0.8288
Epoch 306/500
25/25 [=====] - 0s 2ms/step - loss: 0.3589 - accuracy:
0.8338
Epoch 307/500
25/25 [=====] - 0s 2ms/step - loss: 0.3582 - accuracy:
0.8350
Epoch 308/500
25/25 [=====] - 0s 2ms/step - loss: 0.3583 - accuracy:
0.8350
Epoch 309/500
25/25 [=====] - 0s 2ms/step - loss: 0.3574 - accuracy:
0.8350
Epoch 310/500
25/25 [=====] - 0s 2ms/step - loss: 0.3575 - accuracy:
0.8363
Epoch 311/500
25/25 [=====] - 0s 2ms/step - loss: 0.3577 - accuracy:
0.8388

Epoch 312/500
25/25 [=====] - 0s 2ms/step - loss: 0.3567 - accuracy:
0.8350
Epoch 313/500
25/25 [=====] - 0s 2ms/step - loss: 0.3573 - accuracy:
0.8363
Epoch 314/500
25/25 [=====] - 0s 2ms/step - loss: 0.3568 - accuracy:
0.8363
Epoch 315/500
25/25 [=====] - 0s 2ms/step - loss: 0.3560 - accuracy:
0.8375
Epoch 316/500
25/25 [=====] - 0s 2ms/step - loss: 0.3570 - accuracy:
0.8375
Epoch 317/500
25/25 [=====] - 0s 2ms/step - loss: 0.3558 - accuracy:
0.8363
Epoch 318/500
25/25 [=====] - 0s 2ms/step - loss: 0.3560 - accuracy:
0.8363
Epoch 319/500
25/25 [=====] - 0s 2ms/step - loss: 0.3557 - accuracy:
0.8350
Epoch 320/500
25/25 [=====] - 0s 2ms/step - loss: 0.3561 - accuracy:
0.8363
Epoch 321/500
25/25 [=====] - 0s 2ms/step - loss: 0.3567 - accuracy:
0.8325
Epoch 322/500
25/25 [=====] - 0s 2ms/step - loss: 0.3556 - accuracy:
0.8375
Epoch 323/500
25/25 [=====] - 0s 2ms/step - loss: 0.3555 - accuracy:
0.8363
Epoch 324/500
25/25 [=====] - 0s 2ms/step - loss: 0.3552 - accuracy:
0.8375
Epoch 325/500
25/25 [=====] - 0s 2ms/step - loss: 0.3545 - accuracy:
0.8363
Epoch 326/500
25/25 [=====] - 0s 2ms/step - loss: 0.3541 - accuracy:
0.8388
Epoch 327/500
25/25 [=====] - 0s 2ms/step - loss: 0.3541 - accuracy:
0.8363

Epoch 328/500
25/25 [=====] - 0s 2ms/step - loss: 0.3537 - accuracy: 0.8363

Epoch 329/500
25/25 [=====] - 0s 2ms/step - loss: 0.3537 - accuracy: 0.8363

Epoch 330/500
25/25 [=====] - 0s 2ms/step - loss: 0.3537 - accuracy: 0.8400

Epoch 331/500
25/25 [=====] - 0s 2ms/step - loss: 0.3533 - accuracy: 0.8363

Epoch 332/500
25/25 [=====] - 0s 2ms/step - loss: 0.3534 - accuracy: 0.8388

Epoch 333/500
25/25 [=====] - 0s 2ms/step - loss: 0.3527 - accuracy: 0.8388

Epoch 334/500
25/25 [=====] - 0s 2ms/step - loss: 0.3535 - accuracy: 0.8375

Epoch 335/500
25/25 [=====] - 0s 2ms/step - loss: 0.3534 - accuracy: 0.8350

Epoch 336/500
25/25 [=====] - 0s 1ms/step - loss: 0.3524 - accuracy: 0.8363

Epoch 337/500
25/25 [=====] - 0s 2ms/step - loss: 0.3522 - accuracy: 0.8363

Epoch 338/500
25/25 [=====] - 0s 2ms/step - loss: 0.3525 - accuracy: 0.8338

Epoch 339/500
25/25 [=====] - 0s 2ms/step - loss: 0.3520 - accuracy: 0.8375

Epoch 340/500
25/25 [=====] - 0s 2ms/step - loss: 0.3522 - accuracy: 0.8375

Epoch 341/500
25/25 [=====] - 0s 1ms/step - loss: 0.3515 - accuracy: 0.8413

Epoch 342/500
25/25 [=====] - 0s 2ms/step - loss: 0.3520 - accuracy: 0.8425

Epoch 343/500
25/25 [=====] - 0s 2ms/step - loss: 0.3521 - accuracy: 0.8363

Epoch 344/500
25/25 [=====] - 0s 2ms/step - loss: 0.3514 - accuracy: 0.8363

Epoch 345/500
25/25 [=====] - 0s 2ms/step - loss: 0.3507 - accuracy: 0.8375

Epoch 346/500
25/25 [=====] - 0s 2ms/step - loss: 0.3504 - accuracy: 0.8363

Epoch 347/500
25/25 [=====] - 0s 2ms/step - loss: 0.3507 - accuracy: 0.8350

Epoch 348/500
25/25 [=====] - 0s 1ms/step - loss: 0.3508 - accuracy: 0.8375

Epoch 349/500
25/25 [=====] - 0s 2ms/step - loss: 0.3499 - accuracy: 0.8400

Epoch 350/500
25/25 [=====] - 0s 2ms/step - loss: 0.3493 - accuracy: 0.8400

Epoch 351/500
25/25 [=====] - 0s 2ms/step - loss: 0.3494 - accuracy: 0.8388

Epoch 352/500
25/25 [=====] - 0s 2ms/step - loss: 0.3499 - accuracy: 0.8363

Epoch 353/500
25/25 [=====] - 0s 2ms/step - loss: 0.3497 - accuracy: 0.8400

Epoch 354/500
25/25 [=====] - 0s 2ms/step - loss: 0.3490 - accuracy: 0.8400

Epoch 355/500
25/25 [=====] - 0s 2ms/step - loss: 0.3491 - accuracy: 0.8388

Epoch 356/500
25/25 [=====] - 0s 2ms/step - loss: 0.3488 - accuracy: 0.8413

Epoch 357/500
25/25 [=====] - 0s 2ms/step - loss: 0.3484 - accuracy: 0.8425

Epoch 358/500
25/25 [=====] - 0s 1ms/step - loss: 0.3484 - accuracy: 0.8400

Epoch 359/500
25/25 [=====] - 0s 2ms/step - loss: 0.3489 - accuracy: 0.8400

Epoch 360/500
25/25 [=====] - 0s 2ms/step - loss: 0.3482 - accuracy: 0.8400

Epoch 361/500
25/25 [=====] - 0s 2ms/step - loss: 0.3479 - accuracy: 0.8388

Epoch 362/500
25/25 [=====] - 0s 2ms/step - loss: 0.3479 - accuracy: 0.8388

Epoch 363/500
25/25 [=====] - 0s 2ms/step - loss: 0.3468 - accuracy: 0.8388

Epoch 364/500
25/25 [=====] - 0s 2ms/step - loss: 0.3469 - accuracy: 0.8425

Epoch 365/500
25/25 [=====] - 0s 2ms/step - loss: 0.3473 - accuracy: 0.8425

Epoch 366/500
25/25 [=====] - 0s 2ms/step - loss: 0.3462 - accuracy: 0.8413

Epoch 367/500
25/25 [=====] - 0s 2ms/step - loss: 0.3468 - accuracy: 0.8400

Epoch 368/500
25/25 [=====] - 0s 2ms/step - loss: 0.3460 - accuracy: 0.8487

Epoch 369/500
25/25 [=====] - 0s 2ms/step - loss: 0.3467 - accuracy: 0.8425

Epoch 370/500
25/25 [=====] - 0s 2ms/step - loss: 0.3460 - accuracy: 0.8462

Epoch 371/500
25/25 [=====] - 0s 1ms/step - loss: 0.3452 - accuracy: 0.8450

Epoch 372/500
25/25 [=====] - 0s 2ms/step - loss: 0.3462 - accuracy: 0.8413

Epoch 373/500
25/25 [=====] - 0s 2ms/step - loss: 0.3447 - accuracy: 0.8450

Epoch 374/500
25/25 [=====] - 0s 1ms/step - loss: 0.3449 - accuracy: 0.8425

Epoch 375/500
25/25 [=====] - 0s 1ms/step - loss: 0.3452 - accuracy: 0.8425

Epoch 376/500
25/25 [=====] - 0s 1ms/step - loss: 0.3446 - accuracy:
0.8438
Epoch 377/500
25/25 [=====] - 0s 2ms/step - loss: 0.3445 - accuracy:
0.8475
Epoch 378/500
25/25 [=====] - 0s 2ms/step - loss: 0.3443 - accuracy:
0.8450
Epoch 379/500
25/25 [=====] - 0s 2ms/step - loss: 0.3442 - accuracy:
0.8400
Epoch 380/500
25/25 [=====] - 0s 2ms/step - loss: 0.3440 - accuracy:
0.8425
Epoch 381/500
25/25 [=====] - 0s 2ms/step - loss: 0.3450 - accuracy:
0.8425
Epoch 382/500
25/25 [=====] - 0s 2ms/step - loss: 0.3450 - accuracy:
0.8475
Epoch 383/500
25/25 [=====] - 0s 2ms/step - loss: 0.3435 - accuracy:
0.8450
Epoch 384/500
25/25 [=====] - 0s 2ms/step - loss: 0.3436 - accuracy:
0.8450
Epoch 385/500
25/25 [=====] - 0s 2ms/step - loss: 0.3433 - accuracy:
0.8413
Epoch 386/500
25/25 [=====] - 0s 2ms/step - loss: 0.3432 - accuracy:
0.8475
Epoch 387/500
25/25 [=====] - 0s 2ms/step - loss: 0.3428 - accuracy:
0.8425
Epoch 388/500
25/25 [=====] - 0s 2ms/step - loss: 0.3426 - accuracy:
0.8438
Epoch 389/500
25/25 [=====] - 0s 2ms/step - loss: 0.3424 - accuracy:
0.8462
Epoch 390/500
25/25 [=====] - 0s 2ms/step - loss: 0.3425 - accuracy:
0.8512
Epoch 391/500
25/25 [=====] - 0s 2ms/step - loss: 0.3423 - accuracy:
0.8450

Epoch 392/500
25/25 [=====] - 0s 2ms/step - loss: 0.3428 - accuracy:
0.8462
Epoch 393/500
25/25 [=====] - 0s 2ms/step - loss: 0.3424 - accuracy:
0.8500
Epoch 394/500
25/25 [=====] - 0s 1ms/step - loss: 0.3424 - accuracy:
0.8450
Epoch 395/500
25/25 [=====] - 0s 2ms/step - loss: 0.3438 - accuracy:
0.8487
Epoch 396/500
25/25 [=====] - 0s 2ms/step - loss: 0.3415 - accuracy:
0.8487
Epoch 397/500
25/25 [=====] - 0s 1ms/step - loss: 0.3419 - accuracy:
0.8475
Epoch 398/500
25/25 [=====] - 0s 2ms/step - loss: 0.3416 - accuracy:
0.8450
Epoch 399/500
25/25 [=====] - 0s 2ms/step - loss: 0.3414 - accuracy:
0.8512
Epoch 400/500
25/25 [=====] - 0s 2ms/step - loss: 0.3412 - accuracy:
0.8500
Epoch 401/500
25/25 [=====] - 0s 2ms/step - loss: 0.3407 - accuracy:
0.8462
Epoch 402/500
25/25 [=====] - 0s 2ms/step - loss: 0.3405 - accuracy:
0.8512
Epoch 403/500
25/25 [=====] - 0s 2ms/step - loss: 0.3407 - accuracy:
0.8500
Epoch 404/500
25/25 [=====] - 0s 2ms/step - loss: 0.3401 - accuracy:
0.8512
Epoch 405/500
25/25 [=====] - 0s 1ms/step - loss: 0.3403 - accuracy:
0.8500
Epoch 406/500
25/25 [=====] - 0s 2ms/step - loss: 0.3404 - accuracy:
0.8475
Epoch 407/500
25/25 [=====] - 0s 2ms/step - loss: 0.3416 - accuracy:
0.8462

Epoch 408/500
25/25 [=====] - 0s 2ms/step - loss: 0.3405 - accuracy: 0.8462

Epoch 409/500
25/25 [=====] - 0s 2ms/step - loss: 0.3399 - accuracy: 0.8525

Epoch 410/500
25/25 [=====] - 0s 2ms/step - loss: 0.3396 - accuracy: 0.8500

Epoch 411/500
25/25 [=====] - 0s 2ms/step - loss: 0.3391 - accuracy: 0.8512

Epoch 412/500
25/25 [=====] - 0s 2ms/step - loss: 0.3402 - accuracy: 0.8537

Epoch 413/500
25/25 [=====] - 0s 2ms/step - loss: 0.3401 - accuracy: 0.8450

Epoch 414/500
25/25 [=====] - 0s 2ms/step - loss: 0.3390 - accuracy: 0.8487

Epoch 415/500
25/25 [=====] - 0s 2ms/step - loss: 0.3390 - accuracy: 0.8512

Epoch 416/500
25/25 [=====] - 0s 2ms/step - loss: 0.3391 - accuracy: 0.8500

Epoch 417/500
25/25 [=====] - 0s 2ms/step - loss: 0.3397 - accuracy: 0.8525

Epoch 418/500
25/25 [=====] - 0s 2ms/step - loss: 0.3386 - accuracy: 0.8462

Epoch 419/500
25/25 [=====] - 0s 2ms/step - loss: 0.3381 - accuracy: 0.8512

Epoch 420/500
25/25 [=====] - 0s 2ms/step - loss: 0.3384 - accuracy: 0.8550

Epoch 421/500
25/25 [=====] - 0s 2ms/step - loss: 0.3389 - accuracy: 0.8475

Epoch 422/500
25/25 [=====] - 0s 2ms/step - loss: 0.3379 - accuracy: 0.8487

Epoch 423/500
25/25 [=====] - 0s 2ms/step - loss: 0.3373 - accuracy: 0.8487

Epoch 424/500
25/25 [=====] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8525

Epoch 425/500
25/25 [=====] - 0s 2ms/step - loss: 0.3388 - accuracy: 0.8512

Epoch 426/500
25/25 [=====] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8525

Epoch 427/500
25/25 [=====] - 0s 2ms/step - loss: 0.3368 - accuracy: 0.8525

Epoch 428/500
25/25 [=====] - 0s 2ms/step - loss: 0.3367 - accuracy: 0.8525

Epoch 429/500
25/25 [=====] - 0s 2ms/step - loss: 0.3368 - accuracy: 0.8512

Epoch 430/500
25/25 [=====] - 0s 2ms/step - loss: 0.3367 - accuracy: 0.8537

Epoch 431/500
25/25 [=====] - 0s 2ms/step - loss: 0.3368 - accuracy: 0.8487

Epoch 432/500
25/25 [=====] - 0s 2ms/step - loss: 0.3363 - accuracy: 0.8537

Epoch 433/500
25/25 [=====] - 0s 3ms/step - loss: 0.3369 - accuracy: 0.8525

Epoch 434/500
25/25 [=====] - 0s 2ms/step - loss: 0.3372 - accuracy: 0.8525

Epoch 435/500
25/25 [=====] - 0s 2ms/step - loss: 0.3366 - accuracy: 0.8487

Epoch 436/500
25/25 [=====] - 0s 2ms/step - loss: 0.3361 - accuracy: 0.8525

Epoch 437/500
25/25 [=====] - 0s 2ms/step - loss: 0.3361 - accuracy: 0.8550

Epoch 438/500
25/25 [=====] - 0s 2ms/step - loss: 0.3358 - accuracy: 0.8500

Epoch 439/500
25/25 [=====] - 0s 2ms/step - loss: 0.3356 - accuracy: 0.8525

Epoch 440/500
25/25 [=====] - 0s 2ms/step - loss: 0.3355 - accuracy: 0.8487

Epoch 441/500
25/25 [=====] - 0s 2ms/step - loss: 0.3352 - accuracy: 0.8487

Epoch 442/500
25/25 [=====] - 0s 2ms/step - loss: 0.3348 - accuracy: 0.8550

Epoch 443/500
25/25 [=====] - 0s 2ms/step - loss: 0.3357 - accuracy: 0.8537

Epoch 444/500
25/25 [=====] - 0s 1ms/step - loss: 0.3351 - accuracy: 0.8512

Epoch 445/500
25/25 [=====] - 0s 2ms/step - loss: 0.3349 - accuracy: 0.8500

Epoch 446/500
25/25 [=====] - 0s 1ms/step - loss: 0.3342 - accuracy: 0.8512

Epoch 447/500
25/25 [=====] - 0s 2ms/step - loss: 0.3353 - accuracy: 0.8512

Epoch 448/500
25/25 [=====] - 0s 2ms/step - loss: 0.3343 - accuracy: 0.8512

Epoch 449/500
25/25 [=====] - 0s 2ms/step - loss: 0.3349 - accuracy: 0.8537

Epoch 450/500
25/25 [=====] - 0s 2ms/step - loss: 0.3343 - accuracy: 0.8512

Epoch 451/500
25/25 [=====] - 0s 2ms/step - loss: 0.3334 - accuracy: 0.8512

Epoch 452/500
25/25 [=====] - 0s 1ms/step - loss: 0.3335 - accuracy: 0.8525

Epoch 453/500
25/25 [=====] - 0s 2ms/step - loss: 0.3338 - accuracy: 0.8500

Epoch 454/500
25/25 [=====] - 0s 2ms/step - loss: 0.3333 - accuracy: 0.8525

Epoch 455/500
25/25 [=====] - 0s 2ms/step - loss: 0.3333 - accuracy: 0.8512

Epoch 456/500
25/25 [=====] - 0s 2ms/step - loss: 0.3329 - accuracy: 0.8500

Epoch 457/500
25/25 [=====] - 0s 2ms/step - loss: 0.3324 - accuracy: 0.8487

Epoch 458/500
25/25 [=====] - 0s 2ms/step - loss: 0.3327 - accuracy: 0.8512

Epoch 459/500
25/25 [=====] - 0s 1ms/step - loss: 0.3328 - accuracy: 0.8537

Epoch 460/500
25/25 [=====] - 0s 2ms/step - loss: 0.3330 - accuracy: 0.8537

Epoch 461/500
25/25 [=====] - 0s 2ms/step - loss: 0.3325 - accuracy: 0.8525

Epoch 462/500
25/25 [=====] - 0s 2ms/step - loss: 0.3326 - accuracy: 0.8537

Epoch 463/500
25/25 [=====] - 0s 2ms/step - loss: 0.3324 - accuracy: 0.8525

Epoch 464/500
25/25 [=====] - 0s 2ms/step - loss: 0.3325 - accuracy: 0.8537

Epoch 465/500
25/25 [=====] - 0s 2ms/step - loss: 0.3324 - accuracy: 0.8525

Epoch 466/500
25/25 [=====] - 0s 2ms/step - loss: 0.3315 - accuracy: 0.8537

Epoch 467/500
25/25 [=====] - 0s 2ms/step - loss: 0.3322 - accuracy: 0.8550

Epoch 468/500
25/25 [=====] - 0s 2ms/step - loss: 0.3320 - accuracy: 0.8550

Epoch 469/500
25/25 [=====] - 0s 2ms/step - loss: 0.3314 - accuracy: 0.8575

Epoch 470/500
25/25 [=====] - 0s 2ms/step - loss: 0.3313 - accuracy: 0.8512

Epoch 471/500
25/25 [=====] - 0s 2ms/step - loss: 0.3320 - accuracy: 0.8562

Epoch 472/500
25/25 [=====] - 0s 2ms/step - loss: 0.3316 - accuracy: 0.8537

Epoch 473/500
25/25 [=====] - 0s 2ms/step - loss: 0.3311 - accuracy: 0.8575

Epoch 474/500
25/25 [=====] - 0s 2ms/step - loss: 0.3311 - accuracy: 0.8525

Epoch 475/500
25/25 [=====] - 0s 2ms/step - loss: 0.3311 - accuracy: 0.8512

Epoch 476/500
25/25 [=====] - 0s 2ms/step - loss: 0.3307 - accuracy: 0.8550

Epoch 477/500
25/25 [=====] - 0s 2ms/step - loss: 0.3313 - accuracy: 0.8587

Epoch 478/500
25/25 [=====] - 0s 2ms/step - loss: 0.3303 - accuracy: 0.8587

Epoch 479/500
25/25 [=====] - 0s 2ms/step - loss: 0.3305 - accuracy: 0.8575

Epoch 480/500
25/25 [=====] - 0s 2ms/step - loss: 0.3312 - accuracy: 0.8550

Epoch 481/500
25/25 [=====] - 0s 2ms/step - loss: 0.3300 - accuracy: 0.8600

Epoch 482/500
25/25 [=====] - 0s 2ms/step - loss: 0.3301 - accuracy: 0.8587

Epoch 483/500
25/25 [=====] - 0s 2ms/step - loss: 0.3300 - accuracy: 0.8587

Epoch 484/500
25/25 [=====] - 0s 2ms/step - loss: 0.3294 - accuracy: 0.8575

Epoch 485/500
25/25 [=====] - 0s 2ms/step - loss: 0.3298 - accuracy: 0.8575

Epoch 486/500
25/25 [=====] - 0s 2ms/step - loss: 0.3292 - accuracy: 0.8575

Epoch 487/500
25/25 [=====] - 0s 2ms/step - loss: 0.3303 - accuracy: 0.8562

```

Epoch 488/500
25/25 [=====] - 0s 2ms/step - loss: 0.3293 - accuracy:
0.8600
Epoch 489/500
25/25 [=====] - 0s 1ms/step - loss: 0.3288 - accuracy:
0.8587
Epoch 490/500
25/25 [=====] - 0s 2ms/step - loss: 0.3292 - accuracy:
0.8562
Epoch 491/500
25/25 [=====] - 0s 2ms/step - loss: 0.3290 - accuracy:
0.8550
Epoch 492/500
25/25 [=====] - 0s 2ms/step - loss: 0.3287 - accuracy:
0.8600
Epoch 493/500
25/25 [=====] - 0s 2ms/step - loss: 0.3292 - accuracy:
0.8600
Epoch 494/500
25/25 [=====] - 0s 2ms/step - loss: 0.3293 - accuracy:
0.8587
Epoch 495/500
25/25 [=====] - 0s 2ms/step - loss: 0.3282 - accuracy:
0.8637
Epoch 496/500
25/25 [=====] - 0s 2ms/step - loss: 0.3283 - accuracy:
0.8587
Epoch 497/500
25/25 [=====] - 0s 2ms/step - loss: 0.3281 - accuracy:
0.8587
Epoch 498/500
25/25 [=====] - 0s 2ms/step - loss: 0.3284 - accuracy:
0.8612
Epoch 499/500
25/25 [=====] - 0s 2ms/step - loss: 0.3294 - accuracy:
0.8562
Epoch 500/500
25/25 [=====] - 0s 2ms/step - loss: 0.3285 - accuracy:
0.8575

```

[36]: <keras.src.callbacks.History at 0x2055e893990>

[37]: `model.evaluate(x_test,y_test)`

```

7/7 [=====] - 0s 3ms/step - loss: 0.4418 - accuracy:
0.7950

```

[37]: [0.4418371915817261, 0.7950000166893005]


```
[38]: y_test.tail(10)
```

```
[38]:      Churn
948      1
829      0
656      0
199      1
213      0
408      0
332      1
208      0
613      1
78       1
```

```
[39]: y_pred=model.predict(x_test)
```

```
7/7 [=====] - 0s 2ms/step
```

```
[40]: y_pred[:5]
```

```
[40]: array([[0.05995844],
          [0.03129396],
          [0.96678823],
          [0.03129396],
          [0.44097596]], dtype=float32)
```

```
[41]: y_prediction = []
      for element in y_pred:
          if element > 0.5:
              y_prediction.append(1)
          else:
              y_prediction.append(0)
```

```
[42]: model.predict([[0,1,0.222222,1,1,1,0,1,0,0.812950,0.165880,1,0,0,0,1,0,0]])
```

```
1/1 [=====] - 0s 69ms/step
```

```
[42]: array([[0.53606355]], dtype=float32)
```

```
[45]: #compare y_test and y_pred value to see whether the values is correct or not
      y_prediction[:10]
```

```
[45]: [0, 0, 1, 0, 0, 0, 0, 0, 0, 0]
```

```
[46]: y_test[:10]
```

```
[46]:      Churn
      521      0
      737      0
      740      1
      660      0
      411      0
      678      1
      626      0
      513      0
      859      0
      136      0
```

```
[48]: residuals=y_pred-y_test
```

```
[49]: residuals
```

```
[49]:      Churn
      521  0.059958
      737  0.031294
      740 -0.033212
      660  0.031294
      411  0.440976
      ..      ...
      408  0.043860
      332 -0.652077
      208  0.127946
      613 -0.185992
      78  -0.045756
```

```
[200 rows x 1 columns]
```

```
[ ]:
```