

CROSS-VALIDATION

DATASET – 2,77,500 images

TRAINING DATA - 80% - 2,22,000 images

TESTING DATA - 20% - 55,500 images

SPLITTING DATA - 10% - 27,750 images

PARTITIONS	TRAINING DATA	TESTING DATA
1)	0-221999	221999-277500
2)	27751-249749	0-27750, 249749-277500
3)	55501-277500	0-55500
4)	83251-277500 , 0-27750	27751-83250
5)	111001-277500 , 0-55500	27751-111000
6)	138751-277500 , 0-83250	27751-138750
7)	166501-277500 , 0-111000	27751-166500
8)	194251-277500 , 0-138750	27751-194250
9)	222001-277500, 0-166500	27751-222000
10)	249751-277500, 0-194250	27751-249750

Results obtained = (average of all the results obtained in the partitions)

Accuracy = 0.856,

Specificity = 0.643,

Sensitivity = 0.929.

Partition 1

-> Training data - 0 - 2,21,999

-> Testing data – 2,21,999-2,77,500

Accuracy obtained = 0.81

Specifivity = 0.795

Sensitivity = 0.813

```
Mon 5:05 PM • rohiniraja@rohini-raj: ~/Desktop/breast-cancer-classification
- accuracy: 0.112/331 [=====] - ETA: 58s - loss: 0.2827 - accuracy: 0.113/331 [=====] - ETA: 5
7s - loss: 0.2826 - accuracy: 0.114/331 [=====] - ETA: 57s - loss: 0.2819 - accuracy: 0.115/331 [=====]
- ETA: 57s - loss: 0.2818 - accuracy: 0.116/331 [=====] - ETA: 56s - loss: 0.2809 - accuracy: 0.117/331 [=====]
- ETA: 56s - loss: 0.2800 - accuracy: 0.118/331 [=====] - ETA: 56s - loss: 0.2798 - accuracy:
0.119/331 [=====] - ETA: 56s - loss: 0.2796 - accuracy: 0.120/331 [=====] - ETA: 55s - loss: 0
.2793 - accuracy: 0.121/331 [=====] - ETA: 55s - loss: 0.2807 - accuracy: 0.122/331 [=====] - E
TA: 55s - loss: 0.2801 - accuracy: 0.123/331 [=====] - ETA: 55s - loss: 0.2790 - accuracy: 0.124/331 [=====]
- ETA: 54s - loss: 0.2806 - accuracy: 0.125/331 [=====] - ETA: 54s - loss: 0.2805 - accuracy: 0.126/331 [=
=====] - ETA: 54s - loss: 0.2801 - accuracy: 0.127/331 [=====] - ETA: 53s - loss: 0.2797 - accu
racy: 0.128/331 [=====] - ETA: 53s - loss: 0.2790 - accuracy: 0.129/331 [=====] - ETA: 53s - lo
ss: 0.2814 - accuracy: 0.130/331 [=====] - ETA: 53s - loss: 0.2812 - accuracy: 0.131/331 [=====]
- ETA: 52s - loss: 0.2803 - accuracy: 0.132/331 [=====] - ETA: 52s - loss: 0.2802 - accuracy: 0.133/331 [=====]
- ETA: 52s - loss: 0.2803 - accuracy: 0.134/331 [=====] - ETA: 52s - loss: 0.2809 - accuracy: 0.135/3
31 [=====] - ETA: 52s - loss: 0.2808 - accuracy: 0.136/331 [=====] - ETA: 51s - loss: 0.2803 -
accuracy: 0.137/331 [=====] - ETA: 51s - loss: 0.2802 - accuracy: 0.138/331 [=====] - ETA: 51s
- loss: 0.2799 - accuracy: 0.139/331 [=====] - ETA: 51s - loss: 0.2796 - accuracy: 0.140/331 [=====]
- ETA: 50s - loss: 0.2793 - accuracy: 0.141/331 [=====] - ETA: 50s - loss: 0.2789 - accuracy: 0.142/331 [=====]
- ETA: 50s - loss: 0.2787 - accuracy: 0.143/331 [=====] - ETA: 49s - loss: 0.2784 - accuracy: 0
.144/331 [=====] - ETA: 49s - loss: 0.2800 - accuracy: 0.145/331 [=====] - ETA: 49s - loss: 0.2
809 - accuracy: 0.146/331 [=====] - ETA: 49s - loss: 0.2804 - accuracy: 0.147/331 [=====] - ETA
- 48s - loss: 0.2808 - accuracy: 0.148/331 [=====] - ETA: 48s - loss: 0.2815 - accuracy: 0.149/331 [=====]
- ETA: 48s - loss: 0.2818 - accuracy: 0.150/331 [=====] - ETA: 48s - loss: 0.2814 - accuracy: 0.151/331 [=====]
- ETA: 47s - loss: 0.2804 - accuracy: 0.152/331 [=====] - ETA: 47s - loss: 0.2811 - accuracy: 0.153/331 [=====]
- ETA: 47s - loss: 0.2810 - accuracy: 0.155/331 [=====] - ETA: 46s - loss: 0.2801 - accuracy: 0.156/331 [=====]
- ETA: 46s - loss: 0.2804 - accuracy: 0.157/331 [=====] - ETA: 46s - loss: 0.2804 - accuracy: 0.158/331 [=====]
- ETA: 46s - loss: 0.2797 - accuracy: 0.159/331 [=====] - ETA: 45s - loss: 0.2796 - accuracy: 0.160/331
- ETA: 45s - loss: 0.2802 - accuracy: 0.161/331 [=====] - ETA: 45s - loss: 0.2795 - accuracy: 0.162/331 [=====]
- ETA: 44s - loss: 0.2793 - accuracy: 0.163/331 [=====] - ETA: 44s - loss: 0.2787 - accuracy: 0.164/331 [=====]
- ETA: 44s - loss: 0.2783 - accuracy: 0.166/331 [=====] - ETA: 44s - loss: 0.2783 - accuracy: 0.167/331 [=====]
- ETA: 43s - loss: 0.2784 - accuracy: 0.168/331 [=====] - ETA: 43s - loss: 0.2780 - accuracy: 0.16
9/331 [=====] - ETA: 43s - loss: 0.2779 - accuracy: 0.170/331 [=====] - ETA: 43s - loss: 0.277
4 - accuracy: 0.171/331 [=====] - ETA: 42s - loss: 0.2772 - accuracy: 0.172/331 [=====] - ETA:
42s - loss: 0.2762 - accuracy: 0.173/331 [=====] - ETA: 42s - loss: 0.2766 - accuracy: 0.174/331 [=====]
- ETA: 41s - loss: 0.2758 - accuracy: 0.175/331 [=====] - ETA: 41s - loss: 0.2757 - accuracy: 0.176/331 [=====]
- ETA: 41s - loss: 0.2767 - accuracy: 0.177/331 [=====] - ETA: 41s - loss: 0.2767 - accuracy
: 0.178/331 [=====] - ETA: 40s - loss: 0.2763 - accuracy: 0.179/331 [=====] - ETA: 40s - loss:

Mon 4:53 PM • build_dataset.py
rohiniraja@rohini-raj: ~/Desktop/breast-cancer-classification
5 oriEpoch 6/10
6 ran109/109 [=====] - 31s 287ms/step - loss: 0.3104 - accuracy: 0.8746 - val_loss: 0.4988 - val_accuracy: 0.5095
7 ranEpoch 7/10
8 109/109 [=====] - 31s 289ms/step - loss: 0.2891 - accuracy: 0.8812 - val_loss: 1.5642 - val_accuracy: 0.8313
9 indEpoch 8/10
10 tra109/109 [=====] - 32s 290ms/step - loss: 0.2977 - accuracy: 0.8741 - val_loss: 0.8186 - val_accuracy: 0.8114
11 tesEpoch 9/10
12 109/109 [=====] - 32s 290ms/step - loss: 0.2912 - accuracy: 0.8781 - val_loss: 1.1171 - val_accuracy: 0.8521
13 indEpoch 10/10
14 val109/109 [=====] - 32s 291ms/step - loss: 0.2815 - accuracy: 0.8801 - val_loss: 0.1931 - val_accuracy: 0.8196
15 traNow evaluating the model
16
17 dat
18      0      0.95      0.81      0.88      3213
19      1      0.48      0.80      0.60      696
20 ]
21 accuracy      0.81
22 for macro avg      0.71      0.80      0.74      3909
23 weighted avg      0.87      0.81      0.83      3909
24
25 [[2615 598]
26  [ 142 554]]
27 Accuracy: 0.8106932719365567
28 Specificity: 0.7959770114942529
29 Sensitivity: 0.813881107998755
30 Traceback (most recent call last):
31   File "train_model.py", line 100, in <module>
32     plt.plot(np.arange(0,N), M.history["acc"], label="train_acc")
33   KeyError: 'acc'
34 rohiniraja@rohini-raj:~/Desktop/breast-cancer-classification$
35 print(f'Building directory {labelPath}')
36 os.makedirs(labelPath)
37
38 newPath=os.path.sep.join([labelPath, file])
39 shutil.copy2(path, newPath)
```

2)

Partition 2

-> Training data - 27,751 - 2,49,749

-> Testing data – 0-27,750 , 2,49,749 – 2,77,500

Accuracy obtained = 0.851

Specificity = 0.847

Sensitivity = 0.853

The top screenshot shows the training progress of a breast cancer classification model. The terminal output displays a list of epochs, ETA, loss, and accuracy. The bottom screenshot shows the evaluation results, including a confusion matrix and various performance metrics.

Training Progress (Epochs 85-107):

Epoch	ETA	loss	accuracy
85/432	1:26	0.5280	accuracy:
86/432	1:25	0.5257	accuracy:
87/432	1:25	0.5222	accuracy:
88/432	1:25	0.5197	accuracy:
89/432	1:24	0.5190	accuracy:
90/432	1:24	0.5149	accuracy:
91/432	1:24	0.5154	accuracy:
92/432	1:23	0.5121	accuracy:
93/432	1:23	0.5109	accuracy:
94/432	1:23	0.5132	accuracy:
95/432	1:23	0.5117	accuracy:
96/432	1:22	0.5095	accuracy:
97/432	1:22	0.5083	accuracy:
98/432	1:22	0.5055	accuracy:
99/432	1:21	0.5029	accuracy:
100/432	1:21	0.5011	accuracy:
101/432	1:21	0.5015	accuracy:
102/432	1:21	0.5037	accuracy:
103/432	1:20	0.5038	accuracy:
104/432	1:20	0.5031	accuracy:
105/432	1:20	0.5023	accuracy:
106/432	1:19	0.4991	accuracy:
107/432	1:19	0.4982	accuracy:

Evaluation Results:

trainAcc: 0.8834 - val_loss: 0.5730 - val_accuracy: 0.8617

Now evaluating the model

	precision	recall	f1-score	support
0	0.96	0.85	0.90	4864
1	0.60	0.85	0.70	1262
tr accuracy			0.85	6126
le macro avg	0.78	0.85	0.80	6126
le weighted avg	0.88	0.85	0.86	6126

Confusion Matrix:

	Actual 0	Actual 1
Predicted 0	4146	718
Predicted 1	192	1070

Performance Metrics:

- trAccuracy: 0.85145282402873
- clSpecificity: 0.8478605388272583
- clSensitivity: 0.8523848684210527

3)

Partition 3

-> Training data – 55,501-2,77,500

-> Testing data – 0-55,500

Accuracy obtained = 0.854

Specifivity = 0.828

Sensitivity = 0.861

5)

Partition 5

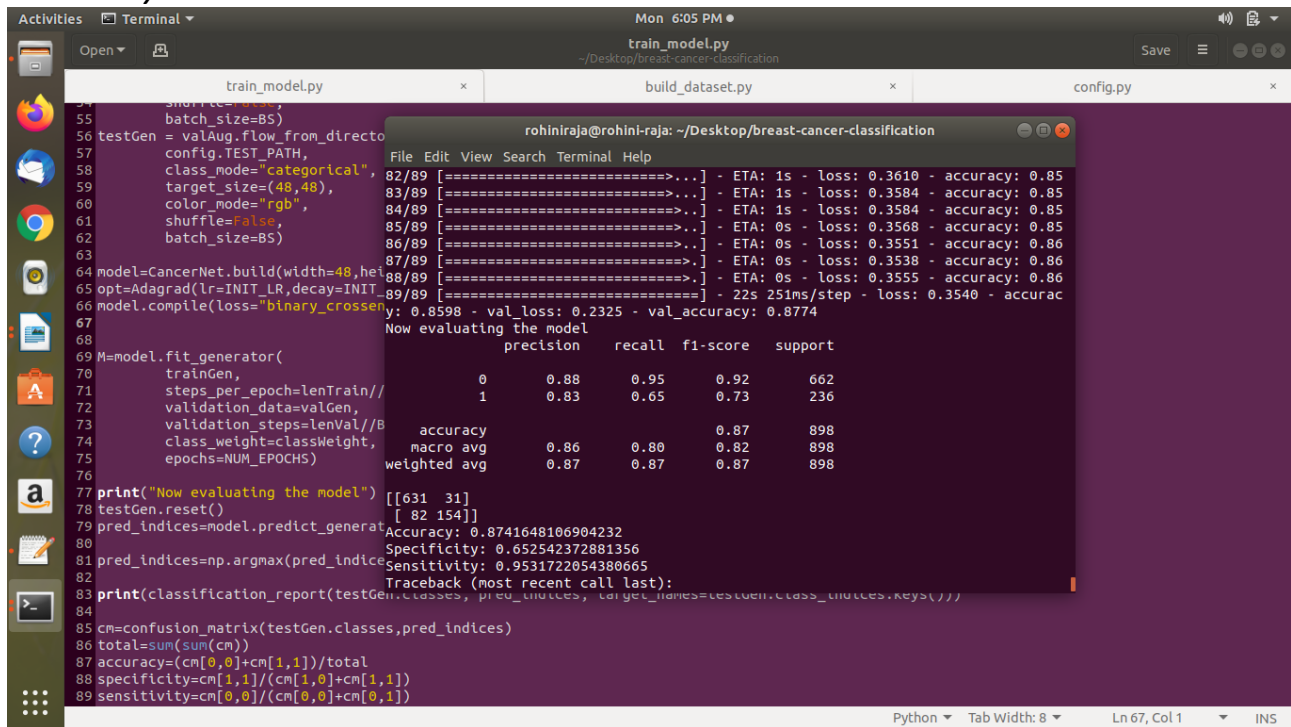
-> Training data - 1,11,001-2,77,500 , 0-55,500

-> Testing data – 27,751-1,11,000

Accuracy obtained = 0.8741

Specifivity = 0.652

Sensitivity = 0.953



```
train_model.py
55
56 testGen = valAug.flow_from_directory(
57     config.TEST_PATH,
58     class_mode="categorical",
59     target_size=(48,48),
60     color_mode="rgb",
61     shuffle=False,
62     batch_size=BS)
63
64 model=CancerNet.build(width=48,height=48,depth=32,
65     opt=Adagrad(lr=INIT_LR,decay=INIT_DECAY))
66 model.compile(loss="binary_crossentropy",
67     optimizer=opt,metrics=['accuracy'])
68
69 M=model.fit_generator(
70     trainGen,
71     steps_per_epoch=lenTrain,
72     validation_data=valGen,
73     validation_steps=lenVal,
74     class_weight=classWeight,
75     epochs=NUM_EPOCHS)
76
77 print("Now evaluating the model")
78 testGen.reset()
79 pred_indices=model.predict_generator(testGen,1)
80
81 pred_indices=np.argmax(pred_indices,axis=-1)
82
83 print(classification_report(testGen.classes, pred_indices, target_names=testGen.class_indices.keys()))
84
85 cm=confusion_matrix(testGen.classes,pred_indices)
86 total=sum(sum(cm))
87 accuracy=(cm[0,0]+cm[1,1])/total
88 specificity=(cm[1,1]/(cm[1,0]+cm[1,1]))
89 sensitivity=(cm[0,0]/(cm[0,0]+cm[0,1]))
```

rohiniraja@rohiniraja: ~/Desktop/breast-cancer-classification

```
File Edit View Search Terminal Help
82/89 [=====] - ETA: 1s - loss: 0.3610 - accuracy: 0.85
83/89 [=====] - ETA: 1s - loss: 0.3584 - accuracy: 0.85
84/89 [=====] - ETA: 1s - loss: 0.3584 - accuracy: 0.85
85/89 [=====] - ETA: 0s - loss: 0.3568 - accuracy: 0.85
86/89 [=====] - ETA: 0s - loss: 0.3551 - accuracy: 0.86
87/89 [=====] - ETA: 0s - loss: 0.3538 - accuracy: 0.86
88/89 [=====] - ETA: 0s - loss: 0.3555 - accuracy: 0.86
89/89 [=====] - 22s 251ms/step - loss: 0.3540 - accuracy: 0.8598 - val_loss: 0.2325 - val_accuracy: 0.8774

Now evaluating the model
precision    recall  f1-score   support

0           0.88    0.95    0.92         662
1           0.83    0.65    0.73         236

 accuracy
macro avg   0.86    0.80    0.87         898
weighted avg 0.87    0.87    0.87         898

[[631  31]
 [ 82 154]]
Accuracy: 0.8741648106904232
Specificity: 0.652542372881356
Sensitivity: 0.9531722054380665
Traceback (most recent call last):
```

6)

Partition 6

-> Training data - 1,11,001-2,77,500 , 0-83,250

-> Testing data – 27,751-1,38,750

Accuracy obtained = 0.850

Specifivity = 0.601

Sensitivity = 0.939

8) Partition 8

-> Training data - 1,94,251-2,77,500 , 0-1,38,750

-> Testing data – 27,751-1,94,250

Accuracy obtained = 0.8363

Specificity = 0.4449

Sensitivity = 0.9758

Activities

Terminal

Mon 5:53 PM

Open

train_model.py

build_dataset.py

config.py

```
54 model = keras.Sequential([
55     Dense(128),
56     batch_size=BS)
57 testGen = valAug.flow_from_directory(
58     config.TEST_PATH,
59     class_mode="categorical",
60     target_size=(48,48),
61     color_mode="rgb",
62     shuffle=False,
63     batch_size=BS)
64 model=CancerNet.build(width=48,height=48,depth=64,
65     opt=Adagrad(lr=INIT_LR,decay=INIT_LR/NUM_EPOCHS))
66 model.compile(loss="binary_crossentropy",metrics=[accuracy],
67     optimizer=opt)
68 M=model.fit_generator(
69     trainGen,
70     steps_per_epoch=lenTrain//BS,
71     validation_data=valGen,
72     validation_steps=lenVal//BS,
73     class_weight=classWeight,
74     epochs=NUM_EPOCHS)
75
76 print("Now evaluating the model")
77 testGen.reset()
78 pred_indices=model.predict_generator(testGen,1)
79 pred_indices=np.argmax(pred_indices,axis=-1)
80
81 pred_indices=np.argmax(pred_indices,axis=-1)
82 print(classification_report(testGen.classes,pred_indices))
83
84 cm=confusion_matrix(testGen.classes,pred_indices)
85 total=sum(sum(cm))
86 accuracy=(cm[0,0]+cm[1,1])/total
87 specificity=cm[0,1]/(cm[0,1]+cm[1,1])
88 sensitivity=cm[1,0]/(cm[0,0]+cm[1,0])
```

rohiniraja@rohini-raja: ~/Desktop/breast-cancer-classification

File Edit View Search Terminal Help

84/89 [=====] - ETA: 1s - loss: 0.3450 - accuracy: 0.86
85/89 [=====] - ETA: 0s - loss: 0.3422 - accuracy: 0.86
86/89 [=====] - ETA: 0s - loss: 0.3436 - accuracy: 0.86
87/89 [=====] - ETA: 0s - loss: 0.3434 - accuracy: 0.86
88/89 [=====] - ETA: 0s - loss: 0.3423 - accuracy: 0.86
89/89 [=====] - 23s 260ms/step - loss: 0.3421 - accuracy: 0.86
y: 0.8637 - val_loss: 0.0433 - val_accuracy: 0.8555
Now evaluating the model
precision recall f1-score support
0.83 0.98 0.90 662
1.00 0.87 0.59 236
accuracy 0.84 898
macro avg 0.85 0.71 0.74 898
weighted avg 0.84 0.84 0.82 898
[[646 16]
 [131 105]]
Accuracy: 0.8363028953229399
Specificity: 0.4449152542372881
Sensitivity: 0.9758308157099698
Traceback (most recent call last):
 File "train_model.py", line 100, in <module>

9) Partition 9

-> Training data - 2,22,001-2,77,500 , 0-1,66,500

-> Testing data – 27,751-2,22,000

Accuracy obtained = 0.8118

Specificity = 0.3601

Sensitivity = 0.9728

[illegible]

10) Partition 10

-> Training data - 2,49,751-2,77,500 , 0-1,94,250

-> Testing data – 27,751 – 2,49,750

Accuracy obtained = 0.920

Specifivity = 0.621

Sensitivity = 0.958

```
gowsalya@gowsalya-Lenovo-ideapad-330-15IKB: ~/Documents/breast-cancer-classification
File Edit View Search Terminal Help
98/98 [=====] - 20s 208ms/step - loss: 0.1895 - accuracy: 0.9316 - val_loss: 0.0018 - val_accuracy: 0.8899
Epoch 30/40
98/98 [=====] - 20s 207ms/step - loss: 0.1903 - accuracy: 0.9332 - val_loss: 0.2139 - val_accuracy: 0.8820
Epoch 31/40
98/98 [=====] - 20s 208ms/step - loss: 0.1897 - accuracy: 0.9261 - val_loss: 0.1999 - val_accuracy: 0.8912
Epoch 32/40
98/98 [=====] - 20s 209ms/step - loss: 0.2102 - accuracy: 0.9232 - val_loss: 0.0330 - val_accuracy: 0.8859
Epoch 33/40
98/98 [=====] - 20s 209ms/step - loss: 0.2022 - accuracy: 0.9232 - val_loss: 0.0150 - val_accuracy: 0.8846
Epoch 34/40
98/98 [=====] - 21s 209ms/step - loss: 0.1993 - accuracy: 0.9298 - val_loss: 0.0814 - val_accuracy: 0.8806
Epoch 35/40
98/98 [=====] - 20s 209ms/step - loss: 0.2064 - accuracy: 0.9171 - val_loss: 0.0070 - val_accuracy: 0.8899
Epoch 36/40
98/98 [=====] - 20s 208ms/step - loss: 0.1916 - accuracy: 0.9322 - val_loss: 0.0113 - val_accuracy: 0.9019
Epoch 37/40
98/98 [=====] - 20s 208ms/step - loss: 0.1847 - accuracy: 0.9274 - val_loss: 0.0881 - val_accuracy: 0.8820
Epoch 38/40
98/98 [=====] - 20s 208ms/step - loss: 0.2044 - accuracy: 0.9227 - val_loss: 0.0393 - val_accuracy: 0.8793
Epoch 39/40
98/98 [=====] - 21s 215ms/step - loss: 0.1861 - accuracy: 0.9337 - val_loss: 0.0731 - val_accuracy: 0.8714
Epoch 40/40
98/98 [=====] - 20s 208ms/step - loss: 0.2010 - accuracy: 0.9230 - val_loss: 0.4909 - val_accuracy: 0.9005
Now evaluating the model
      precision    recall  f1-score   support
     0           0.95       0.96       0.96         872
     1           0.66       0.62       0.64         111

 accuracy          0.92          983
macro avg          0.80          983
weighted avg       0.92          983

[[836 36]
 [ 42 69]]
Accuracy: 0.9206510681586979
Specificity: 0.6216216216216216
Sensitivity: 0.9587155963302753
```