

```
In [1]: import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow.keras import models, layers
import numpy as np
import tensorflow as tf
import math
from tensorflow.keras.applications import ResNet50
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import BatchNormalization
from sklearn.metrics import confusion_matrix
import seaborn as sns
import matplotlib.offsetbox as offsetbox
from PIL import Image
import os
```

```
In [2]: df = tf.keras.preprocessing.image_dataset_from_directory(r"C:\Users\soura\OneDrive\Desktop\AI vs Real",  
                                                               shuffle=True,  
                                                               image_size=(256, 256),  
                                                               batch_size=32)
```

Found 2000 files belonging to 2 classes.

```
In [3]: classes = df.class_names  
classes
```

```
Out[3]: ['AI', 'Real']
```

```
In [4]: train_size = 0.7  
len(df)*train_size
```

```
Out[4]: 44.099999999999994
```

```
In [8]: train_ds = df.take(44)  
len(train_ds)
```

```
Out[8]: 44
```

```
In [10]: test_ds = df.skip(44)  
len(test_ds)
```

```
Out[10]: 19
```

```
In [11]: val_ds = test_ds.take(19)  
len(val_ds)
```

```
Out[11]: 19
```

```
In [12]: train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
test_ds = test_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
```

```
In [13]: resize_and_rescale = tf.keras.Sequential([
    layers.experimental.preprocessing.Resizing(256, 256),
    layers.experimental.preprocessing.Rescaling(1./255),
])
```

```
In [14]: @tf.function
def preprocess_data(x, y):
    x = tf.image.random_flip_left_right(x)
    x = tf.image.random_flip_up_down(x)
    k = tf.random.uniform(shape=[], minval=0, maxval=4, dtype=tf.int32)
    x = tf.image.rot90(x, k=k)
    x = tf.image.random_brightness(x, max_delta=0.1)
    x = tf.image.random_contrast(x, lower=0.8, upper=1.2)
    x = tf.image.random_hue(x, max_delta=0.1)
    x = tf.image.per_image_standardization(x)

    return x, y
batch_size = 32

preprocessed_train_ds = train_ds.map(preprocess_data).prefetch(buffer_size=tf.data.AUTOTUNE)
preprocessed_val_ds = val_ds.map(preprocess_data).prefetch(buffer_size=tf.data.AUTOTUNE)
```

```
In [15]: base_model = ResNet50(weights='imagenet', include_top=False, input_shape=(256, 256, 3))
```

```
In [16]: initial_learning_rate = 0.001
decay_rate = 0.1
decay_steps = 10

num_classes = 2
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(1024, activation='relu')(x)
x = Dropout(0.5)(x)
x = Dense(512, activation='relu')(x)
x = Dropout(0.5)(x)
x = Dense(256, activation='relu')(x)
x = Dropout(0.5)(x)
x = Dense(128, activation='relu')(x)
x = Dropout(0.5)(x)
x = Dense(64, activation='relu')(x)
predictions = Dense(num_classes, activation='softmax')(x)

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

# Freeze the Layers of the base model
for layer in base_model.layers:
    layer.trainable = False
```

```
In [17]: model.summary()
```

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
<hr/>			
input_1 (InputLayer)	[(None, 256, 256, 3 0 )]		[]
conv1_pad (ZeroPadding2D)	(None, 262, 262, 3) 0		['input_1[0][0]']
conv1_conv (Conv2D)	(None, 128, 128, 64 9472 )		['conv1_pad[0][0]']
conv1_bn (BatchNormalization)	(None, 128, 128, 64 256 )		['conv1_conv[0][0]']
conv1_relu (Activation)	(None, 128, 128, 64 0 )		['conv1_bn[0][0]']
pool1_pad (ZeroPadding2D)	(None, 130, 130, 64 0 )		['conv1_relu[0][0]']
pool1_pool (MaxPooling2D)	(None, 64, 64, 64) 0		['pool1_pad[0][0]']
conv2_block1_1_conv (Conv2D)	(None, 64, 64, 64) 4160		['pool1_pool[0][0]']
conv2_block1_1_bn (BatchNormal v[0][0])	(None, 64, 64, 64) 256		['conv2_block1_1_con
conv2_block1_1_relu (Activatio n[0][0])	(None, 64, 64, 64) 0		['conv2_block1_1_bn
conv2_block1_2_conv (Conv2D)	(None, 64, 64, 64) 36928		['conv2_block1_1_rel
conv2_block1_2_bn (BatchNormal v[0][0])	(None, 64, 64, 64) 256		['conv2_block1_2_con
conv2_block1_2_relu (Activatio n[0][0])	(None, 64, 64, 64) 0		['conv2_block1_2_bn
conv2_block1_0_conv (Conv2D)	(None, 64, 64, 256) 16640		['pool1_pool[0][0]']
conv2_block1_3_conv (Conv2D)	(None, 64, 64, 256) 16640		['conv2_block1_2_rel
conv2_block1_0_bn (BatchNormal v[0][0])	(None, 64, 64, 256) 1024		['conv2_block1_0_con
conv2_block1_3_bn (BatchNormal v[0][0])	(None, 64, 64, 256) 1024		['conv2_block1_3_con
conv2_block1_add (Add)	(None, 64, 64, 256) 0		['conv2_block1_0_bn

[0][0]',		'conv2_block1_3_bn
[0][0]'		
conv2_block1_out (Activation) (None, 64, 64, 256) 0		['conv2_block1_add
[0][0]'		
conv2_block2_1_conv (Conv2D) (None, 64, 64, 64) 16448		['conv2_block1_out
[0][0]'		
conv2_block2_1_bn (BatchNormal (None, 64, 64, 64) 256		['conv2_block2_1_con
v[0][0]'		
ization)		
conv2_block2_1_relu (Activatio (None, 64, 64, 64) 0		['conv2_block2_1_bn
[0][0]'		
n)		
conv2_block2_2_conv (Conv2D) (None, 64, 64, 64) 36928		['conv2_block2_1_rel
u[0][0]'		
conv2_block2_2_bn (BatchNormal (None, 64, 64, 64) 256		['conv2_block2_2_con
v[0][0]'		
ization)		
conv2_block2_2_relu (Activatio (None, 64, 64, 64) 0		['conv2_block2_2_bn
[0][0]'		
n)		
conv2_block2_3_conv (Conv2D) (None, 64, 64, 256) 16640		['conv2_block2_2_rel
u[0][0]'		
conv2_block2_3_bn (BatchNormal (None, 64, 64, 256) 1024		['conv2_block2_3_con
v[0][0]'		
ization)		
conv2_block2_add (Add) (None, 64, 64, 256) 0		['conv2_block1_out
[0][0]',		
[0][0]'		'conv2_block2_3_bn
conv2_block2_out (Activation) (None, 64, 64, 256) 0		['conv2_block2_add
[0][0]'		
conv2_block3_1_conv (Conv2D) (None, 64, 64, 64) 16448		['conv2_block2_out
[0][0]'		
conv2_block3_1_bn (BatchNormal (None, 64, 64, 64) 256		['conv2_block3_1_con
v[0][0]'		
ization)		
conv2_block3_1_relu (Activatio (None, 64, 64, 64) 0		['conv2_block3_1_bn
[0][0]'		
n)		
conv2_block3_2_conv (Conv2D) (None, 64, 64, 64) 36928		['conv2_block3_1_rel
u[0][0]'		
conv2_block3_2_bn (BatchNormal (None, 64, 64, 64) 256		['conv2_block3_2_con
v[0][0]'		

ization)			
conv2_block3_2_relu (Activation) [0][0]'	(None, 64, 64, 64) 0	16640	['conv2_block3_2_bn', 'conv2_block3_2_relu[0][0]']
conv2_block3_3_conv (Conv2D) u[0][0]'	(None, 64, 64, 256)	1024	['conv2_block3_3_conv[0][0]']
conv2_block3_3_bn (BatchNormal v[0][0]'	(None, 64, 64, 256)	1024	['conv2_block3_3_bnv[0][0]']
conv2_block3_add (Add) [0][0]', [0][0]'	(None, 64, 64, 256) 0		['conv2_block2_out', 'conv2_block3_3_bn[0][0]']
conv2_block3_out (Activation) [0][0]'	(None, 64, 64, 256) 0		['conv2_block3_add[0][0]']
conv3_block1_1_conv (Conv2D) [0][0]'	(None, 32, 32, 128) 32896		['conv2_block3_out[0][0]']
conv3_block1_1_bn (BatchNormal v[0][0]'	(None, 32, 32, 128) 512		['conv3_block1_1_bnv[0][0]']
conv3_block1_1_relu (Activatio n) [0][0]'	(None, 32, 32, 128) 0		['conv3_block1_1_bn[0][0]']
conv3_block1_2_conv (Conv2D) u[0][0]'	(None, 32, 32, 128) 147584		['conv3_block1_1_relu[0][0]']
conv3_block1_2_bn (BatchNormal v[0][0]'	(None, 32, 32, 128) 512		['conv3_block1_2_conv[0][0]']
conv3_block1_2_relu (Activatio n) [0][0]'	(None, 32, 32, 128) 0		['conv3_block1_2_bn[0][0]']
conv3_block1_0_conv (Conv2D) [0][0]'	(None, 32, 32, 512) 131584		['conv2_block3_out[0][0]']
conv3_block1_3_conv (Conv2D) u[0][0]'	(None, 32, 32, 512) 66048		['conv3_block1_2_relu[0][0]']
conv3_block1_0_bn (BatchNormal v[0][0]'	(None, 32, 32, 512) 2048		['conv3_block1_0_conv[0][0]']
conv3_block1_3_bn (BatchNormal v[0][0]'	(None, 32, 32, 512) 2048		['conv3_block1_3_conv[0][0]']
conv3_block1_add (Add) [0][0]',	(None, 32, 32, 512) 0		['conv3_block1_0_bn[0][0]', 'conv3_block1_3_bn[0][0]']

[0][0]'			
conv3_block1_out (Activation) (None, 32, 32, 512) 0			['conv3_block1_add
[0][0]'			
conv3_block2_1_conv (Conv2D) (None, 32, 32, 128) 65664			['conv3_block1_out
[0][0]'			
conv3_block2_1_bn (BatchNormal (None, 32, 32, 128) 512			['conv3_block2_1_con
v[0][0]'			ization)
conv3_block2_1_relu (Activatio (None, 32, 32, 128) 0			['conv3_block2_1_bn
[0][0]'			n)
conv3_block2_2_conv (Conv2D) (None, 32, 32, 128) 147584			['conv3_block2_1_rel
u[0][0]'			
conv3_block2_2_bn (BatchNormal (None, 32, 32, 128) 512			['conv3_block2_2_con
v[0][0]'			ization)
conv3_block2_2_relu (Activatio (None, 32, 32, 128) 0			['conv3_block2_2_bn
[0][0]'			n)
conv3_block2_3_conv (Conv2D) (None, 32, 32, 512) 66048			['conv3_block2_2_rel
u[0][0]'			
conv3_block2_3_bn (BatchNormal (None, 32, 32, 512) 2048			['conv3_block2_3_con
v[0][0]'			ization)
conv3_block2_add (Add) (None, 32, 32, 512) 0			['conv3_block1_out
[0][0]',			'conv3_block2_3_bn
[0][0]'			
conv3_block2_out (Activation) (None, 32, 32, 512) 0			['conv3_block2_add
[0][0]'			
conv3_block3_1_conv (Conv2D) (None, 32, 32, 128) 65664			['conv3_block2_out
[0][0]'			
conv3_block3_1_bn (BatchNormal (None, 32, 32, 128) 512			['conv3_block3_1_con
v[0][0]'			ization)
conv3_block3_1_relu (Activatio (None, 32, 32, 128) 0			['conv3_block3_1_bn
[0][0]'			n)
conv3_block3_2_conv (Conv2D) (None, 32, 32, 128) 147584			['conv3_block3_1_rel
u[0][0]'			
conv3_block3_2_bn (BatchNormal (None, 32, 32, 128) 512			['conv3_block3_2_con
v[0][0]'			ization)

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conv3_block3_2_relu (Activation) (None, 32, 32, 128) 0	[ 'conv3_block3_2_bn [0][0]' ]
conv3_block3_3_conv (Conv2D) (None, 32, 32, 512) 66048	[ 'conv3_block3_2_relu [0][0]' ]
conv3_block3_3_bn (BatchNormal (None, 32, 32, 512) 2048	[ 'conv3_block3_3_con v[0][0]' ]
conv3_block3_3_relu (Activation) (None, 32, 32, 512) 0	[ 'conv3_block3_3_ization' ]
conv3_block3_add (Add) (None, 32, 32, 512) 0	[ 'conv3_block2_out [0][0]',
[0][0]' ]	'conv3_block3_3_bn
conv3_block3_out (Activation) (None, 32, 32, 512) 0	[ 'conv3_block3_add [0][0]' ]
conv3_block4_1_conv (Conv2D) (None, 32, 32, 128) 65664	[ 'conv3_block3_out [0][0]' ]
conv3_block4_1_bn (BatchNormal (None, 32, 32, 128) 512	[ 'conv3_block4_1_con v[0][0]' ]
conv3_block4_1_relu (Activation) (None, 32, 32, 128) 0	[ 'conv3_block4_1_ization' ]
[0][0]' ]	n)
conv3_block4_2_conv (Conv2D) (None, 32, 32, 128) 147584	[ 'conv3_block4_1_rel u[0][0]' ]
conv3_block4_2_bn (BatchNormal (None, 32, 32, 128) 512	[ 'conv3_block4_2_con v[0][0]' ]
conv3_block4_2_relu (Activation) (None, 32, 32, 128) 0	[ 'conv3_block4_2_ization' ]
[0][0]' ]	n)
conv3_block4_3_conv (Conv2D) (None, 32, 32, 512) 66048	[ 'conv3_block4_2_rel u[0][0]' ]
conv3_block4_3_bn (BatchNormal (None, 32, 32, 512) 2048	[ 'conv3_block4_3_con v[0][0]' ]
conv3_block4_3_relu (Activation) (None, 32, 32, 512) 0	[ 'conv3_block4_3_ization' ]
conv3_block4_add (Add) (None, 32, 32, 512) 0	[ 'conv3_block3_out [0][0]',
[0][0]' ]	'conv3_block4_3_bn
conv3_block4_out (Activation) (None, 32, 32, 512) 0	[ 'conv3_block4_add [0][0]' ]
conv4_block1_1_conv (Conv2D) (None, 16, 16, 256) 131328	[ 'conv3_block4_out [0][0]' ]
conv4_block1_1_bn (BatchNormal (None, 16, 16, 256) 1024	[ 'conv4_block1_1_con

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v[0][0]['  
    ziation)  
  
    conv4_block1_1_relu (Activatio (None, 16, 16, 256) 0  
[0][0]['  
    n)  
  
    conv4_block1_2_conv (Conv2D) (None, 16, 16, 256) 590080  
u[0][0]['  
  
    conv4_block1_2_bn (BatchNormal (None, 16, 16, 256) 1024  
v[0][0]['  
    ziation)  
  
    conv4_block1_2_relu (Activatio (None, 16, 16, 256) 0  
[0][0]['  
    n)  
  
    conv4_block1_0_conv (Conv2D) (None, 16, 16, 1024 525312  
[0][0]['  
        )  
  
    conv4_block1_3_conv (Conv2D) (None, 16, 16, 1024 263168  
u[0][0]['  
        )  
  
    conv4_block1_0_bn (BatchNormal (None, 16, 16, 1024 4096  
v[0][0]['  
        ziation)  
        )  
  
    conv4_block1_3_bn (BatchNormal (None, 16, 16, 1024 4096  
v[0][0]['  
        ziation)  
        )  
  
    conv4_block1_add (Add) (None, 16, 16, 1024 0  
[0][0]',  
        )  
[0][0]'  
  
    conv4_block1_out (Activation) (None, 16, 16, 1024 0  
[0][0]')  
        )  
  
    conv4_block2_1_conv (Conv2D) (None, 16, 16, 256) 262400  
[0][0]'  
  
    conv4_block2_1_bn (BatchNormal (None, 16, 16, 256) 1024  
v[0][0]['  
        ziation)  
  
    conv4_block2_1_relu (Activatio (None, 16, 16, 256) 0  
[0][0]'  
        n)  
  
    conv4_block2_2_conv (Conv2D) (None, 16, 16, 256) 590080  
u[0][0]'  
  
    conv4_block2_2_bn (BatchNormal (None, 16, 16, 256) 1024  
v[0][0]'  
        ziation)
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conv4_block2_2_relu (Activation) (None, 16, 16, 256) 0      ['conv4_block2_2_bn
[0][0]']
n)

conv4_block2_3_conv (Conv2D)    (None, 16, 16, 1024  263168  ['conv4_block2_2_rel
u[0][0]')
)

conv4_block2_3_bn (BatchNormal (None, 16, 16, 1024  4096  ['conv4_block2_3_con
v[0][0]']
ization)           )

conv4_block2_add (Add)        (None, 16, 16, 1024  0      ['conv4_block1_out
[0][0]',           )
[0][0]']

conv4_block2_out (Activation) (None, 16, 16, 1024  0      ['conv4_block2_add
[0][0]']
)

conv4_block3_1_conv (Conv2D)   (None, 16, 16, 256)  262400  ['conv4_block2_out
[0][0]']

conv4_block3_1_bn (BatchNormal (None, 16, 16, 256)  1024  ['conv4_block3_1_con
v[0][0]']
ization)

conv4_block3_1_relu (Activatio (None, 16, 16, 256)  0      ['conv4_block3_1_bn
[0][0]']
n)

conv4_block3_2_conv (Conv2D)   (None, 16, 16, 256)  590080  ['conv4_block3_1_rel
u[0][0]']

conv4_block3_2_bn (BatchNormal (None, 16, 16, 256)  1024  ['conv4_block3_2_con
v[0][0]']
ization)

conv4_block3_2_relu (Activatio (None, 16, 16, 256)  0      ['conv4_block3_2_bn
[0][0]']
n)

conv4_block3_3_conv (Conv2D)   (None, 16, 16, 1024  263168  ['conv4_block3_2_rel
u[0][0]']
)

conv4_block3_3_bn (BatchNormal (None, 16, 16, 1024  4096  ['conv4_block3_3_con
v[0][0]']
ization)           )

conv4_block3_add (Add)        (None, 16, 16, 1024  0      ['conv4_block2_out
[0][0]',           )
[0][0]']

conv4_block3_out (Activation) (None, 16, 16, 1024  0      ['conv4_block3_add
[0][0]']
)

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conv4_block4_1_conv (Conv2D)    (None, 16, 16, 256)  262400      ['conv4_block3_out
[0][0]']

conv4_block4_1_bn (BatchNormal (None, 16, 16, 256)  1024       ['conv4_block4_1_con
v[0][0]']
   ziation)

conv4_block4_1_relu (Activatio (None, 16, 16, 256)  0        ['conv4_block4_1_bn
[0][0]']
   n)

conv4_block4_2_conv (Conv2D)    (None, 16, 16, 256)  590080      ['conv4_block4_1_rel
u[0][0]']

conv4_block4_2_bn (BatchNormal (None, 16, 16, 256)  1024       ['conv4_block4_2_con
v[0][0]']
   ziation)

conv4_block4_2_relu (Activatio (None, 16, 16, 256)  0        ['conv4_block4_2_bn
[0][0]']
   n)

conv4_block4_3_conv (Conv2D)    (None, 16, 16, 1024  263168      ['conv4_block4_2_rel
u[0][0]']
                               )

conv4_block4_3_bn (BatchNormal (None, 16, 16, 1024  4096       ['conv4_block4_3_con
v[0][0]']
   ziation)
                               )

conv4_block4_add (Add)         (None, 16, 16, 1024  0        ['conv4_block3_out
[0][0]'],
                               )
   [0][0]']

conv4_block4_out (Activation)  (None, 16, 16, 1024  0        ['conv4_block4_add
[0][0]']
                               )

conv4_block5_1_conv (Conv2D)    (None, 16, 16, 256)  262400      ['conv4_block4_out
[0][0]']

conv4_block5_1_bn (BatchNormal (None, 16, 16, 256)  1024       ['conv4_block5_1_con
v[0][0]']
   ziation)

conv4_block5_1_relu (Activatio (None, 16, 16, 256)  0        ['conv4_block5_1_bn
[0][0]']
   n)

conv4_block5_2_conv (Conv2D)    (None, 16, 16, 256)  590080      ['conv4_block5_1_rel
u[0][0]']

conv4_block5_2_bn (BatchNormal (None, 16, 16, 256)  1024       ['conv4_block5_2_con
v[0][0]']
   ziation)

conv4_block5_2_relu (Activatio (None, 16, 16, 256)  0        ['conv4_block5_2_bn
[0][0]']
   n)

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n)

conv4_block5_3_conv (Conv2D)  (None, 16, 16, 1024  263168  ['conv4_block5_2_rel
u[0][0]')
                                )

conv4_block5_3_bn (BatchNormal (None, 16, 16, 1024  4096  ['conv4_block5_3_con
v[0][0]')
                                ization)
                                )

conv4_block5_add (Add)       (None, 16, 16, 1024  0  ['conv4_block4_out
[0][0]',]
                                )
                                [0][0]']

conv4_block5_out (Activation) (None, 16, 16, 1024  0  ['conv4_block5_add
[0][0]')
                                )

conv4_block6_1_conv (Conv2D)  (None, 16, 16, 256)  262400  ['conv4_block5_out
[0][0]']

conv4_block6_1_bn (BatchNormal (None, 16, 16, 256)  1024  ['conv4_block6_1_con
v[0][0]')
                                ization)

conv4_block6_1_relu (Activatio (None, 16, 16, 256)  0  ['conv4_block6_1_bn
[0][0]')
                                n)

conv4_block6_2_conv (Conv2D)  (None, 16, 16, 256)  590080  ['conv4_block6_1_rel
u[0][0]']

conv4_block6_2_bn (BatchNormal (None, 16, 16, 256)  1024  ['conv4_block6_2_con
v[0][0]')
                                ization)

conv4_block6_2_relu (Activatio (None, 16, 16, 256)  0  ['conv4_block6_2_bn
[0][0]')
                                n)

conv4_block6_3_conv (Conv2D)  (None, 16, 16, 1024  263168  ['conv4_block6_2_rel
u[0][0]')
                                )

conv4_block6_3_bn (BatchNormal (None, 16, 16, 1024  4096  ['conv4_block6_3_con
v[0][0]')
                                ization)
                                )

conv4_block6_add (Add)       (None, 16, 16, 1024  0  ['conv4_block5_out
[0][0]',]
                                )
                                [0][0]']

conv4_block6_out (Activation) (None, 16, 16, 1024  0  ['conv4_block6_add
[0][0]')
                                )

conv5_block1_1_conv (Conv2D)  (None, 8, 8, 512)   524800  ['conv4_block6_out
[0][0]']

```

conv5_block1_1_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 512)	2048	['conv5_block1_1_con v[0][0]']
conv5_block1_1_relu (Activatio n[0][0]) n)	(None, 8, 8, 512)	0	['conv5_block1_1_bn v[0][0]']
conv5_block1_2_conv (Conv2D u[0][0])	(None, 8, 8, 512)	2359808	['conv5_block1_1_rel u[0][0]']
conv5_block1_2_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 512)	2048	['conv5_block1_2_con v[0][0]']
conv5_block1_2_relu (Activatio n[0][0]) n)	(None, 8, 8, 512)	0	['conv5_block1_2_bn v[0][0]']
conv5_block1_0_conv (Conv2D [0][0])	(None, 8, 8, 2048)	2099200	['conv4_block6_out v[0][0]']
conv5_block1_3_conv (Conv2D u[0][0])	(None, 8, 8, 2048)	1050624	['conv5_block1_2_rel u[0][0]']
conv5_block1_0_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 2048)	8192	['conv5_block1_0_con v[0][0]']
conv5_block1_3_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 2048)	8192	['conv5_block1_3_con v[0][0]']
conv5_block1_add (Add [0][0]), [0][0])	(None, 8, 8, 2048)	0	['conv5_block1_0_bn 'conv5_block1_3_bn v[0][0]']
conv5_block1_out (Activation) [0][0])	(None, 8, 8, 2048)	0	['conv5_block1_add v[0][0]']
conv5_block2_1_conv (Conv2D [0][0])	(None, 8, 8, 512)	1049088	['conv5_block1_out v[0][0]']
conv5_block2_1_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 512)	2048	['conv5_block2_1_con v[0][0]']
conv5_block2_1_relu (Activatio n[0][0]) n)	(None, 8, 8, 512)	0	['conv5_block2_1_bn v[0][0]']
conv5_block2_2_conv (Conv2D u[0][0])	(None, 8, 8, 512)	2359808	['conv5_block2_1_rel u[0][0]']
conv5_block2_2_bn (BatchNormal v[0][0]) ization)	(None, 8, 8, 512)	2048	['conv5_block2_2_con v[0][0]']

conv5_block2_2_relu (Activation) [0][0]'	(None, 8, 8, 512)	0	['conv5_block2_2_bn']
conv5_block2_3_conv (Conv2D) u[0][0]'	(None, 8, 8, 2048)	1050624	['conv5_block2_2_relu']
conv5_block2_3_bn (BatchNormal v[0][0]'	(None, 8, 8, 2048)	8192	['conv5_block2_3_con
ization)			ization)
conv5_block2_add (Add) [0][0]',	(None, 8, 8, 2048)	0	['conv5_block1_out
[0][0]']			'conv5_block2_3_bn
conv5_block2_out (Activation) [0][0]'	(None, 8, 8, 2048)	0	['conv5_block2_add
[0][0]']			']
conv5_block3_1_conv (Conv2D) [0][0]'	(None, 8, 8, 512)	1049088	['conv5_block2_out
			']
conv5_block3_1_bn (BatchNormal v[0][0]'	(None, 8, 8, 512)	2048	['conv5_block3_1_con
ization)			zation)
conv5_block3_1_relu (Activatio n) [0][0]'	(None, 8, 8, 512)	0	['conv5_block3_1_bn
n)			']
conv5_block3_2_conv (Conv2D) u[0][0]'	(None, 8, 8, 512)	2359808	['conv5_block3_1_rel
			u]']
conv5_block3_2_bn (BatchNormal v[0][0]'	(None, 8, 8, 512)	2048	['conv5_block3_2_con
ization)			zation)
conv5_block3_2_relu (Activatio n) [0][0]'	(None, 8, 8, 512)	0	['conv5_block3_2_bn
n)			']
conv5_block3_3_conv (Conv2D) u[0][0]'	(None, 8, 8, 2048)	1050624	['conv5_block3_2_rel
			u]']
conv5_block3_3_bn (BatchNormal v[0][0]'	(None, 8, 8, 2048)	8192	['conv5_block3_3_con
ization)			zation)
conv5_block3_add (Add) [0][0]',	(None, 8, 8, 2048)	0	['conv5_block2_out
[0][0]']			'conv5_block3_3_bn
conv5_block3_out (Activation) [0][0]'	(None, 8, 8, 2048)	0	['conv5_block3_add
[0][0]']			']
global_average_pooling2d (Glob alAveragePooling2D) [0][0]'	(None, 2048)	0	['conv5_block3_out
			']

		Resonet	
dense (Dense) ling2d[0][0]'	(None, 1024)	2098176	[ 'global_average_poo ]
dropout (Dropout)	(None, 1024)	0	[ 'dense[0][0]' ]
dense_1 (Dense)	(None, 512)	524800	[ 'dropout[0][0]' ]
dropout_1 (Dropout)	(None, 512)	0	[ 'dense_1[0][0]' ]
dense_2 (Dense)	(None, 256)	131328	[ 'dropout_1[0][0]' ]
dropout_2 (Dropout)	(None, 256)	0	[ 'dense_2[0][0]' ]
dense_3 (Dense)	(None, 128)	32896	[ 'dropout_2[0][0]' ]
dropout_3 (Dropout)	(None, 128)	0	[ 'dense_3[0][0]' ]
dense_4 (Dense)	(None, 64)	8256	[ 'dropout_3[0][0]' ]
dense_5 (Dense)	(None, 2)	130	[ 'dense_4[0][0]' ]
<hr/>			
<hr/>			
Total params: 26,383,298			
Trainable params: 2,795,586			
Non-trainable params: 23,587,712			

---

```
In [18]: def exponential_decay(epoch, initial_lr=0.001, decay_rate=0.1, decay_steps=10):
    return initial_lr * math.pow(decay_rate, epoch / decay_steps)
lr_scheduler = tf.keras.callbacks.LearningRateScheduler(exponential_decay)
```

```
In [19]: model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001), # Set the init
                    loss='sparse_categorical_crossentropy',
                    metrics=['accuracy'])
```

```
In [20]: BATCH_SIZE = 32
history = model.fit(
    preprocessed_train_ds,
    batch_size=BATCH_SIZE,
    validation_data=preprocessed_val_ds,
    epochs=20,
    callbacks=[lr_scheduler],
    verbose=1
)
```

```
Epoch 1/20
44/44 [=====] - 170s 4s/step - loss: 0.8586 - accuracy: 0.50
36 - val_loss: 0.6911 - val_accuracy: 0.4932 - lr: 0.0010
Epoch 2/20
44/44 [=====] - 229s 5s/step - loss: 0.7555 - accuracy: 0.52
41 - val_loss: 0.6872 - val_accuracy: 0.5152 - lr: 7.9433e-04
Epoch 3/20
44/44 [=====] - 265s 6s/step - loss: 0.7252 - accuracy: 0.49
86 - val_loss: 0.6878 - val_accuracy: 0.5372 - lr: 5.0119e-04
Epoch 4/20
44/44 [=====] - 272s 6s/step - loss: 0.6975 - accuracy: 0.54
62 - val_loss: 0.6825 - val_accuracy: 0.6081 - lr: 2.5119e-04
Epoch 5/20
44/44 [=====] - 298s 7s/step - loss: 0.7131 - accuracy: 0.49
57 - val_loss: 0.6837 - val_accuracy: 0.6182 - lr: 1.0000e-04
Epoch 6/20
44/44 [=====] - 351s 8s/step - loss: 0.7125 - accuracy: 0.51
21 - val_loss: 0.6829 - val_accuracy: 0.6081 - lr: 3.1623e-05
Epoch 7/20
44/44 [=====] - 323s 7s/step - loss: 0.6974 - accuracy: 0.53
05 - val_loss: 0.6828 - val_accuracy: 0.6199 - lr: 7.9433e-06
Epoch 8/20
44/44 [=====] - 333s 7s/step - loss: 0.6994 - accuracy: 0.53
98 - val_loss: 0.6833 - val_accuracy: 0.6014 - lr: 1.5849e-06
Epoch 9/20
44/44 [=====] - 365s 8s/step - loss: 0.7062 - accuracy: 0.51
35 - val_loss: 0.6836 - val_accuracy: 0.6098 - lr: 2.5119e-07
Epoch 10/20
44/44 [=====] - 379s 8s/step - loss: 0.6946 - accuracy: 0.53
05 - val_loss: 0.6824 - val_accuracy: 0.6166 - lr: 3.1623e-08
Epoch 11/20
44/44 [=====] - 388s 9s/step - loss: 0.7051 - accuracy: 0.52
70 - val_loss: 0.6830 - val_accuracy: 0.6132 - lr: 3.1623e-09
Epoch 12/20
44/44 [=====] - 356s 8s/step - loss: 0.6986 - accuracy: 0.52
13 - val_loss: 0.6822 - val_accuracy: 0.6182 - lr: 2.5119e-10
Epoch 13/20
44/44 [=====] - 349s 8s/step - loss: 0.6946 - accuracy: 0.51
63 - val_loss: 0.6836 - val_accuracy: 0.6132 - lr: 1.5849e-11
Epoch 14/20
44/44 [=====] - 208s 5s/step - loss: 0.6947 - accuracy: 0.55
47 - val_loss: 0.6826 - val_accuracy: 0.6233 - lr: 7.9433e-13
Epoch 15/20
44/44 [=====] - 159s 4s/step - loss: 0.7009 - accuracy: 0.52
41 - val_loss: 0.6826 - val_accuracy: 0.6334 - lr: 3.1623e-14
Epoch 16/20
44/44 [=====] - 193s 4s/step - loss: 0.7014 - accuracy: 0.51
99 - val_loss: 0.6835 - val_accuracy: 0.6081 - lr: 1.0000e-15
Epoch 17/20
44/44 [=====] - 187s 4s/step - loss: 0.6959 - accuracy: 0.52
84 - val_loss: 0.6825 - val_accuracy: 0.6318 - lr: 2.5119e-17
Epoch 18/20
44/44 [=====] - 185s 4s/step - loss: 0.7067 - accuracy: 0.51
70 - val_loss: 0.6831 - val_accuracy: 0.5929 - lr: 5.0119e-19
Epoch 19/20
44/44 [=====] - 179s 4s/step - loss: 0.7001 - accuracy: 0.53
12 - val_loss: 0.6840 - val_accuracy: 0.5980 - lr: 7.9433e-21
Epoch 20/20
44/44 [=====] - 186s 4s/step - loss: 0.6940 - accuracy: 0.53
62 - val_loss: 0.6835 - val_accuracy: 0.6132 - lr: 1.0000e-22
```

In [ ]: