ELL 888

ASSIGNMENT 1 REPORT

BRAIN TUMOUR CLASSIFICATION FROM GIVEN IMAGE

SUBMITTED BY:

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CNN ARCH1:
CNN_Normal_loss=cross_entropy

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 949,825
Trainable params: 949,825
Non-trainable params: 0
_________________________________________________________________
Train on 19314 samples, validate on 942 samples
Epoch 1/50
2019-02-21 18:38:00.316011: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1105] Found device 0 with properties:
name: Tesla K40m major: 3 minor: 5 memoryClockRate(GHz): 0.745
pciBusID: 0000:02:00.0
totalMemory: 11.17GiB freeMemory: 11.02GiB
2019-02-21 18:38:00.513033: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1105] Found device 1 with properties:
```

Output:

```
2019-02-21 18:38:00.513254: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1195] Creating TensorFlow device (/device:GPU:1) -> (devic
id: 0000:84:00.0, compute capability: 3.5)
19314/19314 [==============================] - 81s 4ms/step - loss: 3.2619 - acc: 0.7923 - val_loss: 8.9697 - val_acc: 0.4374
Epoch 2/50
19314/19314 [==============================] - 67s 3ms/step - loss: 3.2596 - acc: 0.7955 - val_loss: 8.9697 - val_acc: 0.4374
Epoch 3/50
19314/19314 [==============================] - 67s 3ms/step - loss: 3.2596 - acc: 0.7955 - val_loss: 8.9697 - val_acc: 0.4374
Epoch 4/50
 3072/19314 [===>..........................] - ETA: 55s - loss: 3.1501 - acc: 0.8024^CTraceback (most recent call last):
  File "CNN_Arch_Avi.py", line 97, in <module>
    model.fit(x_data,y_data, epochs=EPOCHS, batch_size=BATCH_SIZE, callbacks=callbacks, verbose=1,validation_data=(x_test,y_test))
  File "build/bdist.linux-x86_64/egg/keras/models.py", line 960, in fit
  File "build/bdist.linux-x86_64/egg/keras/engine/training.py", line 1650, in fit
```

CNN ARCH2:

CNN_Normal_loss=weighted_ cross_entropy

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 949,825
Trainable params: 949,825
Non-trainable params: 0
_________________________________________________________________
```

Output:

```
2019-02-21 19:02:28.425523: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1195] Creating TensorFlow device (/device:GPU:1) ->
 id: 0000:84:00.0, compute capability: 3.5)
19314/19314 [==============================] - 82s 4ms/step - loss: 3.7113 - acc: 0.5689 - val_loss: 0.6737 - val_acc: 0.5839
Epoch 2/50
19314/19314 [==============================] - 67s 3ms/step - loss: 1.0473 - acc: 0.6428 - val_loss: 0.7284 - val_acc: 0.5913
Epoch 3/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.9414 - acc: 0.6939 - val_loss: 0.7442 - val_acc: 0.6380
Epoch 4/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.8462 - acc: 0.7222 - val_loss: 0.7223 - val_acc: 0.6476
Epoch 5/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.7547 - acc: 0.7584 - val_loss: 1.1311 - val_acc: 0.5106
Epoch 6/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.6924 - acc: 0.7750 - val_loss: 0.9220 - val_acc: 0.6316
Epoch 7/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.6193 - acc: 0.7986 - val_loss: 1.0835 - val_acc: 0.6253
Epoch 8/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.5589 - acc: 0.8242 - val_loss: 1.2166 - val_acc: 0.5425
Epoch 9/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.5228 - acc: 0.8277 - val_loss: 1.1689 - val_acc: 0.5913
Epoch 10/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.4913 - acc: 0.8379 - val_loss: 1.5011 - val_acc: 0.4979
Epoch 11/50
19314/19314 [==============================] - 67s 3ms/step - loss: 0.4543 - acc: 0.8450 - val_loss: 1.5903 - val_acc: 0.5955
Traceback (most recent call last):
```

CNN ARCH3:

CNN_batchnorm_loss=weighted

```
keep_dims is deprecated, use keepdims instead
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
batch_normalization_1 (Batch (None, 188, 188, 32)      128
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
batch_normalization_2 (Batch (None, 92, 92, 32)        128
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
batch_normalization_3 (Batch (None, 89, 89, 64)        256
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
batch_normalization_4 (Batch (None, 42, 42, 32)        128
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 950,465
Trainable params: 950,145
Non-trainable params: 320
_________________________________________________________________
Train on 19314 samples, validate on 942 samples
```

Output:

```
19314/19314 [==============================] - 120s 6ms/step - loss: 1.3213 - acc: 0.4120 - val_loss: 0.7295 - val_acc: 0.5425
Epoch 2/50
19314/19314 [==============================] - 103s 5ms/step - loss: 1.0866 - acc: 0.4376 - val_loss: 0.7388 - val_acc: 0.5361
Epoch 3/50
19314/19314 [==============================] - 103s 5ms/step - loss: 1.0064 - acc: 0.5041 - val_loss: 0.9818 - val_acc: 0.5053
Epoch 4/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.8618 - acc: 0.6648 - val_loss: 0.8776 - val_acc: 0.5085
Epoch 5/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.7405 - acc: 0.7986 - val_loss: 0.8054 - val_acc: 0.4703
Epoch 6/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.6806 - acc: 0.8242 - val_loss: 1.0537 - val_acc: 0.4841
Epoch 7/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.6167 - acc: 0.8436 - val_loss: 0.9594 - val_acc: 0.4724
Epoch 8/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.5100 - acc: 0.8771 - val_loss: 0.8021 - val_acc: 0.5775
Epoch 9/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.4946 - acc: 0.8889 - val_loss: 0.9151 - val_acc: 0.4915
Epoch 10/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.4642 - acc: 0.9030 - val_loss: 1.3626 - val_acc: 0.4820
Epoch 11/50
19314/19314 [==============================] - 103s 5ms/step - loss: 0.4064 - acc: 0.9166 - val_loss: 1.5274 - val_acc: 0.4352
[cs1150223@gpu160 ~]
```

CNN ARCH4:

CNN_batchnorm_dropoutat2_loss=weighted

```
keep_dims is deprecated, use keepdims instead
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
batch_normalization_1 (Batch (None, 188, 188, 32)      128
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
batch_normalization_2 (Batch (None, 92, 92, 32)        128
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
dropout_1 (Dropout)          (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
batch_normalization_3 (Batch (None, 89, 89, 64)        256
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
batch_normalization_4 (Batch (None, 42, 42, 32)        128
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_2 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 950,465
Trainable params: 950,145
Non-trainable params: 320
_________________________________________________________________
```

Output:

```
2019-02-21 20:05:13.610025: W tensorflow/core/common_runtime/bfc_allocator.cc:217] Allocator (GPU_0_bfc) ran out of memory trying to allocate
tes that this is not a failure, but may mean that there could be performance gains if more memory is available.
19314/19314 [==============================] - 124s 6ms/step - loss: 1.7565 - acc: 0.3552 - val_loss: 0.7253 - val_acc: 0.5106
Epoch 2/50
19314/19314 [==============================] - 106s 5ms/step - loss: 1.1343 - acc: 0.3960 - val_loss: 0.6960 - val_acc: 0.5531
Epoch 3/50
19314/19314 [==============================] - 106s 5ms/step - loss: 1.0869 - acc: 0.4008 - val_loss: 0.7364 - val_acc: 0.5265
Epoch 4/50
19314/19314 [==============================] - 106s 5ms/step - loss: 1.0436 - acc: 0.3999 - val_loss: 0.7294 - val_acc: 0.4915
Epoch 5/50
19314/19314 [==============================] - 106s 5ms/step - loss: 1.0119 - acc: 0.4400 - val_loss: 0.9547 - val_acc: 0.4437
Epoch 6/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.9504 - acc: 0.5222 - val_loss: 0.9185 - val_acc: 0.4735
Epoch 7/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.9006 - acc: 0.5497 - val_loss: 2.5762 - val_acc: 0.4331
Epoch 8/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.8648 - acc: 0.5695 - val_loss: 5.1209 - val_acc: 0.4374
Epoch 9/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.8193 - acc: 0.5910 - val_loss: 2.8587 - val_acc: 0.4331
Epoch 10/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.7958 - acc: 0.5904 - val_loss: 4.9000 - val_acc: 0.4342
Epoch 11/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.7692 - acc: 0.6204 - val_loss: 4.7429 - val_acc: 0.4331
Epoch 12/50
19314/19314 [==============================] - 106s 5ms/step - loss: 0.7104 - acc: 0.6570 - val_loss: 5.9769 - val_acc: 0.4342
[sa1150223@gpu160 ~]
```

CNN ARCH5:

CNN_Normal_loss=weighted_ cross_entropy_Size=100 and 300 sample from test as training and validate on 650 test data

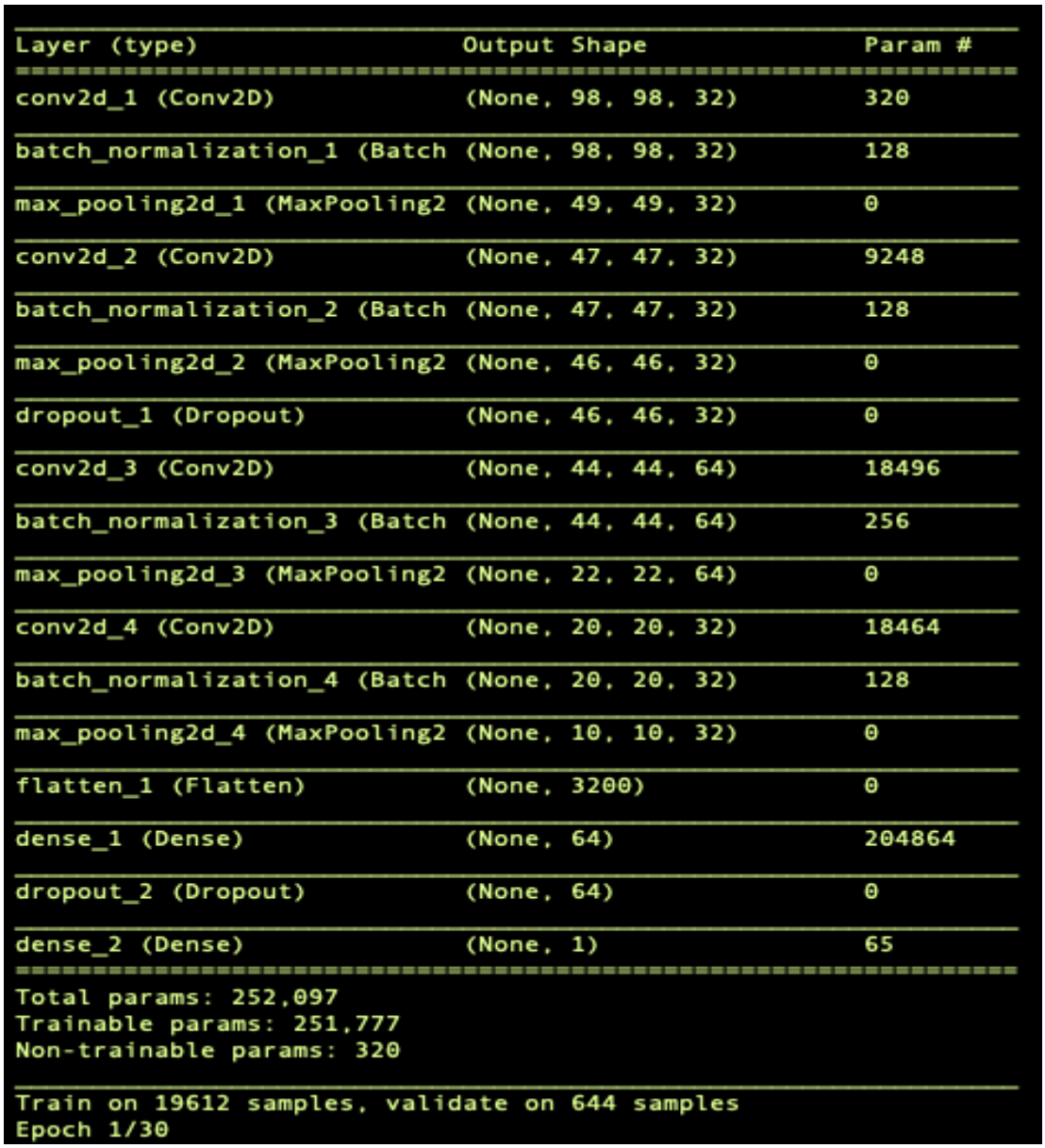
```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 98, 98, 32)        320
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 49, 49, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 47, 47, 32)        9248
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 46, 46, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 44, 44, 64)        18496
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 22, 22, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 20, 20, 32)        18464
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 10, 10, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 3200)              0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                204864
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 251,457
Trainable params: 251,457
Non-trainable params: 0
_________________________________________________________________
Train on 19612 samples, validate on 644 samples
Epoch 1/20
```

Output:

```
19612/19612 [==============================] - 27s 1ms/step - loss: 1.7039 - acc: 0.5916 - val_loss: 0.6990 - val_acc: 0.5916
Epoch 2/50
19612/19612 [==============================] - 18s 921us/step - loss: 1.0736 - acc: 0.6213 - val_loss: 0.7268 - val_acc: 0.5916
Epoch 3/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.9658 - acc: 0.6641 - val_loss: 0.6389 - val_acc: 0.6071
Epoch 4/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.8556 - acc: 0.7062 - val_loss: 0.5223 - val_acc: 0.7019
Epoch 5/50
19612/19612 [==============================] - 18s 923us/step - loss: 0.7645 - acc: 0.7440 - val_loss: 0.4625 - val_acc: 0.7764
Epoch 6/50
19612/19612 [==============================] - 18s 923us/step - loss: 0.6945 - acc: 0.7720 - val_loss: 0.5742 - val_acc: 0.6661
Epoch 7/50
19612/19612 [==============================] - 18s 924us/step - loss: 0.6271 - acc: 0.7945 - val_loss: 0.4131 - val_acc: 0.8245
Epoch 8/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.5760 - acc: 0.8177 - val_loss: 0.4337 - val_acc: 0.8168
Epoch 9/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.5376 - acc: 0.8309 - val_loss: 0.5521 - val_acc: 0.7267
Epoch 10/50
19612/19612 [==============================] - 18s 923us/step - loss: 0.5060 - acc: 0.8430 - val_loss: 0.3736 - val_acc: 0.8307
Epoch 11/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.4376 - acc: 0.8691 - val_loss: 0.4293 - val_acc: 0.8587
Epoch 12/50
19612/19612 [==============================] - 18s 924us/step - loss: 0.4162 - acc: 0.8729 - val_loss: 0.3442 - val_acc: 0.8634
Epoch 13/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.3620 - acc: 0.8909 - val_loss: 0.3781 - val_acc: 0.8571
Epoch 14/50
19612/19612 [==============================] - 18s 923us/step - loss: 0.3333 - acc: 0.9004 - val_loss: 0.3685 - val_acc: 0.8758
Epoch 15/50
19612/19612 [==============================] - 18s 924us/step - loss: 0.3384 - acc: 0.8945 - val_loss: 0.3217 - val_acc: 0.8789
Epoch 16/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2941 - acc: 0.9130 - val_loss: 0.3912 - val_acc: 0.8727
Epoch 17/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2626 - acc: 0.9244 - val_loss: 0.3360 - val_acc: 0.8820
Epoch 18/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2631 - acc: 0.9246 - val_loss: 0.3548 - val_acc: 0.8711
Epoch 19/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2499 - acc: 0.9254 - val_loss: 0.3603 - val_acc: 0.8540
Epoch 20/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2448 - acc: 0.9275 - val_loss: 0.3627 - val_acc: 0.8804
Epoch 21/50
19612/19612 [==============================] - 18s 922us/step - loss: 0.2354 - acc: 0.9323 - val_loss: 0.3952 - val_acc: 0.8820
Epoch 22/50
19612/19612 [==============================] - 18s 924us/step - loss: 0.2178 - acc: 0.9345 - val_loss: 0.3849 - val_acc: 0.8649
Epoch 23/50
19612/19612 [==============================] - 18s 939us/step - loss: 0.1954 - acc: 0.9430 - val_loss: 0.4151 - val_acc: 0.8696
Epoch 24/50
19612/19612 [==============================] - 18s 939us/step - loss: 0.1925 - acc: 0.9434 - val_loss: 0.3114 - val_acc: 0.9022
```

CNN ARCH6:

CNN_Batchnorm_dropoutat2_loss=weighted_ cross_entropy_reSize=100 and 300 sample from test as training and validate on 650 test data



```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 98, 98, 32)        320
_________________________________________________________________
batch_normalization_1 (Batch (None, 98, 98, 32)        128
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 49, 49, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 47, 47, 32)        9248
_________________________________________________________________
batch_normalization_2 (Batch (None, 47, 47, 32)        128
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 46, 46, 32)        0
_________________________________________________________________
dropout_1 (Dropout)          (None, 46, 46, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 44, 44, 64)        18496
_________________________________________________________________
batch_normalization_3 (Batch (None, 44, 44, 64)        256
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 22, 22, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 20, 20, 32)        18464
_________________________________________________________________
batch_normalization_4 (Batch (None, 20, 20, 32)        128
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 10, 10, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 3200)              0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                204864
_________________________________________________________________
dropout_2 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 252,097
Trainable params: 251,777
Non-trainable params: 320
_________________________________________________________________
Train on 19612 samples, validate on 644 samples
Epoch 1/30
```

Output:

```
y: 3.5)
19612/19612 [==============================] - 65s 3ms/step - loss: 1.2133 - acc: 0.5177 - val_loss: 0.7575 - val_acc: 0.5901
Epoch 2/30
19612/19612 [==============================] - 53s 3ms/step - loss: 1.0544 - acc: 0.5563 - val_loss: 0.6865 - val_acc: 0.6071
Epoch 3/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.9593 - acc: 0.6011 - val_loss: 0.7043 - val_acc: 0.6025
Epoch 4/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.8877 - acc: 0.6598 - val_loss: 0.5644 - val_acc: 0.7003
Epoch 5/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.8121 - acc: 0.6915 - val_loss: 0.4899 - val_acc: 0.7811
Epoch 6/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.7580 - acc: 0.7128 - val_loss: 1.4770 - val_acc: 0.4550
Epoch 7/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.6964 - acc: 0.7436 - val_loss: 0.9900 - val_acc: 0.5668
Epoch 8/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.6498 - acc: 0.7693 - val_loss: 0.9276 - val_acc: 0.5543
Epoch 9/30
19612/19612 [==============================] - 52s 3ms/step - loss: 0.6049 - acc: 0.7882 - val_loss: 0.4850 - val_acc: 0.7997
Epoch 10/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.5537 - acc: 0.8057 - val_loss: 0.7017 - val_acc: 0.7376
Epoch 11/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.5092 - acc: 0.8260 - val_loss: 1.5850 - val_acc: 0.5963
Epoch 12/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.4922 - acc: 0.8257 - val_loss: 0.6747 - val_acc: 0.7919
Epoch 13/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.4416 - acc: 0.8490 - val_loss: 0.4743 - val_acc: 0.8323
Epoch 14/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.4190 - acc: 0.8569 - val_loss: 0.4733 - val_acc: 0.8416
Epoch 15/30
19612/19612 [==============================] - 52s 3ms/step - loss: 0.4034 - acc: 0.8626 - val_loss: 0.4392 - val_acc: 0.8820
Epoch 16/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.3721 - acc: 0.8757 - val_loss: 0.4787 - val_acc: 0.8370
Epoch 17/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.3509 - acc: 0.8864 - val_loss: 0.4938 - val_acc: 0.8680
Epoch 18/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.3422 - acc: 0.8873 - val_loss: 1.0220 - val_acc: 0.7127
Epoch 19/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.3156 - acc: 0.8967 - val_loss: 0.2589 - val_acc: 0.9146
Epoch 20/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.2865 - acc: 0.9092 - val_loss: 0.3380 - val_acc: 0.8944
Epoch 21/30
19612/19612 [==============================] - 53s 3ms/step - loss: 0.2866 - acc: 0.9118 - val_loss: 0.3976 - val_acc: 0.9053
```

CNN ARCH7:

CNN_Batchnorm_dropoutat2_loss=weighted_ cross_entropy_reSize=190 and 300 sample from test as training and validate on 650 test data

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 949,825
Trainable params: 949,825
Non-trainable params: 0
_________________________________________________________________
Train on 19612 samples, validate on 644 samples
Epoch 1/30
```

Output:

```
19612/19612 [==============================] - 68s 3ms/step - loss: 1.0385 - acc: 0.6452 - val_loss: 0.6049 - val_acc: 0.6258
Epoch 3/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.9330 - acc: 0.6846 - val_loss: 0.5564 - val_acc: 0.6863
Epoch 4/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.8299 - acc: 0.7310 - val_loss: 0.5343 - val_acc: 0.7717
Epoch 5/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.7232 - acc: 0.7704 - val_loss: 0.4908 - val_acc: 0.8090
Epoch 6/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.6555 - acc: 0.7857 - val_loss: 0.5016 - val_acc: 0.8339
Epoch 7/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.5882 - acc: 0.8141 - val_loss: 0.4900 - val_acc: 0.8696
Epoch 8/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.5597 - acc: 0.8224 - val_loss: 0.4177 - val_acc: 0.8727
Epoch 9/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.4929 - acc: 0.8477 - val_loss: 0.3988 - val_acc: 0.8773
Epoch 10/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.4614 - acc: 0.8578 - val_loss: 0.3812 - val_acc: 0.8571
Epoch 11/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.4350 - acc: 0.8682 - val_loss: 0.3961 - val_acc: 0.8680
Epoch 12/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.3842 - acc: 0.8770 - val_loss: 0.4422 - val_acc: 0.8804
Epoch 13/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.3745 - acc: 0.8822 - val_loss: 0.3889 - val_acc: 0.8804
Epoch 14/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.3450 - acc: 0.8938 - val_loss: 0.3926 - val_acc: 0.8820
Epoch 15/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.3384 - acc: 0.8953 - val_loss: 0.4384 - val_acc: 0.8789
Epoch 16/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.3103 - acc: 0.9020 - val_loss: 0.4789 - val_acc: 0.8882
Epoch 17/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.2774 - acc: 0.9091 - val_loss: 0.4571 - val_acc: 0.8929
Epoch 18/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.2709 - acc: 0.9119 - val_loss: 0.5146 - val_acc: 0.8913
Epoch 19/30
19612/19612 [==============================] - 68s 3ms/step - loss: 0.2496 - acc: 0.9187 - val_loss: 0.5677 - val_acc: 0.8944
```

CNN ARCH 8:

CNN_loss=weighted_ cross_entropy_reSize=100 and 100 sample from test as training and validate on 850 test data

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 98, 98, 32)        320
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 49, 49, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 47, 47, 32)        9248
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 46, 46, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 44, 44, 64)        18496
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 22, 22, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 20, 20, 32)        18464
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 10, 10, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 3200)              0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                204864
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 251,457
Trainable params: 251,457
Non-trainable params: 0
_________________________________________________________________
Train on 19412 samples, validate on 844 samples
Epoch 1/20
```

Output:

```
19412/19412 [==============================] - 46s 2ms/step - loss: 1.4530 - acc: 0.5362 - val_loss: 0.6752 - val_acc: 0.5498
Epoch 2/20
19412/19412 [==============================] - 34s 2ms/step - loss: 1.1001 - acc: 0.5847 - val_loss: 0.6676 - val_acc: 0.5545
Epoch 3/20
19412/19412 [==============================] - 35s 2ms/step - loss: 1.0445 - acc: 0.6399 - val_loss: 0.6453 - val_acc: 0.6268
Epoch 4/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.9554 - acc: 0.6652 - val_loss: 0.6577 - val_acc: 0.6268
Epoch 5/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.9044 - acc: 0.6637 - val_loss: 0.6209 - val_acc: 0.6481
Epoch 6/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.8403 - acc: 0.6772 - val_loss: 0.6716 - val_acc: 0.6505
Epoch 7/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.7829 - acc: 0.7047 - val_loss: 0.7285 - val_acc: 0.5960
Epoch 8/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.7437 - acc: 0.7250 - val_loss: 0.6162 - val_acc: 0.6836
Epoch 9/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.6753 - acc: 0.7514 - val_loss: 0.6215 - val_acc: 0.7073
Epoch 10/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.6427 - acc: 0.7634 - val_loss: 0.6669 - val_acc: 0.6659
Epoch 11/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.5788 - acc: 0.7935 - val_loss: 0.5934 - val_acc: 0.7488
Epoch 12/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.5759 - acc: 0.7967 - val_loss: 0.5956 - val_acc: 0.7334
Epoch 13/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.5376 - acc: 0.8134 - val_loss: 0.6420 - val_acc: 0.7192
Epoch 14/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.4914 - acc: 0.8229 - val_loss: 0.6795 - val_acc: 0.7192
Epoch 15/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.4575 - acc: 0.8369 - val_loss: 0.8186 - val_acc: 0.7109
Epoch 16/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.4476 - acc: 0.8374 - val_loss: 0.7481 - val_acc: 0.7263
Epoch 17/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.4020 - acc: 0.8581 - val_loss: 0.6797 - val_acc: 0.7867
Epoch 18/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.3716 - acc: 0.8679 - val_loss: 0.7102 - val_acc: 0.7666
Epoch 19/20
19412/19412 [==============================] - 35s 2ms/step - loss: 0.4205 - acc: 0.8507 - val_loss: 0.8425 - val_acc: 0.7322
Epoch 20/20
19412/19412 [==============================] - 34s 2ms/step - loss: 0.3747 - acc: 0.8695 - val_loss: 0.7581 - val_acc: 0.7393
```

CNN ARCH 9:

CNN_Batchnorm_dropoutat2_loss=weighted_ cross_entropy_reSize=190 and 100 sample from test as training and validate on 850 test data.

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 188, 188, 32)      320
_________________________________________________________________
batch_normalization_1 (Batch (None, 188, 188, 32)      128
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 94, 94, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 92, 92, 32)        9248
_________________________________________________________________
batch_normalization_2 (Batch (None, 92, 92, 32)        128
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 91, 91, 32)        0
_________________________________________________________________
dropout_1 (Dropout)          (None, 91, 91, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 89, 89, 64)        18496
_________________________________________________________________
batch_normalization_3 (Batch (None, 89, 89, 64)        256
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 44, 44, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 42, 42, 32)        18464
_________________________________________________________________
batch_normalization_4 (Batch (None, 42, 42, 32)        128
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 21, 21, 32)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 14112)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                903232
_________________________________________________________________
dropout_2 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65
=================================================================
Total params: 950,465
Trainable params: 950,145
Non-trainable params: 320
_________________________________________________________________
Train on 19412 samples, validate on 844 samples
Epoch 1/30
```

Output:

```
19412/19412 [==============================] - 190s 10ms/step - loss: 1.5004 - acc: 0.4242 - val_loss: 0.6972 - val_acc: 0.5640
Epoch 2/30
19412/19412 [==============================] - 166s 9ms/step - loss: 1.1523 - acc: 0.4494 - val_loss: 0.6870 - val_acc: 0.5438
Epoch 3/30
19412/19412 [==============================] - 166s 9ms/step - loss: 1.0888 - acc: 0.4850 - val_loss: 0.6798 - val_acc: 0.5474
Epoch 4/30
19412/19412 [==============================] - 167s 9ms/step - loss: 0.9862 - acc: 0.5443 - val_loss: 0.6781 - val_acc: 0.5735
Epoch 5/30
19412/19412 [==============================] - 166s 9ms/step - loss: 0.9004 - acc: 0.5883 - val_loss: 0.6176 - val_acc: 0.6493
Epoch 6/30
19412/19412 [==============================] - 166s 9ms/step - loss: 0.8426 - acc: 0.5984 - val_loss: 0.6245 - val_acc: 0.6777
Epoch 7/30
19412/19412 [==============================] - 167s 9ms/step - loss: 0.7551 - acc: 0.6411 - val_loss: 0.6850 - val_acc: 0.6303
Epoch 8/30
19412/19412 [==============================] - 166s 9ms/step - loss: 0.7091 - acc: 0.6576 - val_loss: 0.7854 - val_acc: 0.6528
Epoch 9/30
19412/19412 [==============================] - 166s 9ms/step - loss: 0.6488 - acc: 0.6860 - val_loss: 0.6593 - val_acc: 0.7062
Epoch 10/30
19412/19412 [==============================] - 167s 9ms/step - loss: 0.5946 - acc: 0.7078 - val_loss: 0.7054 - val_acc: 0.6991
Epoch 11/30
19412/19412 [==============================] - 166s 9ms/step - loss: 0.5650 - acc: 0.7205 - val_loss: 0.6840 - val_acc: 0.7322
Epoch 12/30
19412/19412 [==============================] - 167s 9ms/step - loss: 0.5242 - acc: 0.7348 - val_loss: 1.1937 - val_acc: 0.6919
Epoch 13/30
```

SUMMARY:

First, CNN Arch1 was only based on binary cross entropy loss from which learning was not happening well since due to class imbalance in training examples. So, we used weighted_cross_entropy_loss function, which are very good for class imbalance.

After that we have experimented with Batch normalization and Dropout technique. We have made CNN Arch3 only stacking batch normalization layer at each end of each convolution layer. And CNN Arch4 we stacked dropout after 2 convolution layer and 2 batch norm layer.

Accuracy with Arch3 is good as compared to Arch4.

But overall Arch 2 is good and giving accuracy of 65% on test data set.

We are getting fluctuating validation loss because of Using a weighted loss function (which is used in case of highly imbalanced class-problems). At train step, you weigh your loss function based on class-weights, while at dev step you just calculate the un-weighted loss.

Now, problem arises that In test image, every image have skull. But no training image have skull image. So, our model learns to identify tumour to better extent but due to skull part it is not giving better accuracy, since it has not seen skull during training and during testing, gray scale is showing white in place of skull. So, even if brain have no tumour due to skull part, we get tumour.

That's why we pick some images like 300 out of 950 images as training images for training skull part since it is able to identify tumour to better accuracy.

And we test on 650 images as test images. So, we develop CNN Arch5 and Arch6 to do so. Now we got 91.46% accuracy with CNN Arch6 which include weighted_cross_entropy_loss, Batch Normalization, Dropout, etc.

Then we also experimented with different number of samples we take as training images from test images. We took 300 in CNN Arch5 and Arch6 and 100 in CNN Arch8 and Arch9. We found out that if we take 100 images we are getting accuracy of 80%. The reason is because we give less images to train the skull part.