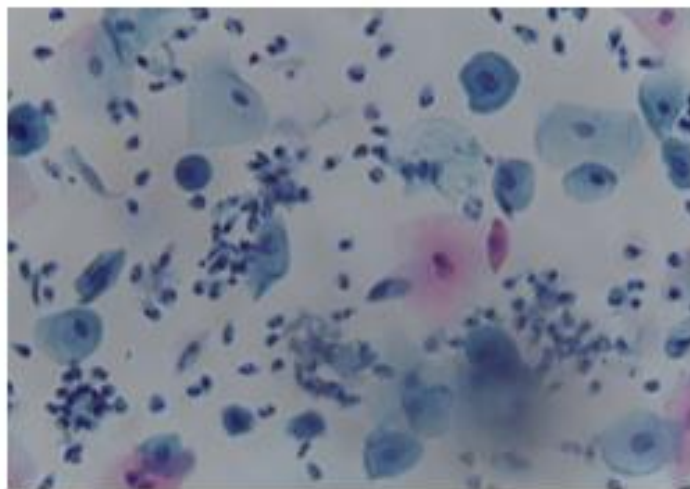
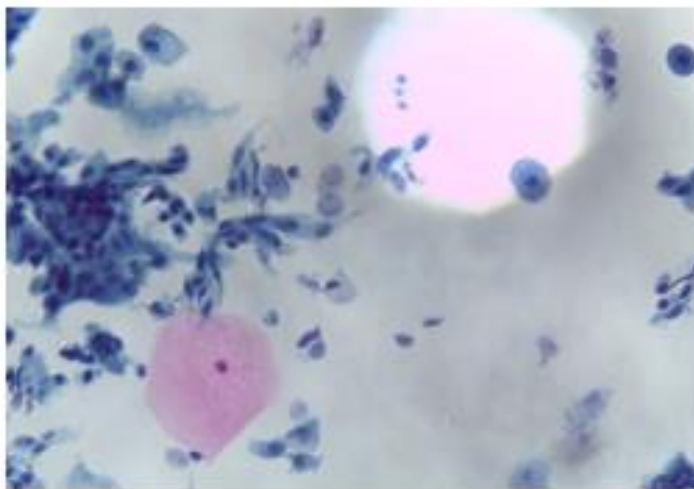
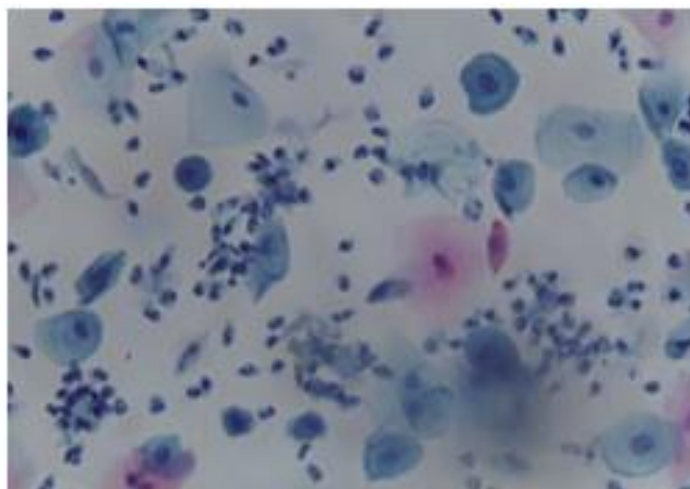
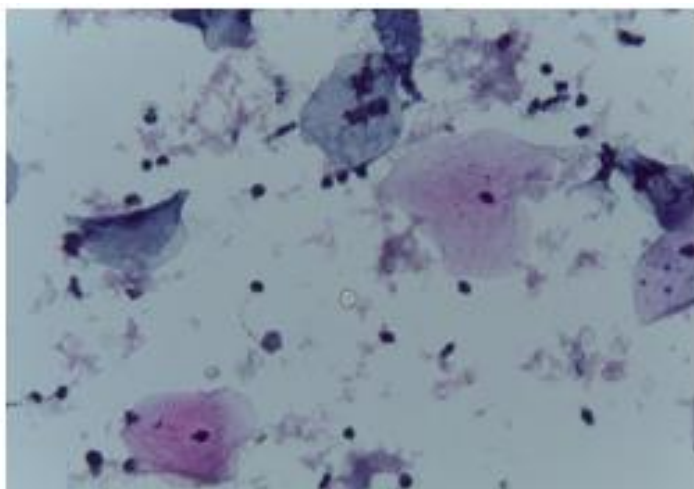


Histopathological Image-based Detection of Cervical Cancer Using Deep Neural Networks

KOMAL PARDESHI, YE XU

08/08/2023



Introduction

Data Preprocessing

- ❑ Image Preprocessing

 - ❑ Data Augmentation:

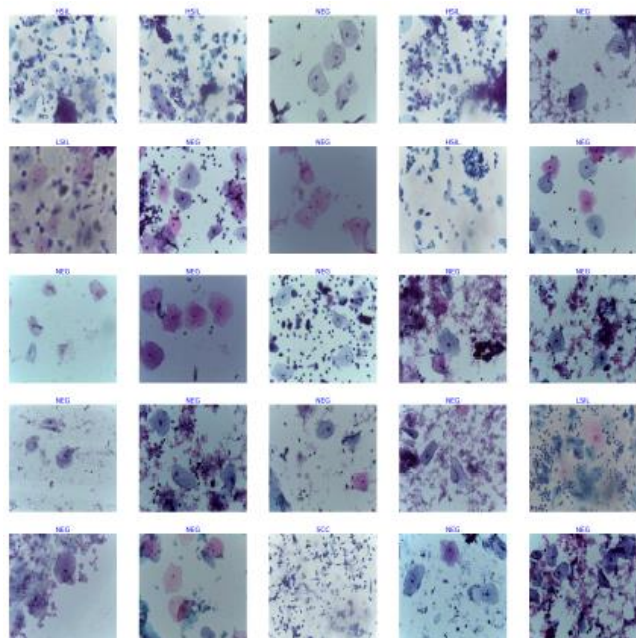
 - ❑ Oversampled

- ❑ Image-to-Data Generator

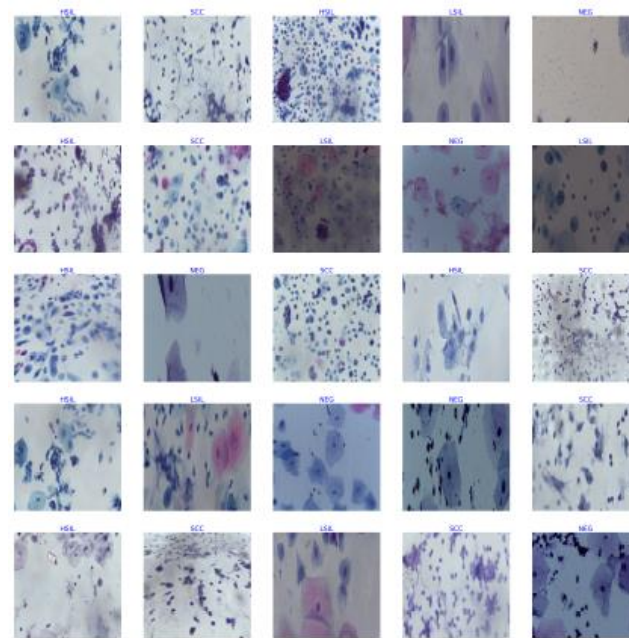
 - ❑ Horizontal flip, Vertical flip, rotation range, and height shift range

- ❑ Train/Validation/Test Dataset Split

Test from Original data



Train from Oversampled data



Checking Images

Model: "CNNModel"

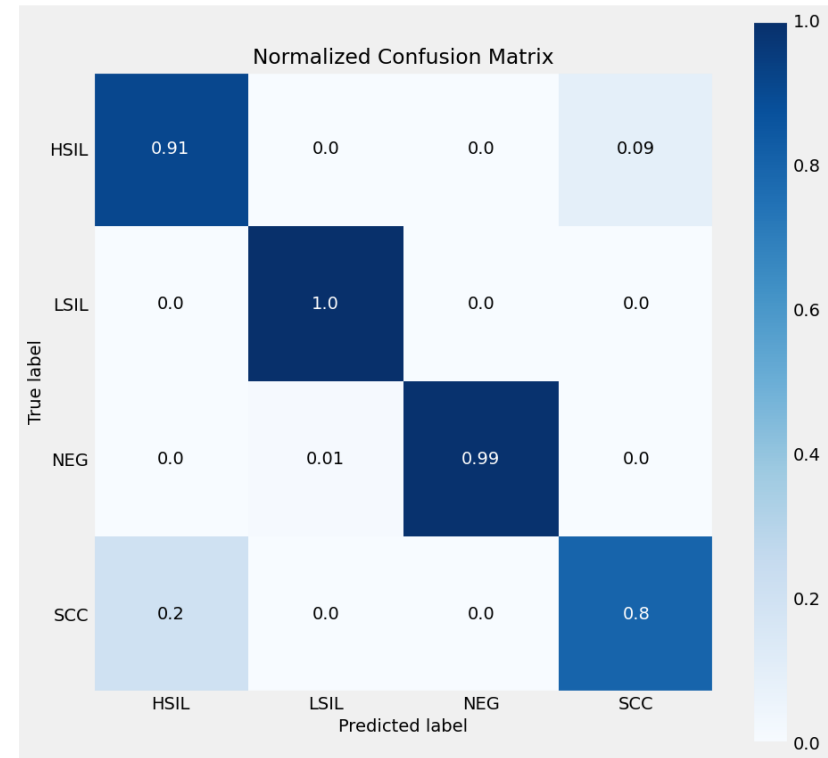
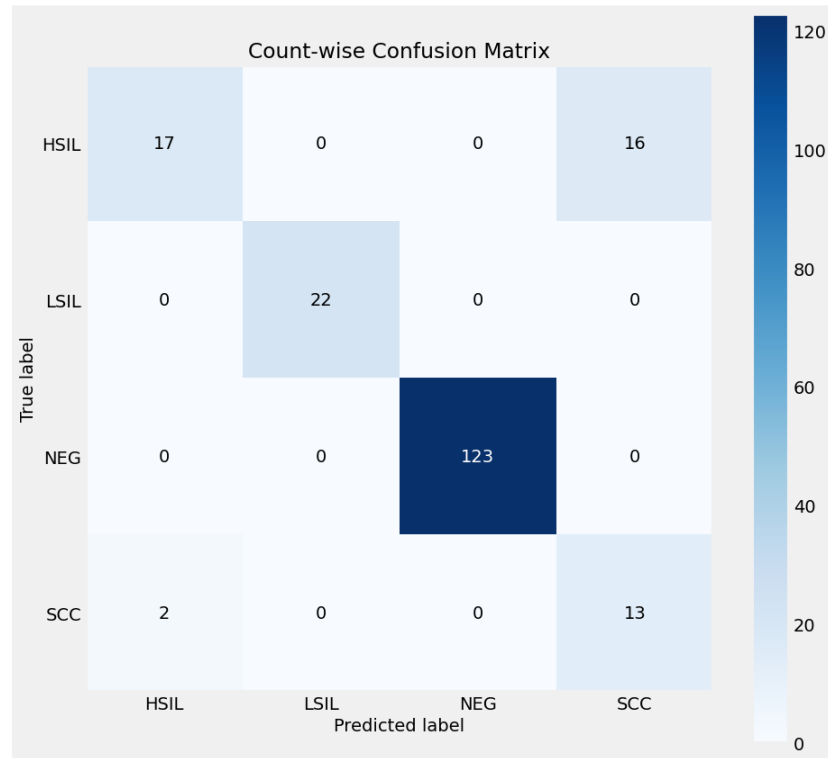
Layer (type)	Output Shape	Param #
separable_conv2d_6 (SeparableConv2D)	(None, 126, 126, 32)	155
max_pooling2d_16 (MaxPooling2D)	(None, 63, 63, 32)	0
conv2d_10 (Conv2D)	(None, 61, 61, 64)	18496
max_pooling2d_17 (MaxPooling2D)	(None, 30, 30, 64)	0
separable_conv2d_7 (SeparableConv2D)	(None, 30, 30, 128)	8896
max_pooling2d_18 (MaxPooling2D)	(None, 15, 15, 128)	0
spatial_dropout2d_4 (SpatialDropout2D)	(None, 15, 15, 128)	0
conv2d_11 (Conv2D)	(None, 15, 15, 128)	147584
max_pooling2d_19 (MaxPooling2D)	(None, 8, 8, 128)	0
flatten_4 (Flatten)	(None, 8192)	0
dense_12 (Dense)	(None, 128)	1048704
dropout_3 (Dropout)	(None, 128)	0
dense_13 (Dense)	(None, 32)	4128
dense_14 (Dense)	(None, 4)	132

Total params: 1,228,095
Trainable params: 1,228,095
Non-trainable params: 0

Test Accuracy: 96.37%

	precision	recall	f1-score	support
HSIL	0.91	0.91	0.91	33
LSIL	0.96	1.00	0.98	22
NEG	1.00	0.99	1.00	123
SCC	0.80	0.80	0.80	15
accuracy			0.96	193
macro avg	0.92	0.93	0.92	193
weighted avg	0.96	0.96	0.96	193

CNN Base Model



CNN Base Model:

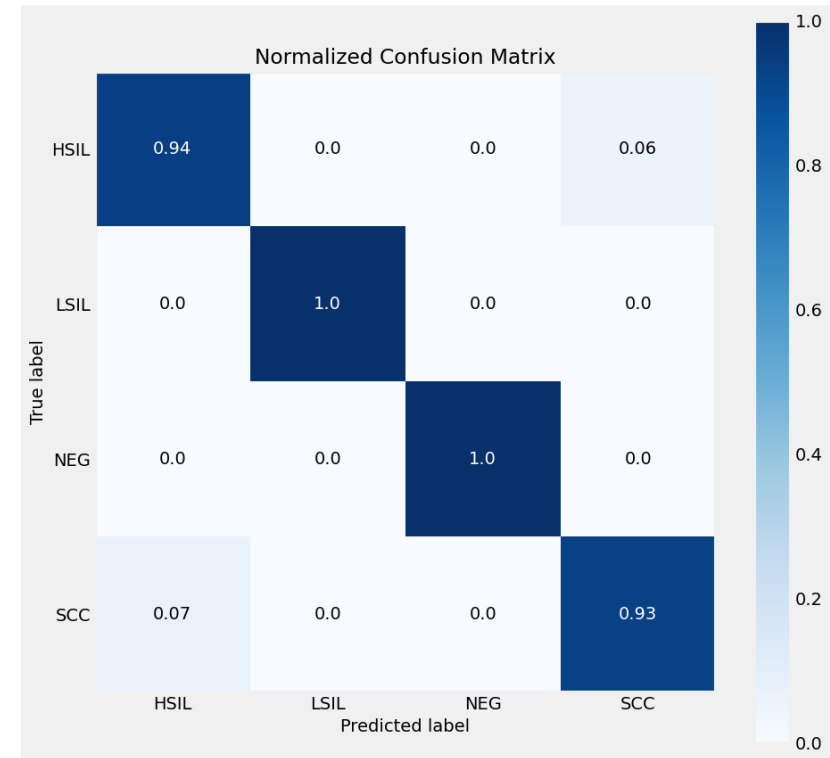
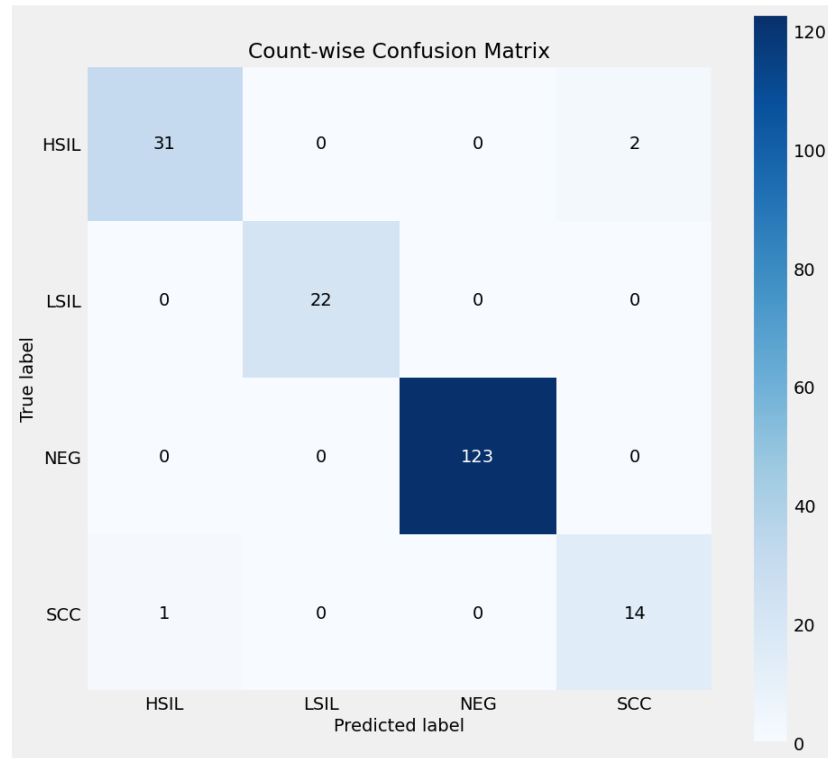
Test Accuracy: 98.45%

	precision	recall	f1-score	support
HSIL	0.97	0.94	0.95	33
LSIL	1.00	1.00	1.00	22
NEG	1.00	1.00	1.00	123
SCC	0.88	0.93	0.90	15
accuracy			0.98	193
macro avg	0.96	0.97	0.96	193
weighted avg	0.98	0.98	0.98	193

spatial_dropout2d_9 (SpatialDropout2D)	(None, 15, 15, 128)	0
conv2d_21 (Conv2D)	(None, 15, 15, 128)	147584
max_pooling2d_38 (MaxPooling2D)	(None, 8, 8, 128)	0
batch_normalization_22 (Batch Normalization)	(None, 8, 8, 128)	512
flatten_9 (Flatten)	(None, 8192)	0
dense_27 (Dense)	(None, 128)	1048704
batch_normalization_23 (Batch Normalization)	(None, 128)	512
dropout_8 (Dropout)	(None, 128)	0
dense_28 (Dense)	(None, 32)	4128
batch_normalization_24 (Batch Normalization)	(None, 32)	128
dense_29 (Dense)	(None, 4)	132

=====
Total params: 1,230,143
Trainable params: 1,229,119
Non-trainable params: 1,024
=====

CNN Base Model (With Batch-Normalization):

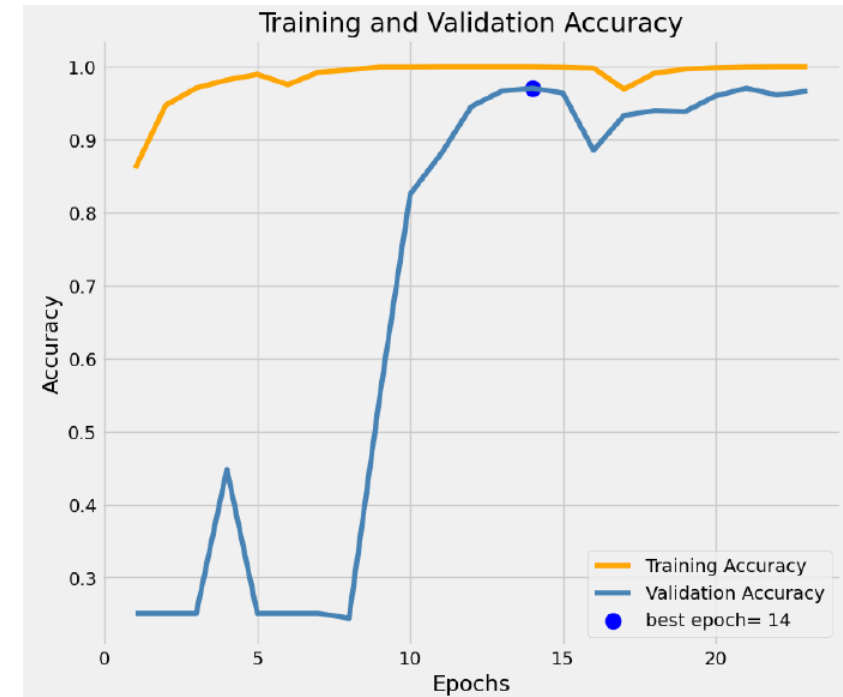
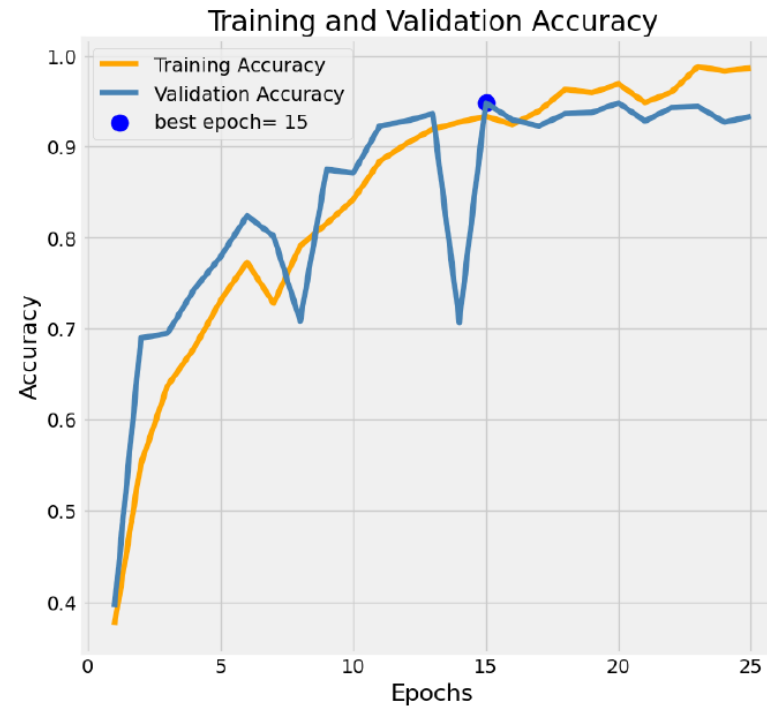


CNN Base Model (With Batch-Normalization):

CNN Base Model with/without Batch-Normalization

Batch Normalization (BN):

- Allows for higher learning rates
- Improves generalization performance
- Leading to better and more efficient neural network training



Test Accuracy: 91.19%

	precision	recall	f1-score	support
HSIL	0.81	0.67	0.73	33
LSIL	0.96	1.00	0.98	22
NEG	0.99	0.96	0.98	123
SCC	0.58	0.93	0.72	15
accuracy			0.91	193
macro avg	0.84	0.89	0.85	193
weighted avg	0.93	0.91	0.91	193

Model: "sequential"

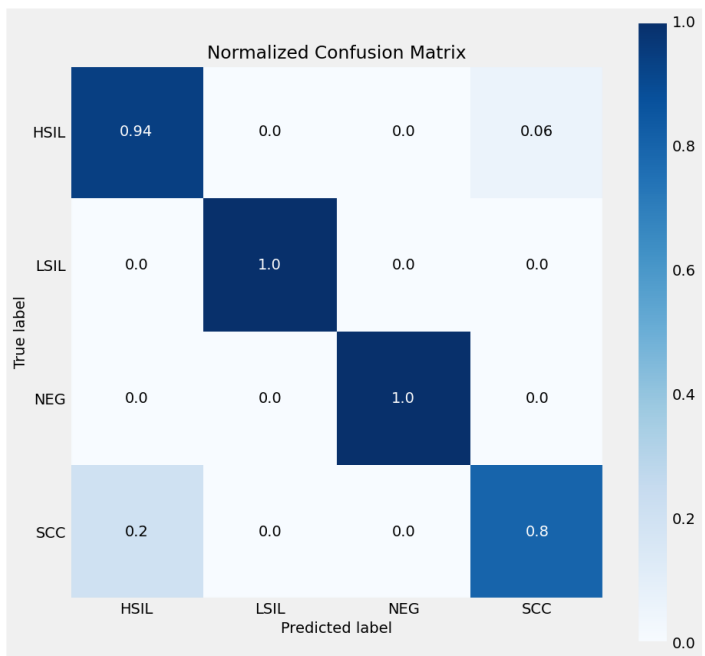
Layer (type)	Output Shape	Param #
vgg16 (Functional)	(None, 4, 4, 512)	14714688
flatten_10 (Flatten)	(None, 8192)	0
dense_30 (Dense)	(None, 4096)	33558528
batch_normalization_25 (Batch Normalization)	(None, 4096)	16384
dropout_9 (Dropout)	(None, 4096)	0
dense_31 (Dense)	(None, 4096)	16781312
batch_normalization_26 (Batch Normalization)	(None, 4096)	16384
dropout_10 (Dropout)	(None, 4096)	0
dense_32 (Dense)	(None, 4)	16388

=====
Total params: 65,103,684

Trainable params: 50,372,612

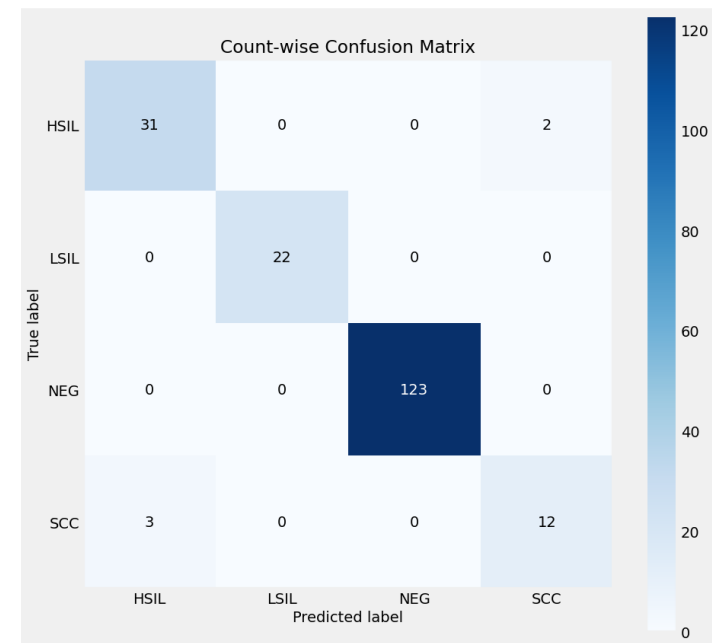
Non-trainable params: 14,731,072

VGG16 Model



Test Accuracy: 97.41%

	precision	recall	f1-score	support
HSIL	0.91	0.94	0.93	33
LSIL	1.00	1.00	1.00	22
NEG	1.00	1.00	1.00	123
SCC	0.86	0.80	0.83	15
accuracy			0.97	193
macro avg	0.94	0.93	0.94	193
weighted avg	0.97	0.97	0.97	193



ResNet50

Model	F1 Score of test set	Total Epoch	Best Epoch
Base Model	0.98	23	14
VGG16 Model	0.91	18	12
ResNet50	0.97	30	24

Result



Thank You