

# Final Project Submission

Please fill out:

- Student name: Deztany Jackson
- Student pace: DS Flex
- Scheduled project review date/time: March 30, 2023
- Instructor name: Morgan Jones
- Blog post URL: <http://dmvinedata.com/systembias/>

## X-ray Image Predictions: Pneumonia or Normal



## Summary

A local hospital wants to explore their image recognition options for pneumonia cases. They want eventually replace a few doctors due to staffing issues. They want to test it out for a trial version. Worldwide Pneumonia is a deadly and expensive condition, especially for children and the elderly. Using Convolutional Neural Networks, X-Ray images of Normal and Pneumonia patients, data scientists will attempt to build models that detect pneumonia with the goal of minimizing False Negatives (predicting no pneumonia, while there is). Because of the severity this is a main focus.

The dataset is from Chest X-Ray of "Normal" and "Pneumonia" images from [Kaggle](#) with a total of 5856 .jpeg files.

Based on the business goal and data, the main metrics will be Recall, F1-Score, and Loss, Accuracy will be secondary.

There is a data imbalance between categories and splits. After the images are loaded, the Train and Validation images are combined and then split 80/20 for each respective category (Normal, Pneumonia). This does not solve the data and split imbalance but improves the offset to support more accurate modeling evaluation metrics.

Modeling was done over 10 iterations (including a Transfer Model) with Hyperparameter tweaks: (Batch Size, Epochs, Dropout, Activation, Class Weight). The best models had no False Negatives or False Positives with scores of 1. The chosen model had the smallest loss.

Hospital Recommendations:

- Usage: The model is best as a learning tool and not an official diagnosis.
- Strategy: Use the model as an initial reviewer of the images.
- Staffing: The model is best used with a doctor, not standalone.

Technical Recommendations:

- Scope, review and process images more beforehand
- Visualize the activation functions to see better what areas the model layers are diagnosing
- Iterate model improvement with augmented data
- Visually inspect the images that were FN and FP.

## Import Libraries

```
In [1]: import os
import glob

#from google.colab import drive #Google Collab

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import pickle

import tensorflow as tf

from tensorflow import keras
from tensorflow.keras.metrics import Accuracy, Precision, Recall
from tensorflow.keras.preprocessing.image import ImageDataGenerator, array_to_i
from tensorflow.keras import models, layers, optimizers, activations
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout
from tensorflow.keras.utils import plot_model

from sklearn.model_selection import train_test_split

from sklearn.model_selection import GridSearchCV
from tensorflow.keras.wrappers.scikit_learn import KerasClassifier
from keras.optimizers import Adam

from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping
from tensorflow.keras.applications import VGG19 #Pretrained Transfer Modeling
from sklearn.utils.class_weight import compute_class_weight

from keras.preprocessing import image
from PIL import Image

from sklearn.metrics import make_scorer
from sklearn.metrics import precision_score, f1_score, recall_score, accuracy_soc
from sklearn.metrics import precision_recall_curve, PrecisionRecallDisplay, ave
from sklearn.metrics import confusion_matrix as cm
from sklearn.metrics import classification_report, ConfusionMatrixDisplay
from sklearn.utils.class_weight import compute_class_weight
```

```
import datetime

#Used to move files
import shutil

#Ignore warnings
import warnings
warnings.filterwarnings('ignore')
tf.__version__

# Stop Tensorflow errors from showing especially
import logging
#tf.get_logger().setLevel(logging.ERROR)

# Showing the areas of the image boundaries
import lime
from lime import lime_base
from lime import lime_image
from skimage.segmentation import mark_boundaries
```

In [2]: #Getting start time  
original\_start = datetime.datetime.now()

The following modeling effort was developed on a Apple M2 Max 64GB computer.  
There may be tasks that may longer execute on other hardware

## Data Understanding

The dataset is from Chest X-Ray of "Normal" and "Pneumonia" images from [Kaggle](#) with a total of 5856 .jpeg files. This data set is already broken up into three folders (train, validation and test) and a folder for each category ("NORMAL" or "PNEUMONIA").

### Original Dataset Splits

- Train [1341 NORMAL, 3875 PNEUMONIA]
- Validation [8 NORMAL, 8 PNEUMONIA]
- Test [234 NORMAL, 390 PNEUMONIA]

There is a data imbalance between categories and splits. After the images are loaded, the Train and Validation images are combined and then split 80/20 for each respective category (Normal, Pneumonia). This does not solve the data and split imbalance but improves the offset to support more accurate modeling evaluation metrics.

The original dataset is already split by the time this notebook is turned it. The following code will still work with the original dataset and previously shifted images

## Loading Images

Images are loaded from the current directory joined with the location of the dataset. The python "glob" module [Glob, Tara Boyle, 2021](#) is used to retrieve files recursively. Without knowing all the file names "\*" asterisks are used in place to get all fo the files.

```
In [3]: #Get Current directory
cur_dir = os.getcwd()
cur_dir
```

```
Out[3]: '/Users/deztanyjackson/Documents/0_Flatiron/Phase_4/Project_4/Image_Classification_P4'
```

Understanding the total images split among the respective directories

```
In [4]: def print_image_lengths():
    """
    Retrieving data and the lengths of the training, validation and test for
    #Retrieving dataset in the respective folders
    train_data = glob.glob(os.path.join(cur_dir,'data/chest_xray/train/**/*.jpeg'))
    val_data = glob.glob(os.path.join(cur_dir,'data/chest_xray/val/**/*.jpeg'))
    test_data = glob.glob(os.path.join(cur_dir,'data/chest_xray/test/**/*.jpeg'))

    #Printing total number of images in different directories
    print(f"Training Set has: {len(train_data)} images")
    print(f"Validation Set has: {len(val_data)} images")
    print(f"Testing Set has: {len(test_data)} images")

    return train_data, val_data, test_data
```

Understanding the total categories (Normal and Pneumonia) split among the respective directories

---

## Initial Data Balancing

The data splitting and moving will not solve the data imbalance for training, but supports better modeling metric evaluations.

- Orinally started with 16 Validation Images
- Moving validation images to train set.
- Perform Random Train/Valid split 80/20 on Normal and Pneumonia images
- Move 20% of each back to validation folder

Retrieves Normal and Pneumonia specific images for each dataset

```
In [5]: #Pulling in Normal and Pneumonia specific data

#Training Data
t_norm = glob.glob(os.path.join(cur_dir,'data/chest_xray/train/NORMAL/*.jpeg'))
t_pneu = glob.glob(os.path.join(cur_dir,'data/chest_xray/train/PNEUMONIA/*.jpeg'))
#Validation Data
v_pneu = glob.glob(os.path.join(cur_dir,'data/chest_xray/val/PNEUMONIA/*.jpeg'))
v_norm = glob.glob(os.path.join(cur_dir,'data/chest_xray/val/NORMAL/*.jpeg'))
#Test Data
```

```
test_norm = glob.glob(os.path.join(cur_dir, 'data/chest_xray/test/NORMAL/*.jpeg'))
test_pneu = glob.glob(os.path.join(cur_dir, 'data/chest_xray/test/PNEUMONIA/*.jp
```

## Moving and Splitting Files (If Necessary)

Moving the validation data to the respective Normal and Pneumonia Training folders if the amount of files in the folders are less than 20 (This number is arbitrary)... If so, there will be a 80/20 split of the data and then the 20% of files are moved back to the respective Validation folder. The original dataset had 8 images per folder. The goal is to only move files if there is an huge value offset. If not, then the files don't need to move.

```
In [6]: if (len(v_pneu) <= 20) & (len(v_norm) <= 20): # Only perform action if validation folders have less than 20 images
    #Moving Validation to Test
    cat = [v_norm,v_pneu]
    for c in cat:
        if c == v_norm:
            images = [f for f in v_norm if '.jpeg' in f.lower()]
            for img in images:
                new_path = os.path.join(cur_dir,"data/chest_xray/train/NORMAL/")
                shutil.move(img,new_path)
        elif c == v_pneu:
            images = [f for f in v_pneu if '.jpeg' in f.lower()]
            for img in images:
                new_path = os.path.join(cur_dir,"data/chest_xray/train/PNEUMONIA/")
                shutil.move(img,new_path)
        else:
            pass

    #Splitting the data 80/20 for the Normal and Pneumonia categories.
    #Moving the 20% split to the respective Validation directories.
    train_cat = [t_norm,t_pneu]
    for cat in train_cat:
        train,val = train_test_split(cat, train_size=.85, random_state=42)
        if cat == t_norm:
            for img in val:
                new_path = os.path.join(cur_dir,"data/chest_xray/val/NORMAL/")
                shutil.move(img,new_path)
        elif cat == t_pneu:
            for img in val:
                new_path = os.path.join(cur_dir,"data/chest_xray/val/PNEUMONIA/")
                shutil.move(img,new_path)
        else:
            pass
    else: #If validation folders doesnt have less than 20 images then don't do anything
        print("The folders are split well")
```

The folders are split well

```
In [7]: #Printing Dataset values
train_data, val_data, test_data = print_image_lengths()
print("\n")
#Training Data
print(f"Training Pneumonia Amount: {len(t_pneu)} images")
print(f"Training Normal Amount: {len(t_norm)} images")
print(f"Training Normal to Pneumonia Ratio: {round(len(t_norm)/len(t_pneu),2)}")
print("\n")
```

```
#Validation Data
print(f"Validation Pneumonia Amount: {len(v_pneu)} images")
print(f"Validation Normal Amount: {len(v_norm)} images")
print(f"Validation Normal to Pneumonia Ratio: {round(len(v_norm)/len(v_pneu),2)}")

Training Set has: 4509 images
Validation Set has: 723 images
Testing Set has: 624 images
```

Training Pneumonia Amount: 3347 images  
 Training Normal Amount: 1162 images  
 Training Normal to Pneumonia Ratio: 0.35

Validation Pneumonia Amount: 536 images  
 Validation Normal Amount: 187 images  
 Validation Normal to Pneumonia Ratio: 0.35

**There is still imbalance but better offset.**

---

## Normal and Pneumonia Images

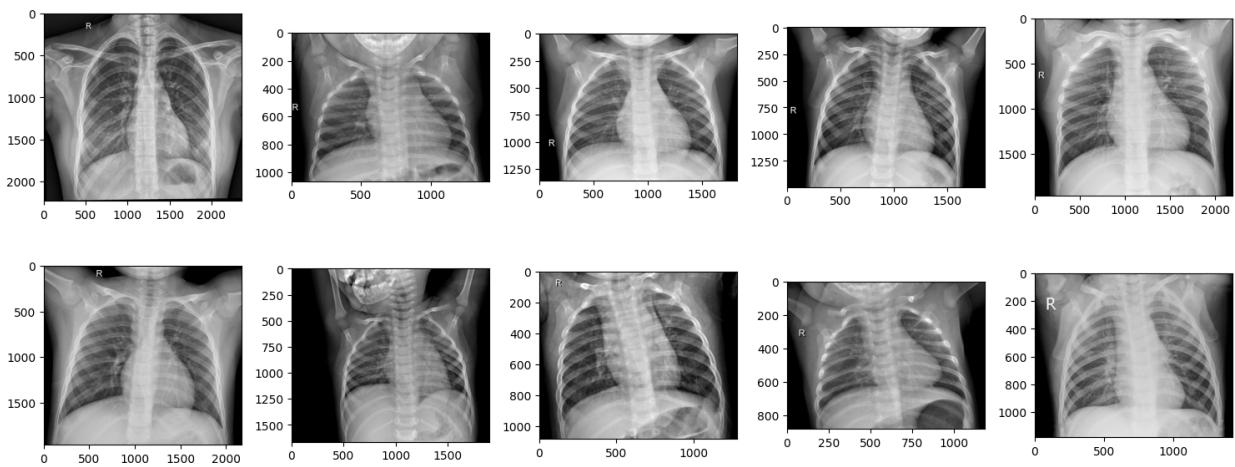
Displaying 10 of the first images in the Normal and Pneumonia Training folders.  
 ".imread()" method reads images from file into an array. All the images will be displayed a grid to show size and in the color gray. For the images below, the higher pixel intensity is associated with lighter color (possible, light gray or white). Because of the cloudiness that Pneumonia displays, it would have a higher pixel intensity.

### NORMAL IMAGES

In [8]:

```
#Plotting 10 images from the train folder
plt.figure(figsize = (15,15))
print ("Sample of Normal Pictures")
for i in range(10):
    plt.subplot(5,5,i+1)
    #Reads images from file into an array
    img = plt.imread(t_norm[i])
    plt.imshow(img, cmap = "gray")
    plt.tight_layout()
plt.savefig('images/Img_Norm.png')
```

Sample of Normal Pictures

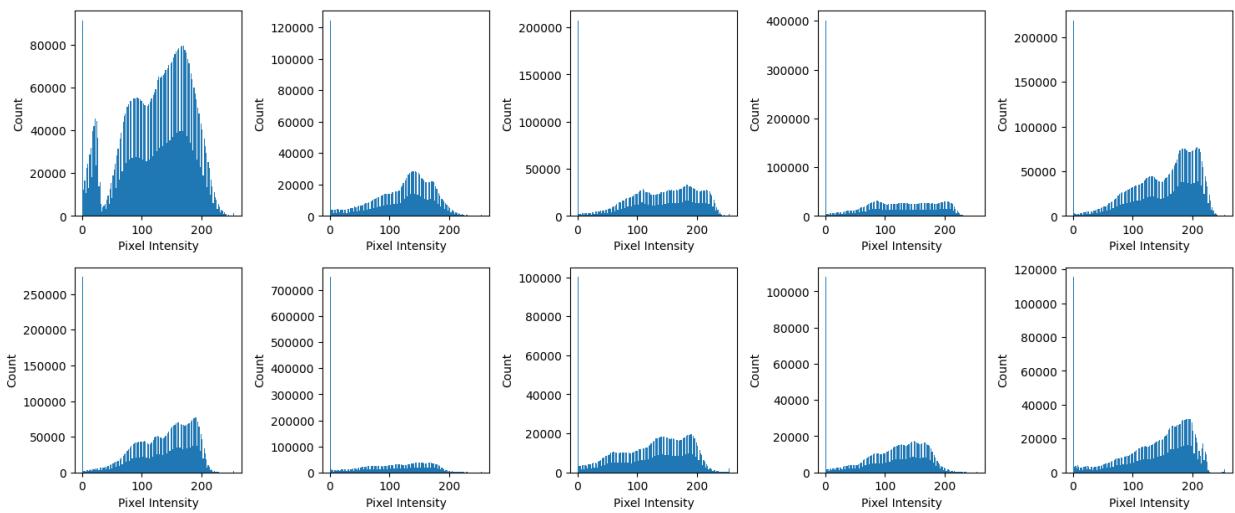


## NORMAL PIXEL INTENSITY

Displaying pixel intensity associated with the plotted images. An image has 256 values (0,255). Zero is associated to the color black and 255 associated to the color white. [Pixel Understanding](#)

```
In [9]: #Plotting 10 image pixels from the train folder
plt.figure(figsize = (15,15),facecolor="White")
print ("Associated Normal Pixel Intensities")
for i in range(10):
    plt.subplot(5,5,i+1)
    img = plt.imread(t_norm[i])
    plt.hist(img.ravel(), bins=150)
    plt.tight_layout()
    plt.ylabel("Count")
    plt.xlabel("Pixel Intensity")
plt.savefig('images/Hist_Norm.png')
#plt.axis('off')
```

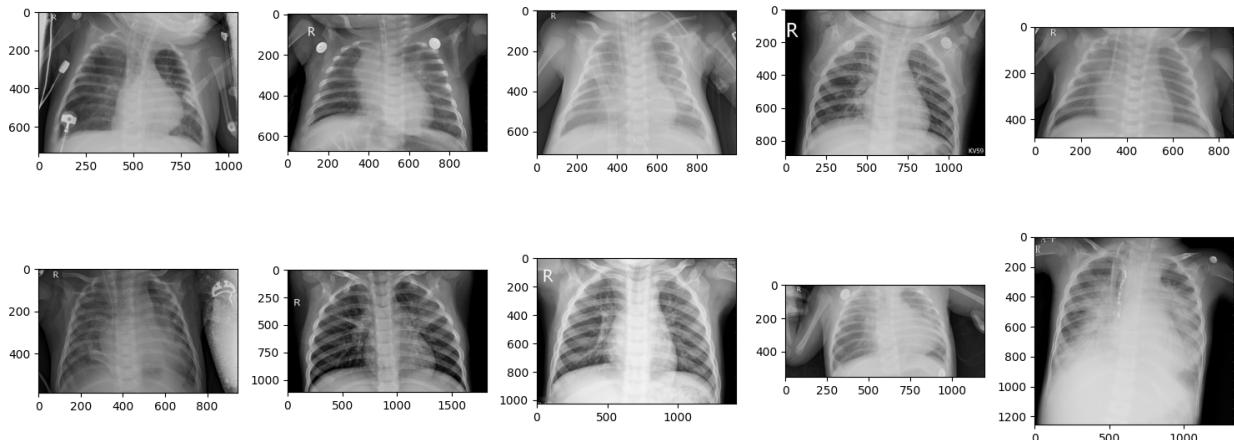
Associated Normal Pixel Intensities




---

## PNEUMONIA IMAGES

```
In [10]: plt.figure(figsize = (15,15))
print ("Sample of Random Pneumonia Pictures")
for i in range(10):
    plt.subplot(5,5,i+1)
    img = plt.imread(t_pneu[i])
    plt.imshow(img, cmap = "gray")
    plt.tight_layout()
plt.savefig('images/Img_Pneu.png')
# plt.axis('off')
```

**Sample of Random Pneumonia Pictures**

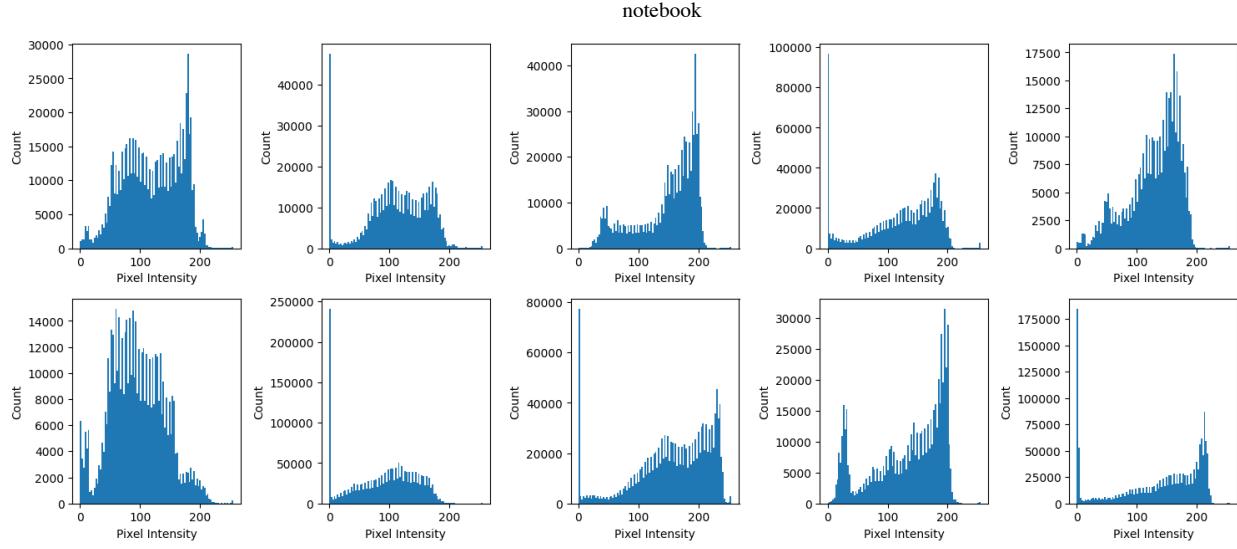
**Visually, both the Normal and Pneumonia pictures vary in size. Pneumonia pictures have a cloudier visual look.**

## PNEUMONIA PIXEL IMAGES

Displaying pixel intensity associated with the plotted images.

```
In [11]: plt.figure(figsize = (15,15), facecolor="White")
print ("Associated Pneumonia Pixel Intensities")
for i in range(10):
    plt.subplot(5,5,i+1)
    img = plt.imread(t_pneu[i])
    plt.hist(img.ravel(), bins=100)
    plt.tight_layout()
    plt.ylabel("Count")
    plt.xlabel("Pixel Intensity")
plt.savefig('images/Hist_Pneu.png')
# plt.axis('off')
```

**Associated Pneumonia Pixel Intensities**



It appears the pixel intensity is more with Pneumonia.

---

## Preprocessing Images

### Rescaling the image Rescaling

For the initial dataset, the only preprocessing will be rescaling, creating target size and scoping the batch size. Further data augmentation will be done during the modeling.

### Image Generator

Generating batches of tensor image data with real-time data augmentation.

```
In [12]: #ImageDataGenerator without pre data augmentation
train_datagen = ImageDataGenerator(rescale=1./255)
val_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)
```

Creating directories for augmentation. The subdirectories will be understood by the operation.

```
In [13]: #Create Current Directories
train_directory= 'data/chest_xray/train'
validation_directory= 'data/chest_xray/val'
test_directory = 'data/chest_xray/test'
```

With the tensor image data and directory we will generate batches of augmented data.

Describe:

- Target Size - Dimensions the images will be resized to
- Batch Size - Size of batches of data
- Classes - Class names

- Class Mode - "Binary" 1D Binary labels
- Shuffle - Sorts data in a random matter, Default is True.
- Seed - Random seed for shuffling

```
In [14]: #Using a generator for the images to work with.
train_gen = train_datagen.flow_from_directory(train_directory,
                                              target_size = (224, 224),
                                              batch_size=300,
                                              classes = ["NORMAL", "PNEUMONIA"],
                                              class_mode = 'binary',
                                              seed = 42)

val_gen = val_datagen.flow_from_directory(validation_directory,
                                             target_size = (224, 224),
                                             batch_size = 100,
                                             classes = ["NORMAL", "PNEUMONIA"],
                                             class_mode = 'binary',
                                             seed = 42)

#Testing data will be used on Final Model only
test_gen = test_datagen.flow_from_directory(test_directory,
                                              target_size = (224, 224),
                                              batch_size = 624,
                                              classes = ["NORMAL", "PNEUMONIA"],
                                              class_mode = 'binary',
                                              seed = 42,
                                              shuffle= False)
```

Found 4509 images belonging to 2 classes.  
 Found 723 images belonging to 2 classes.  
 Found 624 images belonging to 2 classes.

```
In [15]: #Checking the class label and index match
print(train_gen.class_indices)
print(val_gen.class_indices)

{'NORMAL': 0, 'PNEUMONIA': 1}
{'NORMAL': 0, 'PNEUMONIA': 1}
```

Iterating through the generated images. X and y are the images and labels respectively. It is a sample equal to the batch size above.

```
In [16]: X_train, y_train = next(train_gen)
X_val, y_val = next(val_gen)
X_test, y_test = next(test_gen)

print("X_train:", len(X_train), "y_train:", len(y_train))
print("X_val:", len(X_val), "y_val:", len(y_val))
print("X_test:", len(X_test), "y_test:", len(y_test))

X_train: 300 y_train: 300
X_val: 100 y_val: 100
X_test: 624 y_test: 624
```

## Modeling

### Custom Functions for Model Evaluation

## Visualization Metrics,A.Jang 2023

```
In [17]: #Create a new directory for saved files
directory = "saved_files"
save_path = os.path.join(cur_dir,directory)
try:
    os.mkdir(save_path)
except OSError as error:
    print(error)

[Errno 17] File exists: '/Users/deztanyjackson/Documents/0_Flatiron/Phase_4/Project_4/Image_Classification_P4/saved_files'
```

```
In [18]: #Using Pickle in a function to save files
def save_file(name,file):
    """ Saving file to a specific directory using pickle"""
    saved_name = os.path.join(save_path,name)
    with open(saved_name, 'wb') as f:
        pickle.dump(file, f)
```

```
In [19]: #loading Pickle Files
def load_file(name):
    """ Loading file from a specific directory using pickle"""
    saved_name = os.path.join(save_path,name)
    with open(saved_name, 'rb') as f:
        file = pickle.load(f)
    return file
```

```
In [20]: #Printing metric subplots of training and validation per epoch
def eval_metrics(history):
    """ Plots Train and Validation metrics["acc","loss","recall","precision"]
    from a model's evaluation results."""

    fig, ax = plt.subplots(1,4, figsize = (25,5))
    fig.suptitle('Model Metrics Results')

    metrics = ["loss","recall","acc","precision"]

    for i, metric in enumerate(metrics):

        ax[i].plot(history.history[metric])
        ax[i].plot(history.history["val_" + metric])
        ax[i].set_title('Model {}'.format(metric))
        ax[i].set_ylabel(metric)
        ax[i].set_xlabel("Epochs")
        ax[i].legend(['train', 'val'])
```

## Predictor Algorithm with Shuffle,by Jakob, 2021

```
In [21]: def predict_results(model,generator):
    """Generates prediction results and true labels from a specific model and s
    This formula works well for shuffled generated data."""

    # Create lists for storing the predictions and labels
    predictions = []
```

```

labels = []

# Get the total number of labels in generator
# (i.e. the length of the dataset where the generator generates batches from)
n = len(generator.labels)

# Loop over the generator
for data, label in generator:
    # Make predictions on data using the model. Store the results.
    predictions.extend(model.predict(data).flatten())

    # Store corresponding labels
    labels.extend(label)

    # We have to break out from the generator when we've processed
    # the entire once (otherwise we would end up with duplicates).
    if (len(label) < generator.batch_size) and (len(predictions) == n):
        break

return labels, predictions #y_true, y_hat_train/y_pred

```

In [22]:

```

def conf_matrix(y_true,y_pred, norm_bool):
    """Prints confusion matrix for the Normal and Pneumonia true and predicted
    y_pred = np.round(y_pred,0) #Rounding to the nearest 0 or 1, assumes threshold
    cmatrix= cm(y_true, y_pred, normalize=norm_bool)# Allows normalized matrix
    matrix_disp= ConfusionMatrixDisplay(cmatrix, display_labels= ["NORMAL", "PNEUMONIA"])
    matrix_disp.plot()

    plt.xlabel('Predictions')
    plt.ylabel('Actual')
    plt.title('Model Confusion Matrix')
    plt.show()

```

In [23]:

```

def eval_report(y_true, y_pred, gen, history):
    """ Displaying the classification report and loss from the model results"""
    y_pred = np.round(y_pred,0) # Rounding to the nearest 0 or 1
    #Display Precision, Recall, F1 and Accuracy
    print(classification_report(y_true, y_pred, digits = 3))
    print('\n')

    #Display Model Metrics
    loss, _, _, _ = history.model.evaluate(gen)

    print(f'Loss: {np.round(loss,4)}')

```

In [24]:

```

# set up the class weights using y_train
def calc_weight(labels):
    """ Setting the weights and pairing it with the classes for the class weight
    Labels can also be thought of as y_train"""
    classes = [0,1]
    weights = compute_class_weight(class_weight='balanced', classes=classes, y=labels)
    class_weights = dict(zip(classes, weights))
    return class_weights

```

The following is the outline of each model iteration:

- Sequence
- Compile
- Summary
- Fit
- Predict
- Conf\_matrix
- Eval report
- Model Evaluation

Each iteration will have slight changes for improvement. They will be described more at the General descriptions of specific iterations.

The main metrics focused on are:

- Recall, F1 Score, Loss (Primary)
- and Accuracy (Secondary)

Because the goal is to minimized False Negatives of Pneumonia (predicting no Pneumonia, while there is). The True Positives will be looked at secondary.

There are a total of 10\* model iterations with a Final Model. The model iterations are trained on the training data and tested on validation data. Both the training and validation data metrics will be displayed.

The Final Model will be chosen based on the main metrics. This final model will be used with the test data.

## Main Hyperparameters & Parameters

### [NN Hyperparameters, Rukshan P, 2022](#)

- Model
  - layers:
    - Conv2D:
    - MaxPooling2D:
    - Dense output:
  - filters:
  - activation:
    - Relu
    - Sigmoid:
  - dropout: Regularization technique that supports overfitting. Smaller network allows parameters to update more.
- Model Compile
  - loss:
    - binary\_crossentropy
  - optimizer:

- adam
- learning rate:
- Fit
  - batchsize:
  - epochs:
  - early stopping: After convergence, stopping the training process after the validation and training error diverge
  - class weights:

## Baseline Modeling (1)

Description of the main model hyperparameters and data parameters:

- Model
  - layers: 3 Conv2D each w/ MaxPooling2D, 2 Dense output layers
  - filters: 32,64,96 for Conv2D, 64,1 Dense layer
  - activation: Relu for all except Sigmoid for output layer
- Model Compile
  - loss: binary\_crossentropy
  - optimizer:adam
  - learning rate: .001 (Default)
  - metrics: Accuracy,Recall,Precision
- Fit
  - data: train\_gen, val\_gen
  - train batchsize: 64
  - epochs: 10
- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

In [25]:

```
# Baseline Model Stack
baseline = models.Sequential([
    Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
           padding = 'same', input_shape=(224,224,3)),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),
    Flatten(),
    Dense(units=64, activation='relu'),
    Dense(units=1, activation='sigmoid'),
])
```

```
#Compile Model
baseline.compile(loss='binary_crossentropy',
                  optimizer='adam',
                  metrics=[ "acc", "Recall", "Precision"])
```

Metal device set to: Apple M2 Max

```
2023-03-31 16:12:40.382188: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU
ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2023-03-31 16:12:40.382389: I tensorflow/core/common_runtime/pluggable_device/
pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/rep
lica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (devi
ce: 0, name: METAL, pci bus id: <undefined>)
```

The model summary provides a description of the sequential Layers, Output Shapes and Learning Parameters.

In [26]:

```
#Display model summary ()
baseline.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
<hr/>		
conv2d (Conv2D)	(None, 224, 224, 32)	896
max_pooling2d (MaxPooling2D )	(None, 112, 112, 32)	0
conv2d_1 (Conv2D)	(None, 112, 112, 64)	18496
max_pooling2d_1 (MaxPooling 2D)	(None, 56, 56, 64)	0
conv2d_2 (Conv2D)	(None, 56, 56, 96)	55392
max_pooling2d_2 (MaxPooling 2D)	(None, 28, 28, 96)	0
flatten (Flatten)	(None, 75264)	0
dense (Dense)	(None, 64)	4816960
dense_1 (Dense)	(None, 1)	65
<hr/>		
Total params: 4,891,809		
Trainable params: 4,891,809		
Non-trainable params: 0		

---

Returning a model object that contains model evaluation metrics, and hyperparameter attributes

In [27]:

```
#Fiting the data
history = baseline.fit(train_gen,
                       batch_size= 50,
                       epochs=10,
```

```
verbose = 1,
validation_data=val_gen)
```

**Epoch 1/10**

```
2023-03-31 16:12:42.027133: W tensorflow/core/platform/profile_utils/cpu_utils.cc:128] Failed to get CPU frequency: 0 Hz
2023-03-31 16:12:42.315609: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 0.8577 - acc: 0.6629
- recall: 0.7983 - precision: 0.7597
```

```
2023-03-31 16:13:05.043573: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - 27s 2s/step - loss: 0.8577 - acc: 0.6
629 - recall: 0.7983 - precision: 0.7597 - val_loss: 0.4455 - val_acc: 0.7414
- val_recall: 1.0000 - val_precision: 0.7414
```

**Epoch 2/10**

```
16/16 [=====] - 27s 2s/step - loss: 0.3453 - acc: 0.8
394 - recall: 0.9169 - precision: 0.8731 - val_loss: 0.2827 - val_acc: 0.8811
- val_recall: 0.8825 - val_precision: 0.9536
```

**Epoch 3/10**

```
16/16 [=====] - 26s 2s/step - loss: 0.2257 - acc: 0.9
062 - recall: 0.9089 - precision: 0.9627 - val_loss: 0.1622 - val_acc: 0.9308
- val_recall: 0.9440 - val_precision: 0.9620
```

**Epoch 4/10**

```
16/16 [=====] - 26s 2s/step - loss: 0.1634 - acc: 0.9
426 - recall: 0.9659 - precision: 0.9571 - val_loss: 0.2146 - val_acc: 0.9212
- val_recall: 0.8993 - val_precision: 0.9938
```

**Epoch 5/10**

```
16/16 [=====] - 25s 2s/step - loss: 0.1453 - acc: 0.9
439 - recall: 0.9555 - precision: 0.9685 - val_loss: 0.1426 - val_acc: 0.9447
- val_recall: 0.9571 - val_precision: 0.9679
```

**Epoch 6/10**

```
16/16 [=====] - 25s 2s/step - loss: 0.0948 - acc: 0.9
650 - recall: 0.9758 - precision: 0.9770 - val_loss: 0.1078 - val_acc: 0.9585
- val_recall: 0.9590 - val_precision: 0.9847
```

**Epoch 7/10**

```
16/16 [=====] - 25s 2s/step - loss: 0.0841 - acc: 0.9
703 - recall: 0.9788 - precision: 0.9811 - val_loss: 0.1271 - val_acc: 0.9557
- val_recall: 0.9869 - val_precision: 0.9549
```

**Epoch 8/10**

```
16/16 [=====] - 26s 2s/step - loss: 0.0750 - acc: 0.9
743 - recall: 0.9815 - precision: 0.9838 - val_loss: 0.1131 - val_acc: 0.9613
- val_recall: 0.9851 - val_precision: 0.9635
```

**Epoch 9/10**

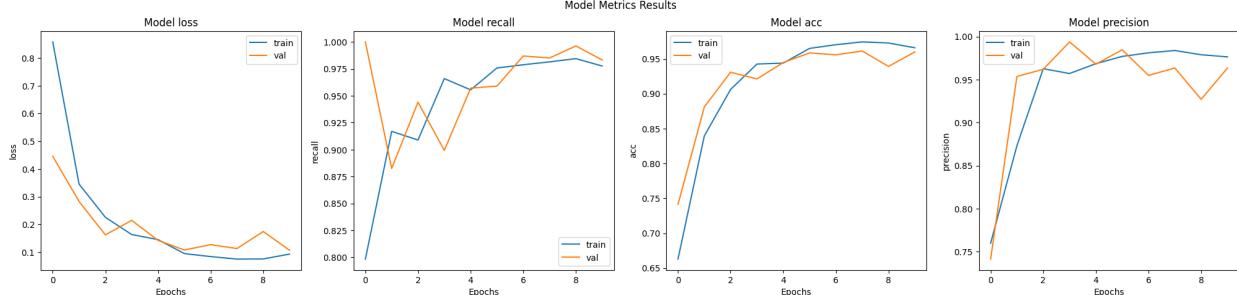
```
16/16 [=====] - 26s 2s/step - loss: 0.0755 - acc: 0.9
727 - recall: 0.9845 - precision: 0.9789 - val_loss: 0.1743 - val_acc: 0.9391
- val_recall: 0.9963 - val_precision: 0.9271
```

**Epoch 10/10**

```
16/16 [=====] - 26s 2s/step - loss: 0.0931 - acc: 0.9
658 - recall: 0.9776 - precision: 0.9764 - val_loss: 0.1068 - val_acc: 0.9599
- val_recall: 0.9832 - val_precision: 0.9634
```

**Baseline Metrics**

In [28]: `#Plotting chosen Train and Validation Metrics  
eval_metrics(history)`



In [29]:

```
#Returns Train and Validation labels and predictions
train_labels, train_predictions = predict_results(baseline,train_gen)
val_labels, val_predictions = predict_results(baseline,val_gen)
```

4/10 [=====>.....] - ETA: 0s

2023-03-31 16:17:01.120332: I tensorflow/core/grappler/optimizers/custom\_graph\_optimizer\_registry.cc:113] Plugin optimizer for device\_type GPU is enabled.

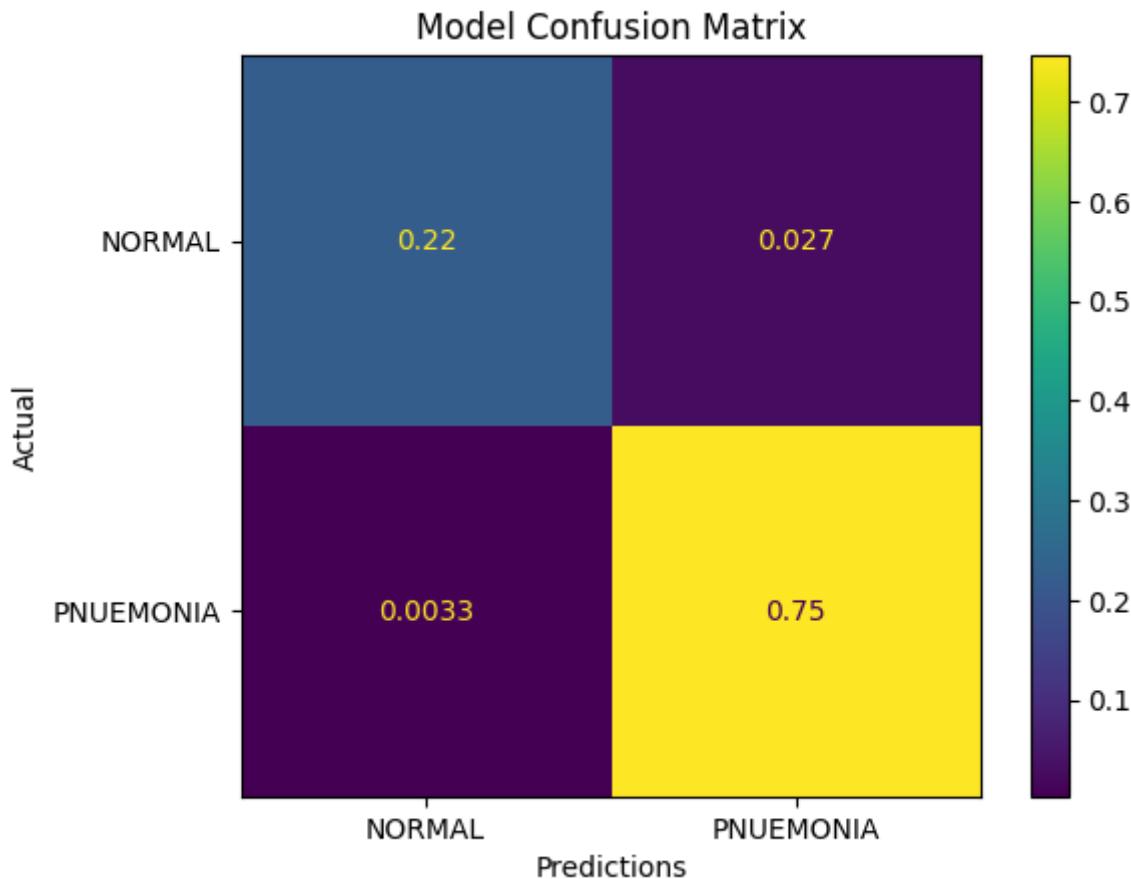
10/10 [=====] - 0s 46ms/step

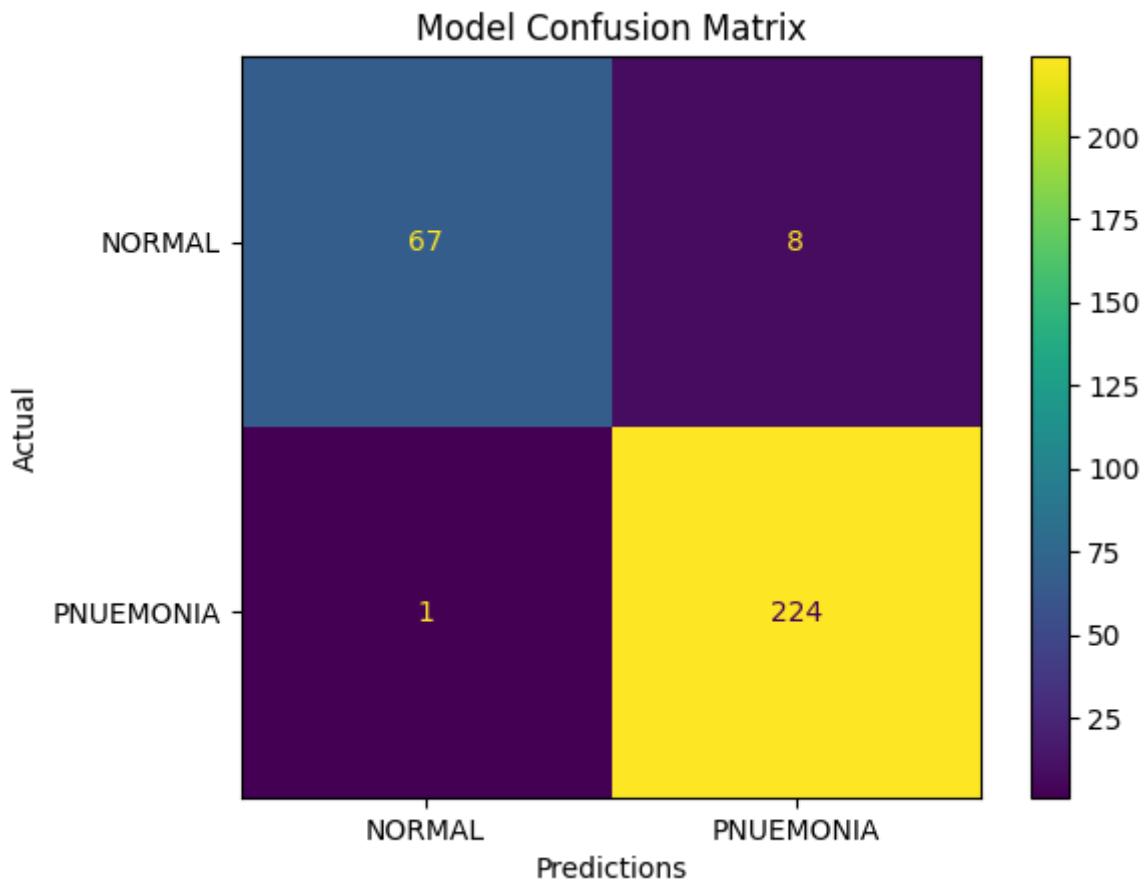
4/4 [=====] - 0s 41ms/step

In [30]:

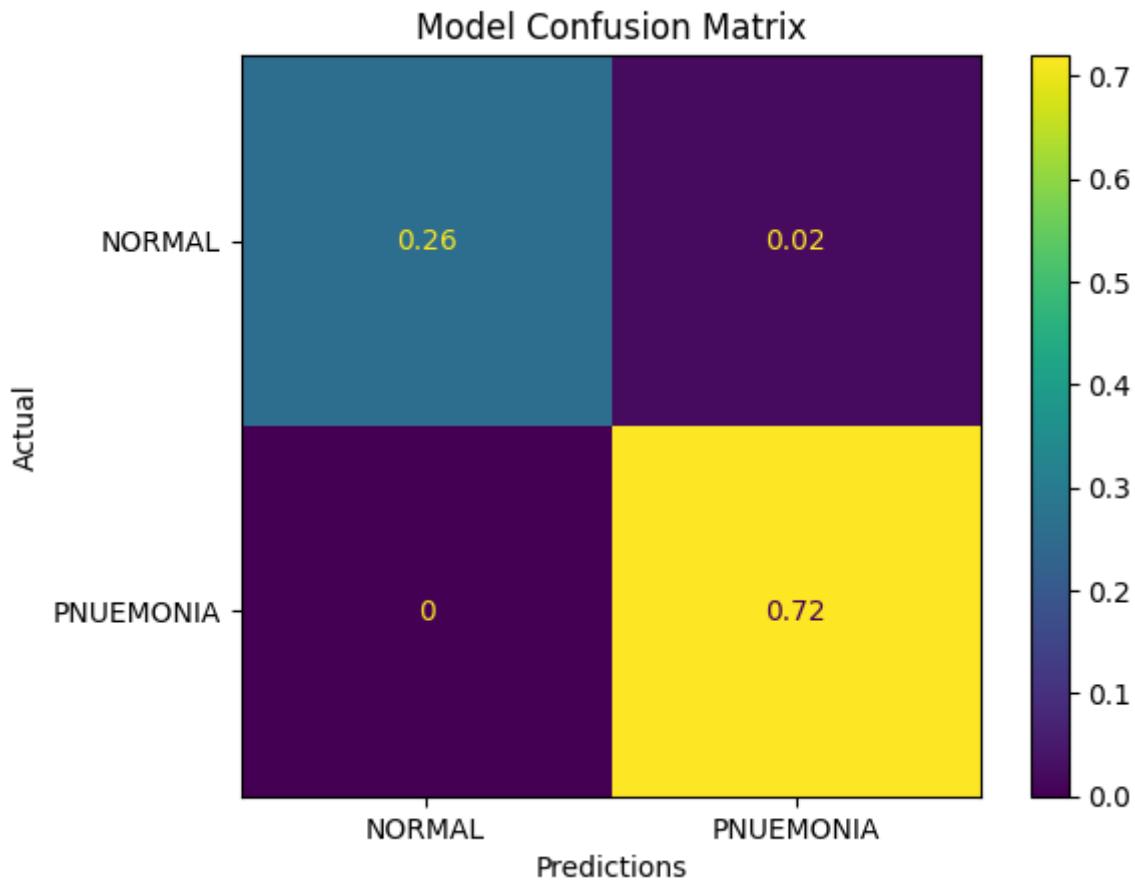
```
#Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, "all")
conf_matrix(train_labels,train_predictions, None)
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, "all")
conf_matrix(val_labels, val_predictions, None)
```

Training Confusion Matrices:

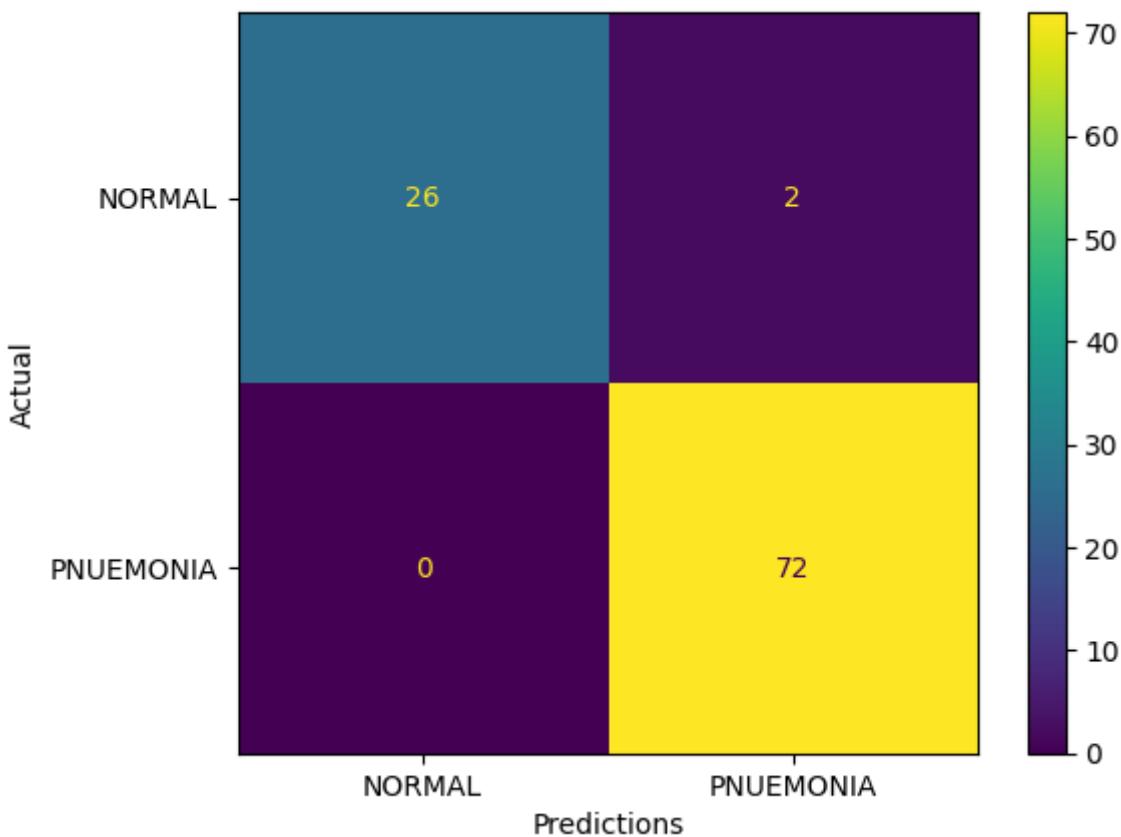




Validation Confusion Matrices:



Model Confusion Matrix



```
In [31]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.985	0.893	0.937	75
1.0	0.966	0.996	0.980	225
accuracy			0.970	300
macro avg	0.975	0.944	0.959	300
weighted avg	0.970	0.970	0.969	300

```
16/16 [=====] - 21s 1s/step - loss: 0.0646 - acc: 0.974 - recall: 0.9886 - precision: 0.9810
Loss: 0.0646
```

```
In [32]: #Validation Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	1.000	0.929	0.963	28
1.0	0.973	1.000	0.986	72
<b>accuracy</b>			0.980	100
<b>macro avg</b>	<b>0.986</b>	<b>0.964</b>	<b>0.975</b>	<b>100</b>
<b>weighted avg</b>	<b>0.981</b>	<b>0.980</b>	<b>0.980</b>	<b>100</b>

```
8/8 [=====] - 4s 395ms/step - loss: 0.1068 - acc: 0.9
599 - recall: 0.9832 - precision: 0.9634
Loss: 0.1068
```

## Baseline (1) Model Evaluation

- **Model Plots:** The baseline model is actually really good. There is slight variation and divergence but that may be due to the limited epochs.
  - **Confusion Matrix:** With the current batch size and imbalanced data, the model predicted everything as true, even on the training set. This led to no False Negatives, but many False Positives. This is with the validation model having 40% Normal images.
  - **Report:** The loss in the validation model is only slightly worse than the training model.
  - **The model is solid.** ThereTo help with the lingering data balance, we will work to improve that.
- 

## Baseline Model (2) with Class Weights

### Change Description:

- Adding class weights to see if it helps with class imbalance.

### Description of the model hyperparameters and data parameters:

- **Model**
  - layers: 3 Conv2D each w/ MaxPooling2D, 2 Dense output layers
  - filters: 32,64,96 for Conv2D, 64,1 Dense layer
  - activation: Relu for all except Sigmoid for output layer
- **Model Compile**
  - loss: binary\_crossentropy
  - optimizer: adam
  - learning rate: .001 (Default)

- metrics: Accuracy, Recall, Precision
- Fit
  - data: train\_gen, val\_gen
  - train batchsize: 64
  - epochs: 10
  - Added class weights: {0: 1.6, 1: 0.7272727272727273}
- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

```
In [33]: # Baseline Model Stack
baseline2 = models.Sequential([
    Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
           padding = 'same', input_shape=(224,224,3)),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),
    Flatten(),
    Dense(units=64, activation='relu'),
    Dense(units=1, activation='sigmoid'),
])

#Compile Model
baseline2.compile(loss='binary_crossentropy',
                  optimizer='adam',
                  metrics=['acc', "Recall", "Precision"])
```

Calculating class weights help to balance the dataset by weighting respectively.

```
In [34]: #Calculating class weights for imbalance
class_weights = calc_weight(y_train)
class_weights
```

```
Out[34]: {0: 1.8987341772151898, 1: 0.6787330316742082}
```

```
In [35]: #Fitting the data on the baseline model with class weight
history2 = baseline2.fit(train_gen,
                         epochs=10,
                         verbose = 1,
                         class_weight=class_weights,
                         validation_data=val_gen)
```

Epoch 1/10

```
2023-03-31 16:17:30.497503: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 0.5543 - acc: 0.7208
- recall: 0.7565 - precision: 0.8508
```

```
2023-03-31 16:17:53.376173: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
16/16 [=====] - 27s 2s/step - loss: 0.5543 - acc: 0.7  
208 - recall: 0.7565 - precision: 0.8508 - val_loss: 0.3376 - val_acc: 0.8617  
- val_recall: 0.8825 - val_precision: 0.9275  
Epoch 2/10  
16/16 [=====] - 27s 2s/step - loss: 0.2684 - acc: 0.8  
889 - recall: 0.8790 - precision: 0.9684 - val_loss: 0.1835 - val_acc: 0.9253  
- val_recall: 0.9179 - val_precision: 0.9801  
Epoch 3/10  
16/16 [=====] - 26s 2s/step - loss: 0.1899 - acc: 0.9  
255 - recall: 0.9238 - precision: 0.9745 - val_loss: 0.1273 - val_acc: 0.9530  
- val_recall: 0.9739 - val_precision: 0.9631  
Epoch 4/10  
16/16 [=====] - 26s 2s/step - loss: 0.1247 - acc: 0.9  
554 - recall: 0.9564 - precision: 0.9831 - val_loss: 0.1349 - val_acc: 0.9544  
- val_recall: 0.9608 - val_precision: 0.9772  
Epoch 5/10  
16/16 [=====] - 25s 2s/step - loss: 0.0972 - acc: 0.9  
632 - recall: 0.9606 - precision: 0.9895 - val_loss: 0.0937 - val_acc: 0.9640  
- val_recall: 0.9720 - val_precision: 0.9793  
Epoch 6/10  
16/16 [=====] - 26s 2s/step - loss: 0.0836 - acc: 0.9  
701 - recall: 0.9701 - precision: 0.9893 - val_loss: 0.1158 - val_acc: 0.9557  
- val_recall: 0.9478 - val_precision: 0.9922  
Epoch 7/10  
16/16 [=====] - 26s 2s/step - loss: 0.0704 - acc: 0.9  
732 - recall: 0.9707 - precision: 0.9930 - val_loss: 0.1363 - val_acc: 0.9433  
- val_recall: 0.9272 - val_precision: 0.9960  
Epoch 8/10  
16/16 [=====] - 24s 2s/step - loss: 0.0758 - acc: 0.9  
701 - recall: 0.9683 - precision: 0.9911 - val_loss: 0.0884 - val_acc: 0.9654  
- val_recall: 0.9701 - val_precision: 0.9830  
Epoch 9/10  
16/16 [=====] - 25s 2s/step - loss: 0.0760 - acc: 0.9  
698 - recall: 0.9650 - precision: 0.9942 - val_loss: 0.2897 - val_acc: 0.9059  
- val_recall: 0.8731 - val_precision: 1.0000  
Epoch 10/10  
16/16 [=====] - 26s 2s/step - loss: 0.1066 - acc: 0.9  
581 - recall: 0.9528 - precision: 0.9904 - val_loss: 0.1167 - val_acc: 0.9557  
- val_recall: 0.9739 - val_precision: 0.9667
```

In [36]: #Baseline2 Summary  
baseline2.summary()

Model: "sequential\_1"

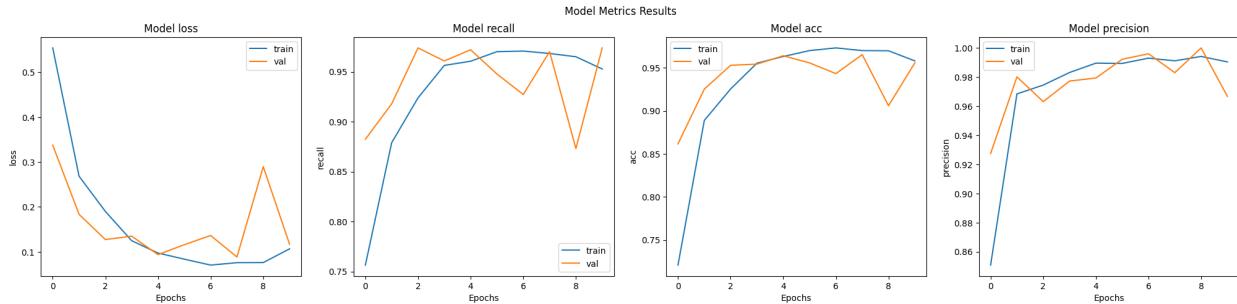
Layer (type)	Output Shape	Param #
conv2d_3 (Conv2D)	(None, 224, 224, 32)	896
max_pooling2d_3 (MaxPooling 2D)	(None, 112, 112, 32)	0
conv2d_4 (Conv2D)	(None, 112, 112, 64)	18496
max_pooling2d_4 (MaxPooling 2D)	(None, 56, 56, 64)	0
conv2d_5 (Conv2D)	(None, 56, 56, 96)	55392
max_pooling2d_5 (MaxPooling 2D)	(None, 28, 28, 96)	0
flatten_1 (Flatten)	(None, 75264)	0
dense_2 (Dense)	(None, 64)	4816960
dense_3 (Dense)	(None, 1)	65

---

Total params: 4,891,809  
Trainable params: 4,891,809  
Non-trainable params: 0

```
In [37]: print("Baseline Evaluation Metrics w/ Class Weights :\n")
eval_metrics(history2)
```

Baseline Evaluation Metrics w/ Class Weights :



```
In [38]: #Returns Train and Validation labels and predictions
train_labels, train_predictions = predict_results(baseline2,train_gen)
val_labels, val_predictions = predict_results(baseline2,val_gen)
```

1/10 [==>.....] - ETA: 0s

2023-03-31 16:21:49.112372: I tensorflow/core/grappler/optimizers/custom\_graph\_optimizer\_registry.cc:113] Plugin optimizer for device\_type GPU is enabled.

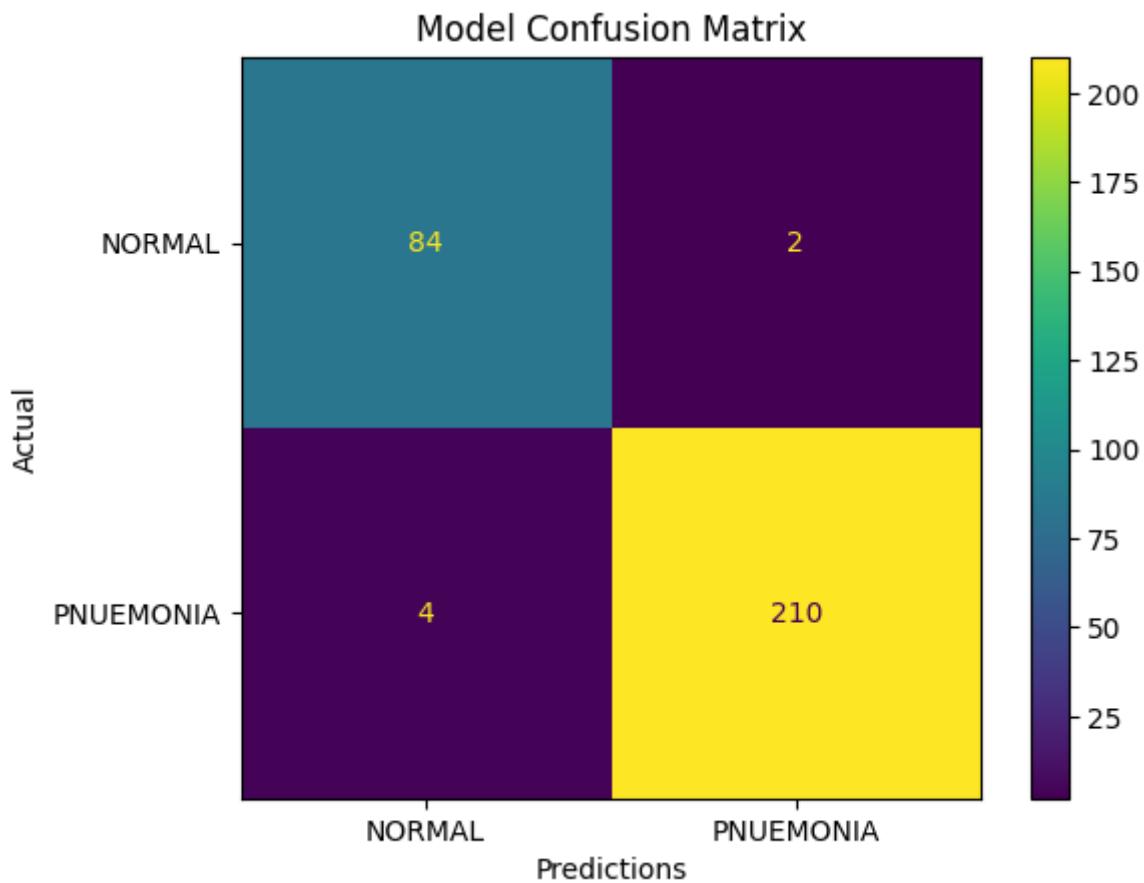
10/10 [=====] - 1s 50ms/step

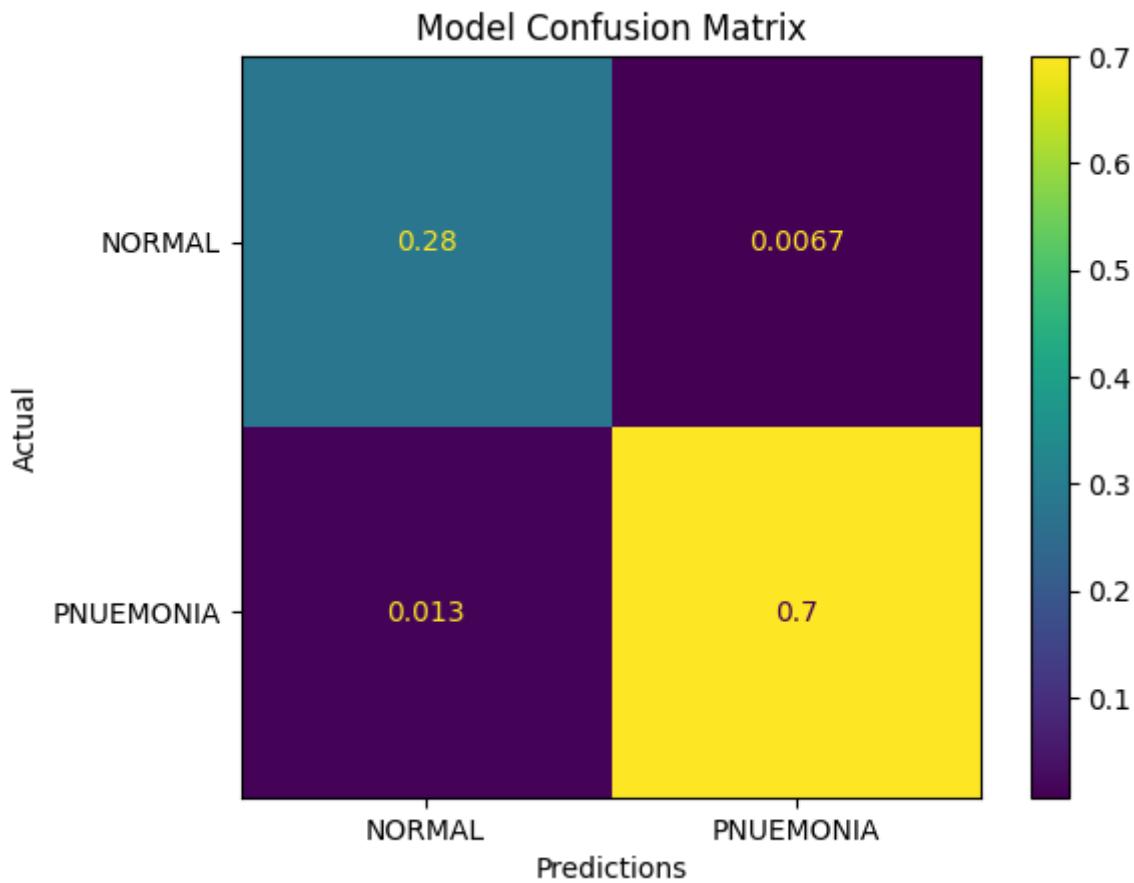
4/4 [=====] - 0s 40ms/step

```
In [39]: #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, None)
```

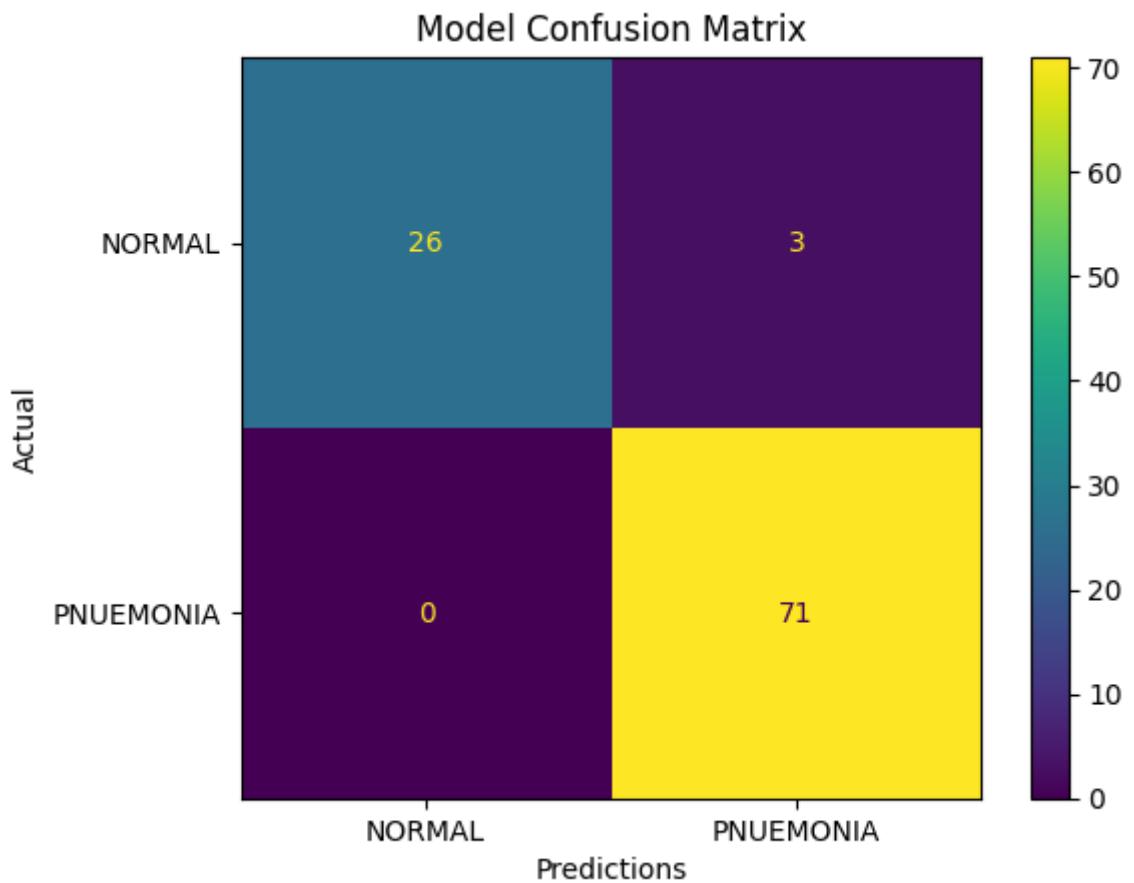
```
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

Training Confusion Matrices:

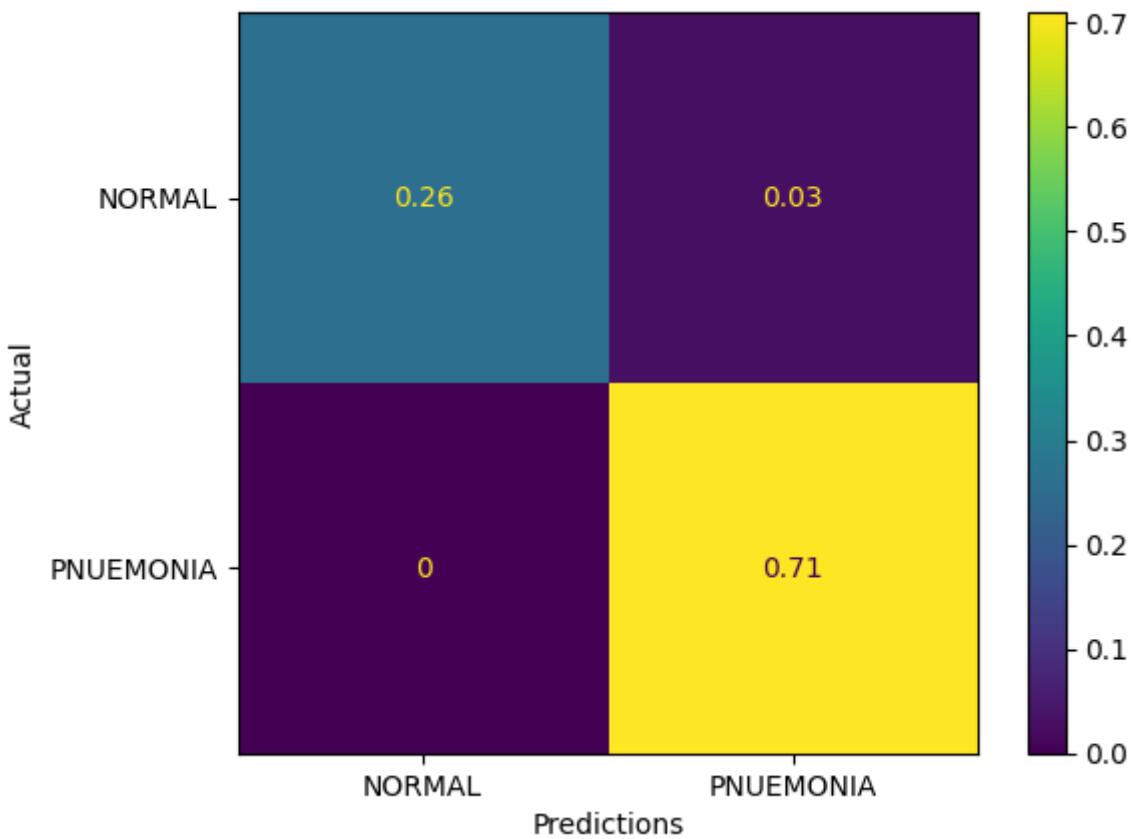




Validation Confusion Matrices:



Model Confusion Matrix



```
In [40]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history2)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.955	0.977	0.966	86
1.0	0.991	0.981	0.986	214
accuracy			0.980	300
macro avg	0.973	0.979	0.976	300
weighted avg	0.980	0.980	0.980	300

```
16/16 [=====] - 21s 1s/step - loss: 0.0857 - acc: 0.9
723 - recall: 0.9788 - precision: 0.9838
Loss: 0.0857
```

```
In [41]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history2)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	1.000	0.897	0.945	29
1.0	0.959	1.000	0.979	71
<b>accuracy</b>			0.970	100
<b>macro avg</b>	<b>0.980</b>	<b>0.948</b>	<b>0.962</b>	<b>100</b>
<b>weighted avg</b>	<b>0.971</b>	<b>0.970</b>	<b>0.969</b>	<b>100</b>

```
8/8 [=====] - 3s 395ms/step - loss: 0.1167 - acc: 0.9557 - recall: 0.9739 - precision: 0.9667
Loss: 0.1167
```

## Baseline (2) Model Evaluation

- **Model Plots:** Slight improvement with the class weight. The recall and accuracy do not diverge as much.
  - **Confusion Matrix:** There is one FN with the validation set and no False Positives. The validation set had 25% Normal images this time.
  - **Report:** The loss in the validation set decreased from the previous model, but slightly higher than the current training set
  - This model wasn't bad either. The loss decreased but the amount of FN increased.. The validation and training set are getting comparable results. The next models will add and tweak some hyperparameters to see if we can improve.
- 

## Model Iteration 3

### Change Description:

- Increase Epochs, Adding EarlyStop and Dropout between Dense layers

### Description of the model hyperparameters and data parameters:

- **Model**
  - layers: 3 Conv2D each w/ MaxPooling2D, 2 Dense output layers
  - filters: 32,64,96 for Conv2D, 64,1 Dense layer
  - activation: Relu for all except Sigmoid for output layer
  - dropout: .3
- **Model Compile**
  - loss: binary\_crossentropy
  - optimizer:adam
  - learning rate: .001 (Default)

- metrics: Accuracy, Recall, Precision
- Fit
  - data: train\_gen, val\_gen
  - train batchsize: 64
  - epochs: 30
  - early stopping : True
  - class weights: {0: 1.6, 1: 0.7272727272727273}
- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

```
In [42]: #Model 3 Sequential Layers
model_3= models.Sequential([
    Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
           padding = 'same', input_shape=(224,224,3)),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),
    Flatten(),
    Dense(units=64, activation='relu'),
    Dropout(0.3),
    Dense(units=1, activation='sigmoid'),
])
#Compile model
model_3.compile(loss='binary_crossentropy',
                 optimizer='adam',
                 metrics=["acc", "Recall", "Precision"])
)
```

Early stopping allows the execution of the model fitting to stop when the model has stopped improving.

```
In [43]: #Adding early stopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=2)
#Calculating class weights for imbalance
```

```
In [44]: history3 = model_3.fit(train_gen,
                           epochs=30,
                           verbose = 1,
                           class_weight=class_weights,
                           validation_data=val_gen,
                           callbacks = es)
```

Epoch 1/30

```
2023-03-31 16:22:18.326001: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 0.6376 - acc: 0.7010
- recall: 0.6970 - precision: 0.8748
```

```
2023-03-31 16:22:40.126825: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
16/16 [=====] - 25s 2s/step - loss: 0.6376 - acc: 0.7  
010 - recall: 0.6970 - precision: 0.8748 - val_loss: 0.3449 - val_acc: 0.8617  
- val_recall: 0.8489 - val_precision: 0.9599  
Epoch 2/30  
16/16 [=====] - 25s 2s/step - loss: 0.2785 - acc: 0.8  
831 - recall: 0.8694 - precision: 0.9700 - val_loss: 0.1918 - val_acc: 0.9253  
- val_recall: 0.9254 - val_precision: 0.9725  
Epoch 3/30  
16/16 [=====] - 26s 2s/step - loss: 0.1813 - acc: 0.9  
264 - recall: 0.9181 - precision: 0.9815 - val_loss: 0.1485 - val_acc: 0.9516  
- val_recall: 0.9795 - val_precision: 0.9563  
Epoch 4/30  
16/16 [=====] - 26s 2s/step - loss: 0.1894 - acc: 0.9  
368 - recall: 0.9402 - precision: 0.9737 - val_loss: 0.1654 - val_acc: 0.9391  
- val_recall: 0.9328 - val_precision: 0.9843  
Epoch 5/30  
16/16 [=====] - 26s 2s/step - loss: 0.1263 - acc: 0.9  
483 - recall: 0.9429 - precision: 0.9869 - val_loss: 0.1189 - val_acc: 0.9530  
- val_recall: 0.9552 - val_precision: 0.9808  
Epoch 6/30  
16/16 [=====] - 26s 2s/step - loss: 0.0925 - acc: 0.9  
643 - recall: 0.9618 - precision: 0.9899 - val_loss: 0.0923 - val_acc: 0.9613  
- val_recall: 0.9757 - val_precision: 0.9721  
Epoch 7/30  
16/16 [=====] - 26s 2s/step - loss: 0.0898 - acc: 0.9  
672 - recall: 0.9656 - precision: 0.9899 - val_loss: 0.1040 - val_acc: 0.9640  
- val_recall: 0.9608 - val_precision: 0.9904  
Epoch 8/30  
16/16 [=====] - 26s 2s/step - loss: 0.1017 - acc: 0.9  
639 - recall: 0.9606 - precision: 0.9904 - val_loss: 0.1105 - val_acc: 0.9557  
- val_recall: 0.9701 - val_precision: 0.9701  
Epoch 8: early stopping
```

In [45]: `model_3.summary()`

Model: "sequential\_2"

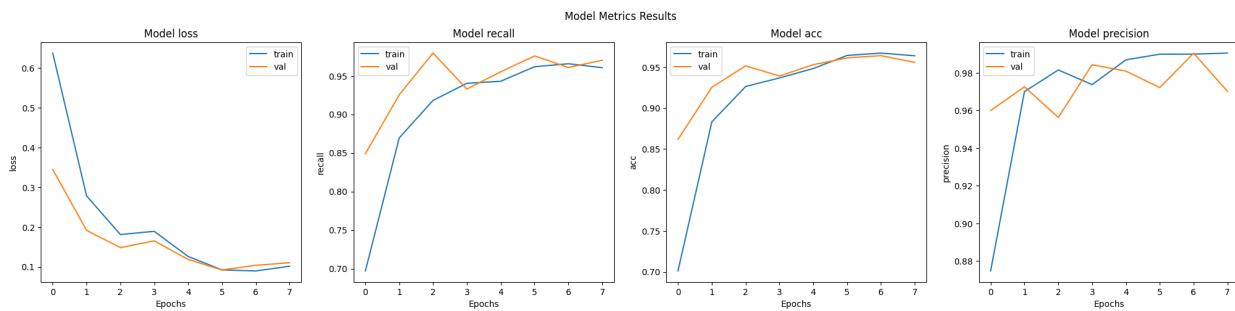
Layer (type)	Output Shape	Param #
conv2d_6 (Conv2D)	(None, 224, 224, 32)	896
max_pooling2d_6 (MaxPooling 2D)	(None, 112, 112, 32)	0
conv2d_7 (Conv2D)	(None, 112, 112, 64)	18496
max_pooling2d_7 (MaxPooling 2D)	(None, 56, 56, 64)	0
conv2d_8 (Conv2D)	(None, 56, 56, 96)	55392
max_pooling2d_8 (MaxPooling 2D)	(None, 28, 28, 96)	0
flatten_2 (Flatten)	(None, 75264)	0
dense_4 (Dense)	(None, 64)	4816960
dropout (Dropout)	(None, 64)	0
dense_5 (Dense)	(None, 1)	65

---

Total params: 4,891,809  
Trainable params: 4,891,809  
Non-trainable params: 0

```
In [46]: print("Model 3: Dropout, EarlyStopping and 30 Epochs :\n")
eval_metrics(history3)
```

Model 3: Dropout, EarlyStopping and 30 Epochs :



```
In [47]: train_labels, train_predictions = predict_results(model_3,train_gen)
val_labels, val_predictions = predict_results(model_3,val_gen)
```

5/10 [=====>.....] - ETA: 0s

2023-03-31 16:25:46.212139: I tensorflow/core/grappler/optimizers/custom\_graph\_optimizer\_registry.cc:113] Plugin optimizer for device\_type GPU is enabled.

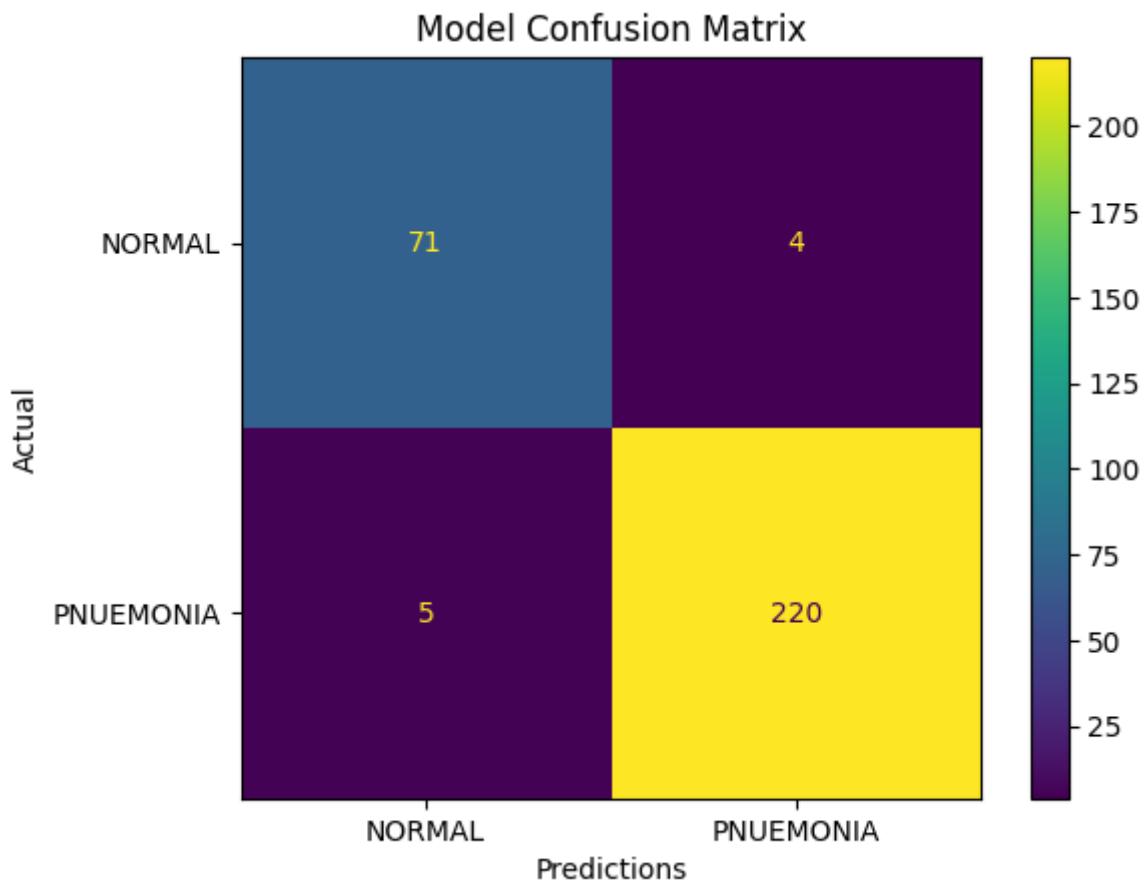
10/10 [=====] - 0s 34ms/step

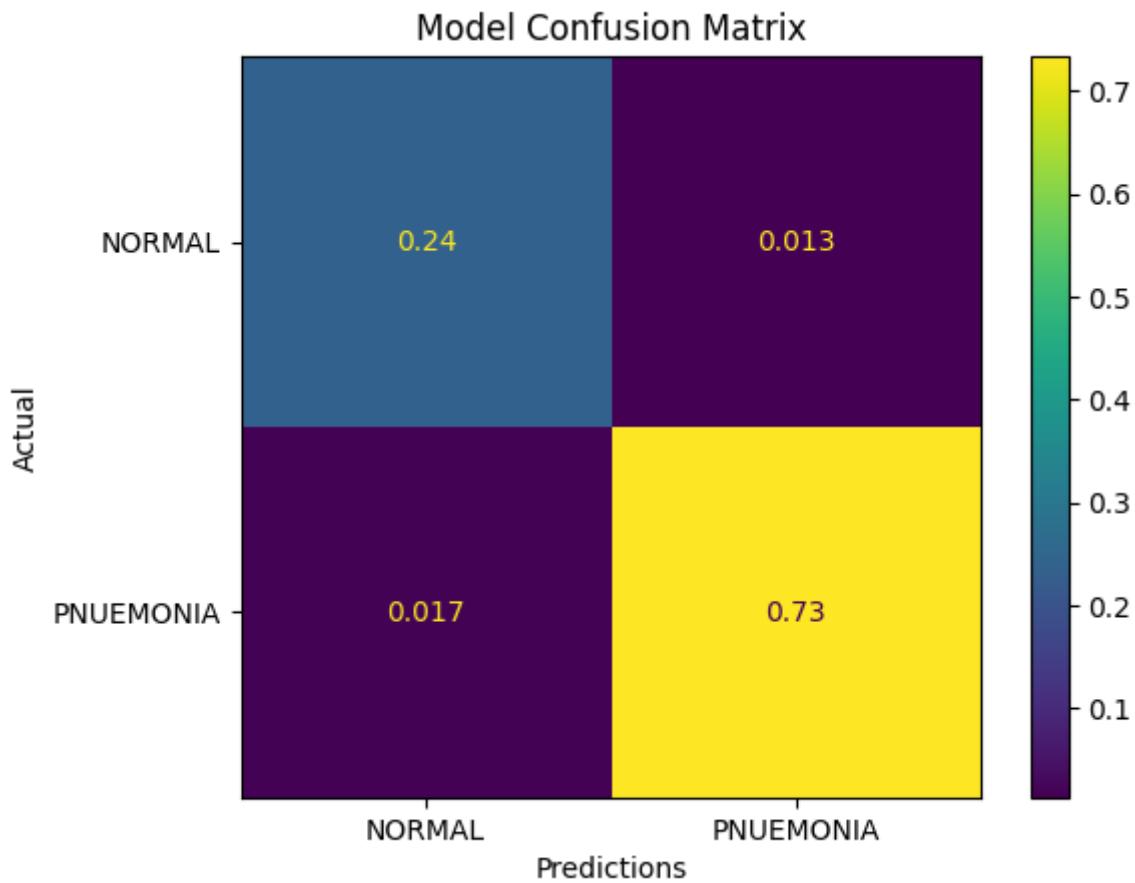
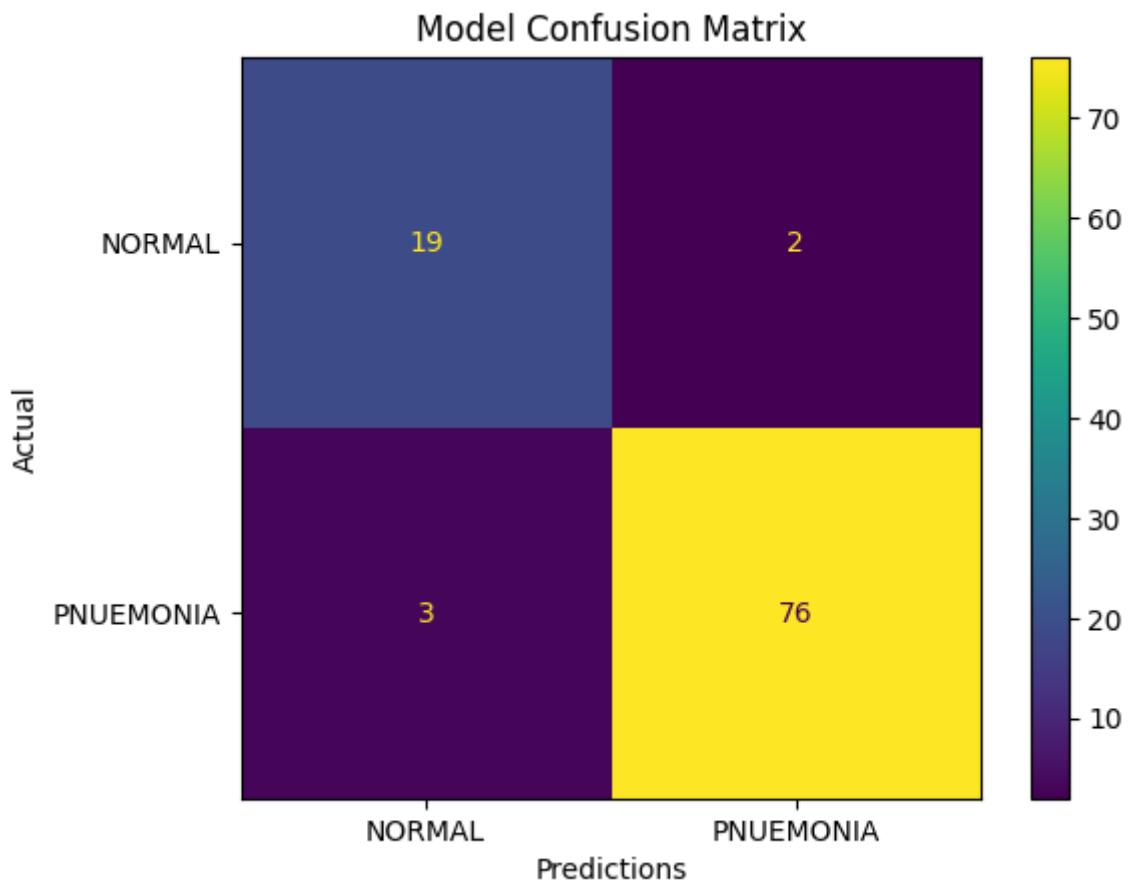
4/4 [=====] - 0s 44ms/step

```
In [48]: #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
```

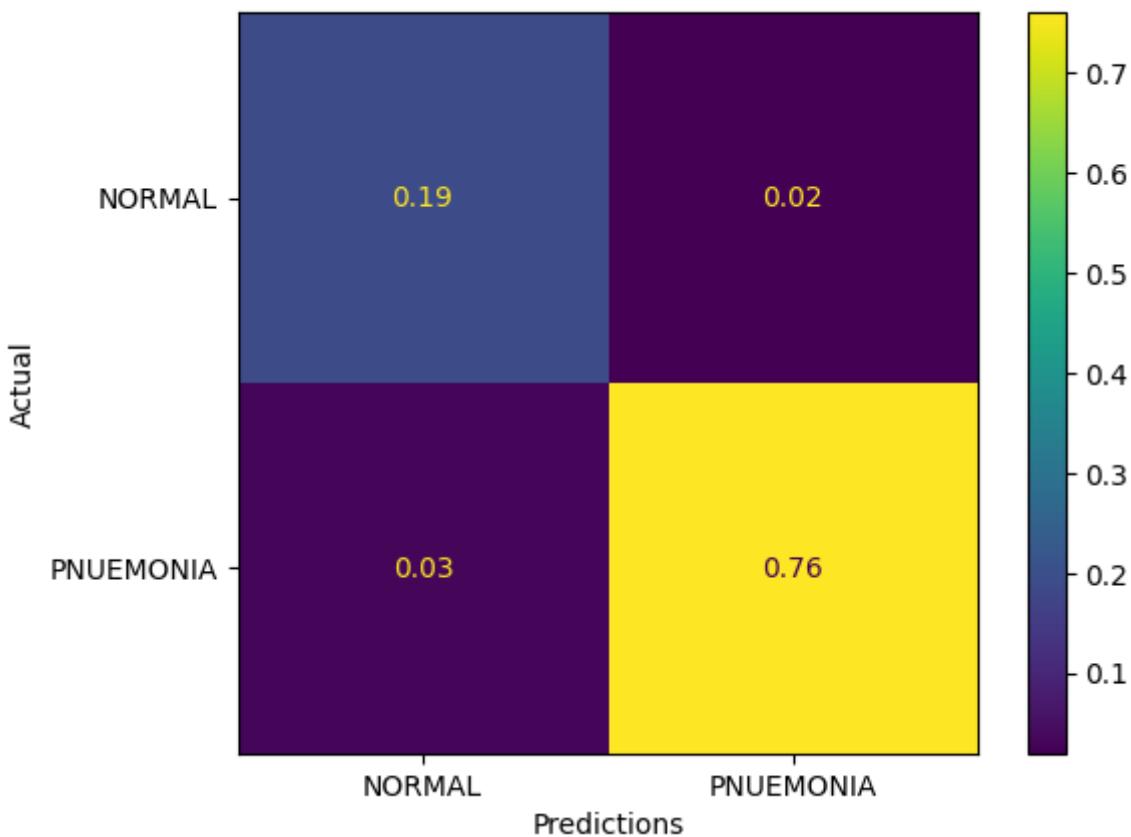
```
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

Training Confusion Matrices:



**Validation Confusion Matrices:**

Model Confusion Matrix



```
In [49]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history3)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.934	0.947	0.940	75
1.0	0.982	0.978	0.980	225
accuracy			0.970	300
macro avg	0.958	0.962	0.960	300
weighted avg	0.970	0.970	0.970	300

```
16/16 [=====] - 22s 1s/step - loss: 0.0712 - acc: 0.9
758 - recall: 0.9824 - precision: 0.9850
Loss: 0.0712
```

```
In [50]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history3)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.864	0.905	0.884	21
1.0	0.974	0.962	0.968	79
<b>accuracy</b>			0.950	100
<b>macro avg</b>	0.919	0.933	0.926	100
<b>weighted avg</b>	0.951	0.950	0.950	100

```
8/8 [=====] - 3s 391ms/step - loss: 0.1105 - acc: 0.9
557 - recall: 0.9701 - precision: 0.9701
Loss: 0.1105
```

## Model 3 Evaluation

- **Model Plots:** The validation data seems to be fitting well.
  - **Confusion Matrix:** There is one FN.
  - **Report:** The validation loss is slightly more than the training model. The amount of Normal Validation images decreased to about 30%. This could have lead to slightly lower scores.
  - It isn't clear what to improve, optimizing this model with gridsearch will be the next step.
- 

## Model Iterations 4-7

These models will use Keras wrappers and GridSearchCV to optimize various hyperparameters in the models. The best parameters will be applied along to the model.

---

## Model 4

Using gridsearch and keras wrappers to do some hyperparameter optimization

- **batch\_size = [32,64,96,128]**
- **epochs = [30,45,60,90]**

Description of the model hyperparameters and data parameters:

- **Model**
  - **layers: 3 Conv2D each w/ MaxPooling2D, 2 Dense output layers**

- filters: 32,64,96 for Conv2D, 64,1 Dense layer
- activation: Relu for all except Sigmoid for output layer
- dropout: .3
- Model Compile
  - loss: binary\_crossentropy
  - optimizer:adam
  - learning rate: .001 (Default)
  - metrics: Accuracy,Recall,Precision
- Fit
  - data: train\_gen, val\_gen
  - train batchsize: 128
  - epochs: 90
  - early stopping : True
  - class weights: {0: 1.6, 1: 0.7272727272727273}
- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

In [51]: `# Creating a function to supply to the Keras wrapper`

```
def buildModel():

    model= models.Sequential([
        Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
               padding = 'same', input_shape=(224,224,3)),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Flatten(),
        Dense(units=64, activation='relu'),
        Dropout(0.3),
        Dense(units=1, activation='sigmoid'),])

    model.compile(loss='binary_crossentropy',
                  optimizer="adam",
                  metrics=["acc", "Recall", "Precision"])
)
return model
```

Choosing hyperparameters range to optimize. Being mindful of hardware and software resources.

In [52]: `#Choosing Paramers for Optimization`

```
batch_size = [32,64,96,128]
```

```
epochs = [30, 45, 60, 90]
parameters = dict(batch_size=batch_size, epochs=epochs )
```

In [53]:

```
#Early Stopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=2)
```

[GridSearchCV with CNN, Aaryn Dhore, 2020](#)

[GridSearch for Deep Learning, J. Brownlee, 2022](#)

KerasClassifier creates a classifier from the Model Sequence build model to use as an estimator. The created parameters will be used as the parameters in the Gridsearch to help optimize.

In [54]:

```
#Creating a wrapped classifier
classifier = KerasClassifier(build_fn=buildModel, class_weight = class_weights)

#Gridsearch Creating
grid_search = GridSearchCV(estimator = classifier,
                           param_grid = parameters,
                           refit = "Acc",
                           scoring = "accuracy",
                           cv = 3,return_train_score=True)

#Fitting Gridsearch
gs = grid_search.fit(X_train, y_train, verbose = 0)
```

```
2023-03-31 16:26:14.564326: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 37ms/step
1/7 [==>.....] - ETA: 0s

2023-03-31 16:26:25.595087: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 35ms/step

2023-03-31 16:26:26.367123: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 37ms/step

2023-03-31 16:26:37.152673: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 36ms/step

2023-03-31 16:26:38.120919: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 37ms/step
1/7 [==>.....] - ETA: 0s

2023-03-31 16:26:49.006099: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 35ms/step

2023-03-31 16:26:49.774806: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 39ms/step

2023-03-31 16:27:05.780229: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 35ms/step

2023-03-31 16:27:06.572485: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 37ms/step
```

```
2023-03-31 16:27:22.582419: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:27:23.391679: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 43ms/step  
2023-03-31 16:27:39.215755: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 36ms/step  
2023-03-31 16:27:40.294844: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 37ms/step  
1/7 [==>.....] - ETA: 0s  
2023-03-31 16:28:01.248630: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 35ms/step  
2023-03-31 16:28:02.047242: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 41ms/step  
2023-03-31 16:28:23.425361: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:28:24.275368: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 40ms/step  
2023-03-31 16:28:45.555693: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 38ms/step  
2023-03-31 16:28:46.707662: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 41ms/step  
2023-03-31 16:29:18.227327: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:29:19.086323: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 42ms/step  
2023-03-31 16:29:50.554617: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 38ms/step  
2023-03-31 16:29:51.396827: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 41ms/step  
2023-03-31 16:30:22.800683: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 38ms/step  
2023-03-31 16:30:23.627165: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 43ms/step  
2023-03-31 16:30:32.548259: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:30:33.657656: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 42ms/step
2023-03-31 16:30:42.598536: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 38ms/step
2023-03-31 16:30:43.423159: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 43ms/step
2023-03-31 16:30:52.316055: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 37ms/step
2023-03-31 16:30:53.133574: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 41ms/step
2023-03-31 16:31:05.835438: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 39ms/step
2023-03-31 16:31:06.655991: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 45ms/step
2023-03-31 16:31:20.270765: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 40ms/step
2023-03-31 16:31:21.112226: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 45ms/step
2023-03-31 16:31:34.248289: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 41ms/step
2023-03-31 16:31:35.108715: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [======>.....] - ETA: 0s
2023-03-31 16:31:52.812537: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 52ms/step
7/7 [=====] - 0s 39ms/step
2023-03-31 16:31:53.666791: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 46ms/step
2023-03-31 16:32:11.107298: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 39ms/step
2023-03-31 16:32:12.218261: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 46ms/step
2023-03-31 16:32:29.147741: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 74ms/step
2023-03-31 16:32:30.197226: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 45ms/step
2023-03-31 16:32:55.338364: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
7/7 [=====] - 0s 38ms/step
```

```
2023-03-31 16:32:56.177024: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:33:21.200299: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 46ms/step  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:33:22.298970: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:33:46.812541: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 54ms/step  
7/7 [=====] - 0s 37ms/step  
2023-03-31 16:33:47.673752: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 41ms/step  
2023-03-31 16:33:57.054439: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 38ms/step  
2023-03-31 16:33:57.882355: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 41ms/step  
2023-03-31 16:34:06.335255: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
7/7 [=====] - 0s 36ms/step  
2023-03-31 16:34:07.140181: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:34:16.003559: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 53ms/step  
7/7 [=====] - 0s 39ms/step  
2023-03-31 16:34:16.897333: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:34:29.648948: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 48ms/step  
7/7 [=====] - 0s 39ms/step  
2023-03-31 16:34:30.538235: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
1/4 [====>.....] - ETA: 0s  
2023-03-31 16:34:42.962236: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 120ms/step  
7/7 [=====] - 0s 42ms/step  
2023-03-31 16:34:44.087623: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:34:56.750177: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 49ms/step  
7/7 [=====] - 0s 42ms/step
```

```
2023-03-31 16:34:57.939271: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:35:14.213377: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 49ms/step  
7/7 [=====] - 0s 44ms/step  
2023-03-31 16:35:15.138331: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:35:31.419359: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 48ms/step  
7/7 [=====] - 0s 42ms/step  
2023-03-31 16:35:32.312893: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:35:49.032431: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 49ms/step  
7/7 [=====] - 0s 41ms/step  
2023-03-31 16:35:50.186808: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:36:14.033118: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 49ms/step  
7/7 [=====] - 0s 44ms/step  
2023-03-31 16:36:14.939074: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:36:38.811420: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 50ms/step  
7/7 [=====] - 0s 43ms/step  
2023-03-31 16:36:39.739129: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:37:03.281728: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 55ms/step  
7/7 [=====] - 0s 41ms/step  
2023-03-31 16:37:04.229043: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:37:13.919178: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 51ms/step  
7/7 [=====] - 0s 41ms/step  
2023-03-31 16:37:15.203872: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
3/4 [=====>.....] - ETA: 0s  
2023-03-31 16:37:23.675255: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 55ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:37:24.595443: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:37:33.051328: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 56ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:37:33.961257: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:37:45.865473: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 51ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:37:46.787489: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:37:59.060205: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 50ms/step
7/7 [=====] - 0s 45ms/step
2023-03-31 16:38:00.004691: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:38:11.882620: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 57ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:38:12.803915: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:38:28.140114: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 53ms/step
7/7 [=====] - 0s 44ms/step
2023-03-31 16:38:29.069190: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:38:44.924015: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 57ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:38:46.192799: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:39:01.642596: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 57ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:39:02.570320: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:39:25.914900: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 56ms/step
7/7 [=====] - 0s 46ms/step
2023-03-31 16:39:26.890851: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:39:49.392639: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 51ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:39:50.547350: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
3/4 [=====>.....] - ETA: 0s
2023-03-31 16:40:13.206795: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 51ms/step
7/7 [=====] - 0s 41ms/step
2023-03-31 16:40:14.112250: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

In [55]:

```
#Printing best score and parameters
best_batch = gs.best_params_["batch_size"]
best_epoch = gs.best_params_["epoch"]
print("Best: %f using %s" % (gs.best_score_, gs.best_params_))

Best: 0.923333 using {'batch_size': 128, 'epoch': 90}
```

## Plotting Model 4 with best parameters

In [56]:

```
# Model 4
model_4= models.Sequential([
    Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
           padding = 'same', input_shape=(224,224,3)),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Flatten(),
    Dense(units=64, activation='relu'),
    Dropout(0.3),
    Dense(units=1, activation='sigmoid'),
])

model_4.compile(loss='binary_crossentropy',
                 optimizer='adam',
                 metrics=["acc","Recall","Precision"])
```

In [57]:

```
#Fitting model with best parameters
history4 = model_4.fit(train_gen,batch_size= best_batch,
```

```
        epochs=best_epoch,
        verbose = 1,
        class_weight=class_weights,
        validation_data=val_gen,
        callbacks = es) #stopping early because of time resources
```

Epoch 1/90

```
2023-03-31 16:40:50.248343: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 0.7353 - acc: 0.6520
- recall: 0.6218 - precision: 0.8729
```

```
2023-03-31 16:41:13.216190: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - 27s 2s/step - loss: 0.7353 - acc: 0.6520
- recall: 0.6218 - precision: 0.8729 - val_loss: 0.3950 - val_acc: 0.8506
- val_recall: 0.8284 - val_precision: 0.9652
```

Epoch 2/90

```
16/16 [=====] - 26s 2s/step - loss: 0.2841 - acc: 0.8765
- recall: 0.8626 - precision: 0.9675 - val_loss: 0.2249 - val_acc: 0.9156
- val_recall: 0.9049 - val_precision: 0.9798
```

Epoch 3/90

```
16/16 [=====] - 26s 2s/step - loss: 0.1824 - acc: 0.9312
- recall: 0.9322 - precision: 0.9741 - val_loss: 0.1768 - val_acc: 0.9281
- val_recall: 0.9160 - val_precision: 0.9859
```

Epoch 4/90

```
16/16 [=====] - 26s 2s/step - loss: 0.1404 - acc: 0.9472
- recall: 0.9471 - precision: 0.9811 - val_loss: 0.1214 - val_acc: 0.9516
- val_recall: 0.9571 - val_precision: 0.9771
```

Epoch 5/90

```
16/16 [=====] - 26s 2s/step - loss: 0.0995 - acc: 0.9592
- recall: 0.9549 - precision: 0.9898 - val_loss: 0.0969 - val_acc: 0.9599
- val_recall: 0.9664 - val_precision: 0.9792
```

Epoch 6/90

```
16/16 [=====] - 26s 2s/step - loss: 0.0874 - acc: 0.9670
- recall: 0.9650 - precision: 0.9902 - val_loss: 0.0974 - val_acc: 0.9640
- val_recall: 0.9664 - val_precision: 0.9848
```

Epoch 7/90

```
16/16 [=====] - 26s 2s/step - loss: 0.0753 - acc: 0.9712
- recall: 0.9692 - precision: 0.9917 - val_loss: 0.0901 - val_acc: 0.9613
- val_recall: 0.9627 - val_precision: 0.9847
```

Epoch 8/90

```
16/16 [=====] - 26s 2s/step - loss: 0.0830 - acc: 0.9670
- recall: 0.9641 - precision: 0.9911 - val_loss: 0.0928 - val_acc: 0.9599
- val_recall: 0.9608 - val_precision: 0.9847
```

Epoch 9/90

```
16/16 [=====] - 26s 2s/step - loss: 0.0688 - acc: 0.9732
- recall: 0.9722 - precision: 0.9915 - val_loss: 0.0974 - val_acc: 0.9627
- val_recall: 0.9590 - val_precision: 0.9904
```

Epoch 9: early stopping

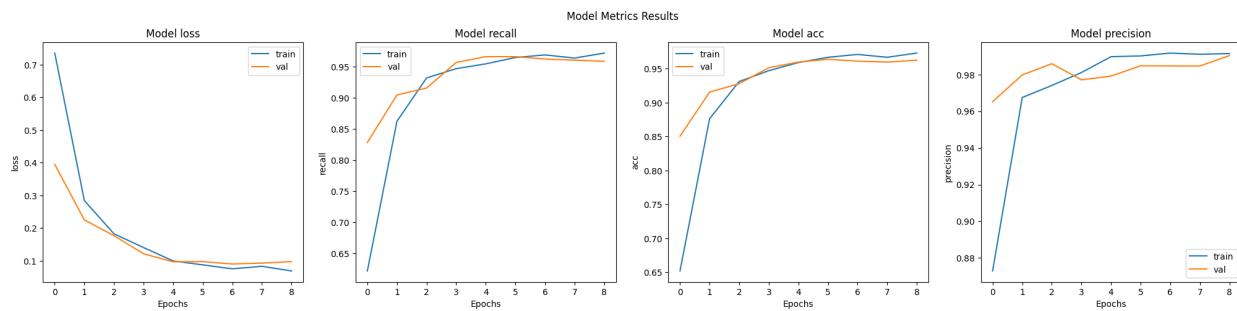
In [58]: `#Model Summary`  
`model_4.summary()`

Model: "sequential\_52"

Layer (type)	Output Shape	Param #
conv2d_156 (Conv2D)	(None, 224, 224, 32)	896
max_pooling2d_156 (MaxPooling2D)	(None, 112, 112, 32)	0
conv2d_157 (Conv2D)	(None, 112, 112, 64)	18496
max_pooling2d_157 (MaxPooling2D)	(None, 56, 56, 64)	0
conv2d_158 (Conv2D)	(None, 56, 56, 96)	55392
max_pooling2d_158 (MaxPooling2D)	(None, 28, 28, 96)	0
flatten_52 (Flatten)	(None, 75264)	0
dense_104 (Dense)	(None, 64)	4816960
dropout_50 (Dropout)	(None, 64)	0
dense_105 (Dense)	(None, 1)	65
<hr/>		
Total params:	4,891,809	
Trainable params:	4,891,809	
Non-trainable params:	0	

```
In [59]: print("Baseline Evaluation Metrics Best Metrics : \n")
eval_metrics(history4)
```

Baseline Evaluation Metrics Best Metrics :



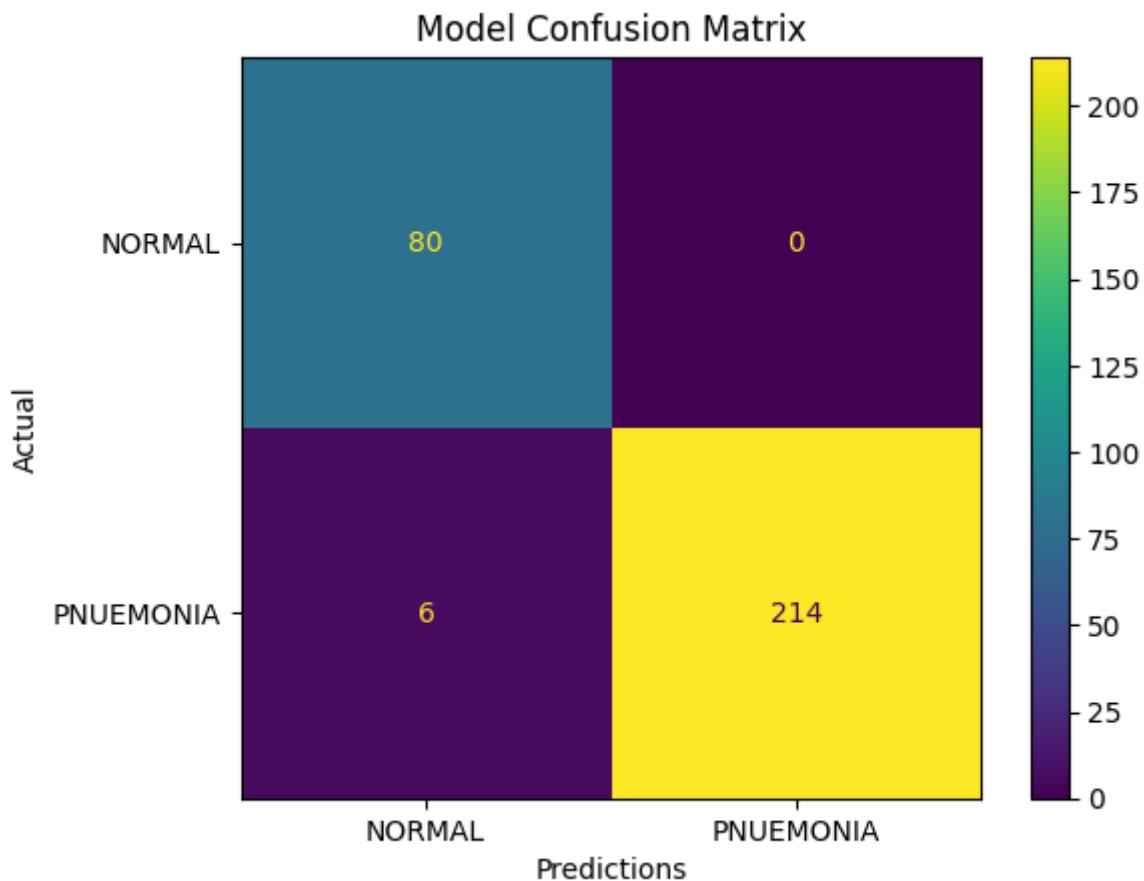
```
In [60]: train_labels, train_predictions = predict_results(model_4, train_gen)
val_labels, val_predictions = predict_results(model_4, val_gen)
```

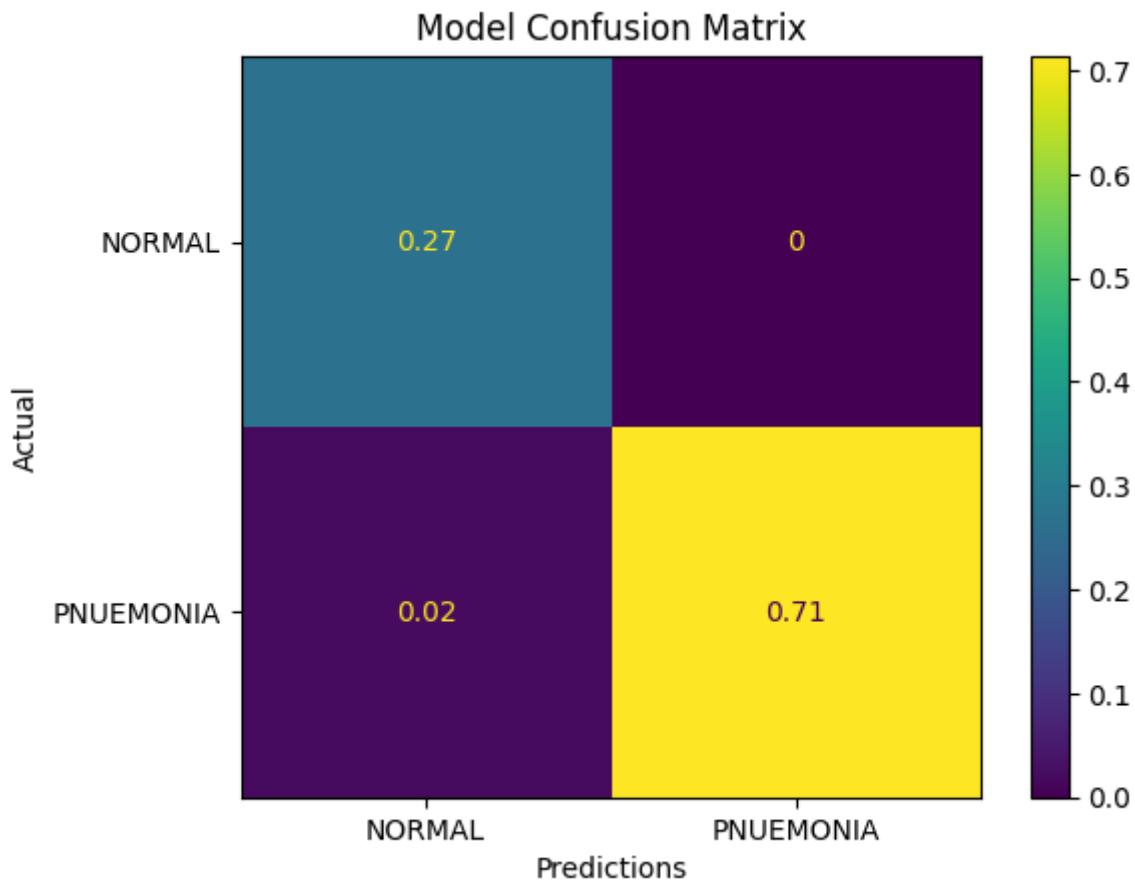
```
1/10 [==>.....] - ETA: 1s
2023-03-31 16:44:45.389042: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
10/10 [=====] - 1s 51ms/step
4/4 [=====] - 0s 58ms/step
```

```
In [61]: #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
```

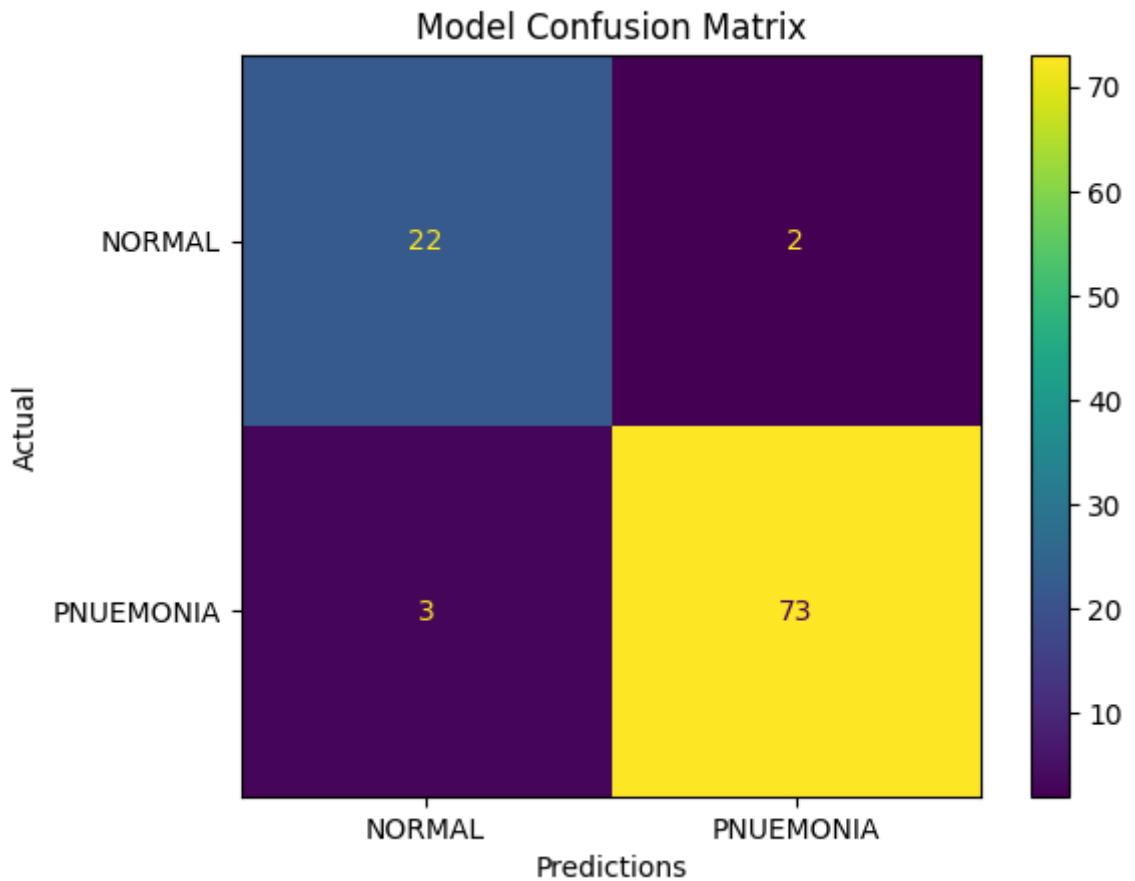
```
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

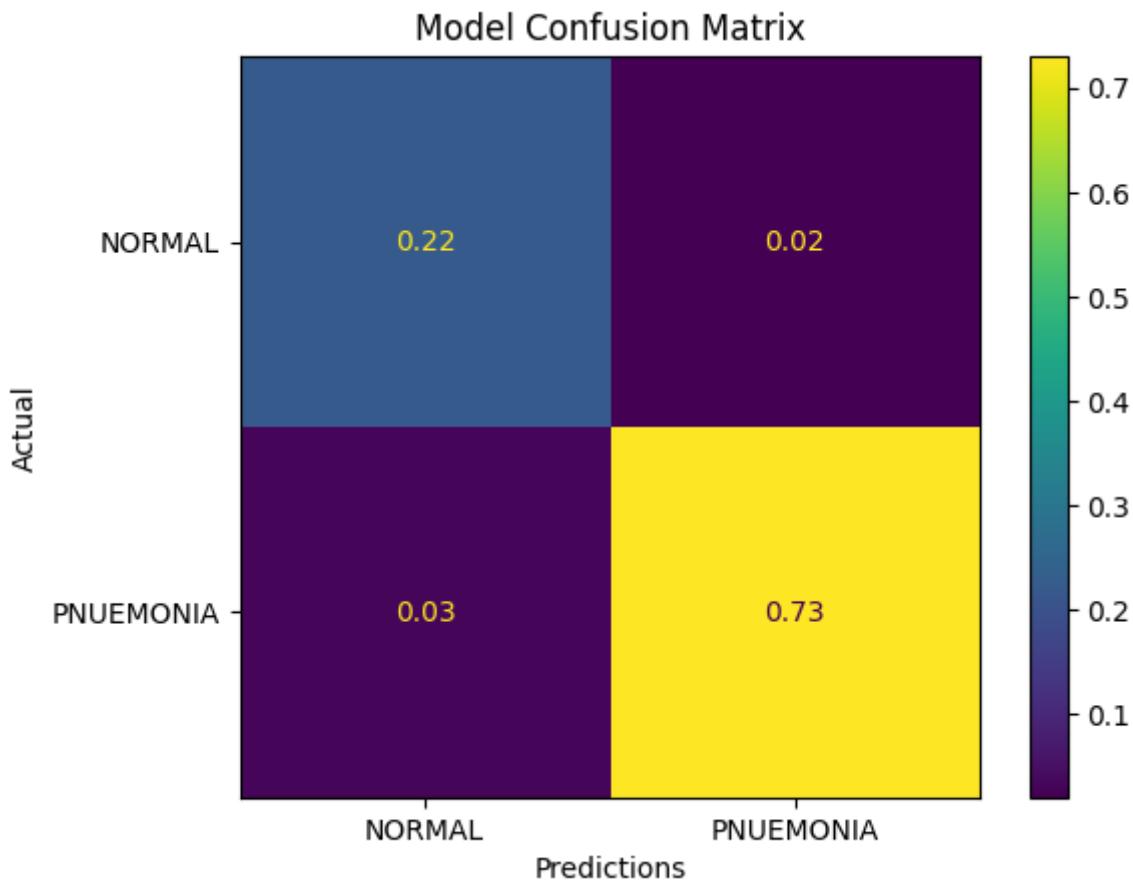
Training Confusion Matrices:





Validation Confusion Matrices:





```
In [62]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history4)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.930	1.000	0.964	80
1.0	1.000	0.973	0.986	220
accuracy			0.980	300
macro avg	0.965	0.986	0.975	300
weighted avg	0.981	0.980	0.980	300

```
16/16 [=====] - 21s 1s/step - loss: 0.0688 - acc: 0.9
743 - recall: 0.9677 - precision: 0.9975
Loss: 0.0688
```

```
In [63]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history4)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.880	0.917	0.898	24
1.0	0.973	0.961	0.967	76
<b>accuracy</b>			0.950	100
<b>macro avg</b>	0.927	0.939	0.932	100
<b>weighted avg</b>	0.951	0.950	0.950	100

```
8/8 [=====] - 3s 410ms/step - loss: 0.0974 - acc: 0.9
627 - recall: 0.9590 - precision: 0.9904
Loss: 0.0974
```

## Model 4 Evaluation

- **Model Plots:** The validation metrics are slightly worse than the training metrics, but not far off.
  - **Confusion Matrix:** The validation model had no FN, but 2 FP.
  - **Report:** The Validation Normal Recall scores are the lowest yet.
  - Overall the Recall and Loss are still acceptable
- 

## Model 5

Using gridsearch and keras wrappers to do some hyperparameter optimization

- epochs = [45,65,90]
- optimizer = ['adam', "SGD"]
- dropout\_rate = [.3,.5]
- Will add Conv2D and a Dense layer for more complexity.

Description of the model hyperparameters and data parameters:

- **Model\***
  - \*\*layers: 4 Conv2D each w/ MaxPooling2D, 3 Dense output layers
  - filters: 32,64,96,128 for Conv2D, 128, 64,1 Dense layer
  - activation: Relu for all except Sigmoid for output layer
  - dropout: .5 between the dense output layers
- **Model Compile**
  - loss: binary\_crossentropy
  - optimizer:adam
  - learning rate: .001 (Default)
  - metrics: Accuracy,Recall,Precision

- Fit
  - data: train\_gen, val\_gen
  - train batchsize: 128
  - epochs: 90
  - early stopping : True
  - class weights: {0: 1.6, 1: 0.7272727272727273}
- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

```
In [64]: #Build model for classifier with parameters in signature
def buildModel(dropout_rate, optimizer = "adam"):

    model= models.Sequential([
        Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
               padding = 'same', input_shape=(224,224,3)),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=128, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Flatten(),

        Dense(units=128, activation='relu'),
        Dropout(dropout_rate),
        Dense(units=64, activation='relu'),
        Dropout(dropout_rate),
        Dense(units=1, activation='sigmoid'),
    ])

    model.compile(loss='binary_crossentropy',
                  optimizer= optimizer,
                  metrics=[ "acc", "Recall", "Precision"]
                 )
    return model
```

```
In [65]: #Hyperparameters for GridsearchCV
epochs = [45,65,90]
optimizer = ['adam', "SGD"]
dropout_rate = [.3,.5]

#Creating a dictionary to use as parameters
parameters_2 = dict(optimizer=optimizer, dropout_rate=dropout_rate, epochs=epochs)
parameters_2
```

```
Out[65]: {'optimizer': ['adam', 'SGD'],
           'dropout_rate': [0.3, 0.5],
           'epochs': [45, 65, 90]}
```

```
In [66]: #Creating a wrapped classifier
classifier = KerasClassifier(build_fn=buildModel, batch_size = 128, class_weight=None)

#Gridsearch Creation
grid_search = GridSearchCV(estimator = classifier,
                           param_grid = parameters_2,
                           refit = "Acc",
                           scoring = "accuracy",
                           cv = 3, return_train_score=True)

#Gridsearch Fitting
gs_2 = grid_search.fit(X_train, y_train, verbose = 1)
```

Epoch 1/45

```
2023-03-31 16:45:13.814853: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 999ms/step - loss: 0.7949 - acc: 0.6  
200 - recall: 0.7724 - precision: 0.7226  
Epoch 2/45  
2/2 [=====] - 0s 168ms/step - loss: 0.7229 - acc: 0.3  
300 - recall: 0.0966 - precision: 0.8235  
Epoch 3/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6978 - acc: 0.3  
200 - recall: 0.0759 - precision: 0.8462  
Epoch 4/45  
2/2 [=====] - 0s 126ms/step - loss: 0.6867 - acc: 0.6  
000 - recall: 0.5103 - precision: 0.8916  
Epoch 5/45  
2/2 [=====] - 0s 119ms/step - loss: 0.6797 - acc: 0.4  
700 - recall: 0.3517 - precision: 0.8095  
Epoch 6/45  
2/2 [=====] - 0s 162ms/step - loss: 0.6231 - acc: 0.6  
700 - recall: 0.5655 - precision: 0.9647  
Epoch 7/45  
2/2 [=====] - 0s 93ms/step - loss: 0.5705 - acc: 0.82  
00 - recall: 0.8483 - precision: 0.8978  
Epoch 8/45  
2/2 [=====] - 0s 91ms/step - loss: 0.4510 - acc: 0.80  
50 - recall: 0.7448 - precision: 0.9818  
Epoch 9/45  
2/2 [=====] - 0s 91ms/step - loss: 0.4106 - acc: 0.82  
50 - recall: 0.8138 - precision: 0.9365  
Epoch 10/45  
2/2 [=====] - 0s 104ms/step - loss: 0.4995 - acc: 0.8  
000 - recall: 0.7724 - precision: 0.9412  
Epoch 11/45  
2/2 [=====] - 0s 114ms/step - loss: 0.4256 - acc: 0.8  
300 - recall: 0.8552 - precision: 0.9051  
Epoch 12/45  
2/2 [=====] - 0s 110ms/step - loss: 0.3512 - acc: 0.8  
050 - recall: 0.7379 - precision: 0.9907  
Epoch 13/45  
2/2 [=====] - 0s 106ms/step - loss: 0.3409 - acc: 0.8  
400 - recall: 0.8069 - precision: 0.9669  
Epoch 14/45  
2/2 [=====] - 0s 90ms/step - loss: 0.2988 - acc: 0.86  
50 - recall: 0.8690 - precision: 0.9403  
Epoch 15/45  
2/2 [=====] - 0s 105ms/step - loss: 0.2737 - acc: 0.8  
700 - recall: 0.8552 - precision: 0.9612  
Epoch 16/45  
2/2 [=====] - 0s 102ms/step - loss: 0.2255 - acc: 0.9  
200 - recall: 0.9103 - precision: 0.9778  
Epoch 17/45  
2/2 [=====] - 0s 173ms/step - loss: 0.1778 - acc: 0.9  
350 - recall: 0.9448 - precision: 0.9648  
Epoch 18/45  
2/2 [=====] - 0s 77ms/step - loss: 0.1938 - acc: 0.92  
00 - recall: 0.8966 - precision: 0.9924  
Epoch 19/45  
2/2 [=====] - 0s 96ms/step - loss: 0.1407 - acc: 0.94  
00 - recall: 0.9379 - precision: 0.9784  
Epoch 20/45  
2/2 [=====] - 0s 138ms/step - loss: 0.1492 - acc: 0.9  
500 - recall: 0.9586 - precision: 0.9720  
Epoch 21/45
```

```
2/2 [=====] - 0s 167ms/step - loss: 0.1412 - acc: 0.9  
250 - recall: 0.9034 - precision: 0.9924  
Epoch 22/45  
2/2 [=====] - 0s 107ms/step - loss: 0.0833 - acc: 0.9  
700 - recall: 0.9586 - precision: 1.0000  
Epoch 23/45  
2/2 [=====] - 0s 74ms/step - loss: 0.0828 - acc: 0.98  
00 - recall: 0.9724 - precision: 1.0000  
Epoch 24/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0828 - acc: 0.96  
00 - recall: 0.9448 - precision: 1.0000  
Epoch 25/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0785 - acc: 0.96  
00 - recall: 0.9586 - precision: 0.9858  
Epoch 26/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0442 - acc: 0.98  
50 - recall: 0.9793 - precision: 1.0000  
Epoch 27/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0395 - acc: 0.98  
00 - recall: 0.9724 - precision: 1.0000  
Epoch 28/45  
2/2 [=====] - 0s 141ms/step - loss: 0.0603 - acc: 0.9  
850 - recall: 0.9862 - precision: 0.9931  
Epoch 29/45  
2/2 [=====] - 0s 89ms/step - loss: 0.0380 - acc: 0.98  
50 - recall: 0.9793 - precision: 1.0000  
Epoch 30/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0326 - acc: 0.98  
00 - recall: 0.9724 - precision: 1.0000  
Epoch 31/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0298 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 32/45  
2/2 [=====] - 0s 87ms/step - loss: 0.0193 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 33/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0181 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 34/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0115 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 35/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0075 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 36/45  
2/2 [=====] - 0s 102ms/step - loss: 0.0192 - acc: 0.9  
950 - recall: 0.9931 - precision: 1.0000  
Epoch 37/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0401 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 38/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0087 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 39/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0265 - acc: 0.98  
50 - recall: 0.9793 - precision: 1.0000  
Epoch 40/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0219 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 41/45
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.0178 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 75ms/step - loss: 0.0148 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 43/45
2/2 [=====] - 0s 77ms/step - loss: 0.0161 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 44/45
2/2 [=====] - 0s 85ms/step - loss: 0.0032 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 45/45
2/2 [=====] - 0s 93ms/step - loss: 0.0073 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:45:27.065475: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 47ms/step
7/7 [=====] - 0s 26ms/step
Epoch 1/45
2023-03-31 16:45:28.006184: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 539ms/step - loss: 0.7248 - acc: 0.6  
300 - recall: 0.7500 - precision: 0.7500  
Epoch 2/45  
2/2 [=====] - 0s 144ms/step - loss: 0.6883 - acc: 0.2  
900 - recall: 0.0473 - precision: 0.8750  
Epoch 3/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6707 - acc: 0.50  
50 - recall: 0.3986 - precision: 0.8551  
Epoch 4/45  
2/2 [=====] - 0s 158ms/step - loss: 0.6395 - acc: 0.6  
550 - recall: 0.6419 - precision: 0.8559  
Epoch 5/45  
2/2 [=====] - 0s 139ms/step - loss: 0.5591 - acc: 0.8  
000 - recall: 0.8919 - precision: 0.8462  
Epoch 6/45  
2/2 [=====] - 0s 149ms/step - loss: 0.4892 - acc: 0.7  
550 - recall: 0.7027 - precision: 0.9541  
Epoch 7/45  
2/2 [=====] - 0s 305ms/step - loss: 0.4158 - acc: 0.7  
850 - recall: 0.7973 - precision: 0.9008  
Epoch 8/45  
2/2 [=====] - 0s 109ms/step - loss: 0.5029 - acc: 0.7  
500 - recall: 0.6892 - precision: 0.9623  
Epoch 9/45  
2/2 [=====] - 0s 78ms/step - loss: 0.4600 - acc: 0.83  
00 - recall: 0.8581 - precision: 0.9071  
Epoch 10/45  
2/2 [=====] - 0s 113ms/step - loss: 0.4323 - acc: 0.8  
200 - recall: 0.8243 - precision: 0.9242  
Epoch 11/45  
2/2 [=====] - 0s 140ms/step - loss: 0.3877 - acc: 0.8  
250 - recall: 0.7905 - precision: 0.9669  
Epoch 12/45  
2/2 [=====] - 0s 75ms/step - loss: 0.3357 - acc: 0.83  
50 - recall: 0.7905 - precision: 0.9832  
Epoch 13/45  
2/2 [=====] - 0s 106ms/step - loss: 0.2833 - acc: 0.8  
500 - recall: 0.8378 - precision: 0.9538  
Epoch 14/45  
2/2 [=====] - 0s 120ms/step - loss: 0.2682 - acc: 0.8  
550 - recall: 0.8176 - precision: 0.9837  
Epoch 15/45  
2/2 [=====] - 0s 124ms/step - loss: 0.2767 - acc: 0.8  
950 - recall: 0.8919 - precision: 0.9635  
Epoch 16/45  
2/2 [=====] - 0s 76ms/step - loss: 0.2305 - acc: 0.86  
50 - recall: 0.8446 - precision: 0.9690  
Epoch 17/45  
2/2 [=====] - 0s 99ms/step - loss: 0.2085 - acc: 0.89  
00 - recall: 0.8514 - precision: 1.0000  
Epoch 18/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1663 - acc: 0.93  
50 - recall: 0.9324 - precision: 0.9787  
Epoch 19/45  
2/2 [=====] - 0s 99ms/step - loss: 0.1307 - acc: 0.95  
00 - recall: 0.9324 - precision: 1.0000  
Epoch 20/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1190 - acc: 0.95  
00 - recall: 0.9392 - precision: 0.9929  
Epoch 21/45
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.1658 - acc: 0.93
50 - recall: 0.9595 - precision: 0.9530
Epoch 22/45
2/2 [=====] - 0s 75ms/step - loss: 0.1025 - acc: 0.94
00 - recall: 0.9189 - precision: 1.0000
Epoch 23/45
2/2 [=====] - 0s 75ms/step - loss: 0.1315 - acc: 0.95
50 - recall: 0.9797 - precision: 0.9603
Epoch 24/45
2/2 [=====] - 0s 75ms/step - loss: 0.1129 - acc: 0.94
00 - recall: 0.9257 - precision: 0.9928
Epoch 25/45
2/2 [=====] - 0s 75ms/step - loss: 0.1554 - acc: 0.92
50 - recall: 0.8986 - precision: 1.0000
Epoch 26/45
2/2 [=====] - 0s 76ms/step - loss: 0.0894 - acc: 0.95
00 - recall: 0.9324 - precision: 1.0000
Epoch 27/45
2/2 [=====] - 0s 87ms/step - loss: 0.0654 - acc: 0.97
50 - recall: 0.9662 - precision: 1.0000
Epoch 28/45
2/2 [=====] - 0s 81ms/step - loss: 0.0750 - acc: 0.97
50 - recall: 0.9662 - precision: 1.0000
Epoch 29/45
2/2 [=====] - 0s 92ms/step - loss: 0.0522 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 30/45
2/2 [=====] - 0s 93ms/step - loss: 0.0399 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 31/45
2/2 [=====] - 0s 100ms/step - loss: 0.0199 - acc: 0.9
900 - recall: 0.9865 - precision: 1.0000
Epoch 32/45
2/2 [=====] - 0s 87ms/step - loss: 0.0208 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 33/45
2/2 [=====] - 0s 87ms/step - loss: 0.0249 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 34/45
2/2 [=====] - 0s 90ms/step - loss: 0.0115 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 35/45
2/2 [=====] - 0s 93ms/step - loss: 0.0182 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 36/45
2/2 [=====] - 0s 92ms/step - loss: 0.0108 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 37/45
2/2 [=====] - 0s 89ms/step - loss: 0.0293 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 38/45
2/2 [=====] - 0s 88ms/step - loss: 0.0034 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 39/45
2/2 [=====] - 0s 87ms/step - loss: 0.0048 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 40/45
2/2 [=====] - 0s 85ms/step - loss: 0.0457 - acc: 0.99
00 - recall: 0.9932 - precision: 0.9932
Epoch 41/45
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.0052 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 85ms/step - loss: 0.0097 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 43/45
2/2 [=====] - 0s 109ms/step - loss: 0.0162 - acc: 0.9
950 - recall: 0.9932 - precision: 1.0000
Epoch 44/45
2/2 [=====] - 0s 93ms/step - loss: 0.0167 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 45/45
2/2 [=====] - 0s 83ms/step - loss: 0.0298 - acc: 0.98
50 - recall: 0.9797 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:45:40.149305: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 48ms/step
7/7 [=====] - 0s 31ms/step
Epoch 1/45
2023-03-31 16:45:41.085242: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 586ms/step - loss: 0.7091 - acc: 0.5  
450 - recall: 0.5839 - precision: 0.7500  
Epoch 2/45  
2/2 [=====] - 0s 156ms/step - loss: 0.7052 - acc: 0.7  
250 - recall: 0.8926 - precision: 0.7733  
Epoch 3/45  
2/2 [=====] - 0s 151ms/step - loss: 0.6602 - acc: 0.5  
050 - recall: 0.3758 - precision: 0.9032  
Epoch 4/45  
2/2 [=====] - 0s 123ms/step - loss: 0.6373 - acc: 0.7  
600 - recall: 0.8792 - precision: 0.8137  
Epoch 5/45  
2/2 [=====] - 0s 120ms/step - loss: 0.5291 - acc: 0.7  
750 - recall: 0.7450 - precision: 0.9407  
Epoch 6/45  
2/2 [=====] - 0s 134ms/step - loss: 0.4757 - acc: 0.8  
150 - recall: 0.8658 - precision: 0.8836  
Epoch 7/45  
2/2 [=====] - 0s 89ms/step - loss: 0.3964 - acc: 0.81  
50 - recall: 0.7919 - precision: 0.9516  
Epoch 8/45  
2/2 [=====] - 0s 87ms/step - loss: 0.3990 - acc: 0.84  
00 - recall: 0.8389 - precision: 0.9398  
Epoch 9/45  
2/2 [=====] - 0s 117ms/step - loss: 0.3510 - acc: 0.8  
400 - recall: 0.8322 - precision: 0.9466  
Epoch 10/45  
2/2 [=====] - 0s 104ms/step - loss: 0.3070 - acc: 0.8  
550 - recall: 0.8188 - precision: 0.9839  
Epoch 11/45  
2/2 [=====] - 0s 117ms/step - loss: 0.2995 - acc: 0.8  
750 - recall: 0.8591 - precision: 0.9697  
Epoch 12/45  
2/2 [=====] - 0s 109ms/step - loss: 0.2921 - acc: 0.8  
950 - recall: 0.9396 - precision: 0.9211  
Epoch 13/45  
2/2 [=====] - 0s 101ms/step - loss: 0.2472 - acc: 0.8  
800 - recall: 0.8523 - precision: 0.9845  
Epoch 14/45  
2/2 [=====] - 0s 115ms/step - loss: 0.1649 - acc: 0.9  
450 - recall: 0.9530 - precision: 0.9726  
Epoch 15/45  
2/2 [=====] - 0s 97ms/step - loss: 0.1408 - acc: 0.95  
50 - recall: 0.9664 - precision: 0.9730  
Epoch 16/45  
2/2 [=====] - 1s 486ms/step - loss: 0.1894 - acc: 0.9  
250 - recall: 0.9060 - precision: 0.9926  
Epoch 17/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1488 - acc: 0.94  
00 - recall: 0.9664 - precision: 0.9536  
Epoch 18/45  
2/2 [=====] - 0s 98ms/step - loss: 0.1073 - acc: 0.95  
50 - recall: 0.9396 - precision: 1.0000  
Epoch 19/45  
2/2 [=====] - 0s 97ms/step - loss: 0.0959 - acc: 0.95  
00 - recall: 0.9329 - precision: 1.0000  
Epoch 20/45  
2/2 [=====] - 0s 105ms/step - loss: 0.0883 - acc: 0.9  
650 - recall: 0.9530 - precision: 1.0000  
Epoch 21/45
```

```
2/2 [=====] - 0s 100ms/step - loss: 0.0979 - acc: 0.9  
750 - recall: 0.9933 - precision: 0.9737  
Epoch 22/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0566 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 23/45  
2/2 [=====] - 0s 96ms/step - loss: 0.0578 - acc: 0.96  
50 - recall: 0.9530 - precision: 1.0000  
Epoch 24/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0503 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 25/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0759 - acc: 0.97  
50 - recall: 0.9732 - precision: 0.9932  
Epoch 26/45  
2/2 [=====] - 0s 103ms/step - loss: 0.0602 - acc: 0.9  
700 - recall: 0.9597 - precision: 1.0000  
Epoch 27/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0933 - acc: 0.96  
50 - recall: 0.9799 - precision: 0.9733  
Epoch 28/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0319 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 29/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0580 - acc: 0.97  
50 - recall: 0.9664 - precision: 1.0000  
Epoch 30/45  
2/2 [=====] - 0s 87ms/step - loss: 0.0429 - acc: 0.99  
00 - recall: 0.9933 - precision: 0.9933  
Epoch 31/45  
2/2 [=====] - 0s 74ms/step - loss: 0.0249 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 32/45  
2/2 [=====] - 0s 78ms/step - loss: 0.0355 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 33/45  
2/2 [=====] - 0s 84ms/step - loss: 0.0539 - acc: 0.98  
00 - recall: 0.9933 - precision: 0.9801  
Epoch 34/45  
2/2 [=====] - 0s 89ms/step - loss: 0.0468 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 35/45  
2/2 [=====] - 0s 93ms/step - loss: 0.0229 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 36/45  
2/2 [=====] - 0s 90ms/step - loss: 0.0228 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 37/45  
2/2 [=====] - 0s 185ms/step - loss: 0.0504 - acc: 0.9  
900 - recall: 0.9933 - precision: 0.9933  
Epoch 38/45  
2/2 [=====] - 0s 83ms/step - loss: 0.0207 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 39/45  
2/2 [=====] - 0s 102ms/step - loss: 0.0327 - acc: 0.9  
850 - recall: 0.9799 - precision: 1.0000  
Epoch 40/45  
2/2 [=====] - 0s 91ms/step - loss: 0.0408 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 41/45
```

```
2/2 [=====] - 0s 108ms/step - loss: 0.0111 - acc: 0.9  
950 - recall: 0.9933 - precision: 1.0000  
Epoch 42/45  
2/2 [=====] - 0s 85ms/step - loss: 0.0434 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 43/45  
2/2 [=====] - 0s 86ms/step - loss: 0.0417 - acc: 0.98  
50 - recall: 0.9866 - precision: 0.9932  
Epoch 44/45  
2/2 [=====] - 0s 87ms/step - loss: 0.0083 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 45/45  
2/2 [=====] - 0s 87ms/step - loss: 0.0200 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
1/4 [=====>.....] - ETA: 0s  
2023-03-31 16:45:54.476879: I tensorflow/core/grappler/optimizers/custom_graph  
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 45ms/step  
7/7 [=====] - 0s 31ms/step  
Epoch 1/45  
2023-03-31 16:45:55.681817: I tensorflow/core/grappler/optimizers/custom_graph  
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 546ms/step - loss: 0.6996 - acc: 0.6  
550 - recall: 0.7517 - precision: 0.7676  
Epoch 2/45  
2/2 [=====] - 0s 139ms/step - loss: 0.7036 - acc: 0.5  
100 - recall: 0.4828 - precision: 0.7527  
Epoch 3/45  
2/2 [=====] - 0s 151ms/step - loss: 0.7023 - acc: 0.5  
300 - recall: 0.5103 - precision: 0.7629  
Epoch 4/45  
2/2 [=====] - 0s 142ms/step - loss: 0.7028 - acc: 0.4  
750 - recall: 0.4207 - precision: 0.7439  
Epoch 5/45  
2/2 [=====] - 0s 128ms/step - loss: 0.7010 - acc: 0.4  
750 - recall: 0.4000 - precision: 0.7632  
Epoch 6/45  
2/2 [=====] - 0s 87ms/step - loss: 0.7038 - acc: 0.41  
50 - recall: 0.3517 - precision: 0.6892  
Epoch 7/45  
2/2 [=====] - 0s 109ms/step - loss: 0.6975 - acc: 0.4  
500 - recall: 0.3103 - precision: 0.8182  
Epoch 8/45  
2/2 [=====] - 0s 121ms/step - loss: 0.6960 - acc: 0.4  
450 - recall: 0.2897 - precision: 0.8400  
Epoch 9/45  
2/2 [=====] - 0s 112ms/step - loss: 0.7002 - acc: 0.4  
350 - recall: 0.2966 - precision: 0.7963  
Epoch 10/45  
2/2 [=====] - 0s 77ms/step - loss: 0.6954 - acc: 0.45  
00 - recall: 0.2897 - precision: 0.8571  
Epoch 11/45  
2/2 [=====] - 0s 114ms/step - loss: 0.6957 - acc: 0.4  
750 - recall: 0.3310 - precision: 0.8571  
Epoch 12/45  
2/2 [=====] - 0s 99ms/step - loss: 0.7051 - acc: 0.37  
50 - recall: 0.2828 - precision: 0.6613  
Epoch 13/45  
2/2 [=====] - 0s 142ms/step - loss: 0.7001 - acc: 0.4  
300 - recall: 0.3034 - precision: 0.7719  
Epoch 14/45  
2/2 [=====] - 0s 95ms/step - loss: 0.6940 - acc: 0.53  
50 - recall: 0.4276 - precision: 0.8611  
Epoch 15/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6961 - acc: 0.56  
50 - recall: 0.4897 - precision: 0.8452  
Epoch 16/45  
2/2 [=====] - 0s 97ms/step - loss: 0.6960 - acc: 0.51  
50 - recall: 0.3931 - precision: 0.8636  
Epoch 17/45  
2/2 [=====] - 0s 108ms/step - loss: 0.6928 - acc: 0.4  
650 - recall: 0.3103 - precision: 0.8654  
Epoch 18/45  
2/2 [=====] - 0s 112ms/step - loss: 0.6936 - acc: 0.3  
950 - recall: 0.2207 - precision: 0.8000  
Epoch 19/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6955 - acc: 0.49  
50 - recall: 0.3586 - precision: 0.8667  
Epoch 20/45  
2/2 [=====] - 0s 86ms/step - loss: 0.6926 - acc: 0.44  
00 - recall: 0.2897 - precision: 0.8235  
Epoch 21/45
```

```
2/2 [=====] - 0s 74ms/step - loss: 0.6961 - acc: 0.41
00 - recall: 0.2345 - precision: 0.8293
Epoch 22/45
2/2 [=====] - 0s 75ms/step - loss: 0.6920 - acc: 0.44
00 - recall: 0.2414 - precision: 0.9459
Epoch 23/45
2/2 [=====] - 0s 86ms/step - loss: 0.6922 - acc: 0.36
50 - recall: 0.1517 - precision: 0.8462
Epoch 24/45
2/2 [=====] - 0s 180ms/step - loss: 0.6939 - acc: 0.3
350 - recall: 0.1034 - precision: 0.8333
Epoch 25/45
2/2 [=====] - 0s 110ms/step - loss: 0.6928 - acc: 0.4
150 - recall: 0.2207 - precision: 0.8889
Epoch 26/45
2/2 [=====] - 0s 87ms/step - loss: 0.6900 - acc: 0.41
00 - recall: 0.2138 - precision: 0.8857
Epoch 27/45
2/2 [=====] - 0s 81ms/step - loss: 0.6898 - acc: 0.37
00 - recall: 0.1379 - precision: 0.9524
Epoch 28/45
2/2 [=====] - 0s 112ms/step - loss: 0.6915 - acc: 0.3
900 - recall: 0.1724 - precision: 0.9259
Epoch 29/45
2/2 [=====] - 0s 93ms/step - loss: 0.6921 - acc: 0.31
50 - recall: 0.0759 - precision: 0.7857
Epoch 30/45
2/2 [=====] - 0s 100ms/step - loss: 0.6941 - acc: 0.3
100 - recall: 0.0759 - precision: 0.7333
Epoch 31/45
2/2 [=====] - 0s 89ms/step - loss: 0.6883 - acc: 0.43
00 - recall: 0.2345 - precision: 0.9189
Epoch 32/45
2/2 [=====] - 0s 90ms/step - loss: 0.6896 - acc: 0.45
00 - recall: 0.2759 - precision: 0.8889
Epoch 33/45
2/2 [=====] - 0s 110ms/step - loss: 0.6853 - acc: 0.4
650 - recall: 0.2690 - precision: 0.9750
Epoch 34/45
2/2 [=====] - 0s 86ms/step - loss: 0.6859 - acc: 0.50
00 - recall: 0.3517 - precision: 0.8947
Epoch 35/45
2/2 [=====] - 0s 87ms/step - loss: 0.6863 - acc: 0.41
00 - recall: 0.2483 - precision: 0.8000
Epoch 36/45
2/2 [=====] - 0s 89ms/step - loss: 0.6842 - acc: 0.54
00 - recall: 0.3862 - precision: 0.9492
Epoch 37/45
2/2 [=====] - 0s 110ms/step - loss: 0.6818 - acc: 0.6
150 - recall: 0.5379 - precision: 0.8864
Epoch 38/45
2/2 [=====] - 0s 86ms/step - loss: 0.6843 - acc: 0.39
50 - recall: 0.1931 - precision: 0.8750
Epoch 39/45
2/2 [=====] - 0s 87ms/step - loss: 0.6798 - acc: 0.45
50 - recall: 0.2690 - precision: 0.9286
Epoch 40/45
2/2 [=====] - 0s 86ms/step - loss: 0.6836 - acc: 0.42
50 - recall: 0.2207 - precision: 0.9412
Epoch 41/45
```

```
2/2 [=====] - 0s 89ms/step - loss: 0.6838 - acc: 0.51
50 - recall: 0.3862 - precision: 0.8750
Epoch 42/45
2/2 [=====] - 0s 87ms/step - loss: 0.6844 - acc: 0.49
50 - recall: 0.3517 - precision: 0.8793
Epoch 43/45
2/2 [=====] - 0s 86ms/step - loss: 0.6884 - acc: 0.54
50 - recall: 0.4345 - precision: 0.8750
Epoch 44/45
2/2 [=====] - 0s 86ms/step - loss: 0.6810 - acc: 0.47
50 - recall: 0.3310 - precision: 0.8571
Epoch 45/45
2/2 [=====] - 0s 87ms/step - loss: 0.6771 - acc: 0.63
50 - recall: 0.5586 - precision: 0.9000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:46:07.796685: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 39ms/step
7/7 [=====] - 0s 24ms/step
Epoch 1/45
2023-03-31 16:46:08.587780: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 526ms/step - loss: 0.6895 - acc: 0.5
300 - recall: 0.5473 - precision: 0.7500
Epoch 2/45
2/2 [=====] - 0s 127ms/step - loss: 0.6891 - acc: 0.6
250 - recall: 0.6959 - precision: 0.7744
Epoch 3/45
2/2 [=====] - 0s 142ms/step - loss: 0.6873 - acc: 0.5
900 - recall: 0.6284 - precision: 0.7750
Epoch 4/45
2/2 [=====] - 0s 152ms/step - loss: 0.6922 - acc: 0.5
300 - recall: 0.6149 - precision: 0.7109
Epoch 5/45
2/2 [=====] - 0s 140ms/step - loss: 0.6887 - acc: 0.6
400 - recall: 0.7162 - precision: 0.7794
Epoch 6/45
2/2 [=====] - 0s 144ms/step - loss: 0.6869 - acc: 0.6
300 - recall: 0.6554 - precision: 0.8083
Epoch 7/45
2/2 [=====] - 0s 136ms/step - loss: 0.6887 - acc: 0.5
800 - recall: 0.5878 - precision: 0.7909
Epoch 8/45
2/2 [=====] - 0s 118ms/step - loss: 0.6866 - acc: 0.5
900 - recall: 0.6351 - precision: 0.7705
Epoch 9/45
2/2 [=====] - 0s 101ms/step - loss: 0.6864 - acc: 0.6
100 - recall: 0.6284 - precision: 0.8017
Epoch 10/45
2/2 [=====] - 0s 103ms/step - loss: 0.6857 - acc: 0.5
550 - recall: 0.4797 - precision: 0.8554
Epoch 11/45
2/2 [=====] - 0s 123ms/step - loss: 0.6894 - acc: 0.4
800 - recall: 0.4257 - precision: 0.7683
Epoch 12/45
2/2 [=====] - 0s 210ms/step - loss: 0.6833 - acc: 0.5
500 - recall: 0.4865 - precision: 0.8372
Epoch 13/45
2/2 [=====] - 0s 100ms/step - loss: 0.6860 - acc: 0.5
250 - recall: 0.5270 - precision: 0.7573
Epoch 14/45
2/2 [=====] - 0s 75ms/step - loss: 0.6836 - acc: 0.56
50 - recall: 0.5676 - precision: 0.7850
Epoch 15/45
2/2 [=====] - 0s 75ms/step - loss: 0.6820 - acc: 0.60
50 - recall: 0.6081 - precision: 0.8108
Epoch 16/45
2/2 [=====] - 0s 87ms/step - loss: 0.6833 - acc: 0.58
00 - recall: 0.5338 - precision: 0.8404
Epoch 17/45
2/2 [=====] - 0s 87ms/step - loss: 0.6842 - acc: 0.68
50 - recall: 0.7297 - precision: 0.8244
Epoch 18/45
2/2 [=====] - 0s 77ms/step - loss: 0.6786 - acc: 0.75
00 - recall: 0.8108 - precision: 0.8451
Epoch 19/45
2/2 [=====] - 0s 76ms/step - loss: 0.6825 - acc: 0.68
00 - recall: 0.7500 - precision: 0.8043
Epoch 20/45
2/2 [=====] - 0s 74ms/step - loss: 0.6858 - acc: 0.59
50 - recall: 0.6419 - precision: 0.7724
Epoch 21/45
```

```
2/2 [=====] - 0s 111ms/step - loss: 0.6830 - acc: 0.6  
050 - recall: 0.6284 - precision: 0.7949  
Epoch 22/45  
2/2 [=====] - 0s 100ms/step - loss: 0.6824 - acc: 0.5  
700 - recall: 0.5473 - precision: 0.8100  
Epoch 23/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6845 - acc: 0.62  
50 - recall: 0.6419 - precision: 0.8120  
Epoch 24/45  
2/2 [=====] - 0s 85ms/step - loss: 0.6801 - acc: 0.61  
00 - recall: 0.5676 - precision: 0.8571  
Epoch 25/45  
2/2 [=====] - 0s 93ms/step - loss: 0.6785 - acc: 0.71  
00 - recall: 0.7230 - precision: 0.8629  
Epoch 26/45  
2/2 [=====] - 0s 92ms/step - loss: 0.6770 - acc: 0.65  
00 - recall: 0.6081 - precision: 0.8824  
Epoch 27/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6803 - acc: 0.60  
00 - recall: 0.5878 - precision: 0.8208  
Epoch 28/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6783 - acc: 0.58  
50 - recall: 0.5000 - precision: 0.8916  
Epoch 29/45  
2/2 [=====] - 0s 88ms/step - loss: 0.6788 - acc: 0.47  
00 - recall: 0.3514 - precision: 0.8387  
Epoch 30/45  
2/2 [=====] - 0s 90ms/step - loss: 0.6782 - acc: 0.49  
00 - recall: 0.3716 - precision: 0.8594  
Epoch 31/45  
2/2 [=====] - 0s 90ms/step - loss: 0.6736 - acc: 0.60  
50 - recall: 0.5338 - precision: 0.8876  
Epoch 32/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6711 - acc: 0.58  
50 - recall: 0.4730 - precision: 0.9333  
Epoch 33/45  
2/2 [=====] - 0s 88ms/step - loss: 0.6680 - acc: 0.65  
00 - recall: 0.5878 - precision: 0.9062  
Epoch 34/45  
2/2 [=====] - 0s 97ms/step - loss: 0.6670 - acc: 0.71  
00 - recall: 0.7095 - precision: 0.8750  
Epoch 35/45  
2/2 [=====] - 0s 84ms/step - loss: 0.6790 - acc: 0.63  
00 - recall: 0.6351 - precision: 0.8246  
Epoch 36/45  
2/2 [=====] - 0s 108ms/step - loss: 0.6712 - acc: 0.6  
400 - recall: 0.6149 - precision: 0.8585  
Epoch 37/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6662 - acc: 0.64  
00 - recall: 0.5811 - precision: 0.8958  
Epoch 38/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6705 - acc: 0.76  
00 - recall: 0.8243 - precision: 0.8472  
Epoch 39/45  
2/2 [=====] - 0s 88ms/step - loss: 0.6673 - acc: 0.62  
50 - recall: 0.5541 - precision: 0.9011  
Epoch 40/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6688 - acc: 0.54  
00 - recall: 0.4459 - precision: 0.8684  
Epoch 41/45
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.6661 - acc: 0.59
00 - recall: 0.4865 - precision: 0.9231
Epoch 42/45
2/2 [=====] - 0s 107ms/step - loss: 0.6665 - acc: 0.6
250 - recall: 0.5676 - precision: 0.8842
Epoch 43/45
2/2 [=====] - 0s 84ms/step - loss: 0.6687 - acc: 0.62
00 - recall: 0.6014 - precision: 0.8396
Epoch 44/45
2/2 [=====] - 0s 88ms/step - loss: 0.6595 - acc: 0.68
00 - recall: 0.6351 - precision: 0.9038
Epoch 45/45
2/2 [=====] - 0s 90ms/step - loss: 0.6629 - acc: 0.67
00 - recall: 0.6622 - precision: 0.8596
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:46:20.770960: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 43ms/step
7/7 [=====] - 0s 25ms/step
Epoch 1/45
2023-03-31 16:46:21.578705: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 1s 493ms/step - loss: 0.6861 - acc: 0.6  
150 - recall: 0.7248 - precision: 0.7500  
Epoch 2/45  
2/2 [=====] - 1s 354ms/step - loss: 0.6846 - acc: 0.5  
450 - recall: 0.5973 - precision: 0.7417  
Epoch 3/45  
2/2 [=====] - 0s 117ms/step - loss: 0.6816 - acc: 0.6  
300 - recall: 0.6980 - precision: 0.7820  
Epoch 4/45  
2/2 [=====] - 0s 142ms/step - loss: 0.6840 - acc: 0.5  
500 - recall: 0.5839 - precision: 0.7565  
Epoch 5/45  
2/2 [=====] - 0s 157ms/step - loss: 0.6849 - acc: 0.5  
750 - recall: 0.5772 - precision: 0.7963  
Epoch 6/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6832 - acc: 0.5  
950 - recall: 0.6376 - precision: 0.7787  
Epoch 7/45  
2/2 [=====] - 0s 86ms/step - loss: 0.6819 - acc: 0.58  
50 - recall: 0.6376 - precision: 0.7661  
Epoch 8/45  
2/2 [=====] - 0s 100ms/step - loss: 0.6793 - acc: 0.6  
350 - recall: 0.6644 - precision: 0.8115  
Epoch 9/45  
2/2 [=====] - 0s 79ms/step - loss: 0.6831 - acc: 0.58  
50 - recall: 0.6040 - precision: 0.7895  
Epoch 10/45  
2/2 [=====] - 0s 125ms/step - loss: 0.6800 - acc: 0.5  
850 - recall: 0.5705 - precision: 0.8173  
Epoch 11/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6854 - acc: 0.63  
00 - recall: 0.6779 - precision: 0.7953  
Epoch 12/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6808 - acc: 0.61  
00 - recall: 0.6242 - precision: 0.8087  
Epoch 13/45  
2/2 [=====] - 0s 99ms/step - loss: 0.6820 - acc: 0.54  
50 - recall: 0.5101 - precision: 0.8085  
Epoch 14/45  
2/2 [=====] - 0s 90ms/step - loss: 0.6740 - acc: 0.61  
50 - recall: 0.5772 - precision: 0.8600  
Epoch 15/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6801 - acc: 0.51  
00 - recall: 0.4362 - precision: 0.8228  
Epoch 16/45  
2/2 [=====] - 0s 143ms/step - loss: 0.6739 - acc: 0.6  
350 - recall: 0.5973 - precision: 0.8725  
Epoch 17/45  
2/2 [=====] - 0s 120ms/step - loss: 0.6750 - acc: 0.6  
650 - recall: 0.6711 - precision: 0.8475  
Epoch 18/45  
2/2 [=====] - 0s 116ms/step - loss: 0.6756 - acc: 0.6  
700 - recall: 0.6913 - precision: 0.8374  
Epoch 19/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6777 - acc: 0.58  
00 - recall: 0.5168 - precision: 0.8652  
Epoch 20/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6770 - acc: 0.62  
50 - recall: 0.6376 - precision: 0.8190  
Epoch 21/45
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.6801 - acc: 0.61
50 - recall: 0.6174 - precision: 0.8214
Epoch 22/45
2/2 [=====] - 0s 128ms/step - loss: 0.6759 - acc: 0.6
650 - recall: 0.7181 - precision: 0.8106
Epoch 23/45
2/2 [=====] - 0s 96ms/step - loss: 0.6778 - acc: 0.62
50 - recall: 0.6174 - precision: 0.8364
Epoch 24/45
2/2 [=====] - 0s 76ms/step - loss: 0.6803 - acc: 0.55
00 - recall: 0.5235 - precision: 0.8041
Epoch 25/45
2/2 [=====] - 0s 104ms/step - loss: 0.6738 - acc: 0.6
450 - recall: 0.6309 - precision: 0.8545
Epoch 26/45
2/2 [=====] - 0s 92ms/step - loss: 0.6748 - acc: 0.74
00 - recall: 0.8255 - precision: 0.8255
Epoch 27/45
2/2 [=====] - 0s 98ms/step - loss: 0.6778 - acc: 0.65
00 - recall: 0.7114 - precision: 0.7970
Epoch 28/45
2/2 [=====] - 0s 94ms/step - loss: 0.6757 - acc: 0.65
50 - recall: 0.6711 - precision: 0.8333
Epoch 29/45
2/2 [=====] - 0s 90ms/step - loss: 0.6722 - acc: 0.70
50 - recall: 0.7383 - precision: 0.8462
Epoch 30/45
2/2 [=====] - 0s 89ms/step - loss: 0.6717 - acc: 0.74
00 - recall: 0.8054 - precision: 0.8392
Epoch 31/45
2/2 [=====] - 0s 111ms/step - loss: 0.6712 - acc: 0.7
300 - recall: 0.7651 - precision: 0.8571
Epoch 32/45
2/2 [=====] - 0s 89ms/step - loss: 0.6690 - acc: 0.66
00 - recall: 0.6711 - precision: 0.8403
Epoch 33/45
2/2 [=====] - 0s 90ms/step - loss: 0.6698 - acc: 0.64
00 - recall: 0.6040 - precision: 0.8738
Epoch 34/45
2/2 [=====] - 0s 97ms/step - loss: 0.6688 - acc: 0.74
00 - recall: 0.8188 - precision: 0.8299
Epoch 35/45
2/2 [=====] - 0s 89ms/step - loss: 0.6667 - acc: 0.73
00 - recall: 0.7584 - precision: 0.8626
Epoch 36/45
2/2 [=====] - 0s 99ms/step - loss: 0.6658 - acc: 0.68
50 - recall: 0.6376 - precision: 0.9135
Epoch 37/45
2/2 [=====] - 0s 84ms/step - loss: 0.6632 - acc: 0.75
50 - recall: 0.7584 - precision: 0.8968
Epoch 38/45
2/2 [=====] - 0s 89ms/step - loss: 0.6690 - acc: 0.63
50 - recall: 0.6040 - precision: 0.8654
Epoch 39/45
2/2 [=====] - 0s 88ms/step - loss: 0.6587 - acc: 0.70
50 - recall: 0.6846 - precision: 0.8947
Epoch 40/45
2/2 [=====] - 0s 97ms/step - loss: 0.6613 - acc: 0.62
50 - recall: 0.5705 - precision: 0.8854
Epoch 41/45
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6662 - acc: 0.64
00 - recall: 0.5973 - precision: 0.8812
Epoch 42/45
2/2 [=====] - 0s 88ms/step - loss: 0.6645 - acc: 0.71
50 - recall: 0.7315 - precision: 0.8651
Epoch 43/45
2/2 [=====] - 0s 86ms/step - loss: 0.6628 - acc: 0.66
50 - recall: 0.6577 - precision: 0.8596
Epoch 44/45
2/2 [=====] - 0s 84ms/step - loss: 0.6637 - acc: 0.68
50 - recall: 0.6577 - precision: 0.8909
Epoch 45/45
2/2 [=====] - 0s 88ms/step - loss: 0.6678 - acc: 0.56
00 - recall: 0.4899 - precision: 0.8588
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:46:33.955189: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 38ms/step
7/7 [=====] - 0s 26ms/step
Epoch 1/65
2023-03-31 16:46:34.849795: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 590ms/step - loss: 0.7403 - acc: 0.5  
750 - recall: 0.6966 - precision: 0.7113  
Epoch 2/65  
2/2 [=====] - 0s 179ms/step - loss: 0.7269 - acc: 0.2  
950 - recall: 0.0552 - precision: 0.6667  
Epoch 3/65  
2/2 [=====] - 0s 217ms/step - loss: 0.6933 - acc: 0.3  
600 - recall: 0.1310 - precision: 0.9048  
Epoch 4/65  
2/2 [=====] - 0s 178ms/step - loss: 0.6628 - acc: 0.4  
400 - recall: 0.2345 - precision: 0.9714  
Epoch 5/65  
2/2 [=====] - 0s 147ms/step - loss: 0.6150 - acc: 0.5  
700 - recall: 0.4345 - precision: 0.9403  
Epoch 6/65  
2/2 [=====] - 0s 166ms/step - loss: 0.5691 - acc: 0.7  
450 - recall: 0.7172 - precision: 0.9123  
Epoch 7/65  
2/2 [=====] - 0s 118ms/step - loss: 0.5439 - acc: 0.7  
700 - recall: 0.8552 - precision: 0.8322  
Epoch 8/65  
2/2 [=====] - 0s 77ms/step - loss: 0.4957 - acc: 0.81  
00 - recall: 0.8138 - precision: 0.9147  
Epoch 9/65  
2/2 [=====] - 0s 146ms/step - loss: 0.4489 - acc: 0.7  
850 - recall: 0.7448 - precision: 0.9474  
Epoch 10/65  
2/2 [=====] - 0s 108ms/step - loss: 0.3782 - acc: 0.8  
150 - recall: 0.7931 - precision: 0.9426  
Epoch 11/65  
2/2 [=====] - 0s 115ms/step - loss: 0.4082 - acc: 0.7  
850 - recall: 0.7448 - precision: 0.9474  
Epoch 12/65  
2/2 [=====] - 1s 148ms/step - loss: 0.3183 - acc: 0.8  
600 - recall: 0.8483 - precision: 0.9535  
Epoch 13/65  
2/2 [=====] - 0s 89ms/step - loss: 0.2802 - acc: 0.85  
50 - recall: 0.8207 - precision: 0.9754  
Epoch 14/65  
2/2 [=====] - 0s 105ms/step - loss: 0.2205 - acc: 0.8  
750 - recall: 0.8483 - precision: 0.9762  
Epoch 15/65  
2/2 [=====] - 0s 101ms/step - loss: 0.2734 - acc: 0.9  
100 - recall: 0.9241 - precision: 0.9504  
Epoch 16/65  
2/2 [=====] - 0s 105ms/step - loss: 0.1841 - acc: 0.9  
100 - recall: 0.8966 - precision: 0.9774  
Epoch 17/65  
2/2 [=====] - 0s 76ms/step - loss: 0.1804 - acc: 0.92  
50 - recall: 0.9034 - precision: 0.9924  
Epoch 18/65  
2/2 [=====] - 0s 103ms/step - loss: 0.2077 - acc: 0.9  
500 - recall: 0.9655 - precision: 0.9655  
Epoch 19/65  
2/2 [=====] - 0s 77ms/step - loss: 0.1688 - acc: 0.90  
50 - recall: 0.8690 - precision: 1.0000  
Epoch 20/65  
2/2 [=====] - 0s 93ms/step - loss: 0.1349 - acc: 0.94  
50 - recall: 0.9310 - precision: 0.9926  
Epoch 21/65
```

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2/2 [=====] - 0s 76ms/step - loss: 0.1173 - acc: 0.96
50 - recall: 0.9586 - precision: 0.9929
Epoch 22/65
2/2 [=====] - 0s 98ms/step - loss: 0.0897 - acc: 0.96
00 - recall: 0.9448 - precision: 1.0000
Epoch 23/65
2/2 [=====] - 0s 76ms/step - loss: 0.0947 - acc: 0.95
00 - recall: 0.9310 - precision: 1.0000
Epoch 24/65
2/2 [=====] - 0s 93ms/step - loss: 0.0527 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 25/65
2/2 [=====] - 0s 76ms/step - loss: 0.0602 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 26/65
2/2 [=====] - 0s 74ms/step - loss: 0.0585 - acc: 0.97
00 - recall: 0.9724 - precision: 0.9860
Epoch 27/65
2/2 [=====] - 0s 76ms/step - loss: 0.0329 - acc: 0.98
00 - recall: 0.9724 - precision: 1.0000
Epoch 28/65
2/2 [=====] - 0s 175ms/step - loss: 0.0405 - acc: 0.9
800 - recall: 0.9793 - precision: 0.9930
Epoch 29/65
2/2 [=====] - 0s 156ms/step - loss: 0.0199 - acc: 0.9
950 - recall: 0.9931 - precision: 1.0000
Epoch 30/65
2/2 [=====] - 0s 93ms/step - loss: 0.0157 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 31/65
2/2 [=====] - 0s 102ms/step - loss: 0.0283 - acc: 0.9
850 - recall: 0.9931 - precision: 0.9863
Epoch 32/65
2/2 [=====] - 0s 94ms/step - loss: 0.0260 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 33/65
2/2 [=====] - 0s 92ms/step - loss: 0.0461 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 34/65
2/2 [=====] - 0s 90ms/step - loss: 0.0479 - acc: 0.98
00 - recall: 0.9724 - precision: 1.0000
Epoch 35/65
2/2 [=====] - 0s 125ms/step - loss: 0.0171 - acc: 0.9
950 - recall: 0.9931 - precision: 1.0000
Epoch 36/65
2/2 [=====] - 0s 88ms/step - loss: 0.0248 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 37/65
2/2 [=====] - 0s 88ms/step - loss: 0.0140 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 38/65
2/2 [=====] - 0s 90ms/step - loss: 0.0106 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 39/65
2/2 [=====] - 0s 90ms/step - loss: 0.0074 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 40/65
2/2 [=====] - 0s 89ms/step - loss: 0.0135 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 41/65
```

```
2/2 [=====] - 0s 89ms/step - loss: 0.0130 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 42/65
2/2 [=====] - 0s 88ms/step - loss: 0.0195 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 43/65
2/2 [=====] - 0s 89ms/step - loss: 0.0071 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 44/65
2/2 [=====] - 0s 87ms/step - loss: 0.0081 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 45/65
2/2 [=====] - 0s 88ms/step - loss: 0.0210 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 46/65
2/2 [=====] - 0s 88ms/step - loss: 0.0089 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 47/65
2/2 [=====] - 0s 88ms/step - loss: 0.0063 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 48/65
2/2 [=====] - 0s 87ms/step - loss: 0.0081 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 49/65
2/2 [=====] - 0s 88ms/step - loss: 0.0042 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 50/65
2/2 [=====] - 0s 90ms/step - loss: 0.0042 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 51/65
2/2 [=====] - 0s 93ms/step - loss: 0.0010 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 52/65
2/2 [=====] - 0s 87ms/step - loss: 0.0074 - acc: 0.99
50 - recall: 0.9862 - precision: 1.0000
Epoch 53/65
2/2 [=====] - 0s 87ms/step - loss: 0.0049 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 54/65
2/2 [=====] - 0s 89ms/step - loss: 0.0022 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 55/65
2/2 [=====] - 0s 89ms/step - loss: 0.0027 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 56/65
2/2 [=====] - 0s 88ms/step - loss: 0.0021 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 57/65
2/2 [=====] - 0s 87ms/step - loss: 0.0015 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 58/65
2/2 [=====] - 0s 87ms/step - loss: 0.0013 - acc: 1.00
50 - recall: 1.0000 - precision: 1.0000
Epoch 59/65
2/2 [=====] - 0s 88ms/step - loss: 5.8449e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 60/65
2/2 [=====] - 0s 86ms/step - loss: 0.0074 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 61/65
```

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2/2 [=====] - 0s 86ms/step - loss: 0.0013 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 62/65
2/2 [=====] - 0s 87ms/step - loss: 6.0722e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 87ms/step - loss: 5.7431e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 64/65
2/2 [=====] - 0s 105ms/step - loss: 4.1701e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:46:52.617742: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 50ms/step
7/7 [=====] - 0s 34ms/step
Epoch 1/65
2023-03-31 16:46:54.204054: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 652ms/step - loss: 0.7232 - acc: 0.5  
600 - recall: 0.6284 - precision: 0.7381  
Epoch 2/65  
2/2 [=====] - 0s 212ms/step - loss: 0.7006 - acc: 0.3  
950 - recall: 0.2838 - precision: 0.7368  
Epoch 3/65  
2/2 [=====] - 0s 177ms/step - loss: 0.6888 - acc: 0.3  
900 - recall: 0.2230 - precision: 0.8250  
Epoch 4/65  
2/2 [=====] - 0s 160ms/step - loss: 0.6702 - acc: 0.5  
650 - recall: 0.4797 - precision: 0.8765  
Epoch 5/65  
2/2 [=====] - 0s 195ms/step - loss: 0.6388 - acc: 0.8  
050 - recall: 0.9324 - precision: 0.8263  
Epoch 6/65  
2/2 [=====] - 0s 112ms/step - loss: 0.5921 - acc: 0.6  
250 - recall: 0.5135 - precision: 0.9620  
Epoch 7/65  
2/2 [=====] - 0s 144ms/step - loss: 0.5005 - acc: 0.8  
000 - recall: 0.8243 - precision: 0.8971  
Epoch 8/65  
2/2 [=====] - 0s 101ms/step - loss: 0.4643 - acc: 0.7  
650 - recall: 0.7162 - precision: 0.9550  
Epoch 9/65  
2/2 [=====] - 0s 206ms/step - loss: 0.4238 - acc: 0.8  
200 - recall: 0.8311 - precision: 0.9179  
Epoch 10/65  
2/2 [=====] - 0s 116ms/step - loss: 0.3725 - acc: 0.8  
250 - recall: 0.7905 - precision: 0.9669  
Epoch 11/65  
2/2 [=====] - 0s 96ms/step - loss: 0.3284 - acc: 0.82  
00 - recall: 0.7770 - precision: 0.9746  
Epoch 12/65  
2/2 [=====] - 0s 141ms/step - loss: 0.3050 - acc: 0.8  
450 - recall: 0.8041 - precision: 0.9835  
Epoch 13/65  
2/2 [=====] - 0s 77ms/step - loss: 0.2829 - acc: 0.88  
00 - recall: 0.8649 - precision: 0.9697  
Epoch 14/65  
2/2 [=====] - 0s 156ms/step - loss: 0.2715 - acc: 0.8  
500 - recall: 0.8041 - precision: 0.9917  
Epoch 15/65  
2/2 [=====] - 0s 132ms/step - loss: 0.2315 - acc: 0.8  
850 - recall: 0.8581 - precision: 0.9845  
Epoch 16/65  
2/2 [=====] - 0s 74ms/step - loss: 0.1759 - acc: 0.93  
00 - recall: 0.9189 - precision: 0.9855  
Epoch 17/65  
2/2 [=====] - 0s 99ms/step - loss: 0.1396 - acc: 0.92  
00 - recall: 0.8919 - precision: 1.0000  
Epoch 18/65  
2/2 [=====] - 0s 77ms/step - loss: 0.1053 - acc: 0.95  
50 - recall: 0.9392 - precision: 1.0000  
Epoch 19/65  
2/2 [=====] - 0s 74ms/step - loss: 0.1740 - acc: 0.92  
50 - recall: 0.9324 - precision: 0.9650  
Epoch 20/65  
2/2 [=====] - 0s 75ms/step - loss: 0.1275 - acc: 0.95  
50 - recall: 0.9662 - precision: 0.9728  
Epoch 21/65
```

```
2/2 [=====] - 0s 107ms/step - loss: 0.0856 - acc: 0.9  
650 - recall: 0.9527 - precision: 1.0000  
Epoch 22/65  
2/2 [=====] - 0s 76ms/step - loss: 0.0931 - acc: 0.95  
50 - recall: 0.9392 - precision: 1.0000  
Epoch 23/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0632 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 24/65  
2/2 [=====] - 0s 98ms/step - loss: 0.0653 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 25/65  
2/2 [=====] - 0s 77ms/step - loss: 0.0447 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 26/65  
2/2 [=====] - 1s 465ms/step - loss: 0.0476 - acc: 0.9  
800 - recall: 0.9730 - precision: 1.0000  
Epoch 27/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0342 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 28/65  
2/2 [=====] - 0s 76ms/step - loss: 0.0413 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 29/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0666 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 30/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0680 - acc: 0.98  
00 - recall: 0.9932 - precision: 0.9800  
Epoch 31/65  
2/2 [=====] - 0s 81ms/step - loss: 0.0336 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 32/65  
2/2 [=====] - 0s 81ms/step - loss: 0.0418 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 33/65  
2/2 [=====] - 0s 96ms/step - loss: 0.0302 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 34/65  
2/2 [=====] - 0s 105ms/step - loss: 0.0244 - acc: 0.9  
900 - recall: 0.9865 - precision: 1.0000  
Epoch 35/65  
2/2 [=====] - 0s 108ms/step - loss: 0.0255 - acc: 0.9  
950 - recall: 0.9932 - precision: 1.0000  
Epoch 36/65  
2/2 [=====] - 0s 92ms/step - loss: 0.0183 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 37/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0213 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 38/65  
2/2 [=====] - 0s 92ms/step - loss: 0.0101 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 39/65  
2/2 [=====] - 0s 90ms/step - loss: 0.0075 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 40/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0101 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 41/65
```

```
2/2 [=====] - 0s 126ms/step - loss: 0.0104 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 42/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0065 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 43/65  
2/2 [=====] - 0s 92ms/step - loss: 0.0151 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 44/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0055 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 45/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0047 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 46/65  
2/2 [=====] - 0s 110ms/step - loss: 0.0016 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 47/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0035 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 48/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0103 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 49/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0685 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9867  
Epoch 50/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0944 - acc: 0.97  
00 - recall: 0.9595 - precision: 1.0000  
Epoch 51/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0879 - acc: 0.98  
00 - recall: 0.9865 - precision: 0.9865  
Epoch 52/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0276 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 53/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0653 - acc: 0.98  
00 - recall: 0.9932 - precision: 0.9800  
Epoch 54/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0623 - acc: 0.95  
00 - recall: 0.9324 - precision: 1.0000  
Epoch 55/65  
2/2 [=====] - 0s 97ms/step - loss: 0.0436 - acc: 0.97  
00 - recall: 0.9595 - precision: 1.0000  
Epoch 56/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0287 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 57/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0170 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 58/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0243 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 59/65  
2/2 [=====] - 0s 106ms/step - loss: 0.0206 - acc: 0.9950  
recall: 1.0000 - precision: 0.9933  
Epoch 60/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0049 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 61/65
```

```
2/2 [=====] - 0s 87ms/step - loss: 0.0075 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 62/65
2/2 [=====] - 0s 88ms/step - loss: 0.0030 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 89ms/step - loss: 0.0122 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 64/65
2/2 [=====] - 0s 87ms/step - loss: 0.0028 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 65/65
2/2 [=====] - 0s 87ms/step - loss: 0.0038 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:47:12.299078: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 43ms/step
7/7 [=====] - 0s 37ms/step
Epoch 1/65
2023-03-31 16:47:13.270564: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 811ms/step - loss: 0.7058 - acc: 0.5  
850 - recall: 0.6577 - precision: 0.7538  
Epoch 2/65  
2/2 [=====] - 0s 174ms/step - loss: 0.6895 - acc: 0.3  
800 - recall: 0.1946 - precision: 0.8788  
Epoch 3/65  
2/2 [=====] - 0s 174ms/step - loss: 0.6739 - acc: 0.7  
650 - recall: 0.9463 - precision: 0.7833  
Epoch 4/65  
2/2 [=====] - 0s 163ms/step - loss: 0.6314 - acc: 0.7  
000 - recall: 0.6846 - precision: 0.8870  
Epoch 5/65  
2/2 [=====] - 0s 154ms/step - loss: 0.5786 - acc: 0.7  
700 - recall: 0.8456 - precision: 0.8456  
Epoch 6/65  
2/2 [=====] - 0s 176ms/step - loss: 0.4941 - acc: 0.7  
350 - recall: 0.6711 - precision: 0.9615  
Epoch 7/65  
2/2 [=====] - 0s 171ms/step - loss: 0.4882 - acc: 0.8  
150 - recall: 0.8859 - precision: 0.8684  
Epoch 8/65  
2/2 [=====] - 0s 97ms/step - loss: 0.3874 - acc: 0.83  
00 - recall: 0.8188 - precision: 0.9457  
Epoch 9/65  
2/2 [=====] - 0s 135ms/step - loss: 0.4102 - acc: 0.8  
050 - recall: 0.7584 - precision: 0.9741  
Epoch 10/65  
2/2 [=====] - 0s 110ms/step - loss: 0.3109 - acc: 0.8  
650 - recall: 0.8523 - precision: 0.9621  
Epoch 11/65  
2/2 [=====] - 0s 106ms/step - loss: 0.2734 - acc: 0.8  
800 - recall: 0.8591 - precision: 0.9771  
Epoch 12/65  
2/2 [=====] - 0s 75ms/step - loss: 0.2710 - acc: 0.86  
50 - recall: 0.8591 - precision: 0.9552  
Epoch 13/65  
2/2 [=====] - 0s 154ms/step - loss: 0.2080 - acc: 0.9  
200 - recall: 0.9262 - precision: 0.9650  
Epoch 14/65  
2/2 [=====] - 0s 99ms/step - loss: 0.2134 - acc: 0.89  
50 - recall: 0.8658 - precision: 0.9923  
Epoch 15/65  
2/2 [=====] - 0s 77ms/step - loss: 0.2157 - acc: 0.93  
50 - recall: 0.9597 - precision: 0.9533  
Epoch 16/65  
2/2 [=====] - 0s 118ms/step - loss: 0.1608 - acc: 0.9  
450 - recall: 0.9329 - precision: 0.9929  
Epoch 17/65  
2/2 [=====] - 0s 76ms/step - loss: 0.1792 - acc: 0.91  
50 - recall: 0.8993 - precision: 0.9853  
Epoch 18/65  
2/2 [=====] - 0s 116ms/step - loss: 0.1701 - acc: 0.9  
300 - recall: 0.9530 - precision: 0.9530  
Epoch 19/65  
2/2 [=====] - 0s 90ms/step - loss: 0.0915 - acc: 0.96  
00 - recall: 0.9463 - precision: 1.0000  
Epoch 20/65  
2/2 [=====] - 0s 100ms/step - loss: 0.0768 - acc: 0.9  
750 - recall: 0.9664 - precision: 1.0000  
Epoch 21/65
```

```
2/2 [=====] - 0s 99ms/step - loss: 0.1048 - acc: 0.96
00 - recall: 0.9799 - precision: 0.9669
Epoch 22/65
2/2 [=====] - 0s 76ms/step - loss: 0.0807 - acc: 0.96
50 - recall: 0.9664 - precision: 0.9863
Epoch 23/65
2/2 [=====] - 0s 85ms/step - loss: 0.1002 - acc: 0.96
50 - recall: 0.9530 - precision: 1.0000
Epoch 24/65
2/2 [=====] - 0s 75ms/step - loss: 0.0767 - acc: 0.96
00 - recall: 0.9463 - precision: 1.0000
Epoch 25/65
2/2 [=====] - 0s 117ms/step - loss: 0.0931 - acc: 0.9
700 - recall: 0.9732 - precision: 0.9864
Epoch 26/65
2/2 [=====] - 0s 76ms/step - loss: 0.0699 - acc: 0.97
50 - recall: 0.9664 - precision: 1.0000
Epoch 27/65
2/2 [=====] - 0s 81ms/step - loss: 0.0471 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 28/65
2/2 [=====] - 0s 85ms/step - loss: 0.0554 - acc: 0.99
00 - recall: 0.9933 - precision: 0.9933
Epoch 29/65
2/2 [=====] - 0s 101ms/step - loss: 0.0325 - acc: 0.9
800 - recall: 0.9732 - precision: 1.0000
Epoch 30/65
2/2 [=====] - 0s 97ms/step - loss: 0.0265 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 31/65
2/2 [=====] - 0s 93ms/step - loss: 0.0199 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 32/65
2/2 [=====] - 0s 86ms/step - loss: 0.0189 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 33/65
2/2 [=====] - 0s 289ms/step - loss: 0.0201 - acc: 0.9
850 - recall: 0.9799 - precision: 1.0000
Epoch 34/65
2/2 [=====] - 0s 78ms/step - loss: 0.0098 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 35/65
2/2 [=====] - 0s 76ms/step - loss: 0.0227 - acc: 0.99
00 - recall: 0.9933 - precision: 0.9933
Epoch 36/65
2/2 [=====] - 0s 98ms/step - loss: 0.0143 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 37/65
2/2 [=====] - 0s 90ms/step - loss: 0.0125 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 38/65
2/2 [=====] - 0s 286ms/step - loss: 0.0158 - acc: 0.9
950 - recall: 0.9933 - precision: 1.0000
Epoch 39/65
2/2 [=====] - 0s 92ms/step - loss: 0.0112 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 40/65
2/2 [=====] - 0s 89ms/step - loss: 0.0106 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 41/65
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.0085 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 42/65  
2/2 [=====] - 0s 90ms/step - loss: 0.0091 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 43/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0055 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 44/65  
2/2 [=====] - 0s 134ms/step - loss: 0.0029 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 45/65  
2/2 [=====] - 0s 85ms/step - loss: 0.0135 - acc: 0.9950 -  
recall: 1.0000 - precision: 0.9933  
Epoch 46/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0062 - acc: 0.9950 -  
recall: 0.9933 - precision: 1.0000  
Epoch 47/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0166 - acc: 0.9950 -  
recall: 0.9933 - precision: 1.0000  
Epoch 48/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0077 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 49/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0055 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 50/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0047 - acc: 0.9950 -  
recall: 0.9933 - precision: 1.0000  
Epoch 51/65  
2/2 [=====] - 0s 88ms/step - loss: 0.0068 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 52/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0103 - acc: 0.9950 -  
recall: 0.9933 - precision: 1.0000  
Epoch 53/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0037 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 54/65  
2/2 [=====] - 0s 88ms/step - loss: 7.9553e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 55/65  
2/2 [=====] - 0s 87ms/step - loss: 3.5307e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 56/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0030 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 57/65  
2/2 [=====] - 0s 94ms/step - loss: 0.0035 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 58/65  
2/2 [=====] - 0s 98ms/step - loss: 0.0031 - acc: 1.0000 -  
recall: 1.0000 - precision: 1.0000  
Epoch 59/65  
2/2 [=====] - 0s 124ms/step - loss: 0.0040 - acc: 0.9950 -  
recall: 0.9933 - precision: 1.0000  
Epoch 60/65  
2/2 [=====] - 0s 86ms/step - loss: 9.4963e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 61/65
```

```
2/2 [=====] - 0s 87ms/step - loss: 4.6834e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 62/65
2/2 [=====] - 0s 89ms/step - loss: 0.0014 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 90ms/step - loss: 4.9537e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 64/65
2/2 [=====] - 0s 88ms/step - loss: 5.5866e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 65/65
2/2 [=====] - 0s 86ms/step - loss: 5.1389e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:47:31.519000: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 50ms/step
7/7 [=====] - 0s 28ms/step
Epoch 1/65
2023-03-31 16:47:32.497721: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 642ms/step - loss: 0.7032 - acc: 0.5
850 - recall: 0.6966 - precision: 0.7214
Epoch 2/65
2/2 [=====] - 0s 152ms/step - loss: 0.7018 - acc: 0.5
250 - recall: 0.5310 - precision: 0.7404
Epoch 3/65
2/2 [=====] - 0s 216ms/step - loss: 0.6993 - acc: 0.5
300 - recall: 0.4552 - precision: 0.8148
Epoch 4/65
2/2 [=====] - 1s 138ms/step - loss: 0.6984 - acc: 0.5
250 - recall: 0.4552 - precision: 0.8049
Epoch 5/65
2/2 [=====] - 0s 134ms/step - loss: 0.7023 - acc: 0.4
400 - recall: 0.3379 - precision: 0.7538
Epoch 6/65
2/2 [=====] - 0s 153ms/step - loss: 0.7010 - acc: 0.4
100 - recall: 0.2690 - precision: 0.7647
Epoch 7/65
2/2 [=====] - 0s 141ms/step - loss: 0.6957 - acc: 0.4
750 - recall: 0.3310 - precision: 0.8571
Epoch 8/65
2/2 [=====] - 0s 117ms/step - loss: 0.6983 - acc: 0.4
350 - recall: 0.2828 - precision: 0.8200
Epoch 9/65
2/2 [=====] - 0s 189ms/step - loss: 0.6962 - acc: 0.4
400 - recall: 0.3034 - precision: 0.8000
Epoch 10/65
2/2 [=====] - 0s 99ms/step - loss: 0.6986 - acc: 0.42
50 - recall: 0.2621 - precision: 0.8261
Epoch 11/65
2/2 [=====] - 0s 132ms/step - loss: 0.7004 - acc: 0.3
850 - recall: 0.2138 - precision: 0.7750
Epoch 12/65
2/2 [=====] - 0s 100ms/step - loss: 0.6960 - acc: 0.4
900 - recall: 0.3724 - precision: 0.8308
Epoch 13/65
2/2 [=====] - 0s 95ms/step - loss: 0.6986 - acc: 0.41
00 - recall: 0.2552 - precision: 0.7872
Epoch 14/65
2/2 [=====] - 0s 99ms/step - loss: 0.6975 - acc: 0.39
00 - recall: 0.2207 - precision: 0.7805
Epoch 15/65
2/2 [=====] - 0s 129ms/step - loss: 0.6958 - acc: 0.3
900 - recall: 0.2621 - precision: 0.7170
Epoch 16/65
2/2 [=====] - 0s 75ms/step - loss: 0.6935 - acc: 0.43
00 - recall: 0.2483 - precision: 0.8780
Epoch 17/65
2/2 [=====] - 0s 124ms/step - loss: 0.6928 - acc: 0.4
300 - recall: 0.2483 - precision: 0.8780
Epoch 18/65
2/2 [=====] - 0s 84ms/step - loss: 0.6961 - acc: 0.41
50 - recall: 0.2138 - precision: 0.9118
Epoch 19/65
2/2 [=====] - 0s 75ms/step - loss: 0.6912 - acc: 0.41
00 - recall: 0.2000 - precision: 0.9355
Epoch 20/65
2/2 [=====] - 0s 74ms/step - loss: 0.6934 - acc: 0.39
00 - recall: 0.2207 - precision: 0.7805
Epoch 21/65
```

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2/2 [=====] - 0s 76ms/step - loss: 0.6935 - acc: 0.46
00 - recall: 0.3034 - precision: 0.8627
Epoch 22/65
2/2 [=====] - 0s 79ms/step - loss: 0.6902 - acc: 0.44
50 - recall: 0.2552 - precision: 0.9250
Epoch 23/65
2/2 [=====] - 0s 75ms/step - loss: 0.6938 - acc: 0.37
00 - recall: 0.1724 - precision: 0.8065
Epoch 24/65
2/2 [=====] - 0s 74ms/step - loss: 0.6917 - acc: 0.35
50 - recall: 0.1448 - precision: 0.8077
Epoch 25/65
2/2 [=====] - 0s 93ms/step - loss: 0.6918 - acc: 0.45
00 - recall: 0.2621 - precision: 0.9268
Epoch 26/65
2/2 [=====] - 0s 77ms/step - loss: 0.6958 - acc: 0.39
50 - recall: 0.2138 - precision: 0.8158
Epoch 27/65
2/2 [=====] - 0s 96ms/step - loss: 0.6922 - acc: 0.42
50 - recall: 0.2621 - precision: 0.8261
Epoch 28/65
2/2 [=====] - 0s 87ms/step - loss: 0.6902 - acc: 0.46
00 - recall: 0.2828 - precision: 0.9111
Epoch 29/65
2/2 [=====] - 0s 104ms/step - loss: 0.6886 - acc: 0.4
950 - recall: 0.3310 - precision: 0.9231
Epoch 30/65
2/2 [=====] - 0s 103ms/step - loss: 0.6880 - acc: 0.4
450 - recall: 0.2621 - precision: 0.9048
Epoch 31/65
2/2 [=====] - 0s 135ms/step - loss: 0.6868 - acc: 0.4
850 - recall: 0.3172 - precision: 0.9200
Epoch 32/65
2/2 [=====] - 0s 105ms/step - loss: 0.6873 - acc: 0.4
150 - recall: 0.2138 - precision: 0.9118
Epoch 33/65
2/2 [=====] - 0s 93ms/step - loss: 0.6843 - acc: 0.50
50 - recall: 0.3448 - precision: 0.9259
Epoch 34/65
2/2 [=====] - 0s 94ms/step - loss: 0.6841 - acc: 0.48
50 - recall: 0.3034 - precision: 0.9565
Epoch 35/65
2/2 [=====] - 0s 95ms/step - loss: 0.6853 - acc: 0.41
00 - recall: 0.2138 - precision: 0.8857
Epoch 36/65
2/2 [=====] - 0s 105ms/step - loss: 0.6899 - acc: 0.4
050 - recall: 0.2207 - precision: 0.8421
Epoch 37/65
2/2 [=====] - 0s 91ms/step - loss: 0.6849 - acc: 0.37
50 - recall: 0.1655 - precision: 0.8571
Epoch 38/65
2/2 [=====] - 0s 91ms/step - loss: 0.6807 - acc: 0.50
50 - recall: 0.3586 - precision: 0.8966
Epoch 39/65
2/2 [=====] - 0s 91ms/step - loss: 0.6824 - acc: 0.54
50 - recall: 0.4138 - precision: 0.9091
Epoch 40/65
2/2 [=====] - 0s 90ms/step - loss: 0.6757 - acc: 0.66
00 - recall: 0.5862 - precision: 0.9140
Epoch 41/65
```

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2/2 [=====] - 0s 90ms/step - loss: 0.6786 - acc: 0.53
50 - recall: 0.3931 - precision: 0.9194
Epoch 42/65
2/2 [=====] - 0s 91ms/step - loss: 0.6773 - acc: 0.50
00 - recall: 0.3379 - precision: 0.9245
Epoch 43/65
2/2 [=====] - 0s 172ms/step - loss: 0.6803 - acc: 0.6
000 - recall: 0.5241 - precision: 0.8736
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.6800 - acc: 0.53
00 - recall: 0.3655 - precision: 0.9636
Epoch 45/65
2/2 [=====] - 0s 92ms/step - loss: 0.6707 - acc: 0.62
50 - recall: 0.5172 - precision: 0.9375
Epoch 46/65
2/2 [=====] - 0s 91ms/step - loss: 0.6800 - acc: 0.51
50 - recall: 0.4207 - precision: 0.8243
Epoch 47/65
2/2 [=====] - 0s 90ms/step - loss: 0.6782 - acc: 0.63
00 - recall: 0.5379 - precision: 0.9176
Epoch 48/65
2/2 [=====] - 0s 89ms/step - loss: 0.6788 - acc: 0.50
50 - recall: 0.4000 - precision: 0.8286
Epoch 49/65
2/2 [=====] - 0s 89ms/step - loss: 0.6726 - acc: 0.65
00 - recall: 0.6207 - precision: 0.8571
Epoch 50/65
2/2 [=====] - 0s 96ms/step - loss: 0.6791 - acc: 0.60
50 - recall: 0.5448 - precision: 0.8587
Epoch 51/65
2/2 [=====] - 0s 88ms/step - loss: 0.6737 - acc: 0.61
00 - recall: 0.4966 - precision: 0.9351
Epoch 52/65
2/2 [=====] - 0s 91ms/step - loss: 0.6668 - acc: 0.66
50 - recall: 0.6000 - precision: 0.9062
Epoch 53/65
2/2 [=====] - 0s 89ms/step - loss: 0.6701 - acc: 0.63
00 - recall: 0.5379 - precision: 0.9176
Epoch 54/65
2/2 [=====] - 0s 88ms/step - loss: 0.6712 - acc: 0.49
50 - recall: 0.3241 - precision: 0.9400
Epoch 55/65
2/2 [=====] - 0s 88ms/step - loss: 0.6687 - acc: 0.72
00 - recall: 0.7448 - precision: 0.8504
Epoch 56/65
2/2 [=====] - 0s 89ms/step - loss: 0.6636 - acc: 0.66
50 - recall: 0.5793 - precision: 0.9333
Epoch 57/65
2/2 [=====] - 0s 88ms/step - loss: 0.6594 - acc: 0.73
00 - recall: 0.6966 - precision: 0.9099
Epoch 58/65
2/2 [=====] - 0s 89ms/step - loss: 0.6644 - acc: 0.70
00 - recall: 0.6345 - precision: 0.9293
Epoch 59/65
2/2 [=====] - 0s 89ms/step - loss: 0.6611 - acc: 0.56
00 - recall: 0.4138 - precision: 0.9524
Epoch 60/65
2/2 [=====] - 0s 90ms/step - loss: 0.6674 - acc: 0.76
50 - recall: 0.8552 - precision: 0.8267
Epoch 61/65
```

```
2/2 [=====] - 0s 87ms/step - loss: 0.6627 - acc: 0.51
00 - recall: 0.3310 - precision: 0.9796
Epoch 62/65
2/2 [=====] - 0s 87ms/step - loss: 0.6567 - acc: 0.74
00 - recall: 0.7379 - precision: 0.8843
Epoch 63/65
2/2 [=====] - 0s 89ms/step - loss: 0.6529 - acc: 0.69
00 - recall: 0.6414 - precision: 0.9029
Epoch 64/65
2/2 [=====] - 0s 89ms/step - loss: 0.6565 - acc: 0.76
00 - recall: 0.7448 - precision: 0.9076
Epoch 65/65
2/2 [=====] - 0s 88ms/step - loss: 0.6583 - acc: 0.63
50 - recall: 0.6069 - precision: 0.8462
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:47:50.768550: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 56ms/step
7/7 [=====] - 0s 28ms/step
Epoch 1/65
2023-03-31 16:47:51.744399: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 633ms/step - loss: 0.6936 - acc: 0.5  
600 - recall: 0.6757 - precision: 0.7143  
Epoch 2/65  
2/2 [=====] - 0s 178ms/step - loss: 0.6911 - acc: 0.5  
150 - recall: 0.5473 - precision: 0.7297  
Epoch 3/65  
2/2 [=====] - 0s 129ms/step - loss: 0.6892 - acc: 0.5  
150 - recall: 0.5068 - precision: 0.7576  
Epoch 4/65  
2/2 [=====] - 0s 156ms/step - loss: 0.6874 - acc: 0.6  
300 - recall: 0.6689 - precision: 0.7984  
Epoch 5/65  
2/2 [=====] - 0s 142ms/step - loss: 0.6875 - acc: 0.6  
250 - recall: 0.7095 - precision: 0.7664  
Epoch 6/65  
2/2 [=====] - 0s 110ms/step - loss: 0.6858 - acc: 0.5  
350 - recall: 0.5000 - precision: 0.7957  
Epoch 7/65  
2/2 [=====] - 0s 197ms/step - loss: 0.6854 - acc: 0.6  
050 - recall: 0.5405 - precision: 0.8791  
Epoch 8/65  
2/2 [=====] - 1s 172ms/step - loss: 0.6857 - acc: 0.5  
550 - recall: 0.5000 - precision: 0.8315  
Epoch 9/65  
2/2 [=====] - 0s 132ms/step - loss: 0.6885 - acc: 0.5  
850 - recall: 0.6284 - precision: 0.7686  
Epoch 10/65  
2/2 [=====] - 0s 132ms/step - loss: 0.6863 - acc: 0.6  
350 - recall: 0.6757 - precision: 0.8000  
Epoch 11/65  
2/2 [=====] - 0s 132ms/step - loss: 0.6847 - acc: 0.6  
300 - recall: 0.6486 - precision: 0.8136  
Epoch 12/65  
2/2 [=====] - 0s 145ms/step - loss: 0.6835 - acc: 0.5  
850 - recall: 0.5676 - precision: 0.8155  
Epoch 13/65  
2/2 [=====] - 0s 153ms/step - loss: 0.6824 - acc: 0.6  
600 - recall: 0.6284 - precision: 0.8774  
Epoch 14/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6866 - acc: 0.53  
00 - recall: 0.5068 - precision: 0.7812  
Epoch 15/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6863 - acc: 0.60  
50 - recall: 0.6351 - precision: 0.7899  
Epoch 16/65  
2/2 [=====] - 0s 97ms/step - loss: 0.6847 - acc: 0.57  
00 - recall: 0.5068 - precision: 0.8523  
Epoch 17/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6837 - acc: 0.52  
00 - recall: 0.4459 - precision: 0.8250  
Epoch 18/65  
2/2 [=====] - 0s 131ms/step - loss: 0.6815 - acc: 0.5  
950 - recall: 0.5541 - precision: 0.8454  
Epoch 19/65  
2/2 [=====] - 0s 92ms/step - loss: 0.6803 - acc: 0.59  
50 - recall: 0.5405 - precision: 0.8602  
Epoch 20/65  
2/2 [=====] - 0s 120ms/step - loss: 0.6835 - acc: 0.5  
250 - recall: 0.4459 - precision: 0.8354  
Epoch 21/65
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.6776 - acc: 0.64
50 - recall: 0.6216 - precision: 0.8598
Epoch 22/65
2/2 [=====] - 0s 86ms/step - loss: 0.6799 - acc: 0.68
00 - recall: 0.7635 - precision: 0.7958
Epoch 23/65
2/2 [=====] - 0s 75ms/step - loss: 0.6817 - acc: 0.57
50 - recall: 0.5405 - precision: 0.8247
Epoch 24/65
2/2 [=====] - 0s 95ms/step - loss: 0.6777 - acc: 0.67
00 - recall: 0.6554 - precision: 0.8661
Epoch 25/65
2/2 [=====] - 0s 75ms/step - loss: 0.6754 - acc: 0.68
00 - recall: 0.6689 - precision: 0.8684
Epoch 26/65
2/2 [=====] - 0s 75ms/step - loss: 0.6752 - acc: 0.61
50 - recall: 0.5608 - precision: 0.8737
Epoch 27/65
2/2 [=====] - 0s 84ms/step - loss: 0.6780 - acc: 0.58
00 - recall: 0.5270 - precision: 0.8478
Epoch 28/65
2/2 [=====] - 0s 96ms/step - loss: 0.6759 - acc: 0.63
50 - recall: 0.6284 - precision: 0.8378
Epoch 29/65
2/2 [=====] - 0s 103ms/step - loss: 0.6690 - acc: 0.7
250 - recall: 0.7027 - precision: 0.9043
Epoch 30/65
2/2 [=====] - 0s 95ms/step - loss: 0.6775 - acc: 0.62
00 - recall: 0.6351 - precision: 0.8103
Epoch 31/65
2/2 [=====] - 0s 99ms/step - loss: 0.6755 - acc: 0.64
50 - recall: 0.6081 - precision: 0.8738
Epoch 32/65
2/2 [=====] - 0s 131ms/step - loss: 0.6722 - acc: 0.7
450 - recall: 0.7838 - precision: 0.8593
Epoch 33/65
2/2 [=====] - 0s 94ms/step - loss: 0.6702 - acc: 0.63
50 - recall: 0.5811 - precision: 0.8866
Epoch 34/65
2/2 [=====] - 0s 96ms/step - loss: 0.6768 - acc: 0.65
00 - recall: 0.6892 - precision: 0.8095
Epoch 35/65
2/2 [=====] - 0s 104ms/step - loss: 0.6679 - acc: 0.5
800 - recall: 0.5000 - precision: 0.8810
Epoch 36/65
2/2 [=====] - 0s 127ms/step - loss: 0.6694 - acc: 0.6
350 - recall: 0.5946 - precision: 0.8713
Epoch 37/65
2/2 [=====] - 0s 90ms/step - loss: 0.6752 - acc: 0.66
00 - recall: 0.6419 - precision: 0.8636
Epoch 38/65
2/2 [=====] - 0s 96ms/step - loss: 0.6729 - acc: 0.65
50 - recall: 0.6216 - precision: 0.8762
Epoch 39/65
2/2 [=====] - 0s 93ms/step - loss: 0.6665 - acc: 0.66
50 - recall: 0.6216 - precision: 0.8932
Epoch 40/65
2/2 [=====] - 0s 94ms/step - loss: 0.6642 - acc: 0.68
00 - recall: 0.6419 - precision: 0.8962
Epoch 41/65
```

```
2/2 [=====] - 0s 90ms/step - loss: 0.6716 - acc: 0.61
50 - recall: 0.5878 - precision: 0.8447
Epoch 42/65
2/2 [=====] - 0s 86ms/step - loss: 0.6680 - acc: 0.74
50 - recall: 0.7635 - precision: 0.8760
Epoch 43/65
2/2 [=====] - 0s 90ms/step - loss: 0.6654 - acc: 0.72
50 - recall: 0.7027 - precision: 0.9043
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.6700 - acc: 0.58
00 - recall: 0.5338 - precision: 0.8404
Epoch 45/65
2/2 [=====] - 0s 90ms/step - loss: 0.6598 - acc: 0.64
00 - recall: 0.5743 - precision: 0.9043
Epoch 46/65
2/2 [=====] - 0s 104ms/step - loss: 0.6552 - acc: 0.7
300 - recall: 0.7162 - precision: 0.8983
Epoch 47/65
2/2 [=====] - 0s 88ms/step - loss: 0.6666 - acc: 0.62
50 - recall: 0.5541 - precision: 0.9011
Epoch 48/65
2/2 [=====] - 0s 207ms/step - loss: 0.6565 - acc: 0.7
650 - recall: 0.7703 - precision: 0.8976
Epoch 49/65
2/2 [=====] - 0s 87ms/step - loss: 0.6574 - acc: 0.74
00 - recall: 0.7635 - precision: 0.8692
Epoch 50/65
2/2 [=====] - 0s 91ms/step - loss: 0.6494 - acc: 0.79
50 - recall: 0.8243 - precision: 0.8905
Epoch 51/65
2/2 [=====] - 0s 136ms/step - loss: 0.6584 - acc: 0.7
400 - recall: 0.7703 - precision: 0.8636
Epoch 52/65
2/2 [=====] - 0s 86ms/step - loss: 0.6574 - acc: 0.69
50 - recall: 0.6689 - precision: 0.8919
Epoch 53/65
2/2 [=====] - 0s 88ms/step - loss: 0.6472 - acc: 0.72
00 - recall: 0.6959 - precision: 0.9035
Epoch 54/65
2/2 [=====] - 0s 90ms/step - loss: 0.6418 - acc: 0.74
50 - recall: 0.7230 - precision: 0.9145
Epoch 55/65
2/2 [=====] - 0s 90ms/step - loss: 0.6462 - acc: 0.70
50 - recall: 0.6824 - precision: 0.8938
Epoch 56/65
2/2 [=====] - 0s 88ms/step - loss: 0.6429 - acc: 0.66
50 - recall: 0.6014 - precision: 0.9175
Epoch 57/65
2/2 [=====] - 0s 89ms/step - loss: 0.6549 - acc: 0.74
50 - recall: 0.7635 - precision: 0.8760
Epoch 58/65
2/2 [=====] - 0s 90ms/step - loss: 0.6537 - acc: 0.49
00 - recall: 0.3311 - precision: 0.9423
Epoch 59/65
2/2 [=====] - 0s 89ms/step - loss: 0.6366 - acc: 0.81
50 - recall: 0.8716 - precision: 0.8776
Epoch 60/65
2/2 [=====] - 0s 89ms/step - loss: 0.6300 - acc: 0.74
50 - recall: 0.6959 - precision: 0.9450
Epoch 61/65
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6389 - acc: 0.76
00 - recall: 0.7635 - precision: 0.8968
Epoch 62/65
2/2 [=====] - 0s 86ms/step - loss: 0.6252 - acc: 0.80
00 - recall: 0.8108 - precision: 0.9091
Epoch 63/65
2/2 [=====] - 0s 87ms/step - loss: 0.6200 - acc: 0.83
00 - recall: 0.8581 - precision: 0.9071
Epoch 64/65
2/2 [=====] - 0s 103ms/step - loss: 0.6311 - acc: 0.5
800 - recall: 0.4730 - precision: 0.9211
Epoch 65/65
2/2 [=====] - 0s 86ms/step - loss: 0.6144 - acc: 0.76
00 - recall: 0.7365 - precision: 0.9237
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:48:10.233526: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 58ms/step
7/7 [=====] - 0s 37ms/step
Epoch 1/65
2023-03-31 16:48:11.594145: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 709ms/step - loss: 0.6864 - acc: 0.5
500 - recall: 0.6040 - precision: 0.7438
Epoch 2/65
2/2 [=====] - 0s 192ms/step - loss: 0.6882 - acc: 0.5
550 - recall: 0.6107 - precision: 0.7459
Epoch 3/65
2/2 [=====] - 0s 152ms/step - loss: 0.6846 - acc: 0.6
100 - recall: 0.6644 - precision: 0.7795
Epoch 4/65
2/2 [=====] - 0s 192ms/step - loss: 0.6853 - acc: 0.5
950 - recall: 0.6711 - precision: 0.7576
Epoch 5/65
2/2 [=====] - 0s 143ms/step - loss: 0.6850 - acc: 0.6
000 - recall: 0.7047 - precision: 0.7447
Epoch 6/65
2/2 [=====] - 0s 140ms/step - loss: 0.6841 - acc: 0.6
100 - recall: 0.6644 - precision: 0.7795
Epoch 7/65
2/2 [=====] - 0s 156ms/step - loss: 0.6848 - acc: 0.6
450 - recall: 0.7383 - precision: 0.7746
Epoch 8/65
2/2 [=====] - 0s 139ms/step - loss: 0.6788 - acc: 0.6
650 - recall: 0.7248 - precision: 0.8060
Epoch 9/65
2/2 [=====] - 0s 74ms/step - loss: 0.6820 - acc: 0.64
50 - recall: 0.7047 - precision: 0.7955
Epoch 10/65
2/2 [=====] - 0s 191ms/step - loss: 0.6811 - acc: 0.5
950 - recall: 0.6107 - precision: 0.7982
Epoch 11/65
2/2 [=====] - 0s 75ms/step - loss: 0.6826 - acc: 0.63
50 - recall: 0.6779 - precision: 0.8016
Epoch 12/65
2/2 [=====] - 0s 118ms/step - loss: 0.6797 - acc: 0.6
500 - recall: 0.6980 - precision: 0.8062
Epoch 13/65
2/2 [=====] - 0s 141ms/step - loss: 0.6834 - acc: 0.6
800 - recall: 0.7718 - precision: 0.7931
Epoch 14/65
2/2 [=====] - 0s 74ms/step - loss: 0.6797 - acc: 0.72
50 - recall: 0.8389 - precision: 0.8013
Epoch 15/65
2/2 [=====] - 0s 77ms/step - loss: 0.6790 - acc: 0.76
00 - recall: 0.8859 - precision: 0.8098
Epoch 16/65
2/2 [=====] - 0s 172ms/step - loss: 0.6774 - acc: 0.6
300 - recall: 0.6711 - precision: 0.8000
Epoch 17/65
2/2 [=====] - 0s 131ms/step - loss: 0.6793 - acc: 0.6
500 - recall: 0.6846 - precision: 0.8160
Epoch 18/65
2/2 [=====] - 0s 155ms/step - loss: 0.6775 - acc: 0.6
850 - recall: 0.7248 - precision: 0.8308
Epoch 19/65
2/2 [=====] - 0s 76ms/step - loss: 0.6762 - acc: 0.65
00 - recall: 0.6577 - precision: 0.8376
Epoch 20/65
2/2 [=====] - 0s 97ms/step - loss: 0.6778 - acc: 0.67
50 - recall: 0.7450 - precision: 0.8043
Epoch 21/65
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.6733 - acc: 0.69  
00 - recall: 0.7047 - precision: 0.8537  
Epoch 22/65  
2/2 [=====] - 0s 84ms/step - loss: 0.6820 - acc: 0.62  
50 - recall: 0.6913 - precision: 0.7803  
Epoch 23/65  
2/2 [=====] - 0s 134ms/step - loss: 0.6760 - acc: 0.6  
750 - recall: 0.6779 - precision: 0.8559  
Epoch 24/65  
2/2 [=====] - 0s 98ms/step - loss: 0.6741 - acc: 0.70  
00 - recall: 0.7248 - precision: 0.8504  
Epoch 25/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6707 - acc: 0.59  
00 - recall: 0.5369 - precision: 0.8602  
Epoch 26/65  
2/2 [=====] - 0s 75ms/step - loss: 0.6726 - acc: 0.62  
00 - recall: 0.5839 - precision: 0.8614  
Epoch 27/65  
2/2 [=====] - 0s 122ms/step - loss: 0.6715 - acc: 0.6  
550 - recall: 0.6376 - precision: 0.8636  
Epoch 28/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6761 - acc: 0.62  
00 - recall: 0.6107 - precision: 0.8349  
Epoch 29/65  
2/2 [=====] - 0s 95ms/step - loss: 0.6736 - acc: 0.65  
00 - recall: 0.6242 - precision: 0.8692  
Epoch 30/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6673 - acc: 0.64  
00 - recall: 0.5772 - precision: 0.9053  
Epoch 31/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6692 - acc: 0.63  
50 - recall: 0.6242 - precision: 0.8455  
Epoch 32/65  
2/2 [=====] - 0s 75ms/step - loss: 0.6690 - acc: 0.61  
50 - recall: 0.5570 - precision: 0.8830  
Epoch 33/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6687 - acc: 0.64  
00 - recall: 0.6443 - precision: 0.8348  
Epoch 34/65  
2/2 [=====] - 0s 139ms/step - loss: 0.6736 - acc: 0.6  
600 - recall: 0.7114 - precision: 0.8092  
Epoch 35/65  
2/2 [=====] - 0s 99ms/step - loss: 0.6707 - acc: 0.65  
50 - recall: 0.7181 - precision: 0.7985  
Epoch 36/65  
2/2 [=====] - 0s 121ms/step - loss: 0.6632 - acc: 0.7  
950 - recall: 0.8456 - precision: 0.8750  
Epoch 37/65  
2/2 [=====] - 0s 96ms/step - loss: 0.6601 - acc: 0.77  
00 - recall: 0.8322 - precision: 0.8552  
Epoch 38/65  
2/2 [=====] - 0s 95ms/step - loss: 0.6730 - acc: 0.57  
00 - recall: 0.5503 - precision: 0.8119  
Epoch 39/65  
2/2 [=====] - 0s 94ms/step - loss: 0.6682 - acc: 0.57  
00 - recall: 0.5302 - precision: 0.8316  
Epoch 40/65  
2/2 [=====] - 0s 90ms/step - loss: 0.6681 - acc: 0.65  
00 - recall: 0.6309 - precision: 0.8624  
Epoch 41/65
```

```
2/2 [=====] - 0s 95ms/step - loss: 0.6742 - acc: 0.65
50 - recall: 0.6846 - precision: 0.8226
Epoch 42/65
2/2 [=====] - 0s 107ms/step - loss: 0.6627 - acc: 0.6
600 - recall: 0.6376 - precision: 0.8716
Epoch 43/65
2/2 [=====] - 0s 91ms/step - loss: 0.6650 - acc: 0.63
00 - recall: 0.5705 - precision: 0.8947
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.6639 - acc: 0.75
50 - recall: 0.8255 - precision: 0.8425
Epoch 45/65
2/2 [=====] - 0s 91ms/step - loss: 0.6570 - acc: 0.76
00 - recall: 0.8255 - precision: 0.8483
Epoch 46/65
2/2 [=====] - 0s 92ms/step - loss: 0.6579 - acc: 0.72
00 - recall: 0.7315 - precision: 0.8720
Epoch 47/65
2/2 [=====] - 0s 128ms/step - loss: 0.6639 - acc: 0.7
100 - recall: 0.7517 - precision: 0.8421
Epoch 48/65
2/2 [=====] - 0s 88ms/step - loss: 0.6539 - acc: 0.77
50 - recall: 0.8322 - precision: 0.8611
Epoch 49/65
2/2 [=====] - 0s 89ms/step - loss: 0.6592 - acc: 0.67
00 - recall: 0.6443 - precision: 0.8807
Epoch 50/65
2/2 [=====] - 0s 89ms/step - loss: 0.6562 - acc: 0.79
00 - recall: 0.8658 - precision: 0.8543
Epoch 51/65
2/2 [=====] - 0s 89ms/step - loss: 0.6662 - acc: 0.70
00 - recall: 0.7584 - precision: 0.8248
Epoch 52/65
2/2 [=====] - 0s 83ms/step - loss: 0.6667 - acc: 0.67
50 - recall: 0.7315 - precision: 0.8134
Epoch 53/65
2/2 [=====] - 0s 87ms/step - loss: 0.6516 - acc: 0.71
00 - recall: 0.7114 - precision: 0.8760
Epoch 54/65
2/2 [=====] - 0s 91ms/step - loss: 0.6547 - acc: 0.70
50 - recall: 0.7383 - precision: 0.8462
Epoch 55/65
2/2 [=====] - 0s 90ms/step - loss: 0.6627 - acc: 0.65
00 - recall: 0.6779 - precision: 0.8211
Epoch 56/65
2/2 [=====] - 0s 89ms/step - loss: 0.6469 - acc: 0.68
00 - recall: 0.6242 - precision: 0.9208
Epoch 57/65
2/2 [=====] - 0s 89ms/step - loss: 0.6493 - acc: 0.74
00 - recall: 0.7718 - precision: 0.8647
Epoch 58/65
2/2 [=====] - 0s 87ms/step - loss: 0.6476 - acc: 0.71
50 - recall: 0.6779 - precision: 0.9182
Epoch 59/65
2/2 [=====] - 0s 87ms/step - loss: 0.6444 - acc: 0.78
00 - recall: 0.8121 - precision: 0.8832
Epoch 60/65
2/2 [=====] - 0s 88ms/step - loss: 0.6508 - acc: 0.70
00 - recall: 0.7248 - precision: 0.8504
Epoch 61/65
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6455 - acc: 0.56
00 - recall: 0.4497 - precision: 0.9178
Epoch 62/65
2/2 [=====] - 0s 103ms/step - loss: 0.6393 - acc: 0.7
350 - recall: 0.7517 - precision: 0.8750
Epoch 63/65
2/2 [=====] - 0s 87ms/step - loss: 0.6355 - acc: 0.77
00 - recall: 0.8188 - precision: 0.8652
Epoch 64/65
2/2 [=====] - 0s 87ms/step - loss: 0.6400 - acc: 0.72
00 - recall: 0.7181 - precision: 0.8843
Epoch 65/65
2/2 [=====] - 0s 88ms/step - loss: 0.6332 - acc: 0.76
00 - recall: 0.7987 - precision: 0.8686
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:48:29.990487: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 41ms/step
7/7 [=====] - 0s 26ms/step
Epoch 1/90
2023-03-31 16:48:30.903968: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 802ms/step - loss: 0.7516 - acc: 0.4  
700 - recall: 0.4414 - precision: 0.7191  
Epoch 2/90  
2/2 [=====] - 0s 169ms/step - loss: 0.7228 - acc: 0.6  
400 - recall: 0.8414 - precision: 0.7135  
Epoch 3/90  
2/2 [=====] - 0s 140ms/step - loss: 0.6962 - acc: 0.4  
300 - recall: 0.2552 - precision: 0.8605  
Epoch 4/90  
2/2 [=====] - 0s 165ms/step - loss: 0.6816 - acc: 0.3  
500 - recall: 0.1034 - precision: 1.0000  
Epoch 5/90  
2/2 [=====] - 0s 130ms/step - loss: 0.6631 - acc: 0.4  
900 - recall: 0.3448 - precision: 0.8772  
Epoch 6/90  
2/2 [=====] - 0s 199ms/step - loss: 0.6064 - acc: 0.6  
150 - recall: 0.5103 - precision: 0.9250  
Epoch 7/90  
2/2 [=====] - 0s 161ms/step - loss: 0.5337 - acc: 0.7  
550 - recall: 0.7517 - precision: 0.8934  
Epoch 8/90  
2/2 [=====] - 0s 78ms/step - loss: 0.4600 - acc: 0.80  
50 - recall: 0.7862 - precision: 0.9344  
Epoch 9/90  
2/2 [=====] - 0s 127ms/step - loss: 0.4108 - acc: 0.8  
250 - recall: 0.8138 - precision: 0.9365  
Epoch 10/90  
2/2 [=====] - 0s 180ms/step - loss: 0.4011 - acc: 0.7  
900 - recall: 0.7172 - precision: 0.9905  
Epoch 11/90  
2/2 [=====] - 0s 116ms/step - loss: 0.4161 - acc: 0.8  
300 - recall: 0.8483 - precision: 0.9111  
Epoch 12/90  
2/2 [=====] - 0s 137ms/step - loss: 0.3460 - acc: 0.8  
100 - recall: 0.7586 - precision: 0.9735  
Epoch 13/90  
2/2 [=====] - 0s 78ms/step - loss: 0.3096 - acc: 0.83  
00 - recall: 0.7724 - precision: 0.9912  
Epoch 14/90  
2/2 [=====] - 0s 154ms/step - loss: 0.3109 - acc: 0.8  
850 - recall: 0.8621 - precision: 0.9766  
Epoch 15/90  
2/2 [=====] - 0s 259ms/step - loss: 0.2582 - acc: 0.8  
800 - recall: 0.8621 - precision: 0.9690  
Epoch 16/90  
2/2 [=====] - 0s 83ms/step - loss: 0.2202 - acc: 0.86  
50 - recall: 0.8207 - precision: 0.9917  
Epoch 17/90  
2/2 [=====] - 0s 144ms/step - loss: 0.1710 - acc: 0.9  
150 - recall: 0.8966 - precision: 0.9848  
Epoch 18/90  
2/2 [=====] - 0s 95ms/step - loss: 0.1927 - acc: 0.93  
50 - recall: 0.9379 - precision: 0.9714  
Epoch 19/90  
2/2 [=====] - 0s 200ms/step - loss: 0.1377 - acc: 0.9  
500 - recall: 0.9379 - precision: 0.9927  
Epoch 20/90  
2/2 [=====] - 0s 77ms/step - loss: 0.1149 - acc: 0.94  
00 - recall: 0.9241 - precision: 0.9926  
Epoch 21/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.1174 - acc: 0.94
50 - recall: 0.9517 - precision: 0.9718
Epoch 22/90
2/2 [=====] - 0s 86ms/step - loss: 0.0953 - acc: 0.96
50 - recall: 0.9517 - precision: 1.0000
Epoch 23/90
2/2 [=====] - 0s 170ms/step - loss: 0.1116 - acc: 0.9
550 - recall: 0.9586 - precision: 0.9789
Epoch 24/90
2/2 [=====] - 0s 75ms/step - loss: 0.0896 - acc: 0.94
50 - recall: 0.9241 - precision: 1.0000
Epoch 25/90
2/2 [=====] - 0s 77ms/step - loss: 0.0845 - acc: 0.96
50 - recall: 0.9517 - precision: 1.0000
Epoch 26/90
2/2 [=====] - 0s 77ms/step - loss: 0.0511 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 27/90
2/2 [=====] - 0s 118ms/step - loss: 0.0472 - acc: 0.9
800 - recall: 0.9724 - precision: 1.0000
Epoch 28/90
2/2 [=====] - 0s 134ms/step - loss: 0.0687 - acc: 0.9
800 - recall: 0.9724 - precision: 1.0000
Epoch 29/90
2/2 [=====] - 0s 77ms/step - loss: 0.0747 - acc: 0.98
50 - recall: 1.0000 - precision: 0.9797
Epoch 30/90
2/2 [=====] - 0s 130ms/step - loss: 0.0899 - acc: 0.9
550 - recall: 0.9379 - precision: 1.0000
Epoch 31/90
2/2 [=====] - 0s 75ms/step - loss: 0.0395 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 32/90
2/2 [=====] - 0s 75ms/step - loss: 0.0430 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 33/90
2/2 [=====] - 0s 85ms/step - loss: 0.0205 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 34/90
2/2 [=====] - 0s 77ms/step - loss: 0.0441 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 35/90
2/2 [=====] - 0s 92ms/step - loss: 0.0219 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 36/90
2/2 [=====] - 0s 88ms/step - loss: 0.0183 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 37/90
2/2 [=====] - 0s 99ms/step - loss: 0.0192 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 38/90
2/2 [=====] - 0s 98ms/step - loss: 0.0248 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 39/90
2/2 [=====] - 0s 90ms/step - loss: 0.0266 - acc: 0.97
50 - recall: 0.9655 - precision: 1.0000
Epoch 40/90
2/2 [=====] - 0s 90ms/step - loss: 0.0291 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 41/90
```

```
2/2 [=====] - 0s 92ms/step - loss: 0.0116 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 42/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0785 - acc: 0.97  
50 - recall: 1.0000 - precision: 0.9667  
Epoch 43/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0161 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 44/90  
2/2 [=====] - 0s 88ms/step - loss: 0.1065 - acc: 0.97  
00 - recall: 0.9793 - precision: 0.9793  
Epoch 45/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0447 - acc: 0.96  
00 - recall: 0.9448 - precision: 1.0000  
Epoch 46/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0852 - acc: 0.97  
00 - recall: 0.9586 - precision: 1.0000  
Epoch 47/90  
2/2 [=====] - 0s 88ms/step - loss: 0.1050 - acc: 0.97  
50 - recall: 0.9793 - precision: 0.9861  
Epoch 48/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0734 - acc: 0.96  
50 - recall: 0.9517 - precision: 1.0000  
Epoch 49/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0391 - acc: 0.97  
50 - recall: 0.9655 - precision: 1.0000  
Epoch 50/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0363 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 51/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0228 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 52/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0146 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 53/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0178 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 54/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0144 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0355 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9864  
Epoch 56/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0155 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 57/90  
2/2 [=====] - 0s 190ms/step - loss: 0.0089 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 58/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0082 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 59/90  
2/2 [=====] - 0s 92ms/step - loss: 0.0055 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0129 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 61/90
```

```
2/2 [=====] - 0s 89ms/step - loss: 0.0055 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 62/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0017 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 63/90  
2/2 [=====] - 0s 86ms/step - loss: 9.5225e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 64/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0220 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 65/90  
2/2 [=====] - 0s 86ms/step - loss: 5.0696e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 66/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0014 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 67/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0015 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 68/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0012 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 69/90  
2/2 [=====] - 0s 87ms/step - loss: 7.4803e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 70/90  
2/2 [=====] - 0s 87ms/step - loss: 4.6249e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 71/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0030 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 72/90  
2/2 [=====] - 0s 85ms/step - loss: 7.4304e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 73/90  
2/2 [=====] - 0s 87ms/step - loss: 9.1916e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 74/90  
2/2 [=====] - 0s 87ms/step - loss: 2.1924e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 75/90  
2/2 [=====] - 0s 87ms/step - loss: 9.7166e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 76/90  
2/2 [=====] - 0s 85ms/step - loss: 2.9544e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 77/90  
2/2 [=====] - 0s 86ms/step - loss: 6.3439e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 78/90  
2/2 [=====] - 0s 86ms/step - loss: 1.1870e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 79/90  
2/2 [=====] - 0s 87ms/step - loss: 4.6881e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 80/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0011 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 81/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 3.0451e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 82/90
2/2 [=====] - 0s 86ms/step - loss: 2.9823e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 83/90
2/2 [=====] - 0s 88ms/step - loss: 7.5316e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 86ms/step - loss: 7.7791e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 87ms/step - loss: 7.5558e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 87ms/step - loss: 4.2200e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 86ms/step - loss: 3.8655e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 85ms/step - loss: 4.0440e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 6.0235e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 90/90
2/2 [=====] - 0s 84ms/step - loss: 9.2518e-05 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:48:55.062744: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 71ms/step
7/7 [=====] - 0s 34ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:48:56.141755: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 964ms/step - loss: 0.7185 - acc: 0.4  
600 - recall: 0.4324 - precision: 0.7273  
Epoch 2/90  
2/2 [=====] - 1s 223ms/step - loss: 0.6930 - acc: 0.7  
100 - recall: 0.9257 - precision: 0.7446  
Epoch 3/90  
2/2 [=====] - 0s 201ms/step - loss: 0.6853 - acc: 0.6  
050 - recall: 0.6149 - precision: 0.8053  
Epoch 4/90  
2/2 [=====] - 0s 205ms/step - loss: 0.6789 - acc: 0.6  
200 - recall: 0.6554 - precision: 0.7951  
Epoch 5/90  
2/2 [=====] - 0s 148ms/step - loss: 0.6306 - acc: 0.7  
200 - recall: 0.7432 - precision: 0.8594  
Epoch 6/90  
2/2 [=====] - 0s 127ms/step - loss: 0.6008 - acc: 0.6  
450 - recall: 0.6081 - precision: 0.8738  
Epoch 7/90  
2/2 [=====] - 0s 143ms/step - loss: 0.5606 - acc: 0.6  
800 - recall: 0.6216 - precision: 0.9200  
Epoch 8/90  
2/2 [=====] - 0s 77ms/step - loss: 0.4220 - acc: 0.83  
50 - recall: 0.8243 - precision: 0.9457  
Epoch 9/90  
2/2 [=====] - 0s 143ms/step - loss: 0.4002 - acc: 0.8  
050 - recall: 0.7770 - precision: 0.9504  
Epoch 10/90  
2/2 [=====] - 0s 165ms/step - loss: 0.3417 - acc: 0.8  
450 - recall: 0.8378 - precision: 0.9466  
Epoch 11/90  
2/2 [=====] - 0s 77ms/step - loss: 0.4434 - acc: 0.79  
50 - recall: 0.7365 - precision: 0.9820  
Epoch 12/90  
2/2 [=====] - 0s 95ms/step - loss: 0.4070 - acc: 0.84  
50 - recall: 0.9189 - precision: 0.8774  
Epoch 13/90  
2/2 [=====] - 0s 116ms/step - loss: 0.3254 - acc: 0.8  
650 - recall: 0.8716 - precision: 0.9416  
Epoch 14/90  
2/2 [=====] - 0s 126ms/step - loss: 0.2782 - acc: 0.8  
600 - recall: 0.8108 - precision: 1.0000  
Epoch 15/90  
2/2 [=====] - 0s 117ms/step - loss: 0.2502 - acc: 0.8  
750 - recall: 0.8311 - precision: 1.0000  
Epoch 16/90  
2/2 [=====] - 0s 132ms/step - loss: 0.2292 - acc: 0.8  
950 - recall: 0.8784 - precision: 0.9774  
Epoch 17/90  
2/2 [=====] - 0s 75ms/step - loss: 0.1973 - acc: 0.91  
50 - recall: 0.9189 - precision: 0.9645  
Epoch 18/90  
2/2 [=====] - 0s 171ms/step - loss: 0.2144 - acc: 0.8  
850 - recall: 0.8716 - precision: 0.9699  
Epoch 19/90  
2/2 [=====] - 0s 75ms/step - loss: 0.1304 - acc: 0.95  
00 - recall: 0.9392 - precision: 0.9929  
Epoch 20/90  
2/2 [=====] - 0s 323ms/step - loss: 0.1493 - acc: 0.9  
550 - recall: 0.9662 - precision: 0.9728  
Epoch 21/90
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.1141 - acc: 0.93
50 - recall: 0.9122 - precision: 1.0000
Epoch 22/90
2/2 [=====] - 0s 78ms/step - loss: 0.1054 - acc: 0.95
50 - recall: 0.9392 - precision: 1.0000
Epoch 23/90
2/2 [=====] - 0s 75ms/step - loss: 0.1140 - acc: 0.96
50 - recall: 0.9595 - precision: 0.9861
Epoch 24/90
2/2 [=====] - 0s 170ms/step - loss: 0.0785 - acc: 0.9650
50 - recall: 0.9527 - precision: 1.0000
Epoch 25/90
2/2 [=====] - 0s 81ms/step - loss: 0.0868 - acc: 0.9550
50 - recall: 0.9392 - precision: 1.0000
Epoch 26/90
2/2 [=====] - 0s 77ms/step - loss: 0.0545 - acc: 0.9850
50 - recall: 0.9797 - precision: 1.0000
Epoch 27/90
2/2 [=====] - 0s 129ms/step - loss: 0.0649 - acc: 0.98800
50 - recall: 0.9865 - precision: 0.9865
Epoch 28/90
2/2 [=====] - 0s 74ms/step - loss: 0.0837 - acc: 0.9650
50 - recall: 0.9527 - precision: 1.0000
Epoch 29/90
2/2 [=====] - 0s 77ms/step - loss: 0.0759 - acc: 0.9650
50 - recall: 0.9595 - precision: 0.9930
Epoch 30/90
2/2 [=====] - 0s 131ms/step - loss: 0.0700 - acc: 0.98800
50 - recall: 0.9932 - precision: 0.9800
Epoch 31/90
2/2 [=====] - 0s 93ms/step - loss: 0.0446 - acc: 0.9850
50 - recall: 0.9730 - precision: 1.0000
Epoch 32/90
2/2 [=====] - 0s 74ms/step - loss: 0.0481 - acc: 0.9850
50 - recall: 0.9797 - precision: 1.0000
Epoch 33/90
2/2 [=====] - 0s 75ms/step - loss: 0.0261 - acc: 0.9950
50 - recall: 1.0000 - precision: 0.9933
Epoch 34/90
2/2 [=====] - 0s 76ms/step - loss: 0.0447 - acc: 0.9950
50 - recall: 0.9932 - precision: 1.0000
Epoch 35/90
2/2 [=====] - 0s 318ms/step - loss: 0.0271 - acc: 0.98850
50 - recall: 0.9797 - precision: 1.0000
Epoch 36/90
2/2 [=====] - 0s 78ms/step - loss: 0.0151 - acc: 0.9950
50 - recall: 0.9865 - precision: 1.0000
Epoch 37/90
2/2 [=====] - 0s 80ms/step - loss: 0.0089 - acc: 1.0050
50 - recall: 1.0000 - precision: 1.0000
Epoch 38/90
2/2 [=====] - 0s 94ms/step - loss: 0.0060 - acc: 1.0050
50 - recall: 1.0000 - precision: 1.0000
Epoch 39/90
2/2 [=====] - 0s 98ms/step - loss: 0.0141 - acc: 1.0050
50 - recall: 1.0000 - precision: 1.0000
Epoch 40/90
2/2 [=====] - 0s 94ms/step - loss: 0.0071 - acc: 1.0050
50 - recall: 1.0000 - precision: 1.0000
Epoch 41/90
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.0027 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 42/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0054 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 43/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0037 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 44/90  
2/2 [=====] - 0s 106ms/step - loss: 0.0117 - acc: 0.9  
950 - recall: 0.9932 - precision: 1.0000  
Epoch 45/90  
2/2 [=====] - 0s 98ms/step - loss: 7.8181e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 46/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0023 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 47/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0027 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 48/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0024 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 49/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0016 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 50/90  
2/2 [=====] - 0s 100ms/step - loss: 8.2183e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 51/90  
2/2 [=====] - 0s 90ms/step - loss: 5.7183e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 52/90  
2/2 [=====] - 0s 87ms/step - loss: 8.0530e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 53/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0012 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 54/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0015 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 88ms/step - loss: 8.6056e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 56/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0036 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 57/90  
2/2 [=====] - 0s 85ms/step - loss: 2.0918e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 58/90  
2/2 [=====] - 0s 89ms/step - loss: 4.9366e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 59/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0013 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 314ms/step - loss: 0.0035 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 61/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 7.3353e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 62/90
2/2 [=====] - 0s 76ms/step - loss: 5.6825e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 63/90
2/2 [=====] - 0s 78ms/step - loss: 0.0047 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 64/90
2/2 [=====] - 0s 84ms/step - loss: 6.6110e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 65/90
2/2 [=====] - 0s 88ms/step - loss: 4.5095e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 66/90
2/2 [=====] - 0s 89ms/step - loss: 0.0036 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 67/90
2/2 [=====] - 0s 87ms/step - loss: 2.7849e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 68/90
2/2 [=====] - 0s 87ms/step - loss: 8.8435e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 69/90
2/2 [=====] - 0s 86ms/step - loss: 0.0038 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 70/90
2/2 [=====] - 0s 86ms/step - loss: 0.0034 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 71/90
2/2 [=====] - 0s 86ms/step - loss: 6.5684e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 72/90
2/2 [=====] - 0s 87ms/step - loss: 0.0022 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 73/90
2/2 [=====] - 0s 101ms/step - loss: 4.1228e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 74/90
2/2 [=====] - 0s 99ms/step - loss: 5.7500e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 75/90
2/2 [=====] - 0s 85ms/step - loss: 0.0120 - acc: 0.9950 - recall: 0.9932 - precision: 1.0000
Epoch 76/90
2/2 [=====] - 0s 85ms/step - loss: 1.0960e-04 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 77/90
2/2 [=====] - 0s 87ms/step - loss: 0.0048 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 78/90
2/2 [=====] - 0s 184ms/step - loss: 0.0176 - acc: 1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 79/90
2/2 [=====] - 0s 85ms/step - loss: 0.0088 - acc: 0.9950 - recall: 0.9932 - precision: 1.0000
Epoch 80/90
2/2 [=====] - 0s 89ms/step - loss: 0.0066 - acc: 0.9950 - recall: 0.9932 - precision: 1.0000
Epoch 81/90
```

```
2/2 [=====] - 0s 89ms/step - loss: 0.0118 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 82/90
2/2 [=====] - 0s 88ms/step - loss: 0.0024 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 83/90
2/2 [=====] - 0s 88ms/step - loss: 0.0198 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 85ms/step - loss: 0.0365 - acc: 0.98
50 - recall: 0.9797 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 85ms/step - loss: 0.0041 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 86ms/step - loss: 0.0083 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 86ms/step - loss: 0.0033 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 86ms/step - loss: 0.0168 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 86ms/step - loss: 0.0078 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 90/90
2/2 [=====] - 0s 86ms/step - loss: 0.0023 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====] - ETA: 0s
```

```
2023-03-31 16:49:21.073210: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 56ms/step
```

```
7/7 [=====] - 0s 35ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:49:22.393938: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 788ms/step - loss: 0.6863 - acc: 0.5  
850 - recall: 0.7114 - precision: 0.7260  
Epoch 2/90  
2/2 [=====] - 0s 167ms/step - loss: 0.6761 - acc: 0.4  
400 - recall: 0.3087 - precision: 0.8364  
Epoch 3/90  
2/2 [=====] - 0s 204ms/step - loss: 0.6838 - acc: 0.6  
400 - recall: 0.7785 - precision: 0.7484  
Epoch 4/90  
2/2 [=====] - 0s 159ms/step - loss: 0.6319 - acc: 0.7  
700 - recall: 0.8322 - precision: 0.8552  
Epoch 5/90  
2/2 [=====] - 0s 94ms/step - loss: 0.5158 - acc: 0.79  
50 - recall: 0.7987 - precision: 0.9154  
Epoch 6/90  
2/2 [=====] - 0s 210ms/step - loss: 0.5714 - acc: 0.7  
000 - recall: 0.6376 - precision: 0.9406  
Epoch 7/90  
2/2 [=====] - 0s 174ms/step - loss: 0.5549 - acc: 0.8  
200 - recall: 0.9396 - precision: 0.8383  
Epoch 8/90  
2/2 [=====] - 0s 158ms/step - loss: 0.4532 - acc: 0.8  
250 - recall: 0.8255 - precision: 0.9318  
Epoch 9/90  
2/2 [=====] - 0s 138ms/step - loss: 0.4286 - acc: 0.7  
700 - recall: 0.7181 - precision: 0.9640  
Epoch 10/90  
2/2 [=====] - 0s 170ms/step - loss: 0.4395 - acc: 0.8  
300 - recall: 0.8121 - precision: 0.9528  
Epoch 11/90  
2/2 [=====] - 0s 78ms/step - loss: 0.3892 - acc: 0.86  
00 - recall: 0.8591 - precision: 0.9481  
Epoch 12/90  
2/2 [=====] - 0s 100ms/step - loss: 0.3483 - acc: 0.8  
450 - recall: 0.8322 - precision: 0.9538  
Epoch 13/90  
2/2 [=====] - 0s 136ms/step - loss: 0.3241 - acc: 0.8  
000 - recall: 0.7584 - precision: 0.9658  
Epoch 14/90  
2/2 [=====] - 0s 100ms/step - loss: 0.3232 - acc: 0.8  
100 - recall: 0.7718 - precision: 0.9664  
Epoch 15/90  
2/2 [=====] - 0s 116ms/step - loss: 0.2830 - acc: 0.8  
550 - recall: 0.8322 - precision: 0.9688  
Epoch 16/90  
2/2 [=====] - 0s 76ms/step - loss: 0.2625 - acc: 0.87  
50 - recall: 0.8523 - precision: 0.9769  
Epoch 17/90  
2/2 [=====] - 0s 77ms/step - loss: 0.2214 - acc: 0.91  
00 - recall: 0.9128 - precision: 0.9645  
Epoch 18/90  
2/2 [=====] - 0s 193ms/step - loss: 0.1990 - acc: 0.9  
150 - recall: 0.9128 - precision: 0.9714  
Epoch 19/90  
2/2 [=====] - 0s 153ms/step - loss: 0.1710 - acc: 0.9  
250 - recall: 0.9195 - precision: 0.9786  
Epoch 20/90  
2/2 [=====] - 0s 95ms/step - loss: 0.1454 - acc: 0.95  
00 - recall: 0.9597 - precision: 0.9728  
Epoch 21/90
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.3044 - acc: 0.85
00 - recall: 0.8054 - precision: 0.9917
Epoch 22/90
2/2 [=====] - 0s 116ms/step - loss: 0.2278 - acc: 0.9
400 - recall: 0.9732 - precision: 0.9477
Epoch 23/90
2/2 [=====] - 0s 89ms/step - loss: 0.1402 - acc: 0.96
50 - recall: 0.9597 - precision: 0.9931
Epoch 24/90
2/2 [=====] - 0s 75ms/step - loss: 0.1512 - acc: 0.94
00 - recall: 0.9463 - precision: 0.9724
Epoch 25/90
2/2 [=====] - 0s 74ms/step - loss: 0.1338 - acc: 0.95
50 - recall: 0.9530 - precision: 0.9861
Epoch 26/90
2/2 [=====] - 0s 74ms/step - loss: 0.1175 - acc: 0.94
50 - recall: 0.9329 - precision: 0.9929
Epoch 27/90
2/2 [=====] - 0s 76ms/step - loss: 0.1008 - acc: 0.98
00 - recall: 0.9799 - precision: 0.9932
Epoch 28/90
2/2 [=====] - 0s 75ms/step - loss: 0.0625 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 29/90
2/2 [=====] - 0s 76ms/step - loss: 0.0716 - acc: 0.97
50 - recall: 0.9664 - precision: 1.0000
Epoch 30/90
2/2 [=====] - 0s 76ms/step - loss: 0.0497 - acc: 0.98
00 - recall: 0.9732 - precision: 1.0000
Epoch 31/90
2/2 [=====] - 0s 75ms/step - loss: 0.0447 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 32/90
2/2 [=====] - 0s 78ms/step - loss: 0.0576 - acc: 0.97
00 - recall: 0.9664 - precision: 0.9931
Epoch 33/90
2/2 [=====] - 0s 81ms/step - loss: 0.0245 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 34/90
2/2 [=====] - 0s 90ms/step - loss: 0.0251 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 35/90
2/2 [=====] - 0s 96ms/step - loss: 0.0231 - acc: 0.98
50 - recall: 0.9866 - precision: 0.9932
Epoch 36/90
2/2 [=====] - 0s 95ms/step - loss: 0.0467 - acc: 0.98
00 - recall: 0.9866 - precision: 0.9866
Epoch 37/90
2/2 [=====] - 0s 87ms/step - loss: 0.0381 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 38/90
2/2 [=====] - 0s 87ms/step - loss: 0.0206 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 39/90
2/2 [=====] - 0s 89ms/step - loss: 0.0077 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 40/90
2/2 [=====] - 0s 90ms/step - loss: 0.0168 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 41/90
```

```
2/2 [=====] - 0s 89ms/step - loss: 0.0076 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 42/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0182 - acc: 0.98  
50 - recall: 0.9799 - precision: 1.0000  
Epoch 43/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0163 - acc: 0.98  
50 - recall: 0.9799 - precision: 1.0000  
Epoch 44/90  
2/2 [=====] - 0s 125ms/step - loss: 0.0125 - acc: 0.9  
950 - recall: 0.9933 - precision: 1.0000  
Epoch 45/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0307 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 46/90  
2/2 [=====] - 0s 135ms/step - loss: 0.0080 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 47/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0032 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 48/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0181 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 49/90  
2/2 [=====] - 0s 88ms/step - loss: 7.1216e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 50/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0144 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 51/90  
2/2 [=====] - 0s 87ms/step - loss: 7.0154e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 52/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0071 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 53/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0077 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 54/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0034 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0011 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 56/90  
2/2 [=====] - 0s 161ms/step - loss: 0.0162 - acc: 0.9  
950 - recall: 1.0000 - precision: 0.9933  
Epoch 57/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0175 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 58/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0365 - acc: 0.97  
00 - recall: 0.9597 - precision: 1.0000  
Epoch 59/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0051 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0334 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9868  
Epoch 61/90
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.0236 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 62/90  
2/2 [=====] - 0s 124ms/step - loss: 0.0168 - acc: 0.9  
950 - recall: 0.9933 - precision: 1.0000  
Epoch 63/90  
2/2 [=====] - 0s 94ms/step - loss: 0.0105 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 64/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0172 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 65/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0063 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 66/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0032 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 67/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0028 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 68/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0037 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 69/90  
2/2 [=====] - 0s 85ms/step - loss: 7.2775e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 70/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0015 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 71/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0038 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 72/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0014 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 73/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0015 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 74/90  
2/2 [=====] - 0s 85ms/step - loss: 6.0819e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 75/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0027 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 76/90  
2/2 [=====] - 0s 85ms/step - loss: 3.8080e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 77/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0021 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 78/90  
2/2 [=====] - 0s 86ms/step - loss: 1.5909e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 79/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0286 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 80/90  
2/2 [=====] - 0s 90ms/step - loss: 9.6144e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 81/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.0102 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 82/90
2/2 [=====] - 0s 86ms/step - loss: 0.0088 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 83/90
2/2 [=====] - 0s 86ms/step - loss: 0.0013 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 84ms/step - loss: 0.0062 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 85ms/step - loss: 0.0035 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 85ms/step - loss: 0.0026 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 86ms/step - loss: 2.1090e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 85ms/step - loss: 0.0043 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 86ms/step - loss: 4.4361e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 90/90
2/2 [=====] - 0s 85ms/step - loss: 0.0080 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
1/4 [=====] - ETA: 0s
2023-03-31 16:49:46.587544: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 57ms/step
7/7 [=====] - 0s 38ms/step
Epoch 1/90
2023-03-31 16:49:47.590838: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 1s/step - loss: 0.6998 - acc: 0.6600
- recall: 0.6897 - precision: 0.8130
Epoch 2/90
2/2 [=====] - 0s 94ms/step - loss: 0.7043 - acc: 0.46
50 - recall: 0.4552 - precision: 0.7021
Epoch 3/90
2/2 [=====] - 0s 201ms/step - loss: 0.7021 - acc: 0.4
350 - recall: 0.3517 - precision: 0.7286
Epoch 4/90
2/2 [=====] - 0s 229ms/step - loss: 0.6960 - acc: 0.4
900 - recall: 0.3793 - precision: 0.8209
Epoch 5/90
2/2 [=====] - 0s 215ms/step - loss: 0.7009 - acc: 0.4
050 - recall: 0.3172 - precision: 0.6970
Epoch 6/90
2/2 [=====] - 0s 192ms/step - loss: 0.6972 - acc: 0.5
050 - recall: 0.3931 - precision: 0.8382
Epoch 7/90
2/2 [=====] - 0s 200ms/step - loss: 0.6994 - acc: 0.4
350 - recall: 0.3034 - precision: 0.7857
Epoch 8/90
2/2 [=====] - 0s 183ms/step - loss: 0.6994 - acc: 0.3
900 - recall: 0.2552 - precision: 0.7255
Epoch 9/90
2/2 [=====] - 0s 106ms/step - loss: 0.6993 - acc: 0.4
000 - recall: 0.2759 - precision: 0.7273
Epoch 10/90
2/2 [=====] - 0s 138ms/step - loss: 0.6922 - acc: 0.4
200 - recall: 0.2552 - precision: 0.8222
Epoch 11/90
2/2 [=====] - 0s 105ms/step - loss: 0.7000 - acc: 0.3
900 - recall: 0.2621 - precision: 0.7170
Epoch 12/90
2/2 [=====] - 0s 127ms/step - loss: 0.7000 - acc: 0.4
050 - recall: 0.2690 - precision: 0.7500
Epoch 13/90
2/2 [=====] - 0s 139ms/step - loss: 0.6954 - acc: 0.3
650 - recall: 0.1793 - precision: 0.7647
Epoch 14/90
2/2 [=====] - 0s 80ms/step - loss: 0.6944 - acc: 0.40
00 - recall: 0.2276 - precision: 0.8049
Epoch 15/90
2/2 [=====] - 0s 138ms/step - loss: 0.6931 - acc: 0.4
400 - recall: 0.2828 - precision: 0.8367
Epoch 16/90
2/2 [=====] - 0s 74ms/step - loss: 0.6973 - acc: 0.38
50 - recall: 0.1862 - precision: 0.8438
Epoch 17/90
2/2 [=====] - 0s 118ms/step - loss: 0.6981 - acc: 0.3
600 - recall: 0.1655 - precision: 0.7742
Epoch 18/90
2/2 [=====] - 0s 74ms/step - loss: 0.6963 - acc: 0.34
50 - recall: 0.1517 - precision: 0.7333
Epoch 19/90
2/2 [=====] - 0s 102ms/step - loss: 0.6902 - acc: 0.4
450 - recall: 0.2621 - precision: 0.9048
Epoch 20/90
2/2 [=====] - 0s 134ms/step - loss: 0.6943 - acc: 0.4
100 - recall: 0.2483 - precision: 0.8000
Epoch 21/90
```

```
2/2 [=====] - 0s 130ms/step - loss: 0.6945 - acc: 0.3  
900 - recall: 0.2138 - precision: 0.7949  
Epoch 22/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6927 - acc: 0.49  
50 - recall: 0.3448 - precision: 0.8929  
Epoch 23/90  
2/2 [=====] - 0s 130ms/step - loss: 0.6915 - acc: 0.5  
000 - recall: 0.3793 - precision: 0.8462  
Epoch 24/90  
2/2 [=====] - 0s 93ms/step - loss: 0.6922 - acc: 0.46  
00 - recall: 0.2897 - precision: 0.8936  
Epoch 25/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6893 - acc: 0.40  
50 - recall: 0.2276 - precision: 0.8250  
Epoch 26/90  
2/2 [=====] - 0s 127ms/step - loss: 0.6846 - acc: 0.4  
650 - recall: 0.2897 - precision: 0.9130  
Epoch 27/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6899 - acc: 0.50  
00 - recall: 0.3655 - precision: 0.8689  
Epoch 28/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6869 - acc: 0.46  
50 - recall: 0.2897 - precision: 0.9130  
Epoch 29/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6878 - acc: 0.42  
50 - recall: 0.2414 - precision: 0.8750  
Epoch 30/90  
2/2 [=====] - 0s 149ms/step - loss: 0.6938 - acc: 0.3  
900 - recall: 0.2138 - precision: 0.7949  
Epoch 31/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6856 - acc: 0.48  
50 - recall: 0.3310 - precision: 0.8889  
Epoch 32/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6874 - acc: 0.41  
00 - recall: 0.2207 - precision: 0.8649  
Epoch 33/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6844 - acc: 0.43  
50 - recall: 0.2552 - precision: 0.8810  
Epoch 34/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6867 - acc: 0.49  
50 - recall: 0.3517 - precision: 0.8793  
Epoch 35/90  
2/2 [=====] - 0s 81ms/step - loss: 0.6838 - acc: 0.51  
00 - recall: 0.3655 - precision: 0.8983  
Epoch 36/90  
2/2 [=====] - 0s 89ms/step - loss: 0.6800 - acc: 0.55  
00 - recall: 0.4414 - precision: 0.8767  
Epoch 37/90  
2/2 [=====] - 0s 90ms/step - loss: 0.6807 - acc: 0.51  
00 - recall: 0.3448 - precision: 0.9434  
Epoch 38/90  
2/2 [=====] - 0s 90ms/step - loss: 0.6890 - acc: 0.42  
00 - recall: 0.2483 - precision: 0.8372  
Epoch 39/90  
2/2 [=====] - 0s 92ms/step - loss: 0.6832 - acc: 0.53  
00 - recall: 0.4138 - precision: 0.8696  
Epoch 40/90  
2/2 [=====] - 0s 90ms/step - loss: 0.6812 - acc: 0.56  
00 - recall: 0.4690 - precision: 0.8608  
Epoch 41/90
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.6806 - acc: 0.62
50 - recall: 0.5655 - precision: 0.8723
Epoch 42/90
2/2 [=====] - 0s 90ms/step - loss: 0.6837 - acc: 0.58
00 - recall: 0.4966 - precision: 0.8675
Epoch 43/90
2/2 [=====] - 0s 85ms/step - loss: 0.6778 - acc: 0.57
50 - recall: 0.4897 - precision: 0.8659
Epoch 44/90
2/2 [=====] - 0s 88ms/step - loss: 0.6781 - acc: 0.57
00 - recall: 0.5034 - precision: 0.8391
Epoch 45/90
2/2 [=====] - 0s 87ms/step - loss: 0.6707 - acc: 0.71
50 - recall: 0.6759 - precision: 0.9074
Epoch 46/90
2/2 [=====] - 0s 89ms/step - loss: 0.6705 - acc: 0.72
50 - recall: 0.7034 - precision: 0.8947
Epoch 47/90
2/2 [=====] - 0s 89ms/step - loss: 0.6766 - acc: 0.57
50 - recall: 0.4690 - precision: 0.8947
Epoch 48/90
2/2 [=====] - 0s 88ms/step - loss: 0.6699 - acc: 0.61
50 - recall: 0.5379 - precision: 0.8864
Epoch 49/90
2/2 [=====] - 0s 88ms/step - loss: 0.6810 - acc: 0.70
00 - recall: 0.7172 - precision: 0.8455
Epoch 50/90
2/2 [=====] - 0s 87ms/step - loss: 0.6784 - acc: 0.55
00 - recall: 0.4138 - precision: 0.9231
Epoch 51/90
2/2 [=====] - 0s 87ms/step - loss: 0.6829 - acc: 0.55
00 - recall: 0.4483 - precision: 0.8667
Epoch 52/90
2/2 [=====] - 0s 86ms/step - loss: 0.6698 - acc: 0.62
00 - recall: 0.4966 - precision: 0.9600
Epoch 53/90
2/2 [=====] - 0s 87ms/step - loss: 0.6684 - acc: 0.58
00 - recall: 0.4759 - precision: 0.8961
Epoch 54/90
2/2 [=====] - 0s 87ms/step - loss: 0.6639 - acc: 0.65
50 - recall: 0.5862 - precision: 0.9043
Epoch 55/90
2/2 [=====] - 0s 87ms/step - loss: 0.6725 - acc: 0.75
00 - recall: 0.8276 - precision: 0.8276
Epoch 56/90
2/2 [=====] - 0s 87ms/step - loss: 0.6700 - acc: 0.52
50 - recall: 0.3931 - precision: 0.8906
Epoch 57/90
2/2 [=====] - 0s 85ms/step - loss: 0.6689 - acc: 0.62
50 - recall: 0.5517 - precision: 0.8889
Epoch 58/90
2/2 [=====] - 0s 87ms/step - loss: 0.6628 - acc: 0.67
00 - recall: 0.6138 - precision: 0.8990
Epoch 59/90
2/2 [=====] - 0s 87ms/step - loss: 0.6697 - acc: 0.60
00 - recall: 0.5517 - precision: 0.8421
Epoch 60/90
2/2 [=====] - 0s 81ms/step - loss: 0.6712 - acc: 0.48
50 - recall: 0.3310 - precision: 0.8889
Epoch 61/90
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.6618 - acc: 0.72
50 - recall: 0.7310 - precision: 0.8689
Epoch 62/90
2/2 [=====] - 0s 86ms/step - loss: 0.6569 - acc: 0.72
00 - recall: 0.7103 - precision: 0.8803
Epoch 63/90
2/2 [=====] - 0s 88ms/step - loss: 0.6468 - acc: 0.56
00 - recall: 0.3931 - precision: 1.0000
Epoch 64/90
2/2 [=====] - 0s 88ms/step - loss: 0.6527 - acc: 0.77
50 - recall: 0.8138 - precision: 0.8676
Epoch 65/90
2/2 [=====] - 0s 86ms/step - loss: 0.6563 - acc: 0.68
00 - recall: 0.6414 - precision: 0.8857
Epoch 66/90
2/2 [=====] - 0s 85ms/step - loss: 0.6434 - acc: 0.67
50 - recall: 0.6000 - precision: 0.9255
Epoch 67/90
2/2 [=====] - 0s 86ms/step - loss: 0.6504 - acc: 0.70
00 - recall: 0.6552 - precision: 0.9048
Epoch 68/90
2/2 [=====] - 0s 86ms/step - loss: 0.6447 - acc: 0.73
50 - recall: 0.7310 - precision: 0.8833
Epoch 69/90
2/2 [=====] - 0s 86ms/step - loss: 0.6412 - acc: 0.54
00 - recall: 0.3862 - precision: 0.9492
Epoch 70/90
2/2 [=====] - 0s 86ms/step - loss: 0.6301 - acc: 0.75
50 - recall: 0.7310 - precision: 0.9138
Epoch 71/90
2/2 [=====] - 0s 84ms/step - loss: 0.6251 - acc: 0.61
50 - recall: 0.4897 - precision: 0.9595
Epoch 72/90
2/2 [=====] - 0s 86ms/step - loss: 0.6180 - acc: 0.79
50 - recall: 0.8345 - precision: 0.8768
Epoch 73/90
2/2 [=====] - 0s 87ms/step - loss: 0.6214 - acc: 0.63
50 - recall: 0.5241 - precision: 0.9500
Epoch 74/90
2/2 [=====] - 0s 87ms/step - loss: 0.6229 - acc: 0.68
00 - recall: 0.6552 - precision: 0.8716
Epoch 75/90
2/2 [=====] - 0s 86ms/step - loss: 0.6179 - acc: 0.62
50 - recall: 0.5310 - precision: 0.9167
Epoch 76/90
2/2 [=====] - 0s 85ms/step - loss: 0.6577 - acc: 0.66
50 - recall: 0.7448 - precision: 0.7826
Epoch 77/90
2/2 [=====] - 0s 85ms/step - loss: 0.6679 - acc: 0.60
50 - recall: 0.6207 - precision: 0.7895
Epoch 78/90
2/2 [=====] - 0s 86ms/step - loss: 0.6354 - acc: 0.71
50 - recall: 0.7655 - precision: 0.8284
Epoch 79/90
2/2 [=====] - 0s 86ms/step - loss: 0.6409 - acc: 0.64
00 - recall: 0.6483 - precision: 0.8174
Epoch 80/90
2/2 [=====] - 0s 85ms/step - loss: 0.6021 - acc: 0.79
50 - recall: 0.8552 - precision: 0.8611
Epoch 81/90
```

```
2/2 [=====] - 0s 83ms/step - loss: 0.6610 - acc: 0.52
00 - recall: 0.3793 - precision: 0.9016
Epoch 82/90
2/2 [=====] - 0s 89ms/step - loss: 0.6081 - acc: 0.55
50 - recall: 0.4138 - precision: 0.9375
Epoch 83/90
2/2 [=====] - 0s 90ms/step - loss: 0.6033 - acc: 0.75
50 - recall: 0.7517 - precision: 0.8934
Epoch 84/90
2/2 [=====] - 0s 88ms/step - loss: 0.6493 - acc: 0.65
50 - recall: 0.6828 - precision: 0.8115
Epoch 85/90
2/2 [=====] - 0s 86ms/step - loss: 0.6156 - acc: 0.78
50 - recall: 0.9172 - precision: 0.8110
Epoch 86/90
2/2 [=====] - 0s 86ms/step - loss: 0.6362 - acc: 0.56
00 - recall: 0.4690 - precision: 0.8608
Epoch 87/90
2/2 [=====] - 0s 85ms/step - loss: 0.6370 - acc: 0.52
50 - recall: 0.3586 - precision: 0.9630
Epoch 88/90
2/2 [=====] - 0s 84ms/step - loss: 0.6034 - acc: 0.68
00 - recall: 0.6138 - precision: 0.9175
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 0.6973 - acc: 0.62
00 - recall: 0.7034 - precision: 0.7556
Epoch 90/90
2/2 [=====] - 0s 86ms/step - loss: 0.5930 - acc: 0.76
50 - recall: 0.7586 - precision: 0.9016
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:50:11.984522: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 69ms/step
```

```
7/7 [=====] - 0s 33ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:50:12.994963: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 789ms/step - loss: 0.6888 - acc: 0.6  
700 - recall: 0.7568 - precision: 0.7887  
Epoch 2/90  
2/2 [=====] - 0s 164ms/step - loss: 0.6882 - acc: 0.6  
100 - recall: 0.6757 - precision: 0.7692  
Epoch 3/90  
2/2 [=====] - 0s 145ms/step - loss: 0.6874 - acc: 0.5  
850 - recall: 0.6284 - precision: 0.7686  
Epoch 4/90  
2/2 [=====] - 0s 157ms/step - loss: 0.6886 - acc: 0.5  
800 - recall: 0.6216 - precision: 0.7667  
Epoch 5/90  
2/2 [=====] - 0s 135ms/step - loss: 0.6888 - acc: 0.5  
700 - recall: 0.6284 - precision: 0.7500  
Epoch 6/90  
2/2 [=====] - 0s 216ms/step - loss: 0.6875 - acc: 0.6  
350 - recall: 0.6824 - precision: 0.7953  
Epoch 7/90  
2/2 [=====] - 0s 145ms/step - loss: 0.6864 - acc: 0.6  
450 - recall: 0.6554 - precision: 0.8291  
Epoch 8/90  
2/2 [=====] - 0s 156ms/step - loss: 0.6883 - acc: 0.5  
500 - recall: 0.5676 - precision: 0.7636  
Epoch 9/90  
2/2 [=====] - 0s 147ms/step - loss: 0.6864 - acc: 0.6  
250 - recall: 0.6892 - precision: 0.7786  
Epoch 10/90  
2/2 [=====] - 0s 140ms/step - loss: 0.6815 - acc: 0.6  
550 - recall: 0.6824 - precision: 0.8211  
Epoch 11/90  
2/2 [=====] - 0s 137ms/step - loss: 0.6867 - acc: 0.6  
000 - recall: 0.6149 - precision: 0.7982  
Epoch 12/90  
2/2 [=====] - 0s 190ms/step - loss: 0.6820 - acc: 0.7  
000 - recall: 0.7703 - precision: 0.8143  
Epoch 13/90  
2/2 [=====] - 0s 137ms/step - loss: 0.6832 - acc: 0.6  
800 - recall: 0.7500 - precision: 0.8043  
Epoch 14/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6846 - acc: 0.66  
00 - recall: 0.7162 - precision: 0.8030  
Epoch 15/90  
2/2 [=====] - 0s 121ms/step - loss: 0.6841 - acc: 0.6  
100 - recall: 0.6351 - precision: 0.7966  
Epoch 16/90  
2/2 [=====] - 0s 288ms/step - loss: 0.6850 - acc: 0.5  
450 - recall: 0.4595 - precision: 0.8608  
Epoch 17/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6824 - acc: 0.56  
00 - recall: 0.4797 - precision: 0.8659  
Epoch 18/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6836 - acc: 0.61  
00 - recall: 0.5811 - precision: 0.8431  
Epoch 19/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6807 - acc: 0.59  
50 - recall: 0.5608 - precision: 0.8384  
Epoch 20/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6828 - acc: 0.59  
00 - recall: 0.5473 - precision: 0.8438  
Epoch 21/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.6810 - acc: 0.64
00 - recall: 0.6216 - precision: 0.8519
Epoch 22/90
2/2 [=====] - 0s 118ms/step - loss: 0.6801 - acc: 0.6
850 - recall: 0.7365 - precision: 0.8195
Epoch 23/90
2/2 [=====] - 0s 124ms/step - loss: 0.6794 - acc: 0.6
950 - recall: 0.7432 - precision: 0.8271
Epoch 24/90
2/2 [=====] - 0s 74ms/step - loss: 0.6822 - acc: 0.63
00 - recall: 0.6351 - precision: 0.8246
Epoch 25/90
2/2 [=====] - 0s 74ms/step - loss: 0.6794 - acc: 0.61
50 - recall: 0.5608 - precision: 0.8737
Epoch 26/90
2/2 [=====] - 0s 74ms/step - loss: 0.6786 - acc: 0.65
50 - recall: 0.6419 - precision: 0.8559
Epoch 27/90
2/2 [=====] - 0s 128ms/step - loss: 0.6776 - acc: 0.6
400 - recall: 0.6554 - precision: 0.8220
Epoch 28/90
2/2 [=====] - 0s 75ms/step - loss: 0.6785 - acc: 0.58
00 - recall: 0.5405 - precision: 0.8333
Epoch 29/90
2/2 [=====] - 0s 74ms/step - loss: 0.6758 - acc: 0.70
00 - recall: 0.7297 - precision: 0.8438
Epoch 30/90
2/2 [=====] - 0s 74ms/step - loss: 0.6780 - acc: 0.62
50 - recall: 0.6149 - precision: 0.8349
Epoch 31/90
2/2 [=====] - 0s 76ms/step - loss: 0.6737 - acc: 0.72
50 - recall: 0.7432 - precision: 0.8661
Epoch 32/90
2/2 [=====] - 0s 80ms/step - loss: 0.6785 - acc: 0.71
00 - recall: 0.7635 - precision: 0.8309
Epoch 33/90
2/2 [=====] - 0s 93ms/step - loss: 0.6710 - acc: 0.73
50 - recall: 0.7703 - precision: 0.8571
Epoch 34/90
2/2 [=====] - 0s 97ms/step - loss: 0.6723 - acc: 0.60
50 - recall: 0.5338 - precision: 0.8876
Epoch 35/90
2/2 [=====] - 0s 91ms/step - loss: 0.6713 - acc: 0.68
00 - recall: 0.6757 - precision: 0.8621
Epoch 36/90
2/2 [=====] - 0s 175ms/step - loss: 0.6694 - acc: 0.7
100 - recall: 0.7027 - precision: 0.8814
Epoch 37/90
2/2 [=====] - 0s 81ms/step - loss: 0.6673 - acc: 0.74
50 - recall: 0.7770 - precision: 0.8647
Epoch 38/90
2/2 [=====] - 0s 86ms/step - loss: 0.6622 - acc: 0.65
00 - recall: 0.5811 - precision: 0.9149
Epoch 39/90
2/2 [=====] - 0s 90ms/step - loss: 0.6710 - acc: 0.66
50 - recall: 0.6824 - precision: 0.8347
Epoch 40/90
2/2 [=====] - 0s 136ms/step - loss: 0.6673 - acc: 0.7
100 - recall: 0.7027 - precision: 0.8814
Epoch 41/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.6667 - acc: 0.78
00 - recall: 0.8649 - precision: 0.8421
Epoch 42/90
2/2 [=====] - 0s 87ms/step - loss: 0.6673 - acc: 0.75
50 - recall: 0.7905 - precision: 0.8667
Epoch 43/90
2/2 [=====] - 0s 88ms/step - loss: 0.6632 - acc: 0.70
50 - recall: 0.6757 - precision: 0.9009
Epoch 44/90
2/2 [=====] - 0s 103ms/step - loss: 0.6598 - acc: 0.7
500 - recall: 0.7905 - precision: 0.8603
Epoch 45/90
2/2 [=====] - 0s 133ms/step - loss: 0.6546 - acc: 0.7
950 - recall: 0.8311 - precision: 0.8849
Epoch 46/90
2/2 [=====] - 0s 82ms/step - loss: 0.6581 - acc: 0.65
50 - recall: 0.5811 - precision: 0.9247
Epoch 47/90
2/2 [=====] - 0s 80ms/step - loss: 0.6639 - acc: 0.63
00 - recall: 0.5676 - precision: 0.8936
Epoch 48/90
2/2 [=====] - 0s 100ms/step - loss: 0.6563 - acc: 0.7
650 - recall: 0.8243 - precision: 0.8531
Epoch 49/90
2/2 [=====] - 0s 86ms/step - loss: 0.6505 - acc: 0.67
50 - recall: 0.6216 - precision: 0.9109
Epoch 50/90
2/2 [=====] - 0s 88ms/step - loss: 0.6664 - acc: 0.67
50 - recall: 0.7027 - precision: 0.8320
Epoch 51/90
2/2 [=====] - 0s 88ms/step - loss: 0.6606 - acc: 0.73
00 - recall: 0.7703 - precision: 0.8507
Epoch 52/90
2/2 [=====] - 0s 86ms/step - loss: 0.6457 - acc: 0.76
00 - recall: 0.7770 - precision: 0.8846
Epoch 53/90
2/2 [=====] - 0s 85ms/step - loss: 0.6518 - acc: 0.78
00 - recall: 0.9122 - precision: 0.8133
Epoch 54/90
2/2 [=====] - 0s 87ms/step - loss: 0.6507 - acc: 0.71
00 - recall: 0.6824 - precision: 0.9018
Epoch 55/90
2/2 [=====] - 0s 86ms/step - loss: 0.6558 - acc: 0.68
00 - recall: 0.7027 - precision: 0.8387
Epoch 56/90
2/2 [=====] - 0s 85ms/step - loss: 0.6415 - acc: 0.77
00 - recall: 0.8176 - precision: 0.8643
Epoch 57/90
2/2 [=====] - 0s 87ms/step - loss: 0.6482 - acc: 0.74
00 - recall: 0.7838 - precision: 0.8529
Epoch 58/90
2/2 [=====] - 0s 86ms/step - loss: 0.6347 - acc: 0.73
50 - recall: 0.6892 - precision: 0.9358
Epoch 59/90
2/2 [=====] - 0s 85ms/step - loss: 0.6361 - acc: 0.66
50 - recall: 0.6149 - precision: 0.9010
Epoch 60/90
2/2 [=====] - 0s 145ms/step - loss: 0.6355 - acc: 0.7
800 - recall: 0.8446 - precision: 0.8562
Epoch 61/90
```

```
2/2 [=====] - 0s 87ms/step - loss: 0.6320 - acc: 0.72
00 - recall: 0.6892 - precision: 0.9107
Epoch 62/90
2/2 [=====] - 0s 89ms/step - loss: 0.6408 - acc: 0.67
50 - recall: 0.6622 - precision: 0.8673
Epoch 63/90
2/2 [=====] - 0s 87ms/step - loss: 0.6356 - acc: 0.77
00 - recall: 0.8581 - precision: 0.8355
Epoch 64/90
2/2 [=====] - 0s 87ms/step - loss: 0.6216 - acc: 0.74
00 - recall: 0.7297 - precision: 0.9000
Epoch 65/90
2/2 [=====] - 0s 86ms/step - loss: 0.6196 - acc: 0.74
00 - recall: 0.7162 - precision: 0.9138
Epoch 66/90
2/2 [=====] - 0s 86ms/step - loss: 0.6214 - acc: 0.72
50 - recall: 0.7162 - precision: 0.8908
Epoch 67/90
2/2 [=====] - 0s 85ms/step - loss: 0.6143 - acc: 0.72
00 - recall: 0.6757 - precision: 0.9259
Epoch 68/90
2/2 [=====] - 0s 86ms/step - loss: 0.6098 - acc: 0.83
00 - recall: 0.9054 - precision: 0.8701
Epoch 69/90
2/2 [=====] - 0s 87ms/step - loss: 0.6213 - acc: 0.67
00 - recall: 0.6351 - precision: 0.8868
Epoch 70/90
2/2 [=====] - 0s 86ms/step - loss: 0.6185 - acc: 0.64
00 - recall: 0.5878 - precision: 0.8878
Epoch 71/90
2/2 [=====] - 0s 86ms/step - loss: 0.6627 - acc: 0.63
00 - recall: 0.7568 - precision: 0.7467
Epoch 72/90
2/2 [=====] - 0s 86ms/step - loss: 0.5984 - acc: 0.80
50 - recall: 0.8514 - precision: 0.8811
Epoch 73/90
2/2 [=====] - 0s 85ms/step - loss: 0.6009 - acc: 0.79
50 - recall: 0.8311 - precision: 0.8849
Epoch 74/90
2/2 [=====] - 0s 85ms/step - loss: 0.5809 - acc: 0.75
00 - recall: 0.7365 - precision: 0.9083
Epoch 75/90
2/2 [=====] - 0s 86ms/step - loss: 0.5829 - acc: 0.77
50 - recall: 0.7703 - precision: 0.9120
Epoch 76/90
2/2 [=====] - 0s 86ms/step - loss: 0.5827 - acc: 0.76
00 - recall: 0.7635 - precision: 0.8968
Epoch 77/90
2/2 [=====] - 0s 85ms/step - loss: 0.6235 - acc: 0.57
00 - recall: 0.5000 - precision: 0.8605
Epoch 78/90
2/2 [=====] - 0s 85ms/step - loss: 0.5959 - acc: 0.66
50 - recall: 0.6351 - precision: 0.8785
Epoch 79/90
2/2 [=====] - 0s 86ms/step - loss: 0.6025 - acc: 0.60
00 - recall: 0.5270 - precision: 0.8864
Epoch 80/90
2/2 [=====] - 0s 86ms/step - loss: 0.5885 - acc: 0.66
50 - recall: 0.6149 - precision: 0.9010
Epoch 81/90
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.5964 - acc: 0.66
50 - recall: 0.6149 - precision: 0.9010
Epoch 82/90
2/2 [=====] - 0s 89ms/step - loss: 0.6022 - acc: 0.66
50 - recall: 0.6486 - precision: 0.8649
Epoch 83/90
2/2 [=====] - 0s 87ms/step - loss: 0.6076 - acc: 0.58
00 - recall: 0.5000 - precision: 0.8810
Epoch 84/90
2/2 [=====] - 0s 88ms/step - loss: 0.5711 - acc: 0.64
50 - recall: 0.5608 - precision: 0.9326
Epoch 85/90
2/2 [=====] - 0s 90ms/step - loss: 0.5369 - acc: 0.82
00 - recall: 0.8514 - precision: 0.9000
Epoch 86/90
2/2 [=====] - 0s 87ms/step - loss: 0.6282 - acc: 0.66
50 - recall: 0.6892 - precision: 0.8293
Epoch 87/90
2/2 [=====] - 0s 86ms/step - loss: 0.6830 - acc: 0.40
50 - recall: 0.2027 - precision: 0.9677
Epoch 88/90
2/2 [=====] - 0s 84ms/step - loss: 0.5975 - acc: 0.73
50 - recall: 0.8108 - precision: 0.8276
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 0.5591 - acc: 0.83
50 - recall: 0.8784 - precision: 0.8966
Epoch 90/90
2/2 [=====] - 0s 86ms/step - loss: 0.5522 - acc: 0.77
00 - recall: 0.7568 - precision: 0.9180
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:50:37.152925: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 58ms/step
7/7 [=====] - 0s 33ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:50:38.130263: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 762ms/step - loss: 0.6859 - acc: 0.6  
150 - recall: 0.6846 - precision: 0.7727  
Epoch 2/90  
2/2 [=====] - 1s 445ms/step - loss: 0.6863 - acc: 0.5  
850 - recall: 0.6443 - precision: 0.7619  
Epoch 3/90  
2/2 [=====] - 0s 105ms/step - loss: 0.6806 - acc: 0.6  
650 - recall: 0.7248 - precision: 0.8060  
Epoch 4/90  
2/2 [=====] - 0s 182ms/step - loss: 0.6873 - acc: 0.5  
350 - recall: 0.6040 - precision: 0.7258  
Epoch 5/90  
2/2 [=====] - 0s 196ms/step - loss: 0.6863 - acc: 0.5  
500 - recall: 0.5638 - precision: 0.7706  
Epoch 6/90  
2/2 [=====] - 0s 221ms/step - loss: 0.6829 - acc: 0.5  
950 - recall: 0.5973 - precision: 0.8091  
Epoch 7/90  
2/2 [=====] - 0s 142ms/step - loss: 0.6842 - acc: 0.5  
400 - recall: 0.5034 - precision: 0.8065  
Epoch 8/90  
2/2 [=====] - 0s 139ms/step - loss: 0.6830 - acc: 0.6  
250 - recall: 0.6577 - precision: 0.8033  
Epoch 9/90  
2/2 [=====] - 0s 140ms/step - loss: 0.6841 - acc: 0.5  
450 - recall: 0.5436 - precision: 0.7788  
Epoch 10/90  
2/2 [=====] - 0s 157ms/step - loss: 0.6851 - acc: 0.5  
300 - recall: 0.5638 - precision: 0.7434  
Epoch 11/90  
2/2 [=====] - 0s 175ms/step - loss: 0.6796 - acc: 0.6  
450 - recall: 0.6711 - precision: 0.8197  
Epoch 12/90  
2/2 [=====] - 0s 119ms/step - loss: 0.6835 - acc: 0.6  
500 - recall: 0.7517 - precision: 0.7724  
Epoch 13/90  
2/2 [=====] - 0s 78ms/step - loss: 0.6829 - acc: 0.64  
00 - recall: 0.7315 - precision: 0.7730  
Epoch 14/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6810 - acc: 0.69  
50 - recall: 0.8255 - precision: 0.7785  
Epoch 15/90  
2/2 [=====] - 0s 96ms/step - loss: 0.6820 - acc: 0.69  
50 - recall: 0.8389 - precision: 0.7716  
Epoch 16/90  
2/2 [=====] - 0s 233ms/step - loss: 0.6806 - acc: 0.7  
200 - recall: 0.8523 - precision: 0.7888  
Epoch 17/90  
2/2 [=====] - 0s 151ms/step - loss: 0.6741 - acc: 0.7  
900 - recall: 0.8658 - precision: 0.8543  
Epoch 18/90  
2/2 [=====] - 0s 132ms/step - loss: 0.6823 - acc: 0.6  
600 - recall: 0.8054 - precision: 0.7547  
Epoch 19/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6778 - acc: 0.73  
00 - recall: 0.8658 - precision: 0.7914  
Epoch 20/90  
2/2 [=====] - 0s 76ms/step - loss: 0.6800 - acc: 0.71  
00 - recall: 0.8389 - precision: 0.7862  
Epoch 21/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.6763 - acc: 0.70
50 - recall: 0.8188 - precision: 0.7922
Epoch 22/90
2/2 [=====] - 0s 77ms/step - loss: 0.6754 - acc: 0.74
00 - recall: 0.8591 - precision: 0.8050
Epoch 23/90
2/2 [=====] - 0s 132ms/step - loss: 0.6751 - acc: 0.7
550 - recall: 0.8591 - precision: 0.8205
Epoch 24/90
2/2 [=====] - 0s 98ms/step - loss: 0.6729 - acc: 0.71
50 - recall: 0.7450 - precision: 0.8538
Epoch 25/90
2/2 [=====] - 0s 74ms/step - loss: 0.6761 - acc: 0.66
50 - recall: 0.6443 - precision: 0.8727
Epoch 26/90
2/2 [=====] - 0s 76ms/step - loss: 0.6757 - acc: 0.70
50 - recall: 0.7718 - precision: 0.8214
Epoch 27/90
2/2 [=====] - 0s 167ms/step - loss: 0.6776 - acc: 0.7
250 - recall: 0.7919 - precision: 0.8310
Epoch 28/90
2/2 [=====] - 0s 76ms/step - loss: 0.6771 - acc: 0.61
50 - recall: 0.5973 - precision: 0.8396
Epoch 29/90
2/2 [=====] - 0s 75ms/step - loss: 0.6755 - acc: 0.59
50 - recall: 0.5369 - precision: 0.8696
Epoch 30/90
2/2 [=====] - 0s 118ms/step - loss: 0.6798 - acc: 0.5
250 - recall: 0.4631 - precision: 0.8214
Epoch 31/90
2/2 [=====] - 0s 75ms/step - loss: 0.6718 - acc: 0.77
00 - recall: 0.8591 - precision: 0.8366
Epoch 32/90
2/2 [=====] - 0s 78ms/step - loss: 0.6755 - acc: 0.71
50 - recall: 0.7919 - precision: 0.8194
Epoch 33/90
2/2 [=====] - 0s 76ms/step - loss: 0.6753 - acc: 0.71
50 - recall: 0.7919 - precision: 0.8194
Epoch 34/90
2/2 [=====] - 0s 75ms/step - loss: 0.6722 - acc: 0.72
50 - recall: 0.7718 - precision: 0.8456
Epoch 35/90
2/2 [=====] - 0s 120ms/step - loss: 0.6681 - acc: 0.8
150 - recall: 0.8523 - precision: 0.8944
Epoch 36/90
2/2 [=====] - 0s 75ms/step - loss: 0.6703 - acc: 0.71
50 - recall: 0.7651 - precision: 0.8382
Epoch 37/90
2/2 [=====] - 0s 75ms/step - loss: 0.6695 - acc: 0.78
50 - recall: 0.8926 - precision: 0.8313
Epoch 38/90
2/2 [=====] - 0s 75ms/step - loss: 0.6739 - acc: 0.58
50 - recall: 0.5503 - precision: 0.8367
Epoch 39/90
2/2 [=====] - 0s 263ms/step - loss: 0.6650 - acc: 0.7
950 - recall: 0.8591 - precision: 0.8649
Epoch 40/90
2/2 [=====] - 0s 85ms/step - loss: 0.6616 - acc: 0.73
50 - recall: 0.7248 - precision: 0.9000
Epoch 41/90
```

```
2/2 [=====] - 0s 95ms/step - loss: 0.6717 - acc: 0.67  
00 - recall: 0.6980 - precision: 0.8320  
Epoch 42/90  
2/2 [=====] - 0s 97ms/step - loss: 0.6635 - acc: 0.70  
50 - recall: 0.6711 - precision: 0.9091  
Epoch 43/90  
2/2 [=====] - 0s 90ms/step - loss: 0.6614 - acc: 0.74  
50 - recall: 0.7450 - precision: 0.8952  
Epoch 44/90  
2/2 [=====] - 0s 89ms/step - loss: 0.6572 - acc: 0.70  
50 - recall: 0.6644 - precision: 0.9167  
Epoch 45/90  
2/2 [=====] - 0s 88ms/step - loss: 0.6678 - acc: 0.72  
50 - recall: 0.7248 - precision: 0.8852  
Epoch 46/90  
2/2 [=====] - 0s 89ms/step - loss: 0.6636 - acc: 0.72  
00 - recall: 0.7450 - precision: 0.8605  
Epoch 47/90  
2/2 [=====] - 0s 88ms/step - loss: 0.6617 - acc: 0.81  
00 - recall: 0.8993 - precision: 0.8535  
Epoch 48/90  
2/2 [=====] - 0s 88ms/step - loss: 0.6570 - acc: 0.69  
00 - recall: 0.6577 - precision: 0.8991  
Epoch 49/90  
2/2 [=====] - 0s 88ms/step - loss: 0.6617 - acc: 0.74  
50 - recall: 0.7987 - precision: 0.8500  
Epoch 50/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6638 - acc: 0.64  
50 - recall: 0.5906 - precision: 0.8980  
Epoch 51/90  
2/2 [=====] - 0s 84ms/step - loss: 0.6581 - acc: 0.71  
50 - recall: 0.7114 - precision: 0.8833  
Epoch 52/90  
2/2 [=====] - 0s 89ms/step - loss: 0.6622 - acc: 0.76  
50 - recall: 0.8322 - precision: 0.8493  
Epoch 53/90  
2/2 [=====] - 0s 91ms/step - loss: 0.6568 - acc: 0.70  
00 - recall: 0.7047 - precision: 0.8678  
Epoch 54/90  
2/2 [=====] - 0s 89ms/step - loss: 0.6504 - acc: 0.75  
00 - recall: 0.7517 - precision: 0.8960  
Epoch 55/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6595 - acc: 0.70  
50 - recall: 0.7315 - precision: 0.8516  
Epoch 56/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6500 - acc: 0.76  
00 - recall: 0.8054 - precision: 0.8633  
Epoch 57/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6459 - acc: 0.73  
50 - recall: 0.7517 - precision: 0.8750  
Epoch 58/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6469 - acc: 0.78  
00 - recall: 0.8322 - precision: 0.8671  
Epoch 59/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6423 - acc: 0.71  
00 - recall: 0.6376 - precision: 0.9596  
Epoch 60/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6520 - acc: 0.77  
00 - recall: 0.8725 - precision: 0.8280  
Epoch 61/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.6441 - acc: 0.66  
00 - recall: 0.6174 - precision: 0.8932  
Epoch 62/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6538 - acc: 0.70  
50 - recall: 0.7315 - precision: 0.8516  
Epoch 63/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6496 - acc: 0.56  
00 - recall: 0.4430 - precision: 0.9296  
Epoch 64/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6378 - acc: 0.73  
00 - recall: 0.6980 - precision: 0.9204  
Epoch 65/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6475 - acc: 0.77  
00 - recall: 0.8859 - precision: 0.8199  
Epoch 66/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6294 - acc: 0.78  
00 - recall: 0.7919 - precision: 0.9008  
Epoch 67/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6339 - acc: 0.77  
50 - recall: 0.8121 - precision: 0.8768  
Epoch 68/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6370 - acc: 0.75  
50 - recall: 0.8322 - precision: 0.8378  
Epoch 69/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6287 - acc: 0.59  
50 - recall: 0.4832 - precision: 0.9474  
Epoch 70/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6233 - acc: 0.81  
00 - recall: 0.9060 - precision: 0.8491  
Epoch 71/90  
2/2 [=====] - 0s 88ms/step - loss: 0.6269 - acc: 0.66  
00 - recall: 0.6040 - precision: 0.9091  
Epoch 72/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6147 - acc: 0.73  
00 - recall: 0.6913 - precision: 0.9279  
Epoch 73/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6269 - acc: 0.77  
50 - recall: 0.8255 - precision: 0.8662  
Epoch 74/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6323 - acc: 0.70  
50 - recall: 0.7181 - precision: 0.8629  
Epoch 75/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6077 - acc: 0.69  
50 - recall: 0.6309 - precision: 0.9400  
Epoch 76/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6176 - acc: 0.71  
00 - recall: 0.6846 - precision: 0.9027  
Epoch 77/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6124 - acc: 0.76  
50 - recall: 0.7718 - precision: 0.8984  
Epoch 78/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6155 - acc: 0.73  
50 - recall: 0.7450 - precision: 0.8810  
Epoch 79/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6052 - acc: 0.77  
50 - recall: 0.7987 - precision: 0.8881  
Epoch 80/90  
2/2 [=====] - 0s 86ms/step - loss: 0.5925 - acc: 0.82  
00 - recall: 0.8456 - precision: 0.9065  
Epoch 81/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.5955 - acc: 0.71
50 - recall: 0.6711 - precision: 0.9259
Epoch 82/90
2/2 [=====] - 0s 85ms/step - loss: 0.5805 - acc: 0.77
50 - recall: 0.7987 - precision: 0.8881
Epoch 83/90
2/2 [=====] - 0s 151ms/step - loss: 0.5981 - acc: 0.7
850 - recall: 0.8389 - precision: 0.8681
Epoch 84/90
2/2 [=====] - 0s 86ms/step - loss: 0.5953 - acc: 0.77
00 - recall: 0.7718 - precision: 0.9055
Epoch 85/90
2/2 [=====] - 0s 87ms/step - loss: 0.6094 - acc: 0.74
50 - recall: 0.7584 - precision: 0.8828
Epoch 86/90
2/2 [=====] - 0s 88ms/step - loss: 0.5846 - acc: 0.66
50 - recall: 0.6443 - precision: 0.8727
Epoch 87/90
2/2 [=====] - 0s 86ms/step - loss: 0.5781 - acc: 0.77
00 - recall: 0.7450 - precision: 0.9328
Epoch 88/90
2/2 [=====] - 0s 85ms/step - loss: 0.5769 - acc: 0.83
50 - recall: 0.8859 - precision: 0.8919
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 0.6203 - acc: 0.55
50 - recall: 0.4899 - precision: 0.8488
Epoch 90/90
2/2 [=====] - 0s 85ms/step - loss: 0.5971 - acc: 0.60
50 - recall: 0.5436 - precision: 0.8804
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:51:02.815044: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 68ms/step
```

```
7/7 [=====] - 0s 33ms/step
```

```
Epoch 1/45
```

```
2023-03-31 16:51:04.215735: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 795ms/step - loss: 0.7582 - acc: 0.5
400 - recall: 0.5103 - precision: 0.7789
Epoch 2/45
2/2 [=====] - 0s 205ms/step - loss: 0.7863 - acc: 0.6
250 - recall: 0.8138 - precision: 0.7108
Epoch 3/45
2/2 [=====] - 0s 172ms/step - loss: 0.7001 - acc: 0.4
900 - recall: 0.4138 - precision: 0.7792
Epoch 4/45
2/2 [=====] - 0s 215ms/step - loss: 0.6941 - acc: 0.3
750 - recall: 0.1931 - precision: 0.7778
Epoch 5/45
2/2 [=====] - 0s 160ms/step - loss: 0.6800 - acc: 0.5
950 - recall: 0.4897 - precision: 0.9103
Epoch 6/45
2/2 [=====] - 0s 189ms/step - loss: 0.6610 - acc: 0.5
250 - recall: 0.3724 - precision: 0.9310
Epoch 7/45
2/2 [=====] - 0s 94ms/step - loss: 0.6267 - acc: 0.65
00 - recall: 0.5862 - precision: 0.8947
Epoch 8/45
2/2 [=====] - 0s 156ms/step - loss: 0.5283 - acc: 0.7
900 - recall: 0.7448 - precision: 0.9558
Epoch 9/45
2/2 [=====] - 0s 153ms/step - loss: 0.4956 - acc: 0.8
100 - recall: 0.8621 - precision: 0.8741
Epoch 10/45
2/2 [=====] - 0s 118ms/step - loss: 0.5383 - acc: 0.7
300 - recall: 0.6828 - precision: 0.9252
Epoch 11/45
2/2 [=====] - 0s 121ms/step - loss: 0.4648 - acc: 0.8
250 - recall: 0.8414 - precision: 0.9104
Epoch 12/45
2/2 [=====] - 0s 177ms/step - loss: 0.4121 - acc: 0.8
150 - recall: 0.7862 - precision: 0.9500
Epoch 13/45
2/2 [=====] - 0s 98ms/step - loss: 0.4498 - acc: 0.76
00 - recall: 0.7103 - precision: 0.9450
Epoch 14/45
2/2 [=====] - 0s 159ms/step - loss: 0.3617 - acc: 0.8
150 - recall: 0.7862 - precision: 0.9500
Epoch 15/45
2/2 [=====] - 0s 130ms/step - loss: 0.3468 - acc: 0.8
350 - recall: 0.8276 - precision: 0.9375
Epoch 16/45
2/2 [=====] - 0s 315ms/step - loss: 0.3503 - acc: 0.8
300 - recall: 0.8000 - precision: 0.9587
Epoch 17/45
2/2 [=====] - 0s 133ms/step - loss: 0.2922 - acc: 0.8
600 - recall: 0.8414 - precision: 0.9606
Epoch 18/45
2/2 [=====] - 0s 99ms/step - loss: 0.2520 - acc: 0.88
00 - recall: 0.8414 - precision: 0.9919
Epoch 19/45
2/2 [=====] - 0s 125ms/step - loss: 0.2401 - acc: 0.8
750 - recall: 0.8552 - precision: 0.9688
Epoch 20/45
2/2 [=====] - 0s 76ms/step - loss: 0.2422 - acc: 0.88
00 - recall: 0.8483 - precision: 0.9840
Epoch 21/45
```

```
2/2 [=====] - 0s 74ms/step - loss: 0.2144 - acc: 0.90
50 - recall: 0.8897 - precision: 0.9773
Epoch 22/45
2/2 [=====] - 0s 93ms/step - loss: 0.1750 - acc: 0.91
00 - recall: 0.8828 - precision: 0.9922
Epoch 23/45
2/2 [=====] - 0s 75ms/step - loss: 0.2028 - acc: 0.92
50 - recall: 0.9310 - precision: 0.9643
Epoch 24/45
2/2 [=====] - 0s 135ms/step - loss: 0.1659 - acc: 0.9
300 - recall: 0.9172 - precision: 0.9852
Epoch 25/45
2/2 [=====] - 0s 117ms/step - loss: 0.1400 - acc: 0.9
450 - recall: 0.9379 - precision: 0.9855
Epoch 26/45
2/2 [=====] - 0s 77ms/step - loss: 0.2011 - acc: 0.93
00 - recall: 0.9448 - precision: 0.9580
Epoch 27/45
2/2 [=====] - 0s 81ms/step - loss: 0.1796 - acc: 0.90
50 - recall: 0.8690 - precision: 1.0000
Epoch 28/45
2/2 [=====] - 0s 132ms/step - loss: 0.1338 - acc: 0.9
600 - recall: 0.9448 - precision: 1.0000
Epoch 29/45
2/2 [=====] - 0s 76ms/step - loss: 0.0927 - acc: 0.96
50 - recall: 0.9517 - precision: 1.0000
Epoch 30/45
2/2 [=====] - 0s 76ms/step - loss: 0.1064 - acc: 0.96
00 - recall: 0.9517 - precision: 0.9928
Epoch 31/45
2/2 [=====] - 0s 75ms/step - loss: 0.0957 - acc: 0.96
00 - recall: 0.9517 - precision: 0.9928
Epoch 32/45
2/2 [=====] - 0s 76ms/step - loss: 0.0657 - acc: 0.97
00 - recall: 0.9586 - precision: 1.0000
Epoch 33/45
2/2 [=====] - 0s 76ms/step - loss: 0.0830 - acc: 0.96
00 - recall: 0.9724 - precision: 0.9724
Epoch 34/45
2/2 [=====] - 0s 76ms/step - loss: 0.0977 - acc: 0.96
50 - recall: 0.9586 - precision: 0.9929
Epoch 35/45
2/2 [=====] - 0s 75ms/step - loss: 0.0697 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 36/45
2/2 [=====] - 0s 75ms/step - loss: 0.0971 - acc: 0.96
50 - recall: 0.9724 - precision: 0.9792
Epoch 37/45
2/2 [=====] - 0s 75ms/step - loss: 0.0762 - acc: 0.95
00 - recall: 0.9310 - precision: 1.0000
Epoch 38/45
2/2 [=====] - 0s 78ms/step - loss: 0.0504 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 39/45
2/2 [=====] - 0s 84ms/step - loss: 0.0444 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 40/45
2/2 [=====] - 0s 89ms/step - loss: 0.0448 - acc: 0.97
50 - recall: 0.9724 - precision: 0.9930
Epoch 41/45
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.0373 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 90ms/step - loss: 0.0645 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 43/45
2/2 [=====] - 0s 89ms/step - loss: 0.0594 - acc: 0.98
00 - recall: 0.9862 - precision: 0.9862
Epoch 44/45
2/2 [=====] - 0s 88ms/step - loss: 0.0395 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 45/45
2/2 [=====] - 0s 89ms/step - loss: 0.0608 - acc: 0.96
00 - recall: 0.9517 - precision: 0.9928
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:51:18.296455: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 55ms/step
7/7 [=====] - 0s 31ms/step
Epoch 1/45
2023-03-31 16:51:19.315763: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 802ms/step - loss: 0.6978 - acc: 0.5  
400 - recall: 0.5473 - precision: 0.7642  
Epoch 2/45  
2/2 [=====] - 1s 507ms/step - loss: 0.6922 - acc: 0.6  
400 - recall: 0.7230 - precision: 0.7754  
Epoch 3/45  
2/2 [=====] - 0s 148ms/step - loss: 0.6810 - acc: 0.4  
900 - recall: 0.4257 - precision: 0.7875  
Epoch 4/45  
2/2 [=====] - 0s 215ms/step - loss: 0.6693 - acc: 0.5  
350 - recall: 0.4527 - precision: 0.8481  
Epoch 5/45  
2/2 [=====] - 0s 218ms/step - loss: 0.6298 - acc: 0.6  
550 - recall: 0.6689 - precision: 0.8319  
Epoch 6/45  
2/2 [=====] - 0s 176ms/step - loss: 0.6066 - acc: 0.6  
550 - recall: 0.6149 - precision: 0.8835  
Epoch 7/45  
2/2 [=====] - 0s 148ms/step - loss: 0.5339 - acc: 0.7  
900 - recall: 0.8108 - precision: 0.8955  
Epoch 8/45  
2/2 [=====] - 0s 104ms/step - loss: 0.4789 - acc: 0.8  
100 - recall: 0.8243 - precision: 0.9104  
Epoch 9/45  
2/2 [=====] - 0s 156ms/step - loss: 0.4844 - acc: 0.7  
550 - recall: 0.7365 - precision: 0.9160  
Epoch 10/45  
2/2 [=====] - 0s 201ms/step - loss: 0.4148 - acc: 0.8  
200 - recall: 0.7973 - precision: 0.9516  
Epoch 11/45  
2/2 [=====] - 0s 154ms/step - loss: 0.4137 - acc: 0.8  
300 - recall: 0.8243 - precision: 0.9385  
Epoch 12/45  
2/2 [=====] - 0s 120ms/step - loss: 0.4006 - acc: 0.7  
900 - recall: 0.7770 - precision: 0.9274  
Epoch 13/45  
2/2 [=====] - 0s 179ms/step - loss: 0.3309 - acc: 0.8  
250 - recall: 0.7905 - precision: 0.9669  
Epoch 14/45  
2/2 [=====] - 0s 76ms/step - loss: 0.3142 - acc: 0.85  
50 - recall: 0.8649 - precision: 0.9343  
Epoch 15/45  
2/2 [=====] - 0s 180ms/step - loss: 0.2610 - acc: 0.8  
800 - recall: 0.8581 - precision: 0.9769  
Epoch 16/45  
2/2 [=====] - 0s 75ms/step - loss: 0.2537 - acc: 0.87  
00 - recall: 0.8446 - precision: 0.9766  
Epoch 17/45  
2/2 [=====] - 0s 131ms/step - loss: 0.2526 - acc: 0.9  
100 - recall: 0.9392 - precision: 0.9392  
Epoch 18/45  
2/2 [=====] - 0s 77ms/step - loss: 0.1996 - acc: 0.90  
50 - recall: 0.8784 - precision: 0.9924  
Epoch 19/45  
2/2 [=====] - 0s 96ms/step - loss: 0.2439 - acc: 0.88  
00 - recall: 0.8581 - precision: 0.9769  
Epoch 20/45  
2/2 [=====] - 0s 136ms/step - loss: 0.1288 - acc: 0.9  
550 - recall: 0.9459 - precision: 0.9929  
Epoch 21/45
```

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2/2 [=====] - 0s 167ms/step - loss: 0.2000 - acc: 0.9  
350 - recall: 0.9392 - precision: 0.9720  
Epoch 22/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1666 - acc: 0.93  
00 - recall: 0.9122 - precision: 0.9926  
Epoch 23/45  
2/2 [=====] - 0s 77ms/step - loss: 0.1598 - acc: 0.91  
50 - recall: 0.9054 - precision: 0.9781  
Epoch 24/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1298 - acc: 0.94  
00 - recall: 0.9324 - precision: 0.9857  
Epoch 25/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0968 - acc: 0.97  
50 - recall: 0.9797 - precision: 0.9864  
Epoch 26/45  
2/2 [=====] - 0s 74ms/step - loss: 0.0832 - acc: 0.97  
00 - recall: 0.9662 - precision: 0.9931  
Epoch 27/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0801 - acc: 0.96  
50 - recall: 0.9527 - precision: 1.0000  
Epoch 28/45  
2/2 [=====] - 0s 86ms/step - loss: 0.0660 - acc: 0.97  
50 - recall: 0.9662 - precision: 1.0000  
Epoch 29/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0627 - acc: 0.97  
50 - recall: 0.9865 - precision: 0.9799  
Epoch 30/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0756 - acc: 0.97  
00 - recall: 0.9797 - precision: 0.9864  
Epoch 31/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0637 - acc: 0.97  
00 - recall: 0.9662 - precision: 0.9931  
Epoch 32/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0615 - acc: 0.97  
00 - recall: 0.9730 - precision: 0.9863  
Epoch 33/45  
2/2 [=====] - 0s 93ms/step - loss: 0.0552 - acc: 0.97  
50 - recall: 0.9662 - precision: 1.0000  
Epoch 34/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0316 - acc: 0.98  
50 - recall: 0.9865 - precision: 0.9932  
Epoch 35/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1104 - acc: 0.97  
00 - recall: 1.0000 - precision: 0.9610  
Epoch 36/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0999 - acc: 0.94  
50 - recall: 0.9257 - precision: 1.0000  
Epoch 37/45  
2/2 [=====] - 0s 77ms/step - loss: 0.0935 - acc: 0.97  
50 - recall: 0.9797 - precision: 0.9864  
Epoch 38/45  
2/2 [=====] - 0s 78ms/step - loss: 0.0491 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 39/45  
2/2 [=====] - 1s 452ms/step - loss: 0.1145 - acc: 0.9  
700 - recall: 0.9797 - precision: 0.9797  
Epoch 40/45  
2/2 [=====] - 0s 82ms/step - loss: 0.0950 - acc: 0.96  
50 - recall: 0.9730 - precision: 0.9796  
Epoch 41/45
```

```
2/2 [=====] - 0s 99ms/step - loss: 0.0759 - acc: 0.95
50 - recall: 0.9392 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 88ms/step - loss: 0.0539 - acc: 0.97
50 - recall: 0.9730 - precision: 0.9931
Epoch 43/45
2/2 [=====] - 0s 94ms/step - loss: 0.0444 - acc: 0.99
00 - recall: 0.9932 - precision: 0.9932
Epoch 44/45
2/2 [=====] - 0s 91ms/step - loss: 0.0323 - acc: 0.98
50 - recall: 0.9865 - precision: 0.9932
Epoch 45/45
2/2 [=====] - 0s 90ms/step - loss: 0.0488 - acc: 0.98
00 - recall: 0.9730 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:51:33.835631: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 63ms/step
7/7 [=====] - 0s 32ms/step
Epoch 1/45
2023-03-31 16:51:34.909192: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 809ms/step - loss: 0.7363 - acc: 0.5  
050 - recall: 0.5436 - precision: 0.7232  
Epoch 2/45  
2/2 [=====] - 0s 227ms/step - loss: 0.7328 - acc: 0.5  
950 - recall: 0.7047 - precision: 0.7394  
Epoch 3/45  
2/2 [=====] - 0s 235ms/step - loss: 0.6839 - acc: 0.6  
500 - recall: 0.7651 - precision: 0.7651  
Epoch 4/45  
2/2 [=====] - 0s 226ms/step - loss: 0.6779 - acc: 0.6  
850 - recall: 0.8322 - precision: 0.7654  
Epoch 5/45  
2/2 [=====] - 0s 201ms/step - loss: 0.6720 - acc: 0.6  
250 - recall: 0.7248 - precision: 0.7606  
Epoch 6/45  
2/2 [=====] - 0s 208ms/step - loss: 0.6585 - acc: 0.5  
650 - recall: 0.5436 - precision: 0.8100  
Epoch 7/45  
2/2 [=====] - 0s 164ms/step - loss: 0.6077 - acc: 0.7  
450 - recall: 0.7852 - precision: 0.8603  
Epoch 8/45  
2/2 [=====] - 0s 119ms/step - loss: 0.5395 - acc: 0.7  
700 - recall: 0.7718 - precision: 0.9055  
Epoch 9/45  
2/2 [=====] - 0s 77ms/step - loss: 0.5244 - acc: 0.82  
00 - recall: 0.9128 - precision: 0.8553  
Epoch 10/45  
2/2 [=====] - 0s 97ms/step - loss: 0.4783 - acc: 0.82  
00 - recall: 0.8725 - precision: 0.8844  
Epoch 11/45  
2/2 [=====] - 0s 163ms/step - loss: 0.4245 - acc: 0.7  
600 - recall: 0.7047 - precision: 0.9633  
Epoch 12/45  
2/2 [=====] - 0s 74ms/step - loss: 0.4369 - acc: 0.80  
50 - recall: 0.7852 - precision: 0.9435  
Epoch 13/45  
2/2 [=====] - 0s 130ms/step - loss: 0.4216 - acc: 0.8  
000 - recall: 0.7919 - precision: 0.9291  
Epoch 14/45  
2/2 [=====] - 0s 84ms/step - loss: 0.3579 - acc: 0.85  
00 - recall: 0.8322 - precision: 0.9612  
Epoch 15/45  
2/2 [=====] - 0s 143ms/step - loss: 0.3717 - acc: 0.8  
200 - recall: 0.8188 - precision: 0.9313  
Epoch 16/45  
2/2 [=====] - 0s 134ms/step - loss: 0.3113 - acc: 0.8  
900 - recall: 0.8859 - precision: 0.9635  
Epoch 17/45  
2/2 [=====] - 0s 98ms/step - loss: 0.3392 - acc: 0.85  
00 - recall: 0.8456 - precision: 0.9474  
Epoch 18/45  
2/2 [=====] - 0s 198ms/step - loss: 0.3060 - acc: 0.8  
700 - recall: 0.8658 - precision: 0.9556  
Epoch 19/45  
2/2 [=====] - 0s 76ms/step - loss: 0.2744 - acc: 0.84  
50 - recall: 0.8389 - precision: 0.9470  
Epoch 20/45  
2/2 [=====] - 0s 75ms/step - loss: 0.2219 - acc: 0.90  
00 - recall: 0.8859 - precision: 0.9778  
Epoch 21/45
```

```
2/2 [=====] - 0s 94ms/step - loss: 0.1958 - acc: 0.92
00 - recall: 0.9060 - precision: 0.9854
Epoch 22/45
2/2 [=====] - 0s 266ms/step - loss: 0.2136 - acc: 0.9
000 - recall: 0.8792 - precision: 0.9850
Epoch 23/45
2/2 [=====] - 0s 77ms/step - loss: 0.1674 - acc: 0.94
00 - recall: 0.9396 - precision: 0.9790
Epoch 24/45
2/2 [=====] - 0s 76ms/step - loss: 0.1425 - acc: 0.92
00 - recall: 0.8993 - precision: 0.9926
Epoch 25/45
2/2 [=====] - 0s 137ms/step - loss: 0.1590 - acc: 0.9
100 - recall: 0.8926 - precision: 0.9852
Epoch 26/45
2/2 [=====] - 0s 181ms/step - loss: 0.2327 - acc: 0.9
350 - recall: 0.9664 - precision: 0.9474
Epoch 27/45
2/2 [=====] - 0s 77ms/step - loss: 0.1878 - acc: 0.90
50 - recall: 0.8926 - precision: 0.9779
Epoch 28/45
2/2 [=====] - 0s 76ms/step - loss: 0.1944 - acc: 0.91
00 - recall: 0.8993 - precision: 0.9781
Epoch 29/45
2/2 [=====] - 0s 82ms/step - loss: 0.1744 - acc: 0.94
50 - recall: 0.9597 - precision: 0.9662
Epoch 30/45
2/2 [=====] - 0s 83ms/step - loss: 0.1705 - acc: 0.94
50 - recall: 0.9396 - precision: 0.9859
Epoch 31/45
2/2 [=====] - 0s 77ms/step - loss: 0.1376 - acc: 0.93
00 - recall: 0.9128 - precision: 0.9927
Epoch 32/45
2/2 [=====] - 0s 75ms/step - loss: 0.1594 - acc: 0.90
50 - recall: 0.8725 - precision: 1.0000
Epoch 33/45
2/2 [=====] - 0s 75ms/step - loss: 0.0963 - acc: 0.96
00 - recall: 0.9530 - precision: 0.9930
Epoch 34/45
2/2 [=====] - 0s 75ms/step - loss: 0.1591 - acc: 0.96
50 - recall: 0.9866 - precision: 0.9671
Epoch 35/45
2/2 [=====] - 0s 75ms/step - loss: 0.0934 - acc: 0.96
50 - recall: 0.9664 - precision: 0.9863
Epoch 36/45
2/2 [=====] - 0s 135ms/step - loss: 0.1166 - acc: 0.9
550 - recall: 0.9396 - precision: 1.0000
Epoch 37/45
2/2 [=====] - 0s 77ms/step - loss: 0.0982 - acc: 0.94
50 - recall: 0.9396 - precision: 0.9859
Epoch 38/45
2/2 [=====] - 0s 120ms/step - loss: 0.0677 - acc: 0.9
650 - recall: 0.9530 - precision: 1.0000
Epoch 39/45
2/2 [=====] - 0s 77ms/step - loss: 0.0749 - acc: 0.98
00 - recall: 0.9799 - precision: 0.9932
Epoch 40/45
2/2 [=====] - 0s 78ms/step - loss: 0.0407 - acc: 0.98
00 - recall: 0.9732 - precision: 1.0000
Epoch 41/45
```

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2/2 [=====] - 0s 85ms/step - loss: 0.0468 - acc: 0.97
50 - recall: 0.9799 - precision: 0.9865
Epoch 42/45
2/2 [=====] - 0s 89ms/step - loss: 0.0449 - acc: 0.97
50 - recall: 0.9732 - precision: 0.9932
Epoch 43/45
2/2 [=====] - 0s 85ms/step - loss: 0.0368 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 44/45
2/2 [=====] - 0s 85ms/step - loss: 0.0408 - acc: 0.97
00 - recall: 0.9732 - precision: 0.9864
Epoch 45/45
2/2 [=====] - 0s 87ms/step - loss: 0.0243 - acc: 0.98
00 - recall: 0.9732 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:51:49.022549: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 59ms/step
7/7 [=====] - 0s 39ms/step
Epoch 1/45
2023-03-31 16:51:50.352191: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 801ms/step - loss: 0.7044 - acc: 0.5  
750 - recall: 0.6276 - precision: 0.7459  
Epoch 2/45  
2/2 [=====] - 1s 429ms/step - loss: 0.7101 - acc: 0.5  
000 - recall: 0.5586 - precision: 0.6923  
Epoch 3/45  
2/2 [=====] - 0s 204ms/step - loss: 0.7032 - acc: 0.5  
350 - recall: 0.5793 - precision: 0.7241  
Epoch 4/45  
2/2 [=====] - 0s 204ms/step - loss: 0.6984 - acc: 0.5  
800 - recall: 0.6276 - precision: 0.7521  
Epoch 5/45  
2/2 [=====] - 0s 169ms/step - loss: 0.6956 - acc: 0.5  
900 - recall: 0.5724 - precision: 0.8058  
Epoch 6/45  
2/2 [=====] - 0s 137ms/step - loss: 0.7059 - acc: 0.4  
550 - recall: 0.4345 - precision: 0.7000  
Epoch 7/45  
2/2 [=====] - 0s 144ms/step - loss: 0.7033 - acc: 0.4  
850 - recall: 0.4552 - precision: 0.7333  
Epoch 8/45  
2/2 [=====] - 0s 106ms/step - loss: 0.7041 - acc: 0.4  
750 - recall: 0.4276 - precision: 0.7381  
Epoch 9/45  
2/2 [=====] - 0s 160ms/step - loss: 0.7058 - acc: 0.5  
100 - recall: 0.5034 - precision: 0.7374  
Epoch 10/45  
2/2 [=====] - 0s 222ms/step - loss: 0.7029 - acc: 0.4  
750 - recall: 0.4138 - precision: 0.7500  
Epoch 11/45  
2/2 [=====] - 0s 94ms/step - loss: 0.6987 - acc: 0.47  
50 - recall: 0.3724 - precision: 0.7941  
Epoch 12/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6991 - acc: 0.45  
50 - recall: 0.3379 - precision: 0.7903  
Epoch 13/45  
2/2 [=====] - 0s 74ms/step - loss: 0.7056 - acc: 0.36  
50 - recall: 0.2828 - precision: 0.6406  
Epoch 14/45  
2/2 [=====] - 0s 131ms/step - loss: 0.6988 - acc: 0.4  
550 - recall: 0.3655 - precision: 0.7571  
Epoch 15/45  
2/2 [=====] - 0s 97ms/step - loss: 0.6959 - acc: 0.50  
50 - recall: 0.4069 - precision: 0.8194  
Epoch 16/45  
2/2 [=====] - 0s 133ms/step - loss: 0.6953 - acc: 0.4  
650 - recall: 0.3655 - precision: 0.7794  
Epoch 17/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6958 - acc: 0.50  
00 - recall: 0.3655 - precision: 0.8689  
Epoch 18/45  
2/2 [=====] - 0s 120ms/step - loss: 0.6977 - acc: 0.4  
700 - recall: 0.3655 - precision: 0.7910  
Epoch 19/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6941 - acc: 0.49  
00 - recall: 0.4000 - precision: 0.7945  
Epoch 20/45  
2/2 [=====] - 0s 136ms/step - loss: 0.6987 - acc: 0.5  
250 - recall: 0.4345 - precision: 0.8289  
Epoch 21/45
```

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2/2 [=====] - 0s 100ms/step - loss: 0.6948 - acc: 0.4  
850 - recall: 0.3793 - precision: 0.8088  
Epoch 22/45  
2/2 [=====] - 0s 151ms/step - loss: 0.6939 - acc: 0.4  
800 - recall: 0.3655 - precision: 0.8154  
Epoch 23/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6954 - acc: 0.48  
50 - recall: 0.4069 - precision: 0.7763  
Epoch 24/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6907 - acc: 0.54  
00 - recall: 0.4414 - precision: 0.8533  
Epoch 25/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6989 - acc: 0.46  
00 - recall: 0.3793 - precision: 0.7534  
Epoch 26/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6954 - acc: 0.48  
50 - recall: 0.3586 - precision: 0.8387  
Epoch 27/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6959 - acc: 0.48  
00 - recall: 0.3724 - precision: 0.8060  
Epoch 28/45  
2/2 [=====] - 0s 142ms/step - loss: 0.6926 - acc: 0.4  
800 - recall: 0.3448 - precision: 0.8475  
Epoch 29/45  
2/2 [=====] - 0s 120ms/step - loss: 0.6958 - acc: 0.4  
300 - recall: 0.2759 - precision: 0.8163  
Epoch 30/45  
2/2 [=====] - 0s 134ms/step - loss: 0.6896 - acc: 0.4  
650 - recall: 0.3172 - precision: 0.8519  
Epoch 31/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6960 - acc: 0.45  
00 - recall: 0.3172 - precision: 0.8070  
Epoch 32/45  
2/2 [=====] - 0s 94ms/step - loss: 0.6975 - acc: 0.43  
00 - recall: 0.3103 - precision: 0.7627  
Epoch 33/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6950 - acc: 0.4  
550 - recall: 0.3379 - precision: 0.7903  
Epoch 34/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6973 - acc: 0.46  
00 - recall: 0.3241 - precision: 0.8246  
Epoch 35/45  
2/2 [=====] - 0s 73ms/step - loss: 0.6935 - acc: 0.47  
00 - recall: 0.3586 - precision: 0.8000  
Epoch 36/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6980 - acc: 0.41  
00 - recall: 0.2690 - precision: 0.7647  
Epoch 37/45  
2/2 [=====] - 0s 119ms/step - loss: 0.6935 - acc: 0.4  
150 - recall: 0.2552 - precision: 0.8043  
Epoch 38/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6861 - acc: 0.53  
00 - recall: 0.4069 - precision: 0.8806  
Epoch 39/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6885 - acc: 0.52  
50 - recall: 0.3931 - precision: 0.8906  
Epoch 40/45  
2/2 [=====] - 0s 185ms/step - loss: 0.6905 - acc: 0.4  
750 - recall: 0.3172 - precision: 0.8846  
Epoch 41/45
```

```
2/2 [=====] - 0s 90ms/step - loss: 0.6925 - acc: 0.45
50 - recall: 0.3517 - precision: 0.7727
Epoch 42/45
2/2 [=====] - 0s 91ms/step - loss: 0.6909 - acc: 0.46
50 - recall: 0.3586 - precision: 0.7879
Epoch 43/45
2/2 [=====] - 0s 92ms/step - loss: 0.6893 - acc: 0.44
50 - recall: 0.3103 - precision: 0.8036
Epoch 44/45
2/2 [=====] - 0s 89ms/step - loss: 0.6806 - acc: 0.53
50 - recall: 0.4207 - precision: 0.8714
Epoch 45/45
2/2 [=====] - 0s 88ms/step - loss: 0.6915 - acc: 0.45
50 - recall: 0.3241 - precision: 0.8103
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:52:04.362235: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 71ms/step
7/7 [=====] - 0s 33ms/step
Epoch 1/45
2023-03-31 16:52:05.386229: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 747ms/step - loss: 0.6928 - acc: 0.5
200 - recall: 0.5743 - precision: 0.7203
Epoch 2/45
2/2 [=====] - 0s 230ms/step - loss: 0.6921 - acc: 0.5
100 - recall: 0.5676 - precision: 0.7119
Epoch 3/45
2/2 [=====] - 0s 141ms/step - loss: 0.6934 - acc: 0.4
850 - recall: 0.5338 - precision: 0.6991
Epoch 4/45
2/2 [=====] - 0s 224ms/step - loss: 0.6936 - acc: 0.5
300 - recall: 0.5946 - precision: 0.7213
Epoch 5/45
2/2 [=====] - 0s 156ms/step - loss: 0.6851 - acc: 0.5
950 - recall: 0.6554 - precision: 0.7638
Epoch 6/45
2/2 [=====] - 0s 215ms/step - loss: 0.6814 - acc: 0.6
000 - recall: 0.6081 - precision: 0.8036
Epoch 7/45
2/2 [=====] - 0s 196ms/step - loss: 0.6883 - acc: 0.6
150 - recall: 0.6689 - precision: 0.7795
Epoch 8/45
2/2 [=====] - 0s 195ms/step - loss: 0.6828 - acc: 0.5
850 - recall: 0.6216 - precision: 0.7731
Epoch 9/45
2/2 [=====] - 0s 81ms/step - loss: 0.6947 - acc: 0.52
50 - recall: 0.5946 - precision: 0.7154
Epoch 10/45
2/2 [=====] - 0s 101ms/step - loss: 0.6852 - acc: 0.6
200 - recall: 0.6824 - precision: 0.7769
Epoch 11/45
2/2 [=====] - 0s 143ms/step - loss: 0.6854 - acc: 0.6
000 - recall: 0.6351 - precision: 0.7833
Epoch 12/45
2/2 [=====] - 0s 124ms/step - loss: 0.6902 - acc: 0.5
250 - recall: 0.5473 - precision: 0.7431
Epoch 13/45
2/2 [=====] - 0s 143ms/step - loss: 0.6792 - acc: 0.6
200 - recall: 0.6149 - precision: 0.8273
Epoch 14/45
2/2 [=====] - 0s 135ms/step - loss: 0.6795 - acc: 0.5
850 - recall: 0.6014 - precision: 0.7876
Epoch 15/45
2/2 [=====] - 0s 144ms/step - loss: 0.6931 - acc: 0.5
300 - recall: 0.5405 - precision: 0.7547
Epoch 16/45
2/2 [=====] - 0s 74ms/step - loss: 0.6829 - acc: 0.55
00 - recall: 0.5473 - precision: 0.7788
Epoch 17/45
2/2 [=====] - 0s 102ms/step - loss: 0.6822 - acc: 0.5
650 - recall: 0.5405 - precision: 0.8081
Epoch 18/45
2/2 [=====] - 0s 129ms/step - loss: 0.6834 - acc: 0.5
300 - recall: 0.5000 - precision: 0.7872
Epoch 19/45
2/2 [=====] - 0s 130ms/step - loss: 0.6808 - acc: 0.5
600 - recall: 0.5676 - precision: 0.7778
Epoch 20/45
2/2 [=====] - 0s 260ms/step - loss: 0.6758 - acc: 0.5
950 - recall: 0.5608 - precision: 0.8384
Epoch 21/45
```

```
2/2 [=====] - 0s 119ms/step - loss: 0.6876 - acc: 0.5  
400 - recall: 0.5541 - precision: 0.7593  
Epoch 22/45  
2/2 [=====] - 0s 134ms/step - loss: 0.6749 - acc: 0.6  
150 - recall: 0.6081 - precision: 0.8257  
Epoch 23/45  
2/2 [=====] - 0s 92ms/step - loss: 0.6866 - acc: 0.57  
50 - recall: 0.6081 - precision: 0.7692  
Epoch 24/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6870 - acc: 0.53  
00 - recall: 0.5405 - precision: 0.7547  
Epoch 25/45  
2/2 [=====] - 0s 95ms/step - loss: 0.6833 - acc: 0.55  
00 - recall: 0.5743 - precision: 0.7589  
Epoch 26/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6807 - acc: 0.61  
00 - recall: 0.6554 - precision: 0.7823  
Epoch 27/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6879 - acc: 0.57  
00 - recall: 0.5878 - precision: 0.7768  
Epoch 28/45  
2/2 [=====] - 0s 77ms/step - loss: 0.6857 - acc: 0.55  
00 - recall: 0.5405 - precision: 0.7843  
Epoch 29/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6850 - acc: 0.58  
50 - recall: 0.6081 - precision: 0.7826  
Epoch 30/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6785 - acc: 0.63  
50 - recall: 0.6149 - precision: 0.8505  
Epoch 31/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6755 - acc: 0.59  
00 - recall: 0.5473 - precision: 0.8438  
Epoch 32/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6780 - acc: 0.60  
00 - recall: 0.6014 - precision: 0.8091  
Epoch 33/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6804 - acc: 0.53  
50 - recall: 0.5000 - precision: 0.7957  
Epoch 34/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6795 - acc: 0.61  
50 - recall: 0.6081 - precision: 0.8257  
Epoch 35/45  
2/2 [=====] - 0s 77ms/step - loss: 0.6855 - acc: 0.53  
50 - recall: 0.5338 - precision: 0.7670  
Epoch 36/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6734 - acc: 0.60  
50 - recall: 0.5946 - precision: 0.8224  
Epoch 37/45  
2/2 [=====] - 0s 83ms/step - loss: 0.6727 - acc: 0.62  
50 - recall: 0.6014 - precision: 0.8476  
Epoch 38/45  
2/2 [=====] - 0s 90ms/step - loss: 0.6797 - acc: 0.63  
50 - recall: 0.6149 - precision: 0.8505  
Epoch 39/45  
2/2 [=====] - 0s 91ms/step - loss: 0.6745 - acc: 0.63  
00 - recall: 0.6486 - precision: 0.8136  
Epoch 40/45  
2/2 [=====] - 0s 106ms/step - loss: 0.6763 - acc: 0.6  
000 - recall: 0.5811 - precision: 0.8269  
Epoch 41/45
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6786 - acc: 0.59
00 - recall: 0.6081 - precision: 0.7895
Epoch 42/45
2/2 [=====] - 0s 89ms/step - loss: 0.6746 - acc: 0.61
50 - recall: 0.6284 - precision: 0.8087
Epoch 43/45
2/2 [=====] - 0s 88ms/step - loss: 0.6724 - acc: 0.60
50 - recall: 0.6351 - precision: 0.7899
Epoch 44/45
2/2 [=====] - 0s 88ms/step - loss: 0.6751 - acc: 0.63
50 - recall: 0.6757 - precision: 0.8000
Epoch 45/45
2/2 [=====] - 0s 88ms/step - loss: 0.6743 - acc: 0.65
50 - recall: 0.6351 - precision: 0.8624
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:52:19.142500: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 63ms/step
7/7 [=====] - 0s 38ms/step
Epoch 1/45
2023-03-31 16:52:20.202444: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 739ms/step - loss: 0.6876 - acc: 0.5  
550 - recall: 0.6443 - precision: 0.7273  
Epoch 2/45  
2/2 [=====] - 0s 175ms/step - loss: 0.6879 - acc: 0.5  
300 - recall: 0.5839 - precision: 0.7311  
Epoch 3/45  
2/2 [=====] - 0s 217ms/step - loss: 0.6835 - acc: 0.5  
450 - recall: 0.5906 - precision: 0.7458  
Epoch 4/45  
2/2 [=====] - 0s 145ms/step - loss: 0.6874 - acc: 0.5  
450 - recall: 0.5772 - precision: 0.7544  
Epoch 5/45  
2/2 [=====] - 0s 89ms/step - loss: 0.6914 - acc: 0.53  
00 - recall: 0.5906 - precision: 0.7273  
Epoch 6/45  
2/2 [=====] - 0s 224ms/step - loss: 0.6821 - acc: 0.5  
600 - recall: 0.5973 - precision: 0.7607  
Epoch 7/45  
2/2 [=====] - 0s 98ms/step - loss: 0.6809 - acc: 0.63  
00 - recall: 0.6510 - precision: 0.8151  
Epoch 8/45  
2/2 [=====] - 0s 219ms/step - loss: 0.6823 - acc: 0.5  
500 - recall: 0.5705 - precision: 0.7658  
Epoch 9/45  
2/2 [=====] - 0s 102ms/step - loss: 0.6827 - acc: 0.5  
450 - recall: 0.5436 - precision: 0.7788  
Epoch 10/45  
2/2 [=====] - 0s 142ms/step - loss: 0.6862 - acc: 0.5  
200 - recall: 0.5302 - precision: 0.7524  
Epoch 11/45  
2/2 [=====] - 0s 204ms/step - loss: 0.6826 - acc: 0.5  
750 - recall: 0.6040 - precision: 0.7759  
Epoch 12/45  
2/2 [=====] - 0s 200ms/step - loss: 0.6831 - acc: 0.5  
550 - recall: 0.5906 - precision: 0.7586  
Epoch 13/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6800 - acc: 0.58  
00 - recall: 0.5772 - precision: 0.8037  
Epoch 14/45  
2/2 [=====] - 0s 121ms/step - loss: 0.6805 - acc: 0.6  
500 - recall: 0.6913 - precision: 0.8110  
Epoch 15/45  
2/2 [=====] - 0s 91ms/step - loss: 0.6896 - acc: 0.58  
00 - recall: 0.6309 - precision: 0.7642  
Epoch 16/45  
2/2 [=====] - 0s 138ms/step - loss: 0.6763 - acc: 0.6  
050 - recall: 0.6040 - precision: 0.8182  
Epoch 17/45  
2/2 [=====] - 0s 149ms/step - loss: 0.6825 - acc: 0.5  
800 - recall: 0.6107 - precision: 0.7778  
Epoch 18/45  
2/2 [=====] - 0s 88ms/step - loss: 0.6834 - acc: 0.54  
00 - recall: 0.5436 - precision: 0.7714  
Epoch 19/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6780 - acc: 0.59  
00 - recall: 0.5973 - precision: 0.8018  
Epoch 20/45  
2/2 [=====] - 0s 95ms/step - loss: 0.6726 - acc: 0.64  
50 - recall: 0.6309 - precision: 0.8545  
Epoch 21/45
```

```
2/2 [=====] - 0s 94ms/step - loss: 0.6768 - acc: 0.65
00 - recall: 0.6779 - precision: 0.8211
Epoch 22/45
2/2 [=====] - 0s 184ms/step - loss: 0.6810 - acc: 0.6
250 - recall: 0.6644 - precision: 0.7984
Epoch 23/45
2/2 [=====] - 0s 131ms/step - loss: 0.6763 - acc: 0.6
250 - recall: 0.6779 - precision: 0.7891
Epoch 24/45
2/2 [=====] - 0s 75ms/step - loss: 0.6817 - acc: 0.63
50 - recall: 0.7315 - precision: 0.7676
Epoch 25/45
2/2 [=====] - 0s 131ms/step - loss: 0.6731 - acc: 0.6
300 - recall: 0.6376 - precision: 0.8261
Epoch 26/45
2/2 [=====] - 0s 75ms/step - loss: 0.6838 - acc: 0.58
00 - recall: 0.6107 - precision: 0.7778
Epoch 27/45
2/2 [=====] - 0s 75ms/step - loss: 0.6811 - acc: 0.56
50 - recall: 0.5503 - precision: 0.8039
Epoch 28/45
2/2 [=====] - 0s 75ms/step - loss: 0.6727 - acc: 0.58
50 - recall: 0.5302 - precision: 0.8587
Epoch 29/45
2/2 [=====] - 0s 75ms/step - loss: 0.6807 - acc: 0.52
50 - recall: 0.4832 - precision: 0.8000
Epoch 30/45
2/2 [=====] - 0s 130ms/step - loss: 0.6795 - acc: 0.5
650 - recall: 0.5436 - precision: 0.8100
Epoch 31/45
2/2 [=====] - 0s 75ms/step - loss: 0.6759 - acc: 0.59
50 - recall: 0.5906 - precision: 0.8148
Epoch 32/45
2/2 [=====] - 0s 78ms/step - loss: 0.6782 - acc: 0.59
50 - recall: 0.6107 - precision: 0.7982
Epoch 33/45
2/2 [=====] - 0s 75ms/step - loss: 0.6811 - acc: 0.51
00 - recall: 0.5034 - precision: 0.7576
Epoch 34/45
2/2 [=====] - 0s 74ms/step - loss: 0.6797 - acc: 0.54
50 - recall: 0.5034 - precision: 0.8152
Epoch 35/45
2/2 [=====] - 0s 77ms/step - loss: 0.6773 - acc: 0.57
00 - recall: 0.5839 - precision: 0.7838
Epoch 36/45
2/2 [=====] - 0s 74ms/step - loss: 0.6674 - acc: 0.63
50 - recall: 0.6309 - precision: 0.8393
Epoch 37/45
2/2 [=====] - 0s 76ms/step - loss: 0.6740 - acc: 0.64
00 - recall: 0.6846 - precision: 0.8031
Epoch 38/45
2/2 [=====] - 0s 123ms/step - loss: 0.6737 - acc: 0.6
050 - recall: 0.6242 - precision: 0.8017
Epoch 39/45
2/2 [=====] - 0s 85ms/step - loss: 0.6724 - acc: 0.62
50 - recall: 0.6309 - precision: 0.8246
Epoch 40/45
2/2 [=====] - 0s 96ms/step - loss: 0.6758 - acc: 0.60
00 - recall: 0.6174 - precision: 0.8000
Epoch 41/45
```

```
2/2 [=====] - 0s 131ms/step - loss: 0.6787 - acc: 0.6  
300 - recall: 0.6711 - precision: 0.8000  
Epoch 42/45  
2/2 [=====] - 0s 86ms/step - loss: 0.6653 - acc: 0.64  
50 - recall: 0.6846 - precision: 0.8095  
Epoch 43/45  
2/2 [=====] - 0s 261ms/step - loss: 0.6797 - acc: 0.6  
300 - recall: 0.6846 - precision: 0.7907  
Epoch 44/45  
2/2 [=====] - 0s 88ms/step - loss: 0.6767 - acc: 0.65  
50 - recall: 0.7785 - precision: 0.7632  
Epoch 45/45  
2/2 [=====] - 0s 90ms/step - loss: 0.6716 - acc: 0.67  
50 - recall: 0.7248 - precision: 0.8182  
1/4 [=====>.....] - ETA: 0s  
2023-03-31 16:52:34.453612: I tensorflow/core/grappler/optimizers/custom_graph  
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
4/4 [=====] - 0s 62ms/step  
7/7 [=====] - 0s 32ms/step  
Epoch 1/65  
2023-03-31 16:52:35.504535: I tensorflow/core/grappler/optimizers/custom_graph  
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 829ms/step - loss: 0.7166 - acc: 0.5  
800 - recall: 0.6345 - precision: 0.7480  
Epoch 2/65  
2/2 [=====] - 0s 247ms/step - loss: 0.7066 - acc: 0.4  
550 - recall: 0.3931 - precision: 0.7308  
Epoch 3/65  
2/2 [=====] - 0s 222ms/step - loss: 0.6923 - acc: 0.4  
700 - recall: 0.3448 - precision: 0.8197  
Epoch 4/65  
2/2 [=====] - 0s 169ms/step - loss: 0.6777 - acc: 0.5  
450 - recall: 0.4621 - precision: 0.8375  
Epoch 5/65  
2/2 [=====] - 0s 147ms/step - loss: 0.6613 - acc: 0.5  
350 - recall: 0.4483 - precision: 0.8333  
Epoch 6/65  
2/2 [=====] - 0s 161ms/step - loss: 0.5879 - acc: 0.7  
550 - recall: 0.7241 - precision: 0.9211  
Epoch 7/65  
2/2 [=====] - 0s 200ms/step - loss: 0.5215 - acc: 0.7  
550 - recall: 0.7241 - precision: 0.9211  
Epoch 8/65  
2/2 [=====] - 0s 222ms/step - loss: 0.4731 - acc: 0.7  
750 - recall: 0.7862 - precision: 0.8906  
Epoch 9/65  
2/2 [=====] - 0s 218ms/step - loss: 0.4282 - acc: 0.8  
250 - recall: 0.8207 - precision: 0.9297  
Epoch 10/65  
2/2 [=====] - 0s 244ms/step - loss: 0.4708 - acc: 0.8  
000 - recall: 0.7586 - precision: 0.9565  
Epoch 11/65  
2/2 [=====] - 0s 144ms/step - loss: 0.4566 - acc: 0.8  
250 - recall: 0.8759 - precision: 0.8819  
Epoch 12/65  
2/2 [=====] - 0s 137ms/step - loss: 0.3873 - acc: 0.8  
100 - recall: 0.7724 - precision: 0.9573  
Epoch 13/65  
2/2 [=====] - 0s 123ms/step - loss: 0.4054 - acc: 0.7  
950 - recall: 0.7310 - precision: 0.9815  
Epoch 14/65  
2/2 [=====] - 0s 82ms/step - loss: 0.2899 - acc: 0.85  
50 - recall: 0.8345 - precision: 0.9603  
Epoch 15/65  
2/2 [=====] - 0s 81ms/step - loss: 0.3009 - acc: 0.89  
00 - recall: 0.8966 - precision: 0.9489  
Epoch 16/65  
2/2 [=====] - 0s 137ms/step - loss: 0.3440 - acc: 0.8  
150 - recall: 0.7586 - precision: 0.9821  
Epoch 17/65  
2/2 [=====] - 0s 75ms/step - loss: 0.2845 - acc: 0.89  
50 - recall: 0.9103 - precision: 0.9429  
Epoch 18/65  
2/2 [=====] - 0s 119ms/step - loss: 0.3444 - acc: 0.8  
750 - recall: 0.9310 - precision: 0.9000  
Epoch 19/65  
2/2 [=====] - 0s 83ms/step - loss: 0.2647 - acc: 0.88  
00 - recall: 0.8690 - precision: 0.9618  
Epoch 20/65  
2/2 [=====] - 1s 260ms/step - loss: 0.2435 - acc: 0.8  
750 - recall: 0.8276 - precision: 1.0000  
Epoch 21/65
```

```
2/2 [=====] - 0s 78ms/step - loss: 0.2354 - acc: 0.87
50 - recall: 0.8414 - precision: 0.9839
Epoch 22/65
2/2 [=====] - 0s 75ms/step - loss: 0.2271 - acc: 0.89
00 - recall: 0.8552 - precision: 0.9920
Epoch 23/65
2/2 [=====] - 0s 75ms/step - loss: 0.2100 - acc: 0.90
50 - recall: 0.9172 - precision: 0.9500
Epoch 24/65
2/2 [=====] - 0s 77ms/step - loss: 0.1609 - acc: 0.94
00 - recall: 0.9448 - precision: 0.9716
Epoch 25/65
2/2 [=====] - 0s 75ms/step - loss: 0.1433 - acc: 0.96
00 - recall: 0.9448 - precision: 1.0000
Epoch 26/65
2/2 [=====] - 0s 94ms/step - loss: 0.1407 - acc: 0.93
00 - recall: 0.9103 - precision: 0.9925
Epoch 27/65
2/2 [=====] - 0s 94ms/step - loss: 0.1050 - acc: 0.94
50 - recall: 0.9241 - precision: 1.0000
Epoch 28/65
2/2 [=====] - 0s 75ms/step - loss: 0.1210 - acc: 0.95
50 - recall: 0.9655 - precision: 0.9722
Epoch 29/65
2/2 [=====] - 0s 84ms/step - loss: 0.0843 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 30/65
2/2 [=====] - 0s 96ms/step - loss: 0.0848 - acc: 0.97
00 - recall: 0.9655 - precision: 0.9929
Epoch 31/65
2/2 [=====] - 0s 77ms/step - loss: 0.0779 - acc: 0.97
50 - recall: 0.9793 - precision: 0.9861
Epoch 32/65
2/2 [=====] - 0s 75ms/step - loss: 0.0745 - acc: 0.96
50 - recall: 0.9586 - precision: 0.9929
Epoch 33/65
2/2 [=====] - 0s 75ms/step - loss: 0.0771 - acc: 0.97
50 - recall: 0.9724 - precision: 0.9930
Epoch 34/65
2/2 [=====] - 0s 75ms/step - loss: 0.0589 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 35/65
2/2 [=====] - 0s 78ms/step - loss: 0.0669 - acc: 0.98
00 - recall: 0.9862 - precision: 0.9862
Epoch 36/65
2/2 [=====] - 0s 132ms/step - loss: 0.0366 - acc: 0.9
750 - recall: 0.9655 - precision: 1.0000
Epoch 37/65
2/2 [=====] - 0s 120ms/step - loss: 0.0376 - acc: 0.9
900 - recall: 0.9862 - precision: 1.0000
Epoch 38/65
2/2 [=====] - 0s 95ms/step - loss: 0.0380 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 39/65
2/2 [=====] - 0s 139ms/step - loss: 0.0781 - acc: 0.9
800 - recall: 0.9862 - precision: 0.9862
Epoch 40/65
2/2 [=====] - 0s 79ms/step - loss: 0.0241 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 41/65
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.0301 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 42/65
2/2 [=====] - 0s 91ms/step - loss: 0.0426 - acc: 0.98
50 - recall: 0.9931 - precision: 0.9863
Epoch 43/65
2/2 [=====] - 0s 91ms/step - loss: 0.0175 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.0243 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 45/65
2/2 [=====] - 0s 89ms/step - loss: 0.0388 - acc: 0.98
50 - recall: 0.9931 - precision: 0.9863
Epoch 46/65
2/2 [=====] - 0s 88ms/step - loss: 0.0100 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 47/65
2/2 [=====] - 0s 103ms/step - loss: 0.0321 - acc: 0.9
850 - recall: 0.9862 - precision: 0.9931
Epoch 48/65
2/2 [=====] - 0s 85ms/step - loss: 0.0560 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 49/65
2/2 [=====] - 0s 86ms/step - loss: 0.0450 - acc: 0.97
50 - recall: 0.9724 - precision: 0.9930
Epoch 50/65
2/2 [=====] - 0s 85ms/step - loss: 0.0309 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 51/65
2/2 [=====] - 0s 86ms/step - loss: 0.0371 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 52/65
2/2 [=====] - 0s 87ms/step - loss: 0.0164 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 53/65
2/2 [=====] - 0s 96ms/step - loss: 0.0309 - acc: 0.97
50 - recall: 0.9724 - precision: 0.9930
Epoch 54/65
2/2 [=====] - 0s 85ms/step - loss: 0.0201 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 55/65
2/2 [=====] - 0s 85ms/step - loss: 0.0238 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 56/65
2/2 [=====] - 0s 86ms/step - loss: 0.0291 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 57/65
2/2 [=====] - 0s 85ms/step - loss: 0.0264 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 58/65
2/2 [=====] - 0s 84ms/step - loss: 0.0225 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 59/65
2/2 [=====] - 0s 87ms/step - loss: 0.0231 - acc: 0.98
50 - recall: 0.9793 - precision: 1.0000
Epoch 60/65
2/2 [=====] - 0s 86ms/step - loss: 0.0144 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 61/65
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.0211 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 62/65
2/2 [=====] - 0s 87ms/step - loss: 0.0206 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 86ms/step - loss: 0.0048 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 64/65
2/2 [=====] - 0s 84ms/step - loss: 0.0176 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 65/65
2/2 [=====] - 0s 181ms/step - loss: 0.0014 - acc: 1.0000
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:52:54.608616: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 59ms/step
7/7 [=====] - 0s 34ms/step
Epoch 1/65
2023-03-31 16:52:56.023921: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 827ms/step - loss: 0.7076 - acc: 0.5
400 - recall: 0.6081 - precision: 0.7258
Epoch 2/65
2/2 [=====] - 0s 174ms/step - loss: 0.6817 - acc: 0.4
850 - recall: 0.4122 - precision: 0.7922
Epoch 3/65
2/2 [=====] - 0s 231ms/step - loss: 0.6770 - acc: 0.5
200 - recall: 0.5000 - precision: 0.7708
Epoch 4/65
2/2 [=====] - 0s 188ms/step - loss: 0.6336 - acc: 0.6
300 - recall: 0.5676 - precision: 0.8936
Epoch 5/65
2/2 [=====] - 0s 231ms/step - loss: 0.6361 - acc: 0.5
650 - recall: 0.4595 - precision: 0.9067
Epoch 6/65
2/2 [=====] - 0s 82ms/step - loss: 0.5513 - acc: 0.77
00 - recall: 0.8311 - precision: 0.8542
Epoch 7/65
2/2 [=====] - 0s 137ms/step - loss: 0.4790 - acc: 0.8
150 - recall: 0.8378 - precision: 0.9051
Epoch 8/65
2/2 [=====] - 0s 211ms/step - loss: 0.5943 - acc: 0.7
050 - recall: 0.6824 - precision: 0.8938
Epoch 9/65
2/2 [=====] - 0s 96ms/step - loss: 0.4012 - acc: 0.82
50 - recall: 0.8311 - precision: 0.9248
Epoch 10/65
2/2 [=====] - 0s 200ms/step - loss: 0.4136 - acc: 0.8
050 - recall: 0.8041 - precision: 0.9225
Epoch 11/65
2/2 [=====] - 0s 159ms/step - loss: 0.4256 - acc: 0.8
000 - recall: 0.7973 - precision: 0.9219
Epoch 12/65
2/2 [=====] - 0s 146ms/step - loss: 0.3408 - acc: 0.8
450 - recall: 0.8311 - precision: 0.9535
Epoch 13/65
2/2 [=====] - 0s 119ms/step - loss: 0.3698 - acc: 0.8
250 - recall: 0.8041 - precision: 0.9520
Epoch 14/65
2/2 [=====] - 0s 139ms/step - loss: 0.3152 - acc: 0.8
900 - recall: 0.8784 - precision: 0.9701
Epoch 15/65
2/2 [=====] - 0s 194ms/step - loss: 0.3203 - acc: 0.8
650 - recall: 0.8716 - precision: 0.9416
Epoch 16/65
2/2 [=====] - 0s 76ms/step - loss: 0.2721 - acc: 0.86
50 - recall: 0.8243 - precision: 0.9919
Epoch 17/65
2/2 [=====] - 0s 143ms/step - loss: 0.2469 - acc: 0.9
000 - recall: 0.8784 - precision: 0.9848
Epoch 18/65
2/2 [=====] - 0s 83ms/step - loss: 0.2553 - acc: 0.91
00 - recall: 0.9257 - precision: 0.9514
Epoch 19/65
2/2 [=====] - 0s 77ms/step - loss: 0.1820 - acc: 0.91
50 - recall: 0.8919 - precision: 0.9925
Epoch 20/65
2/2 [=====] - 0s 95ms/step - loss: 0.2257 - acc: 0.88
00 - recall: 0.8514 - precision: 0.9844
Epoch 21/65
```

```
2/2 [=====] - 0s 79ms/step - loss: 0.1752 - acc: 0.91
00 - recall: 0.8986 - precision: 0.9779
Epoch 22/65
2/2 [=====] - 0s 219ms/step - loss: 0.2188 - acc: 0.9
350 - recall: 0.9527 - precision: 0.9592
Epoch 23/65
2/2 [=====] - 0s 77ms/step - loss: 0.1373 - acc: 0.95
00 - recall: 0.9527 - precision: 0.9792
Epoch 24/65
2/2 [=====] - 0s 77ms/step - loss: 0.1424 - acc: 0.93
00 - recall: 0.9122 - precision: 0.9926
Epoch 25/65
2/2 [=====] - 0s 115ms/step - loss: 0.1014 - acc: 0.9
600 - recall: 0.9459 - precision: 1.0000
Epoch 26/65
2/2 [=====] - 0s 76ms/step - loss: 0.0789 - acc: 0.97
50 - recall: 0.9797 - precision: 0.9864
Epoch 27/65
2/2 [=====] - 0s 75ms/step - loss: 0.1224 - acc: 0.95
50 - recall: 0.9662 - precision: 0.9728
Epoch 28/65
2/2 [=====] - 0s 75ms/step - loss: 0.1246 - acc: 0.95
00 - recall: 0.9392 - precision: 0.9929
Epoch 29/65
2/2 [=====] - 0s 76ms/step - loss: 0.0640 - acc: 0.98
00 - recall: 0.9730 - precision: 1.0000
Epoch 30/65
2/2 [=====] - 0s 132ms/step - loss: 0.0747 - acc: 0.9
900 - recall: 0.9932 - precision: 0.9932
Epoch 31/65
2/2 [=====] - 0s 86ms/step - loss: 0.0401 - acc: 0.98
00 - recall: 0.9797 - precision: 0.9932
Epoch 32/65
2/2 [=====] - 0s 117ms/step - loss: 0.0684 - acc: 0.9
600 - recall: 0.9459 - precision: 1.0000
Epoch 33/65
2/2 [=====] - 0s 77ms/step - loss: 0.0611 - acc: 0.97
00 - recall: 0.9662 - precision: 0.9931
Epoch 34/65
2/2 [=====] - 0s 75ms/step - loss: 0.0488 - acc: 0.98
50 - recall: 0.9865 - precision: 0.9932
Epoch 35/65
2/2 [=====] - 0s 74ms/step - loss: 0.0384 - acc: 0.98
50 - recall: 0.9865 - precision: 0.9932
Epoch 36/65
2/2 [=====] - 0s 75ms/step - loss: 0.0498 - acc: 0.97
50 - recall: 0.9797 - precision: 0.9864
Epoch 37/65
2/2 [=====] - 0s 80ms/step - loss: 0.0212 - acc: 0.98
50 - recall: 0.9797 - precision: 1.0000
Epoch 38/65
2/2 [=====] - 0s 77ms/step - loss: 0.0362 - acc: 0.99
00 - recall: 0.9932 - precision: 0.9932
Epoch 39/65
2/2 [=====] - 0s 79ms/step - loss: 0.0160 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 40/65
2/2 [=====] - 0s 87ms/step - loss: 0.0084 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 41/65
```

```
2/2 [=====] - 0s 92ms/step - loss: 0.0175 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 42/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0207 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 43/65  
2/2 [=====] - 0s 90ms/step - loss: 0.0099 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 44/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0409 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9867  
Epoch 45/65  
2/2 [=====] - 0s 104ms/step - loss: 0.0059 - acc: 1.0000  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 46/65  
2/2 [=====] - 0s 112ms/step - loss: 0.0142 - acc: 0.9950  
00 - recall: 0.9932 - precision: 1.0000  
Epoch 47/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0317 - acc: 0.9800  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 48/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0231 - acc: 0.9900  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 49/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0230 - acc: 0.9950  
00 - recall: 0.9932 - precision: 1.0000  
Epoch 50/65  
2/2 [=====] - 0s 89ms/step - loss: 0.0495 - acc: 0.9900  
00 - recall: 1.0000 - precision: 0.9867  
Epoch 51/65  
2/2 [=====] - 0s 91ms/step - loss: 0.0285 - acc: 0.9900  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 52/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0152 - acc: 0.9900  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 53/65  
2/2 [=====] - 0s 84ms/step - loss: 0.0285 - acc: 0.9850  
00 - recall: 0.9797 - precision: 1.0000  
Epoch 54/65  
2/2 [=====] - 0s 87ms/step - loss: 0.0176 - acc: 0.9900  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 55/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0171 - acc: 0.9900  
00 - recall: 0.9932 - precision: 1.0000  
Epoch 56/65  
2/2 [=====] - 0s 95ms/step - loss: 0.0135 - acc: 1.0000  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 57/65  
2/2 [=====] - 0s 85ms/step - loss: 0.0097 - acc: 1.0000  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 58/65  
2/2 [=====] - 0s 86ms/step - loss: 0.0185 - acc: 0.9950  
00 - recall: 1.0000 - precision: 0.9933  
Epoch 59/65  
2/2 [=====] - 0s 155ms/step - loss: 0.0026 - acc: 1.0000  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 60/65  
2/2 [=====] - 0s 79ms/step - loss: 0.0098 - acc: 1.0000  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 61/65
```

```
2/2 [=====] - 0s 137ms/step - loss: 0.0033 - acc: 1.0
000 - recall: 1.0000 - precision: 1.0000
Epoch 62/65
2/2 [=====] - 0s 81ms/step - loss: 0.0082 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 85ms/step - loss: 0.0142 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 64/65
2/2 [=====] - 0s 86ms/step - loss: 0.0016 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 65/65
2/2 [=====] - 0s 86ms/step - loss: 0.0026 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
2023-03-31 16:53:14.813820: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 70ms/step
7/7 [=====] - 0s 33ms/step
Epoch 1/65
2023-03-31 16:53:16.081149: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 744ms/step - loss: 0.7100 - acc: 0.5
450 - recall: 0.6174 - precision: 0.7302
Epoch 2/65
2/2 [=====] - 0s 171ms/step - loss: 0.7007 - acc: 0.4
600 - recall: 0.4631 - precision: 0.7113
Epoch 3/65
2/2 [=====] - 0s 232ms/step - loss: 0.6805 - acc: 0.5
200 - recall: 0.4899 - precision: 0.7849
Epoch 4/65
2/2 [=====] - 0s 208ms/step - loss: 0.6570 - acc: 0.6
700 - recall: 0.6913 - precision: 0.8374
Epoch 5/65
2/2 [=====] - 0s 158ms/step - loss: 0.6364 - acc: 0.6
700 - recall: 0.6980 - precision: 0.8320
Epoch 6/65
2/2 [=====] - 0s 235ms/step - loss: 0.6633 - acc: 0.7
050 - recall: 0.8054 - precision: 0.8000
Epoch 7/65
2/2 [=====] - 0s 164ms/step - loss: 0.5413 - acc: 0.8
500 - recall: 0.8591 - precision: 0.9343
Epoch 8/65
2/2 [=====] - 0s 188ms/step - loss: 0.4818 - acc: 0.7
800 - recall: 0.7517 - precision: 0.9412
Epoch 9/65
2/2 [=====] - 0s 97ms/step - loss: 0.4554 - acc: 0.83
50 - recall: 0.8591 - precision: 0.9143
Epoch 10/65
2/2 [=====] - 0s 220ms/step - loss: 0.4662 - acc: 0.8
050 - recall: 0.7718 - precision: 0.9583
Epoch 11/65
2/2 [=====] - 0s 174ms/step - loss: 0.4571 - acc: 0.8
500 - recall: 0.9128 - precision: 0.8889
Epoch 12/65
2/2 [=====] - 0s 138ms/step - loss: 0.4740 - acc: 0.8
500 - recall: 0.8993 - precision: 0.8993
Epoch 13/65
2/2 [=====] - 0s 78ms/step - loss: 0.4638 - acc: 0.83
00 - recall: 0.8523 - precision: 0.9137
Epoch 14/65
2/2 [=====] - 0s 90ms/step - loss: 0.4450 - acc: 0.82
00 - recall: 0.8054 - precision: 0.9449
Epoch 15/65
2/2 [=====] - 0s 135ms/step - loss: 0.4021 - acc: 0.8
000 - recall: 0.7852 - precision: 0.9360
Epoch 16/65
2/2 [=====] - 0s 122ms/step - loss: 0.3628 - acc: 0.8
200 - recall: 0.7987 - precision: 0.9520
Epoch 17/65
2/2 [=====] - 0s 78ms/step - loss: 0.3189 - acc: 0.84
50 - recall: 0.8322 - precision: 0.9538
Epoch 18/65
2/2 [=====] - 0s 102ms/step - loss: 0.3315 - acc: 0.8
600 - recall: 0.8658 - precision: 0.9416
Epoch 19/65
2/2 [=====] - 0s 154ms/step - loss: 0.2958 - acc: 0.8
800 - recall: 0.8993 - precision: 0.9371
Epoch 20/65
2/2 [=====] - 0s 77ms/step - loss: 0.2592 - acc: 0.86
50 - recall: 0.8658 - precision: 0.9485
Epoch 21/65
```

```
2/2 [=====] - 0s 141ms/step - loss: 0.2107 - acc: 0.8  
900 - recall: 0.8658 - precision: 0.9847  
Epoch 22/65  
2/2 [=====] - 0s 75ms/step - loss: 0.1797 - acc: 0.94  
00 - recall: 0.9530 - precision: 0.9660  
Epoch 23/65  
2/2 [=====] - 0s 75ms/step - loss: 0.1942 - acc: 0.91  
50 - recall: 0.9262 - precision: 0.9583  
Epoch 24/65  
2/2 [=====] - 0s 188ms/step - loss: 0.2069 - acc: 0.9  
050 - recall: 0.8859 - precision: 0.9851  
Epoch 25/65  
2/2 [=====] - 0s 96ms/step - loss: 0.1462 - acc: 0.94  
00 - recall: 0.9463 - precision: 0.9724  
Epoch 26/65  
2/2 [=====] - 0s 130ms/step - loss: 0.1825 - acc: 0.9  
400 - recall: 0.9329 - precision: 0.9858  
Epoch 27/65  
2/2 [=====] - 0s 75ms/step - loss: 0.1308 - acc: 0.95  
50 - recall: 0.9463 - precision: 0.9930  
Epoch 28/65  
2/2 [=====] - 0s 74ms/step - loss: 0.0917 - acc: 0.97  
50 - recall: 0.9732 - precision: 0.9932  
Epoch 29/65  
2/2 [=====] - 0s 122ms/step - loss: 0.1067 - acc: 0.9  
700 - recall: 0.9732 - precision: 0.9864  
Epoch 30/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0794 - acc: 0.97  
00 - recall: 0.9664 - precision: 0.9931  
Epoch 31/65  
2/2 [=====] - 0s 78ms/step - loss: 0.0850 - acc: 0.96  
00 - recall: 0.9597 - precision: 0.9862  
Epoch 32/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0648 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 33/65  
2/2 [=====] - 0s 75ms/step - loss: 0.0584 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 34/65  
2/2 [=====] - 0s 81ms/step - loss: 0.0444 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 35/65  
2/2 [=====] - 0s 96ms/step - loss: 0.0420 - acc: 0.97  
50 - recall: 0.9732 - precision: 0.9932  
Epoch 36/65  
2/2 [=====] - 0s 76ms/step - loss: 0.0279 - acc: 0.98  
50 - recall: 0.9799 - precision: 1.0000  
Epoch 37/65  
2/2 [=====] - 0s 82ms/step - loss: 0.1427 - acc: 0.98  
00 - recall: 0.9866 - precision: 0.9866  
Epoch 38/65  
2/2 [=====] - 0s 80ms/step - loss: 0.0525 - acc: 0.98  
50 - recall: 0.9933 - precision: 0.9867  
Epoch 39/65  
2/2 [=====] - 0s 86ms/step - loss: 0.1250 - acc: 0.95  
50 - recall: 0.9463 - precision: 0.9930  
Epoch 40/65  
2/2 [=====] - 0s 93ms/step - loss: 0.1970 - acc: 0.91  
00 - recall: 0.8792 - precision: 1.0000  
Epoch 41/65
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.1354 - acc: 0.93
50 - recall: 0.9128 - precision: 1.0000
Epoch 42/65
2/2 [=====] - 0s 87ms/step - loss: 0.1070 - acc: 0.96
00 - recall: 0.9463 - precision: 1.0000
Epoch 43/65
2/2 [=====] - 0s 87ms/step - loss: 0.0886 - acc: 0.96
00 - recall: 0.9530 - precision: 0.9930
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.1178 - acc: 0.96
00 - recall: 0.9664 - precision: 0.9796
Epoch 45/65
2/2 [=====] - 0s 87ms/step - loss: 0.0590 - acc: 0.97
00 - recall: 0.9732 - precision: 0.9864
Epoch 46/65
2/2 [=====] - 0s 87ms/step - loss: 0.0472 - acc: 0.98
00 - recall: 0.9799 - precision: 0.9932
Epoch 47/65
2/2 [=====] - 0s 86ms/step - loss: 0.0410 - acc: 0.98
00 - recall: 0.9732 - precision: 1.0000
Epoch 48/65
2/2 [=====] - 0s 86ms/step - loss: 0.0552 - acc: 0.97
50 - recall: 0.9866 - precision: 0.9800
Epoch 49/65
2/2 [=====] - 0s 87ms/step - loss: 0.0444 - acc: 0.98
00 - recall: 0.9732 - precision: 1.0000
Epoch 50/65
2/2 [=====] - 0s 86ms/step - loss: 0.0494 - acc: 0.96
50 - recall: 0.9530 - precision: 1.0000
Epoch 51/65
2/2 [=====] - 0s 85ms/step - loss: 0.0283 - acc: 0.98
50 - recall: 0.9866 - precision: 0.9932
Epoch 52/65
2/2 [=====] - 0s 86ms/step - loss: 0.0356 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 53/65
2/2 [=====] - 0s 85ms/step - loss: 0.0507 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 54/65
2/2 [=====] - 0s 86ms/step - loss: 0.0325 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 55/65
2/2 [=====] - 0s 84ms/step - loss: 0.0323 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
Epoch 56/65
2/2 [=====] - 0s 86ms/step - loss: 0.0269 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 57/65
2/2 [=====] - 0s 78ms/step - loss: 0.0261 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 58/65
2/2 [=====] - 0s 77ms/step - loss: 0.0223 - acc: 0.99
00 - recall: 0.9933 - precision: 0.9933
Epoch 59/65
2/2 [=====] - 0s 79ms/step - loss: 0.0187 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 60/65
2/2 [=====] - 0s 84ms/step - loss: 0.0117 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 61/65
```

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2/2 [=====] - 0s 87ms/step - loss: 0.0038 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 62/65
2/2 [=====] - 0s 86ms/step - loss: 0.0056 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 63/65
2/2 [=====] - 0s 87ms/step - loss: 0.0020 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 64/65
2/2 [=====] - 0s 84ms/step - loss: 0.0055 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 65/65
2/2 [=====] - 0s 83ms/step - loss: 0.0043 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:53:34.748094: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 60ms/step
7/7 [=====] - 0s 69ms/step
Epoch 1/65
2023-03-31 16:53:35.995145: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

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2/2 [=====] - 2s 837ms/step - loss: 0.7061 - acc: 0.5  
650 - recall: 0.6414 - precision: 0.7266  
Epoch 2/65  
2/2 [=====] - 0s 225ms/step - loss: 0.7051 - acc: 0.5  
350 - recall: 0.5862 - precision: 0.7203  
Epoch 3/65  
2/2 [=====] - 0s 205ms/step - loss: 0.7063 - acc: 0.4  
950 - recall: 0.5241 - precision: 0.7037  
Epoch 4/65  
2/2 [=====] - 0s 227ms/step - loss: 0.7041 - acc: 0.4  
950 - recall: 0.4897 - precision: 0.7245  
Epoch 5/65  
2/2 [=====] - 0s 202ms/step - loss: 0.6954 - acc: 0.5  
350 - recall: 0.4966 - precision: 0.7826  
Epoch 6/65  
2/2 [=====] - 0s 80ms/step - loss: 0.7045 - acc: 0.50  
00 - recall: 0.4966 - precision: 0.7273  
Epoch 7/65  
2/2 [=====] - 0s 215ms/step - loss: 0.6988 - acc: 0.5  
650 - recall: 0.5724 - precision: 0.7685  
Epoch 8/65  
2/2 [=====] - 0s 140ms/step - loss: 0.7067 - acc: 0.5  
200 - recall: 0.5241 - precision: 0.7379  
Epoch 9/65  
2/2 [=====] - 0s 200ms/step - loss: 0.7049 - acc: 0.4  
700 - recall: 0.4207 - precision: 0.7349  
Epoch 10/65  
2/2 [=====] - 0s 138ms/step - loss: 0.6984 - acc: 0.4  
850 - recall: 0.3793 - precision: 0.8088  
Epoch 11/65  
2/2 [=====] - 0s 196ms/step - loss: 0.6947 - acc: 0.5  
200 - recall: 0.4000 - precision: 0.8657  
Epoch 12/65  
2/2 [=====] - 0s 97ms/step - loss: 0.6984 - acc: 0.46  
50 - recall: 0.3724 - precision: 0.7714  
Epoch 13/65  
2/2 [=====] - 0s 125ms/step - loss: 0.6973 - acc: 0.4  
300 - recall: 0.2897 - precision: 0.7925  
Epoch 14/65  
2/2 [=====] - 0s 99ms/step - loss: 0.6946 - acc: 0.47  
00 - recall: 0.3448 - precision: 0.8197  
Epoch 15/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6973 - acc: 0.46  
50 - recall: 0.3517 - precision: 0.7969  
Epoch 16/65  
2/2 [=====] - 0s 132ms/step - loss: 0.6933 - acc: 0.4  
650 - recall: 0.3172 - precision: 0.8519  
Epoch 17/65  
2/2 [=====] - 0s 74ms/step - loss: 0.7033 - acc: 0.42  
00 - recall: 0.3172 - precision: 0.7302  
Epoch 18/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6984 - acc: 0.38  
50 - recall: 0.2483 - precision: 0.7200  
Epoch 19/65  
2/2 [=====] - 0s 100ms/step - loss: 0.6982 - acc: 0.4  
450 - recall: 0.3172 - precision: 0.7931  
Epoch 20/65  
2/2 [=====] - 0s 119ms/step - loss: 0.6966 - acc: 0.4  
250 - recall: 0.2759 - precision: 0.8000  
Epoch 21/65
```

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2/2 [=====] - 0s 96ms/step - loss: 0.6956 - acc: 0.42
00 - recall: 0.2690 - precision: 0.7959
Epoch 22/65
2/2 [=====] - 0s 74ms/step - loss: 0.6977 - acc: 0.41
00 - recall: 0.2621 - precision: 0.7755
Epoch 23/65
2/2 [=====] - 0s 74ms/step - loss: 0.6936 - acc: 0.43
50 - recall: 0.2897 - precision: 0.8077
Epoch 24/65
2/2 [=====] - 0s 76ms/step - loss: 0.6949 - acc: 0.43
50 - recall: 0.2828 - precision: 0.8200
Epoch 25/65
2/2 [=====] - 0s 74ms/step - loss: 0.6950 - acc: 0.42
00 - recall: 0.2483 - precision: 0.8372
Epoch 26/65
2/2 [=====] - 0s 92ms/step - loss: 0.6970 - acc: 0.43
00 - recall: 0.3103 - precision: 0.7627
Epoch 27/65
2/2 [=====] - 0s 78ms/step - loss: 0.6884 - acc: 0.49
50 - recall: 0.3793 - precision: 0.8333
Epoch 28/65
2/2 [=====] - 0s 77ms/step - loss: 0.6993 - acc: 0.44
00 - recall: 0.3034 - precision: 0.8000
Epoch 29/65
2/2 [=====] - 0s 77ms/step - loss: 0.6906 - acc: 0.45
50 - recall: 0.3034 - precision: 0.8462
Epoch 30/65
2/2 [=====] - 0s 75ms/step - loss: 0.6894 - acc: 0.48
00 - recall: 0.3724 - precision: 0.8060
Epoch 31/65
2/2 [=====] - 0s 79ms/step - loss: 0.6888 - acc: 0.50
00 - recall: 0.3724 - precision: 0.8571
Epoch 32/65
2/2 [=====] - 0s 127ms/step - loss: 0.6912 - acc: 0.4
550 - recall: 0.3379 - precision: 0.7903
Epoch 33/65
2/2 [=====] - 0s 84ms/step - loss: 0.6867 - acc: 0.53
00 - recall: 0.4069 - precision: 0.8806
Epoch 34/65
2/2 [=====] - 0s 86ms/step - loss: 0.6940 - acc: 0.46
00 - recall: 0.3655 - precision: 0.7681
Epoch 35/65
2/2 [=====] - 0s 85ms/step - loss: 0.6849 - acc: 0.48
00 - recall: 0.3241 - precision: 0.8868
Epoch 36/65
2/2 [=====] - 0s 86ms/step - loss: 0.6855 - acc: 0.46
00 - recall: 0.3379 - precision: 0.8033
Epoch 37/65
2/2 [=====] - 0s 101ms/step - loss: 0.6995 - acc: 0.3
750 - recall: 0.2414 - precision: 0.7000
Epoch 38/65
2/2 [=====] - 0s 83ms/step - loss: 0.6812 - acc: 0.47
00 - recall: 0.3034 - precision: 0.8980
Epoch 39/65
2/2 [=====] - 0s 87ms/step - loss: 0.6914 - acc: 0.44
50 - recall: 0.3172 - precision: 0.7931
Epoch 40/65
2/2 [=====] - 0s 81ms/step - loss: 0.6925 - acc: 0.43
00 - recall: 0.2897 - precision: 0.7925
Epoch 41/65
```

```
2/2 [=====] - 0s 125ms/step - loss: 0.6964 - acc: 0.4  
250 - recall: 0.2966 - precision: 0.7679  
Epoch 42/65  
2/2 [=====] - 0s 79ms/step - loss: 0.6886 - acc: 0.44  
50 - recall: 0.3034 - precision: 0.8148  
Epoch 43/65  
2/2 [=====] - 0s 133ms/step - loss: 0.6871 - acc: 0.4  
600 - recall: 0.3034 - precision: 0.8627  
Epoch 44/65  
2/2 [=====] - 0s 81ms/step - loss: 0.6874 - acc: 0.47  
50 - recall: 0.3793 - precision: 0.7857  
Epoch 45/65  
2/2 [=====] - 0s 84ms/step - loss: 0.6941 - acc: 0.47  
50 - recall: 0.4000 - precision: 0.7632  
Epoch 46/65  
2/2 [=====] - 0s 87ms/step - loss: 0.6876 - acc: 0.54  
50 - recall: 0.4414 - precision: 0.8649  
Epoch 47/65  
2/2 [=====] - 0s 86ms/step - loss: 0.6830 - acc: 0.56  
50 - recall: 0.4552 - precision: 0.8919  
Epoch 48/65  
2/2 [=====] - 0s 86ms/step - loss: 0.6860 - acc: 0.59  
50 - recall: 0.5517 - precision: 0.8333  
Epoch 49/65  
2/2 [=====] - 0s 84ms/step - loss: 0.6922 - acc: 0.44  
50 - recall: 0.3379 - precision: 0.7656  
Epoch 50/65  
2/2 [=====] - 0s 83ms/step - loss: 0.6753 - acc: 0.59  
00 - recall: 0.4759 - precision: 0.9200  
Epoch 51/65  
2/2 [=====] - 0s 85ms/step - loss: 0.6813 - acc: 0.54  
00 - recall: 0.4552 - precision: 0.8354  
Epoch 52/65  
2/2 [=====] - 0s 86ms/step - loss: 0.6820 - acc: 0.56  
50 - recall: 0.5034 - precision: 0.8295  
Epoch 53/65  
2/2 [=====] - 0s 84ms/step - loss: 0.6841 - acc: 0.53  
50 - recall: 0.4552 - precision: 0.8250  
Epoch 54/65  
2/2 [=====] - 0s 85ms/step - loss: 0.6832 - acc: 0.52  
00 - recall: 0.4207 - precision: 0.8356  
Epoch 55/65  
2/2 [=====] - 0s 85ms/step - loss: 0.6805 - acc: 0.50  
50 - recall: 0.4000 - precision: 0.8286  
Epoch 56/65  
2/2 [=====] - 0s 86ms/step - loss: 0.6715 - acc: 0.62  
00 - recall: 0.5655 - precision: 0.8632  
Epoch 57/65  
2/2 [=====] - 0s 86ms/step - loss: 0.6888 - acc: 0.49  
50 - recall: 0.4207 - precision: 0.7821  
Epoch 58/65  
2/2 [=====] - 0s 85ms/step - loss: 0.6807 - acc: 0.53  
50 - recall: 0.4345 - precision: 0.8514  
Epoch 59/65  
2/2 [=====] - 0s 85ms/step - loss: 0.6800 - acc: 0.48  
50 - recall: 0.3862 - precision: 0.8000  
Epoch 60/65  
2/2 [=====] - 0s 84ms/step - loss: 0.6843 - acc: 0.52  
50 - recall: 0.4345 - precision: 0.8289  
Epoch 61/65
```

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2/2 [=====] - 0s 85ms/step - loss: 0.6708 - acc: 0.52
50 - recall: 0.3724 - precision: 0.9310
Epoch 62/65
2/2 [=====] - 0s 85ms/step - loss: 0.6900 - acc: 0.45
00 - recall: 0.3310 - precision: 0.7869
Epoch 63/65
2/2 [=====] - 0s 86ms/step - loss: 0.6842 - acc: 0.55
00 - recall: 0.4828 - precision: 0.8235
Epoch 64/65
2/2 [=====] - 0s 85ms/step - loss: 0.6706 - acc: 0.59
50 - recall: 0.5379 - precision: 0.8478
Epoch 65/65
2/2 [=====] - 0s 84ms/step - loss: 0.6679 - acc: 0.60
00 - recall: 0.5103 - precision: 0.8916
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:53:54.409455: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 67ms/step
7/7 [=====] - 0s 32ms/step
Epoch 1/65
2023-03-31 16:53:55.727115: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

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2/2 [=====] - 3s 774ms/step - loss: 0.6882 - acc: 0.6  
050 - recall: 0.6486 - precision: 0.7805  
Epoch 2/65  
2/2 [=====] - 0s 214ms/step - loss: 0.6903 - acc: 0.5  
000 - recall: 0.5270 - precision: 0.7222  
Epoch 3/65  
2/2 [=====] - 0s 167ms/step - loss: 0.6917 - acc: 0.4  
900 - recall: 0.5068 - precision: 0.7212  
Epoch 4/65  
2/2 [=====] - 0s 163ms/step - loss: 0.6910 - acc: 0.5  
150 - recall: 0.5203 - precision: 0.7476  
Epoch 5/65  
2/2 [=====] - 0s 196ms/step - loss: 0.6857 - acc: 0.5  
150 - recall: 0.4797 - precision: 0.7802  
Epoch 6/65  
2/2 [=====] - 0s 197ms/step - loss: 0.6924 - acc: 0.5  
050 - recall: 0.5338 - precision: 0.7248  
Epoch 7/65  
2/2 [=====] - 0s 145ms/step - loss: 0.6886 - acc: 0.5  
550 - recall: 0.5541 - precision: 0.7810  
Epoch 8/65  
2/2 [=====] - 0s 143ms/step - loss: 0.6886 - acc: 0.5  
600 - recall: 0.5676 - precision: 0.7778  
Epoch 9/65  
2/2 [=====] - 0s 156ms/step - loss: 0.6859 - acc: 0.5  
700 - recall: 0.5473 - precision: 0.8100  
Epoch 10/65  
2/2 [=====] - 0s 102ms/step - loss: 0.6916 - acc: 0.5  
150 - recall: 0.5405 - precision: 0.7339  
Epoch 11/65  
2/2 [=====] - 0s 78ms/step - loss: 0.6904 - acc: 0.50  
00 - recall: 0.4797 - precision: 0.7553  
Epoch 12/65  
2/2 [=====] - 0s 162ms/step - loss: 0.6848 - acc: 0.4  
950 - recall: 0.4459 - precision: 0.7765  
Epoch 13/65  
2/2 [=====] - 0s 197ms/step - loss: 0.6884 - acc: 0.5  
200 - recall: 0.5541 - precision: 0.7321  
Epoch 14/65  
2/2 [=====] - 0s 134ms/step - loss: 0.6865 - acc: 0.5  
550 - recall: 0.5608 - precision: 0.7757  
Epoch 15/65  
2/2 [=====] - 0s 151ms/step - loss: 0.6885 - acc: 0.5  
250 - recall: 0.5135 - precision: 0.7677  
Epoch 16/65  
2/2 [=====] - 0s 174ms/step - loss: 0.6815 - acc: 0.4  
850 - recall: 0.4189 - precision: 0.7848  
Epoch 17/65  
2/2 [=====] - 0s 132ms/step - loss: 0.6815 - acc: 0.5  
800 - recall: 0.5405 - precision: 0.8333  
Epoch 18/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6847 - acc: 0.46  
00 - recall: 0.4054 - precision: 0.7500  
Epoch 19/65  
2/2 [=====] - 0s 77ms/step - loss: 0.6751 - acc: 0.54  
00 - recall: 0.4865 - precision: 0.8182  
Epoch 20/65  
2/2 [=====] - 0s 118ms/step - loss: 0.6847 - acc: 0.5  
350 - recall: 0.5135 - precision: 0.7835  
Epoch 21/65
```

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2/2 [=====] - 0s 78ms/step - loss: 0.6846 - acc: 0.52
50 - recall: 0.5000 - precision: 0.7789
Epoch 22/65
2/2 [=====] - 0s 75ms/step - loss: 0.6816 - acc: 0.51
00 - recall: 0.4392 - precision: 0.8125
Epoch 23/65
2/2 [=====] - 0s 75ms/step - loss: 0.6886 - acc: 0.51
00 - recall: 0.4662 - precision: 0.7841
Epoch 24/65
2/2 [=====] - 0s 75ms/step - loss: 0.6851 - acc: 0.54
50 - recall: 0.5338 - precision: 0.7822
Epoch 25/65
2/2 [=====] - 0s 74ms/step - loss: 0.6792 - acc: 0.62
00 - recall: 0.6149 - precision: 0.8273
Epoch 26/65
2/2 [=====] - 0s 77ms/step - loss: 0.6771 - acc: 0.60
00 - recall: 0.5676 - precision: 0.8400
Epoch 27/65
2/2 [=====] - 0s 74ms/step - loss: 0.6869 - acc: 0.52
00 - recall: 0.5270 - precision: 0.7500
Epoch 28/65
2/2 [=====] - 0s 74ms/step - loss: 0.6774 - acc: 0.60
00 - recall: 0.6149 - precision: 0.7982
Epoch 29/65
2/2 [=====] - 0s 78ms/step - loss: 0.6809 - acc: 0.66
00 - recall: 0.7162 - precision: 0.8030
Epoch 30/65
2/2 [=====] - 0s 75ms/step - loss: 0.6797 - acc: 0.63
00 - recall: 0.6892 - precision: 0.7846
Epoch 31/65
2/2 [=====] - 0s 156ms/step - loss: 0.6788 - acc: 0.6
550 - recall: 0.6892 - precision: 0.8160
Epoch 32/65
2/2 [=====] - 0s 75ms/step - loss: 0.6782 - acc: 0.65
50 - recall: 0.6892 - precision: 0.8160
Epoch 33/65
2/2 [=====] - 0s 109ms/step - loss: 0.6823 - acc: 0.6
250 - recall: 0.6419 - precision: 0.8120
Epoch 34/65
2/2 [=====] - 0s 136ms/step - loss: 0.6868 - acc: 0.5
900 - recall: 0.6149 - precision: 0.7845
Epoch 35/65
2/2 [=====] - 0s 88ms/step - loss: 0.6776 - acc: 0.64
00 - recall: 0.6892 - precision: 0.7969
Epoch 36/65
2/2 [=====] - 0s 95ms/step - loss: 0.6768 - acc: 0.62
50 - recall: 0.6351 - precision: 0.8174
Epoch 37/65
2/2 [=====] - 0s 94ms/step - loss: 0.6725 - acc: 0.64
00 - recall: 0.6486 - precision: 0.8276
Epoch 38/65
2/2 [=====] - 0s 90ms/step - loss: 0.6827 - acc: 0.63
50 - recall: 0.6892 - precision: 0.7907
Epoch 39/65
2/2 [=====] - 0s 89ms/step - loss: 0.6739 - acc: 0.68
50 - recall: 0.7162 - precision: 0.8346
Epoch 40/65
2/2 [=====] - 0s 88ms/step - loss: 0.6776 - acc: 0.62
50 - recall: 0.6419 - precision: 0.8120
Epoch 41/65
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6724 - acc: 0.65
00 - recall: 0.6419 - precision: 0.8482
Epoch 42/65
2/2 [=====] - 0s 88ms/step - loss: 0.6651 - acc: 0.66
50 - recall: 0.6757 - precision: 0.8403
Epoch 43/65
2/2 [=====] - 0s 89ms/step - loss: 0.6776 - acc: 0.64
00 - recall: 0.6486 - precision: 0.8276
Epoch 44/65
2/2 [=====] - 0s 84ms/step - loss: 0.6741 - acc: 0.60
50 - recall: 0.6149 - precision: 0.8053
Epoch 45/65
2/2 [=====] - 0s 85ms/step - loss: 0.6800 - acc: 0.57
00 - recall: 0.5270 - precision: 0.8298
Epoch 46/65
2/2 [=====] - 0s 129ms/step - loss: 0.6677 - acc: 0.6
450 - recall: 0.6081 - precision: 0.8738
Epoch 47/65
2/2 [=====] - 0s 84ms/step - loss: 0.6735 - acc: 0.58
00 - recall: 0.5338 - precision: 0.8404
Epoch 48/65
2/2 [=====] - 0s 85ms/step - loss: 0.6789 - acc: 0.62
50 - recall: 0.6486 - precision: 0.8067
Epoch 49/65
2/2 [=====] - 0s 89ms/step - loss: 0.6648 - acc: 0.71
00 - recall: 0.7162 - precision: 0.8689
Epoch 50/65
2/2 [=====] - 0s 86ms/step - loss: 0.6754 - acc: 0.63
00 - recall: 0.6081 - precision: 0.8491
Epoch 51/65
2/2 [=====] - 0s 86ms/step - loss: 0.6702 - acc: 0.62
50 - recall: 0.6216 - precision: 0.8288
Epoch 52/65
2/2 [=====] - 0s 87ms/step - loss: 0.6600 - acc: 0.72
00 - recall: 0.7230 - precision: 0.8770
Epoch 53/65
2/2 [=====] - 0s 86ms/step - loss: 0.6669 - acc: 0.61
00 - recall: 0.5878 - precision: 0.8365
Epoch 54/65
2/2 [=====] - 0s 86ms/step - loss: 0.6694 - acc: 0.58
50 - recall: 0.5338 - precision: 0.8495
Epoch 55/65
2/2 [=====] - 0s 85ms/step - loss: 0.6672 - acc: 0.61
00 - recall: 0.6014 - precision: 0.8241
Epoch 56/65
2/2 [=====] - 0s 85ms/step - loss: 0.6577 - acc: 0.66
50 - recall: 0.6284 - precision: 0.8857
Epoch 57/65
2/2 [=====] - 0s 86ms/step - loss: 0.6493 - acc: 0.70
00 - recall: 0.6959 - precision: 0.8729
Epoch 58/65
2/2 [=====] - 0s 86ms/step - loss: 0.6669 - acc: 0.64
00 - recall: 0.6824 - precision: 0.8016
Epoch 59/65
2/2 [=====] - 0s 87ms/step - loss: 0.6707 - acc: 0.60
50 - recall: 0.6014 - precision: 0.8165
Epoch 60/65
2/2 [=====] - 0s 85ms/step - loss: 0.6568 - acc: 0.66
50 - recall: 0.6486 - precision: 0.8649
Epoch 61/65
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.6552 - acc: 0.67
00 - recall: 0.6757 - precision: 0.8475
Epoch 62/65
2/2 [=====] - 0s 85ms/step - loss: 0.6609 - acc: 0.68
50 - recall: 0.7635 - precision: 0.8014
Epoch 63/65
2/2 [=====] - 0s 84ms/step - loss: 0.6504 - acc: 0.68
50 - recall: 0.6554 - precision: 0.8899
Epoch 64/65
2/2 [=====] - 0s 85ms/step - loss: 0.6654 - acc: 0.65
50 - recall: 0.7027 - precision: 0.8062
Epoch 65/65
2/2 [=====] - 0s 85ms/step - loss: 0.6611 - acc: 0.61
50 - recall: 0.5743 - precision: 0.8586
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:54:14.377604: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 59ms/step
7/7 [=====] - 0s 38ms/step
Epoch 1/65
2023-03-31 16:54:15.374166: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

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2/2 [=====] - 2s 971ms/step - loss: 0.6908 - acc: 0.5  
550 - recall: 0.6443 - precision: 0.7273  
Epoch 2/65  
2/2 [=====] - 0s 224ms/step - loss: 0.6900 - acc: 0.5  
200 - recall: 0.5839 - precision: 0.7190  
Epoch 3/65  
2/2 [=====] - 0s 225ms/step - loss: 0.6888 - acc: 0.5  
250 - recall: 0.5772 - precision: 0.7288  
Epoch 4/65  
2/2 [=====] - 0s 227ms/step - loss: 0.6881 - acc: 0.5  
250 - recall: 0.5638 - precision: 0.7368  
Epoch 5/65  
2/2 [=====] - 0s 137ms/step - loss: 0.6870 - acc: 0.5  
500 - recall: 0.5906 - precision: 0.7521  
Epoch 6/65  
2/2 [=====] - 0s 159ms/step - loss: 0.6795 - acc: 0.6  
100 - recall: 0.6309 - precision: 0.8034  
Epoch 7/65  
2/2 [=====] - 0s 74ms/step - loss: 0.6819 - acc: 0.60  
50 - recall: 0.6376 - precision: 0.7917  
Epoch 8/65  
2/2 [=====] - 0s 202ms/step - loss: 0.6843 - acc: 0.5  
200 - recall: 0.5302 - precision: 0.7524  
Epoch 9/65  
2/2 [=====] - 0s 103ms/step - loss: 0.6777 - acc: 0.5  
950 - recall: 0.5705 - precision: 0.8333  
Epoch 10/65  
2/2 [=====] - 0s 160ms/step - loss: 0.6800 - acc: 0.5  
850 - recall: 0.6040 - precision: 0.7895  
Epoch 11/65  
2/2 [=====] - 0s 126ms/step - loss: 0.6805 - acc: 0.5  
950 - recall: 0.6376 - precision: 0.7787  
Epoch 12/65  
2/2 [=====] - 0s 106ms/step - loss: 0.6861 - acc: 0.5  
750 - recall: 0.5973 - precision: 0.7807  
Epoch 13/65  
2/2 [=====] - 0s 151ms/step - loss: 0.6857 - acc: 0.5  
550 - recall: 0.5772 - precision: 0.7679  
Epoch 14/65  
2/2 [=====] - 0s 179ms/step - loss: 0.6813 - acc: 0.5  
400 - recall: 0.5772 - precision: 0.7478  
Epoch 15/65  
2/2 [=====] - 0s 140ms/step - loss: 0.6814 - acc: 0.5  
650 - recall: 0.5906 - precision: 0.7719  
Epoch 16/65  
2/2 [=====] - 0s 95ms/step - loss: 0.6820 - acc: 0.57  
00 - recall: 0.5906 - precision: 0.7788  
Epoch 17/65  
2/2 [=====] - 0s 75ms/step - loss: 0.6820 - acc: 0.55  
50 - recall: 0.6040 - precision: 0.7500  
Epoch 18/65  
2/2 [=====] - 0s 120ms/step - loss: 0.6838 - acc: 0.5  
650 - recall: 0.6242 - precision: 0.7500  
Epoch 19/65  
2/2 [=====] - 0s 94ms/step - loss: 0.6889 - acc: 0.55  
00 - recall: 0.6242 - precision: 0.7323  
Epoch 20/65  
2/2 [=====] - 0s 136ms/step - loss: 0.6801 - acc: 0.6  
200 - recall: 0.6577 - precision: 0.7967  
Epoch 21/65
```

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2/2 [=====] - 0s 75ms/step - loss: 0.6764 - acc: 0.64
00 - recall: 0.6779 - precision: 0.8080
Epoch 22/65
2/2 [=====] - 0s 75ms/step - loss: 0.6776 - acc: 0.63
00 - recall: 0.6510 - precision: 0.8151
Epoch 23/65
2/2 [=====] - 0s 74ms/step - loss: 0.6761 - acc: 0.60
00 - recall: 0.5839 - precision: 0.8286
Epoch 24/65
2/2 [=====] - 0s 122ms/step - loss: 0.6837 - acc: 0.5
600 - recall: 0.5705 - precision: 0.7798
Epoch 25/65
2/2 [=====] - 0s 75ms/step - loss: 0.6810 - acc: 0.57
00 - recall: 0.6040 - precision: 0.7692
Epoch 26/65
2/2 [=====] - 0s 85ms/step - loss: 0.6799 - acc: 0.58
00 - recall: 0.6107 - precision: 0.7778
Epoch 27/65
2/2 [=====] - 0s 77ms/step - loss: 0.6789 - acc: 0.60
00 - recall: 0.6644 - precision: 0.7674
Epoch 28/65
2/2 [=====] - 0s 75ms/step - loss: 0.6783 - acc: 0.63
00 - recall: 0.6779 - precision: 0.7953
Epoch 29/65
2/2 [=====] - 0s 75ms/step - loss: 0.6791 - acc: 0.62
00 - recall: 0.6711 - precision: 0.7874
Epoch 30/65
2/2 [=====] - 0s 94ms/step - loss: 0.6809 - acc: 0.63
00 - recall: 0.6711 - precision: 0.8000
Epoch 31/65
2/2 [=====] - 0s 136ms/step - loss: 0.6797 - acc: 0.6
050 - recall: 0.6309 - precision: 0.7966
Epoch 32/65
2/2 [=====] - 0s 75ms/step - loss: 0.6788 - acc: 0.67
50 - recall: 0.7248 - precision: 0.8182
Epoch 33/65
2/2 [=====] - 0s 81ms/step - loss: 0.6814 - acc: 0.63
00 - recall: 0.6980 - precision: 0.7820
Epoch 34/65
2/2 [=====] - 0s 165ms/step - loss: 0.6798 - acc: 0.6
300 - recall: 0.6779 - precision: 0.7953
Epoch 35/65
2/2 [=====] - 0s 75ms/step - loss: 0.6779 - acc: 0.61
50 - recall: 0.6644 - precision: 0.7857
Epoch 36/65
2/2 [=====] - 0s 135ms/step - loss: 0.6766 - acc: 0.6
450 - recall: 0.6846 - precision: 0.8095
Epoch 37/65
2/2 [=====] - 0s 81ms/step - loss: 0.6760 - acc: 0.63
50 - recall: 0.6644 - precision: 0.8115
Epoch 38/65
2/2 [=====] - 0s 86ms/step - loss: 0.6804 - acc: 0.61
00 - recall: 0.6510 - precision: 0.7886
Epoch 39/65
2/2 [=====] - 0s 93ms/step - loss: 0.6717 - acc: 0.67
00 - recall: 0.6980 - precision: 0.8320
Epoch 40/65
2/2 [=====] - 0s 92ms/step - loss: 0.6770 - acc: 0.62
50 - recall: 0.6309 - precision: 0.8246
Epoch 41/65
```

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2/2 [=====] - 0s 89ms/step - loss: 0.6806 - acc: 0.61
50 - recall: 0.6644 - precision: 0.7857
Epoch 42/65
2/2 [=====] - 0s 91ms/step - loss: 0.6725 - acc: 0.66
00 - recall: 0.6846 - precision: 0.8293
Epoch 43/65
2/2 [=====] - 0s 89ms/step - loss: 0.6730 - acc: 0.65
50 - recall: 0.6913 - precision: 0.8175
Epoch 44/65
2/2 [=====] - 0s 89ms/step - loss: 0.6695 - acc: 0.66
50 - recall: 0.7383 - precision: 0.7971
Epoch 45/65
2/2 [=====] - 0s 88ms/step - loss: 0.6739 - acc: 0.62
50 - recall: 0.6376 - precision: 0.8190
Epoch 46/65
2/2 [=====] - 0s 88ms/step - loss: 0.6687 - acc: 0.65
00 - recall: 0.6980 - precision: 0.8062
Epoch 47/65
2/2 [=====] - 0s 87ms/step - loss: 0.6711 - acc: 0.65
50 - recall: 0.7047 - precision: 0.8077
Epoch 48/65
2/2 [=====] - 0s 131ms/step - loss: 0.6750 - acc: 0.6
600 - recall: 0.7315 - precision: 0.7956
Epoch 49/65
2/2 [=====] - 0s 85ms/step - loss: 0.6791 - acc: 0.62
50 - recall: 0.6980 - precision: 0.7761
Epoch 50/65
2/2 [=====] - 0s 85ms/step - loss: 0.6724 - acc: 0.66
00 - recall: 0.7181 - precision: 0.8045
Epoch 51/65
2/2 [=====] - 0s 86ms/step - loss: 0.6652 - acc: 0.69
50 - recall: 0.7181 - precision: 0.8492
Epoch 52/65
2/2 [=====] - 0s 87ms/step - loss: 0.6763 - acc: 0.65
50 - recall: 0.6913 - precision: 0.8175
Epoch 53/65
2/2 [=====] - 0s 85ms/step - loss: 0.6687 - acc: 0.67
50 - recall: 0.7114 - precision: 0.8281
Epoch 54/65
2/2 [=====] - 0s 87ms/step - loss: 0.6690 - acc: 0.70
00 - recall: 0.7785 - precision: 0.8112
Epoch 55/65
2/2 [=====] - 0s 86ms/step - loss: 0.6710 - acc: 0.63
00 - recall: 0.6644 - precision: 0.8049
Epoch 56/65
2/2 [=====] - 0s 87ms/step - loss: 0.6720 - acc: 0.68
50 - recall: 0.7181 - precision: 0.8359
Epoch 57/65
2/2 [=====] - 0s 87ms/step - loss: 0.6705 - acc: 0.63
00 - recall: 0.6510 - precision: 0.8151
Epoch 58/65
2/2 [=====] - 0s 86ms/step - loss: 0.6734 - acc: 0.60
50 - recall: 0.6443 - precision: 0.7869
Epoch 59/65
2/2 [=====] - 0s 86ms/step - loss: 0.6645 - acc: 0.70
50 - recall: 0.7248 - precision: 0.8571
Epoch 60/65
2/2 [=====] - 0s 86ms/step - loss: 0.6650 - acc: 0.62
50 - recall: 0.6242 - precision: 0.8304
Epoch 61/65
```

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2/2 [=====] - 0s 85ms/step - loss: 0.6655 - acc: 0.70
00 - recall: 0.7517 - precision: 0.8296
Epoch 62/65
2/2 [=====] - 0s 83ms/step - loss: 0.6618 - acc: 0.72
50 - recall: 0.7785 - precision: 0.8406
Epoch 63/65
2/2 [=====] - 0s 86ms/step - loss: 0.6639 - acc: 0.68
50 - recall: 0.7181 - precision: 0.8359
Epoch 64/65
2/2 [=====] - 0s 86ms/step - loss: 0.6618 - acc: 0.69
00 - recall: 0.6913 - precision: 0.8655
Epoch 65/65
2/2 [=====] - 0s 87ms/step - loss: 0.6678 - acc: 0.62
50 - recall: 0.6376 - precision: 0.8190
1/4 [=====>.....] - ETA: 0s
2023-03-31 16:54:34.201321: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 64ms/step
7/7 [=====] - 0s 33ms/step
Epoch 1/90
2023-03-31 16:54:35.245269: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 987ms/step - loss: 0.7080 - acc: 0.5  
750 - recall: 0.6345 - precision: 0.7419  
Epoch 2/90  
2/2 [=====] - 0s 224ms/step - loss: 0.7065 - acc: 0.4  
400 - recall: 0.3655 - precision: 0.7260  
Epoch 3/90  
2/2 [=====] - 0s 212ms/step - loss: 0.6928 - acc: 0.5  
250 - recall: 0.4690 - precision: 0.7907  
Epoch 4/90  
2/2 [=====] - 0s 227ms/step - loss: 0.6916 - acc: 0.5  
150 - recall: 0.4414 - precision: 0.8000  
Epoch 5/90  
2/2 [=====] - 0s 202ms/step - loss: 0.6498 - acc: 0.7  
000 - recall: 0.6759 - precision: 0.8829  
Epoch 6/90  
2/2 [=====] - 0s 98ms/step - loss: 0.6298 - acc: 0.66  
50 - recall: 0.6828 - precision: 0.8250  
Epoch 7/90  
2/2 [=====] - 0s 149ms/step - loss: 0.5269 - acc: 0.7  
900 - recall: 0.7655 - precision: 0.9328  
Epoch 8/90  
2/2 [=====] - 0s 75ms/step - loss: 0.4521 - acc: 0.79  
00 - recall: 0.7793 - precision: 0.9187  
Epoch 9/90  
2/2 [=====] - 0s 217ms/step - loss: 0.5024 - acc: 0.8  
000 - recall: 0.7862 - precision: 0.9268  
Epoch 10/90  
2/2 [=====] - 0s 144ms/step - loss: 0.4482 - acc: 0.8  
050 - recall: 0.8138 - precision: 0.9077  
Epoch 11/90  
2/2 [=====] - 0s 178ms/step - loss: 0.3890 - acc: 0.8  
300 - recall: 0.8069 - precision: 0.9512  
Epoch 12/90  
2/2 [=====] - 0s 179ms/step - loss: 0.3342 - acc: 0.8  
200 - recall: 0.7655 - precision: 0.9823  
Epoch 13/90  
2/2 [=====] - 0s 75ms/step - loss: 0.3386 - acc: 0.83  
50 - recall: 0.8207 - precision: 0.9444  
Epoch 14/90  
2/2 [=====] - 0s 130ms/step - loss: 0.3040 - acc: 0.8  
550 - recall: 0.8345 - precision: 0.9603  
Epoch 15/90  
2/2 [=====] - 0s 94ms/step - loss: 0.2728 - acc: 0.90  
50 - recall: 0.9034 - precision: 0.9632  
Epoch 16/90  
2/2 [=====] - 0s 74ms/step - loss: 0.2970 - acc: 0.88  
50 - recall: 0.8966 - precision: 0.9420  
Epoch 17/90  
2/2 [=====] - 0s 76ms/step - loss: 0.2470 - acc: 0.88  
50 - recall: 0.8483 - precision: 0.9919  
Epoch 18/90  
2/2 [=====] - 0s 75ms/step - loss: 0.2244 - acc: 0.88  
00 - recall: 0.8345 - precision: 1.0000  
Epoch 19/90  
2/2 [=====] - 0s 96ms/step - loss: 0.1971 - acc: 0.91  
00 - recall: 0.8966 - precision: 0.9774  
Epoch 20/90  
2/2 [=====] - 0s 128ms/step - loss: 0.1877 - acc: 0.9  
150 - recall: 0.9172 - precision: 0.9638  
Epoch 21/90
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.1423 - acc: 0.94
00 - recall: 0.9241 - precision: 0.9926
Epoch 22/90
2/2 [=====] - 0s 95ms/step - loss: 0.1727 - acc: 0.93
00 - recall: 0.9241 - precision: 0.9781
Epoch 23/90
2/2 [=====] - 0s 74ms/step - loss: 0.1301 - acc: 0.95
00 - recall: 0.9517 - precision: 0.9787
Epoch 24/90
2/2 [=====] - 0s 79ms/step - loss: 0.1385 - acc: 0.94
00 - recall: 0.9379 - precision: 0.9784
Epoch 25/90
2/2 [=====] - 0s 77ms/step - loss: 0.1355 - acc: 0.94
00 - recall: 0.9448 - precision: 0.9716
Epoch 26/90
2/2 [=====] - 0s 75ms/step - loss: 0.1072 - acc: 0.94
50 - recall: 0.9310 - precision: 0.9926
Epoch 27/90
2/2 [=====] - 0s 127ms/step - loss: 0.0849 - acc: 0.9
700 - recall: 0.9655 - precision: 0.9929
Epoch 28/90
2/2 [=====] - 0s 119ms/step - loss: 0.0879 - acc: 0.9
550 - recall: 0.9517 - precision: 0.9857
Epoch 29/90
2/2 [=====] - 0s 134ms/step - loss: 0.0672 - acc: 0.9
750 - recall: 0.9724 - precision: 0.9930
Epoch 30/90
2/2 [=====] - 0s 76ms/step - loss: 0.0774 - acc: 0.97
00 - recall: 0.9793 - precision: 0.9793
Epoch 31/90
2/2 [=====] - 0s 118ms/step - loss: 0.0627 - acc: 0.9
650 - recall: 0.9517 - precision: 1.0000
Epoch 32/90
2/2 [=====] - 0s 75ms/step - loss: 0.0794 - acc: 0.97
00 - recall: 0.9724 - precision: 0.9860
Epoch 33/90
2/2 [=====] - 0s 74ms/step - loss: 0.0406 - acc: 0.98
00 - recall: 0.9793 - precision: 0.9930
Epoch 34/90
2/2 [=====] - 0s 74ms/step - loss: 0.0696 - acc: 0.97
50 - recall: 0.9724 - precision: 0.9930
Epoch 35/90
2/2 [=====] - 0s 75ms/step - loss: 0.0378 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 36/90
2/2 [=====] - 0s 79ms/step - loss: 0.0403 - acc: 0.98
50 - recall: 0.9862 - precision: 0.9931
Epoch 37/90
2/2 [=====] - 0s 78ms/step - loss: 0.0287 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 38/90
2/2 [=====] - 0s 84ms/step - loss: 0.0308 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 39/90
2/2 [=====] - 0s 119ms/step - loss: 0.0359 - acc: 0.9
850 - recall: 0.9793 - precision: 1.0000
Epoch 40/90
2/2 [=====] - 0s 82ms/step - loss: 0.0389 - acc: 0.98
50 - recall: 0.9931 - precision: 0.9863
Epoch 41/90
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.0395 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 42/90  
2/2 [=====] - 0s 93ms/step - loss: 0.0218 - acc: 0.98  
50 - recall: 0.9793 - precision: 1.0000  
Epoch 43/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0379 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 44/90  
2/2 [=====] - 0s 101ms/step - loss: 0.0310 - acc: 0.9  
850 - recall: 0.9931 - precision: 0.9863  
Epoch 45/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0108 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 46/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0239 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 47/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0221 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 48/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0294 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9864  
Epoch 49/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0109 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 50/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0153 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 51/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0051 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 52/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0148 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 53/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0211 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 54/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0042 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0168 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 56/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0150 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 57/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0124 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 58/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0030 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 59/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0056 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0117 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 61/90
```

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2/2 [=====] - 0s 97ms/step - loss: 0.0088 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 62/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0124 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 63/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0576 - acc: 0.98  
00 - recall: 1.0000 - precision: 0.9732  
Epoch 64/90  
2/2 [=====] - 0s 87ms/step - loss: 0.2019 - acc: 0.96  
00 - recall: 0.9517 - precision: 0.9928  
Epoch 65/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0352 - acc: 0.98  
50 - recall: 0.9862 - precision: 0.9931  
Epoch 66/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0598 - acc: 0.98  
00 - recall: 0.9793 - precision: 0.9930  
Epoch 67/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0533 - acc: 0.97  
50 - recall: 0.9793 - precision: 0.9861  
Epoch 68/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0428 - acc: 0.98  
50 - recall: 0.9931 - precision: 0.9863  
Epoch 69/90  
2/2 [=====] - 0s 193ms/step - loss: 0.0532 - acc: 0.9  
750 - recall: 0.9793 - precision: 0.9861  
Epoch 70/90  
2/2 [=====] - 0s 76ms/step - loss: 0.0255 - acc: 0.99  
00 - recall: 0.9931 - precision: 0.9931  
Epoch 71/90  
2/2 [=====] - 0s 79ms/step - loss: 0.0246 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 72/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0333 - acc: 0.99  
00 - recall: 1.0000 - precision: 0.9864  
Epoch 73/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0150 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 74/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0132 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 75/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0038 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 76/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0152 - acc: 0.99  
00 - recall: 0.9862 - precision: 1.0000  
Epoch 77/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0125 - acc: 0.99  
50 - recall: 0.9931 - precision: 1.0000  
Epoch 78/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0128 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 79/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0101 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 80/90  
2/2 [=====] - 0s 91ms/step - loss: 0.0108 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9932  
Epoch 81/90
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.0089 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 82/90
2/2 [=====] - 0s 92ms/step - loss: 0.0088 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9932
Epoch 83/90
2/2 [=====] - 0s 85ms/step - loss: 3.3638e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 86ms/step - loss: 0.0011 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 86ms/step - loss: 8.1120e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 85ms/step - loss: 0.0036 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 83ms/step - loss: 0.0045 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 83ms/step - loss: 0.0076 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 82ms/step - loss: 0.0151 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 90/90
2/2 [=====] - 0s 84ms/step - loss: 8.7450e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
1/4 [=====] - ETA: 0s
2023-03-31 16:54:59.859181: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 60ms/step
7/7 [=====] - 0s 38ms/step
Epoch 1/90
2023-03-31 16:55:00.941562: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 825ms/step - loss: 0.6876 - acc: 0.5  
700 - recall: 0.6284 - precision: 0.7500  
Epoch 2/90  
2/2 [=====] - 1s 253ms/step - loss: 0.7289 - acc: 0.3  
700 - recall: 0.1959 - precision: 0.8056  
Epoch 3/90  
2/2 [=====] - 0s 210ms/step - loss: 0.6889 - acc: 0.5  
450 - recall: 0.5608 - precision: 0.7615  
Epoch 4/90  
2/2 [=====] - 0s 146ms/step - loss: 0.6724 - acc: 0.5  
550 - recall: 0.5338 - precision: 0.7980  
Epoch 5/90  
2/2 [=====] - 0s 233ms/step - loss: 0.6559 - acc: 0.6  
550 - recall: 0.6757 - precision: 0.8264  
Epoch 6/90  
2/2 [=====] - 0s 201ms/step - loss: 0.6267 - acc: 0.7  
400 - recall: 0.8041 - precision: 0.8380  
Epoch 7/90  
2/2 [=====] - 0s 165ms/step - loss: 0.5415 - acc: 0.7  
350 - recall: 0.6824 - precision: 0.9439  
Epoch 8/90  
2/2 [=====] - 0s 123ms/step - loss: 0.5346 - acc: 0.7  
900 - recall: 0.8649 - precision: 0.8533  
Epoch 9/90  
2/2 [=====] - 0s 140ms/step - loss: 0.5366 - acc: 0.7  
700 - recall: 0.8311 - precision: 0.8542  
Epoch 10/90  
2/2 [=====] - 0s 76ms/step - loss: 0.4837 - acc: 0.75  
50 - recall: 0.7162 - precision: 0.9381  
Epoch 11/90  
2/2 [=====] - 0s 152ms/step - loss: 0.4128 - acc: 0.7  
950 - recall: 0.7432 - precision: 0.9735  
Epoch 12/90  
2/2 [=====] - 0s 96ms/step - loss: 0.3427 - acc: 0.83  
50 - recall: 0.8108 - precision: 0.9600  
Epoch 13/90  
2/2 [=====] - 0s 80ms/step - loss: 0.4092 - acc: 0.81  
50 - recall: 0.7770 - precision: 0.9664  
Epoch 14/90  
2/2 [=====] - 0s 77ms/step - loss: 0.3493 - acc: 0.85  
50 - recall: 0.8716 - precision: 0.9281  
Epoch 15/90  
2/2 [=====] - 0s 138ms/step - loss: 0.2795 - acc: 0.8  
650 - recall: 0.8446 - precision: 0.9690  
Epoch 16/90  
2/2 [=====] - 0s 165ms/step - loss: 0.3114 - acc: 0.8  
500 - recall: 0.8041 - precision: 0.9917  
Epoch 17/90  
2/2 [=====] - 0s 132ms/step - loss: 0.2553 - acc: 0.8  
750 - recall: 0.8716 - precision: 0.9556  
Epoch 18/90  
2/2 [=====] - 0s 156ms/step - loss: 0.2463 - acc: 0.9  
000 - recall: 0.8919 - precision: 0.9706  
Epoch 19/90  
2/2 [=====] - 0s 75ms/step - loss: 0.2523 - acc: 0.86  
50 - recall: 0.8243 - precision: 0.9919  
Epoch 20/90  
2/2 [=====] - 0s 102ms/step - loss: 0.2111 - acc: 0.9  
200 - recall: 0.9122 - precision: 0.9783  
Epoch 21/90
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.2039 - acc: 0.93
00 - recall: 0.9324 - precision: 0.9718
Epoch 22/90
2/2 [=====] - 0s 74ms/step - loss: 0.1655 - acc: 0.92
50 - recall: 0.8986 - precision: 1.0000
Epoch 23/90
2/2 [=====] - 0s 119ms/step - loss: 0.1450 - acc: 0.9
300 - recall: 0.9189 - precision: 0.9855
Epoch 24/90
2/2 [=====] - 0s 74ms/step - loss: 0.1057 - acc: 0.96
00 - recall: 0.9595 - precision: 0.9861
Epoch 25/90
2/2 [=====] - 0s 75ms/step - loss: 0.1209 - acc: 0.96
50 - recall: 0.9662 - precision: 0.9862
Epoch 26/90
2/2 [=====] - 0s 119ms/step - loss: 0.0888 - acc: 0.9
450 - recall: 0.9257 - precision: 1.0000
Epoch 27/90
2/2 [=====] - 0s 75ms/step - loss: 0.1130 - acc: 0.93
50 - recall: 0.9324 - precision: 0.9787
Epoch 28/90
2/2 [=====] - 0s 77ms/step - loss: 0.0763 - acc: 0.97
00 - recall: 0.9797 - precision: 0.9797
Epoch 29/90
2/2 [=====] - 0s 74ms/step - loss: 0.0830 - acc: 0.96
00 - recall: 0.9527 - precision: 0.9930
Epoch 30/90
2/2 [=====] - 0s 76ms/step - loss: 0.0980 - acc: 0.95
00 - recall: 0.9527 - precision: 0.9792
Epoch 31/90
2/2 [=====] - 0s 75ms/step - loss: 0.0804 - acc: 0.97
00 - recall: 0.9595 - precision: 1.0000
Epoch 32/90
2/2 [=====] - 0s 95ms/step - loss: 0.0774 - acc: 0.98
00 - recall: 0.9797 - precision: 0.9932
Epoch 33/90
2/2 [=====] - 0s 75ms/step - loss: 0.0631 - acc: 0.97
00 - recall: 0.9595 - precision: 1.0000
Epoch 34/90
2/2 [=====] - 0s 75ms/step - loss: 0.0669 - acc: 0.97
50 - recall: 0.9662 - precision: 1.0000
Epoch 35/90
2/2 [=====] - 0s 75ms/step - loss: 0.0387 - acc: 0.98
00 - recall: 0.9730 - precision: 1.0000
Epoch 36/90
2/2 [=====] - 0s 79ms/step - loss: 0.0473 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 37/90
2/2 [=====] - 0s 140ms/step - loss: 0.0486 - acc: 0.9
850 - recall: 0.9797 - precision: 1.0000
Epoch 38/90
2/2 [=====] - 0s 127ms/step - loss: 0.0287 - acc: 0.9
950 - recall: 0.9932 - precision: 1.0000
Epoch 39/90
2/2 [=====] - 0s 89ms/step - loss: 0.0301 - acc: 0.98
00 - recall: 0.9730 - precision: 1.0000
Epoch 40/90
2/2 [=====] - 0s 135ms/step - loss: 0.0635 - acc: 0.9
800 - recall: 1.0000 - precision: 0.9737
Epoch 41/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.0514 - acc: 0.98  
00 - recall: 0.9730 - precision: 1.0000  
Epoch 42/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0429 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 43/90  
2/2 [=====] - 1s 370ms/step - loss: 0.0886 - acc: 0.9  
700 - recall: 0.9932 - precision: 0.9671  
Epoch 44/90  
2/2 [=====] - 0s 76ms/step - loss: 0.0268 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 45/90  
2/2 [=====] - 0s 75ms/step - loss: 0.0509 - acc: 0.97  
00 - recall: 0.9662 - precision: 0.9931  
Epoch 46/90  
2/2 [=====] - 0s 160ms/step - loss: 0.0396 - acc: 0.9  
900 - recall: 0.9932 - precision: 0.9932  
Epoch 47/90  
2/2 [=====] - 0s 96ms/step - loss: 0.0265 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 48/90  
2/2 [=====] - 0s 77ms/step - loss: 0.0222 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 49/90  
2/2 [=====] - 0s 82ms/step - loss: 0.0194 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 50/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0239 - acc: 0.98  
50 - recall: 0.9865 - precision: 0.9932  
Epoch 51/90  
2/2 [=====] - 0s 92ms/step - loss: 0.0257 - acc: 0.99  
00 - recall: 0.9932 - precision: 0.9932  
Epoch 52/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0095 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 53/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0045 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 54/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0071 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0024 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 56/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0053 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 57/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0019 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 58/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0163 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 59/90  
2/2 [=====] - 0s 162ms/step - loss: 0.0102 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 101ms/step - loss: 0.0059 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 61/90
```

```
2/2 [=====] - 0s 86ms/step - loss: 0.0093 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 62/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0076 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 63/90  
2/2 [=====] - 0s 87ms/step - loss: 6.9263e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 64/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0019 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 65/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0050 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 66/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0030 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 67/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0070 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 68/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0089 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 69/90  
2/2 [=====] - 0s 87ms/step - loss: 7.1676e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 70/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0294 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 71/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0063 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 72/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0157 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 73/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0148 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 74/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0147 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 75/90  
2/2 [=====] - 0s 115ms/step - loss: 0.0090 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 76/90  
2/2 [=====] - 0s 80ms/step - loss: 0.0131 - acc: 0.99  
50 - recall: 0.9932 - precision: 1.0000  
Epoch 77/90  
2/2 [=====] - 0s 82ms/step - loss: 0.0013 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 78/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0113 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 79/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0037 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 80/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0085 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 81/90
```

```
2/2 [=====] - 0s 95ms/step - loss: 0.0194 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 82/90
2/2 [=====] - 0s 84ms/step - loss: 0.0018 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 83/90
2/2 [=====] - 0s 85ms/step - loss: 0.0037 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 87ms/step - loss: 0.0063 - acc: 0.99
50 - recall: 0.9932 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 84ms/step - loss: 0.0054 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 83ms/step - loss: 0.0015 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 96ms/step - loss: 0.0059 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 84ms/step - loss: 0.0020 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 0.0066 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
1/4 [=====] - ETA: 0s
```

```
2023-03-31 16:55:25.601309: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 69ms/step
```

```
7/7 [=====] - 0s 35ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:55:27.101228: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 1s/step - loss: 0.6884 - acc: 0.5850
- recall: 0.6107 - precision: 0.7845
Epoch 2/90
2/2 [=====] - 1s 305ms/step - loss: 0.7386 - acc: 0.6
650 - recall: 0.8054 - precision: 0.7595
Epoch 3/90
2/2 [=====] - 0s 173ms/step - loss: 0.6859 - acc: 0.5
500 - recall: 0.5570 - precision: 0.7757
Epoch 4/90
2/2 [=====] - 0s 214ms/step - loss: 0.6533 - acc: 0.6
700 - recall: 0.6040 - precision: 0.9278
Epoch 5/90
2/2 [=====] - 0s 144ms/step - loss: 0.6556 - acc: 0.6
550 - recall: 0.6644 - precision: 0.8390
Epoch 6/90
2/2 [=====] - 0s 155ms/step - loss: 0.5908 - acc: 0.7
350 - recall: 0.7315 - precision: 0.8934
Epoch 7/90
2/2 [=====] - 0s 78ms/step - loss: 0.5284 - acc: 0.80
00 - recall: 0.8322 - precision: 0.8921
Epoch 8/90
2/2 [=====] - 0s 76ms/step - loss: 0.6096 - acc: 0.70
00 - recall: 0.6309 - precision: 0.9495
Epoch 9/90
2/2 [=====] - 0s 140ms/step - loss: 0.4535 - acc: 0.8
250 - recall: 0.8523 - precision: 0.9071
Epoch 10/90
2/2 [=====] - 0s 151ms/step - loss: 0.5011 - acc: 0.8
200 - recall: 0.9195 - precision: 0.8509
Epoch 11/90
2/2 [=====] - 0s 154ms/step - loss: 0.5036 - acc: 0.8
100 - recall: 0.8792 - precision: 0.8675
Epoch 12/90
2/2 [=====] - 0s 170ms/step - loss: 0.4463 - acc: 0.8
150 - recall: 0.8255 - precision: 0.9179
Epoch 13/90
2/2 [=====] - 0s 156ms/step - loss: 0.4502 - acc: 0.8
100 - recall: 0.7852 - precision: 0.9512
Epoch 14/90
2/2 [=====] - 0s 78ms/step - loss: 0.3857 - acc: 0.80
00 - recall: 0.7785 - precision: 0.9431
Epoch 15/90
2/2 [=====] - 0s 95ms/step - loss: 0.3737 - acc: 0.84
00 - recall: 0.8255 - precision: 0.9535
Epoch 16/90
2/2 [=====] - 0s 85ms/step - loss: 0.3933 - acc: 0.82
00 - recall: 0.8054 - precision: 0.9449
Epoch 17/90
2/2 [=====] - 0s 122ms/step - loss: 0.3397 - acc: 0.8
450 - recall: 0.8322 - precision: 0.9538
Epoch 18/90
2/2 [=====] - 0s 143ms/step - loss: 0.3329 - acc: 0.8
450 - recall: 0.8255 - precision: 0.9609
Epoch 19/90
2/2 [=====] - 0s 79ms/step - loss: 0.2895 - acc: 0.82
00 - recall: 0.7919 - precision: 0.9593
Epoch 20/90
2/2 [=====] - 0s 137ms/step - loss: 0.2634 - acc: 0.8
450 - recall: 0.8121 - precision: 0.9758
Epoch 21/90
```

```
2/2 [=====] - 0s 143ms/step - loss: 0.2524 - acc: 0.8  
650 - recall: 0.8523 - precision: 0.9621  
Epoch 22/90  
2/2 [=====] - 0s 75ms/step - loss: 0.2662 - acc: 0.86  
00 - recall: 0.8456 - precision: 0.9618  
Epoch 23/90  
2/2 [=====] - 0s 78ms/step - loss: 0.2096 - acc: 0.92  
50 - recall: 0.9195 - precision: 0.9786  
Epoch 24/90  
2/2 [=====] - 0s 77ms/step - loss: 0.2117 - acc: 0.89  
00 - recall: 0.8523 - precision: 1.0000  
Epoch 25/90  
2/2 [=====] - 0s 133ms/step - loss: 0.1693 - acc: 0.9  
300 - recall: 0.9262 - precision: 0.9787  
Epoch 26/90  
2/2 [=====] - 0s 102ms/step - loss: 0.1802 - acc: 0.9  
300 - recall: 0.9329 - precision: 0.9720  
Epoch 27/90  
2/2 [=====] - 0s 137ms/step - loss: 0.1308 - acc: 0.9  
650 - recall: 0.9530 - precision: 1.0000  
Epoch 28/90  
2/2 [=====] - 0s 76ms/step - loss: 0.1369 - acc: 0.95  
00 - recall: 0.9597 - precision: 0.9728  
Epoch 29/90  
2/2 [=====] - 0s 77ms/step - loss: 0.1416 - acc: 0.94  
00 - recall: 0.9329 - precision: 0.9858  
Epoch 30/90  
2/2 [=====] - 0s 75ms/step - loss: 0.1091 - acc: 0.95  
00 - recall: 0.9664 - precision: 0.9664  
Epoch 31/90  
2/2 [=====] - 0s 117ms/step - loss: 0.1285 - acc: 0.9  
400 - recall: 0.9262 - precision: 0.9928  
Epoch 32/90  
2/2 [=====] - 0s 105ms/step - loss: 0.0996 - acc: 0.9  
550 - recall: 0.9463 - precision: 0.9930  
Epoch 33/90  
2/2 [=====] - 0s 136ms/step - loss: 0.0972 - acc: 0.9  
800 - recall: 0.9866 - precision: 0.9866  
Epoch 34/90  
2/2 [=====] - 0s 76ms/step - loss: 0.1202 - acc: 0.94  
50 - recall: 0.9597 - precision: 0.9662  
Epoch 35/90  
2/2 [=====] - 0s 184ms/step - loss: 0.0696 - acc: 0.9  
700 - recall: 0.9597 - precision: 1.0000  
Epoch 36/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0641 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 37/90  
2/2 [=====] - 0s 81ms/step - loss: 0.0926 - acc: 0.97  
00 - recall: 0.9866 - precision: 0.9735  
Epoch 38/90  
2/2 [=====] - 0s 77ms/step - loss: 0.0620 - acc: 0.97  
00 - recall: 0.9597 - precision: 1.0000  
Epoch 39/90  
2/2 [=====] - 0s 80ms/step - loss: 0.1133 - acc: 0.96  
00 - recall: 0.9732 - precision: 0.9732  
Epoch 40/90  
2/2 [=====] - 0s 93ms/step - loss: 0.0573 - acc: 0.97  
00 - recall: 0.9664 - precision: 0.9931  
Epoch 41/90
```

```
2/2 [=====] - 0s 143ms/step - loss: 0.0687 - acc: 0.9  
900 - recall: 0.9866 - precision: 1.0000  
Epoch 42/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0600 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 43/90  
2/2 [=====] - 0s 91ms/step - loss: 0.0650 - acc: 0.97  
50 - recall: 0.9732 - precision: 0.9932  
Epoch 44/90  
2/2 [=====] - 0s 141ms/step - loss: 0.0424 - acc: 0.9  
800 - recall: 0.9866 - precision: 0.9866  
Epoch 45/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0479 - acc: 0.98  
00 - recall: 0.9799 - precision: 0.9932  
Epoch 46/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0304 - acc: 0.99  
00 - recall: 0.9933 - precision: 0.9933  
Epoch 47/90  
2/2 [=====] - 0s 92ms/step - loss: 0.0145 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 48/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0366 - acc: 0.98  
00 - recall: 0.9732 - precision: 1.0000  
Epoch 49/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0442 - acc: 0.98  
50 - recall: 0.9866 - precision: 0.9932  
Epoch 50/90  
2/2 [=====] - 0s 345ms/step - loss: 0.0285 - acc: 0.9  
950 - recall: 0.9933 - precision: 1.0000  
Epoch 51/90  
2/2 [=====] - 0s 78ms/step - loss: 0.0181 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 52/90  
2/2 [=====] - 0s 75ms/step - loss: 0.0270 - acc: 0.99  
00 - recall: 0.9933 - precision: 0.9933  
Epoch 53/90  
2/2 [=====] - 0s 79ms/step - loss: 0.0221 - acc: 0.98  
50 - recall: 0.9799 - precision: 1.0000  
Epoch 54/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0114 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 55/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0260 - acc: 0.98  
50 - recall: 0.9933 - precision: 0.9867  
Epoch 56/90  
2/2 [=====] - 0s 90ms/step - loss: 0.0109 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 57/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0094 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 58/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0194 - acc: 0.99  
00 - recall: 0.9933 - precision: 0.9933  
Epoch 59/90  
2/2 [=====] - 0s 89ms/step - loss: 0.0174 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 60/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0255 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 61/90
```

```
2/2 [=====] - 0s 87ms/step - loss: 0.0097 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 62/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0202 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 63/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0101 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 64/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0056 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 65/90  
2/2 [=====] - 0s 93ms/step - loss: 0.0134 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 66/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0023 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 67/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0205 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 68/90  
2/2 [=====] - 0s 99ms/step - loss: 0.0103 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 69/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0176 - acc: 0.99  
00 - recall: 0.9933 - precision: 0.9933  
Epoch 70/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0063 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 71/90  
2/2 [=====] - 0s 88ms/step - loss: 0.0069 - acc: 0.99  
50 - recall: 0.9933 - precision: 1.0000  
Epoch 72/90  
2/2 [=====] - 0s 101ms/step - loss: 0.0096 - acc: 0.9  
950 - recall: 1.0000 - precision: 0.9933  
Epoch 73/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0038 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 74/90  
2/2 [=====] - 0s 86ms/step - loss: 0.0025 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 75/90  
2/2 [=====] - 0s 85ms/step - loss: 0.0053 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 76/90  
2/2 [=====] - 0s 87ms/step - loss: 0.0013 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 77/90  
2/2 [=====] - 0s 83ms/step - loss: 0.0073 - acc: 0.99  
00 - recall: 0.9866 - precision: 1.0000  
Epoch 78/90  
2/2 [=====] - 0s 79ms/step - loss: 0.0124 - acc: 0.99  
50 - recall: 1.0000 - precision: 0.9933  
Epoch 79/90  
2/2 [=====] - 0s 84ms/step - loss: 3.3116e-04 - acc:  
1.0000 - recall: 1.0000 - precision: 1.0000  
Epoch 80/90  
2/2 [=====] - 0s 84ms/step - loss: 0.0015 - acc: 1.00  
00 - recall: 1.0000 - precision: 1.0000  
Epoch 81/90
```

```
2/2 [=====] - 0s 84ms/step - loss: 0.0120 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 82/90
2/2 [=====] - 0s 84ms/step - loss: 0.0086 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 83/90
2/2 [=====] - 0s 86ms/step - loss: 0.0105 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 84/90
2/2 [=====] - 0s 85ms/step - loss: 0.0024 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 85/90
2/2 [=====] - 0s 94ms/step - loss: 0.0010 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 86/90
2/2 [=====] - 0s 86ms/step - loss: 0.0094 - acc: 0.99
00 - recall: 0.9866 - precision: 1.0000
Epoch 87/90
2/2 [=====] - 0s 85ms/step - loss: 0.0071 - acc: 0.99
50 - recall: 0.9933 - precision: 1.0000
Epoch 88/90
2/2 [=====] - 0s 82ms/step - loss: 0.0015 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 89/90
2/2 [=====] - 0s 84ms/step - loss: 9.3642e-04 - acc:
1.0000 - recall: 1.0000 - precision: 1.0000
Epoch 90/90
2/2 [=====] - 0s 90ms/step - loss: 0.0073 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:55:52.327301: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 50ms/step
7/7 [=====] - 0s 32ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:55:53.339190: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 851ms/step - loss: 0.7040 - acc: 0.5
500 - recall: 0.5862 - precision: 0.7391
Epoch 2/90
2/2 [=====] - 0s 228ms/step - loss: 0.7035 - acc: 0.5
200 - recall: 0.5586 - precision: 0.7168
Epoch 3/90
2/2 [=====] - 0s 227ms/step - loss: 0.7022 - acc: 0.5
300 - recall: 0.5448 - precision: 0.7383
Epoch 4/90
2/2 [=====] - 0s 163ms/step - loss: 0.6999 - acc: 0.5
350 - recall: 0.5379 - precision: 0.7500
Epoch 5/90
2/2 [=====] - 0s 204ms/step - loss: 0.7029 - acc: 0.5
200 - recall: 0.5103 - precision: 0.7475
Epoch 6/90
2/2 [=====] - 0s 160ms/step - loss: 0.7057 - acc: 0.4
550 - recall: 0.4621 - precision: 0.6837
Epoch 7/90
2/2 [=====] - 0s 84ms/step - loss: 0.6945 - acc: 0.55
00 - recall: 0.5241 - precision: 0.7835
Epoch 8/90
2/2 [=====] - 0s 204ms/step - loss: 0.6975 - acc: 0.4
750 - recall: 0.4138 - precision: 0.7500
Epoch 9/90
2/2 [=====] - 0s 178ms/step - loss: 0.6954 - acc: 0.4
950 - recall: 0.3931 - precision: 0.8143
Epoch 10/90
2/2 [=====] - 0s 163ms/step - loss: 0.6983 - acc: 0.4
850 - recall: 0.3931 - precision: 0.7917
Epoch 11/90
2/2 [=====] - 0s 136ms/step - loss: 0.6963 - acc: 0.5
150 - recall: 0.4276 - precision: 0.8158
Epoch 12/90
2/2 [=====] - 0s 139ms/step - loss: 0.6992 - acc: 0.4
950 - recall: 0.4207 - precision: 0.7821
Epoch 13/90
2/2 [=====] - 0s 328ms/step - loss: 0.6995 - acc: 0.4
400 - recall: 0.3241 - precision: 0.7705
Epoch 14/90
2/2 [=====] - 0s 103ms/step - loss: 0.6947 - acc: 0.4
950 - recall: 0.4069 - precision: 0.7973
Epoch 15/90
2/2 [=====] - 0s 91ms/step - loss: 0.7019 - acc: 0.45
00 - recall: 0.3793 - precision: 0.7333
Epoch 16/90
2/2 [=====] - 0s 120ms/step - loss: 0.6924 - acc: 0.4
750 - recall: 0.3448 - precision: 0.8333
Epoch 17/90
2/2 [=====] - 0s 95ms/step - loss: 0.6974 - acc: 0.43
00 - recall: 0.3172 - precision: 0.7541
Epoch 18/90
2/2 [=====] - 0s 96ms/step - loss: 0.6999 - acc: 0.40
50 - recall: 0.2690 - precision: 0.7500
Epoch 19/90
2/2 [=====] - 0s 76ms/step - loss: 0.7012 - acc: 0.42
50 - recall: 0.3241 - precision: 0.7344
Epoch 20/90
2/2 [=====] - 0s 78ms/step - loss: 0.6998 - acc: 0.43
00 - recall: 0.3379 - precision: 0.7313
Epoch 21/90
```

```
2/2 [=====] - 0s 74ms/step - loss: 0.6913 - acc: 0.49
50 - recall: 0.3724 - precision: 0.8438
Epoch 22/90
2/2 [=====] - 0s 194ms/step - loss: 0.6969 - acc: 0.3
950 - recall: 0.2414 - precision: 0.7609
Epoch 23/90
2/2 [=====] - 0s 96ms/step - loss: 0.6949 - acc: 0.38
50 - recall: 0.2483 - precision: 0.7200
Epoch 24/90
2/2 [=====] - 0s 79ms/step - loss: 0.6989 - acc: 0.40
00 - recall: 0.2483 - precision: 0.7660
Epoch 25/90
2/2 [=====] - 0s 96ms/step - loss: 0.6883 - acc: 0.44
00 - recall: 0.2897 - precision: 0.8235
Epoch 26/90
2/2 [=====] - 0s 78ms/step - loss: 0.6872 - acc: 0.45
00 - recall: 0.3241 - precision: 0.7966
Epoch 27/90
2/2 [=====] - 0s 75ms/step - loss: 0.6946 - acc: 0.41
50 - recall: 0.2414 - precision: 0.8333
Epoch 28/90
2/2 [=====] - 0s 128ms/step - loss: 0.6911 - acc: 0.4
250 - recall: 0.2897 - precision: 0.7778
Epoch 29/90
2/2 [=====] - 0s 75ms/step - loss: 0.6991 - acc: 0.47
00 - recall: 0.3517 - precision: 0.8095
Epoch 30/90
2/2 [=====] - 0s 75ms/step - loss: 0.6944 - acc: 0.42
00 - recall: 0.2897 - precision: 0.7636
Epoch 31/90
2/2 [=====] - 0s 76ms/step - loss: 0.6966 - acc: 0.44
00 - recall: 0.2966 - precision: 0.8113
Epoch 32/90
2/2 [=====] - 0s 133ms/step - loss: 0.6866 - acc: 0.5
350 - recall: 0.4276 - precision: 0.8611
Epoch 33/90
2/2 [=====] - 0s 76ms/step - loss: 0.6906 - acc: 0.54
50 - recall: 0.4621 - precision: 0.8375
Epoch 34/90
2/2 [=====] - 0s 75ms/step - loss: 0.6860 - acc: 0.52
50 - recall: 0.4207 - precision: 0.8472
Epoch 35/90
2/2 [=====] - 0s 75ms/step - loss: 0.6943 - acc: 0.51
00 - recall: 0.4069 - precision: 0.8310
Epoch 36/90
2/2 [=====] - 0s 78ms/step - loss: 0.6870 - acc: 0.45
00 - recall: 0.2897 - precision: 0.8571
Epoch 37/90
2/2 [=====] - 0s 124ms/step - loss: 0.6899 - acc: 0.4
750 - recall: 0.3310 - precision: 0.8571
Epoch 38/90
2/2 [=====] - 0s 89ms/step - loss: 0.6886 - acc: 0.56
50 - recall: 0.4759 - precision: 0.8625
Epoch 39/90
2/2 [=====] - 0s 98ms/step - loss: 0.6886 - acc: 0.43
50 - recall: 0.2690 - precision: 0.8478
Epoch 40/90
2/2 [=====] - 0s 94ms/step - loss: 0.6815 - acc: 0.43
50 - recall: 0.2690 - precision: 0.8478
Epoch 41/90
```

```
2/2 [=====] - 0s 91ms/step - loss: 0.6851 - acc: 0.49
00 - recall: 0.3655 - precision: 0.8413
Epoch 42/90
2/2 [=====] - 0s 87ms/step - loss: 0.6791 - acc: 0.50
50 - recall: 0.3655 - precision: 0.8833
Epoch 43/90
2/2 [=====] - 0s 89ms/step - loss: 0.6838 - acc: 0.48
00 - recall: 0.3448 - precision: 0.8475
Epoch 44/90
2/2 [=====] - 0s 90ms/step - loss: 0.6805 - acc: 0.49
50 - recall: 0.3448 - precision: 0.8929
Epoch 45/90
2/2 [=====] - 0s 90ms/step - loss: 0.6736 - acc: 0.50
50 - recall: 0.3517 - precision: 0.9107
Epoch 46/90
2/2 [=====] - 0s 87ms/step - loss: 0.6818 - acc: 0.49
50 - recall: 0.3724 - precision: 0.8438
Epoch 47/90
2/2 [=====] - 0s 88ms/step - loss: 0.7037 - acc: 0.42
50 - recall: 0.3172 - precision: 0.7419
Epoch 48/90
2/2 [=====] - 0s 87ms/step - loss: 0.6714 - acc: 0.57
50 - recall: 0.4414 - precision: 0.9412
Epoch 49/90
2/2 [=====] - 0s 89ms/step - loss: 0.6805 - acc: 0.49
50 - recall: 0.3448 - precision: 0.8929
Epoch 50/90
2/2 [=====] - 0s 87ms/step - loss: 0.6862 - acc: 0.56
00 - recall: 0.4966 - precision: 0.8276
Epoch 51/90
2/2 [=====] - 0s 92ms/step - loss: 0.6826 - acc: 0.52
00 - recall: 0.4000 - precision: 0.8657
Epoch 52/90
2/2 [=====] - 0s 87ms/step - loss: 0.6826 - acc: 0.54
50 - recall: 0.4621 - precision: 0.8375
Epoch 53/90
2/2 [=====] - 0s 88ms/step - loss: 0.6845 - acc: 0.49
50 - recall: 0.3586 - precision: 0.8667
Epoch 54/90
2/2 [=====] - 0s 86ms/step - loss: 0.6726 - acc: 0.53
50 - recall: 0.4000 - precision: 0.9062
Epoch 55/90
2/2 [=====] - 0s 86ms/step - loss: 0.6796 - acc: 0.50
50 - recall: 0.3724 - precision: 0.8710
Epoch 56/90
2/2 [=====] - 0s 80ms/step - loss: 0.6842 - acc: 0.56
00 - recall: 0.4483 - precision: 0.8904
Epoch 57/90
2/2 [=====] - 0s 89ms/step - loss: 0.6737 - acc: 0.56
50 - recall: 0.4759 - precision: 0.8625
Epoch 58/90
2/2 [=====] - 0s 90ms/step - loss: 0.6797 - acc: 0.53
50 - recall: 0.4207 - precision: 0.8714
Epoch 59/90
2/2 [=====] - 0s 88ms/step - loss: 0.6818 - acc: 0.55
00 - recall: 0.4897 - precision: 0.8161
Epoch 60/90
2/2 [=====] - 0s 85ms/step - loss: 0.6778 - acc: 0.54
50 - recall: 0.4414 - precision: 0.8649
Epoch 61/90
```

```
2/2 [=====] - 0s 84ms/step - loss: 0.6684 - acc: 0.56
00 - recall: 0.4621 - precision: 0.8701
Epoch 62/90
2/2 [=====] - 0s 86ms/step - loss: 0.6662 - acc: 0.56
50 - recall: 0.4345 - precision: 0.9265
Epoch 63/90
2/2 [=====] - 0s 86ms/step - loss: 0.6714 - acc: 0.56
00 - recall: 0.4828 - precision: 0.8434
Epoch 64/90
2/2 [=====] - 0s 86ms/step - loss: 0.6679 - acc: 0.61
00 - recall: 0.5724 - precision: 0.8384
Epoch 65/90
2/2 [=====] - 0s 85ms/step - loss: 0.6765 - acc: 0.56
00 - recall: 0.4690 - precision: 0.8608
Epoch 66/90
2/2 [=====] - 0s 85ms/step - loss: 0.6727 - acc: 0.61
00 - recall: 0.5379 - precision: 0.8764
Epoch 67/90
2/2 [=====] - 0s 87ms/step - loss: 0.6732 - acc: 0.64
00 - recall: 0.6069 - precision: 0.8544
Epoch 68/90
2/2 [=====] - 0s 85ms/step - loss: 0.6757 - acc: 0.52
50 - recall: 0.4345 - precision: 0.8289
Epoch 69/90
2/2 [=====] - 0s 85ms/step - loss: 0.6605 - acc: 0.62
00 - recall: 0.5172 - precision: 0.9259
Epoch 70/90
2/2 [=====] - 0s 84ms/step - loss: 0.6692 - acc: 0.63
00 - recall: 0.6138 - precision: 0.8318
Epoch 71/90
2/2 [=====] - 0s 85ms/step - loss: 0.6696 - acc: 0.51
00 - recall: 0.4000 - precision: 0.8406
Epoch 72/90
2/2 [=====] - 0s 84ms/step - loss: 0.6647 - acc: 0.63
50 - recall: 0.5793 - precision: 0.8750
Epoch 73/90
2/2 [=====] - 0s 85ms/step - loss: 0.6778 - acc: 0.56
50 - recall: 0.5034 - precision: 0.8295
Epoch 74/90
2/2 [=====] - 0s 85ms/step - loss: 0.6681 - acc: 0.56
50 - recall: 0.4897 - precision: 0.8452
Epoch 75/90
2/2 [=====] - 0s 85ms/step - loss: 0.6590 - acc: 0.68
50 - recall: 0.6483 - precision: 0.8868
Epoch 76/90
2/2 [=====] - 0s 85ms/step - loss: 0.6571 - acc: 0.53
50 - recall: 0.3931 - precision: 0.9194
Epoch 77/90
2/2 [=====] - 0s 85ms/step - loss: 0.6595 - acc: 0.65
00 - recall: 0.5931 - precision: 0.8866
Epoch 78/90
2/2 [=====] - 0s 85ms/step - loss: 0.6722 - acc: 0.58
50 - recall: 0.5310 - precision: 0.8370
Epoch 79/90
2/2 [=====] - 0s 207ms/step - loss: 0.6385 - acc: 0.6
700 - recall: 0.6138 - precision: 0.8990
Epoch 80/90
2/2 [=====] - 0s 79ms/step - loss: 0.6565 - acc: 0.61
50 - recall: 0.5034 - precision: 0.9359
Epoch 81/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.6545 - acc: 0.64
50 - recall: 0.6828 - precision: 0.7984
Epoch 82/90
2/2 [=====] - 0s 82ms/step - loss: 0.6692 - acc: 0.58
50 - recall: 0.5310 - precision: 0.8370
Epoch 83/90
2/2 [=====] - 0s 86ms/step - loss: 0.6666 - acc: 0.49
00 - recall: 0.3379 - precision: 0.8909
Epoch 84/90
2/2 [=====] - 0s 94ms/step - loss: 0.6359 - acc: 0.68
00 - recall: 0.6414 - precision: 0.8857
Epoch 85/90
2/2 [=====] - 0s 84ms/step - loss: 0.6532 - acc: 0.50
50 - recall: 0.3724 - precision: 0.8710
Epoch 86/90
2/2 [=====] - 0s 84ms/step - loss: 0.6414 - acc: 0.70
50 - recall: 0.6759 - precision: 0.8909
Epoch 87/90
2/2 [=====] - 0s 85ms/step - loss: 0.6551 - acc: 0.62
00 - recall: 0.5931 - precision: 0.8350
Epoch 88/90
2/2 [=====] - 0s 86ms/step - loss: 0.6315 - acc: 0.66
50 - recall: 0.6207 - precision: 0.8824
Epoch 89/90
2/2 [=====] - 0s 86ms/step - loss: 0.6507 - acc: 0.68
50 - recall: 0.6966 - precision: 0.8417
Epoch 90/90
2/2 [=====] - 0s 85ms/step - loss: 0.6324 - acc: 0.71
00 - recall: 0.7103 - precision: 0.8655
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:56:17.984708: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 72ms/step
```

```
7/7 [=====] - 0s 34ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:56:19.019025: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 2s 822ms/step - loss: 0.6923 - acc: 0.5  
500 - recall: 0.6149 - precision: 0.7339  
Epoch 2/90  
2/2 [=====] - 0s 206ms/step - loss: 0.6902 - acc: 0.5  
950 - recall: 0.6554 - precision: 0.7638  
Epoch 3/90  
2/2 [=====] - 0s 224ms/step - loss: 0.6934 - acc: 0.5  
650 - recall: 0.6216 - precision: 0.7480  
Epoch 4/90  
2/2 [=====] - 0s 204ms/step - loss: 0.6926 - acc: 0.5  
850 - recall: 0.6554 - precision: 0.7519  
Epoch 5/90  
2/2 [=====] - 0s 110ms/step - loss: 0.6896 - acc: 0.5  
850 - recall: 0.6622 - precision: 0.7481  
Epoch 6/90  
2/2 [=====] - 0s 217ms/step - loss: 0.6879 - acc: 0.6  
000 - recall: 0.6689 - precision: 0.7615  
Epoch 7/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6902 - acc: 0.56  
00 - recall: 0.6284 - precision: 0.7381  
Epoch 8/90  
2/2 [=====] - 0s 214ms/step - loss: 0.6927 - acc: 0.5  
850 - recall: 0.6554 - precision: 0.7519  
Epoch 9/90  
2/2 [=====] - 0s 132ms/step - loss: 0.6889 - acc: 0.5  
550 - recall: 0.5878 - precision: 0.7565  
Epoch 10/90  
2/2 [=====] - 0s 199ms/step - loss: 0.6855 - acc: 0.5  
800 - recall: 0.6216 - precision: 0.7667  
Epoch 11/90  
2/2 [=====] - 0s 163ms/step - loss: 0.6917 - acc: 0.5  
650 - recall: 0.6419 - precision: 0.7364  
Epoch 12/90  
2/2 [=====] - 0s 149ms/step - loss: 0.6886 - acc: 0.5  
650 - recall: 0.5811 - precision: 0.7748  
Epoch 13/90  
2/2 [=====] - 0s 146ms/step - loss: 0.6852 - acc: 0.6  
150 - recall: 0.6486 - precision: 0.7934  
Epoch 14/90  
2/2 [=====] - 0s 147ms/step - loss: 0.6829 - acc: 0.6  
050 - recall: 0.6351 - precision: 0.7899  
Epoch 15/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6872 - acc: 0.56  
00 - recall: 0.5878 - precision: 0.7632  
Epoch 16/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6829 - acc: 0.58  
50 - recall: 0.6419 - precision: 0.7600  
Epoch 17/90  
2/2 [=====] - 0s 137ms/step - loss: 0.6813 - acc: 0.6  
150 - recall: 0.6081 - precision: 0.8257  
Epoch 18/90  
2/2 [=====] - 0s 74ms/step - loss: 0.6877 - acc: 0.57  
00 - recall: 0.6081 - precision: 0.7627  
Epoch 19/90  
2/2 [=====] - 0s 135ms/step - loss: 0.6810 - acc: 0.6  
150 - recall: 0.5946 - precision: 0.8381  
Epoch 20/90  
2/2 [=====] - 0s 73ms/step - loss: 0.6840 - acc: 0.62  
50 - recall: 0.6689 - precision: 0.7920  
Epoch 21/90
```

```
2/2 [=====] - 0s 74ms/step - loss: 0.6844 - acc: 0.56
50 - recall: 0.5405 - precision: 0.8081
Epoch 22/90
2/2 [=====] - 0s 78ms/step - loss: 0.6801 - acc: 0.53
50 - recall: 0.4865 - precision: 0.8090
Epoch 23/90
2/2 [=====] - 0s 97ms/step - loss: 0.6835 - acc: 0.60
00 - recall: 0.6081 - precision: 0.8036
Epoch 24/90
2/2 [=====] - 0s 119ms/step - loss: 0.6812 - acc: 0.55
500 - recall: 0.5270 - precision: 0.8041
Epoch 25/90
2/2 [=====] - 0s 75ms/step - loss: 0.6814 - acc: 0.58
00 - recall: 0.5878 - precision: 0.7909
Epoch 26/90
2/2 [=====] - 0s 74ms/step - loss: 0.6755 - acc: 0.62
00 - recall: 0.6014 - precision: 0.8396
Epoch 27/90
2/2 [=====] - 0s 75ms/step - loss: 0.6836 - acc: 0.57
00 - recall: 0.5811 - precision: 0.7818
Epoch 28/90
2/2 [=====] - 0s 76ms/step - loss: 0.6746 - acc: 0.65
00 - recall: 0.6419 - precision: 0.8482
Epoch 29/90
2/2 [=====] - 0s 76ms/step - loss: 0.6771 - acc: 0.61
00 - recall: 0.5946 - precision: 0.8302
Epoch 30/90
2/2 [=====] - 0s 93ms/step - loss: 0.6787 - acc: 0.65
50 - recall: 0.6892 - precision: 0.8160
Epoch 31/90
2/2 [=====] - 0s 75ms/step - loss: 0.6825 - acc: 0.58
00 - recall: 0.5946 - precision: 0.7857
Epoch 32/90
2/2 [=====] - 0s 75ms/step - loss: 0.6780 - acc: 0.64
50 - recall: 0.6351 - precision: 0.8468
Epoch 33/90
2/2 [=====] - 0s 74ms/step - loss: 0.6807 - acc: 0.59
50 - recall: 0.6351 - precision: 0.7769
Epoch 34/90
2/2 [=====] - 0s 75ms/step - loss: 0.6781 - acc: 0.61
00 - recall: 0.6081 - precision: 0.8182
Epoch 35/90
2/2 [=====] - 0s 88ms/step - loss: 0.6727 - acc: 0.65
50 - recall: 0.6284 - precision: 0.8692
Epoch 36/90
2/2 [=====] - 0s 99ms/step - loss: 0.6786 - acc: 0.56
00 - recall: 0.5000 - precision: 0.8409
Epoch 37/90
2/2 [=====] - 0s 93ms/step - loss: 0.6749 - acc: 0.61
00 - recall: 0.5405 - precision: 0.8889
Epoch 38/90
2/2 [=====] - 0s 130ms/step - loss: 0.6800 - acc: 0.5400
recall: 0.5135 - precision: 0.7917
Epoch 39/90
2/2 [=====] - 0s 126ms/step - loss: 0.6793 - acc: 0.5650
recall: 0.5338 - precision: 0.8144
Epoch 40/90
2/2 [=====] - 0s 88ms/step - loss: 0.6791 - acc: 0.5800
recall: 0.5270 - precision: 0.8478
Epoch 41/90
```

```
2/2 [=====] - 0s 96ms/step - loss: 0.6762 - acc: 0.59
50 - recall: 0.5473 - precision: 0.8526
Epoch 42/90
2/2 [=====] - 0s 91ms/step - loss: 0.6795 - acc: 0.60
50 - recall: 0.5946 - precision: 0.8148
Epoch 43/90
2/2 [=====] - 0s 91ms/step - loss: 0.6744 - acc: 0.59
50 - recall: 0.5676 - precision: 0.8317
Epoch 44/90
2/2 [=====] - 0s 88ms/step - loss: 0.6695 - acc: 0.61
50 - recall: 0.6014 - precision: 0.8318
Epoch 45/90
2/2 [=====] - 0s 87ms/step - loss: 0.6779 - acc: 0.50
50 - recall: 0.4459 - precision: 0.7952
Epoch 46/90
2/2 [=====] - 0s 87ms/step - loss: 0.6786 - acc: 0.55
50 - recall: 0.5270 - precision: 0.8041
Epoch 47/90
2/2 [=====] - 0s 81ms/step - loss: 0.6671 - acc: 0.62
50 - recall: 0.6014 - precision: 0.8396
Epoch 48/90
2/2 [=====] - 0s 86ms/step - loss: 0.6723 - acc: 0.62
50 - recall: 0.6284 - precision: 0.8158
Epoch 49/90
2/2 [=====] - 0s 84ms/step - loss: 0.6657 - acc: 0.58
50 - recall: 0.5270 - precision: 0.8478
Epoch 50/90
2/2 [=====] - 0s 87ms/step - loss: 0.6676 - acc: 0.63
50 - recall: 0.6284 - precision: 0.8304
Epoch 51/90
2/2 [=====] - 0s 87ms/step - loss: 0.6646 - acc: 0.62
50 - recall: 0.5473 - precision: 0.9101
Epoch 52/90
2/2 [=====] - 0s 86ms/step - loss: 0.6585 - acc: 0.60
50 - recall: 0.5878 - precision: 0.8286
Epoch 53/90
2/2 [=====] - 0s 85ms/step - loss: 0.6685 - acc: 0.62
50 - recall: 0.6014 - precision: 0.8476
Epoch 54/90
2/2 [=====] - 0s 88ms/step - loss: 0.6619 - acc: 0.65
50 - recall: 0.6622 - precision: 0.8305
Epoch 55/90
2/2 [=====] - 0s 86ms/step - loss: 0.6566 - acc: 0.64
50 - recall: 0.6149 - precision: 0.8585
Epoch 56/90
2/2 [=====] - 0s 86ms/step - loss: 0.6643 - acc: 0.67
50 - recall: 0.7095 - precision: 0.8268
Epoch 57/90
2/2 [=====] - 0s 85ms/step - loss: 0.6685 - acc: 0.62
50 - recall: 0.6419 - precision: 0.8120
Epoch 58/90
2/2 [=====] - 0s 86ms/step - loss: 0.6687 - acc: 0.51
50 - recall: 0.4257 - precision: 0.8289
Epoch 59/90
2/2 [=====] - 0s 85ms/step - loss: 0.6714 - acc: 0.50
50 - recall: 0.4189 - precision: 0.8267
Epoch 60/90
2/2 [=====] - 0s 84ms/step - loss: 0.6548 - acc: 0.67
50 - recall: 0.6419 - precision: 0.8879
Epoch 61/90
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.6680 - acc: 0.58
00 - recall: 0.5135 - precision: 0.8636
Epoch 62/90
2/2 [=====] - 0s 83ms/step - loss: 0.6562 - acc: 0.64
50 - recall: 0.6081 - precision: 0.8738
Epoch 63/90
2/2 [=====] - 0s 90ms/step - loss: 0.6530 - acc: 0.66
50 - recall: 0.6554 - precision: 0.8584
Epoch 64/90
2/2 [=====] - 0s 84ms/step - loss: 0.6579 - acc: 0.68
00 - recall: 0.6351 - precision: 0.9038
Epoch 65/90
2/2 [=====] - 0s 85ms/step - loss: 0.6504 - acc: 0.66
50 - recall: 0.6554 - precision: 0.8584
Epoch 66/90
2/2 [=====] - 0s 86ms/step - loss: 0.6477 - acc: 0.67
00 - recall: 0.6419 - precision: 0.8796
Epoch 67/90
2/2 [=====] - 0s 85ms/step - loss: 0.6354 - acc: 0.74
00 - recall: 0.7365 - precision: 0.8934
Epoch 68/90
2/2 [=====] - 0s 84ms/step - loss: 0.6503 - acc: 0.64
50 - recall: 0.6216 - precision: 0.8598
Epoch 69/90
2/2 [=====] - 0s 85ms/step - loss: 0.6452 - acc: 0.68
50 - recall: 0.6622 - precision: 0.8829
Epoch 70/90
2/2 [=====] - 0s 86ms/step - loss: 0.6505 - acc: 0.68
00 - recall: 0.6892 - precision: 0.8500
Epoch 71/90
2/2 [=====] - 0s 85ms/step - loss: 0.6480 - acc: 0.72
50 - recall: 0.7703 - precision: 0.8444
Epoch 72/90
2/2 [=====] - 0s 85ms/step - loss: 0.6502 - acc: 0.71
00 - recall: 0.7095 - precision: 0.8750
Epoch 73/90
2/2 [=====] - 0s 86ms/step - loss: 0.6539 - acc: 0.66
00 - recall: 0.7162 - precision: 0.8030
Epoch 74/90
2/2 [=====] - 0s 86ms/step - loss: 0.6500 - acc: 0.63
50 - recall: 0.6081 - precision: 0.8571
Epoch 75/90
2/2 [=====] - 0s 86ms/step - loss: 0.6378 - acc: 0.71
50 - recall: 0.7162 - precision: 0.8760
Epoch 76/90
2/2 [=====] - 0s 85ms/step - loss: 0.6390 - acc: 0.75
00 - recall: 0.7703 - precision: 0.8769
Epoch 77/90
2/2 [=====] - 0s 84ms/step - loss: 0.6416 - acc: 0.71
50 - recall: 0.7365 - precision: 0.8583
Epoch 78/90
2/2 [=====] - 0s 178ms/step - loss: 0.6312 - acc: 0.7
350 - recall: 0.7703 - precision: 0.8571
Epoch 79/90
2/2 [=====] - 0s 86ms/step - loss: 0.6461 - acc: 0.67
00 - recall: 0.6959 - precision: 0.8306
Epoch 80/90
2/2 [=====] - 0s 88ms/step - loss: 0.6337 - acc: 0.72
50 - recall: 0.7973 - precision: 0.8252
Epoch 81/90
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6276 - acc: 0.72
50 - recall: 0.7230 - precision: 0.8843
Epoch 82/90
2/2 [=====] - 0s 86ms/step - loss: 0.6372 - acc: 0.71
00 - recall: 0.7568 - precision: 0.8358
Epoch 83/90
2/2 [=====] - 0s 86ms/step - loss: 0.6060 - acc: 0.69
00 - recall: 0.6486 - precision: 0.9057
Epoch 84/90
2/2 [=====] - 0s 85ms/step - loss: 0.6281 - acc: 0.63
00 - recall: 0.6149 - precision: 0.8426
Epoch 85/90
2/2 [=====] - 0s 89ms/step - loss: 0.6213 - acc: 0.69
00 - recall: 0.6757 - precision: 0.8772
Epoch 86/90
2/2 [=====] - 0s 85ms/step - loss: 0.6288 - acc: 0.71
00 - recall: 0.7500 - precision: 0.8409
Epoch 87/90
2/2 [=====] - 0s 87ms/step - loss: 0.6092 - acc: 0.71
50 - recall: 0.6959 - precision: 0.8957
Epoch 88/90
2/2 [=====] - 0s 85ms/step - loss: 0.6048 - acc: 0.75
00 - recall: 0.7432 - precision: 0.9016
Epoch 89/90
2/2 [=====] - 0s 87ms/step - loss: 0.6083 - acc: 0.66
00 - recall: 0.6014 - precision: 0.9082
Epoch 90/90
2/2 [=====] - 0s 86ms/step - loss: 0.6204 - acc: 0.61
50 - recall: 0.5608 - precision: 0.8737
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:56:43.744266: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 75ms/step
```

```
7/7 [=====] - 0s 34ms/step
```

```
Epoch 1/90
```

```
2023-03-31 16:56:45.086471: I tensorflow/core/grappler/optimizers/custom_graph
```

```
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 854ms/step - loss: 0.6895 - acc: 0.5  
450 - recall: 0.5973 - precision: 0.7417  
Epoch 2/90  
2/2 [=====] - 0s 230ms/step - loss: 0.6846 - acc: 0.6  
200 - recall: 0.7047 - precision: 0.7664  
Epoch 3/90  
2/2 [=====] - 0s 164ms/step - loss: 0.6770 - acc: 0.6  
250 - recall: 0.6711 - precision: 0.7937  
Epoch 4/90  
2/2 [=====] - 0s 224ms/step - loss: 0.6817 - acc: 0.5  
900 - recall: 0.6107 - precision: 0.7913  
Epoch 5/90  
2/2 [=====] - 0s 139ms/step - loss: 0.6836 - acc: 0.5  
700 - recall: 0.5973 - precision: 0.7739  
Epoch 6/90  
2/2 [=====] - 0s 122ms/step - loss: 0.6859 - acc: 0.5  
450 - recall: 0.6107 - precision: 0.7339  
Epoch 7/90  
2/2 [=====] - 0s 206ms/step - loss: 0.6827 - acc: 0.5  
300 - recall: 0.5570 - precision: 0.7477  
Epoch 8/90  
2/2 [=====] - 0s 79ms/step - loss: 0.6800 - acc: 0.64  
00 - recall: 0.6577 - precision: 0.8235  
Epoch 9/90  
2/2 [=====] - 0s 224ms/step - loss: 0.6870 - acc: 0.5  
450 - recall: 0.6040 - precision: 0.7377  
Epoch 10/90  
2/2 [=====] - 0s 148ms/step - loss: 0.6817 - acc: 0.5  
500 - recall: 0.6040 - precision: 0.7438  
Epoch 11/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6862 - acc: 0.52  
50 - recall: 0.5705 - precision: 0.7328  
Epoch 12/90  
2/2 [=====] - 0s 179ms/step - loss: 0.6858 - acc: 0.5  
850 - recall: 0.6376 - precision: 0.7661  
Epoch 13/90  
2/2 [=====] - 0s 77ms/step - loss: 0.6794 - acc: 0.59  
00 - recall: 0.5973 - precision: 0.8018  
Epoch 14/90  
2/2 [=====] - 0s 143ms/step - loss: 0.6777 - acc: 0.6  
050 - recall: 0.6443 - precision: 0.7869  
Epoch 15/90  
2/2 [=====] - 0s 132ms/step - loss: 0.6816 - acc: 0.6  
250 - recall: 0.6913 - precision: 0.7803  
Epoch 16/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6755 - acc: 0.65  
00 - recall: 0.6980 - precision: 0.8062  
Epoch 17/90  
2/2 [=====] - 0s 76ms/step - loss: 0.6828 - acc: 0.59  
00 - recall: 0.6309 - precision: 0.7769  
Epoch 18/90  
2/2 [=====] - 0s 95ms/step - loss: 0.6773 - acc: 0.57  
50 - recall: 0.5839 - precision: 0.7909  
Epoch 19/90  
2/2 [=====] - 0s 75ms/step - loss: 0.6809 - acc: 0.62  
00 - recall: 0.6711 - precision: 0.7874  
Epoch 20/90  
2/2 [=====] - 0s 230ms/step - loss: 0.6760 - acc: 0.6  
400 - recall: 0.6711 - precision: 0.8130  
Epoch 21/90
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.6846 - acc: 0.55
50 - recall: 0.5772 - precision: 0.7679
Epoch 22/90
2/2 [=====] - 0s 76ms/step - loss: 0.6720 - acc: 0.65
00 - recall: 0.6510 - precision: 0.8435
Epoch 23/90
2/2 [=====] - 0s 75ms/step - loss: 0.6796 - acc: 0.56
00 - recall: 0.5638 - precision: 0.7850
Epoch 24/90
2/2 [=====] - 0s 78ms/step - loss: 0.6830 - acc: 0.54
50 - recall: 0.5503 - precision: 0.7736
Epoch 25/90
2/2 [=====] - 0s 94ms/step - loss: 0.6771 - acc: 0.55
50 - recall: 0.5101 - precision: 0.8261
Epoch 26/90
2/2 [=====] - 0s 76ms/step - loss: 0.6853 - acc: 0.51
50 - recall: 0.5436 - precision: 0.7364
Epoch 27/90
2/2 [=====] - 0s 137ms/step - loss: 0.6777 - acc: 0.5
550 - recall: 0.5168 - precision: 0.8191
Epoch 28/90
2/2 [=====] - 0s 75ms/step - loss: 0.6793 - acc: 0.57
50 - recall: 0.5369 - precision: 0.8333
Epoch 29/90
2/2 [=====] - 0s 125ms/step - loss: 0.6788 - acc: 0.4
450 - recall: 0.3960 - precision: 0.7375
Epoch 30/90
2/2 [=====] - 0s 75ms/step - loss: 0.6757 - acc: 0.62
50 - recall: 0.6309 - precision: 0.8246
Epoch 31/90
2/2 [=====] - 0s 77ms/step - loss: 0.6835 - acc: 0.57
50 - recall: 0.6242 - precision: 0.7623
Epoch 32/90
2/2 [=====] - 0s 76ms/step - loss: 0.6831 - acc: 0.55
00 - recall: 0.5503 - precision: 0.7810
Epoch 33/90
2/2 [=====] - 0s 75ms/step - loss: 0.6805 - acc: 0.56
50 - recall: 0.5302 - precision: 0.8229
Epoch 34/90
2/2 [=====] - 0s 78ms/step - loss: 0.6739 - acc: 0.55
00 - recall: 0.4832 - precision: 0.8471
Epoch 35/90
2/2 [=====] - 0s 81ms/step - loss: 0.6739 - acc: 0.53
00 - recall: 0.4564 - precision: 0.8395
Epoch 36/90
2/2 [=====] - 0s 96ms/step - loss: 0.6717 - acc: 0.58
00 - recall: 0.5168 - precision: 0.8652
Epoch 37/90
2/2 [=====] - 0s 94ms/step - loss: 0.6759 - acc: 0.61
00 - recall: 0.6309 - precision: 0.8034
Epoch 38/90
2/2 [=====] - 0s 90ms/step - loss: 0.6799 - acc: 0.56
50 - recall: 0.5503 - precision: 0.8039
Epoch 39/90
2/2 [=====] - 0s 90ms/step - loss: 0.6735 - acc: 0.62
50 - recall: 0.5906 - precision: 0.8627
Epoch 40/90
2/2 [=====] - 0s 86ms/step - loss: 0.6779 - acc: 0.55
50 - recall: 0.5839 - precision: 0.7632
Epoch 41/90
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.6692 - acc: 0.63
00 - recall: 0.6577 - precision: 0.8099
Epoch 42/90
2/2 [=====] - 0s 88ms/step - loss: 0.6757 - acc: 0.59
50 - recall: 0.6309 - precision: 0.7833
Epoch 43/90
2/2 [=====] - 0s 87ms/step - loss: 0.6724 - acc: 0.62
00 - recall: 0.6242 - precision: 0.8230
Epoch 44/90
2/2 [=====] - 0s 90ms/step - loss: 0.6726 - acc: 0.63
50 - recall: 0.6644 - precision: 0.8115
Epoch 45/90
2/2 [=====] - 0s 135ms/step - loss: 0.6764 - acc: 0.5
400 - recall: 0.5034 - precision: 0.8065
Epoch 46/90
2/2 [=====] - 0s 171ms/step - loss: 0.6727 - acc: 0.6
250 - recall: 0.6242 - precision: 0.8304
Epoch 47/90
2/2 [=====] - 0s 99ms/step - loss: 0.6658 - acc: 0.58
00 - recall: 0.5369 - precision: 0.8421
Epoch 48/90
2/2 [=====] - 0s 89ms/step - loss: 0.6769 - acc: 0.63
50 - recall: 0.6443 - precision: 0.8276
Epoch 49/90
2/2 [=====] - 0s 94ms/step - loss: 0.6782 - acc: 0.63
50 - recall: 0.6711 - precision: 0.8065
Epoch 50/90
2/2 [=====] - 0s 88ms/step - loss: 0.6652 - acc: 0.65
00 - recall: 0.6376 - precision: 0.8559
Epoch 51/90
2/2 [=====] - 0s 87ms/step - loss: 0.6740 - acc: 0.59
50 - recall: 0.6107 - precision: 0.7982
Epoch 52/90
2/2 [=====] - 0s 87ms/step - loss: 0.6752 - acc: 0.56
00 - recall: 0.5235 - precision: 0.8211
Epoch 53/90
2/2 [=====] - 0s 86ms/step - loss: 0.6644 - acc: 0.65
00 - recall: 0.6107 - precision: 0.8835
Epoch 54/90
2/2 [=====] - 0s 188ms/step - loss: 0.6658 - acc: 0.6
250 - recall: 0.6040 - precision: 0.8491
Epoch 55/90
2/2 [=====] - 0s 89ms/step - loss: 0.6643 - acc: 0.61
50 - recall: 0.5705 - precision: 0.8673
Epoch 56/90
2/2 [=====] - 0s 84ms/step - loss: 0.6712 - acc: 0.60
50 - recall: 0.5638 - precision: 0.8571
Epoch 57/90
2/2 [=====] - 0s 90ms/step - loss: 0.6662 - acc: 0.72
00 - recall: 0.7450 - precision: 0.8605
Epoch 58/90
2/2 [=====] - 0s 94ms/step - loss: 0.6607 - acc: 0.70
00 - recall: 0.6846 - precision: 0.8870
Epoch 59/90
2/2 [=====] - 0s 96ms/step - loss: 0.6672 - acc: 0.63
00 - recall: 0.6040 - precision: 0.8571
Epoch 60/90
2/2 [=====] - 0s 87ms/step - loss: 0.6629 - acc: 0.65
00 - recall: 0.6242 - precision: 0.8692
Epoch 61/90
```

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2/2 [=====] - 0s 84ms/step - loss: 0.6609 - acc: 0.69  
00 - recall: 0.6577 - precision: 0.8991  
Epoch 62/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6659 - acc: 0.62  
50 - recall: 0.6510 - precision: 0.8083  
Epoch 63/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6625 - acc: 0.60  
50 - recall: 0.5638 - precision: 0.8571  
Epoch 64/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6702 - acc: 0.67  
00 - recall: 0.6846 - precision: 0.8430  
Epoch 65/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6705 - acc: 0.64  
50 - recall: 0.6913 - precision: 0.8047  
Epoch 66/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6594 - acc: 0.66  
00 - recall: 0.6846 - precision: 0.8293  
Epoch 67/90  
2/2 [=====] - 0s 122ms/step - loss: 0.6591 - acc: 0.6  
850 - recall: 0.7114 - precision: 0.8413  
Epoch 68/90  
2/2 [=====] - 0s 83ms/step - loss: 0.6625 - acc: 0.67  
50 - recall: 0.6913 - precision: 0.8443  
Epoch 69/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6585 - acc: 0.67  
00 - recall: 0.6577 - precision: 0.8673  
Epoch 70/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6554 - acc: 0.71  
50 - recall: 0.7651 - precision: 0.8382  
Epoch 71/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6527 - acc: 0.71  
00 - recall: 0.7852 - precision: 0.8182  
Epoch 72/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6511 - acc: 0.74  
50 - recall: 0.7584 - precision: 0.8828  
Epoch 73/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6652 - acc: 0.56  
00 - recall: 0.5369 - precision: 0.8081  
Epoch 74/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6522 - acc: 0.67  
50 - recall: 0.6846 - precision: 0.8500  
Epoch 75/90  
2/2 [=====] - 0s 85ms/step - loss: 0.6555 - acc: 0.70  
50 - recall: 0.7383 - precision: 0.8462  
Epoch 76/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6653 - acc: 0.65  
00 - recall: 0.6242 - precision: 0.8692  
Epoch 77/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6552 - acc: 0.70  
00 - recall: 0.7315 - precision: 0.8450  
Epoch 78/90  
2/2 [=====] - 0s 87ms/step - loss: 0.6547 - acc: 0.70  
50 - recall: 0.7181 - precision: 0.8629  
Epoch 79/90  
2/2 [=====] - 0s 86ms/step - loss: 0.6416 - acc: 0.73  
00 - recall: 0.7651 - precision: 0.8571  
Epoch 80/90  
2/2 [=====] - 0s 91ms/step - loss: 0.6482 - acc: 0.71  
00 - recall: 0.7517 - precision: 0.8421  
Epoch 81/90
```

```
2/2 [=====] - 0s 85ms/step - loss: 0.6489 - acc: 0.67
50 - recall: 0.7114 - precision: 0.8281
Epoch 82/90
2/2 [=====] - 0s 86ms/step - loss: 0.6476 - acc: 0.74
00 - recall: 0.7651 - precision: 0.8702
Epoch 83/90
2/2 [=====] - 0s 87ms/step - loss: 0.6459 - acc: 0.72
00 - recall: 0.7584 - precision: 0.8496
Epoch 84/90
2/2 [=====] - 0s 86ms/step - loss: 0.6415 - acc: 0.72
00 - recall: 0.7315 - precision: 0.8720
Epoch 85/90
2/2 [=====] - 0s 86ms/step - loss: 0.6456 - acc: 0.72
50 - recall: 0.8054 - precision: 0.8219
Epoch 86/90
2/2 [=====] - 0s 87ms/step - loss: 0.6595 - acc: 0.61
50 - recall: 0.5772 - precision: 0.8600
Epoch 87/90
2/2 [=====] - 0s 84ms/step - loss: 0.6263 - acc: 0.74
50 - recall: 0.7785 - precision: 0.8657
Epoch 88/90
2/2 [=====] - 0s 85ms/step - loss: 0.6443 - acc: 0.69
00 - recall: 0.7383 - precision: 0.8271
Epoch 89/90
2/2 [=====] - 0s 85ms/step - loss: 0.6528 - acc: 0.65
50 - recall: 0.6711 - precision: 0.8333
Epoch 90/90
2/2 [=====] - 0s 87ms/step - loss: 0.6366 - acc: 0.73
00 - recall: 0.7785 - precision: 0.8467
1/4 [=====>.....] - ETA: 0s
```

```
2023-03-31 16:57:09.838021: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
4/4 [=====] - 0s 50ms/step
```

```
7/7 [=====] - 0s 45ms/step
```

```
Epoch 1/45
```

```
2023-03-31 16:57:10.906438: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
3/3 [=====] - 3s 566ms/step - loss: 0.7440 - acc: 0.4  
767 - recall: 0.4525 - precision: 0.7353  
Epoch 2/45  
3/3 [=====] - 1s 244ms/step - loss: 0.7078 - acc: 0.7  
233 - recall: 0.9593 - precision: 0.7413  
Epoch 3/45  
3/3 [=====] - 1s 178ms/step - loss: 0.6859 - acc: 0.7  
167 - recall: 0.8597 - precision: 0.7787  
Epoch 4/45  
3/3 [=====] - 1s 198ms/step - loss: 0.6384 - acc: 0.7  
800 - recall: 0.8688 - precision: 0.8384  
Epoch 5/45  
3/3 [=====] - 1s 169ms/step - loss: 0.5521 - acc: 0.7  
433 - recall: 0.7195 - precision: 0.9138  
Epoch 6/45  
3/3 [=====] - 0s 152ms/step - loss: 0.4688 - acc: 0.7  
867 - recall: 0.7647 - precision: 0.9337  
Epoch 7/45  
3/3 [=====] - 1s 252ms/step - loss: 0.4486 - acc: 0.8  
033 - recall: 0.8009 - precision: 0.9219  
Epoch 8/45  
3/3 [=====] - 0s 141ms/step - loss: 0.3913 - acc: 0.8  
200 - recall: 0.7919 - precision: 0.9563  
Epoch 9/45  
3/3 [=====] - 0s 181ms/step - loss: 0.3439 - acc: 0.8  
400 - recall: 0.7964 - precision: 0.9832  
Epoch 10/45  
3/3 [=====] - 0s 143ms/step - loss: 0.2997 - acc: 0.8  
500 - recall: 0.8371 - precision: 0.9536  
Epoch 11/45  
3/3 [=====] - 1s 191ms/step - loss: 0.2560 - acc: 0.8  
833 - recall: 0.8552 - precision: 0.9844  
Epoch 12/45  
3/3 [=====] - 0s 89ms/step - loss: 0.2503 - acc: 0.89  
67 - recall: 0.8733 - precision: 0.9847  
Epoch 13/45  
3/3 [=====] - 0s 87ms/step - loss: 0.1881 - acc: 0.91  
67 - recall: 0.9095 - precision: 0.9757  
Epoch 14/45  
3/3 [=====] - 0s 86ms/step - loss: 0.1708 - acc: 0.94  
67 - recall: 0.9457 - precision: 0.9812  
Epoch 15/45  
3/3 [=====] - 0s 146ms/step - loss: 0.1651 - acc: 0.9  
133 - recall: 0.8914 - precision: 0.9899  
Epoch 16/45  
3/3 [=====] - 0s 86ms/step - loss: 0.1564 - acc: 0.94  
00 - recall: 0.9593 - precision: 0.9593  
Epoch 17/45  
3/3 [=====] - 0s 132ms/step - loss: 0.1123 - acc: 0.9  
633 - recall: 0.9502 - precision: 1.0000  
Epoch 18/45  
3/3 [=====] - 1s 200ms/step - loss: 0.1058 - acc: 0.9  
567 - recall: 0.9457 - precision: 0.9952  
Epoch 19/45  
3/3 [=====] - 1s 229ms/step - loss: 0.0841 - acc: 0.9  
700 - recall: 0.9638 - precision: 0.9953  
Epoch 20/45  
3/3 [=====] - 0s 105ms/step - loss: 0.1200 - acc: 0.9  
467 - recall: 0.9367 - precision: 0.9904  
Epoch 21/45
```

```
3/3 [=====] - 0s 97ms/step - loss: 0.0680 - acc: 0.98
00 - recall: 0.9774 - precision: 0.9954
Epoch 22/45
3/3 [=====] - 0s 96ms/step - loss: 0.0864 - acc: 0.96
00 - recall: 0.9548 - precision: 0.9906
Epoch 23/45
3/3 [=====] - 0s 99ms/step - loss: 0.0376 - acc: 0.99
00 - recall: 0.9864 - precision: 1.0000
Epoch 24/45
3/3 [=====] - 0s 86ms/step - loss: 0.0363 - acc: 0.98
67 - recall: 0.9819 - precision: 1.0000
Epoch 25/45
3/3 [=====] - 0s 99ms/step - loss: 0.0386 - acc: 0.99
00 - recall: 0.9864 - precision: 1.0000
Epoch 26/45
3/3 [=====] - 0s 87ms/step - loss: 0.0466 - acc: 0.98
67 - recall: 0.9864 - precision: 0.9954
Epoch 27/45
3/3 [=====] - 0s 110ms/step - loss: 0.0374 - acc: 0.9
900 - recall: 0.9864 - precision: 1.0000
Epoch 28/45
3/3 [=====] - 0s 106ms/step - loss: 0.0723 - acc: 0.9
800 - recall: 0.9955 - precision: 0.9778
Epoch 29/45
3/3 [=====] - 0s 108ms/step - loss: 0.0571 - acc: 0.9
700 - recall: 0.9593 - precision: 1.0000
Epoch 30/45
3/3 [=====] - 0s 100ms/step - loss: 0.2283 - acc: 0.9
433 - recall: 0.9593 - precision: 0.9636
Epoch 31/45
3/3 [=====] - 0s 126ms/step - loss: 0.1733 - acc: 0.9
167 - recall: 0.9095 - precision: 0.9757
Epoch 32/45
3/3 [=====] - 0s 166ms/step - loss: 0.2460 - acc: 0.8
867 - recall: 0.8869 - precision: 0.9561
Epoch 33/45
3/3 [=====] - 0s 89ms/step - loss: 0.2519 - acc: 0.83
67 - recall: 0.7919 - precision: 0.9831
Epoch 34/45
3/3 [=====] - 0s 96ms/step - loss: 0.2009 - acc: 0.91
67 - recall: 0.9050 - precision: 0.9804
Epoch 35/45
3/3 [=====] - 0s 126ms/step - loss: 0.1536 - acc: 0.9
100 - recall: 0.8778 - precision: 1.0000
Epoch 36/45
3/3 [=====] - 0s 96ms/step - loss: 0.1537 - acc: 0.95
67 - recall: 0.9774 - precision: 0.9643
Epoch 37/45
3/3 [=====] - 0s 100ms/step - loss: 0.1814 - acc: 0.9
133 - recall: 0.8824 - precision: 1.0000
Epoch 38/45
3/3 [=====] - 0s 98ms/step - loss: 0.1675 - acc: 0.94
67 - recall: 0.9774 - precision: 0.9515
Epoch 39/45
3/3 [=====] - 0s 98ms/step - loss: 0.1050 - acc: 0.94
33 - recall: 0.9231 - precision: 1.0000
Epoch 40/45
3/3 [=====] - 0s 103ms/step - loss: 0.0863 - acc: 0.9
633 - recall: 0.9548 - precision: 0.9953
Epoch 41/45
```

```
3/3 [=====] - 0s 98ms/step - loss: 0.0743 - acc: 0.98
67 - recall: 0.9955 - precision: 0.9865
Epoch 42/45
3/3 [=====] - 0s 97ms/step - loss: 0.0531 - acc: 0.97
33 - recall: 0.9638 - precision: 1.0000
Epoch 43/45
3/3 [=====] - 0s 97ms/step - loss: 0.0481 - acc: 0.98
33 - recall: 0.9774 - precision: 1.0000
Epoch 44/45
3/3 [=====] - 0s 97ms/step - loss: 0.0439 - acc: 0.98
33 - recall: 0.9819 - precision: 0.9954
Epoch 45/45
3/3 [=====] - 0s 96ms/step - loss: 0.0319 - acc: 0.98
67 - recall: 0.9819 - precision: 1.0000
```

In [67]:

```
best_optimizer = gs_2.best_params_["optimizer"]
best_epoch2 = gs_2.best_params_["epochs"]
best_drop = gs_2.best_params_["dropout_rate"]
print("Best: %f using %s" % (gs_2.best_score_, gs_2.best_params_))

Best: 0.930000 using {'dropout_rate': 0.3, 'epochs': 45, 'optimizer': 'adam'}
```

## Model 5 with Best Parameters

In [68]:

```
model_5 = models.Sequential([
    Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
           padding = 'same', input_shape=(224,224,3)),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Conv2D(filters=128, kernel_size=(3, 3), activation='relu',
           padding = 'same'),
    MaxPooling2D(pool_size=(2, 2), strides=2),

    Flatten(),

    Dense(units=128, activation='relu'),
    Dropout(best_drop),
    Dense(units=64, activation='relu'),
    Dropout(best_drop),
    Dense(units=1, activation='sigmoid'),
])

model_5.compile(loss='binary_crossentropy',
                 optimizer= best_optimizer,
                 metrics=[ "acc", "Recall", "Precision"])
)
```

In [69]:

```
#Model 5 Summary
model_5.summary()
```

Model: "sequential\_90"

Layer (type)	Output Shape	Param #
conv2d_307 (Conv2D)	(None, 224, 224, 32)	896
max_pooling2d_307 (MaxPooling2D)	(None, 112, 112, 32)	0
conv2d_308 (Conv2D)	(None, 112, 112, 64)	18496
max_pooling2d_308 (MaxPooling2D)	(None, 56, 56, 64)	0
conv2d_309 (Conv2D)	(None, 56, 56, 96)	55392
max_pooling2d_309 (MaxPooling2D)	(None, 28, 28, 96)	0
conv2d_310 (Conv2D)	(None, 28, 28, 128)	110720
max_pooling2d_310 (MaxPooling2D)	(None, 14, 14, 128)	0
flatten_90 (Flatten)	(None, 25088)	0
dense_217 (Dense)	(None, 128)	3211392
dropout_125 (Dropout)	(None, 128)	0
dense_218 (Dense)	(None, 64)	8256
dropout_126 (Dropout)	(None, 64)	0
dense_219 (Dense)	(None, 1)	65
<hr/>		
Total params: 3,405,217		
Trainable params: 3,405,217		
Non-trainable params: 0		

In [70]:

```
#Modeling with best parameters
history5 = model_5.fit(train_gen,
                       epochs=best_epoch2,
                       verbose = 1,
                       class_weight=class_weights,
                       validation_data=val_gen,
                       callbacks = es) #stopping early because of time resources
```

Epoch 1/45

```
2023-03-31 16:57:33.105584: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 0.5711 - acc: 0.7022
- recall: 0.6976 - precision: 0.8758
```

```
2023-03-31 16:57:57.822302: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

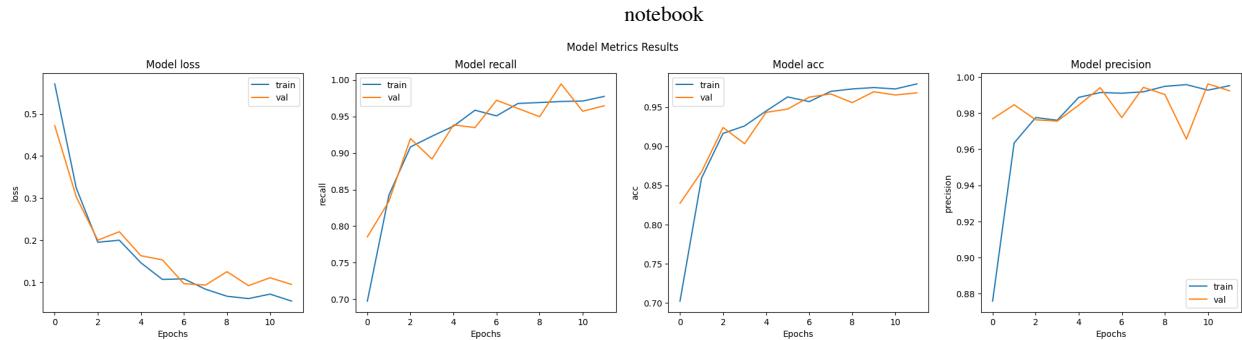
```

16/16 [=====] - 29s 2s/step - loss: 0.5711 - acc: 0.7
022 - recall: 0.6976 - precision: 0.8758 - val_loss: 0.4723 - val_acc: 0.8271
- val_recall: 0.7854 - val_precision: 0.9768
Epoch 2/45
16/16 [=====] - 27s 2s/step - loss: 0.3240 - acc: 0.8
592 - recall: 0.8422 - precision: 0.9634 - val_loss: 0.3030 - val_acc: 0.8672
- val_recall: 0.8340 - val_precision: 0.9846
Epoch 3/45
16/16 [=====] - 26s 2s/step - loss: 0.1955 - acc: 0.9
164 - recall: 0.9083 - precision: 0.9775 - val_loss: 0.2005 - val_acc: 0.9239
- val_recall: 0.9198 - val_precision: 0.9762
Epoch 4/45
16/16 [=====] - 26s 2s/step - loss: 0.2004 - acc: 0.9
259 - recall: 0.9229 - precision: 0.9760 - val_loss: 0.2206 - val_acc: 0.9032
- val_recall: 0.8918 - val_precision: 0.9755
Epoch 5/45
16/16 [=====] - 27s 2s/step - loss: 0.1469 - acc: 0.9
450 - recall: 0.9367 - precision: 0.9886 - val_loss: 0.1637 - val_acc: 0.9433
- val_recall: 0.9384 - val_precision: 0.9843
Epoch 6/45
16/16 [=====] - 26s 2s/step - loss: 0.1074 - acc: 0.9
630 - recall: 0.9585 - precision: 0.9913 - val_loss: 0.1538 - val_acc: 0.9474
- val_recall: 0.9347 - val_precision: 0.9940
Epoch 7/45
16/16 [=====] - 26s 2s/step - loss: 0.1088 - acc: 0.9
570 - recall: 0.9507 - precision: 0.9910 - val_loss: 0.0974 - val_acc: 0.9627
- val_recall: 0.9720 - val_precision: 0.9775
Epoch 8/45
16/16 [=====] - 26s 2s/step - loss: 0.0843 - acc: 0.9
701 - recall: 0.9677 - precision: 0.9917 - val_loss: 0.0940 - val_acc: 0.9668
- val_recall: 0.9608 - val_precision: 0.9942
Epoch 9/45
16/16 [=====] - 26s 2s/step - loss: 0.0675 - acc: 0.9
732 - recall: 0.9689 - precision: 0.9948 - val_loss: 0.1257 - val_acc: 0.9557
- val_recall: 0.9496 - val_precision: 0.9903
Epoch 10/45
16/16 [=====] - 26s 2s/step - loss: 0.0620 - acc: 0.9
749 - recall: 0.9704 - precision: 0.9957 - val_loss: 0.0927 - val_acc: 0.9696
- val_recall: 0.9944 - val_precision: 0.9656
Epoch 11/45
16/16 [=====] - 28s 2s/step - loss: 0.0726 - acc: 0.9
732 - recall: 0.9710 - precision: 0.9927 - val_loss: 0.1114 - val_acc: 0.9654
- val_recall: 0.9571 - val_precision: 0.9961
Epoch 12/45
16/16 [=====] - 27s 2s/step - loss: 0.0561 - acc: 0.9
796 - recall: 0.9773 - precision: 0.9951 - val_loss: 0.0956 - val_acc: 0.9682
- val_recall: 0.9646 - val_precision: 0.9923
Epoch 12: early stopping

```

```
In [71]: print("Model 5 with updated hyperparamters :\n")
eval_metrics(history5)
```

Model 5 with updated hyperparamters :

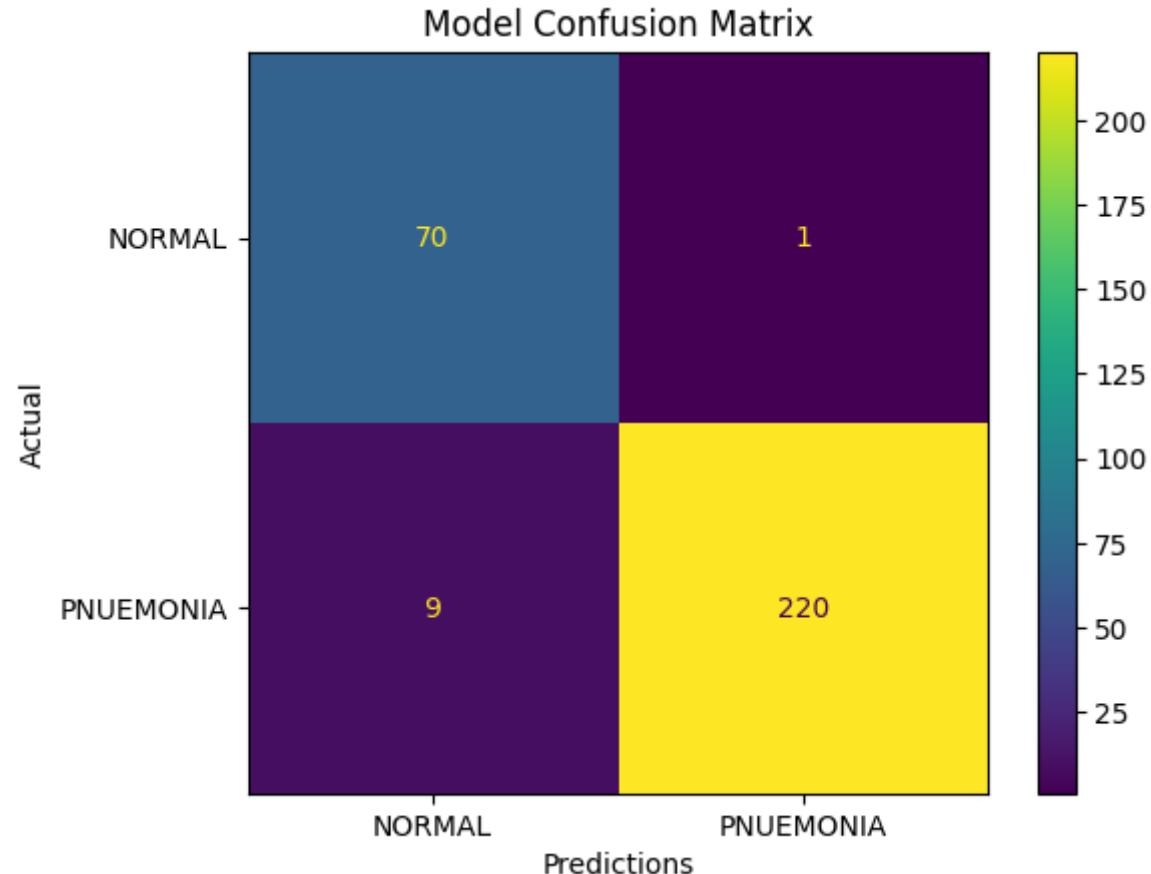


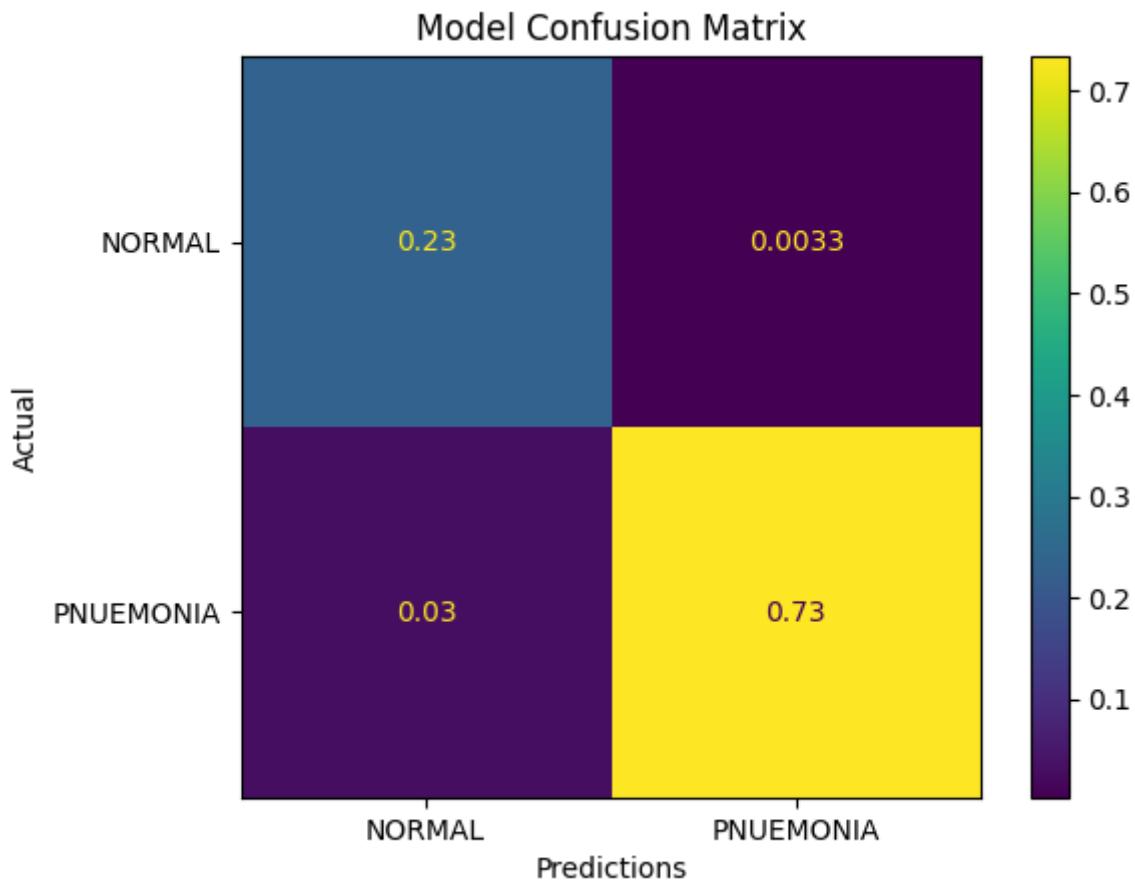
```
In [72]: train_labels, train_predictions = predict_results(model_5,train_gen)
val_labels, val_predictions = predict_results(model_5,val_gen)
```

```
2023-03-31 17:02:54.409837: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
10/10 [=====] - 1s 31ms/step
4/4 [=====] - 0s 73ms/step
```

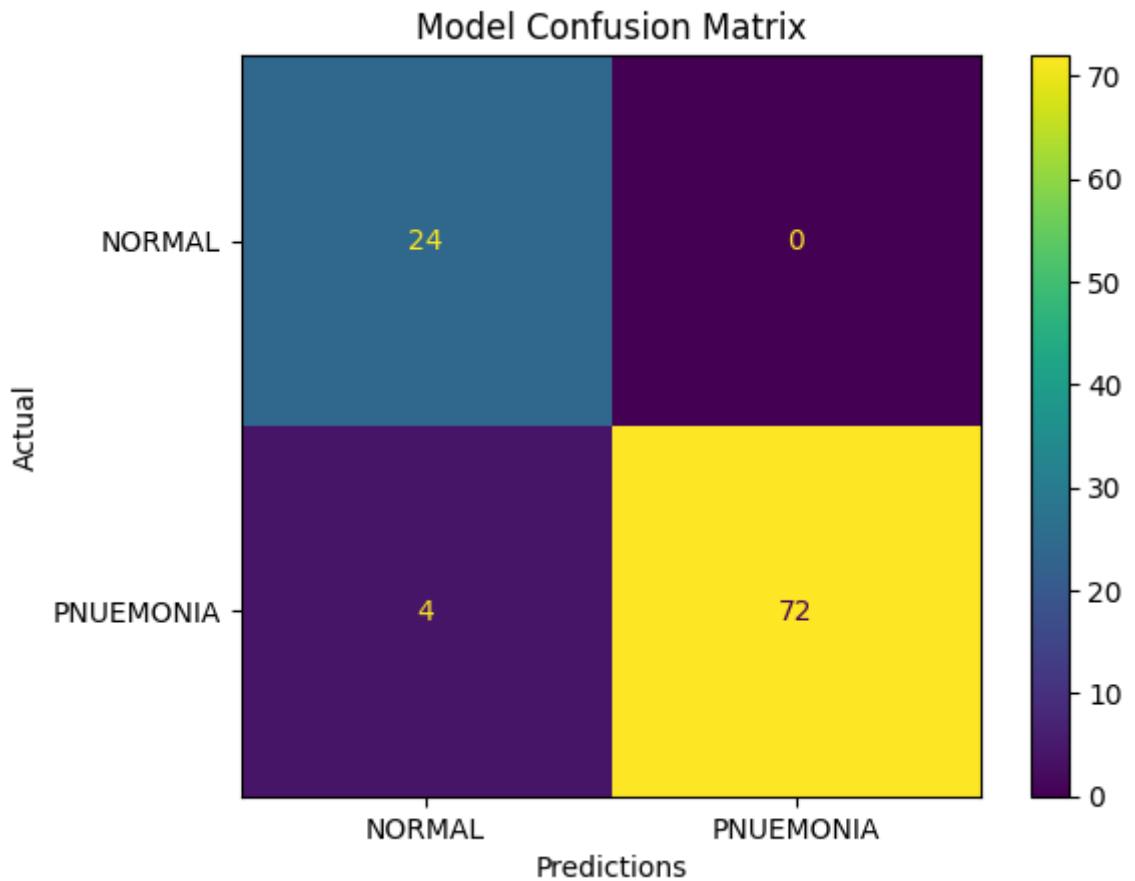
```
In [73]: #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

Training Confusion Matrices:

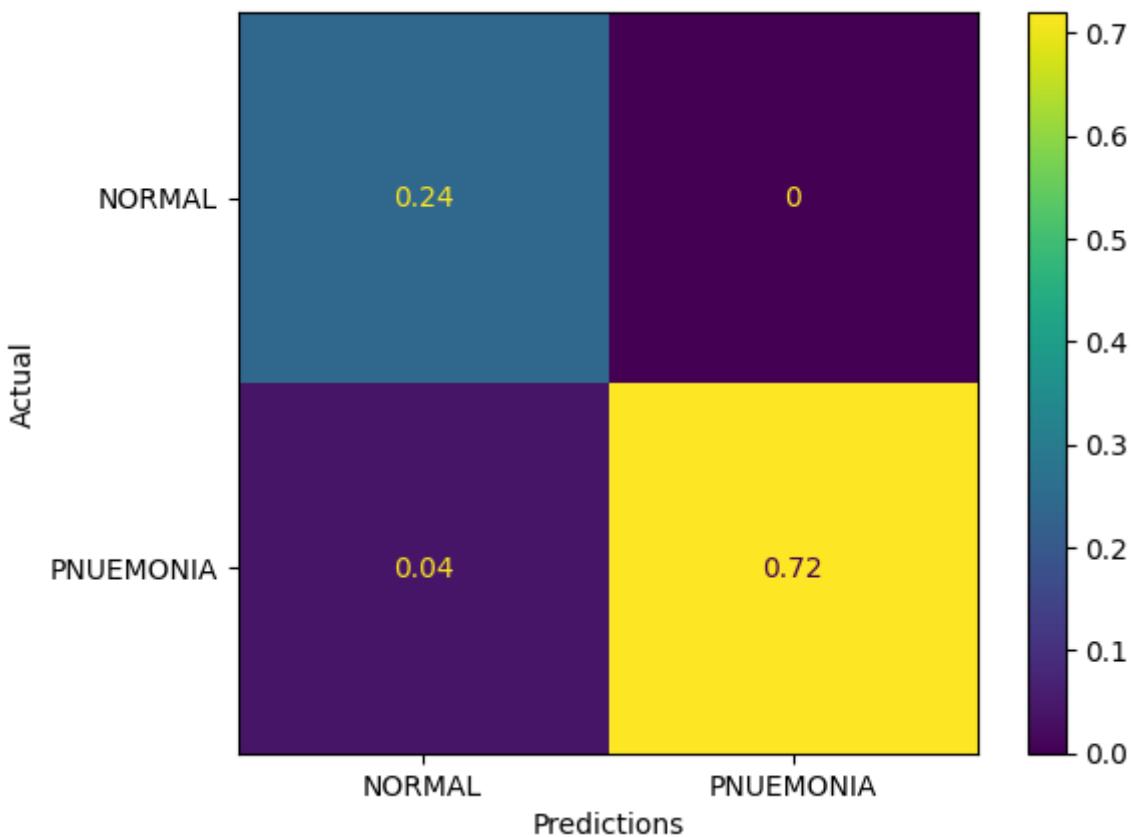




**Validation Confusion Matrices:**



Model Confusion Matrix



```
In [74]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history5)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.886	0.986	0.933	71
1.0	0.995	0.961	0.978	229
accuracy			0.967	300
macro avg	0.941	0.973	0.956	300
weighted avg	0.970	0.967	0.967	300

```
16/16 [=====] - 22s 1s/step - loss: 0.0575 - acc: 0.9
769 - recall: 0.9692 - precision: 0.9997
Loss: 0.0575
```

```
In [75]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history5)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.857	1.000	0.923	24
1.0	1.000	0.947	0.973	76
<b>accuracy</b>			0.960	100
<b>macro avg</b>	0.929	0.974	0.948	100
<b>weighted avg</b>	0.966	0.960	0.961	100

```
8/8 [=====] - 3s 416ms/step - loss: 0.0956 - acc: 0.9
682 - recall: 0.9646 - precision: 0.9923
Loss: 0.0956
```

## Model 5 Evaluation - Needs Update

- **Model Plots:** The metrics seem to be converging better.
  - **Confusion Matrix:** None of the models have FN or FP.
  - **Report:** The validation recall is about .98, less than other models but still solid.
  - This model wasn't bad. The validation's loss increased. The recall and f1score decreased from the previous model metrics.
- 

## Data Augmentation

### Data Augmentation, YASSINE GHOUZAM, 2017

After several iterations of hyperparameter changes, the data will be augmented to see if this helps the models.

- `rotation_range=10`, randomly rotate images in the range (degrees, 0 to 180)
- `zoom_range = [.1,.2]`, Randomly zoom image
- `width_shift_range=[.1,.2]`, randomly shift images horizontally (fraction of total width)
- `height_shift_range=[.1,.2]`, Shift height

```
In [76]: datagen = ImageDataGenerator(rescale=1/255,
                                    rotation_range=10, # randomly rotate images in the range (degrees, 0 to 180)
                                    zoom_range = [.1,.2], # Randomly zoom image
                                    width_shift_range=[.1,.2], # randomly shift images horizontally (fraction of total width)
                                    height_shift_range=[.1,.2], # randomly shift images vertically (fraction of total height)
                                    )
```

```
In [77]: train_gen_aug = datagen.flow_from_directory(train_directory,
                                                 target_size = (224, 224),
                                                 batch_size=128,
```

```
classes = ["NORMAL", "PNEUMONIA"]
class_mode = 'binary',
seed = 42)
```

Found 4509 images belonging to 2 classes.

## Model 6 (Model 5 with different augmented training data)

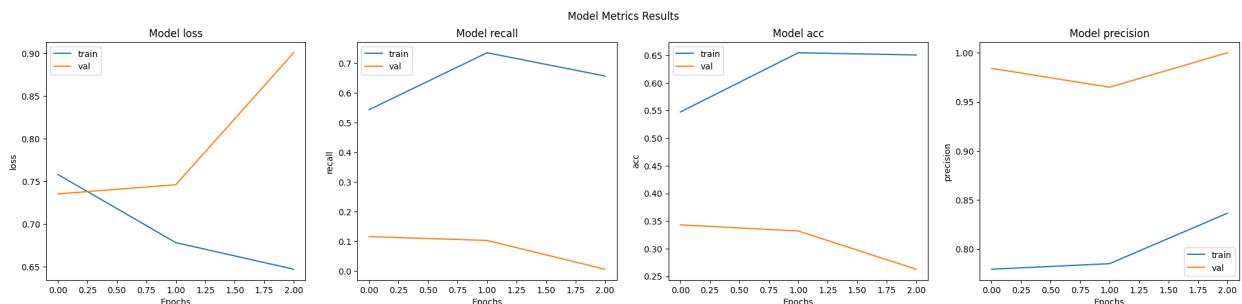
```
In [78]: #Using the same model with augmented data
model_6 = model_5
```

```
In [79]: history6 = model_5.fit(train_gen_aug,batch_size=best_batch,
                           epochs=best_epoch,
                           verbose = 1,
                           class_weight=class_weights,
                           validation_data=val_gen,
                           callbacks = es) #stopping early because of time resources
```

```
Epoch 1/90
36/36 [=====] - 45s 1s/step - loss: 0.7580 - acc: 0.5
471 - recall: 0.5438 - precision: 0.7794 - val_loss: 0.7353 - val_acc: 0.3430
- val_recall: 0.1157 - val_precision: 0.9841
Epoch 2/90
36/36 [=====] - 44s 1s/step - loss: 0.6782 - acc: 0.6
542 - recall: 0.7356 - precision: 0.7851 - val_loss: 0.7461 - val_acc: 0.3320
- val_recall: 0.1026 - val_precision: 0.9649
Epoch 3/90
36/36 [=====] - 44s 1s/step - loss: 0.6470 - acc: 0.6
503 - recall: 0.6573 - precision: 0.8365 - val_loss: 0.9008 - val_acc: 0.2628
- val_recall: 0.0056 - val_precision: 1.0000
Epoch 3: early stopping
```

```
In [80]: print("Model 6 with augmented data :\n")
eval_metrics(history6)
```

Model 6 with augmented data :

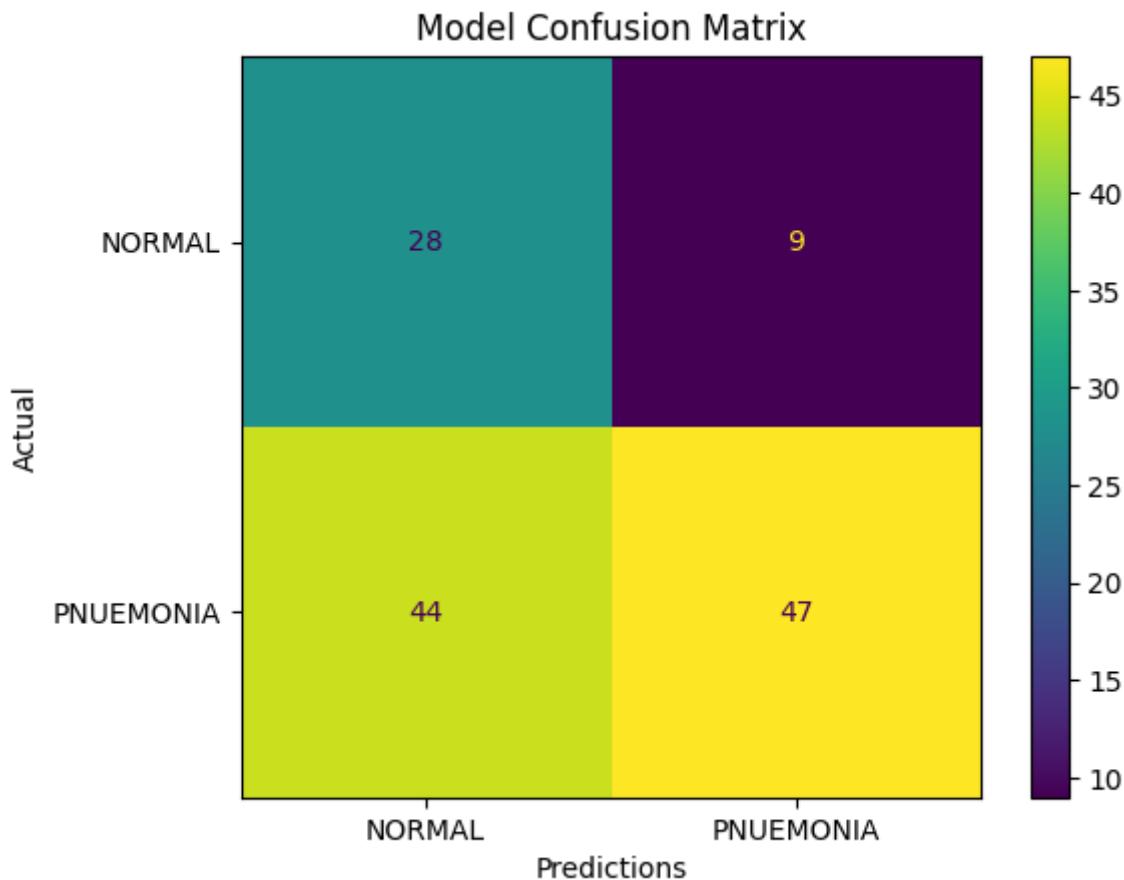


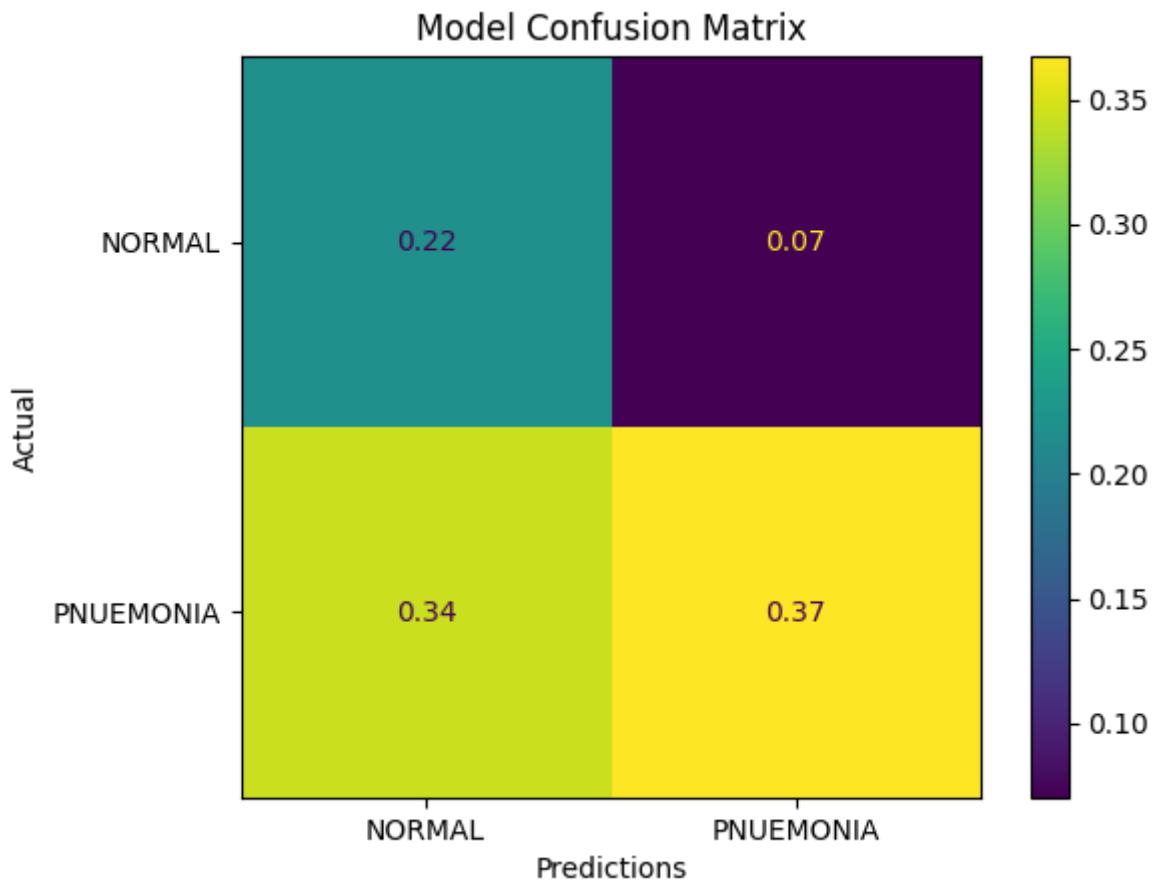
```
In [81]: train_labels, train_predictions = predict_results(model_5,train_gen_aug)
val_labels, val_predictions = predict_results(model_5,val_gen)
```

```
4/4 [=====] - 0s 24ms/step
4/4 [=====] - 0s 24ms/step
```

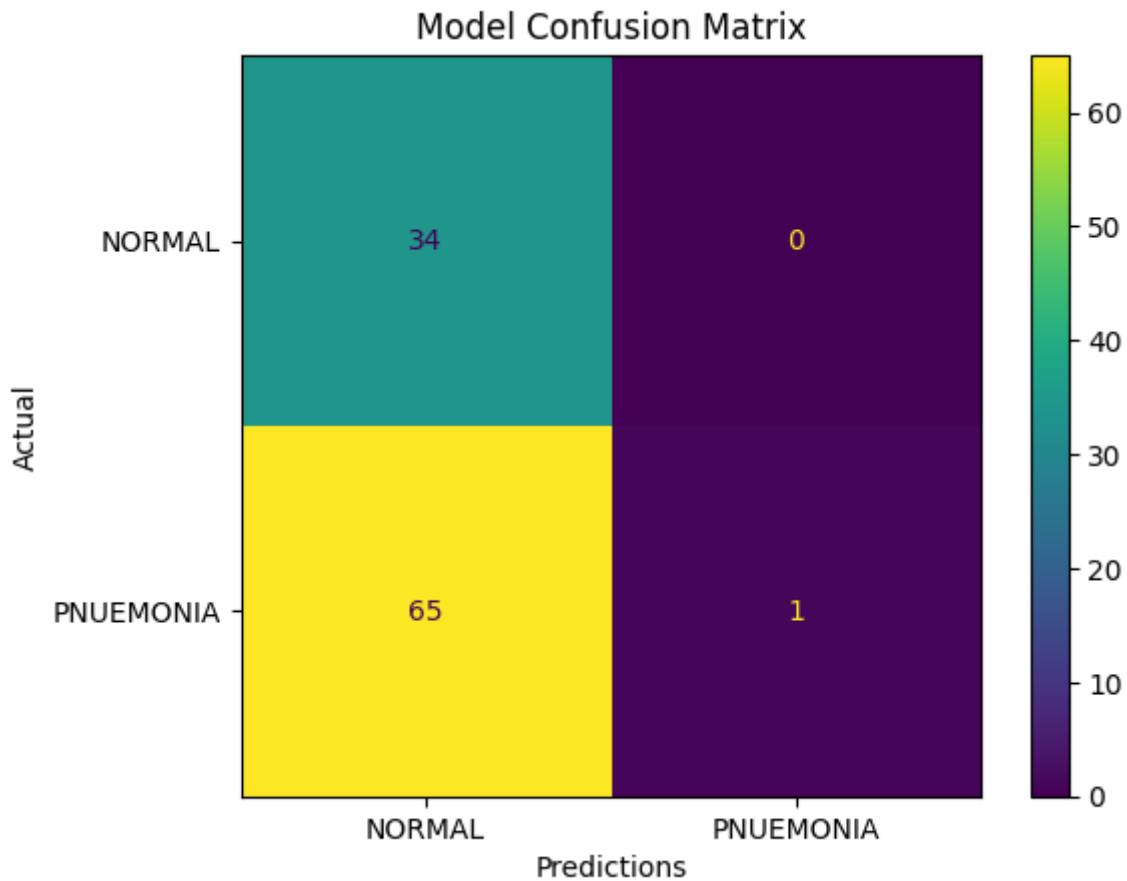
```
In [82]: #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

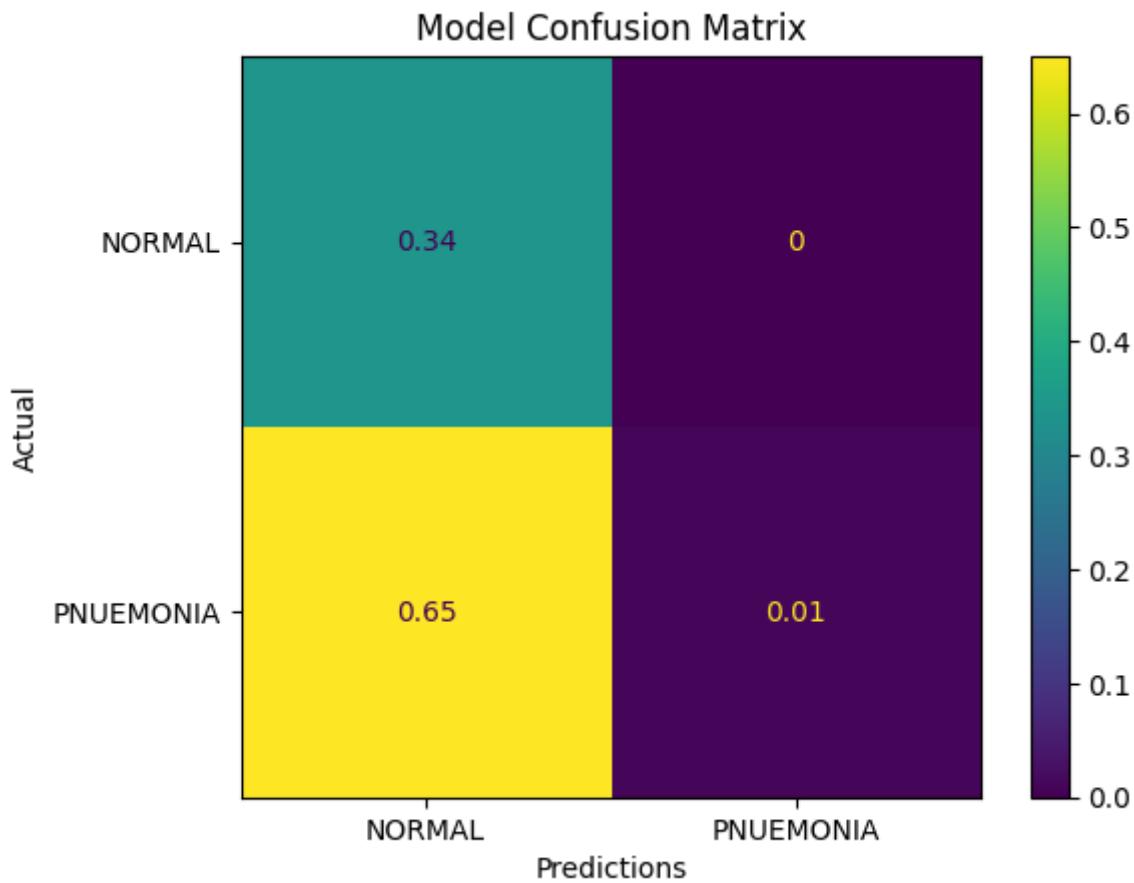
Training Confusion Matrices:





Validation Confusion Matrices:





```
In [83]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history6)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.389	0.757	0.514	37
1.0	0.839	0.516	0.639	91
accuracy			0.586	128
macro avg	0.614	0.637	0.577	128
weighted avg	0.709	0.586	0.603	128

```
16/16 [=====] - 23s 1s/step - loss: 0.8898 - acc: 0.2
633 - recall: 0.0075 - precision: 1.0000
Loss: 0.8898
```

```
In [84]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history6)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.343	1.000	0.511	34
1.0	1.000	0.015	0.030	66
<b>accuracy</b>			0.350	100
<b>macro avg</b>	0.672	0.508	0.271	100
<b>weighted avg</b>	0.777	0.350	0.194	100

```
8/8 [=====] - 4s 430ms/step - loss: 0.9008 - acc: 0.2
628 - recall: 0.0056 - precision: 1.0000
Loss: 0.9008
```

## Model 6 Evaluation - Needs Updating

Using augmented training data produced the worst results so far. Epoch 2 caused the most variation. The model had no False Negatives, but many False Positives. The training data trained on 30% of Normal values in a batch. The loss is the highest so far in all iterations. The augmented data will not be used in the next iteration.

## Model 7 - Learning Rate Optimization

Using gridsearch and keras wrappers to do some hyperparameter optimization

- `learning_rate = [.001,.01,.1,.2]`

Description of the model hyperparameters and data parameters:

- Model\*
  - layers: 3 Conv2D each w/ MaxPooling2D, 3 Dense output layers
  - filters: 32,64,96,128 for Conv2D, 64,1 Dense layer
  - activation: Relu for all except Sigmoid for output layer
  - dropout:\*\* .5 between the dense output layers
- Model Compile
  - loss: `binary_crossentropy`
  - optimizer:`adam`
  - learning rate: `.001 (Default)`
  - metrics: `Accuracy,Recall,Precision`
- Fit
  - data: `train_gen, val_gen`
  - train batchsize: 128
  - epochs: 90
  - early stopping : True
  - class weights: {0: 1.6, 1: 0.7272727272727273}

- Additional Comments
  - Conv2D model is best for images
  - MaxPooling 2D is a downsampling strategy CNNs

```
In [85]: def buildModel(learning_rate):

    model= models.Sequential([
        Conv2D(filters=32, kernel_size=(3, 3), activation='relu',
               padding = 'same', input_shape=(224,224,3)),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=64, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=96, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=128, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Conv2D(filters=128, kernel_size=(3, 3), activation='relu',
               padding = 'same'),
        MaxPooling2D(pool_size=(2, 2), strides=2),

        Flatten(),

        Dense(units=128, activation='relu'),
        Dropout(.3),
        Dense(units=64, activation='relu'),
        Dropout(.3),
        Dense(units=1, activation='sigmoid'),
    ])

    model.compile(loss='binary_crossentropy',
                  optimizer = Adam(learning_rate = learning_rate, ),
                  metrics=[ "acc", "Recall", "Precision"])

    return model
```

Learning rate determines the weights of our neural network with respect to the loss gradient.

```
In [86]: learning_rate = [.001,.01,.1,.2]
parameters_3 = dict( learning_rate=learning_rate)
parameters_3

Out[86]: {'learning_rate': [0.001, 0.01, 0.1, 0.2]}
```

```
In [87]: classifier = KerasClassifier(build_fn=buildModel, batch_size = best_batch, epochs=100)
#What hyperparameter we want to play with

grid_search = GridSearchCV(estimator = classifier,
                           error_score="raise",
                           param_grid = parameters_3,
                           refit = "Acc",
                           scoring = "accuracy",
                           cv = 3,return_train_score=True)
gs_3 = grid_search.fit(X_train, y_train, verbose = 1)
```

Epoch 1/45

```
2023-03-31 17:06:08.420805: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 4s 1s/step - loss: 0.7012 - acc: 0.4800
- recall: 0.4414 - precision: 0.7356
Epoch 2/45
2/2 [=====] - 1s 199ms/step - loss: 0.7011 - acc: 0.3
700 - recall: 0.2069 - precision: 0.7317
Epoch 3/45
2/2 [=====] - 1s 162ms/step - loss: 0.6886 - acc: 0.4
650 - recall: 0.3655 - precision: 0.7794
Epoch 4/45
2/2 [=====] - 0s 264ms/step - loss: 0.6948 - acc: 0.4
350 - recall: 0.3517 - precision: 0.7286
Epoch 5/45
2/2 [=====] - 1s 156ms/step - loss: 0.7037 - acc: 0.5
700 - recall: 0.5586 - precision: 0.7864
Epoch 6/45
2/2 [=====] - 0s 187ms/step - loss: 0.6909 - acc: 0.6
050 - recall: 0.6207 - precision: 0.7895
Epoch 7/45
2/2 [=====] - 0s 154ms/step - loss: 0.6822 - acc: 0.4
400 - recall: 0.2690 - precision: 0.8667
Epoch 8/45
2/2 [=====] - 0s 221ms/step - loss: 0.6527 - acc: 0.5
500 - recall: 0.4069 - precision: 0.9365
Epoch 9/45
2/2 [=====] - 0s 177ms/step - loss: 0.6284 - acc: 0.5
500 - recall: 0.4207 - precision: 0.9104
Epoch 10/45
2/2 [=====] - 1s 375ms/step - loss: 0.5858 - acc: 0.7
550 - recall: 0.7793 - precision: 0.8692
Epoch 11/45
2/2 [=====] - 0s 95ms/step - loss: 0.5874 - acc: 0.75
50 - recall: 0.7655 - precision: 0.8810
Epoch 12/45
2/2 [=====] - 0s 151ms/step - loss: 0.4939 - acc: 0.7
250 - recall: 0.6759 - precision: 0.9245
Epoch 13/45
2/2 [=====] - 0s 105ms/step - loss: 0.4654 - acc: 0.7
800 - recall: 0.7517 - precision: 0.9316
Epoch 14/45
2/2 [=====] - 0s 199ms/step - loss: 0.4102 - acc: 0.7
900 - recall: 0.7448 - precision: 0.9558
Epoch 15/45
2/2 [=====] - 0s 81ms/step - loss: 0.3481 - acc: 0.81
00 - recall: 0.7655 - precision: 0.9652
Epoch 16/45
2/2 [=====] - 0s 77ms/step - loss: 0.3635 - acc: 0.85
00 - recall: 0.8552 - precision: 0.9323
Epoch 17/45
2/2 [=====] - 0s 153ms/step - loss: 0.3152 - acc: 0.8
250 - recall: 0.7655 - precision: 0.9911
Epoch 18/45
2/2 [=====] - 0s 77ms/step - loss: 0.2298 - acc: 0.88
00 - recall: 0.8552 - precision: 0.9764
Epoch 19/45
2/2 [=====] - 0s 150ms/step - loss: 0.2573 - acc: 0.9
050 - recall: 0.9103 - precision: 0.9565
Epoch 20/45
2/2 [=====] - 0s 75ms/step - loss: 0.2285 - acc: 0.89
00 - recall: 0.8483 - precision: 1.0000
Epoch 21/45
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.1898 - acc: 0.92
50 - recall: 0.9241 - precision: 0.9710
Epoch 22/45
2/2 [=====] - 0s 76ms/step - loss: 0.1733 - acc: 0.92
00 - recall: 0.8966 - precision: 0.9924
Epoch 23/45
2/2 [=====] - 0s 136ms/step - loss: 0.1735 - acc: 0.9
300 - recall: 0.9172 - precision: 0.9852
Epoch 24/45
2/2 [=====] - 0s 75ms/step - loss: 0.1182 - acc: 0.96
00 - recall: 0.9655 - precision: 0.9790
Epoch 25/45
2/2 [=====] - 0s 167ms/step - loss: 0.1802 - acc: 0.8
900 - recall: 0.8483 - precision: 1.0000
Epoch 26/45
2/2 [=====] - 0s 75ms/step - loss: 0.1944 - acc: 0.92
50 - recall: 0.9310 - precision: 0.9643
Epoch 27/45
2/2 [=====] - 0s 165ms/step - loss: 0.1403 - acc: 0.9
250 - recall: 0.9034 - precision: 0.9924
Epoch 28/45
2/2 [=====] - 0s 95ms/step - loss: 0.1906 - acc: 0.90
50 - recall: 0.8690 - precision: 1.0000
Epoch 29/45
2/2 [=====] - 0s 74ms/step - loss: 0.1401 - acc: 0.96
50 - recall: 0.9655 - precision: 0.9859
Epoch 30/45
2/2 [=====] - 0s 76ms/step - loss: 0.0985 - acc: 0.97
00 - recall: 0.9724 - precision: 0.9860
Epoch 31/45
2/2 [=====] - 0s 75ms/step - loss: 0.0916 - acc: 0.95
50 - recall: 0.9379 - precision: 1.0000
Epoch 32/45
2/2 [=====] - 0s 74ms/step - loss: 0.1016 - acc: 0.94
50 - recall: 0.9241 - precision: 1.0000
Epoch 33/45
2/2 [=====] - 0s 74ms/step - loss: 0.0889 - acc: 0.97
00 - recall: 0.9931 - precision: 0.9664
Epoch 34/45
2/2 [=====] - 0s 74ms/step - loss: 0.0471 - acc: 0.98
00 - recall: 0.9724 - precision: 1.0000
Epoch 35/45
2/2 [=====] - 0s 142ms/step - loss: 0.0402 - acc: 0.9
700 - recall: 0.9586 - precision: 1.0000
Epoch 36/45
2/2 [=====] - 0s 95ms/step - loss: 0.0496 - acc: 0.98
50 - recall: 0.9931 - precision: 0.9863
Epoch 37/45
2/2 [=====] - 0s 74ms/step - loss: 0.0666 - acc: 0.97
50 - recall: 0.9793 - precision: 0.9861
Epoch 38/45
2/2 [=====] - 0s 135ms/step - loss: 0.0536 - acc: 0.9
700 - recall: 0.9586 - precision: 1.0000
Epoch 39/45
2/2 [=====] - 0s 74ms/step - loss: 0.0318 - acc: 0.99
00 - recall: 0.9931 - precision: 0.9931
Epoch 40/45
2/2 [=====] - 0s 73ms/step - loss: 0.0155 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 41/45
```

```
2/2 [=====] - 0s 74ms/step - loss: 0.0104 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 74ms/step - loss: 0.0219 - acc: 0.99
00 - recall: 0.9862 - precision: 1.0000
Epoch 43/45
2/2 [=====] - 0s 74ms/step - loss: 0.0088 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 44/45
2/2 [=====] - 0s 74ms/step - loss: 0.0150 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
Epoch 45/45
2/2 [=====] - 0s 76ms/step - loss: 0.0083 - acc: 0.99
50 - recall: 0.9931 - precision: 1.0000
2023-03-31 17:06:24.984211: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 152ms/step
7/7 [=====] - 0s 55ms/step
Epoch 1/45
2023-03-31 17:06:26.768499: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 949ms/step - loss: 0.6931 - acc: 0.5  
950 - recall: 0.7162 - precision: 0.7310  
Epoch 2/45  
2/2 [=====] - 0s 302ms/step - loss: 0.6904 - acc: 0.3  
200 - recall: 0.1081 - precision: 0.8000  
Epoch 3/45  
2/2 [=====] - 1s 265ms/step - loss: 0.6925 - acc: 0.3  
100 - recall: 0.0946 - precision: 0.7778  
Epoch 4/45  
2/2 [=====] - 1s 314ms/step - loss: 0.6895 - acc: 0.4  
000 - recall: 0.2905 - precision: 0.7414  
Epoch 5/45  
2/2 [=====] - 0s 235ms/step - loss: 0.6889 - acc: 0.4  
100 - recall: 0.2500 - precision: 0.8409  
Epoch 6/45  
2/2 [=====] - 0s 110ms/step - loss: 0.6824 - acc: 0.5  
300 - recall: 0.4189 - precision: 0.8857  
Epoch 7/45  
2/2 [=====] - 0s 182ms/step - loss: 0.6722 - acc: 0.6  
400 - recall: 0.5743 - precision: 0.9043  
Epoch 8/45  
2/2 [=====] - 0s 221ms/step - loss: 0.6365 - acc: 0.5  
600 - recall: 0.4257 - precision: 0.9545  
Epoch 9/45  
2/2 [=====] - 0s 76ms/step - loss: 0.5840 - acc: 0.72  
00 - recall: 0.6622 - precision: 0.9423  
Epoch 10/45  
2/2 [=====] - 0s 236ms/step - loss: 0.5208 - acc: 0.7  
450 - recall: 0.7297 - precision: 0.9076  
Epoch 11/45  
2/2 [=====] - 0s 156ms/step - loss: 0.5443 - acc: 0.8  
050 - recall: 0.8378 - precision: 0.8921  
Epoch 12/45  
2/2 [=====] - 0s 75ms/step - loss: 0.5048 - acc: 0.81  
50 - recall: 0.8446 - precision: 0.8993  
Epoch 13/45  
2/2 [=====] - 0s 169ms/step - loss: 0.4778 - acc: 0.8  
150 - recall: 0.8041 - precision: 0.9370  
Epoch 14/45  
2/2 [=====] - 0s 76ms/step - loss: 0.4692 - acc: 0.75  
50 - recall: 0.6959 - precision: 0.9626  
Epoch 15/45  
2/2 [=====] - 0s 99ms/step - loss: 0.4372 - acc: 0.79  
00 - recall: 0.7635 - precision: 0.9417  
Epoch 16/45  
2/2 [=====] - 0s 76ms/step - loss: 0.3989 - acc: 0.82  
00 - recall: 0.7973 - precision: 0.9516  
Epoch 17/45  
2/2 [=====] - 0s 79ms/step - loss: 0.3551 - acc: 0.82  
50 - recall: 0.7838 - precision: 0.9748  
Epoch 18/45  
2/2 [=====] - 0s 75ms/step - loss: 0.3337 - acc: 0.87  
00 - recall: 0.8649 - precision: 0.9552  
Epoch 19/45  
2/2 [=====] - 0s 228ms/step - loss: 0.3169 - acc: 0.8  
100 - recall: 0.7568 - precision: 0.9825  
Epoch 20/45  
2/2 [=====] - 0s 146ms/step - loss: 0.2789 - acc: 0.8  
750 - recall: 0.8716 - precision: 0.9556  
Epoch 21/45
```

```
2/2 [=====] - 0s 134ms/step - loss: 0.2956 - acc: 0.8  
950 - recall: 0.8716 - precision: 0.9847  
Epoch 22/45  
2/2 [=====] - 0s 97ms/step - loss: 0.2801 - acc: 0.83  
50 - recall: 0.7770 - precision: 1.0000  
Epoch 23/45  
2/2 [=====] - 0s 168ms/step - loss: 0.2846 - acc: 0.8  
750 - recall: 0.8514 - precision: 0.9767  
Epoch 24/45  
2/2 [=====] - 0s 91ms/step - loss: 0.2916 - acc: 0.88  
00 - recall: 0.8649 - precision: 0.9697  
Epoch 25/45  
2/2 [=====] - 0s 77ms/step - loss: 0.2036 - acc: 0.90  
00 - recall: 0.8716 - precision: 0.9923  
Epoch 26/45  
2/2 [=====] - 0s 132ms/step - loss: 0.2085 - acc: 0.8  
900 - recall: 0.8514 - precision: 1.0000  
Epoch 27/45  
2/2 [=====] - 0s 74ms/step - loss: 0.1781 - acc: 0.95  
00 - recall: 0.9595 - precision: 0.9726  
Epoch 28/45  
2/2 [=====] - 0s 79ms/step - loss: 0.1343 - acc: 0.92  
50 - recall: 0.8986 - precision: 1.0000  
Epoch 29/45  
2/2 [=====] - 0s 74ms/step - loss: 0.1174 - acc: 0.94  
50 - recall: 0.9257 - precision: 1.0000  
Epoch 30/45  
2/2 [=====] - 0s 88ms/step - loss: 0.1645 - acc: 0.94  
50 - recall: 0.9459 - precision: 0.9790  
Epoch 31/45  
2/2 [=====] - 0s 77ms/step - loss: 0.1696 - acc: 0.92  
50 - recall: 0.8986 - precision: 1.0000  
Epoch 32/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1541 - acc: 0.96  
50 - recall: 0.9797 - precision: 0.9732  
Epoch 33/45  
2/2 [=====] - 0s 76ms/step - loss: 0.1327 - acc: 0.92  
00 - recall: 0.8919 - precision: 1.0000  
Epoch 34/45  
2/2 [=====] - 0s 75ms/step - loss: 0.1099 - acc: 0.94  
00 - recall: 0.9324 - precision: 0.9857  
Epoch 35/45  
2/2 [=====] - 0s 130ms/step - loss: 0.1124 - acc: 0.9  
600 - recall: 0.9662 - precision: 0.9795  
Epoch 36/45  
2/2 [=====] - 0s 75ms/step - loss: 0.0782 - acc: 0.97  
50 - recall: 0.9662 - precision: 1.0000  
Epoch 37/45  
2/2 [=====] - 0s 78ms/step - loss: 0.0494 - acc: 0.97  
00 - recall: 0.9595 - precision: 1.0000  
Epoch 38/45  
2/2 [=====] - 0s 76ms/step - loss: 0.0681 - acc: 0.98  
00 - recall: 0.9865 - precision: 0.9865  
Epoch 39/45  
2/2 [=====] - 0s 98ms/step - loss: 0.0445 - acc: 0.97  
50 - recall: 0.9662 - precision: 1.0000  
Epoch 40/45  
2/2 [=====] - 0s 83ms/step - loss: 0.0232 - acc: 0.99  
00 - recall: 0.9865 - precision: 1.0000  
Epoch 41/45
```

```
2/2 [=====] - 0s 94ms/step - loss: 0.0359 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 42/45
2/2 [=====] - 0s 96ms/step - loss: 0.0198 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 43/45
2/2 [=====] - 0s 89ms/step - loss: 0.0199 - acc: 0.99
00 - recall: 0.9865 - precision: 1.0000
Epoch 44/45
2/2 [=====] - 0s 90ms/step - loss: 0.0248 - acc: 0.99
50 - recall: 1.0000 - precision: 0.9933
Epoch 45/45
2/2 [=====] - 0s 92ms/step - loss: 0.0053 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
2023-03-31 17:06:42.233748: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 92ms/step
7/7 [=====] - 0s 40ms/step
Epoch 1/45
2023-03-31 17:06:43.868762: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 984ms/step - loss: 0.6844 - acc: 0.5
650 - recall: 0.5906 - precision: 0.7719
Epoch 2/45
2/2 [=====] - 1s 208ms/step - loss: 0.6878 - acc: 0.4
650 - recall: 0.3960 - precision: 0.7763
Epoch 3/45
2/2 [=====] - 0s 164ms/step - loss: 0.6846 - acc: 0.5
100 - recall: 0.5302 - precision: 0.7383
Epoch 4/45
2/2 [=====] - 0s 179ms/step - loss: 0.6718 - acc: 0.4
050 - recall: 0.2550 - precision: 0.8261
Epoch 5/45
2/2 [=====] - 0s 164ms/step - loss: 0.6498 - acc: 0.4
700 - recall: 0.3154 - precision: 0.9216
Epoch 6/45
2/2 [=====] - 0s 235ms/step - loss: 0.6525 - acc: 0.7
150 - recall: 0.7785 - precision: 0.8286
Epoch 7/45
2/2 [=====] - 0s 157ms/step - loss: 0.5924 - acc: 0.7
650 - recall: 0.8456 - precision: 0.8400
Epoch 8/45
2/2 [=====] - 0s 103ms/step - loss: 0.5021 - acc: 0.7
450 - recall: 0.7181 - precision: 0.9224
Epoch 9/45
2/2 [=====] - 0s 231ms/step - loss: 0.4979 - acc: 0.7
250 - recall: 0.6510 - precision: 0.9700
Epoch 10/45
2/2 [=====] - 0s 163ms/step - loss: 0.4881 - acc: 0.7
850 - recall: 0.7651 - precision: 0.9344
Epoch 11/45
2/2 [=====] - 0s 171ms/step - loss: 0.5166 - acc: 0.8
350 - recall: 0.8725 - precision: 0.9028
Epoch 12/45
2/2 [=====] - 0s 199ms/step - loss: 0.4746 - acc: 0.8
400 - recall: 0.8255 - precision: 0.9535
Epoch 13/45
2/2 [=====] - 0s 97ms/step - loss: 0.4389 - acc: 0.83
00 - recall: 0.7987 - precision: 0.9675
Epoch 14/45
2/2 [=====] - 0s 132ms/step - loss: 0.3807 - acc: 0.8
100 - recall: 0.7584 - precision: 0.9826
Epoch 15/45
2/2 [=====] - 0s 77ms/step - loss: 0.3355 - acc: 0.81
00 - recall: 0.7584 - precision: 0.9826
Epoch 16/45
2/2 [=====] - 0s 75ms/step - loss: 0.3189 - acc: 0.84
00 - recall: 0.8255 - precision: 0.9535
Epoch 17/45
2/2 [=====] - 0s 77ms/step - loss: 0.3039 - acc: 0.86
50 - recall: 0.8523 - precision: 0.9621
Epoch 18/45
2/2 [=====] - 0s 148ms/step - loss: 0.2720 - acc: 0.8
600 - recall: 0.8389 - precision: 0.9690
Epoch 19/45
2/2 [=====] - 0s 94ms/step - loss: 0.2634 - acc: 0.88
00 - recall: 0.8859 - precision: 0.9496
Epoch 20/45
2/2 [=====] - 0s 77ms/step - loss: 0.2393 - acc: 0.91
00 - recall: 0.9195 - precision: 0.9580
Epoch 21/45
```

```
2/2 [=====] - 0s 78ms/step - loss: 0.2508 - acc: 0.83
00 - recall: 0.7785 - precision: 0.9915
Epoch 22/45
2/2 [=====] - 0s 75ms/step - loss: 0.2610 - acc: 0.89
50 - recall: 0.9195 - precision: 0.9384
Epoch 23/45
2/2 [=====] - 0s 195ms/step - loss: 0.1735 - acc: 0.9
100 - recall: 0.8792 - precision: 1.0000
Epoch 24/45
2/2 [=====] - 0s 74ms/step - loss: 0.2303 - acc: 0.88
50 - recall: 0.8456 - precision: 1.0000
Epoch 25/45
2/2 [=====] - 0s 153ms/step - loss: 0.1520 - acc: 0.9
100 - recall: 0.8792 - precision: 1.0000
Epoch 26/45
2/2 [=====] - 0s 94ms/step - loss: 0.1659 - acc: 0.93
50 - recall: 0.9530 - precision: 0.9595
Epoch 27/45
2/2 [=====] - 0s 76ms/step - loss: 0.1545 - acc: 0.94
00 - recall: 0.9463 - precision: 0.9724
Epoch 28/45
2/2 [=====] - 0s 142ms/step - loss: 0.1444 - acc: 0.9
350 - recall: 0.9195 - precision: 0.9928
Epoch 29/45
2/2 [=====] - 0s 86ms/step - loss: 0.1110 - acc: 0.95
00 - recall: 0.9329 - precision: 1.0000
Epoch 30/45
2/2 [=====] - 0s 96ms/step - loss: 0.1306 - acc: 0.94
50 - recall: 0.9530 - precision: 0.9726
Epoch 31/45
2/2 [=====] - 0s 134ms/step - loss: 0.1154 - acc: 0.9
450 - recall: 0.9262 - precision: 1.0000
Epoch 32/45
2/2 [=====] - 1s 477ms/step - loss: 0.1066 - acc: 0.9
400 - recall: 0.9195 - precision: 1.0000
Epoch 33/45
2/2 [=====] - 0s 76ms/step - loss: 0.1273 - acc: 0.96
50 - recall: 0.9799 - precision: 0.9733
Epoch 34/45
2/2 [=====] - 0s 75ms/step - loss: 0.0994 - acc: 0.95
00 - recall: 0.9329 - precision: 1.0000
Epoch 35/45
2/2 [=====] - 0s 75ms/step - loss: 0.1576 - acc: 0.91
50 - recall: 0.8859 - precision: 1.0000
Epoch 36/45
2/2 [=====] - 0s 75ms/step - loss: 0.1386 - acc: 0.95
00 - recall: 0.9597 - precision: 0.9728
Epoch 37/45
2/2 [=====] - 0s 80ms/step - loss: 0.1110 - acc: 0.97
50 - recall: 0.9732 - precision: 0.9932
Epoch 38/45
2/2 [=====] - 0s 155ms/step - loss: 0.0958 - acc: 0.9
700 - recall: 0.9597 - precision: 1.0000
Epoch 39/45
2/2 [=====] - 0s 74ms/step - loss: 0.0863 - acc: 0.96
50 - recall: 0.9530 - precision: 1.0000
Epoch 40/45
2/2 [=====] - 0s 76ms/step - loss: 0.0781 - acc: 0.97
00 - recall: 0.9664 - precision: 0.9931
Epoch 41/45
```

```
2/2 [=====] - 0s 80ms/step - loss: 0.0584 - acc: 0.98
00 - recall: 0.9799 - precision: 0.9932
Epoch 42/45
2/2 [=====] - 0s 87ms/step - loss: 0.0447 - acc: 0.98
00 - recall: 0.9799 - precision: 0.9932
Epoch 43/45
2/2 [=====] - 0s 100ms/step - loss: 0.0622 - acc: 0.9
750 - recall: 0.9664 - precision: 1.0000
Epoch 44/45
2/2 [=====] - 0s 88ms/step - loss: 0.0450 - acc: 0.97
50 - recall: 0.9732 - precision: 0.9932
Epoch 45/45
2/2 [=====] - 0s 90ms/step - loss: 0.0230 - acc: 0.98
50 - recall: 0.9799 - precision: 1.0000
2023-03-31 17:06:59.438625: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 71ms/step
7/7 [=====] - 0s 54ms/step
Epoch 1/45
2023-03-31 17:07:00.797195: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 944ms/step - loss: 13.5640 - acc: 0.  
4700 - recall: 0.3862 - precision: 0.7671  
Epoch 2/45  
2/2 [=====] - 1s 248ms/step - loss: 0.7196 - acc: 0.7  
250 - recall: 1.0000 - precision: 0.7250  
Epoch 3/45  
2/2 [=====] - 1s 260ms/step - loss: 0.7148 - acc: 0.6  
550 - recall: 0.8759 - precision: 0.7135  
Epoch 4/45  
2/2 [=====] - 0s 199ms/step - loss: 0.7054 - acc: 0.6  
350 - recall: 0.7724 - precision: 0.7368  
Epoch 5/45  
2/2 [=====] - 1s 257ms/step - loss: 0.7014 - acc: 0.5  
650 - recall: 0.6207 - precision: 0.7377  
Epoch 6/45  
2/2 [=====] - 0s 173ms/step - loss: 0.7058 - acc: 0.3  
450 - recall: 0.1379 - precision: 0.7692  
Epoch 7/45  
2/2 [=====] - 0s 175ms/step - loss: 0.7076 - acc: 0.7  
050 - recall: 0.9310 - precision: 0.7337  
Epoch 8/45  
2/2 [=====] - 0s 81ms/step - loss: 0.7062 - acc: 0.72  
00 - recall: 0.9931 - precision: 0.7236  
Epoch 9/45  
2/2 [=====] - 0s 97ms/step - loss: 0.7048 - acc: 0.67  
50 - recall: 0.9310 - precision: 0.7105  
Epoch 10/45  
2/2 [=====] - 0s 146ms/step - loss: 0.7055 - acc: 0.6  
050 - recall: 0.8000 - precision: 0.6988  
Epoch 11/45  
2/2 [=====] - 0s 219ms/step - loss: 0.7021 - acc: 0.5  
950 - recall: 0.6828 - precision: 0.7388  
Epoch 12/45  
2/2 [=====] - 0s 178ms/step - loss: 0.7032 - acc: 0.4  
950 - recall: 0.5379 - precision: 0.6964  
Epoch 13/45  
2/2 [=====] - 1s 424ms/step - loss: 0.7037 - acc: 0.4  
950 - recall: 0.4828 - precision: 0.7292  
Epoch 14/45  
2/2 [=====] - 0s 152ms/step - loss: 0.7033 - acc: 0.3  
500 - recall: 0.2069 - precision: 0.6667  
Epoch 15/45  
2/2 [=====] - 0s 147ms/step - loss: 0.7026 - acc: 0.3  
100 - recall: 0.0828 - precision: 0.7059  
Epoch 16/45  
2/2 [=====] - 0s 78ms/step - loss: 0.7035 - acc: 0.31  
00 - recall: 0.0621 - precision: 0.8182  
Epoch 17/45  
2/2 [=====] - 0s 76ms/step - loss: 0.7024 - acc: 0.30  
50 - recall: 0.0414 - precision: 1.0000  
Epoch 18/45  
2/2 [=====] - 0s 75ms/step - loss: 0.7030 - acc: 0.27  
50 - recall: 0.0138 - precision: 0.5000  
Epoch 19/45  
2/2 [=====] - 0s 145ms/step - loss: 0.7026 - acc: 0.2  
850 - recall: 0.0207 - precision: 0.7500  
Epoch 20/45  
2/2 [=====] - 0s 92ms/step - loss: 0.7037 - acc: 0.27  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 21/45
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.7016 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 22/45
2/2 [=====] - 0s 74ms/step - loss: 0.7031 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 23/45
2/2 [=====] - 0s 74ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0069 - precision: 0.5000
Epoch 24/45
2/2 [=====] - 0s 74ms/step - loss: 0.7028 - acc: 0.27
50 - recall: 0.0069 - precision: 0.5000
Epoch 25/45
2/2 [=====] - 0s 77ms/step - loss: 0.7040 - acc: 0.30
00 - recall: 0.0414 - precision: 0.8571
Epoch 26/45
2/2 [=====] - 0s 155ms/step - loss: 0.7030 - acc: 0.2
900 - recall: 0.0414 - precision: 0.6667
Epoch 27/45
2/2 [=====] - 0s 76ms/step - loss: 0.7031 - acc: 0.29
00 - recall: 0.0690 - precision: 0.5882
Epoch 28/45
2/2 [=====] - 0s 79ms/step - loss: 0.7025 - acc: 0.33
50 - recall: 0.1448 - precision: 0.7000
Epoch 29/45
2/2 [=====] - 0s 78ms/step - loss: 0.7034 - acc: 0.35
50 - recall: 0.1862 - precision: 0.7105
Epoch 30/45
2/2 [=====] - 0s 125ms/step - loss: 0.7037 - acc: 0.3
250 - recall: 0.1586 - precision: 0.6389
Epoch 31/45
2/2 [=====] - 0s 77ms/step - loss: 0.7030 - acc: 0.37
00 - recall: 0.1862 - precision: 0.7714
Epoch 32/45
2/2 [=====] - 0s 136ms/step - loss: 0.7029 - acc: 0.3
550 - recall: 0.1724 - precision: 0.7353
Epoch 33/45
2/2 [=====] - 0s 129ms/step - loss: 0.7026 - acc: 0.3
250 - recall: 0.1310 - precision: 0.6786
Epoch 34/45
2/2 [=====] - 0s 76ms/step - loss: 0.7035 - acc: 0.32
50 - recall: 0.1241 - precision: 0.6923
Epoch 35/45
2/2 [=====] - 0s 145ms/step - loss: 0.7027 - acc: 0.3
400 - recall: 0.1310 - precision: 0.7600
Epoch 36/45
2/2 [=====] - 0s 76ms/step - loss: 0.7035 - acc: 0.31
50 - recall: 0.1034 - precision: 0.6818
Epoch 37/45
2/2 [=====] - 0s 74ms/step - loss: 0.7027 - acc: 0.30
50 - recall: 0.1034 - precision: 0.6250
Epoch 38/45
2/2 [=====] - 0s 76ms/step - loss: 0.7026 - acc: 0.31
00 - recall: 0.0897 - precision: 0.6842
Epoch 39/45
2/2 [=====] - 0s 83ms/step - loss: 0.7023 - acc: 0.28
50 - recall: 0.0345 - precision: 0.6250
Epoch 40/45
2/2 [=====] - 0s 74ms/step - loss: 0.7025 - acc: 0.29
00 - recall: 0.0207 - precision: 1.0000
Epoch 41/45
```

```
2/2 [=====] - 0s 76ms/step - loss: 0.7016 - acc: 0.28
00 - recall: 0.0069 - precision: 1.0000
Epoch 42/45
2/2 [=====] - 0s 75ms/step - loss: 0.7032 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 43/45
2/2 [=====] - 0s 73ms/step - loss: 0.7027 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 44/45
2/2 [=====] - 0s 73ms/step - loss: 0.7018 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 45/45
2/2 [=====] - 0s 76ms/step - loss: 0.7017 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
2023-03-31 17:07:15.642797: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 75ms/step
7/7 [=====] - 0s 40ms/step
Epoch 1/45
2023-03-31 17:07:16.868267: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 948ms/step - loss: 11.0549 - acc: 0.  
4600 - recall: 0.4122 - precision: 0.7439  
Epoch 2/45  
2/2 [=====] - 0s 187ms/step - loss: 0.8639 - acc: 0.7  
400 - recall: 1.0000 - precision: 0.7400  
Epoch 3/45  
2/2 [=====] - 0s 258ms/step - loss: 0.6943 - acc: 0.7  
400 - recall: 1.0000 - precision: 0.7400  
Epoch 4/45  
2/2 [=====] - 0s 148ms/step - loss: 0.6903 - acc: 0.6  
500 - recall: 0.7905 - precision: 0.7500  
Epoch 5/45  
2/2 [=====] - 0s 153ms/step - loss: 0.6905 - acc: 0.4  
350 - recall: 0.3986 - precision: 0.7108  
Epoch 6/45  
2/2 [=====] - 0s 173ms/step - loss: 0.6867 - acc: 0.5  
700 - recall: 0.5203 - precision: 0.8370  
Epoch 7/45  
2/2 [=====] - 0s 194ms/step - loss: 0.6920 - acc: 0.4  
650 - recall: 0.4595 - precision: 0.7158  
Epoch 8/45  
2/2 [=====] - 0s 182ms/step - loss: 0.6945 - acc: 0.4  
550 - recall: 0.4392 - precision: 0.7143  
Epoch 9/45  
2/2 [=====] - 0s 150ms/step - loss: 0.6885 - acc: 0.4  
950 - recall: 0.4527 - precision: 0.7701  
Epoch 10/45  
2/2 [=====] - 0s 157ms/step - loss: 0.6925 - acc: 0.4  
400 - recall: 0.3649 - precision: 0.7500  
Epoch 11/45  
2/2 [=====] - 0s 146ms/step - loss: 0.6947 - acc: 0.4  
300 - recall: 0.3986 - precision: 0.7024  
Epoch 12/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6903 - acc: 0.54  
50 - recall: 0.5405 - precision: 0.7767  
Epoch 13/45  
2/2 [=====] - 0s 241ms/step - loss: 0.6904 - acc: 0.5  
600 - recall: 0.6149 - precision: 0.7459  
Epoch 14/45  
2/2 [=====] - 0s 195ms/step - loss: 0.6892 - acc: 0.6  
450 - recall: 0.7432 - precision: 0.7692  
Epoch 15/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6911 - acc: 0.61  
50 - recall: 0.7568 - precision: 0.7320  
Epoch 16/45  
2/2 [=====] - 0s 141ms/step - loss: 0.6897 - acc: 0.6  
650 - recall: 0.8311 - precision: 0.7455  
Epoch 17/45  
2/2 [=====] - 0s 133ms/step - loss: 0.6898 - acc: 0.6  
950 - recall: 0.8986 - precision: 0.7430  
Epoch 18/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6901 - acc: 0.7  
100 - recall: 0.9324 - precision: 0.7419  
Epoch 19/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6912 - acc: 0.74  
00 - recall: 0.9797 - precision: 0.7474  
Epoch 20/45  
2/2 [=====] - 0s 97ms/step - loss: 0.6901 - acc: 0.73  
00 - recall: 0.9865 - precision: 0.7374  
Epoch 21/45
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.6884 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 22/45
2/2 [=====] - 0s 180ms/step - loss: 0.6896 - acc: 0.7
400 - recall: 1.0000 - precision: 0.7400
Epoch 23/45
2/2 [=====] - 0s 94ms/step - loss: 0.6905 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7437
Epoch 24/45
2/2 [=====] - 0s 74ms/step - loss: 0.6915 - acc: 0.73
50 - recall: 0.9730 - precision: 0.7461
Epoch 25/45
2/2 [=====] - 0s 75ms/step - loss: 0.6898 - acc: 0.70
50 - recall: 0.9392 - precision: 0.7354
Epoch 26/45
2/2 [=====] - 0s 74ms/step - loss: 0.6911 - acc: 0.68
50 - recall: 0.9189 - precision: 0.7273
Epoch 27/45
2/2 [=====] - 0s 94ms/step - loss: 0.6928 - acc: 0.68
50 - recall: 0.9054 - precision: 0.7322
Epoch 28/45
2/2 [=====] - 0s 75ms/step - loss: 0.6905 - acc: 0.69
00 - recall: 0.8919 - precision: 0.7416
Epoch 29/45
2/2 [=====] - 0s 170ms/step - loss: 0.6910 - acc: 0.6
150 - recall: 0.7703 - precision: 0.7261
Epoch 30/45
2/2 [=====] - 0s 89ms/step - loss: 0.6895 - acc: 0.60
50 - recall: 0.7162 - precision: 0.7413
Epoch 31/45
2/2 [=====] - 0s 78ms/step - loss: 0.6917 - acc: 0.55
50 - recall: 0.6284 - precision: 0.7323
Epoch 32/45
2/2 [=====] - 0s 75ms/step - loss: 0.6919 - acc: 0.53
50 - recall: 0.5946 - precision: 0.7273
Epoch 33/45
2/2 [=====] - 0s 74ms/step - loss: 0.6898 - acc: 0.59
00 - recall: 0.6486 - precision: 0.7619
Epoch 34/45
2/2 [=====] - 0s 76ms/step - loss: 0.6904 - acc: 0.64
00 - recall: 0.7568 - precision: 0.7568
Epoch 35/45
2/2 [=====] - 0s 205ms/step - loss: 0.6906 - acc: 0.6
550 - recall: 0.8108 - precision: 0.7453
Epoch 36/45
2/2 [=====] - 0s 79ms/step - loss: 0.6905 - acc: 0.66
00 - recall: 0.8243 - precision: 0.7439
Epoch 37/45
2/2 [=====] - 0s 95ms/step - loss: 0.6915 - acc: 0.64
00 - recall: 0.8176 - precision: 0.7289
Epoch 38/45
2/2 [=====] - 0s 75ms/step - loss: 0.6905 - acc: 0.65
00 - recall: 0.8243 - precision: 0.7349
Epoch 39/45
2/2 [=====] - 0s 94ms/step - loss: 0.6911 - acc: 0.63
50 - recall: 0.8108 - precision: 0.7273
Epoch 40/45
2/2 [=====] - 0s 74ms/step - loss: 0.6915 - acc: 0.61
50 - recall: 0.7635 - precision: 0.7290
Epoch 41/45
```

```
2/2 [=====] - 0s 73ms/step - loss: 0.6898 - acc: 0.62
50 - recall: 0.6892 - precision: 0.7786
Epoch 42/45
2/2 [=====] - 0s 74ms/step - loss: 0.6904 - acc: 0.54
50 - recall: 0.5878 - precision: 0.7436
Epoch 43/45
2/2 [=====] - 0s 75ms/step - loss: 0.6908 - acc: 0.48
50 - recall: 0.5203 - precision: 0.7000
Epoch 44/45
2/2 [=====] - 0s 82ms/step - loss: 0.6908 - acc: 0.49
50 - recall: 0.5203 - precision: 0.7130
Epoch 45/45
2/2 [=====] - 0s 88ms/step - loss: 0.6892 - acc: 0.52
50 - recall: 0.4730 - precision: 0.8046
2023-03-31 17:07:32.016237: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 78ms/step
7/7 [=====] - 0s 47ms/step
Epoch 1/45
2023-03-31 17:07:33.296190: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 941ms/step - loss: 13.6932 - acc: 0.  
4500 - recall: 0.3758 - precision: 0.7671  
Epoch 2/45  
2/2 [=====] - 1s 251ms/step - loss: 0.6971 - acc: 0.7  
450 - recall: 1.0000 - precision: 0.7450  
Epoch 3/45  
2/2 [=====] - 1s 193ms/step - loss: 0.6860 - acc: 0.7  
400 - recall: 0.9933 - precision: 0.7437  
Epoch 4/45  
2/2 [=====] - 0s 162ms/step - loss: 0.6897 - acc: 0.6  
250 - recall: 0.7718 - precision: 0.7372  
Epoch 5/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6888 - acc: 0.6  
800 - recall: 0.8591 - precision: 0.7485  
Epoch 6/45  
2/2 [=====] - 0s 180ms/step - loss: 0.6847 - acc: 0.7  
400 - recall: 0.9933 - precision: 0.7437  
Epoch 7/45  
2/2 [=====] - 0s 235ms/step - loss: 0.6873 - acc: 0.7  
400 - recall: 0.9933 - precision: 0.7437  
Epoch 8/45  
2/2 [=====] - 0s 100ms/step - loss: 0.6863 - acc: 0.7  
400 - recall: 0.9866 - precision: 0.7462  
Epoch 9/45  
2/2 [=====] - 1s 266ms/step - loss: 0.6855 - acc: 0.7  
100 - recall: 0.9060 - precision: 0.7542  
Epoch 10/45  
2/2 [=====] - 0s 118ms/step - loss: 0.6881 - acc: 0.6  
100 - recall: 0.7114 - precision: 0.7518  
Epoch 11/45  
2/2 [=====] - 0s 153ms/step - loss: 0.6861 - acc: 0.5  
250 - recall: 0.6107 - precision: 0.7109  
Epoch 12/45  
2/2 [=====] - 0s 144ms/step - loss: 0.6871 - acc: 0.6  
200 - recall: 0.7517 - precision: 0.7417  
Epoch 13/45  
2/2 [=====] - 0s 205ms/step - loss: 0.6888 - acc: 0.6  
500 - recall: 0.7987 - precision: 0.7484  
Epoch 14/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6855 - acc: 0.67  
00 - recall: 0.8523 - precision: 0.7427  
Epoch 15/45  
2/2 [=====] - 0s 163ms/step - loss: 0.6872 - acc: 0.6  
650 - recall: 0.8725 - precision: 0.7303  
Epoch 16/45  
2/2 [=====] - 0s 77ms/step - loss: 0.6861 - acc: 0.65  
00 - recall: 0.7919 - precision: 0.7516  
Epoch 17/45  
2/2 [=====] - 0s 219ms/step - loss: 0.6886 - acc: 0.4  
850 - recall: 0.5369 - precision: 0.7018  
Epoch 18/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6873 - acc: 0.53  
00 - recall: 0.5973 - precision: 0.7236  
Epoch 19/45  
2/2 [=====] - 0s 164ms/step - loss: 0.6881 - acc: 0.5  
150 - recall: 0.5973 - precision: 0.7063  
Epoch 20/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6865 - acc: 0.59  
50 - recall: 0.7047 - precision: 0.7394  
Epoch 21/45
```

```
2/2 [=====] - 0s 79ms/step - loss: 0.6902 - acc: 0.63
50 - recall: 0.8322 - precision: 0.7209
Epoch 22/45
2/2 [=====] - 0s 77ms/step - loss: 0.6868 - acc: 0.67
00 - recall: 0.8725 - precision: 0.7345
Epoch 23/45
2/2 [=====] - 0s 73ms/step - loss: 0.6884 - acc: 0.70
50 - recall: 0.9329 - precision: 0.7394
Epoch 24/45
2/2 [=====] - 0s 93ms/step - loss: 0.6853 - acc: 0.74
00 - recall: 0.9866 - precision: 0.7462
Epoch 25/45
2/2 [=====] - 0s 75ms/step - loss: 0.6872 - acc: 0.74
00 - recall: 0.9933 - precision: 0.7437
Epoch 26/45
2/2 [=====] - 0s 77ms/step - loss: 0.6853 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 27/45
2/2 [=====] - 0s 75ms/step - loss: 0.6865 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 28/45
2/2 [=====] - 0s 142ms/step - loss: 0.6843 - acc: 0.7
450 - recall: 1.0000 - precision: 0.7450
Epoch 29/45
2/2 [=====] - 0s 74ms/step - loss: 0.6873 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 30/45
2/2 [=====] - 0s 77ms/step - loss: 0.6864 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 31/45
2/2 [=====] - 0s 99ms/step - loss: 0.6863 - acc: 0.74
00 - recall: 0.9866 - precision: 0.7462
Epoch 32/45
2/2 [=====] - 0s 74ms/step - loss: 0.6857 - acc: 0.74
50 - recall: 0.9866 - precision: 0.7500
Epoch 33/45
2/2 [=====] - 0s 75ms/step - loss: 0.6861 - acc: 0.73
50 - recall: 0.9799 - precision: 0.7449
Epoch 34/45
2/2 [=====] - 0s 73ms/step - loss: 0.6862 - acc: 0.72
00 - recall: 0.9664 - precision: 0.7385
Epoch 35/45
2/2 [=====] - 0s 74ms/step - loss: 0.6869 - acc: 0.69
50 - recall: 0.9128 - precision: 0.7391
Epoch 36/45
2/2 [=====] - 0s 75ms/step - loss: 0.6870 - acc: 0.69
00 - recall: 0.9128 - precision: 0.7351
Epoch 37/45
2/2 [=====] - 0s 75ms/step - loss: 0.6862 - acc: 0.69
00 - recall: 0.9128 - precision: 0.7351
Epoch 38/45
2/2 [=====] - 0s 74ms/step - loss: 0.6870 - acc: 0.68
00 - recall: 0.9060 - precision: 0.7297
Epoch 39/45
2/2 [=====] - 0s 73ms/step - loss: 0.6856 - acc: 0.73
00 - recall: 0.9396 - precision: 0.7568
Epoch 40/45
2/2 [=====] - 0s 74ms/step - loss: 0.6867 - acc: 0.67
50 - recall: 0.8792 - precision: 0.7360
Epoch 41/45
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.6845 - acc: 0.69
50 - recall: 0.8792 - precision: 0.7529
Epoch 42/45
2/2 [=====] - 0s 83ms/step - loss: 0.6868 - acc: 0.66
50 - recall: 0.8523 - precision: 0.7384
Epoch 43/45
2/2 [=====] - 0s 88ms/step - loss: 0.6868 - acc: 0.66
00 - recall: 0.8456 - precision: 0.7368
Epoch 44/45
2/2 [=====] - 0s 91ms/step - loss: 0.6874 - acc: 0.61
50 - recall: 0.8121 - precision: 0.7118
Epoch 45/45
2/2 [=====] - 0s 139ms/step - loss: 0.6854 - acc: 0.6
950 - recall: 0.8658 - precision: 0.7588
2023-03-31 17:07:48.064972: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 75ms/step
7/7 [=====] - 0s 47ms/step
Epoch 1/45
2023-03-31 17:07:50.021102: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 857ms/step - loss: 128352736.0000 -  
acc: 0.3950 - recall: 0.3586 - precision: 0.6500  
Epoch 2/45  
2/2 [=====] - 1s 264ms/step - loss: 75116.8047 - acc:  
0.7200 - recall: 0.9931 - precision: 0.7236  
Epoch 3/45  
2/2 [=====] - 0s 205ms/step - loss: 90016.6172 - acc:  
0.5850 - recall: 0.6552 - precision: 0.7422  
Epoch 4/45  
2/2 [=====] - 0s 247ms/step - loss: 17.3649 - acc: 0.  
4350 - recall: 0.3517 - precision: 0.7286  
Epoch 5/45  
2/2 [=====] - 0s 83ms/step - loss: 12.5939 - acc: 0.7  
200 - recall: 0.9103 - precision: 0.7543  
Epoch 6/45  
2/2 [=====] - 0s 161ms/step - loss: 9.5350 - acc: 0.7  
300 - recall: 1.0000 - precision: 0.7286  
Epoch 7/45  
2/2 [=====] - 0s 224ms/step - loss: 16.5485 - acc: 0.  
6050 - recall: 0.7586 - precision: 0.7143  
Epoch 8/45  
2/2 [=====] - 0s 176ms/step - loss: 16.4197 - acc: 0.  
4500 - recall: 0.5172 - precision: 0.6522  
Epoch 9/45  
2/2 [=====] - 0s 244ms/step - loss: 128.7421 - acc:  
0.4650 - recall: 0.3724 - precision: 0.7714  
Epoch 10/45  
2/2 [=====] - 0s 226ms/step - loss: 57.4520 - acc: 0.  
5600 - recall: 0.5862 - precision: 0.7522  
Epoch 11/45  
2/2 [=====] - 0s 169ms/step - loss: 74.7944 - acc: 0.  
4300 - recall: 0.3448 - precision: 0.7246  
Epoch 12/45  
2/2 [=====] - 0s 159ms/step - loss: 27.3197 - acc: 0.  
6800 - recall: 0.8276 - precision: 0.7547  
Epoch 13/45  
2/2 [=====] - 0s 77ms/step - loss: 14.3507 - acc: 0.4  
550 - recall: 0.3586 - precision: 0.7647  
Epoch 14/45  
2/2 [=====] - 0s 202ms/step - loss: 6.5107 - acc: 0.4  
800 - recall: 0.4759 - precision: 0.7113  
Epoch 15/45  
2/2 [=====] - 0s 103ms/step - loss: 1.4870 - acc: 0.4  
950 - recall: 0.4276 - precision: 0.7750  
Epoch 16/45  
2/2 [=====] - 0s 132ms/step - loss: 0.9099 - acc: 0.2  
750 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 17/45  
2/2 [=====] - 0s 98ms/step - loss: 0.8507 - acc: 0.27  
50 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 18/45  
2/2 [=====] - 0s 75ms/step - loss: 0.8088 - acc: 0.27  
50 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 19/45  
2/2 [=====] - 0s 148ms/step - loss: 0.7798 - acc: 0.2  
750 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 20/45  
2/2 [=====] - 0s 78ms/step - loss: 0.7646 - acc: 0.27  
50 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 21/45
```

```
2/2 [=====] - 0s 93ms/step - loss: 0.7502 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 22/45
2/2 [=====] - 0s 133ms/step - loss: 0.7391 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 23/45
2/2 [=====] - 0s 81ms/step - loss: 0.7279 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 24/45
2/2 [=====] - 0s 78ms/step - loss: 0.7124 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 25/45
2/2 [=====] - 0s 76ms/step - loss: 0.7147 - acc: 0.35
50 - recall: 0.2276 - precision: 0.6471
Epoch 26/45
2/2 [=====] - 0s 74ms/step - loss: 0.7209 - acc: 0.55
50 - recall: 0.6690 - precision: 0.7029
Epoch 27/45
2/2 [=====] - 0s 74ms/step - loss: 0.7038 - acc: 0.60
50 - recall: 0.7034 - precision: 0.7391
Epoch 28/45
2/2 [=====] - 0s 92ms/step - loss: 0.7082 - acc: 0.57
50 - recall: 0.6828 - precision: 0.7174
Epoch 29/45
2/2 [=====] - 0s 74ms/step - loss: 0.7089 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 30/45
2/2 [=====] - 0s 75ms/step - loss: 0.7071 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 31/45
2/2 [=====] - 0s 75ms/step - loss: 0.7051 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 32/45
2/2 [=====] - 0s 74ms/step - loss: 0.7048 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 33/45
2/2 [=====] - 0s 93ms/step - loss: 0.7039 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 34/45
2/2 [=====] - 0s 75ms/step - loss: 0.7060 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 35/45
2/2 [=====] - 0s 74ms/step - loss: 0.7024 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 36/45
2/2 [=====] - 0s 147ms/step - loss: 0.7022 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 37/45
2/2 [=====] - 0s 74ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 38/45
2/2 [=====] - 0s 75ms/step - loss: 0.7031 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 39/45
2/2 [=====] - 0s 76ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 40/45
2/2 [=====] - 0s 74ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 41/45
```

```
2/2 [=====] - 0s 81ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 42/45
2/2 [=====] - 0s 83ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 43/45
2/2 [=====] - 0s 223ms/step - loss: 0.7026 - acc: 0.2
750 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 44/45
2/2 [=====] - 0s 85ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 45/45
2/2 [=====] - 0s 80ms/step - loss: 0.7026 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
2023-03-31 17:08:04.959622: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 72ms/step
7/7 [=====] - 0s 39ms/step
Epoch 1/45
2023-03-31 17:08:06.208820: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 979ms/step - loss: 213275520.0000 -  
acc: 0.4250 - recall: 0.3716 - precision: 0.7143  
Epoch 2/45  
2/2 [=====] - 1s 263ms/step - loss: 13010.4658 - acc:  
0.7400 - recall: 1.0000 - precision: 0.7400  
Epoch 3/45  
2/2 [=====] - 1s 266ms/step - loss: 331.0985 - acc:  
0.7250 - recall: 0.9730 - precision: 0.7385  
Epoch 4/45  
2/2 [=====] - 1s 179ms/step - loss: 72.6920 - acc: 0.  
3550 - recall: 0.2027 - precision: 0.7317  
Epoch 5/45  
2/2 [=====] - 0s 221ms/step - loss: 51.2583 - acc: 0.  
2600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 6/45  
2/2 [=====] - 0s 151ms/step - loss: 591.4014 - acc:  
0.3700 - recall: 0.2095 - precision: 0.7750  
Epoch 7/45  
2/2 [=====] - 0s 107ms/step - loss: 176.5613 - acc:  
0.7050 - recall: 0.9054 - precision: 0.7486  
Epoch 8/45  
2/2 [=====] - 0s 84ms/step - loss: 257.7215 - acc: 0.  
6450 - recall: 0.8649 - precision: 0.7151  
Epoch 9/45  
2/2 [=====] - 0s 79ms/step - loss: 15.9525 - acc: 0.6  
550 - recall: 0.7905 - precision: 0.7548  
Epoch 10/45  
2/2 [=====] - 0s 214ms/step - loss: 16.3489 - acc: 0.  
4350 - recall: 0.3311 - precision: 0.7778  
Epoch 11/45  
2/2 [=====] - 0s 74ms/step - loss: 0.7208 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 12/45  
2/2 [=====] - 0s 170ms/step - loss: 0.7221 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 13/45  
2/2 [=====] - 0s 167ms/step - loss: 0.7304 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 14/45  
2/2 [=====] - 0s 208ms/step - loss: 0.7261 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 15/45  
2/2 [=====] - 0s 75ms/step - loss: 0.7187 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 16/45  
2/2 [=====] - 0s 131ms/step - loss: 0.7078 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 17/45  
2/2 [=====] - 0s 145ms/step - loss: 0.7035 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 18/45  
2/2 [=====] - 0s 129ms/step - loss: 0.6997 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 19/45  
2/2 [=====] - 0s 77ms/step - loss: 0.6970 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 20/45  
2/2 [=====] - 0s 94ms/step - loss: 0.6950 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 21/45
```

```
2/2 [=====] - 0s 132ms/step - loss: 0.6930 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 22/45  
2/2 [=====] - 0s 78ms/step - loss: 0.6919 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 23/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6911 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 24/45  
2/2 [=====] - 0s 133ms/step - loss: 0.6909 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 25/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6903 - acc: 0.44  
00 - recall: 0.3649 - precision: 0.7500  
Epoch 26/45  
2/2 [=====] - 0s 262ms/step - loss: 0.6904 - acc: 0.7  
400 - recall: 1.0000 - precision: 0.7400  
Epoch 27/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6904 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 28/45  
2/2 [=====] - 0s 95ms/step - loss: 0.6905 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 29/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6906 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 30/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6907 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 31/45  
2/2 [=====] - 0s 82ms/step - loss: 0.6908 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 32/45  
2/2 [=====] - 0s 160ms/step - loss: 0.6908 - acc: 0.7  
400 - recall: 1.0000 - precision: 0.7400  
Epoch 33/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6909 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 34/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6908 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 35/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6935 - acc: 0.39  
50 - recall: 0.3108 - precision: 0.7077  
Epoch 36/45  
2/2 [=====] - 0s 76ms/step - loss: 0.6902 - acc: 0.42  
50 - recall: 0.3311 - precision: 0.7538  
Epoch 37/45  
2/2 [=====] - 0s 93ms/step - loss: 0.6923 - acc: 0.38  
50 - recall: 0.3041 - precision: 0.6923  
Epoch 38/45  
2/2 [=====] - 0s 82ms/step - loss: 0.6908 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 39/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6907 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 40/45  
2/2 [=====] - 0s 201ms/step - loss: 0.6906 - acc: 0.7  
400 - recall: 1.0000 - precision: 0.7400  
Epoch 41/45
```

```
2/2 [=====] - 0s 84ms/step - loss: 0.6906 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 42/45
2/2 [=====] - 0s 141ms/step - loss: 0.6906 - acc: 0.7
400 - recall: 1.0000 - precision: 0.7400
Epoch 43/45
2/2 [=====] - 0s 88ms/step - loss: 0.6904 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 44/45
2/2 [=====] - 0s 90ms/step - loss: 0.6904 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 45/45
2/2 [=====] - 0s 91ms/step - loss: 0.6904 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
2023-03-31 17:08:21.516737: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 78ms/step
7/7 [=====] - 0s 45ms/step
Epoch 1/45
2023-03-31 17:08:22.840360: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 954ms/step - loss: 233808304.0000 -  
acc: 0.4100 - recall: 0.3624 - precision: 0.7013  
Epoch 2/45  
2/2 [=====] - 0s 182ms/step - loss: 11295.5859 - acc:  
0.7450 - recall: 1.0000 - precision: 0.7450  
Epoch 3/45  
2/2 [=====] - 0s 203ms/step - loss: 948.8784 - acc:  
0.5500 - recall: 0.6040 - precision: 0.7438  
Epoch 4/45  
2/2 [=====] - 0s 185ms/step - loss: 8549.7959 - acc:  
0.5900 - recall: 0.6846 - precision: 0.7445  
Epoch 5/45  
2/2 [=====] - 0s 158ms/step - loss: 488.1347 - acc:  
0.6050 - recall: 0.6443 - precision: 0.7869  
Epoch 6/45  
2/2 [=====] - 1s 254ms/step - loss: 497.4266 - acc:  
0.7350 - recall: 0.9664 - precision: 0.7500  
Epoch 7/45  
2/2 [=====] - 0s 104ms/step - loss: 9.3951 - acc: 0.6  
000 - recall: 0.7383 - precision: 0.7285  
Epoch 8/45  
2/2 [=====] - 0s 200ms/step - loss: 9.2764 - acc: 0.4  
550 - recall: 0.3423 - precision: 0.8226  
Epoch 9/45  
2/2 [=====] - 0s 220ms/step - loss: 14.6463 - acc: 0.  
6100 - recall: 0.7517 - precision: 0.7320  
Epoch 10/45  
2/2 [=====] - 0s 154ms/step - loss: 630.8401 - acc:  
0.5000 - recall: 0.4765 - precision: 0.7634  
Epoch 11/45  
2/2 [=====] - 0s 179ms/step - loss: 15.3151 - acc: 0.  
7050 - recall: 0.8926 - precision: 0.7557  
Epoch 12/45  
2/2 [=====] - 0s 163ms/step - loss: 40.8405 - acc: 0.  
7400 - recall: 0.9732 - precision: 0.7513  
Epoch 13/45  
2/2 [=====] - 0s 154ms/step - loss: 71.1405 - acc: 0.  
6350 - recall: 0.7047 - precision: 0.7836  
Epoch 14/45  
2/2 [=====] - 1s 423ms/step - loss: 70.1804 - acc: 0.  
7100 - recall: 0.9329 - precision: 0.7433  
Epoch 15/45  
2/2 [=====] - 0s 99ms/step - loss: 79.1490 - acc: 0.5  
200 - recall: 0.5839 - precision: 0.7190  
Epoch 16/45  
2/2 [=====] - 0s 102ms/step - loss: 79.6947 - acc: 0.  
4800 - recall: 0.5436 - precision: 0.6923  
Epoch 17/45  
2/2 [=====] - 0s 75ms/step - loss: 68.7219 - acc: 0.5  
050 - recall: 0.5638 - precision: 0.7119  
Epoch 18/45  
2/2 [=====] - 0s 98ms/step - loss: 22.0198 - acc: 0.3  
600 - recall: 0.2215 - precision: 0.7333  
Epoch 19/45  
2/2 [=====] - 0s 133ms/step - loss: 1.3732 - acc: 0.2  
550 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 20/45  
2/2 [=====] - 0s 84ms/step - loss: 1.2890 - acc: 0.25  
50 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 21/45
```

```
2/2 [=====] - 0s 76ms/step - loss: 1.1496 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 22/45
2/2 [=====] - 0s 75ms/step - loss: 1.0393 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 23/45
2/2 [=====] - 0s 76ms/step - loss: 0.9486 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 24/45
2/2 [=====] - 0s 140ms/step - loss: 0.8622 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 25/45
2/2 [=====] - 0s 75ms/step - loss: 0.8025 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 26/45
2/2 [=====] - 0s 77ms/step - loss: 0.7727 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 27/45
2/2 [=====] - 0s 140ms/step - loss: 0.7486 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 28/45
2/2 [=====] - 0s 158ms/step - loss: 0.7299 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 29/45
2/2 [=====] - 0s 132ms/step - loss: 0.7164 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 30/45
2/2 [=====] - 0s 76ms/step - loss: 0.7021 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 31/45
2/2 [=====] - 0s 95ms/step - loss: 0.6952 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 32/45
2/2 [=====] - 0s 74ms/step - loss: 0.6905 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 33/45
2/2 [=====] - 0s 74ms/step - loss: 0.6862 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 34/45
2/2 [=====] - 0s 350ms/step - loss: 0.6855 - acc: 0.7
450 - recall: 1.0000 - precision: 0.7450
Epoch 35/45
2/2 [=====] - 0s 79ms/step - loss: 0.6867 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 36/45
2/2 [=====] - 0s 77ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 37/45
2/2 [=====] - 0s 78ms/step - loss: 0.6875 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 38/45
2/2 [=====] - 0s 75ms/step - loss: 0.6885 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 39/45
2/2 [=====] - 0s 77ms/step - loss: 0.6890 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 40/45
2/2 [=====] - 0s 77ms/step - loss: 0.6892 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 41/45
```

```
2/2 [=====] - 0s 81ms/step - loss: 0.6893 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 42/45
2/2 [=====] - 0s 95ms/step - loss: 0.6890 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 43/45
2/2 [=====] - 0s 84ms/step - loss: 0.6889 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 44/45
2/2 [=====] - 0s 84ms/step - loss: 0.6880 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 45/45
2/2 [=====] - 0s 87ms/step - loss: 0.6875 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
2023-03-31 17:08:38.204289: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 77ms/step
7/7 [=====] - 0s 48ms/step
Epoch 1/45
2023-03-31 17:08:39.971386: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 966ms/step - loss: 5314214912.0000 - acc: 0.5700 - recall: 0.6897 - precision: 0.7092
Epoch 2/45
2/2 [=====] - 1s 256ms/step - loss: 96886104.0000 - acc: 0.2750 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 3/45
2/2 [=====] - 0s 184ms/step - loss: 1937920128.0000 - acc: 0.3700 - recall: 0.2552 - precision: 0.6727
Epoch 4/45
2/2 [=====] - 0s 255ms/step - loss: 2287.8196 - acc: 0.4600 - recall: 0.3241 - precision: 0.8246
Epoch 5/45
2/2 [=====] - 0s 254ms/step - loss: 3220.8762 - acc: 0.4900 - recall: 0.4966 - precision: 0.7129
Epoch 6/45
2/2 [=====] - 0s 223ms/step - loss: 1339.2531 - acc: 0.4750 - recall: 0.4276 - precision: 0.7381
Epoch 7/45
2/2 [=====] - 0s 162ms/step - loss: 1060.3540 - acc: 0.4800 - recall: 0.4897 - precision: 0.7030
Epoch 8/45
2/2 [=====] - 0s 93ms/step - loss: 895.5028 - acc: 0.4700 - recall: 0.4414 - precision: 0.7191
Epoch 9/45
2/2 [=====] - 0s 104ms/step - loss: 458.7306 - acc: 0.5000 - recall: 0.5034 - precision: 0.7228
Epoch 10/45
2/2 [=====] - 0s 209ms/step - loss: 179.8418 - acc: 0.3550 - recall: 0.2483 - precision: 0.6429
Epoch 11/45
2/2 [=====] - 0s 142ms/step - loss: 20.4419 - acc: 0.5900 - recall: 0.7793 - precision: 0.6933
Epoch 12/45
2/2 [=====] - 0s 217ms/step - loss: 19.9421 - acc: 0.7200 - recall: 0.9793 - precision: 0.7282
Epoch 13/45
2/2 [=====] - 0s 101ms/step - loss: 13.3402 - acc: 0.6750 - recall: 0.9034 - precision: 0.7198
Epoch 14/45
2/2 [=====] - 0s 154ms/step - loss: 34.8687 - acc: 0.6650 - recall: 0.8552 - precision: 0.7294
Epoch 15/45
2/2 [=====] - 0s 78ms/step - loss: 19.8980 - acc: 0.7100 - recall: 0.9379 - precision: 0.7351
Epoch 16/45
2/2 [=====] - 0s 144ms/step - loss: 11.0375 - acc: 0.6950 - recall: 0.9448 - precision: 0.7211
Epoch 17/45
2/2 [=====] - 0s 76ms/step - loss: 4.2915 - acc: 0.7050 - recall: 0.9655 - precision: 0.7216
Epoch 18/45
2/2 [=====] - 0s 75ms/step - loss: 0.7590 - acc: 0.7250 - recall: 0.9931 - precision: 0.7273
Epoch 19/45
2/2 [=====] - 0s 146ms/step - loss: 1.0027 - acc: 0.7200 - recall: 0.9862 - precision: 0.7259
Epoch 20/45
2/2 [=====] - 0s 169ms/step - loss: 1.8918 - acc: 0.2750 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 21/45
```

```
2/2 [=====] - 0s 76ms/step - loss: 1.1232 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 22/45
2/2 [=====] - 0s 146ms/step - loss: 0.9219 - acc: 0.2
750 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 23/45
2/2 [=====] - 0s 152ms/step - loss: 0.7056 - acc: 0.2
800 - recall: 0.0069 - precision: 1.0000
Epoch 24/45
2/2 [=====] - 0s 74ms/step - loss: 1.7840 - acc: 0.27
50 - recall: 0.0069 - precision: 0.5000
Epoch 25/45
2/2 [=====] - 0s 75ms/step - loss: 1.1127 - acc: 0.27
50 - recall: 0.0069 - precision: 0.5000
Epoch 26/45
2/2 [=====] - 0s 75ms/step - loss: 0.9453 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 27/45
2/2 [=====] - 0s 74ms/step - loss: 1.9273 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 28/45
2/2 [=====] - 0s 78ms/step - loss: 1.6015 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 29/45
2/2 [=====] - 0s 76ms/step - loss: 1.3107 - acc: 0.28
00 - recall: 0.0069 - precision: 1.0000
Epoch 30/45
2/2 [=====] - 0s 89ms/step - loss: 1.0234 - acc: 0.28
00 - recall: 0.0069 - precision: 1.0000
Epoch 31/45
2/2 [=====] - 0s 82ms/step - loss: 0.7444 - acc: 0.28
00 - recall: 0.0069 - precision: 1.0000
Epoch 32/45
2/2 [=====] - 0s 75ms/step - loss: 4.1756 - acc: 0.73
00 - recall: 1.0000 - precision: 0.7286
Epoch 33/45
2/2 [=====] - 0s 135ms/step - loss: 1.5200 - acc: 0.7
300 - recall: 1.0000 - precision: 0.7286
Epoch 34/45
2/2 [=====] - 0s 76ms/step - loss: 0.6984 - acc: 0.56
50 - recall: 0.6414 - precision: 0.7266
Epoch 35/45
2/2 [=====] - 0s 75ms/step - loss: 1.8813 - acc: 0.28
50 - recall: 0.0138 - precision: 1.0000
Epoch 36/45
2/2 [=====] - 0s 272ms/step - loss: 0.6941 - acc: 0.2
800 - recall: 0.0069 - precision: 1.0000
Epoch 37/45
2/2 [=====] - 0s 75ms/step - loss: 0.8506 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 38/45
2/2 [=====] - 0s 75ms/step - loss: 0.7774 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 39/45
2/2 [=====] - 0s 79ms/step - loss: 1.1318 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 40/45
2/2 [=====] - 0s 75ms/step - loss: 0.8770 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 41/45
```

```
2/2 [=====] - 0s 99ms/step - loss: 0.6901 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 42/45
2/2 [=====] - 0s 82ms/step - loss: 1.0227 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 43/45
2/2 [=====] - 0s 84ms/step - loss: 0.7104 - acc: 0.27
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 44/45
2/2 [=====] - 0s 84ms/step - loss: 0.7885 - acc: 0.27
00 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 45/45
2/2 [=====] - 0s 82ms/step - loss: 0.6940 - acc: 0.28
00 - recall: 0.0069 - precision: 1.0000
2023-03-31 17:08:55.228186: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 76ms/step
7/7 [=====] - 0s 38ms/step
Epoch 1/45
2023-03-31 17:08:56.451313: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 937ms/step - loss: 30564009984.0000  
- acc: 0.5800 - recall: 0.7230 - precision: 0.7133  
Epoch 2/45  
2/2 [=====] - 1s 260ms/step - loss: 405269920.0000 -  
acc: 0.2600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 3/45  
2/2 [=====] - 1s 254ms/step - loss: 1609135872.0000 -  
acc: 0.4600 - recall: 0.3919 - precision: 0.7632  
Epoch 4/45  
2/2 [=====] - 0s 261ms/step - loss: 189616.6719 - ac  
c: 0.5700 - recall: 0.6689 - precision: 0.7279  
Epoch 5/45  
2/2 [=====] - 0s 245ms/step - loss: 118228.6953 - ac  
c: 0.4150 - recall: 0.3108 - precision: 0.7541  
Epoch 6/45  
2/2 [=====] - 1s 491ms/step - loss: 1097939.3750 - ac  
c: 0.2900 - recall: 0.0608 - precision: 0.7500  
Epoch 7/45  
2/2 [=====] - 0s 156ms/step - loss: 133364.5625 - ac  
c: 0.6250 - recall: 0.7703 - precision: 0.7355  
Epoch 8/45  
2/2 [=====] - 0s 152ms/step - loss: 63650.2383 - acc:  
0.6550 - recall: 0.8311 - precision: 0.7365  
Epoch 9/45  
2/2 [=====] - 0s 215ms/step - loss: 67695.6250 - acc:  
0.4550 - recall: 0.4122 - precision: 0.7349  
Epoch 10/45  
2/2 [=====] - 0s 235ms/step - loss: 283105.0625 - ac  
c: 0.4450 - recall: 0.3716 - precision: 0.7534  
Epoch 11/45  
2/2 [=====] - 0s 105ms/step - loss: 35288.0234 - acc:  
0.6100 - recall: 0.7432 - precision: 0.7333  
Epoch 12/45  
2/2 [=====] - 0s 159ms/step - loss: 91.5064 - acc: 0.  
4950 - recall: 0.4324 - precision: 0.7901  
Epoch 13/45  
2/2 [=====] - 0s 137ms/step - loss: 130.6109 - acc:  
0.5000 - recall: 0.5270 - precision: 0.7222  
Epoch 14/45  
2/2 [=====] - 0s 76ms/step - loss: 181.2161 - acc: 0.  
5100 - recall: 0.5608 - precision: 0.7155  
Epoch 15/45  
2/2 [=====] - 0s 86ms/step - loss: 157.5767 - acc: 0.  
6050 - recall: 0.6486 - precision: 0.7805  
Epoch 16/45  
2/2 [=====] - 0s 151ms/step - loss: 164.1565 - acc:  
0.6100 - recall: 0.7027 - precision: 0.7536  
Epoch 17/45  
2/2 [=====] - 0s 149ms/step - loss: 163.8724 - acc:  
0.6650 - recall: 0.8176 - precision: 0.7516  
Epoch 18/45  
2/2 [=====] - 0s 146ms/step - loss: 154.9373 - acc:  
0.6750 - recall: 0.8716 - precision: 0.7371  
Epoch 19/45  
2/2 [=====] - 0s 101ms/step - loss: 156.1593 - acc:  
0.6200 - recall: 0.7905 - precision: 0.7222  
Epoch 20/45  
2/2 [=====] - 0s 366ms/step - loss: 67.8460 - acc: 0.  
6450 - recall: 0.8108 - precision: 0.7362  
Epoch 21/45
```

```
2/2 [=====] - 0s 145ms/step - loss: 35.9331 - acc: 0.  
3850 - recall: 0.3176 - precision: 0.6812  
Epoch 22/45  
2/2 [=====] - 0s 80ms/step - loss: 15.5092 - acc: 0.3  
750 - recall: 0.2297 - precision: 0.7556  
Epoch 23/45  
2/2 [=====] - 0s 74ms/step - loss: 12.0465 - acc: 0.5  
300 - recall: 0.5676 - precision: 0.7368  
Epoch 24/45  
2/2 [=====] - 0s 100ms/step - loss: 23.4862 - acc: 0.  
6450 - recall: 0.7703 - precision: 0.7550  
Epoch 25/45  
2/2 [=====] - 0s 75ms/step - loss: 5.4886 - acc: 0.43  
50 - recall: 0.3851 - precision: 0.7215  
Epoch 26/45  
2/2 [=====] - 0s 139ms/step - loss: 5.5040 - acc: 0.4  
250 - recall: 0.3851 - precision: 0.7037  
Epoch 27/45  
2/2 [=====] - 0s 81ms/step - loss: 4.1304 - acc: 0.47  
50 - recall: 0.4189 - precision: 0.7654  
Epoch 28/45  
2/2 [=====] - 0s 76ms/step - loss: 3.6350 - acc: 0.47  
50 - recall: 0.4189 - precision: 0.7654  
Epoch 29/45  
2/2 [=====] - 0s 78ms/step - loss: 4.0229 - acc: 0.41  
50 - recall: 0.3581 - precision: 0.7067  
Epoch 30/45  
2/2 [=====] - 0s 75ms/step - loss: 3.0848 - acc: 0.40  
00 - recall: 0.3176 - precision: 0.7121  
Epoch 31/45  
2/2 [=====] - 0s 76ms/step - loss: 2.1589 - acc: 0.34  
50 - recall: 0.2162 - precision: 0.6809  
Epoch 32/45  
2/2 [=====] - 0s 77ms/step - loss: 1.2859 - acc: 0.28  
00 - recall: 0.0676 - precision: 0.6250  
Epoch 33/45  
2/2 [=====] - 0s 77ms/step - loss: 0.7500 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 34/45  
2/2 [=====] - 0s 161ms/step - loss: 0.7165 - acc: 0.2  
600 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 35/45  
2/2 [=====] - 0s 75ms/step - loss: 0.7005 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 36/45  
2/2 [=====] - 0s 73ms/step - loss: 0.6941 - acc: 0.26  
00 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 37/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6917 - acc: 0.40  
00 - recall: 0.3378 - precision: 0.6944  
Epoch 38/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6910 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 39/45  
2/2 [=====] - 0s 75ms/step - loss: 0.6943 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 40/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6977 - acc: 0.74  
00 - recall: 1.0000 - precision: 0.7400  
Epoch 41/45
```

```
2/2 [=====] - 0s 77ms/step - loss: 0.6985 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 42/45
2/2 [=====] - 0s 83ms/step - loss: 0.6987 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 43/45
2/2 [=====] - 0s 185ms/step - loss: 0.6979 - acc: 0.7
400 - recall: 1.0000 - precision: 0.7400
Epoch 44/45
2/2 [=====] - 0s 84ms/step - loss: 0.6972 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
Epoch 45/45
2/2 [=====] - 0s 89ms/step - loss: 0.6942 - acc: 0.74
00 - recall: 1.0000 - precision: 0.7400
2023-03-31 17:09:12.080651: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 1s 88ms/step
7/7 [=====] - 0s 51ms/step
Epoch 1/45
2023-03-31 17:09:13.412372: I tensorflow/core/grappler/optimizers/custom_graph_
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
2/2 [=====] - 3s 930ms/step - loss: 33843748864.0000  
- acc: 0.6300 - recall: 0.7651 - precision: 0.7451  
Epoch 2/45  
2/2 [=====] - 1s 257ms/step - loss: 105029104.0000 -  
acc: 0.2550 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 3/45  
2/2 [=====] - 0s 253ms/step - loss: 96464.8750 - acc:  
0.4200 - recall: 0.3154 - precision: 0.7705  
Epoch 4/45  
2/2 [=====] - 1s 226ms/step - loss: 13212.9707 - acc:  
0.3500 - recall: 0.1678 - precision: 0.8065  
Epoch 5/45  
2/2 [=====] - 0s 183ms/step - loss: 1953.3049 - acc:  
0.6600 - recall: 0.8188 - precision: 0.7485  
Epoch 6/45  
2/2 [=====] - 0s 232ms/step - loss: 361.6555 - acc:  
0.4950 - recall: 0.4698 - precision: 0.7609  
Epoch 7/45  
2/2 [=====] - 0s 161ms/step - loss: 12642.7695 - acc:  
0.5850 - recall: 0.6443 - precision: 0.7619  
Epoch 8/45  
2/2 [=====] - 0s 176ms/step - loss: 560.7081 - acc:  
0.5400 - recall: 0.6040 - precision: 0.7317  
Epoch 9/45  
2/2 [=====] - 0s 148ms/step - loss: 339.4415 - acc:  
0.4750 - recall: 0.4564 - precision: 0.7391  
Epoch 10/45  
2/2 [=====] - 0s 178ms/step - loss: 132.2394 - acc:  
0.7100 - recall: 0.8993 - precision: 0.7571  
Epoch 11/45  
2/2 [=====] - 0s 80ms/step - loss: 0.7186 - acc: 0.74  
50 - recall: 1.0000 - precision: 0.7450  
Epoch 12/45  
2/2 [=====] - 0s 79ms/step - loss: 215.5269 - acc: 0.  
7450 - recall: 1.0000 - precision: 0.7450  
Epoch 13/45  
2/2 [=====] - 0s 94ms/step - loss: 0.7087 - acc: 0.74  
50 - recall: 1.0000 - precision: 0.7450  
Epoch 14/45  
2/2 [=====] - 0s 138ms/step - loss: 142.3644 - acc:  
0.7250 - recall: 0.9732 - precision: 0.7398  
Epoch 15/45  
2/2 [=====] - 0s 162ms/step - loss: 0.6946 - acc: 0.7  
450 - recall: 1.0000 - precision: 0.7450  
Epoch 16/45  
2/2 [=====] - 0s 82ms/step - loss: 0.6905 - acc: 0.74  
50 - recall: 1.0000 - precision: 0.7450  
Epoch 17/45  
2/2 [=====] - 0s 74ms/step - loss: 0.6877 - acc: 0.74  
50 - recall: 1.0000 - precision: 0.7450  
Epoch 18/45  
2/2 [=====] - 0s 365ms/step - loss: 0.6860 - acc: 0.7  
450 - recall: 1.0000 - precision: 0.7450  
Epoch 19/45  
2/2 [=====] - 0s 132ms/step - loss: 0.6861 - acc: 0.5  
750 - recall: 0.6443 - precision: 0.7500  
Epoch 20/45  
2/2 [=====] - 0s 157ms/step - loss: 0.6868 - acc: 0.2  
550 - recall: 0.0000e+00 - precision: 0.0000e+00  
Epoch 21/45
```

```
2/2 [=====] - 0s 75ms/step - loss: 0.7819 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 22/45
2/2 [=====] - 0s 172ms/step - loss: 0.8761 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 23/45
2/2 [=====] - 0s 130ms/step - loss: 0.6891 - acc: 0.2
550 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 24/45
2/2 [=====] - 0s 77ms/step - loss: 0.6888 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 25/45
2/2 [=====] - 0s 74ms/step - loss: 0.6879 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 26/45
2/2 [=====] - 0s 75ms/step - loss: 0.6882 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 27/45
2/2 [=====] - 0s 76ms/step - loss: 0.6870 - acc: 0.25
50 - recall: 0.0000e+00 - precision: 0.0000e+00
Epoch 28/45
2/2 [=====] - 0s 75ms/step - loss: 0.6862 - acc: 0.42
50 - recall: 0.3557 - precision: 0.7361
Epoch 29/45
2/2 [=====] - 0s 75ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 30/45
2/2 [=====] - 0s 76ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 31/45
2/2 [=====] - 0s 78ms/step - loss: 0.6860 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 32/45
2/2 [=====] - 0s 76ms/step - loss: 0.6862 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 33/45
2/2 [=====] - 0s 82ms/step - loss: 0.6860 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 34/45
2/2 [=====] - 0s 79ms/step - loss: 0.6860 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 35/45
2/2 [=====] - 0s 144ms/step - loss: 0.6860 - acc: 0.7
450 - recall: 1.0000 - precision: 0.7450
Epoch 36/45
2/2 [=====] - 0s 100ms/step - loss: 0.6860 - acc: 0.7
450 - recall: 1.0000 - precision: 0.7450
Epoch 37/45
2/2 [=====] - 0s 84ms/step - loss: 0.6860 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 38/45
2/2 [=====] - 0s 84ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 39/45
2/2 [=====] - 0s 85ms/step - loss: 0.6866 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 40/45
2/2 [=====] - 0s 87ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 41/45
```

```
2/2 [=====] - 0s 88ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 42/45
2/2 [=====] - 0s 92ms/step - loss: 0.6860 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 43/45
2/2 [=====] - 0s 94ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 44/45
2/2 [=====] - 0s 95ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
Epoch 45/45
2/2 [=====] - 0s 97ms/step - loss: 0.6859 - acc: 0.74
50 - recall: 1.0000 - precision: 0.7450
2023-03-31 17:09:28.589673: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 0s 64ms/step
7/7 [=====] - 0s 46ms/step
Epoch 1/45
2023-03-31 17:09:29.869352: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```
3/3 [=====] - 3s 877ms/step - loss: 0.6966 - acc: 0.6  
000 - recall: 0.7014 - precision: 0.7416  
Epoch 2/45  
3/3 [=====] - 1s 223ms/step - loss: 0.6913 - acc: 0.3  
067 - recall: 0.0588 - precision: 1.0000  
Epoch 3/45  
3/3 [=====] - 1s 303ms/step - loss: 0.6905 - acc: 0.3  
100 - recall: 0.0905 - precision: 0.7692  
Epoch 4/45  
3/3 [=====] - 1s 191ms/step - loss: 0.6875 - acc: 0.3  
100 - recall: 0.1041 - precision: 0.7188  
Epoch 5/45  
3/3 [=====] - 1s 196ms/step - loss: 0.6776 - acc: 0.4  
933 - recall: 0.3846 - precision: 0.8416  
Epoch 6/45  
3/3 [=====] - 0s 140ms/step - loss: 0.6476 - acc: 0.7  
100 - recall: 0.6968 - precision: 0.8851  
Epoch 7/45  
3/3 [=====] - 0s 145ms/step - loss: 0.5682 - acc: 0.7  
500 - recall: 0.7421 - precision: 0.9011  
Epoch 8/45  
3/3 [=====] - 1s 143ms/step - loss: 0.5741 - acc: 0.6  
733 - recall: 0.6154 - precision: 0.9128  
Epoch 9/45  
3/3 [=====] - 1s 192ms/step - loss: 0.5571 - acc: 0.8  
100 - recall: 0.8371 - precision: 0.8981  
Epoch 10/45  
3/3 [=====] - 0s 114ms/step - loss: 0.5119 - acc: 0.8  
000 - recall: 0.7964 - precision: 0.9215  
Epoch 11/45  
3/3 [=====] - 0s 89ms/step - loss: 0.4690 - acc: 0.76  
67 - recall: 0.7330 - precision: 0.9364  
Epoch 12/45  
3/3 [=====] - 1s 176ms/step - loss: 0.3970 - acc: 0.8  
033 - recall: 0.7647 - precision: 0.9602  
Epoch 13/45  
3/3 [=====] - 0s 88ms/step - loss: 0.3750 - acc: 0.80  
33 - recall: 0.7511 - precision: 0.9765  
Epoch 14/45  
3/3 [=====] - 0s 135ms/step - loss: 0.3363 - acc: 0.8  
000 - recall: 0.7466 - precision: 0.9763  
Epoch 15/45  
3/3 [=====] - 0s 89ms/step - loss: 0.3100 - acc: 0.87  
33 - recall: 0.8597 - precision: 0.9645  
Epoch 16/45  
3/3 [=====] - 0s 128ms/step - loss: 0.3132 - acc: 0.8  
300 - recall: 0.7738 - precision: 0.9942  
Epoch 17/45  
3/3 [=====] - 0s 131ms/step - loss: 0.2798 - acc: 0.9  
033 - recall: 0.8959 - precision: 0.9706  
Epoch 18/45  
3/3 [=====] - 0s 85ms/step - loss: 0.2700 - acc: 0.85  
00 - recall: 0.7964 - precision: 1.0000  
Epoch 19/45  
3/3 [=====] - 0s 119ms/step - loss: 0.2291 - acc: 0.8  
933 - recall: 0.8688 - precision: 0.9846  
Epoch 20/45  
3/3 [=====] - 0s 86ms/step - loss: 0.2017 - acc: 0.92  
00 - recall: 0.9095 - precision: 0.9805  
Epoch 21/45
```

```
3/3 [=====] - 1s 231ms/step - loss: 0.2659 - acc: 0.8  
633 - recall: 0.8281 - precision: 0.9839  
Epoch 22/45  
3/3 [=====] - 0s 92ms/step - loss: 0.1747 - acc: 0.91  
67 - recall: 0.9050 - precision: 0.9804  
Epoch 23/45  
3/3 [=====] - 0s 98ms/step - loss: 0.1755 - acc: 0.90  
167 - recall: 0.8824 - precision: 0.9898  
Epoch 24/45  
3/3 [=====] - 0s 107ms/step - loss: 0.1504 - acc: 0.9  
167 - recall: 0.8914 - precision: 0.9949  
Epoch 25/45  
3/3 [=====] - 0s 105ms/step - loss: 0.0986 - acc: 0.9  
600 - recall: 0.9502 - precision: 0.9953  
Epoch 26/45  
3/3 [=====] - 0s 104ms/step - loss: 0.1261 - acc: 0.9  
600 - recall: 0.9683 - precision: 0.9772  
Epoch 27/45  
3/3 [=====] - 0s 102ms/step - loss: 0.0913 - acc: 0.9  
500 - recall: 0.9321 - precision: 1.0000  
Epoch 28/45  
3/3 [=====] - 1s 91ms/step - loss: 0.0870 - acc: 0.96  
67 - recall: 0.9593 - precision: 0.9953  
Epoch 29/45  
3/3 [=====] - 0s 130ms/step - loss: 0.0500 - acc: 0.9  
867 - recall: 0.9864 - precision: 0.9954  
Epoch 30/45  
3/3 [=====] - 0s 94ms/step - loss: 0.0383 - acc: 0.97  
67 - recall: 0.9729 - precision: 0.9954  
Epoch 31/45  
3/3 [=====] - 0s 104ms/step - loss: 0.0486 - acc: 0.9  
867 - recall: 0.9819 - precision: 1.0000  
Epoch 32/45  
3/3 [=====] - 0s 106ms/step - loss: 0.1496 - acc: 0.9  
167 - recall: 0.8869 - precision: 1.0000  
Epoch 33/45  
3/3 [=====] - 0s 104ms/step - loss: 0.1357 - acc: 0.9  
567 - recall: 0.9955 - precision: 0.9483  
Epoch 34/45  
3/3 [=====] - 0s 102ms/step - loss: 0.2215 - acc: 0.9  
067 - recall: 0.8778 - precision: 0.9949  
Epoch 35/45  
3/3 [=====] - 0s 101ms/step - loss: 0.1485 - acc: 0.9  
200 - recall: 0.8959 - precision: 0.9950  
Epoch 36/45  
3/3 [=====] - 0s 100ms/step - loss: 0.1015 - acc: 0.9  
633 - recall: 0.9502 - precision: 1.0000  
Epoch 37/45  
3/3 [=====] - 0s 142ms/step - loss: 0.0867 - acc: 0.9  
733 - recall: 0.9638 - precision: 1.0000  
Epoch 38/45  
3/3 [=====] - 0s 95ms/step - loss: 0.0612 - acc: 0.99  
00 - recall: 0.9910 - precision: 0.9955  
Epoch 39/45  
3/3 [=====] - 0s 100ms/step - loss: 0.0308 - acc: 1.0  
000 - recall: 1.0000 - precision: 1.0000  
Epoch 40/45  
3/3 [=====] - 0s 105ms/step - loss: 0.0163 - acc: 0.9  
900 - recall: 0.9864 - precision: 1.0000  
Epoch 41/45
```

```
3/3 [=====] - 0s 133ms/step - loss: 0.0139 - acc: 0.9
967 - recall: 0.9955 - precision: 1.0000
Epoch 42/45
3/3 [=====] - 0s 91ms/step - loss: 0.0018 - acc: 1.00
00 - recall: 1.0000 - precision: 1.0000
Epoch 43/45
3/3 [=====] - 0s 105ms/step - loss: 0.0181 - acc: 0.9
933 - recall: 0.9955 - precision: 0.9955
Epoch 44/45
3/3 [=====] - 0s 102ms/step - loss: 0.0134 - acc: 0.9
900 - recall: 0.9864 - precision: 1.0000
Epoch 45/45
3/3 [=====] - 0s 100ms/step - loss: 0.0185 - acc: 0.9
967 - recall: 1.0000 - precision: 0.9955
```

In [88]:

```
best_rate = gs_3.best_params_["learning_rate"]
print("Best: %f using %s" % (gs_3.best_score_, gs_3.best_params_))

Best: 0.883333 using {'learning_rate': 0.001}
```

This .001 is the defult learning rate, nothing modifications and additons will be done.  
The results will be same as Model Iteration 5.

---

## Transfer Learning

Using pretrained models from another problem and using them on another problem

- **VGG19 Pre-Trained Model**  
This method has faster training speed, fewer training samples per time, and higher accuracy
- **Feature Extraction without augmented data**
- **Feature Extraction with augmented data**
- **Fine Tuning**

In [89]:

```
#The imagenet weights are downloaded from online
cnn_base = VGG19(weights="imagenet",
                  include_top=False,
                  input_shape=(224, 224, 3))
```

In [90]:

```
#Creating the model layer architecture including cnn_base (19 layers)
model_8 = models.Sequential()
model_8.add(cnn_base)
model_8.add(layers.Flatten())
model_8.add(layers.Dense(132, activation='relu'))
model_8.add(layers.Dense(1, activation='sigmoid'))
```

In [91]:

```
cnn_base.summary()
```

**Model: "vgg19"**

Layer (type)	Output Shape	Param #
<hr/>		
input_1 (InputLayer)	[ (None, 224, 224, 3) ]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv4 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv4 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv4 (Conv2D)	(None, 14, 14, 512)	2359808
block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0
<hr/>		
Total params:	20,024,384	
Trainable params:	20,024,384	
Non-trainable params:	0	

In [92]: `model_8.summary()`

```
Model: "sequential_104"
```

Layer (type)	Output Shape	Param #
vgg19 (Functional)	(None, 7, 7, 512)	20024384
flatten_104 (Flatten)	(None, 25088)	0
dense_259 (Dense)	(None, 132)	3311748
dense_260 (Dense)	(None, 1)	133
<hr/>		
<b>Total params: 23,336,265</b>		
<b>Trainable params: 23,336,265</b>		
<b>Non-trainable params: 0</b>		

```
In [93]: # You can check whether a layer is trainable (or alter its setting) through the
for layer in model_8.layers:
    print(layer.name, layer.trainable)

# Similarly, you can check how many trainable weights are in the model
print(len(model_8.trainable_weights))
```

vgg19 True  
 flatten\_104 True  
 dense\_259 True  
 dense\_260 True  
 36

```
In [94]: # Freeze the model
cnn_base.trainable = False
```

```
In [95]: # You can check whether a layer is trainable (or alter its setting) through the
for layer in model_8.layers:
    print(layer.name, layer.trainable)

# Similarly, you can check how many trainable weights are in the model
print(len(model_8.trainable_weights))
```

vgg19 False  
 flatten\_104 True  
 dense\_259 True  
 dense\_260 True  
 4

```
In [96]: model_8.compile(loss='binary_crossentropy',
                      optimizer= "adam",
                      metrics=[ "acc", "Recall", "Precision"]
                     )
```

```
In [97]: #Copying model before trained for Augmented Data Fitting
model_9 = model_8
```

Created sepearate data generator to allow variation from the regular training batch.  
 The Kernel frequently dies with too high of a training size number

```
In [98]: #Using a generator for the images to work with.  
trans_gen = train_datagen.flow_from_directory(train_directory,  
                                              target_size = (224, 224),  
                                              batch_size=300,  
                                              classes = [ "NORMAL", "PNEUMONIA"],  
                                              class_mode = 'binary',  
                                              seed = 42)
```

Found 4509 images belonging to 2 classes.

```
In [99]: X_trans, y_trans = next(trans_gen)
```

```
In [100]: #Adding early stopping  
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=2)  
#Calculating class weights for imbalance  
  
class_weights = calc_weight(y_trans)  
class_weights
```

```
Out[100]: {0: 1.8987341772151898, 1: 0.6787330316742082}
```

```
In [101]: #Fitting with regular training data  
history8 = model_8.fit(trans_gen,  
                        epochs=90,  
                        verbose = 1,  
                        class_weight=class_weights,  
                        validation_data=val_gen,  
                        callbacks = es) #stopping early because of time resources
```

Epoch 1/90

```
2023-03-31 17:09:55.729140: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.  
16/16 [=====] - ETA: 0s - loss: 0.7672 - acc: 0.7607  
- recall: 0.7374 - precision: 0.9250
```

```
2023-03-31 17:10:24.693549: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

```

16/16 [=====] - 39s 2s/step - loss: 0.7672 - acc: 0.7
607 - recall: 0.7374 - precision: 0.9250 - val_loss: 0.2375 - val_acc: 0.8976
- val_recall: 0.8899 - val_precision: 0.9695
Epoch 2/90
16/16 [=====] - 35s 2s/step - loss: 0.1819 - acc: 0.9
233 - recall: 0.9154 - precision: 0.9799 - val_loss: 0.1982 - val_acc: 0.9129
- val_recall: 0.8993 - val_precision: 0.9817
Epoch 3/90
16/16 [=====] - 34s 2s/step - loss: 0.1322 - acc: 0.9
468 - recall: 0.9385 - precision: 0.9893 - val_loss: 0.1329 - val_acc: 0.9474
- val_recall: 0.9459 - val_precision: 0.9826
Epoch 4/90
16/16 [=====] - 34s 2s/step - loss: 0.1019 - acc: 0.9
654 - recall: 0.9618 - precision: 0.9914 - val_loss: 0.1298 - val_acc: 0.9530
- val_recall: 0.9422 - val_precision: 0.9941
Epoch 5/90
16/16 [=====] - 32s 2s/step - loss: 0.0996 - acc: 0.9
605 - recall: 0.9546 - precision: 0.9919 - val_loss: 0.0916 - val_acc: 0.9640
- val_recall: 0.9739 - val_precision: 0.9775
Epoch 6/90
16/16 [=====] - 32s 2s/step - loss: 0.0812 - acc: 0.9
712 - recall: 0.9689 - precision: 0.9920 - val_loss: 0.1156 - val_acc: 0.9571
- val_recall: 0.9478 - val_precision: 0.9941
Epoch 7/90
16/16 [=====] - 33s 2s/step - loss: 0.0738 - acc: 0.9
754 - recall: 0.9737 - precision: 0.9930 - val_loss: 0.1084 - val_acc: 0.9585
- val_recall: 0.9478 - val_precision: 0.9961
Epoch 7: early stopping

```

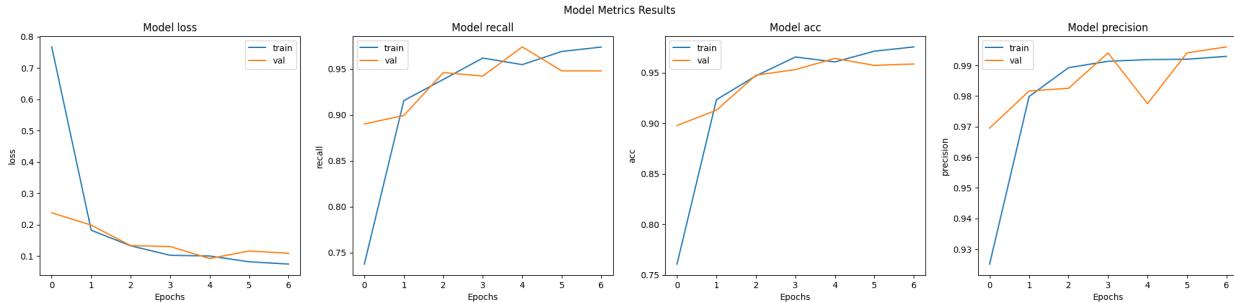
In [102...]:

```

print("Model 8 with augmented data :\n")
eval_metrics(history8)

```

Model 8 with augmented data :



In [103...]:

```

train_labels, train_predictions = predict_results(model_8, train_gen_aug)
val_labels, val_predictions = predict_results(model_8, val_gen)

```

```

2023-03-31 17:13:55.574641: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
4/4 [=====] - 2s 87ms/step
2023-03-31 17:13:57.800816: I tensorflow/core/grappler/optimizers/custom_graph
_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
1/1 [=====] - 1s 550ms/step

```

In [104...]:

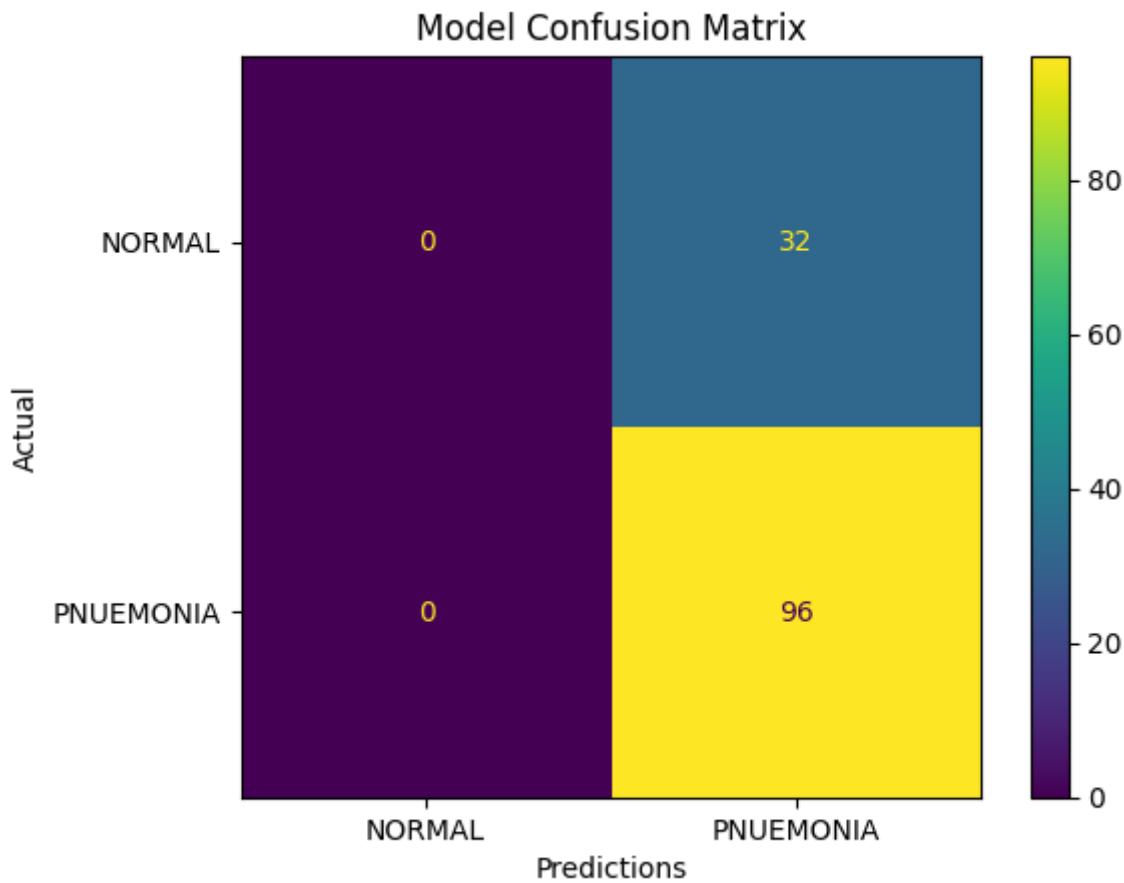
```

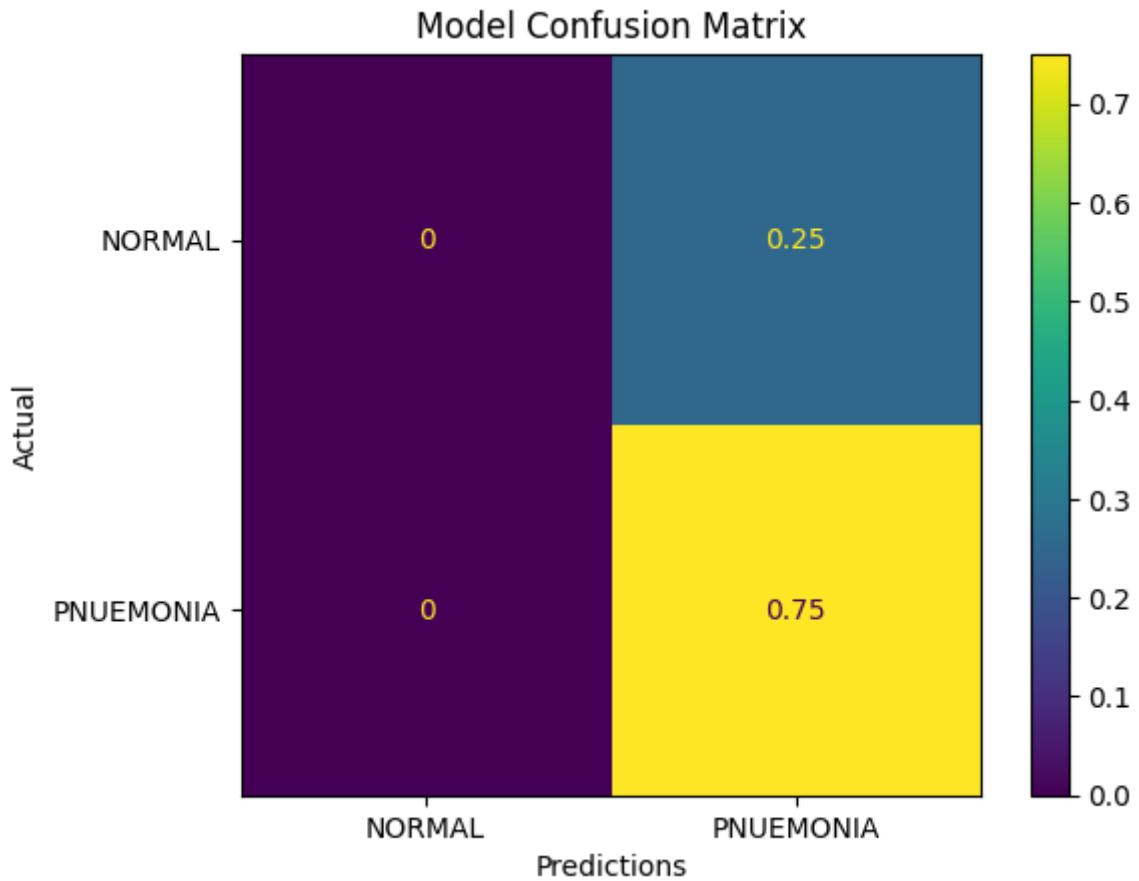
#printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")

```

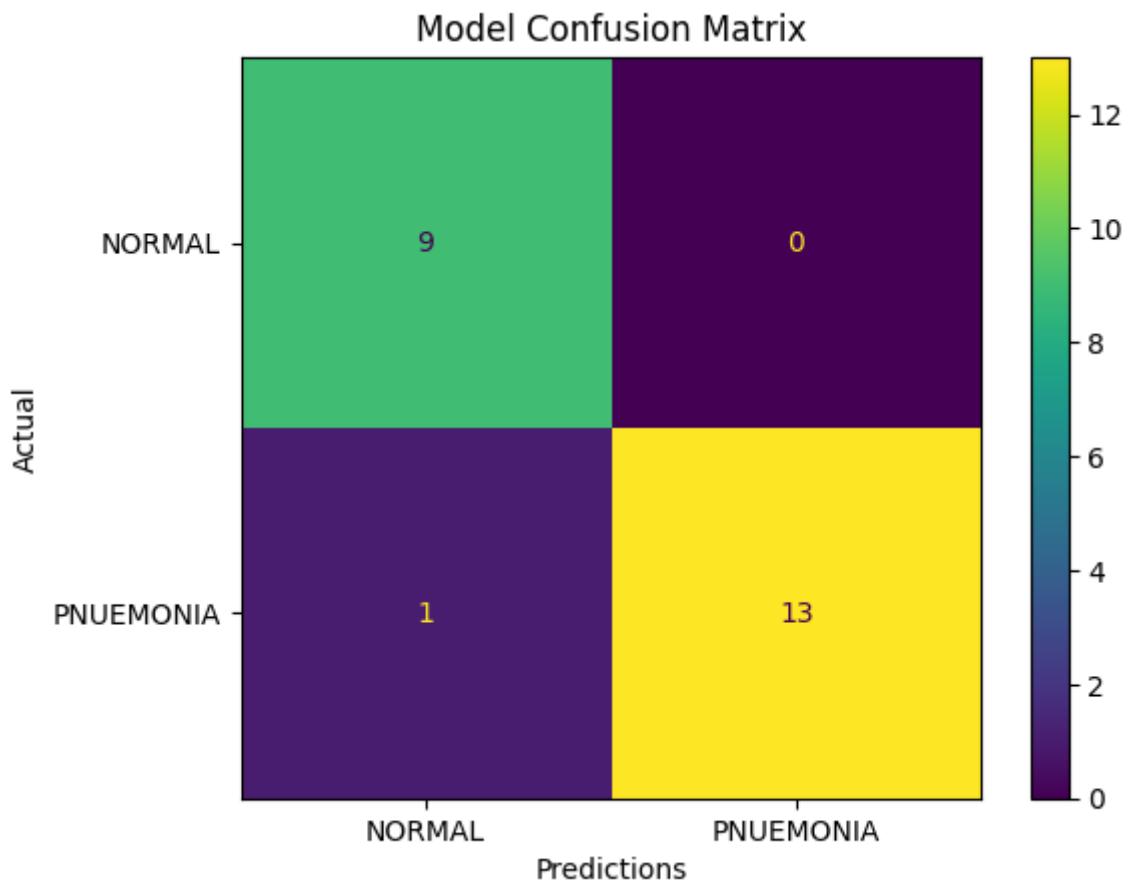
```
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

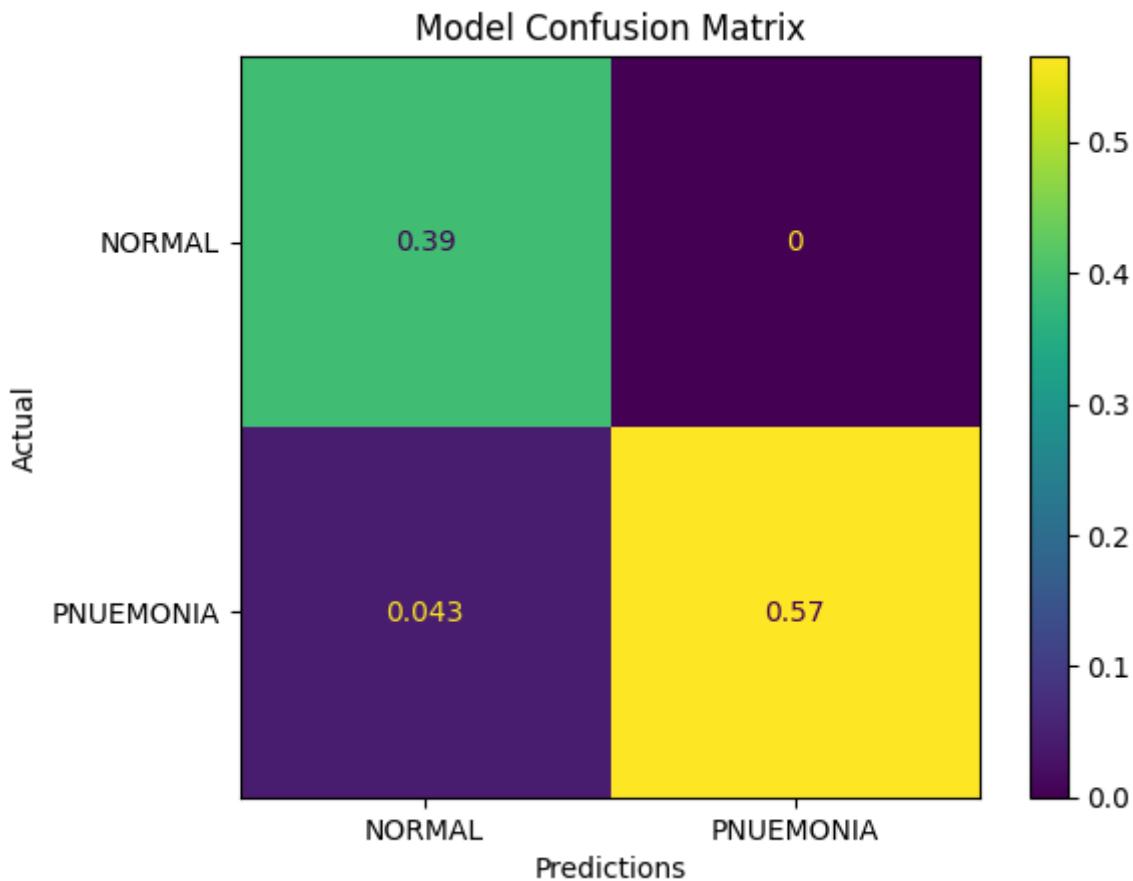
Training Confusion Matrices:





Validation Confusion Matrices:





```
In [105]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen_aug,history8)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.000	0.000	0.000	32
1.0	0.750	1.000	0.857	96
accuracy			0.750	128
macro avg	0.375	0.500	0.429	128
weighted avg	0.562	0.750	0.643	128

```
36/36 [=====] - 43s 1s/step - loss: 1.2226 - acc: 0.7
423 - recall: 1.0000 - precision: 0.7423
Loss: 1.2226
```

```
In [106]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history8)
```

**Validation Classification Report:**

	precision	recall	f1-score	support
0.0	0.900	1.000	0.947	9
1.0	1.000	0.929	0.963	14
accuracy			0.957	23
macro avg	0.950	0.964	0.955	23
weighted avg	0.961	0.957	0.957	23

```
8/8 [=====] - 5s 446ms/step - loss: 0.1084 - acc: 0.9
585 - recall: 0.9478 - precision: 0.9961
Loss: 0.1084
```

## Transfer Model 10 Evaluation

The model is one of top models. The validation data performed better than the training data score. There were no wrong predictions on the validation data and the loss is much less than the training set.

---

## Transfer Model 9 w/ Augmented Data

In [107...]

```
#Fitting with augmented data
history9 = model_9.fit(train_gen_aug,batch_size=50,
                       epochs=90,
                       verbose = 1,
                       class_weight=class_weights,
                       validation_data=val_gen,
                       callbacks = es) #stopping early because of time resources
```

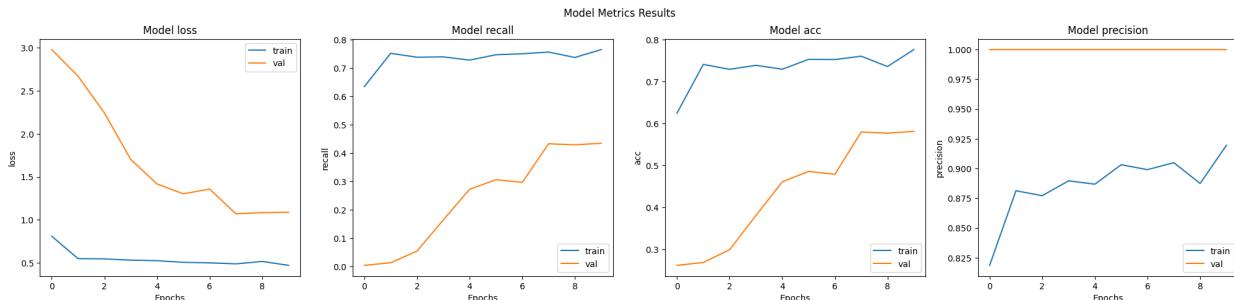
```

Epoch 1/90
36/36 [=====] - 46s 1s/step - loss: 0.8093 - acc: 0.6
245 - recall: 0.6349 - precision: 0.8186 - val_loss: 2.9782 - val_acc: 0.2614
- val_recall: 0.0037 - val_precision: 1.0000
Epoch 2/90
36/36 [=====] - 45s 1s/step - loss: 0.5490 - acc: 0.7
407 - recall: 0.7520 - precision: 0.8813 - val_loss: 2.6691 - val_acc: 0.2683
- val_recall: 0.0131 - val_precision: 1.0000
Epoch 3/90
36/36 [=====] - 45s 1s/step - loss: 0.5463 - acc: 0.7
290 - recall: 0.7383 - precision: 0.8772 - val_loss: 2.2425 - val_acc: 0.2988
- val_recall: 0.0541 - val_precision: 1.0000
Epoch 4/90
36/36 [=====] - 45s 1s/step - loss: 0.5315 - acc: 0.7
385 - recall: 0.7395 - precision: 0.8896 - val_loss: 1.7023 - val_acc: 0.3804
- val_recall: 0.1642 - val_precision: 1.0000
Epoch 5/90
36/36 [=====] - 45s 1s/step - loss: 0.5251 - acc: 0.7
292 - recall: 0.7281 - precision: 0.8868 - val_loss: 1.4166 - val_acc: 0.4606
- val_recall: 0.2724 - val_precision: 1.0000
Epoch 6/90
36/36 [=====] - 46s 1s/step - loss: 0.5062 - acc: 0.7
527 - recall: 0.7469 - precision: 0.9032 - val_loss: 1.3028 - val_acc: 0.4855
- val_recall: 0.3060 - val_precision: 1.0000
Epoch 7/90
36/36 [=====] - 45s 1s/step - loss: 0.5002 - acc: 0.7
523 - recall: 0.7505 - precision: 0.8991 - val_loss: 1.3572 - val_acc: 0.4786
- val_recall: 0.2966 - val_precision: 1.0000
Epoch 8/90
36/36 [=====] - 45s 1s/step - loss: 0.4880 - acc: 0.7
603 - recall: 0.7565 - precision: 0.9049 - val_loss: 1.0696 - val_acc: 0.5795
- val_recall: 0.4328 - val_precision: 1.0000
Epoch 9/90
36/36 [=====] - 46s 1s/step - loss: 0.5165 - acc: 0.7
356 - recall: 0.7374 - precision: 0.8875 - val_loss: 1.0832 - val_acc: 0.5768
- val_recall: 0.4291 - val_precision: 1.0000
Epoch 10/90
36/36 [=====] - 45s 1s/step - loss: 0.4708 - acc: 0.7
760 - recall: 0.7652 - precision: 0.9196 - val_loss: 1.0885 - val_acc: 0.5809
- val_recall: 0.4347 - val_precision: 1.0000
Epoch 10: early stopping

```

```
In [108...]: print("Model 9 w augmented data : \n")
eval_metrics(history9)
```

Model 9 w augmented data :



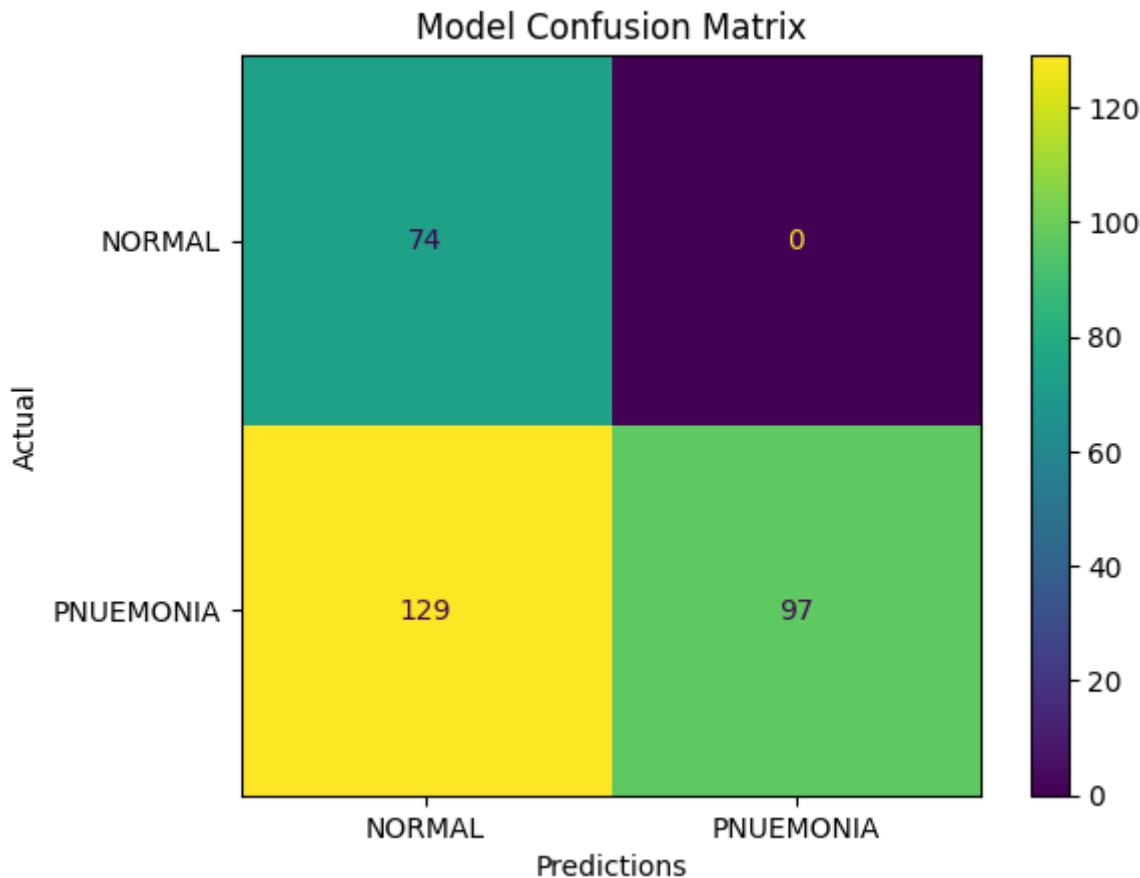
```
In [109...]: train_labels, train_predictions = predict_results(model_9, train_gen)
val_labels, val_predictions = predict_results(model_9, val_gen)
```

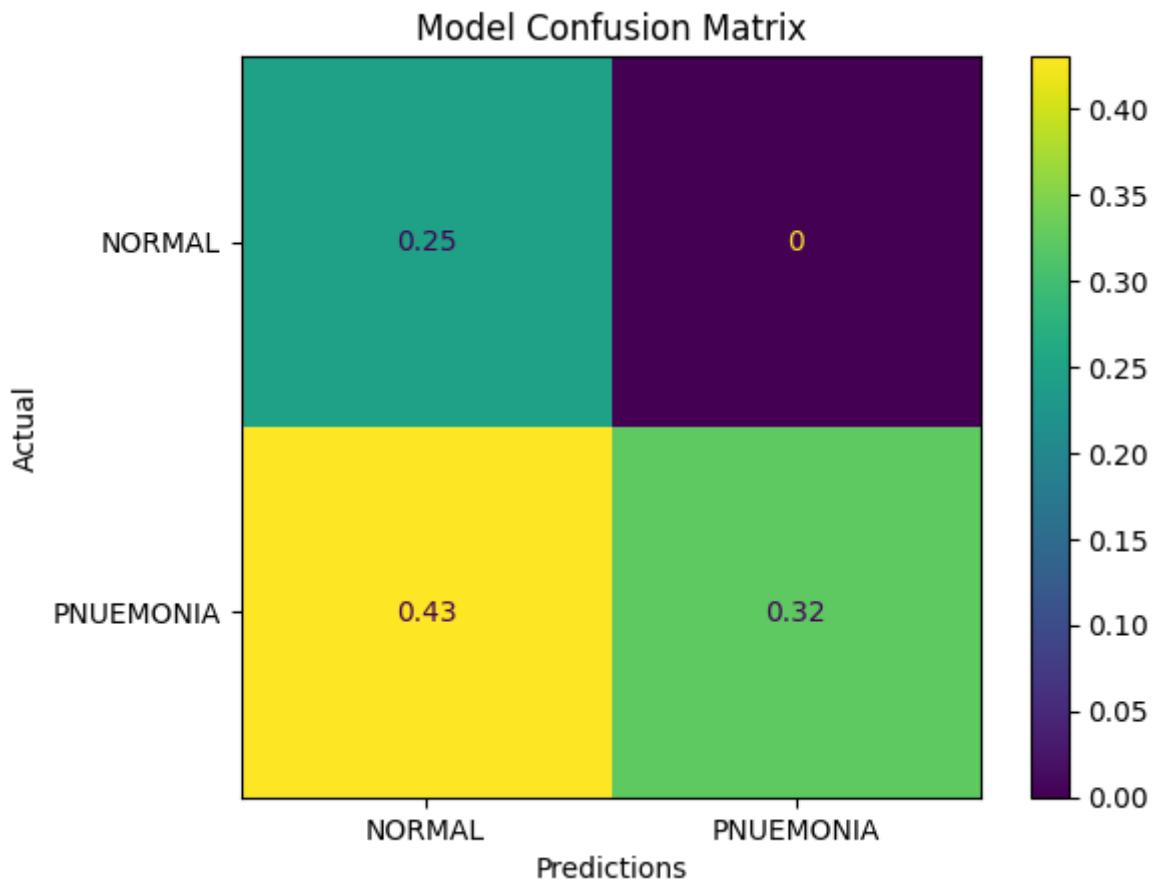
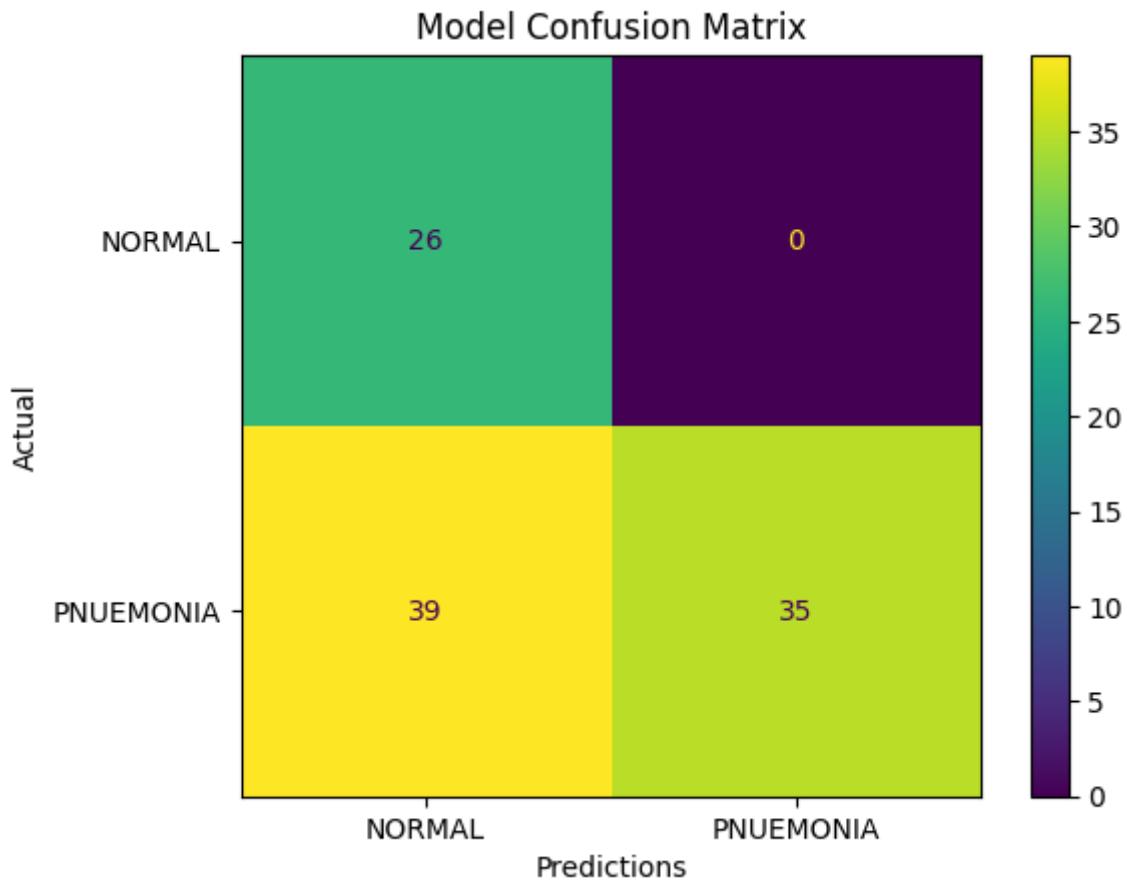
```
10/10 [=====] - 2s 182ms/step  
4/4 [=====] - 1s 250ms/step
```

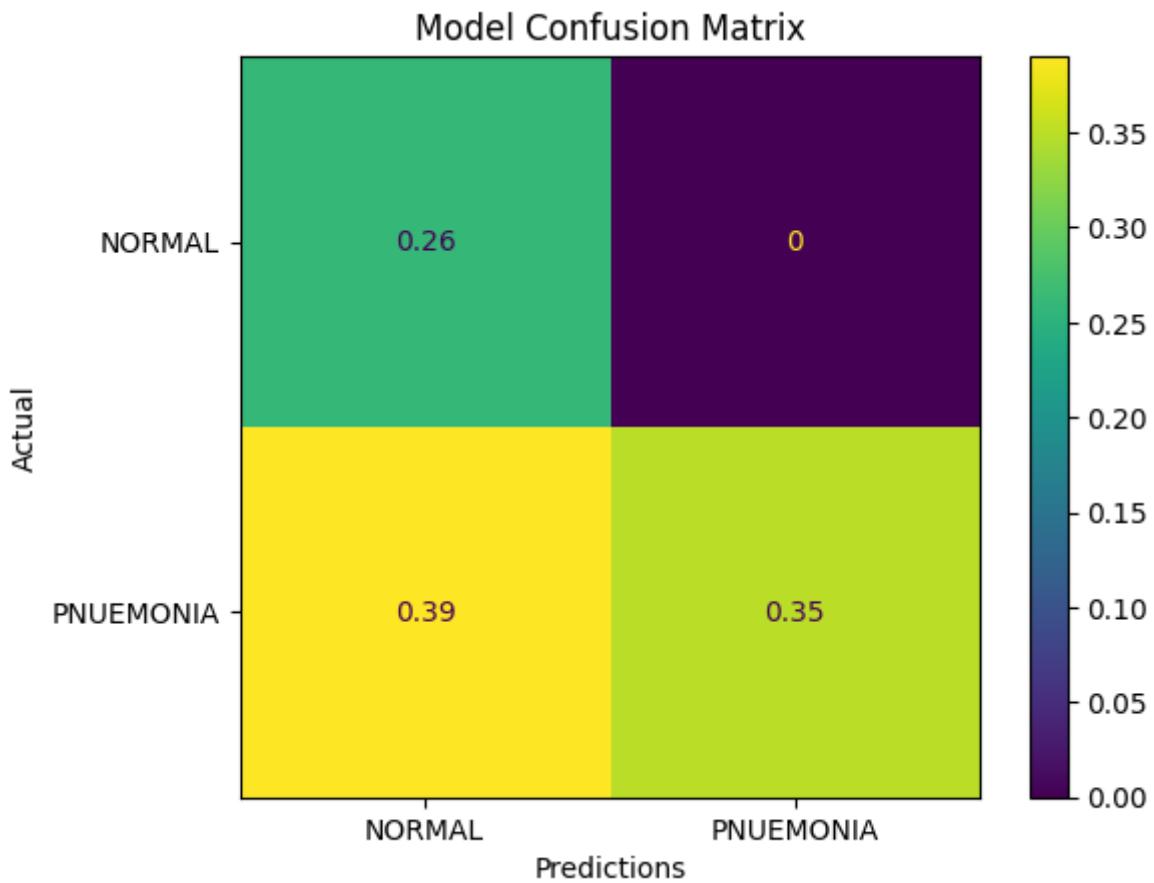
In [110...]

```
#Printing regular and normalized Confusion Matrices  
print("Training Confusion Matrices:\n")  
conf_matrix(train_labels,train_predictions, None)  
conf_matrix(train_labels,train_predictions, "all")  
print("Validation Confusion Matrices:\n")  
conf_matrix(val_labels, val_predictions, None)  
conf_matrix(val_labels, val_predictions, "all")
```

Training Confusion Matrices:



**Validation Confusion Matrices:**



```
In [111]: #Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history9)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.365	1.000	0.534	74
1.0	1.000	0.429	0.601	226
accuracy			0.570	300
macro avg	0.682	0.715	0.567	300
weighted avg	0.843	0.570	0.584	300

```
16/16 [=====] - 34s 2s/step - loss: 1.0444 - acc: 0.5
793 - recall: 0.4332 - precision: 1.0000
Loss: 1.0444
```

```
In [112]: #Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history9)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.400	1.000	0.571	26
1.0	1.000	0.473	0.642	74
<b>accuracy</b>			0.610	100
<b>macro avg</b>	0.700	0.736	0.607	100
<b>weighted avg</b>	0.844	0.610	0.624	100

```
8/8 [=====] - 6s 469ms/step - loss: 1.0885 - acc: 0.5  
809 - recall: 0.4347 - precision: 1.0000  
Loss: 1.0885
```

## Transfer Model 9 Evaluation

The Transfer VGG19 model with augmented data was the worst so far. For the validation data there were mostly FN and some TNs. Pneumonia was not detected.

Models trained on the augmented training data will not be used.

---

## Transfer Model 10 w/ Fine Tuning

Removing a dense layer from the pre trained model

The fine tuning model is using the original training size

```
In [113...]: #Copying the models to fine tune  
model_10 = model_8  
cnn_base_tuned = cnn_base
```

```
In [114...]: model_10.summary()
```

Model: "sequential\_104"

Layer (type)	Output Shape	Param #
vgg19 (Functional)	(None, 7, 7, 512)	20024384
flatten_104 (Flatten)	(None, 25088)	0
dense_259 (Dense)	(None, 132)	3311748
dense_260 (Dense)	(None, 1)	133
<hr/>		
Total params: 23,336,265		
Trainable params: 3,311,881		
Non-trainable params: 20,024,384		

In [115]: `cnn_base_tuned.trainable = True`

In [116]: `cnn_base_tuned.summary()`

Model: "vgg19"

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	[ (None, 224, 224, 3) ]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv4 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv4 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv4 (Conv2D)	(None, 14, 14, 512)	2359808
block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0

Total params: 20,024,384  
 Trainable params: 20,024,384  
 Non-trainable params: 0

### Removing one of the last layers from the pretrained model

In [117...]

```
cnn_base_tuned.trainable = True
set_trainable = False
for layer in cnn_base_tuned.layers:
```

```
if layer.name == 'block5_conv1':
    set_trainable = True
if set_trainable:
    layer.trainable = True
else:
    layer.trainable = False
```

```
In [118]: model_10.compile(loss='binary_crossentropy',
                        optimizer= "adam",
                        metrics=[ "acc", "Recall", "Precision" ]
                      )
```

```
In [119]: history10 = model_10.fit(train_gen,batch_size=128,
                                 epochs=90,
                                 verbose = 1,
                                 class_weight=class_weights,
                                 validation_data=val_gen,
                                 callbacks = es) #stopping early because of time resources
```

Epoch 1/90

```
2023-03-31 17:23:10.732521: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
16/16 [=====] - ETA: 0s - loss: 5.4487 - acc: 0.5345
- recall: 0.5653 - precision: 0.7461
2023-03-31 17:23:54.356184: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
```

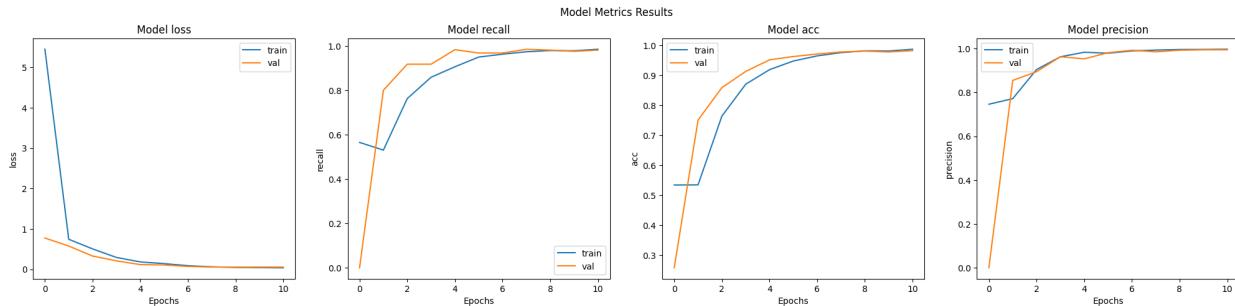
```

16/16 [=====] - 50s 3s/step - loss: 5.4487 - acc: 0.5
345 - recall: 0.5653 - precision: 0.7461 - val_loss: 0.7758 - val_acc: 0.2586
- val_recall: 0.0000e+00 - val_precision: 0.0000e+00
Epoch 2/90
16/16 [=====] - 37s 2s/step - loss: 0.7446 - acc: 0.5
349 - recall: 0.5306 - precision: 0.7715 - val_loss: 0.5770 - val_acc: 0.7510
- val_recall: 0.8004 - val_precision: 0.8546
Epoch 3/90
16/16 [=====] - 36s 2s/step - loss: 0.5063 - acc: 0.7
640 - recall: 0.7628 - precision: 0.9044 - val_loss: 0.3294 - val_acc: 0.8589
- val_recall: 0.9179 - val_precision: 0.8945
Epoch 4/90
16/16 [=====] - 36s 2s/step - loss: 0.2949 - acc: 0.8
705 - recall: 0.8590 - precision: 0.9625 - val_loss: 0.2110 - val_acc: 0.9129
- val_recall: 0.9179 - val_precision: 0.9628
Epoch 5/90
16/16 [=====] - 36s 2s/step - loss: 0.1840 - acc: 0.9
188 - recall: 0.9062 - precision: 0.9831 - val_loss: 0.1175 - val_acc: 0.9516
- val_recall: 0.9832 - val_precision: 0.9530
Epoch 6/90
16/16 [=====] - 35s 2s/step - loss: 0.1423 - acc: 0.9
477 - recall: 0.9501 - precision: 0.9788 - val_loss: 0.1088 - val_acc: 0.9627
- val_recall: 0.9683 - val_precision: 0.9811
Epoch 7/90
16/16 [=====] - 35s 2s/step - loss: 0.0908 - acc: 0.9
647 - recall: 0.9630 - precision: 0.9893 - val_loss: 0.0718 - val_acc: 0.9710
- val_recall: 0.9683 - val_precision: 0.9924
Epoch 8/90
16/16 [=====] - 35s 2s/step - loss: 0.0625 - acc: 0.9
756 - recall: 0.9740 - precision: 0.9930 - val_loss: 0.0584 - val_acc: 0.9779
- val_recall: 0.9851 - val_precision: 0.9851
Epoch 9/90
16/16 [=====] - 35s 2s/step - loss: 0.0481 - acc: 0.9
816 - recall: 0.9794 - precision: 0.9957 - val_loss: 0.0537 - val_acc: 0.9806
- val_recall: 0.9813 - val_precision: 0.9925
Epoch 10/90
16/16 [=====] - 36s 2s/step - loss: 0.0439 - acc: 0.9
809 - recall: 0.9782 - precision: 0.9960 - val_loss: 0.0567 - val_acc: 0.9779
- val_recall: 0.9757 - val_precision: 0.9943
Epoch 11/90
16/16 [=====] - 41s 2s/step - loss: 0.0385 - acc: 0.9
869 - recall: 0.9854 - precision: 0.9970 - val_loss: 0.0555 - val_acc: 0.9820
- val_recall: 0.9813 - val_precision: 0.9943
Epoch 11: early stopping

```

```
In [120]: print("Model 9 w/o augmented data :\n")
eval_metrics(history10)
```

Model 9 w/o augmented data :

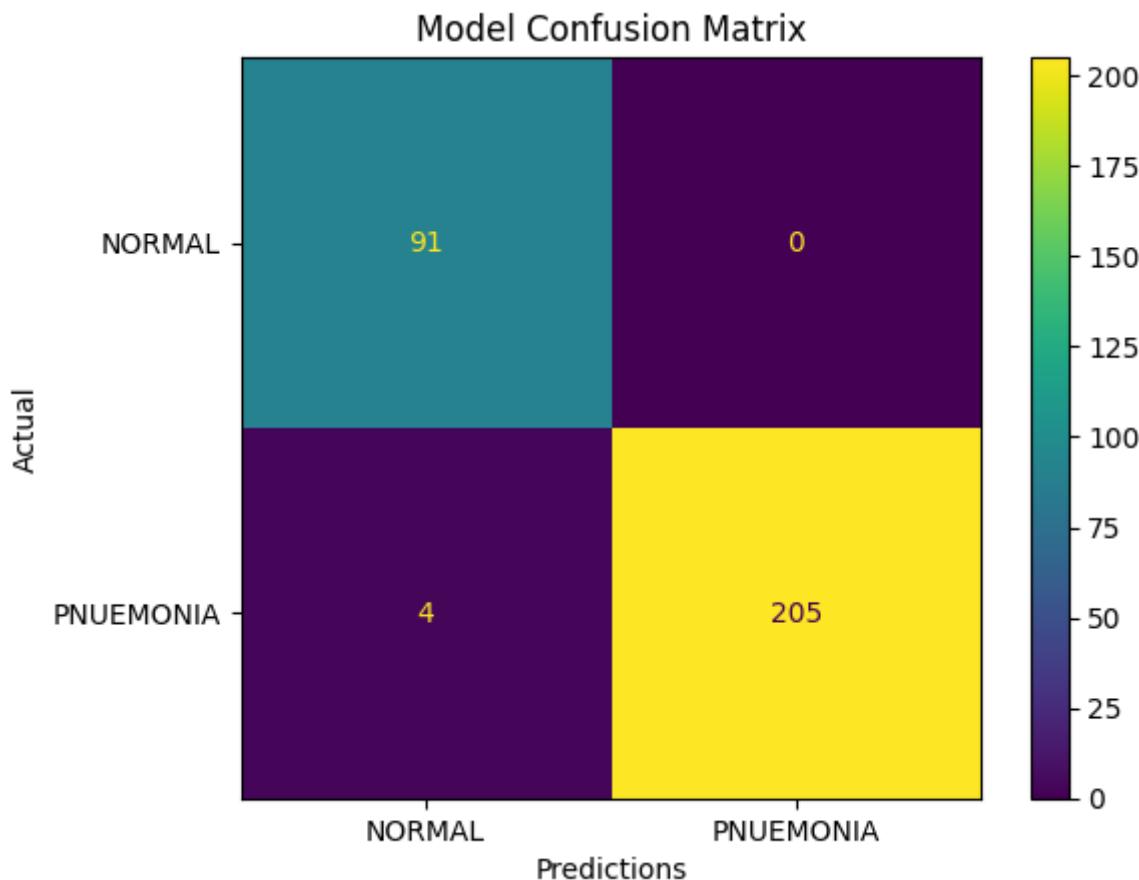


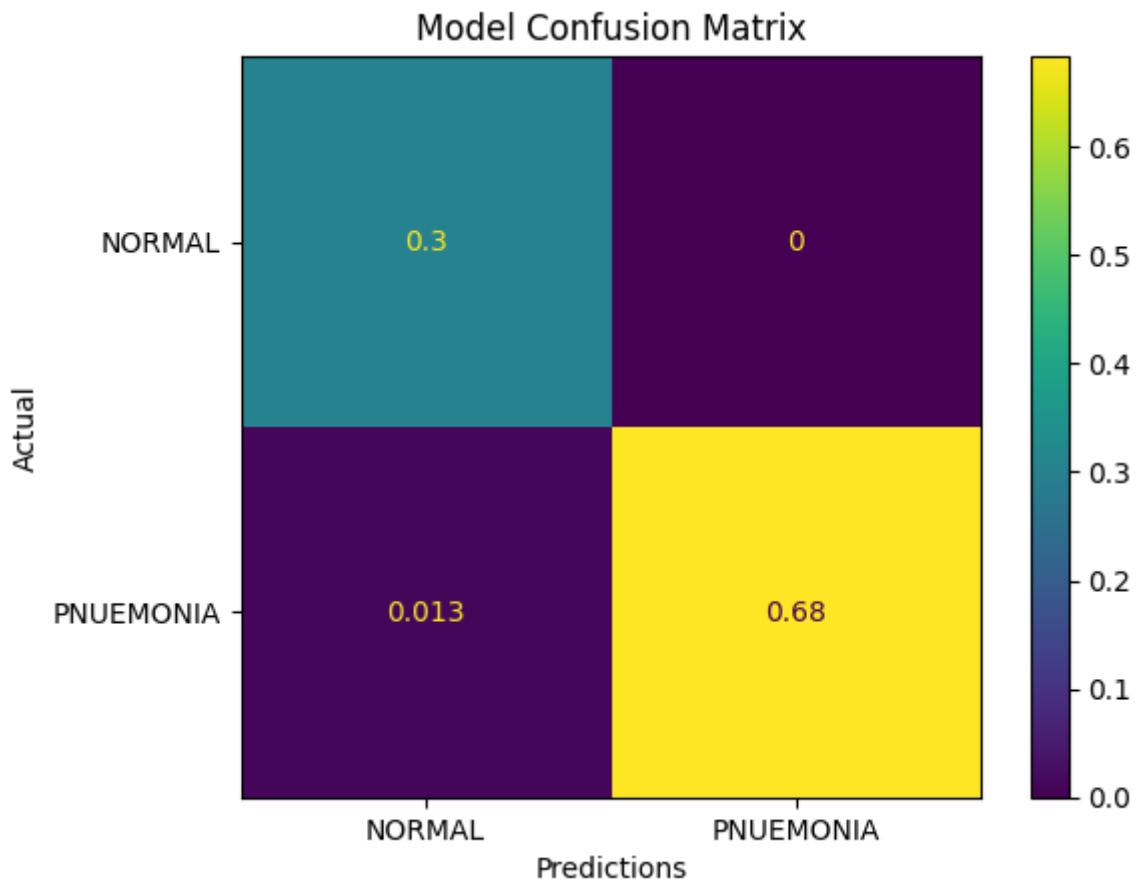
```
In [121... train_labels, train_predictions = predict_results(model_10,train_gen)
val_labels, val_predictions = predict_results(model_10,val_gen)
```

```
2023-03-31 17:30:04.429722: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:113] Plugin optimizer for device_type GPU is enabled.
10/10 [=====] - 2s 151ms/step
4/4 [=====] - 1s 345ms/step
```

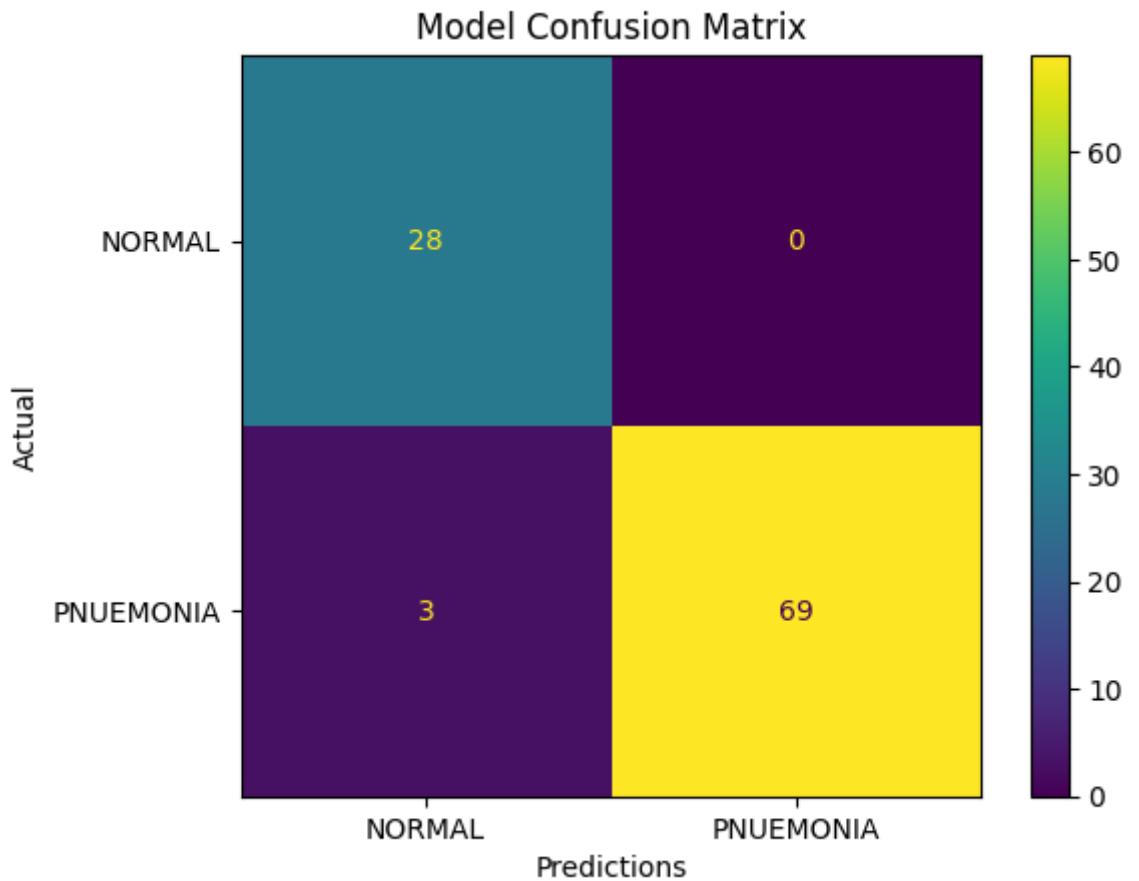
```
In [122... #Printing regular and normalized Confusion Matrices
print("Training Confusion Matrices:\n")
conf_matrix(train_labels,train_predictions, None)
conf_matrix(train_labels,train_predictions, "all")
print("Validation Confusion Matrices:\n")
conf_matrix(val_labels, val_predictions, None)
conf_matrix(val_labels, val_predictions, "all")
```

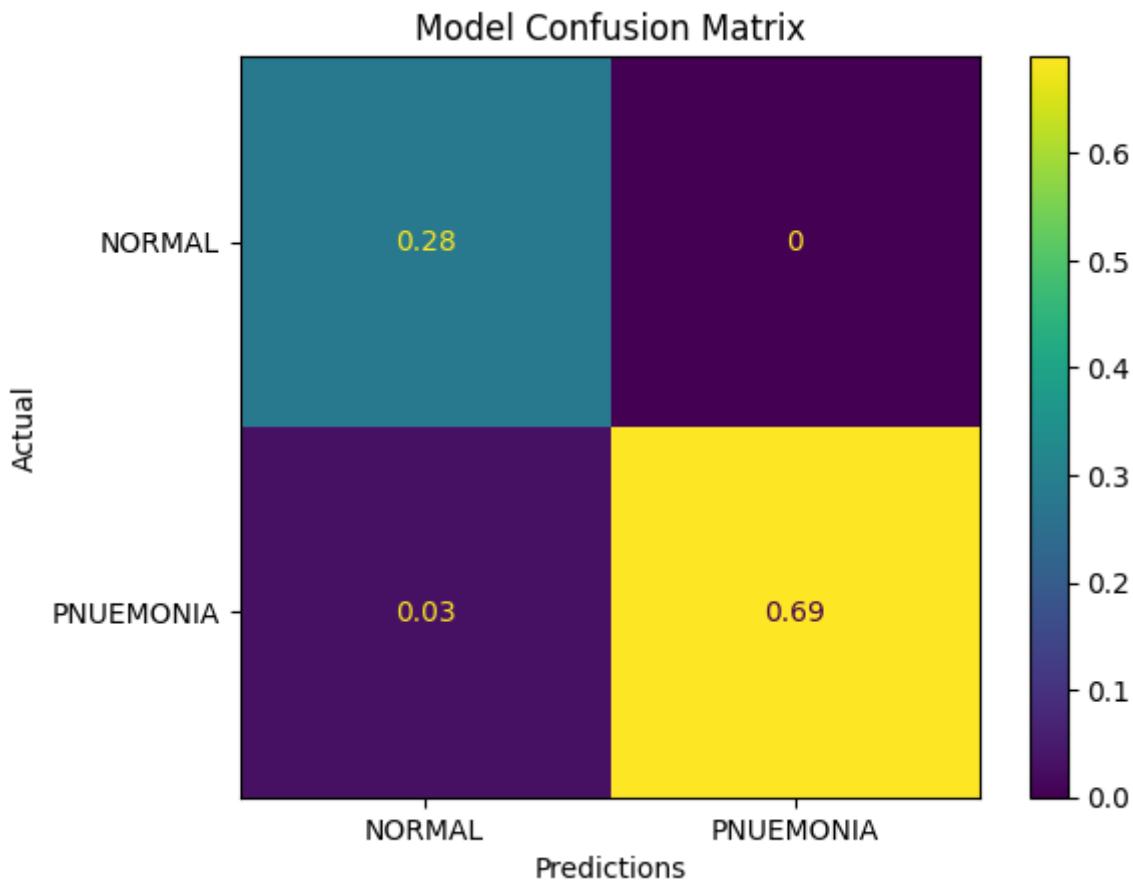
Training Confusion Matrices:





Validation Confusion Matrices:





In [123...]

```
#Training Classification Report
print("Training Classificaiton Report:\n")
eval_report(train_labels,train_predictions,train_gen,history10)
```

Training Classificaiton Report:

	precision	recall	f1-score	support
0.0	0.958	1.000	0.978	91
1.0	1.000	0.981	0.990	209
accuracy			0.987	300
macro avg	0.979	0.990	0.984	300
weighted avg	0.987	0.987	0.987	300

```
16/16 [=====] - 30s 2s/step - loss: 0.0403 - acc: 0.9
876 - recall: 0.9842 - precision: 0.9991
Loss: 0.0403
```

In [124...]

```
#Training Classification Report
print("Validation Classificaiton Report:\n")
eval_report(val_labels,val_predictions,val_gen,history10)
```

**Validation Classification Report:**

	<b>precision</b>	<b>recall</b>	<b>f1-score</b>	<b>support</b>
0.0	0.903	1.000	0.949	28
1.0	1.000	0.958	0.979	72
<b>accuracy</b>			0.970	100
<b>macro avg</b>	0.952	0.979	0.964	100
<b>weighted avg</b>	0.973	0.970	0.970	100

```
8/8 [=====] - 5s 462ms/step - loss: 0.0555 - acc: 0.9
820 - recall: 0.9813 - precision: 0.9943
Loss: 0.0555
```

## Transfer Model 10 Evaluation

The fine tuning effort of the model made it drastically worse. The Loss of both training and validation was extremely high. The recall and f1score on the Normal data is a 0. This model will not work.

---

## Final Model

### Best Model

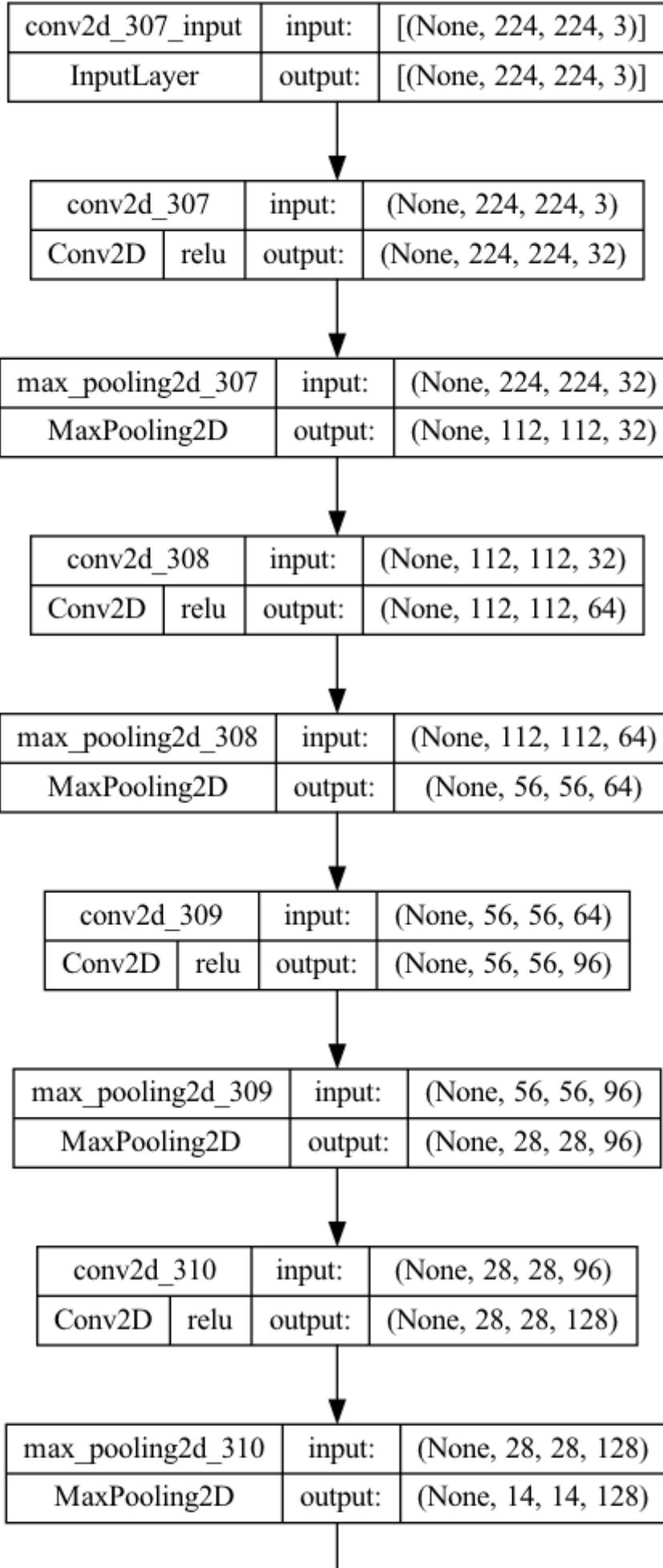
The top 3 models listed all had metrics list around 1, the main differences are the loss metrics for the validation data. Based on this information, Model 5 will be chosen

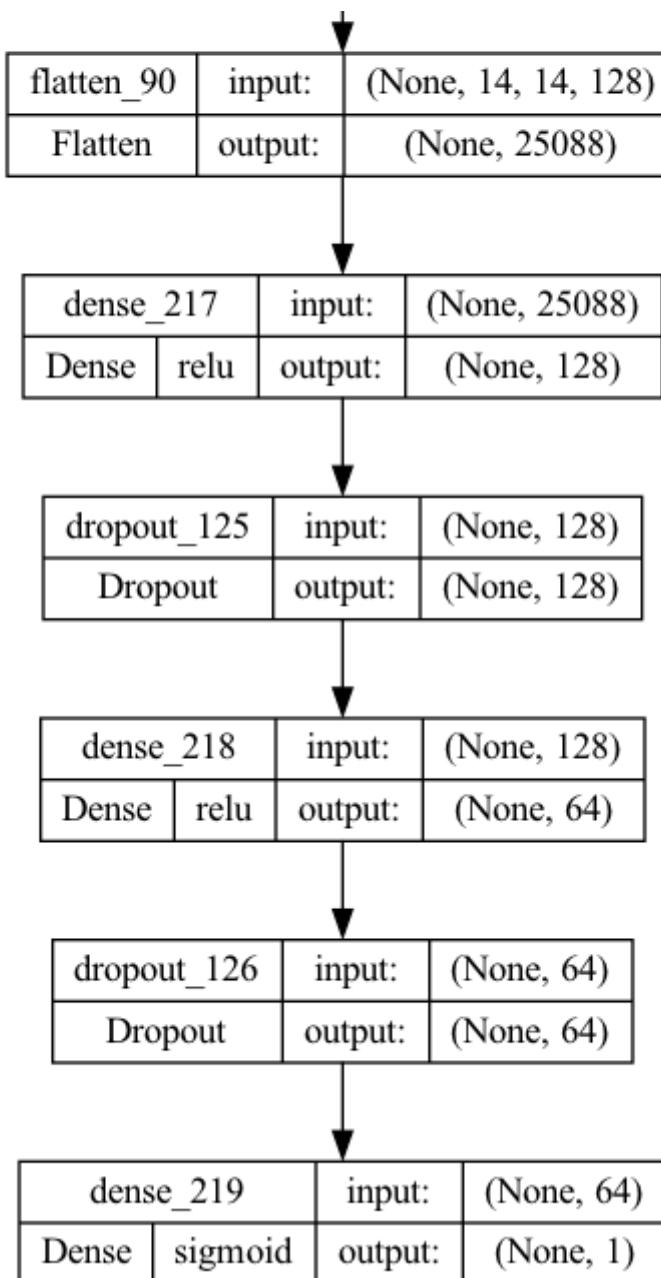
- Model 1 (Baseline) - Loss: .0865
- Model 5 ( 4 Conv2D Layers, 3 Dense Layers, Batchsize = 128, Epoch = 90, Dropout = .5, classweight ) - Loss: .06
- Model 9 (VGG19 Model w/ Feature Extraction) - Loss: .0714

In [125...]

```
#Plotting model architecture
plot_model(model_5, show_shapes=True, show_layer_names=True, show_layer_activat
```

Out[125]:





In [126...]

```
#Saving Model 5
save_file("model_5",model_5)
```

```
WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op while saving (showing 4 of 4). These functions will not be directly callable after loading.
```

```
INFO:tensorflow:Assets written to: ram://a34c2d0a-2b5d-4814-998c-7d23eb8c5390/assets
```

```
INFO:tensorflow:Assets written to: ram://a34c2d0a-2b5d-4814-998c-7d23eb8c5390/assets
```

## Prediction

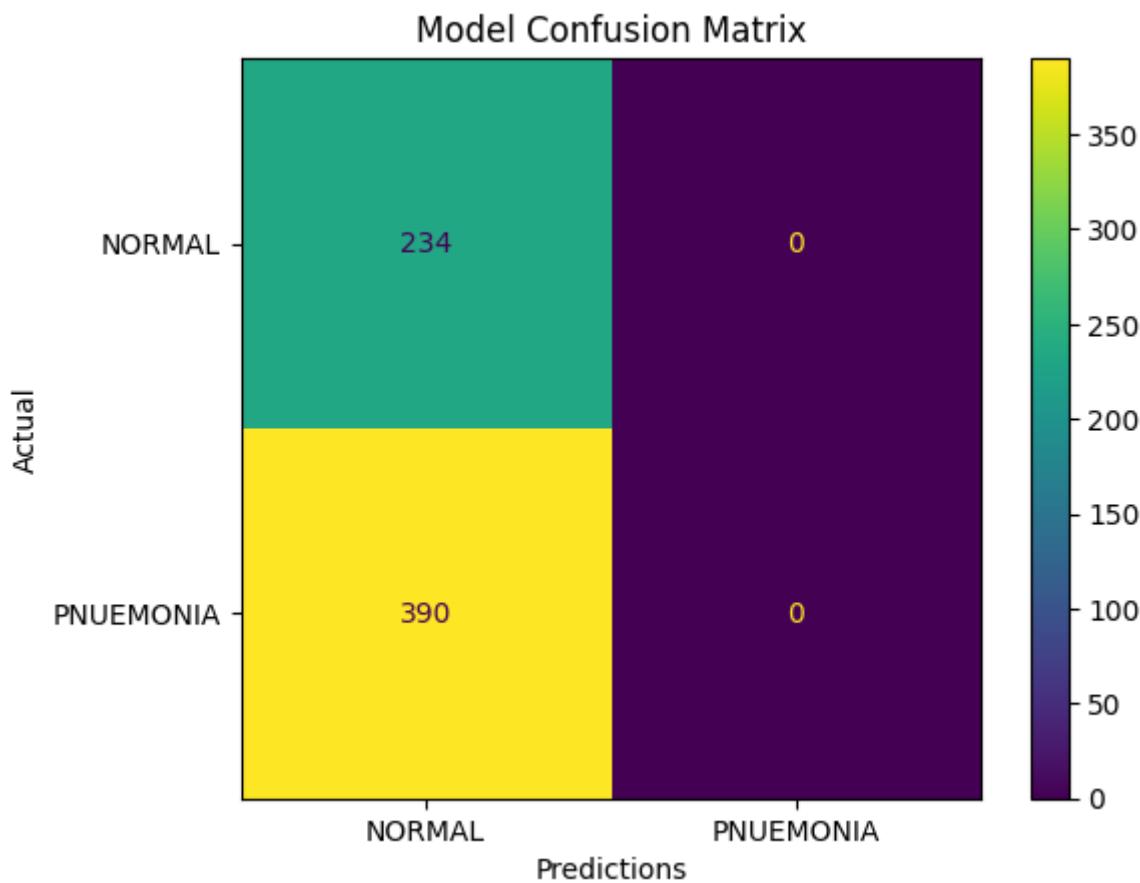
Using the chosen model and test data to predict

```
In [127... #Test data previously generated in preprocessing step, Batch Size = 624
test_labels, test_predictions = predict_results(model_5,test_gen)
```

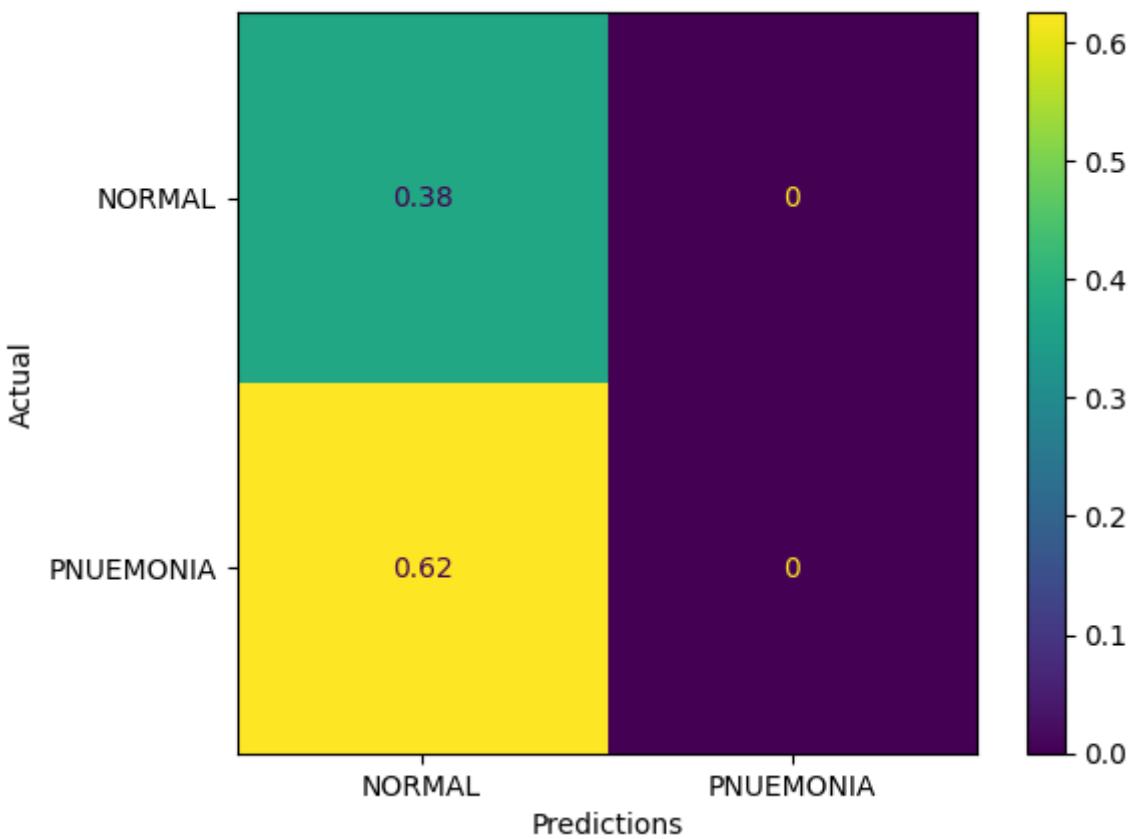
20/20 [=====] - 1s 31ms/step

```
In [128... print("Test Confusion Matrices:\n")
conf_matrix(test_labels, test_predictions, None)
conf_matrix(test_labels, test_predictions, "all")
```

Test Confusion Matrices:



Model Confusion Matrix



```
In [129]: test_pred_round = np.round(test_predictions,0)
classification_report(test_labels,test_pred_round, output_dict=True)
```

```
Out[129]: {'0.0': {'precision': 0.375,
'recall': 1.0,
'f1-score': 0.5454545454545454,
'support': 234},
'1.0': {'precision': 0.0, 'recall': 0.0, 'f1-score': 0.0, 'support': 390},
'accuracy': 0.375,
'macro avg': {'precision': 0.1875,
'recall': 0.5,
'f1-score': 0.2727272727272727,
'support': 624},
'weighted avg': {'precision': 0.140625,
'recall': 0.375,
'f1-score': 0.20454545454545453,
'support': 624}}
```

```
In [130]: #Evaluating Model With Training Data
test_results = model_5.evaluate(test_gen, return_dict= True)
test_results
```

```
1/1 [=====] - 4s 4s/step - loss: 0.8379 - acc: 0.3750
- recall: 0.0000e+00 - precision: 0.0000e+00
Out[130]: {'loss': 0.8378646969795227, 'acc': 0.375, 'recall': 0.0, 'precision': 0.0}
```

The model doesn't perform as well on the test data as it did on the training and validation data.

From the 624 Data pieces:

- .59% True Positive (366)<br>
- .014% True Negative (9)<br>
- .04% False Negative (24)<br>
- .36% False Positive (225)<br>

Normal:

- Recall:.04 <br>
- F1-Score:.07 <br>

Pneumonia:

- Recall:.94 <br>
- F1-Score:.75 <br>

- Loss:.68
- Accuracy:.6

## Model Explainer

The Lime Module will outline images and support explanation by highlighting important areas

In [131...]

```
def img_array_pred(y_label, x_image_array,model,num):
    """ Inputing the data set and model to retrieve an image and prediction
    Lime Explainer module"""

    #num = np.random.randint(0,20) If want to later generate random pictures

    label = y_label[num]
    img = x_image_array[num]

    # Get Model Prediction
    pred = model.predict(np.array([img]))
    pred_round = np.round(pred,0)

    # Print True and Predicted Image
    if pred_round == 0:
        print('Image predicted as Normal (0)!')
    else:
        print('Image predicted as Pneumonia (1)')

    if label == 0:
        print('Image is Normal (0)!')
    else:
        print('Image is Pneumonia (1)')

    print (f"Image Index {num} was chosen.")
```

```
return array_to_img(img)
```

## Analysis of True Positive Image

In [132]:

```
#Prints Prediction, True Label, Associate Predicted Image and Index
img = img_array_pred(y_test, x_test, model_5, 300)
img
```

```
1/1 [=====] - 1s 574ms/step
Image predicted as Normal (0)!
Image is Pneumonia (1)!
Image Index 300 was chosen.
```

Out[132]:



In [133]:

```
explainer = lime_image.LimeImageExplainer()
```

In [134]:

```
explanation = explainer.explain_instance(x_test[300].astype('double'), model_5,
                                         top_labels=3, hide_color=0, num_samples=1000)

0% | 0/1000 [00:00<?, ?it/s]
20/20 [=====] - 1s 35ms/step
12/12 [=====] - 0s 29ms/step
```

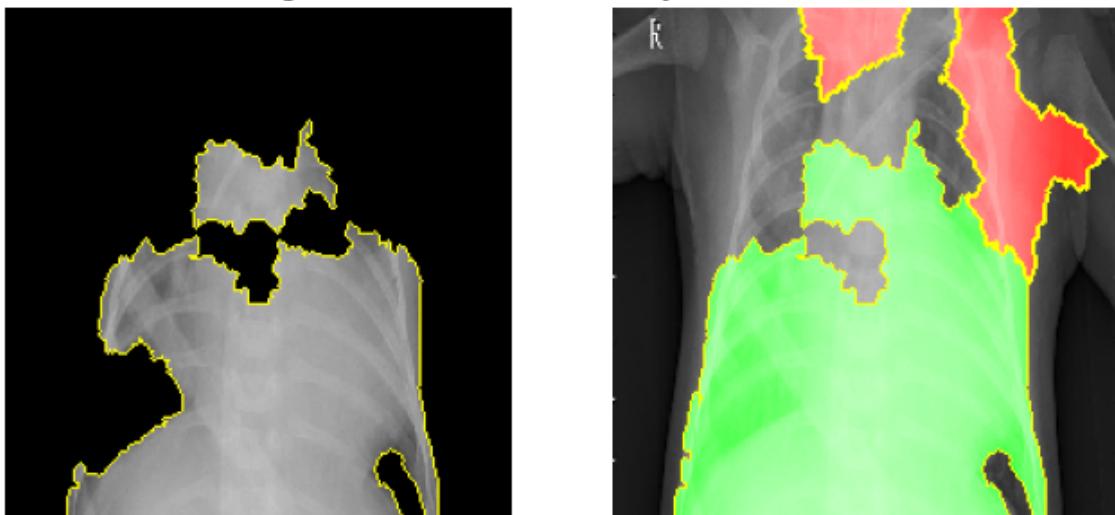
In [135]:

```
temp_1, mask_1 = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=True)
temp_2, mask_2 = explanation.get_image_and_mask(explanation.top_labels[0], positive_only=False)
```

In [136]:

```
fig, axes = plt.subplots(1, 2, figsize=(8, 8))
axes[0].imshow(mark_boundaries(temp_1, mask_1))
axes[0].set_title("Areas Contributing to Prediction")
axes[1].imshow(mark_boundaries(temp_2, mask_2))
axes[1].set_title("Probability Enablers (Green) & Disablers (Red)")
axes[0].axis('off')
axes[1].axis('off')
plt.savefig('images/Lime_TP.png')
```

## Areas Contributing to Prediction Probability Enablers (Green) &amp; Disenablers (Red)



## Analysis of False Positive Image

```
In [137]: img2 = img_array_pred(y_test, x_test, model_5, 581)
img2
1/1 [=====] - 0s 42ms/step
Image predicted as Normal (0)!
Image is Pneumonia (1) !
Image Index 581 was chosen.
```

Out[137]:



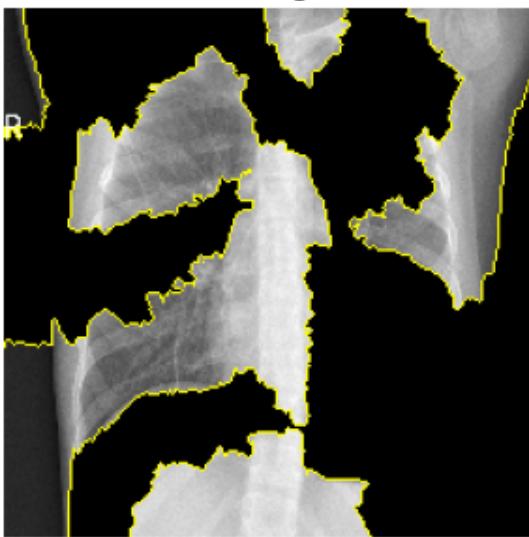
```
In [138]: explainer = lime_image.LimeImageExplainer()
explanation2 = explainer.explain_instance(x_test[1].astype
                                         ("double"), model_5.predict,
                                         top_labels=3, hide_color=None, num_sam
                                         0% | 0/1000 [00:00<?, ?it/s]
```



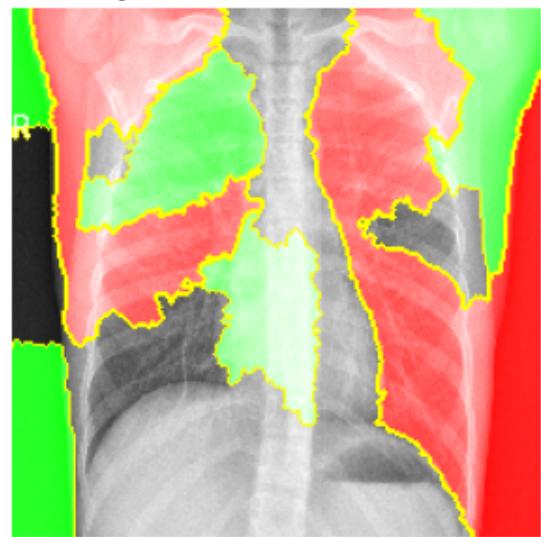
```
In [139...]: temp_12, mask_12 = explanation2.get_image_and_mask(explanation.top_labels[0], k=1)
temp_22, mask_22 = explanation2.get_image_and_mask(explanation.top_labels[0], k=2)
```

```
In [140...]: fig, axes = plt.subplots(1,2,figsize=(8,8))
axes[0].imshow(mark_boundaries(temp_12, mask_12))
axes[0].set_title("Areas Contributing to Prediction")
axes[1].imshow(mark_boundaries(temp_22, mask_22))
axes[1].set_title("Probability Enablers (G) & Disablers (R)")
axes[0].axis('off')
axes[1].axis('off')
plt.savefig('images/Lime_FN.png')
```

Areas Contributing to Prediction



Probability Enablers (G) &amp; Disablers (R)



The model seems like it best with edges, the center areas decrease the percentage of guessing correctly.

In [141...]

```
#Calculating end time
end = datetime.datetime.now()
duration = end - original_start
print('Notebook model execution: {}'.format(duration))
```

```
Notebook model execution: 1:18:38.422856
```

## Conclusion

### Reccommendation

The intended use was to correctly identify Normal or Pneumonia diagnosis. The primary goal was to minimize False Negative diagnosis (identifying Normal when Pneumonia is present).

#### Hospital:

- Usage: The model is best as a learning tool and not an official diagnosis.
- Strategy: Use the model as an initial reviewer of the images.
- Staffing: The model is best used with a doctor, not standalone.

#### Technical:

- Scope, review and process images more beforehand
- Visualize the activation functions to see better what areas the model layers are diagnosing
- Iterate model improvement with with augmented data
- Visually inspect the images that were FN and FP.

# Limitations

## Hospital:

- **Important image areas**
- **Radiologist SME knowledge**

## Technical:

- **Hardware and Software Compatibility (Modeling on M2 GPU Laptop)**
- **Hyperparameter optimization limits**
- **Blackbox of Hidden Layers**