cifar10

October 4, 2023

1 Deep Learning

1.0.1 Musel Tabares

1.0.2 A00830710

Importamos librerias

[ ]:
```
#para utilizar tensores etc
import torch
#para el modelo
from torch import nn
#para importar datasets
import torchvision
#para transformar imagenes
import torchvision.transforms as transforms
#para visualizaciones
import matplotlib.pyplot as plt
#ver a detalle el modelo
from torchsummary import summary
# barra de progreso
from tqdm.auto import tqdm

#importamos funciones
from utils import *
```

```
c:\Users\musel\anaconda3\envs\pytorch\lib\site-packages\tqdm\auto.py:21:
TqdmWarning: IProgress not found. Please update jupyter and ipywidgets. See
https://ipywidgets.readthedocs.io/en/stable/user_install.html
  from .autonotebook import tqdm as notebook_tqdm
```

1.1 Cifar10

Importamos datos

[ ]:
```
trainset = torchvision.datasets.CIFAR10(root='./data',␣
↪train=True,download=True, transform=transforms.ToTensor())
testset = torchvision.datasets.CIFAR10(root='./data',␣
↪train=False,download=True, transform=transforms.ToTensor())
```

```
classes = ('plane', 'car', 'bird', 'cat','deer', 'dog', 'frog', 'horse',␣
 ↪'ship', 'truck')
```

```
Files already downloaded and verified
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```

Observamos la dimension de las imagenes

[ ]:
```
# desplegamos primer imagen
image, label = trainset[0]
image.shape, label
```

[ ]:
```
(torch.Size([3, 32, 32]), 6)
```

Observamos cantidad de datos en train y test

[ ]:
```
len(trainset.data), len(trainset.targets), len(testset.data), len(testset.
 ↪targets)
```

[ ]:
```
(50000, 50000, 10000, 10000)
```

Creamos batches de los datos

[ ]:
```
batch_size = 32
trainloader = torch.utils.data.DataLoader(trainset,␣
 ↪batch_size=batch_size,shuffle=True, num_workers=2)
testloader = torch.utils.data.DataLoader(testset,␣
 ↪batch_size=batch_size,shuffle=False, num_workers=2)
```

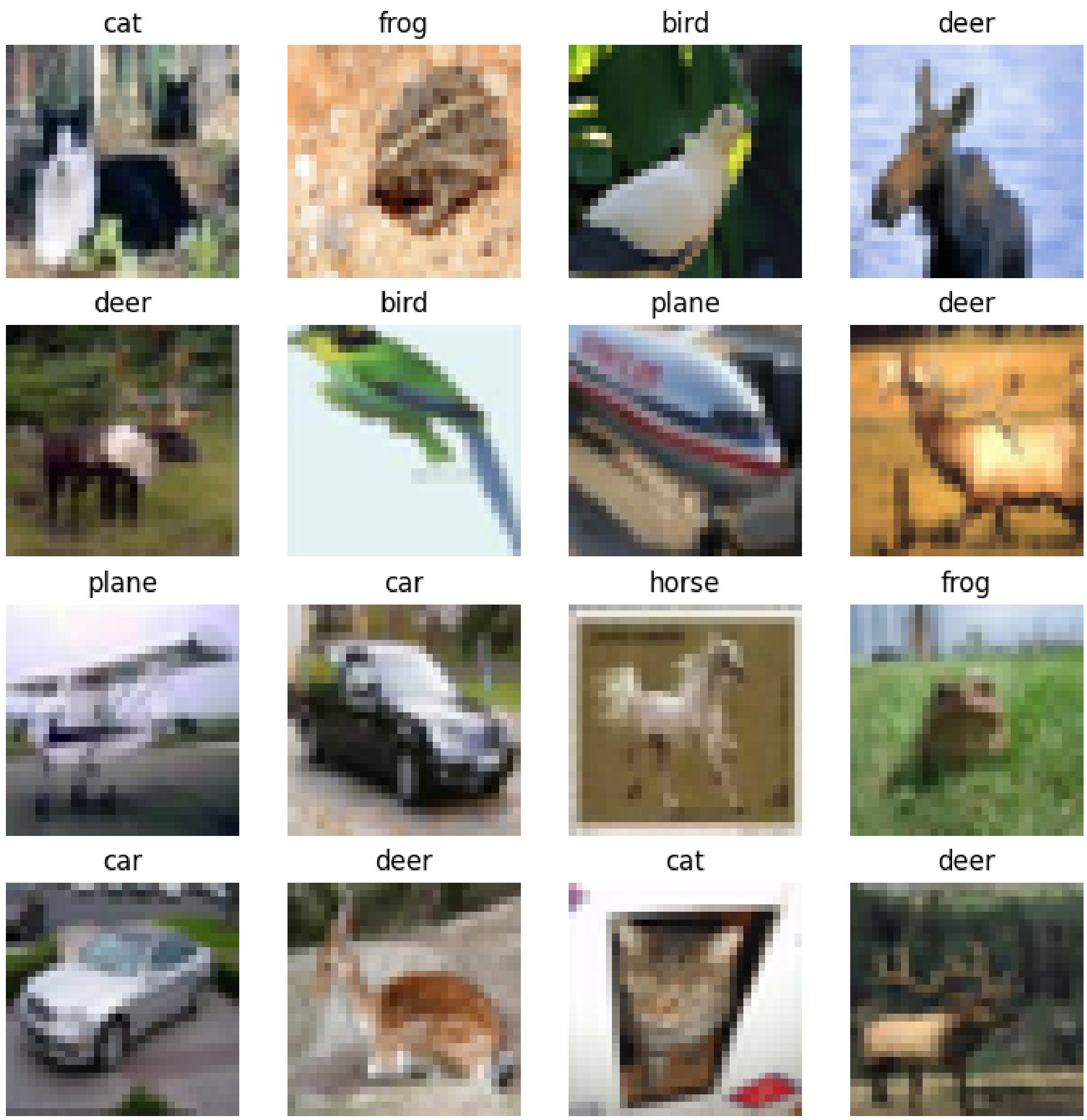
Observamos cuantos batches se crearon

[ ]:
```
print(f"Length of train dataloader: {len(trainloader)} batches of {batch_size}")
print(f"Length of test dataloader: {len(testloader)} batches of {batch_size}")
```

```
Length of train dataloader: 782 batches of 64
Length of test dataloader: 157 batches of 64
```

visualizamos 16 imagenes de manera aleatoria

[ ]:
```
plot_sample_images(trainset, classes, 4, 4)
```



Creamos modelo

[ ]:
```
class conv(nn.Module):

    def __init__(self):
        super().__init__()
        self.block_1 = nn.Sequential(
            nn.Conv2d(3,32, kernel_size=(3,3), stride=1),
            nn.ReLU(),
            nn.MaxPool2d(kernel_size=(2, 2)),
            nn.Conv2d(32,64, kernel_size=(3,3), stride=1),
            nn.ReLU(),
```

```
            nn.MaxPool2d(kernel_size=(2, 2)),
            nn.Conv2d(64,256, kernel_size=(3,3), stride=1),
            nn.ReLU(),

        )
        self.block_2 = nn.Sequential(
            nn.Flatten(),
            nn.Linear(4096, 64),
            nn.ReLU(),
            nn.Linear(64, 10),
            nn.Sigmoid()
        )

    def forward(self, x):
        x = self.block_1(x)
        x = self.block_2(x)
        return x
```

instanciamos el modelo

[ ]:
```
device = torch.device('cuda:0' if torch.cuda.is_available() else 'cpu')
model_0 = conv().to(device)
summary(model_0, (3,32,32))
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 32, 30, 30]             896
              ReLU-2           [-1, 32, 30, 30]               0
         MaxPool2d-3           [-1, 32, 15, 15]               0
            Conv2d-4           [-1, 64, 13, 13]          18,496
              ReLU-5           [-1, 64, 13, 13]               0
         MaxPool2d-6             [-1, 64, 6, 6]               0
            Conv2d-7            [-1, 256, 4, 4]         147,712
              ReLU-8            [-1, 256, 4, 4]               0
           Flatten-9                 [-1, 4096]               0
           Linear-10                   [-1, 64]         262,208
             ReLU-11                   [-1, 64]               0
           Linear-12                   [-1, 10]             650
          Sigmoid-13                   [-1, 10]               0
================================================================
Total params: 429,962
Trainable params: 429,962
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.01
Forward/backward pass size (MB): 0.77
Params size (MB): 1.64
```

```
Estimated Total Size (MB): 2.42
----------------------------------------------------------------
```

definimos funcion de perdida y optimizador

[ ]:
```
loss_fn = nn.CrossEntropyLoss()
optimizer = torch.optim.Adam(params=model_0.parameters())
```

corremos modelo

[ ]:
```
NUM_EPOCHS = 10
model_0_results = train(model=model_0,
                        train_dataloader=trainloader,
                        test_dataloader=testloader,
                        optimizer=optimizer,
                        loss_fn=loss_fn,
                        epochs=NUM_EPOCHS,
                        device=device)
```

```
 10%|          | 1/10 [00:10<01:38, 10.99s/it]

Epoch: 1 | train_loss: 2.0208 | train_acc: 0.3043 | test_loss: 1.9209 |
test_acc: 0.3851

 20%|         | 2/10 [00:22<01:28, 11.10s/it]

Epoch: 2 | train_loss: 1.9020 | train_acc: 0.4245 | test_loss: 1.8609 |
test_acc: 0.4719

 30%|        | 3/10 [00:35<01:25, 12.24s/it]

Epoch: 3 | train_loss: 1.8583 | train_acc: 0.4710 | test_loss: 1.8420 |
test_acc: 0.4918

 40%|        | 4/10 [00:49<01:18, 13.03s/it]

Epoch: 4 | train_loss: 1.8310 | train_acc: 0.5045 | test_loss: 1.8302 |
test_acc: 0.5021

 50%|       | 5/10 [01:04<01:08, 13.62s/it]

Epoch: 5 | train_loss: 1.8095 | train_acc: 0.5291 | test_loss: 1.8049 |
test_acc: 0.5448

 60%|       | 6/10 [01:19<00:55, 13.90s/it]

Epoch: 6 | train_loss: 1.7858 | train_acc: 0.5581 | test_loss: 1.7883 |
test_acc: 0.5737

 70%|      | 7/10 [01:33<00:42, 14.13s/it]

Epoch: 7 | train_loss: 1.7692 | train_acc: 0.5841 | test_loss: 1.7871 |
test_acc: 0.5632

 80%|      | 8/10 [01:48<00:28, 14.33s/it]
```

```
Epoch: 8 | train_loss: 1.7534 | train_acc: 0.6042 | test_loss: 1.7711 |
test_acc: 0.5850

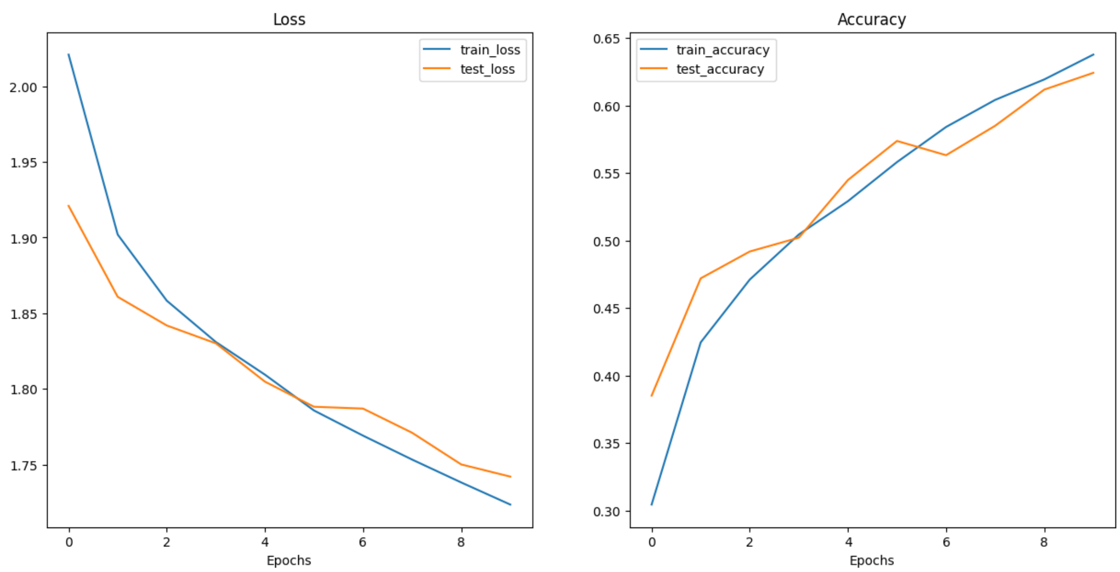
 90%|      | 9/10 [01:59<00:13, 13.20s/it]

Epoch: 9 | train_loss: 1.7383 | train_acc: 0.6193 | test_loss: 1.7502 |
test_acc: 0.6118

100%|      | 10/10 [02:10<00:00, 13.07s/it]

Epoch: 10 | train_loss: 1.7237 | train_acc: 0.6377 | test_loss: 1.7421 |
test_acc: 0.6242
```

[ ]:
```
plot_loss_curves(model_0_results)
```



obtenemos una muestra de los datos del test set

[ ]:
```
import random

test_samples = []
test_labels = []

for sample, label in random.sample(list(testset), k=9):
    test_samples.append(sample)
    test_labels.append(label)
```

hacemos predicciones con la muestra que tomamos

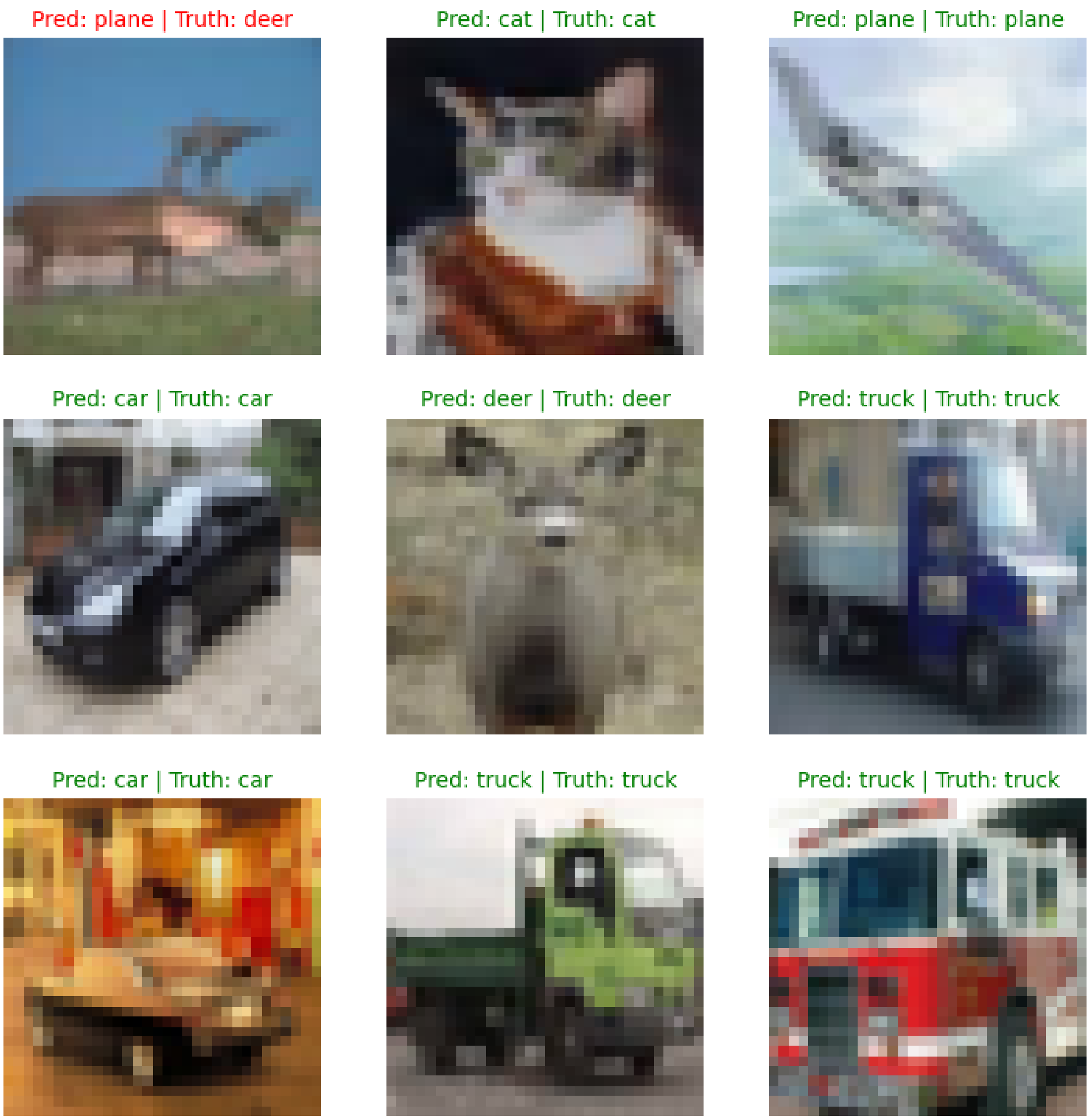
[ ]:
```
pred_classes= make_predictions(model=model_0, data=test_samples, device=device)
```

[ ]:
```
classes[pred_classes[0]]
```

[ ]: 'plane'

visualizamos las predicciones

[ ]:
```
plot_predictions(test_samples, test_labels, classes, pred_classes)
```



1.2 mejoramos accuracy

1.2.1 para ello aplicamos un poco de data augmentation, batch normalization y agregamos mas capas y filtros en el modelo

[ ]:
```
from torchvision import transforms
```

[ ]:
```
mean,std = mean_std(trainloader)
print(mean)
print(std)
```

```
tensor([0.4914, 0.4822, 0.4466])
tensor([0.2470, 0.2435, 0.2616])
```

[ ]:
```
train_transform = transforms.Compose([
    transforms.RandomHorizontalFlip(p=0.5),
    transforms.ToTensor(),
   transforms.Normalize((mean),(std))])

test_transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Normalize((mean),(std))])
```

[ ]:
```
trainset = torchvision.datasets.CIFAR10(root='./data',␣
 ↪train=True,download=True, transform=train_transform)
testset = torchvision.datasets.CIFAR10(root='./data',␣
 ↪train=False,download=True, transform=test_transform)

trainloader = torch.utils.data.DataLoader(trainset,␣
 ↪batch_size=batch_size,shuffle=True, num_workers=2)
testloader = torch.utils.data.DataLoader(testset,␣
 ↪batch_size=batch_size,shuffle=False, num_workers=2)
```

```
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Files already downloaded and verified
```

[ ]:
```
plot_sample_images(trainset, classes, 4, 4)
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
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floats or [0..255] for integers).
```

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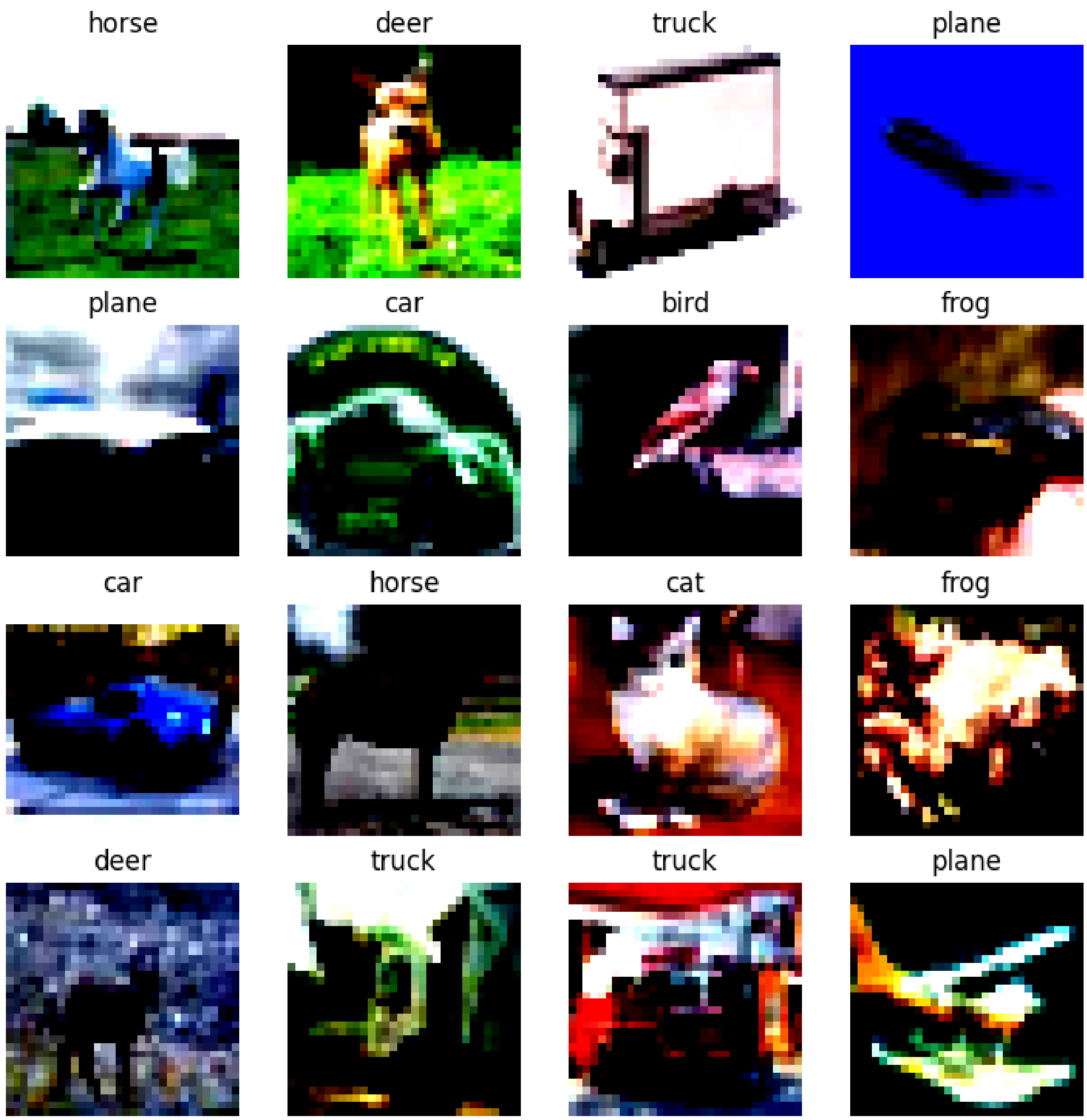
floats or [0..255] for integers).
```



[ ]:

```
class conv(nn.Module):

    def __init__(self):
        super().__init__()
        self.block_1 = nn.Sequential(
           nn.Conv2d(3, 32, kernel_size=3, padding=1),
            nn.ReLU(),
            nn.Conv2d(32, 64, kernel_size=3, stride=1, padding=1),
            nn.ReLU(),
            nn.MaxPool2d(2, 2), # output: 64 x 16 x 16

            nn.Conv2d(64, 128, kernel_size=3, stride=1, padding=1),
```

```
            nn.ReLU(),
            nn.Conv2d(128, 128, kernel_size=3, stride=1, padding=1),
            nn.ReLU(),
            nn.MaxPool2d(2, 2), # output: 128 x 8 x 8

            nn.Conv2d(128, 256, kernel_size=3, stride=1, padding=1),
            nn.ReLU(),
            nn.Conv2d(256, 256, kernel_size=3, stride=1, padding=1),
            nn.ReLU(),
            nn.MaxPool2d(2, 2), # output: 256 x 4 x 4

            )

        self.block_2 = nn.Sequential(
            nn.Flatten(),
            nn.Linear(256*4*4, 1024),
            nn.ReLU(),
            nn.Linear(1024, 512),
            nn.ReLU(),
            nn.Linear(512, 10)
        )

    def forward(self, x):
        x = self.block_1(x)
        x = self.block_2(x)
        return x
```

[ ]:

```
device = torch.device('cuda:0' if torch.cuda.is_available() else 'cpu')
model_0 = conv().to(device)
summary(model_0, (3,32,32))
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 32, 32, 32]             896
              ReLU-2           [-1, 32, 32, 32]               0
            Conv2d-3           [-1, 64, 32, 32]          18,496
              ReLU-4           [-1, 64, 32, 32]               0
         MaxPool2d-5           [-1, 64, 16, 16]               0
            Conv2d-6          [-1, 128, 16, 16]          73,856
              ReLU-7          [-1, 128, 16, 16]               0
            Conv2d-8          [-1, 128, 16, 16]         147,584
              ReLU-9          [-1, 128, 16, 16]               0
        MaxPool2d-10            [-1, 128, 8, 8]               0
           Conv2d-11            [-1, 256, 8, 8]         295,168
             ReLU-12            [-1, 256, 8, 8]               0
           Conv2d-13            [-1, 256, 8, 8]         590,080
             ReLU-14            [-1, 256, 8, 8]               0
```

```
         MaxPool2d-15            [-1, 256, 4, 4]               0
           Flatten-16                  [-1, 4096]               0
            Linear-17                  [-1, 1024]       4,195,328
              ReLU-18                  [-1, 1024]               0
            Linear-19                   [-1, 512]         524,800
              ReLU-20                   [-1, 512]               0
            Linear-21                    [-1, 10]           5,130
================================================================
Total params: 5,851,338
Trainable params: 5,851,338
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.01
Forward/backward pass size (MB): 3.27
Params size (MB): 22.32
Estimated Total Size (MB): 25.61
----------------------------------------------------------------
```

[ ]:
```
optimizer = torch.optim.Adam(params=model_0.parameters(), lr  = 0.0001)
```

[ ]:
```
NUM_EPOCHS = 10
model_0_results = train(model=model_0,
                        train_dataloader=trainloader,
                        test_dataloader=testloader,
                        optimizer=optimizer,
                        loss_fn=loss_fn,
                        epochs=NUM_EPOCHS,
                        device=device)
```

```
 10%|          | 1/10 [00:18<02:50, 18.99s/it]

Epoch: 1 | train_loss: 1.5957 | train_acc: 0.4056 | test_loss: 1.3171 |
test_acc: 0.5115

 20%|          | 2/10 [00:40<02:45, 20.63s/it]

Epoch: 2 | train_loss: 1.2102 | train_acc: 0.5595 | test_loss: 1.0964 |
test_acc: 0.6058

 30%|          | 3/10 [01:04<02:34, 22.12s/it]

Epoch: 3 | train_loss: 1.0035 | train_acc: 0.6430 | test_loss: 0.9250 |
test_acc: 0.6780

 40%|          | 4/10 [01:29<02:19, 23.24s/it]

Epoch: 4 | train_loss: 0.8501 | train_acc: 0.6998 | test_loss: 0.8487 |
test_acc: 0.7036

 50%|          | 5/10 [01:54<01:59, 23.99s/it]

Epoch: 5 | train_loss: 0.7391 | train_acc: 0.7412 | test_loss: 0.7852 |
test_acc: 0.7273
```

```
 60%|        | 6/10 [02:20<01:38, 24.56s/it]
Epoch: 6 | train_loss: 0.6490 | train_acc: 0.7737 | test_loss: 0.6748 |
test_acc: 0.7639
 70%|        | 7/10 [02:43<01:12, 24.13s/it]
Epoch: 7 | train_loss: 0.5688 | train_acc: 0.8013 | test_loss: 0.6730 |
test_acc: 0.7662
 80%|        | 8/10 [03:04<00:46, 23.02s/it]
Epoch: 8 | train_loss: 0.5001 | train_acc: 0.8255 | test_loss: 0.6010 |
test_acc: 0.7936
 90%|        | 9/10 [03:25<00:22, 22.29s/it]
Epoch: 9 | train_loss: 0.4351 | train_acc: 0.8495 | test_loss: 0.6145 |
test_acc: 0.7857
100%|        | 10/10 [03:46<00:00, 22.62s/it]
Epoch: 10 | train_loss: 0.3835 | train_acc: 0.8672 | test_loss: 0.6071 |
test_acc: 0.7975
```

[ ]:
```
plot_loss_curves(model_0_results)
```