

```
1 C:\Users\iitfypvadmin\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
2
3 import sys; print('Python %s on %s' % (sys.version, sys.platform))
4 sys.path.extend(['C:\\Users\\iitfypvadmin\\PycharmProjects\\IIT-MSc-FYP-ML'])
5
6 PyDev console: starting.
7
8 Python 3.10.10 (tags/v3.10.10:aad5f6a, Feb  7 2023, 17:20:36) [MSC v.1929 64 bit (AMD64)] on win32
9 >>> runfile('C:\\Users\\iitfypvadmin\\PycharmProjects\\IIT-MSc-FYP-ML\\ds_train\\CNN_Training.py',
  wdir='C:\\Users\\iitfypvadmin\\PycharmProjects\\IIT-MSc-FYP-ML\\ds_train')
10 Device -  cpu
11 Full Train Set -  3840
12 Train Set -  3072
13 Validation Set -  768
14 Test Set -  1631
15 Available Classes ['0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '00', '00', '00', '00
  ', '00', '00', '00', '00']
16 Net -  Net(
17     (conv1): Conv2d(1, 16, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
18     (bn1): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
19     (conv2): Conv2d(16, 16, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
20     (bn2): BatchNorm2d(16, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
21     (pool1): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
22     (conv3): Conv2d(16, 32, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
23     (bn3): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
24     (conv4): Conv2d(32, 32, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
25     (bn4): BatchNorm2d(32, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
26     (pool2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
27     (conv5): Conv2d(32, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
28     (bn5): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
29     (conv6): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
30     (bn6): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
31     (pool3): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
32     (fc1): Linear(in_features=4096, out_features=1024, bias=True)
33     (bn7): BatchNorm1d(1024, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
34     (fc2): Linear(in_features=1024, out_features=256, bias=True)
35     (bn8): BatchNorm1d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
36     (fc3): Linear(in_features=256, out_features=31, bias=True)
37 )
38 -----
39 EPOCH          : 1
40 Training loss   : 0.8010311226050059
41 Training accuracy : 78.25520833333333%
42 Validation loss  : 0.2164478674530983
43 Validation accuracy: 94.40104166666667%
44 -----
45 EPOCH          : 2
46 Training loss   : 0.07720095400388043
47 Training accuracy : 98.66536458333333%
48 Validation loss  : 0.12360151670873165
49 Validation accuracy: 96.35416666666667%
50 -----
51 EPOCH          : 3
52 Training loss   : 0.02528201330763598
53 Training accuracy : 99.8046875%
54 Validation loss  : 0.10179066347579162
55 Validation accuracy: 97.13541666666667%
56 -----
57 EPOCH          : 4
58 Training loss   : 0.014590620810243612
59 Training accuracy : 99.83723958333333%
60 Validation loss  : 0.10148972800622384
61 Validation accuracy: 96.875%
62 -----
63 EPOCH          : 5
64 Training loss   : 0.010130403282043213
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65 Training accuracy : 100.0%
66 Validation loss   : 0.10632985038682818
67 Validation accuracy: 97.00520833333333%
68 -----
69 EPOCH             : 6
70 Training loss      : 0.02909348240549055
71 Training accuracy  : 99.64192708333333%
72 Validation loss     : 0.16329924513896307
73 Validation accuracy: 95.44270833333333%
74 -----
75 EPOCH             : 7
76 Training loss      : 0.17332507270233086
77 Training accuracy  : 95.703125%
78 Validation loss     : 0.2354018228749434
79 Validation accuracy: 92.83854166666667%
80 -----
81 EPOCH             : 8
82 Training loss      : 0.09875882719643414
83 Training accuracy  : 97.65625%
84 Validation loss     : 0.11756004424144824
85 Validation accuracy: 96.35416666666667%
86 -----
87 EPOCH             : 9
88 Training loss      : 0.045185178673515715
89 Training accuracy  : 99.15364583333333%
90 Validation loss     : 0.12583270311976472
91 Validation accuracy: 96.35416666666667%
92 -----
93 EPOCH             : 10
94 Training loss      : 0.022846321905187022
95 Training accuracy  : 99.57682291666667%
96 Validation loss     : 0.10215443093329668
97 Validation accuracy: 97.265625%
98 -----
99 EPOCH             : 11
100 Training loss     : 0.014057578451077765
101 Training accuracy  : 99.90234375%
102 Validation loss    : 0.11088017374277115
103 Validation accuracy: 96.61458333333333%
104 -----
105 EPOCH             : 12
106 Training loss     : 0.030700915318448097
107 Training accuracy  : 99.73958333333333%
108 Validation loss    : 0.1451496115575234
109 Validation accuracy: 96.484375%
110 -----
111 EPOCH             : 13
112 Training loss     : 0.034933045642295234
113 Training accuracy  : 99.70703125%
114 Validation loss    : 0.13260237127542496
115 Validation accuracy: 96.875%
116 -----
117 EPOCH             : 14
118 Training loss     : 0.0915701175108552
119 Training accuracy  : 98.20963541666667%
120 Validation loss    : 0.21804593689739704
121 Validation accuracy: 93.22916666666667%
122 -----
123 EPOCH             : 15
124 Training loss     : 0.08152814659600456
125 Training accuracy  : 98.47005208333333%
126 Validation loss    : 0.13919811757902303
127 Validation accuracy: 96.09375%
128 -----
129 EPOCH             : 16
130 Training loss     : 0.028304347089336563
131 Training accuracy  : 99.83723958333333%
132 Validation loss    : 0.10643911858399709
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133 Validation accuracy: 96.875%
134 -----
135 EPOCH          : 17
136 Training loss   : 0.01340604453192403
137 Training accuracy : 100.0%
138 Validation loss  : 0.07364284262682001
139 Validation accuracy: 97.91666666666667%
140 -----
141 EPOCH          : 18
142 Training loss   : 0.0106451147973227
143 Training accuracy : 100.0%
144 Validation loss  : 0.08445796432594459
145 Validation accuracy: 97.13541666666667%
146 -----
147 EPOCH          : 19
148 Training loss   : 0.012986229868450513
149 Training accuracy : 100.0%
150 Validation loss  : 0.08295392477884889
151 Validation accuracy: 98.17708333333333%
152 -----
153 EPOCH          : 20
154 Training loss   : 0.014846057805698365
155 Training accuracy : 100.0%
156 Validation loss  : 0.0892504978304108
157 Validation accuracy: 97.78645833333333%
158 -----
159 EPOCH          : 21
160 Training loss   : 0.04214827015918369
161 Training accuracy : 99.77213541666667%
162 Validation loss  : 0.2312325487534205
163 Validation accuracy: 94.66145833333333%
164 -----
165 EPOCH          : 22
166 Training loss   : 0.12191796163097024
167 Training accuracy : 97.75390625%
168 Validation loss  : 0.19851196060578027
169 Validation accuracy: 95.703125%
170 -----
171 EPOCH          : 23
172 Training loss   : 0.06422426062636077
173 Training accuracy : 99.12109375%
174 Validation loss  : 0.10821394436061382
175 Validation accuracy: 97.265625%
176 -----
177 EPOCH          : 24
178 Training loss   : 0.032361341873183846
179 Training accuracy : 99.64192708333333%
180 Validation loss  : 0.1298920437693596
181 Validation accuracy: 97.13541666666667%
182 -----
183 EPOCH          : 25
184 Training loss   : 0.029636923398356885
185 Training accuracy : 99.73958333333333%
186 Validation loss  : 0.127412935718894
187 Validation accuracy: 96.484375%
188 -----
189 EPOCH          : 26
190 Training loss   : 0.037434588943142444
191 Training accuracy : 99.83723958333333%
192 Validation loss  : 0.11560722036908071
193 Validation accuracy: 96.875%
194 -----
195 EPOCH          : 27
196 Training loss   : 0.029965065012220293
197 Training accuracy : 99.73958333333333%
198 Validation loss  : 0.146293876071771
199 Validation accuracy: 96.74479166666667%
200 -----
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201 EPOCH : 28
202 Training loss : 0.06181555256868402
203 Training accuracy : 99.21875%
204 Validation loss : 0.18155237721900144
205 Validation accuracy: 95.703125%
206 -----
207 EPOCH : 29
208 Training loss : 0.05009473095803211
209 Training accuracy : 99.47916666666667%
210 Validation loss : 0.11719742013762395
211 Validation accuracy: 97.65625%
212 -----
213 EPOCH : 30
214 Training loss : 0.04079048665395627
215 Training accuracy : 99.4140625%
216 Validation loss : 0.139665886759758
217 Validation accuracy: 96.484375%
218 -----
219 EPOCH : 31
220 Training loss : 0.06112740173315009
221 Training accuracy : 99.05598958333333%
222 Validation loss : 0.15254802349954844
223 Validation accuracy: 96.35416666666667%
224 -----
225 EPOCH : 32
226 Training loss : 0.02926494008473431
227 Training accuracy : 99.8046875%
228 Validation loss : 0.10544451636572678
229 Validation accuracy: 97.13541666666667%
230 -----
231 EPOCH : 33
232 Training loss : 0.02013449601751442
233 Training accuracy : 99.96744791666667%
234 Validation loss : 0.08691879749918978
235 Validation accuracy: 98.046875%
236 -----
237 EPOCH : 34
238 Training loss : 0.03630136492817352
239 Training accuracy : 99.38151041666667%
240 Validation loss : 0.17346647009253502
241 Validation accuracy: 96.484375%
242 -----
243 EPOCH : 35
244 Training loss : 0.08537025734161337
245 Training accuracy : 98.50260416666667%
246 Validation loss : 0.19086969643831253
247 Validation accuracy: 95.18229166666667%
248 -----
249 EPOCH : 36
250 Training loss : 0.06755961132391046
251 Training accuracy : 99.05598958333333%
252 Validation loss : 0.10416385220984618
253 Validation accuracy: 97.265625%
254 -----
255 EPOCH : 37
256 Training loss : 0.025347564738088597
257 Training accuracy : 99.8046875%
258 Validation loss : 0.08768784813582897
259 Validation accuracy: 98.17708333333333%
260 -----
261 EPOCH : 38
262 Training loss : 0.018984259436062228
263 Training accuracy : 99.96744791666667%
264 Validation loss : 0.05378951923921704
265 Validation accuracy: 99.47916666666667%
266 -----
267 EPOCH : 39
268 Training loss : 0.01848271394070859
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269 Training accuracy : 99.93489583333333%
270 Validation loss   : 0.10963892890140414
271 Validation accuracy: 97.52604166666667%
272 -----
273 EPOCH              : 40
274 Training loss      : 0.02069649474772935
275 Training accuracy  : 100.0%
276 Validation loss    : 0.0929801029463609
277 Validation accuracy: 98.30729166666667%
278 -----
279 EPOCH              : 41
280 Training loss      : 0.030314574503184605
281 Training accuracy  : 99.93489583333333%
282 Validation loss    : 0.11784088052809238
283 Validation accuracy: 97.78645833333333%
284 -----
285 EPOCH              : 42
286 Training loss      : 0.07284230680670589
287 Training accuracy  : 99.08854166666667%
288 Validation loss    : 0.1655824619034926
289 Validation accuracy: 95.703125%
290 -----
291 EPOCH              : 43
292 Training loss      : 0.07420931620678554
293 Training accuracy  : 98.92578125%
294 Validation loss    : 0.11777998972684145
295 Validation accuracy: 97.00520833333333%
296 -----
297 EPOCH              : 44
298 Training loss      : 0.043083292276908956
299 Training accuracy  : 99.54427083333333%
300 Validation loss    : 0.08480106169978778
301 Validation accuracy: 97.78645833333333%
302 -----
303 EPOCH              : 45
304 Training loss      : 0.02579409848355378
305 Training accuracy  : 99.93489583333333%
306 Validation loss    : 0.08161268476396799
307 Validation accuracy: 97.91666666666667%
308 -----
309 EPOCH              : 46
310 Training loss      : 0.015561280364636332
311 Training accuracy  : 99.96744791666667%
312 Validation loss    : 0.07993353065103292
313 Validation accuracy: 98.046875%
314 -----
315 EPOCH              : 47
316 Training loss      : 0.014969340001698583
317 Training accuracy  : 100.0%
318 Validation loss    : 0.07371007309605677
319 Validation accuracy: 98.30729166666667%
320 -----
321 EPOCH              : 48
322 Training loss      : 0.018874571522853028
323 Training accuracy  : 100.0%
324 Validation loss    : 0.0889974491049846
325 Validation accuracy: 98.046875%
326 -----
327 EPOCH              : 49
328 Training loss      : 0.019458120436562847
329 Training accuracy  : 100.0%
330 Validation loss    : 0.08772427743921678
331 Validation accuracy: 98.4375%
332 -----
333 EPOCH              : 50
334 Training loss      : 0.020061590301338583
335 Training accuracy  : 100.0%
336 Validation loss    : 0.07903149398043752
```

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337 Validation accuracy: 98.4375%
338 -----
339 EPOCH          : 51
340 Training loss   : 0.01892602222505957
341 Training accuracy : 100.0%
342 Validation loss  : 0.08442477214460571
343 Validation accuracy: 98.17708333333333%
344 -----
345 EPOCH          : 52
346 Training loss   : 0.02592743238589416
347 Training accuracy : 100.0%
348 Validation loss  : 0.09766229925056298
349 Validation accuracy: 98.30729166666667%
350 -----
351 EPOCH          : 53
352 Training loss   : 0.057532750690976776
353 Training accuracy : 99.54427083333333%
354 Validation loss  : 0.20422172360122204
355 Validation accuracy: 95.83333333333333%
356 -----
357 EPOCH          : 54
358 Training loss   : 0.16663758169549206
359 Training accuracy : 96.12630208333333%
360 Validation loss  : 0.19255086655418077
361 Validation accuracy: 94.53125%
362 -----
363 EPOCH          : 55
364 Training loss   : 0.0844618232222274
365 Training accuracy : 98.27473958333333%
366 Validation loss  : 0.0924316664847235
367 Validation accuracy: 97.78645833333333%
368 -----
369 EPOCH          : 56
370 Training loss   : 0.0485962211775283
371 Training accuracy : 99.12109375%
372 Validation loss  : 0.08866309157262246
373 Validation accuracy: 97.91666666666667%
374 -----
375 EPOCH          : 57
376 Training loss   : 0.0214518621408691
377 Training accuracy : 99.90234375%
378 Validation loss  : 0.06564088507244985
379 Validation accuracy: 98.828125%
380 -----
381 EPOCH          : 58
382 Training loss   : 0.014432688476517797
383 Training accuracy : 100.0%
384 Validation loss  : 0.059824245205769934
385 Validation accuracy: 98.69791666666667%
386 -----
387 EPOCH          : 59
388 Training loss   : 0.015011727111414075
389 Training accuracy : 100.0%
390 Validation loss  : 0.06515344651415944
391 Validation accuracy: 98.95833333333333%
392 -----
393 EPOCH          : 60
394 Training loss   : 0.018585747592927266
395 Training accuracy : 100.0%
396 Validation loss  : 0.06457358660797279
397 Validation accuracy: 98.95833333333333%
398 -----
399 EPOCH          : 61
400 Training loss   : 0.018313144779919337
401 Training accuracy : 100.0%
402 Validation loss  : 0.058220559265464544
403 Validation accuracy: 99.08854166666667%
404 -----
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```
405 EPOCH : 62
406 Training loss : 0.018141717184334993
407 Training accuracy : 100.0%
408 Validation loss : 0.07555290746192138
409 Validation accuracy: 98.69791666666667%
410 -----
411 GroundTruth:  00 00 00 00 00 00 00 00 00 00
412 Predicted:    0 00 00 0 00 00 00 00 00 00
413 Accuracy of the network on the test images: 84.304108 %
414 Non-normalized Confusion Matrix
415 Confusion Matrix for Test Set
416 [[ 56  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
417      3  0]
418 [  1 47  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
419      0  0]
420 [  2  0 49 12  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
421      0  0]
422 [  0  0  1 46  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0
423      5  0]
424 [  0  0  0  0 52  0  0  0  0  0  0  0  0  0  0  0  0  0  0
425      2  2]
426 [  0  0  0  0  0 37  3  2  1  0  0  0  0  0  0  0  0  0  0
427      0  0]
428 [  0  0  0  0  0  0 44  0  0  0  0  0  0  0  0  0  0  0  0
429      0  0]
430 [  0  0  0  0  0  2  5 54  5  0  0  0  0  0  0  0  2  0  0
431      0  1]
432 [  0  0  0  0  0  0  0  0 65  0  0  0  0  0  0  0  0  3  0
433      0 13]
434 [  0  0  0  0  0  0  1  0  0 61  1  0  0  0  0  0  0  0  8
435      0  0]
436 [  0  0  0  0  2  0  4  1  2  6 65  2  0  0  0  0  2  3  2
437      0  0]
438 [  0  1  0  0  0  1  1  0  0  8  2 67 11  0  0  0  6  0 12
439      1  1]
440 [  0  0  0  0  0  0  1  0  0  0  0  0 116  1  0  0  0  0  0
441      0  0]
442 [  0  0  0  2  0  0  2  0  0  0  0  0  0  0 92 18  0  0  3
443      1  0]
444 [  0  0  0  1  0  0  0  0  0  0  0  0  0  0  6 79  0  0  2
445      3  0]
446 [  0  0  0  0  0  1  0  0  0  0  0  2  2  0  0  0 79 23  2
447      1  0]
448 [  0  0  1  2  0  4 10 13  4  0  1  4  0  1  0  0  0 69  0
449      0  0]
450 [  2  5  4  3  6  2  5  2  0  7  0  7  0  4  2  0  0  0 47
451      0  0]
452 [  6  1  0  1 12  0  5  1  0  1  0 10  0  3  7  0  0  0 11
453     46  0]
454 [  0  5  0  0  0  3  0  0 12  5  3  1  0  4  1  5  0  0  0
455      0 57]]
456 Classification report
457           precision    recall  f1-score   support
458
459          0           0.89      0.95      0.92         60
460          1           0.84      0.98      0.90         48
461          2           0.94      0.81      0.87         63
462          3           0.78      0.87      0.82         54
463          4           0.93      0.96      0.95         56
464          5           0.80      0.86      0.83         43
465          6           0.65      1.00      0.79         44
466          7           0.92      0.80      0.85         69
467          8           0.87      0.90      0.88         81
468          9           0.82      0.94      0.88         71
469         10           0.93      0.75      0.83         89
470         11           0.80      0.68      0.74        111
471         12           0.89      0.97      0.93        118
472         13           0.88      0.73      0.80        118
```

473	14	0.72	0.89	0.80	91
474	15	0.88	0.80	0.84	110
475	16	0.85	0.85	0.85	109
476	17	0.71	0.81	0.76	96
477	18	0.91	0.71	0.80	104
478	19	0.92	0.90	0.91	96
479					
480	accuracy			0.84	1631
481	macro avg	0.85	0.86	0.85	1631
482	weighted avg	0.85	0.84	0.84	1631
483					
484					