

# AMS 691 Project 2

Zhiwei Lin

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## Q1

I completed the data loading function for the CIFAR-10 dataset. It would read each batch file in the specified directory using the pickle module. First, we discarded the file name with "html" and "meta". Then, data would be deserialized, which contains keys 'data' and 'labels', representing the features (x) and labels (y) of the dataset. For the files named starting with "test," we use them as test data, and for the files named starting with "data," we aggregate data and use them as train data. The dataset would be stored as arrays, such as x\_train, y\_train, x\_test, and y\_test.

Then we write a data split function to split the train data into new train data and validation data.

## Q2

The parse record function is already completed. It would take one row of the data, reshape and transpose it to 3x32x32. It performs data preprocessing using the preprocess\_image function, which preprocesses the image by padding, random cropping, horizontal flipping, and normalization.

## Q3

I completed the Network.py file, which is the network architecture. It utilizes PyTorch to construct both a standard ResNet and a preactivation bottleneck ResNet.

For the standard ResNet, the input is a tensor of size 3x32x32, which undergoes the initial convolutional layer (conv1) and then passes through three stacks. Each stack contains several blocks, and each block consists of two 3x3 convolutional layers. Additionally, a projection shortcut is performed, which performs the addition of the input to the output. If the input and output dimensions do not match, a 1x1 convolution with strides greater than 1 is applied to ensure consistent dimensions for element-wise addition.

For the preactivation bottleneck ResNet, it also takes an input tensor of size  $3 \times 32 \times 32$ . The network comprises three stacks, each containing several blocks. However, the structure of each block differs from the standard ResNet. It includes a  $1 \times 1$  convolution followed by a  $3 \times 3$  convolution and another  $1 \times 1$  convolution. Similar to the standard ResNet, if the dimensions of the input and output do not match, we perform a projection shortcut to allow for element-wise addition.

## Q4

The `Model.py` file contains the training, validation, and testing processes for a ResNet model. It uses cross-entropy loss and stochastic gradient descent for training. Additionally, during training, data in each batch use batch mean and deviation to perform normalization; however, during testing, the overall mean and standard deviation are utilized for normalization.

## Q5

I tuned hyperparameters with the following settings: `weight_decay = 2e-4`, `learning_rate = 0.1` with a decay of 0.1 every 80 epochs, `Nesterov momentum = 0.9`, `epochs = 200`, and `first_num_filter = 16`. In the batch normalization layer, I used `eps = 1e-5` and `momentum = 0.1`. I believe these hyperparameters are good, as I ran my models multiple times.

For the `resnet_size`, I tested with  $n = 3$  and  $n = 18$  for both the standard ResNet and the preactivation bottleneck model. For  $n = 3$ , the accuracy of the standard ResNet is 0.9034, and the accuracy of the preactivation bottleneck is 0.9073.

```
### Test or Validation ###
Restored model parameters from model_v1/model-10.ckpt
100% 10000/10000 [00:35<00:00, 281.46it/s]
Test accuracy: 0.9034
```

Figure 1: Accuracy of Standard ResNet with `resnet_size = 3`

```
checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v2_n3/model-10.ckpt
100% 10000/10000 [00:51<00:00, 194.25it/s]
Test accuracy: 0.9073
```

Figure 2: Accuracy of Preactivation Bottleneck with `resnet_size = 3`

For  $n = 18$ , the accuracy of the standard ResNet is 0.9222, and the accuracy of the preactivation bottleneck is 0.9406

```

checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v1_n18/model-10.ckpt
100% 10000/10000 [02:49<00:00, 58.85it/s]
Test accuracy: 0.9222

```

Figure 3: Accuracy of Standard ResNet with resnet size = 18

```

### Test or Validation ###
Restored model parameters from model_v2_n18/model-10.ckpt
100% 10000/10000 [03:49<00:00, 43.59it/s]
Test accuracy: 0.9406

```

Figure 4: Accuracy of Preactivation Bottleneck with resnet size = 18

## Appendix

resnet\_version = 1, resnet\_size = 3, batch\_size = 128, weight\_decay = 2e-4,  
 LR = 0.1, decay of 0.1 every 80 epochs, momentum = 0.9, nesterov = True, epoch = 200

Accuracy:0.9034

```

--- Preparing Data ---
### Training... ###
Epoch 1 Loss 1.469237 Duration 28.176 seconds.
Epoch 2 Loss 1.003345 Duration 28.645 seconds.
Epoch 3 Loss 0.815143 Duration 26.605 seconds.
Epoch 4 Loss 0.705779 Duration 26.397 seconds.
Epoch 5 Loss 0.646931 Duration 26.565 seconds.
Epoch 6 Loss 0.595773 Duration 26.566 seconds.
Epoch 7 Loss 0.557507 Duration 27.204 seconds.
Epoch 8 Loss 0.529437 Duration 27.272 seconds.
Epoch 9 Loss 0.506943 Duration 26.987 seconds.
Epoch 10 Loss 0.485549 Duration 26.600 seconds.
Checkpoint has been created.
Epoch 11 Loss 0.473197 Duration 26.063 seconds.
Epoch 12 Loss 0.452293 Duration 26.349 seconds.
Epoch 13 Loss 0.442180 Duration 25.339 seconds.
Epoch 14 Loss 0.436354 Duration 25.721 seconds.
Epoch 15 Loss 0.424594 Duration 28.209 seconds.
Epoch 16 Loss 0.414742 Duration 26.522 seconds.
Epoch 17 Loss 0.401656 Duration 26.795 seconds.
Epoch 18 Loss 0.401997 Duration 26.590 seconds.
Epoch 19 Loss 0.397723 Duration 25.694 seconds.
Epoch 20 Loss 0.386292 Duration 25.351 seconds.
Checkpoint has been created.
Epoch 21 Loss 0.380757 Duration 26.816 seconds.

```

Epoch 22 Loss 0.374190 Duration 26.386 seconds.  
Epoch 23 Loss 0.366959 Duration 26.074 seconds.  
Epoch 24 Loss 0.368990 Duration 27.116 seconds.  
Epoch 25 Loss 0.358824 Duration 26.831 seconds.  
Epoch 26 Loss 0.357948 Duration 26.757 seconds.  
Epoch 27 Loss 0.358699 Duration 26.060 seconds.  
Epoch 28 Loss 0.349443 Duration 27.324 seconds.  
Epoch 29 Loss 0.346272 Duration 27.720 seconds.  
Epoch 30 Loss 0.342856 Duration 26.873 seconds.  
Checkpoint has been created.  
Epoch 31 Loss 0.347952 Duration 26.437 seconds.  
Epoch 32 Loss 0.335813 Duration 26.815 seconds.  
Epoch 33 Loss 0.334102 Duration 26.513 seconds.  
Epoch 34 Loss 0.334461 Duration 26.345 seconds.  
Epoch 35 Loss 0.332414 Duration 26.200 seconds.  
Epoch 36 Loss 0.329579 Duration 25.897 seconds.  
Epoch 37 Loss 0.326880 Duration 26.286 seconds.  
Epoch 38 Loss 0.324992 Duration 26.352 seconds.  
Epoch 39 Loss 0.321605 Duration 26.533 seconds.  
Epoch 40 Loss 0.319390 Duration 26.311 seconds.  
Checkpoint has been created.  
Epoch 41 Loss 0.325243 Duration 26.789 seconds.  
Epoch 42 Loss 0.315222 Duration 27.684 seconds.  
Epoch 43 Loss 0.315423 Duration 26.026 seconds.  
Epoch 44 Loss 0.311208 Duration 26.592 seconds.  
Epoch 45 Loss 0.315927 Duration 26.666 seconds.  
Epoch 46 Loss 0.313066 Duration 26.633 seconds.  
Epoch 47 Loss 0.306616 Duration 26.351 seconds.  
Epoch 48 Loss 0.305790 Duration 26.638 seconds.  
Epoch 49 Loss 0.306415 Duration 26.940 seconds.  
Epoch 50 Loss 0.313026 Duration 26.293 seconds.  
Checkpoint has been created.  
Epoch 51 Loss 0.207557 Duration 25.727 seconds.  
Epoch 52 Loss 0.167120 Duration 26.786 seconds.  
Epoch 53 Loss 0.155861 Duration 27.437 seconds.  
Epoch 54 Loss 0.145665 Duration 27.340 seconds.  
Epoch 55 Loss 0.136070 Duration 28.535 seconds.  
Epoch 56 Loss 0.130095 Duration 26.923 seconds.  
Epoch 57 Loss 0.124862 Duration 27.111 seconds.  
Epoch 58 Loss 0.119564 Duration 27.335 seconds.  
Epoch 59 Loss 0.114401 Duration 27.064 seconds.  
Epoch 60 Loss 0.111743 Duration 26.230 seconds.  
Checkpoint has been created.  
Epoch 61 Loss 0.107095 Duration 26.734 seconds.  
Epoch 62 Loss 0.103643 Duration 26.587 seconds.  
Epoch 63 Loss 0.102197 Duration 27.028 seconds.

Epoch 64 Loss 0.099357 Duration 26.944 seconds.  
Epoch 65 Loss 0.095534 Duration 27.240 seconds.  
Epoch 66 Loss 0.093782 Duration 27.115 seconds.  
Epoch 67 Loss 0.090781 Duration 27.277 seconds.  
Epoch 68 Loss 0.087750 Duration 28.651 seconds.  
Epoch 69 Loss 0.084783 Duration 27.347 seconds.  
Epoch 70 Loss 0.085251 Duration 26.089 seconds.  
Checkpoint has been created.  
Epoch 71 Loss 0.082733 Duration 26.170 seconds.  
Epoch 72 Loss 0.081726 Duration 26.231 seconds.  
Epoch 73 Loss 0.079323 Duration 26.422 seconds.  
Epoch 74 Loss 0.076566 Duration 26.698 seconds.  
Epoch 75 Loss 0.075768 Duration 26.281 seconds.  
Epoch 76 Loss 0.072724 Duration 28.183 seconds.  
Epoch 77 Loss 0.075744 Duration 26.243 seconds.  
Epoch 78 Loss 0.071641 Duration 26.456 seconds.  
Epoch 79 Loss 0.070353 Duration 25.252 seconds.  
Epoch 80 Loss 0.068020 Duration 25.940 seconds.  
Checkpoint has been created.  
Epoch 81 Loss 0.066083 Duration 27.285 seconds.  
Epoch 82 Loss 0.067571 Duration 26.516 seconds.  
Epoch 83 Loss 0.067754 Duration 26.661 seconds.  
Epoch 84 Loss 0.066016 Duration 26.541 seconds.  
Epoch 85 Loss 0.064206 Duration 26.883 seconds.  
Epoch 86 Loss 0.064474 Duration 26.689 seconds.  
Epoch 87 Loss 0.066226 Duration 26.260 seconds.  
Epoch 88 Loss 0.061926 Duration 26.246 seconds.  
Epoch 89 Loss 0.065114 Duration 27.305 seconds.  
Epoch 90 Loss 0.061985 Duration 27.032 seconds.  
Checkpoint has been created.  
Epoch 91 Loss 0.061238 Duration 27.218 seconds.  
Epoch 92 Loss 0.060664 Duration 27.332 seconds.  
Epoch 93 Loss 0.058854 Duration 26.627 seconds.  
Epoch 94 Loss 0.062161 Duration 28.898 seconds.  
Epoch 95 Loss 0.060768 Duration 27.566 seconds.  
Epoch 96 Loss 0.062971 Duration 27.481 seconds.  
Epoch 97 Loss 0.061864 Duration 27.283 seconds.  
Epoch 98 Loss 0.060673 Duration 27.153 seconds.  
Epoch 99 Loss 0.059218 Duration 26.823 seconds.  
Epoch 100 Loss 0.059492 Duration 27.361 seconds.  
Checkpoint has been created.  
Epoch 101 Loss 0.045444 Duration 27.273 seconds.  
Epoch 102 Loss 0.038535 Duration 26.948 seconds.  
Epoch 103 Loss 0.035374 Duration 27.293 seconds.  
Epoch 104 Loss 0.032224 Duration 27.831 seconds.  
Epoch 105 Loss 0.032759 Duration 27.491 seconds.

Epoch 106 Loss 0.030828 Duration 28.103 seconds.  
Epoch 107 Loss 0.031655 Duration 27.222 seconds.  
Epoch 108 Loss 0.030232 Duration 26.904 seconds.  
Epoch 109 Loss 0.028836 Duration 26.770 seconds.  
Epoch 110 Loss 0.028350 Duration 26.924 seconds.  
Checkpoint has been created.  
Epoch 111 Loss 0.027387 Duration 26.159 seconds.  
Epoch 112 Loss 0.028701 Duration 26.578 seconds.  
Epoch 113 Loss 0.026360 Duration 27.140 seconds.  
Epoch 114 Loss 0.027641 Duration 26.727 seconds.  
Epoch 115 Loss 0.026263 Duration 26.885 seconds.  
Epoch 116 Loss 0.025824 Duration 26.739 seconds.  
Epoch 117 Loss 0.025533 Duration 26.829 seconds.  
Epoch 118 Loss 0.025246 Duration 26.321 seconds.  
Epoch 119 Loss 0.024253 Duration 28.038 seconds.  
Epoch 120 Loss 0.024722 Duration 26.315 seconds.  
Checkpoint has been created.  
Epoch 121 Loss 0.025109 Duration 27.276 seconds.  
Epoch 122 Loss 0.025331 Duration 27.003 seconds.  
Epoch 123 Loss 0.023984 Duration 26.844 seconds.  
Epoch 124 Loss 0.023372 Duration 26.305 seconds.  
Epoch 125 Loss 0.024708 Duration 26.445 seconds.  
Epoch 126 Loss 0.024371 Duration 25.880 seconds.  
Epoch 127 Loss 0.023624 Duration 25.613 seconds.  
Epoch 128 Loss 0.023601 Duration 25.939 seconds.  
Epoch 129 Loss 0.023139 Duration 26.204 seconds.  
Epoch 130 Loss 0.023419 Duration 26.091 seconds.  
Checkpoint has been created.  
Epoch 131 Loss 0.022932 Duration 27.407 seconds.  
Epoch 132 Loss 0.022452 Duration 25.883 seconds.  
Epoch 133 Loss 0.022851 Duration 26.466 seconds.  
Epoch 134 Loss 0.021431 Duration 24.973 seconds.  
Epoch 135 Loss 0.022188 Duration 25.907 seconds.  
Epoch 136 Loss 0.021982 Duration 25.918 seconds.  
Epoch 137 Loss 0.021287 Duration 26.326 seconds.  
Epoch 138 Loss 0.021377 Duration 26.048 seconds.  
Epoch 139 Loss 0.020994 Duration 25.714 seconds.  
Epoch 140 Loss 0.021243 Duration 25.810 seconds.  
Checkpoint has been created.  
Epoch 141 Loss 0.021441 Duration 25.738 seconds.  
Epoch 142 Loss 0.020508 Duration 26.123 seconds.  
Epoch 143 Loss 0.021369 Duration 26.304 seconds.  
Epoch 144 Loss 0.021450 Duration 28.904 seconds.  
Epoch 145 Loss 0.020601 Duration 26.983 seconds.  
Epoch 146 Loss 0.020003 Duration 25.883 seconds.  
Epoch 147 Loss 0.019317 Duration 25.834 seconds.

Epoch 148 Loss 0.021253 Duration 26.413 seconds.  
Epoch 149 Loss 0.021239 Duration 26.602 seconds.  
Epoch 150 Loss 0.018897 Duration 26.276 seconds.  
Checkpoint has been created.  
Epoch 151 Loss 0.019770 Duration 26.203 seconds.  
Epoch 152 Loss 0.019315 Duration 26.042 seconds.  
Epoch 153 Loss 0.019250 Duration 26.072 seconds.  
Epoch 154 Loss 0.019313 Duration 25.632 seconds.  
Epoch 155 Loss 0.019597 Duration 25.864 seconds.  
Epoch 156 Loss 0.019426 Duration 27.251 seconds.  
Epoch 157 Loss 0.019060 Duration 26.122 seconds.  
Epoch 158 Loss 0.020334 Duration 26.102 seconds.  
Epoch 159 Loss 0.018669 Duration 25.573 seconds.  
Epoch 160 Loss 0.019558 Duration 25.293 seconds.  
Checkpoint has been created.  
Epoch 161 Loss 0.018952 Duration 26.247 seconds.  
Epoch 162 Loss 0.019106 Duration 26.086 seconds.  
Epoch 163 Loss 0.019359 Duration 26.252 seconds.  
Epoch 164 Loss 0.019916 Duration 26.303 seconds.  
Epoch 165 Loss 0.019508 Duration 25.716 seconds.  
Epoch 166 Loss 0.018642 Duration 25.432 seconds.  
Epoch 167 Loss 0.017995 Duration 26.082 seconds.  
Epoch 168 Loss 0.018313 Duration 27.658 seconds.  
Epoch 169 Loss 0.018488 Duration 26.514 seconds.  
Epoch 170 Loss 0.019289 Duration 26.232 seconds.  
Checkpoint has been created.  
Epoch 171 Loss 0.019246 Duration 26.368 seconds.  
Epoch 172 Loss 0.018694 Duration 26.471 seconds.  
Epoch 173 Loss 0.018030 Duration 25.713 seconds.  
Epoch 174 Loss 0.018310 Duration 25.711 seconds.  
Epoch 175 Loss 0.018559 Duration 26.264 seconds.  
Epoch 176 Loss 0.019130 Duration 26.170 seconds.  
Epoch 177 Loss 0.017370 Duration 26.170 seconds.  
Epoch 178 Loss 0.018269 Duration 26.210 seconds.  
Epoch 179 Loss 0.019176 Duration 26.487 seconds.  
Epoch 180 Loss 0.018192 Duration 25.654 seconds.  
Checkpoint has been created.  
Epoch 181 Loss 0.020061 Duration 27.317 seconds.  
Epoch 182 Loss 0.018292 Duration 25.643 seconds.  
Epoch 183 Loss 0.019870 Duration 26.428 seconds.  
Epoch 184 Loss 0.018453 Duration 26.030 seconds.  
Epoch 185 Loss 0.018621 Duration 25.732 seconds.  
Epoch 186 Loss 0.018544 Duration 26.065 seconds.  
Epoch 187 Loss 0.018860 Duration 25.222 seconds.  
Epoch 188 Loss 0.017860 Duration 25.608 seconds.  
Epoch 189 Loss 0.018575 Duration 25.727 seconds.

```

Epoch 190 Loss 0.018929 Duration 26.382 seconds.
Checkpoint has been created.
Epoch 191 Loss 0.018331 Duration 26.263 seconds.
Epoch 192 Loss 0.018551 Duration 26.099 seconds.
Epoch 193 Loss 0.018287 Duration 26.719 seconds.
Epoch 194 Loss 0.018197 Duration 26.354 seconds.
Epoch 195 Loss 0.018920 Duration 25.743 seconds.
Epoch 196 Loss 0.019662 Duration 25.605 seconds.
Epoch 197 Loss 0.018064 Duration 26.118 seconds.
Epoch 198 Loss 0.018100 Duration 25.465 seconds.
Epoch 199 Loss 0.019162 Duration 25.811 seconds.
Epoch 200 Loss 0.018277 Duration 26.421 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v1/model-160.ckpt
100% 5000/5000 [00:17<00:00, 283.95it/s]
Test accuracy: 0.9066
Restored model parameters from model_v1/model-170.ckpt
100% 5000/5000 [00:17<00:00, 285.11it/s]
/content/Model.py:114: UserWarning: To copy construct from a tensor, it is recommended to use
    y = torch.tensor(y).cuda()
Test accuracy: 0.9064
Restored model parameters from model_v1/model-180.ckpt
100% 5000/5000 [00:17<00:00, 289.45it/s]
Test accuracy: 0.9042
Restored model parameters from model_v1/model-190.ckpt
100% 5000/5000 [00:17<00:00, 293.75it/s]
Test accuracy: 0.9068
Restored model parameters from model_v1/model-200.ckpt
100% 5000/5000 [00:18<00:00, 275.27it/s]
Test accuracy: 0.9074
### Training... ###
Epoch 1 Loss 0.051473 Duration 29.266 seconds.
Epoch 2 Loss 0.051010 Duration 30.261 seconds.
Epoch 3 Loss 0.052888 Duration 28.636 seconds.
Epoch 4 Loss 0.052346 Duration 28.935 seconds.
Epoch 5 Loss 0.050711 Duration 28.706 seconds.
Epoch 6 Loss 0.050999 Duration 29.004 seconds.
Epoch 7 Loss 0.051862 Duration 28.947 seconds.
Epoch 8 Loss 0.052131 Duration 28.912 seconds.
Epoch 9 Loss 0.048788 Duration 28.947 seconds.
Epoch 10 Loss 0.052899 Duration 28.834 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v1/model-10.ckpt
100% 10000/10000 [00:35<00:00, 281.46it/s]

```



Test accuracy: 0.9034

```
=====

resnet_version = 2,
resnet_size = 3, batch_size = 128,
weight_decay = 2e-4,
LR = 0.1 and decay of 0.1 every 80 epochs momentum = 0.9, nesterov = True, epoch = 200.
```

```
BN(eps=1e-5, momentum=0.1)
```

accuracy: 0.9073

--- Preparing Data ---

### Training... ###

```
Epoch 1 Loss 1.420054 Duration 37.884 seconds.
Epoch 2 Loss 1.003707 Duration 35.429 seconds.
Epoch 3 Loss 0.858339 Duration 36.421 seconds.
Epoch 4 Loss 0.756054 Duration 36.011 seconds.
Epoch 5 Loss 0.682925 Duration 37.602 seconds.
Epoch 6 Loss 0.627407 Duration 36.551 seconds.
Epoch 7 Loss 0.595330 Duration 35.362 seconds.
Epoch 8 Loss 0.565279 Duration 36.509 seconds.
Epoch 9 Loss 0.537754 Duration 35.309 seconds.
Epoch 10 Loss 0.516086 Duration 36.829 seconds.
Checkpoint has been created.
Epoch 11 Loss 0.500790 Duration 36.690 seconds.
Epoch 12 Loss 0.490878 Duration 36.496 seconds.
Epoch 13 Loss 0.475559 Duration 35.741 seconds.
Epoch 14 Loss 0.467961 Duration 36.427 seconds.
Epoch 15 Loss 0.459315 Duration 36.854 seconds.
Epoch 16 Loss 0.457099 Duration 36.192 seconds.
Epoch 17 Loss 0.435695 Duration 35.692 seconds.
Epoch 18 Loss 0.432502 Duration 36.141 seconds.
Epoch 19 Loss 0.433855 Duration 35.717 seconds.
Epoch 20 Loss 0.423471 Duration 36.279 seconds.
Checkpoint has been created.
Epoch 21 Loss 0.419942 Duration 37.498 seconds.
Epoch 22 Loss 0.412217 Duration 36.723 seconds.
Epoch 23 Loss 0.408254 Duration 36.058 seconds.
Epoch 24 Loss 0.399031 Duration 36.446 seconds.
Epoch 25 Loss 0.397918 Duration 35.871 seconds.
Epoch 26 Loss 0.395795 Duration 36.587 seconds.
Epoch 27 Loss 0.385079 Duration 36.294 seconds.
Epoch 28 Loss 0.389846 Duration 35.660 seconds.
Epoch 29 Loss 0.385101 Duration 37.317 seconds.
Epoch 30 Loss 0.380455 Duration 35.594 seconds.
```

Checkpoint has been created.

Epoch	31	Loss	0.373384	Duration	37.788	seconds.
Epoch	32	Loss	0.377358	Duration	35.314	seconds.
Epoch	33	Loss	0.367922	Duration	36.364	seconds.
Epoch	34	Loss	0.367476	Duration	35.737	seconds.
Epoch	35	Loss	0.360835	Duration	36.693	seconds.
Epoch	36	Loss	0.363932	Duration	37.079	seconds.
Epoch	37	Loss	0.366629	Duration	36.441	seconds.
Epoch	38	Loss	0.359489	Duration	35.494	seconds.
Epoch	39	Loss	0.354220	Duration	36.727	seconds.
Epoch	40	Loss	0.353819	Duration	35.703	seconds.

Checkpoint has been created.

Epoch	41	Loss	0.351024	Duration	36.578	seconds.
Epoch	42	Loss	0.353476	Duration	36.823	seconds.
Epoch	43	Loss	0.347549	Duration	36.758	seconds.
Epoch	44	Loss	0.342782	Duration	35.759	seconds.
Epoch	45	Loss	0.346176	Duration	37.271	seconds.
Epoch	46	Loss	0.345242	Duration	36.931	seconds.
Epoch	47	Loss	0.338815	Duration	36.897	seconds.
Epoch	48	Loss	0.339175	Duration	35.960	seconds.
Epoch	49	Loss	0.339390	Duration	36.794	seconds.
Epoch	50	Loss	0.331970	Duration	35.794	seconds.

Checkpoint has been created.

Epoch	51	Loss	0.331895	Duration	37.191	seconds.
Epoch	52	Loss	0.331728	Duration	37.632	seconds.
Epoch	53	Loss	0.332165	Duration	36.837	seconds.
Epoch	54	Loss	0.327088	Duration	36.266	seconds.
Epoch	55	Loss	0.328156	Duration	36.441	seconds.
Epoch	56	Loss	0.332698	Duration	36.736	seconds.
Epoch	57	Loss	0.324565	Duration	37.211	seconds.
Epoch	58	Loss	0.330946	Duration	37.070	seconds.
Epoch	59	Loss	0.321901	Duration	36.153	seconds.
Epoch	60	Loss	0.328811	Duration	36.795	seconds.

Checkpoint has been created.

Epoch	61	Loss	0.322894	Duration	36.053	seconds.
Epoch	62	Loss	0.322727	Duration	38.402	seconds.
Epoch	63	Loss	0.320126	Duration	36.193	seconds.
Epoch	64	Loss	0.316170	Duration	37.482	seconds.
Epoch	65	Loss	0.317319	Duration	36.061	seconds.
Epoch	66	Loss	0.316482	Duration	37.528	seconds.
Epoch	67	Loss	0.313023	Duration	37.863	seconds.
Epoch	68	Loss	0.315493	Duration	37.302	seconds.
Epoch	69	Loss	0.315978	Duration	36.876	seconds.
Epoch	70	Loss	0.311816	Duration	37.635	seconds.

Checkpoint has been created.

Epoch	71	Loss	0.311906	Duration	36.215	seconds.
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Epoch 72 Loss 0.309302 Duration 38.704 seconds.  
Epoch 73 Loss 0.312226 Duration 36.731 seconds.  
Epoch 74 Loss 0.313915 Duration 36.958 seconds.  
Epoch 75 Loss 0.305460 Duration 37.210 seconds.  
Epoch 76 Loss 0.310810 Duration 37.032 seconds.  
Epoch 77 Loss 0.309083 Duration 38.594 seconds.  
Epoch 78 Loss 0.304402 Duration 37.496 seconds.  
Epoch 79 Loss 0.300711 Duration 38.038 seconds.  
Epoch 80 Loss 0.303020 Duration 36.572 seconds.  
Checkpoint has been created.  
Epoch 81 Loss 0.190265 Duration 37.746 seconds.  
Epoch 82 Loss 0.150457 Duration 37.936 seconds.  
Epoch 83 Loss 0.138524 Duration 37.310 seconds.  
Epoch 84 Loss 0.129914 Duration 37.026 seconds.  
Epoch 85 Loss 0.122325 Duration 37.284 seconds.  
Epoch 86 Loss 0.116601 Duration 37.511 seconds.  
Epoch 87 Loss 0.112268 Duration 38.167 seconds.  
Epoch 88 Loss 0.106742 Duration 37.679 seconds.  
Epoch 89 Loss 0.102728 Duration 36.475 seconds.  
Epoch 90 Loss 0.100068 Duration 37.631 seconds.  
Checkpoint has been created.  
Epoch 91 Loss 0.093922 Duration 36.739 seconds.  
Epoch 92 Loss 0.090944 Duration 38.107 seconds.  
Epoch 93 Loss 0.088472 Duration 38.797 seconds.  
Epoch 94 Loss 0.083934 Duration 37.156 seconds.  
Epoch 95 Loss 0.083337 Duration 38.214 seconds.  
Epoch 96 Loss 0.079896 Duration 37.273 seconds.  
Epoch 97 Loss 0.079280 Duration 39.597 seconds.  
Epoch 98 Loss 0.075748 Duration 36.935 seconds.  
Epoch 99 Loss 0.075332 Duration 38.947 seconds.  
Epoch 100 Loss 0.072816 Duration 37.474 seconds.  
Checkpoint has been created.  
Epoch 101 Loss 0.069917 Duration 37.935 seconds.  
Epoch 102 Loss 0.067504 Duration 38.474 seconds.  
Epoch 103 Loss 0.067147 Duration 38.200 seconds.  
Epoch 104 Loss 0.068243 Duration 36.938 seconds.  
Epoch 105 Loss 0.063378 Duration 36.835 seconds.  
Epoch 106 Loss 0.062404 Duration 37.289 seconds.  
Epoch 107 Loss 0.065683 Duration 37.337 seconds.  
Epoch 108 Loss 0.063705 Duration 36.945 seconds.  
Epoch 109 Loss 0.059734 Duration 37.475 seconds.  
Epoch 110 Loss 0.061365 Duration 37.397 seconds.  
Checkpoint has been created.  
Epoch 111 Loss 0.059000 Duration 37.410 seconds.  
Epoch 112 Loss 0.060630 Duration 38.155 seconds.  
Epoch 113 Loss 0.059641 Duration 37.139 seconds.

Epoch 114 Loss 0.057970 Duration 37.206 seconds.  
Epoch 115 Loss 0.057528 Duration 37.139 seconds.  
Epoch 116 Loss 0.057783 Duration 37.620 seconds.  
Epoch 117 Loss 0.053596 Duration 37.829 seconds.  
Epoch 118 Loss 0.055321 Duration 37.374 seconds.  
Epoch 119 Loss 0.055366 Duration 36.133 seconds.  
Epoch 120 Loss 0.052934 Duration 37.621 seconds.  
Checkpoint has been created.  
Epoch 121 Loss 0.051992 Duration 36.341 seconds.  
Epoch 122 Loss 0.053819 Duration 37.197 seconds.  
Epoch 123 Loss 0.056239 Duration 37.599 seconds.  
Epoch 124 Loss 0.049817 Duration 37.116 seconds.  
Epoch 125 Loss 0.055053 Duration 36.416 seconds.  
Epoch 126 Loss 0.049428 Duration 36.705 seconds.  
Epoch 127 Loss 0.051647 Duration 38.008 seconds.  
Epoch 128 Loss 0.050991 Duration 36.139 seconds.  
Epoch 129 Loss 0.052844 Duration 37.196 seconds.  
Epoch 130 Loss 0.049144 Duration 36.899 seconds.  
Checkpoint has been created.  
Epoch 131 Loss 0.053073 Duration 37.395 seconds.  
Epoch 132 Loss 0.051776 Duration 36.601 seconds.  
Epoch 133 Loss 0.049120 Duration 38.529 seconds.  
Epoch 134 Loss 0.051068 Duration 36.245 seconds.  
Epoch 135 Loss 0.048144 Duration 37.652 seconds.  
Epoch 136 Loss 0.049958 Duration 36.997 seconds.  
Epoch 137 Loss 0.051407 Duration 38.197 seconds.  
Epoch 138 Loss 0.049358 Duration 36.524 seconds.  
Epoch 139 Loss 0.051072 Duration 37.693 seconds.  
Epoch 140 Loss 0.048722 Duration 36.899 seconds.  
Checkpoint has been created.  
Epoch 141 Loss 0.049725 Duration 37.444 seconds.  
Epoch 142 Loss 0.050008 Duration 37.575 seconds.  
Epoch 143 Loss 0.051892 Duration 38.353 seconds.  
Epoch 144 Loss 0.050284 Duration 37.241 seconds.  
Epoch 145 Loss 0.054069 Duration 37.952 seconds.  
Epoch 146 Loss 0.050396 Duration 38.158 seconds.  
Epoch 147 Loss 0.050627 Duration 37.648 seconds.  
Epoch 148 Loss 0.053422 Duration 37.490 seconds.  
Epoch 149 Loss 0.052209 Duration 36.303 seconds.  
Epoch 150 Loss 0.051159 Duration 36.624 seconds.  
Checkpoint has been created.  
Epoch 151 Loss 0.052790 Duration 36.016 seconds.  
Epoch 152 Loss 0.052508 Duration 37.574 seconds.  
Epoch 153 Loss 0.052633 Duration 37.223 seconds.  
Epoch 154 Loss 0.052561 Duration 37.096 seconds.  
Epoch 155 Loss 0.054598 Duration 36.798 seconds.

Epoch 156 Loss 0.052458 Duration 37.835 seconds.  
Epoch 157 Loss 0.050288 Duration 38.019 seconds.  
Epoch 158 Loss 0.051870 Duration 36.879 seconds.  
Epoch 159 Loss 0.052913 Duration 36.567 seconds.  
Epoch 160 Loss 0.052228 Duration 36.327 seconds.  
Checkpoint has been created.  
Epoch 161 Loss 0.032977 Duration 37.248 seconds.  
Epoch 162 Loss 0.025332 Duration 36.263 seconds.  
Epoch 163 Loss 0.023558 Duration 38.337 seconds.  
Epoch 164 Loss 0.021125 Duration 37.033 seconds.  
Epoch 165 Loss 0.020455 Duration 37.656 seconds.  
Epoch 166 Loss 0.019550 Duration 36.598 seconds.  
Epoch 167 Loss 0.018880 Duration 38.739 seconds.  
Epoch 168 Loss 0.019106 Duration 36.904 seconds.  
Epoch 169 Loss 0.017192 Duration 38.056 seconds.  
Epoch 170 Loss 0.016599 Duration 36.546 seconds.  
Checkpoint has been created.  
Epoch 171 Loss 0.016005 Duration 37.493 seconds.  
Epoch 172 Loss 0.016865 Duration 36.441 seconds.  
Epoch 173 Loss 0.016091 Duration 39.146 seconds.  
Epoch 174 Loss 0.016501 Duration 36.258 seconds.  
Epoch 175 Loss 0.015704 Duration 37.436 seconds.  
Epoch 176 Loss 0.015253 Duration 36.775 seconds.  
Epoch 177 Loss 0.015167 Duration 37.602 seconds.  
Epoch 178 Loss 0.015387 Duration 37.102 seconds.  
Epoch 179 Loss 0.014832 Duration 36.781 seconds.  
Epoch 180 Loss 0.014585 Duration 36.025 seconds.  
Checkpoint has been created.  
Epoch 181 Loss 0.014122 Duration 36.696 seconds.  
Epoch 182 Loss 0.014011 Duration 36.899 seconds.  
Epoch 183 Loss 0.014034 Duration 37.082 seconds.  
Epoch 184 Loss 0.013166 Duration 37.110 seconds.  
Epoch 185 Loss 0.013158 Duration 36.454 seconds.  
Epoch 186 Loss 0.012932 Duration 36.649 seconds.  
Epoch 187 Loss 0.013545 Duration 36.649 seconds.  
Epoch 188 Loss 0.012525 Duration 38.462 seconds.  
Epoch 189 Loss 0.013225 Duration 35.577 seconds.  
Epoch 190 Loss 0.012829 Duration 37.141 seconds.  
Checkpoint has been created.  
Epoch 191 Loss 0.012523 Duration 36.248 seconds.  
Epoch 192 Loss 0.013028 Duration 36.825 seconds.  
Epoch 193 Loss 0.012017 Duration 37.166 seconds.  
Epoch 194 Loss 0.012148 Duration 37.019 seconds.  
Epoch 195 Loss 0.012744 Duration 35.880 seconds.  
Epoch 196 Loss 0.012042 Duration 37.021 seconds.  
Epoch 197 Loss 0.012551 Duration 36.689 seconds.

```

Epoch 198 Loss 0.012060 Duration 37.762 seconds.
Epoch 199 Loss 0.012053 Duration 36.824 seconds.
Epoch 200 Loss 0.011597 Duration 36.835 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v2_n3/model-160.ckpt
100% 5000/5000 [00:25<00:00, 196.55it/s]
Test accuracy: 0.8886
Restored model parameters from model_v2_n3/model-170.ckpt
100% 5000/5000 [00:25<00:00, 196.69it/s]
/content/Model.py:114: UserWarning: To copy construct from a tensor, it is recommended to use
    y = torch.tensor(y).cuda()
Test accuracy: 0.9116
Restored model parameters from model_v2_n3/model-180.ckpt
100% 5000/5000 [00:25<00:00, 199.01it/s]
Test accuracy: 0.9130
Restored model parameters from model_v2_n3/model-190.ckpt
100% 5000/5000 [00:24<00:00, 205.27it/s]
Test accuracy: 0.9102
Restored model parameters from model_v2_n3/model-200.ckpt
100% 5000/5000 [00:26<00:00, 188.64it/s]
Test accuracy: 0.9126
### Training... ###
Epoch 1 Loss 0.043903 Duration 41.495 seconds.
Epoch 2 Loss 0.039443 Duration 40.903 seconds.
Epoch 3 Loss 0.038453 Duration 40.800 seconds.
Epoch 4 Loss 0.034202 Duration 41.633 seconds.
Epoch 5 Loss 0.033430 Duration 39.891 seconds.
Epoch 6 Loss 0.033305 Duration 41.015 seconds.
Epoch 7 Loss 0.032057 Duration 40.725 seconds.
Epoch 8 Loss 0.030406 Duration 41.190 seconds.
Epoch 9 Loss 0.028661 Duration 41.498 seconds.
Epoch 10 Loss 0.028851 Duration 41.431 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v2_n3/model-10.ckpt
100% 10000/10000 [00:51<00:00, 194.25it/s]
Test accuracy: 0.9073

=====

resnet_version = 1,
resnet_size = 18,
batch_size = 128, weight_decay = 2e-4,
LR = 0.1 and decay of 0.1 every 80 epochs momentum = 0.9, nesterov = True, epoch = 200.

BN(eps=1e-5, momentum=0.1)

```

```

accuracy: 0.9222
--- Preparing Data ---
### Training... ###
Epoch 1 Loss 2.442919 Duration 73.921 seconds.
Epoch 2 Loss 2.245195 Duration 73.699 seconds.
Epoch 3 Loss 2.005884 Duration 74.243 seconds.
Epoch 4 Loss 1.814488 Duration 75.625 seconds.
Epoch 5 Loss 1.663162 Duration 75.137 seconds.
Epoch 6 Loss 1.485809 Duration 75.816 seconds.
Epoch 7 Loss 1.249761 Duration 76.052 seconds.
Epoch 8 Loss 1.080875 Duration 76.072 seconds.
Epoch 9 Loss 0.985216 Duration 75.658 seconds.
Epoch 10 Loss 0.897179 Duration 75.890 seconds.
Checkpoint has been created.
Epoch 11 Loss 0.833729 Duration 75.708 seconds.
Epoch 12 Loss 0.777086 Duration 75.832 seconds.
Epoch 13 Loss 0.725891 Duration 75.718 seconds.
Epoch 14 Loss 0.691664 Duration 75.902 seconds.
Epoch 15 Loss 0.649690 Duration 75.722 seconds.
Epoch 16 Loss 0.614360 Duration 75.735 seconds.
Epoch 17 Loss 0.595303 Duration 75.605 seconds.
Epoch 18 Loss 0.568039 Duration 76.024 seconds.
Epoch 19 Loss 0.552122 Duration 75.656 seconds.
Epoch 20 Loss 0.531889 Duration 75.939 seconds.
Checkpoint has been created.
Epoch 21 Loss 0.517147 Duration 75.339 seconds.
Epoch 22 Loss 0.504820 Duration 75.645 seconds.
Epoch 23 Loss 0.495787 Duration 75.404 seconds.
Epoch 24 Loss 0.474238 Duration 75.796 seconds.
Epoch 25 Loss 0.472963 Duration 75.667 seconds.
Epoch 26 Loss 0.454138 Duration 76.018 seconds.
Epoch 27 Loss 0.445400 Duration 75.613 seconds.
Epoch 28 Loss 0.440064 Duration 75.570 seconds.
Epoch 29 Loss 0.429134 Duration 75.875 seconds.
Epoch 30 Loss 0.425694 Duration 75.566 seconds.
Checkpoint has been created.
Epoch 31 Loss 0.416482 Duration 75.487 seconds.
Epoch 32 Loss 0.408755 Duration 75.419 seconds.
Epoch 33 Loss 0.405388 Duration 75.675 seconds.
Epoch 34 Loss 0.394705 Duration 75.589 seconds.
Epoch 35 Loss 0.393522 Duration 75.511 seconds.
Epoch 36 Loss 0.385429 Duration 75.215 seconds.
Epoch 37 Loss 0.378601 Duration 75.121 seconds.
Epoch 38 Loss 0.376184 Duration 74.878 seconds.
Epoch 39 Loss 0.372598 Duration 75.283 seconds.

```

Epoch 40 Loss 0.364871 Duration 74.958 seconds.  
Checkpoint has been created.  
Epoch 41 Loss 0.363533 Duration 75.297 seconds.  
Epoch 42 Loss 0.360637 Duration 74.893 seconds.  
Epoch 43 Loss 0.350642 Duration 75.203 seconds.  
Epoch 44 Loss 0.350198 Duration 74.554 seconds.  
Epoch 45 Loss 0.349394 Duration 74.795 seconds.  
Epoch 46 Loss 0.345464 Duration 75.744 seconds.  
Epoch 47 Loss 0.338830 Duration 76.283 seconds.  
Epoch 48 Loss 0.341706 Duration 75.663 seconds.  
Epoch 49 Loss 0.335864 Duration 75.601 seconds.  
Epoch 50 Loss 0.328500 Duration 75.723 seconds.  
Checkpoint has been created.  
Epoch 51 Loss 0.331836 Duration 75.241 seconds.  
Epoch 52 Loss 0.325448 Duration 75.507 seconds.  
Epoch 53 Loss 0.324595 Duration 75.179 seconds.  
Epoch 54 Loss 0.319635 Duration 75.199 seconds.  
Epoch 55 Loss 0.319560 Duration 75.344 seconds.  
Epoch 56 Loss 0.319613 Duration 75.613 seconds.  
Epoch 57 Loss 0.314338 Duration 75.500 seconds.  
Epoch 58 Loss 0.305616 Duration 75.101 seconds.  
Epoch 59 Loss 0.305590 Duration 75.529 seconds.  
Epoch 60 Loss 0.310441 Duration 75.016 seconds.  
Checkpoint has been created.  
Epoch 61 Loss 0.304216 Duration 75.415 seconds.  
Epoch 62 Loss 0.304411 Duration 75.018 seconds.  
Epoch 63 Loss 0.301253 Duration 75.071 seconds.  
Epoch 64 Loss 0.301703 Duration 75.336 seconds.  
Epoch 65 Loss 0.295206 Duration 75.318 seconds.  
Epoch 66 Loss 0.294517 Duration 75.121 seconds.  
Epoch 67 Loss 0.289972 Duration 74.926 seconds.  
Epoch 68 Loss 0.293374 Duration 75.343 seconds.  
Epoch 69 Loss 0.289473 Duration 75.453 seconds.  
Epoch 70 Loss 0.285834 Duration 75.655 seconds.  
Checkpoint has been created.  
Epoch 71 Loss 0.287623 Duration 75.220 seconds.  
Epoch 72 Loss 0.285266 Duration 75.401 seconds.  
Epoch 73 Loss 0.283280 Duration 75.688 seconds.  
Epoch 74 Loss 0.281590 Duration 75.399 seconds.  
Epoch 75 Loss 0.278760 Duration 75.601 seconds.  
Epoch 76 Loss 0.279970 Duration 75.341 seconds.  
Epoch 77 Loss 0.274835 Duration 75.431 seconds.  
Epoch 78 Loss 0.277455 Duration 75.664 seconds.  
Epoch 79 Loss 0.272467 Duration 75.611 seconds.  
Epoch 80 Loss 0.271573 Duration 75.141 seconds.  
Checkpoint has been created.



Epoch 81 Loss 0.160656 Duration 75.046 seconds.  
Epoch 82 Loss 0.120025 Duration 75.794 seconds.  
Epoch 83 Loss 0.104284 Duration 75.389 seconds.  
Epoch 84 Loss 0.095150 Duration 75.236 seconds.  
Epoch 85 Loss 0.087189 Duration 74.511 seconds.  
Epoch 86 Loss 0.078411 Duration 74.781 seconds.  
Epoch 87 Loss 0.071075 Duration 75.195 seconds.  
Epoch 88 Loss 0.067639 Duration 75.253 seconds.  
Epoch 89 Loss 0.062353 Duration 75.012 seconds.  
Epoch 90 Loss 0.058121 Duration 74.810 seconds.  
Checkpoint has been created.  
Epoch 91 Loss 0.056261 Duration 75.065 seconds.  
Epoch 92 Loss 0.050482 Duration 74.824 seconds.  
Epoch 93 Loss 0.045948 Duration 75.063 seconds.  
Epoch 94 Loss 0.042415 Duration 75.422 seconds.  
Epoch 95 Loss 0.041405 Duration 75.895 seconds.  
Epoch 96 Loss 0.037485 Duration 76.072 seconds.  
Epoch 97 Loss 0.036182 Duration 76.031 seconds.  
Epoch 98 Loss 0.033986 Duration 75.796 seconds.  
Epoch 99 Loss 0.032304 Duration 75.639 seconds.  
Epoch 100 Loss 0.031654 Duration 75.446 seconds.  
Checkpoint has been created.  
Epoch 101 Loss 0.029280 Duration 75.220 seconds.  
Epoch 102 Loss 0.029446 Duration 75.570 seconds.  
Epoch 103 Loss 0.027002 Duration 75.235 seconds.  
Epoch 104 Loss 0.027774 Duration 75.181 seconds.  
Epoch 105 Loss 0.027136 Duration 75.601 seconds.  
Epoch 106 Loss 0.024401 Duration 75.349 seconds.  
Epoch 107 Loss 0.024370 Duration 75.777 seconds.  
Epoch 108 Loss 0.022875 Duration 75.528 seconds.  
Epoch 109 Loss 0.025047 Duration 75.435 seconds.  
Epoch 110 Loss 0.025488 Duration 75.861 seconds.  
Checkpoint has been created.  
Epoch 111 Loss 0.023339 Duration 75.741 seconds.  
Epoch 112 Loss 0.021397 Duration 75.365 seconds.  
Epoch 113 Loss 0.021831 Duration 75.211 seconds.  
Epoch 114 Loss 0.022057 Duration 75.437 seconds.  
Epoch 115 Loss 0.021003 Duration 75.315 seconds.  
Epoch 116 Loss 0.020587 Duration 75.268 seconds.  
Epoch 117 Loss 0.017391 Duration 75.106 seconds.  
Epoch 118 Loss 0.019575 Duration 75.119 seconds.  
Epoch 119 Loss 0.020322 Duration 75.463 seconds.  
Epoch 120 Loss 0.020009 Duration 75.588 seconds.  
Checkpoint has been created.  
Epoch 121 Loss 0.019021 Duration 75.522 seconds.  
Epoch 122 Loss 0.019441 Duration 75.622 seconds.

Epoch 123 Loss 0.018592 Duration 75.871 seconds.  
Epoch 124 Loss 0.022928 Duration 75.540 seconds.  
Epoch 125 Loss 0.021052 Duration 75.878 seconds.  
Epoch 126 Loss 0.018297 Duration 75.686 seconds.  
Epoch 127 Loss 0.021285 Duration 75.799 seconds.  
Epoch 128 Loss 0.019767 Duration 77.257 seconds.  
Epoch 129 Loss 0.020810 Duration 76.823 seconds.  
Epoch 130 Loss 0.019587 Duration 76.320 seconds.  
Checkpoint has been created.  
Epoch 131 Loss 0.019322 Duration 76.660 seconds.  
Epoch 132 Loss 0.018382 Duration 76.741 seconds.  
Epoch 133 Loss 0.020991 Duration 75.850 seconds.  
Epoch 134 Loss 0.019521 Duration 75.597 seconds.  
Epoch 135 Loss 0.018440 Duration 75.047 seconds.  
Epoch 136 Loss 0.021325 Duration 75.063 seconds.  
Epoch 137 Loss 0.020591 Duration 75.302 seconds.  
Epoch 138 Loss 0.022146 Duration 75.398 seconds.  
Epoch 139 Loss 0.022115 Duration 74.843 seconds.  
Epoch 140 Loss 0.024501 Duration 74.962 seconds.  
Checkpoint has been created.  
Epoch 141 Loss 0.022300 Duration 75.423 seconds.  
Epoch 142 Loss 0.024231 Duration 75.724 seconds.  
Epoch 143 Loss 0.022314 Duration 76.314 seconds.  
Epoch 144 Loss 0.020341 Duration 76.078 seconds.  
Epoch 145 Loss 0.021816 Duration 76.484 seconds.  
Epoch 146 Loss 0.017527 Duration 76.022 seconds.  
Epoch 147 Loss 0.022079 Duration 76.028 seconds.  
Epoch 148 Loss 0.021940 Duration 75.712 seconds.  
Epoch 149 Loss 0.021367 Duration 75.651 seconds.  
Epoch 150 Loss 0.023844 Duration 75.836 seconds.  
Checkpoint has been created.  
Epoch 151 Loss 0.022317 Duration 75.765 seconds.  
Epoch 152 Loss 0.021763 Duration 75.180 seconds.  
Epoch 153 Loss 0.024526 Duration 74.952 seconds.  
Epoch 154 Loss 0.022991 Duration 75.554 seconds.  
Epoch 155 Loss 0.025140 Duration 75.033 seconds.  
Epoch 156 Loss 0.025519 Duration 75.532 seconds.  
Epoch 157 Loss 0.025668 Duration 75.510 seconds.  
Epoch 158 Loss 0.029313 Duration 75.704 seconds.  
Epoch 159 Loss 0.027730 Duration 75.271 seconds.  
Epoch 160 Loss 0.027793 Duration 75.766 seconds.  
Checkpoint has been created.  
Epoch 161 Loss 0.016651 Duration 75.449 seconds.  
Epoch 162 Loss 0.010849 Duration 75.513 seconds.  
Epoch 163 Loss 0.008896 Duration 75.768 seconds.  
Epoch 164 Loss 0.008218 Duration 75.606 seconds.

Epoch 165 Loss 0.006988 Duration 75.222 seconds.  
 Epoch 166 Loss 0.006082 Duration 75.323 seconds.  
 Epoch 167 Loss 0.006161 Duration 75.505 seconds.  
 Epoch 168 Loss 0.005703 Duration 75.201 seconds.  
 Epoch 169 Loss 0.005163 Duration 75.401 seconds.  
 Epoch 170 Loss 0.005562 Duration 75.039 seconds.  
 Checkpoint has been created.  
 Epoch 171 Loss 0.004721 Duration 74.949 seconds.  
 Epoch 172 Loss 0.004626 Duration 75.188 seconds.  
 Epoch 173 Loss 0.003989 Duration 75.325 seconds.  
 Epoch 174 Loss 0.004240 Duration 75.178 seconds.  
 Epoch 175 Loss 0.003966 Duration 75.092 seconds.  
 Epoch 176 Loss 0.003994 Duration 75.424 seconds.  
 Epoch 177 Loss 0.003796 Duration 75.108 seconds.  
 Epoch 178 Loss 0.003742 Duration 75.245 seconds.  
 Epoch 179 Loss 0.003744 Duration 74.988 seconds.  
 Epoch 180 Loss 0.003533 Duration 74.703 seconds.  
 Checkpoint has been created.  
 Epoch 181 Loss 0.003394 Duration 74.579 seconds.  
 Epoch 182 Loss 0.003254 Duration 74.966 seconds.  
 Epoch 183 Loss 0.003780 Duration 74.576 seconds.  
 Epoch 184 Loss 0.003493 Duration 74.674 seconds.  
 Epoch 185 Loss 0.003223 Duration 74.886 seconds.  
 Epoch 186 Loss 0.003209 Duration 74.603 seconds.  
 Epoch 187 Loss 0.003200 Duration 74.779 seconds.  
 Epoch 188 Loss 0.002940 Duration 74.355 seconds.  
 Epoch 189 Loss 0.003561 Duration 75.208 seconds.  
 Epoch 190 Loss 0.002931 Duration 75.778 seconds.  
 Checkpoint has been created.  
 Epoch 191 Loss 0.003107 Duration 75.799 seconds.  
 Epoch 192 Loss 0.002700 Duration 75.405 seconds.  
 Epoch 193 Loss 0.002588 Duration 75.379 seconds.  
 Epoch 194 Loss 0.002629 Duration 75.596 seconds.  
 Epoch 195 Loss 0.002601 Duration 75.075 seconds.  
 Epoch 196 Loss 0.002706 Duration 75.340 seconds.  
 Epoch 197 Loss 0.002522 Duration 74.897 seconds.  
 Epoch 198 Loss 0.002658 Duration 75.318 seconds.  
 Epoch 199 Loss 0.002757 Duration 75.241 seconds.  
 Epoch 200 Loss 0.002609 Duration 75.396 seconds.  
 Checkpoint has been created.  
 ### Test or Validation ###  
 Restored model parameters from model\_v1\_n18/model-160.ckpt  
 100% 5000/5000 [01:23<00:00, 59.61it/s]  
 Test accuracy: 0.9092  
 Restored model parameters from model\_v1\_n18/model-170.ckpt  
 100% 5000/5000 [01:24<00:00, 59.06it/s]

```

/content/Model.py:114: UserWarning: To copy construct from a tensor, it is recommended to use
  y = torch.tensor(y).cuda()
Test accuracy: 0.9240
Restored model parameters from model_v1_n18/model-180.ckpt
100% 5000/5000 [01:24<00:00, 59.30it/s]
Test accuracy: 0.9242
Restored model parameters from model_v1_n18/model-190.ckpt
100% 5000/5000 [01:24<00:00, 59.13it/s]
Test accuracy: 0.9238
Restored model parameters from model_v1_n18/model-200.ckpt
100% 5000/5000 [01:22<00:00, 60.27it/s]
Test accuracy: 0.9240
### Training... ###
Epoch 1 Loss 0.030744 Duration 80.811 seconds.
Epoch 2 Loss 0.026452 Duration 81.931 seconds.
Epoch 3 Loss 0.023731 Duration 82.926 seconds.
Epoch 4 Loss 0.021965 Duration 83.131 seconds.
Epoch 5 Loss 0.017737 Duration 83.223 seconds.
Epoch 6 Loss 0.017583 Duration 83.728 seconds.
Epoch 7 Loss 0.015310 Duration 83.545 seconds.
Epoch 8 Loss 0.015186 Duration 83.908 seconds.
Epoch 9 Loss 0.013610 Duration 83.832 seconds.
Epoch 10 Loss 0.012618 Duration 84.039 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v1_n18/model-10.ckpt
100% 10000/10000 [02:49<00:00, 58.85it/s]
Test accuracy: 0.9222

```

```

=====

resnet_version = 2,
resnet_size = 18, batch_size = 128,
weight_decay = 2e-4, LR = 0.1 and decay of 0.1 every 80 epochs momentum = 0.9,
nesterov = True, epoch = 200.

```

```

BN(eps=1e-5, momentum=0.1)

```

```

--- Preparing Data ---
### Training... ###
Epoch 1 Loss 1.371965 Duration 50.583 seconds.
Epoch 2 Loss 0.890587 Duration 47.854 seconds.
Epoch 3 Loss 0.710562 Duration 47.746 seconds.
Epoch 4 Loss 0.606971 Duration 47.905 seconds.
Epoch 5 Loss 0.534031 Duration 48.245 seconds.
Epoch 6 Loss 0.490309 Duration 47.720 seconds.

```

Epoch 7 Loss 0.457722 Duration 47.770 seconds.  
Epoch 8 Loss 0.425988 Duration 47.783 seconds.  
Epoch 9 Loss 0.406020 Duration 47.676 seconds.  
Epoch 10 Loss 0.383866 Duration 47.654 seconds.  
Checkpoint has been created.  
Epoch 11 Loss 0.372568 Duration 47.350 seconds.  
Epoch 12 Loss 0.356697 Duration 47.502 seconds.  
Epoch 13 Loss 0.346008 Duration 48.164 seconds.  
Epoch 14 Loss 0.338266 Duration 47.859 seconds.  
Epoch 15 Loss 0.330402 Duration 48.062 seconds.  
Epoch 16 Loss 0.326424 Duration 48.264 seconds.  
Epoch 17 Loss 0.312399 Duration 47.973 seconds.  
Epoch 18 Loss 0.308438 Duration 48.082 seconds.  
Epoch 19 Loss 0.305813 Duration 47.747 seconds.  
Epoch 20 Loss 0.298471 Duration 47.894 seconds.  
Checkpoint has been created.  
Epoch 21 Loss 0.293403 Duration 47.585 seconds.  
Epoch 22 Loss 0.294449 Duration 47.676 seconds.  
Epoch 23 Loss 0.289934 Duration 47.916 seconds.  
Epoch 24 Loss 0.286282 Duration 47.481 seconds.  
Epoch 25 Loss 0.280789 Duration 47.688 seconds.  
Epoch 26 Loss 0.277478 Duration 47.975 seconds.  
Epoch 27 Loss 0.278563 Duration 47.586 seconds.  
Epoch 28 Loss 0.270719 Duration 47.603 seconds.  
Epoch 29 Loss 0.275338 Duration 46.972 seconds.  
Epoch 30 Loss 0.270247 Duration 47.151 seconds.  
Checkpoint has been created.  
Epoch 31 Loss 0.263983 Duration 47.161 seconds.  
Epoch 32 Loss 0.265649 Duration 46.879 seconds.  
Epoch 33 Loss 0.258315 Duration 46.985 seconds.  
Epoch 34 Loss 0.262525 Duration 47.301 seconds.  
Epoch 35 Loss 0.260059 Duration 47.543 seconds.  
Epoch 36 Loss 0.255221 Duration 47.556 seconds.  
Epoch 37 Loss 0.256656 Duration 47.136 seconds.  
Epoch 38 Loss 0.252231 Duration 46.975 seconds.  
Epoch 39 Loss 0.246490 Duration 47.471 seconds.  
Epoch 40 Loss 0.245255 Duration 46.940 seconds.  
Checkpoint has been created.  
Epoch 41 Loss 0.251221 Duration 47.261 seconds.  
Epoch 42 Loss 0.245905 Duration 47.621 seconds.  
Epoch 43 Loss 0.239487 Duration 46.855 seconds.  
Epoch 44 Loss 0.237226 Duration 46.052 seconds.  
Epoch 45 Loss 0.239705 Duration 45.731 seconds.  
Epoch 46 Loss 0.235352 Duration 45.003 seconds.  
Epoch 47 Loss 0.234648 Duration 44.580 seconds.  
Epoch 48 Loss 0.238538 Duration 44.796 seconds.

Epoch 49 Loss 0.235030 Duration 44.518 seconds.  
Epoch 50 Loss 0.234609 Duration 44.375 seconds.  
Checkpoint has been created.  
Epoch 51 Loss 0.228770 Duration 44.522 seconds.  
Epoch 52 Loss 0.231407 Duration 44.698 seconds.  
Epoch 53 Loss 0.227837 Duration 44.569 seconds.  
Epoch 54 Loss 0.227754 Duration 44.809 seconds.  
Epoch 55 Loss 0.221784 Duration 44.725 seconds.  
Epoch 56 Loss 0.225168 Duration 44.620 seconds.  
Epoch 57 Loss 0.226950 Duration 44.735 seconds.  
Epoch 58 Loss 0.218879 Duration 44.109 seconds.  
Epoch 59 Loss 0.221112 Duration 44.046 seconds.  
Epoch 60 Loss 0.221703 Duration 44.188 seconds.  
Checkpoint has been created.  
Epoch 61 Loss 0.219268 Duration 44.155 seconds.  
Epoch 62 Loss 0.215452 Duration 44.289 seconds.  
Epoch 63 Loss 0.218873 Duration 44.390 seconds.  
Epoch 64 Loss 0.215154 Duration 44.735 seconds.  
Epoch 65 Loss 0.213236 Duration 44.639 seconds.  
Epoch 66 Loss 0.211875 Duration 44.592 seconds.  
Epoch 67 Loss 0.212991 Duration 46.250 seconds.  
Epoch 68 Loss 0.208945 Duration 46.101 seconds.  
Epoch 69 Loss 0.212546 Duration 44.536 seconds.  
Epoch 70 Loss 0.216862 Duration 44.740 seconds.  
Checkpoint has been created.  
Epoch 71 Loss 0.209690 Duration 44.709 seconds.  
Epoch 72 Loss 0.208729 Duration 44.788 seconds.  
Epoch 73 Loss 0.214554 Duration 44.592 seconds.  
Epoch 74 Loss 0.208283 Duration 44.795 seconds.  
Epoch 75 Loss 0.209421 Duration 44.875 seconds.  
Epoch 76 Loss 0.207851 Duration 44.368 seconds.  
Epoch 77 Loss 0.201991 Duration 44.774 seconds.  
Epoch 78 Loss 0.205746 Duration 44.592 seconds.  
Epoch 79 Loss 0.204255 Duration 44.890 seconds.  
Epoch 80 Loss 0.203946 Duration 45.001 seconds.  
Checkpoint has been created.  
Epoch 81 Loss 0.100898 Duration 44.876 seconds.  
Epoch 82 Loss 0.067415 Duration 44.811 seconds.  
Epoch 83 Loss 0.054964 Duration 44.716 seconds.  
Epoch 84 Loss 0.047497 Duration 44.599 seconds.  
Epoch 85 Loss 0.039021 Duration 44.687 seconds.  
Epoch 86 Loss 0.037155 Duration 44.982 seconds.  
Epoch 87 Loss 0.032136 Duration 44.868 seconds.  
Epoch 88 Loss 0.028410 Duration 45.041 seconds.  
Epoch 89 Loss 0.026248 Duration 44.519 seconds.  
Epoch 90 Loss 0.023744 Duration 44.722 seconds.

Checkpoint has been created.  
Epoch 91 Loss 0.023006 Duration 44.785 seconds.  
Epoch 92 Loss 0.021089 Duration 44.543 seconds.  
Epoch 93 Loss 0.018405 Duration 44.837 seconds.  
Epoch 94 Loss 0.017069 Duration 45.028 seconds.  
Epoch 95 Loss 0.016383 Duration 44.524 seconds.  
Epoch 96 Loss 0.015050 Duration 44.308 seconds.  
Epoch 97 Loss 0.014860 Duration 44.545 seconds.  
Epoch 98 Loss 0.015400 Duration 44.533 seconds.  
Epoch 99 Loss 0.014075 Duration 44.485 seconds.  
Epoch 100 Loss 0.012643 Duration 44.046 seconds.  
Checkpoint has been created.  
Epoch 101 Loss 0.011849 Duration 44.299 seconds.  
Epoch 102 Loss 0.011724 Duration 44.569 seconds.  
Epoch 103 Loss 0.011491 Duration 44.417 seconds.  
Epoch 104 Loss 0.010678 Duration 44.506 seconds.  
Epoch 105 Loss 0.011002 Duration 44.415 seconds.  
Epoch 106 Loss 0.010997 Duration 44.474 seconds.  
Epoch 107 Loss 0.012414 Duration 44.491 seconds.  
Epoch 108 Loss 0.009444 Duration 44.441 seconds.  
Epoch 109 Loss 0.010383 Duration 44.266 seconds.  
Epoch 110 Loss 0.009810 Duration 44.606 seconds.  
Checkpoint has been created.  
Epoch 111 Loss 0.009919 Duration 44.284 seconds.  
Epoch 112 Loss 0.009486 Duration 44.320 seconds.  
Epoch 113 Loss 0.009135 Duration 44.447 seconds.  
Epoch 114 Loss 0.009650 Duration 44.082 seconds.  
Epoch 115 Loss 0.008715 Duration 44.298 seconds.  
Epoch 116 Loss 0.008548 Duration 44.453 seconds.  
Epoch 117 Loss 0.008961 Duration 44.280 seconds.  
Epoch 118 Loss 0.008641 Duration 44.237 seconds.  
Epoch 119 Loss 0.010205 Duration 44.558 seconds.  
Epoch 120 Loss 0.009778 Duration 44.124 seconds.  
Checkpoint has been created.  
Epoch 121 Loss 0.009643 Duration 44.293 seconds.  
Epoch 122 Loss 0.009115 Duration 44.377 seconds.  
Epoch 123 Loss 0.010469 Duration 44.280 seconds.  
Epoch 124 Loss 0.009603 Duration 44.465 seconds.  
Epoch 125 Loss 0.010973 Duration 44.283 seconds.  
Epoch 126 Loss 0.010184 Duration 44.294 seconds.  
Epoch 127 Loss 0.010811 Duration 44.181 seconds.  
Epoch 128 Loss 0.009732 Duration 44.301 seconds.  
Epoch 129 Loss 0.008497 Duration 44.030 seconds.  
Epoch 130 Loss 0.010400 Duration 44.018 seconds.  
Checkpoint has been created.  
Epoch 131 Loss 0.009395 Duration 44.136 seconds.

Epoch 132 Loss 0.009177 Duration 44.214 seconds.  
Epoch 133 Loss 0.012186 Duration 44.286 seconds.  
Epoch 134 Loss 0.010316 Duration 44.525 seconds.  
Epoch 135 Loss 0.009991 Duration 44.307 seconds.  
Epoch 136 Loss 0.010487 Duration 44.439 seconds.  
Epoch 137 Loss 0.012847 Duration 44.245 seconds.  
Epoch 138 Loss 0.010388 Duration 44.238 seconds.  
Epoch 139 Loss 0.011906 Duration 44.399 seconds.  
Epoch 140 Loss 0.013174 Duration 44.116 seconds.  
Checkpoint has been created.  
Epoch 141 Loss 0.012355 Duration 44.242 seconds.  
Epoch 142 Loss 0.011785 Duration 44.319 seconds.  
Epoch 143 Loss 0.014354 Duration 44.196 seconds.  
Epoch 144 Loss 0.012043 Duration 44.376 seconds.  
Epoch 145 Loss 0.013533 Duration 44.004 seconds.  
Epoch 146 Loss 0.014987 Duration 43.966 seconds.  
Epoch 147 Loss 0.015866 Duration 44.124 seconds.  
Epoch 148 Loss 0.011117 Duration 43.984 seconds.  
Epoch 149 Loss 0.013478 Duration 43.924 seconds.  
Epoch 150 Loss 0.015588 Duration 44.278 seconds.  
Checkpoint has been created.  
Epoch 151 Loss 0.014087 Duration 43.996 seconds.  
Epoch 152 Loss 0.015380 Duration 44.064 seconds.  
Epoch 153 Loss 0.015082 Duration 44.153 seconds.  
Epoch 154 Loss 0.017648 Duration 43.889 seconds.  
Epoch 155 Loss 0.017333 Duration 44.109 seconds.  
Epoch 156 Loss 0.013307 Duration 44.052 seconds.  
Epoch 157 Loss 0.013406 Duration 44.066 seconds.  
Epoch 158 Loss 0.014363 Duration 44.118 seconds.  
Epoch 159 Loss 0.014450 Duration 44.218 seconds.  
Epoch 160 Loss 0.016688 Duration 44.038 seconds.  
Checkpoint has been created.  
Epoch 161 Loss 0.008947 Duration 44.145 seconds.  
Epoch 162 Loss 0.006593 Duration 44.135 seconds.  
Epoch 163 Loss 0.005783 Duration 44.019 seconds.  
Epoch 164 Loss 0.004397 Duration 43.992 seconds.  
Epoch 165 Loss 0.004267 Duration 44.333 seconds.  
Epoch 166 Loss 0.003878 Duration 44.063 seconds.  
Epoch 167 Loss 0.003908 Duration 44.049 seconds.  
Epoch 168 Loss 0.003563 Duration 44.149 seconds.  
Epoch 169 Loss 0.003118 Duration 44.136 seconds.  
Epoch 170 Loss 0.003201 Duration 44.135 seconds.  
Checkpoint has been created.  
Epoch 171 Loss 0.003115 Duration 43.941 seconds.  
Epoch 172 Loss 0.002702 Duration 44.142 seconds.  
Epoch 173 Loss 0.002585 Duration 44.227 seconds.



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Epoch 174 Loss 0.002885 Duration 44.025 seconds.
Epoch 175 Loss 0.002637 Duration 43.871 seconds.
Epoch 176 Loss 0.002339 Duration 44.210 seconds.
Epoch 177 Loss 0.002457 Duration 44.040 seconds.
Epoch 178 Loss 0.002508 Duration 44.098 seconds.
Epoch 179 Loss 0.002243 Duration 43.982 seconds.
Epoch 180 Loss 0.002603 Duration 43.928 seconds.
Checkpoint has been created.
Epoch 181 Loss 0.002382 Duration 44.148 seconds.
Epoch 182 Loss 0.002198 Duration 43.809 seconds.
Epoch 183 Loss 0.001946 Duration 44.085 seconds.
Epoch 184 Loss 0.001888 Duration 44.173 seconds.
Epoch 185 Loss 0.002042 Duration 44.150 seconds.
Epoch 186 Loss 0.002180 Duration 44.220 seconds.
Epoch 187 Loss 0.001939 Duration 44.145 seconds.
Epoch 188 Loss 0.001942 Duration 44.371 seconds.
Epoch 189 Loss 0.002076 Duration 44.006 seconds.
Epoch 190 Loss 0.001999 Duration 43.885 seconds.
Checkpoint has been created.
Epoch 191 Loss 0.001846 Duration 43.931 seconds.
Epoch 192 Loss 0.001937 Duration 43.880 seconds.
Epoch 193 Loss 0.001810 Duration 44.529 seconds.
Epoch 194 Loss 0.001647 Duration 45.330 seconds.
Epoch 195 Loss 0.001637 Duration 46.384 seconds.
Epoch 196 Loss 0.001854 Duration 46.075 seconds.
Epoch 197 Loss 0.001685 Duration 46.539 seconds.
Epoch 198 Loss 0.001722 Duration 44.812 seconds.
Epoch 199 Loss 0.001671 Duration 46.007 seconds.
Epoch 200 Loss 0.001600 Duration 47.546 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v2_n18/model-160.ckpt
100% 5000/5000 [02:02<00:00, 40.70it/s]
Test accuracy: 0.9348
Restored model parameters from model_v2_n18/model-170.ckpt
100% 5000/5000 [02:03<00:00, 40.56it/s]
/content/Model.py:114: UserWarning: To copy construct from a tensor, it is recommended to use
    y = torch.tensor(y).cuda()
Test accuracy: 0.9466
Restored model parameters from model_v2_n18/model-180.ckpt
100% 5000/5000 [02:00<00:00, 41.52it/s]
Test accuracy: 0.9456
Restored model parameters from model_v2_n18/model-190.ckpt
100% 5000/5000 [01:55<00:00, 43.42it/s]
Test accuracy: 0.9438
Restored model parameters from model_v2_n18/model-200.ckpt

```

```
100% 5000/5000 [01:53<00:00, 43.95it/s]
Test accuracy: 0.9452
### Training... ###
Epoch 1 Loss 0.024752 Duration 49.970 seconds.
Epoch 2 Loss 0.019738 Duration 49.943 seconds.
Epoch 3 Loss 0.016616 Duration 49.903 seconds.
Epoch 4 Loss 0.014414 Duration 49.873 seconds.
Epoch 5 Loss 0.012819 Duration 50.008 seconds.
Epoch 6 Loss 0.011831 Duration 49.837 seconds.
Epoch 7 Loss 0.009829 Duration 49.868 seconds.
Epoch 8 Loss 0.009435 Duration 49.922 seconds.
Epoch 9 Loss 0.008548 Duration 49.944 seconds.
Epoch 10 Loss 0.007509 Duration 49.740 seconds.
Checkpoint has been created.
### Test or Validation ###
Restored model parameters from model_v2_n18/model-10.ckpt
100% 10000/10000 [03:49<00:00, 43.59it/s]
Test accuracy: 0.9406
```