```
# Setting up Environment
import os
import json
import numpy as np
from PIL import Image
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import VGG16
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Flatten, Dropout
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint
from tensorflow.keras.optimizers import Adam
from sklearn.model_selection import train_test_split
```

```
# Paths to the dataset
img_dir = '/content/drive/MyDrive/Datasets/BOUNDING_BOXES_ALLINONE/agri_data/data'
classes_file = '/content/drive/MyDrive/Datasets/BOUNDING_BOXES_ALLINONE/classes.txt'

# Loading class names
with open(classes_file, 'r') as f:
    classes = f.read().splitlines()
    classes = {i: cls for i, cls in enumerate(classes)}

# Loading images and annotations
def load_data(img_dir):
    images = []
    labels = []
    n = 0
    for img_name in os.listdir(img_dir):
        if img_name.endswith('.jpeg') or img_name.endswith('.png'):
            img_path = os.path.join(img_dir, img_name)
            ann_path = os.path.join(img_dir, os.path.splitext(img_name)[0] + '.txt')

            # Load image
            img = Image.open(img_path)
            img = img.resize((100,100))
            images.append(np.array(img) / 255.0)  # Normalize to [0, 1]
            n += 1

            # Load annotation and set label (1 for weed, 0 for crop)
            with open(ann_path, 'r') as f:
                anns = f.read().strip().split('\n')
                is_weed = False
                for ann in anns:
                    cls_id = int(ann.split(' ')[0])
                    if classes[cls_id] == 'weed':
                        is_weed = True
                        break
                labels.append(1 if is_weed else 0)
    print(n, "images found")
    return np.array(images), np.array(labels)

# Loading the dataset
images, labels = load_data(img_dir)
```

```
1300 images found
```

```
X_train, X_val, y_train, y_val = train_test_split(images, labels, test_size=0.2, random_state=42)
```

```
# Step 3: Data Augmentation
train_datagen = ImageDataGenerator(
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest'
)

val_datagen = ImageDataGenerator()

train_generator = train_datagen.flow(X_train, y_train, batch_size=32)
val_generator = val_datagen.flow(X_val, y_val, batch_size=32)
```

```
# Step 4: Model Setup
base_model = InceptionV3(weights='imagenet', include_top=False, input_shape=(100, 100, 3))
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(1024, activation='relu')(x)
predictions = Dense(1, activation='sigmoid')(x)

model = Model(inputs=base_model.input, outputs=predictions)

for layer in base_model.layers:
    layer.trainable = False
model.summary()
```

Model: "functional_2"

Layer (type)	Output Shape	Param #	Connected to
input_layer_2 (InputLayer)	(None, 100, 100, 3)	0	-
conv2d_188 (Conv2D)	(None, 49, 49, 32)	864	input_layer_2[0][0]
batch_normalization_188 (BatchNormalization)	(None, 49, 49, 32)	96	conv2d_188[0][0]
activation_188 (Activation)	(None, 49, 49, 32)	0	batch_normalization_1…
conv2d_189 (Conv2D)	(None, 47, 47, 32)	9,216	activation_188[0][0]
batch_normalization_189 (BatchNormalization)	(None, 47, 47, 32)	96	conv2d_189[0][0]
activation_189 (Activation)	(None, 47, 47, 32)	0	batch_normalization_1…
conv2d_190 (Conv2D)	(None, 47, 47, 64)	18,432	activation_189[0][0]
batch_normalization_190 (BatchNormalization)	(None, 47, 47, 64)	192	conv2d_190[0][0]
activation_190 (Activation)	(None, 47, 47, 64)	0	batch_normalization_1…
max_pooling2d_8 (MaxPooling2D)	(None, 23, 23, 64)	0	activation_190[0][0]
conv2d_191 (Conv2D)	(None, 23, 23, 80)	5,120	max_pooling2d_8[0][0]
batch_normalization_191 (BatchNormalization)	(None, 23, 23, 80)	240	conv2d_191[0][0]
activation_191 (Activation)	(None, 23, 23, 80)	0	batch_normalization_1…
conv2d_192 (Conv2D)	(None, 21, 21, 192)	138,240	activation_191[0][0]
batch_normalization_192 (BatchNormalization)	(None, 21, 21, 192)	576	conv2d_192[0][0]
activation_192 (Activation)	(None, 21, 21, 192)	0	batch_normalization_1…
max_pooling2d_9 (MaxPooling2D)	(None, 10, 10, 192)	0	activation_192[0][0]
conv2d_196 (Conv2D)	(None, 10, 10, 64)	12,288	max_pooling2d_9[0][0]
batch_normalization_196 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_196[0][0]
activation_196 (Activation)	(None, 10, 10, 64)	0	batch_normalization_1…
conv2d_194 (Conv2D)	(None, 10, 10, 48)	9,216	max_pooling2d_9[0][0]
conv2d_197 (Conv2D)	(None, 10, 10, 96)	55,296	activation_196[0][0]
batch_normalization_194 (BatchNormalization)	(None, 10, 10, 48)	144	conv2d_194[0][0]
batch_normalization_197 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_197[0][0]
activation_194 (Activation)	(None, 10, 10, 48)	0	batch_normalization_1…
activation_197 (Activation)	(None, 10, 10, 96)	0	batch_normalization_1…
average_pooling2d_18 (AveragePooling2D)	(None, 10, 10, 192)	0	max_pooling2d_9[0][0]
conv2d_193 (Conv2D)	(None, 10, 10, 64)	12,288	max_pooling2d_9[0][0]
conv2d_195 (Conv2D)	(None, 10, 10, 64)	76,800	activation_194[0][0]
conv2d_198 (Conv2D)	(None, 10, 10, 96)	82,944	activation_197[0][0]
conv2d_199 (Conv2D)	(None, 10, 10, 32)	6,144	average_pooling2d_18[…
batch_normalization_193 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_193[0][0]
batch_normalization_195 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_195[0][0]
batch_normalization_198 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_198[0][0]
batch_normalization_199	(None, 10, 10, 32)	96	conv2d_199[0][0]

(BatchNormalization)			
activation_193 (Activation)	(None, 10, 10, 64)	0	batch_normalization_1…
activation_195 (Activation)	(None, 10, 10, 64)	0	batch_normalization_1…
activation_198 (Activation)	(None, 10, 10, 96)	0	batch_normalization_1…
activation_199 (Activation)	(None, 10, 10, 32)	0	batch_normalization_1…
mixed0 (Concatenate)	(None, 10, 10, 256)	0	activation_193[0][0], activation_195[0][0], activation_198[0][0], activation_199[0][0]
conv2d_203 (Conv2D)	(None, 10, 10, 64)	16,384	mixed0[0][0]
batch_normalization_203 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_203[0][0]
activation_203 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
conv2d_201 (Conv2D)	(None, 10, 10, 48)	12,288	mixed0[0][0]
conv2d_204 (Conv2D)	(None, 10, 10, 96)	55,296	activation_203[0][0]
batch_normalization_201 (BatchNormalization)	(None, 10, 10, 48)	144	conv2d_201[0][0]
batch_normalization_204 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_204[0][0]
activation_201 (Activation)	(None, 10, 10, 48)	0	batch_normalization_2…
activation_204 (Activation)	(None, 10, 10, 96)	0	batch_normalization_2…
average_pooling2d_19 (AveragePooling2D)	(None, 10, 10, 256)	0	mixed0[0][0]
conv2d_200 (Conv2D)	(None, 10, 10, 64)	16,384	mixed0[0][0]
conv2d_202 (Conv2D)	(None, 10, 10, 64)	76,800	activation_201[0][0]
conv2d_205 (Conv2D)	(None, 10, 10, 96)	82,944	activation_204[0][0]
conv2d_206 (Conv2D)	(None, 10, 10, 64)	16,384	average_pooling2d_19[…
batch_normalization_200 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_200[0][0]
batch_normalization_202 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_202[0][0]
batch_normalization_205 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_205[0][0]
batch_normalization_206 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_206[0][0]
activation_200 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
activation_202 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
activation_205 (Activation)	(None, 10, 10, 96)	0	batch_normalization_2…
activation_206 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
mixed1 (Concatenate)	(None, 10, 10, 288)	0	activation_200[0][0], activation_202[0][0], activation_205[0][0], activation_206[0][0]
conv2d_210 (Conv2D)	(None, 10, 10, 64)	18,432	mixed1[0][0]
batch_normalization_210 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_210[0][0]
activation_210 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
conv2d_208 (Conv2D)	(None, 10, 10, 48)	13,824	mixed1[0][0]
conv2d_211 (Conv2D)	(None, 10, 10, 96)	55,296	activation_210[0][0]
batch_normalization_208 (BatchNormalization)	(None, 10, 10, 48)	144	conv2d_208[0][0]

batch_normalization_211 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_211[0][0]
activation_208 (Activation)	(None, 10, 10, 48)	0	batch_normalization_2…
activation_211 (Activation)	(None, 10, 10, 96)	0	batch_normalization_2…
average_pooling2d_20 (AveragePooling2D)	(None, 10, 10, 288)	0	mixed1[0][0]
conv2d_207 (Conv2D)	(None, 10, 10, 64)	18,432	mixed1[0][0]
conv2d_209 (Conv2D)	(None, 10, 10, 64)	76,800	activation_208[0][0]
conv2d_212 (Conv2D)	(None, 10, 10, 96)	82,944	activation_211[0][0]
conv2d_213 (Conv2D)	(None, 10, 10, 64)	18,432	average_pooling2d_20[…
batch_normalization_207 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_207[0][0]
batch_normalization_209 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_209[0][0]
batch_normalization_212 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_212[0][0]
batch_normalization_213 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_213[0][0]
activation_207 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
activation_209 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
activation_212 (Activation)	(None, 10, 10, 96)	0	batch_normalization_2…
activation_213 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
mixed2 (Concatenate)	(None, 10, 10, 288)	0	activation_207[0][0], activation_209[0][0], activation_212[0][0], activation_213[0][0]
conv2d_215 (Conv2D)	(None, 10, 10, 64)	18,432	mixed2[0][0]
batch_normalization_215 (BatchNormalization)	(None, 10, 10, 64)	192	conv2d_215[0][0]
activation_215 (Activation)	(None, 10, 10, 64)	0	batch_normalization_2…
conv2d_216 (Conv2D)	(None, 10, 10, 96)	55,296	activation_215[0][0]
batch_normalization_216 (BatchNormalization)	(None, 10, 10, 96)	288	conv2d_216[0][0]
activation_216 (Activation)	(None, 10, 10, 96)	0	batch_normalization_2…
conv2d_214 (Conv2D)	(None, 4, 4, 384)	995,328	mixed2[0][0]
conv2d_217 (Conv2D)	(None, 4, 4, 96)	82,944	activation_216[0][0]
batch_normalization_214 (BatchNormalization)	(None, 4, 4, 384)	1,152	conv2d_214[0][0]
batch_normalization_217 (BatchNormalization)	(None, 4, 4, 96)	288	conv2d_217[0][0]
activation_214 (Activation)	(None, 4, 4, 384)	0	batch_normalization_2…
activation_217 (Activation)	(None, 4, 4, 96)	0	batch_normalization_2…
max_pooling2d_10 (MaxPooling2D)	(None, 4, 4, 288)	0	mixed2[0][0]
mixed3 (Concatenate)	(None, 4, 4, 768)	0	activation_214[0][0], activation_217[0][0], max_pooling2d_10[0][0]
conv2d_222 (Conv2D)	(None, 4, 4, 128)	98,304	mixed3[0][0]
batch_normalization_222 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_222[0][0]
activation_222 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
conv2d_223 (Conv2D)	(None, 4, 4, 128)	114,688	activation_222[0][0]

batch_normalization_223 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_223[0][0]
activation_223 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
conv2d_219 (Conv2D)	(None, 4, 4, 128)	98,304	mixed3[0][0]
conv2d_224 (Conv2D)	(None, 4, 4, 128)	114,688	activation_223[0][0]
batch_normalization_219 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_219[0][0]
batch_normalization_224 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_224[0][0]
activation_219 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
activation_224 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
conv2d_220 (Conv2D)	(None, 4, 4, 128)	114,688	activation_219[0][0]
conv2d_225 (Conv2D)	(None, 4, 4, 128)	114,688	activation_224[0][0]
batch_normalization_220 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_220[0][0]
batch_normalization_225 (BatchNormalization)	(None, 4, 4, 128)	384	conv2d_225[0][0]
activation_220 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
activation_225 (Activation)	(None, 4, 4, 128)	0	batch_normalization_2…
average_pooling2d_21 (AveragePooling2D)	(None, 4, 4, 768)	0	mixed3[0][0]
conv2d_218 (Conv2D)	(None, 4, 4, 192)	147,456	mixed3[0][0]
conv2d_221 (Conv2D)	(None, 4, 4, 192)	172,032	activation_220[0][0]
conv2d_226 (Conv2D)	(None, 4, 4, 192)	172,032	activation_225[0][0]
conv2d_227 (Conv2D)	(None, 4, 4, 192)	147,456	average_pooling2d_21[…
batch_normalization_218 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_218[0][0]
batch_normalization_221 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_221[0][0]
batch_normalization_226 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_226[0][0]
batch_normalization_227 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_227[0][0]
activation_218 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_221 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_226 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_227 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
mixed4 (Concatenate)	(None, 4, 4, 768)	0	activation_218[0][0], activation_221[0][0], activation_226[0][0], activation_227[0][0]
conv2d_232 (Conv2D)	(None, 4, 4, 160)	122,880	mixed4[0][0]
batch_normalization_232 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_232[0][0]
activation_232 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
conv2d_233 (Conv2D)	(None, 4, 4, 160)	179,200	activation_232[0][0]
batch_normalization_233 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_233[0][0]
activation_233 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
conv2d_229 (Conv2D)	(None, 4, 4, 160)	122,880	mixed4[0][0]
conv2d_234 (Conv2D)	(None, 4, 4, 160)	179,200	activation_233[0][0]

batch_normalization_229 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_229[0][0]
batch_normalization_234 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_234[0][0]
activation_229 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
activation_234 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
conv2d_230 (Conv2D)	(None, 4, 4, 160)	179,200	activation_229[0][0]
conv2d_235 (Conv2D)	(None, 4, 4, 160)	179,200	activation_234[0][0]
batch_normalization_230 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_230[0][0]
batch_normalization_235 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_235[0][0]
activation_230 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
activation_235 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
average_pooling2d_22 (AveragePooling2D)	(None, 4, 4, 768)	0	mixed4[0][0]
conv2d_228 (Conv2D)	(None, 4, 4, 192)	147,456	mixed4[0][0]
conv2d_231 (Conv2D)	(None, 4, 4, 192)	215,040	activation_230[0][0]
conv2d_236 (Conv2D)	(None, 4, 4, 192)	215,040	activation_235[0][0]
conv2d_237 (Conv2D)	(None, 4, 4, 192)	147,456	average_pooling2d_22[…
batch_normalization_228 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_228[0][0]
batch_normalization_231 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_231[0][0]
batch_normalization_236 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_236[0][0]
batch_normalization_237 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_237[0][0]
activation_228 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_231 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_236 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_237 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
mixed5 (Concatenate)	(None, 4, 4, 768)	0	activation_228[0][0], activation_231[0][0], activation_236[0][0], activation_237[0][0]
conv2d_242 (Conv2D)	(None, 4, 4, 160)	122,880	mixed5[0][0]
batch_normalization_242 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_242[0][0]
activation_242 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
conv2d_243 (Conv2D)	(None, 4, 4, 160)	179,200	activation_242[0][0]
batch_normalization_243 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_243[0][0]
activation_243 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
conv2d_239 (Conv2D)	(None, 4, 4, 160)	122,880	mixed5[0][0]
conv2d_244 (Conv2D)	(None, 4, 4, 160)	179,200	activation_243[0][0]
batch_normalization_239 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_239[0][0]
batch_normalization_244 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_244[0][0]
activation_239 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
activation_244 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…

(Activation)			
conv2d_240 (Conv2D)	(None, 4, 4, 160)	179,200	activation_239[0][0]
conv2d_245 (Conv2D)	(None, 4, 4, 160)	179,200	activation_244[0][0]
batch_normalization_240 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_240[0][0]
batch_normalization_245 (BatchNormalization)	(None, 4, 4, 160)	480	conv2d_245[0][0]
activation_240 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
activation_245 (Activation)	(None, 4, 4, 160)	0	batch_normalization_2…
average_pooling2d_23 (AveragePooling2D)	(None, 4, 4, 768)	0	mixed5[0][0]
conv2d_238 (Conv2D)	(None, 4, 4, 192)	147,456	mixed5[0][0]
conv2d_241 (Conv2D)	(None, 4, 4, 192)	215,040	activation_240[0][0]
conv2d_246 (Conv2D)	(None, 4, 4, 192)	215,040	activation_245[0][0]
conv2d_247 (Conv2D)	(None, 4, 4, 192)	147,456	average_pooling2d_23[…
batch_normalization_238 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_238[0][0]
batch_normalization_241 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_241[0][0]
batch_normalization_246 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_246[0][0]
batch_normalization_247 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_247[0][0]
activation_238 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_241 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_246 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_247 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
mixed6 (Concatenate)	(None, 4, 4, 768)	0	activation_238[0][0], activation_241[0][0], activation_246[0][0], activation_247[0][0]
conv2d_252 (Conv2D)	(None, 4, 4, 192)	147,456	mixed6[0][0]
batch_normalization_252 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_252[0][0]
activation_252 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_253 (Conv2D)	(None, 4, 4, 192)	258,048	activation_252[0][0]
batch_normalization_253 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_253[0][0]
activation_253 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_249 (Conv2D)	(None, 4, 4, 192)	147,456	mixed6[0][0]
conv2d_254 (Conv2D)	(None, 4, 4, 192)	258,048	activation_253[0][0]
batch_normalization_249 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_249[0][0]
batch_normalization_254 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_254[0][0]
activation_249 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_254 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_250 (Conv2D)	(None, 4, 4, 192)	258,048	activation_249[0][0]
conv2d_255 (Conv2D)	(None, 4, 4, 192)	258,048	activation_254[0][0]
batch_normalization_250 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_250[0][0]
batch_normalization_255 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_255[0][0]

activation_250 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_255 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
average_pooling2d_24 (AveragePooling2D)	(None, 4, 4, 768)	0	mixed6[0][0]
conv2d_248 (Conv2D)	(None, 4, 4, 192)	147,456	mixed6[0][0]
conv2d_251 (Conv2D)	(None, 4, 4, 192)	258,048	activation_250[0][0]
conv2d_256 (Conv2D)	(None, 4, 4, 192)	258,048	activation_255[0][0]
conv2d_257 (Conv2D)	(None, 4, 4, 192)	147,456	average_pooling2d_24[…
batch_normalization_248 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_248[0][0]
batch_normalization_251 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_251[0][0]
batch_normalization_256 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_256[0][0]
batch_normalization_257 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_257[0][0]
activation_248 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_251 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_256 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_257 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
mixed7 (Concatenate)	(None, 4, 4, 768)	0	activation_248[0][0], activation_251[0][0], activation_256[0][0], activation_257[0][0]
conv2d_260 (Conv2D)	(None, 4, 4, 192)	147,456	mixed7[0][0]
batch_normalization_260 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_260[0][0]
activation_260 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_261 (Conv2D)	(None, 4, 4, 192)	258,048	activation_260[0][0]
batch_normalization_261 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_261[0][0]
activation_261 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_258 (Conv2D)	(None, 4, 4, 192)	147,456	mixed7[0][0]
conv2d_262 (Conv2D)	(None, 4, 4, 192)	258,048	activation_261[0][0]
batch_normalization_258 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_258[0][0]
batch_normalization_262 (BatchNormalization)	(None, 4, 4, 192)	576	conv2d_262[0][0]
activation_258 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
activation_262 (Activation)	(None, 4, 4, 192)	0	batch_normalization_2…
conv2d_259 (Conv2D)	(None, 1, 1, 320)	552,960	activation_258[0][0]
conv2d_263 (Conv2D)	(None, 1, 1, 192)	331,776	activation_262[0][0]
batch_normalization_259 (BatchNormalization)	(None, 1, 1, 320)	960	conv2d_259[0][0]
batch_normalization_263 (BatchNormalization)	(None, 1, 1, 192)	576	conv2d_263[0][0]
activation_259 (Activation)	(None, 1, 1, 320)	0	batch_normalization_2…
activation_263 (Activation)	(None, 1, 1, 192)	0	batch_normalization_2…
max_pooling2d_11 (MaxPooling2D)	(None, 1, 1, 768)	0	mixed7[0][0]

mixed8 (Concatenate)	(None, 1, 1, 1280)	0	activation_259[0][0], activation_263[0][0], max_pooling2d_11[0][0]
conv2d_268 (Conv2D)	(None, 1, 1, 448)	573,440	mixed8[0][0]
batch_normalization_268 (BatchNormalization)	(None, 1, 1, 448)	1,344	conv2d_268[0][0]
activation_268 (Activation)	(None, 1, 1, 448)	0	batch_normalization_2…
conv2d_265 (Conv2D)	(None, 1, 1, 384)	491,520	mixed8[0][0]
conv2d_269 (Conv2D)	(None, 1, 1, 384)	1,548,288	activation_268[0][0]
batch_normalization_265 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_265[0][0]
batch_normalization_269 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_269[0][0]
activation_265 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_269 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
conv2d_266 (Conv2D)	(None, 1, 1, 384)	442,368	activation_265[0][0]
conv2d_267 (Conv2D)	(None, 1, 1, 384)	442,368	activation_265[0][0]
conv2d_270 (Conv2D)	(None, 1, 1, 384)	442,368	activation_269[0][0]
conv2d_271 (Conv2D)	(None, 1, 1, 384)	442,368	activation_269[0][0]
average_pooling2d_25 (AveragePooling2D)	(None, 1, 1, 1280)	0	mixed8[0][0]
conv2d_264 (Conv2D)	(None, 1, 1, 320)	409,600	mixed8[0][0]
batch_normalization_266 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_266[0][0]
batch_normalization_267 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_267[0][0]
batch_normalization_270 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_270[0][0]
batch_normalization_271 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_271[0][0]
conv2d_272 (Conv2D)	(None, 1, 1, 192)	245,760	average_pooling2d_25[…
batch_normalization_264 (BatchNormalization)	(None, 1, 1, 320)	960	conv2d_264[0][0]
activation_266 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_267 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_270 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_271 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
batch_normalization_272 (BatchNormalization)	(None, 1, 1, 192)	576	conv2d_272[0][0]
activation_264 (Activation)	(None, 1, 1, 320)	0	batch_normalization_2…
mixed9_0 (Concatenate)	(None, 1, 1, 768)	0	activation_266[0][0], activation_267[0][0]
concatenate_4 (Concatenate)	(None, 1, 1, 768)	0	activation_270[0][0], activation_271[0][0]
activation_272 (Activation)	(None, 1, 1, 192)	0	batch_normalization_2…
mixed9 (Concatenate)	(None, 1, 1, 2048)	0	activation_264[0][0], mixed9_0[0][0], concatenate_4[0][0], activation_272[0][0]
conv2d_277 (Conv2D)	(None, 1, 1, 448)	917,504	mixed9[0][0]
batch_normalization_277 (BatchNormalization)	(None, 1, 1, 448)	1,344	conv2d_277[0][0]
activation_277 (Activation)	(None, 1, 1, 448)	0	batch_normalization_2…

conv2d_274 (Conv2D)	(None, 1, 1, 384)	786,432	mixed9[0][0]
conv2d_278 (Conv2D)	(None, 1, 1, 384)	1,548,288	activation_277[0][0]
batch_normalization_274 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_274[0][0]
batch_normalization_278 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_278[0][0]
activation_274 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_278 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
conv2d_275 (Conv2D)	(None, 1, 1, 384)	442,368	activation_274[0][0]
conv2d_276 (Conv2D)	(None, 1, 1, 384)	442,368	activation_274[0][0]
conv2d_279 (Conv2D)	(None, 1, 1, 384)	442,368	activation_278[0][0]
conv2d_280 (Conv2D)	(None, 1, 1, 384)	442,368	activation_278[0][0]
average_pooling2d_26 (AveragePooling2D)	(None, 1, 1, 2048)	0	mixed9[0][0]
conv2d_273 (Conv2D)	(None, 1, 1, 320)	655,360	mixed9[0][0]
batch_normalization_275 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_275[0][0]
batch_normalization_276 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_276[0][0]
batch_normalization_279 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_279[0][0]
batch_normalization_280 (BatchNormalization)	(None, 1, 1, 384)	1,152	conv2d_280[0][0]
conv2d_281 (Conv2D)	(None, 1, 1, 192)	393,216	average_pooling2d_26[…
batch_normalization_273 (BatchNormalization)	(None, 1, 1, 320)	960	conv2d_273[0][0]
activation_275 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_276 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_279 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
activation_280 (Activation)	(None, 1, 1, 384)	0	batch_normalization_2…
batch_normalization_281 (BatchNormalization)	(None, 1, 1, 192)	576	conv2d_281[0][0]
activation_273 (Activation)	(None, 1, 1, 320)	0	batch_normalization_2…
mixed9_1 (Concatenate)	(None, 1, 1, 768)	0	activation_275[0][0], activation_276[0][0]
concatenate_5 (Concatenate)	(None, 1, 1, 768)	0	activation_279[0][0], activation_280[0][0]
activation_281 (Activation)	(None, 1, 1, 192)	0	batch_normalization_2…
mixed10 (Concatenate)	(None, 1, 1, 2048)	0	activation_273[0][0], mixed9_1[0][0], concatenate_5[0][0], activation_281[0][0]
global_average_pooling2d… (GlobalAveragePooling2D)	(None, 2048)	0	mixed10[0][0]
dense_4 (Dense)	(None, 1024)	2,098,176	global_average_poolin…
dense_5 (Dense)	(None, 1)	1,025	dense_4[0][0]

Total params: 23,901,985 (91.18 MB)
Trainable params: 2,099,201 (8.01 MB)

```
# Step 5: Training
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])

history = model.fit(
    train_generator,
    epochs=10,
    validation_data=val_generator
)
```

```
Epoch 1/10
/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()
33/33 ━━━━━━━━━━━━━━━━━━━━ 37s 646ms/step - accuracy: 0.7046 - loss: 1.1739 - val_accuracy: 0.8923 - val_loss: 0.2862
Epoch 2/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 16s 84ms/step - accuracy: 0.8878 - loss: 0.2849 - val_accuracy: 0.9038 - val_loss: 0.2972
Epoch 3/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 3s 82ms/step - accuracy: 0.9183 - loss: 0.2499 - val_accuracy: 0.9077 - val_loss: 0.2611
Epoch 4/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 4s 121ms/step - accuracy: 0.8856 - loss: 0.3089 - val_accuracy: 0.9154 - val_loss: 0.2524
Epoch 5/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 3s 79ms/step - accuracy: 0.8824 - loss: 0.2917 - val_accuracy: 0.9192 - val_loss: 0.2357
Epoch 6/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 3s 79ms/step - accuracy: 0.9021 - loss: 0.2894 - val_accuracy: 0.9192 - val_loss: 0.2274
Epoch 7/10
33/33 ━━━━━━━━━━━━━━━━━━━━ 3s 83ms/step - accuracy: 0.9112 - loss: 0.2132 - val_accuracy: 0.9231 - val_loss: 0.2594
```

```
# Step 6: Evaluation
y_val_pred = (model.predict(X_val) > 0.5).astype("int32")

print(classification_report(y_val, y_val_pred, target_names=['crop', 'weed']))

conf_mat = confusion_matrix(y_val, y_val_pred)
sns.heatmap(conf_mat, annot=True, fmt='d', cmap='Blues', xticklabels=['crop', 'weed'], yticklabels=['crop', 'weed'])
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()

# Plot training & validation accuracy values
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')

# Plot training & validation loss values
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')
plt.show()
```

```
9/9 ━━━━━━━━━━━━━━━━━━━━ 9s 565ms/step
              precision    recall  f1-score   support

        crop       0.91      0.93      0.92       127
        weed       0.93      0.92      0.92       133

    accuracy                           0.92       260
   macro avg       0.92      0.92      0.92       260
```