Data Augmentation

```
import torch
import torchvision
import numpy as np
import matplotlib.pyplot as plt
import PIL
from torchsummary import summary
```

```
# From local helper files
from helper_evaluation import set_all_seeds, set_deterministic, compute_confusion_ma
from helper_train import train_model
from helper_plotting import plot_training_loss, plot_accuracy, show_examples, plot_c
from helper_dataset import get_dataloaders_cifar10, UnNormalize
```

```
RANDOM_SEED = 123
BATCH_SIZE = 256
NUM_EPOCHS = 40
DEVICE = torch.device('cuda:0' if torch.cuda.is_available() else 'cpu')
```

```
train_transforms = torchvision.transforms.Compose([
    torchvision.transforms.Resize((16, 16)),
    torchvision.transforms.ToTensor(),
    torchvision.transforms.RandomRotation(degrees=30, interpolation=PIL.Image.BILINE
    torchvision.transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
])

test_transforms = torchvision.transforms.Compose([
      torchvision.transforms.Resize((16, 16)),
    torchvision.transforms.ToTensor(),
    torchvision.transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
])
```

```
train_loader_augmented, valid_loader_augmented, test_loader_augmented = get_dataload
    batch_size=BATCH_SIZE,
    validation_fraction=0.1,
    train_transforms=train_transforms,
    test_transforms=test_transforms,
    num_workers=2)
```

```
/usr/local/lib/python3.7/dist-packages/torchvision/transforms/transforms.py:1306
  "Argument 'interpolation' of type int is deprecated since 0.13 and will be rem
Downloading https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz to data/cifa
100%                                 170498071/170498071 [00:02<00:00, 86044312.77it/s]
```

```
class CNN1(torch.nn.Module):
  def __init__(self, num_classes):
    super().__init__()
    self.features = torch.nn.Sequential(
            # Conv 1
            torch.nn.Conv2d(3, 16, kernel_size=3, padding="same"), # output 16 - 3 +
                            # , stride=4, padding=2),
            torch.nn.ReLU(inplace=True),
            torch.nn.MaxPool2d(kernel_size=2), # 16 / 2 => output 8

            # Conv 2
            torch.nn.Conv2d(16, 32, kernel_size=2, padding="same"), # output 7 - 2 +
                            # , padding=2),
            torch.nn.ReLU(inplace=True),
            torch.nn.MaxPool2d(kernel_size=2) #output 8 / 2 => output 4
    )

    self.classifier = torch.nn.Sequential(
         torch.nn.Linear(32*4*4, 100),
          torch.nn.ReLU(inplace=True),
          torch.nn.Linear(100, num_classes),
    )

  def forward(self, x):
    x = self.features(x)
    x = torch.flatten(x, 1)
    # print(x.size())
    logits = self.classifier(x)
    return logits


model1_augmented = CNN1(num_classes=10)


model1_augmented = model1_augmented.to(DEVICE)


print(summary(model1_augmented, (3, 16, 16)))
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 16, 16, 16]             448
              ReLU-2           [-1, 16, 16, 16]               0
         MaxPool2d-3             [-1, 16, 8, 8]               0
```

```
            Conv2d-4             [-1, 32, 8, 8]           2,080
              ReLU-5             [-1, 32, 8, 8]               0
         MaxPool2d-6             [-1, 32, 4, 4]               0
            Linear-7                  [-1, 100]          51,300
              ReLU-8                  [-1, 100]               0
            Linear-9                   [-1, 10]           1,010
================================================================
Total params: 54,838
Trainable params: 54,838
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 0.11
Params size (MB): 0.21
Estimated Total Size (MB): 0.32
----------------------------------------------------------------
None
/usr/local/lib/python3.7/dist-packages/torch/nn/modules/conv.py:454: UserWarning
  self.padding, self.dilation, self.groups)
```

```
optimizer_augmented = torch.optim.SGD(model1_augmented.parameters(), lr=0.1)
scheduler_augmented = torch.optim.lr_scheduler.ReduceLROnPlateau(optimizer_augmented
                                                       factor=0.1,
                                                       mode='max',
                                                       verbose=True)
```

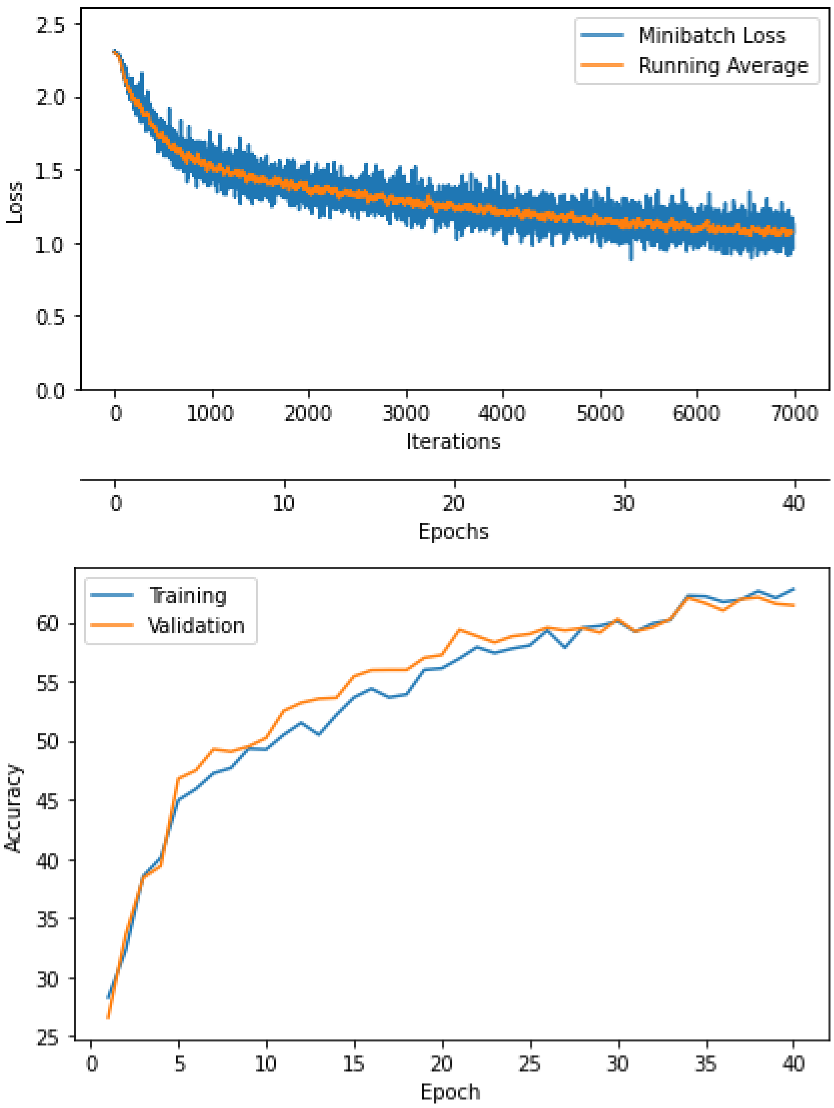
```
minibatch_loss_list_augmented1, train_acc_list_augmented1, valid_acc_list_augmented1
    model=model1_augmented,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader_augmented,
    valid_loader=valid_loader_augmented,
    test_loader=test_loader_augmented,
    optimizer=optimizer_augmented,
    device=DEVICE,
    scheduler=None,
    scheduler_on='valid_acc',
    logging_interval=100)
```

```
plot_training_loss(minibatch_loss_list=minibatch_loss_list_augmented1,
                   num_epochs=NUM_EPOCHS,
                   iter_per_epoch=len(train_loader_augmented),
                   results_dir=None,
                   averaging_iterations=20)

plt.show()

plot_accuracy(train_acc_list=train_acc_list_augmented1,
              valid_acc_list=valid_acc_list_augmented1,
              results_dir=None)

# plt.ylim([80, 100])
plt.show()
```



```
class CNN2(torch.nn.Module):
  def __init__(self, num_classes):
    super().__init__()
    self.features = torch.nn.Sequential(
            # Conv 1
            torch.nn.Conv2d(3, 16, kernel_size=3, padding="same"), # output 16 - 3 +
                            # , stride=4, padding=2),
            torch.nn.ReLU(inplace=True),
            torch.nn.MaxPool2d(kernel_size=2), # 16 / 2 => output 8

            # Conv 2
            torch.nn.Conv2d(16, 32, kernel_size=2, padding="same"), # output 7 - 2 +
                            # , padding=2),
            torch.nn.ReLU(inplace=True),
            torch.nn.MaxPool2d(kernel_size=2), #output 8 / 2 => output 4

            # Conv 3
            torch.nn.Conv2d(32, 64, kernel_size=2, padding="same"), # output 7 - 2 +
                            # , padding=2),
            torch.nn.ReLU(inplace=True),
            torch.nn.MaxPool2d(kernel_size=2) #output 4 / 2 => output 2

    )

    self.classifier = torch.nn.Sequential(
         torch.nn.Linear(64*2*2, 100),
          torch.nn.ReLU(inplace=True),
          torch.nn.Linear(100, num_classes),
    )

  def forward(self, x):
    x = self.features(x)
    x = torch.flatten(x, 1)
    # print(x.size())
    logits = self.classifier(x)
    return logits


model2_augmented = CNN2(num_classes=10)


model2_augmented = model2_augmented.to(DEVICE)


print(summary(model2_augmented, (3, 16, 16)))
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 16, 16, 16]             448
              ReLU-2           [-1, 16, 16, 16]               0
         MaxPool2d-3             [-1, 16, 8, 8]               0
            Conv2d-4             [-1, 32, 8, 8]           2,080
              ReLU-5             [-1, 32, 8, 8]               0
         MaxPool2d-6             [-1, 32, 4, 4]               0
            Conv2d-7             [-1, 64, 4, 4]           8,256
              ReLU-8             [-1, 64, 4, 4]               0
         MaxPool2d-9             [-1, 64, 2, 2]               0
           Linear-10                  [-1, 100]          25,700
```

```
             ReLU-11                  [-1, 100]               0
           Linear-12                   [-1, 10]           1,010
================================================================
Total params: 37,494
Trainable params: 37,494
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 0.12
Params size (MB): 0.14
Estimated Total Size (MB): 0.27
----------------------------------------------------------------
None
```

```
optimizer_augmented2 = torch.optim.SGD(model2_augmented.parameters(), lr=0.1)
scheduler_augmented2 = torch.optim.lr_scheduler.ReduceLROnPlateau(optimizer_augmente
                                                       factor=0.1,
                                                       mode='max',
                                                       verbose=True)
```

```
minibatch_loss_list_augmented2, train_acc_list_augmented2, valid_acc_list_augmented2
    model=model2_augmented,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader_augmented,
    valid_loader=valid_loader_augmented,
    test_loader=test_loader_augmented,
    optimizer=optimizer_augmented2,
    device=DEVICE,
    scheduler=None,
    scheduler_on='valid_acc',
    logging_interval=100)
```

```
plot_training_loss(minibatch_loss_list=minibatch_loss_list_augmented2,
                   num_epochs=NUM_EPOCHS,
                   iter_per_epoch=len(train_loader_augmented),
                   results_dir=None,
                   averaging_iterations=20)

plt.show()

plot_accuracy(train_acc_list=train_acc_list_augmented2,
              valid_acc_list=valid_acc_list_augmented2,
              results_dir=None)

# plt.ylim([80, 100])
plt.show()
```

```
import pandas as pd
```

```
results = pd.DataFrame({"Number of Parameters": [54838, 37494], "Accuracy": [63, 59]}
```

```
results
```

	Number of Parameters	Accuracy
CNN1	54838	63
CNN2	37494	59

Even with data augmentation the simpler CNN works better as there are more pixels to work with.

```
Start coding or generate with AI.
```