```
from google.colab import drive
drive.mount('/content/drive',force_remount=True)
```

```
Go to this URL in a browser:
https://accounts.google.com/o/oauth2/auth?client_id=947318989803-
6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_u
ri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email
%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f
%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f
%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f
%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly

Enter your authorization code:
··········
Mounted at /content/drive
```

```
import tensorflow as tf
tf.test.gpu_device_name()
```

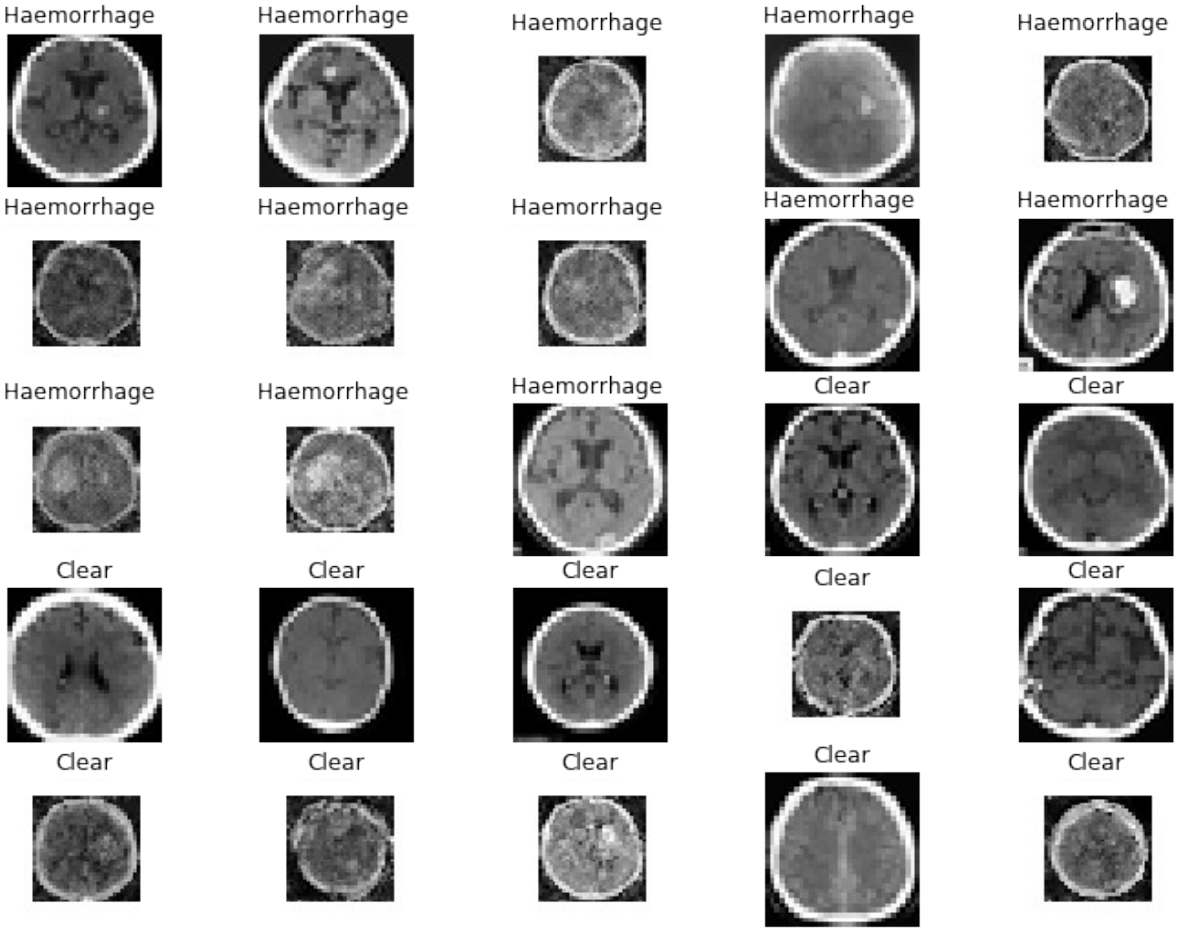
```
<IPython.core.display.HTML object>
```

```
'/device:GPU:0'
```

```
!pip install -q keras
```

```
from glob import glob
from os import listdir
from sklearn.model_selection import train_test_split

haemorrhage = glob('cs682-gan/train/Haemorrhage/*.jpg')
clear = glob('cs682-gan/train/Clear/*.jpg')
haemorrhage_train, haemorrhage_test = train_test_split(haemorrhage,
test_size=0.30)
clear_train, clear_test = train_test_split(clear, test_size=0.30)

TRAIN_DIR = 'cs682-gan/train'
TEST_DIR = 'cs682-gan/test'

# print(clear_test)
!mkdir cs682-gan/test

!mkdir cs682-gan/test/Haemorrhage
files = ' '.join(haemorrhage_test)
!mv -t cs682-gan/test/Haemorrhage $files

!mkdir cs682-gan/test/Clear
files = ' '.join(clear_test)
!mv -t cs682-gan/test/Clear $files

import numpy as np
from PIL import Image
```

```
import matplotlib.pyplot as plt

haemorrhage = np.random.choice(haemorrhage_train, 13)
clear = np.random.choice(clear_train, 12)
data = np.concatenate((haemorrhage, clear))
labels = 13 * ['Haemorrhage '] + 12 *['Clear']

N, R, C = 25, 5, 5
plt.figure(figsize=(12, 9))
for k, (src, label) in enumerate(zip(data, labels)):
    im = Image.open(src).convert('RGB')
    plt.subplot(R, C, k+1)
    plt.title(label)
    plt.imshow(np.asarray(im))
    plt.axis('off')
```




```
from keras.models import Model
from keras.layers import Dense, GlobalAveragePooling2D, Dropout
from keras.applications.resnet50 import ResNet50
from keras.applications.resnet50 import preprocess_input,
```

```
decode_predictions
from keras import backend as K

def sensitivity(y_true, y_pred):
    true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
    possible_positives = K.sum(K.round(K.clip(y_true, 0, 1)))
    return true_positives / (possible_positives + K.epsilon())

def specificity(y_true, y_pred):
    true_negatives = K.sum(K.round(K.clip((1-y_true) * (1-y_pred), 0,
1)))
    possible_negatives = K.sum(K.round(K.clip(1-y_true, 0, 1)))
    return true_negatives / (possible_negatives + K.epsilon())

CLASSES = 2

# setup model
base_model = ResNet50(weights= 'imagenet', include_top=False)

x = base_model.output
x = GlobalAveragePooling2D(name='avg_pool')(x)
x = Dropout(0.4)(x)
predictions = Dense(CLASSES, activation='softmax')(x)
model = Model(inputs=base_model.input, outputs=predictions)


# transfer learning
for layer in base_model.layers:
    layer.trainable = False

model.compile(optimizer='rmsprop',
              loss='categorical_crossentropy',
              metrics=['accuracy'])
```

```
/usr/local/lib/python3.6/dist-packages/keras_applications/
resnet50.py:265: UserWarning: The output shape of
`ResNet50(include_top=False)` has been changed since Keras 2.2.0.
  warnings.warn('The output shape of `ResNet50(include_top=False)` '
```

```
from keras.preprocessing.image import ImageDataGenerator

WIDTH = 128
HEIGHT = 128
BATCH_SIZE = 32

# data prep
train_datagen = ImageDataGenerator(
    preprocessing_function=preprocess_input,
    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')

validation_datagen = ImageDataGenerator(
    preprocessing_function=preprocess_input,
    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')

train_generator = train_datagen.flow_from_directory(
    TRAIN_DIR,
    target_size=(HEIGHT, WIDTH),
           batch_size=BATCH_SIZE,
           class_mode='categorical')

validation_generator = validation_datagen.flow_from_directory(
    TEST_DIR,
    target_size=(HEIGHT, WIDTH),
    batch_size=BATCH_SIZE,
    class_mode='categorical')
```

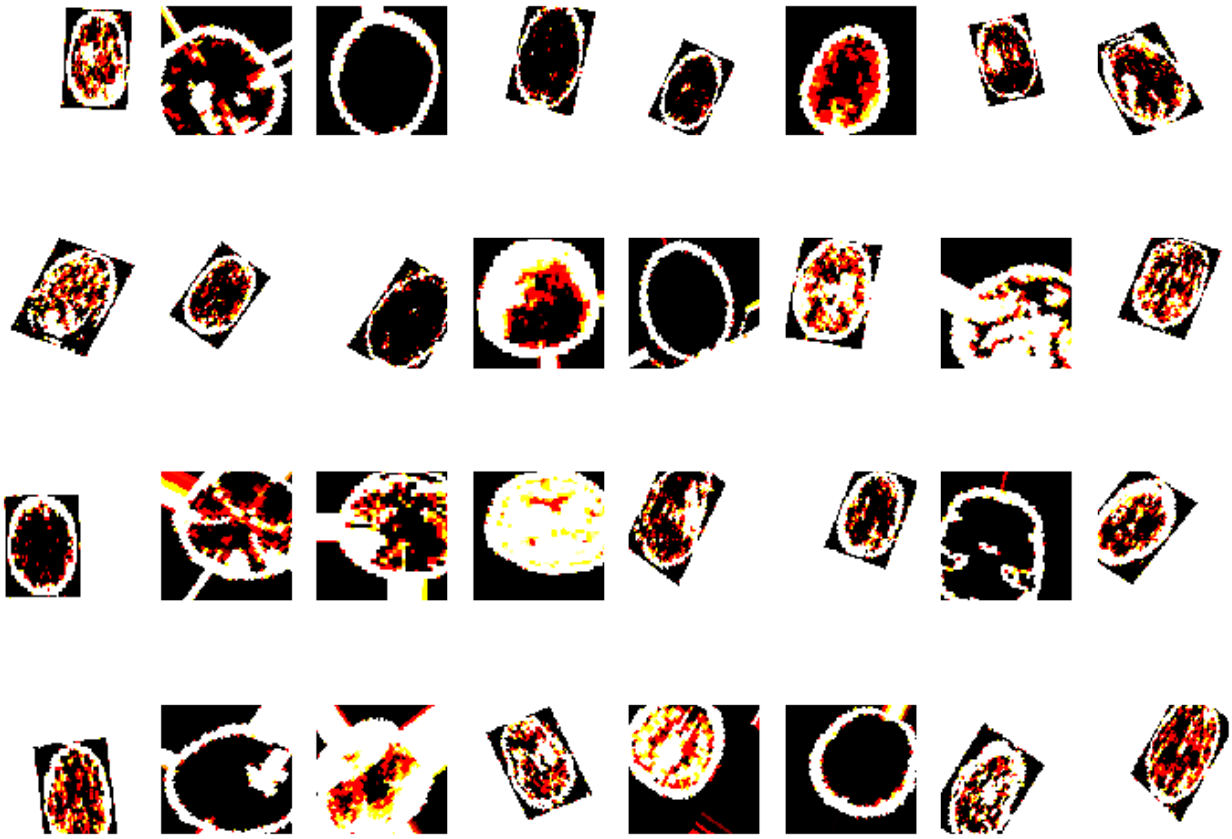
```
Found 280 images belonging to 2 classes.
Found 120 images belonging to 2 classes.
```

```
x_batch, y_batch = next(train_generator)

plt.figure(figsize=(12, 9))
for k, (img, lbl) in enumerate(zip(x_batch, y_batch)):
    plt.subplot(4, 8, k+1)
    plt.imshow((img + 1) / 2)
    plt.axis('off')
```

```
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
```

```
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
```

```
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data
([0..1] for floats or [0..255] for integers).
```



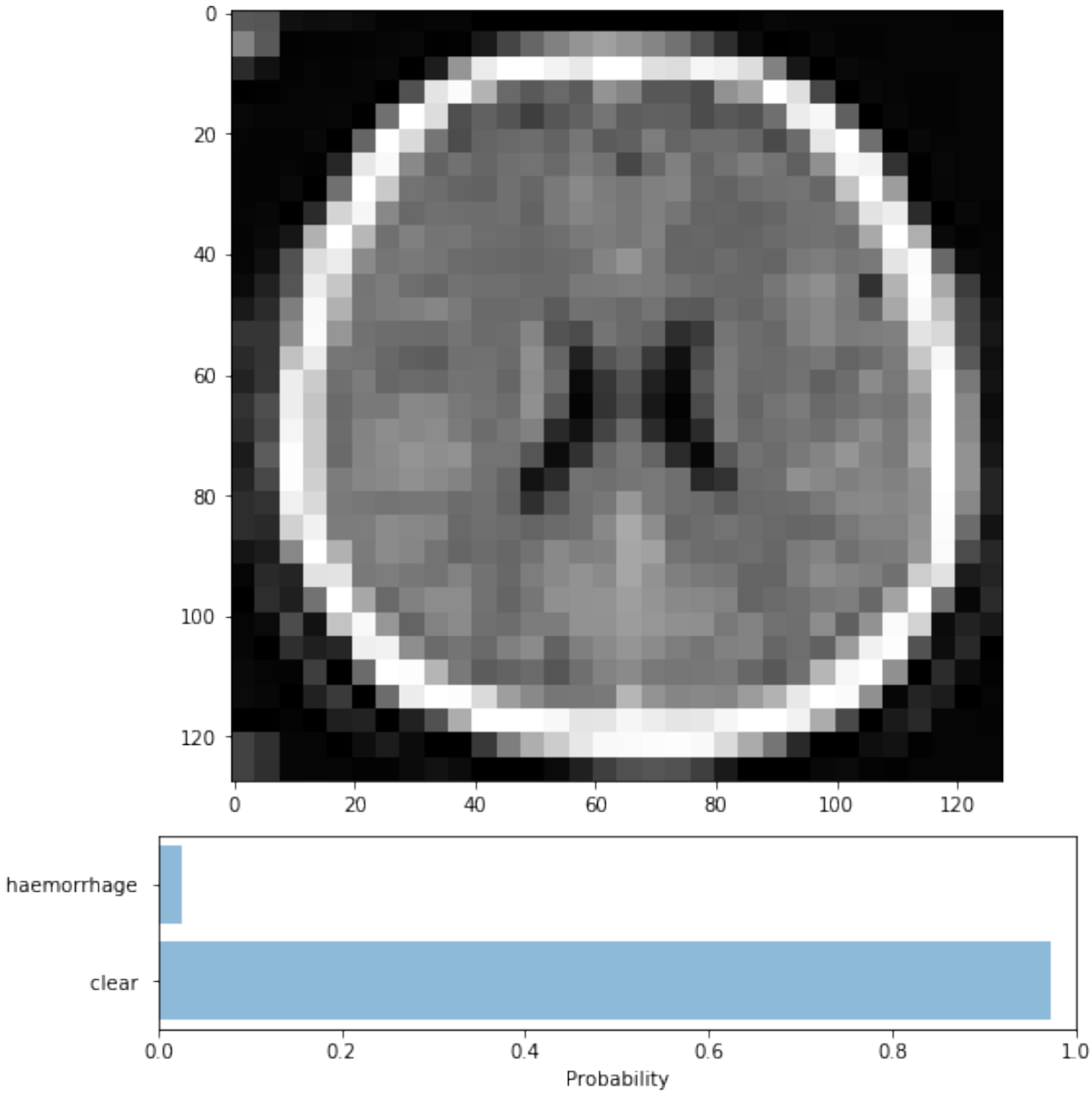
```
EPOCHS = 5
BATCH_SIZE = 32
STEPS_PER_EPOCH = 320
VALIDATION_STEPS = 64

MODEL_FILE = 'gan.model'

history = model.fit_generator(
    train_generator,
    epochs=EPOCHS,
    steps_per_epoch=STEPS_PER_EPOCH,
    validation_data=validation_generator,
    validation_steps=VALIDATION_STEPS)

model.save(MODEL_FILE)

Epoch 1/5
320/320 [==============================] - 69s 215ms/step - loss:
```

```
0.5716 - acc: 0.7277 - val_loss: 1.0437 - val_acc: 0.6245
Epoch 2/5
320/320 [==============================] - 58s 180ms/step - loss:
0.4649 - acc: 0.7879 - val_loss: 0.8061 - val_acc: 0.6865
Epoch 3/5
320/320 [==============================] - 56s 176ms/step - loss:
0.4482 - acc: 0.8029 - val_loss: 1.0573 - val_acc: 0.6359
Epoch 4/5
320/320 [==============================] - 58s 183ms/step - loss:
0.4292 - acc: 0.8083 - val_loss: 1.3332 - val_acc: 0.6109
Epoch 5/5
320/320 [==============================] - 57s 178ms/step - loss:
0.4394 - acc: 0.8061 - val_loss: 0.9817 - val_acc: 0.6651
```

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec

from keras.preprocessing import image
from keras.models import load_model


def predict(model, img):
    """Run model prediction on image
    Args:
        model: keras model
        img: PIL format image
    Returns:
        list of predicted labels and their probabilities
    """
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    x = preprocess_input(x)
    preds = model.predict(x)
    return preds[0]


def plot_preds(img, preds):
    """Displays image and the top-n predicted probabilities in a bar
graph
    Args:
        preds: list of predicted labels and their probabilities
    """
    labels = ("clear ", "haemorrhage ")
    gs = gridspec.GridSpec(2, 1, height_ratios=[4, 1])
    plt.figure(figsize=(8,8))
    plt.subplot(gs[0])
    plt.imshow(np.asarray(img))
    plt.subplot(gs[1])
    plt.barh([0, 1], preds, alpha=0.5)
```

```
    plt.yticks([0, 1], labels)
    plt.xlabel('Probability')
    plt.xlim(0, 1)
    plt.tight_layout()

model = load_model(MODEL_FILE)

img = image.load_img('cs682-gan/test/Clear/122.jpg',
target_size=(HEIGHT, WIDTH))
preds = predict(model, img)

plot_preds(np.asarray(img), preds)
preds
```

```
array([0.97391933, 0.02608062], dtype=float32)
```




```
model.summary()

Model: "model_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
Connected to
=================================================================
input_1 (InputLayer)         (None, None, None, 3 0

_________________________________________________________________
```

```
____________________________________
conv1_pad (ZeroPadding2D)       (None, None, None, 3 0
input_1[0][0]
____________________________________________________________________________________
____________________________________
conv1 (Conv2D)                  (None, None, None, 6 9472
conv1_pad[0][0]
____________________________________________________________________________________
____________________________________
bn_conv1 (BatchNormalization)   (None, None, None, 6 256
conv1[0][0]
____________________________________________________________________________________
____________________________________
activation_1 (Activation)       (None, None, None, 6 0
bn_conv1[0][0]
____________________________________________________________________________________
____________________________________
pool1_pad (ZeroPadding2D)       (None, None, None, 6 0
activation_1[0][0]
____________________________________________________________________________________
____________________________________
max_pooling2d_1 (MaxPooling2D)  (None, None, None, 6 0
pool1_pad[0][0]
____________________________________________________________________________________
____________________________________
res2a_branch2a (Conv2D)         (None, None, None, 6 4160
max_pooling2d_1[0][0]
____________________________________________________________________________________
____________________________________
bn2a_branch2a (BatchNormalizati (None, None, None, 6 256
res2a_branch2a[0][0]
____________________________________________________________________________________
____________________________________
activation_2 (Activation)       (None, None, None, 6 0
bn2a_branch2a[0][0]
____________________________________________________________________________________
____________________________________
res2a_branch2b (Conv2D)         (None, None, None, 6 36928
activation_2[0][0]
____________________________________________________________________________________
____________________________________
bn2a_branch2b (BatchNormalizati (None, None, None, 6 256
res2a_branch2b[0][0]
____________________________________________________________________________________
____________________________________
activation_3 (Activation)       (None, None, None, 6 0
bn2a_branch2b[0][0]
____________________________________________________________________________________
____________________________________
```

```
res2a_branch2c (Conv2D)          (None, None, None, 2 16640
activation_3[0][0]
__________________________________________________________________________________
_______________________________
res2a_branch1 (Conv2D)           (None, None, None, 2 16640
max_pooling2d_1[0][0]
__________________________________________________________________________________
_______________________________
bn2a_branch2c (BatchNormalizati (None, None, None, 2 1024
res2a_branch2c[0][0]
__________________________________________________________________________________
_______________________________
bn2a_branch1 (BatchNormalizatio (None, None, None, 2 1024
res2a_branch1[0][0]
__________________________________________________________________________________
_______________________________
add_1 (Add)                      (None, None, None, 2 0
bn2a_branch2c[0][0]

bn2a_branch1[0][0]
__________________________________________________________________________________
_______________________________
activation_4 (Activation)        (None, None, None, 2 0
add_1[0][0]
__________________________________________________________________________________
_______________________________
res2b_branch2a (Conv2D)          (None, None, None, 6 16448
activation_4[0][0]
__________________________________________________________________________________
_______________________________
bn2b_branch2a (BatchNormalizati (None, None, None, 6 256
res2b_branch2a[0][0]
__________________________________________________________________________________
_______________________________
activation_5 (Activation)        (None, None, None, 6 0
bn2b_branch2a[0][0]
__________________________________________________________________________________
_______________________________
res2b_branch2b (Conv2D)          (None, None, None, 6 36928
activation_5[0][0]
__________________________________________________________________________________
_______________________________
bn2b_branch2b (BatchNormalizati (None, None, None, 6 256
res2b_branch2b[0][0]
__________________________________________________________________________________
_______________________________
activation_6 (Activation)        (None, None, None, 6 0
bn2b_branch2b[0][0]
__________________________________________________________________________________
```

```
__________________________________
res2b_branch2c (Conv2D)         (None, None, None, 2 16640
activation_6[0][0]
__________________________________________________________________________________
__________________________________
bn2b_branch2c (BatchNormalizati (None, None, None, 2 1024
res2b_branch2c[0][0]
__________________________________________________________________________________
__________________________________
add_2 (Add)                     (None, None, None, 2 0
bn2b_branch2c[0][0]

activation_4[0][0]
__________________________________________________________________________________
__________________________________
activation_7 (Activation)       (None, None, None, 2 0
add_2[0][0]
__________________________________________________________________________________
__________________________________
res2c_branch2a (Conv2D)         (None, None, None, 6 16448
activation_7[0][0]
__________________________________________________________________________________
__________________________________
bn2c_branch2a (BatchNormalizati (None, None, None, 6 256
res2c_branch2a[0][0]
__________________________________________________________________________________
__________________________________
activation_8 (Activation)       (None, None, None, 6 0
bn2c_branch2a[0][0]
__________________________________________________________________________________
__________________________________
res2c_branch2b (Conv2D)         (None, None, None, 6 36928
activation_8[0][0]
__________________________________________________________________________________
__________________________________
bn2c_branch2b (BatchNormalizati (None, None, None, 6 256
res2c_branch2b[0][0]
__________________________________________________________________________________
__________________________________
activation_9 (Activation)       (None, None, None, 6 0
bn2c_branch2b[0][0]
__________________________________________________________________________________
__________________________________
res2c_branch2c (Conv2D)         (None, None, None, 2 16640
activation_9[0][0]
__________________________________________________________________________________
__________________________________
bn2c_branch2c (BatchNormalizati (None, None, None, 2 1024
res2c_branch2c[0][0]
```

```
__________________________________________________________________________________
_____________________________
add_3 (Add)                     (None, None, None, 2 0
bn2c_branch2c[0][0]

activation_7[0][0]
__________________________________________________________________________________
_____________________________
activation_10 (Activation)      (None, None, None, 2 0
add_3[0][0]
__________________________________________________________________________________
_____________________________
res3a_branch2a (Conv2D)         (None, None, None, 1 32896
activation_10[0][0]
__________________________________________________________________________________
_____________________________
bn3a_branch2a (BatchNormalizati (None, None, None, 1 512
res3a_branch2a[0][0]
__________________________________________________________________________________
_____________________________
activation_11 (Activation)      (None, None, None, 1 0
bn3a_branch2a[0][0]
__________________________________________________________________________________
_____________________________
res3a_branch2b (Conv2D)         (None, None, None, 1 147584
activation_11[0][0]
__________________________________________________________________________________
_____________________________
bn3a_branch2b (BatchNormalizati (None, None, None, 1 512
res3a_branch2b[0][0]
__________________________________________________________________________________
_____________________________
activation_12 (Activation)      (None, None, None, 1 0
bn3a_branch2b[0][0]
__________________________________________________________________________________
_____________________________
res3a_branch2c (Conv2D)         (None, None, None, 5 66048
activation_12[0][0]
__________________________________________________________________________________
_____________________________
res3a_branch1 (Conv2D)          (None, None, None, 5 131584
activation_10[0][0]
__________________________________________________________________________________
_____________________________
bn3a_branch2c (BatchNormalizati (None, None, None, 5 2048
res3a_branch2c[0][0]
__________________________________________________________________________________
_____________________________
bn3a_branch1 (BatchNormalizatio (None, None, None, 5 2048
```

```
res3a_branch1[0][0]
__________________________________________________________________________________
_____________________________
add_4 (Add)                     (None, None, None, 5 0
bn3a_branch2c[0][0]

bn3a_branch1[0][0]
__________________________________________________________________________________
_____________________________
activation_13 (Activation)      (None, None, None, 5 0
add_4[0][0]
__________________________________________________________________________________
_____________________________
res3b_branch2a (Conv2D)         (None, None, None, 1 65664
activation_13[0][0]
__________________________________________________________________________________
_____________________________
bn3b_branch2a (BatchNormalizati (None, None, None, 1 512
res3b_branch2a[0][0]
__________________________________________________________________________________
_____________________________
activation_14 (Activation)      (None, None, None, 1 0
bn3b_branch2a[0][0]
__________________________________________________________________________________
_____________________________
res3b_branch2b (Conv2D)         (None, None, None, 1 147584
activation_14[0][0]
__________________________________________________________________________________
_____________________________
bn3b_branch2b (BatchNormalizati (None, None, None, 1 512
res3b_branch2b[0][0]
__________________________________________________________________________________
_____________________________
activation_15 (Activation)      (None, None, None, 1 0
bn3b_branch2b[0][0]
__________________________________________________________________________________
_____________________________
res3b_branch2c (Conv2D)         (None, None, None, 5 66048
activation_15[0][0]
__________________________________________________________________________________
_____________________________
bn3b_branch2c (BatchNormalizati (None, None, None, 5 2048
res3b_branch2c[0][0]
__________________________________________________________________________________
_____________________________
add_5 (Add)                     (None, None, None, 5 0
bn3b_branch2c[0][0]

activation_13[0][0]
```

```
__________________________________________________________________________________________
_____________________________
activation_16 (Activation)      (None, None, None, 5 0
add_5[0][0]
__________________________________________________________________________________________
_____________________________
res3c_branch2a (Conv2D)         (None, None, None, 1 65664
activation_16[0][0]
__________________________________________________________________________________________
_____________________________
bn3c_branch2a (BatchNormalizati (None, None, None, 1 512
res3c_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
activation_17 (Activation)      (None, None, None, 1 0
bn3c_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
res3c_branch2b (Conv2D)         (None, None, None, 1 147584
activation_17[0][0]
__________________________________________________________________________________________
_____________________________
bn3c_branch2b (BatchNormalizati (None, None, None, 1 512
res3c_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
activation_18 (Activation)      (None, None, None, 1 0
bn3c_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
res3c_branch2c (Conv2D)         (None, None, None, 5 66048
activation_18[0][0]
__________________________________________________________________________________________
_____________________________
bn3c_branch2c (BatchNormalizati (None, None, None, 5 2048
res3c_branch2c[0][0]
__________________________________________________________________________________________
_____________________________
add_6 (Add)                     (None, None, None, 5 0
bn3c_branch2c[0][0]

activation_16[0][0]
__________________________________________________________________________________________
_____________________________
activation_19 (Activation)      (None, None, None, 5 0
add_6[0][0]
__________________________________________________________________________________________
_____________________________
res3d_branch2a (Conv2D)         (None, None, None, 1 65664
```

```
activation_19[0][0]
__________________________________________________________________________________________________
bn3d_branch2a (BatchNormalizati (None, None, None, 1 512
res3d_branch2a[0][0]
__________________________________________________________________________________________________
activation_20 (Activation)      (None, None, None, 1 0
bn3d_branch2a[0][0]
__________________________________________________________________________________________________
res3d_branch2b (Conv2D)         (None, None, None, 1 147584
activation_20[0][0]
__________________________________________________________________________________________________
bn3d_branch2b (BatchNormalizati (None, None, None, 1 512
res3d_branch2b[0][0]
__________________________________________________________________________________________________
activation_21 (Activation)      (None, None, None, 1 0
bn3d_branch2b[0][0]
__________________________________________________________________________________________________
res3d_branch2c (Conv2D)         (None, None, None, 5 66048
activation_21[0][0]
__________________________________________________________________________________________________
bn3d_branch2c (BatchNormalizati (None, None, None, 5 2048
res3d_branch2c[0][0]
__________________________________________________________________________________________________
add_7 (Add)                     (None, None, None, 5 0
bn3d_branch2c[0][0]

activation_19[0][0]
__________________________________________________________________________________________________
activation_22 (Activation)      (None, None, None, 5 0
add_7[0][0]
__________________________________________________________________________________________________
res4a_branch2a (Conv2D)         (None, None, None, 2 131328
activation_22[0][0]
__________________________________________________________________________________________________
bn4a_branch2a (BatchNormalizati (None, None, None, 2 1024
res4a_branch2a[0][0]
__________________________________________________________________________________________________
```

```
activation_23 (Activation)      (None, None, None, 2 0
bn4a_branch2a[0][0]
__________________________________________________________________________________
_____________________________
res4a_branch2b (Conv2D)         (None, None, None, 2 590080
activation_23[0][0]
__________________________________________________________________________________
_____________________________
bn4a_branch2b (BatchNormalizati (None, None, None, 2 1024
res4a_branch2b[0][0]
__________________________________________________________________________________
_____________________________
activation_24 (Activation)      (None, None, None, 2 0
bn4a_branch2b[0][0]
__________________________________________________________________________________
_____________________________
res4a_branch2c (Conv2D)         (None, None, None, 1 263168
activation_24[0][0]
__________________________________________________________________________________
_____________________________
res4a_branch1 (Conv2D)          (None, None, None, 1 525312
activation_22[0][0]
__________________________________________________________________________________
_____________________________
bn4a_branch2c (BatchNormalizati (None, None, None, 1 4096
res4a_branch2c[0][0]
__________________________________________________________________________________
_____________________________
bn4a_branch1 (BatchNormalizatio (None, None, None, 1 4096
res4a_branch1[0][0]
__________________________________________________________________________________
_____________________________
add_8 (Add)                     (None, None, None, 1 0
bn4a_branch2c[0][0]

bn4a_branch1[0][0]
__________________________________________________________________________________
_____________________________
activation_25 (Activation)      (None, None, None, 1 0
add_8[0][0]
__________________________________________________________________________________
_____________________________
res4b_branch2a (Conv2D)         (None, None, None, 2 262400
activation_25[0][0]
__________________________________________________________________________________
_____________________________
bn4b_branch2a (BatchNormalizati (None, None, None, 2 1024
res4b_branch2a[0][0]
__________________________________________________________________________________
```

```
__________________________________
activation_26 (Activation)      (None, None, None, 2 0
bn4b_branch2a[0][0]
__________________________________________________________________________________
__________________________________
res4b_branch2b (Conv2D)         (None, None, None, 2 590080
activation_26[0][0]
__________________________________________________________________________________
__________________________________
bn4b_branch2b (BatchNormalizati (None, None, None, 2 1024
res4b_branch2b[0][0]
__________________________________________________________________________________
__________________________________
activation_27 (Activation)      (None, None, None, 2 0
bn4b_branch2b[0][0]
__________________________________________________________________________________
__________________________________
res4b_branch2c (Conv2D)         (None, None, None, 1 263168
activation_27[0][0]
__________________________________________________________________________________
__________________________________
bn4b_branch2c (BatchNormalizati (None, None, None, 1 4096
res4b_branch2c[0][0]
__________________________________________________________________________________
__________________________________
add_9 (Add)                     (None, None, None, 1 0
bn4b_branch2c[0][0]

activation_25[0][0]
__________________________________________________________________________________
__________________________________
activation_28 (Activation)      (None, None, None, 1 0
add_9[0][0]
__________________________________________________________________________________
__________________________________
res4c_branch2a (Conv2D)         (None, None, None, 2 262400
activation_28[0][0]
__________________________________________________________________________________
__________________________________
bn4c_branch2a (BatchNormalizati (None, None, None, 2 1024
res4c_branch2a[0][0]
__________________________________________________________________________________
__________________________________
activation_29 (Activation)      (None, None, None, 2 0
bn4c_branch2a[0][0]
__________________________________________________________________________________
__________________________________
res4c_branch2b (Conv2D)         (None, None, None, 2 590080
activation_29[0][0]
```

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__________________________________________________________________________________________
_____________________________
bn4c_branch2b (BatchNormalizati (None, None, None, 2 1024
res4c_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
activation_30 (Activation)      (None, None, None, 2 0
bn4c_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
res4c_branch2c (Conv2D)         (None, None, None, 1 263168
activation_30[0][0]
__________________________________________________________________________________________
_____________________________
bn4c_branch2c (BatchNormalizati (None, None, None, 1 4096
res4c_branch2c[0][0]
__________________________________________________________________________________________
_____________________________
add_10 (Add)                    (None, None, None, 1 0
bn4c_branch2c[0][0]

activation_28[0][0]
__________________________________________________________________________________________
_____________________________
activation_31 (Activation)      (None, None, None, 1 0
add_10[0][0]
__________________________________________________________________________________________
_____________________________
res4d_branch2a (Conv2D)         (None, None, None, 2 262400
activation_31[0][0]
__________________________________________________________________________________________
_____________________________
bn4d_branch2a (BatchNormalizati (None, None, None, 2 1024
res4d_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
activation_32 (Activation)      (None, None, None, 2 0
bn4d_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
res4d_branch2b (Conv2D)         (None, None, None, 2 590080
activation_32[0][0]
__________________________________________________________________________________________
_____________________________
bn4d_branch2b (BatchNormalizati (None, None, None, 2 1024
res4d_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
activation_33 (Activation)      (None, None, None, 2 0
bn4d_branch2b[0][0]
```

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__________________________________________________________________________________________
_____________________________
res4d_branch2c (Conv2D)         (None, None, None, 1 263168
activation_33[0][0]
__________________________________________________________________________________________
_____________________________
bn4d_branch2c (BatchNormalizati (None, None, None, 1 4096
res4d_branch2c[0][0]
__________________________________________________________________________________________
_____________________________
add_11 (Add)                    (None, None, None, 1 0
bn4d_branch2c[0][0]

activation_31[0][0]
__________________________________________________________________________________________
_____________________________
activation_34 (Activation)      (None, None, None, 1 0
add_11[0][0]
__________________________________________________________________________________________
_____________________________
res4e_branch2a (Conv2D)         (None, None, None, 2 262400
activation_34[0][0]
__________________________________________________________________________________________
_____________________________
bn4e_branch2a (BatchNormalizati (None, None, None, 2 1024
res4e_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
activation_35 (Activation)      (None, None, None, 2 0
bn4e_branch2a[0][0]
__________________________________________________________________________________________
_____________________________
res4e_branch2b (Conv2D)         (None, None, None, 2 590080
activation_35[0][0]
__________________________________________________________________________________________
_____________________________
bn4e_branch2b (BatchNormalizati (None, None, None, 2 1024
res4e_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
activation_36 (Activation)      (None, None, None, 2 0
bn4e_branch2b[0][0]
__________________________________________________________________________________________
_____________________________
res4e_branch2c (Conv2D)         (None, None, None, 1 263168
activation_36[0][0]
__________________________________________________________________________________________
_____________________________
bn4e_branch2c (BatchNormalizati (None, None, None, 1 4096
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res4e_branch2c[0][0]
__________________________________________________________________________________
_____________________________
add_12 (Add)                    (None, None, None, 1 0
bn4e_branch2c[0][0]

activation_34[0][0]
__________________________________________________________________________________
_____________________________
activation_37 (Activation)      (None, None, None, 1 0
add_12[0][0]
__________________________________________________________________________________
_____________________________
res4f_branch2a (Conv2D)         (None, None, None, 2 262400
activation_37[0][0]
__________________________________________________________________________________
_____________________________
bn4f_branch2a (BatchNormalizati (None, None, None, 2 1024
res4f_branch2a[0][0]
__________________________________________________________________________________
_____________________________
activation_38 (Activation)      (None, None, None, 2 0
bn4f_branch2a[0][0]
__________________________________________________________________________________
_____________________________
res4f_branch2b (Conv2D)         (None, None, None, 2 590080
activation_38[0][0]
__________________________________________________________________________________
_____________________________
bn4f_branch2b (BatchNormalizati (None, None, None, 2 1024
res4f_branch2b[0][0]
__________________________________________________________________________________
_____________________________
activation_39 (Activation)      (None, None, None, 2 0
bn4f_branch2b[0][0]
__________________________________________________________________________________
_____________________________
res4f_branch2c (Conv2D)         (None, None, None, 1 263168
activation_39[0][0]
__________________________________________________________________________________
_____________________________
bn4f_branch2c (BatchNormalizati (None, None, None, 1 4096
res4f_branch2c[0][0]
__________________________________________________________________________________
_____________________________
add_13 (Add)                    (None, None, None, 1 0
bn4f_branch2c[0][0]

activation_37[0][0]
```

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__________________________________________________________________________________________________
activation_40 (Activation)      (None, None, None, 1 0
add_13[0][0]
__________________________________________________________________________________________________
res5a_branch2a (Conv2D)         (None, None, None, 5 524800
activation_40[0][0]
__________________________________________________________________________________________________
bn5a_branch2a (BatchNormalizati (None, None, None, 5 2048
res5a_branch2a[0][0]
__________________________________________________________________________________________________
activation_41 (Activation)      (None, None, None, 5 0
bn5a_branch2a[0][0]
__________________________________________________________________________________________________
res5a_branch2b (Conv2D)         (None, None, None, 5 2359808
activation_41[0][0]
__________________________________________________________________________________________________
bn5a_branch2b (BatchNormalizati (None, None, None, 5 2048
res5a_branch2b[0][0]
__________________________________________________________________________________________________
activation_42 (Activation)      (None, None, None, 5 0
bn5a_branch2b[0][0]
__________________________________________________________________________________________________
res5a_branch2c (Conv2D)         (None, None, None, 2 1050624
activation_42[0][0]
__________________________________________________________________________________________________
res5a_branch1 (Conv2D)          (None, None, None, 2 2099200
activation_40[0][0]
__________________________________________________________________________________________________
bn5a_branch2c (BatchNormalizati (None, None, None, 2 8192
res5a_branch2c[0][0]
__________________________________________________________________________________________________
bn5a_branch1 (BatchNormalizatio (None, None, None, 2 8192
res5a_branch1[0][0]
__________________________________________________________________________________________________
add_14 (Add)                    (None, None, None, 2 0
bn5a_branch2c[0][0]
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bn5a_branch1[0][0]
__________________________________________________________________________________
_____________________________
activation_43 (Activation)      (None, None, None, 2 0
add_14[0][0]
__________________________________________________________________________________
_____________________________
res5b_branch2a (Conv2D)         (None, None, None, 5 1049088
activation_43[0][0]
__________________________________________________________________________________
_____________________________
bn5b_branch2a (BatchNormalizati (None, None, None, 5 2048
res5b_branch2a[0][0]
__________________________________________________________________________________
_____________________________
activation_44 (Activation)      (None, None, None, 5 0
bn5b_branch2a[0][0]
__________________________________________________________________________________
_____________________________
res5b_branch2b (Conv2D)         (None, None, None, 5 2359808
activation_44[0][0]
__________________________________________________________________________________
_____________________________
bn5b_branch2b (BatchNormalizati (None, None, None, 5 2048
res5b_branch2b[0][0]
__________________________________________________________________________________
_____________________________
activation_45 (Activation)      (None, None, None, 5 0
bn5b_branch2b[0][0]
__________________________________________________________________________________
_____________________________
res5b_branch2c (Conv2D)         (None, None, None, 2 1050624
activation_45[0][0]
__________________________________________________________________________________
_____________________________
bn5b_branch2c (BatchNormalizati (None, None, None, 2 8192
res5b_branch2c[0][0]
__________________________________________________________________________________
_____________________________
add_15 (Add)                    (None, None, None, 2 0
bn5b_branch2c[0][0]

activation_43[0][0]
__________________________________________________________________________________
_____________________________
activation_46 (Activation)      (None, None, None, 2 0
add_15[0][0]
__________________________________________________________________________________
_____________________________
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res5c_branch2a (Conv2D)          (None, None, None, 5 1049088
activation_46[0][0]
__________________________________________________________________________________
_______________________________
bn5c_branch2a (BatchNormalizati (None, None, None, 5 2048
res5c_branch2a[0][0]
__________________________________________________________________________________
_______________________________
activation_47 (Activation)       (None, None, None, 5 0
bn5c_branch2a[0][0]
__________________________________________________________________________________
_______________________________
res5c_branch2b (Conv2D)          (None, None, None, 5 2359808
activation_47[0][0]
__________________________________________________________________________________
_______________________________
bn5c_branch2b (BatchNormalizati (None, None, None, 5 2048
res5c_branch2b[0][0]
__________________________________________________________________________________
_______________________________
activation_48 (Activation)       (None, None, None, 5 0
bn5c_branch2b[0][0]
__________________________________________________________________________________
_______________________________
res5c_branch2c (Conv2D)          (None, None, None, 2 1050624
activation_48[0][0]
__________________________________________________________________________________
_______________________________
bn5c_branch2c (BatchNormalizati (None, None, None, 2 8192
res5c_branch2c[0][0]
__________________________________________________________________________________
_______________________________
add_16 (Add)                     (None, None, None, 2 0
bn5c_branch2c[0][0]

activation_46[0][0]
__________________________________________________________________________________
_______________________________
activation_49 (Activation)       (None, None, None, 2 0
add_16[0][0]
__________________________________________________________________________________
_______________________________
avg_pool (GlobalAveragePooling2 (None, 2048)         0
activation_49[0][0]
__________________________________________________________________________________
_______________________________
dropout_1 (Dropout)              (None, 2048)         0
avg_pool[0][0]
__________________________________________________________________________________
```

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_________________________________
dense_1 (Dense)                 (None, 2)            4098
dropout_1[0][0]
==================================================================================
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Total params: 23,591,810
Trainable params: 4,098
Non-trainable params: 23,587,712
__________________________________________________________________________________
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```