Lab_11_aa07190

November 8, 2024

1 CS 316 : Introduction to Deep Learning - Fall 2024

1.1 Lab 11 : Convolutional Neural Networks and ResNet

1.1.1 Dr. Abdul Samad

2 Instructions

1. Make a copy of this notebook on google colab at start of the lab.
2. Please rename your notebook as *Lab_11_aa12345.ipynb* before starting the lab. Notebooks which do not follow appropriate naming convention will not be graded.
3. You have to submit this lab during the lab timings. You are allowed to submit till 11:59 PM on the day of your lab with a 30% penalty. No submissions will be accepted afterwards.
4. Use of AI is strictly prohibited. Anyone caught using Any AI tool during lab or while grading will be immediately reported to OCVS without any further discussion.
5. At the end of the lab, download the notebook (ipynb extension file) and upload it on canvas as a file. Submitting link to notebook or any other file will not be accepted.
6. Each task has points assigned to it. Total Lab is of 100 points.
7. Use of for loops is strictly prohibited.
8. For every theoretical question, there is a separate cell given at the end. You have to write your answer there.
9. If you have any questions, please feel free to reach out to the course instructor or RA.

2.1 Task Overview

In this lab we will again work on CNNs. This Lab is going to be a little long. Work through the cells below, running each cell in turn. In various places you will see the words "TODO". Follow the instructions at these places and make predictions about what is going to happen or write code to complete the functions.

Let's start with importing Libraries first

[1]:
```
import numpy as np
import torch
import torch.nn as nn
```

```
import torchvision
from torch.autograd import Variable
import torch.nn.functional as F
import torch.optim as optim
import matplotlib.pyplot as plt
import random
```

3 Convolution for CIFAR10

This notebook builds a proper network for 2D convolution. It works with the CIFAR10 dataset , which was the original classic dataset for classifying images. The network will take a 32x32x3 image and classify it into one of 10 classes representing an object.

[2]:
```
# Run this once to load the train and test data straight into a dataloader class
# that will provide the batches

# (It may complain that some files are missing because the files seem to have␣
 ↪been
# reorganized on the underlying website, but it still seems to work). If␣
 ↪everything is working
# properly, then the whole notebook should run to the end without further␣
 ↪problems
# even before you make changes.
batch_size_train = 20
batch_size_test = 16
train_loader = torch.utils.data.DataLoader(
    torchvision.datasets.CIFAR10('/cifar10_data/', train=True, download=True,
                             transform=torchvision.transforms.Compose([
                                 torchvision.transforms.CenterCrop(28),
                                 torchvision.transforms.ToTensor(),
                             ])),
  batch_size=batch_size_train, shuffle=True)

test_loader = torch.utils.data.DataLoader(
  torchvision.datasets.CIFAR10('/cifar10_data/', train=False, download=True,
                             transform=torchvision.transforms.Compose([
                                 torchvision.transforms.CenterCrop(28),
                                 torchvision.transforms.ToTensor(),
                             ])),
  batch_size=batch_size_test, shuffle=True)
```

```
Downloading https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz to
/cifar10_data/cifar-10-python.tar.gz
```

```
100%|      | 170M/170M [00:04<00:00, 35.1MB/s]
```

```
Extracting /cifar10_data/cifar-10-python.tar.gz to /cifar10_data/
Files already downloaded and verified
```

[3]:
```
# Let's draw some of the training data
examples = enumerate(test_loader)
batch_idx, (example_data, example_targets) = next(examples)
classes = ('Airplane', 'Car', 'Bird', 'Cat', 'Deer', 'Dog', 'Frog', 'Horse',␣
 ↪'Ship', 'Truck')

def imshow(img):    # unnormalize
    npimg = img.numpy()
    plt.imshow(np.transpose(npimg, (1, 2, 0)))
    plt.show()

# show images
imshow(torchvision.utils.make_grid(example_data))
```

Before we go in depth on declaring the network, Let's look at another way of writing network architecture. Look at the code block given below.

This is implementation of the below given network: 1. A valid convolution with kernel size 5, 1 input channel and 10 output channels 2. A max pooling operation over a 2x2 area 3. A Relu 4. A valid convolution with kernel size 5, 10 input channels and 20 output channels 5. A Relu 5. A 2D Dropout layer 6. A flattening operation 7. A fully connected layer 8. A softmax function.

[4]:
```
class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()


        # 1. A valid convolution with kernel size 5, 1 input channel, and 10␣
 ↪output channels
        self.conv1 = nn.Conv2d(in_channels=1, out_channels=10, kernel_size=5)

        # 4. A valid convolution with kernel size 5, 10 input channels, and 20␣
 ↪output channels
        self.conv2 = nn.Conv2d(in_channels=10, out_channels=20, kernel_size=5)
```

```
        # 5. A 2D Dropout layer
        self.drop = nn.Dropout2d()

        # 9. A fully connected layer mapping from whatever dimensions to 50
        self.fc1 = nn.Linear(20 * 4 * 4, 50)

    def forward(self, x):
        # 1. Convolution layer 1
        x = self.conv1(x)

        # 2. A max pooling operation over a 2x2 area
        x = F.max_pool2d(x, 2)

        # 3. A ReLU
        x = F.relu(x)

        # 4. Convolution layer 2
        x = self.conv2(x)

        # 7. A ReLU
        x = F.relu(x)

        # 5. Apply Dropout
        x = self.drop(x)

        # 8. Flatten the output
        x = x.flatten(1)

        # 9. Fully connected layer mapping to 50
        x = self.fc1(x)

        # 12. Apply softmax to the output
        x = F.log_softmax(x, dim=1)

        return x
```

As you can see, this network actually declares the layers first in init function and then calls them in forward function. Here, you will also see passing of data using x. Both methods (one you studied in last lab and this one) are completely valid forimplementation. That method has some limitations though. Let's start working on network architectures again now.

4 Q1: TODO [35 Points]

We will again build Alexnet Architecture in this lab. Only difference is it is this time on cifar10 dataset instead. cifar10 has images of size 32x32x3. However, if you go to dataloader, you will see that this has been cropped. So you will take input size as 28x28x3. Here is the architecture: 1. A convolution with kernel size 11, 3 input channel, 64 output channels and padding 1 3. A Relu 2.

A max pooling operation with kernel size 3 and stride 1 4. A valid convolution with kernel size 5, padding 1 and 128 output channels 3. A Relu 2. A max pooling operation with kernel size 3 and stride 1 4. A valid convolution with kernel size 3, padding 1 and 256 output channels 3. A Relu 4. A valid convolution with kernel size 3, padding 1 and 128 output channels 3. A Relu 4. A valid convolution with kernel size 3, padding 1 and 128 output channels 3. A Relu 2. A max pooling operation with kernel size 3 and stride 1 8. A flattening operation 5. A 2D Dropout layer 9. A fully connected layer mapping from (whatever dimensions we are at– find out using formulas studied in class. You will also need to submit picture of calculation. Without that this question will not be graded) to 4096 10. A ReLU 5. A 2D Dropout layer 11. A fully connected layer mapping from 4096 to 4096 dimensions 10. A ReLU 11. A fully connected layer mapping from 4096 to 10 dimensions 12. A Log softmax function.

[5]:
```
class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        #TODO
        self.conv1 = nn.Conv2d(3, 64, kernel_size=11, stride=1, padding=1)

        # self.pool1 = nn.MaxPool2d(kernel_size=3, stride=1)
        self.conv2 = nn.Conv2d(64, 128, kernel_size=5, stride=1, padding=1)

        # self.pool2 = nn.MaxPool2d(kernel_size=3, stride=1)
        self.conv3 = nn.Conv2d(128, 256, kernel_size=3, stride=1, padding=1)
        self.conv4 = nn.Conv2d(256, 128, kernel_size=3, stride=1, padding=1)
        self.conv5 = nn.Conv2d(128, 128, kernel_size=3, stride=1, padding=1)

        # self.pool3 = nn.MaxPool2d(kernel_size=3, stride=1)

        self.drop1 = nn.Dropout2d()

        self.fc1 = nn.Linear(128 * 12 * 12, 4096)

        self.drop2 = nn.Dropout2d()

        self.fc2 = nn.Linear(4096, 4096)

        self.fc3 = nn.Linear(4096, 10)
        #END TODO
    def forward(self, x):
        #TODO

        x = self.conv1(x)                                    # 1
        x = F.relu(x)                                      # 2
        x = F.max_pool2d(x, kernel_size=3, stride=1)         # 3
        x = self.conv2(x)                                    # 4
        x = F.relu(x)                                    # 5
        x = F.max_pool2d(x, kernel_size=3, stride=1)     # 6
```

```
        x = self.conv3(x)                                    # 7
        x = F.relu(x)                                      # 8
        x = self.conv4(x)                                    # 9
        x = F.relu(x)                                      # 10
        x = self.conv5(x)                                    # 11
        x = F.relu(x)                                      # 12
        x = F.max_pool2d(x, kernel_size=3, stride=1)     # 13
        x = x.flatten(1)                                   # 14
        x = self.drop2(x)                                   # 15
        x = self.fc1(x)                                     # 16
        x = F.relu(x)                                      # 17
        x = self.drop2(x)                                   # 18
        x = self.fc2(x)                                     # 19
        x = F.relu(x)                                      # 20
        x = self.fc3(x)                                     # 21
        x = F.log_softmax(x, dim=1)                       # 22
        #END TODO
        return x
```

[6]:
```
# Initialization of weights
def weights_init(layer_in):
  if isinstance(layer_in, nn.Linear):
    nn.init.kaiming_uniform_(layer_in.weight)
    layer_in.bias.data.fill_(0.0)
```

[7]:
```
# Main training routine
def train(epoch):
  model.train()
  # Get each
  for batch_idx, (data, target) in enumerate(train_loader):
    if torch.cuda.is_available():
      data, target = data.cuda(), target.cuda()
    data, target = Variable(data), Variable(target)
    optimizer.zero_grad()
    output = model(data)
    loss = F.cross_entropy(output, target)
    loss.backward()
    optimizer.step()
    # Store results
    if batch_idx % 10 == 0:
      print('Train Epoch: {} [{}/{}]\tLoss: {:.6f}'.format(
        epoch, batch_idx * len(data), len(train_loader.dataset), loss.item()))
```

[8]:
```
# Run on test data
def test():
  model.eval()
  test_loss = 0
```

```
  correct = 0
  for data, target in test_loader:
      if torch.cuda.is_available():
          data, target = data.cuda(), target.cuda()
      data, target = Variable(data, volatile=True), Variable(target)
      output = model(data)
      test_loss += F.cross_entropy(output, target, size_average=False).item()#␣
 ↪sum up batch loss
      pred = output.data.max(1, keepdim=True)[1]# get the index of the max␣
 ↪log-probability
      correct += pred.eq(target.data.view_as(pred)).long().cpu().sum()
  test_loss /= len(test_loader.dataset)
  correct=float(correct.to(torch.device('cpu')).numpy())
  print('\nTest set: Avg. loss: {:.4f}, Accuracy: {}/{} ({:.0f}%)\n'.format(
    test_loss, correct, len(test_loader.dataset),
    100. * correct / len(test_loader.dataset)))
```

[9]:
```
model = Net()
print(model)
if torch.cuda.is_available():
    model.cuda()
optimizer = optim.Adam(model.parameters(), lr=0.0001)
```

```
Net(
  (conv1): Conv2d(3, 64, kernel_size=(11, 11), stride=(1, 1), padding=(1, 1))
  (conv2): Conv2d(64, 128, kernel_size=(5, 5), stride=(1, 1), padding=(1, 1))
  (conv3): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv4): Conv2d(256, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv5): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (drop1): Dropout2d(p=0.5, inplace=False)
  (fc1): Linear(in_features=18432, out_features=4096, bias=True)
  (drop2): Dropout2d(p=0.5, inplace=False)
  (fc2): Linear(in_features=4096, out_features=4096, bias=True)
  (fc3): Linear(in_features=4096, out_features=10, bias=True)
)
```

[10]:
```
# Train for three epochs
n_epochs = 3
for epoch in range(1,n_epochs+1):
  train(epoch)
  test()
```

```
/usr/local/lib/python3.10/dist-packages/torch/nn/functional.py:1538:
UserWarning: dropout2d: Received a 2-D input to dropout2d, which is deprecated
and will result in an error in a future release. To retain the behavior and
silence this warning, please use dropout instead. Note that dropout2d exists to
provide channel-wise dropout on inputs with 2 spatial dimensions, a channel
dimension, and an optional batch dimension (i.e. 3D or 4D inputs).
```

```
  warnings.warn(warn_msg)
Train Epoch: 1 [0/50000]        Loss: 2.302180
Train Epoch: 1 [200/50000]      Loss: 2.309025
Train Epoch: 1 [400/50000]      Loss: 2.371207
Train Epoch: 1 [600/50000]      Loss: 2.329133
Train Epoch: 1 [800/50000]      Loss: 2.300487
Train Epoch: 1 [1000/50000]     Loss: 2.290645
Train Epoch: 1 [1200/50000]     Loss: 2.290099
Train Epoch: 1 [1400/50000]     Loss: 2.158215
Train Epoch: 1 [1600/50000]     Loss: 2.309336
Train Epoch: 1 [1800/50000]     Loss: 2.182426
Train Epoch: 1 [2000/50000]     Loss: 2.289562
Train Epoch: 1 [2200/50000]     Loss: 2.158749
Train Epoch: 1 [2400/50000]     Loss: 2.127350
Train Epoch: 1 [2600/50000]     Loss: 2.140686
Train Epoch: 1 [2800/50000]     Loss: 1.835191
Train Epoch: 1 [3000/50000]     Loss: 2.016897
Train Epoch: 1 [3200/50000]     Loss: 1.982921
Train Epoch: 1 [3400/50000]     Loss: 1.952608
Train Epoch: 1 [3600/50000]     Loss: 2.039061
Train Epoch: 1 [3800/50000]     Loss: 2.193171
Train Epoch: 1 [4000/50000]     Loss: 2.285091
Train Epoch: 1 [4200/50000]     Loss: 2.054374
Train Epoch: 1 [4400/50000]     Loss: 2.200417
Train Epoch: 1 [4600/50000]     Loss: 2.158078
Train Epoch: 1 [4800/50000]     Loss: 1.957872
Train Epoch: 1 [5000/50000]     Loss: 1.675266
Train Epoch: 1 [5200/50000]     Loss: 2.119234
Train Epoch: 1 [5400/50000]     Loss: 1.750938
Train Epoch: 1 [5600/50000]     Loss: 1.823179
Train Epoch: 1 [5800/50000]     Loss: 2.333947
Train Epoch: 1 [6000/50000]     Loss: 1.927541
Train Epoch: 1 [6200/50000]     Loss: 1.745059
Train Epoch: 1 [6400/50000]     Loss: 2.000028
Train Epoch: 1 [6600/50000]     Loss: 1.992890
Train Epoch: 1 [6800/50000]     Loss: 1.905033
Train Epoch: 1 [7000/50000]     Loss: 1.805808
Train Epoch: 1 [7200/50000]     Loss: 2.019243
Train Epoch: 1 [7400/50000]     Loss: 1.837725
Train Epoch: 1 [7600/50000]     Loss: 1.695552
Train Epoch: 1 [7800/50000]     Loss: 1.750303
Train Epoch: 1 [8000/50000]     Loss: 2.051463
Train Epoch: 1 [8200/50000]     Loss: 2.055710
Train Epoch: 1 [8400/50000]     Loss: 1.947042
Train Epoch: 1 [8600/50000]     Loss: 1.926353
Train Epoch: 1 [8800/50000]     Loss: 1.911016
Train Epoch: 1 [9000/50000]     Loss: 1.490052
```

```
Train Epoch: 1 [9200/50000]     Loss: 1.791820
Train Epoch: 1 [9400/50000]     Loss: 2.049005
Train Epoch: 1 [9600/50000]     Loss: 1.771921
Train Epoch: 1 [9800/50000]     Loss: 1.834584
Train Epoch: 1 [10000/50000]    Loss: 1.874187
Train Epoch: 1 [10200/50000]    Loss: 1.583594
Train Epoch: 1 [10400/50000]    Loss: 1.966091
Train Epoch: 1 [10600/50000]    Loss: 1.753684
Train Epoch: 1 [10800/50000]    Loss: 1.881297
Train Epoch: 1 [11000/50000]    Loss: 1.854712
Train Epoch: 1 [11200/50000]    Loss: 1.688243
Train Epoch: 1 [11400/50000]    Loss: 1.701907
Train Epoch: 1 [11600/50000]    Loss: 1.811977
Train Epoch: 1 [11800/50000]    Loss: 2.215246
Train Epoch: 1 [12000/50000]    Loss: 1.460854
Train Epoch: 1 [12200/50000]    Loss: 1.548302
Train Epoch: 1 [12400/50000]    Loss: 2.096788
Train Epoch: 1 [12600/50000]    Loss: 1.980349
Train Epoch: 1 [12800/50000]    Loss: 1.839265
Train Epoch: 1 [13000/50000]    Loss: 1.889339
Train Epoch: 1 [13200/50000]    Loss: 1.579069
Train Epoch: 1 [13400/50000]    Loss: 1.598148
Train Epoch: 1 [13600/50000]    Loss: 1.831747
Train Epoch: 1 [13800/50000]    Loss: 1.969011
Train Epoch: 1 [14000/50000]    Loss: 1.916683
Train Epoch: 1 [14200/50000]    Loss: 1.752258
Train Epoch: 1 [14400/50000]    Loss: 1.583692
Train Epoch: 1 [14600/50000]    Loss: 1.544309
Train Epoch: 1 [14800/50000]    Loss: 1.568040
Train Epoch: 1 [15000/50000]    Loss: 1.572025
Train Epoch: 1 [15200/50000]    Loss: 2.283026
Train Epoch: 1 [15400/50000]    Loss: 1.541390
Train Epoch: 1 [15600/50000]    Loss: 1.672703
Train Epoch: 1 [15800/50000]    Loss: 2.009354
Train Epoch: 1 [16000/50000]    Loss: 1.707979
Train Epoch: 1 [16200/50000]    Loss: 1.867001
Train Epoch: 1 [16400/50000]    Loss: 1.776345
Train Epoch: 1 [16600/50000]    Loss: 2.134456
Train Epoch: 1 [16800/50000]    Loss: 1.617783
Train Epoch: 1 [17000/50000]    Loss: 1.868253
Train Epoch: 1 [17200/50000]    Loss: 1.896826
Train Epoch: 1 [17400/50000]    Loss: 1.732843
Train Epoch: 1 [17600/50000]    Loss: 1.431105
Train Epoch: 1 [17800/50000]    Loss: 1.850593
Train Epoch: 1 [18000/50000]    Loss: 1.767050
Train Epoch: 1 [18200/50000]    Loss: 1.886331
Train Epoch: 1 [18400/50000]    Loss: 2.052521
Train Epoch: 1 [18600/50000]    Loss: 2.014092
```

```
Train Epoch: 1 [18800/50000]    Loss: 2.087120
Train Epoch: 1 [19000/50000]    Loss: 1.671015
Train Epoch: 1 [19200/50000]    Loss: 1.361102
Train Epoch: 1 [19400/50000]    Loss: 1.741910
Train Epoch: 1 [19600/50000]    Loss: 1.710244
Train Epoch: 1 [19800/50000]    Loss: 1.598283
Train Epoch: 1 [20000/50000]    Loss: 1.828799
Train Epoch: 1 [20200/50000]    Loss: 1.967329
Train Epoch: 1 [20400/50000]    Loss: 1.697796
Train Epoch: 1 [20600/50000]    Loss: 1.553479
Train Epoch: 1 [20800/50000]    Loss: 1.602387
Train Epoch: 1 [21000/50000]    Loss: 1.711336
Train Epoch: 1 [21200/50000]    Loss: 2.195683
Train Epoch: 1 [21400/50000]    Loss: 1.557765
Train Epoch: 1 [21600/50000]    Loss: 1.419136
Train Epoch: 1 [21800/50000]    Loss: 1.583458
Train Epoch: 1 [22000/50000]    Loss: 1.761681
Train Epoch: 1 [22200/50000]    Loss: 1.808474
Train Epoch: 1 [22400/50000]    Loss: 1.830995
Train Epoch: 1 [22600/50000]    Loss: 1.704759
Train Epoch: 1 [22800/50000]    Loss: 1.988135
Train Epoch: 1 [23000/50000]    Loss: 1.413216
Train Epoch: 1 [23200/50000]    Loss: 1.645971
Train Epoch: 1 [23400/50000]    Loss: 1.690214
Train Epoch: 1 [23600/50000]    Loss: 1.809142
Train Epoch: 1 [23800/50000]    Loss: 1.628234
Train Epoch: 1 [24000/50000]    Loss: 1.566000
Train Epoch: 1 [24200/50000]    Loss: 1.638290
Train Epoch: 1 [24400/50000]    Loss: 1.816758
Train Epoch: 1 [24600/50000]    Loss: 1.812968
Train Epoch: 1 [24800/50000]    Loss: 1.552461
Train Epoch: 1 [25000/50000]    Loss: 1.722002
Train Epoch: 1 [25200/50000]    Loss: 1.765018
Train Epoch: 1 [25400/50000]    Loss: 1.611843
Train Epoch: 1 [25600/50000]    Loss: 1.504817
Train Epoch: 1 [25800/50000]    Loss: 1.586428
Train Epoch: 1 [26000/50000]    Loss: 1.582921
Train Epoch: 1 [26200/50000]    Loss: 1.650517
Train Epoch: 1 [26400/50000]    Loss: 1.653960
Train Epoch: 1 [26600/50000]    Loss: 1.386154
Train Epoch: 1 [26800/50000]    Loss: 1.595308
Train Epoch: 1 [27000/50000]    Loss: 1.363970
Train Epoch: 1 [27200/50000]    Loss: 1.925480
Train Epoch: 1 [27400/50000]    Loss: 1.394867
Train Epoch: 1 [27600/50000]    Loss: 1.506619
Train Epoch: 1 [27800/50000]    Loss: 1.376759
Train Epoch: 1 [28000/50000]    Loss: 1.746032
Train Epoch: 1 [28200/50000]    Loss: 1.770545
```

```
Train Epoch: 1 [28400/50000]    Loss: 2.037697
Train Epoch: 1 [28600/50000]    Loss: 1.391380
Train Epoch: 1 [28800/50000]    Loss: 1.697807
Train Epoch: 1 [29000/50000]    Loss: 1.570910
Train Epoch: 1 [29200/50000]    Loss: 1.812301
Train Epoch: 1 [29400/50000]    Loss: 1.296941
Train Epoch: 1 [29600/50000]    Loss: 1.487836
Train Epoch: 1 [29800/50000]    Loss: 1.167650
Train Epoch: 1 [30000/50000]    Loss: 1.470652
Train Epoch: 1 [30200/50000]    Loss: 1.492151
Train Epoch: 1 [30400/50000]    Loss: 2.362293
Train Epoch: 1 [30600/50000]    Loss: 1.731172
Train Epoch: 1 [30800/50000]    Loss: 1.816119
Train Epoch: 1 [31000/50000]    Loss: 1.774521
Train Epoch: 1 [31200/50000]    Loss: 1.856052
Train Epoch: 1 [31400/50000]    Loss: 1.747076
Train Epoch: 1 [31600/50000]    Loss: 1.683441
Train Epoch: 1 [31800/50000]    Loss: 1.679246
Train Epoch: 1 [32000/50000]    Loss: 1.610792
Train Epoch: 1 [32200/50000]    Loss: 1.831522
Train Epoch: 1 [32400/50000]    Loss: 1.922616
Train Epoch: 1 [32600/50000]    Loss: 1.141998
Train Epoch: 1 [32800/50000]    Loss: 1.749274
Train Epoch: 1 [33000/50000]    Loss: 1.436123
Train Epoch: 1 [33200/50000]    Loss: 1.877156
Train Epoch: 1 [33400/50000]    Loss: 1.679171
Train Epoch: 1 [33600/50000]    Loss: 1.590996
Train Epoch: 1 [33800/50000]    Loss: 1.449646
Train Epoch: 1 [34000/50000]    Loss: 1.718568
Train Epoch: 1 [34200/50000]    Loss: 1.820708
Train Epoch: 1 [34400/50000]    Loss: 1.364657
Train Epoch: 1 [34600/50000]    Loss: 1.774520
Train Epoch: 1 [34800/50000]    Loss: 1.556080
Train Epoch: 1 [35000/50000]    Loss: 1.691601
Train Epoch: 1 [35200/50000]    Loss: 1.764571
Train Epoch: 1 [35400/50000]    Loss: 1.606405
Train Epoch: 1 [35600/50000]    Loss: 1.680787
Train Epoch: 1 [35800/50000]    Loss: 1.825502
Train Epoch: 1 [36000/50000]    Loss: 1.831182
Train Epoch: 1 [36200/50000]    Loss: 1.977852
Train Epoch: 1 [36400/50000]    Loss: 1.706174
Train Epoch: 1 [36600/50000]    Loss: 1.763146
Train Epoch: 1 [36800/50000]    Loss: 1.312939
Train Epoch: 1 [37000/50000]    Loss: 1.592847
Train Epoch: 1 [37200/50000]    Loss: 1.106462
Train Epoch: 1 [37400/50000]    Loss: 1.948928
Train Epoch: 1 [37600/50000]    Loss: 1.393841
Train Epoch: 1 [37800/50000]    Loss: 1.126496
```

```
Train Epoch: 1 [38000/50000]    Loss: 1.593492
Train Epoch: 1 [38200/50000]    Loss: 1.750577
Train Epoch: 1 [38400/50000]    Loss: 1.397308
Train Epoch: 1 [38600/50000]    Loss: 1.356729
Train Epoch: 1 [38800/50000]    Loss: 1.492058
Train Epoch: 1 [39000/50000]    Loss: 1.976525
Train Epoch: 1 [39200/50000]    Loss: 2.416873
Train Epoch: 1 [39400/50000]    Loss: 1.768861
Train Epoch: 1 [39600/50000]    Loss: 1.197655
Train Epoch: 1 [39800/50000]    Loss: 1.229407
Train Epoch: 1 [40000/50000]    Loss: 1.727726
Train Epoch: 1 [40200/50000]    Loss: 1.344951
Train Epoch: 1 [40400/50000]    Loss: 1.608322
Train Epoch: 1 [40600/50000]    Loss: 1.712419
Train Epoch: 1 [40800/50000]    Loss: 1.702594
Train Epoch: 1 [41000/50000]    Loss: 2.000328
Train Epoch: 1 [41200/50000]    Loss: 1.763826
Train Epoch: 1 [41400/50000]    Loss: 1.443500
Train Epoch: 1 [41600/50000]    Loss: 1.895712
Train Epoch: 1 [41800/50000]    Loss: 1.507347
Train Epoch: 1 [42000/50000]    Loss: 1.804024
Train Epoch: 1 [42200/50000]    Loss: 1.823999
Train Epoch: 1 [42400/50000]    Loss: 1.811633
Train Epoch: 1 [42600/50000]    Loss: 1.560582
Train Epoch: 1 [42800/50000]    Loss: 1.378327
Train Epoch: 1 [43000/50000]    Loss: 1.512872
Train Epoch: 1 [43200/50000]    Loss: 1.602454
Train Epoch: 1 [43400/50000]    Loss: 1.453055
Train Epoch: 1 [43600/50000]    Loss: 1.473767
Train Epoch: 1 [43800/50000]    Loss: 1.528711
Train Epoch: 1 [44000/50000]    Loss: 1.551181
Train Epoch: 1 [44200/50000]    Loss: 1.663144
Train Epoch: 1 [44400/50000]    Loss: 1.326647
Train Epoch: 1 [44600/50000]    Loss: 1.404837
Train Epoch: 1 [44800/50000]    Loss: 1.705463
Train Epoch: 1 [45000/50000]    Loss: 1.532957
Train Epoch: 1 [45200/50000]    Loss: 1.369559
Train Epoch: 1 [45400/50000]    Loss: 1.717368
Train Epoch: 1 [45600/50000]    Loss: 1.568988
Train Epoch: 1 [45800/50000]    Loss: 1.329228
Train Epoch: 1 [46000/50000]    Loss: 2.081066
Train Epoch: 1 [46200/50000]    Loss: 1.693159
Train Epoch: 1 [46400/50000]    Loss: 1.834148
Train Epoch: 1 [46600/50000]    Loss: 1.269248
Train Epoch: 1 [46800/50000]    Loss: 1.448531
Train Epoch: 1 [47000/50000]    Loss: 1.061418
Train Epoch: 1 [47200/50000]    Loss: 1.390223
Train Epoch: 1 [47400/50000]    Loss: 1.629018
```

```
Train Epoch: 1 [47600/50000]    Loss: 1.536116
Train Epoch: 1 [47800/50000]    Loss: 1.322411
Train Epoch: 1 [48000/50000]    Loss: 1.401611
Train Epoch: 1 [48200/50000]    Loss: 1.498459
Train Epoch: 1 [48400/50000]    Loss: 1.438830
Train Epoch: 1 [48600/50000]    Loss: 1.272395
Train Epoch: 1 [48800/50000]    Loss: 1.485327
Train Epoch: 1 [49000/50000]    Loss: 1.861872
Train Epoch: 1 [49200/50000]    Loss: 1.724803
Train Epoch: 1 [49400/50000]    Loss: 1.434844
Train Epoch: 1 [49600/50000]    Loss: 1.394900
Train Epoch: 1 [49800/50000]    Loss: 1.975153

<ipython-input-8-0b1ccd3c1330>:9: UserWarning: volatile was removed and now has
no effect. Use `with torch.no_grad():` instead.
  data, target = Variable(data, volatile=True), Variable(target)
/usr/local/lib/python3.10/dist-packages/torch/nn/_reduction.py:51: UserWarning:
size_average and reduce args will be deprecated, please use reduction='sum'
instead.
  warnings.warn(warning.format(ret))


Test set: Avg. loss: 1.5343, Accuracy: 4381.0/10000 (44%)

Train Epoch: 2 [0/50000]        Loss: 1.765718
Train Epoch: 2 [200/50000]      Loss: 1.432773
Train Epoch: 2 [400/50000]      Loss: 1.279602
Train Epoch: 2 [600/50000]      Loss: 1.418874
Train Epoch: 2 [800/50000]      Loss: 1.685287
Train Epoch: 2 [1000/50000]     Loss: 1.502149
Train Epoch: 2 [1200/50000]     Loss: 1.423574
Train Epoch: 2 [1400/50000]     Loss: 1.379793
Train Epoch: 2 [1600/50000]     Loss: 1.801830
Train Epoch: 2 [1800/50000]     Loss: 1.204981
Train Epoch: 2 [2000/50000]     Loss: 1.249524
Train Epoch: 2 [2200/50000]     Loss: 1.177025
Train Epoch: 2 [2400/50000]     Loss: 1.453322
Train Epoch: 2 [2600/50000]     Loss: 1.312431
Train Epoch: 2 [2800/50000]     Loss: 1.399197
Train Epoch: 2 [3000/50000]     Loss: 1.585746
Train Epoch: 2 [3200/50000]     Loss: 1.467619
Train Epoch: 2 [3400/50000]     Loss: 1.781183
Train Epoch: 2 [3600/50000]     Loss: 1.348298
Train Epoch: 2 [3800/50000]     Loss: 1.335227
Train Epoch: 2 [4000/50000]     Loss: 1.343191
Train Epoch: 2 [4200/50000]     Loss: 1.343863
Train Epoch: 2 [4400/50000]     Loss: 1.677262
Train Epoch: 2 [4600/50000]     Loss: 1.346333
Train Epoch: 2 [4800/50000]     Loss: 1.457752
```

```
Train Epoch: 2 [5000/50000]     Loss: 1.682343
Train Epoch: 2 [5200/50000]     Loss: 1.683763
Train Epoch: 2 [5400/50000]     Loss: 1.637594
Train Epoch: 2 [5600/50000]     Loss: 1.149499
Train Epoch: 2 [5800/50000]     Loss: 1.866484
Train Epoch: 2 [6000/50000]     Loss: 1.387991
Train Epoch: 2 [6200/50000]     Loss: 1.693689
Train Epoch: 2 [6400/50000]     Loss: 1.859394
Train Epoch: 2 [6600/50000]     Loss: 1.921118
Train Epoch: 2 [6800/50000]     Loss: 1.448368
Train Epoch: 2 [7000/50000]     Loss: 1.797489
Train Epoch: 2 [7200/50000]     Loss: 1.603557
Train Epoch: 2 [7400/50000]     Loss: 1.383013
Train Epoch: 2 [7600/50000]     Loss: 1.431422
Train Epoch: 2 [7800/50000]     Loss: 1.025861
Train Epoch: 2 [8000/50000]     Loss: 1.725158
Train Epoch: 2 [8200/50000]     Loss: 1.183416
Train Epoch: 2 [8400/50000]     Loss: 1.544997
Train Epoch: 2 [8600/50000]     Loss: 1.346455
Train Epoch: 2 [8800/50000]     Loss: 1.614474
Train Epoch: 2 [9000/50000]     Loss: 1.672877
Train Epoch: 2 [9200/50000]     Loss: 1.656845
Train Epoch: 2 [9400/50000]     Loss: 1.419840
Train Epoch: 2 [9600/50000]     Loss: 1.333963
Train Epoch: 2 [9800/50000]     Loss: 1.364203
Train Epoch: 2 [10000/50000]    Loss: 1.288690
Train Epoch: 2 [10200/50000]    Loss: 1.803220
Train Epoch: 2 [10400/50000]    Loss: 1.377183
Train Epoch: 2 [10600/50000]    Loss: 1.510136
Train Epoch: 2 [10800/50000]    Loss: 1.248065
Train Epoch: 2 [11000/50000]    Loss: 1.347719
Train Epoch: 2 [11200/50000]    Loss: 1.295193
Train Epoch: 2 [11400/50000]    Loss: 1.510260
Train Epoch: 2 [11600/50000]    Loss: 1.466982
Train Epoch: 2 [11800/50000]    Loss: 1.386983
Train Epoch: 2 [12000/50000]    Loss: 1.665751
Train Epoch: 2 [12200/50000]    Loss: 1.198521
Train Epoch: 2 [12400/50000]    Loss: 1.917272
Train Epoch: 2 [12600/50000]    Loss: 1.250519
Train Epoch: 2 [12800/50000]    Loss: 2.016233
Train Epoch: 2 [13000/50000]    Loss: 1.520307
Train Epoch: 2 [13200/50000]    Loss: 1.318458
Train Epoch: 2 [13400/50000]    Loss: 1.387304
Train Epoch: 2 [13600/50000]    Loss: 1.453424
Train Epoch: 2 [13800/50000]    Loss: 1.415397
Train Epoch: 2 [14000/50000]    Loss: 1.511270
Train Epoch: 2 [14200/50000]    Loss: 1.931052
Train Epoch: 2 [14400/50000]    Loss: 1.852628
```

```
Train Epoch: 2 [14600/50000]    Loss: 1.382213
Train Epoch: 2 [14800/50000]    Loss: 1.702558
Train Epoch: 2 [15000/50000]    Loss: 1.318324
Train Epoch: 2 [15200/50000]    Loss: 1.431095
Train Epoch: 2 [15400/50000]    Loss: 2.024039
Train Epoch: 2 [15600/50000]    Loss: 1.384503
Train Epoch: 2 [15800/50000]    Loss: 1.308640
Train Epoch: 2 [16000/50000]    Loss: 1.041248
Train Epoch: 2 [16200/50000]    Loss: 1.567633
Train Epoch: 2 [16400/50000]    Loss: 1.757187
Train Epoch: 2 [16600/50000]    Loss: 1.448416
Train Epoch: 2 [16800/50000]    Loss: 1.839238
Train Epoch: 2 [17000/50000]    Loss: 1.465809
Train Epoch: 2 [17200/50000]    Loss: 1.288408
Train Epoch: 2 [17400/50000]    Loss: 1.329578
Train Epoch: 2 [17600/50000]    Loss: 1.532949
Train Epoch: 2 [17800/50000]    Loss: 1.383655
Train Epoch: 2 [18000/50000]    Loss: 1.624876
Train Epoch: 2 [18200/50000]    Loss: 1.480403
Train Epoch: 2 [18400/50000]    Loss: 1.623586
Train Epoch: 2 [18600/50000]    Loss: 1.140751
Train Epoch: 2 [18800/50000]    Loss: 1.334562
Train Epoch: 2 [19000/50000]    Loss: 1.188268
Train Epoch: 2 [19200/50000]    Loss: 1.777593
Train Epoch: 2 [19400/50000]    Loss: 1.774850
Train Epoch: 2 [19600/50000]    Loss: 1.418212
Train Epoch: 2 [19800/50000]    Loss: 1.815265
Train Epoch: 2 [20000/50000]    Loss: 1.365153
Train Epoch: 2 [20200/50000]    Loss: 1.022211
Train Epoch: 2 [20400/50000]    Loss: 1.481873
Train Epoch: 2 [20600/50000]    Loss: 1.386383
Train Epoch: 2 [20800/50000]    Loss: 1.746495
Train Epoch: 2 [21000/50000]    Loss: 1.713032
Train Epoch: 2 [21200/50000]    Loss: 1.176581
Train Epoch: 2 [21400/50000]    Loss: 1.475500
Train Epoch: 2 [21600/50000]    Loss: 1.288423
Train Epoch: 2 [21800/50000]    Loss: 1.371141
Train Epoch: 2 [22000/50000]    Loss: 1.460462
Train Epoch: 2 [22200/50000]    Loss: 1.194931
Train Epoch: 2 [22400/50000]    Loss: 1.587610
Train Epoch: 2 [22600/50000]    Loss: 1.782650
Train Epoch: 2 [22800/50000]    Loss: 1.227513
Train Epoch: 2 [23000/50000]    Loss: 1.265689
Train Epoch: 2 [23200/50000]    Loss: 1.005846
Train Epoch: 2 [23400/50000]    Loss: 1.531873
Train Epoch: 2 [23600/50000]    Loss: 1.215380
Train Epoch: 2 [23800/50000]    Loss: 0.980950
Train Epoch: 2 [24000/50000]    Loss: 1.265113
```

```
Train Epoch: 2 [24200/50000]    Loss: 1.116889
Train Epoch: 2 [24400/50000]    Loss: 1.461587
Train Epoch: 2 [24600/50000]    Loss: 1.470443
Train Epoch: 2 [24800/50000]    Loss: 1.513249
Train Epoch: 2 [25000/50000]    Loss: 1.552528
Train Epoch: 2 [25200/50000]    Loss: 1.787337
Train Epoch: 2 [25400/50000]    Loss: 1.386449
Train Epoch: 2 [25600/50000]    Loss: 1.425062
Train Epoch: 2 [25800/50000]    Loss: 1.392151
Train Epoch: 2 [26000/50000]    Loss: 1.129966
Train Epoch: 2 [26200/50000]    Loss: 1.731020
Train Epoch: 2 [26400/50000]    Loss: 1.940010
Train Epoch: 2 [26600/50000]    Loss: 1.642434
Train Epoch: 2 [26800/50000]    Loss: 1.636373
Train Epoch: 2 [27000/50000]    Loss: 1.341206
Train Epoch: 2 [27200/50000]    Loss: 1.701372
Train Epoch: 2 [27400/50000]    Loss: 1.565317
Train Epoch: 2 [27600/50000]    Loss: 1.368845
Train Epoch: 2 [27800/50000]    Loss: 1.461383
Train Epoch: 2 [28000/50000]    Loss: 1.159498
Train Epoch: 2 [28200/50000]    Loss: 1.566265
Train Epoch: 2 [28400/50000]    Loss: 1.433927
Train Epoch: 2 [28600/50000]    Loss: 1.161101
Train Epoch: 2 [28800/50000]    Loss: 1.587091
Train Epoch: 2 [29000/50000]    Loss: 1.646183
Train Epoch: 2 [29200/50000]    Loss: 1.411427
Train Epoch: 2 [29400/50000]    Loss: 1.505025
Train Epoch: 2 [29600/50000]    Loss: 1.163142
Train Epoch: 2 [29800/50000]    Loss: 1.005440
Train Epoch: 2 [30000/50000]    Loss: 1.747907
Train Epoch: 2 [30200/50000]    Loss: 1.518479
Train Epoch: 2 [30400/50000]    Loss: 1.003065
Train Epoch: 2 [30600/50000]    Loss: 1.399374
Train Epoch: 2 [30800/50000]    Loss: 1.200723
Train Epoch: 2 [31000/50000]    Loss: 1.432340
Train Epoch: 2 [31200/50000]    Loss: 1.662041
Train Epoch: 2 [31400/50000]    Loss: 2.039534
Train Epoch: 2 [31600/50000]    Loss: 1.025113
Train Epoch: 2 [31800/50000]    Loss: 1.568120
Train Epoch: 2 [32000/50000]    Loss: 1.594388
Train Epoch: 2 [32200/50000]    Loss: 1.527692
Train Epoch: 2 [32400/50000]    Loss: 1.440124
Train Epoch: 2 [32600/50000]    Loss: 1.207371
Train Epoch: 2 [32800/50000]    Loss: 1.452210
Train Epoch: 2 [33000/50000]    Loss: 1.373812
Train Epoch: 2 [33200/50000]    Loss: 1.360713
Train Epoch: 2 [33400/50000]    Loss: 1.340413
Train Epoch: 2 [33600/50000]    Loss: 1.236745
```

```
Train Epoch: 2 [33800/50000]    Loss: 1.329515
Train Epoch: 2 [34000/50000]    Loss: 1.146669
Train Epoch: 2 [34200/50000]    Loss: 1.333332
Train Epoch: 2 [34400/50000]    Loss: 1.466129
Train Epoch: 2 [34600/50000]    Loss: 1.501480
Train Epoch: 2 [34800/50000]    Loss: 1.465412
Train Epoch: 2 [35000/50000]    Loss: 1.239793
Train Epoch: 2 [35200/50000]    Loss: 1.867796
Train Epoch: 2 [35400/50000]    Loss: 1.181941
Train Epoch: 2 [35600/50000]    Loss: 1.499366
Train Epoch: 2 [35800/50000]    Loss: 1.393101
Train Epoch: 2 [36000/50000]    Loss: 1.289967
Train Epoch: 2 [36200/50000]    Loss: 1.005839
Train Epoch: 2 [36400/50000]    Loss: 1.935139
Train Epoch: 2 [36600/50000]    Loss: 1.310736
Train Epoch: 2 [36800/50000]    Loss: 1.034869
Train Epoch: 2 [37000/50000]    Loss: 1.013356
Train Epoch: 2 [37200/50000]    Loss: 1.844029
Train Epoch: 2 [37400/50000]    Loss: 1.092797
Train Epoch: 2 [37600/50000]    Loss: 1.529908
Train Epoch: 2 [37800/50000]    Loss: 1.745865
Train Epoch: 2 [38000/50000]    Loss: 1.316756
Train Epoch: 2 [38200/50000]    Loss: 1.560919
Train Epoch: 2 [38400/50000]    Loss: 1.641968
Train Epoch: 2 [38600/50000]    Loss: 1.507075
Train Epoch: 2 [38800/50000]    Loss: 1.249846
Train Epoch: 2 [39000/50000]    Loss: 1.217809
Train Epoch: 2 [39200/50000]    Loss: 1.786787
Train Epoch: 2 [39400/50000]    Loss: 1.690722
Train Epoch: 2 [39600/50000]    Loss: 1.270418
Train Epoch: 2 [39800/50000]    Loss: 1.459431
Train Epoch: 2 [40000/50000]    Loss: 1.444552
Train Epoch: 2 [40200/50000]    Loss: 1.337847
Train Epoch: 2 [40400/50000]    Loss: 1.436642
Train Epoch: 2 [40600/50000]    Loss: 1.646763
Train Epoch: 2 [40800/50000]    Loss: 1.414485
Train Epoch: 2 [41000/50000]    Loss: 1.114250
Train Epoch: 2 [41200/50000]    Loss: 1.132757
Train Epoch: 2 [41400/50000]    Loss: 1.248255
Train Epoch: 2 [41600/50000]    Loss: 1.330506
Train Epoch: 2 [41800/50000]    Loss: 1.217092
Train Epoch: 2 [42000/50000]    Loss: 1.436601
Train Epoch: 2 [42200/50000]    Loss: 0.974084
Train Epoch: 2 [42400/50000]    Loss: 1.097423
Train Epoch: 2 [42600/50000]    Loss: 1.433440
Train Epoch: 2 [42800/50000]    Loss: 1.452808
Train Epoch: 2 [43000/50000]    Loss: 1.592219
Train Epoch: 2 [43200/50000]    Loss: 1.617077
```

```
Train Epoch: 2 [43400/50000]    Loss: 1.713598
Train Epoch: 2 [43600/50000]    Loss: 1.442775
Train Epoch: 2 [43800/50000]    Loss: 1.558097
Train Epoch: 2 [44000/50000]    Loss: 1.374522
Train Epoch: 2 [44200/50000]    Loss: 1.067635
Train Epoch: 2 [44400/50000]    Loss: 1.566194
Train Epoch: 2 [44600/50000]    Loss: 0.976000
Train Epoch: 2 [44800/50000]    Loss: 1.249800
Train Epoch: 2 [45000/50000]    Loss: 1.287750
Train Epoch: 2 [45200/50000]    Loss: 1.672569
Train Epoch: 2 [45400/50000]    Loss: 1.007378
Train Epoch: 2 [45600/50000]    Loss: 1.362506
Train Epoch: 2 [45800/50000]    Loss: 1.405588
Train Epoch: 2 [46000/50000]    Loss: 1.457147
Train Epoch: 2 [46200/50000]    Loss: 1.584711
Train Epoch: 2 [46400/50000]    Loss: 1.474437
Train Epoch: 2 [46600/50000]    Loss: 1.397152
Train Epoch: 2 [46800/50000]    Loss: 1.164692
Train Epoch: 2 [47000/50000]    Loss: 1.048562
Train Epoch: 2 [47200/50000]    Loss: 1.092097
Train Epoch: 2 [47400/50000]    Loss: 1.179286
Train Epoch: 2 [47600/50000]    Loss: 1.448136
Train Epoch: 2 [47800/50000]    Loss: 1.368495
Train Epoch: 2 [48000/50000]    Loss: 0.998338
Train Epoch: 2 [48200/50000]    Loss: 1.356710
Train Epoch: 2 [48400/50000]    Loss: 1.384957
Train Epoch: 2 [48600/50000]    Loss: 1.077582
Train Epoch: 2 [48800/50000]    Loss: 1.489943
Train Epoch: 2 [49000/50000]    Loss: 1.433128
Train Epoch: 2 [49200/50000]    Loss: 1.164564
Train Epoch: 2 [49400/50000]    Loss: 1.495977
Train Epoch: 2 [49600/50000]    Loss: 1.052173
Train Epoch: 2 [49800/50000]    Loss: 1.668420

Test set: Avg. loss: 1.3591, Accuracy: 5152.0/10000 (52%)

Train Epoch: 3 [0/50000]        Loss: 1.171126
Train Epoch: 3 [200/50000]      Loss: 1.156042
Train Epoch: 3 [400/50000]      Loss: 1.415813
Train Epoch: 3 [600/50000]      Loss: 1.093082
Train Epoch: 3 [800/50000]      Loss: 1.312788
Train Epoch: 3 [1000/50000]     Loss: 1.073560
Train Epoch: 3 [1200/50000]     Loss: 0.872142
Train Epoch: 3 [1400/50000]     Loss: 1.440896
Train Epoch: 3 [1600/50000]     Loss: 1.457370
Train Epoch: 3 [1800/50000]     Loss: 1.471476
Train Epoch: 3 [2000/50000]     Loss: 1.532866
Train Epoch: 3 [2200/50000]     Loss: 1.212602
```

```
Train Epoch: 3 [2400/50000]     Loss: 1.042121
Train Epoch: 3 [2600/50000]     Loss: 1.105261
Train Epoch: 3 [2800/50000]     Loss: 1.324717
Train Epoch: 3 [3000/50000]     Loss: 1.219795
Train Epoch: 3 [3200/50000]     Loss: 1.098103
Train Epoch: 3 [3400/50000]     Loss: 1.195775
Train Epoch: 3 [3600/50000]     Loss: 1.764443
Train Epoch: 3 [3800/50000]     Loss: 1.282875
Train Epoch: 3 [4000/50000]     Loss: 0.959041
Train Epoch: 3 [4200/50000]     Loss: 1.560283
Train Epoch: 3 [4400/50000]     Loss: 0.949174
Train Epoch: 3 [4600/50000]     Loss: 1.803157
Train Epoch: 3 [4800/50000]     Loss: 1.521549
Train Epoch: 3 [5000/50000]     Loss: 1.265459
Train Epoch: 3 [5200/50000]     Loss: 1.212103
Train Epoch: 3 [5400/50000]     Loss: 1.131354
Train Epoch: 3 [5600/50000]     Loss: 1.376782
Train Epoch: 3 [5800/50000]     Loss: 1.335041
Train Epoch: 3 [6000/50000]     Loss: 1.594922
Train Epoch: 3 [6200/50000]     Loss: 1.267957
Train Epoch: 3 [6400/50000]     Loss: 1.309189
Train Epoch: 3 [6600/50000]     Loss: 0.819902
Train Epoch: 3 [6800/50000]     Loss: 1.125907
Train Epoch: 3 [7000/50000]     Loss: 1.603648
Train Epoch: 3 [7200/50000]     Loss: 1.218538
Train Epoch: 3 [7400/50000]     Loss: 1.347606
Train Epoch: 3 [7600/50000]     Loss: 1.519285
Train Epoch: 3 [7800/50000]     Loss: 1.717982
Train Epoch: 3 [8000/50000]     Loss: 1.769067
Train Epoch: 3 [8200/50000]     Loss: 0.985532
Train Epoch: 3 [8400/50000]     Loss: 1.332297
Train Epoch: 3 [8600/50000]     Loss: 1.519214
Train Epoch: 3 [8800/50000]     Loss: 0.984045
Train Epoch: 3 [9000/50000]     Loss: 1.337943
Train Epoch: 3 [9200/50000]     Loss: 1.285210
Train Epoch: 3 [9400/50000]     Loss: 1.211105
Train Epoch: 3 [9600/50000]     Loss: 1.161159
Train Epoch: 3 [9800/50000]     Loss: 1.354351
Train Epoch: 3 [10000/50000]    Loss: 1.366805
Train Epoch: 3 [10200/50000]    Loss: 1.198770
Train Epoch: 3 [10400/50000]    Loss: 1.345309
Train Epoch: 3 [10600/50000]    Loss: 1.262893
Train Epoch: 3 [10800/50000]    Loss: 1.342252
Train Epoch: 3 [11000/50000]    Loss: 1.602824
Train Epoch: 3 [11200/50000]    Loss: 1.349512
Train Epoch: 3 [11400/50000]    Loss: 1.012097
Train Epoch: 3 [11600/50000]    Loss: 0.909547
Train Epoch: 3 [11800/50000]    Loss: 1.108759
```

```
Train Epoch: 3 [12000/50000]    Loss: 1.275902
Train Epoch: 3 [12200/50000]    Loss: 1.420765
Train Epoch: 3 [12400/50000]    Loss: 1.576018
Train Epoch: 3 [12600/50000]    Loss: 1.369738
Train Epoch: 3 [12800/50000]    Loss: 1.207162
Train Epoch: 3 [13000/50000]    Loss: 1.119178
Train Epoch: 3 [13200/50000]    Loss: 1.553887
Train Epoch: 3 [13400/50000]    Loss: 1.474203
Train Epoch: 3 [13600/50000]    Loss: 1.514876
Train Epoch: 3 [13800/50000]    Loss: 1.067212
Train Epoch: 3 [14000/50000]    Loss: 1.256886
Train Epoch: 3 [14200/50000]    Loss: 1.163221
Train Epoch: 3 [14400/50000]    Loss: 1.295029
Train Epoch: 3 [14600/50000]    Loss: 2.194099
Train Epoch: 3 [14800/50000]    Loss: 1.053339
Train Epoch: 3 [15000/50000]    Loss: 1.021728
Train Epoch: 3 [15200/50000]    Loss: 1.152430
Train Epoch: 3 [15400/50000]    Loss: 1.187379
Train Epoch: 3 [15600/50000]    Loss: 1.675063
Train Epoch: 3 [15800/50000]    Loss: 1.141747
Train Epoch: 3 [16000/50000]    Loss: 1.839003
Train Epoch: 3 [16200/50000]    Loss: 1.372667
Train Epoch: 3 [16400/50000]    Loss: 1.649345
Train Epoch: 3 [16600/50000]    Loss: 1.187612
Train Epoch: 3 [16800/50000]    Loss: 1.562293
Train Epoch: 3 [17000/50000]    Loss: 1.322756
Train Epoch: 3 [17200/50000]    Loss: 1.098176
Train Epoch: 3 [17400/50000]    Loss: 1.366824
Train Epoch: 3 [17600/50000]    Loss: 1.410633
Train Epoch: 3 [17800/50000]    Loss: 1.425097
Train Epoch: 3 [18000/50000]    Loss: 0.986892
Train Epoch: 3 [18200/50000]    Loss: 1.230114
Train Epoch: 3 [18400/50000]    Loss: 1.172824
Train Epoch: 3 [18600/50000]    Loss: 1.303093
Train Epoch: 3 [18800/50000]    Loss: 1.039935
Train Epoch: 3 [19000/50000]    Loss: 1.302238
Train Epoch: 3 [19200/50000]    Loss: 1.239028
Train Epoch: 3 [19400/50000]    Loss: 1.193345
Train Epoch: 3 [19600/50000]    Loss: 1.117305
Train Epoch: 3 [19800/50000]    Loss: 1.903698
Train Epoch: 3 [20000/50000]    Loss: 1.377869
Train Epoch: 3 [20200/50000]    Loss: 1.152749
Train Epoch: 3 [20400/50000]    Loss: 1.127526
Train Epoch: 3 [20600/50000]    Loss: 1.178190
Train Epoch: 3 [20800/50000]    Loss: 1.404651
Train Epoch: 3 [21000/50000]    Loss: 1.153566
Train Epoch: 3 [21200/50000]    Loss: 1.309543
Train Epoch: 3 [21400/50000]    Loss: 1.275720
```

```
Train Epoch: 3 [21600/50000]    Loss: 1.027284
Train Epoch: 3 [21800/50000]    Loss: 1.382176
Train Epoch: 3 [22000/50000]    Loss: 1.552153
Train Epoch: 3 [22200/50000]    Loss: 1.176721
Train Epoch: 3 [22400/50000]    Loss: 1.303074
Train Epoch: 3 [22600/50000]    Loss: 1.136546
Train Epoch: 3 [22800/50000]    Loss: 1.101057
Train Epoch: 3 [23000/50000]    Loss: 1.513383
Train Epoch: 3 [23200/50000]    Loss: 1.476781
Train Epoch: 3 [23400/50000]    Loss: 1.213918
Train Epoch: 3 [23600/50000]    Loss: 1.228479
Train Epoch: 3 [23800/50000]    Loss: 1.306133
Train Epoch: 3 [24000/50000]    Loss: 1.618488
Train Epoch: 3 [24200/50000]    Loss: 1.614441
Train Epoch: 3 [24400/50000]    Loss: 1.111070
Train Epoch: 3 [24600/50000]    Loss: 1.274446
Train Epoch: 3 [24800/50000]    Loss: 1.306512
Train Epoch: 3 [25000/50000]    Loss: 0.980109
Train Epoch: 3 [25200/50000]    Loss: 1.244223
Train Epoch: 3 [25400/50000]    Loss: 1.022991
Train Epoch: 3 [25600/50000]    Loss: 1.769106
Train Epoch: 3 [25800/50000]    Loss: 1.214433
Train Epoch: 3 [26000/50000]    Loss: 1.207215
Train Epoch: 3 [26200/50000]    Loss: 1.291693
Train Epoch: 3 [26400/50000]    Loss: 1.612241
Train Epoch: 3 [26600/50000]    Loss: 1.245016
Train Epoch: 3 [26800/50000]    Loss: 1.175517
Train Epoch: 3 [27000/50000]    Loss: 1.261691
Train Epoch: 3 [27200/50000]    Loss: 0.798384
Train Epoch: 3 [27400/50000]    Loss: 1.711096
Train Epoch: 3 [27600/50000]    Loss: 1.045145
Train Epoch: 3 [27800/50000]    Loss: 1.792833
Train Epoch: 3 [28000/50000]    Loss: 0.926698
Train Epoch: 3 [28200/50000]    Loss: 1.373145
Train Epoch: 3 [28400/50000]    Loss: 1.107326
Train Epoch: 3 [28600/50000]    Loss: 1.374780
Train Epoch: 3 [28800/50000]    Loss: 1.302688
Train Epoch: 3 [29000/50000]    Loss: 1.073904
Train Epoch: 3 [29200/50000]    Loss: 1.257625
Train Epoch: 3 [29400/50000]    Loss: 1.278140
Train Epoch: 3 [29600/50000]    Loss: 1.218510
Train Epoch: 3 [29800/50000]    Loss: 1.809391
Train Epoch: 3 [30000/50000]    Loss: 1.201155
Train Epoch: 3 [30200/50000]    Loss: 0.881054
Train Epoch: 3 [30400/50000]    Loss: 1.732926
Train Epoch: 3 [30600/50000]    Loss: 1.067984
Train Epoch: 3 [30800/50000]    Loss: 1.170325
Train Epoch: 3 [31000/50000]    Loss: 1.601407
```

```
Train Epoch: 3 [31200/50000]    Loss: 1.307364
Train Epoch: 3 [31400/50000]    Loss: 1.457881
Train Epoch: 3 [31600/50000]    Loss: 1.100493
Train Epoch: 3 [31800/50000]    Loss: 1.025366
Train Epoch: 3 [32000/50000]    Loss: 1.215972
Train Epoch: 3 [32200/50000]    Loss: 1.258811
Train Epoch: 3 [32400/50000]    Loss: 1.023242
Train Epoch: 3 [32600/50000]    Loss: 1.447613
Train Epoch: 3 [32800/50000]    Loss: 1.331040
Train Epoch: 3 [33000/50000]    Loss: 1.374605
Train Epoch: 3 [33200/50000]    Loss: 1.426011
Train Epoch: 3 [33400/50000]    Loss: 1.189231
Train Epoch: 3 [33600/50000]    Loss: 1.754214
Train Epoch: 3 [33800/50000]    Loss: 1.247042
Train Epoch: 3 [34000/50000]    Loss: 0.977893
Train Epoch: 3 [34200/50000]    Loss: 1.226128
Train Epoch: 3 [34400/50000]    Loss: 1.382878
Train Epoch: 3 [34600/50000]    Loss: 1.001381
Train Epoch: 3 [34800/50000]    Loss: 1.370764
Train Epoch: 3 [35000/50000]    Loss: 1.590565
Train Epoch: 3 [35200/50000]    Loss: 1.071483
Train Epoch: 3 [35400/50000]    Loss: 0.868687
Train Epoch: 3 [35600/50000]    Loss: 1.330672
Train Epoch: 3 [35800/50000]    Loss: 1.628823
Train Epoch: 3 [36000/50000]    Loss: 1.200699
Train Epoch: 3 [36200/50000]    Loss: 0.869714
Train Epoch: 3 [36400/50000]    Loss: 1.290348
Train Epoch: 3 [36600/50000]    Loss: 1.050940
Train Epoch: 3 [36800/50000]    Loss: 0.959955
Train Epoch: 3 [37000/50000]    Loss: 1.118724
Train Epoch: 3 [37200/50000]    Loss: 0.884366
Train Epoch: 3 [37400/50000]    Loss: 1.472360
Train Epoch: 3 [37600/50000]    Loss: 0.994365
Train Epoch: 3 [37800/50000]    Loss: 1.221806
Train Epoch: 3 [38000/50000]    Loss: 1.312436
Train Epoch: 3 [38200/50000]    Loss: 0.808991
Train Epoch: 3 [38400/50000]    Loss: 1.156035
Train Epoch: 3 [38600/50000]    Loss: 1.195368
Train Epoch: 3 [38800/50000]    Loss: 1.415133
Train Epoch: 3 [39000/50000]    Loss: 1.009832
Train Epoch: 3 [39200/50000]    Loss: 0.928769
Train Epoch: 3 [39400/50000]    Loss: 0.918929
Train Epoch: 3 [39600/50000]    Loss: 0.957790
Train Epoch: 3 [39800/50000]    Loss: 1.228335
Train Epoch: 3 [40000/50000]    Loss: 1.166245
Train Epoch: 3 [40200/50000]    Loss: 1.223456
Train Epoch: 3 [40400/50000]    Loss: 1.193135
Train Epoch: 3 [40600/50000]    Loss: 1.565855
```

```
Train Epoch: 3 [40800/50000]    Loss: 1.357948
Train Epoch: 3 [41000/50000]    Loss: 1.420452
Train Epoch: 3 [41200/50000]    Loss: 1.227505
Train Epoch: 3 [41400/50000]    Loss: 1.258622
Train Epoch: 3 [41600/50000]    Loss: 1.363699
Train Epoch: 3 [41800/50000]    Loss: 1.096670
Train Epoch: 3 [42000/50000]    Loss: 0.996868
Train Epoch: 3 [42200/50000]    Loss: 1.581223
Train Epoch: 3 [42400/50000]    Loss: 1.330928
Train Epoch: 3 [42600/50000]    Loss: 1.540003
Train Epoch: 3 [42800/50000]    Loss: 1.215364
Train Epoch: 3 [43000/50000]    Loss: 1.060982
Train Epoch: 3 [43200/50000]    Loss: 0.975498
Train Epoch: 3 [43400/50000]    Loss: 1.079756
Train Epoch: 3 [43600/50000]    Loss: 1.132775
Train Epoch: 3 [43800/50000]    Loss: 1.276749
Train Epoch: 3 [44000/50000]    Loss: 2.001158
Train Epoch: 3 [44200/50000]    Loss: 1.263069
Train Epoch: 3 [44400/50000]    Loss: 1.033107
Train Epoch: 3 [44600/50000]    Loss: 1.247164
Train Epoch: 3 [44800/50000]    Loss: 1.661152
Train Epoch: 3 [45000/50000]    Loss: 1.485455
Train Epoch: 3 [45200/50000]    Loss: 1.597025
Train Epoch: 3 [45400/50000]    Loss: 1.222135
Train Epoch: 3 [45600/50000]    Loss: 1.173325
Train Epoch: 3 [45800/50000]    Loss: 1.054304
Train Epoch: 3 [46000/50000]    Loss: 1.130157
Train Epoch: 3 [46200/50000]    Loss: 1.452874
Train Epoch: 3 [46400/50000]    Loss: 1.906715
Train Epoch: 3 [46600/50000]    Loss: 1.018249
Train Epoch: 3 [46800/50000]    Loss: 1.109064
Train Epoch: 3 [47000/50000]    Loss: 1.233594
Train Epoch: 3 [47200/50000]    Loss: 1.552159
Train Epoch: 3 [47400/50000]    Loss: 1.283309
Train Epoch: 3 [47600/50000]    Loss: 1.072379
Train Epoch: 3 [47800/50000]    Loss: 1.044450
Train Epoch: 3 [48000/50000]    Loss: 1.644084
Train Epoch: 3 [48200/50000]    Loss: 1.177352
Train Epoch: 3 [48400/50000]    Loss: 1.051910
Train Epoch: 3 [48600/50000]    Loss: 1.400093
Train Epoch: 3 [48800/50000]    Loss: 1.408085
Train Epoch: 3 [49000/50000]    Loss: 1.247257
Train Epoch: 3 [49200/50000]    Loss: 1.178069
Train Epoch: 3 [49400/50000]    Loss: 1.447533
Train Epoch: 3 [49600/50000]    Loss: 0.987127
Train Epoch: 3 [49800/50000]    Loss: 1.060122

Test set: Avg. loss: 1.2111, Accuracy: 5599.0/10000 (56%)
```

[11]:
```
# Run network on data we got before and show predictions
examples = enumerate(test_loader)
batch_idx, (example_data, example_target) = next(examples)
if torch.cuda.is_available():
  example_data, example_target = example_data.cuda(), example_target.cuda()
example_data, example_target = Variable(example_data, volatile=True),␣
 ↪Variable(example_target)
output = model(example_data)

def imshow(img):    # unnormalize
    npimg = img.cpu().numpy()
    plt.imshow(np.transpose(npimg, (1, 2, 0)))
    plt.show()

# show images
imshow(torchvision.utils.make_grid(example_data[:10,:]))
# print labels
print(' '.join('%5s' % classes[example_targets[j]] for j in range(10)))
```

```
<ipython-input-11-3adadbd67f9a>:6: UserWarning: volatile was removed and now has
no effect. Use `with torch.no_grad():` instead.
  example_data, example_target = Variable(example_data, volatile=True),
Variable(example_target)
```


```
Truck Airplane  Bird  Frog Horse   Cat Airplane  Frog   Cat   Car
```

5 Q2: TODO [30 Points]

After being done with AlexNet, Let's do the same thing on VGGNet.

if you don't know what VGG is, don't worry. This lab doesn't require the background of it. Its just an architecture and we are implementing it.

Here is VGGNet Architecture:

1. A convolution with kernel size 3, 3 input channels, 64 output channels and padding 1
2. A Relu
3. A valid convolution with kernel size 3, padding 1 and 64 output channels
4. A Relu
5. A max pooling operation with kernel size 2 and stride 2
6. A valid convolution with kernel size 3, padding 1 and 128 output channels
7. A Relu
8. A valid convolution with kernel size 3, padding 1 and 128 4output channels
9. A Relu
10. A max pooling operation with kernel size 2 and stride 2
11. A valid convolution with kernel size 3, padding 1 and 256 output channels
12. A Relu
13. A valid convolution with kernel size 3, padding 1 and 256 output channels
14. A Relu
15. A valid convolution with kernel size 3, padding 1 and 256 output channels
16. A Relu
17. A max pooling operation with kernel size 2 and stride 1
18. A valid convolution with kernel size 3, padding 1 and 512 output channels
19. A Relu
20. A valid convolution with kernel size 3, padding 1 and 512 4output channels
21. A Relu
22. A valid convolution with kernel size 3, padding 1 and 512 4output channels
23. A Relu
24. A max pooling operation with kernel size 2 and stride 1
25. A valid convolution with kernel size 3, padding 1 and 512 output channels
26. A Relu
27. A valid convolution with kernel size 3, padding 1 and 512 output channels
28. A Relu
29. A valid convolution with kernel size 3, padding 1 and 512 output channels
30. A Relu
31. A max pooling operation with kernel size 2 and stride 1
32. A flattening operation
33. A fully connected layer mapping from (whatever dimensions we are at– find out using formulas studied in class. You will also need to submit picture of calculation. Without that this question will not be graded) to 4096
34. A ReLU
35. A Dropout Layer
36. A fully connected layer mapping from 4096 to 4096 dimensions
37. A ReLU
38. A Dropout Layer
39. A fully connected layer mapping from 4096 to 10 dimensions
40. A Log softmax function.

[12]:
```
class Net(nn.Module):
    def __init__(self, num=10):
        super(Net, self).__init__()
        #TODO
```

```
        self.conv1 = nn.Conv2d(3, 64, kernel_size=3, stride=1, padding=1)
        self.conv2 = nn.Conv2d(64, 64, kernel_size=3, stride=1, padding=1)
        self.conv3 = nn.Conv2d(64, 128, kernel_size=3, stride=1, padding=1)
        self.conv4 = nn.Conv2d(128, 128, kernel_size=3, stride=1, padding=1)
        self.conv5 = nn.Conv2d(128, 256, kernel_size=3, stride=1, padding=1)
        self.conv6 = nn.Conv2d(256, 256, kernel_size=3, stride=1, padding=1)
        self.conv7 = nn.Conv2d(256, 256, kernel_size=3, stride=1, padding=1)
        self.conv8 = nn.Conv2d(256, 512, kernel_size=3, stride=1, padding=1)
        self.conv9 = nn.Conv2d(512, 512, kernel_size=3, stride=1, padding=1)
        self.conv10 = nn.Conv2d(512, 512, kernel_size=3, stride=1, padding=1)
        self.conv11 = nn.Conv2d(512, 512, kernel_size=3, stride=1, padding=1)
        self.conv12 = nn.Conv2d(512, 512, kernel_size=3, stride=1, padding=1)
        self.conv13 = nn.Conv2d(512, 512, kernel_size=3, stride=1, padding=1)

        self.fc1 = nn.Linear(4*4*512, 4096)
        self.fc2 = nn.Linear(4096, 4096)
        self.fc3 = nn.Linear(4096, num)

        self.drop1 = nn.Dropout2d()
        self.drop2 = nn.Dropout2d()
        #END TODO
    def forward(self, x):
        #TODO

        x = self.conv1(x)                                    # 1
        x = F.relu(x)                                      # 2
        x = self.conv2(x)                                    # 3
        x = F.relu(x)                                      # 4
        x = F.max_pool2d(x, kernel_size=2, stride=2)         # 5
        x = self.conv3(x)                                    # 6
        x = F.relu(x)                                      # 7
        x = self.conv4(x)                                    # 8
        x = F.relu(x)                                      # 9
        x = F.max_pool2d(x, kernel_size=2, stride=2)         # 10
        x = self.conv5(x)                                    # 11
        x = F.relu(x)                                      # 12
        x = self.conv6(x)                                    # 13
        x = F.relu(x)                                      # 14
        x = self.conv7(x)                                    # 15
        x = F.relu(x)                                      # 16
        x = F.max_pool2d(x, kernel_size=2, stride=1)         # 17
        x = self.conv8(x)                                    # 18
        x = F.relu(x)                                      # 19
        x = self.conv9(x)                                    # 20
        x = F.relu(x)                                      # 21
        x = self.conv10(x)                                   # 22
        x = F.relu(x)                                      # 23
```

```
        x = F.max_pool2d(x, kernel_size=2, stride=1)        # 24
        x = self.conv11(x)                                  # 25
        x = F.relu(x)                                       # 26
        x = self.conv12(x)                                  # 27
        x = F.relu(x)                                       # 28
        x = self.conv13(x)                                  # 29
        x = F.relu(x)                                       # 30
        x = F.max_pool2d(x, kernel_size=2, stride=1)        # 31
        x = x.flatten(1)                                    # 32
        x = self.fc1(x)                                     # 33
        x = F.relu(x)                                       # 34
        x = self.drop1(x)                                   # 35
        x = self.fc2(x)                                     # 36
        x = F.relu(x)                                       # 37
        x = self.drop2(x)                                   # 38
        x = self.fc3(x)                                     # 39
        x = F.log_softmax(x, dim=1)                         # 40
        #END TODO
        return x
```

[13]:
```
# Main training routine
def train(epoch):
  model.train()
  # Get each
  for batch_idx, (data, target) in enumerate(train_loader):
    if torch.cuda.is_available():
      data, target = data.cuda(), target.cuda()
    data, target = Variable(data), Variable(target)
    optimizer.zero_grad()
    output = model(data)
    loss = F.cross_entropy(output, target)
    loss.backward()
    optimizer.step()
    # Store results
    if batch_idx % 10 == 0:
      print('Train Epoch: {} [{}/{}]\tLoss: {:.6f}'.format(
        epoch, batch_idx * len(data), len(train_loader.dataset), loss.item()))
```

[14]:
```
# Run on test data
def test():
  model.eval()
  test_loss = 0
  correct = 0
  for data, target in test_loader:
      if torch.cuda.is_available():
          data, target = data.cuda(), target.cuda()
      data, target = Variable(data, volatile=True), Variable(target)
```

```
      output = model(data)
      test_loss += F.cross_entropy(output, target, size_average=False).item()#␣
 ↪sum up batch loss
      pred = output.data.max(1, keepdim=True)[1]# get the index of the max␣
 ↪log-probability
      correct += pred.eq(target.data.view_as(pred)).long().cpu().sum()
  test_loss /= len(test_loader.dataset)
  correct=float(correct.to(torch.device('cpu')).numpy())
  print('\nTest set: Avg. loss: {:.4f}, Accuracy: {}/{} ({:.0f}%)\n'.format(
    test_loss, correct, len(test_loader.dataset),
    100. * correct / len(test_loader.dataset)))
```

[15]:
```
model = Net()
print(model)
if torch.cuda.is_available():
    model.cuda()
optimizer = optim.SGD(model.parameters(), lr=0.01, momentum=0.5)
```

```
Net(
  (conv1): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv3): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv4): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv5): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv6): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv7): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv8): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv9): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv10): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv11): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv12): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (conv13): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
  (fc1): Linear(in_features=8192, out_features=4096, bias=True)
  (fc2): Linear(in_features=4096, out_features=4096, bias=True)
  (fc3): Linear(in_features=4096, out_features=10, bias=True)
  (drop1): Dropout2d(p=0.5, inplace=False)
  (drop2): Dropout2d(p=0.5, inplace=False)
)
```

[16]:
```
# Train for three epochs
n_epochs = 3
for epoch in range(1, n_epochs + 1):
  train(epoch)
  test()
```

```
Train Epoch: 1 [0/50000]        Loss: 2.300760
Train Epoch: 1 [200/50000]      Loss: 2.300475
Train Epoch: 1 [400/50000]      Loss: 2.303923
```

```
Train Epoch: 1 [600/50000]      Loss: 2.306436
Train Epoch: 1 [800/50000]      Loss: 2.308926
Train Epoch: 1 [1000/50000]     Loss: 2.299180
Train Epoch: 1 [1200/50000]     Loss: 2.303665
Train Epoch: 1 [1400/50000]     Loss: 2.301714
Train Epoch: 1 [1600/50000]     Loss: 2.299780
Train Epoch: 1 [1800/50000]     Loss: 2.299190
Train Epoch: 1 [2000/50000]     Loss: 2.306396
Train Epoch: 1 [2200/50000]     Loss: 2.307463
Train Epoch: 1 [2400/50000]     Loss: 2.303869
Train Epoch: 1 [2600/50000]     Loss: 2.302402
Train Epoch: 1 [2800/50000]     Loss: 2.304625
Train Epoch: 1 [3000/50000]     Loss: 2.303334
Train Epoch: 1 [3200/50000]     Loss: 2.301796
Train Epoch: 1 [3400/50000]     Loss: 2.304515
Train Epoch: 1 [3600/50000]     Loss: 2.304254
Train Epoch: 1 [3800/50000]     Loss: 2.303032
Train Epoch: 1 [4000/50000]     Loss: 2.303515
Train Epoch: 1 [4200/50000]     Loss: 2.304121
Train Epoch: 1 [4400/50000]     Loss: 2.305342
Train Epoch: 1 [4600/50000]     Loss: 2.307952
Train Epoch: 1 [4800/50000]     Loss: 2.310018
Train Epoch: 1 [5000/50000]     Loss: 2.301631
Train Epoch: 1 [5200/50000]     Loss: 2.303527
Train Epoch: 1 [5400/50000]     Loss: 2.307066
Train Epoch: 1 [5600/50000]     Loss: 2.306757
Train Epoch: 1 [5800/50000]     Loss: 2.299976
Train Epoch: 1 [6000/50000]     Loss: 2.305386
Train Epoch: 1 [6200/50000]     Loss: 2.299674
Train Epoch: 1 [6400/50000]     Loss: 2.302053
Train Epoch: 1 [6600/50000]     Loss: 2.303663
Train Epoch: 1 [6800/50000]     Loss: 2.295549
Train Epoch: 1 [7000/50000]     Loss: 2.301232
Train Epoch: 1 [7200/50000]     Loss: 2.313278
Train Epoch: 1 [7400/50000]     Loss: 2.309716
Train Epoch: 1 [7600/50000]     Loss: 2.311820
Train Epoch: 1 [7800/50000]     Loss: 2.294149
Train Epoch: 1 [8000/50000]     Loss: 2.304828
Train Epoch: 1 [8200/50000]     Loss: 2.307294
Train Epoch: 1 [8400/50000]     Loss: 2.304889
Train Epoch: 1 [8600/50000]     Loss: 2.304368
Train Epoch: 1 [8800/50000]     Loss: 2.307625
Train Epoch: 1 [9000/50000]     Loss: 2.304435
Train Epoch: 1 [9200/50000]     Loss: 2.298671
Train Epoch: 1 [9400/50000]     Loss: 2.305079
Train Epoch: 1 [9600/50000]     Loss: 2.297802
Train Epoch: 1 [9800/50000]     Loss: 2.299977
Train Epoch: 1 [10000/50000]    Loss: 2.306403
```

```
Train Epoch: 1 [10200/50000]    Loss: 2.300488
Train Epoch: 1 [10400/50000]    Loss: 2.309149
Train Epoch: 1 [10600/50000]    Loss: 2.304908
Train Epoch: 1 [10800/50000]    Loss: 2.307510
Train Epoch: 1 [11000/50000]    Loss: 2.309710
Train Epoch: 1 [11200/50000]    Loss: 2.297723
Train Epoch: 1 [11400/50000]    Loss: 2.305613
Train Epoch: 1 [11600/50000]    Loss: 2.294616
Train Epoch: 1 [11800/50000]    Loss: 2.302774
Train Epoch: 1 [12000/50000]    Loss: 2.297328
Train Epoch: 1 [12200/50000]    Loss: 2.303280
Train Epoch: 1 [12400/50000]    Loss: 2.299815
Train Epoch: 1 [12600/50000]    Loss: 2.300671
Train Epoch: 1 [12800/50000]    Loss: 2.302058
Train Epoch: 1 [13000/50000]    Loss: 2.308101
Train Epoch: 1 [13200/50000]    Loss: 2.298320
Train Epoch: 1 [13400/50000]    Loss: 2.303284
Train Epoch: 1 [13600/50000]    Loss: 2.299329
Train Epoch: 1 [13800/50000]    Loss: 2.307077
Train Epoch: 1 [14000/50000]    Loss: 2.304524
Train Epoch: 1 [14200/50000]    Loss: 2.300450
Train Epoch: 1 [14400/50000]    Loss: 2.302883
Train Epoch: 1 [14600/50000]    Loss: 2.301778
Train Epoch: 1 [14800/50000]    Loss: 2.309348
Train Epoch: 1 [15000/50000]    Loss: 2.304417
Train Epoch: 1 [15200/50000]    Loss: 2.305476
Train Epoch: 1 [15400/50000]    Loss: 2.301996
Train Epoch: 1 [15600/50000]    Loss: 2.305563
Train Epoch: 1 [15800/50000]    Loss: 2.301129
Train Epoch: 1 [16000/50000]    Loss: 2.294592
Train Epoch: 1 [16200/50000]    Loss: 2.305545
Train Epoch: 1 [16400/50000]    Loss: 2.303336
Train Epoch: 1 [16600/50000]    Loss: 2.312023
Train Epoch: 1 [16800/50000]    Loss: 2.296365
Train Epoch: 1 [17000/50000]    Loss: 2.304785
Train Epoch: 1 [17200/50000]    Loss: 2.302297
Train Epoch: 1 [17400/50000]    Loss: 2.313862
Train Epoch: 1 [17600/50000]    Loss: 2.305371
Train Epoch: 1 [17800/50000]    Loss: 2.300786
Train Epoch: 1 [18000/50000]    Loss: 2.305063
Train Epoch: 1 [18200/50000]    Loss: 2.305351
Train Epoch: 1 [18400/50000]    Loss: 2.303805
Train Epoch: 1 [18600/50000]    Loss: 2.308781
Train Epoch: 1 [18800/50000]    Loss: 2.301977
Train Epoch: 1 [19000/50000]    Loss: 2.303353
Train Epoch: 1 [19200/50000]    Loss: 2.305556
Train Epoch: 1 [19400/50000]    Loss: 2.306247
Train Epoch: 1 [19600/50000]    Loss: 2.305792
```

```
Train Epoch: 1 [19800/50000]    Loss: 2.305696
Train Epoch: 1 [20000/50000]    Loss: 2.296891
Train Epoch: 1 [20200/50000]    Loss: 2.300380
Train Epoch: 1 [20400/50000]    Loss: 2.300048
Train Epoch: 1 [20600/50000]    Loss: 2.301409
Train Epoch: 1 [20800/50000]    Loss: 2.296912
Train Epoch: 1 [21000/50000]    Loss: 2.302068
Train Epoch: 1 [21200/50000]    Loss: 2.305720
Train Epoch: 1 [21400/50000]    Loss: 2.305727
Train Epoch: 1 [21600/50000]    Loss: 2.304033
Train Epoch: 1 [21800/50000]    Loss: 2.305584
Train Epoch: 1 [22000/50000]    Loss: 2.306201
Train Epoch: 1 [22200/50000]    Loss: 2.304824
Train Epoch: 1 [22400/50000]    Loss: 2.303684
Train Epoch: 1 [22600/50000]    Loss: 2.300291
Train Epoch: 1 [22800/50000]    Loss: 2.300969
Train Epoch: 1 [23000/50000]    Loss: 2.299209
Train Epoch: 1 [23200/50000]    Loss: 2.301727
Train Epoch: 1 [23400/50000]    Loss: 2.302106
Train Epoch: 1 [23600/50000]    Loss: 2.302227
Train Epoch: 1 [23800/50000]    Loss: 2.309465
Train Epoch: 1 [24000/50000]    Loss: 2.298461
Train Epoch: 1 [24200/50000]    Loss: 2.304429
Train Epoch: 1 [24400/50000]    Loss: 2.311496
Train Epoch: 1 [24600/50000]    Loss: 2.309572
Train Epoch: 1 [24800/50000]    Loss: 2.304105
Train Epoch: 1 [25000/50000]    Loss: 2.302492
Train Epoch: 1 [25200/50000]    Loss: 2.304258
Train Epoch: 1 [25400/50000]    Loss: 2.304856
Train Epoch: 1 [25600/50000]    Loss: 2.301576
Train Epoch: 1 [25800/50000]    Loss: 2.303782
Train Epoch: 1 [26000/50000]    Loss: 2.311934
Train Epoch: 1 [26200/50000]    Loss: 2.300144
Train Epoch: 1 [26400/50000]    Loss: 2.310825
Train Epoch: 1 [26600/50000]    Loss: 2.309925
Train Epoch: 1 [26800/50000]    Loss: 2.301632
Train Epoch: 1 [27000/50000]    Loss: 2.308797
Train Epoch: 1 [27200/50000]    Loss: 2.303386
Train Epoch: 1 [27400/50000]    Loss: 2.299504
Train Epoch: 1 [27600/50000]    Loss: 2.304563
Train Epoch: 1 [27800/50000]    Loss: 2.301939
Train Epoch: 1 [28000/50000]    Loss: 2.304335
Train Epoch: 1 [28200/50000]    Loss: 2.307611
Train Epoch: 1 [28400/50000]    Loss: 2.305305
Train Epoch: 1 [28600/50000]    Loss: 2.306874
Train Epoch: 1 [28800/50000]    Loss: 2.304513
Train Epoch: 1 [29000/50000]    Loss: 2.305971
Train Epoch: 1 [29200/50000]    Loss: 2.302200
```

```
Train Epoch: 1 [29400/50000]    Loss: 2.303610
Train Epoch: 1 [29600/50000]    Loss: 2.308610
Train Epoch: 1 [29800/50000]    Loss: 2.303262
Train Epoch: 1 [30000/50000]    Loss: 2.301625
Train Epoch: 1 [30200/50000]    Loss: 2.305730
Train Epoch: 1 [30400/50000]    Loss: 2.299179
Train Epoch: 1 [30600/50000]    Loss: 2.302042
Train Epoch: 1 [30800/50000]    Loss: 2.303205
Train Epoch: 1 [31000/50000]    Loss: 2.306407
Train Epoch: 1 [31200/50000]    Loss: 2.302279
Train Epoch: 1 [31400/50000]    Loss: 2.301620
Train Epoch: 1 [31600/50000]    Loss: 2.301173
Train Epoch: 1 [31800/50000]    Loss: 2.303177
Train Epoch: 1 [32000/50000]    Loss: 2.302206
Train Epoch: 1 [32200/50000]    Loss: 2.306071
Train Epoch: 1 [32400/50000]    Loss: 2.303883
Train Epoch: 1 [32600/50000]    Loss: 2.301769
Train Epoch: 1 [32800/50000]    Loss: 2.304405
Train Epoch: 1 [33000/50000]    Loss: 2.303751
Train Epoch: 1 [33200/50000]    Loss: 2.302201
Train Epoch: 1 [33400/50000]    Loss: 2.301030
Train Epoch: 1 [33600/50000]    Loss: 2.303521
Train Epoch: 1 [33800/50000]    Loss: 2.303313
Train Epoch: 1 [34000/50000]    Loss: 2.300702
Train Epoch: 1 [34200/50000]    Loss: 2.302896
Train Epoch: 1 [34400/50000]    Loss: 2.296902
Train Epoch: 1 [34600/50000]    Loss: 2.302252
Train Epoch: 1 [34800/50000]    Loss: 2.304922
Train Epoch: 1 [35000/50000]    Loss: 2.302881
Train Epoch: 1 [35200/50000]    Loss: 2.296269
Train Epoch: 1 [35400/50000]    Loss: 2.304347
Train Epoch: 1 [35600/50000]    Loss: 2.302866
Train Epoch: 1 [35800/50000]    Loss: 2.304028
Train Epoch: 1 [36000/50000]    Loss: 2.305846
Train Epoch: 1 [36200/50000]    Loss: 2.303705
Train Epoch: 1 [36400/50000]    Loss: 2.299750
Train Epoch: 1 [36600/50000]    Loss: 2.305866
Train Epoch: 1 [36800/50000]    Loss: 2.303055
Train Epoch: 1 [37000/50000]    Loss: 2.306058
Train Epoch: 1 [37200/50000]    Loss: 2.306780
Train Epoch: 1 [37400/50000]    Loss: 2.302687
Train Epoch: 1 [37600/50000]    Loss: 2.300341
Train Epoch: 1 [37800/50000]    Loss: 2.300704
Train Epoch: 1 [38000/50000]    Loss: 2.300676
Train Epoch: 1 [38200/50000]    Loss: 2.301494
Train Epoch: 1 [38400/50000]    Loss: 2.307936
Train Epoch: 1 [38600/50000]    Loss: 2.299469
Train Epoch: 1 [38800/50000]    Loss: 2.308705
```

```
Train Epoch: 1 [39000/50000]    Loss: 2.297047
Train Epoch: 1 [39200/50000]    Loss: 2.298996
Train Epoch: 1 [39400/50000]    Loss: 2.307497
Train Epoch: 1 [39600/50000]    Loss: 2.300596
Train Epoch: 1 [39800/50000]    Loss: 2.306685
Train Epoch: 1 [40000/50000]    Loss: 2.304054
Train Epoch: 1 [40200/50000]    Loss: 2.304525
Train Epoch: 1 [40400/50000]    Loss: 2.302502
Train Epoch: 1 [40600/50000]    Loss: 2.303208
Train Epoch: 1 [40800/50000]    Loss: 2.301500
Train Epoch: 1 [41000/50000]    Loss: 2.298318
Train Epoch: 1 [41200/50000]    Loss: 2.308792
Train Epoch: 1 [41400/50000]    Loss: 2.301879
Train Epoch: 1 [41600/50000]    Loss: 2.296562
Train Epoch: 1 [41800/50000]    Loss: 2.298614
Train Epoch: 1 [42000/50000]    Loss: 2.302113
Train Epoch: 1 [42200/50000]    Loss: 2.300622
Train Epoch: 1 [42400/50000]    Loss: 2.296659
Train Epoch: 1 [42600/50000]    Loss: 2.309407
Train Epoch: 1 [42800/50000]    Loss: 2.308230
Train Epoch: 1 [43000/50000]    Loss: 2.298763
Train Epoch: 1 [43200/50000]    Loss: 2.305635
Train Epoch: 1 [43400/50000]    Loss: 2.301552
Train Epoch: 1 [43600/50000]    Loss: 2.297200
Train Epoch: 1 [43800/50000]    Loss: 2.302713
Train Epoch: 1 [44000/50000]    Loss: 2.306587
Train Epoch: 1 [44200/50000]    Loss: 2.304623
Train Epoch: 1 [44400/50000]    Loss: 2.303614
Train Epoch: 1 [44600/50000]    Loss: 2.299868
Train Epoch: 1 [44800/50000]    Loss: 2.304708
Train Epoch: 1 [45000/50000]    Loss: 2.306274
Train Epoch: 1 [45200/50000]    Loss: 2.308122
Train Epoch: 1 [45400/50000]    Loss: 2.295686
Train Epoch: 1 [45600/50000]    Loss: 2.303793
Train Epoch: 1 [45800/50000]    Loss: 2.300892
Train Epoch: 1 [46000/50000]    Loss: 2.303697
Train Epoch: 1 [46200/50000]    Loss: 2.304409
Train Epoch: 1 [46400/50000]    Loss: 2.304579
Train Epoch: 1 [46600/50000]    Loss: 2.306639
Train Epoch: 1 [46800/50000]    Loss: 2.303669
Train Epoch: 1 [47000/50000]    Loss: 2.310740
Train Epoch: 1 [47200/50000]    Loss: 2.299751
Train Epoch: 1 [47400/50000]    Loss: 2.308138
Train Epoch: 1 [47600/50000]    Loss: 2.298065
Train Epoch: 1 [47800/50000]    Loss: 2.303896
Train Epoch: 1 [48000/50000]    Loss: 2.298547
Train Epoch: 1 [48200/50000]    Loss: 2.301968
Train Epoch: 1 [48400/50000]    Loss: 2.302533
```

```
Train Epoch: 1 [48600/50000]    Loss: 2.303744
Train Epoch: 1 [48800/50000]    Loss: 2.298384
Train Epoch: 1 [49000/50000]    Loss: 2.298812
Train Epoch: 1 [49200/50000]    Loss: 2.302134
Train Epoch: 1 [49400/50000]    Loss: 2.307966
Train Epoch: 1 [49600/50000]    Loss: 2.300028
Train Epoch: 1 [49800/50000]    Loss: 2.301228
```

```
<ipython-input-14-0b1ccd3c1330>:9: UserWarning: volatile was removed and now has
no effect. Use `with torch.no_grad():` instead.
  data, target = Variable(data, volatile=True), Variable(target)
```

```
Test set: Avg. loss: 2.3028, Accuracy: 1000.0/10000 (10%)
```

```
Train Epoch: 2 [0/50000]        Loss: 2.305796
Train Epoch: 2 [200/50000]      Loss: 2.300662
Train Epoch: 2 [400/50000]      Loss: 2.314102
Train Epoch: 2 [600/50000]      Loss: 2.307076
Train Epoch: 2 [800/50000]      Loss: 2.298326
Train Epoch: 2 [1000/50000]     Loss: 2.303477
Train Epoch: 2 [1200/50000]     Loss: 2.295156
Train Epoch: 2 [1400/50000]     Loss: 2.301655
Train Epoch: 2 [1600/50000]     Loss: 2.302938
Train Epoch: 2 [1800/50000]     Loss: 2.306079
Train Epoch: 2 [2000/50000]     Loss: 2.299943
Train Epoch: 2 [2200/50000]     Loss: 2.298223
Train Epoch: 2 [2400/50000]     Loss: 2.303936
Train Epoch: 2 [2600/50000]     Loss: 2.301372
Train Epoch: 2 [2800/50000]     Loss: 2.294582
Train Epoch: 2 [3000/50000]     Loss: 2.301991
Train Epoch: 2 [3200/50000]     Loss: 2.310151
Train Epoch: 2 [3400/50000]     Loss: 2.303352
Train Epoch: 2 [3600/50000]     Loss: 2.295336
Train Epoch: 2 [3800/50000]     Loss: 2.296387
Train Epoch: 2 [4000/50000]     Loss: 2.298602
Train Epoch: 2 [4200/50000]     Loss: 2.285804
Train Epoch: 2 [4400/50000]     Loss: 2.301571
Train Epoch: 2 [4600/50000]     Loss: 2.302604
Train Epoch: 2 [4800/50000]     Loss: 2.308204
Train Epoch: 2 [5000/50000]     Loss: 2.304866
Train Epoch: 2 [5200/50000]     Loss: 2.292910
Train Epoch: 2 [5400/50000]     Loss: 2.296819
Train Epoch: 2 [5600/50000]     Loss: 2.315557
Train Epoch: 2 [5800/50000]     Loss: 2.303554
Train Epoch: 2 [6000/50000]     Loss: 2.300486
Train Epoch: 2 [6200/50000]     Loss: 2.315058
Train Epoch: 2 [6400/50000]     Loss: 2.296872
Train Epoch: 2 [6600/50000]     Loss: 2.303329
```

```
Train Epoch: 2 [6800/50000]     Loss: 2.311884
Train Epoch: 2 [7000/50000]     Loss: 2.302816
Train Epoch: 2 [7200/50000]     Loss: 2.300875
Train Epoch: 2 [7400/50000]     Loss: 2.300097
Train Epoch: 2 [7600/50000]     Loss: 2.298459
Train Epoch: 2 [7800/50000]     Loss: 2.310889
Train Epoch: 2 [8000/50000]     Loss: 2.298537
Train Epoch: 2 [8200/50000]     Loss: 2.308251
Train Epoch: 2 [8400/50000]     Loss: 2.291097
Train Epoch: 2 [8600/50000]     Loss: 2.303794
Train Epoch: 2 [8800/50000]     Loss: 2.313496
Train Epoch: 2 [9000/50000]     Loss: 2.306741
Train Epoch: 2 [9200/50000]     Loss: 2.301967
Train Epoch: 2 [9400/50000]     Loss: 2.304875
Train Epoch: 2 [9600/50000]     Loss: 2.305103
Train Epoch: 2 [9800/50000]     Loss: 2.309328
Train Epoch: 2 [10000/50000]    Loss: 2.307324
Train Epoch: 2 [10200/50000]    Loss: 2.307751
Train Epoch: 2 [10400/50000]    Loss: 2.304676
Train Epoch: 2 [10600/50000]    Loss: 2.298790
Train Epoch: 2 [10800/50000]    Loss: 2.302302
Train Epoch: 2 [11000/50000]    Loss: 2.294457
Train Epoch: 2 [11200/50000]    Loss: 2.308523
Train Epoch: 2 [11400/50000]    Loss: 2.309967
Train Epoch: 2 [11600/50000]    Loss: 2.313495
Train Epoch: 2 [11800/50000]    Loss: 2.304144
Train Epoch: 2 [12000/50000]    Loss: 2.305188
Train Epoch: 2 [12200/50000]    Loss: 2.297645
Train Epoch: 2 [12400/50000]    Loss: 2.296369
Train Epoch: 2 [12600/50000]    Loss: 2.302511
Train Epoch: 2 [12800/50000]    Loss: 2.312041
Train Epoch: 2 [13000/50000]    Loss: 2.299654
Train Epoch: 2 [13200/50000]    Loss: 2.312917
Train Epoch: 2 [13400/50000]    Loss: 2.299572
Train Epoch: 2 [13600/50000]    Loss: 2.299862
Train Epoch: 2 [13800/50000]    Loss: 2.311416
Train Epoch: 2 [14000/50000]    Loss: 2.305314
Train Epoch: 2 [14200/50000]    Loss: 2.315096
Train Epoch: 2 [14400/50000]    Loss: 2.303514
Train Epoch: 2 [14600/50000]    Loss: 2.298420
Train Epoch: 2 [14800/50000]    Loss: 2.297627
Train Epoch: 2 [15000/50000]    Loss: 2.307458
Train Epoch: 2 [15200/50000]    Loss: 2.309226
Train Epoch: 2 [15400/50000]    Loss: 2.296986
Train Epoch: 2 [15600/50000]    Loss: 2.298189
Train Epoch: 2 [15800/50000]    Loss: 2.306238
Train Epoch: 2 [16000/50000]    Loss: 2.299246
Train Epoch: 2 [16200/50000]    Loss: 2.298754
```

```
Train Epoch: 2 [16400/50000]    Loss: 2.303946
Train Epoch: 2 [16600/50000]    Loss: 2.301820
Train Epoch: 2 [16800/50000]    Loss: 2.310985
Train Epoch: 2 [17000/50000]    Loss: 2.296372
Train Epoch: 2 [17200/50000]    Loss: 2.297947
Train Epoch: 2 [17400/50000]    Loss: 2.306121
Train Epoch: 2 [17600/50000]    Loss: 2.300280
Train Epoch: 2 [17800/50000]    Loss: 2.314599
Train Epoch: 2 [18000/50000]    Loss: 2.301571
Train Epoch: 2 [18200/50000]    Loss: 2.295409
Train Epoch: 2 [18400/50000]    Loss: 2.296563
Train Epoch: 2 [18600/50000]    Loss: 2.299485
Train Epoch: 2 [18800/50000]    Loss: 2.301335
Train Epoch: 2 [19000/50000]    Loss: 2.299949
Train Epoch: 2 [19200/50000]    Loss: 2.300219
Train Epoch: 2 [19400/50000]    Loss: 2.304533
Train Epoch: 2 [19600/50000]    Loss: 2.293073
Train Epoch: 2 [19800/50000]    Loss: 2.300417
Train Epoch: 2 [20000/50000]    Loss: 2.312342
Train Epoch: 2 [20200/50000]    Loss: 2.304381
Train Epoch: 2 [20400/50000]    Loss: 2.301732
Train Epoch: 2 [20600/50000]    Loss: 2.303738
Train Epoch: 2 [20800/50000]    Loss: 2.303706
Train Epoch: 2 [21000/50000]    Loss: 2.301677
Train Epoch: 2 [21200/50000]    Loss: 2.310838
Train Epoch: 2 [21400/50000]    Loss: 2.295990
Train Epoch: 2 [21600/50000]    Loss: 2.302860
Train Epoch: 2 [21800/50000]    Loss: 2.308612
Train Epoch: 2 [22000/50000]    Loss: 2.302413
Train Epoch: 2 [22200/50000]    Loss: 2.300586
Train Epoch: 2 [22400/50000]    Loss: 2.306698
Train Epoch: 2 [22600/50000]    Loss: 2.303325
Train Epoch: 2 [22800/50000]    Loss: 2.305250
Train Epoch: 2 [23000/50000]    Loss: 2.301037
Train Epoch: 2 [23200/50000]    Loss: 2.298311
Train Epoch: 2 [23400/50000]    Loss: 2.305592
Train Epoch: 2 [23600/50000]    Loss: 2.296897
Train Epoch: 2 [23800/50000]    Loss: 2.299888
Train Epoch: 2 [24000/50000]    Loss: 2.309214
Train Epoch: 2 [24200/50000]    Loss: 2.297440
Train Epoch: 2 [24400/50000]    Loss: 2.305370
Train Epoch: 2 [24600/50000]    Loss: 2.305105
Train Epoch: 2 [24800/50000]    Loss: 2.303381
Train Epoch: 2 [25000/50000]    Loss: 2.308211
Train Epoch: 2 [25200/50000]    Loss: 2.305813
Train Epoch: 2 [25400/50000]    Loss: 2.299269
Train Epoch: 2 [25600/50000]    Loss: 2.309322
Train Epoch: 2 [25800/50000]    Loss: 2.296212
```

```
Train Epoch: 2 [26000/50000]    Loss: 2.310872
Train Epoch: 2 [26200/50000]    Loss: 2.303373
Train Epoch: 2 [26400/50000]    Loss: 2.309034
Train Epoch: 2 [26600/50000]    Loss: 2.302630
Train Epoch: 2 [26800/50000]    Loss: 2.300843
Train Epoch: 2 [27000/50000]    Loss: 2.298761
Train Epoch: 2 [27200/50000]    Loss: 2.303891
Train Epoch: 2 [27400/50000]    Loss: 2.300067
Train Epoch: 2 [27600/50000]    Loss: 2.296936
Train Epoch: 2 [27800/50000]    Loss: 2.312846
Train Epoch: 2 [28000/50000]    Loss: 2.304438
Train Epoch: 2 [28200/50000]    Loss: 2.294522
Train Epoch: 2 [28400/50000]    Loss: 2.303310
Train Epoch: 2 [28600/50000]    Loss: 2.311747
Train Epoch: 2 [28800/50000]    Loss: 2.296276
Train Epoch: 2 [29000/50000]    Loss: 2.299223
Train Epoch: 2 [29200/50000]    Loss: 2.305267
Train Epoch: 2 [29400/50000]    Loss: 2.301735
Train Epoch: 2 [29600/50000]    Loss: 2.312031
Train Epoch: 2 [29800/50000]    Loss: 2.304288
Train Epoch: 2 [30000/50000]    Loss: 2.305733
Train Epoch: 2 [30200/50000]    Loss: 2.302547
Train Epoch: 2 [30400/50000]    Loss: 2.305466
Train Epoch: 2 [30600/50000]    Loss: 2.302047
Train Epoch: 2 [30800/50000]    Loss: 2.300467
Train Epoch: 2 [31000/50000]    Loss: 2.305644
Train Epoch: 2 [31200/50000]    Loss: 2.301516
Train Epoch: 2 [31400/50000]    Loss: 2.300420
Train Epoch: 2 [31600/50000]    Loss: 2.310768
Train Epoch: 2 [31800/50000]    Loss: 2.295603
Train Epoch: 2 [32000/50000]    Loss: 2.312900
Train Epoch: 2 [32200/50000]    Loss: 2.301568
Train Epoch: 2 [32400/50000]    Loss: 2.301223
Train Epoch: 2 [32600/50000]    Loss: 2.301201
Train Epoch: 2 [32800/50000]    Loss: 2.298759
Train Epoch: 2 [33000/50000]    Loss: 2.304553
Train Epoch: 2 [33200/50000]    Loss: 2.303007
Train Epoch: 2 [33400/50000]    Loss: 2.313472
Train Epoch: 2 [33600/50000]    Loss: 2.302745
Train Epoch: 2 [33800/50000]    Loss: 2.300213
Train Epoch: 2 [34000/50000]    Loss: 2.298088
Train Epoch: 2 [34200/50000]    Loss: 2.307979
Train Epoch: 2 [34400/50000]    Loss: 2.299812
Train Epoch: 2 [34600/50000]    Loss: 2.298056
Train Epoch: 2 [34800/50000]    Loss: 2.295948
Train Epoch: 2 [35000/50000]    Loss: 2.305824
Train Epoch: 2 [35200/50000]    Loss: 2.311066
Train Epoch: 2 [35400/50000]    Loss: 2.299571
```

```
Train Epoch: 2 [35600/50000]    Loss: 2.310112
Train Epoch: 2 [35800/50000]    Loss: 2.309227
Train Epoch: 2 [36000/50000]    Loss: 2.304139
Train Epoch: 2 [36200/50000]    Loss: 2.300893
Train Epoch: 2 [36400/50000]    Loss: 2.294581
Train Epoch: 2 [36600/50000]    Loss: 2.312545
Train Epoch: 2 [36800/50000]    Loss: 2.306928
Train Epoch: 2 [37000/50000]    Loss: 2.300131
Train Epoch: 2 [37200/50000]    Loss: 2.298858
Train Epoch: 2 [37400/50000]    Loss: 2.308465
Train Epoch: 2 [37600/50000]    Loss: 2.304200
Train Epoch: 2 [37800/50000]    Loss: 2.299373
Train Epoch: 2 [38000/50000]    Loss: 2.301575
Train Epoch: 2 [38200/50000]    Loss: 2.305262
Train Epoch: 2 [38400/50000]    Loss: 2.300145
Train Epoch: 2 [38600/50000]    Loss: 2.303479
Train Epoch: 2 [38800/50000]    Loss: 2.312930
Train Epoch: 2 [39000/50000]    Loss: 2.292170
Train Epoch: 2 [39200/50000]    Loss: 2.302520
Train Epoch: 2 [39400/50000]    Loss: 2.311610
Train Epoch: 2 [39600/50000]    Loss: 2.304393
Train Epoch: 2 [39800/50000]    Loss: 2.294907
Train Epoch: 2 [40000/50000]    Loss: 2.300017
Train Epoch: 2 [40200/50000]    Loss: 2.309302
Train Epoch: 2 [40400/50000]    Loss: 2.305495
Train Epoch: 2 [40600/50000]    Loss: 2.301343
Train Epoch: 2 [40800/50000]    Loss: 2.313649
Train Epoch: 2 [41000/50000]    Loss: 2.300003
Train Epoch: 2 [41200/50000]    Loss: 2.308510
Train Epoch: 2 [41400/50000]    Loss: 2.307024
Train Epoch: 2 [41600/50000]    Loss: 2.310273
Train Epoch: 2 [41800/50000]    Loss: 2.313983
Train Epoch: 2 [42000/50000]    Loss: 2.293971
Train Epoch: 2 [42200/50000]    Loss: 2.297204
Train Epoch: 2 [42400/50000]    Loss: 2.310687
Train Epoch: 2 [42600/50000]    Loss: 2.307522
Train Epoch: 2 [42800/50000]    Loss: 2.296762
Train Epoch: 2 [43000/50000]    Loss: 2.305229
Train Epoch: 2 [43200/50000]    Loss: 2.300457
Train Epoch: 2 [43400/50000]    Loss: 2.310644
Train Epoch: 2 [43600/50000]    Loss: 2.296906
Train Epoch: 2 [43800/50000]    Loss: 2.299433
Train Epoch: 2 [44000/50000]    Loss: 2.294961
Train Epoch: 2 [44200/50000]    Loss: 2.299719
Train Epoch: 2 [44400/50000]    Loss: 2.305328
Train Epoch: 2 [44600/50000]    Loss: 2.306850
Train Epoch: 2 [44800/50000]    Loss: 2.302972
Train Epoch: 2 [45000/50000]    Loss: 2.298942
```

```
Train Epoch: 2 [45200/50000]    Loss: 2.301743
Train Epoch: 2 [45400/50000]    Loss: 2.306681
Train Epoch: 2 [45600/50000]    Loss: 2.300439
Train Epoch: 2 [45800/50000]    Loss: 2.296287
Train Epoch: 2 [46000/50000]    Loss: 2.305223
Train Epoch: 2 [46200/50000]    Loss: 2.313346
Train Epoch: 2 [46400/50000]    Loss: 2.302347
Train Epoch: 2 [46600/50000]    Loss: 2.303070
Train Epoch: 2 [46800/50000]    Loss: 2.297054
Train Epoch: 2 [47000/50000]    Loss: 2.298881
Train Epoch: 2 [47200/50000]    Loss: 2.303972
Train Epoch: 2 [47400/50000]    Loss: 2.298608
Train Epoch: 2 [47600/50000]    Loss: 2.306163
Train Epoch: 2 [47800/50000]    Loss: 2.300945
Train Epoch: 2 [48000/50000]    Loss: 2.306141
Train Epoch: 2 [48200/50000]    Loss: 2.305459
Train Epoch: 2 [48400/50000]    Loss: 2.295666
Train Epoch: 2 [48600/50000]    Loss: 2.304113
Train Epoch: 2 [48800/50000]    Loss: 2.295226
Train Epoch: 2 [49000/50000]    Loss: 2.304579
Train Epoch: 2 [49200/50000]    Loss: 2.307152
Train Epoch: 2 [49400/50000]    Loss: 2.304591
Train Epoch: 2 [49600/50000]    Loss: 2.304461
Train Epoch: 2 [49800/50000]    Loss: 2.302373

Test set: Avg. loss: 2.3027, Accuracy: 1000.0/10000 (10%)

Train Epoch: 3 [0/50000]        Loss: 2.306945
Train Epoch: 3 [200/50000]      Loss: 2.305523
Train Epoch: 3 [400/50000]      Loss: 2.299882
Train Epoch: 3 [600/50000]      Loss: 2.299690
Train Epoch: 3 [800/50000]      Loss: 2.303615
Train Epoch: 3 [1000/50000]     Loss: 2.293569
Train Epoch: 3 [1200/50000]     Loss: 2.308144
Train Epoch: 3 [1400/50000]     Loss: 2.303189
Train Epoch: 3 [1600/50000]     Loss: 2.303828
Train Epoch: 3 [1800/50000]     Loss: 2.312261
Train Epoch: 3 [2000/50000]     Loss: 2.306180
Train Epoch: 3 [2200/50000]     Loss: 2.305040
Train Epoch: 3 [2400/50000]     Loss: 2.300668
Train Epoch: 3 [2600/50000]     Loss: 2.310718
Train Epoch: 3 [2800/50000]     Loss: 2.301452
Train Epoch: 3 [3000/50000]     Loss: 2.296068
Train Epoch: 3 [3200/50000]     Loss: 2.300785
Train Epoch: 3 [3400/50000]     Loss: 2.297255
Train Epoch: 3 [3600/50000]     Loss: 2.314438
Train Epoch: 3 [3800/50000]     Loss: 2.304402
Train Epoch: 3 [4000/50000]     Loss: 2.297643
```

```
Train Epoch: 3 [4200/50000]     Loss: 2.298383
Train Epoch: 3 [4400/50000]     Loss: 2.304905
Train Epoch: 3 [4600/50000]     Loss: 2.304506
Train Epoch: 3 [4800/50000]     Loss: 2.304015
Train Epoch: 3 [5000/50000]     Loss: 2.309804
Train Epoch: 3 [5200/50000]     Loss: 2.301056
Train Epoch: 3 [5400/50000]     Loss: 2.313859
Train Epoch: 3 [5600/50000]     Loss: 2.299453
Train Epoch: 3 [5800/50000]     Loss: 2.305027
Train Epoch: 3 [6000/50000]     Loss: 2.304951
Train Epoch: 3 [6200/50000]     Loss: 2.300655
Train Epoch: 3 [6400/50000]     Loss: 2.316051
Train Epoch: 3 [6600/50000]     Loss: 2.303540
Train Epoch: 3 [6800/50000]     Loss: 2.303673
Train Epoch: 3 [7000/50000]     Loss: 2.299824
Train Epoch: 3 [7200/50000]     Loss: 2.299013
Train Epoch: 3 [7400/50000]     Loss: 2.289390
Train Epoch: 3 [7600/50000]     Loss: 2.307193
Train Epoch: 3 [7800/50000]     Loss: 2.315242
Train Epoch: 3 [8000/50000]     Loss: 2.306346
Train Epoch: 3 [8200/50000]     Loss: 2.299098
Train Epoch: 3 [8400/50000]     Loss: 2.301386
Train Epoch: 3 [8600/50000]     Loss: 2.307791
Train Epoch: 3 [8800/50000]     Loss: 2.308400
Train Epoch: 3 [9000/50000]     Loss: 2.306481
Train Epoch: 3 [9200/50000]     Loss: 2.295420
Train Epoch: 3 [9400/50000]     Loss: 2.308994
Train Epoch: 3 [9600/50000]     Loss: 2.313435
Train Epoch: 3 [9800/50000]     Loss: 2.303777
Train Epoch: 3 [10000/50000]    Loss: 2.312790
Train Epoch: 3 [10200/50000]    Loss: 2.295785
Train Epoch: 3 [10400/50000]    Loss: 2.309713
Train Epoch: 3 [10600/50000]    Loss: 2.302473
Train Epoch: 3 [10800/50000]    Loss: 2.315917
Train Epoch: 3 [11000/50000]    Loss: 2.300488
Train Epoch: 3 [11200/50000]    Loss: 2.304550
Train Epoch: 3 [11400/50000]    Loss: 2.308007
Train Epoch: 3 [11600/50000]    Loss: 2.304089
Train Epoch: 3 [11800/50000]    Loss: 2.307356
Train Epoch: 3 [12000/50000]    Loss: 2.298629
Train Epoch: 3 [12200/50000]    Loss: 2.297198
Train Epoch: 3 [12400/50000]    Loss: 2.304377
Train Epoch: 3 [12600/50000]    Loss: 2.297143
Train Epoch: 3 [12800/50000]    Loss: 2.305177
Train Epoch: 3 [13000/50000]    Loss: 2.296000
Train Epoch: 3 [13200/50000]    Loss: 2.299962
Train Epoch: 3 [13400/50000]    Loss: 2.307476
Train Epoch: 3 [13600/50000]    Loss: 2.300213
```

```
Train Epoch: 3 [13800/50000]    Loss: 2.299709
Train Epoch: 3 [14000/50000]    Loss: 2.297905
Train Epoch: 3 [14200/50000]    Loss: 2.297033
Train Epoch: 3 [14400/50000]    Loss: 2.317926
Train Epoch: 3 [14600/50000]    Loss: 2.300492
Train Epoch: 3 [14800/50000]    Loss: 2.313295
Train Epoch: 3 [15000/50000]    Loss: 2.301442
Train Epoch: 3 [15200/50000]    Loss: 2.299809
Train Epoch: 3 [15400/50000]    Loss: 2.306638
Train Epoch: 3 [15600/50000]    Loss: 2.302290
Train Epoch: 3 [15800/50000]    Loss: 2.299242
Train Epoch: 3 [16000/50000]    Loss: 2.311947
Train Epoch: 3 [16200/50000]    Loss: 2.297319
Train Epoch: 3 [16400/50000]    Loss: 2.305600
Train Epoch: 3 [16600/50000]    Loss: 2.310861
Train Epoch: 3 [16800/50000]    Loss: 2.297148
Train Epoch: 3 [17000/50000]    Loss: 2.308165
Train Epoch: 3 [17200/50000]    Loss: 2.303389
Train Epoch: 3 [17400/50000]    Loss: 2.305590
Train Epoch: 3 [17600/50000]    Loss: 2.304196
Train Epoch: 3 [17800/50000]    Loss: 2.307203
Train Epoch: 3 [18000/50000]    Loss: 2.302688
Train Epoch: 3 [18200/50000]    Loss: 2.302417
Train Epoch: 3 [18400/50000]    Loss: 2.304007
Train Epoch: 3 [18600/50000]    Loss: 2.311943
Train Epoch: 3 [18800/50000]    Loss: 2.304303
Train Epoch: 3 [19000/50000]    Loss: 2.295317
Train Epoch: 3 [19200/50000]    Loss: 2.294935
Train Epoch: 3 [19400/50000]    Loss: 2.306153
Train Epoch: 3 [19600/50000]    Loss: 2.310308
Train Epoch: 3 [19800/50000]    Loss: 2.306705
Train Epoch: 3 [20000/50000]    Loss: 2.300175
Train Epoch: 3 [20200/50000]    Loss: 2.305974
Train Epoch: 3 [20400/50000]    Loss: 2.301637
Train Epoch: 3 [20600/50000]    Loss: 2.312904
Train Epoch: 3 [20800/50000]    Loss: 2.313293
Train Epoch: 3 [21000/50000]    Loss: 2.306032
Train Epoch: 3 [21200/50000]    Loss: 2.304748
Train Epoch: 3 [21400/50000]    Loss: 2.298183
Train Epoch: 3 [21600/50000]    Loss: 2.299565
Train Epoch: 3 [21800/50000]    Loss: 2.306241
Train Epoch: 3 [22000/50000]    Loss: 2.302498
Train Epoch: 3 [22200/50000]    Loss: 2.307414
Train Epoch: 3 [22400/50000]    Loss: 2.307080
Train Epoch: 3 [22600/50000]    Loss: 2.302722
Train Epoch: 3 [22800/50000]    Loss: 2.305067
Train Epoch: 3 [23000/50000]    Loss: 2.305596
Train Epoch: 3 [23200/50000]    Loss: 2.301387
```

```
Train Epoch: 3 [23400/50000]    Loss: 2.302267
Train Epoch: 3 [23600/50000]    Loss: 2.303428
Train Epoch: 3 [23800/50000]    Loss: 2.303688
Train Epoch: 3 [24000/50000]    Loss: 2.303697
Train Epoch: 3 [24200/50000]    Loss: 2.299803
Train Epoch: 3 [24400/50000]    Loss: 2.299210
Train Epoch: 3 [24600/50000]    Loss: 2.306659
Train Epoch: 3 [24800/50000]    Loss: 2.299856
Train Epoch: 3 [25000/50000]    Loss: 2.306761
Train Epoch: 3 [25200/50000]    Loss: 2.299345
Train Epoch: 3 [25400/50000]    Loss: 2.305302
Train Epoch: 3 [25600/50000]    Loss: 2.305791
Train Epoch: 3 [25800/50000]    Loss: 2.303505
Train Epoch: 3 [26000/50000]    Loss: 2.298324
Train Epoch: 3 [26200/50000]    Loss: 2.304208
Train Epoch: 3 [26400/50000]    Loss: 2.304154
Train Epoch: 3 [26600/50000]    Loss: 2.304424
Train Epoch: 3 [26800/50000]    Loss: 2.299614
Train Epoch: 3 [27000/50000]    Loss: 2.298536
Train Epoch: 3 [27200/50000]    Loss: 2.303167
Train Epoch: 3 [27400/50000]    Loss: 2.306868
Train Epoch: 3 [27600/50000]    Loss: 2.309941
Train Epoch: 3 [27800/50000]    Loss: 2.301151
Train Epoch: 3 [28000/50000]    Loss: 2.299184
Train Epoch: 3 [28200/50000]    Loss: 2.306644
Train Epoch: 3 [28400/50000]    Loss: 2.309795
Train Epoch: 3 [28600/50000]    Loss: 2.306930
Train Epoch: 3 [28800/50000]    Loss: 2.302884
Train Epoch: 3 [29000/50000]    Loss: 2.297407
Train Epoch: 3 [29200/50000]    Loss: 2.311243
Train Epoch: 3 [29400/50000]    Loss: 2.302089
Train Epoch: 3 [29600/50000]    Loss: 2.303730
Train Epoch: 3 [29800/50000]    Loss: 2.304925
Train Epoch: 3 [30000/50000]    Loss: 2.298652
Train Epoch: 3 [30200/50000]    Loss: 2.301614
Train Epoch: 3 [30400/50000]    Loss: 2.305368
Train Epoch: 3 [30600/50000]    Loss: 2.298274
Train Epoch: 3 [30800/50000]    Loss: 2.306530
Train Epoch: 3 [31000/50000]    Loss: 2.301618
Train Epoch: 3 [31200/50000]    Loss: 2.303839
Train Epoch: 3 [31400/50000]    Loss: 2.298748
Train Epoch: 3 [31600/50000]    Loss: 2.295351
Train Epoch: 3 [31800/50000]    Loss: 2.308337
Train Epoch: 3 [32000/50000]    Loss: 2.300889
Train Epoch: 3 [32200/50000]    Loss: 2.306887
Train Epoch: 3 [32400/50000]    Loss: 2.303493
Train Epoch: 3 [32600/50000]    Loss: 2.302181
Train Epoch: 3 [32800/50000]    Loss: 2.300334
```

```
Train Epoch: 3 [33000/50000]    Loss: 2.303312
Train Epoch: 3 [33200/50000]    Loss: 2.302618
Train Epoch: 3 [33400/50000]    Loss: 2.299319
Train Epoch: 3 [33600/50000]    Loss: 2.305458
Train Epoch: 3 [33800/50000]    Loss: 2.305166
Train Epoch: 3 [34000/50000]    Loss: 2.309366
Train Epoch: 3 [34200/50000]    Loss: 2.306436
Train Epoch: 3 [34400/50000]    Loss: 2.304809
Train Epoch: 3 [34600/50000]    Loss: 2.303779
Train Epoch: 3 [34800/50000]    Loss: 2.297465
Train Epoch: 3 [35000/50000]    Loss: 2.295162
Train Epoch: 3 [35200/50000]    Loss: 2.310694
Train Epoch: 3 [35400/50000]    Loss: 2.308325
Train Epoch: 3 [35600/50000]    Loss: 2.304568
Train Epoch: 3 [35800/50000]    Loss: 2.299548
Train Epoch: 3 [36000/50000]    Loss: 2.298293
Train Epoch: 3 [36200/50000]    Loss: 2.304241
Train Epoch: 3 [36400/50000]    Loss: 2.300699
Train Epoch: 3 [36600/50000]    Loss: 2.298582
Train Epoch: 3 [36800/50000]    Loss: 2.296385
Train Epoch: 3 [37000/50000]    Loss: 2.301793
Train Epoch: 3 [37200/50000]    Loss: 2.304338
Train Epoch: 3 [37400/50000]    Loss: 2.301290
Train Epoch: 3 [37600/50000]    Loss: 2.297594
Train Epoch: 3 [37800/50000]    Loss: 2.300114
Train Epoch: 3 [38000/50000]    Loss: 2.298041
Train Epoch: 3 [38200/50000]    Loss: 2.306816
Train Epoch: 3 [38400/50000]    Loss: 2.301303
Train Epoch: 3 [38600/50000]    Loss: 2.302082
Train Epoch: 3 [38800/50000]    Loss: 2.303230
Train Epoch: 3 [39000/50000]    Loss: 2.299173
Train Epoch: 3 [39200/50000]    Loss: 2.301784
Train Epoch: 3 [39400/50000]    Loss: 2.300067
Train Epoch: 3 [39600/50000]    Loss: 2.308934
Train Epoch: 3 [39800/50000]    Loss: 2.299836
Train Epoch: 3 [40000/50000]    Loss: 2.305910
Train Epoch: 3 [40200/50000]    Loss: 2.296680
Train Epoch: 3 [40400/50000]    Loss: 2.301491
Train Epoch: 3 [40600/50000]    Loss: 2.304342
Train Epoch: 3 [40800/50000]    Loss: 2.302487
Train Epoch: 3 [41000/50000]    Loss: 2.297323
Train Epoch: 3 [41200/50000]    Loss: 2.302922
Train Epoch: 3 [41400/50000]    Loss: 2.302180
Train Epoch: 3 [41600/50000]    Loss: 2.310099
Train Epoch: 3 [41800/50000]    Loss: 2.305407
Train Epoch: 3 [42000/50000]    Loss: 2.305892
Train Epoch: 3 [42200/50000]    Loss: 2.304007
Train Epoch: 3 [42400/50000]    Loss: 2.304066
```

```
Train Epoch: 3 [42600/50000]    Loss: 2.303809
Train Epoch: 3 [42800/50000]    Loss: 2.310410
Train Epoch: 3 [43000/50000]    Loss: 2.297512
Train Epoch: 3 [43200/50000]    Loss: 2.307835
Train Epoch: 3 [43400/50000]    Loss: 2.308324
Train Epoch: 3 [43600/50000]    Loss: 2.301992
Train Epoch: 3 [43800/50000]    Loss: 2.309462
Train Epoch: 3 [44000/50000]    Loss: 2.305036
Train Epoch: 3 [44200/50000]    Loss: 2.293268
Train Epoch: 3 [44400/50000]    Loss: 2.307321
Train Epoch: 3 [44600/50000]    Loss: 2.303979
Train Epoch: 3 [44800/50000]    Loss: 2.311184
Train Epoch: 3 [45000/50000]    Loss: 2.301327
Train Epoch: 3 [45200/50000]    Loss: 2.302638
Train Epoch: 3 [45400/50000]    Loss: 2.306500
Train Epoch: 3 [45600/50000]    Loss: 2.293587
Train Epoch: 3 [45800/50000]    Loss: 2.302463
Train Epoch: 3 [46000/50000]    Loss: 2.295654
Train Epoch: 3 [46200/50000]    Loss: 2.306977
Train Epoch: 3 [46400/50000]    Loss: 2.311295
Train Epoch: 3 [46600/50000]    Loss: 2.307970
Train Epoch: 3 [46800/50000]    Loss: 2.309427
Train Epoch: 3 [47000/50000]    Loss: 2.308887
Train Epoch: 3 [47200/50000]    Loss: 2.300506
Train Epoch: 3 [47400/50000]    Loss: 2.304848
Train Epoch: 3 [47600/50000]    Loss: 2.302048
Train Epoch: 3 [47800/50000]    Loss: 2.304940
Train Epoch: 3 [48000/50000]    Loss: 2.304858
Train Epoch: 3 [48200/50000]    Loss: 2.303564
Train Epoch: 3 [48400/50000]    Loss: 2.302773
Train Epoch: 3 [48600/50000]    Loss: 2.299906
Train Epoch: 3 [48800/50000]    Loss: 2.299197
Train Epoch: 3 [49000/50000]    Loss: 2.291026
Train Epoch: 3 [49200/50000]    Loss: 2.306349
Train Epoch: 3 [49400/50000]    Loss: 2.302961
Train Epoch: 3 [49600/50000]    Loss: 2.303831
Train Epoch: 3 [49800/50000]    Loss: 2.295992

Test set: Avg. loss: 2.3029, Accuracy: 1000.0/10000 (10%)
```

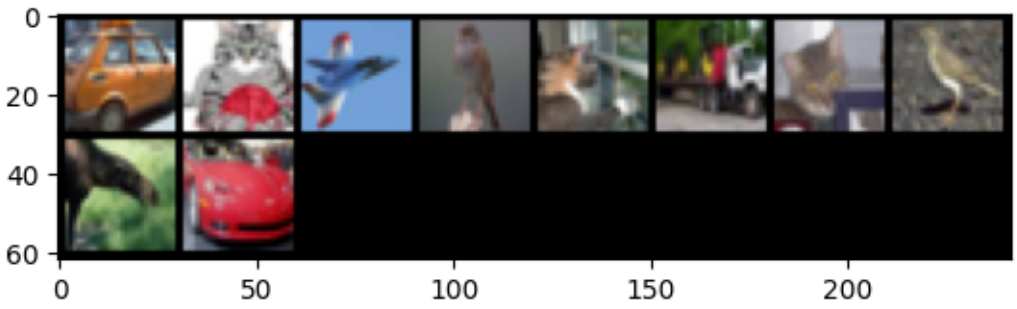
[17]:
```
# Run network on data we got before and show predictions
examples = enumerate(test_loader)
batch_idx, (example_data, example_target) = next(examples)
if torch.cuda.is_available():
  example_data, example_target = example_data.cuda(), example_target.cuda()
```

```
example_data, example_target = Variable(example_data, volatile=True),␣
 ↪Variable(example_target)
output = model(example_data)

def imshow(img):    # unnormalize
    npimg = img.cpu().numpy()
    plt.imshow(np.transpose(npimg, (1, 2, 0)))
    plt.show()

# show images
imshow(torchvision.utils.make_grid(example_data[:10,:]))
# print labels
print(' '.join('%5s' % classes[example_targets[j]] for j in range(10)))
```

```
<ipython-input-17-3adadbd67f9a>:6: UserWarning: volatile was removed and now has
no effect. Use `with torch.no_grad():` instead.
  example_data, example_target = Variable(example_data, volatile=True),
Variable(example_target)
```




```
Truck Airplane  Bird  Frog Horse   Cat Airplane  Frog   Cat   Car
```

6 TODO

This doesn't give a good accuracy though right? We applied the same amount of layers (no of conv nets and fully connected neurons in this and the vgg is same. no of neurons in fully connected is also same). This aprt isn't graded but can you try it at home and find out what changed will increase the accuracy of this network? Then can be abount anything including learning rate, epochs data etc.

7 Q3: TODO [30 Points]

After being done with VGGNet, Let's work on ResNet.

if you don't know what ResNet is, don't worry. This lab doesn't require the background of it. Its just an architecture and we are implementing it. Here is ResNet architecture (output from first

image goes into seocnd image i.e. both are connected):

Resnet Blocks are similar to any other network except they carry some previous stored info to next layer or in other words some residue to next layer. In the above given image where you are seeing add function, there you will see that output is coming from the most recent layer and also from some previous layer. We will study in depth about it in class as well. Right now, let's try implementing it. Some portion of code is already given. You just need to fill in missing pieces by looking at the image above and formulas which you studied during your classes.

This code actually has a conv_block function which can make layer blocks based on input. This function is being called in Class Net and as you can see first conv1 block is made by calling it. You can then see that block is connected in Forward Function. You can compare it with the image as well.

Now to make a few things easy, each pooling block is of same size and hence size has been made fixed in conv block. for convolutional layers, kernel size is fixed at 3 and padding at 1. Only major change gence is of input and output channels so here is the info for that.

```
conv layer 1: in_channels=3, out_channels=64
conv layer 2: in_channels=64, out_channels=128
conv layer 3: in_channels=128, out_channels=128
conv layer 4: in_channels=128, out_channels=128
conv layer 5: in_channels=128, out_channels=256
conv layer 6: in_channels=256, out_channels=512
conv layer 7: in_channels=512, out_channels=512
conv layer 8: in_channels=512, out_channels=512
```

[18]:
```
def conv_block(in_channels, out_channels, pool=False):
    layers = [nn.Conv2d(in_channels, out_channels, kernel_size=3, padding=1),
              nn.BatchNorm2d(out_channels),
              nn.ReLU(inplace=True)]
    if pool: layers.append(nn.MaxPool2d(2))
    return nn.Sequential(*layers)


class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()

        self.conv1 = conv_block(3, 64)
        self.conv2 = conv_block(64, 128, pool=True)
        self.res1 = nn.Sequential(conv_block(128, 128), conv_block(128, 128))

        # TODO
        self.conv3 = conv_block(128, 256, pool=True)
        self.conv4 = conv_block(256, 512, pool=True)
        self.res2 = nn.Sequential(conv_block(512, 512), conv_block(512, 512))
        # END TODO
        self.classifier = nn.Sequential(nn.MaxPool2d(2),
```

```
                                        nn.Flatten(),
                                        nn.Linear(512, 10))

    def forward(self, x):
        out = self.conv1(x)
        out = self.conv2(out)
        out = self.res1(out) + out
        # TODO

        out = self.conv3(out)
        out = self.conv4(out)

        out = self.res2(out) + out

        out = self.classifier(out)

        #END TODO
        return out
```

[19]:
```
model = Net()
print(model)
if torch.cuda.is_available():
    model.cuda()
optimizer = optim.SGD(model.parameters(), lr=0.01, momentum=0.5)
```

```
Net(
  (conv1): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
  )
  (conv2): Sequential(
    (0): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  )
  (res1): Sequential(
    (0): Sequential(
      (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
      (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
    (1): Sequential(
```

```
      (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
      (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
  )
  (conv3): Sequential(
    (0): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  )
  (conv4): Sequential(
    (0): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
  )
  (res2): Sequential(
    (0): Sequential(
      (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
      (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
    (1): Sequential(
      (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
      (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
  )
  (classifier): Sequential(
    (0): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1,
ceil_mode=False)
    (1): Flatten(start_dim=1, end_dim=-1)
    (2): Linear(in_features=512, out_features=10, bias=True)
  )
)
```

[20]:
```
# Train for three epochs
n_epochs = 3
for epoch in range(1, n_epochs + 1):
```

```
train(epoch)
test()
```

```
Train Epoch: 1 [0/50000]        Loss: 3.731579
Train Epoch: 1 [200/50000]      Loss: 3.845282
Train Epoch: 1 [400/50000]      Loss: 3.068728
Train Epoch: 1 [600/50000]      Loss: 2.558751
Train Epoch: 1 [800/50000]      Loss: 2.364724
Train Epoch: 1 [1000/50000]     Loss: 1.754061
Train Epoch: 1 [1200/50000]     Loss: 1.766104
Train Epoch: 1 [1400/50000]     Loss: 1.960237
Train Epoch: 1 [1600/50000]     Loss: 2.526944
Train Epoch: 1 [1800/50000]     Loss: 2.034320
Train Epoch: 1 [2000/50000]     Loss: 1.501211
Train Epoch: 1 [2200/50000]     Loss: 1.849944
Train Epoch: 1 [2400/50000]     Loss: 2.089311
Train Epoch: 1 [2600/50000]     Loss: 1.663869
Train Epoch: 1 [2800/50000]     Loss: 1.838159
Train Epoch: 1 [3000/50000]     Loss: 2.078507
Train Epoch: 1 [3200/50000]     Loss: 2.168740
Train Epoch: 1 [3400/50000]     Loss: 1.856550
Train Epoch: 1 [3600/50000]     Loss: 1.200735
Train Epoch: 1 [3800/50000]     Loss: 1.700612
Train Epoch: 1 [4000/50000]     Loss: 1.480917
Train Epoch: 1 [4200/50000]     Loss: 1.696421
Train Epoch: 1 [4400/50000]     Loss: 2.034388
Train Epoch: 1 [4600/50000]     Loss: 1.318608
Train Epoch: 1 [4800/50000]     Loss: 1.492832
Train Epoch: 1 [5000/50000]     Loss: 1.632298
Train Epoch: 1 [5200/50000]     Loss: 1.499051
Train Epoch: 1 [5400/50000]     Loss: 1.960772
Train Epoch: 1 [5600/50000]     Loss: 1.416634
Train Epoch: 1 [5800/50000]     Loss: 2.114648
Train Epoch: 1 [6000/50000]     Loss: 1.624153
Train Epoch: 1 [6200/50000]     Loss: 1.609074
Train Epoch: 1 [6400/50000]     Loss: 1.448991
Train Epoch: 1 [6600/50000]     Loss: 1.357250
Train Epoch: 1 [6800/50000]     Loss: 1.778993
Train Epoch: 1 [7000/50000]     Loss: 1.665436
Train Epoch: 1 [7200/50000]     Loss: 1.295787
Train Epoch: 1 [7400/50000]     Loss: 1.219730
Train Epoch: 1 [7600/50000]     Loss: 1.461060
Train Epoch: 1 [7800/50000]     Loss: 1.412478
Train Epoch: 1 [8000/50000]     Loss: 0.972340
Train Epoch: 1 [8200/50000]     Loss: 1.422080
Train Epoch: 1 [8400/50000]     Loss: 1.487367
Train Epoch: 1 [8600/50000]     Loss: 1.163396
Train Epoch: 1 [8800/50000]     Loss: 1.182753
```

```
Train Epoch: 1 [9000/50000]     Loss: 1.847768
Train Epoch: 1 [9200/50000]     Loss: 1.081056
Train Epoch: 1 [9400/50000]     Loss: 1.359882
Train Epoch: 1 [9600/50000]     Loss: 1.125977
Train Epoch: 1 [9800/50000]     Loss: 1.068419
Train Epoch: 1 [10000/50000]    Loss: 1.846747
Train Epoch: 1 [10200/50000]    Loss: 1.416642
Train Epoch: 1 [10400/50000]    Loss: 1.894654
Train Epoch: 1 [10600/50000]    Loss: 1.524623
Train Epoch: 1 [10800/50000]    Loss: 1.183961
Train Epoch: 1 [11000/50000]    Loss: 1.884563
Train Epoch: 1 [11200/50000]    Loss: 1.649499
Train Epoch: 1 [11400/50000]    Loss: 1.273354
Train Epoch: 1 [11600/50000]    Loss: 1.315624
Train Epoch: 1 [11800/50000]    Loss: 0.916909
Train Epoch: 1 [12000/50000]    Loss: 0.978714
Train Epoch: 1 [12200/50000]    Loss: 1.686446
Train Epoch: 1 [12400/50000]    Loss: 1.443461
Train Epoch: 1 [12600/50000]    Loss: 1.603462
Train Epoch: 1 [12800/50000]    Loss: 1.472552
Train Epoch: 1 [13000/50000]    Loss: 1.434821
Train Epoch: 1 [13200/50000]    Loss: 1.474571
Train Epoch: 1 [13400/50000]    Loss: 1.561908
Train Epoch: 1 [13600/50000]    Loss: 1.503291
Train Epoch: 1 [13800/50000]    Loss: 1.057458
Train Epoch: 1 [14000/50000]    Loss: 1.745626
Train Epoch: 1 [14200/50000]    Loss: 1.011908
Train Epoch: 1 [14400/50000]    Loss: 1.337948
Train Epoch: 1 [14600/50000]    Loss: 1.027881
Train Epoch: 1 [14800/50000]    Loss: 1.472725
Train Epoch: 1 [15000/50000]    Loss: 1.218852
Train Epoch: 1 [15200/50000]    Loss: 1.097761
Train Epoch: 1 [15400/50000]    Loss: 1.733565
Train Epoch: 1 [15600/50000]    Loss: 1.275257
Train Epoch: 1 [15800/50000]    Loss: 1.480244
Train Epoch: 1 [16000/50000]    Loss: 0.983288
Train Epoch: 1 [16200/50000]    Loss: 0.712094
Train Epoch: 1 [16400/50000]    Loss: 1.367369
Train Epoch: 1 [16600/50000]    Loss: 1.349883
Train Epoch: 1 [16800/50000]    Loss: 1.061927
Train Epoch: 1 [17000/50000]    Loss: 0.951214
Train Epoch: 1 [17200/50000]    Loss: 1.308497
Train Epoch: 1 [17400/50000]    Loss: 1.625483
Train Epoch: 1 [17600/50000]    Loss: 0.945806
Train Epoch: 1 [17800/50000]    Loss: 1.175179
Train Epoch: 1 [18000/50000]    Loss: 1.155746
Train Epoch: 1 [18200/50000]    Loss: 1.013066
Train Epoch: 1 [18400/50000]    Loss: 1.161711
```

```
Train Epoch: 1 [18600/50000]    Loss: 1.588693
Train Epoch: 1 [18800/50000]    Loss: 1.916063
Train Epoch: 1 [19000/50000]    Loss: 1.746563
Train Epoch: 1 [19200/50000]    Loss: 1.419912
Train Epoch: 1 [19400/50000]    Loss: 1.182107
Train Epoch: 1 [19600/50000]    Loss: 1.121398
Train Epoch: 1 [19800/50000]    Loss: 1.323335
Train Epoch: 1 [20000/50000]    Loss: 1.234651
Train Epoch: 1 [20200/50000]    Loss: 0.867598
Train Epoch: 1 [20400/50000]    Loss: 1.189319
Train Epoch: 1 [20600/50000]    Loss: 1.239048
Train Epoch: 1 [20800/50000]    Loss: 1.738647
Train Epoch: 1 [21000/50000]    Loss: 0.750951
Train Epoch: 1 [21200/50000]    Loss: 1.343618
Train Epoch: 1 [21400/50000]    Loss: 1.018711
Train Epoch: 1 [21600/50000]    Loss: 1.060532
Train Epoch: 1 [21800/50000]    Loss: 0.960371
Train Epoch: 1 [22000/50000]    Loss: 1.491678
Train Epoch: 1 [22200/50000]    Loss: 1.411234
Train Epoch: 1 [22400/50000]    Loss: 0.832322
Train Epoch: 1 [22600/50000]    Loss: 0.905524
Train Epoch: 1 [22800/50000]    Loss: 1.578456
Train Epoch: 1 [23000/50000]    Loss: 1.110731
Train Epoch: 1 [23200/50000]    Loss: 0.549604
Train Epoch: 1 [23400/50000]    Loss: 0.957260
Train Epoch: 1 [23600/50000]    Loss: 1.018300
Train Epoch: 1 [23800/50000]    Loss: 1.501385
Train Epoch: 1 [24000/50000]    Loss: 1.233257
Train Epoch: 1 [24200/50000]    Loss: 1.011847
Train Epoch: 1 [24400/50000]    Loss: 1.160806
Train Epoch: 1 [24600/50000]    Loss: 1.266435
Train Epoch: 1 [24800/50000]    Loss: 1.145587
Train Epoch: 1 [25000/50000]    Loss: 1.077122
Train Epoch: 1 [25200/50000]    Loss: 1.045336
Train Epoch: 1 [25400/50000]    Loss: 0.768823
Train Epoch: 1 [25600/50000]    Loss: 1.006773
Train Epoch: 1 [25800/50000]    Loss: 1.586975
Train Epoch: 1 [26000/50000]    Loss: 0.542039
Train Epoch: 1 [26200/50000]    Loss: 1.127221
Train Epoch: 1 [26400/50000]    Loss: 0.912868
Train Epoch: 1 [26600/50000]    Loss: 1.024427
Train Epoch: 1 [26800/50000]    Loss: 0.966509
Train Epoch: 1 [27000/50000]    Loss: 1.216844
Train Epoch: 1 [27200/50000]    Loss: 0.781181
Train Epoch: 1 [27400/50000]    Loss: 1.510199
Train Epoch: 1 [27600/50000]    Loss: 1.376901
Train Epoch: 1 [27800/50000]    Loss: 0.916623
Train Epoch: 1 [28000/50000]    Loss: 0.789983
```

```
Train Epoch: 1 [28200/50000]    Loss: 0.932105
Train Epoch: 1 [28400/50000]    Loss: 1.154930
Train Epoch: 1 [28600/50000]    Loss: 0.633320
Train Epoch: 1 [28800/50000]    Loss: 1.190146
Train Epoch: 1 [29000/50000]    Loss: 1.038195
Train Epoch: 1 [29200/50000]    Loss: 0.997856
Train Epoch: 1 [29400/50000]    Loss: 1.517922
Train Epoch: 1 [29600/50000]    Loss: 0.861667
Train Epoch: 1 [29800/50000]    Loss: 1.346462
Train Epoch: 1 [30000/50000]    Loss: 0.642658
Train Epoch: 1 [30200/50000]    Loss: 1.000845
Train Epoch: 1 [30400/50000]    Loss: 1.218469
Train Epoch: 1 [30600/50000]    Loss: 0.842872
Train Epoch: 1 [30800/50000]    Loss: 0.746335
Train Epoch: 1 [31000/50000]    Loss: 1.111200
Train Epoch: 1 [31200/50000]    Loss: 1.117150
Train Epoch: 1 [31400/50000]    Loss: 0.748897
Train Epoch: 1 [31600/50000]    Loss: 0.602110
Train Epoch: 1 [31800/50000]    Loss: 0.639976
Train Epoch: 1 [32000/50000]    Loss: 1.493471
Train Epoch: 1 [32200/50000]    Loss: 0.766107
Train Epoch: 1 [32400/50000]    Loss: 1.021016
Train Epoch: 1 [32600/50000]    Loss: 1.267348
Train Epoch: 1 [32800/50000]    Loss: 0.841135
Train Epoch: 1 [33000/50000]    Loss: 0.873952
Train Epoch: 1 [33200/50000]    Loss: 0.815647
Train Epoch: 1 [33400/50000]    Loss: 1.079646
Train Epoch: 1 [33600/50000]    Loss: 1.184213
Train Epoch: 1 [33800/50000]    Loss: 0.871698
Train Epoch: 1 [34000/50000]    Loss: 0.912154
Train Epoch: 1 [34200/50000]    Loss: 1.236425
Train Epoch: 1 [34400/50000]    Loss: 0.869748
Train Epoch: 1 [34600/50000]    Loss: 0.630819
Train Epoch: 1 [34800/50000]    Loss: 1.273198
Train Epoch: 1 [35000/50000]    Loss: 0.995049
Train Epoch: 1 [35200/50000]    Loss: 0.707089
Train Epoch: 1 [35400/50000]    Loss: 0.626135
Train Epoch: 1 [35600/50000]    Loss: 0.972544
Train Epoch: 1 [35800/50000]    Loss: 0.964553
Train Epoch: 1 [36000/50000]    Loss: 0.493003
Train Epoch: 1 [36200/50000]    Loss: 1.175366
Train Epoch: 1 [36400/50000]    Loss: 0.876507
Train Epoch: 1 [36600/50000]    Loss: 0.735749
Train Epoch: 1 [36800/50000]    Loss: 0.992696
Train Epoch: 1 [37000/50000]    Loss: 1.041049
Train Epoch: 1 [37200/50000]    Loss: 1.264310
Train Epoch: 1 [37400/50000]    Loss: 0.985459
Train Epoch: 1 [37600/50000]    Loss: 0.933183
```

```
Train Epoch: 1 [37800/50000]    Loss: 1.285801
Train Epoch: 1 [38000/50000]    Loss: 0.824300
Train Epoch: 1 [38200/50000]    Loss: 1.318889
Train Epoch: 1 [38400/50000]    Loss: 0.793809
Train Epoch: 1 [38600/50000]    Loss: 0.906094
Train Epoch: 1 [38800/50000]    Loss: 1.040345
Train Epoch: 1 [39000/50000]    Loss: 0.763759
Train Epoch: 1 [39200/50000]    Loss: 1.450847
Train Epoch: 1 [39400/50000]    Loss: 1.203962
Train Epoch: 1 [39600/50000]    Loss: 0.683850
Train Epoch: 1 [39800/50000]    Loss: 0.873281
Train Epoch: 1 [40000/50000]    Loss: 1.198866
Train Epoch: 1 [40200/50000]    Loss: 0.485358
Train Epoch: 1 [40400/50000]    Loss: 0.545553
Train Epoch: 1 [40600/50000]    Loss: 1.248111
Train Epoch: 1 [40800/50000]    Loss: 1.021577
Train Epoch: 1 [41000/50000]    Loss: 0.809533
Train Epoch: 1 [41200/50000]    Loss: 1.163743
Train Epoch: 1 [41400/50000]    Loss: 1.234959
Train Epoch: 1 [41600/50000]    Loss: 1.429584
Train Epoch: 1 [41800/50000]    Loss: 0.580382
Train Epoch: 1 [42000/50000]    Loss: 0.979552
Train Epoch: 1 [42200/50000]    Loss: 0.980967
Train Epoch: 1 [42400/50000]    Loss: 0.647443
Train Epoch: 1 [42600/50000]    Loss: 1.156485
Train Epoch: 1 [42800/50000]    Loss: 0.627365
Train Epoch: 1 [43000/50000]    Loss: 0.823555
Train Epoch: 1 [43200/50000]    Loss: 0.439539
Train Epoch: 1 [43400/50000]    Loss: 1.031454
Train Epoch: 1 [43600/50000]    Loss: 0.786226
Train Epoch: 1 [43800/50000]    Loss: 0.850945
Train Epoch: 1 [44000/50000]    Loss: 1.092021
Train Epoch: 1 [44200/50000]    Loss: 1.426649
Train Epoch: 1 [44400/50000]    Loss: 0.777811
Train Epoch: 1 [44600/50000]    Loss: 1.132651
Train Epoch: 1 [44800/50000]    Loss: 0.864615
Train Epoch: 1 [45000/50000]    Loss: 0.672004
Train Epoch: 1 [45200/50000]    Loss: 0.838518
Train Epoch: 1 [45400/50000]    Loss: 1.078938
Train Epoch: 1 [45600/50000]    Loss: 1.227055
Train Epoch: 1 [45800/50000]    Loss: 0.859607
Train Epoch: 1 [46000/50000]    Loss: 0.944770
Train Epoch: 1 [46200/50000]    Loss: 1.232480
Train Epoch: 1 [46400/50000]    Loss: 0.454321
Train Epoch: 1 [46600/50000]    Loss: 1.145662
Train Epoch: 1 [46800/50000]    Loss: 0.713018
Train Epoch: 1 [47000/50000]    Loss: 1.164750
Train Epoch: 1 [47200/50000]    Loss: 0.888634
```

```
Train Epoch: 1 [47400/50000]    Loss: 0.979105
Train Epoch: 1 [47600/50000]    Loss: 1.475491
Train Epoch: 1 [47800/50000]    Loss: 0.703944
Train Epoch: 1 [48000/50000]    Loss: 1.205883
Train Epoch: 1 [48200/50000]    Loss: 1.060452
Train Epoch: 1 [48400/50000]    Loss: 1.081008
Train Epoch: 1 [48600/50000]    Loss: 1.094419
Train Epoch: 1 [48800/50000]    Loss: 0.543058
Train Epoch: 1 [49000/50000]    Loss: 0.456335
Train Epoch: 1 [49200/50000]    Loss: 0.991718
Train Epoch: 1 [49400/50000]    Loss: 0.615764
Train Epoch: 1 [49600/50000]    Loss: 0.579546
Train Epoch: 1 [49800/50000]    Loss: 0.790494
```

```
<ipython-input-14-0b1ccd3c1330>:9: UserWarning: volatile was removed and now has
no effect. Use `with torch.no_grad():` instead.
  data, target = Variable(data, volatile=True), Variable(target)
```

```
Test set: Avg. loss: 0.8981, Accuracy: 6825.0/10000 (68%)
```

```
Train Epoch: 2 [0/50000]        Loss: 0.654532
Train Epoch: 2 [200/50000]      Loss: 1.029810
Train Epoch: 2 [400/50000]      Loss: 0.870169
Train Epoch: 2 [600/50000]      Loss: 0.665053
Train Epoch: 2 [800/50000]      Loss: 0.593758
Train Epoch: 2 [1000/50000]     Loss: 1.296146
Train Epoch: 2 [1200/50000]     Loss: 0.548591
Train Epoch: 2 [1400/50000]     Loss: 0.929894
Train Epoch: 2 [1600/50000]     Loss: 1.216652
Train Epoch: 2 [1800/50000]     Loss: 1.067426
Train Epoch: 2 [2000/50000]     Loss: 0.684273
Train Epoch: 2 [2200/50000]     Loss: 0.957926
Train Epoch: 2 [2400/50000]     Loss: 0.771030
Train Epoch: 2 [2600/50000]     Loss: 0.537830
Train Epoch: 2 [2800/50000]     Loss: 1.144055
Train Epoch: 2 [3000/50000]     Loss: 0.567103
Train Epoch: 2 [3200/50000]     Loss: 0.974064
Train Epoch: 2 [3400/50000]     Loss: 0.506676
Train Epoch: 2 [3600/50000]     Loss: 0.779136
Train Epoch: 2 [3800/50000]     Loss: 0.822205
Train Epoch: 2 [4000/50000]     Loss: 0.768403
Train Epoch: 2 [4200/50000]     Loss: 1.080364
Train Epoch: 2 [4400/50000]     Loss: 0.285992
Train Epoch: 2 [4600/50000]     Loss: 0.579498
Train Epoch: 2 [4800/50000]     Loss: 0.601920
Train Epoch: 2 [5000/50000]     Loss: 0.710141
Train Epoch: 2 [5200/50000]     Loss: 0.614403
Train Epoch: 2 [5400/50000]     Loss: 0.974027
```

```
Train Epoch: 2 [5600/50000]     Loss: 0.808183
Train Epoch: 2 [5800/50000]     Loss: 1.008623
Train Epoch: 2 [6000/50000]     Loss: 0.852783
Train Epoch: 2 [6200/50000]     Loss: 0.475453
Train Epoch: 2 [6400/50000]     Loss: 0.327658
Train Epoch: 2 [6600/50000]     Loss: 0.412129
Train Epoch: 2 [6800/50000]     Loss: 1.013659
Train Epoch: 2 [7000/50000]     Loss: 1.123056
Train Epoch: 2 [7200/50000]     Loss: 0.433353
Train Epoch: 2 [7400/50000]     Loss: 0.893112
Train Epoch: 2 [7600/50000]     Loss: 0.811885
Train Epoch: 2 [7800/50000]     Loss: 0.832328
Train Epoch: 2 [8000/50000]     Loss: 1.030569
Train Epoch: 2 [8200/50000]     Loss: 0.628036
Train Epoch: 2 [8400/50000]     Loss: 1.130880
Train Epoch: 2 [8600/50000]     Loss: 0.875845
Train Epoch: 2 [8800/50000]     Loss: 0.789894
Train Epoch: 2 [9000/50000]     Loss: 0.479765
Train Epoch: 2 [9200/50000]     Loss: 0.864536
Train Epoch: 2 [9400/50000]     Loss: 0.713661
Train Epoch: 2 [9600/50000]     Loss: 0.518885
Train Epoch: 2 [9800/50000]     Loss: 1.376597
Train Epoch: 2 [10000/50000]    Loss: 0.681633
Train Epoch: 2 [10200/50000]    Loss: 0.635439
Train Epoch: 2 [10400/50000]    Loss: 0.810555
Train Epoch: 2 [10600/50000]    Loss: 0.606856
Train Epoch: 2 [10800/50000]    Loss: 0.901835
Train Epoch: 2 [11000/50000]    Loss: 0.570580
Train Epoch: 2 [11200/50000]    Loss: 0.366694
Train Epoch: 2 [11400/50000]    Loss: 0.857698
Train Epoch: 2 [11600/50000]    Loss: 0.592030
Train Epoch: 2 [11800/50000]    Loss: 0.686546
Train Epoch: 2 [12000/50000]    Loss: 0.560130
Train Epoch: 2 [12200/50000]    Loss: 0.867422
Train Epoch: 2 [12400/50000]    Loss: 0.616177
Train Epoch: 2 [12600/50000]    Loss: 0.405967
Train Epoch: 2 [12800/50000]    Loss: 0.821926
Train Epoch: 2 [13000/50000]    Loss: 1.088094
Train Epoch: 2 [13200/50000]    Loss: 1.024757
Train Epoch: 2 [13400/50000]    Loss: 0.528844
Train Epoch: 2 [13600/50000]    Loss: 0.793599
Train Epoch: 2 [13800/50000]    Loss: 1.063498
Train Epoch: 2 [14000/50000]    Loss: 0.507384
Train Epoch: 2 [14200/50000]    Loss: 0.654369
Train Epoch: 2 [14400/50000]    Loss: 0.342883
Train Epoch: 2 [14600/50000]    Loss: 1.010989
Train Epoch: 2 [14800/50000]    Loss: 0.490469
Train Epoch: 2 [15000/50000]    Loss: 0.815723
```

```
Train Epoch: 2 [15200/50000]    Loss: 1.221889
Train Epoch: 2 [15400/50000]    Loss: 0.420052
Train Epoch: 2 [15600/50000]    Loss: 0.687196
Train Epoch: 2 [15800/50000]    Loss: 0.763221
Train Epoch: 2 [16000/50000]    Loss: 1.036977
Train Epoch: 2 [16200/50000]    Loss: 0.490855
Train Epoch: 2 [16400/50000]    Loss: 0.614861
Train Epoch: 2 [16600/50000]    Loss: 0.678863
Train Epoch: 2 [16800/50000]    Loss: 0.681634
Train Epoch: 2 [17000/50000]    Loss: 0.746933
Train Epoch: 2 [17200/50000]    Loss: 1.068181
Train Epoch: 2 [17400/50000]    Loss: 0.556523
Train Epoch: 2 [17600/50000]    Loss: 0.615530
Train Epoch: 2 [17800/50000]    Loss: 0.649614
Train Epoch: 2 [18000/50000]    Loss: 0.526017
Train Epoch: 2 [18200/50000]    Loss: 0.906584
Train Epoch: 2 [18400/50000]    Loss: 0.478166
Train Epoch: 2 [18600/50000]    Loss: 1.063414
Train Epoch: 2 [18800/50000]    Loss: 0.326592
Train Epoch: 2 [19000/50000]    Loss: 0.397606
Train Epoch: 2 [19200/50000]    Loss: 0.651215
Train Epoch: 2 [19400/50000]    Loss: 0.882603
Train Epoch: 2 [19600/50000]    Loss: 0.800969
Train Epoch: 2 [19800/50000]    Loss: 0.474000
Train Epoch: 2 [20000/50000]    Loss: 0.969089
Train Epoch: 2 [20200/50000]    Loss: 0.693422
Train Epoch: 2 [20400/50000]    Loss: 0.815063
Train Epoch: 2 [20600/50000]    Loss: 0.838548
Train Epoch: 2 [20800/50000]    Loss: 0.970645
Train Epoch: 2 [21000/50000]    Loss: 1.062261
Train Epoch: 2 [21200/50000]    Loss: 0.915075
Train Epoch: 2 [21400/50000]    Loss: 0.564237
Train Epoch: 2 [21600/50000]    Loss: 0.499967
Train Epoch: 2 [21800/50000]    Loss: 0.391775
Train Epoch: 2 [22000/50000]    Loss: 0.523867
Train Epoch: 2 [22200/50000]    Loss: 0.567313
Train Epoch: 2 [22400/50000]    Loss: 0.890389
Train Epoch: 2 [22600/50000]    Loss: 0.844662
Train Epoch: 2 [22800/50000]    Loss: 0.794324
Train Epoch: 2 [23000/50000]    Loss: 0.624869
Train Epoch: 2 [23200/50000]    Loss: 0.445303
Train Epoch: 2 [23400/50000]    Loss: 0.646268
Train Epoch: 2 [23600/50000]    Loss: 0.290534
Train Epoch: 2 [23800/50000]    Loss: 0.965979
Train Epoch: 2 [24000/50000]    Loss: 0.671062
Train Epoch: 2 [24200/50000]    Loss: 0.569050
Train Epoch: 2 [24400/50000]    Loss: 0.562605
Train Epoch: 2 [24600/50000]    Loss: 0.327941
```

```
Train Epoch: 2 [24800/50000]    Loss: 0.750865
Train Epoch: 2 [25000/50000]    Loss: 0.295088
Train Epoch: 2 [25200/50000]    Loss: 0.409695
Train Epoch: 2 [25400/50000]    Loss: 1.000589
Train Epoch: 2 [25600/50000]    Loss: 0.577015
Train Epoch: 2 [25800/50000]    Loss: 0.410979
Train Epoch: 2 [26000/50000]    Loss: 0.542117
Train Epoch: 2 [26200/50000]    Loss: 0.537692
Train Epoch: 2 [26400/50000]    Loss: 0.476498
Train Epoch: 2 [26600/50000]    Loss: 1.038498
Train Epoch: 2 [26800/50000]    Loss: 0.639601
Train Epoch: 2 [27000/50000]    Loss: 0.829595
Train Epoch: 2 [27200/50000]    Loss: 0.504169
Train Epoch: 2 [27400/50000]    Loss: 0.615707
Train Epoch: 2 [27600/50000]    Loss: 0.600195
Train Epoch: 2 [27800/50000]    Loss: 0.934570
Train Epoch: 2 [28000/50000]    Loss: 1.214850
Train Epoch: 2 [28200/50000]    Loss: 0.365700
Train Epoch: 2 [28400/50000]    Loss: 0.617009
Train Epoch: 2 [28600/50000]    Loss: 0.565135
Train Epoch: 2 [28800/50000]    Loss: 0.329403
Train Epoch: 2 [29000/50000]    Loss: 1.721246
Train Epoch: 2 [29200/50000]    Loss: 0.834374
Train Epoch: 2 [29400/50000]    Loss: 0.745119
Train Epoch: 2 [29600/50000]    Loss: 0.815988
Train Epoch: 2 [29800/50000]    Loss: 0.601722
Train Epoch: 2 [30000/50000]    Loss: 0.707610
Train Epoch: 2 [30200/50000]    Loss: 0.556655
Train Epoch: 2 [30400/50000]    Loss: 0.504812
Train Epoch: 2 [30600/50000]    Loss: 0.422750
Train Epoch: 2 [30800/50000]    Loss: 0.820822
Train Epoch: 2 [31000/50000]    Loss: 0.922690
Train Epoch: 2 [31200/50000]    Loss: 0.781753
Train Epoch: 2 [31400/50000]    Loss: 0.520284
Train Epoch: 2 [31600/50000]    Loss: 0.469028
Train Epoch: 2 [31800/50000]    Loss: 0.467663
Train Epoch: 2 [32000/50000]    Loss: 0.531727
Train Epoch: 2 [32200/50000]    Loss: 0.856697
Train Epoch: 2 [32400/50000]    Loss: 0.346957
Train Epoch: 2 [32600/50000]    Loss: 0.514006
Train Epoch: 2 [32800/50000]    Loss: 0.758797
Train Epoch: 2 [33000/50000]    Loss: 0.514112
Train Epoch: 2 [33200/50000]    Loss: 1.020859
Train Epoch: 2 [33400/50000]    Loss: 0.840861
Train Epoch: 2 [33600/50000]    Loss: 0.509668
Train Epoch: 2 [33800/50000]    Loss: 0.920582
Train Epoch: 2 [34000/50000]    Loss: 0.776490
Train Epoch: 2 [34200/50000]    Loss: 1.383571
```

```
Train Epoch: 2 [34400/50000]    Loss: 0.731618
Train Epoch: 2 [34600/50000]    Loss: 0.666015
Train Epoch: 2 [34800/50000]    Loss: 0.560051
Train Epoch: 2 [35000/50000]    Loss: 0.694690
Train Epoch: 2 [35200/50000]    Loss: 0.322834
Train Epoch: 2 [35400/50000]    Loss: 0.930365
Train Epoch: 2 [35600/50000]    Loss: 0.583081
Train Epoch: 2 [35800/50000]    Loss: 0.777639
Train Epoch: 2 [36000/50000]    Loss: 0.901834
Train Epoch: 2 [36200/50000]    Loss: 0.422819
Train Epoch: 2 [36400/50000]    Loss: 0.493609
Train Epoch: 2 [36600/50000]    Loss: 0.691012
Train Epoch: 2 [36800/50000]    Loss: 0.458132
Train Epoch: 2 [37000/50000]    Loss: 0.653430
Train Epoch: 2 [37200/50000]    Loss: 0.651054
Train Epoch: 2 [37400/50000]    Loss: 0.408631
Train Epoch: 2 [37600/50000]    Loss: 0.469473
Train Epoch: 2 [37800/50000]    Loss: 0.319632
Train Epoch: 2 [38000/50000]    Loss: 0.468349
Train Epoch: 2 [38200/50000]    Loss: 1.241018
Train Epoch: 2 [38400/50000]    Loss: 0.743703
Train Epoch: 2 [38600/50000]    Loss: 0.789914
Train Epoch: 2 [38800/50000]    Loss: 0.538561
Train Epoch: 2 [39000/50000]    Loss: 0.842700
Train Epoch: 2 [39200/50000]    Loss: 0.566307
Train Epoch: 2 [39400/50000]    Loss: 0.661250
Train Epoch: 2 [39600/50000]    Loss: 0.867728
Train Epoch: 2 [39800/50000]    Loss: 0.667067
Train Epoch: 2 [40000/50000]    Loss: 0.528006
Train Epoch: 2 [40200/50000]    Loss: 0.640040
Train Epoch: 2 [40400/50000]    Loss: 0.446430
Train Epoch: 2 [40600/50000]    Loss: 0.531515
Train Epoch: 2 [40800/50000]    Loss: 0.445959
Train Epoch: 2 [41000/50000]    Loss: 0.411820
Train Epoch: 2 [41200/50000]    Loss: 0.542259
Train Epoch: 2 [41400/50000]    Loss: 0.599100
Train Epoch: 2 [41600/50000]    Loss: 1.177429
Train Epoch: 2 [41800/50000]    Loss: 0.327563
Train Epoch: 2 [42000/50000]    Loss: 0.709161
Train Epoch: 2 [42200/50000]    Loss: 0.696615
Train Epoch: 2 [42400/50000]    Loss: 0.946126
Train Epoch: 2 [42600/50000]    Loss: 0.737239
Train Epoch: 2 [42800/50000]    Loss: 0.850307
Train Epoch: 2 [43000/50000]    Loss: 0.587437
Train Epoch: 2 [43200/50000]    Loss: 0.632235
Train Epoch: 2 [43400/50000]    Loss: 0.588831
Train Epoch: 2 [43600/50000]    Loss: 0.576913
Train Epoch: 2 [43800/50000]    Loss: 0.581667
```

```
Train Epoch: 2 [44000/50000]    Loss: 0.566125
Train Epoch: 2 [44200/50000]    Loss: 0.599356
Train Epoch: 2 [44400/50000]    Loss: 0.799812
Train Epoch: 2 [44600/50000]    Loss: 0.527207
Train Epoch: 2 [44800/50000]    Loss: 0.485900
Train Epoch: 2 [45000/50000]    Loss: 0.280151
Train Epoch: 2 [45200/50000]    Loss: 0.451955
Train Epoch: 2 [45400/50000]    Loss: 0.688517
Train Epoch: 2 [45600/50000]    Loss: 0.869955
Train Epoch: 2 [45800/50000]    Loss: 0.631022
Train Epoch: 2 [46000/50000]    Loss: 0.696083
Train Epoch: 2 [46200/50000]    Loss: 0.438077
Train Epoch: 2 [46400/50000]    Loss: 0.593526
Train Epoch: 2 [46600/50000]    Loss: 0.747158
Train Epoch: 2 [46800/50000]    Loss: 0.366264
Train Epoch: 2 [47000/50000]    Loss: 0.390057
Train Epoch: 2 [47200/50000]    Loss: 0.323158
Train Epoch: 2 [47400/50000]    Loss: 1.022141
Train Epoch: 2 [47600/50000]    Loss: 0.390911
Train Epoch: 2 [47800/50000]    Loss: 0.730117
Train Epoch: 2 [48000/50000]    Loss: 0.366423
Train Epoch: 2 [48200/50000]    Loss: 0.917360
Train Epoch: 2 [48400/50000]    Loss: 0.317739
Train Epoch: 2 [48600/50000]    Loss: 0.248078
Train Epoch: 2 [48800/50000]    Loss: 0.666824
Train Epoch: 2 [49000/50000]    Loss: 0.558469
Train Epoch: 2 [49200/50000]    Loss: 0.618191
Train Epoch: 2 [49400/50000]    Loss: 0.506321
Train Epoch: 2 [49600/50000]    Loss: 0.359132
Train Epoch: 2 [49800/50000]    Loss: 0.812299

Test set: Avg. loss: 0.7141, Accuracy: 7494.0/10000 (75%)

Train Epoch: 3 [0/50000]        Loss: 0.300335
Train Epoch: 3 [200/50000]      Loss: 0.321648
Train Epoch: 3 [400/50000]      Loss: 0.869843
Train Epoch: 3 [600/50000]      Loss: 0.546737
Train Epoch: 3 [800/50000]      Loss: 0.390136
Train Epoch: 3 [1000/50000]     Loss: 0.773302
Train Epoch: 3 [1200/50000]     Loss: 0.528283
Train Epoch: 3 [1400/50000]     Loss: 0.520601
Train Epoch: 3 [1600/50000]     Loss: 0.577919
Train Epoch: 3 [1800/50000]     Loss: 0.395520
Train Epoch: 3 [2000/50000]     Loss: 0.467150
Train Epoch: 3 [2200/50000]     Loss: 0.651813
Train Epoch: 3 [2400/50000]     Loss: 0.267557
Train Epoch: 3 [2600/50000]     Loss: 0.943774
Train Epoch: 3 [2800/50000]     Loss: 0.524996
```

```
Train Epoch: 3 [3000/50000]     Loss: 0.876747
Train Epoch: 3 [3200/50000]     Loss: 0.805563
Train Epoch: 3 [3400/50000]     Loss: 0.114127
Train Epoch: 3 [3600/50000]     Loss: 0.287052
Train Epoch: 3 [3800/50000]     Loss: 0.192914
Train Epoch: 3 [4000/50000]     Loss: 0.243885
Train Epoch: 3 [4200/50000]     Loss: 0.469093
Train Epoch: 3 [4400/50000]     Loss: 0.646217
Train Epoch: 3 [4600/50000]     Loss: 0.802924
Train Epoch: 3 [4800/50000]     Loss: 0.358405
Train Epoch: 3 [5000/50000]     Loss: 0.210161
Train Epoch: 3 [5200/50000]     Loss: 0.865108
Train Epoch: 3 [5400/50000]     Loss: 0.294279
Train Epoch: 3 [5600/50000]     Loss: 0.911768
Train Epoch: 3 [5800/50000]     Loss: 0.735077
Train Epoch: 3 [6000/50000]     Loss: 0.524129
Train Epoch: 3 [6200/50000]     Loss: 0.681751
Train Epoch: 3 [6400/50000]     Loss: 0.135072
Train Epoch: 3 [6600/50000]     Loss: 0.540470
Train Epoch: 3 [6800/50000]     Loss: 0.275004
Train Epoch: 3 [7000/50000]     Loss: 0.431830
Train Epoch: 3 [7200/50000]     Loss: 0.383060
Train Epoch: 3 [7400/50000]     Loss: 0.458538
Train Epoch: 3 [7600/50000]     Loss: 0.767218
Train Epoch: 3 [7800/50000]     Loss: 0.582301
Train Epoch: 3 [8000/50000]     Loss: 0.363832
Train Epoch: 3 [8200/50000]     Loss: 0.332681
Train Epoch: 3 [8400/50000]     Loss: 0.688376
Train Epoch: 3 [8600/50000]     Loss: 0.368382
Train Epoch: 3 [8800/50000]     Loss: 0.383428
Train Epoch: 3 [9000/50000]     Loss: 0.323784
Train Epoch: 3 [9200/50000]     Loss: 0.242443
Train Epoch: 3 [9400/50000]     Loss: 0.319731
Train Epoch: 3 [9600/50000]     Loss: 0.681184
Train Epoch: 3 [9800/50000]     Loss: 0.958869
Train Epoch: 3 [10000/50000]    Loss: 0.346664
Train Epoch: 3 [10200/50000]    Loss: 0.641065
Train Epoch: 3 [10400/50000]    Loss: 0.507868
Train Epoch: 3 [10600/50000]    Loss: 0.709955
Train Epoch: 3 [10800/50000]    Loss: 0.390960
Train Epoch: 3 [11000/50000]    Loss: 0.430111
Train Epoch: 3 [11200/50000]    Loss: 0.396109
Train Epoch: 3 [11400/50000]    Loss: 0.492584
Train Epoch: 3 [11600/50000]    Loss: 0.612672
Train Epoch: 3 [11800/50000]    Loss: 0.378965
Train Epoch: 3 [12000/50000]    Loss: 0.778388
Train Epoch: 3 [12200/50000]    Loss: 0.323754
Train Epoch: 3 [12400/50000]    Loss: 0.339921
```

```
Train Epoch: 3 [12600/50000]    Loss: 0.337305
Train Epoch: 3 [12800/50000]    Loss: 0.257536
Train Epoch: 3 [13000/50000]    Loss: 0.698159
Train Epoch: 3 [13200/50000]    Loss: 0.604306
Train Epoch: 3 [13400/50000]    Loss: 0.539808
Train Epoch: 3 [13600/50000]    Loss: 0.323783
Train Epoch: 3 [13800/50000]    Loss: 0.716992
Train Epoch: 3 [14000/50000]    Loss: 0.678299
Train Epoch: 3 [14200/50000]    Loss: 0.596135
Train Epoch: 3 [14400/50000]    Loss: 0.774636
Train Epoch: 3 [14600/50000]    Loss: 0.489575
Train Epoch: 3 [14800/50000]    Loss: 0.748090
Train Epoch: 3 [15000/50000]    Loss: 0.334778
Train Epoch: 3 [15200/50000]    Loss: 0.163025
Train Epoch: 3 [15400/50000]    Loss: 0.184554
Train Epoch: 3 [15600/50000]    Loss: 0.630633
Train Epoch: 3 [15800/50000]    Loss: 0.764278
Train Epoch: 3 [16000/50000]    Loss: 0.475271
Train Epoch: 3 [16200/50000]    Loss: 0.951359
Train Epoch: 3 [16400/50000]    Loss: 1.164521
Train Epoch: 3 [16600/50000]    Loss: 1.031597
Train Epoch: 3 [16800/50000]    Loss: 0.599827
Train Epoch: 3 [17000/50000]    Loss: 0.371649
Train Epoch: 3 [17200/50000]    Loss: 0.363256
Train Epoch: 3 [17400/50000]    Loss: 0.436770
Train Epoch: 3 [17600/50000]    Loss: 0.501337
Train Epoch: 3 [17800/50000]    Loss: 0.794515
Train Epoch: 3 [18000/50000]    Loss: 0.574391
Train Epoch: 3 [18200/50000]    Loss: 0.716767
Train Epoch: 3 [18400/50000]    Loss: 0.328427
Train Epoch: 3 [18600/50000]    Loss: 0.393800
Train Epoch: 3 [18800/50000]    Loss: 0.462057
Train Epoch: 3 [19000/50000]    Loss: 0.284997
Train Epoch: 3 [19200/50000]    Loss: 0.487143
Train Epoch: 3 [19400/50000]    Loss: 0.727394
Train Epoch: 3 [19600/50000]    Loss: 0.205159
Train Epoch: 3 [19800/50000]    Loss: 0.767379
Train Epoch: 3 [20000/50000]    Loss: 0.513621
Train Epoch: 3 [20200/50000]    Loss: 0.530636
Train Epoch: 3 [20400/50000]    Loss: 0.612346
Train Epoch: 3 [20600/50000]    Loss: 0.332595
Train Epoch: 3 [20800/50000]    Loss: 0.685433
Train Epoch: 3 [21000/50000]    Loss: 0.249412
Train Epoch: 3 [21200/50000]    Loss: 0.464923
Train Epoch: 3 [21400/50000]    Loss: 0.771705
Train Epoch: 3 [21600/50000]    Loss: 0.562839
Train Epoch: 3 [21800/50000]    Loss: 0.462670
Train Epoch: 3 [22000/50000]    Loss: 0.451251
```

```
Train Epoch: 3 [22200/50000]    Loss: 0.219797
Train Epoch: 3 [22400/50000]    Loss: 0.359080
Train Epoch: 3 [22600/50000]    Loss: 0.448290
Train Epoch: 3 [22800/50000]    Loss: 0.254424
Train Epoch: 3 [23000/50000]    Loss: 0.305425
Train Epoch: 3 [23200/50000]    Loss: 0.291168
Train Epoch: 3 [23400/50000]    Loss: 0.610439
Train Epoch: 3 [23600/50000]    Loss: 0.617087
Train Epoch: 3 [23800/50000]    Loss: 0.528595
Train Epoch: 3 [24000/50000]    Loss: 0.265641
Train Epoch: 3 [24200/50000]    Loss: 0.639313
Train Epoch: 3 [24400/50000]    Loss: 0.642289
Train Epoch: 3 [24600/50000]    Loss: 0.271468
Train Epoch: 3 [24800/50000]    Loss: 0.334106
Train Epoch: 3 [25000/50000]    Loss: 0.361519
Train Epoch: 3 [25200/50000]    Loss: 0.719388
Train Epoch: 3 [25400/50000]    Loss: 0.515341
Train Epoch: 3 [25600/50000]    Loss: 0.875745
Train Epoch: 3 [25800/50000]    Loss: 0.418481
Train Epoch: 3 [26000/50000]    Loss: 0.442242
Train Epoch: 3 [26200/50000]    Loss: 0.618127
Train Epoch: 3 [26400/50000]    Loss: 0.266039
Train Epoch: 3 [26600/50000]    Loss: 0.468925
Train Epoch: 3 [26800/50000]    Loss: 0.128359
Train Epoch: 3 [27000/50000]    Loss: 0.777240
Train Epoch: 3 [27200/50000]    Loss: 0.606114
Train Epoch: 3 [27400/50000]    Loss: 0.337058
Train Epoch: 3 [27600/50000]    Loss: 0.808925
Train Epoch: 3 [27800/50000]    Loss: 0.288162
Train Epoch: 3 [28000/50000]    Loss: 0.574000
Train Epoch: 3 [28200/50000]    Loss: 0.903957
Train Epoch: 3 [28400/50000]    Loss: 0.392408
Train Epoch: 3 [28600/50000]    Loss: 0.492492
Train Epoch: 3 [28800/50000]    Loss: 0.174346
Train Epoch: 3 [29000/50000]    Loss: 0.368181
Train Epoch: 3 [29200/50000]    Loss: 0.169802
Train Epoch: 3 [29400/50000]    Loss: 0.475134
Train Epoch: 3 [29600/50000]    Loss: 0.611573
Train Epoch: 3 [29800/50000]    Loss: 0.715719
Train Epoch: 3 [30000/50000]    Loss: 0.370390
Train Epoch: 3 [30200/50000]    Loss: 0.119544
Train Epoch: 3 [30400/50000]    Loss: 0.746619
Train Epoch: 3 [30600/50000]    Loss: 0.710192
Train Epoch: 3 [30800/50000]    Loss: 0.350459
Train Epoch: 3 [31000/50000]    Loss: 0.715149
Train Epoch: 3 [31200/50000]    Loss: 0.332152
Train Epoch: 3 [31400/50000]    Loss: 0.334018
Train Epoch: 3 [31600/50000]    Loss: 0.850422
```

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Train Epoch: 3 [31800/50000]    Loss: 0.897006
Train Epoch: 3 [32000/50000]    Loss: 0.441123
Train Epoch: 3 [32200/50000]    Loss: 0.442351
Train Epoch: 3 [32400/50000]    Loss: 0.463316
Train Epoch: 3 [32600/50000]    Loss: 0.663761
Train Epoch: 3 [32800/50000]    Loss: 0.562658
Train Epoch: 3 [33000/50000]    Loss: 0.160618
Train Epoch: 3 [33200/50000]    Loss: 0.437442
Train Epoch: 3 [33400/50000]    Loss: 0.328456
Train Epoch: 3 [33600/50000]    Loss: 0.636414
Train Epoch: 3 [33800/50000]    Loss: 0.364086
Train Epoch: 3 [34000/50000]    Loss: 0.220340
Train Epoch: 3 [34200/50000]    Loss: 0.749250
Train Epoch: 3 [34400/50000]    Loss: 0.526088
Train Epoch: 3 [34600/50000]    Loss: 0.427818
Train Epoch: 3 [34800/50000]    Loss: 0.610398
Train Epoch: 3 [35000/50000]    Loss: 0.392658
Train Epoch: 3 [35200/50000]    Loss: 0.508500
Train Epoch: 3 [35400/50000]    Loss: 0.312809
Train Epoch: 3 [35600/50000]    Loss: 0.590046
Train Epoch: 3 [35800/50000]    Loss: 0.426993
Train Epoch: 3 [36000/50000]    Loss: 0.551212
Train Epoch: 3 [36200/50000]    Loss: 0.161708
Train Epoch: 3 [36400/50000]    Loss: 0.612676
Train Epoch: 3 [36600/50000]    Loss: 0.285740
Train Epoch: 3 [36800/50000]    Loss: 0.378042
Train Epoch: 3 [37000/50000]    Loss: 0.459315
Train Epoch: 3 [37200/50000]    Loss: 0.332377
Train Epoch: 3 [37400/50000]    Loss: 0.496258
Train Epoch: 3 [37600/50000]    Loss: 0.496590
Train Epoch: 3 [37800/50000]    Loss: 0.424325
Train Epoch: 3 [38000/50000]    Loss: 0.623249
Train Epoch: 3 [38200/50000]    Loss: 0.486835
Train Epoch: 3 [38400/50000]    Loss: 0.553917
Train Epoch: 3 [38600/50000]    Loss: 0.861699
Train Epoch: 3 [38800/50000]    Loss: 0.753997
Train Epoch: 3 [39000/50000]    Loss: 0.301722
Train Epoch: 3 [39200/50000]    Loss: 0.479036
Train Epoch: 3 [39400/50000]    Loss: 0.741558
Train Epoch: 3 [39600/50000]    Loss: 0.465162
Train Epoch: 3 [39800/50000]    Loss: 0.492274
Train Epoch: 3 [40000/50000]    Loss: 0.585038
Train Epoch: 3 [40200/50000]    Loss: 0.343422
Train Epoch: 3 [40400/50000]    Loss: 0.190135
Train Epoch: 3 [40600/50000]    Loss: 0.653943
Train Epoch: 3 [40800/50000]    Loss: 0.540839
Train Epoch: 3 [41000/50000]    Loss: 0.370065
Train Epoch: 3 [41200/50000]    Loss: 0.944266
```

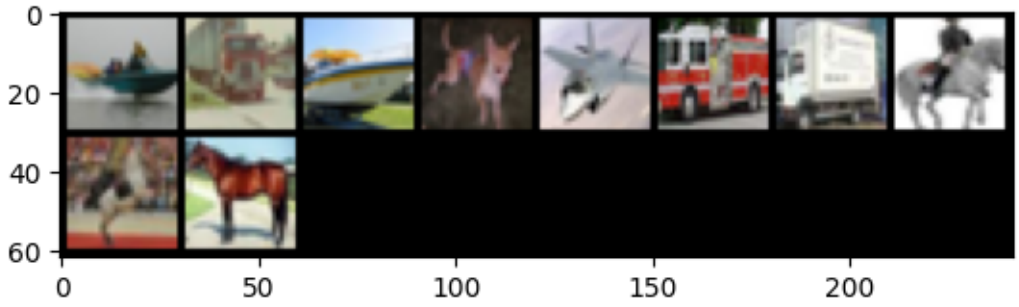
```
Train Epoch: 3 [41400/50000]    Loss: 0.727646
Train Epoch: 3 [41600/50000]    Loss: 0.648009
Train Epoch: 3 [41800/50000]    Loss: 0.239449
Train Epoch: 3 [42000/50000]    Loss: 0.536370
Train Epoch: 3 [42200/50000]    Loss: 0.563043
Train Epoch: 3 [42400/50000]    Loss: 0.548454
Train Epoch: 3 [42600/50000]    Loss: 0.470158
Train Epoch: 3 [42800/50000]    Loss: 0.522977
Train Epoch: 3 [43000/50000]    Loss: 0.465580
Train Epoch: 3 [43200/50000]    Loss: 0.402553
Train Epoch: 3 [43400/50000]    Loss: 0.155543
Train Epoch: 3 [43600/50000]    Loss: 0.688785
Train Epoch: 3 [43800/50000]    Loss: 0.417702
Train Epoch: 3 [44000/50000]    Loss: 0.265122
Train Epoch: 3 [44200/50000]    Loss: 0.250281
Train Epoch: 3 [44400/50000]    Loss: 1.055510
Train Epoch: 3 [44600/50000]    Loss: 0.927928
Train Epoch: 3 [44800/50000]    Loss: 0.523313
Train Epoch: 3 [45000/50000]    Loss: 0.216840
Train Epoch: 3 [45200/50000]    Loss: 0.335507
Train Epoch: 3 [45400/50000]    Loss: 0.387830
Train Epoch: 3 [45600/50000]    Loss: 0.440924
Train Epoch: 3 [45800/50000]    Loss: 0.917895
Train Epoch: 3 [46000/50000]    Loss: 0.718081
Train Epoch: 3 [46200/50000]    Loss: 0.448915
Train Epoch: 3 [46400/50000]    Loss: 0.120028
Train Epoch: 3 [46600/50000]    Loss: 0.108358
Train Epoch: 3 [46800/50000]    Loss: 0.701542
Train Epoch: 3 [47000/50000]    Loss: 0.750619
Train Epoch: 3 [47200/50000]    Loss: 0.597941
Train Epoch: 3 [47400/50000]    Loss: 0.370444
Train Epoch: 3 [47600/50000]    Loss: 0.636897
Train Epoch: 3 [47800/50000]    Loss: 0.477511
Train Epoch: 3 [48000/50000]    Loss: 0.593949
Train Epoch: 3 [48200/50000]    Loss: 0.468678
Train Epoch: 3 [48400/50000]    Loss: 0.488911
Train Epoch: 3 [48600/50000]    Loss: 0.963066
Train Epoch: 3 [48800/50000]    Loss: 0.360941
Train Epoch: 3 [49000/50000]    Loss: 0.201093
Train Epoch: 3 [49200/50000]    Loss: 0.530508
Train Epoch: 3 [49400/50000]    Loss: 0.504239
Train Epoch: 3 [49600/50000]    Loss: 0.956346
Train Epoch: 3 [49800/50000]    Loss: 0.377968

Test set: Avg. loss: 0.6454, Accuracy: 7841.0/10000 (78%)
```

[21]:
```
# Run network on data we got before and show predictions
examples = enumerate(test_loader)
batch_idx, (example_data, example_target) = next(examples)
if torch.cuda.is_available():
  example_data, example_target = example_data.cuda(), example_target.cuda()
output = model(example_data)

def imshow(img):    # unnormalize
    npimg = img.cpu().numpy()
    plt.imshow(np.transpose(npimg, (1, 2, 0)))
    plt.show()

# show images
imshow(torchvision.utils.make_grid(example_data[:10,:]))
# print labels
print(' '.join('%5s' % classes[example_targets[j]] for j in range(10)))
```




```
Truck Airplane  Bird  Frog Horse   Cat Airplane  Frog   Cat   Car
```

7.1 Good Job.