Imports

```
import torch
import numpy as np
import matplotlib.pyplot as plt


# From local helper files
from helper_evaluation import set_all_seeds, set_deterministic
from helper_train import train_model
from helper_plotting import plot_training_loss, plot_accuracy, show_examples
from helper_dataset import get_dataloaders_mnist
```

Settings and Dataset

```
##########################
### SETTINGS
##########################

RANDOM_SEED = 123
BATCH_SIZE = 256
NUM_HIDDEN_1 = 75
NUM_HIDDEN_2 = 45
NUM_EPOCHS = 50
DEVICE = torch.device('cuda:0' if torch.cuda.is_available() else 'cpu')


set_all_seeds(RANDOM_SEED)
set_deterministic()


##########################
### MNIST DATASET
##########################

train_loader, valid_loader, test_loader = get_dataloaders_mnist(
    batch_size=BATCH_SIZE,
    validation_fraction=0.1)

# Checking the dataset
for images, labels in train_loader:
    print('Image batch dimensions:', images.shape)
    print('Image label dimensions:', labels.shape)
    print('Class labels of 10 examples:', labels[:10])
    break
```

```
Image batch dimensions: torch.Size([256, 1, 28, 28])
Image label dimensions: torch.Size([256])
Class labels of 10 examples: tensor([4, 5, 8, 9, 9, 4, 9, 9, 3, 9])
```

Model

```
class MultilayerPerceptron(torch.nn.Module):

    def __init__(self, num_features, num_classes, drop_proba,
                 num_hidden_1, num_hidden_2):
        super().__init__()

        self.my_network = torch.nn.Sequential(
            # 1st hidden layer
            torch.nn.Flatten(),
            torch.nn.Linear(num_features, num_hidden_1),
            torch.nn.ReLU(),
            torch.nn.Dropout(drop_proba),
            # 2nd hidden layer
            torch.nn.Linear(num_hidden_1, num_hidden_2),
            torch.nn.ReLU(),
            torch.nn.Dropout(drop_proba),
            # output layer
            torch.nn.Linear(num_hidden_2, num_classes)
        )

    def forward(self, x):
        logits = self.my_network(x)
        return logits
```

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Without Dropout

```
torch.use_deterministic_algorithms(False)


torch.manual_seed(RANDOM_SEED)
model = MultilayerPerceptron(num_features=28*28,
                             num_hidden_1=NUM_HIDDEN_1,
                             num_hidden_2=NUM_HIDDEN_2,
                             drop_proba=0.0,
                             num_classes=10)
model = model.to(DEVICE)

optimizer = torch.optim.SGD(model.parameters(), lr=0.1)

minibatch_loss_list, train_acc_list, valid_acc_list = train_model(
    model=model,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader,
    valid_loader=valid_loader,
    test_loader=test_loader,
    optimizer=optimizer,
    device=DEVICE)
```

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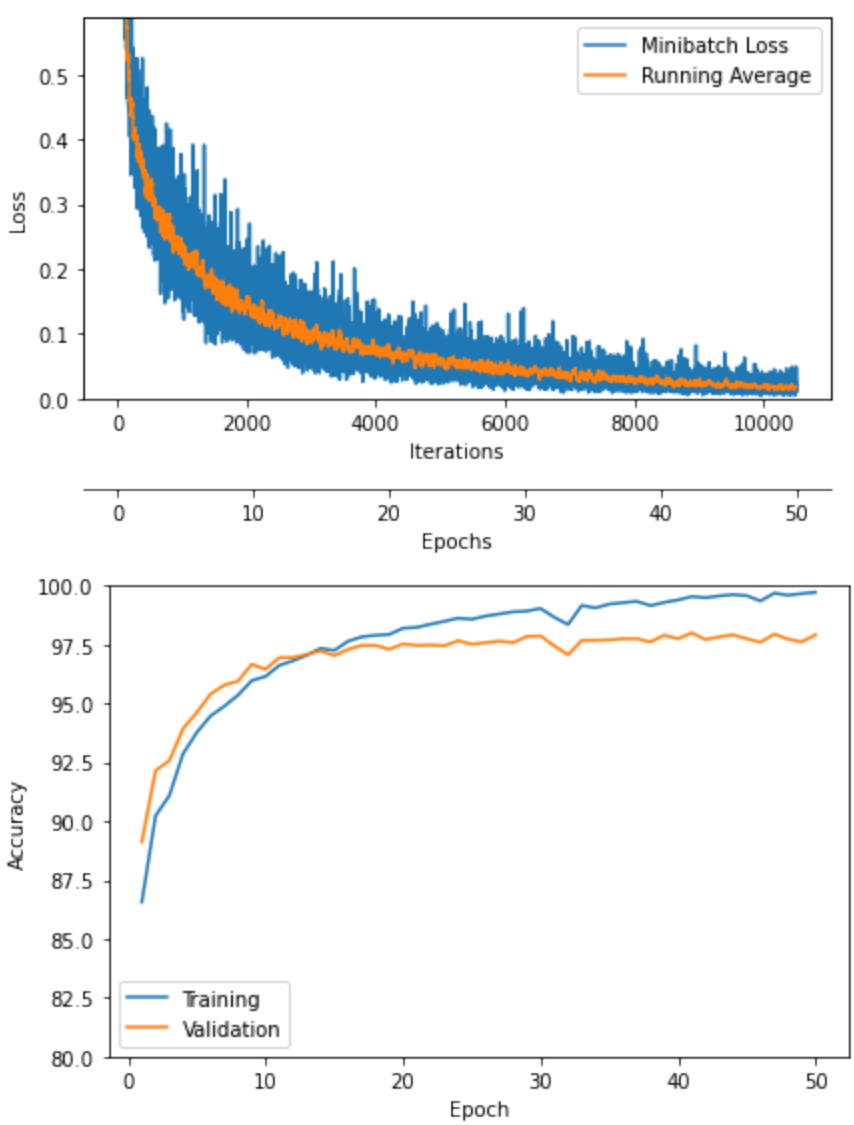
```
plot_training_loss(minibatch_loss_list=minibatch_loss_list,
                   num_epochs=NUM_EPOCHS,
                   iter_per_epoch=len(train_loader),
                   results_dir=None,
```

```
                    averaging_iterations=20)

plt.show()

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

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



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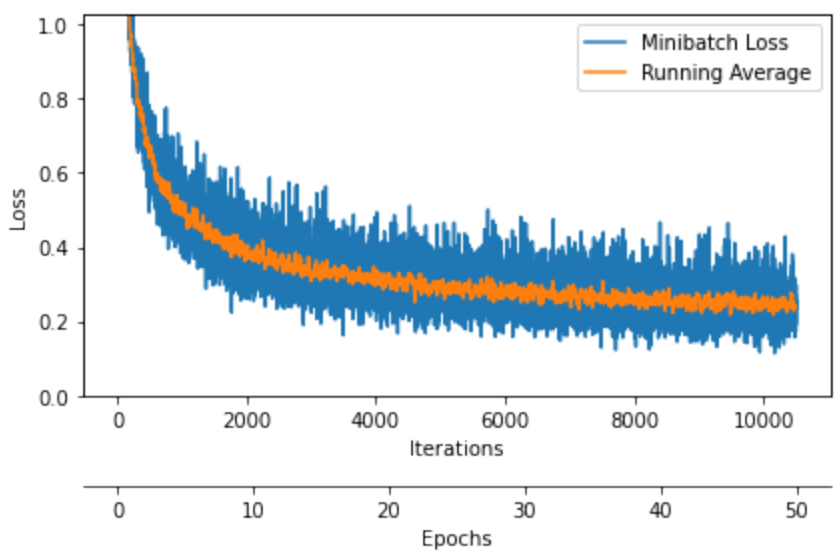
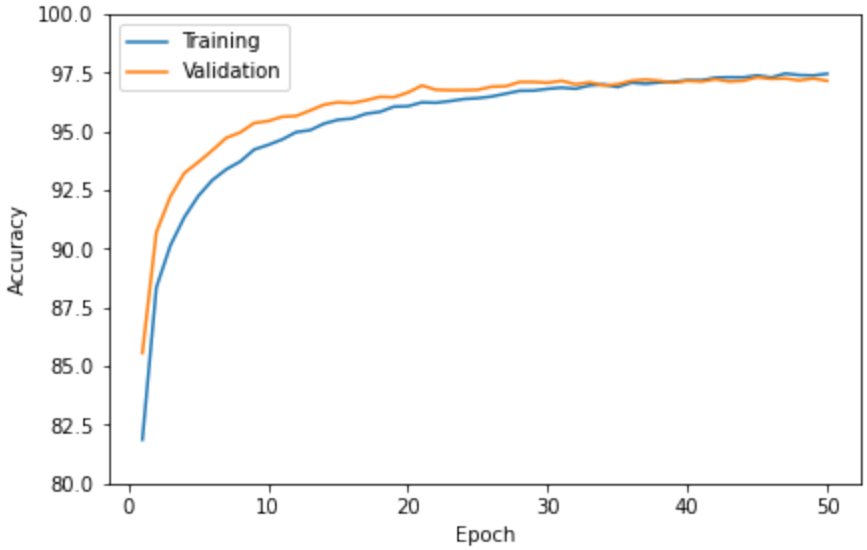
With 50% Dropout

```
torch.manual_seed(RANDOM_SEED)
model = MultilayerPerceptron(num_features=28*28,
                             num_hidden_1=NUM_HIDDEN_1,
                             num_hidden_2=NUM_HIDDEN_2,
                             drop_proba=0.5,
                             num_classes=10)
model = model.to(DEVICE)

optimizer = torch.optim.SGD(model.parameters(), lr=0.1)

minibatch_loss_list, train_acc_list, valid_acc_list = train_model(
    model=model,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader,
    valid_loader=valid_loader,
    test_loader=test_loader,
    optimizer=optimizer,
    device=DEVICE)



plot_training_loss(minibatch_loss_list=minibatch_loss_list,
                   num_epochs=NUM_EPOCHS,
                   iter_per_epoch=len(train_loader),
                   results_dir=None,
                   averaging_iterations=20)
plt.show()

plot_accuracy(train_acc_list=train_acc_list,
              valid_acc_list=valid_acc_list,
              results_dir=None)
plt.ylim([80, 100])
plt.show()
```





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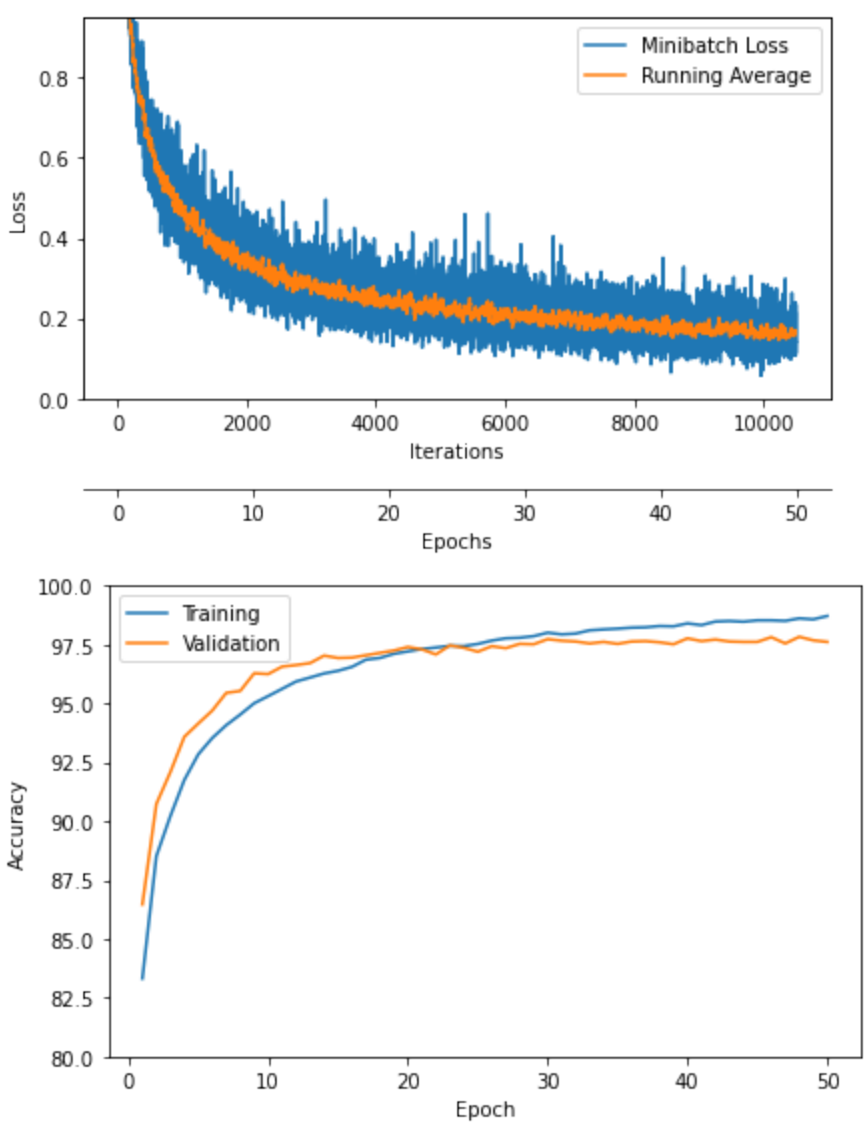
1. With 0-20-60 dropout

```
class MultilayerPerceptron1(torch.nn.Module):

    def __init__(self, num_features, num_classes, drop_probas,
                 num_hidden_1, num_hidden_2):
        super().__init__()

        self.my_network = torch.nn.Sequential(
            torch.nn.Flatten(),
            torch.nn.Dropout(drop_probas[0]),
            # 1st hidden layer
```

```
            torch.nn.Linear(num_features, num_hidden_1),
            torch.nn.ReLU(),
            torch.nn.Dropout(drop_probas[1]),
            # 2nd hidden layer
            torch.nn.Linear(num_hidden_1, num_hidden_2),
            torch.nn.ReLU(),
            torch.nn.Dropout(drop_probas[2]),
            # output layer
            torch.nn.Linear(num_hidden_2, num_classes)
        )

    def forward(self, x):
        logits = self.my_network(x)
        return logits


torch.manual_seed(RANDOM_SEED)
model = MultilayerPerceptron1(num_features=28*28,
                              num_hidden_1=NUM_HIDDEN_1,
                              num_hidden_2=NUM_HIDDEN_2,
                              drop_probas=[0.0, 0.2, 0.6],
                              num_classes=10)
model = model.to(DEVICE)

optimizer = torch.optim.SGD(model.parameters(), lr=0.1)

minibatch_loss_list, train_acc_list, valid_acc_list = train_model(
    model=model,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader,
    valid_loader=valid_loader,
    test_loader=test_loader,
    optimizer=optimizer,
    device=DEVICE)
```

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

plt.show()

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

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



The overfitting is more than that of 50% dropout however, the training accuracy is little larger than that of 50-50 dropout.

This overfitting will only grow with more epochs

2. With 20-20-60

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```
torch.manual_seed(RANDOM_SEED)
model = MultilayerPerceptron1(num_features=28*28,
                              num_hidden_1=NUM_HIDDEN_1,
                              num_hidden_2=NUM_HIDDEN_2,
                              drop_probas=[0.2, 0.2, 0.6],
                              num_classes=10)
model = model.to(DEVICE)

optimizer = torch.optim.SGD(model.parameters(), lr=0.1)

minibatch_loss_list, train_acc_list, valid_acc_list = train_model(
    model=model,
    num_epochs=NUM_EPOCHS,
    train_loader=train_loader,
    valid_loader=valid_loader,
    test_loader=test_loader,
    optimizer=optimizer,
    device=DEVICE)
```

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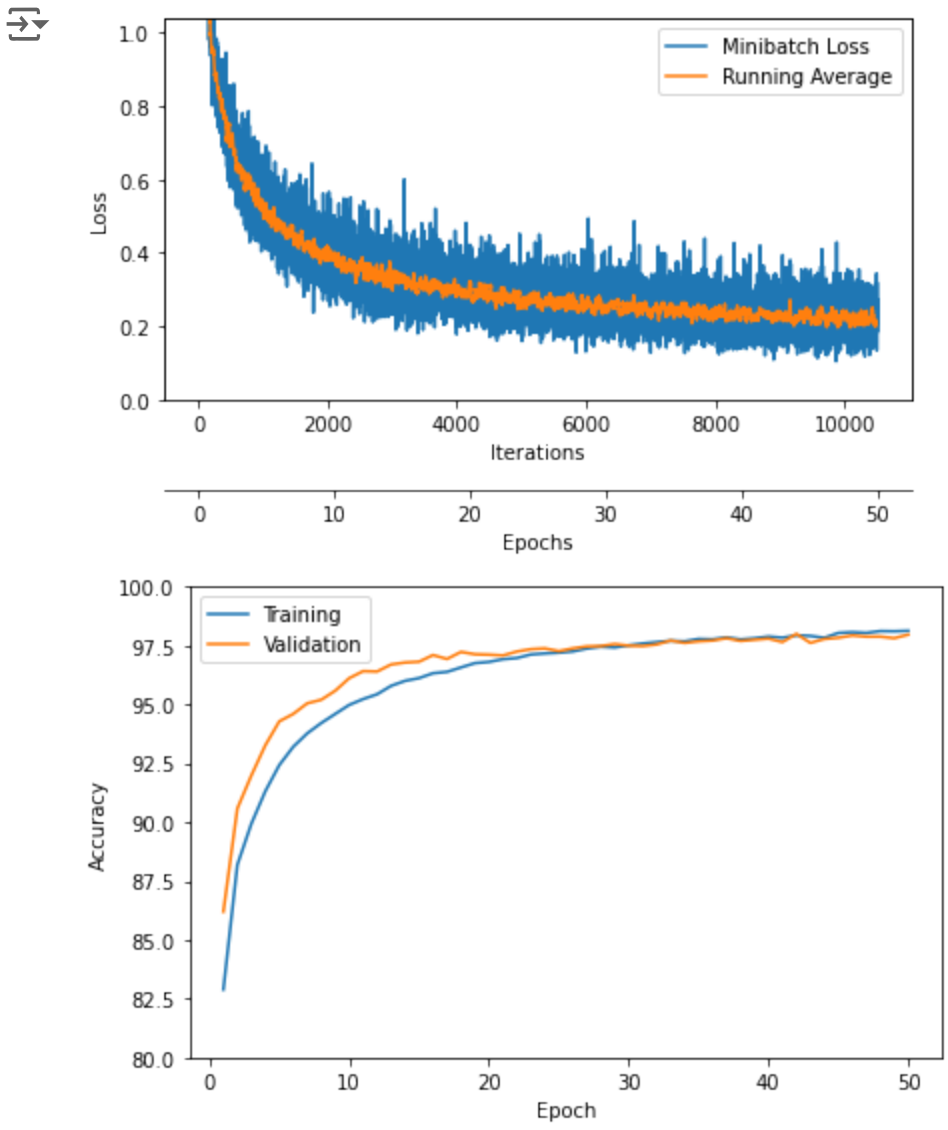
```
plot_training_loss(minibatch_loss_list=minibatch_loss_list,
                   num_epochs=NUM_EPOCHS,
                   iter_per_epoch=len(train_loader),
                   results_dir=None,
                   averaging_iterations=20)

plt.show()

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

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



With 20-20-60, the overfitting is reduced and the accuracy as well is a little greater than that of 97.5%

Compared to 20-60 dropout, the accuracy is just till 97.5% it doesn't reach 100% training accuracy

Compared to the 50-50% dropout, the overfitting and accuracy are almost the same.

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3. Dropout V/S Perturbations

Both of them are similar in increasing the number of training samples data augmentation will increase the data by rotating and transforming data wherease, the dropout will also increase the images count but by just removing image pixels.

Both of them are different in a way, the augmented data has more real world images as they will be rotated and transformed and better prepared for real world whereas, the dropout would reduce the