```
from google.colab import drive
drive.mount('/content/drive')

import os
import json
import numpy as np
import yaml
from PIL import Image
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import InceptionV3
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Flatten, Dropout, GlobalAveragePooling2D
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint
from tensorflow.keras.optimizers import Adam
from sklearn.metrics import confusion_matrix, f1_score, accuracy_score, precision_score, recall_score
```

```
Mounted at /content/drive
```

```
# Paths to the dataset
dataset_dir = '/content/drive/MyDrive/Datasets/WeedCrop.v1i.yolov5pytorch'
train_dir = os.path.join(dataset_dir, 'train')
valid_dir = os.path.join(dataset_dir, 'valid')
test_dir = os.path.join(dataset_dir, 'test')
data_yaml = os.path.join(dataset_dir, 'data.yaml')

# Load class names from data.yaml
with open(data_yaml, 'r') as f:
    data = yaml.safe_load(f)
classes = data['names']

def load_data(img_dir, label_dir):
    images = []
    labels = []
    for img_name in os.listdir(img_dir):
        if img_name.endswith('.jpg'):
            img_path = os.path.join(img_dir, img_name)
            label_path = os.path.join(label_dir, os.path.splitext(img_name)[0] + '.txt')
            # Check if the annotation file exists
            if not os.path.exists(label_path):
                print(f"Annotation file {label_path} not found, skipping...")
                continue
            # Load image
            img = Image.open(img_path)
            img = img.resize((224, 224))
            images.append(np.array(img) / 255.0)  # Normalize to [0, 1]
            # Load annotation and set label (1 for weed, 0 for crop)
            with open(label_path, 'r') as f:
                anns = f.read().strip().split('\n')
                is_weed = False
                for ann in anns:
                    parts = ann.split(' ')
                    if len(parts) > 0 and parts[0].isdigit():
                        cls_id = int(parts[0])
                        if classes[cls_id] == 'weed':
                            is_weed = True
                            break
                labels.append(1 if is_weed else 0)
    return np.array(images), np.array(labels)


# Load the datasets
X_train, y_train = load_data(os.path.join(train_dir, 'images'), os.path.join(train_dir, 'labels'))
X_val, y_val = load_data(os.path.join(valid_dir, 'images'), os.path.join(valid_dir, 'labels'))
X_test, y_test = load_data(os.path.join(test_dir, 'images'), os.path.join(test_dir, 'labels'))
```

Show hidden output

```
# Data augmentation for training data
train_datagen = ImageDataGenerator(
    rotation_range=20,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True
)

# Data augmentation for validation and test data (only rescaling)
val_datagen = ImageDataGenerator()

# Create data generators
train_generator = train_datagen.flow(X_train, y_train, batch_size=32)
val_generator = val_datagen.flow(X_val, y_val, batch_size=32)
test_generator = val_datagen.flow(X_test, y_test, batch_size=32, shuffle=False)
```

```
# Load InceptionV3 model pre-trained on ImageNet, excluding top layers
base_model = InceptionV3(weights='imagenet', include_top=False, input_shape=(224, 224, 3))

# Adding custom top layers for binary classification
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(512, activation='relu')(x)
x = Dropout(0.5)(x)
predictions = Dense(1, activation='sigmoid')(x)
model = Model(inputs=base_model.input, outputs=predictions)
model.summary()
```

Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/inception_v3/inception_v3_weights_tf_dim_ordering
87910968/87910968 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step

Model: "functional"

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, 224, 224, 3)	0	-
conv2d (Conv2D)	(None, 111, 111, 32)	864	input_layer[0][0]
batch_normalization (BatchNormalization)	(None, 111, 111, 32)	96	conv2d[0][0]
activation (Activation)	(None, 111, 111, 32)	0	batch_normalization[0…
conv2d_1 (Conv2D)	(None, 109, 109, 32)	9,216	activation[0][0]
batch_normalization_1 (BatchNormalization)	(None, 109, 109, 32)	96	conv2d_1[0][0]
activation_1 (Activation)	(None, 109, 109, 32)	0	batch_normalization_1…
conv2d_2 (Conv2D)	(None, 109, 109, 64)	18,432	activation_1[0][0]
batch_normalization_2 (BatchNormalization)	(None, 109, 109, 64)	192	conv2d_2[0][0]
activation_2 (Activation)	(None, 109, 109, 64)	0	batch_normalization_2…
max_pooling2d (MaxPooling2D)	(None, 54, 54, 64)	0	activation_2[0][0]
conv2d_3 (Conv2D)	(None, 54, 54, 80)	5,120	max_pooling2d[0][0]
batch_normalization_3 (BatchNormalization)	(None, 54, 54, 80)	240	conv2d_3[0][0]
activation_3 (Activation)	(None, 54, 54, 80)	0	batch_normalization_3…
conv2d_4 (Conv2D)	(None, 52, 52, 192)	138,240	activation_3[0][0]
batch_normalization_4 (BatchNormalization)	(None, 52, 52, 192)	576	conv2d_4[0][0]
activation_4 (Activation)	(None, 52, 52, 192)	0	batch_normalization_4…
max_pooling2d_1 (MaxPooling2D)	(None, 25, 25, 192)	0	activation_4[0][0]
conv2d_8 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_1[0][0]
batch_normalization_8 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_8[0][0]
activation_8 (Activation)	(None, 25, 25, 64)	0	batch_normalization_8…
conv2d_6 (Conv2D)	(None, 25, 25, 48)	9,216	max_pooling2d_1[0][0]
conv2d_9 (Conv2D)	(None, 25, 25, 96)	55,296	activation_8[0][0]
batch_normalization_6 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_6[0][0]
batch_normalization_9 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_9[0][0]
activation_6 (Activation)	(None, 25, 25, 48)	0	batch_normalization_6…
activation_9 (Activation)	(None, 25, 25, 96)	0	batch_normalization_9…
average_pooling2d (AveragePooling2D)	(None, 25, 25, 192)	0	max_pooling2d_1[0][0]
conv2d_5 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_1[0][0]
conv2d_7 (Conv2D)	(None, 25, 25, 64)	76,800	activation_6[0][0]
conv2d_10 (Conv2D)	(None, 25, 25, 96)	82,944	activation_9[0][0]
conv2d_11 (Conv2D)	(None, 25, 25, 32)	6,144	average_pooling2d[0][…
batch_normalization_5 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_5[0][0]
batch_normalization_7 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_7[0][0]
batch_normalization_10 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_10[0][0]
batch_normalization_11 (BatchNormalization)	(None, 25, 25, 32)	96	conv2d_11[0][0]
activation_5 (Activation)	(None, 25, 25, 64)	0	batch_normalization_5…
activation_7 (Activation)	(None, 25, 25, 64)	0	batch_normalization_7…
activation_10	(None, 25, 25, 96)	0	batch_normalization_1

activation_10 (Activation)	(None, 25, 25, 96)	0	batch_normalization_1…
activation_11 (Activation)	(None, 25, 25, 32)	0	batch_normalization_1…
mixed0 (Concatenate)	(None, 25, 25, 256)	0	activation_5[0][0], activation_7[0][0], activation_10[0][0], activation_11[0][0]
conv2d_15 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
batch_normalization_15 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_15[0][0]
activation_15 (Activation)	(None, 25, 25, 64)	0	batch_normalization_1…
conv2d_13 (Conv2D)	(None, 25, 25, 48)	12,288	mixed0[0][0]
conv2d_16 (Conv2D)	(None, 25, 25, 96)	55,296	activation_15[0][0]
batch_normalization_13 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_13[0][0]
batch_normalization_16 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_16[0][0]
activation_13 (Activation)	(None, 25, 25, 48)	0	batch_normalization_1…
activation_16 (Activation)	(None, 25, 25, 96)	0	batch_normalization_1…
average_pooling2d_1 (AveragePooling2D)	(None, 25, 25, 256)	0	mixed0[0][0]
conv2d_12 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
conv2d_14 (Conv2D)	(None, 25, 25, 64)	76,800	activation_13[0][0]
conv2d_17 (Conv2D)	(None, 25, 25, 96)	82,944	activation_16[0][0]
conv2d_18 (Conv2D)	(None, 25, 25, 64)	16,384	average_pooling2d_1[0…
batch_normalization_12 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_12[0][0]
batch_normalization_14 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_14[0][0]
batch_normalization_17 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_17[0][0]
batch_normalization_18 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_18[0][0]
activation_12 (Activation)	(None, 25, 25, 64)	0	batch_normalization_1…
activation_14 (Activation)	(None, 25, 25, 64)	0	batch_normalization_1…
activation_17 (Activation)	(None, 25, 25, 96)	0	batch_normalization_1…
activation_18 (Activation)	(None, 25, 25, 64)	0	batch_normalization_1…
mixed1 (Concatenate)	(None, 25, 25, 288)	0	activation_12[0][0], activation_14[0][0], activation_17[0][0], activation_18[0][0]
conv2d_22 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
batch_normalization_22 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_22[0][0]
activation_22 (Activation)	(None, 25, 25, 64)	0	batch_normalization_2…
conv2d_20 (Conv2D)	(None, 25, 25, 48)	13,824	mixed1[0][0]
conv2d_23 (Conv2D)	(None, 25, 25, 96)	55,296	activation_22[0][0]
batch_normalization_20 (BatchNormalization)	(None, 25, 25, 48)	144	conv2d_20[0][0]
batch_normalization_23 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_23[0][0]
activation_20 (Activation)	(None, 25, 25, 48)	0	batch_normalization_2…
activation_23 (Activation)	(None, 25, 25, 96)	0	batch_normalization_2…

average_pooling2d_2 (AveragePooling2D)	(None, 25, 25, 288)	0	mixed1[0][0]
conv2d_19 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
conv2d_21 (Conv2D)	(None, 25, 25, 64)	76,800	activation_20[0][0]
conv2d_24 (Conv2D)	(None, 25, 25, 96)	82,944	activation_23[0][0]
conv2d_25 (Conv2D)	(None, 25, 25, 64)	18,432	average_pooling2d_2[0…
batch_normalization_19 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_19[0][0]
batch_normalization_21 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_21[0][0]
batch_normalization_24 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_24[0][0]
batch_normalization_25 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_25[0][0]
activation_19 (Activation)	(None, 25, 25, 64)	0	batch_normalization_1…
activation_21 (Activation)	(None, 25, 25, 64)	0	batch_normalization_2…
activation_24 (Activation)	(None, 25, 25, 96)	0	batch_normalization_2…
activation_25 (Activation)	(None, 25, 25, 64)	0	batch_normalization_2…
mixed2 (Concatenate)	(None, 25, 25, 288)	0	activation_19[0][0], activation_21[0][0], activation_24[0][0], activation_25[0][0]
conv2d_27 (Conv2D)	(None, 25, 25, 64)	18,432	mixed2[0][0]
batch_normalization_27 (BatchNormalization)	(None, 25, 25, 64)	192	conv2d_27[0][0]
activation_27 (Activation)	(None, 25, 25, 64)	0	batch_normalization_2…
conv2d_28 (Conv2D)	(None, 25, 25, 96)	55,296	activation_27[0][0]
batch_normalization_28 (BatchNormalization)	(None, 25, 25, 96)	288	conv2d_28[0][0]
activation_28 (Activation)	(None, 25, 25, 96)	0	batch_normalization_2…
conv2d_26 (Conv2D)	(None, 12, 12, 384)	995,328	mixed2[0][0]
conv2d_29 (Conv2D)	(None, 12, 12, 96)	82,944	activation_28[0][0]
batch_normalization_26 (BatchNormalization)	(None, 12, 12, 384)	1,152	conv2d_26[0][0]
batch_normalization_29 (BatchNormalization)	(None, 12, 12, 96)	288	conv2d_29[0][0]
activation_26 (Activation)	(None, 12, 12, 384)	0	batch_normalization_2…
activation_29 (Activation)	(None, 12, 12, 96)	0	batch_normalization_2…
max_pooling2d_2 (MaxPooling2D)	(None, 12, 12, 288)	0	mixed2[0][0]
mixed3 (Concatenate)	(None, 12, 12, 768)	0	activation_26[0][0], activation_29[0][0], max_pooling2d_2[0][0]
conv2d_34 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
batch_normalization_34 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_34[0][0]
activation_34 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
conv2d_35 (Conv2D)	(None, 12, 12, 128)	114,688	activation_34[0][0]
batch_normalization_35 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_35[0][0]
activation_35 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
conv2d_31 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
conv2d_36 (Conv2D)	(None, 12, 12, 128)	114,688	activation_35[0][0]

batch_normalization_31 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_31[0][0]
batch_normalization_36 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_36[0][0]
activation_31 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
activation_36 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
conv2d_32 (Conv2D)	(None, 12, 12, 128)	114,688	activation_31[0][0]
conv2d_37 (Conv2D)	(None, 12, 12, 128)	114,688	activation_36[0][0]
batch_normalization_32 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_32[0][0]
batch_normalization_37 (BatchNormalization)	(None, 12, 12, 128)	384	conv2d_37[0][0]
activation_32 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
activation_37 (Activation)	(None, 12, 12, 128)	0	batch_normalization_3…
average_pooling2d_3 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed3[0][0]
conv2d_30 (Conv2D)	(None, 12, 12, 192)	147,456	mixed3[0][0]
conv2d_33 (Conv2D)	(None, 12, 12, 192)	172,032	activation_32[0][0]
conv2d_38 (Conv2D)	(None, 12, 12, 192)	172,032	activation_37[0][0]
conv2d_39 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2d_3[0…
batch_normalization_30 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_30[0][0]
batch_normalization_33 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_33[0][0]
batch_normalization_38 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_38[0][0]
batch_normalization_39 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_39[0][0]
activation_30 (Activation)	(None, 12, 12, 192)	0	batch_normalization_3…
activation_33 (Activation)	(None, 12, 12, 192)	0	batch_normalization_3…
activation_38 (Activation)	(None, 12, 12, 192)	0	batch_normalization_3…
activation_39 (Activation)	(None, 12, 12, 192)	0	batch_normalization_3…
mixed4 (Concatenate)	(None, 12, 12, 768)	0	activation_30[0][0], activation_33[0][0], activation_38[0][0], activation_39[0][0]
conv2d_44 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
batch_normalization_44 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_44[0][0]
activation_44 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…
conv2d_45 (Conv2D)	(None, 12, 12, 160)	179,200	activation_44[0][0]
batch_normalization_45 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_45[0][0]
activation_45 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…
conv2d_41 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
conv2d_46 (Conv2D)	(None, 12, 12, 160)	179,200	activation_45[0][0]
batch_normalization_41 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_41[0][0]
batch_normalization_46 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_46[0][0]
activation_41 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…

activation_46 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…
conv2d_42 (Conv2D)	(None, 12, 12, 160)	179,200	activation_41[0][0]
conv2d_47 (Conv2D)	(None, 12, 12, 160)	179,200	activation_46[0][0]
batch_normalization_42 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_42[0][0]
batch_normalization_47 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_47[0][0]
activation_42 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…
activation_47 (Activation)	(None, 12, 12, 160)	0	batch_normalization_4…
average_pooling2d_4 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed4[0][0]
conv2d_40 (Conv2D)	(None, 12, 12, 192)	147,456	mixed4[0][0]
conv2d_43 (Conv2D)	(None, 12, 12, 192)	215,040	activation_42[0][0]
conv2d_48 (Conv2D)	(None, 12, 12, 192)	215,040	activation_47[0][0]
conv2d_49 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2d_4[0…
batch_normalization_40 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_40[0][0]
batch_normalization_43 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_43[0][0]
batch_normalization_48 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_48[0][0]
batch_normalization_49 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_49[0][0]
activation_40 (Activation)	(None, 12, 12, 192)	0	batch_normalization_4…
activation_43 (Activation)	(None, 12, 12, 192)	0	batch_normalization_4…
activation_48 (Activation)	(None, 12, 12, 192)	0	batch_normalization_4…
activation_49 (Activation)	(None, 12, 12, 192)	0	batch_normalization_4…
mixed5 (Concatenate)	(None, 12, 12, 768)	0	activation_40[0][0], activation_43[0][0], activation_48[0][0], activation_49[0][0]
conv2d_54 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
batch_normalization_54 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_54[0][0]
activation_54 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
conv2d_55 (Conv2D)	(None, 12, 12, 160)	179,200	activation_54[0][0]
batch_normalization_55 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_55[0][0]
activation_55 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
conv2d_51 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
conv2d_56 (Conv2D)	(None, 12, 12, 160)	179,200	activation_55[0][0]
batch_normalization_51 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_51[0][0]
batch_normalization_56 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_56[0][0]
activation_51 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
activation_56 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
conv2d_52 (Conv2D)	(None, 12, 12, 160)	179,200	activation_51[0][0]
conv2d_57 (Conv2D)	(None, 12, 12, 160)	179,200	activation_56[0][0]
batch_normalization_52 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_52[0][0]

batch_normalization_57 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_57[0][0]
activation_52 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
activation_57 (Activation)	(None, 12, 12, 160)	0	batch_normalization_5…
average_pooling2d_5 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed5[0][0]
conv2d_50 (Conv2D)	(None, 12, 12, 192)	147,456	mixed5[0][0]
conv2d_53 (Conv2D)	(None, 12, 12, 192)	215,040	activation_52[0][0]
conv2d_58 (Conv2D)	(None, 12, 12, 192)	215,040	activation_57[0][0]
conv2d_59 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2d_5[0…
batch_normalization_50 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_50[0][0]
batch_normalization_53 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_53[0][0]
batch_normalization_58 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_58[0][0]
batch_normalization_59 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_59[0][0]
activation_50 (Activation)	(None, 12, 12, 192)	0	batch_normalization_5…
activation_53 (Activation)	(None, 12, 12, 192)	0	batch_normalization_5…
activation_58 (Activation)	(None, 12, 12, 192)	0	batch_normalization_5…
activation_59 (Activation)	(None, 12, 12, 192)	0	batch_normalization_5…
mixed6 (Concatenate)	(None, 12, 12, 768)	0	activation_50[0][0], activation_53[0][0], activation_58[0][0], activation_59[0][0]
conv2d_64 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
batch_normalization_64 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_64[0][0]
activation_64 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
conv2d_65 (Conv2D)	(None, 12, 12, 192)	258,048	activation_64[0][0]
batch_normalization_65 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_65[0][0]
activation_65 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
conv2d_61 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
conv2d_66 (Conv2D)	(None, 12, 12, 192)	258,048	activation_65[0][0]
batch_normalization_61 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_61[0][0]
batch_normalization_66 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_66[0][0]
activation_61 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
activation_66 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
conv2d_62 (Conv2D)	(None, 12, 12, 192)	258,048	activation_61[0][0]
conv2d_67 (Conv2D)	(None, 12, 12, 192)	258,048	activation_66[0][0]
batch_normalization_62 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_62[0][0]
batch_normalization_67 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_67[0][0]
activation_62 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
activation_67 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
average_pooling2d_6 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed6[0][0]

(AveragePooling2D)			
conv2d_60 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
conv2d_63 (Conv2D)	(None, 12, 12, 192)	258,048	activation_62[0][0]
conv2d_68 (Conv2D)	(None, 12, 12, 192)	258,048	activation_67[0][0]
conv2d_69 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2d_6[0…
batch_normalization_60 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_60[0][0]
batch_normalization_63 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_63[0][0]
batch_normalization_68 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_68[0][0]
batch_normalization_69 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_69[0][0]
activation_60 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
activation_63 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
activation_68 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
activation_69 (Activation)	(None, 12, 12, 192)	0	batch_normalization_6…
mixed7 (Concatenate)	(None, 12, 12, 768)	0	activation_60[0][0], activation_63[0][0], activation_68[0][0], activation_69[0][0]
conv2d_72 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
batch_normalization_72 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_72[0][0]
activation_72 (Activation)	(None, 12, 12, 192)	0	batch_normalization_7…
conv2d_73 (Conv2D)	(None, 12, 12, 192)	258,048	activation_72[0][0]
batch_normalization_73 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_73[0][0]
activation_73 (Activation)	(None, 12, 12, 192)	0	batch_normalization_7…
conv2d_70 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
conv2d_74 (Conv2D)	(None, 12, 12, 192)	258,048	activation_73[0][0]
batch_normalization_70 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_70[0][0]
batch_normalization_74 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_74[0][0]
activation_70 (Activation)	(None, 12, 12, 192)	0	batch_normalization_7…
activation_74 (Activation)	(None, 12, 12, 192)	0	batch_normalization_7…
conv2d_71 (Conv2D)	(None, 5, 5, 320)	552,960	activation_70[0][0]
conv2d_75 (Conv2D)	(None, 5, 5, 192)	331,776	activation_74[0][0]
batch_normalization_71 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_71[0][0]
batch_normalization_75 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_75[0][0]
activation_71 (Activation)	(None, 5, 5, 320)	0	batch_normalization_7…
activation_75 (Activation)	(None, 5, 5, 192)	0	batch_normalization_7…
max_pooling2d_3 (MaxPooling2D)	(None, 5, 5, 768)	0	mixed7[0][0]
mixed8 (Concatenate)	(None, 5, 5, 1280)	0	activation_71[0][0], activation_75[0][0], max_pooling2d_3[0][0]
conv2d_80 (Conv2D)	(None, 5, 5, 448)	573,440	mixed8[0][0]
batch_normalization_80 (BatchNormalization)	(None, 5, 5, 448)	1,344	conv2d_80[0][0]

activation_80 (Activation)	(None, 5, 5, 448)	0	batch_normalization_8…
conv2d_77 (Conv2D)	(None, 5, 5, 384)	491,520	mixed8[0][0]
conv2d_81 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_80[0][0]
batch_normalization_77 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_77[0][0]
batch_normalization_81 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_81[0][0]
activation_77 (Activation)	(None, 5, 5, 384)	0	batch_normalization_7…
activation_81 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
conv2d_78 (Conv2D)	(None, 5, 5, 384)	442,368	activation_77[0][0]
conv2d_79 (Conv2D)	(None, 5, 5, 384)	442,368	activation_77[0][0]
conv2d_82 (Conv2D)	(None, 5, 5, 384)	442,368	activation_81[0][0]
conv2d_83 (Conv2D)	(None, 5, 5, 384)	442,368	activation_81[0][0]
average_pooling2d_7 (AveragePooling2D)	(None, 5, 5, 1280)	0	mixed8[0][0]
conv2d_76 (Conv2D)	(None, 5, 5, 320)	409,600	mixed8[0][0]
batch_normalization_78 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_78[0][0]
batch_normalization_79 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_79[0][0]
batch_normalization_82 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_82[0][0]
batch_normalization_83 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_83[0][0]
conv2d_84 (Conv2D)	(None, 5, 5, 192)	245,760	average_pooling2d_7[0…
batch_normalization_76 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_76[0][0]
activation_78 (Activation)	(None, 5, 5, 384)	0	batch_normalization_7…
activation_79 (Activation)	(None, 5, 5, 384)	0	batch_normalization_7…
activation_82 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
activation_83 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
batch_normalization_84 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_84[0][0]
activation_76 (Activation)	(None, 5, 5, 320)	0	batch_normalization_7…
mixed9_0 (Concatenate)	(None, 5, 5, 768)	0	activation_78[0][0], activation_79[0][0]
concatenate (Concatenate)	(None, 5, 5, 768)	0	activation_82[0][0], activation_83[0][0]
activation_84 (Activation)	(None, 5, 5, 192)	0	batch_normalization_8…
mixed9 (Concatenate)	(None, 5, 5, 2048)	0	activation_76[0][0], mixed9_0[0][0], concatenate[0][0], activation_84[0][0]
conv2d_89 (Conv2D)	(None, 5, 5, 448)	917,504	mixed9[0][0]
batch_normalization_89 (BatchNormalization)	(None, 5, 5, 448)	1,344	conv2d_89[0][0]
activation_89 (Activation)	(None, 5, 5, 448)	0	batch_normalization_8…
conv2d_86 (Conv2D)	(None, 5, 5, 384)	786,432	mixed9[0][0]
conv2d_90 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_89[0][0]
batch_normalization_86 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_86[0][0]
batch_normalization_90 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_90[0][0]

activation_86 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
activation_90 (Activation)	(None, 5, 5, 384)	0	batch_normalization_9…
conv2d_87 (Conv2D)	(None, 5, 5, 384)	442,368	activation_86[0][0]
conv2d_88 (Conv2D)	(None, 5, 5, 384)	442,368	activation_86[0][0]
conv2d_91 (Conv2D)	(None, 5, 5, 384)	442,368	activation_90[0][0]
conv2d_92 (Conv2D)	(None, 5, 5, 384)	442,368	activation_90[0][0]
average_pooling2d_8 (AveragePooling2D)	(None, 5, 5, 2048)	0	mixed9[0][0]
conv2d_85 (Conv2D)	(None, 5, 5, 320)	655,360	mixed9[0][0]
batch_normalization_87 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_87[0][0]
batch_normalization_88 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_88[0][0]
batch_normalization_91 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_91[0][0]
batch_normalization_92 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_92[0][0]
conv2d_93 (Conv2D)	(None, 5, 5, 192)	393,216	average_pooling2d_8[0…
batch_normalization_85 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_85[0][0]
activation_87 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
activation_88 (Activation)	(None, 5, 5, 384)	0	batch_normalization_8…
activation_91 (Activation)	(None, 5, 5, 384)	0	batch_normalization_9…
activation_92 (Activation)	(None, 5, 5, 384)	0	batch_normalization_9…
batch_normalization_93 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_93[0][0]
activation_85 (Activation)	(None, 5, 5, 320)	0	batch_normalization_8…
mixed9_1 (Concatenate)	(None, 5, 5, 768)	0	activation_87[0][0], activation_88[0][0]
concatenate_1 (Concatenate)	(None, 5, 5, 768)	0	activation_91[0][0], activation_92[0][0]
activation_93 (Activation)	(None, 5, 5, 192)	0	batch_normalization_9…
mixed10 (Concatenate)	(None, 5, 5, 2048)	0	activation_85[0][0], mixed9_1[0][0], concatenate_1[0][0], activation_93[0][0]
global_average_pooling2d (GlobalAveragePooling2D)	(None, 2048)	0	mixed10[0][0]
dense (Dense)	(None, 512)	1,049,088	global_average_poolin…
dropout (Dropout)	(None, 512)	0	dense[0][0]
dense_1 (Dense)	(None, 1)	513	dropout[0][0]

Total params: 22,852,385 (87.17 MB)
Trainable params: 22,817,953 (87.04 MB)

```
# Create the optimizer
optimizer = Adam(learning_rate=0.0001)
model.compile(optimizer=optimizer, loss='binary_crossentropy', metrics=['accuracy'])

# Callbacks
early_stopping = EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True)
model_checkpoint = ModelCheckpoint('weed_detection_InceptionV3.keras', save_best_only=True, monitor='val_loss')

# Train the model
history = model.fit(
    train_generator,
    validation_data=val_generator,
    epochs=15,
    callbacks=[early_stopping, model_checkpoint]
)

# Save the model
model.save('weed_detection_InceptionV3.h5')
```

```
Epoch 1/15
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset` cl
  self._warn_if_super_not_called()
72/72 ━━━━━━━━━━━━━━━━━━━━ 180s 1s/step - accuracy: 0.8699 - loss: 0.3373 - val_accuracy: 0.9702 - val_loss: 0.3342
Epoch 2/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 91s 422ms/step - accuracy: 0.9385 - loss: 0.2029 - val_accuracy: 0.9702 - val_loss: 0.3415
Epoch 3/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 46s 490ms/step - accuracy: 0.9395 - loss: 0.1695 - val_accuracy: 0.9702 - val_loss: 0.2155
Epoch 4/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 41s 487ms/step - accuracy: 0.9464 - loss: 0.1454 - val_accuracy: 0.9702 - val_loss: 0.1747
Epoch 5/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 49s 629ms/step - accuracy: 0.9493 - loss: 0.1321 - val_accuracy: 0.9702 - val_loss: 0.1743
Epoch 6/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 33s 428ms/step - accuracy: 0.9568 - loss: 0.1162 - val_accuracy: 0.9702 - val_loss: 0.2737
Epoch 7/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 33s 424ms/step - accuracy: 0.9604 - loss: 0.1072 - val_accuracy: 0.9702 - val_loss: 0.2114
Epoch 8/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 34s 416ms/step - accuracy: 0.9657 - loss: 0.0932 - val_accuracy: 0.9702 - val_loss: 0.2134
Epoch 9/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 33s 425ms/step - accuracy: 0.9730 - loss: 0.0709 - val_accuracy: 0.9617 - val_loss: 0.2993
Epoch 10/15
72/72 ━━━━━━━━━━━━━━━━━━━━ 33s 426ms/step - accuracy: 0.9771 - loss: 0.0634 - val_accuracy: 0.9660 - val_loss: 0.2719
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is c
```

```
# Load the best model
model = tf.keras.models.load_model('weed_detection_InceptionV3.h5')

# Evaluate on the test set
y_pred = (model.predict(X_test) > 0.5).astype("int32")

# Confusion Matrix
cm = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", cm)

# F1 Score
f1 = f1_score(y_test, y_pred, average='weighted')
print("F1 Score:", f1)

# Accuracy
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Precision
precision = precision_score(y_test, y_pred, average='weighted')
print("Precision:", precision)

# Recall
recall = recall_score(y_test, y_pred, average='weighted')
print("Recall:", recall)
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until y
4/4 ━━━━━━━━━━━━━━━━━━━━ 14s 3s/step
Confusion Matrix:
 [[  0   9]
 [  0 109]]
F1 Score: 0.8871052042111551
Accuracy: 0.923728813559322
Precision: 0.8532749209997127
Recall: 0.923728813559322
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: UndefinedMetricWarning: Precision is ill-defined ar
```

```
        _warn_prf(average, modifier, msg_start, len(result))
```

```
# Classification test on an image
def load_and_preprocess_image(img_path):
    img = Image.open(img_path)
    img = img.resize((224, 224))
    img = np.array(img) / 255.0  # Normalize to [0, 1]
    img = np.expand_dims(img, axis=0)  # Add batch dimension
    return img

def predict_image(model, img_path):
    img = load_and_preprocess_image(img_path)
    display(Image.open(img_path) )
    prediction = model.predict(img)
    return np.argmax(prediction[0])

example_img_path = '/content/drive/MyDrive/Datasets/WeedCrop.v1i.yolov5pytorch/test/images/301_jpg.rf.e0a19ebd17c5738934d155d4747cecba.jp

# Load the model
model = tf.keras.models.load_model('weed_detection_InceptionV3.h5')

# Make a prediction
prediction = predict_image(model, example_img_path)

# Output the prediction
if prediction > 0.5:
```