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50.039 - Deep Learning Homework #4 (Coding)

Transfer Learning Task

Choice of pretrained network: Resnet-18

Trained over: 15 epochs (batchsize 32, learning rate 0.002)

Loss: Cross Entropy Loss

Transformations:

MEAN = [0.485, 0.456, 0.406]
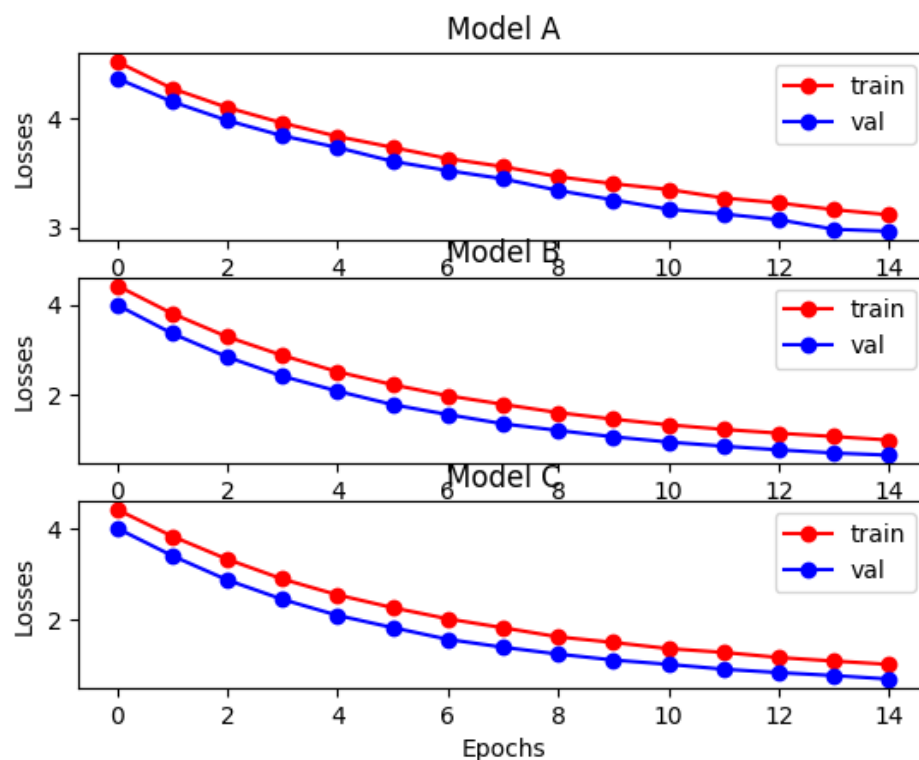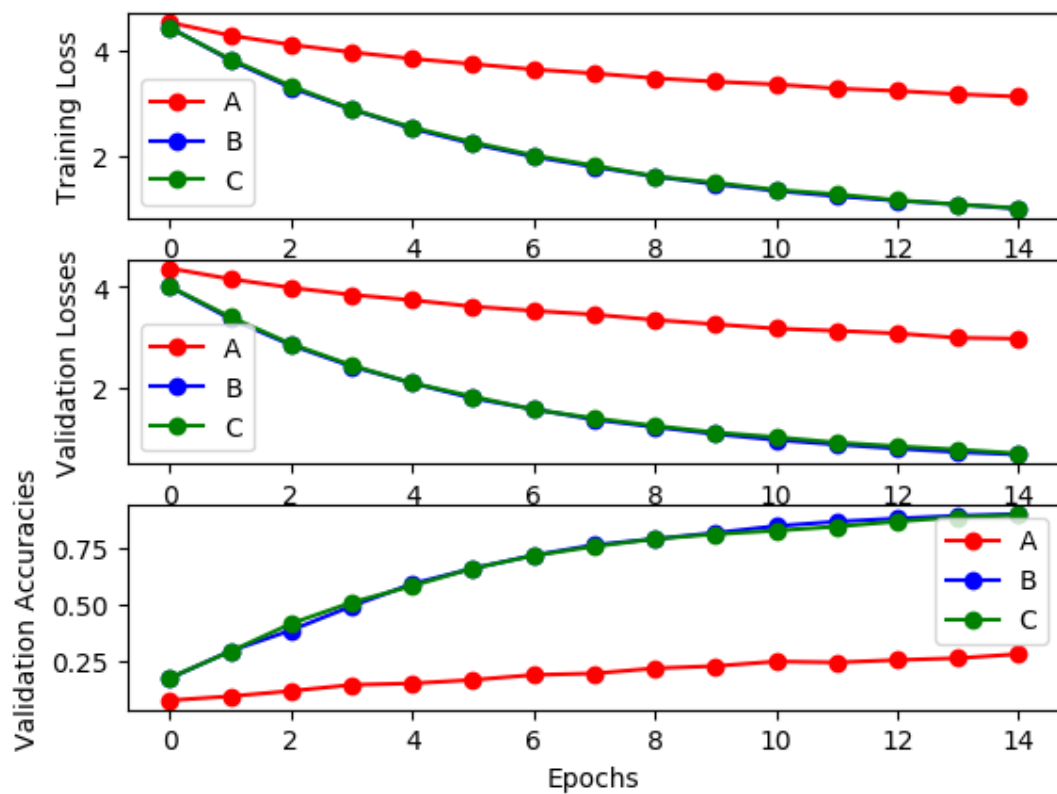STD = [0.229, 0.224, 0.225]
- Training
    - transforms.RandomHorizontalFlip(0.5)
    - transforms.RandomResizedCrop(224)
    - transforms.ToTensor()
    - transforms.Normalize(MEAN,STD)
- Validation/Testing
    - transforms.Resize(224)
    - transforms.CenterCrop(224)
    - transforms.ToTensor()
    - transforms.Normalize(MEAN,STD)

Performance:

Model	Validation Accuracy (Best Epoch)	Test Accuracy	Remarks
A	0.28022875816993464 (epoch 14)	0.2676056338028169	Without pre-trained weights, train all layers
B	0.9019607843137255 (epoch 14)	0.8873239436619719	With pre-trained weights, train all layers
C	0.8978758169934641 (epoch 14)	0.8849765258215962	With pre-trained weights, train last two layers

From all 3 models, testing and validation accuracies are consistently similar, with validation accuracies being slightly higher for all three cases.

Curves of training loss, validation loss and validation accuracy:

Based on the Loss graphs, we observe that there is still some underfitting for the training of all 3 models. This means that more than 15 epochs is necessary for these models to have a good fit of the data.

Appendix

Print log:

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[A]Epoch: [0][178/178] loss: 4.5164
Mode: A Epoch: [0] TRAIN_LOSS: 4.518866796172067 VAL_LOSS: 4.3656780658624115 VAL_ACC:0.07516339869281045
[A]Epoch: [1][178/178] loss: 3.9548
Mode: A Epoch: [1] TRAIN_LOSS: 4.273157713118564 VAL_LOSS: 4.151902742874928 VAL_ACC:0.09313725490196079
[A]Epoch: [2][178/178] loss: 3.8889
Mode: A Epoch: [2] TRAIN_LOSS: 4.098271312338583 VAL_LOSS: 3.9799905067835097 VAL_ACC:0.11683006535947713
[A]Epoch: [3][178/178] loss: 3.9973
Mode: A Epoch: [3] TRAIN_LOSS: 3.956525560175435 VAL_LOSS: 3.8393284051846237 VAL_ACC:0.1437908496732026
[A]Epoch: [4][178/178] loss: 3.5652
Mode: A Epoch: [4] TRAIN_LOSS: 3.833259354816394 VAL_LOSS: 3.731912429516132 VAL_ACC:0.1503267973856209
[A]Epoch: [5][178/178] loss: 3.7254
Mode: A Epoch: [5] TRAIN_LOSS: 3.7328609174556946 VAL_LOSS: 3.604931116104126 VAL_ACC:0.16584967320261437
[A]Epoch: [6][178/178] loss: 3.7088
Mode: A Epoch: [6] TRAIN_LOSS: 3.630580308732022 VAL_LOSS: 3.5205594392923207 VAL_ACC:0.18790849673202614
[A]Epoch: [7][178/178] loss: 3.3799
Mode: A Epoch: [7] TRAIN_LOSS: 3.556385984581508 VAL_LOSS: 3.445020846831493 VAL_ACC:0.19444444444444445
[A]Epoch: [8][178/178] loss: 3.4171
Mode: A Epoch: [8] TRAIN_LOSS: 3.4645602957586226 VAL_LOSS: 3.3382866076934032 VAL_ACC:0.2173202614379085
[A]Epoch: [9][178/178] loss: 3.5184
Mode: A Epoch: [9] TRAIN_LOSS: 3.399865035260661 VAL_LOSS: 3.25204236079485 VAL_ACC:0.22712418300653595
[A]Epoch: [10][178/178] loss: 3.5354
Mode: A Epoch: [10] TRAIN_LOSS: 3.3474564940741893 VAL_LOSS: 3.16621444775508 VAL_ACC:0.24754901960784315
[A]Epoch: [11][178/178] loss: 2.8100
Mode: A Epoch: [11] TRAIN_LOSS: 3.269535352674763 VAL_LOSS: 3.1227488150963416 VAL_ACC:0.2434640522875817
[A]Epoch: [12][178/178] loss: 3.0852
Mode: A Epoch: [12] TRAIN_LOSS: 3.224009442865179 VAL_LOSS: 3.07014947059827 VAL_ACC:0.2540849673202614
[A]Epoch: [13][178/178] loss: 3.5523
Mode: A Epoch: [13] TRAIN_LOSS: 3.1623144015837252 VAL_LOSS: 2.9827661025218473 VAL_ACC:0.2622549019607843
[A]Epoch: [14][178/178] loss: 3.0499
Mode: A Epoch: [14] TRAIN_LOSS: 3.1150975709550837 VAL_LOSS: 2.9646307871891904 VAL_ACC:0.28022875816993464
Mode: A Best acc: 0.28022875816993464, epoch 14

[B]Epoch: [0][178/178] loss: 4.0429
Mode: B Epoch: [0] TRAIN_LOSS: 4.421839071123787 VAL_LOSS: 3.9937824469346266 VAL_ACC:0.17320261437908496
[B]Epoch: [1][178/178] loss: 3.7145
Mode: B Epoch: [1] TRAIN_LOSS: 3.802196832185381 VAL_LOSS: 3.3594959332392764 VAL_ACC:0.29411764705882354
[B]Epoch: [2][178/178] loss: 3.6022
Mode: B Epoch: [2] TRAIN_LOSS: 3.2838968976160112 VAL_LOSS: 2.8370520151578464 VAL_ACC:0.38643790849673204
[B]Epoch: [3][178/178] loss: 3.1919
Mode: B Epoch: [3] TRAIN_LOSS: 2.8723416690076333 VAL_LOSS: 2.4114204003260684 VAL_ACC:0.4934640522875817
[B]Epoch: [4][178/178] loss: 2.0504
Mode: B Epoch: [4] TRAIN_LOSS: 2.50878512792373 VAL_LOSS: 2.0793365240097046 VAL_ACC:0.5923202614379085
[B]Epoch: [5][178/178] loss: 2.1301
Mode: B Epoch: [5] TRAIN_LOSS: 2.221886991784814 VAL_LOSS: 1.7792013027729132 VAL_ACC:0.6609477124183006
[B]Epoch: [6][178/178] loss: 2.0244
Mode: B Epoch: [6] TRAIN_LOSS: 1.9771435495172993 VAL_LOSS: 1.5608572165171306 VAL_ACC:0.7189542483660131
[B]Epoch: [7][178/178] loss: 1.5386
Mode: B Epoch: [7] TRAIN_LOSS: 1.7861792230873965 VAL_LOSS: 1.3540531824796627 VAL_ACC:0.7647058823529411
[B]Epoch: [8][178/178] loss: 1.6422
Mode: B Epoch: [8] TRAIN_LOSS: 1.6029681061091048 VAL_LOSS: 1.2071119409341078 VAL_ACC:0.7916666666666666
[B]Epoch: [9][178/178] loss: 1.0137
Mode: B Epoch: [9] TRAIN_LOSS: 1.4572654975933974 VAL_LOSS: 1.0661619213911204 VAL_ACC:0.8186274509803921
[B]Epoch: [10][178/178] loss: 1.3018
Mode: B Epoch: [10] TRAIN_LOSS: 1.332081492697255 VAL_LOSS: 0.9496363600095113 VAL_ACC:0.8488562091503268
[B]Epoch: [11][178/178] loss: 1.4073
Mode: B Epoch: [11] TRAIN_LOSS: 1.2306914768192205 VAL_LOSS: 0.8584361580701975 VAL_ACC:0.8684640522875817
[B]Epoch: [12][178/178] loss: 1.1948
Mode: B Epoch: [12] TRAIN_LOSS: 1.1457410625527413 VAL_LOSS: 0.7765038930452787 VAL_ACC:0.8823529411764706
[B]Epoch: [13][178/178] loss: 1.5492
Mode: B Epoch: [13] TRAIN_LOSS: 1.0722410407628906 VAL_LOSS: 0.7064753549221234 VAL_ACC:0.8946078431372549
[B]Epoch: [14][178/178] loss: 0.9117
Mode: B Epoch: [14] TRAIN_LOSS: 0.9933793250094639 VAL_LOSS: 0.6592355278822092 VAL_ACC:0.9019607843137255
Mode: B Best acc: 0.9019607843137255, epoch 14
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[C]Epoch: [0][178/178] loss: 4.2142
Mode: C Epoch: [0] TRAIN_LOSS: 4.411984182475658 VAL_LOSS: 4.000441111051119 VAL_ACC:0.17565359477124182
[C]Epoch: [1][178/178] loss: 3.4261
Mode: C Epoch: [1] TRAIN_LOSS: 3.823719193426411 VAL_LOSS: 3.3952556879092484 VAL_ACC:0.29248366013071897
[C]Epoch: [2][178/178] loss: 3.2415
Mode: C Epoch: [2] TRAIN_LOSS: 3.316982616199536 VAL_LOSS: 2.8604581906245303 VAL_ACC:0.4158496732026144
[C]Epoch: [3][178/178] loss: 2.9056
Mode: C Epoch: [3] TRAIN_LOSS: 2.8813908180493986 VAL_LOSS: 2.4341494181217294 VAL_ACC:0.5098039215686274
[C]Epoch: [4][178/178] loss: 2.4376
Mode: C Epoch: [4] TRAIN_LOSS: 2.53221897261866 VAL_LOSS: 2.080655580911881 VAL_ACC:0.5833333333333334
[C]Epoch: [5][178/178] loss: 2.4636
Mode: C Epoch: [5] TRAIN_LOSS: 2.2512146455518316 VAL_LOSS: 1.8127802671530309 VAL_ACC:0.6609477124183006
[C]Epoch: [6][178/178] loss: 2.3810
Mode: C Epoch: [6] TRAIN_LOSS: 2.005146356780877 VAL_LOSS: 1.5543849284832294 VAL_ACC:0.7173202614379085
[C]Epoch: [7][178/178] loss: 1.8523
Mode: C Epoch: [7] TRAIN_LOSS: 1.8094737797640683 VAL_LOSS: 1.3809800545374553 VAL_ACC:0.7581699346405228
[C]Epoch: [8][178/178] loss: 1.7615
Mode: C Epoch: [8] TRAIN_LOSS: 1.6087502874015422 VAL_LOSS: 1.2298676188175495 VAL_ACC:0.7916666666666666
[C]Epoch: [9][178/178] loss: 1.7202
Mode: C Epoch: [9] TRAIN_LOSS: 1.4861439808031147 VAL_LOSS: 1.0995636337842696 VAL_ACC:0.8129084967320261
[C]Epoch: [10][178/178] loss: 1.0711
Mode: C Epoch: [10] TRAIN_LOSS: 1.3506339500459392 VAL_LOSS: 1.00486810085101 VAL_ACC:0.8284313725490197
[C]Epoch: [11][178/178] loss: 1.0768
Mode: C Epoch: [11] TRAIN_LOSS: 1.2674541359537104 VAL_LOSS: 0.89782164647029 VAL_ACC:0.8464052287581699
[C]Epoch: [12][178/178] loss: 1.0787
Mode: C Epoch: [12] TRAIN_LOSS: 1.1552046386713393 VAL_LOSS: 0.8232259903198633 VAL_ACC:0.869281045751634
[C]Epoch: [13][178/178] loss: 1.0837
Mode: C Epoch: [13] TRAIN_LOSS: 1.076619077264593 VAL_LOSS: 0.7577940806364402 VAL_ACC:0.8880718954248366
[C]Epoch: [14][178/178] loss: 1.0358
Mode: C Epoch: [14] TRAIN_LOSS: 1.0043116570188757 VAL_LOSS: 0.680922269821167 VAL_ACC:0.8978758169934641
Mode: C Best acc: 0.8978758169934641, epoch 14

Mode: A TEST_LOSS:3.0140199303627013 TEST_ACC:0.2676056338028169
Mode: B TEST_LOSS:0.6792568504810333 TEST_ACC:0.8873239436619719
Mode: C TEST_LOSS:0.6969432644546032 TEST_ACC:0.8849765258215962
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