CMPT412 (Fall 2021): Project 2
Deep learning by PyTorch
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Part1:

Name of Kaggle: Keenan Byun
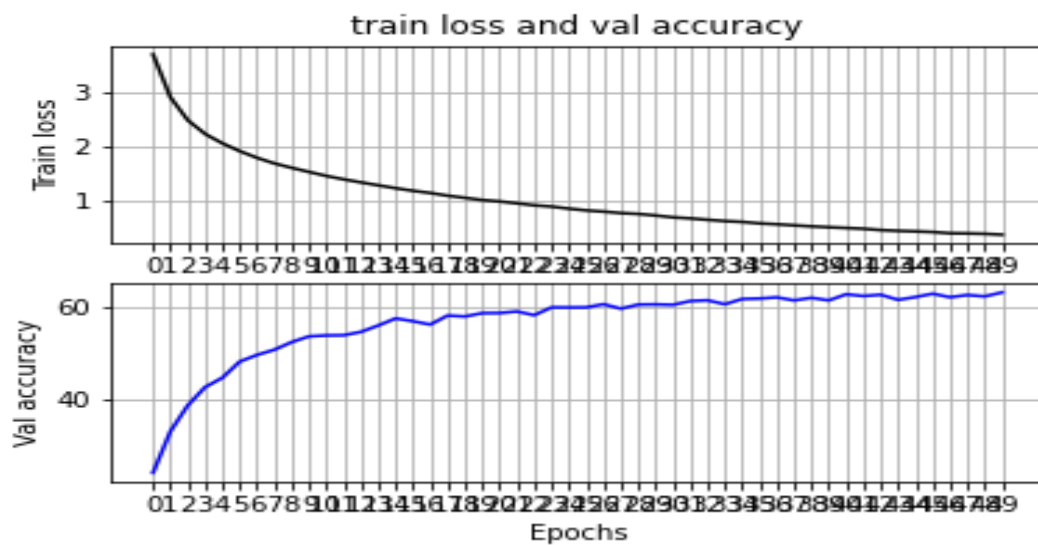Best Accuracy: 0.70100

Layer Table:

Layer No.	Layer Type	Kernel Size	Input|Output dimension	Input|Output channels
1	conv2D	3	32 | 32	3 | 128
2	norm2D	-	32 | 32	-
3	relu	-	32 | 32	-
4	conv2D	3	32 | 32	128 | 128
5	norm2D	-	32 | 32	-
6	relu	-	32 | 32	-
7	maxpool2D	2	32 | 16	-
8	dropout	-	16 | 16	-
9	conv2D	3	16 | 16	128 | 256
10	norm2D	-	16 | 16	-
11	relu	-	16 | 16	-
12	conv2D	3	16 | 16	256 | 256
13	norm2D	-	16 | 16	-
14	relu	-	16 | 16	-
15	maxpool2D	2	16 | 8	-
16	dropout	-	8 | 8	-
17	conv2D	3	8 | 8	256 | 512
18	norm2D	-	8 | 8	-
19	relu	-	8 | 8	-

20	conv2D	3	8 | 8	512 | 512
21	norm2D	-	8 | 8	-
22	relu	-	8 | 8	-
23	maxpool2D	2	8 | 4	-
24	dropout	-	4 | 4	-
25	linear	-	8192 | 3074	-
26	norm1D	-	8192 | 3074	-
27	relu	-	8192 | 3074	-
28	dropout	-	8192 | 3074	-
29	linear	-	3074 | 100	-

Plot Graph:

Epoch = 50

Performance Improvement(validation accuracy):
Base net: **23%**
Normalizations and double convolution layers: **37%**
Channel increases from: 6, 12, 24, 48 to: 32, 64, 128, 256: **46%**
Kernel size from: 5 to: 3: **51%**
Linear Layer channel from: TOTAL_CLASSES/2 to:512: **55%**
Remove image augmentations: **60%**
Dropouts for each network: 0.1, 0.25, 0.5: **63% -> (0.70100 in kaggle)**

Part2:

Fixed Feature Extractor vs Fine-Tuning:
Fixed Feature Extractor(RESNET_LAST_ONLY: True):

```
TRAINING Epoch 1/50 Loss 0.3380 Accuracy 0.0077
TRAINING Epoch 2/50 Loss 0.3244 Accuracy 0.0223
TRAINING Epoch 3/50 Loss 0.3134 Accuracy 0.0393
TRAINING Epoch 4/50 Loss 0.3012 Accuracy 0.0733
TRAINING Epoch 5/50 Loss 0.2920 Accuracy 0.1047
TRAINING Epoch 6/50 Loss 0.2814 Accuracy 0.1373
TRAINING Epoch 7/50 Loss 0.2746 Accuracy 0.1497
TRAINING Epoch 8/50 Loss 0.2650 Accuracy 0.1930
TRAINING Epoch 9/50 Loss 0.2586 Accuracy 0.2030
TRAINING Epoch 10/50 Loss 0.2516 Accuracy 0.2143
TRAINING Epoch 11/50 Loss 0.2427 Accuracy 0.2587
TRAINING Epoch 12/50 Loss 0.2372 Accuracy 0.2593
TRAINING Epoch 13/50 Loss 0.2315 Accuracy 0.2803
TRAINING Epoch 14/50 Loss 0.2265 Accuracy 0.2773
TRAINING Epoch 15/50 Loss 0.2212 Accuracy 0.2973
TRAINING Epoch 16/50 Loss 0.2184 Accuracy 0.2910
TRAINING Epoch 17/50 Loss 0.2133 Accuracy 0.3153
TRAINING Epoch 18/50 Loss 0.2077 Accuracy 0.3267
TRAINING Epoch 19/50 Loss 0.2058 Accuracy 0.3323
TRAINING Epoch 20/50 Loss 0.2006 Accuracy 0.3433
TRAINING Epoch 21/50 Loss 0.1979 Accuracy 0.3450
TRAINING Epoch 22/50 Loss 0.1944 Accuracy 0.3503
TRAINING Epoch 23/50 Loss 0.1902 Accuracy 0.3683
TRAINING Epoch 24/50 Loss 0.1900 Accuracy 0.3650
TRAINING Epoch 25/50 Loss 0.1844 Accuracy 0.3800
TRAINING Epoch 26/50 Loss 0.1832 Accuracy 0.3773
TRAINING Epoch 27/50 Loss 0.1811 Accuracy 0.3923
TRAINING Epoch 28/50 Loss 0.1806 Accuracy 0.3893
TRAINING Epoch 29/50 Loss 0.1767 Accuracy 0.4053
TRAINING Epoch 30/50 Loss 0.1761 Accuracy 0.3990
TRAINING Epoch 31/50 Loss 0.1729 Accuracy 0.3997
TRAINING Epoch 32/50 Loss 0.1693 Accuracy 0.4113
TRAINING Epoch 33/50 Loss 0.1715 Accuracy 0.4097
TRAINING Epoch 34/50 Loss 0.1649 Accuracy 0.4270
TRAINING Epoch 35/50 Loss 0.1673 Accuracy 0.4163
TRAINING Epoch 36/50 Loss 0.1659 Accuracy 0.4117
TRAINING Epoch 37/50 Loss 0.1620 Accuracy 0.4343
TRAINING Epoch 38/50 Loss 0.1634 Accuracy 0.4263
TRAINING Epoch 39/50 Loss 0.1593 Accuracy 0.4297
TRAINING Epoch 40/50 Loss 0.1601 Accuracy 0.4293
TRAINING Epoch 41/50 Loss 0.1601 Accuracy 0.4227
TRAINING Epoch 42/50 Loss 0.1563 Accuracy 0.4483
TRAINING Epoch 43/50 Loss 0.1561 Accuracy 0.4430
TRAINING Epoch 44/50 Loss 0.1566 Accuracy 0.4380
TRAINING Epoch 45/50 Loss 0.1566 Accuracy 0.4293
TRAINING Epoch 46/50 Loss 0.1557 Accuracy 0.4430
TRAINING Epoch 47/50 Loss 0.1523 Accuracy 0.4393
TRAINING Epoch 48/50 Loss 0.1502 Accuracy 0.4577
TRAINING Epoch 49/50 Loss 0.1560 Accuracy 0.4360
TRAINING Epoch 50/50 Loss 0.1490 Accuracy 0.4433
Finished Training
```

Test Loss: 0.1647 Test Accuracy 0.3660

Fine-Tuning(RESNET_LAST_ONLY: False):

```
TRAINING Epoch 1/50 Loss 0.3349 Accuracy 0.0090
TRAINING Epoch 2/50 Loss 0.3096 Accuracy 0.0450
TRAINING Epoch 3/50 Loss 0.2817 Accuracy 0.0970
TRAINING Epoch 4/50 Loss 0.2571 Accuracy 0.1580
TRAINING Epoch 5/50 Loss 0.2366 Accuracy 0.2083
TRAINING Epoch 6/50 Loss 0.2186 Accuracy 0.2737
TRAINING Epoch 7/50 Loss 0.2035 Accuracy 0.3167
TRAINING Epoch 8/50 Loss 0.1899 Accuracy 0.3543
TRAINING Epoch 9/50 Loss 0.1779 Accuracy 0.3913
TRAINING Epoch 10/50 Loss 0.1695 Accuracy 0.4250
TRAINING Epoch 11/50 Loss 0.1578 Accuracy 0.4703
TRAINING Epoch 12/50 Loss 0.1526 Accuracy 0.4730
TRAINING Epoch 13/50 Loss 0.1479 Accuracy 0.4883
TRAINING Epoch 14/50 Loss 0.1364 Accuracy 0.5327
TRAINING Epoch 15/50 Loss 0.1312 Accuracy 0.5427
TRAINING Epoch 16/50 Loss 0.1256 Accuracy 0.5607
TRAINING Epoch 17/50 Loss 0.1234 Accuracy 0.5680
TRAINING Epoch 18/50 Loss 0.1183 Accuracy 0.5830
TRAINING Epoch 19/50 Loss 0.1164 Accuracy 0.5860
TRAINING Epoch 20/50 Loss 0.1119 Accuracy 0.5973
TRAINING Epoch 21/50 Loss 0.1049 Accuracy 0.6263
TRAINING Epoch 22/50 Loss 0.1001 Accuracy 0.6473
TRAINING Epoch 23/50 Loss 0.0999 Accuracy 0.6423
TRAINING Epoch 24/50 Loss 0.0986 Accuracy 0.6430
TRAINING Epoch 25/50 Loss 0.0935 Accuracy 0.6700
TRAINING Epoch 26/50 Loss 0.0897 Accuracy 0.6917
TRAINING Epoch 27/50 Loss 0.0924 Accuracy 0.6610
TRAINING Epoch 28/50 Loss 0.0868 Accuracy 0.6953
TRAINING Epoch 29/50 Loss 0.0860 Accuracy 0.6970
TRAINING Epoch 30/50 Loss 0.0847 Accuracy 0.6873
TRAINING Epoch 31/50 Loss 0.0833 Accuracy 0.7000
TRAINING Epoch 32/50 Loss 0.0822 Accuracy 0.7043
TRAINING Epoch 33/50 Loss 0.0772 Accuracy 0.7280
TRAINING Epoch 34/50 Loss 0.0777 Accuracy 0.7157
TRAINING Epoch 35/50 Loss 0.0738 Accuracy 0.7370
TRAINING Epoch 36/50 Loss 0.0751 Accuracy 0.7313
TRAINING Epoch 37/50 Loss 0.0713 Accuracy 0.7490
TRAINING Epoch 38/50 Loss 0.0716 Accuracy 0.7457
TRAINING Epoch 39/50 Loss 0.0688 Accuracy 0.7570
TRAINING Epoch 40/50 Loss 0.0691 Accuracy 0.7617
TRAINING Epoch 41/50 Loss 0.0716 Accuracy 0.7390
TRAINING Epoch 42/50 Loss 0.0675 Accuracy 0.7570
TRAINING Epoch 43/50 Loss 0.0682 Accuracy 0.7487
TRAINING Epoch 44/50 Loss 0.0649 Accuracy 0.7723
TRAINING Epoch 45/50 Loss 0.0612 Accuracy 0.7810
TRAINING Epoch 46/50 Loss 0.0623 Accuracy 0.7773
TRAINING Epoch 47/50 Loss 0.0593 Accuracy 0.7937
TRAINING Epoch 48/50 Loss 0.0615 Accuracy 0.7823
TRAINING Epoch 49/50 Loss 0.0626 Accuracy 0.7767
TRAINING Epoch 50/50 Loss 0.0570 Accuracy 0.8003
Finished Training
```

```
[45] test(model, criterion)

    /usr/local/lib/python3.7/dist-packages/torch/utils/data/dataloader.py:481: UserWarning: This Da
      cpuset_checked))
    Test Loss: 0.0988 Test Accuracy 0.6047
```

Hyperparameter Used:

```
NUM_EPOCHS = 50
LEARNING_RATE = 0.003
BATCH_SIZE = 16
RESNET_LAST_ONLY = True
```

Test Accuracy: 0.4593

```
NUM_EPOCHS = 50
LEARNING_RATE = 0.003
BATCH_SIZE = 16
RESNET_LAST_ONLY = False
```

Test Accuracy: 0.5038

```
NUM_EPOCHS = 50
LEARNING_RATE = 0.01
BATCH_SIZE = 64
RESNET_LAST_ONLY = False
```

Test Accuracy: 0.5035

```
NUM_EPOCHS = 30
LEARNING_RATE = 0.01
BATCH_SIZE = 64
RESNET_LAST_ONLY = False
```

Test Accuracy: 0.4972
RandomRotation: 30% -> 45%
Test Accuracy: 0.5137
Dropout(0.3) & normalization

```
NUM_EPOCHS = 50
LEARNING_RATE = 0.001
BATCH_SIZE = 16
RESNET_LAST_ONLY = False
```

Test Accuracy: 0.6047