

# Portafolio2\_A00829837

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## 0.1 1. Declaración de Librerías

```
[ ]: from sklearn import model_selection
from sklearn.model_selection import train_test_split
import pandas as pd
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Input, Dense, BatchNormalization, Dropout
from tensorflow.keras import regularizers
import matplotlib.pyplot as plt
```

## 0.2 2. Carga del Dataset

En esta sección se realiza la carga y separación del dataset en conjuntos de entrenamiento y prueba en una proporción 90% a 10%, utilizando la función *train\_test\_split* de la librería *sklearn*. Además, se reserva un 15% del conjunto de entrenamiento como validación durante el proceso de ajuste del modelo.

El dataset contiene un total de 768 instancias caracterizadas por ocho features: Pregnancies, Glucose, Blood Pressure, Skin Thickness, Insulin, BMI, Diabetes Pedigree Function (DPF) y Age. El label está definido por la columna Outcome, la cual toma un valor de 1 si el paciente padece diabetes y 0 si no la padece. No se implementaron técnicas de limpieza ni llenado de datos, ya que el dataset no contiene datos nulos ni presenta problemas relacionados con tipos de datos que incluyan caracteres. Todos los valores del dataset ya están en un formato adecuado para el análisis, lo que permite trabajar directamente con los datos sin necesidad de realizar ajustes previos. De la misma forma, no fue necesario utilizar la técnica de One Hot Encoding, dado que el dataset no contiene variables categóricas. Sin embargo, en el caso de que el target hubiera estado compuesto por valores como “Yes” o “No”, se habría empleado esta técnica para convertir dichos datos en variables binarias, representadas por 0 y 1.

```
[ ]: # 1. Cargar el Dataset
dataOccupancy = pd.read_csv("/Users/axelamoshernandezcardenas/Desktop/IAClase/
↳Portafolio2/diabetes.csv")
print(f'El dataset cuenta con : {len(dataOccupancy)} instancias.')

# 2. Se separa las features del label
X = dataOccupancy[[f for f in dataOccupancy.columns if f != 'Outcome']]
y = dataOccupancy['Outcome']
#print(X, y)
```

```
# 3. Split de train y test set. test_size = 0.1 --> 10% de los datos
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
↳random_state=42)
```

```
# 4. Shapes de los sets resultantes
print(X, y)
print("Columnas de X_train:", X_train.columns)
print("Shape de X_train:", X_train.shape)
print("Shape de y_train:", y_train.shape)
print("Shape de x_test:", X_test.shape)
print("Shape de y_test:", y_test.shape)
```

El dataset cuenta con : 768 instancias.

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI \
0	6	148	72	35	0	33.6
1	1	85	66	29	0	26.6
2	8	183	64	0	0	23.3
3	1	89	66	23	94	28.1
4	0	137	40	35	168	43.1
..	...	...	...	...	...	...
763	10	101	76	48	180	32.9
764	2	122	70	27	0	36.8
765	5	121	72	23	112	26.2
766	1	126	60	0	0	30.1
767	1	93	70	31	0	30.4

	DiabetesPedigreeFunction	Age
0	0.627	50
1	0.351	31
2	0.672	32
3	0.167	21
4	2.288	33
..	...	...
763	0.171	63
764	0.340	27
765	0.245	30
766	0.349	47
767	0.315	23

```
[768 rows x 8 columns] 0      1
1      0
2      1
3      0
4      1
..
763    0
764    0
```

```

765     0
766     1
767     0
Name: Outcome, Length: 768, dtype: int64
Columnas de X_train: Index(['Pregnancies', 'Glucose', 'BloodPressure',
'SkinThickness', 'Insulin',
'BMI', 'DiabetesPedigreeFunction', 'Age'],
dtype='object')
Shape de X_train: (537, 8)
Shape de y_train: (537,)
Shape de x_test: (231, 8)
Shape de y_test: (231,)

```

### 0.2.1 2.1 Código para Realizar Gráficos de:

- Loss vs Epoch
- Accuracy vs Epoch

```

[ ]: # Función para generar gráficos con Matplotlib
def plot_acc_loss(training_history):
    plt.plot(training_history.history['accuracy'])
    plt.plot(training_history.history['val_accuracy'])
    plt.title('Accuracy vs. Epochs')
    plt.ylabel('Accuracy')
    plt.xlabel('Epoch')
    plt.legend(['Training', 'Validation'], loc='lower right')
    plt.show()
    plt.plot(training_history.history['loss'])
    plt.plot(training_history.history['val_loss'])
    plt.title('Loss vs. Epochs')
    plt.ylabel('Loss')
    plt.xlabel('Epoch')
    plt.legend(['Training', 'Validation'], loc='upper right')
    plt.show()

```

## 0.3 3. Perceptrón

En esta sección se construye un perceptrón utilizando la librería *tensorflow.keras*. Este modelo consta de una sola capa densa con una neurona de salida y activación *sigmoid* para la clasificación binaria.

```

[ ]: # Función para crear un perceptrón con Tensorflow.keras
def set_nn_model_architecture_perceptron(X_train):

    # 1. Definición del tipo de red (secuencial)
    model = Sequential(name='Perceptron')

```

```

    # 2. Se define la capa de entrada/salida que consta de una sólo neurona con
    ↪función de activación sigmoid,
    # vector de biases de '1' y pesos iniciales dada una distribución uniforme
    ↪escalada basada en el número de
    # neuronas, en este caso, una.
    model.add(Dense(units=1, input_shape=(X_train.shape[1],),
    ↪activation='sigmoid',
                                kernel_initializer = tf.keras.initializers.
    ↪HeUniform(seed=0),
                                bias_initializer='ones', name='outputlayer'))

    model.summary()
    return model

# 3. Creación del perceptrón
perceptron = set_nn_model_architecture_perceptron(X_train)

# 4. Definición del optimizador y learning rate
adam = tf.keras.optimizers.Adam(learning_rate=0.001)

# 5. Establecer binary_crossentropy por el dataset binario y la métrica de
    ↪accuracy
perceptron.compile(optimizer=adam, loss='binary_crossentropy',
    ↪metrics=['accuracy'])

# 6. Entrenar el perceptrón
training_perceptron = perceptron.fit(X_train, y_train, epochs=300,
    ↪validation_split=0.15, batch_size=128)

# 7. Se grafica el desempeño de Accuracy vs Epoch y Loss vs Epoch
plot_acc_loss(training_perceptron)

```

```

/Users/axelamoshernandezcardenas/Desktop/IAClase/myenv/lib/python3.12/site-
packages/keras/src/layers/core/dense.py:87: 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: "Perceptron"

Layer (type)	Output Shape	Param #
outputlayer (Dense)	(None, 1)	9

Total params: 9 (36.00 B)

Trainable params: 9 (36.00 B)

Non-trainable params: 0 (0.00 B)

Epoch 1/300

4/4 0s 19ms/step -  
accuracy: 0.3649 - loss: 45.6680 - val\_accuracy: 0.3457 - val\_loss: 51.1984

Epoch 2/300

4/4 0s 3ms/step -  
accuracy: 0.3414 - loss: 46.0088 - val\_accuracy: 0.3457 - val\_loss: 50.4273

Epoch 3/300

4/4 0s 3ms/step -  
accuracy: 0.3426 - loss: 44.5008 - val\_accuracy: 0.3457 - val\_loss: 49.6606

Epoch 4/300

4/4 0s 3ms/step -  
accuracy: 0.3363 - loss: 45.3233 - val\_accuracy: 0.3457 - val\_loss: 48.8934

Epoch 5/300

4/4 0s 3ms/step -  
accuracy: 0.3369 - loss: 43.5979 - val\_accuracy: 0.3457 - val\_loss: 48.1328

Epoch 6/300

4/4 0s 3ms/step -  
accuracy: 0.3443 - loss: 42.2550 - val\_accuracy: 0.3457 - val\_loss: 47.3742

Epoch 7/300

4/4 0s 3ms/step -  
accuracy: 0.3565 - loss: 41.0498 - val\_accuracy: 0.3457 - val\_loss: 46.6159

Epoch 8/300

4/4 0s 3ms/step -  
accuracy: 0.3368 - loss: 41.3236 - val\_accuracy: 0.3457 - val\_loss: 45.8543

Epoch 9/300

4/4 0s 3ms/step -  
accuracy: 0.3441 - loss: 40.5431 - val\_accuracy: 0.3457 - val\_loss: 45.0975

Epoch 10/300

4/4 0s 3ms/step -  
accuracy: 0.3342 - loss: 39.9446 - val\_accuracy: 0.3457 - val\_loss: 44.3400

Epoch 11/300

4/4 0s 3ms/step -  
accuracy: 0.3320 - loss: 40.3520 - val\_accuracy: 0.3457 - val\_loss: 43.5857

Epoch 12/300

4/4 0s 3ms/step -  
accuracy: 0.3511 - loss: 37.2141 - val\_accuracy: 0.3457 - val\_loss: 42.8313

Epoch 13/300

4/4 0s 3ms/step -  
accuracy: 0.3569 - loss: 37.1478 - val\_accuracy: 0.3457 - val\_loss: 42.0785

Epoch 14/300

4/4                    0s 3ms/step -  
accuracy: 0.3475 - loss: 36.8344 - val\_accuracy: 0.3457 - val\_loss: 41.3344  
Epoch 15/300

4/4                    0s 3ms/step -  
accuracy: 0.3479 - loss: 36.6455 - val\_accuracy: 0.3457 - val\_loss: 40.6021  
Epoch 16/300

4/4                    0s 3ms/step -  
accuracy: 0.3377 - loss: 36.3831 - val\_accuracy: 0.3457 - val\_loss: 39.8679  
Epoch 17/300

4/4                    0s 3ms/step -  
accuracy: 0.3564 - loss: 34.5720 - val\_accuracy: 0.3457 - val\_loss: 39.1446  
Epoch 18/300

4/4                    0s 3ms/step -  
accuracy: 0.3512 - loss: 33.8085 - val\_accuracy: 0.3457 - val\_loss: 38.4254  
Epoch 19/300

4/4                    0s 3ms/step -  
accuracy: 0.3554 - loss: 33.1677 - val\_accuracy: 0.3457 - val\_loss: 37.7125  
Epoch 20/300

4/4                    0s 3ms/step -  
accuracy: 0.3556 - loss: 32.5550 - val\_accuracy: 0.3457 - val\_loss: 36.9991  
Epoch 21/300

4/4                    0s 3ms/step -  
accuracy: 0.3426 - loss: 32.3577 - val\_accuracy: 0.3457 - val\_loss: 36.2847  
Epoch 22/300

4/4                    0s 3ms/step -  
accuracy: 0.3725 - loss: 30.5775 - val\_accuracy: 0.3457 - val\_loss: 35.5717  
Epoch 23/300

4/4                    0s 3ms/step -  
accuracy: 0.3513 - loss: 30.7720 - val\_accuracy: 0.3457 - val\_loss: 34.8564  
Epoch 24/300

4/4                    0s 3ms/step -  
accuracy: 0.3549 - loss: 30.2011 - val\_accuracy: 0.3457 - val\_loss: 34.1489  
Epoch 25/300

4/4                    0s 3ms/step -  
accuracy: 0.3441 - loss: 30.1685 - val\_accuracy: 0.3457 - val\_loss: 33.4420  
Epoch 26/300

4/4                    0s 3ms/step -  
accuracy: 0.3536 - loss: 28.6055 - val\_accuracy: 0.3457 - val\_loss: 32.7510  
Epoch 27/300

4/4                    0s 3ms/step -  
accuracy: 0.3513 - loss: 28.9296 - val\_accuracy: 0.3580 - val\_loss: 32.0769  
Epoch 28/300

4/4                    0s 3ms/step -  
accuracy: 0.3671 - loss: 26.8209 - val\_accuracy: 0.3457 - val\_loss: 31.4267  
Epoch 29/300

4/4                    0s 3ms/step -  
accuracy: 0.3527 - loss: 27.3222 - val\_accuracy: 0.3457 - val\_loss: 30.7875  
Epoch 30/300

4/4                    0s 3ms/step -  
accuracy: 0.3545 - loss: 26.4523 - val\_accuracy: 0.3457 - val\_loss: 30.1574  
Epoch 31/300

4/4                    0s 3ms/step -  
accuracy: 0.3551 - loss: 26.0658 - val\_accuracy: 0.3333 - val\_loss: 29.5439  
Epoch 32/300

4/4                    0s 3ms/step -  
accuracy: 0.3619 - loss: 25.4325 - val\_accuracy: 0.3333 - val\_loss: 28.9373  
Epoch 33/300

4/4                    0s 3ms/step -  
accuracy: 0.3489 - loss: 25.5853 - val\_accuracy: 0.3333 - val\_loss: 28.3334  
Epoch 34/300

4/4                    0s 3ms/step -  
accuracy: 0.3532 - loss: 24.9537 - val\_accuracy: 0.3333 - val\_loss: 27.7319  
Epoch 35/300

4/4                    0s 3ms/step -  
accuracy: 0.3716 - loss: 23.4685 - val\_accuracy: 0.3333 - val\_loss: 27.1323  
Epoch 36/300

4/4                    0s 3ms/step -  
accuracy: 0.3664 - loss: 23.0036 - val\_accuracy: 0.3210 - val\_loss: 26.5377  
Epoch 37/300

4/4                    0s 3ms/step -  
accuracy: 0.3652 - loss: 22.0978 - val\_accuracy: 0.3210 - val\_loss: 25.9666  
Epoch 38/300

4/4                    0s 4ms/step -  
accuracy: 0.3339 - loss: 23.2665 - val\_accuracy: 0.3086 - val\_loss: 25.4266  
Epoch 39/300

4/4                    0s 4ms/step -  
accuracy: 0.3680 - loss: 21.5516 - val\_accuracy: 0.3086 - val\_loss: 24.9223  
Epoch 40/300

4/4                    0s 3ms/step -  
accuracy: 0.3519 - loss: 21.7920 - val\_accuracy: 0.3457 - val\_loss: 24.4384  
Epoch 41/300

4/4                    0s 3ms/step -  
accuracy: 0.3386 - loss: 21.4422 - val\_accuracy: 0.3457 - val\_loss: 23.9836  
Epoch 42/300

4/4                    0s 3ms/step -  
accuracy: 0.3721 - loss: 20.3741 - val\_accuracy: 0.3333 - val\_loss: 23.5541  
Epoch 43/300

4/4                    0s 3ms/step -  
accuracy: 0.3562 - loss: 21.0052 - val\_accuracy: 0.3210 - val\_loss: 23.1324  
Epoch 44/300

4/4                    0s 3ms/step -  
accuracy: 0.3529 - loss: 19.7019 - val\_accuracy: 0.3086 - val\_loss: 22.7349  
Epoch 45/300

4/4                    0s 3ms/step -  
accuracy: 0.3681 - loss: 18.9774 - val\_accuracy: 0.2963 - val\_loss: 22.3536  
Epoch 46/300

4/4                    0s 3ms/step -  
accuracy: 0.3898 - loss: 18.1470 - val\_accuracy: 0.2963 - val\_loss: 21.9885  
Epoch 47/300

4/4                    0s 3ms/step -  
accuracy: 0.3631 - loss: 18.5458 - val\_accuracy: 0.2963 - val\_loss: 21.6263  
Epoch 48/300

4/4                    0s 3ms/step -  
accuracy: 0.3756 - loss: 16.9973 - val\_accuracy: 0.2963 - val\_loss: 21.2743  
Epoch 49/300

4/4                    0s 3ms/step -  
accuracy: 0.3774 - loss: 17.4323 - val\_accuracy: 0.2840 - val\_loss: 20.9278  
Epoch 50/300

4/4                    0s 3ms/step -  
accuracy: 0.3770 - loss: 17.3409 - val\_accuracy: 0.2840 - val\_loss: 20.5870  
Epoch 51/300

4/4                    0s 3ms/step -  
accuracy: 0.3598 - loss: 17.3536 - val\_accuracy: 0.2963 - val\_loss: 20.2493  
Epoch 52/300

4/4                    0s 3ms/step -  
accuracy: 0.3610 - loss: 17.2225 - val\_accuracy: 0.2840 - val\_loss: 19.9225  
Epoch 53/300

4/4                    0s 3ms/step -  
accuracy: 0.3706 - loss: 16.9739 - val\_accuracy: 0.2840 - val\_loss: 19.6036  
Epoch 54/300

4/4                    0s 3ms/step -  
accuracy: 0.3723 - loss: 16.2797 - val\_accuracy: 0.2963 - val\_loss: 19.2938  
Epoch 55/300

4/4                    0s 3ms/step -  
accuracy: 0.3720 - loss: 15.8762 - val\_accuracy: 0.2963 - val\_loss: 18.9875  
Epoch 56/300

4/4                    0s 3ms/step -  
accuracy: 0.3882 - loss: 15.5860 - val\_accuracy: 0.2963 - val\_loss: 18.6857  
Epoch 57/300

4/4                    0s 3ms/step -  
accuracy: 0.3808 - loss: 15.2767 - val\_accuracy: 0.3086 - val\_loss: 18.3933  
Epoch 58/300

4/4                    0s 3ms/step -  
accuracy: 0.3910 - loss: 14.6935 - val\_accuracy: 0.3210 - val\_loss: 18.1096  
Epoch 59/300

4/4                    0s 4ms/step -  
accuracy: 0.3910 - loss: 15.1215 - val\_accuracy: 0.3210 - val\_loss: 17.8276  
Epoch 60/300

4/4                    0s 5ms/step -  
accuracy: 0.3966 - loss: 14.2345 - val\_accuracy: 0.3210 - val\_loss: 17.5528  
Epoch 61/300

4/4                    0s 4ms/step -  
accuracy: 0.3863 - loss: 14.5393 - val\_accuracy: 0.3086 - val\_loss: 17.2808  
Epoch 62/300



4/4 0s 4ms/step -  
accuracy: 0.3721 - loss: 14.5664 - val\_accuracy: 0.3086 - val\_loss: 17.0148  
Epoch 63/300

4/4 0s 4ms/step -  
accuracy: 0.4072 - loss: 14.0599 - val\_accuracy: 0.3086 - val\_loss: 16.7551  
Epoch 64/300

4/4 0s 4ms/step -  
accuracy: 0.4126 - loss: 13.0495 - val\_accuracy: 0.3086 - val\_loss: 16.5010  
Epoch 65/300

4/4 0s 4ms/step -  
accuracy: 0.4042 - loss: 13.4702 - val\_accuracy: 0.3333 - val\_loss: 16.2475  
Epoch 66/300

4/4 0s 3ms/step -  
accuracy: 0.4033 - loss: 12.9888 - val\_accuracy: 0.3333 - val\_loss: 15.9995  
Epoch 67/300

4/4 0s 4ms/step -  
accuracy: 0.3853 - loss: 13.5325 - val\_accuracy: 0.3457 - val\_loss: 15.7566  
Epoch 68/300

4/4 0s 4ms/step -  
accuracy: 0.3934 - loss: 13.6004 - val\_accuracy: 0.3580 - val\_loss: 15.5184  
Epoch 69/300

4/4 0s 3ms/step -  
accuracy: 0.4200 - loss: 12.3916 - val\_accuracy: 0.3704 - val\_loss: 15.2851  
Epoch 70/300

4/4 0s 4ms/step -  
accuracy: 0.4151 - loss: 11.9838 - val\_accuracy: 0.3704 - val\_loss: 15.0538  
Epoch 71/300

4/4 0s 4ms/step -  
accuracy: 0.4264 - loss: 11.5048 - val\_accuracy: 0.3704 - val\_loss: 14.8240  
Epoch 72/300

4/4 0s 3ms/step -  
accuracy: 0.4376 - loss: 11.9758 - val\_accuracy: 0.3704 - val\_loss: 14.5944  
Epoch 73/300

4/4 0s 3ms/step -  
accuracy: 0.4280 - loss: 11.6167 - val\_accuracy: 0.3704 - val\_loss: 14.3660  
Epoch 74/300

4/4 0s 4ms/step -  
accuracy: 0.4422 - loss: 11.3006 - val\_accuracy: 0.3704 - val\_loss: 14.1394  
Epoch 75/300

4/4 0s 4ms/step -  
accuracy: 0.4379 - loss: 11.3269 - val\_accuracy: 0.3704 - val\_loss: 13.9139  
Epoch 76/300

4/4 0s 4ms/step -  
accuracy: 0.4497 - loss: 11.0313 - val\_accuracy: 0.3704 - val\_loss: 13.6894  
Epoch 77/300

4/4 0s 3ms/step -  
accuracy: 0.4455 - loss: 11.3767 - val\_accuracy: 0.3704 - val\_loss: 13.4639  
Epoch 78/300

4/4                    0s 3ms/step -  
accuracy: 0.4454 - loss: 10.9794 - val\_accuracy: 0.3704 - val\_loss: 13.2411  
Epoch 79/300

4/4                    0s 4ms/step -  
accuracy: 0.4565 - loss: 10.1429 - val\_accuracy: 0.3580 - val\_loss: 13.0222  
Epoch 80/300

4/4                    0s 3ms/step -  
accuracy: 0.4305 - loss: 10.7293 - val\_accuracy: 0.3580 - val\_loss: 12.8050  
Epoch 81/300

4/4                    0s 4ms/step -  
accuracy: 0.4370 - loss: 10.8135 - val\_accuracy: 0.3580 - val\_loss: 12.5930  
Epoch 82/300

4/4                    0s 3ms/step -  
accuracy: 0.4268 - loss: 10.8419 - val\_accuracy: 0.3704 - val\_loss: 12.3862  
Epoch 83/300

4/4                    0s 3ms/step -  
accuracy: 0.4586 - loss: 9.6472 - val\_accuracy: 0.3580 - val\_loss: 12.1855  
Epoch 84/300

4/4                    0s 4ms/step -  
accuracy: 0.4443 - loss: 10.1352 - val\_accuracy: 0.3580 - val\_loss: 11.9866  
Epoch 85/300

4/4                    0s 3ms/step -  
accuracy: 0.4352 - loss: 10.4278 - val\_accuracy: 0.3580 - val\_loss: 11.7902  
Epoch 86/300

4/4                    0s 4ms/step -  
accuracy: 0.4362 - loss: 9.8767 - val\_accuracy: 0.3580 - val\_loss: 11.5989  
Epoch 87/300

4/4                    0s 4ms/step -  
accuracy: 0.4339 - loss: 9.2808 - val\_accuracy: 0.3704 - val\_loss: 11.4137  
Epoch 88/300

4/4                    0s 4ms/step -  
accuracy: 0.4295 - loss: 9.6947 - val\_accuracy: 0.3704 - val\_loss: 11.2276  
Epoch 89/300

4/4                    0s 4ms/step -  
accuracy: 0.4505 - loss: 9.6366 - val\_accuracy: 0.3704 - val\_loss: 11.0456  
Epoch 90/300

4/4                    0s 4ms/step -  
accuracy: 0.4629 - loss: 8.7459 - val\_accuracy: 0.3704 - val\_loss: 10.8688  
Epoch 91/300

4/4                    0s 4ms/step -  
accuracy: 0.4328 - loss: 9.0607 - val\_accuracy: 0.3580 - val\_loss: 10.6897  
Epoch 92/300

4/4                    0s 4ms/step -  
accuracy: 0.4386 - loss: 8.6789 - val\_accuracy: 0.3580 - val\_loss: 10.5134  
Epoch 93/300

4/4                    0s 7ms/step -  
accuracy: 0.4655 - loss: 7.7424 - val\_accuracy: 0.3580 - val\_loss: 10.3416  
Epoch 94/300

4/4                    0s 5ms/step -  
 accuracy: 0.4275 - loss: 8.8691 - val\_accuracy: 0.3704 - val\_loss: 10.1681  
 Epoch 95/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4497 - loss: 8.1841 - val\_accuracy: 0.3704 - val\_loss: 10.0007  
 Epoch 96/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4632 - loss: 8.0458 - val\_accuracy: 0.3704 - val\_loss: 9.8318  
 Epoch 97/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4477 - loss: 8.0405 - val\_accuracy: 0.3704 - val\_loss: 9.6684  
 Epoch 98/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4612 - loss: 7.8123 - val\_accuracy: 0.3827 - val\_loss: 9.5081  
 Epoch 99/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4478 - loss: 7.9206 - val\_accuracy: 0.3827 - val\_loss: 9.3511  
 Epoch 100/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4271 - loss: 7.8008 - val\_accuracy: 0.3827 - val\_loss: 9.1989  
 Epoch 101/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4395 - loss: 7.2224 - val\_accuracy: 0.3827 - val\_loss: 9.0528  
 Epoch 102/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4182 - loss: 7.8403 - val\_accuracy: 0.3827 - val\_loss: 8.8995  
 Epoch 103/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4229 - loss: 7.7829 - val\_accuracy: 0.3827 - val\_loss: 8.7500  
 Epoch 104/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4395 - loss: 7.2699 - val\_accuracy: 0.3827 - val\_loss: 8.6051  
 Epoch 105/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4345 - loss: 7.2850 - val\_accuracy: 0.3827 - val\_loss: 8.4609  
 Epoch 106/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4542 - loss: 6.8921 - val\_accuracy: 0.3827 - val\_loss: 8.3187  
 Epoch 107/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4439 - loss: 7.0385 - val\_accuracy: 0.3827 - val\_loss: 8.1756  
 Epoch 108/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4368 - loss: 6.8913 - val\_accuracy: 0.3827 - val\_loss: 8.0365  
 Epoch 109/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4570 - loss: 6.4597 - val\_accuracy: 0.3827 - val\_loss: 7.9041  
 Epoch 110/300

4/4                    0s 3ms/step -  
 accuracy: 0.4458 - loss: 6.3578 - val\_accuracy: 0.3827 - val\_loss: 7.7729  
 Epoch 111/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4424 - loss: 6.6191 - val\_accuracy: 0.3827 - val\_loss: 7.6419  
 Epoch 112/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4386 - loss: 6.3411 - val\_accuracy: 0.3827 - val\_loss: 7.5152  
 Epoch 113/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4359 - loss: 6.3763 - val\_accuracy: 0.3951 - val\_loss: 7.3896  
 Epoch 114/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4463 - loss: 6.2513 - val\_accuracy: 0.3827 - val\_loss: 7.2664  
 Epoch 115/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4315 - loss: 6.4523 - val\_accuracy: 0.3827 - val\_loss: 7.1462  
 Epoch 116/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4384 - loss: 5.9012 - val\_accuracy: 0.3704 - val\_loss: 7.0311  
 Epoch 117/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4240 - loss: 5.8814 - val\_accuracy: 0.3704 - val\_loss: 6.9179  
 Epoch 118/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4424 - loss: 5.9477 - val\_accuracy: 0.3704 - val\_loss: 6.8075  
 Epoch 119/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4350 - loss: 5.9009 - val\_accuracy: 0.3704 - val\_loss: 6.7013  
 Epoch 120/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4400 - loss: 5.6588 - val\_accuracy: 0.3580 - val\_loss: 6.5947  
 Epoch 121/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4351 - loss: 5.8612 - val\_accuracy: 0.3580 - val\_loss: 6.4894  
 Epoch 122/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4336 - loss: 5.8460 - val\_accuracy: 0.3580 - val\_loss: 6.3893  
 Epoch 123/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4282 - loss: 5.8471 - val\_accuracy: 0.3457 - val\_loss: 6.2948  
 Epoch 124/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4611 - loss: 5.7431 - val\_accuracy: 0.3457 - val\_loss: 6.2028  
 Epoch 125/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4556 - loss: 5.5651 - val\_accuracy: 0.3580 - val\_loss: 6.1118  
 Epoch 126/300

4/4                    0s 3ms/step -  
 accuracy: 0.4244 - loss: 5.6181 - val\_accuracy: 0.3580 - val\_loss: 6.0223  
 Epoch 127/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4434 - loss: 5.2963 - val\_accuracy: 0.3457 - val\_loss: 5.9376  
 Epoch 128/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4317 - loss: 5.6153 - val\_accuracy: 0.3457 - val\_loss: 5.8556  
 Epoch 129/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4457 - loss: 4.9946 - val\_accuracy: 0.3457 - val\_loss: 5.7797  
 Epoch 130/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4236 - loss: 5.2310 - val\_accuracy: 0.3210 - val\_loss: 5.7055  
 Epoch 131/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4313 - loss: 5.4958 - val\_accuracy: 0.3086 - val\_loss: 5.6319  
 Epoch 132/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4328 - loss: 5.2661 - val\_accuracy: 0.3086 - val\_loss: 5.5642  
 Epoch 133/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4425 - loss: 4.9851 - val\_accuracy: 0.2840 - val\_loss: 5.4983  
 Epoch 134/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4425 - loss: 4.8521 - val\_accuracy: 0.3086 - val\_loss: 5.4357  
 Epoch 135/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4401 - loss: 4.9266 - val\_accuracy: 0.3086 - val\_loss: 5.3736  
 Epoch 136/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4162 - loss: 5.1962 - val\_accuracy: 0.3210 - val\_loss: 5.3110  
 Epoch 137/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4370 - loss: 5.2397 - val\_accuracy: 0.3333 - val\_loss: 5.2510  
 Epoch 138/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4507 - loss: 4.5276 - val\_accuracy: 0.3210 - val\_loss: 5.1977  
 Epoch 139/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4164 - loss: 5.1042 - val\_accuracy: 0.3210 - val\_loss: 5.1464  
 Epoch 140/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4066 - loss: 5.0414 - val\_accuracy: 0.3210 - val\_loss: 5.0965  
 Epoch 141/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4349 - loss: 4.9795 - val\_accuracy: 0.3333 - val\_loss: 5.0489  
 Epoch 142/300

4/4                    0s 3ms/step -  
accuracy: 0.4335 - loss: 4.9933 - val\_accuracy: 0.3333 - val\_loss: 5.0024  
Epoch 143/300  
4/4                    0s 3ms/step -  
accuracy: 0.4204 - loss: 5.0199 - val\_accuracy: 0.3333 - val\_loss: 4.9581  
Epoch 144/300  
4/4                    0s 3ms/step -  
accuracy: 0.4277 - loss: 4.9150 - val\_accuracy: 0.3333 - val\_loss: 4.9130  
Epoch 145/300  
4/4                    0s 3ms/step -  
accuracy: 0.4251 - loss: 4.9118 - val\_accuracy: 0.3333 - val\_loss: 4.8713  
Epoch 146/300  
4/4                    0s 3ms/step -  
accuracy: 0.4303 - loss: 4.5121 - val\_accuracy: 0.3333 - val\_loss: 4.8317  
Epoch 147/300  
4/4                    0s 3ms/step -  
accuracy: 0.4026 - loss: 4.8609 - val\_accuracy: 0.3333 - val\_loss: 4.7912  
Epoch 148/300  
4/4                    0s 4ms/step -  
accuracy: 0.4233 - loss: 4.8207 - val\_accuracy: 0.3333 - val\_loss: 4.7538  
Epoch 149/300  
4/4                    0s 3ms/step -  
accuracy: 0.4297 - loss: 4.6364 - val\_accuracy: 0.3333 - val\_loss: 4.7178  
Epoch 150/300  
4/4                    0s 3ms/step -  
accuracy: 0.4070 - loss: 4.8536 - val\_accuracy: 0.3333 - val\_loss: 4.6815  
Epoch 151/300  
4/4                    0s 3ms/step -  
accuracy: 0.4272 - loss: 4.6455 - val\_accuracy: 0.3333 - val\_loss: 4.6469  
Epoch 152/300  
4/4                    0s 3ms/step -  
accuracy: 0.4019 - loss: 4.7811 - val\_accuracy: 0.3704 - val\_loss: 4.6132  
Epoch 153/300  
4/4                    0s 3ms/step -  
accuracy: 0.4095 - loss: 4.5455 - val\_accuracy: 0.3704 - val\_loss: 4.5808  
Epoch 154/300  
4/4                    0s 3ms/step -  
accuracy: 0.4247 - loss: 4.5541 - val\_accuracy: 0.3704 - val\_loss: 4.5499  
Epoch 155/300  
4/4                    0s 3ms/step -  
accuracy: 0.4071 - loss: 4.7491 - val\_accuracy: 0.3704 - val\_loss: 4.5182  
Epoch 156/300  
4/4                    0s 3ms/step -  
accuracy: 0.4158 - loss: 4.5688 - val\_accuracy: 0.3704 - val\_loss: 4.4895  
Epoch 157/300  
4/4                    0s 3ms/step -  
accuracy: 0.4093 - loss: 4.6830 - val\_accuracy: 0.3704 - val\_loss: 4.4613  
Epoch 158/300

4/4                    0s 3ms/step -  
 accuracy: 0.4263 - loss: 4.5676 - val\_accuracy: 0.3704 - val\_loss: 4.4327  
 Epoch 159/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4519 - loss: 4.2263 - val\_accuracy: 0.3704 - val\_loss: 4.4092  
 Epoch 160/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4174 - loss: 4.4034 - val\_accuracy: 0.3704 - val\_loss: 4.3834  
 Epoch 161/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4057 - loss: 4.6497 - val\_accuracy: 0.3704 - val\_loss: 4.3586  
 Epoch 162/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4237 - loss: 4.5485 - val\_accuracy: 0.3704 - val\_loss: 4.3348  
 Epoch 163/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4308 - loss: 4.6137 - val\_accuracy: 0.3704 - val\_loss: 4.3087  
 Epoch 164/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4470 - loss: 4.2196 - val\_accuracy: 0.3704 - val\_loss: 4.2858  
 Epoch 165/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4277 - loss: 4.4082 - val\_accuracy: 0.3704 - val\_loss: 4.2623  
 Epoch 166/300  
 4/4                    0s 6ms/step -  
 accuracy: 0.4319 - loss: 4.4749 - val\_accuracy: 0.3704 - val\_loss: 4.2406  
 Epoch 167/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4243 - loss: 4.5459 - val\_accuracy: 0.3704 - val\_loss: 4.2188  
 Epoch 168/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4459 - loss: 4.2845 - val\_accuracy: 0.3951 - val\_loss: 4.1988  
 Epoch 169/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4531 - loss: 4.2723 - val\_accuracy: 0.3951 - val\_loss: 4.1788  
 Epoch 170/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4424 - loss: 4.4417 - val\_accuracy: 0.4074 - val\_loss: 4.1574  
 Epoch 171/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4350 - loss: 4.0417 - val\_accuracy: 0.3951 - val\_loss: 4.1373  
 Epoch 172/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4485 - loss: 4.0861 - val\_accuracy: 0.4074 - val\_loss: 4.1190  
 Epoch 173/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4521 - loss: 4.2804 - val\_accuracy: 0.4074 - val\_loss: 4.0984  
 Epoch 174/300

4/4                    0s 3ms/step -  
 accuracy: 0.4563 - loss: 3.9541 - val\_accuracy: 0.4074 - val\_loss: 4.0799  
 Epoch 175/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4596 - loss: 4.0995 - val\_accuracy: 0.4074 - val\_loss: 4.0608  
 Epoch 176/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4370 - loss: 4.1774 - val\_accuracy: 0.4074 - val\_loss: 4.0421  
 Epoch 177/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4344 - loss: 4.0620 - val\_accuracy: 0.3951 - val\_loss: 4.0210  
 Epoch 178/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4677 - loss: 3.6787 - val\_accuracy: 0.3951 - val\_loss: 4.0002  
 Epoch 179/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4649 - loss: 3.9404 - val\_accuracy: 0.3951 - val\_loss: 3.9787  
 Epoch 180/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4224 - loss: 4.1745 - val\_accuracy: 0.3951 - val\_loss: 3.9595  
 Epoch 181/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4514 - loss: 4.1921 - val\_accuracy: 0.3951 - val\_loss: 3.9404  
 Epoch 182/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4556 - loss: 4.0754 - val\_accuracy: 0.3951 - val\_loss: 3.9202  
 Epoch 183/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4509 - loss: 3.9970 - val\_accuracy: 0.3951 - val\_loss: 3.9032  
 Epoch 184/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4483 - loss: 3.9712 - val\_accuracy: 0.4074 - val\_loss: 3.8861  
 Epoch 185/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4485 - loss: 3.8846 - val\_accuracy: 0.4074 - val\_loss: 3.8717  
 Epoch 186/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4618 - loss: 3.8388 - val\_accuracy: 0.4074 - val\_loss: 3.8537  
 Epoch 187/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4472 - loss: 3.9569 - val\_accuracy: 0.4074 - val\_loss: 3.8386  
 Epoch 188/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4502 - loss: 4.0747 - val\_accuracy: 0.4074 - val\_loss: 3.8216  
 Epoch 189/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4460 - loss: 4.0245 - val\_accuracy: 0.4074 - val\_loss: 3.8059  
 Epoch 190/300



4/4                    0s 3ms/step -  
 accuracy: 0.4252 - loss: 3.9307 - val\_accuracy: 0.4074 - val\_loss: 3.7895  
 Epoch 191/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4533 - loss: 3.9124 - val\_accuracy: 0.4074 - val\_loss: 3.7712  
 Epoch 192/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4572 - loss: 3.7884 - val\_accuracy: 0.3951 - val\_loss: 3.7542  
 Epoch 193/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4552 - loss: 3.7066 - val\_accuracy: 0.3951 - val\_loss: 3.7385  
 Epoch 194/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4581 - loss: 3.7729 - val\_accuracy: 0.3951 - val\_loss: 3.7207  
 Epoch 195/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4441 - loss: 3.7361 - val\_accuracy: 0.3951 - val\_loss: 3.7010  
 Epoch 196/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4630 - loss: 3.7155 - val\_accuracy: 0.3951 - val\_loss: 3.6839  
 Epoch 197/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4532 - loss: 3.6661 - val\_accuracy: 0.3951 - val\_loss: 3.6701  
 Epoch 198/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4618 - loss: 3.7027 - val\_accuracy: 0.4074 - val\_loss: 3.6545  
 Epoch 199/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4698 - loss: 3.6624 - val\_accuracy: 0.4074 - val\_loss: 3.6421  
 Epoch 200/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4364 - loss: 3.9326 - val\_accuracy: 0.4074 - val\_loss: 3.6257  
 Epoch 201/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4553 - loss: 3.8014 - val\_accuracy: 0.4074 - val\_loss: 3.6110  
 Epoch 202/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4259 - loss: 3.7519 - val\_accuracy: 0.4074 - val\_loss: 3.6006  
 Epoch 203/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4658 - loss: 3.5378 - val\_accuracy: 0.4074 - val\_loss: 3.5871  
 Epoch 204/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4596 - loss: 3.6329 - val\_accuracy: 0.4074 - val\_loss: 3.5747  
 Epoch 205/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4296 - loss: 3.9427 - val\_accuracy: 0.4074 - val\_loss: 3.5608  
 Epoch 206/300

4/4                    0s 3ms/step -  
 accuracy: 0.4429 - loss: 3.6116 - val\_accuracy: 0.3951 - val\_loss: 3.5431  
 Epoch 207/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4496 - loss: 3.4713 - val\_accuracy: 0.3951 - val\_loss: 3.5272  
 Epoch 208/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4349 - loss: 3.6868 - val\_accuracy: 0.3951 - val\_loss: 3.5123  
 Epoch 209/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4505 - loss: 3.5160 - val\_accuracy: 0.3951 - val\_loss: 3.4990  
 Epoch 210/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4361 - loss: 3.7837 - val\_accuracy: 0.3951 - val\_loss: 3.4859  
 Epoch 211/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4347 - loss: 3.7242 - val\_accuracy: 0.3951 - val\_loss: 3.4735  
 Epoch 212/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4454 - loss: 3.5034 - val\_accuracy: 0.3951 - val\_loss: 3.4599  
 Epoch 213/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4614 - loss: 3.3863 - val\_accuracy: 0.3951 - val\_loss: 3.4510  
 Epoch 214/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4665 - loss: 3.2542 - val\_accuracy: 0.3951 - val\_loss: 3.4363  
 Epoch 215/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4429 - loss: 3.6644 - val\_accuracy: 0.3951 - val\_loss: 3.4184  
 Epoch 216/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4387 - loss: 3.6610 - val\_accuracy: 0.3951 - val\_loss: 3.4043  
 Epoch 217/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4376 - loss: 3.5269 - val\_accuracy: 0.3951 - val\_loss: 3.3930  
 Epoch 218/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4443 - loss: 3.5140 - val\_accuracy: 0.3827 - val\_loss: 3.3782  
 Epoch 219/300  
 4/4                    0s 6ms/step -  
 accuracy: 0.4517 - loss: 3.3699 - val\_accuracy: 0.3951 - val\_loss: 3.3659  
 Epoch 220/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4698 - loss: 3.4028 - val\_accuracy: 0.3827 - val\_loss: 3.3483  
 Epoch 221/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4761 - loss: 3.0801 - val\_accuracy: 0.3827 - val\_loss: 3.3342  
 Epoch 222/300

4/4                    0s 4ms/step -  
accuracy: 0.4452 - loss: 3.4292 - val\_accuracy: 0.3827 - val\_loss: 3.3204  
Epoch 223/300  
4/4                    0s 4ms/step -  
accuracy: 0.4470 - loss: 3.4786 - val\_accuracy: 0.3827 - val\_loss: 3.3063  
Epoch 224/300  
4/4                    0s 3ms/step -  
accuracy: 0.4408 - loss: 3.6069 - val\_accuracy: 0.3827 - val\_loss: 3.2962  
Epoch 225/300  
4/4                    0s 4ms/step -  
accuracy: 0.4452 - loss: 3.2813 - val\_accuracy: 0.3827 - val\_loss: 3.2866  
Epoch 226/300  
4/4                    0s 3ms/step -  
accuracy: 0.4541 - loss: 3.4536 - val\_accuracy: 0.3827 - val\_loss: 3.2756  
Epoch 227/300  
4/4                    0s 3ms/step -  
accuracy: 0.4356 - loss: 3.5526 - val\_accuracy: 0.3827 - val\_loss: 3.2672  
Epoch 228/300  
4/4                    0s 3ms/step -  
accuracy: 0.4569 - loss: 3.3684 - val\_accuracy: 0.3827 - val\_loss: 3.2582  
Epoch 229/300  
4/4                    0s 3ms/step -  
accuracy: 0.4589 - loss: 3.2964 - val\_accuracy: 0.3827 - val\_loss: 3.2450  
Epoch 230/300  
4/4                    0s 4ms/step -  
accuracy: 0.4714 - loss: 3.1204 - val\_accuracy: 0.3827 - val\_loss: 3.2325  
Epoch 231/300  
4/4                    0s 4ms/step -  
accuracy: 0.4597 - loss: 3.4428 - val\_accuracy: 0.3827 - val\_loss: 3.2163  
Epoch 232/300  
4/4                    0s 3ms/step -  
accuracy: 0.4779 - loss: 3.1543 - val\_accuracy: 0.3827 - val\_loss: 3.2032  
Epoch 233/300  
4/4                    0s 3ms/step -  
accuracy: 0.4632 - loss: 3.0317 - val\_accuracy: 0.3827 - val\_loss: 3.1880  
Epoch 234/300  
4/4                    0s 3ms/step -  
accuracy: 0.4579 - loss: 3.1919 - val\_accuracy: 0.3827 - val\_loss: 3.1755  
Epoch 235/300  
4/4                    0s 3ms/step -  
accuracy: 0.4574 - loss: 3.1420 - val\_accuracy: 0.3827 - val\_loss: 3.1659  
Epoch 236/300  
4/4                    0s 3ms/step -  
accuracy: 0.4630 - loss: 3.0252 - val\_accuracy: 0.3704 - val\_loss: 3.1533  
Epoch 237/300  
4/4                    0s 4ms/step -  
accuracy: 0.4427 - loss: 3.4920 - val\_accuracy: 0.3704 - val\_loss: 3.1379  
Epoch 238/300

4/4                    0s 4ms/step -  
 accuracy: 0.4741 - loss: 3.1386 - val\_accuracy: 0.3704 - val\_loss: 3.1252  
 Epoch 239/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4463 - loss: 3.1538 - val\_accuracy: 0.3704 - val\_loss: 3.1123  
 Epoch 240/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4486 - loss: 3.1631 - val\_accuracy: 0.3704 - val\_loss: 3.1011  
 Epoch 241/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4486 - loss: 3.2158 - val\_accuracy: 0.3704 - val\_loss: 3.0871  
 Epoch 242/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4442 - loss: 3.2562 - val\_accuracy: 0.3704 - val\_loss: 3.0726  
 Epoch 243/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4589 - loss: 2.9865 - val\_accuracy: 0.3827 - val\_loss: 3.0611  
 Epoch 244/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4586 - loss: 3.0507 - val\_accuracy: 0.3827 - val\_loss: 3.0483  
 Epoch 245/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4441 - loss: 3.1316 - val\_accuracy: 0.3827 - val\_loss: 3.0355  
 Epoch 246/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4569 - loss: 3.0621 - val\_accuracy: 0.3704 - val\_loss: 3.0218  
 Epoch 247/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4642 - loss: 3.1568 - val\_accuracy: 0.3704 - val\_loss: 3.0102  
 Epoch 248/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4583 - loss: 3.1548 - val\_accuracy: 0.3704 - val\_loss: 2.9982  
 Epoch 249/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4555 - loss: 3.1438 - val\_accuracy: 0.3827 - val\_loss: 2.9883  
 Epoch 250/300  
 4/4                    0s 5ms/step -  
 accuracy: 0.4717 - loss: 3.0816 - val\_accuracy: 0.3827 - val\_loss: 2.9755  
 Epoch 251/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4450 - loss: 3.0153 - val\_accuracy: 0.3827 - val\_loss: 2.9676  
 Epoch 252/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4652 - loss: 2.9678 - val\_accuracy: 0.3951 - val\_loss: 2.9598  
 Epoch 253/300  
 4/4                    0s 5ms/step -  
 accuracy: 0.4676 - loss: 2.8186 - val\_accuracy: 0.3827 - val\_loss: 2.9464  
 Epoch 254/300

4/4 0s 4ms/step -  
accuracy: 0.4695 - loss: 3.0138 - val\_accuracy: 0.3951 - val\_loss: 2.9302  
Epoch 255/300

4/4 0s 3ms/step -  
accuracy: 0.4722 - loss: 3.0878 - val\_accuracy: 0.3951 - val\_loss: 2.9144  
Epoch 256/300

4/4 0s 4ms/step -  
accuracy: 0.4679 - loss: 2.9783 - val\_accuracy: 0.3951 - val\_loss: 2.9048  
Epoch 257/300

4/4 0s 4ms/step -  
accuracy: 0.4501 - loss: 2.9184 - val\_accuracy: 0.3951 - val\_loss: 2.8974  
Epoch 258/300

4/4 0s 4ms/step -  
accuracy: 0.4618 - loss: 3.0565 - val\_accuracy: 0.3951 - val\_loss: 2.8875  
Epoch 259/300

4/4 0s 10ms/step -  
accuracy: 0.4710 - loss: 2.7646 - val\_accuracy: 0.3951 - val\_loss: 2.8806  
Epoch 260/300

4/4 0s 4ms/step -  
accuracy: 0.4742 - loss: 2.8120 - val\_accuracy: 0.3951 - val\_loss: 2.8720  
Epoch 261/300

4/4 0s 3ms/step -  
accuracy: 0.4683 - loss: 2.8360 - val\_accuracy: 0.3951 - val\_loss: 2.8619  
Epoch 262/300

4/4 0s 4ms/step -  
accuracy: 0.4735 - loss: 2.8767 - val\_accuracy: 0.3951 - val\_loss: 2.8514  
Epoch 263/300

4/4 0s 5ms/step -  
accuracy: 0.4685 - loss: 2.8128 - val\_accuracy: 0.3951 - val\_loss: 2.8416  
Epoch 264/300

4/4 0s 4ms/step -  
accuracy: 0.4745 - loss: 2.7689 - val\_accuracy: 0.3951 - val\_loss: 2.8317  
Epoch 265/300

4/4 0s 4ms/step -  
accuracy: 0.4465 - loss: 2.8989 - val\_accuracy: 0.4074 - val\_loss: 2.8196  
Epoch 266/300

4/4 0s 4ms/step -  
accuracy: 0.4628 - loss: 2.7940 - val\_accuracy: 0.4074 - val\_loss: 2.8028  
Epoch 267/300

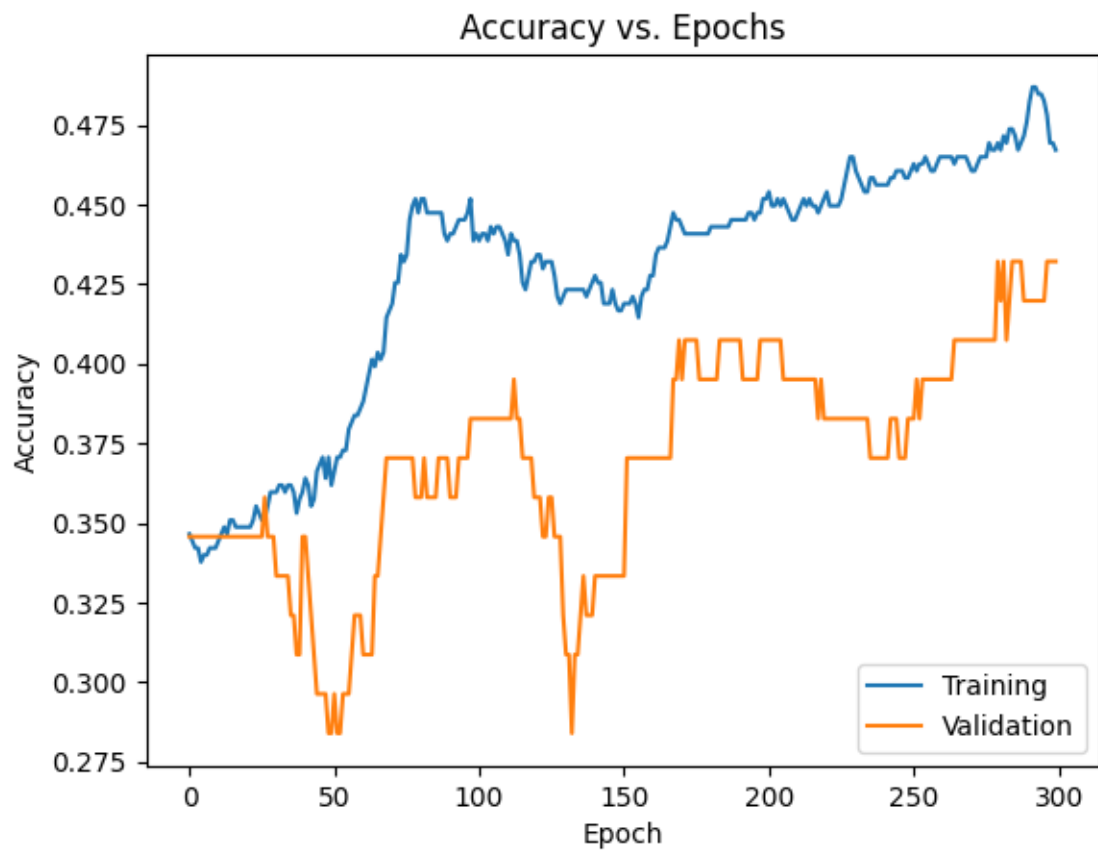
4/4 0s 3ms/step -  
accuracy: 0.4615 - loss: 2.9934 - val\_accuracy: 0.4074 - val\_loss: 2.7916  
Epoch 268/300

4/4 0s 3ms/step -  
accuracy: 0.4615 - loss: 2.7364 - val\_accuracy: 0.4074 - val\_loss: 2.7820  
Epoch 269/300

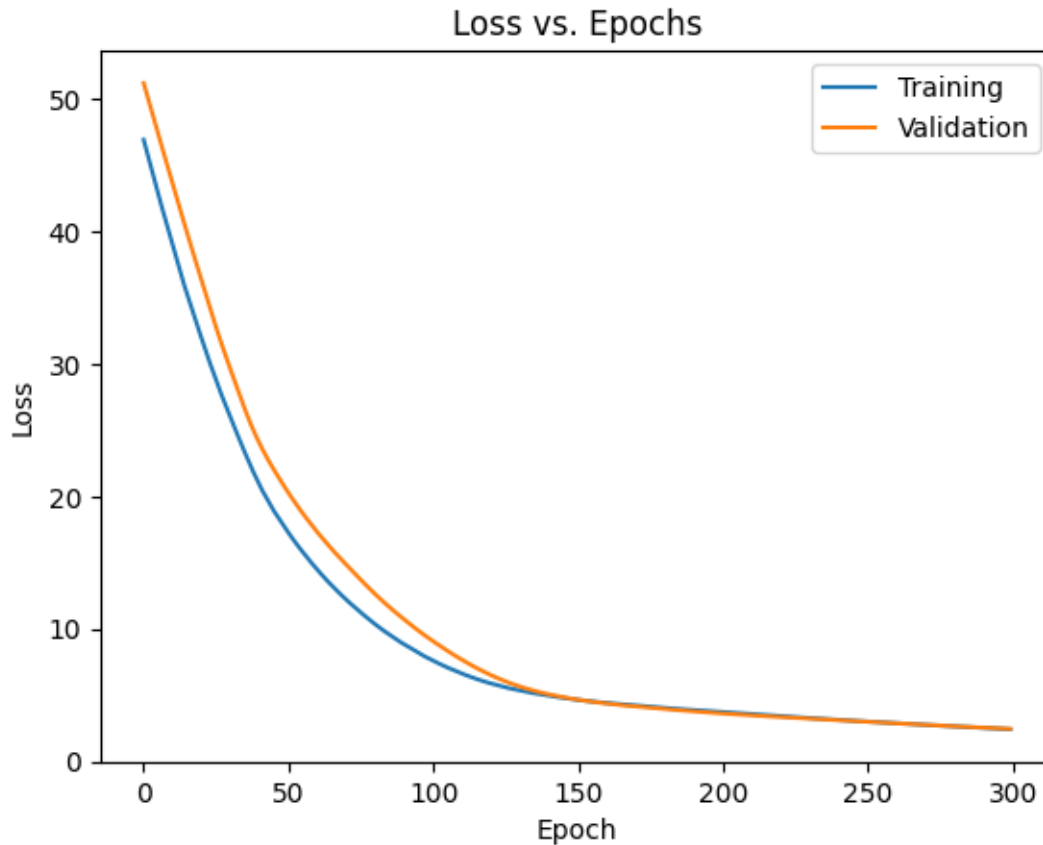
4/4 0s 3ms/step -  
accuracy: 0.4638 - loss: 2.9328 - val\_accuracy: 0.4074 - val\_loss: 2.7705  
Epoch 270/300

4/4                    0s 4ms/step -  
 accuracy: 0.4546 - loss: 2.7987 - val\_accuracy: 0.4074 - val\_loss: 2.7620  
 Epoch 271/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4517 - loss: 2.9134 - val\_accuracy: 0.4074 - val\_loss: 2.7529  
 Epoch 272/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4527 - loss: 2.7429 - val\_accuracy: 0.4074 - val\_loss: 2.7440  
 Epoch 273/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4603 - loss: 2.6143 - val\_accuracy: 0.4074 - val\_loss: 2.7368  
 Epoch 274/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4555 - loss: 2.7544 - val\_accuracy: 0.4074 - val\_loss: 2.7237  
 Epoch 275/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4550 - loss: 2.7058 - val\_accuracy: 0.4074 - val\_loss: 2.7116  
 Epoch 276/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4664 - loss: 2.8052 - val\_accuracy: 0.4074 - val\_loss: 2.6951  
 Epoch 277/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4794 - loss: 2.6963 - val\_accuracy: 0.4074 - val\_loss: 2.6829  
 Epoch 278/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4525 - loss: 2.5808 - val\_accuracy: 0.4074 - val\_loss: 2.6719  
 Epoch 279/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4754 - loss: 2.7320 - val\_accuracy: 0.4074 - val\_loss: 2.6607  
 Epoch 280/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4664 - loss: 2.6234 - val\_accuracy: 0.4321 - val\_loss: 2.6505  
 Epoch 281/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4704 - loss: 2.5857 - val\_accuracy: 0.4198 - val\_loss: 2.6428  
 Epoch 282/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4764 - loss: 2.7128 - val\_accuracy: 0.4321 - val\_loss: 2.6329  
 Epoch 283/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4674 - loss: 2.5072 - val\_accuracy: 0.4074 - val\_loss: 2.6255  
 Epoch 284/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4775 - loss: 2.5857 - val\_accuracy: 0.4198 - val\_loss: 2.6153  
 Epoch 285/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4640 - loss: 2.7018 - val\_accuracy: 0.4321 - val\_loss: 2.6023  
 Epoch 286/300

4/4                    0s 3ms/step -  
 accuracy: 0.4576 - loss: 2.7028 - val\_accuracy: 0.4321 - val\_loss: 2.5897  
 Epoch 287/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4598 - loss: 2.6707 - val\_accuracy: 0.4321 - val\_loss: 2.5783  
 Epoch 288/300  
 4/4                    0s 8ms/step -  
 accuracy: 0.4653 - loss: 2.6944 - val\_accuracy: 0.4321 - val\_loss: 2.5684  
 Epoch 289/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4797 - loss: 2.4910 - val\_accuracy: 0.4198 - val\_loss: 2.5609  
 Epoch 290/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4599 - loss: 2.7532 - val\_accuracy: 0.4198 - val\_loss: 2.5555  
 Epoch 291/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4737 - loss: 2.5552 - val\_accuracy: 0.4198 - val\_loss: 2.5503  
 Epoch 292/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4937 - loss: 2.4852 - val\_accuracy: 0.4198 - val\_loss: 2.5396  
 Epoch 293/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4851 - loss: 2.5294 - val\_accuracy: 0.4198 - val\_loss: 2.5262  
 Epoch 294/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4946 - loss: 2.4738 - val\_accuracy: 0.4198 - val\_loss: 2.5133  
 Epoch 295/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4663 - loss: 2.6547 - val\_accuracy: 0.4198 - val\_loss: 2.4990  
 Epoch 296/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.5060 - loss: 2.2114 - val\_accuracy: 0.4198 - val\_loss: 2.4898  
 Epoch 297/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4535 - loss: 2.5397 - val\_accuracy: 0.4321 - val\_loss: 2.4760  
 Epoch 298/300  
 4/4                    0s 4ms/step -  
 accuracy: 0.4765 - loss: 2.3721 - val\_accuracy: 0.4321 - val\_loss: 2.4677  
 Epoch 299/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4458 - loss: 2.5983 - val\_accuracy: 0.4321 - val\_loss: 2.4582  
 Epoch 300/300  
 4/4                    0s 3ms/step -  
 accuracy: 0.4556 - loss: 2.6273 - val\_accuracy: 0.4321 - val\_loss: 2.4507







### 0.3.1 3.1 Prueba de la perceptrón con conjunto de prueba

```
[ ]: test_loss, test_acc = perceptron.evaluate(X_test, y_test, verbose=0)
print('test_loss: {} \ntest_acc: {} %'.format(round(test_loss,4),
↪round(test_acc*100,4)))
```

```
test_loss: 2.3381
test_acc: 48.4848 %
```

## 0.4 4. Red Neuronal Secuencial Simple

En esta sección se construye una Red Neuronal Secuencial utilizando la librería TensorFlow y Keras.

```
[ ]: # Función para definir un modelo de Red Neuronal con Tensorflow y Keras
def set_nn_model_architecture_simple(X_train):

    # 1. Definición del tipo de NN (Secuencial)
    model = Sequential(name='RedNeuronalSinOptimizar')
```

```

# 2. Se define la capa de entrada, pesos iniciales dada una distribución
↳ uniforme escalada basada en el número de
# neuronas, la función de activación ReLU, vector de biases de 1.
model.add(Dense(units=16, input_shape=(X_train.shape[1],),
↳ activation='relu',
        kernel_initializer=tf.keras.initializers.HeUniform(seed=0),
        bias_initializer='ones', name='hiddenlayer1'))

# 3. Capas ocultas con activación relu
model.add(Dense(units=16, activation='relu', name='hiddenlayer2'))
model.add(Dense(units=32, activation='relu', name='hiddenlayer3'))
model.add(Dense(units=32, activation='relu', name='hiddenlayer4'))
model.add(Dense(units=32, activation='relu', name='hiddenlayer5'))
model.add(Dense(units=16, activation='relu', name='hiddenlayer6'))

# 4. Capa de salida con una neurona y activación sigmoid (por ser binario)
model.add(Dense(units=1, activation='sigmoid', name='outputlayer'))

model.summary()
return model

# 5. Creación de la Red Neuronal
redNeuroSimp = set_nn_model_architecture_simple(X_train)

# 6. Definición del optimizador y learning rate
adam = tf.keras.optimizers.Adam(learning_rate=0.001)

# 7. Establecer binary_crossentropy por el dataset binario y la métrica de
↳ accuracy
redNeuroSimp.compile(optimizer=adam, loss='binary_crossentropy',
↳ metrics=['accuracy'])

# 8. Entrenar la red
trainingRedNeuroSimp = redNeuroSimp.fit(X_train, y_train, epochs=800,
↳ validation_split=0.15, batch_size=64)

# 9. Se grafica el desempeño de Accuracy vs Epoch y Loss vs Epoch
plot_acc_loss(trainingRedNeuroSimp)

```

```

/Users/axelamoshernandezcardenas/Desktop/IAClase/myenv/lib/python3.12/site-
packages/keras/src/layers/core/dense.py:87: 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: "RedNeuronalSinOptimizar"
```

Layer (type)	Output Shape	Param #
hiddenlayer1 (Dense)	(None, 16)	144
hiddenlayer2 (Dense)	(None, 16)	272
hiddenlayer3 (Dense)	(None, 32)	544
hiddenlayer4 (Dense)	(None, 32)	1,056
hiddenlayer5 (Dense)	(None, 32)	1,056
hiddenlayer6 (Dense)	(None, 16)	528
outputlayer (Dense)	(None, 1)	17

Total params: 3,617 (14.13 KB)

Trainable params: 3,617 (14.13 KB)

Non-trainable params: 0 (0.00 B)

Epoch 1/800

8/8 1s 11ms/step -  
accuracy: 0.3980 - loss: 2.0593 - val\_accuracy: 0.6420 - val\_loss: 0.9329

Epoch 2/800

8/8 0s 3ms/step -  
accuracy: 0.6615 - loss: 0.8964 - val\_accuracy: 0.6173 - val\_loss: 0.7036

Epoch 3/800

8/8 0s 5ms/step -  
accuracy: 0.5680 - loss: 0.7187 - val\_accuracy: 0.6667 - val\_loss: 0.6549

Epoch 4/800

8/8 0s 2ms/step -  
accuracy: 0.6057 - loss: 0.6515 - val\_accuracy: 0.6667 - val\_loss: 0.6374

Epoch 5/800

8/8 0s 2ms/step -  
accuracy: 0.6728 - loss: 0.6135 - val\_accuracy: 0.6667 - val\_loss: 0.6064

Epoch 6/800

8/8 0s 2ms/step -  
accuracy: 0.6234 - loss: 0.6362 - val\_accuracy: 0.6790 - val\_loss: 0.5982

Epoch 7/800

8/8 0s 2ms/step -  
accuracy: 0.6396 - loss: 0.6236 - val\_accuracy: 0.7160 - val\_loss: 0.5998

Epoch 8/800

8/8                    0s 3ms/step -  
accuracy: 0.6784 - loss: 0.6196 - val\_accuracy: 0.6667 - val\_loss: 0.6021  
Epoch 9/800

8/8                    0s 2ms/step -  
accuracy: 0.7018 - loss: 0.5894 - val\_accuracy: 0.6543 - val\_loss: 0.5979  
Epoch 10/800

8/8                    0s 2ms/step -  
accuracy: 0.6655 - loss: 0.6115 - val\_accuracy: 0.6914 - val\_loss: 0.6026  
Epoch 11/800

8/8                    0s 2ms/step -  
accuracy: 0.6850 - loss: 0.6059 - val\_accuracy: 0.6914 - val\_loss: 0.6226  
Epoch 12/800

8/8                    0s 2ms/step -  
accuracy: 0.6849 - loss: 0.6044 - val\_accuracy: 0.6296 - val\_loss: 0.6440  
Epoch 13/800

8/8                    0s 2ms/step -  
accuracy: 0.6892 - loss: 0.6054 - val\_accuracy: 0.6420 - val\_loss: 0.6290  
Epoch 14/800

8/8                    0s 2ms/step -  
accuracy: 0.6960 - loss: 0.6108 - val\_accuracy: 0.6543 - val\_loss: 0.6230  
Epoch 15/800

8/8                    0s 2ms/step -  
accuracy: 0.7065 - loss: 0.5781 - val\_accuracy: 0.6543 - val\_loss: 0.6176  
Epoch 16/800

8/8                    0s 2ms/step -  
accuracy: 0.6908 - loss: 0.6018 - val\_accuracy: 0.6420 - val\_loss: 0.6648  
Epoch 17/800

8/8                    0s 2ms/step -  
accuracy: 0.6358 - loss: 0.6614 - val\_accuracy: 0.6667 - val\_loss: 0.6578  
Epoch 18/800

8/8                    0s 2ms/step -  
accuracy: 0.6565 - loss: 0.6143 - val\_accuracy: 0.6790 - val\_loss: 0.6696  
Epoch 19/800

8/8                    0s 2ms/step -  
accuracy: 0.6834 - loss: 0.5910 - val\_accuracy: 0.6420 - val\_loss: 0.6497  
Epoch 20/800

8/8                    0s 2ms/step -  
accuracy: 0.6999 - loss: 0.6106 - val\_accuracy: 0.6049 - val\_loss: 0.6563  
Epoch 21/800

8/8                    0s 2ms/step -  
accuracy: 0.6732 - loss: 0.6007 - val\_accuracy: 0.6667 - val\_loss: 0.6458  
Epoch 22/800

8/8                    0s 2ms/step -  
accuracy: 0.7078 - loss: 0.5772 - val\_accuracy: 0.6543 - val\_loss: 0.6299  
Epoch 23/800

8/8                    0s 2ms/step -  
accuracy: 0.6825 - loss: 0.5873 - val\_accuracy: 0.6173 - val\_loss: 0.6194  
Epoch 24/800

8/8                    0s 2ms/step -  
 accuracy: 0.6990 - loss: 0.5839 - val\_accuracy: 0.6296 - val\_loss: 0.6192  
 Epoch 25/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6704 - loss: 0.5993 - val\_accuracy: 0.6914 - val\_loss: 0.6265  
 Epoch 26/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6660 - loss: 0.6229 - val\_accuracy: 0.6296 - val\_loss: 0.6527  
 Epoch 27/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6539 - loss: 0.5965 - val\_accuracy: 0.6790 - val\_loss: 0.6166  
 Epoch 28/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6967 - loss: 0.5977 - val\_accuracy: 0.7284 - val\_loss: 0.5907  
 Epoch 29/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7081 - loss: 0.5810 - val\_accuracy: 0.6667 - val\_loss: 0.6003  
 Epoch 30/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7076 - loss: 0.5689 - val\_accuracy: 0.6543 - val\_loss: 0.6044  
 Epoch 31/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7189 - loss: 0.5494 - val\_accuracy: 0.6790 - val\_loss: 0.5893  
 Epoch 32/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6901 - loss: 0.5708 - val\_accuracy: 0.7037 - val\_loss: 0.5837  
 Epoch 33/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6940 - loss: 0.5706 - val\_accuracy: 0.7160 - val\_loss: 0.5852  
 Epoch 34/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7200 - loss: 0.5688 - val\_accuracy: 0.7407 - val\_loss: 0.5819  
 Epoch 35/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7219 - loss: 0.5762 - val\_accuracy: 0.7160 - val\_loss: 0.5904  
 Epoch 36/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6961 - loss: 0.5721 - val\_accuracy: 0.7284 - val\_loss: 0.5661  
 Epoch 37/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6826 - loss: 0.5878 - val\_accuracy: 0.7160 - val\_loss: 0.5701  
 Epoch 38/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6846 - loss: 0.5816 - val\_accuracy: 0.7160 - val\_loss: 0.5785  
 Epoch 39/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6742 - loss: 0.5870 - val\_accuracy: 0.6914 - val\_loss: 0.5685  
 Epoch 40/800

8/8                    0s 2ms/step -  
 accuracy: 0.7286 - loss: 0.5580 - val\_accuracy: 0.6914 - val\_loss: 0.5784  
 Epoch 41/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7402 - loss: 0.5737 - val\_accuracy: 0.6667 - val\_loss: 0.5901  
 Epoch 42/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7226 - loss: 0.5693 - val\_accuracy: 0.7037 - val\_loss: 0.5830  
 Epoch 43/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7359 - loss: 0.5433 - val\_accuracy: 0.7160 - val\_loss: 0.5766  
 Epoch 44/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6985 - loss: 0.5471 - val\_accuracy: 0.6914 - val\_loss: 0.5661  
 Epoch 45/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7414 - loss: 0.5470 - val\_accuracy: 0.7037 - val\_loss: 0.5882  
 Epoch 46/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7297 - loss: 0.5491 - val\_accuracy: 0.7160 - val\_loss: 0.5840  
 Epoch 47/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7258 - loss: 0.5477 - val\_accuracy: 0.6914 - val\_loss: 0.5908  
 Epoch 48/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7093 - loss: 0.5618 - val\_accuracy: 0.6914 - val\_loss: 0.5825  
 Epoch 49/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7094 - loss: 0.5558 - val\_accuracy: 0.7284 - val\_loss: 0.5622  
 Epoch 50/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7330 - loss: 0.5456 - val\_accuracy: 0.6543 - val\_loss: 0.5855  
 Epoch 51/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6991 - loss: 0.5764 - val\_accuracy: 0.7407 - val\_loss: 0.5594  
 Epoch 52/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6899 - loss: 0.5719 - val\_accuracy: 0.7160 - val\_loss: 0.5710  
 Epoch 53/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6995 - loss: 0.5606 - val\_accuracy: 0.7160 - val\_loss: 0.5702  
 Epoch 54/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7390 - loss: 0.5359 - val\_accuracy: 0.7037 - val\_loss: 0.5655  
 Epoch 55/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7174 - loss: 0.5427 - val\_accuracy: 0.6914 - val\_loss: 0.5693  
 Epoch 56/800

8/8                    0s 2ms/step -  
 accuracy: 0.7358 - loss: 0.5251 - val\_accuracy: 0.7037 - val\_loss: 0.5670  
 Epoch 57/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7294 - loss: 0.5192 - val\_accuracy: 0.7407 - val\_loss: 0.5560  
 Epoch 58/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7348 - loss: 0.5101 - val\_accuracy: 0.7160 - val\_loss: 0.5716  
 Epoch 59/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7503 - loss: 0.5223 - val\_accuracy: 0.7160 - val\_loss: 0.5510  
 Epoch 60/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7309 - loss: 0.5355 - val\_accuracy: 0.7531 - val\_loss: 0.5429  
 Epoch 61/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7225 - loss: 0.5342 - val\_accuracy: 0.6914 - val\_loss: 0.5591  
 Epoch 62/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7175 - loss: 0.5465 - val\_accuracy: 0.6914 - val\_loss: 0.5575  
 Epoch 63/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6982 - loss: 0.5555 - val\_accuracy: 0.6914 - val\_loss: 0.5380  
 Epoch 64/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7435 - loss: 0.5367 - val\_accuracy: 0.7407 - val\_loss: 0.5527  
 Epoch 65/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7485 - loss: 0.5397 - val\_accuracy: 0.7407 - val\_loss: 0.5610  
 Epoch 66/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7202 - loss: 0.5277 - val\_accuracy: 0.6914 - val\_loss: 0.5668  
 Epoch 67/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.6732 - loss: 0.5719 - val\_accuracy: 0.7284 - val\_loss: 0.5637  
 Epoch 68/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.7348 - loss: 0.5390 - val\_accuracy: 0.7407 - val\_loss: 0.5609  
 Epoch 69/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7328 - loss: 0.5340 - val\_accuracy: 0.7407 - val\_loss: 0.5369  
 Epoch 70/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7335 - loss: 0.5169 - val\_accuracy: 0.7160 - val\_loss: 0.5532  
 Epoch 71/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7430 - loss: 0.5533 - val\_accuracy: 0.7160 - val\_loss: 0.5771  
 Epoch 72/800

8/8                    0s 2ms/step -  
accuracy: 0.7531 - loss: 0.5178 - val\_accuracy: 0.7037 - val\_loss: 0.5556  
Epoch 73/800

8/8                    0s 2ms/step -  
accuracy: 0.7366 - loss: 0.5288 - val\_accuracy: 0.6914 - val\_loss: 0.5671  
Epoch 74/800

8/8                    0s 2ms/step -  
accuracy: 0.7429 - loss: 0.5355 - val\_accuracy: 0.7284 - val\_loss: 0.5542  
Epoch 75/800

8/8                    0s 2ms/step -  
accuracy: 0.6962 - loss: 0.5614 - val\_accuracy: 0.7531 - val\_loss: 0.5352  
Epoch 76/800

8/8                    0s 2ms/step -  
accuracy: 0.7568 - loss: 0.5013 - val\_accuracy: 0.7531 - val\_loss: 0.5546  
Epoch 77/800

8/8                    0s 2ms/step -  
accuracy: 0.7165 - loss: 0.5450 - val\_accuracy: 0.7160 - val\_loss: 0.5537  
Epoch 78/800

8/8                    0s 2ms/step -  
accuracy: 0.7551 - loss: 0.5234 - val\_accuracy: 0.7531 - val\_loss: 0.5340  
Epoch 79/800

8/8                    0s 2ms/step -  
accuracy: 0.7251 - loss: 0.5246 - val\_accuracy: 0.7407 - val\_loss: 0.5519  
Epoch 80/800

8/8                    0s 2ms/step -  
accuracy: 0.7403 - loss: 0.5253 - val\_accuracy: 0.7531 - val\_loss: 0.5622  
Epoch 81/800

8/8                    0s 2ms/step -  
accuracy: 0.7600 - loss: 0.4892 - val\_accuracy: 0.7160 - val\_loss: 0.5545  
Epoch 82/800

8/8                    0s 2ms/step -  
accuracy: 0.7225 - loss: 0.5177 - val\_accuracy: 0.7284 - val\_loss: 0.5431  
Epoch 83/800

8/8                    0s 2ms/step -  
accuracy: 0.7498 - loss: 0.4815 - val\_accuracy: 0.7037 - val\_loss: 0.5619  
Epoch 84/800

8/8                    0s 2ms/step -  
accuracy: 0.7412 - loss: 0.5405 - val\_accuracy: 0.7407 - val\_loss: 0.5606  
Epoch 85/800

8/8                    0s 2ms/step -  
accuracy: 0.7128 - loss: 0.5339 - val\_accuracy: 0.7407 - val\_loss: 0.5464  
Epoch 86/800

8/8                    0s 2ms/step -  
accuracy: 0.7390 - loss: 0.5207 - val\_accuracy: 0.7160 - val\_loss: 0.5464  
Epoch 87/800

8/8                    0s 2ms/step -  
accuracy: 0.7421 - loss: 0.5332 - val\_accuracy: 0.7407 - val\_loss: 0.5301  
Epoch 88/800



8/8                    0s 2ms/step -  
 accuracy: 0.7215 - loss: 0.5200 - val\_accuracy: 0.7160 - val\_loss: 0.5538  
 Epoch 89/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7205 - loss: 0.5352 - val\_accuracy: 0.7284 - val\_loss: 0.5571  
 Epoch 90/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7339 - loss: 0.5286 - val\_accuracy: 0.7901 - val\_loss: 0.5329  
 Epoch 91/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7572 - loss: 0.5070 - val\_accuracy: 0.7160 - val\_loss: 0.5434  
 Epoch 92/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7384 - loss: 0.5023 - val\_accuracy: 0.7407 - val\_loss: 0.5356  
 Epoch 93/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7603 - loss: 0.5006 - val\_accuracy: 0.7778 - val\_loss: 0.5195  
 Epoch 94/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7697 - loss: 0.4721 - val\_accuracy: 0.8025 - val\_loss: 0.5111  
 Epoch 95/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7553 - loss: 0.5048 - val\_accuracy: 0.7778 - val\_loss: 0.5135  
 Epoch 96/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7444 - loss: 0.5044 - val\_accuracy: 0.7778 - val\_loss: 0.5116  
 Epoch 97/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7270 - loss: 0.5034 - val\_accuracy: 0.6914 - val\_loss: 0.5274  
 Epoch 98/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7554 - loss: 0.4842 - val\_accuracy: 0.7778 - val\_loss: 0.5133  
 Epoch 99/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7538 - loss: 0.4883 - val\_accuracy: 0.7531 - val\_loss: 0.5244  
 Epoch 100/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7825 - loss: 0.4815 - val\_accuracy: 0.7778 - val\_loss: 0.5201  
 Epoch 101/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7533 - loss: 0.4795 - val\_accuracy: 0.7901 - val\_loss: 0.5068  
 Epoch 102/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7317 - loss: 0.5176 - val\_accuracy: 0.7901 - val\_loss: 0.5018  
 Epoch 103/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7351 - loss: 0.5315 - val\_accuracy: 0.7654 - val\_loss: 0.5357  
 Epoch 104/800

8/8                    0s 2ms/step -  
 accuracy: 0.7531 - loss: 0.4970 - val\_accuracy: 0.8025 - val\_loss: 0.4939  
 Epoch 105/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7757 - loss: 0.4614 - val\_accuracy: 0.7901 - val\_loss: 0.5209  
 Epoch 106/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7786 - loss: 0.4852 - val\_accuracy: 0.7407 - val\_loss: 0.5307  
 Epoch 107/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7363 - loss: 0.5099 - val\_accuracy: 0.7037 - val\_loss: 0.5266  
 Epoch 108/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7463 - loss: 0.4980 - val\_accuracy: 0.7531 - val\_loss: 0.5256  
 Epoch 109/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7732 - loss: 0.4778 - val\_accuracy: 0.7654 - val\_loss: 0.5271  
 Epoch 110/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7441 - loss: 0.4992 - val\_accuracy: 0.7901 - val\_loss: 0.4990  
 Epoch 111/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7475 - loss: 0.4836 - val\_accuracy: 0.7901 - val\_loss: 0.5066  
 Epoch 112/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7792 - loss: 0.4488 - val\_accuracy: 0.7778 - val\_loss: 0.5072  
 Epoch 113/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.7808 - loss: 0.4505 - val\_accuracy: 0.8025 - val\_loss: 0.5027  
 Epoch 114/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7724 - loss: 0.4774 - val\_accuracy: 0.7531 - val\_loss: 0.5097  
 Epoch 115/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7595 - loss: 0.4824 - val\_accuracy: 0.7778 - val\_loss: 0.5028  
 Epoch 116/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7611 - loss: 0.4985 - val\_accuracy: 0.7778 - val\_loss: 0.4902  
 Epoch 117/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7500 - loss: 0.4765 - val\_accuracy: 0.8025 - val\_loss: 0.5076  
 Epoch 118/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7693 - loss: 0.4648 - val\_accuracy: 0.7160 - val\_loss: 0.5188  
 Epoch 119/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7566 - loss: 0.4662 - val\_accuracy: 0.7407 - val\_loss: 0.5090  
 Epoch 120/800

8/8                    0s 2ms/step -  
 accuracy: 0.7661 - loss: 0.4972 - val\_accuracy: 0.7654 - val\_loss: 0.4943  
 Epoch 121/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7266 - loss: 0.4778 - val\_accuracy: 0.8272 - val\_loss: 0.4888  
 Epoch 122/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7741 - loss: 0.4737 - val\_accuracy: 0.7901 - val\_loss: 0.5052  
 Epoch 123/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7692 - loss: 0.4560 - val\_accuracy: 0.7778 - val\_loss: 0.4913  
 Epoch 124/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7855 - loss: 0.4561 - val\_accuracy: 0.7901 - val\_loss: 0.4911  
 Epoch 125/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7647 - loss: 0.4734 - val\_accuracy: 0.7654 - val\_loss: 0.5180  
 Epoch 126/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7697 - loss: 0.4527 - val\_accuracy: 0.7778 - val\_loss: 0.5044  
 Epoch 127/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7538 - loss: 0.4613 - val\_accuracy: 0.8025 - val\_loss: 0.4973  
 Epoch 128/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7721 - loss: 0.4711 - val\_accuracy: 0.7531 - val\_loss: 0.5091  
 Epoch 129/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7878 - loss: 0.4558 - val\_accuracy: 0.8272 - val\_loss: 0.4882  
 Epoch 130/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8097 - loss: 0.4384 - val\_accuracy: 0.8025 - val\_loss: 0.4940  
 Epoch 131/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7586 - loss: 0.4556 - val\_accuracy: 0.7778 - val\_loss: 0.5172  
 Epoch 132/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7947 - loss: 0.4346 - val\_accuracy: 0.7778 - val\_loss: 0.5240  
 Epoch 133/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7982 - loss: 0.4418 - val\_accuracy: 0.7654 - val\_loss: 0.5301  
 Epoch 134/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7984 - loss: 0.4444 - val\_accuracy: 0.8025 - val\_loss: 0.5093  
 Epoch 135/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7846 - loss: 0.4292 - val\_accuracy: 0.7654 - val\_loss: 0.5056  
 Epoch 136/800

8/8                    0s 2ms/step -  
 accuracy: 0.8217 - loss: 0.4280 - val\_accuracy: 0.7901 - val\_loss: 0.5088  
 Epoch 137/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7886 - loss: 0.4363 - val\_accuracy: 0.8025 - val\_loss: 0.4772  
 Epoch 138/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7358 - loss: 0.4935 - val\_accuracy: 0.7901 - val\_loss: 0.4827  
 Epoch 139/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7855 - loss: 0.4511 - val\_accuracy: 0.7531 - val\_loss: 0.5566  
 Epoch 140/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8074 - loss: 0.4543 - val\_accuracy: 0.7407 - val\_loss: 0.5361  
 Epoch 141/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7928 - loss: 0.4391 - val\_accuracy: 0.7407 - val\_loss: 0.5507  
 Epoch 142/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7931 - loss: 0.4617 - val\_accuracy: 0.7654 - val\_loss: 0.5069  
 Epoch 143/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7772 - loss: 0.4335 - val\_accuracy: 0.7531 - val\_loss: 0.5413  
 Epoch 144/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7804 - loss: 0.4631 - val\_accuracy: 0.7531 - val\_loss: 0.5108  
 Epoch 145/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7748 - loss: 0.4638 - val\_accuracy: 0.7654 - val\_loss: 0.5448  
 Epoch 146/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7804 - loss: 0.4358 - val\_accuracy: 0.8025 - val\_loss: 0.4853  
 Epoch 147/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7397 - loss: 0.5097 - val\_accuracy: 0.7654 - val\_loss: 0.5483  
 Epoch 148/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8187 - loss: 0.4697 - val\_accuracy: 0.7407 - val\_loss: 0.5601  
 Epoch 149/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7841 - loss: 0.4689 - val\_accuracy: 0.7654 - val\_loss: 0.5377  
 Epoch 150/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7906 - loss: 0.4565 - val\_accuracy: 0.7654 - val\_loss: 0.5216  
 Epoch 151/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8023 - loss: 0.4523 - val\_accuracy: 0.7531 - val\_loss: 0.4940  
 Epoch 152/800

8/8                    0s 2ms/step -  
 accuracy: 0.7900 - loss: 0.4390 - val\_accuracy: 0.7531 - val\_loss: 0.5237  
 Epoch 153/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7734 - loss: 0.4559 - val\_accuracy: 0.7654 - val\_loss: 0.5012  
 Epoch 154/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7631 - loss: 0.4470 - val\_accuracy: 0.8025 - val\_loss: 0.5290  
 Epoch 155/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7785 - loss: 0.4485 - val\_accuracy: 0.7407 - val\_loss: 0.5112  
 Epoch 156/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.8073 - loss: 0.4344 - val\_accuracy: 0.7654 - val\_loss: 0.5159  
 Epoch 157/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8193 - loss: 0.4196 - val\_accuracy: 0.8025 - val\_loss: 0.4928  
 Epoch 158/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8080 - loss: 0.4237 - val\_accuracy: 0.7778 - val\_loss: 0.4761  
 Epoch 159/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8160 - loss: 0.4151 - val\_accuracy: 0.7531 - val\_loss: 0.5034  
 Epoch 160/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8298 - loss: 0.3972 - val\_accuracy: 0.7901 - val\_loss: 0.4811  
 Epoch 161/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7703 - loss: 0.4523 - val\_accuracy: 0.7654 - val\_loss: 0.5128  
 Epoch 162/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8116 - loss: 0.4148 - val\_accuracy: 0.7778 - val\_loss: 0.5053  
 Epoch 163/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8168 - loss: 0.4016 - val\_accuracy: 0.8025 - val\_loss: 0.5071  
 Epoch 164/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8181 - loss: 0.4078 - val\_accuracy: 0.7778 - val\_loss: 0.5108  
 Epoch 165/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7997 - loss: 0.4404 - val\_accuracy: 0.7778 - val\_loss: 0.5101  
 Epoch 166/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8234 - loss: 0.4129 - val\_accuracy: 0.7778 - val\_loss: 0.5188  
 Epoch 167/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7751 - loss: 0.4360 - val\_accuracy: 0.7284 - val\_loss: 0.5238  
 Epoch 168/800

8/8                    0s 2ms/step -  
 accuracy: 0.8021 - loss: 0.4354 - val\_accuracy: 0.7901 - val\_loss: 0.5004  
 Epoch 169/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7898 - loss: 0.4480 - val\_accuracy: 0.8148 - val\_loss: 0.4979  
 Epoch 170/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8002 - loss: 0.4005 - val\_accuracy: 0.7778 - val\_loss: 0.4951  
 Epoch 171/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8165 - loss: 0.4018 - val\_accuracy: 0.7778 - val\_loss: 0.5532  
 Epoch 172/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7969 - loss: 0.4040 - val\_accuracy: 0.7901 - val\_loss: 0.5104  
 Epoch 173/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7930 - loss: 0.4254 - val\_accuracy: 0.7654 - val\_loss: 0.4800  
 Epoch 174/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7830 - loss: 0.4340 - val\_accuracy: 0.7654 - val\_loss: 0.5302  
 Epoch 175/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8255 - loss: 0.3907 - val\_accuracy: 0.8025 - val\_loss: 0.4790  
 Epoch 176/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8179 - loss: 0.4247 - val\_accuracy: 0.8148 - val\_loss: 0.4815  
 Epoch 177/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7852 - loss: 0.4290 - val\_accuracy: 0.7901 - val\_loss: 0.5121  
 Epoch 178/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7748 - loss: 0.4380 - val\_accuracy: 0.8025 - val\_loss: 0.5027  
 Epoch 179/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8265 - loss: 0.3949 - val\_accuracy: 0.7778 - val\_loss: 0.5306  
 Epoch 180/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8164 - loss: 0.4159 - val\_accuracy: 0.8025 - val\_loss: 0.4990  
 Epoch 181/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8297 - loss: 0.3947 - val\_accuracy: 0.7284 - val\_loss: 0.5520  
 Epoch 182/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7918 - loss: 0.4469 - val\_accuracy: 0.7654 - val\_loss: 0.5091  
 Epoch 183/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7878 - loss: 0.4563 - val\_accuracy: 0.7654 - val\_loss: 0.5335  
 Epoch 184/800

8/8                    0s 2ms/step -  
 accuracy: 0.7824 - loss: 0.4682 - val\_accuracy: 0.7778 - val\_loss: 0.4829  
 Epoch 185/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7768 - loss: 0.4530 - val\_accuracy: 0.7778 - val\_loss: 0.5191  
 Epoch 186/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8092 - loss: 0.4255 - val\_accuracy: 0.8025 - val\_loss: 0.4884  
 Epoch 187/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7803 - loss: 0.4277 - val\_accuracy: 0.7778 - val\_loss: 0.5514  
 Epoch 188/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8596 - loss: 0.3819 - val\_accuracy: 0.7778 - val\_loss: 0.4963  
 Epoch 189/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8020 - loss: 0.4280 - val\_accuracy: 0.7654 - val\_loss: 0.5311  
 Epoch 190/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8188 - loss: 0.4256 - val\_accuracy: 0.7654 - val\_loss: 0.5209  
 Epoch 191/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8129 - loss: 0.4099 - val\_accuracy: 0.7778 - val\_loss: 0.5293  
 Epoch 192/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8339 - loss: 0.3991 - val\_accuracy: 0.7778 - val\_loss: 0.5299  
 Epoch 193/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8172 - loss: 0.3956 - val\_accuracy: 0.7654 - val\_loss: 0.5439  
 Epoch 194/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.8000 - loss: 0.4198 - val\_accuracy: 0.7901 - val\_loss: 0.5112  
 Epoch 195/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8009 - loss: 0.4136 - val\_accuracy: 0.7531 - val\_loss: 0.5484  
 Epoch 196/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8180 - loss: 0.4244 - val\_accuracy: 0.7654 - val\_loss: 0.5415  
 Epoch 197/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8220 - loss: 0.3843 - val\_accuracy: 0.7654 - val\_loss: 0.5300  
 Epoch 198/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7937 - loss: 0.4650 - val\_accuracy: 0.7778 - val\_loss: 0.4986  
 Epoch 199/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7847 - loss: 0.4476 - val\_accuracy: 0.7284 - val\_loss: 0.5673  
 Epoch 200/800

8/8                    0s 2ms/step -  
 accuracy: 0.8142 - loss: 0.4090 - val\_accuracy: 0.7284 - val\_loss: 0.5491  
 Epoch 201/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8309 - loss: 0.4130 - val\_accuracy: 0.7654 - val\_loss: 0.5233  
 Epoch 202/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8395 - loss: 0.3670 - val\_accuracy: 0.7901 - val\_loss: 0.4893  
 Epoch 203/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8040 - loss: 0.4234 - val\_accuracy: 0.7901 - val\_loss: 0.4861  
 Epoch 204/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8101 - loss: 0.4057 - val\_accuracy: 0.7778 - val\_loss: 0.5075  
 Epoch 205/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8290 - loss: 0.3858 - val\_accuracy: 0.7901 - val\_loss: 0.4982  
 Epoch 206/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8305 - loss: 0.4154 - val\_accuracy: 0.7901 - val\_loss: 0.5096  
 Epoch 207/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8404 - loss: 0.3750 - val\_accuracy: 0.7407 - val\_loss: 0.5511  
 Epoch 208/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8456 - loss: 0.4082 - val\_accuracy: 0.7284 - val\_loss: 0.5463  
 Epoch 209/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8234 - loss: 0.4039 - val\_accuracy: 0.7284 - val\_loss: 0.5411  
 Epoch 210/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8075 - loss: 0.4077 - val\_accuracy: 0.7284 - val\_loss: 0.5872  
 Epoch 211/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7712 - loss: 0.4278 - val\_accuracy: 0.8272 - val\_loss: 0.4894  
 Epoch 212/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8137 - loss: 0.4049 - val\_accuracy: 0.7160 - val\_loss: 0.5452  
 Epoch 213/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8480 - loss: 0.3808 - val\_accuracy: 0.7778 - val\_loss: 0.4697  
 Epoch 214/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8377 - loss: 0.3800 - val\_accuracy: 0.7531 - val\_loss: 0.4861  
 Epoch 215/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8175 - loss: 0.3912 - val\_accuracy: 0.7778 - val\_loss: 0.4881  
 Epoch 216/800



8/8                    0s 2ms/step -  
 accuracy: 0.8259 - loss: 0.3723 - val\_accuracy: 0.8148 - val\_loss: 0.5207  
 Epoch 217/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8338 - loss: 0.3739 - val\_accuracy: 0.7531 - val\_loss: 0.5553  
 Epoch 218/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8137 - loss: 0.3869 - val\_accuracy: 0.7654 - val\_loss: 0.5196  
 Epoch 219/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8166 - loss: 0.3807 - val\_accuracy: 0.7531 - val\_loss: 0.5278  
 Epoch 220/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8446 - loss: 0.3568 - val\_accuracy: 0.7901 - val\_loss: 0.4719  
 Epoch 221/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8185 - loss: 0.3976 - val\_accuracy: 0.7654 - val\_loss: 0.4827  
 Epoch 222/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8387 - loss: 0.3740 - val\_accuracy: 0.7901 - val\_loss: 0.4894  
 Epoch 223/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8667 - loss: 0.3522 - val\_accuracy: 0.8025 - val\_loss: 0.4689  
 Epoch 224/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8517 - loss: 0.3405 - val\_accuracy: 0.7901 - val\_loss: 0.5043  
 Epoch 225/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8490 - loss: 0.3757 - val\_accuracy: 0.7778 - val\_loss: 0.5015  
 Epoch 226/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8253 - loss: 0.3663 - val\_accuracy: 0.8025 - val\_loss: 0.5112  
 Epoch 227/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8474 - loss: 0.3568 - val\_accuracy: 0.7407 - val\_loss: 0.5441  
 Epoch 228/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8147 - loss: 0.3917 - val\_accuracy: 0.8148 - val\_loss: 0.4753  
 Epoch 229/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8268 - loss: 0.3456 - val\_accuracy: 0.7654 - val\_loss: 0.5141  
 Epoch 230/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8639 - loss: 0.3505 - val\_accuracy: 0.8148 - val\_loss: 0.4929  
 Epoch 231/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8575 - loss: 0.3483 - val\_accuracy: 0.7778 - val\_loss: 0.4975  
 Epoch 232/800

8/8                    0s 2ms/step -  
 accuracy: 0.8712 - loss: 0.3401 - val\_accuracy: 0.8025 - val\_loss: 0.4976  
 Epoch 233/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8499 - loss: 0.3564 - val\_accuracy: 0.7901 - val\_loss: 0.4836  
 Epoch 234/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8437 - loss: 0.3518 - val\_accuracy: 0.8025 - val\_loss: 0.4908  
 Epoch 235/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8630 - loss: 0.3367 - val\_accuracy: 0.8025 - val\_loss: 0.4883  
 Epoch 236/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8445 - loss: 0.3623 - val\_accuracy: 0.8148 - val\_loss: 0.4747  
 Epoch 237/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8621 - loss: 0.3175 - val\_accuracy: 0.7901 - val\_loss: 0.5265  
 Epoch 238/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8575 - loss: 0.3362 - val\_accuracy: 0.8395 - val\_loss: 0.4563  
 Epoch 239/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8754 - loss: 0.3200 - val\_accuracy: 0.8272 - val\_loss: 0.5036  
 Epoch 240/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8618 - loss: 0.3363 - val\_accuracy: 0.8025 - val\_loss: 0.4838  
 Epoch 241/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8472 - loss: 0.3336 - val\_accuracy: 0.8025 - val\_loss: 0.5191  
 Epoch 242/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8582 - loss: 0.3452 - val\_accuracy: 0.8148 - val\_loss: 0.4856  
 Epoch 243/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8608 - loss: 0.3338 - val\_accuracy: 0.8148 - val\_loss: 0.5155  
 Epoch 244/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8631 - loss: 0.3174 - val\_accuracy: 0.8148 - val\_loss: 0.4817  
 Epoch 245/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8725 - loss: 0.3266 - val\_accuracy: 0.7778 - val\_loss: 0.5049  
 Epoch 246/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8487 - loss: 0.3565 - val\_accuracy: 0.7531 - val\_loss: 0.5649  
 Epoch 247/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.8426 - loss: 0.3756 - val\_accuracy: 0.7654 - val\_loss: 0.5252  
 Epoch 248/800

8/8                    0s 2ms/step -  
 accuracy: 0.8703 - loss: 0.3169 - val\_accuracy: 0.7778 - val\_loss: 0.5165  
 Epoch 249/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8447 - loss: 0.3425 - val\_accuracy: 0.7901 - val\_loss: 0.4920  
 Epoch 250/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8592 - loss: 0.3195 - val\_accuracy: 0.8272 - val\_loss: 0.5002  
 Epoch 251/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8663 - loss: 0.3208 - val\_accuracy: 0.8148 - val\_loss: 0.5113  
 Epoch 252/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8878 - loss: 0.3059 - val\_accuracy: 0.7778 - val\_loss: 0.5446  
 Epoch 253/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8186 - loss: 0.3774 - val\_accuracy: 0.8025 - val\_loss: 0.4993  
 Epoch 254/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.7825 - loss: 0.4367 - val\_accuracy: 0.7778 - val\_loss: 0.5566  
 Epoch 255/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8611 - loss: 0.3379 - val\_accuracy: 0.7901 - val\_loss: 0.4958  
 Epoch 256/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8516 - loss: 0.3394 - val\_accuracy: 0.8272 - val\_loss: 0.4827  
 Epoch 257/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8515 - loss: 0.3460 - val\_accuracy: 0.7654 - val\_loss: 0.5739  
 Epoch 258/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8641 - loss: 0.3262 - val\_accuracy: 0.8025 - val\_loss: 0.5000  
 Epoch 259/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8580 - loss: 0.3160 - val\_accuracy: 0.8148 - val\_loss: 0.4965  
 Epoch 260/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8590 - loss: 0.3210 - val\_accuracy: 0.8148 - val\_loss: 0.5214  
 Epoch 261/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8646 - loss: 0.3204 - val\_accuracy: 0.7901 - val\_loss: 0.4880  
 Epoch 262/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8705 - loss: 0.3118 - val\_accuracy: 0.7901 - val\_loss: 0.5419  
 Epoch 263/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8623 - loss: 0.3226 - val\_accuracy: 0.8272 - val\_loss: 0.5034  
 Epoch 264/800

8/8                    0s 2ms/step -  
 accuracy: 0.8491 - loss: 0.3330 - val\_accuracy: 0.8025 - val\_loss: 0.5043  
 Epoch 265/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8767 - loss: 0.2959 - val\_accuracy: 0.7407 - val\_loss: 0.5794  
 Epoch 266/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8094 - loss: 0.3655 - val\_accuracy: 0.8148 - val\_loss: 0.4904  
 Epoch 267/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8723 - loss: 0.3276 - val\_accuracy: 0.8025 - val\_loss: 0.4916  
 Epoch 268/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8467 - loss: 0.3363 - val\_accuracy: 0.7654 - val\_loss: 0.5742  
 Epoch 269/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8281 - loss: 0.3550 - val\_accuracy: 0.8148 - val\_loss: 0.4841  
 Epoch 270/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8312 - loss: 0.3182 - val\_accuracy: 0.8025 - val\_loss: 0.5425  
 Epoch 271/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8593 - loss: 0.3070 - val\_accuracy: 0.8025 - val\_loss: 0.5023  
 Epoch 272/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8395 - loss: 0.3254 - val\_accuracy: 0.8148 - val\_loss: 0.5086  
 Epoch 273/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8894 - loss: 0.2878 - val\_accuracy: 0.8025 - val\_loss: 0.5129  
 Epoch 274/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8712 - loss: 0.3027 - val\_accuracy: 0.7901 - val\_loss: 0.5194  
 Epoch 275/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8652 - loss: 0.2998 - val\_accuracy: 0.7531 - val\_loss: 0.5751  
 Epoch 276/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8921 - loss: 0.2980 - val\_accuracy: 0.8148 - val\_loss: 0.5150  
 Epoch 277/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8730 - loss: 0.2954 - val\_accuracy: 0.8148 - val\_loss: 0.5441  
 Epoch 278/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8597 - loss: 0.3082 - val\_accuracy: 0.7901 - val\_loss: 0.5874  
 Epoch 279/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8812 - loss: 0.2939 - val\_accuracy: 0.8148 - val\_loss: 0.5229  
 Epoch 280/800

8/8                    0s 2ms/step -  
 accuracy: 0.8576 - loss: 0.3187 - val\_accuracy: 0.7778 - val\_loss: 0.5847  
 Epoch 281/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8467 - loss: 0.3092 - val\_accuracy: 0.7901 - val\_loss: 0.5748  
 Epoch 282/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8709 - loss: 0.2977 - val\_accuracy: 0.7778 - val\_loss: 0.5490  
 Epoch 283/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8725 - loss: 0.2864 - val\_accuracy: 0.8148 - val\_loss: 0.5239  
 Epoch 284/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8782 - loss: 0.3031 - val\_accuracy: 0.7160 - val\_loss: 0.6432  
 Epoch 285/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8412 - loss: 0.3456 - val\_accuracy: 0.7654 - val\_loss: 0.5728  
 Epoch 286/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8061 - loss: 0.3923 - val\_accuracy: 0.8025 - val\_loss: 0.5528  
 Epoch 287/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8723 - loss: 0.3172 - val\_accuracy: 0.7901 - val\_loss: 0.5143  
 Epoch 288/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8671 - loss: 0.3038 - val\_accuracy: 0.8272 - val\_loss: 0.5069  
 Epoch 289/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8737 - loss: 0.3031 - val\_accuracy: 0.7778 - val\_loss: 0.5371  
 Epoch 290/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8648 - loss: 0.3209 - val\_accuracy: 0.7901 - val\_loss: 0.5420  
 Epoch 291/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8573 - loss: 0.3202 - val\_accuracy: 0.8025 - val\_loss: 0.5211  
 Epoch 292/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8695 - loss: 0.3061 - val\_accuracy: 0.8148 - val\_loss: 0.5269  
 Epoch 293/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8714 - loss: 0.2933 - val\_accuracy: 0.7654 - val\_loss: 0.5846  
 Epoch 294/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8713 - loss: 0.2996 - val\_accuracy: 0.8148 - val\_loss: 0.5259  
 Epoch 295/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8539 - loss: 0.3273 - val\_accuracy: 0.8025 - val\_loss: 0.5604  
 Epoch 296/800

8/8                    0s 2ms/step -  
 accuracy: 0.8499 - loss: 0.3352 - val\_accuracy: 0.7654 - val\_loss: 0.5222  
 Epoch 297/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8316 - loss: 0.3362 - val\_accuracy: 0.8025 - val\_loss: 0.5353  
 Epoch 298/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8467 - loss: 0.3296 - val\_accuracy: 0.7531 - val\_loss: 0.6336  
 Epoch 299/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8361 - loss: 0.3393 - val\_accuracy: 0.8272 - val\_loss: 0.5256  
 Epoch 300/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8779 - loss: 0.3060 - val\_accuracy: 0.8148 - val\_loss: 0.5377  
 Epoch 301/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8379 - loss: 0.3201 - val\_accuracy: 0.7407 - val\_loss: 0.6025  
 Epoch 302/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8661 - loss: 0.3061 - val\_accuracy: 0.7778 - val\_loss: 0.5636  
 Epoch 303/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8566 - loss: 0.3284 - val\_accuracy: 0.7160 - val\_loss: 0.6361  
 Epoch 304/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8644 - loss: 0.3005 - val\_accuracy: 0.8148 - val\_loss: 0.5485  
 Epoch 305/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8560 - loss: 0.2862 - val\_accuracy: 0.8148 - val\_loss: 0.5525  
 Epoch 306/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8462 - loss: 0.3206 - val\_accuracy: 0.7778 - val\_loss: 0.6110  
 Epoch 307/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8476 - loss: 0.3181 - val\_accuracy: 0.8025 - val\_loss: 0.5449  
 Epoch 308/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8926 - loss: 0.2786 - val\_accuracy: 0.7531 - val\_loss: 0.6321  
 Epoch 309/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8586 - loss: 0.3532 - val\_accuracy: 0.7654 - val\_loss: 0.5927  
 Epoch 310/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8607 - loss: 0.3265 - val\_accuracy: 0.7654 - val\_loss: 0.6092  
 Epoch 311/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8789 - loss: 0.2871 - val\_accuracy: 0.7901 - val\_loss: 0.5952  
 Epoch 312/800

8/8                    0s 2ms/step -  
 accuracy: 0.8714 - loss: 0.3023 - val\_accuracy: 0.8148 - val\_loss: 0.5833  
 Epoch 313/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9043 - loss: 0.2615 - val\_accuracy: 0.7901 - val\_loss: 0.6115  
 Epoch 314/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8788 - loss: 0.2695 - val\_accuracy: 0.8025 - val\_loss: 0.5946  
 Epoch 315/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8751 - loss: 0.2736 - val\_accuracy: 0.7901 - val\_loss: 0.6014  
 Epoch 316/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8887 - loss: 0.2703 - val\_accuracy: 0.7901 - val\_loss: 0.6223  
 Epoch 317/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8742 - loss: 0.2817 - val\_accuracy: 0.8148 - val\_loss: 0.5954  
 Epoch 318/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9048 - loss: 0.2701 - val\_accuracy: 0.7654 - val\_loss: 0.6077  
 Epoch 319/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8801 - loss: 0.2890 - val\_accuracy: 0.7778 - val\_loss: 0.6197  
 Epoch 320/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8922 - loss: 0.2603 - val\_accuracy: 0.7531 - val\_loss: 0.6232  
 Epoch 321/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8711 - loss: 0.2746 - val\_accuracy: 0.7778 - val\_loss: 0.6197  
 Epoch 322/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8978 - loss: 0.2641 - val\_accuracy: 0.8148 - val\_loss: 0.5757  
 Epoch 323/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8855 - loss: 0.2652 - val\_accuracy: 0.7531 - val\_loss: 0.6795  
 Epoch 324/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8993 - loss: 0.2643 - val\_accuracy: 0.8272 - val\_loss: 0.5830  
 Epoch 325/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8934 - loss: 0.2635 - val\_accuracy: 0.8025 - val\_loss: 0.6041  
 Epoch 326/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8943 - loss: 0.2893 - val\_accuracy: 0.7284 - val\_loss: 0.6802  
 Epoch 327/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8759 - loss: 0.3054 - val\_accuracy: 0.8025 - val\_loss: 0.5913  
 Epoch 328/800

8/8                    0s 2ms/step -  
 accuracy: 0.8954 - loss: 0.2681 - val\_accuracy: 0.7901 - val\_loss: 0.6127  
 Epoch 329/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8770 - loss: 0.2810 - val\_accuracy: 0.7654 - val\_loss: 0.5887  
 Epoch 330/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8910 - loss: 0.2422 - val\_accuracy: 0.7284 - val\_loss: 0.6282  
 Epoch 331/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8833 - loss: 0.2595 - val\_accuracy: 0.8395 - val\_loss: 0.5763  
 Epoch 332/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8837 - loss: 0.2608 - val\_accuracy: 0.8148 - val\_loss: 0.5688  
 Epoch 333/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8925 - loss: 0.2464 - val\_accuracy: 0.7778 - val\_loss: 0.6443  
 Epoch 334/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8938 - loss: 0.2637 - val\_accuracy: 0.8272 - val\_loss: 0.5911  
 Epoch 335/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8950 - loss: 0.2510 - val\_accuracy: 0.7778 - val\_loss: 0.6025  
 Epoch 336/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8789 - loss: 0.2859 - val\_accuracy: 0.7160 - val\_loss: 0.7024  
 Epoch 337/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.8575 - loss: 0.3121 - val\_accuracy: 0.7531 - val\_loss: 0.6124  
 Epoch 338/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8738 - loss: 0.2953 - val\_accuracy: 0.7037 - val\_loss: 0.7091  
 Epoch 339/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8567 - loss: 0.3008 - val\_accuracy: 0.8025 - val\_loss: 0.5872  
 Epoch 340/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8633 - loss: 0.3003 - val\_accuracy: 0.7901 - val\_loss: 0.6361  
 Epoch 341/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8901 - loss: 0.2787 - val\_accuracy: 0.7901 - val\_loss: 0.6124  
 Epoch 342/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8478 - loss: 0.3070 - val\_accuracy: 0.7531 - val\_loss: 0.6950  
 Epoch 343/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8737 - loss: 0.3319 - val\_accuracy: 0.7654 - val\_loss: 0.6155  
 Epoch 344/800



8/8                    0s 2ms/step -  
 accuracy: 0.8451 - loss: 0.3564 - val\_accuracy: 0.7160 - val\_loss: 0.7185  
 Epoch 345/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8485 - loss: 0.3354 - val\_accuracy: 0.7778 - val\_loss: 0.6327  
 Epoch 346/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8300 - loss: 0.3694 - val\_accuracy: 0.7654 - val\_loss: 0.6149  
 Epoch 347/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8511 - loss: 0.3503 - val\_accuracy: 0.7160 - val\_loss: 0.7001  
 Epoch 348/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8486 - loss: 0.3225 - val\_accuracy: 0.7407 - val\_loss: 0.5790  
 Epoch 349/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8980 - loss: 0.2686 - val\_accuracy: 0.7407 - val\_loss: 0.6545  
 Epoch 350/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8981 - loss: 0.2830 - val\_accuracy: 0.7778 - val\_loss: 0.6003  
 Epoch 351/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8829 - loss: 0.2644 - val\_accuracy: 0.7654 - val\_loss: 0.6161  
 Epoch 352/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8962 - loss: 0.2481 - val\_accuracy: 0.8148 - val\_loss: 0.5769  
 Epoch 353/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8755 - loss: 0.2619 - val\_accuracy: 0.7037 - val\_loss: 0.6600  
 Epoch 354/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8926 - loss: 0.2545 - val\_accuracy: 0.7778 - val\_loss: 0.6456  
 Epoch 355/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9018 - loss: 0.2371 - val\_accuracy: 0.7901 - val\_loss: 0.5970  
 Epoch 356/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8763 - loss: 0.2728 - val\_accuracy: 0.8148 - val\_loss: 0.5901  
 Epoch 357/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8850 - loss: 0.2597 - val\_accuracy: 0.7778 - val\_loss: 0.6106  
 Epoch 358/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8973 - loss: 0.2544 - val\_accuracy: 0.7778 - val\_loss: 0.6219  
 Epoch 359/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8943 - loss: 0.2544 - val\_accuracy: 0.7160 - val\_loss: 0.7066  
 Epoch 360/800

8/8                    0s 2ms/step -  
 accuracy: 0.9034 - loss: 0.2609 - val\_accuracy: 0.7654 - val\_loss: 0.6274  
 Epoch 361/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8965 - loss: 0.2590 - val\_accuracy: 0.7407 - val\_loss: 0.7126  
 Epoch 362/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8936 - loss: 0.2616 - val\_accuracy: 0.7284 - val\_loss: 0.7246  
 Epoch 363/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8823 - loss: 0.2795 - val\_accuracy: 0.8148 - val\_loss: 0.6270  
 Epoch 364/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8892 - loss: 0.2496 - val\_accuracy: 0.7037 - val\_loss: 0.7188  
 Epoch 365/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8983 - loss: 0.2587 - val\_accuracy: 0.8025 - val\_loss: 0.6144  
 Epoch 366/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9201 - loss: 0.2181 - val\_accuracy: 0.7037 - val\_loss: 0.7613  
 Epoch 367/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8679 - loss: 0.2789 - val\_accuracy: 0.8025 - val\_loss: 0.6130  
 Epoch 368/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8645 - loss: 0.3131 - val\_accuracy: 0.7654 - val\_loss: 0.6694  
 Epoch 369/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8677 - loss: 0.2903 - val\_accuracy: 0.7037 - val\_loss: 0.7173  
 Epoch 370/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8892 - loss: 0.2835 - val\_accuracy: 0.7531 - val\_loss: 0.6079  
 Epoch 371/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8538 - loss: 0.3139 - val\_accuracy: 0.7531 - val\_loss: 0.6636  
 Epoch 372/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8745 - loss: 0.2813 - val\_accuracy: 0.7531 - val\_loss: 0.6433  
 Epoch 373/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8542 - loss: 0.2890 - val\_accuracy: 0.7901 - val\_loss: 0.6155  
 Epoch 374/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8934 - loss: 0.2409 - val\_accuracy: 0.7531 - val\_loss: 0.6944  
 Epoch 375/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8950 - loss: 0.2389 - val\_accuracy: 0.7654 - val\_loss: 0.6646  
 Epoch 376/800

8/8                    0s 2ms/step -  
 accuracy: 0.8925 - loss: 0.2398 - val\_accuracy: 0.7531 - val\_loss: 0.7200  
 Epoch 377/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8686 - loss: 0.2721 - val\_accuracy: 0.8025 - val\_loss: 0.6249  
 Epoch 378/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8868 - loss: 0.2517 - val\_accuracy: 0.7284 - val\_loss: 0.7295  
 Epoch 379/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8966 - loss: 0.2713 - val\_accuracy: 0.7407 - val\_loss: 0.6879  
 Epoch 380/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8680 - loss: 0.3017 - val\_accuracy: 0.7778 - val\_loss: 0.6785  
 Epoch 381/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9011 - loss: 0.2490 - val\_accuracy: 0.7407 - val\_loss: 0.6814  
 Epoch 382/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8957 - loss: 0.2661 - val\_accuracy: 0.7654 - val\_loss: 0.6379  
 Epoch 383/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8765 - loss: 0.2779 - val\_accuracy: 0.7037 - val\_loss: 0.7115  
 Epoch 384/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9044 - loss: 0.2343 - val\_accuracy: 0.7778 - val\_loss: 0.6428  
 Epoch 385/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9174 - loss: 0.2214 - val\_accuracy: 0.7531 - val\_loss: 0.7121  
 Epoch 386/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9067 - loss: 0.2416 - val\_accuracy: 0.7407 - val\_loss: 0.6899  
 Epoch 387/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9009 - loss: 0.2410 - val\_accuracy: 0.7778 - val\_loss: 0.6682  
 Epoch 388/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9148 - loss: 0.2344 - val\_accuracy: 0.7160 - val\_loss: 0.7491  
 Epoch 389/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8942 - loss: 0.2476 - val\_accuracy: 0.7654 - val\_loss: 0.6427  
 Epoch 390/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9035 - loss: 0.2494 - val\_accuracy: 0.7407 - val\_loss: 0.7132  
 Epoch 391/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9093 - loss: 0.2377 - val\_accuracy: 0.7654 - val\_loss: 0.6945  
 Epoch 392/800

8/8                    0s 2ms/step -  
 accuracy: 0.9187 - loss: 0.2069 - val\_accuracy: 0.7531 - val\_loss: 0.7259  
 Epoch 393/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9165 - loss: 0.2097 - val\_accuracy: 0.7654 - val\_loss: 0.7032  
 Epoch 394/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9262 - loss: 0.2001 - val\_accuracy: 0.7654 - val\_loss: 0.7154  
 Epoch 395/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9123 - loss: 0.2266 - val\_accuracy: 0.7654 - val\_loss: 0.7306  
 Epoch 396/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9121 - loss: 0.2133 - val\_accuracy: 0.7654 - val\_loss: 0.7435  
 Epoch 397/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9314 - loss: 0.2050 - val\_accuracy: 0.7160 - val\_loss: 0.7655  
 Epoch 398/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9108 - loss: 0.2193 - val\_accuracy: 0.7654 - val\_loss: 0.6984  
 Epoch 399/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8584 - loss: 0.3213 - val\_accuracy: 0.6420 - val\_loss: 0.8144  
 Epoch 400/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8471 - loss: 0.3134 - val\_accuracy: 0.7778 - val\_loss: 0.7205  
 Epoch 401/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8797 - loss: 0.2929 - val\_accuracy: 0.7037 - val\_loss: 0.6552  
 Epoch 402/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8778 - loss: 0.2631 - val\_accuracy: 0.7531 - val\_loss: 0.6197  
 Epoch 403/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9161 - loss: 0.2229 - val\_accuracy: 0.8025 - val\_loss: 0.6018  
 Epoch 404/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8480 - loss: 0.3319 - val\_accuracy: 0.6914 - val\_loss: 0.7198  
 Epoch 405/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8929 - loss: 0.2925 - val\_accuracy: 0.7284 - val\_loss: 0.6477  
 Epoch 406/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8704 - loss: 0.2987 - val\_accuracy: 0.7778 - val\_loss: 0.6427  
 Epoch 407/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8704 - loss: 0.2820 - val\_accuracy: 0.7160 - val\_loss: 0.6729  
 Epoch 408/800

8/8                    0s 2ms/step -  
 accuracy: 0.8940 - loss: 0.2675 - val\_accuracy: 0.7901 - val\_loss: 0.6164  
 Epoch 409/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9158 - loss: 0.2178 - val\_accuracy: 0.7901 - val\_loss: 0.6386  
 Epoch 410/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8836 - loss: 0.2484 - val\_accuracy: 0.7407 - val\_loss: 0.6974  
 Epoch 411/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8922 - loss: 0.2360 - val\_accuracy: 0.7407 - val\_loss: 0.6907  
 Epoch 412/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9236 - loss: 0.2110 - val\_accuracy: 0.7407 - val\_loss: 0.7089  
 Epoch 413/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9210 - loss: 0.2063 - val\_accuracy: 0.7284 - val\_loss: 0.7314  
 Epoch 414/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9276 - loss: 0.2045 - val\_accuracy: 0.7778 - val\_loss: 0.6908  
 Epoch 415/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8925 - loss: 0.2244 - val\_accuracy: 0.7407 - val\_loss: 0.7084  
 Epoch 416/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9145 - loss: 0.2200 - val\_accuracy: 0.7407 - val\_loss: 0.7073  
 Epoch 417/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8967 - loss: 0.2539 - val\_accuracy: 0.7654 - val\_loss: 0.6840  
 Epoch 418/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8938 - loss: 0.2330 - val\_accuracy: 0.7778 - val\_loss: 0.6908  
 Epoch 419/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9173 - loss: 0.2169 - val\_accuracy: 0.7901 - val\_loss: 0.7204  
 Epoch 420/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9122 - loss: 0.2203 - val\_accuracy: 0.7284 - val\_loss: 0.7508  
 Epoch 421/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8951 - loss: 0.2289 - val\_accuracy: 0.7778 - val\_loss: 0.7043  
 Epoch 422/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9195 - loss: 0.2074 - val\_accuracy: 0.7037 - val\_loss: 0.8360  
 Epoch 423/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8895 - loss: 0.2474 - val\_accuracy: 0.7531 - val\_loss: 0.6999  
 Epoch 424/800

8/8                    0s 2ms/step -  
 accuracy: 0.8871 - loss: 0.2587 - val\_accuracy: 0.7901 - val\_loss: 0.6462  
 Epoch 425/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8977 - loss: 0.2444 - val\_accuracy: 0.7160 - val\_loss: 0.7734  
 Epoch 426/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9140 - loss: 0.2426 - val\_accuracy: 0.7778 - val\_loss: 0.7512  
 Epoch 427/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8732 - loss: 0.2774 - val\_accuracy: 0.7654 - val\_loss: 0.7191  
 Epoch 428/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9001 - loss: 0.2518 - val\_accuracy: 0.7778 - val\_loss: 0.7070  
 Epoch 429/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8569 - loss: 0.2760 - val\_accuracy: 0.7160 - val\_loss: 0.8230  
 Epoch 430/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8924 - loss: 0.2370 - val\_accuracy: 0.7531 - val\_loss: 0.7128  
 Epoch 431/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9011 - loss: 0.2544 - val\_accuracy: 0.7407 - val\_loss: 0.7192  
 Epoch 432/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8839 - loss: 0.2613 - val\_accuracy: 0.7037 - val\_loss: 0.8557  
 Epoch 433/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8989 - loss: 0.2474 - val\_accuracy: 0.7778 - val\_loss: 0.7262  
 Epoch 434/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9091 - loss: 0.2174 - val\_accuracy: 0.7160 - val\_loss: 0.7964  
 Epoch 435/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9479 - loss: 0.1904 - val\_accuracy: 0.7407 - val\_loss: 0.7959  
 Epoch 436/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9286 - loss: 0.1945 - val\_accuracy: 0.7654 - val\_loss: 0.7558  
 Epoch 437/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9063 - loss: 0.2142 - val\_accuracy: 0.7407 - val\_loss: 0.8212  
 Epoch 438/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9120 - loss: 0.2207 - val\_accuracy: 0.7901 - val\_loss: 0.7284  
 Epoch 439/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9020 - loss: 0.2332 - val\_accuracy: 0.7778 - val\_loss: 0.7219  
 Epoch 440/800

8/8                    0s 2ms/step -  
 accuracy: 0.9055 - loss: 0.2222 - val\_accuracy: 0.7778 - val\_loss: 0.7622  
 Epoch 441/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9341 - loss: 0.2050 - val\_accuracy: 0.7407 - val\_loss: 0.7820  
 Epoch 442/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9022 - loss: 0.2367 - val\_accuracy: 0.7778 - val\_loss: 0.7467  
 Epoch 443/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9207 - loss: 0.1938 - val\_accuracy: 0.7531 - val\_loss: 0.7566  
 Epoch 444/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9226 - loss: 0.2050 - val\_accuracy: 0.7284 - val\_loss: 0.7958  
 Epoch 445/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9275 - loss: 0.1943 - val\_accuracy: 0.7407 - val\_loss: 0.7739  
 Epoch 446/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9106 - loss: 0.1865 - val\_accuracy: 0.7407 - val\_loss: 0.7850  
 Epoch 447/800  
 8/8                    0s 5ms/step -  
 accuracy: 0.9313 - loss: 0.1956 - val\_accuracy: 0.7407 - val\_loss: 0.8176  
 Epoch 448/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9346 - loss: 0.1953 - val\_accuracy: 0.7531 - val\_loss: 0.7610  
 Epoch 449/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9264 - loss: 0.2035 - val\_accuracy: 0.7160 - val\_loss: 0.8452  
 Epoch 450/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8989 - loss: 0.2288 - val\_accuracy: 0.7531 - val\_loss: 0.8325  
 Epoch 451/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9309 - loss: 0.1826 - val\_accuracy: 0.7160 - val\_loss: 0.8126  
 Epoch 452/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9226 - loss: 0.1953 - val\_accuracy: 0.7531 - val\_loss: 0.7853  
 Epoch 453/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9328 - loss: 0.1971 - val\_accuracy: 0.7901 - val\_loss: 0.7504  
 Epoch 454/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9215 - loss: 0.2029 - val\_accuracy: 0.7160 - val\_loss: 0.8304  
 Epoch 455/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9224 - loss: 0.1925 - val\_accuracy: 0.7037 - val\_loss: 0.8711  
 Epoch 456/800

8/8                    0s 2ms/step -  
 accuracy: 0.9199 - loss: 0.2079 - val\_accuracy: 0.7160 - val\_loss: 0.8173  
 Epoch 457/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9301 - loss: 0.1720 - val\_accuracy: 0.7160 - val\_loss: 0.8591  
 Epoch 458/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9270 - loss: 0.1968 - val\_accuracy: 0.7160 - val\_loss: 0.8681  
 Epoch 459/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9047 - loss: 0.2174 - val\_accuracy: 0.7901 - val\_loss: 0.7779  
 Epoch 460/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8701 - loss: 0.3003 - val\_accuracy: 0.7531 - val\_loss: 0.7972  
 Epoch 461/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9063 - loss: 0.2726 - val\_accuracy: 0.8025 - val\_loss: 0.7019  
 Epoch 462/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9197 - loss: 0.2135 - val\_accuracy: 0.7654 - val\_loss: 0.7886  
 Epoch 463/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8952 - loss: 0.2184 - val\_accuracy: 0.7778 - val\_loss: 0.7712  
 Epoch 464/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9139 - loss: 0.1945 - val\_accuracy: 0.7160 - val\_loss: 0.8321  
 Epoch 465/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9327 - loss: 0.1974 - val\_accuracy: 0.7654 - val\_loss: 0.8058  
 Epoch 466/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9220 - loss: 0.2003 - val\_accuracy: 0.7901 - val\_loss: 0.7985  
 Epoch 467/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9352 - loss: 0.1836 - val\_accuracy: 0.8025 - val\_loss: 0.7588  
 Epoch 468/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9193 - loss: 0.1864 - val\_accuracy: 0.7160 - val\_loss: 0.8308  
 Epoch 469/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9290 - loss: 0.1836 - val\_accuracy: 0.7778 - val\_loss: 0.8100  
 Epoch 470/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8979 - loss: 0.2271 - val\_accuracy: 0.7654 - val\_loss: 0.7924  
 Epoch 471/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8827 - loss: 0.2690 - val\_accuracy: 0.7037 - val\_loss: 0.9084  
 Epoch 472/800



8/8                    0s 2ms/step -  
 accuracy: 0.8776 - loss: 0.2757 - val\_accuracy: 0.7407 - val\_loss: 0.8174  
 Epoch 473/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9143 - loss: 0.2224 - val\_accuracy: 0.7407 - val\_loss: 0.7354  
 Epoch 474/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.8995 - loss: 0.2194 - val\_accuracy: 0.7654 - val\_loss: 0.7556  
 Epoch 475/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9108 - loss: 0.1918 - val\_accuracy: 0.7778 - val\_loss: 0.7943  
 Epoch 476/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9307 - loss: 0.1838 - val\_accuracy: 0.7160 - val\_loss: 0.8825  
 Epoch 477/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9092 - loss: 0.2406 - val\_accuracy: 0.8025 - val\_loss: 0.8023  
 Epoch 478/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9222 - loss: 0.1903 - val\_accuracy: 0.7160 - val\_loss: 0.9791  
 Epoch 479/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8859 - loss: 0.2562 - val\_accuracy: 0.7407 - val\_loss: 0.7928  
 Epoch 480/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8947 - loss: 0.2267 - val\_accuracy: 0.7284 - val\_loss: 0.8057  
 Epoch 481/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9377 - loss: 0.1865 - val\_accuracy: 0.7284 - val\_loss: 0.7972  
 Epoch 482/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8825 - loss: 0.2580 - val\_accuracy: 0.7160 - val\_loss: 0.8242  
 Epoch 483/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8825 - loss: 0.2475 - val\_accuracy: 0.7654 - val\_loss: 0.7458  
 Epoch 484/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8929 - loss: 0.2395 - val\_accuracy: 0.7654 - val\_loss: 0.7537  
 Epoch 485/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9187 - loss: 0.1888 - val\_accuracy: 0.7160 - val\_loss: 0.8228  
 Epoch 486/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9235 - loss: 0.2031 - val\_accuracy: 0.7778 - val\_loss: 0.7780  
 Epoch 487/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9090 - loss: 0.2227 - val\_accuracy: 0.7654 - val\_loss: 0.8332  
 Epoch 488/800

8/8                    0s 2ms/step -  
 accuracy: 0.9002 - loss: 0.2216 - val\_accuracy: 0.7407 - val\_loss: 0.8482  
 Epoch 489/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9121 - loss: 0.2058 - val\_accuracy: 0.7531 - val\_loss: 0.8133  
 Epoch 490/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9261 - loss: 0.1924 - val\_accuracy: 0.7037 - val\_loss: 0.9100  
 Epoch 491/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9298 - loss: 0.1982 - val\_accuracy: 0.7531 - val\_loss: 0.8352  
 Epoch 492/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9364 - loss: 0.1726 - val\_accuracy: 0.7407 - val\_loss: 0.9009  
 Epoch 493/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9250 - loss: 0.1754 - val\_accuracy: 0.7531 - val\_loss: 0.8571  
 Epoch 494/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9215 - loss: 0.1952 - val\_accuracy: 0.7531 - val\_loss: 0.8722  
 Epoch 495/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9289 - loss: 0.1781 - val\_accuracy: 0.7654 - val\_loss: 0.8539  
 Epoch 496/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9236 - loss: 0.1769 - val\_accuracy: 0.7160 - val\_loss: 0.9202  
 Epoch 497/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9339 - loss: 0.1664 - val\_accuracy: 0.7407 - val\_loss: 0.9013  
 Epoch 498/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9384 - loss: 0.1866 - val\_accuracy: 0.7407 - val\_loss: 0.8803  
 Epoch 499/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9143 - loss: 0.2077 - val\_accuracy: 0.6790 - val\_loss: 0.9057  
 Epoch 500/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9137 - loss: 0.2057 - val\_accuracy: 0.7407 - val\_loss: 0.8842  
 Epoch 501/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9039 - loss: 0.2172 - val\_accuracy: 0.7531 - val\_loss: 0.8541  
 Epoch 502/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9005 - loss: 0.2105 - val\_accuracy: 0.7160 - val\_loss: 0.9783  
 Epoch 503/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9345 - loss: 0.1839 - val\_accuracy: 0.7654 - val\_loss: 0.8849  
 Epoch 504/800

8/8                    0s 2ms/step -  
 accuracy: 0.9436 - loss: 0.1575 - val\_accuracy: 0.7037 - val\_loss: 0.9092  
 Epoch 505/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9496 - loss: 0.1729 - val\_accuracy: 0.7284 - val\_loss: 0.8885  
 Epoch 506/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9419 - loss: 0.1706 - val\_accuracy: 0.7407 - val\_loss: 0.9241  
 Epoch 507/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9469 - loss: 0.1817 - val\_accuracy: 0.7778 - val\_loss: 0.8999  
 Epoch 508/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9315 - loss: 0.1692 - val\_accuracy: 0.7531 - val\_loss: 0.8477  
 Epoch 509/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.9397 - loss: 0.1743 - val\_accuracy: 0.7160 - val\_loss: 0.8861  
 Epoch 510/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8869 - loss: 0.2187 - val\_accuracy: 0.7037 - val\_loss: 0.9203  
 Epoch 511/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9080 - loss: 0.1988 - val\_accuracy: 0.7901 - val\_loss: 0.8436  
 Epoch 512/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8957 - loss: 0.2419 - val\_accuracy: 0.7654 - val\_loss: 0.8693  
 Epoch 513/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9015 - loss: 0.2105 - val\_accuracy: 0.7407 - val\_loss: 0.8695  
 Epoch 514/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9168 - loss: 0.2031 - val\_accuracy: 0.7160 - val\_loss: 0.9292  
 Epoch 515/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9243 - loss: 0.2005 - val\_accuracy: 0.7037 - val\_loss: 0.9782  
 Epoch 516/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9344 - loss: 0.1931 - val\_accuracy: 0.7284 - val\_loss: 0.8910  
 Epoch 517/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9272 - loss: 0.1707 - val\_accuracy: 0.7531 - val\_loss: 0.8604  
 Epoch 518/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9079 - loss: 0.2444 - val\_accuracy: 0.6790 - val\_loss: 1.0561  
 Epoch 519/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8881 - loss: 0.2409 - val\_accuracy: 0.7654 - val\_loss: 0.8622  
 Epoch 520/800

8/8                    0s 2ms/step -  
 accuracy: 0.8805 - loss: 0.2636 - val\_accuracy: 0.7284 - val\_loss: 0.8794  
 Epoch 521/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9295 - loss: 0.1738 - val\_accuracy: 0.7160 - val\_loss: 0.8900  
 Epoch 522/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9427 - loss: 0.1656 - val\_accuracy: 0.7654 - val\_loss: 0.8820  
 Epoch 523/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9182 - loss: 0.2048 - val\_accuracy: 0.7531 - val\_loss: 0.9009  
 Epoch 524/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9153 - loss: 0.2224 - val\_accuracy: 0.7531 - val\_loss: 1.0053  
 Epoch 525/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9267 - loss: 0.2340 - val\_accuracy: 0.7160 - val\_loss: 0.9522  
 Epoch 526/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9144 - loss: 0.1826 - val\_accuracy: 0.7160 - val\_loss: 0.9218  
 Epoch 527/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9499 - loss: 0.1623 - val\_accuracy: 0.6790 - val\_loss: 0.9227  
 Epoch 528/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9276 - loss: 0.1887 - val\_accuracy: 0.7531 - val\_loss: 0.8988  
 Epoch 529/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9396 - loss: 0.1670 - val\_accuracy: 0.7284 - val\_loss: 0.8758  
 Epoch 530/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9379 - loss: 0.1584 - val\_accuracy: 0.7284 - val\_loss: 0.9316  
 Epoch 531/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9317 - loss: 0.1894 - val\_accuracy: 0.7160 - val\_loss: 0.9142  
 Epoch 532/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9376 - loss: 0.1602 - val\_accuracy: 0.7654 - val\_loss: 0.8873  
 Epoch 533/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9349 - loss: 0.1644 - val\_accuracy: 0.7037 - val\_loss: 0.9532  
 Epoch 534/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9507 - loss: 0.1595 - val\_accuracy: 0.7654 - val\_loss: 0.9302  
 Epoch 535/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9443 - loss: 0.1489 - val\_accuracy: 0.7037 - val\_loss: 1.0657  
 Epoch 536/800

8/8                    0s 2ms/step -  
 accuracy: 0.9081 - loss: 0.1777 - val\_accuracy: 0.7778 - val\_loss: 0.9256  
 Epoch 537/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9004 - loss: 0.1974 - val\_accuracy: 0.7160 - val\_loss: 1.0490  
 Epoch 538/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9144 - loss: 0.1888 - val\_accuracy: 0.7407 - val\_loss: 0.8900  
 Epoch 539/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9538 - loss: 0.1487 - val\_accuracy: 0.7160 - val\_loss: 0.9761  
 Epoch 540/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9407 - loss: 0.1933 - val\_accuracy: 0.7160 - val\_loss: 0.9669  
 Epoch 541/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9288 - loss: 0.1801 - val\_accuracy: 0.7284 - val\_loss: 0.9612  
 Epoch 542/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9413 - loss: 0.1820 - val\_accuracy: 0.7407 - val\_loss: 0.9497  
 Epoch 543/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9044 - loss: 0.2007 - val\_accuracy: 0.7037 - val\_loss: 0.9663  
 Epoch 544/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9232 - loss: 0.1840 - val\_accuracy: 0.7654 - val\_loss: 0.8961  
 Epoch 545/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9133 - loss: 0.2061 - val\_accuracy: 0.6667 - val\_loss: 1.0660  
 Epoch 546/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9005 - loss: 0.2230 - val\_accuracy: 0.7037 - val\_loss: 1.0220  
 Epoch 547/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9209 - loss: 0.1701 - val\_accuracy: 0.7407 - val\_loss: 0.8508  
 Epoch 548/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9028 - loss: 0.2070 - val\_accuracy: 0.7284 - val\_loss: 0.8699  
 Epoch 549/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9197 - loss: 0.1973 - val\_accuracy: 0.7531 - val\_loss: 0.8800  
 Epoch 550/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9137 - loss: 0.1951 - val\_accuracy: 0.7160 - val\_loss: 0.8758  
 Epoch 551/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9091 - loss: 0.1902 - val\_accuracy: 0.7037 - val\_loss: 0.9720  
 Epoch 552/800

8/8                    0s 2ms/step -  
 accuracy: 0.9194 - loss: 0.1949 - val\_accuracy: 0.7531 - val\_loss: 0.9430  
 Epoch 553/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9453 - loss: 0.1656 - val\_accuracy: 0.7160 - val\_loss: 0.9861  
 Epoch 554/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9256 - loss: 0.1801 - val\_accuracy: 0.7037 - val\_loss: 1.0076  
 Epoch 555/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9289 - loss: 0.1771 - val\_accuracy: 0.7654 - val\_loss: 0.9378  
 Epoch 556/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9433 - loss: 0.1684 - val\_accuracy: 0.7284 - val\_loss: 1.0371  
 Epoch 557/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9195 - loss: 0.1866 - val\_accuracy: 0.7160 - val\_loss: 1.0414  
 Epoch 558/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9235 - loss: 0.1790 - val\_accuracy: 0.7654 - val\_loss: 0.9815  
 Epoch 559/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9331 - loss: 0.1502 - val\_accuracy: 0.7037 - val\_loss: 1.0564  
 Epoch 560/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9313 - loss: 0.1763 - val\_accuracy: 0.7531 - val\_loss: 1.0241  
 Epoch 561/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9242 - loss: 0.1635 - val\_accuracy: 0.7407 - val\_loss: 1.0250  
 Epoch 562/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9054 - loss: 0.2435 - val\_accuracy: 0.6914 - val\_loss: 1.1593  
 Epoch 563/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9102 - loss: 0.1981 - val\_accuracy: 0.7778 - val\_loss: 0.9608  
 Epoch 564/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9254 - loss: 0.1760 - val\_accuracy: 0.7037 - val\_loss: 1.0223  
 Epoch 565/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9405 - loss: 0.1693 - val\_accuracy: 0.7531 - val\_loss: 0.9916  
 Epoch 566/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9459 - loss: 0.1360 - val\_accuracy: 0.7037 - val\_loss: 1.0525  
 Epoch 567/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9096 - loss: 0.2109 - val\_accuracy: 0.7284 - val\_loss: 0.9412  
 Epoch 568/800

8/8                    0s 2ms/step -  
 accuracy: 0.9235 - loss: 0.1815 - val\_accuracy: 0.7037 - val\_loss: 0.9818  
 Epoch 569/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9347 - loss: 0.1675 - val\_accuracy: 0.7407 - val\_loss: 0.9340  
 Epoch 570/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9208 - loss: 0.1833 - val\_accuracy: 0.7284 - val\_loss: 1.0370  
 Epoch 571/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9299 - loss: 0.1602 - val\_accuracy: 0.7160 - val\_loss: 1.0545  
 Epoch 572/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9215 - loss: 0.2002 - val\_accuracy: 0.7160 - val\_loss: 0.9784  
 Epoch 573/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9258 - loss: 0.1589 - val\_accuracy: 0.7037 - val\_loss: 1.0340  
 Epoch 574/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9303 - loss: 0.1580 - val\_accuracy: 0.7407 - val\_loss: 0.9757  
 Epoch 575/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9284 - loss: 0.1585 - val\_accuracy: 0.7284 - val\_loss: 0.9813  
 Epoch 576/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9194 - loss: 0.1646 - val\_accuracy: 0.7284 - val\_loss: 1.0166  
 Epoch 577/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9292 - loss: 0.1602 - val\_accuracy: 0.6790 - val\_loss: 1.0577  
 Epoch 578/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9343 - loss: 0.1676 - val\_accuracy: 0.7654 - val\_loss: 1.0077  
 Epoch 579/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9321 - loss: 0.1585 - val\_accuracy: 0.6667 - val\_loss: 1.1382  
 Epoch 580/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9383 - loss: 0.1580 - val\_accuracy: 0.7284 - val\_loss: 1.0389  
 Epoch 581/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9389 - loss: 0.1636 - val\_accuracy: 0.7037 - val\_loss: 1.0838  
 Epoch 582/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9440 - loss: 0.1443 - val\_accuracy: 0.7778 - val\_loss: 1.0107  
 Epoch 583/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9353 - loss: 0.1630 - val\_accuracy: 0.7284 - val\_loss: 1.1466  
 Epoch 584/800

8/8                    0s 2ms/step -  
 accuracy: 0.9445 - loss: 0.1458 - val\_accuracy: 0.7531 - val\_loss: 1.0551  
 Epoch 585/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9521 - loss: 0.1365 - val\_accuracy: 0.7037 - val\_loss: 1.1043  
 Epoch 586/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9677 - loss: 0.1250 - val\_accuracy: 0.7160 - val\_loss: 1.0579  
 Epoch 587/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9523 - loss: 0.1400 - val\_accuracy: 0.7284 - val\_loss: 1.0840  
 Epoch 588/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9450 - loss: 0.1679 - val\_accuracy: 0.7160 - val\_loss: 1.0505  
 Epoch 589/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9315 - loss: 0.1654 - val\_accuracy: 0.7037 - val\_loss: 1.0518  
 Epoch 590/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9394 - loss: 0.1492 - val\_accuracy: 0.7160 - val\_loss: 1.1237  
 Epoch 591/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9117 - loss: 0.1955 - val\_accuracy: 0.7654 - val\_loss: 1.0425  
 Epoch 592/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9441 - loss: 0.1354 - val\_accuracy: 0.7160 - val\_loss: 1.0659  
 Epoch 593/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9323 - loss: 0.1571 - val\_accuracy: 0.6790 - val\_loss: 1.0886  
 Epoch 594/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9482 - loss: 0.1612 - val\_accuracy: 0.7284 - val\_loss: 1.0826  
 Epoch 595/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9238 - loss: 0.1673 - val\_accuracy: 0.7160 - val\_loss: 1.0545  
 Epoch 596/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9538 - loss: 0.1338 - val\_accuracy: 0.7037 - val\_loss: 1.1212  
 Epoch 597/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9334 - loss: 0.1601 - val\_accuracy: 0.7284 - val\_loss: 1.1104  
 Epoch 598/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9506 - loss: 0.1477 - val\_accuracy: 0.6790 - val\_loss: 1.1706  
 Epoch 599/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9185 - loss: 0.2030 - val\_accuracy: 0.7037 - val\_loss: 1.1225  
 Epoch 600/800



8/8                    0s 2ms/step -  
 accuracy: 0.9241 - loss: 0.1725 - val\_accuracy: 0.7407 - val\_loss: 1.1314  
 Epoch 601/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9073 - loss: 0.2103 - val\_accuracy: 0.7284 - val\_loss: 1.0642  
 Epoch 602/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9207 - loss: 0.1615 - val\_accuracy: 0.7037 - val\_loss: 1.1161  
 Epoch 603/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9518 - loss: 0.1395 - val\_accuracy: 0.7160 - val\_loss: 1.0642  
 Epoch 604/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9362 - loss: 0.1533 - val\_accuracy: 0.7037 - val\_loss: 1.1417  
 Epoch 605/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9389 - loss: 0.1775 - val\_accuracy: 0.7531 - val\_loss: 1.0967  
 Epoch 606/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9368 - loss: 0.1646 - val\_accuracy: 0.7160 - val\_loss: 1.1314  
 Epoch 607/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9341 - loss: 0.1451 - val\_accuracy: 0.7284 - val\_loss: 1.0481  
 Epoch 608/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9423 - loss: 0.1458 - val\_accuracy: 0.7284 - val\_loss: 1.0648  
 Epoch 609/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9088 - loss: 0.1842 - val\_accuracy: 0.6790 - val\_loss: 1.1548  
 Epoch 610/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9446 - loss: 0.1459 - val\_accuracy: 0.7037 - val\_loss: 1.0451  
 Epoch 611/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9309 - loss: 0.1436 - val\_accuracy: 0.6914 - val\_loss: 1.1144  
 Epoch 612/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9469 - loss: 0.1611 - val\_accuracy: 0.7284 - val\_loss: 1.1378  
 Epoch 613/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9445 - loss: 0.1451 - val\_accuracy: 0.7160 - val\_loss: 1.1863  
 Epoch 614/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9271 - loss: 0.1962 - val\_accuracy: 0.7407 - val\_loss: 1.1620  
 Epoch 615/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9119 - loss: 0.2093 - val\_accuracy: 0.7037 - val\_loss: 1.1143  
 Epoch 616/800

8/8                    0s 2ms/step -  
 accuracy: 0.9252 - loss: 0.1830 - val\_accuracy: 0.7160 - val\_loss: 1.2229  
 Epoch 617/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9257 - loss: 0.1827 - val\_accuracy: 0.7037 - val\_loss: 1.2648  
 Epoch 618/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9275 - loss: 0.1875 - val\_accuracy: 0.7407 - val\_loss: 1.1707  
 Epoch 619/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9231 - loss: 0.1804 - val\_accuracy: 0.7160 - val\_loss: 1.1805  
 Epoch 620/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9475 - loss: 0.1613 - val\_accuracy: 0.7037 - val\_loss: 1.1566  
 Epoch 621/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9377 - loss: 0.1626 - val\_accuracy: 0.7037 - val\_loss: 1.1740  
 Epoch 622/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9343 - loss: 0.1851 - val\_accuracy: 0.7407 - val\_loss: 1.0789  
 Epoch 623/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9170 - loss: 0.1777 - val\_accuracy: 0.7531 - val\_loss: 1.0341  
 Epoch 624/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9505 - loss: 0.1436 - val\_accuracy: 0.7037 - val\_loss: 1.1216  
 Epoch 625/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9234 - loss: 0.1658 - val\_accuracy: 0.6914 - val\_loss: 1.0812  
 Epoch 626/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9323 - loss: 0.1562 - val\_accuracy: 0.6914 - val\_loss: 1.0742  
 Epoch 627/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9355 - loss: 0.1744 - val\_accuracy: 0.7037 - val\_loss: 1.1593  
 Epoch 628/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9497 - loss: 0.1230 - val\_accuracy: 0.7037 - val\_loss: 1.1222  
 Epoch 629/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9485 - loss: 0.1400 - val\_accuracy: 0.7160 - val\_loss: 1.1082  
 Epoch 630/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9537 - loss: 0.1406 - val\_accuracy: 0.7531 - val\_loss: 1.1133  
 Epoch 631/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9327 - loss: 0.1619 - val\_accuracy: 0.7284 - val\_loss: 1.1375  
 Epoch 632/800

8/8                    0s 2ms/step -  
 accuracy: 0.9310 - loss: 0.1436 - val\_accuracy: 0.7407 - val\_loss: 1.1489  
 Epoch 633/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9356 - loss: 0.1515 - val\_accuracy: 0.7160 - val\_loss: 1.1286  
 Epoch 634/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9463 - loss: 0.1248 - val\_accuracy: 0.7284 - val\_loss: 1.1820  
 Epoch 635/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9420 - loss: 0.1482 - val\_accuracy: 0.7284 - val\_loss: 1.1509  
 Epoch 636/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9379 - loss: 0.1424 - val\_accuracy: 0.6790 - val\_loss: 1.1293  
 Epoch 637/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9552 - loss: 0.1273 - val\_accuracy: 0.6790 - val\_loss: 1.1697  
 Epoch 638/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9515 - loss: 0.1428 - val\_accuracy: 0.7778 - val\_loss: 1.2297  
 Epoch 639/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9424 - loss: 0.1587 - val\_accuracy: 0.6667 - val\_loss: 1.2083  
 Epoch 640/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9326 - loss: 0.1723 - val\_accuracy: 0.7037 - val\_loss: 1.1336  
 Epoch 641/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9527 - loss: 0.1406 - val\_accuracy: 0.7160 - val\_loss: 1.1601  
 Epoch 642/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9391 - loss: 0.1397 - val\_accuracy: 0.6667 - val\_loss: 1.0756  
 Epoch 643/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9377 - loss: 0.1436 - val\_accuracy: 0.7160 - val\_loss: 1.1058  
 Epoch 644/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9603 - loss: 0.1178 - val\_accuracy: 0.6914 - val\_loss: 1.2019  
 Epoch 645/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9542 - loss: 0.1428 - val\_accuracy: 0.7037 - val\_loss: 1.1398  
 Epoch 646/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9486 - loss: 0.1286 - val\_accuracy: 0.7284 - val\_loss: 1.1209  
 Epoch 647/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9592 - loss: 0.1248 - val\_accuracy: 0.7037 - val\_loss: 1.2191  
 Epoch 648/800

8/8                    0s 2ms/step -  
 accuracy: 0.9610 - loss: 0.1241 - val\_accuracy: 0.6914 - val\_loss: 1.1767  
 Epoch 649/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9449 - loss: 0.1323 - val\_accuracy: 0.7160 - val\_loss: 1.1795  
 Epoch 650/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9278 - loss: 0.1478 - val\_accuracy: 0.7160 - val\_loss: 1.1952  
 Epoch 651/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9371 - loss: 0.1392 - val\_accuracy: 0.6790 - val\_loss: 1.2541  
 Epoch 652/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9630 - loss: 0.1172 - val\_accuracy: 0.7037 - val\_loss: 1.1410  
 Epoch 653/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9521 - loss: 0.1177 - val\_accuracy: 0.6790 - val\_loss: 1.2471  
 Epoch 654/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9678 - loss: 0.1139 - val\_accuracy: 0.7037 - val\_loss: 1.2137  
 Epoch 655/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9579 - loss: 0.1127 - val\_accuracy: 0.7037 - val\_loss: 1.1746  
 Epoch 656/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9540 - loss: 0.1287 - val\_accuracy: 0.7160 - val\_loss: 1.3025  
 Epoch 657/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9685 - loss: 0.1106 - val\_accuracy: 0.7407 - val\_loss: 1.1765  
 Epoch 658/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9357 - loss: 0.1433 - val\_accuracy: 0.7160 - val\_loss: 1.1658  
 Epoch 659/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9472 - loss: 0.1336 - val\_accuracy: 0.6914 - val\_loss: 1.2025  
 Epoch 660/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9697 - loss: 0.1115 - val\_accuracy: 0.7160 - val\_loss: 1.1936  
 Epoch 661/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9694 - loss: 0.1067 - val\_accuracy: 0.7037 - val\_loss: 1.2036  
 Epoch 662/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9579 - loss: 0.1030 - val\_accuracy: 0.6914 - val\_loss: 1.2184  
 Epoch 663/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9536 - loss: 0.1112 - val\_accuracy: 0.7284 - val\_loss: 1.1800  
 Epoch 664/800

8/8                    0s 2ms/step -  
 accuracy: 0.9331 - loss: 0.1599 - val\_accuracy: 0.6790 - val\_loss: 1.0758  
 Epoch 665/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9144 - loss: 0.1944 - val\_accuracy: 0.7284 - val\_loss: 1.0930  
 Epoch 666/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9092 - loss: 0.1867 - val\_accuracy: 0.6914 - val\_loss: 1.1409  
 Epoch 667/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9412 - loss: 0.1533 - val\_accuracy: 0.7284 - val\_loss: 1.1156  
 Epoch 668/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9374 - loss: 0.1580 - val\_accuracy: 0.7160 - val\_loss: 1.2824  
 Epoch 669/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9101 - loss: 0.1923 - val\_accuracy: 0.7407 - val\_loss: 1.0482  
 Epoch 670/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8840 - loss: 0.2496 - val\_accuracy: 0.7160 - val\_loss: 1.1683  
 Epoch 671/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8872 - loss: 0.2637 - val\_accuracy: 0.7284 - val\_loss: 1.2601  
 Epoch 672/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8991 - loss: 0.2376 - val\_accuracy: 0.7407 - val\_loss: 1.1787  
 Epoch 673/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9379 - loss: 0.1646 - val\_accuracy: 0.7037 - val\_loss: 1.1285  
 Epoch 674/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.9197 - loss: 0.1726 - val\_accuracy: 0.7037 - val\_loss: 1.1319  
 Epoch 675/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9574 - loss: 0.1155 - val\_accuracy: 0.6914 - val\_loss: 1.1461  
 Epoch 676/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9140 - loss: 0.1811 - val\_accuracy: 0.7654 - val\_loss: 1.0747  
 Epoch 677/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9006 - loss: 0.2140 - val\_accuracy: 0.7160 - val\_loss: 1.2472  
 Epoch 678/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9157 - loss: 0.2217 - val\_accuracy: 0.7407 - val\_loss: 1.0780  
 Epoch 679/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8950 - loss: 0.2318 - val\_accuracy: 0.6914 - val\_loss: 1.1043  
 Epoch 680/800

8/8                    0s 2ms/step -  
accuracy: 0.8986 - loss: 0.1958 - val\_accuracy: 0.7284 - val\_loss: 1.0281  
Epoch 681/800

8/8                    0s 2ms/step -  
accuracy: 0.9112 - loss: 0.2017 - val\_accuracy: 0.6667 - val\_loss: 1.1250  
Epoch 682/800

8/8                    0s 2ms/step -  
accuracy: 0.9287 - loss: 0.1765 - val\_accuracy: 0.7531 - val\_loss: 1.1635  
Epoch 683/800

8/8                    0s 2ms/step -  
accuracy: 0.9239 - loss: 0.1694 - val\_accuracy: 0.6914 - val\_loss: 1.2972  
Epoch 684/800

8/8                    0s 2ms/step -  
accuracy: 0.9432 - loss: 0.1389 - val\_accuracy: 0.7160 - val\_loss: 1.1515  
Epoch 685/800

8/8                    0s 3ms/step -  
accuracy: 0.9386 - loss: 0.1374 - val\_accuracy: 0.7160 - val\_loss: 1.2244  
Epoch 686/800

8/8                    0s 2ms/step -  
accuracy: 0.9494 - loss: 0.1353 - val\_accuracy: 0.7407 - val\_loss: 1.1547  
Epoch 687/800

8/8                    0s 2ms/step -  
accuracy: 0.9508 - loss: 0.1775 - val\_accuracy: 0.7284 - val\_loss: 1.2092  
Epoch 688/800

8/8                    0s 2ms/step -  
accuracy: 0.9032 - loss: 0.2516 - val\_accuracy: 0.6790 - val\_loss: 1.1426  
Epoch 689/800

8/8                    0s 2ms/step -  
accuracy: 0.9272 - loss: 0.1644 - val\_accuracy: 0.7407 - val\_loss: 1.1166  
Epoch 690/800

8/8                    0s 2ms/step -  
accuracy: 0.9416 - loss: 0.1399 - val\_accuracy: 0.7407 - val\_loss: 1.1634  
Epoch 691/800

8/8                    0s 2ms/step -  
accuracy: 0.9451 - loss: 0.1240 - val\_accuracy: 0.7160 - val\_loss: 1.1276  
Epoch 692/800

8/8                    0s 2ms/step -  
accuracy: 0.9509 - loss: 0.1385 - val\_accuracy: 0.7160 - val\_loss: 1.2532  
Epoch 693/800

8/8                    0s 2ms/step -  
accuracy: 0.9491 - loss: 0.1371 - val\_accuracy: 0.7531 - val\_loss: 1.1663  
Epoch 694/800

8/8                    0s 2ms/step -  
accuracy: 0.9420 - loss: 0.1508 - val\_accuracy: 0.7284 - val\_loss: 1.2478  
Epoch 695/800

8/8                    0s 2ms/step -  
accuracy: 0.9469 - loss: 0.1462 - val\_accuracy: 0.7531 - val\_loss: 1.2727  
Epoch 696/800

8/8                    0s 2ms/step -  
 accuracy: 0.9464 - loss: 0.1475 - val\_accuracy: 0.7407 - val\_loss: 1.2116  
 Epoch 697/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9369 - loss: 0.1585 - val\_accuracy: 0.7160 - val\_loss: 1.1656  
 Epoch 698/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.9508 - loss: 0.1244 - val\_accuracy: 0.7284 - val\_loss: 1.2607  
 Epoch 699/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9265 - loss: 0.1753 - val\_accuracy: 0.7407 - val\_loss: 1.2299  
 Epoch 700/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9691 - loss: 0.1234 - val\_accuracy: 0.7160 - val\_loss: 1.1912  
 Epoch 701/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9434 - loss: 0.1442 - val\_accuracy: 0.7654 - val\_loss: 1.1137  
 Epoch 702/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9597 - loss: 0.1125 - val\_accuracy: 0.7901 - val\_loss: 1.2204  
 Epoch 703/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9422 - loss: 0.1566 - val\_accuracy: 0.7284 - val\_loss: 1.2335  
 Epoch 704/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9403 - loss: 0.1707 - val\_accuracy: 0.6914 - val\_loss: 1.3289  
 Epoch 705/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9059 - loss: 0.2069 - val\_accuracy: 0.7284 - val\_loss: 1.0881  
 Epoch 706/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9199 - loss: 0.1859 - val\_accuracy: 0.7160 - val\_loss: 1.2248  
 Epoch 707/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9304 - loss: 0.1587 - val\_accuracy: 0.7037 - val\_loss: 1.1809  
 Epoch 708/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9124 - loss: 0.1967 - val\_accuracy: 0.6667 - val\_loss: 0.9953  
 Epoch 709/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9209 - loss: 0.1957 - val\_accuracy: 0.7531 - val\_loss: 1.0650  
 Epoch 710/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9289 - loss: 0.2065 - val\_accuracy: 0.7284 - val\_loss: 1.1306  
 Epoch 711/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.8978 - loss: 0.1897 - val\_accuracy: 0.7407 - val\_loss: 1.1397  
 Epoch 712/800

8/8                    0s 2ms/step -  
accuracy: 0.9209 - loss: 0.1577 - val\_accuracy: 0.6790 - val\_loss: 1.2183  
Epoch 713/800

8/8                    0s 2ms/step -  
accuracy: 0.9331 - loss: 0.1454 - val\_accuracy: 0.7654 - val\_loss: 1.2151  
Epoch 714/800

8/8                    0s 2ms/step -  
accuracy: 0.9586 - loss: 0.1106 - val\_accuracy: 0.7531 - val\_loss: 1.2183  
Epoch 715/800

8/8                    0s 2ms/step -  
accuracy: 0.9396 - loss: 0.1353 - val\_accuracy: 0.7160 - val\_loss: 1.2541  
Epoch 716/800

8/8                    0s 2ms/step -  
accuracy: 0.9458 - loss: 0.1385 - val\_accuracy: 0.7531 - val\_loss: 1.1938  
Epoch 717/800

8/8                    0s 2ms/step -  
accuracy: 0.9368 - loss: 0.1385 - val\_accuracy: 0.7037 - val\_loss: 1.2645  
Epoch 718/800

8/8                    0s 2ms/step -  
accuracy: 0.9668 - loss: 0.0969 - val\_accuracy: 0.7284 - val\_loss: 1.2460  
Epoch 719/800

8/8                    0s 3ms/step -  
accuracy: 0.9597 - loss: 0.1122 - val\_accuracy: 0.7407 - val\_loss: 1.2372  
Epoch 720/800

8/8                    0s 2ms/step -  
accuracy: 0.9402 - loss: 0.1471 - val\_accuracy: 0.7037 - val\_loss: 1.2639  
Epoch 721/800

8/8                    0s 2ms/step -  
accuracy: 0.9546 - loss: 0.1002 - val\_accuracy: 0.7037 - val\_loss: 1.2920  
Epoch 722/800

8/8                    0s 2ms/step -  
accuracy: 0.9767 - loss: 0.0948 - val\_accuracy: 0.7037 - val\_loss: 1.3448  
Epoch 723/800

8/8                    0s 2ms/step -  
accuracy: 0.9744 - loss: 0.0954 - val\_accuracy: 0.7407 - val\_loss: 1.2324  
Epoch 724/800

8/8                    0s 2ms/step -  
accuracy: 0.9593 - loss: 0.1047 - val\_accuracy: 0.7284 - val\_loss: 1.2684  
Epoch 725/800

8/8                    0s 2ms/step -  
accuracy: 0.9782 - loss: 0.0936 - val\_accuracy: 0.7037 - val\_loss: 1.2337  
Epoch 726/800

8/8                    0s 4ms/step -  
accuracy: 0.9703 - loss: 0.0888 - val\_accuracy: 0.6914 - val\_loss: 1.2822  
Epoch 727/800

8/8                    0s 2ms/step -  
accuracy: 0.9716 - loss: 0.0871 - val\_accuracy: 0.7160 - val\_loss: 1.2482  
Epoch 728/800



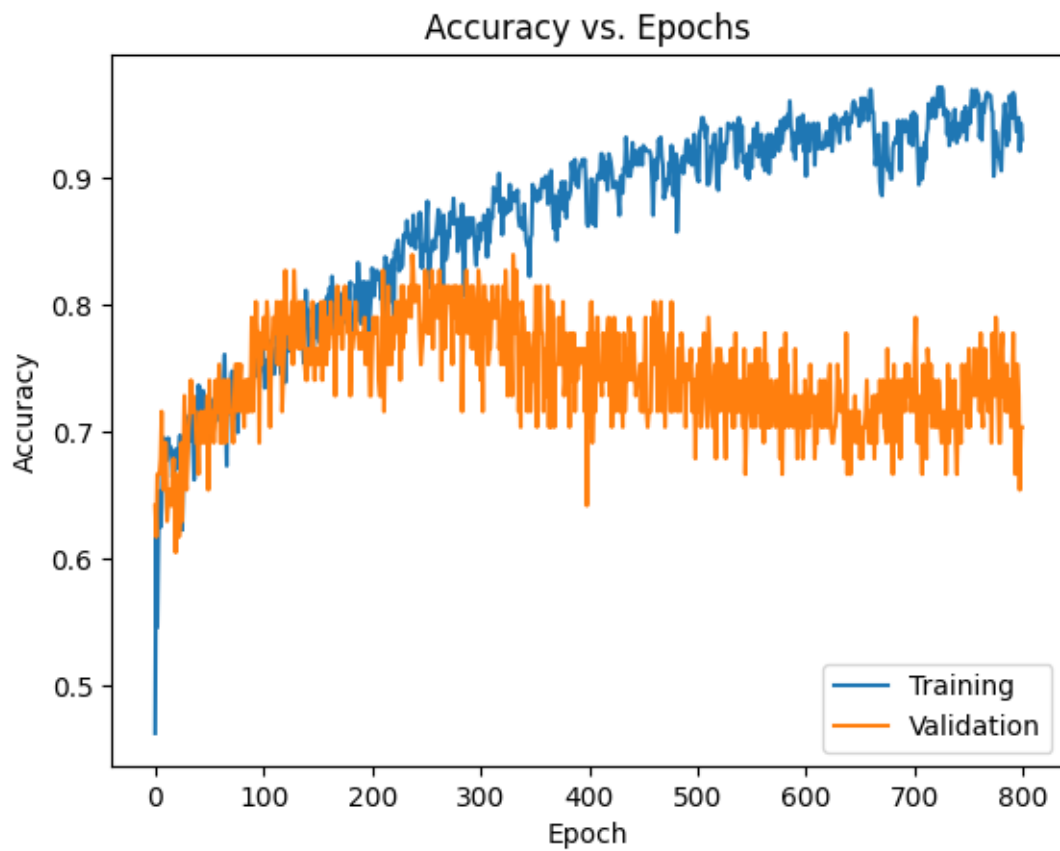
8/8                    0s 2ms/step -  
 accuracy: 0.9550 - loss: 0.1290 - val\_accuracy: 0.7037 - val\_loss: 1.2036  
 Epoch 729/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9564 - loss: 0.1287 - val\_accuracy: 0.7160 - val\_loss: 1.3417  
 Epoch 730/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9573 - loss: 0.1150 - val\_accuracy: 0.6667 - val\_loss: 1.4380  
 Epoch 731/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9336 - loss: 0.1169 - val\_accuracy: 0.7037 - val\_loss: 1.3106  
 Epoch 732/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9594 - loss: 0.1154 - val\_accuracy: 0.7531 - val\_loss: 1.2315  
 Epoch 733/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.9247 - loss: 0.1526 - val\_accuracy: 0.6914 - val\_loss: 1.4391  
 Epoch 734/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9351 - loss: 0.1620 - val\_accuracy: 0.7407 - val\_loss: 1.2593  
 Epoch 735/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9399 - loss: 0.1366 - val\_accuracy: 0.7037 - val\_loss: 1.3165  
 Epoch 736/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9469 - loss: 0.1374 - val\_accuracy: 0.7160 - val\_loss: 1.3730  
 Epoch 737/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9543 - loss: 0.1331 - val\_accuracy: 0.7160 - val\_loss: 1.3499  
 Epoch 738/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9568 - loss: 0.1385 - val\_accuracy: 0.7407 - val\_loss: 1.2362  
 Epoch 739/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9264 - loss: 0.1948 - val\_accuracy: 0.6914 - val\_loss: 1.4199  
 Epoch 740/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9379 - loss: 0.1665 - val\_accuracy: 0.6667 - val\_loss: 1.3220  
 Epoch 741/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9413 - loss: 0.1504 - val\_accuracy: 0.7160 - val\_loss: 1.2366  
 Epoch 742/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9413 - loss: 0.1377 - val\_accuracy: 0.6914 - val\_loss: 1.3557  
 Epoch 743/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9327 - loss: 0.1456 - val\_accuracy: 0.7037 - val\_loss: 1.2654  
 Epoch 744/800

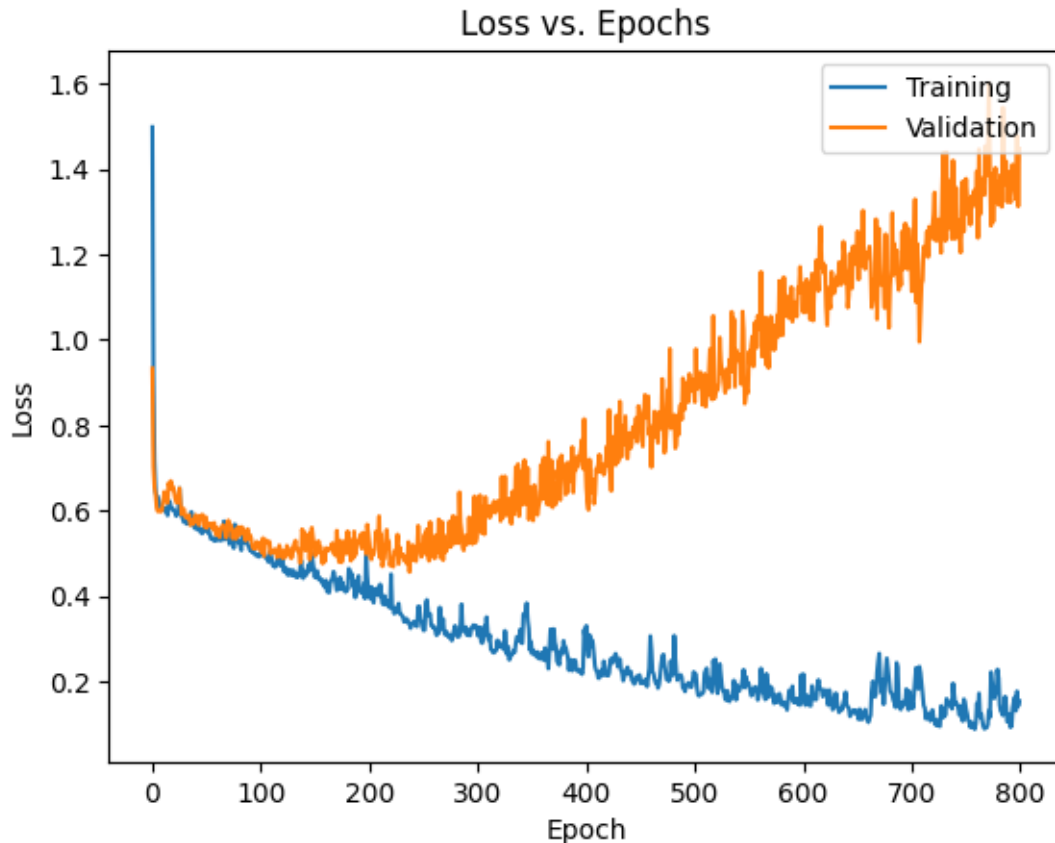
8/8                    0s 2ms/step -  
 accuracy: 0.9335 - loss: 0.1353 - val\_accuracy: 0.6914 - val\_loss: 1.2796  
 Epoch 745/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9560 - loss: 0.1123 - val\_accuracy: 0.7531 - val\_loss: 1.2444  
 Epoch 746/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9588 - loss: 0.1246 - val\_accuracy: 0.7160 - val\_loss: 1.2041  
 Epoch 747/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9459 - loss: 0.1192 - val\_accuracy: 0.7160 - val\_loss: 1.2636  
 Epoch 748/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9363 - loss: 0.1313 - val\_accuracy: 0.7160 - val\_loss: 1.3712  
 Epoch 749/800  
 8/8                    0s 6ms/step -  
 accuracy: 0.9380 - loss: 0.1430 - val\_accuracy: 0.7531 - val\_loss: 1.2536  
 Epoch 750/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9569 - loss: 0.1333 - val\_accuracy: 0.7037 - val\_loss: 1.3389  
 Epoch 751/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9600 - loss: 0.1230 - val\_accuracy: 0.7654 - val\_loss: 1.3771  
 Epoch 752/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9440 - loss: 0.1180 - val\_accuracy: 0.7037 - val\_loss: 1.3356  
 Epoch 753/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9570 - loss: 0.0998 - val\_accuracy: 0.7284 - val\_loss: 1.2941  
 Epoch 754/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9740 - loss: 0.0974 - val\_accuracy: 0.7284 - val\_loss: 1.3274  
 Epoch 755/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9616 - loss: 0.0991 - val\_accuracy: 0.7407 - val\_loss: 1.2695  
 Epoch 756/800  
 8/8                    0s 4ms/step -  
 accuracy: 0.9557 - loss: 0.1034 - val\_accuracy: 0.7654 - val\_loss: 1.3361  
 Epoch 757/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9516 - loss: 0.1109 - val\_accuracy: 0.7284 - val\_loss: 1.3117  
 Epoch 758/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9699 - loss: 0.0896 - val\_accuracy: 0.7407 - val\_loss: 1.3456  
 Epoch 759/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9668 - loss: 0.0909 - val\_accuracy: 0.7531 - val\_loss: 1.3503  
 Epoch 760/800

8/8                    0s 2ms/step -  
 accuracy: 0.9598 - loss: 0.0970 - val\_accuracy: 0.7654 - val\_loss: 1.3164  
 Epoch 761/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9414 - loss: 0.1300 - val\_accuracy: 0.7160 - val\_loss: 1.3949  
 Epoch 762/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9489 - loss: 0.1238 - val\_accuracy: 0.7778 - val\_loss: 1.2387  
 Epoch 763/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9346 - loss: 0.1639 - val\_accuracy: 0.7160 - val\_loss: 1.4462  
 Epoch 764/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9512 - loss: 0.1267 - val\_accuracy: 0.7037 - val\_loss: 1.2940  
 Epoch 765/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9516 - loss: 0.1187 - val\_accuracy: 0.7407 - val\_loss: 1.3782  
 Epoch 766/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9546 - loss: 0.1129 - val\_accuracy: 0.7654 - val\_loss: 1.3722  
 Epoch 767/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9681 - loss: 0.0949 - val\_accuracy: 0.7284 - val\_loss: 1.3440  
 Epoch 768/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9642 - loss: 0.0926 - val\_accuracy: 0.7284 - val\_loss: 1.3388  
 Epoch 769/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9623 - loss: 0.0966 - val\_accuracy: 0.7160 - val\_loss: 1.4535  
 Epoch 770/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9574 - loss: 0.0967 - val\_accuracy: 0.7284 - val\_loss: 1.3855  
 Epoch 771/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9607 - loss: 0.0983 - val\_accuracy: 0.7407 - val\_loss: 1.3912  
 Epoch 772/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9545 - loss: 0.1236 - val\_accuracy: 0.6914 - val\_loss: 1.6011  
 Epoch 773/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9543 - loss: 0.1120 - val\_accuracy: 0.7778 - val\_loss: 1.3937  
 Epoch 774/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9103 - loss: 0.1966 - val\_accuracy: 0.7407 - val\_loss: 1.2670  
 Epoch 775/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9238 - loss: 0.1792 - val\_accuracy: 0.7284 - val\_loss: 1.3870  
 Epoch 776/800

8/8                    0s 2ms/step -  
 accuracy: 0.9481 - loss: 0.1526 - val\_accuracy: 0.7901 - val\_loss: 1.2762  
 Epoch 777/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9193 - loss: 0.1733 - val\_accuracy: 0.7654 - val\_loss: 1.3572  
 Epoch 778/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9074 - loss: 0.1915 - val\_accuracy: 0.7284 - val\_loss: 1.4028  
 Epoch 779/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9249 - loss: 0.1661 - val\_accuracy: 0.6914 - val\_loss: 1.3223  
 Epoch 780/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9321 - loss: 0.1753 - val\_accuracy: 0.6914 - val\_loss: 1.3714  
 Epoch 781/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9098 - loss: 0.1926 - val\_accuracy: 0.7654 - val\_loss: 1.3160  
 Epoch 782/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9390 - loss: 0.1368 - val\_accuracy: 0.7778 - val\_loss: 1.3332  
 Epoch 783/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9431 - loss: 0.1265 - val\_accuracy: 0.7284 - val\_loss: 1.3857  
 Epoch 784/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9588 - loss: 0.1257 - val\_accuracy: 0.7407 - val\_loss: 1.3115  
 Epoch 785/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9514 - loss: 0.1137 - val\_accuracy: 0.7160 - val\_loss: 1.5436  
 Epoch 786/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9223 - loss: 0.1505 - val\_accuracy: 0.7531 - val\_loss: 1.3645  
 Epoch 787/800  
 8/8                    0s 3ms/step -  
 accuracy: 0.9354 - loss: 0.1642 - val\_accuracy: 0.7160 - val\_loss: 1.4082  
 Epoch 788/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9339 - loss: 0.1366 - val\_accuracy: 0.7160 - val\_loss: 1.4178  
 Epoch 789/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9723 - loss: 0.0946 - val\_accuracy: 0.7407 - val\_loss: 1.3224  
 Epoch 790/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9557 - loss: 0.1032 - val\_accuracy: 0.7037 - val\_loss: 1.3927  
 Epoch 791/800  
 8/8                    0s 2ms/step -  
 accuracy: 0.9481 - loss: 0.1350 - val\_accuracy: 0.7407 - val\_loss: 1.3371  
 Epoch 792/800

8/8                    0s 3ms/step -  
accuracy: 0.9737 - loss: 0.0865 - val\_accuracy: 0.7778 - val\_loss: 1.3218  
Epoch 793/800  
8/8                    0s 3ms/step -  
accuracy: 0.9767 - loss: 0.0790 - val\_accuracy: 0.7284 - val\_loss: 1.3602  
Epoch 794/800  
8/8                    0s 2ms/step -  
accuracy: 0.9651 - loss: 0.1177 - val\_accuracy: 0.6667 - val\_loss: 1.4101  
Epoch 795/800  
8/8                    0s 2ms/step -  
accuracy: 0.9316 - loss: 0.1503 - val\_accuracy: 0.7531 - val\_loss: 1.3602  
Epoch 796/800  
8/8                    0s 2ms/step -  
accuracy: 0.9353 - loss: 0.1693 - val\_accuracy: 0.7531 - val\_loss: 1.3646  
Epoch 797/800  
8/8                    0s 2ms/step -  
accuracy: 0.9598 - loss: 0.1119 - val\_accuracy: 0.7284 - val\_loss: 1.3289  
Epoch 798/800  
8/8                    0s 2ms/step -  
accuracy: 0.9195 - loss: 0.1691 - val\_accuracy: 0.6543 - val\_loss: 1.4784  
Epoch 799/800  
8/8                    0s 2ms/step -  
accuracy: 0.9410 - loss: 0.1424 - val\_accuracy: 0.7037 - val\_loss: 1.3123  
Epoch 800/800  
8/8                    0s 2ms/step -  
accuracy: 0.9316 - loss: 0.1439 - val\_accuracy: 0.7037 - val\_loss: 1.4473





#### 0.4.1 4.1 Prueba de la red neuronal con conjunto de prueba

```
[ ]: # Evaluate the model on the test set
test_loss, test_acc = redNeuroSimp.evaluate(X_test, y_test, verbose=0)
print('test_loss: {} \ntest_acc: {} %'.format(round(test_loss,4),
↪round(test_acc*100,4)))
```

```
test_loss: 1.8029
test_acc: 69.2641 %
```

### 0.5 5. Red Neuronal Secuencial Optimizada

En esta sección se construye una Red Neuronal Secuencial Optimizada utilizando la librería TensorFlow y Keras, adicionando técnicas de regularización y callbacks.

```
[ ]: # Funcion para definir un modelo de Red Neuronal utilizando Técnicas de
↪Regularización y Callbacks
def set_nn_model_architecture_optimized(X_train):

    # 1. Definición del tipo de NN (Secuencial)
```

```

model = Sequential(name='RedNeuronalOptimizada')

# 2. Se define la capa de entrada, pesos iniciales dada una distribución
↳ uniforme escalada basada en el número de
# neuronas, la función de activación ReLU, vector de biases de 1.
model.add(Dense(units=8, input_shape=(X_train.shape[1],), activation='relu',
                kernel_initializer=tf.keras.initializers.HeUniform(seed=0),
                bias_initializer='ones',
                name='hiddenlayer1'))

# 3. Capas ocultas con técnicas de regularización implementadas
model.add(Dense(units=16, activation='relu', name='hiddenlayer2'))
model.add(Dense(units=16, activation='relu', name='hiddenlayer3'))
model.add(Dropout(rate=0.1, name='dropout1')) # Primera capa de Dropout
model.add(Dense(units=16, activation='relu', name='hiddenlayer4'))
model.add(Dense(units=16, activation='relu', name='hiddenlayer5'))
model.add(BatchNormalization(name='batch_normalization1')) # Aplicación de
↳ Batch Normalization
model.add(Dense(units=16, activation='relu', name='hiddenlayer6'))
model.add(Dense(units=16, activation='relu', name='hiddenlayer7'))
model.add(BatchNormalization(name='batch_normalization2')) # Aplicación de
↳ un segundo Batch Normalization
model.add(Dropout(rate=0.3, name='dropout2')) # Segunda capa de Dropout
model.add(Dense(units=28, activation='relu', name='hiddenlayer8'))

# 4. Capa de salida con activación sigmoid para clasificación binaria
model.add(Dense(units=1, activation='sigmoid', name='outputlayer'))

model.summary()
return model

# 5. Creación de la Red Neuronal Optimizada
redNeuroOpt = set_nn_model_architecture_optimized(X_train)

# 6. Definición de Callback: Early Stopping - Si el rendimiento no mejora en 90
↳ epochs, parar.
early_stopping = tf.keras.callbacks.EarlyStopping(patience = 90, mode = "min")

# 7. Definición de Callback: Learning Rate Reduction - Ajusta dinámicamente el
↳ learning rate cuando una métrica no ha mejorado en 160 epochs.
lr_reduction = tf.keras.callbacks.ReduceLROnPlateau(patience = 80, factor = 0.1)

# 8. Definición del optimizador y learning rate
adam = tf.keras.optimizers.Adam(learning_rate=0.001)

# 9. Establecer binary_crossentropy por el dataset binario y la métrica de
↳ accuracy

```



```

redNeuroOpt.compile(optimizer=adam, loss='binary_crossentropy',
    ↪metrics=['accuracy'])

# 10. Entrenar la red
training_history_3 = redNeuroOpt.fit(X_train, y_train, epochs=1200,
    ↪validation_split=0.15, batch_size=114,
                                callbacks=[early_stopping, lr_reduction],
    ↪verbose=1)

# 11. Se grafica el desempeño de Accuracy vs Epoch y Loss vs Epoch
plot_acc_loss(training_history_3)

```

/Users/axelamoshernandezcardenas/Desktop/IAClase/myenv/lib/python3.12/site-packages/keras/src/layers/core/dense.py:87: 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: "RedNeuronalOptimizada"

Layer (type)	Output Shape	Param #
hiddenlayer1 (Dense)	(None, 8)	72
hiddenlayer2 (Dense)	(None, 16)	144
hiddenlayer3 (Dense)	(None, 16)	272
dropout1 (Dropout)	(None, 16)	0
hiddenlayer4 (Dense)	(None, 16)	272
hiddenlayer5 (Dense)	(None, 16)	272
batch_normalization1 (BatchNormalization)	(None, 16)	64
hiddenlayer6 (Dense)	(None, 16)	272
hiddenlayer7 (Dense)	(None, 16)	272
batch_normalization2 (BatchNormalization)	(None, 16)	64
dropout2 (Dropout)	(None, 16)	0

hiddenlayer8 (Dense)	(None, 28)	476
outputlayer (Dense)	(None, 1)	29

Total params: 2,209 (8.63 KB)

Trainable params: 2,145 (8.38 KB)

Non-trainable params: 64 (256.00 B)

Epoch 1/1200

4/4 1s 29ms/step -  
accuracy: 0.4635 - loss: 0.7561 - val\_accuracy: 0.3580 - val\_loss: 0.8394 -  
learning\_rate: 0.0010

Epoch 2/1200

4/4 0s 4ms/step -  
accuracy: 0.5988 - loss: 0.6750 - val\_accuracy: 0.3827 - val\_loss: 0.7581 -  
learning\_rate: 0.0010

Epoch 3/1200

4/4 0s 4ms/step -  
accuracy: 0.6456 - loss: 0.6694 - val\_accuracy: 0.3951 - val\_loss: 0.7164 -  
learning\_rate: 0.0010

Epoch 4/1200

4/4 0s 4ms/step -  
accuracy: 0.6602 - loss: 0.6714 - val\_accuracy: 0.4074 - val\_loss: 0.7005 -  
learning\_rate: 0.0010

Epoch 5/1200

4/4 0s 4ms/step -  
accuracy: 0.6190 - loss: 0.6707 - val\_accuracy: 0.4444 - val\_loss: 0.6879 -  
learning\_rate: 0.0010

Epoch 6/1200

4/4 0s 4ms/step -  
accuracy: 0.6412 - loss: 0.6410 - val\_accuracy: 0.4568 - val\_loss: 0.6763 -  
learning\_rate: 0.0010

Epoch 7/1200

4/4 0s 4ms/step -  
accuracy: 0.6538 - loss: 0.6386 - val\_accuracy: 0.4815 - val\_loss: 0.6674 -  
learning\_rate: 0.0010

Epoch 8/1200

4/4 0s 5ms/step -  
accuracy: 0.6599 - loss: 0.6377 - val\_accuracy: 0.4938 - val\_loss: 0.6613 -  
learning\_rate: 0.0010

Epoch 9/1200

4/4 0s 4ms/step -  
accuracy: 0.6930 - loss: 0.6190 - val\_accuracy: 0.5185 - val\_loss: 0.6555 -

learning\_rate: 0.0010  
Epoch 10/1200  
4/4 0s 5ms/step -  
accuracy: 0.6883 - loss: 0.6104 - val\_accuracy: 0.5309 - val\_loss: 0.6499 -  
learning\_rate: 0.0010  
Epoch 11/1200  
4/4 0s 5ms/step -  
accuracy: 0.6737 - loss: 0.6047 - val\_accuracy: 0.5556 - val\_loss: 0.6453 -  
learning\_rate: 0.0010  
Epoch 12/1200  
4/4 0s 5ms/step -  
accuracy: 0.6661 - loss: 0.6251 - val\_accuracy: 0.6049 - val\_loss: 0.6412 -  
learning\_rate: 0.0010  
Epoch 13/1200  
4/4 0s 5ms/step -  
accuracy: 0.6982 - loss: 0.5857 - val\_accuracy: 0.6543 - val\_loss: 0.6377 -  
learning\_rate: 0.0010  
Epoch 14/1200  
4/4 0s 5ms/step -  
accuracy: 0.6667 - loss: 0.6165 - val\_accuracy: 0.6543 - val\_loss: 0.6347 -  
learning\_rate: 0.0010  
Epoch 15/1200  
4/4 0s 5ms/step -  
accuracy: 0.7003 - loss: 0.5832 - val\_accuracy: 0.6296 - val\_loss: 0.6321 -  
learning\_rate: 0.0010  
Epoch 16/1200  
4/4 0s 5ms/step -  
accuracy: 0.6538 - loss: 0.6096 - val\_accuracy: 0.6296 - val\_loss: 0.6316 -  
learning\_rate: 0.0010  
Epoch 17/1200  
4/4 0s 7ms/step -  
accuracy: 0.6746 - loss: 0.6043 - val\_accuracy: 0.6420 - val\_loss: 0.6288 -  
learning\_rate: 0.0010  
Epoch 18/1200  
4/4 0s 5ms/step -  
accuracy: 0.6684 - loss: 0.5856 - val\_accuracy: 0.6420 - val\_loss: 0.6250 -  
learning\_rate: 0.0010  
Epoch 19/1200  
4/4 0s 5ms/step -  
accuracy: 0.6500 - loss: 0.6038 - val\_accuracy: 0.6296 - val\_loss: 0.6212 -  
learning\_rate: 0.0010  
Epoch 20/1200  
4/4 0s 5ms/step -  
accuracy: 0.6795 - loss: 0.5865 - val\_accuracy: 0.6296 - val\_loss: 0.6181 -  
learning\_rate: 0.0010  
Epoch 21/1200  
4/4 0s 5ms/step -  
accuracy: 0.7096 - loss: 0.5799 - val\_accuracy: 0.6790 - val\_loss: 0.6140 -

learning\_rate: 0.0010  
Epoch 22/1200  
4/4 0s 5ms/step -  
accuracy: 0.7213 - loss: 0.5687 - val\_accuracy: 0.7037 - val\_loss: 0.6099 -  
learning\_rate: 0.0010  
Epoch 23/1200  
4/4 0s 4ms/step -  
accuracy: 0.7018 - loss: 0.5688 - val\_accuracy: 0.7037 - val\_loss: 0.6081 -  
learning\_rate: 0.0010  
Epoch 24/1200  
4/4 0s 4ms/step -  
accuracy: 0.7181 - loss: 0.5717 - val\_accuracy: 0.7160 - val\_loss: 0.6078 -  
learning\_rate: 0.0010  
Epoch 25/1200  
4/4 0s 4ms/step -  
accuracy: 0.6886 - loss: 0.5750 - val\_accuracy: 0.6914 - val\_loss: 0.6055 -  
learning\_rate: 0.0010  
Epoch 26/1200  
4/4 0s 5ms/step -  
accuracy: 0.7044 - loss: 0.5661 - val\_accuracy: 0.6914 - val\_loss: 0.6044 -  
learning\_rate: 0.0010  
Epoch 27/1200  
4/4 0s 5ms/step -  
accuracy: 0.6895 - loss: 0.5752 - val\_accuracy: 0.7037 - val\_loss: 0.6005 -  
learning\_rate: 0.0010  
Epoch 28/1200  
4/4 0s 4ms/step -  
accuracy: 0.6953 - loss: 0.5609 - val\_accuracy: 0.7037 - val\_loss: 0.5967 -  
learning\_rate: 0.0010  
Epoch 29/1200  
4/4 0s 5ms/step -  
accuracy: 0.6965 - loss: 0.5793 - val\_accuracy: 0.7037 - val\_loss: 0.5893 -  
learning\_rate: 0.0010  
Epoch 30/1200  
4/4 0s 4ms/step -  
accuracy: 0.7058 - loss: 0.5763 - val\_accuracy: 0.7160 - val\_loss: 0.5841 -  
learning\_rate: 0.0010  
Epoch 31/1200  
4/4 0s 4ms/step -  
accuracy: 0.6845 - loss: 0.5809 - val\_accuracy: 0.7037 - val\_loss: 0.5777 -  
learning\_rate: 0.0010  
Epoch 32/1200  
4/4 0s 4ms/step -  
accuracy: 0.6839 - loss: 0.5619 - val\_accuracy: 0.7037 - val\_loss: 0.5732 -  
learning\_rate: 0.0010  
Epoch 33/1200  
4/4 0s 4ms/step -  
accuracy: 0.6632 - loss: 0.5933 - val\_accuracy: 0.7037 - val\_loss: 0.5712 -

learning\_rate: 0.0010  
Epoch 34/1200  
4/4 0s 4ms/step -  
accuracy: 0.6944 - loss: 0.5731 - val\_accuracy: 0.7037 - val\_loss: 0.5735 -  
learning\_rate: 0.0010  
Epoch 35/1200  
4/4 0s 4ms/step -  
accuracy: 0.7152 - loss: 0.5568 - val\_accuracy: 0.7407 - val\_loss: 0.5775 -  
learning\_rate: 0.0010  
Epoch 36/1200  
4/4 0s 4ms/step -  
accuracy: 0.7032 - loss: 0.5594 - val\_accuracy: 0.7284 - val\_loss: 0.5759 -  
learning\_rate: 0.0010  
Epoch 37/1200  
4/4 0s 4ms/step -  
accuracy: 0.7167 - loss: 0.5663 - val\_accuracy: 0.7284 - val\_loss: 0.5715 -  
learning\_rate: 0.0010  
Epoch 38/1200  
4/4 0s 5ms/step -  
accuracy: 0.7404 - loss: 0.5525 - val\_accuracy: 0.7284 - val\_loss: 0.5621 -  
learning\_rate: 0.0010  
Epoch 39/1200  
4/4 0s 5ms/step -  
accuracy: 0.7076 - loss: 0.5505 - val\_accuracy: 0.7654 - val\_loss: 0.5546 -  
learning\_rate: 0.0010  
Epoch 40/1200  
4/4 0s 4ms/step -  
accuracy: 0.7237 - loss: 0.5275 - val\_accuracy: 0.7531 - val\_loss: 0.5508 -  
learning\_rate: 0.0010  
Epoch 41/1200  
4/4 0s 4ms/step -  
accuracy: 0.6904 - loss: 0.5594 - val\_accuracy: 0.7407 - val\_loss: 0.5500 -  
learning\_rate: 0.0010  
Epoch 42/1200  
4/4 0s 4ms/step -  
accuracy: 0.7009 - loss: 0.5431 - val\_accuracy: 0.7531 - val\_loss: 0.5462 -  
learning\_rate: 0.0010  
Epoch 43/1200  
4/4 0s 5ms/step -  
accuracy: 0.6968 - loss: 0.5718 - val\_accuracy: 0.7407 - val\_loss: 0.5446 -  
learning\_rate: 0.0010  
Epoch 44/1200  
4/4 0s 4ms/step -  
accuracy: 0.6792 - loss: 0.5568 - val\_accuracy: 0.7407 - val\_loss: 0.5432 -  
learning\_rate: 0.0010  
Epoch 45/1200  
4/4 0s 4ms/step -  
accuracy: 0.7272 - loss: 0.5264 - val\_accuracy: 0.7531 - val\_loss: 0.5414 -

learning\_rate: 0.0010  
Epoch 46/1200  
4/4 0s 4ms/step -  
accuracy: 0.7187 - loss: 0.5568 - val\_accuracy: 0.7531 - val\_loss: 0.5390 -  
learning\_rate: 0.0010  
Epoch 47/1200  
4/4 0s 5ms/step -  
accuracy: 0.7032 - loss: 0.5598 - val\_accuracy: 0.7654 - val\_loss: 0.5369 -  
learning\_rate: 0.0010  
Epoch 48/1200  
4/4 0s 4ms/step -  
accuracy: 0.7281 - loss: 0.5519 - val\_accuracy: 0.7654 - val\_loss: 0.5356 -  
learning\_rate: 0.0010  
Epoch 49/1200  
4/4 0s 4ms/step -  
accuracy: 0.6968 - loss: 0.5496 - val\_accuracy: 0.7654 - val\_loss: 0.5343 -  
learning\_rate: 0.0010  
Epoch 50/1200  
4/4 0s 4ms/step -  
accuracy: 0.7064 - loss: 0.5719 - val\_accuracy: 0.7531 - val\_loss: 0.5326 -  
learning\_rate: 0.0010  
Epoch 51/1200  
4/4 0s 4ms/step -  
accuracy: 0.7193 - loss: 0.5436 - val\_accuracy: 0.7531 - val\_loss: 0.5345 -  
learning\_rate: 0.0010  
Epoch 52/1200  
4/4 0s 4ms/step -  
accuracy: 0.7272 - loss: 0.5490 - val\_accuracy: 0.7654 - val\_loss: 0.5362 -  
learning\_rate: 0.0010  
Epoch 53/1200  
4/4 0s 4ms/step -  
accuracy: 0.7073 - loss: 0.5395 - val\_accuracy: 0.7531 - val\_loss: 0.5409 -  
learning\_rate: 0.0010  
Epoch 54/1200  
4/4 0s 4ms/step -  
accuracy: 0.7433 - loss: 0.5329 - val\_accuracy: 0.7531 - val\_loss: 0.5442 -  
learning\_rate: 0.0010  
Epoch 55/1200  
4/4 0s 4ms/step -  
accuracy: 0.7532 - loss: 0.5069 - val\_accuracy: 0.7407 - val\_loss: 0.5457 -  
learning\_rate: 0.0010  
Epoch 56/1200  
4/4 0s 4ms/step -  
accuracy: 0.7155 - loss: 0.5465 - val\_accuracy: 0.7407 - val\_loss: 0.5492 -  
learning\_rate: 0.0010  
Epoch 57/1200  
4/4 0s 4ms/step -  
accuracy: 0.7295 - loss: 0.5406 - val\_accuracy: 0.7407 - val\_loss: 0.5528 -

learning\_rate: 0.0010  
Epoch 58/1200  
4/4 0s 4ms/step -  
accuracy: 0.7640 - loss: 0.5415 - val\_accuracy: 0.7284 - val\_loss: 0.5405 -  
learning\_rate: 0.0010  
Epoch 59/1200  
4/4 0s 4ms/step -  
accuracy: 0.7211 - loss: 0.5567 - val\_accuracy: 0.7407 - val\_loss: 0.5378 -  
learning\_rate: 0.0010  
Epoch 60/1200  
4/4 0s 5ms/step -  
accuracy: 0.7386 - loss: 0.5351 - val\_accuracy: 0.7407 - val\_loss: 0.5368 -  
learning\_rate: 0.0010  
Epoch 61/1200  
4/4 0s 5ms/step -  
accuracy: 0.7468 - loss: 0.5045 - val\_accuracy: 0.7654 - val\_loss: 0.5364 -  
learning\_rate: 0.0010  
Epoch 62/1200  
4/4 0s 8ms/step -  
accuracy: 0.7237 - loss: 0.5376 - val\_accuracy: 0.7778 - val\_loss: 0.5260 -  
learning\_rate: 0.0010  
Epoch 63/1200  
4/4 0s 5ms/step -  
accuracy: 0.6991 - loss: 0.5293 - val\_accuracy: 0.7531 - val\_loss: 0.5200 -  
learning\_rate: 0.0010  
Epoch 64/1200  
4/4 0s 5ms/step -  
accuracy: 0.7295 - loss: 0.5434 - val\_accuracy: 0.7901 - val\_loss: 0.5188 -  
learning\_rate: 0.0010  
Epoch 65/1200  
4/4 0s 5ms/step -  
accuracy: 0.7167 - loss: 0.5474 - val\_accuracy: 0.7901 - val\_loss: 0.5197 -  
learning\_rate: 0.0010  
Epoch 66/1200  
4/4 0s 4ms/step -  
accuracy: 0.7178 - loss: 0.5481 - val\_accuracy: 0.7778 - val\_loss: 0.5207 -  
learning\_rate: 0.0010  
Epoch 67/1200  
4/4 0s 4ms/step -  
accuracy: 0.7450 - loss: 0.4997 - val\_accuracy: 0.7778 - val\_loss: 0.5209 -  
learning\_rate: 0.0010  
Epoch 68/1200  
4/4 0s 4ms/step -  
accuracy: 0.7047 - loss: 0.5416 - val\_accuracy: 0.7901 - val\_loss: 0.5247 -  
learning\_rate: 0.0010  
Epoch 69/1200  
4/4 0s 4ms/step -  
accuracy: 0.7327 - loss: 0.5528 - val\_accuracy: 0.7778 - val\_loss: 0.5323 -

learning\_rate: 0.0010  
Epoch 70/1200  
4/4 0s 4ms/step -  
accuracy: 0.7211 - loss: 0.5533 - val\_accuracy: 0.7407 - val\_loss: 0.5397 -  
learning\_rate: 0.0010  
Epoch 71/1200  
4/4 0s 4ms/step -  
accuracy: 0.7307 - loss: 0.5232 - val\_accuracy: 0.7407 - val\_loss: 0.5433 -  
learning\_rate: 0.0010  
Epoch 72/1200  
4/4 0s 4ms/step -  
accuracy: 0.7129 - loss: 0.5301 - val\_accuracy: 0.7778 - val\_loss: 0.5282 -  
learning\_rate: 0.0010  
Epoch 73/1200  
4/4 0s 4ms/step -  
accuracy: 0.7553 - loss: 0.5065 - val\_accuracy: 0.7654 - val\_loss: 0.5227 -  
learning\_rate: 0.0010  
Epoch 74/1200  
4/4 0s 4ms/step -  
accuracy: 0.7140 - loss: 0.5350 - val\_accuracy: 0.7531 - val\_loss: 0.5340 -  
learning\_rate: 0.0010  
Epoch 75/1200  
4/4 0s 4ms/step -  
accuracy: 0.7205 - loss: 0.5270 - val\_accuracy: 0.7531 - val\_loss: 0.5324 -  
learning\_rate: 0.0010  
Epoch 76/1200  
4/4 0s 4ms/step -  
accuracy: 0.7287 - loss: 0.5217 - val\_accuracy: 0.7654 - val\_loss: 0.5293 -  
learning\_rate: 0.0010  
Epoch 77/1200  
4/4 0s 4ms/step -  
accuracy: 0.7439 - loss: 0.5174 - val\_accuracy: 0.7778 - val\_loss: 0.5254 -  
learning\_rate: 0.0010  
Epoch 78/1200  
4/4 0s 4ms/step -  
accuracy: 0.7418 - loss: 0.5091 - val\_accuracy: 0.7654 - val\_loss: 0.5265 -  
learning\_rate: 0.0010  
Epoch 79/1200  
4/4 0s 4ms/step -  
accuracy: 0.7070 - loss: 0.5291 - val\_accuracy: 0.7654 - val\_loss: 0.5252 -  
learning\_rate: 0.0010  
Epoch 80/1200  
4/4 0s 4ms/step -  
accuracy: 0.7336 - loss: 0.5269 - val\_accuracy: 0.7284 - val\_loss: 0.5343 -  
learning\_rate: 0.0010  
Epoch 81/1200  
4/4 0s 4ms/step -  
accuracy: 0.7404 - loss: 0.5101 - val\_accuracy: 0.7407 - val\_loss: 0.5407 -



learning\_rate: 0.0010  
Epoch 82/1200  
4/4 0s 4ms/step -  
accuracy: 0.7292 - loss: 0.5466 - val\_accuracy: 0.7778 - val\_loss: 0.5211 -  
learning\_rate: 0.0010  
Epoch 83/1200  
4/4 0s 4ms/step -  
accuracy: 0.7380 - loss: 0.5249 - val\_accuracy: 0.7778 - val\_loss: 0.5053 -  
learning\_rate: 0.0010  
Epoch 84/1200  
4/4 0s 4ms/step -  
accuracy: 0.7491 - loss: 0.5162 - val\_accuracy: 0.7901 - val\_loss: 0.5053 -  
learning\_rate: 0.0010  
Epoch 85/1200  
4/4 0s 4ms/step -  
accuracy: 0.7310 - loss: 0.5195 - val\_accuracy: 0.7654 - val\_loss: 0.5128 -  
learning\_rate: 0.0010  
Epoch 86/1200  
4/4 0s 4ms/step -  
accuracy: 0.7395 - loss: 0.5253 - val\_accuracy: 0.7407 - val\_loss: 0.5203 -  
learning\_rate: 0.0010  
Epoch 87/1200  
4/4 0s 4ms/step -  
accuracy: 0.7646 - loss: 0.5056 - val\_accuracy: 0.7407 - val\_loss: 0.5295 -  
learning\_rate: 0.0010  
Epoch 88/1200  
4/4 0s 4ms/step -  
accuracy: 0.7263 - loss: 0.5184 - val\_accuracy: 0.7407 - val\_loss: 0.5237 -  
learning\_rate: 0.0010  
Epoch 89/1200  
4/4 0s 4ms/step -  
accuracy: 0.7626 - loss: 0.4911 - val\_accuracy: 0.7654 - val\_loss: 0.5209 -  
learning\_rate: 0.0010  
Epoch 90/1200  
4/4 0s 4ms/step -  
accuracy: 0.7418 - loss: 0.5118 - val\_accuracy: 0.7778 - val\_loss: 0.5237 -  
learning\_rate: 0.0010  
Epoch 91/1200  
4/4 0s 4ms/step -  
accuracy: 0.7401 - loss: 0.5034 - val\_accuracy: 0.7531 - val\_loss: 0.5373 -  
learning\_rate: 0.0010  
Epoch 92/1200  
4/4 0s 4ms/step -  
accuracy: 0.7240 - loss: 0.5183 - val\_accuracy: 0.7407 - val\_loss: 0.5750 -  
learning\_rate: 0.0010  
Epoch 93/1200  
4/4 0s 4ms/step -  
accuracy: 0.7898 - loss: 0.4720 - val\_accuracy: 0.7531 - val\_loss: 0.5560 -

learning\_rate: 0.0010  
Epoch 94/1200  
4/4 0s 4ms/step -  
accuracy: 0.7602 - loss: 0.4834 - val\_accuracy: 0.7778 - val\_loss: 0.5210 -  
learning\_rate: 0.0010  
Epoch 95/1200  
4/4 0s 5ms/step -  
accuracy: 0.7184 - loss: 0.5468 - val\_accuracy: 0.7531 - val\_loss: 0.4977 -  
learning\_rate: 0.0010  
Epoch 96/1200  
4/4 0s 4ms/step -  
accuracy: 0.7442 - loss: 0.5195 - val\_accuracy: 0.7531 - val\_loss: 0.4978 -  
learning\_rate: 0.0010  
Epoch 97/1200  
4/4 0s 4ms/step -  
accuracy: 0.7412 - loss: 0.5073 - val\_accuracy: 0.7531 - val\_loss: 0.5022 -  
learning\_rate: 0.0010  
Epoch 98/1200  
4/4 0s 4ms/step -  
accuracy: 0.7266 - loss: 0.5133 - val\_accuracy: 0.7778 - val\_loss: 0.5208 -  
learning\_rate: 0.0010  
Epoch 99/1200  
4/4 0s 6ms/step -  
accuracy: 0.7471 - loss: 0.4909 - val\_accuracy: 0.7531 - val\_loss: 0.5584 -  
learning\_rate: 0.0010  
Epoch 100/1200  
4/4 0s 4ms/step -  
accuracy: 0.7436 - loss: 0.5161 - val\_accuracy: 0.7778 - val\_loss: 0.5458 -  
learning\_rate: 0.0010  
Epoch 101/1200  
4/4 0s 4ms/step -  
accuracy: 0.7044 - loss: 0.5451 - val\_accuracy: 0.7654 - val\_loss: 0.5220 -  
learning\_rate: 0.0010  
Epoch 102/1200  
4/4 0s 4ms/step -  
accuracy: 0.7187 - loss: 0.5178 - val\_accuracy: 0.7778 - val\_loss: 0.5155 -  
learning\_rate: 0.0010  
Epoch 103/1200  
4/4 0s 4ms/step -  
accuracy: 0.7082 - loss: 0.5608 - val\_accuracy: 0.7778 - val\_loss: 0.5215 -  
learning\_rate: 0.0010  
Epoch 104/1200  
4/4 0s 4ms/step -  
accuracy: 0.7433 - loss: 0.5078 - val\_accuracy: 0.7654 - val\_loss: 0.5424 -  
learning\_rate: 0.0010  
Epoch 105/1200  
4/4 0s 4ms/step -  
accuracy: 0.7544 - loss: 0.5049 - val\_accuracy: 0.7654 - val\_loss: 0.5609 -

learning\_rate: 0.0010  
Epoch 106/1200  
4/4 0s 4ms/step -  
accuracy: 0.7254 - loss: 0.5238 - val\_accuracy: 0.7654 - val\_loss: 0.5346 -  
learning\_rate: 0.0010  
Epoch 107/1200  
4/4 0s 4ms/step -  
accuracy: 0.7415 - loss: 0.4939 - val\_accuracy: 0.7654 - val\_loss: 0.5050 -  
learning\_rate: 0.0010  
Epoch 108/1200  
4/4 0s 4ms/step -  
accuracy: 0.7728 - loss: 0.4787 - val\_accuracy: 0.7778 - val\_loss: 0.5035 -  
learning\_rate: 0.0010  
Epoch 109/1200  
4/4 0s 4ms/step -  
accuracy: 0.7348 - loss: 0.5043 - val\_accuracy: 0.7778 - val\_loss: 0.5143 -  
learning\_rate: 0.0010  
Epoch 110/1200  
4/4 0s 4ms/step -  
accuracy: 0.7614 - loss: 0.4757 - val\_accuracy: 0.7778 - val\_loss: 0.5021 -  
learning\_rate: 0.0010  
Epoch 111/1200  
4/4 0s 4ms/step -  
accuracy: 0.7439 - loss: 0.5092 - val\_accuracy: 0.7654 - val\_loss: 0.4904 -  
learning\_rate: 0.0010  
Epoch 112/1200  
4/4 0s 4ms/step -  
accuracy: 0.7442 - loss: 0.4947 - val\_accuracy: 0.7531 - val\_loss: 0.4997 -  
learning\_rate: 0.0010  
Epoch 113/1200  
4/4 0s 4ms/step -  
accuracy: 0.7336 - loss: 0.4860 - val\_accuracy: 0.7531 - val\_loss: 0.4950 -  
learning\_rate: 0.0010  
Epoch 114/1200  
4/4 0s 4ms/step -  
accuracy: 0.7614 - loss: 0.4941 - val\_accuracy: 0.7407 - val\_loss: 0.4902 -  
learning\_rate: 0.0010  
Epoch 115/1200  
4/4 0s 4ms/step -  
accuracy: 0.7430 - loss: 0.5118 - val\_accuracy: 0.7407 - val\_loss: 0.4874 -  
learning\_rate: 0.0010  
Epoch 116/1200  
4/4 0s 4ms/step -  
accuracy: 0.7675 - loss: 0.4982 - val\_accuracy: 0.7407 - val\_loss: 0.4898 -  
learning\_rate: 0.0010  
Epoch 117/1200  
4/4 0s 4ms/step -  
accuracy: 0.7529 - loss: 0.4949 - val\_accuracy: 0.7407 - val\_loss: 0.5004 -

learning\_rate: 0.0010  
Epoch 118/1200  
4/4 0s 4ms/step -  
accuracy: 0.7599 - loss: 0.4941 - val\_accuracy: 0.7654 - val\_loss: 0.5002 -  
learning\_rate: 0.0010  
Epoch 119/1200  
4/4 0s 4ms/step -  
accuracy: 0.7585 - loss: 0.4859 - val\_accuracy: 0.7407 - val\_loss: 0.5310 -  
learning\_rate: 0.0010  
Epoch 120/1200  
4/4 0s 4ms/step -  
accuracy: 0.7348 - loss: 0.5020 - val\_accuracy: 0.7284 - val\_loss: 0.5444 -  
learning\_rate: 0.0010  
Epoch 121/1200  
4/4 0s 5ms/step -  
accuracy: 0.7500 - loss: 0.5003 - val\_accuracy: 0.7531 - val\_loss: 0.5337 -  
learning\_rate: 0.0010  
Epoch 122/1200  
4/4 0s 4ms/step -  
accuracy: 0.7629 - loss: 0.4677 - val\_accuracy: 0.7407 - val\_loss: 0.5056 -  
learning\_rate: 0.0010  
Epoch 123/1200  
4/4 0s 4ms/step -  
accuracy: 0.7550 - loss: 0.4897 - val\_accuracy: 0.7778 - val\_loss: 0.5130 -  
learning\_rate: 0.0010  
Epoch 124/1200  
4/4 0s 4ms/step -  
accuracy: 0.7430 - loss: 0.5276 - val\_accuracy: 0.7531 - val\_loss: 0.5529 -  
learning\_rate: 0.0010  
Epoch 125/1200  
4/4 0s 4ms/step -  
accuracy: 0.7365 - loss: 0.5312 - val\_accuracy: 0.7531 - val\_loss: 0.5637 -  
learning\_rate: 0.0010  
Epoch 126/1200  
4/4 0s 4ms/step -  
accuracy: 0.7529 - loss: 0.4912 - val\_accuracy: 0.7901 - val\_loss: 0.5259 -  
learning\_rate: 0.0010  
Epoch 127/1200  
4/4 0s 4ms/step -  
accuracy: 0.7327 - loss: 0.5056 - val\_accuracy: 0.7407 - val\_loss: 0.4864 -  
learning\_rate: 0.0010  
Epoch 128/1200  
4/4 0s 4ms/step -  
accuracy: 0.7506 - loss: 0.4741 - val\_accuracy: 0.7407 - val\_loss: 0.4906 -  
learning\_rate: 0.0010  
Epoch 129/1200  
4/4 0s 6ms/step -  
accuracy: 0.7596 - loss: 0.4788 - val\_accuracy: 0.7407 - val\_loss: 0.5072 -

learning\_rate: 0.0010  
Epoch 130/1200  
4/4 0s 4ms/step -  
accuracy: 0.7640 - loss: 0.4883 - val\_accuracy: 0.7654 - val\_loss: 0.5084 -  
learning\_rate: 0.0010  
Epoch 131/1200  
4/4 0s 4ms/step -  
accuracy: 0.7886 - loss: 0.4774 - val\_accuracy: 0.7778 - val\_loss: 0.5069 -  
learning\_rate: 0.0010  
Epoch 132/1200  
4/4 0s 4ms/step -  
accuracy: 0.7561 - loss: 0.4884 - val\_accuracy: 0.7654 - val\_loss: 0.5046 -  
learning\_rate: 0.0010  
Epoch 133/1200  
4/4 0s 4ms/step -  
accuracy: 0.7737 - loss: 0.4906 - val\_accuracy: 0.7654 - val\_loss: 0.4962 -  
learning\_rate: 0.0010  
Epoch 134/1200  
4/4 0s 4ms/step -  
accuracy: 0.7234 - loss: 0.5152 - val\_accuracy: 0.7654 - val\_loss: 0.4727 -  
learning\_rate: 0.0010  
Epoch 135/1200  
4/4 0s 4ms/step -  
accuracy: 0.7725 - loss: 0.4828 - val\_accuracy: 0.7407 - val\_loss: 0.4677 -  
learning\_rate: 0.0010  
Epoch 136/1200  
4/4 0s 4ms/step -  
accuracy: 0.7614 - loss: 0.4918 - val\_accuracy: 0.7407 - val\_loss: 0.4742 -  
learning\_rate: 0.0010  
Epoch 137/1200  
4/4 0s 4ms/step -  
accuracy: 0.7395 - loss: 0.4989 - val\_accuracy: 0.7531 - val\_loss: 0.4948 -  
learning\_rate: 0.0010  
Epoch 138/1200  
4/4 0s 4ms/step -  
accuracy: 0.7383 - loss: 0.5233 - val\_accuracy: 0.7778 - val\_loss: 0.5173 -  
learning\_rate: 0.0010  
Epoch 139/1200  
4/4 0s 4ms/step -  
accuracy: 0.7494 - loss: 0.5135 - val\_accuracy: 0.7778 - val\_loss: 0.5367 -  
learning\_rate: 0.0010  
Epoch 140/1200  
4/4 0s 4ms/step -  
accuracy: 0.7488 - loss: 0.5169 - val\_accuracy: 0.7778 - val\_loss: 0.5261 -  
learning\_rate: 0.0010  
Epoch 141/1200  
4/4 0s 4ms/step -  
accuracy: 0.7889 - loss: 0.4633 - val\_accuracy: 0.7531 - val\_loss: 0.5115 -

learning\_rate: 0.0010  
Epoch 142/1200  
4/4 0s 4ms/step -  
accuracy: 0.7725 - loss: 0.4842 - val\_accuracy: 0.7654 - val\_loss: 0.5353 -  
learning\_rate: 0.0010  
Epoch 143/1200  
4/4 0s 4ms/step -  
accuracy: 0.7506 - loss: 0.4990 - val\_accuracy: 0.7284 - val\_loss: 0.5827 -  
learning\_rate: 0.0010  
Epoch 144/1200  
4/4 0s 4ms/step -  
accuracy: 0.7591 - loss: 0.5323 - val\_accuracy: 0.7531 - val\_loss: 0.5507 -  
learning\_rate: 0.0010  
Epoch 145/1200  
4/4 0s 4ms/step -  
accuracy: 0.7722 - loss: 0.4851 - val\_accuracy: 0.7407 - val\_loss: 0.5261 -  
learning\_rate: 0.0010  
Epoch 146/1200  
4/4 0s 4ms/step -  
accuracy: 0.7327 - loss: 0.5013 - val\_accuracy: 0.7531 - val\_loss: 0.5178 -  
learning\_rate: 0.0010  
Epoch 147/1200  
4/4 0s 4ms/step -  
accuracy: 0.7465 - loss: 0.5125 - val\_accuracy: 0.7654 - val\_loss: 0.5064 -  
learning\_rate: 0.0010  
Epoch 148/1200  
4/4 0s 4ms/step -  
accuracy: 0.7436 - loss: 0.5042 - val\_accuracy: 0.7778 - val\_loss: 0.5110 -  
learning\_rate: 0.0010  
Epoch 149/1200  
4/4 0s 4ms/step -  
accuracy: 0.7623 - loss: 0.4762 - val\_accuracy: 0.7778 - val\_loss: 0.5125 -  
learning\_rate: 0.0010  
Epoch 150/1200  
4/4 0s 4ms/step -  
accuracy: 0.7427 - loss: 0.5050 - val\_accuracy: 0.7654 - val\_loss: 0.5190 -  
learning\_rate: 0.0010  
Epoch 151/1200  
4/4 0s 4ms/step -  
accuracy: 0.7602 - loss: 0.4769 - val\_accuracy: 0.7778 - val\_loss: 0.5141 -  
learning\_rate: 0.0010  
Epoch 152/1200  
4/4 0s 4ms/step -  
accuracy: 0.7670 - loss: 0.5043 - val\_accuracy: 0.7654 - val\_loss: 0.5055 -  
learning\_rate: 0.0010  
Epoch 153/1200  
4/4 0s 4ms/step -  
accuracy: 0.7389 - loss: 0.5085 - val\_accuracy: 0.7654 - val\_loss: 0.5053 -

learning\_rate: 0.0010  
Epoch 154/1200  
4/4 0s 4ms/step -  
accuracy: 0.7000 - loss: 0.5203 - val\_accuracy: 0.7778 - val\_loss: 0.5112 -  
learning\_rate: 0.0010  
Epoch 155/1200  
4/4 0s 4ms/step -  
accuracy: 0.7629 - loss: 0.4730 - val\_accuracy: 0.7901 - val\_loss: 0.5109 -  
learning\_rate: 0.0010  
Epoch 156/1200  
4/4 0s 6ms/step -  
accuracy: 0.7202 - loss: 0.5310 - val\_accuracy: 0.7654 - val\_loss: 0.5257 -  
learning\_rate: 0.0010  
Epoch 157/1200  
4/4 0s 4ms/step -  
accuracy: 0.7708 - loss: 0.4720 - val\_accuracy: 0.7778 - val\_loss: 0.5251 -  
learning\_rate: 0.0010  
Epoch 158/1200  
4/4 0s 5ms/step -  
accuracy: 0.7485 - loss: 0.4929 - val\_accuracy: 0.7778 - val\_loss: 0.5332 -  
learning\_rate: 0.0010  
Epoch 159/1200  
4/4 0s 4ms/step -  
accuracy: 0.7658 - loss: 0.4874 - val\_accuracy: 0.7901 - val\_loss: 0.5183 -  
learning\_rate: 0.0010  
Epoch 160/1200  
4/4 0s 4ms/step -  
accuracy: 0.7471 - loss: 0.4963 - val\_accuracy: 0.7778 - val\_loss: 0.4978 -  
learning\_rate: 0.0010  
Epoch 161/1200  
4/4 0s 4ms/step -  
accuracy: 0.7787 - loss: 0.4784 - val\_accuracy: 0.7654 - val\_loss: 0.4626 -  
learning\_rate: 0.0010  
Epoch 162/1200  
4/4 0s 4ms/step -  
accuracy: 0.7298 - loss: 0.4931 - val\_accuracy: 0.7901 - val\_loss: 0.4625 -  
learning\_rate: 0.0010  
Epoch 163/1200  
4/4 0s 4ms/step -  
accuracy: 0.7547 - loss: 0.4842 - val\_accuracy: 0.7778 - val\_loss: 0.4736 -  
learning\_rate: 0.0010  
Epoch 164/1200  
4/4 0s 4ms/step -  
accuracy: 0.7602 - loss: 0.4805 - val\_accuracy: 0.7901 - val\_loss: 0.4916 -  
learning\_rate: 0.0010  
Epoch 165/1200  
4/4 0s 4ms/step -  
accuracy: 0.7567 - loss: 0.4874 - val\_accuracy: 0.7901 - val\_loss: 0.4984 -

learning\_rate: 0.0010  
Epoch 166/1200  
4/4 0s 4ms/step -  
accuracy: 0.7825 - loss: 0.4940 - val\_accuracy: 0.7654 - val\_loss: 0.4975 -  
learning\_rate: 0.0010  
Epoch 167/1200  
4/4 0s 4ms/step -  
accuracy: 0.7643 - loss: 0.4704 - val\_accuracy: 0.7531 - val\_loss: 0.4884 -  
learning\_rate: 0.0010  
Epoch 168/1200  
4/4 0s 4ms/step -  
accuracy: 0.7436 - loss: 0.4991 - val\_accuracy: 0.7407 - val\_loss: 0.4819 -  
learning\_rate: 0.0010  
Epoch 169/1200  
4/4 0s 4ms/step -  
accuracy: 0.7936 - loss: 0.4833 - val\_accuracy: 0.7654 - val\_loss: 0.4953 -  
learning\_rate: 0.0010  
Epoch 170/1200  
4/4 0s 4ms/step -  
accuracy: 0.7646 - loss: 0.4831 - val\_accuracy: 0.7654 - val\_loss: 0.5002 -  
learning\_rate: 0.0010  
Epoch 171/1200  
4/4 0s 4ms/step -  
accuracy: 0.7509 - loss: 0.4923 - val\_accuracy: 0.7778 - val\_loss: 0.4930 -  
learning\_rate: 0.0010  
Epoch 172/1200  
4/4 0s 4ms/step -  
accuracy: 0.7591 - loss: 0.4744 - val\_accuracy: 0.7778 - val\_loss: 0.5084 -  
learning\_rate: 0.0010  
Epoch 173/1200  
4/4 0s 4ms/step -  
accuracy: 0.7664 - loss: 0.4832 - val\_accuracy: 0.7901 - val\_loss: 0.5213 -  
learning\_rate: 0.0010  
Epoch 174/1200  
4/4 0s 4ms/step -  
accuracy: 0.7711 - loss: 0.4797 - val\_accuracy: 0.8025 - val\_loss: 0.5377 -  
learning\_rate: 0.0010  
Epoch 175/1200  
4/4 0s 4ms/step -  
accuracy: 0.7678 - loss: 0.4731 - val\_accuracy: 0.7654 - val\_loss: 0.5295 -  
learning\_rate: 0.0010  
Epoch 176/1200  
4/4 0s 4ms/step -  
accuracy: 0.7830 - loss: 0.4583 - val\_accuracy: 0.7531 - val\_loss: 0.5154 -  
learning\_rate: 0.0010  
Epoch 177/1200  
4/4 0s 5ms/step -  
accuracy: 0.7614 - loss: 0.4906 - val\_accuracy: 0.7654 - val\_loss: 0.5050 -



learning\_rate: 0.0010  
Epoch 178/1200  
4/4 0s 4ms/step -  
accuracy: 0.7553 - loss: 0.4748 - val\_accuracy: 0.7778 - val\_loss: 0.4926 -  
learning\_rate: 0.0010  
Epoch 179/1200  
4/4 0s 4ms/step -  
accuracy: 0.7716 - loss: 0.4766 - val\_accuracy: 0.7901 - val\_loss: 0.5082 -  
learning\_rate: 0.0010  
Epoch 180/1200  
4/4 0s 4ms/step -  
accuracy: 0.7772 - loss: 0.4751 - val\_accuracy: 0.7778 - val\_loss: 0.5187 -  
learning\_rate: 0.0010  
Epoch 181/1200  
4/4 0s 4ms/step -  
accuracy: 0.7348 - loss: 0.4988 - val\_accuracy: 0.7531 - val\_loss: 0.5190 -  
learning\_rate: 0.0010  
Epoch 182/1200  
4/4 0s 4ms/step -  
accuracy: 0.7673 - loss: 0.4728 - val\_accuracy: 0.7901 - val\_loss: 0.5167 -  
learning\_rate: 0.0010  
Epoch 183/1200  
4/4 0s 4ms/step -  
accuracy: 0.7319 - loss: 0.4755 - val\_accuracy: 0.7901 - val\_loss: 0.5241 -  
learning\_rate: 0.0010  
Epoch 184/1200  
4/4 0s 4ms/step -  
accuracy: 0.7705 - loss: 0.4577 - val\_accuracy: 0.7531 - val\_loss: 0.5185 -  
learning\_rate: 0.0010  
Epoch 185/1200  
4/4 0s 4ms/step -  
accuracy: 0.7558 - loss: 0.4872 - val\_accuracy: 0.7778 - val\_loss: 0.5196 -  
learning\_rate: 0.0010  
Epoch 186/1200  
4/4 0s 4ms/step -  
accuracy: 0.7623 - loss: 0.4814 - val\_accuracy: 0.7901 - val\_loss: 0.5099 -  
learning\_rate: 0.0010  
Epoch 187/1200  
4/4 0s 4ms/step -  
accuracy: 0.7740 - loss: 0.4631 - val\_accuracy: 0.7901 - val\_loss: 0.5357 -  
learning\_rate: 0.0010  
Epoch 188/1200  
4/4 0s 4ms/step -  
accuracy: 0.7544 - loss: 0.4945 - val\_accuracy: 0.8025 - val\_loss: 0.5312 -  
learning\_rate: 0.0010  
Epoch 189/1200  
4/4 0s 4ms/step -  
accuracy: 0.7471 - loss: 0.4957 - val\_accuracy: 0.7778 - val\_loss: 0.4784 -

```

learning_rate: 0.0010
Epoch 190/1200
4/4          0s 4ms/step -
accuracy: 0.7482 - loss: 0.5001 - val_accuracy: 0.8025 - val_loss: 0.4643 -
learning_rate: 0.0010
Epoch 191/1200
4/4          0s 4ms/step -
accuracy: 0.7544 - loss: 0.5068 - val_accuracy: 0.8148 - val_loss: 0.4592 -
learning_rate: 0.0010
Epoch 192/1200
4/4          0s 4ms/step -
accuracy: 0.7646 - loss: 0.5031 - val_accuracy: 0.8148 - val_loss: 0.4858 -
learning_rate: 0.0010
Epoch 193/1200
4/4          0s 4ms/step -
accuracy: 0.7553 - loss: 0.4873 - val_accuracy: 0.8025 - val_loss: 0.5033 -
learning_rate: 0.0010
Epoch 194/1200
4/4          0s 4ms/step -
accuracy: 0.7734 - loss: 0.4608 - val_accuracy: 0.7901 - val_loss: 0.5096 -
learning_rate: 0.0010
Epoch 195/1200
4/4          0s 4ms/step -
accuracy: 0.7962 - loss: 0.4553 - val_accuracy: 0.7531 - val_loss: 0.5236 -
learning_rate: 0.0010
Epoch 196/1200
4/4          0s 4ms/step -
accuracy: 0.7827 - loss: 0.4788 - val_accuracy: 0.7778 - val_loss: 0.5439 -
learning_rate: 0.0010
Epoch 197/1200
4/4          0s 4ms/step -
accuracy: 0.7430 - loss: 0.5027 - val_accuracy: 0.7901 - val_loss: 0.5504 -
learning_rate: 0.0010
Epoch 198/1200
4/4          0s 4ms/step -
accuracy: 0.7649 - loss: 0.4806 - val_accuracy: 0.8025 - val_loss: 0.4946 -
learning_rate: 0.0010
Epoch 199/1200
4/4          0s 4ms/step -
accuracy: 0.7430 - loss: 0.4896 - val_accuracy: 0.8025 - val_loss: 0.4754 -
learning_rate: 0.0010
Epoch 200/1200
4/4          0s 4ms/step -
accuracy: 0.7693 - loss: 0.4662 - val_accuracy: 0.8148 - val_loss: 0.4922 -
learning_rate: 0.0010
Epoch 201/1200
4/4          0s 6ms/step -
accuracy: 0.7959 - loss: 0.4451 - val_accuracy: 0.7901 - val_loss: 0.5121 -

```

learning\_rate: 0.0010  
Epoch 202/1200  
4/4 0s 5ms/step -  
accuracy: 0.7553 - loss: 0.4680 - val\_accuracy: 0.7654 - val\_loss: 0.5548 -  
learning\_rate: 0.0010  
Epoch 203/1200  
4/4 0s 4ms/step -  
accuracy: 0.7754 - loss: 0.4480 - val\_accuracy: 0.7778 - val\_loss: 0.5639 -  
learning\_rate: 0.0010  
Epoch 204/1200  
4/4 0s 5ms/step -  
accuracy: 0.7924 - loss: 0.4625 - val\_accuracy: 0.7654 - val\_loss: 0.5577 -  
learning\_rate: 0.0010  
Epoch 205/1200  
4/4 0s 5ms/step -  
accuracy: 0.7848 - loss: 0.4604 - val\_accuracy: 0.7654 - val\_loss: 0.5886 -  
learning\_rate: 0.0010  
Epoch 206/1200  
4/4 0s 4ms/step -  
accuracy: 0.7585 - loss: 0.4851 - val\_accuracy: 0.7407 - val\_loss: 0.6080 -  
learning\_rate: 0.0010  
Epoch 207/1200  
4/4 0s 4ms/step -  
accuracy: 0.7711 - loss: 0.4667 - val\_accuracy: 0.7407 - val\_loss: 0.6010 -  
learning\_rate: 0.0010  
Epoch 208/1200  
4/4 0s 4ms/step -  
accuracy: 0.7749 - loss: 0.4658 - val\_accuracy: 0.7778 - val\_loss: 0.5473 -  
learning\_rate: 0.0010  
Epoch 209/1200  
4/4 0s 4ms/step -  
accuracy: 0.7626 - loss: 0.4784 - val\_accuracy: 0.7778 - val\_loss: 0.4948 -  
learning\_rate: 0.0010  
Epoch 210/1200  
4/4 0s 4ms/step -  
accuracy: 0.7857 - loss: 0.4426 - val\_accuracy: 0.7901 - val\_loss: 0.4728 -  
learning\_rate: 0.0010  
Epoch 211/1200  
4/4 0s 4ms/step -  
accuracy: 0.7620 - loss: 0.4760 - val\_accuracy: 0.7654 - val\_loss: 0.4760 -  
learning\_rate: 0.0010  
Epoch 212/1200  
4/4 0s 4ms/step -  
accuracy: 0.7655 - loss: 0.4870 - val\_accuracy: 0.7654 - val\_loss: 0.4721 -  
learning\_rate: 0.0010  
Epoch 213/1200  
4/4 0s 4ms/step -  
accuracy: 0.7588 - loss: 0.4827 - val\_accuracy: 0.7778 - val\_loss: 0.4884 -

learning\_rate: 0.0010  
Epoch 214/1200  
4/4 0s 4ms/step -  
accuracy: 0.7424 - loss: 0.4741 - val\_accuracy: 0.7901 - val\_loss: 0.5136 -  
learning\_rate: 0.0010  
Epoch 215/1200  
4/4 0s 4ms/step -  
accuracy: 0.7769 - loss: 0.4661 - val\_accuracy: 0.7778 - val\_loss: 0.5139 -  
learning\_rate: 0.0010  
Epoch 216/1200  
4/4 0s 4ms/step -  
accuracy: 0.7699 - loss: 0.4764 - val\_accuracy: 0.7901 - val\_loss: 0.4942 -  
learning\_rate: 0.0010  
Epoch 217/1200  
4/4 0s 4ms/step -  
accuracy: 0.7956 - loss: 0.4549 - val\_accuracy: 0.7531 - val\_loss: 0.4996 -  
learning\_rate: 0.0010  
Epoch 218/1200  
4/4 0s 4ms/step -  
accuracy: 0.7520 - loss: 0.4901 - val\_accuracy: 0.7778 - val\_loss: 0.5353 -  
learning\_rate: 0.0010  
Epoch 219/1200  
4/4 0s 5ms/step -  
accuracy: 0.7711 - loss: 0.4648 - val\_accuracy: 0.7901 - val\_loss: 0.5392 -  
learning\_rate: 0.0010  
Epoch 220/1200  
4/4 0s 4ms/step -  
accuracy: 0.7646 - loss: 0.4613 - val\_accuracy: 0.7531 - val\_loss: 0.5092 -  
learning\_rate: 0.0010  
Epoch 221/1200  
4/4 0s 4ms/step -  
accuracy: 0.7918 - loss: 0.4339 - val\_accuracy: 0.7778 - val\_loss: 0.5031 -  
learning\_rate: 0.0010  
Epoch 222/1200  
4/4 0s 4ms/step -  
accuracy: 0.8082 - loss: 0.4432 - val\_accuracy: 0.8025 - val\_loss: 0.5031 -  
learning\_rate: 0.0010  
Epoch 223/1200  
4/4 0s 4ms/step -  
accuracy: 0.7822 - loss: 0.4445 - val\_accuracy: 0.8025 - val\_loss: 0.5026 -  
learning\_rate: 0.0010  
Epoch 224/1200  
4/4 0s 4ms/step -  
accuracy: 0.7684 - loss: 0.4746 - val\_accuracy: 0.7901 - val\_loss: 0.5109 -  
learning\_rate: 0.0010  
Epoch 225/1200  
4/4 0s 4ms/step -  
accuracy: 0.7789 - loss: 0.4677 - val\_accuracy: 0.7654 - val\_loss: 0.5174 -

learning\_rate: 0.0010  
Epoch 226/1200  
4/4 0s 4ms/step -  
accuracy: 0.7284 - loss: 0.5086 - val\_accuracy: 0.7531 - val\_loss: 0.5028 -  
learning\_rate: 0.0010  
Epoch 227/1200  
4/4 0s 4ms/step -  
accuracy: 0.7924 - loss: 0.4603 - val\_accuracy: 0.7778 - val\_loss: 0.4920 -  
learning\_rate: 0.0010  
Epoch 228/1200  
4/4 0s 4ms/step -  
accuracy: 0.7743 - loss: 0.4586 - val\_accuracy: 0.8025 - val\_loss: 0.4909 -  
learning\_rate: 0.0010  
Epoch 229/1200  
4/4 0s 4ms/step -  
accuracy: 0.7620 - loss: 0.4589 - val\_accuracy: 0.7778 - val\_loss: 0.4816 -  
learning\_rate: 0.0010  
Epoch 230/1200  
4/4 0s 4ms/step -  
accuracy: 0.7751 - loss: 0.4279 - val\_accuracy: 0.7654 - val\_loss: 0.5180 -  
learning\_rate: 0.0010  
Epoch 231/1200  
4/4 0s 4ms/step -  
accuracy: 0.7415 - loss: 0.4840 - val\_accuracy: 0.7037 - val\_loss: 0.5744 -  
learning\_rate: 0.0010  
Epoch 232/1200  
4/4 0s 4ms/step -  
accuracy: 0.7652 - loss: 0.4574 - val\_accuracy: 0.7160 - val\_loss: 0.5933 -  
learning\_rate: 0.0010  
Epoch 233/1200  
4/4 0s 4ms/step -  
accuracy: 0.7848 - loss: 0.4502 - val\_accuracy: 0.7407 - val\_loss: 0.5947 -  
learning\_rate: 0.0010  
Epoch 234/1200  
4/4 0s 4ms/step -  
accuracy: 0.7787 - loss: 0.4387 - val\_accuracy: 0.7654 - val\_loss: 0.5874 -  
learning\_rate: 0.0010  
Epoch 235/1200  
4/4 0s 4ms/step -  
accuracy: 0.7684 - loss: 0.4737 - val\_accuracy: 0.7531 - val\_loss: 0.5953 -  
learning\_rate: 0.0010  
Epoch 236/1200  
4/4 0s 4ms/step -  
accuracy: 0.7526 - loss: 0.4903 - val\_accuracy: 0.7407 - val\_loss: 0.5859 -  
learning\_rate: 0.0010  
Epoch 237/1200  
4/4 0s 4ms/step -  
accuracy: 0.7836 - loss: 0.4750 - val\_accuracy: 0.7901 - val\_loss: 0.5248 -

learning\_rate: 0.0010  
Epoch 238/1200  
4/4 0s 5ms/step -  
accuracy: 0.7623 - loss: 0.4583 - val\_accuracy: 0.7778 - val\_loss: 0.5019 -  
learning\_rate: 0.0010  
Epoch 239/1200  
4/4 0s 5ms/step -  
accuracy: 0.7503 - loss: 0.4762 - val\_accuracy: 0.7901 - val\_loss: 0.5054 -  
learning\_rate: 0.0010  
Epoch 240/1200  
4/4 0s 4ms/step -  
accuracy: 0.7851 - loss: 0.4547 - val\_accuracy: 0.7901 - val\_loss: 0.5379 -  
learning\_rate: 0.0010  
Epoch 241/1200  
4/4 0s 4ms/step -  
accuracy: 0.7980 - loss: 0.4405 - val\_accuracy: 0.7901 - val\_loss: 0.5585 -  
learning\_rate: 0.0010  
Epoch 242/1200  
4/4 0s 4ms/step -  
accuracy: 0.7579 - loss: 0.4821 - val\_accuracy: 0.7901 - val\_loss: 0.5486 -  
learning\_rate: 0.0010  
Epoch 243/1200  
4/4 0s 4ms/step -  
accuracy: 0.7959 - loss: 0.4250 - val\_accuracy: 0.7901 - val\_loss: 0.5534 -  
learning\_rate: 0.0010  
Epoch 244/1200  
4/4 0s 4ms/step -  
accuracy: 0.7942 - loss: 0.4437 - val\_accuracy: 0.7901 - val\_loss: 0.5620 -  
learning\_rate: 0.0010  
Epoch 245/1200  
4/4 0s 4ms/step -  
accuracy: 0.7740 - loss: 0.4535 - val\_accuracy: 0.8272 - val\_loss: 0.5521 -  
learning\_rate: 0.0010  
Epoch 246/1200  
4/4 0s 4ms/step -  
accuracy: 0.7722 - loss: 0.4466 - val\_accuracy: 0.7901 - val\_loss: 0.5589 -  
learning\_rate: 0.0010  
Epoch 247/1200  
4/4 0s 4ms/step -  
accuracy: 0.7670 - loss: 0.4467 - val\_accuracy: 0.7778 - val\_loss: 0.5811 -  
learning\_rate: 0.0010  
Epoch 248/1200  
4/4 0s 4ms/step -  
accuracy: 0.7599 - loss: 0.4610 - val\_accuracy: 0.7654 - val\_loss: 0.5872 -  
learning\_rate: 0.0010  
Epoch 249/1200  
4/4 0s 4ms/step -  
accuracy: 0.7766 - loss: 0.4525 - val\_accuracy: 0.7778 - val\_loss: 0.5586 -

```

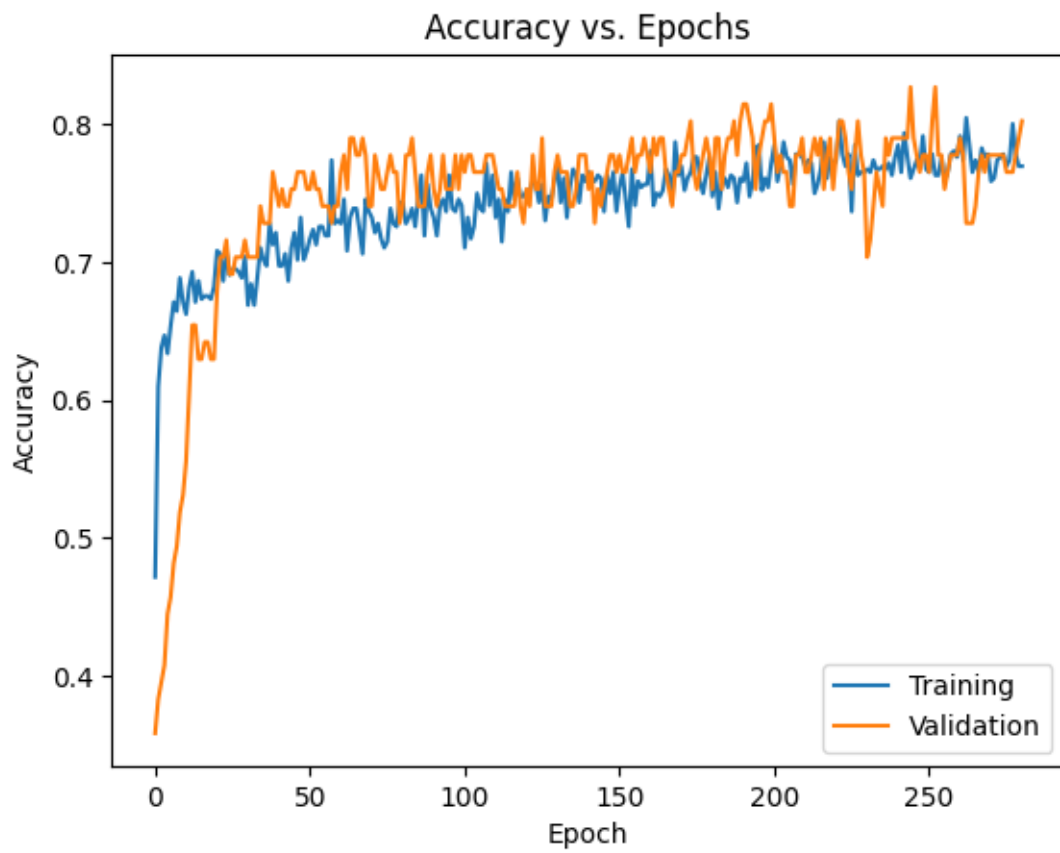
learning_rate: 0.0010
Epoch 250/1200
4/4          0s 4ms/step -
accuracy: 0.7576 - loss: 0.4759 - val_accuracy: 0.7778 - val_loss: 0.5092 -
learning_rate: 0.0010
Epoch 251/1200
4/4          0s 4ms/step -
accuracy: 0.7573 - loss: 0.4768 - val_accuracy: 0.7654 - val_loss: 0.4883 -
learning_rate: 0.0010
Epoch 252/1200
4/4          0s 4ms/step -
accuracy: 0.7956 - loss: 0.4428 - val_accuracy: 0.8025 - val_loss: 0.4866 -
learning_rate: 0.0010
Epoch 253/1200
4/4          0s 4ms/step -
accuracy: 0.7500 - loss: 0.4851 - val_accuracy: 0.8272 - val_loss: 0.4875 -
learning_rate: 0.0010
Epoch 254/1200
4/4          0s 4ms/step -
accuracy: 0.7611 - loss: 0.4635 - val_accuracy: 0.7778 - val_loss: 0.4982 -
learning_rate: 0.0010
Epoch 255/1200
4/4          0s 4ms/step -
accuracy: 0.7906 - loss: 0.4563 - val_accuracy: 0.7778 - val_loss: 0.5361 -
learning_rate: 0.0010
Epoch 256/1200
4/4          0s 7ms/step -
accuracy: 0.7494 - loss: 0.4749 - val_accuracy: 0.7531 - val_loss: 0.5805 -
learning_rate: 0.0010
Epoch 257/1200
4/4          0s 4ms/step -
accuracy: 0.7655 - loss: 0.4934 - val_accuracy: 0.7654 - val_loss: 0.5493 -
learning_rate: 0.0010
Epoch 258/1200
4/4          0s 4ms/step -
accuracy: 0.7833 - loss: 0.4613 - val_accuracy: 0.7778 - val_loss: 0.5119 -
learning_rate: 0.0010
Epoch 259/1200
4/4          0s 4ms/step -
accuracy: 0.7772 - loss: 0.4585 - val_accuracy: 0.7778 - val_loss: 0.5067 -
learning_rate: 0.0010
Epoch 260/1200
4/4          0s 4ms/step -
accuracy: 0.7655 - loss: 0.4699 - val_accuracy: 0.7778 - val_loss: 0.5169 -
learning_rate: 0.0010
Epoch 261/1200
4/4          0s 4ms/step -
accuracy: 0.7959 - loss: 0.4492 - val_accuracy: 0.7901 - val_loss: 0.5681 -

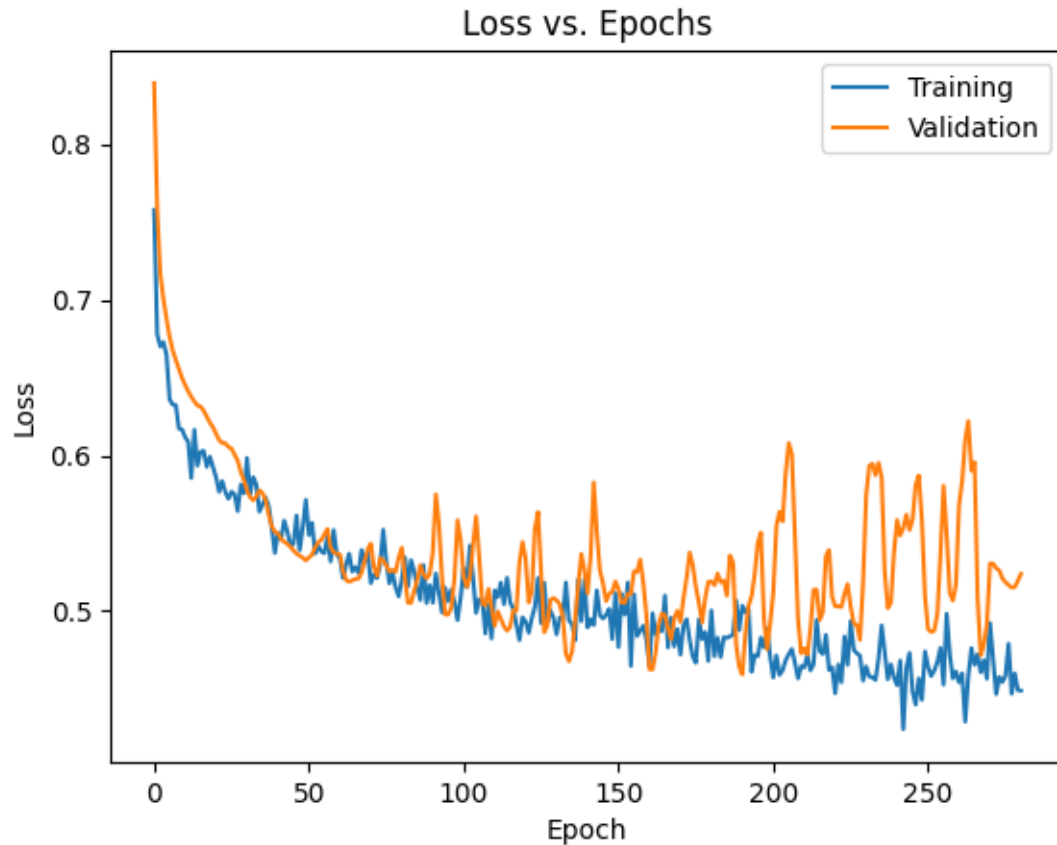
```

learning\_rate: 0.0010  
Epoch 262/1200  
4/4 0s 4ms/step -  
accuracy: 0.7681 - loss: 0.4647 - val\_accuracy: 0.7778 - val\_loss: 0.5834 -  
learning\_rate: 0.0010  
Epoch 263/1200  
4/4 0s 4ms/step -  
accuracy: 0.7988 - loss: 0.4410 - val\_accuracy: 0.7284 - val\_loss: 0.6102 -  
learning\_rate: 0.0010  
Epoch 264/1200  
4/4 0s 4ms/step -  
accuracy: 0.7763 - loss: 0.4570 - val\_accuracy: 0.7284 - val\_loss: 0.6222 -  
learning\_rate: 0.0010  
Epoch 265/1200  
4/4 0s 4ms/step -  
accuracy: 0.7582 - loss: 0.4728 - val\_accuracy: 0.7284 - val\_loss: 0.5902 -  
learning\_rate: 0.0010  
Epoch 266/1200  
4/4 0s 4ms/step -  
accuracy: 0.7725 - loss: 0.4595 - val\_accuracy: 0.7407 - val\_loss: 0.5956 -  
learning\_rate: 0.0010  
Epoch 267/1200  
4/4 0s 4ms/step -  
accuracy: 0.7547 - loss: 0.4829 - val\_accuracy: 0.7654 - val\_loss: 0.5079 -  
learning\_rate: 0.0010  
Epoch 268/1200  
4/4 0s 4ms/step -  
accuracy: 0.7664 - loss: 0.4702 - val\_accuracy: 0.7778 - val\_loss: 0.4715 -  
learning\_rate: 0.0010  
Epoch 269/1200  
4/4 0s 4ms/step -  
accuracy: 0.7848 - loss: 0.4662 - val\_accuracy: 0.7654 - val\_loss: 0.4780 -  
learning\_rate: 0.0010  
Epoch 270/1200  
4/4 0s 4ms/step -  
accuracy: 0.7719 - loss: 0.4582 - val\_accuracy: 0.7778 - val\_loss: 0.4916 -  
learning\_rate: 0.0010  
Epoch 271/1200  
4/4 0s 4ms/step -  
accuracy: 0.7708 - loss: 0.4877 - val\_accuracy: 0.7778 - val\_loss: 0.5306 -  
learning\_rate: 0.0010  
Epoch 272/1200  
4/4 0s 4ms/step -  
accuracy: 0.7819 - loss: 0.4482 - val\_accuracy: 0.7778 - val\_loss: 0.5305 -  
learning\_rate: 1.0000e-04  
Epoch 273/1200  
4/4 0s 5ms/step -  
accuracy: 0.7842 - loss: 0.4331 - val\_accuracy: 0.7778 - val\_loss: 0.5275 -



learning\_rate: 1.0000e-04  
Epoch 274/1200  
4/4 0s 5ms/step -  
accuracy: 0.7696 - loss: 0.4627 - val\_accuracy: 0.7778 - val\_loss: 0.5261 -  
learning\_rate: 1.0000e-04  
Epoch 275/1200  
4/4 0s 4ms/step -  
accuracy: 0.7787 - loss: 0.4568 - val\_accuracy: 0.7778 - val\_loss: 0.5210 -  
learning\_rate: 1.0000e-04  
Epoch 276/1200  
4/4 0s 4ms/step -  
accuracy: 0.7623 - loss: 0.4702 - val\_accuracy: 0.7654 - val\_loss: 0.5185 -  
learning\_rate: 1.0000e-04  
Epoch 277/1200  
4/4 0s 4ms/step -  
accuracy: 0.7816 - loss: 0.4797 - val\_accuracy: 0.7654 - val\_loss: 0.5168 -  
learning\_rate: 1.0000e-04  
Epoch 278/1200  
4/4 0s 4ms/step -  
accuracy: 0.7988 - loss: 0.4532 - val\_accuracy: 0.7654 - val\_loss: 0.5151 -  
learning\_rate: 1.0000e-04  
Epoch 279/1200  
4/4 0s 4ms/step -  
accuracy: 0.7833 - loss: 0.4558 - val\_accuracy: 0.7778 - val\_loss: 0.5154 -  
learning\_rate: 1.0000e-04  
Epoch 280/1200  
4/4 0s 4ms/step -  
accuracy: 0.7798 - loss: 0.4403 - val\_accuracy: 0.7901 - val\_loss: 0.5195 -  
learning\_rate: 1.0000e-04  
Epoch 281/1200  
4/4 0s 5ms/step -  
accuracy: 0.7596 - loss: 0.4524 - val\_accuracy: 0.8025 - val\_loss: 0.5239 -  
learning\_rate: 1.0000e-04





### 0.5.1 5.1 Prueba de la red neuronal optimizada con conjunto de prueba

```
[ ]: # Evaluate the model on the test set
test_loss, test_acc = redNeuroOpt.evaluate(X_test, y_test, verbose=0)
print('test_loss: {} \ntest_acc: {} %'.format(round(test_loss,4),
↪ round(test_acc*100,4)))
```

```
test_loss: 0.6599
test_acc: 70.5628 %
```

## 0.6 6. Predicciones

```
[ ]: prediccionesRedOpt = redNeuroOpt.predict(X_test)

prediccionesBinarias = (prediccionesRedOpt > 0.5).astype(int)

for i, (prediction, actual) in enumerate(zip(prediccionesBinarias[:10], y_test[:
↪ 10]])):
    print(f"y_test {i+1}: {prediction[0]} (ytrain: {actual})", end="\n")
```

```
print("Fin")
```

```
8/8          0s 6ms/step
y_test 1: 0 (ytrain: 0)
y_test 2: 0 (ytrain: 0)
y_test 3: 0 (ytrain: 0)
y_test 4: 0 (ytrain: 0)
y_test 5: 0 (ytrain: 0)
y_test 6: 0 (ytrain: 0)
y_test 7: 0 (ytrain: 0)
y_test 8: 0 (ytrain: 0)
y_test 9: 0 (ytrain: 0)
y_test 10: 1 (ytrain: 0)
Fin
```

## 0.7 7. Referencias

UCI Machine Learning. (2016). Pima Indians Diabetes Database. Kaggle. Retrieved September 4, 2024, from <https://www.kaggle.com/datasets/uciml/pima-indians-diabetes-database>

## 0.8 8. Reporte

### 0. IMPORTANTE

El ipynb se utilizó varias veces para el Portafolio de Análisis. El reporte actual utiliza los valores obtenidos para ese portafolio, pero añade los diferentes ajustes probados a lo largo de la realización del mismo. - Axel

### 1. Introducción

El dataset contiene un total de 768 instancias caracterizadas por ocho features: Pregnancies, Glucose, Blood Pressure, Skin Thickness, Insulin, BMI, Diabetes Pedigree Function (DPF) y Age. El label está definido por la columna Outcome, la cual toma un valor de 1 si el paciente padece diabetes y 0 si no la padece. Para construir el modelo, es necesario separar las features del target para que la red neuronal aprenda a predecir Outcome a partir de las otras 8 variables. Por lo anterior, se decidió dividir el dataset en dos partes: el conjunto de entrenamiento (train set) y el conjunto de prueba (test set).

El conjunto de entrenamiento corresponde al 70% de los datos y se utiliza para entrenar el modelo, permitiendo que los pesos se ajusten de tal manera que nos permita predecir el target correctamente. Por otra parte, el conjunto de prueba corresponde al 30% (`test_size = 0.3`) de los datos y se utiliza para evaluar el rendimiento final del modelo en datos no vistos durante el proceso de entrenamiento, lo cual es importante para verificar que el modelo generaliza bien en datos nuevos. Para realizar lo anterior, se utilizó la función de `train_test_split`, de la librería de `sklearn`, que realiza una división aleatoria, manteniendo la distribución de los datos como se mencionó anteriormente.

Además de los conjuntos mencionados, durante el proceso de entrenamiento también se utilizará un subconjunto del conjunto de entrenamiento del 15% para un conjunto de validación. Esto proporcionará una estimación temprana de la capacidad de generalización del modelo y ayudará a detectar varianza alta (overfitting) antes de probarlo con el conjunto de prueba. Para esto, se utilizó el parámetro `validation_split = 0.15` de la librería `Keras`.

## 2 Parámetros e Hiperparámetros

### 2.1 Learning Rate

El learning rate fue un hiperparámetro muy constante en cuanto a los valores probados. En general, para cada uno de los modelos se probó el arreglo de valores para el learning rate de [0.1, 0.01, 0.001, 0.0001] junto al un optimizador Adam sobre el SGD debido a que mostró un mejor rendimiento en pruebas anteriores.

- Perceptrón: Para este modelo, los valores de learning rate alto resultaban en una pérdida mayor y una precisión menor. Valores muy altos tampoco fueron suficientes, ya que aunque el loss si disminuía no lo hacía de una gran forma. Por lo tanto, el valor de 0.01 fue el valor óptimo de learning rate para el perceptrón, ya que logró minimizar de una mejor forma el error y mejorar la precisión.
- Red Neuronal: Para la red neuronal un learning rate muy elevado suponía un ajuste de pesos y bias muy bajo, debido a que los métricos calculados simplemente no aumentaban lo suficiente. Lo mismo sucedió con un learning rate demasiado bajo, aunque en este si se logró aumentar la precisión, debía de suceder un gran numero de epochs para ver una mejora considerable. Finalmente, learning rates normales mejoraron sólomente el conjunto de entrenamiento. Por lo anterior, se eligió el valor de 0.01 como valor de de learning rate para esta red neuronal.
- Red Neuronal Optimizada: Al ser configuraciones diferentes, este modelo logró utilizar de una mejor manera los valores de learning rate para calcular las métricas. Sin embargo, el patrón continuó, ya que un valor muy alto o muy bajo, estabilizaban la precisión del modelo alrededor del 75% para los conjuntos y los valores más normales para el parámetro lograron que el modelo pudiera superar la barrera del 80% para el conjunto de validación. Por lo anterior, se decidió utilizar el valor de 0.01 para el learning rate.

### 2.2 Epochs

Los epochs que se probaron fueron múltiplos de 100 hasta llegar a los 1,500. Las observaciones son las siguientes:

- Perceptrón: Para este modelo, el número de epochs afectó en gran medida los métricos que calculaban. Un gran número de epochs (600+) ajustaba demasiado al modelo a tal punto que podría considerarse overfitting. Por otra parte, un menor número de epochs hacía que el perceptrón cayera en underfitting. Por lo tanto, se decidió usar un valor de 300 epochs para entrenar al perceptrón, valor que daría un buen ajuste.
- Red Neuronal: Este modelo depende de la naturaleza del dataset definir que tantos epochs se deben incluir. Un numero muy bajo de epochs no entrenaría correctamente al modelo y un número muy alto lo llevaría a estancarse cuando las métricas no puedan mejorar. Por lo anterior, y por ser un modelo mas complejo que el perceptrón, se decidió utilizar un valor de 800 epochs para entrenar al modelo.
- Red Neuronal Optimizada: Para este modelo, el número de epochs generalmente no superó los 300 debido a la implementación de callbacks que detenían el entrenamiento en el momento de que cierta métrica no presentara mejora. Por lo anterior, se decidió utilizar un valor mayor a 300 con el fin de que los callbacks pudieran cumplir su funcionalidad.

### 2.3 Batch Size

El batch size controla el número de muestras usadas en un epoch. Se consideró que un valor bajo podría introducir ruido en el entrenamiento, mientras que uno muy alto podría ralentizar el proceso del mismo al tener que procesar demasiadas muestras a la vez. Por lo anterior, se utilizaron los siguientes valores para este parámetro:

- Perceptrón: 128, al ser una sola neurona el entrenamiento sería lento si se agregara un valor más alto, pero es necesario un valor como el establecido para un buen entrenamiento.
- 
- Red Neuronal: 64, al ser más complejo que el modelo anterior, un batch size menor debe ser utilizado para rapidez en el entrenamiento y verificar que la red y todas sus neuronas calculen correctamente la pérdida.
- Red Neuronal Optimizada: 114, ya que al agregar técnicas de regularización, como el Dropout, el modelo perdería momentáneamente partes de sus neuronas, por lo que un valor alto para este parámetro es necesario para un correcto entrenamiento.

## 2.4 Capas y neuronas

Para una red neuronal entre más capas ocultas y neuronas se tenga, mayor complejidad se obtiene. Esto es importante ya que puede llevarnos al overfitting. Por lo anterior, las configuraciones de capas y número de neuronas fue de la siguiente manera:

- Red Neuronal: Consta de 7 capas (5 ocultas) con una distribución de neuronas de 16, 16, 32, 32, 16, 1. Al no tener optimizaciones, esto puede volver muy complejo al modelo a la hora del entrenamiento, especialmente por el gran número de capas y neuronas.
- Red Neuronal Optimizada: Consta de 9 capas (7 ocultas) con una distribución de neuronas de 8, 16, 16, 16, 16, 16, 16, 28, 1. Al tener optimizaciones, la complejidad del modelo es adecuada y el número de neuronas está ajustado para evitar overfitting a la hora de entrenarlo.

## 2.5 Funciones de Activación

La librería keras ofrece más de 15 funciones de activación, como softmax, leakyReLU o tanh. Para las redes neuronales se decidió utilizar las funciones de activación de la siguiente manera:

- Entrada: ReLu, debido a su uso común y su eficacia para combatir el problema del ‘vanishing gradient’ (gradientes muy pequeños que resultan en actualizaciones de pesos mínimos en las neuronas) en redes neuronales que utilizan backpropagation.
- Ocultas: ReLu por las mismas razones enlistadas en el punto anterior.
- Salida: Sigmoid, ya que devuelve un valor entre 0 y 1, en un threshold de  $[-5, 5]$  para realizar una decisión binaria.

## 2.6 Dropout

El dropout consiste en excluir temporalmente algunas neuronas modificando la estructura de la red neuronal y, por ende, reduciendo su complejidad. Lo anterior ayuda a evitar que el modelo se ajuste a los datos de entrenamiento. Para la red optimizada, se utilizaron dos capas de dropout (después de las capas 3 y 7), con valores de  $[0.1, 0.3]$  con el fin de no perder en el entrenamiento demasiadas neuronas.

## 2.7 Patience

Finalmente, para la red optimizada, los callbacks utilizan el parámetro de patience para parar el entrenamiento cuando un determinado número de epochs ha pasado y los métricos no han mejorado. Un valor alto en estos parámetros no funcionaría de manera correcta para este dataset debido a su corta longitud. Por lo anterior, los valores de patience fueron los siguientes:

- Learning Rate Reduction: 80, se observó que dejar pasar un mayor número de epochs para este dataset mejoraba el rendimiento, por lo que para evitar un entrenamiento más lento y preciso, el valor se fijó en 80.
- Early Stopping: 90, aunque generalmente el modelo no paró por este callback, mantener un valor más elevado que el de Learning Rate Reduction nos permite corroborar que aun y cuando puede no suceder, el learning rate pueda disminuir en dado caso que el primer callback lo vea necesario y aun así tener tiempo de verificar si los métricos cambiaron.

### 3 Métricos y Resultados

Una vez finalizado el entrenamiento, los métricos y resultados fueron los siguientes:

#### 3.1 Perceptrón

- El accuracy en el conjunto de entrenamiento aumentó desde 35.21% hasta 46.56%. Por otra parte, el accuracy en el conjunto de validación fue de 34.57% hasta un máximo de 43.21%. Para el conjunto de prueba, la precisión fue de 48.91%
- El loss en el entrenamiento comenzó en un valor de 46.93 y disminuyó constantemente hasta valores aproximados a 2.39. Por otra parte, el loss de validación también disminuye hasta 2.45, pero sigue siendo más alto que el de entrenamiento. Para el conjunto de prueba, el loss fue de 1.40.
- Este modelo sufrió de un alto bias debido a su simplicidad, lo que lo lleva a caer en underfitting. Esto se evidencia por su pobre desempeño tanto en los conjuntos de entrenamiento como de validación y prueba. Además, no existe una varianza alta, ya que el modelo tampoco presenta una alta precisión en el conjunto de entrenamiento.

#### 3.2 Red Neuronal

- El accuracy en el conjunto de entrenamiento aumentó desde 37.32% hasta 92.04%. Por otra parte, el accuracy en el conjunto de validación se mantuvo en la mayor parte del entrenamiento alrededor del 65.40% hasta un máximo de 66.67%. Para el conjunto de prueba, la precisión fue de 69.69%.
- El loss en el entrenamiento comenzó en un valor de 4.35 y disminuyó hasta valores cercanos a 0.19. Por otra parte, el loss de validación también disminuye hasta 0.58, pero después sube a 1.41. Para el conjunto de prueba, el loss fue de 1.40.
- Este modelo sufrió de overfitting, es decir, varianza alta debido a la alta diferencia de rendimientos entre los datasets. Se puede observar como el único set que desempeñó correctamente fue el de entrenamiento. A comparación con el set de prueba que fue un 23% menos preciso. Por lo tanto, este modelo logró un buen ajuste solamente para los datos de entrenamiento.

#### 3.3 Red Neuronal Optimizada

- El accuracy en el conjunto de entrenamiento aumentó desde 44.47% a 74.71%. Por otra parte, el accuracy en el conjunto de validación se logró una máxima precisión final de 77.78%. Para

el conjunto de prueba, la precisión fue de 74.02%.

- El loss en el entrenamiento comenzó en un valor de 0.85 y disminuyó rápidamente hasta 0.50. Por otra parte, el loss de validación también disminuye de 1.38 a 0.48 a lo largo de los epochs. Para el conjunto de prueba, el loss fue de 0.57.
- Este modelo obtuvo un desempeño aceptable en los tres datasets. Los métricos indican que el modelo generaliza bien para nuevos valores la mayoría de las veces. Por lo anterior, el ajuste del modelo es balanceado aun y cuando la precisión y el loss cuentan con margen de mejora.

#### 4 Conclusiones

Modelo	Precisión Final (%)	Loss Final	Fit
Perceptrón	48.91	2.33	Underfitted
Red Neuronal	69.69	1.40	Overfitted
Red Neuronal Optimizada	74.06	0.57	Balanceado

En conclusión, el modelo optimizado demostró una capacidad de generalización superior en comparación con los modelos más simples y sin optimizaciones, que sufrieron de underfitting y overfitting. Lo anterior es gracias a las técnicas de regularización y los ajustes aplicados a la red neuronal, los cuales permitieron un mejor desempeño al predecir nuevos datos.

Sin embargo, es importante destacar que los modelos aún puede mejorarse y que es muy sencillo de elegir uno sobre otro una vez que modifiquemos los parámetros e hiperparametros y validemos que su capacidad de predicción es correcta.

#### 5 Anexo de Predicciones de Modelo Optimizado

== RED NEURONAL OPTIMIZADA ==

y\_test 1: 0 (ytrain: 0) y\_test 2: 0 (ytrain: 0) y\_test 3: 0 (ytrain: 0) y\_test 4: 0 (ytrain: 0) y\_test 5: 0 (ytrain: 0) y\_test 6: 1 (ytrain: 0) y\_test 7: 0 (ytrain: 0) y\_test 8: 0 (ytrain: 0) y\_test 9: 1 (ytrain: 0) y\_test 10: 0 (ytrain: 0) Fin