C:\Users\iitfypvmadmin\PycharmProjects\IIT-MSc-FYP-ML\venv\Scripts\python.exe "C:/Program Files/JetBrains/PyCharm 2023.1/plugins/python/helpers/pydev/pydevconsole.py" --mode=client --host=127.0.0.1 --port=63871

import sys; print('Python %s on %s' % (sys.version, sys.platform))

sys.path.extend(['C:\\Users\\iitfypvmadmin\\PycharmProjects\\IIT-MSc-FYP-ML'])

PyDev console: starting.

Python 3.10.10 (tags/v3.10.10:aad5f6a, Feb 7 2023, 17:20:36) [MSC v.1929 64 bit (AMD64)] on win32

runfile('C:\\Users\\iitfypvmadmin\\PycharmProjects\\IIT-MSc-FYP-ML\\ds\_train\\CNN\_Training.py', wdir='C:\\Users\\iitfypvmadmin\\PycharmProjects\\IIT-MSc-FYP-ML\\ds\_train')

Device - cpu

Full Train Set - 3840

Train Set - 3072

Validation Set - 768

Test Set - 1631

Available Classes ['අ', 'ආ', 'ඇ', 'ඈ', 'ඉ', 'ඊ', 'උ', 'එ', 'ඒ', 'ඔ', 'ඕ', 'ක', 'කා', 'කැ', 'කෑ', 'කි', 'කී', 'කු', 'කූ', 'ක්']

Net - Net(

(conv1): Conv2d(1, 16, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn1): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(conv2): Conv2d(16, 16, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn2): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(pool1): MaxPool2d(kernel\_size=2, stride=2, padding=0, dilation=1, ceil\_mode=False)

(conv3): Conv2d(16, 32, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn3): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(conv4): Conv2d(32, 32, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn4): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(pool2): MaxPool2d(kernel\_size=2, stride=2, padding=0, dilation=1, ceil\_mode=False)

(conv5): Conv2d(32, 64, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn5): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(conv6): Conv2d(64, 64, kernel\_size=(3, 3), stride=(1, 1), padding=(1, 1))

(bn6): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(pool3): MaxPool2d(kernel\_size=2, stride=2, padding=0, dilation=1, ceil\_mode=False)

(fc1): Linear(in\_features=4096, out\_features=1024, bias=True)

(bn7): BatchNorm1d(1024, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(fc2): Linear(in\_features=1024, out\_features=256, bias=True)

(bn8): BatchNorm1d(256, eps=1e-05, momentum=0.1, affine=True, track\_running\_stats=True)

(fc3): Linear(in\_features=256, out\_features=31, bias=True)

)

----------------------------------------------------

EPOCH : 1

Training loss : 0.8010311226050059

Training accuracy : 78.25520833333333%

Validation loss : 0.2164478674530983

Validation accuracy: 94.40104166666667%

----------------------------------------------------

EPOCH : 2

Training loss : 0.07720095400388043

Training accuracy : 98.66536458333333%

Validation loss : 0.12360151670873165

Validation accuracy: 96.35416666666667%

----------------------------------------------------

EPOCH : 3

Training loss : 0.02528201330763598

Training accuracy : 99.8046875%

Validation loss : 0.10179066347579162

Validation accuracy: 97.13541666666667%

----------------------------------------------------

EPOCH : 4

Training loss : 0.014590620810243612

Training accuracy : 99.83723958333333%

Validation loss : 0.10148972800622384

Validation accuracy: 96.875%

----------------------------------------------------

EPOCH : 5

Training loss : 0.010130403282043213

Training accuracy : 100.0%

Validation loss : 0.10632985038682818

Validation accuracy: 97.00520833333333%

----------------------------------------------------

EPOCH : 6

Training loss : 0.02909348240549055

Training accuracy : 99.64192708333333%

Validation loss : 0.16329924513896307

Validation accuracy: 95.44270833333333%

----------------------------------------------------

EPOCH : 7

Training loss : 0.17332507270233086

Training accuracy : 95.703125%

Validation loss : 0.2354018228749434

Validation accuracy: 92.83854166666667%

----------------------------------------------------

EPOCH : 8

Training loss : 0.09875882719643414

Training accuracy : 97.65625%

Validation loss : 0.11756004424144824

Validation accuracy: 96.35416666666667%

----------------------------------------------------

EPOCH : 9

Training loss : 0.045185178673515715

Training accuracy : 99.15364583333333%

Validation loss : 0.12583270311976472

Validation accuracy: 96.35416666666667%

----------------------------------------------------

EPOCH : 10

Training loss : 0.022846321905187022

Training accuracy : 99.57682291666667%

Validation loss : 0.10215443093329668

Validation accuracy: 97.265625%

----------------------------------------------------

EPOCH : 11

Training loss : 0.014057578451077765

Training accuracy : 99.90234375%

Validation loss : 0.11088017374277115

Validation accuracy: 96.61458333333333%

----------------------------------------------------

EPOCH : 12

Training loss : 0.030700915318448097

Training accuracy : 99.73958333333333%

Validation loss : 0.1451496115575234

Validation accuracy: 96.484375%

----------------------------------------------------

EPOCH : 13

Training loss : 0.034933045642295234

Training accuracy : 99.70703125%

Validation loss : 0.13260237127542496

Validation accuracy: 96.875%

----------------------------------------------------

EPOCH : 14

Training loss : 0.0915701175108552

Training accuracy : 98.20963541666667%

Validation loss : 0.21804593689739704

Validation accuracy: 93.22916666666667%

----------------------------------------------------

EPOCH : 15

Training loss : 0.08152814659600456

Training accuracy : 98.47005208333333%

Validation loss : 0.13919811757902303

Validation accuracy: 96.09375%

----------------------------------------------------

EPOCH : 16

Training loss : 0.028304347089336563

Training accuracy : 99.83723958333333%

Validation loss : 0.10643911858399709

Validation accuracy: 96.875%

----------------------------------------------------

EPOCH : 17

Training loss : 0.01340604453192403

Training accuracy : 100.0%

Validation loss : 0.07364284262682001

Validation accuracy: 97.91666666666667%

----------------------------------------------------

EPOCH : 18

Training loss : 0.0106451147973227

Training accuracy : 100.0%

Validation loss : 0.08445796432594459

Validation accuracy: 97.13541666666667%

----------------------------------------------------

EPOCH : 19

Training loss : 0.012986229868450513

Training accuracy : 100.0%

Validation loss : 0.08295392477884889

Validation accuracy: 98.17708333333333%

----------------------------------------------------

EPOCH : 20

Training loss : 0.014846057805698365

Training accuracy : 100.0%

Validation loss : 0.0892504978304108

Validation accuracy: 97.78645833333333%

----------------------------------------------------

EPOCH : 21

Training loss : 0.04214827015918369

Training accuracy : 99.77213541666667%

Validation loss : 0.2312325487534205

Validation accuracy: 94.66145833333333%

----------------------------------------------------

EPOCH : 22

Training loss : 0.12191796163097024

Training accuracy : 97.75390625%

Validation loss : 0.19851196060578027

Validation accuracy: 95.703125%

----------------------------------------------------

EPOCH : 23

Training loss : 0.06422426062636077

Training accuracy : 99.12109375%

Validation loss : 0.10821394436061382

Validation accuracy: 97.265625%

----------------------------------------------------

EPOCH : 24

Training loss : 0.032361341873183846

Training accuracy : 99.64192708333333%

Validation loss : 0.1298920437693596

Validation accuracy: 97.13541666666667%

----------------------------------------------------

EPOCH : 25

Training loss : 0.029636923398356885

Training accuracy : 99.73958333333333%

Validation loss : 0.127412935718894

Validation accuracy: 96.484375%

----------------------------------------------------

EPOCH : 26

Training loss : 0.037434588943142444

Training accuracy : 99.83723958333333%

Validation loss : 0.11560722036908071

Validation accuracy: 96.875%

----------------------------------------------------

EPOCH : 27

Training loss : 0.029965065012220293

Training accuracy : 99.73958333333333%

Validation loss : 0.146293876071771

Validation accuracy: 96.74479166666667%

----------------------------------------------------

EPOCH : 28

Training loss : 0.06181555256868402

Training accuracy : 99.21875%

Validation loss : 0.18155237721900144

Validation accuracy: 95.703125%

----------------------------------------------------

EPOCH : 29

Training loss : 0.05009473095803211

Training accuracy : 99.47916666666667%

Validation loss : 0.11719742013762395

Validation accuracy: 97.65625%

----------------------------------------------------

EPOCH : 30

Training loss : 0.04079048665395627

Training accuracy : 99.4140625%

Validation loss : 0.139665886759758

Validation accuracy: 96.484375%

----------------------------------------------------

EPOCH : 31

Training loss : 0.06112740173315009

Training accuracy : 99.05598958333333%

Validation loss : 0.15254802349954844

Validation accuracy: 96.35416666666667%

----------------------------------------------------

EPOCH : 32

Training loss : 0.02926494008473431

Training accuracy : 99.8046875%

Validation loss : 0.10544451636572678

Validation accuracy: 97.13541666666667%

----------------------------------------------------

EPOCH : 33

Training loss : 0.02013449601751442

Training accuracy : 99.96744791666667%

Validation loss : 0.08691879749918978

Validation accuracy: 98.046875%

----------------------------------------------------

EPOCH : 34

Training loss : 0.03630136492817352

Training accuracy : 99.38151041666667%

Validation loss : 0.17346647009253502

Validation accuracy: 96.484375%

----------------------------------------------------

EPOCH : 35

Training loss : 0.08537025734161337

Training accuracy : 98.50260416666667%

Validation loss : 0.19086969643831253

Validation accuracy: 95.18229166666667%

----------------------------------------------------

EPOCH : 36

Training loss : 0.06755961132391046

Training accuracy : 99.05598958333333%

Validation loss : 0.10416385220984618

Validation accuracy: 97.265625%

----------------------------------------------------

EPOCH : 37

Training loss : 0.025347564738088597

Training accuracy : 99.8046875%

Validation loss : 0.08768784813582897

Validation accuracy: 98.17708333333333%

----------------------------------------------------

EPOCH : 38

Training loss : 0.018984259436062228

Training accuracy : 99.96744791666667%

Validation loss : 0.05378951923921704

Validation accuracy: 99.47916666666667%

----------------------------------------------------

EPOCH : 39

Training loss : 0.01848271394070859

Training accuracy : 99.93489583333333%

Validation loss : 0.10963892890140414

Validation accuracy: 97.52604166666667%

----------------------------------------------------

EPOCH : 40

Training loss : 0.02069649474772935

Training accuracy : 100.0%

Validation loss : 0.0929801029463609

Validation accuracy: 98.30729166666667%

----------------------------------------------------

EPOCH : 41

Training loss : 0.030314574503184605

Training accuracy : 99.93489583333333%

Validation loss : 0.11784088052809238

Validation accuracy: 97.78645833333333%

----------------------------------------------------

EPOCH : 42

Training loss : 0.07284230680670589

Training accuracy : 99.08854166666667%

Validation loss : 0.1655824619034926

Validation accuracy: 95.703125%

----------------------------------------------------

EPOCH : 43

Training loss : 0.07420931620678554

Training accuracy : 98.92578125%

Validation loss : 0.11777998972684145

Validation accuracy: 97.00520833333333%

----------------------------------------------------

EPOCH : 44

Training loss : 0.043083292276908956

Training accuracy : 99.54427083333333%

Validation loss : 0.08480106169978778

Validation accuracy: 97.78645833333333%

----------------------------------------------------

EPOCH : 45

Training loss : 0.02579409848355378

Training accuracy : 99.93489583333333%

Validation loss : 0.08161268476396799

Validation accuracy: 97.91666666666667%

----------------------------------------------------

EPOCH : 46

Training loss : 0.015561280364636332

Training accuracy : 99.96744791666667%

Validation loss : 0.07993353065103292

Validation accuracy: 98.046875%

----------------------------------------------------

EPOCH : 47

Training loss : 0.014969340001698583

Training accuracy : 100.0%

Validation loss : 0.07371007309605677

Validation accuracy: 98.30729166666667%

----------------------------------------------------

EPOCH : 48

Training loss : 0.018874571522853028

Training accuracy : 100.0%

Validation loss : 0.0889974491049846

Validation accuracy: 98.046875%

----------------------------------------------------

EPOCH : 49

Training loss : 0.019458120436562847

Training accuracy : 100.0%

Validation loss : 0.08772427743921678

Validation accuracy: 98.4375%

----------------------------------------------------

EPOCH : 50

Training loss : 0.020061590301338583

Training accuracy : 100.0%

Validation loss : 0.07903149398043752

Validation accuracy: 98.4375%

----------------------------------------------------

EPOCH : 51

Training loss : 0.01892602222505957

Training accuracy : 100.0%

Validation loss : 0.08442477214460571

Validation accuracy: 98.17708333333333%

----------------------------------------------------

EPOCH : 52

Training loss : 0.02592743238589416

Training accuracy : 100.0%

Validation loss : 0.09766229925056298

Validation accuracy: 98.30729166666667%

----------------------------------------------------

EPOCH : 53

Training loss : 0.057532750690976776

Training accuracy : 99.54427083333333%

Validation loss : 0.20422172360122204

Validation accuracy: 95.83333333333333%

----------------------------------------------------

EPOCH : 54

Training loss : 0.16663758169549206

Training accuracy : 96.12630208333333%

Validation loss : 0.19255086655418077

Validation accuracy: 94.53125%

----------------------------------------------------

EPOCH : 55

Training loss : 0.0844618232222274

Training accuracy : 98.27473958333333%

Validation loss : 0.0924316664847235

Validation accuracy: 97.78645833333333%

----------------------------------------------------

EPOCH : 56

Training loss : 0.0485962211775283

Training accuracy : 99.12109375%

Validation loss : 0.08866309157262246

Validation accuracy: 97.91666666666667%

----------------------------------------------------

EPOCH : 57

Training loss : 0.0214518621408691

Training accuracy : 99.90234375%

Validation loss : 0.06564088507244985

Validation accuracy: 98.828125%

----------------------------------------------------

EPOCH : 58

Training loss : 0.014432688476517797

Training accuracy : 100.0%

Validation loss : 0.059824245205769934

Validation accuracy: 98.69791666666667%

----------------------------------------------------

EPOCH : 59

Training loss : 0.015011727111414075

Training accuracy : 100.0%

Validation loss : 0.06515344651415944

Validation accuracy: 98.95833333333333%

----------------------------------------------------

EPOCH : 60

Training loss : 0.018585747592927266

Training accuracy : 100.0%

Validation loss : 0.06457358660797279

Validation accuracy: 98.95833333333333%

----------------------------------------------------

EPOCH : 61

Training loss : 0.018313144779919337

Training accuracy : 100.0%

Validation loss : 0.058220559265464544

Validation accuracy: 99.08854166666667%

----------------------------------------------------

EPOCH : 62

Training loss : 0.018141717184334993

Training accuracy : 100.0%

Validation loss : 0.07555290746192138

Validation accuracy: 98.69791666666667%

----------------------------------------------------

GroundTruth: ඈ කැ කා කි කි කෑ කෑ කා කූ ක්

Predicted: අ කැ කා ක කී කෑ කෑ කා කූ ක්

Accuracy of the network on the test images: 84.304108 %

Non-normalized Confusion Matrix

Confusion Matrix for Test Set

[[ 56 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

3 0]

[ 1 47 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0]

[ 2 0 49 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0]

[ 0 0 1 46 0 0 2 0 0 0 0 0 0 0 0 0 0 0

5 0]

[ 0 0 0 0 52 0 0 0 0 0 0 0 0 0 0 0 0 0

2 2]

[ 0 0 0 0 0 37 3 2 1 0 0 0 0 0 0 0 0 0

0 0]

[ 0 0 0 0 0 0 44 0 0 0 0 0 0 0 0 0 0 0

0 0]

[ 0 0 0 0 0 2 5 54 5 0 0 0 0 0 0 2 0 0

0 1]

[ 0 0 0 0 0 0 0 0 65 0 0 0 0 0 0 0 3 0

0 13]

[ 0 0 0 0 0 0 1 0 0 61 1 0 0 0 0 0 0 8

0 0]

[ 0 0 0 0 2 0 4 1 2 6 65 2 0 0 0 2 3 2

0 0]

[ 0 1 0 0 0 1 1 0 0 8 2 67 11 0 0 6 0 12

1 1]

[ 0 0 0 0 0 0 1 0 0 0 0 0 116 1 0 0 0 0

0 0]

[ 0 0 0 2 0 0 2 0 0 0 0 0 0 92 18 0 0 3

1 0]

[ 0 0 0 1 0 0 0 0 0 0 0 0 0 6 79 0 0 2

3 0]

[ 0 0 0 0 0 1 0 0 0 0 0 2 2 0 0 79 23 2

1 0]

[ 0 0 1 2 0 4 10 13 4 0 1 4 0 1 0 0 69 0

0 0]

[ 2 5 4 3 6 2 5 2 0 7 0 7 0 4 2 0 0 47

0 0]

[ 6 1 0 1 12 0 5 1 0 1 0 10 0 3 7 0 0 11

46 0]

[ 0 5 0 0 0 3 0 0 12 5 3 1 0 4 1 5 0 0

0 57]]

Classification report

precision recall f1-score support

0 0.89 0.95 0.92 60

1 0.84 0.98 0.90 48

2 0.94 0.81 0.87 63

3 0.78 0.87 0.82 54

4 0.93 0.96 0.95 56

5 0.80 0.86 0.83 43

6 0.65 1.00 0.79 44

7 0.92 0.80 0.85 69

8 0.87 0.90 0.88 81

9 0.82 0.94 0.88 71

10 0.93 0.75 0.83 89

11 0.80 0.68 0.74 111

12 0.89 0.97 0.93 118

13 0.88 0.73 0.80 118

14 0.72 0.89 0.80 91

15 0.88 0.80 0.84 110

16 0.85 0.85 0.85 109

17 0.71 0.81 0.76 96

18 0.91 0.71 0.80 104

19 0.92 0.90 0.91 96

accuracy 0.84 1631

macro avg 0.85 0.86 0.85 1631

weighted avg 0.85 0.84 0.84 1631