In [92]:
```python
'''
Patrick Ballou
ID: 801130521
ECGR 4105
Homework 6
Problem 2
'''
```

Out[92]: `'\nPatrick Ballou\nID: 801130521\nECGR 4105\nHomework 6\nProblem 2\n'`

In [93]:
```python
import torch
from torch import cuda
import torch.nn as nn
from torchvision import transforms
from torchvision import datasets
import datetime
```

In [94]:
```python
data_path = 'C:/Users/patri/Documents/School_Fall_2022/ECGR_4105/Homework/homework_6'
#normalized
cifar10 = datasets.CIFAR10(data_path, train=True, download=True, transform=transforms.
cifar10_val = datasets.CIFAR10(data_path, train=False, download=True, transform=transf
```

Files already downloaded and verified
Files already downloaded and verified

In [95]:
```python
device = 'cuda'
cuda.get_device_name()
```

Out[95]: `'Quadro T2000'`

In [96]:
```python
class Net(nn.Module):
    def __init__(self):
        super().__init__()
        self.conv1 = nn.Conv2d(3, 16, kernel_size=3, padding=1)
        self.act1 = nn.Tanh()
        self.pool1 = nn.MaxPool2d(2)
        self.conv2 = nn.Conv2d(16, 8, kernel_size=3, padding=1)
        self.act2 = nn.Tanh()
        self.pool2 = nn.MaxPool2d(2)
        self.fc1 = nn.Linear(8 * 8 * 8, 32)
        self.act3 = nn.Tanh()
        self.fc2 = nn.Linear(32, 10)

    def forward(self, x):
        out = self.pool1(self.act1(self.conv1(x)))
        out = self.pool2(self.act2(self.conv2(out)))
        out = out.view(-1, 8 * 8 * 8) # <1>
        out = self.act3(self.fc1(out))
        out = self.fc2(out)
        return out
```

In [97]:
```python
def training_loop(n_epochs, optimizer, model, loss_fn, train_loader):
    for epoch in range(1, n_epochs + 1):
        loss_train = 0.0
        for imgs, labels in train_loader:
            imgs, labels = imgs.to(device=device), labels.to(device=device)
            outputs = model(imgs)
```

```
        loss = loss_fn(outputs, labels)

        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        loss_train += loss.item()
    print("{} Epoch {}, Training loss {}".format(datetime.datetime.now(), epoch,loss_t
```

In [98]:
```
l_r = .008
num_epochs = 300
```

In [99]:
```
train_loader = torch.utils.data.DataLoader(cifar10, batch_size=128, shuffle=True)
model_a = Net().to(device=device)
optimizer = torch.optim.SGD(model_a.parameters(), lr=l_r)
loss_fn = nn.CrossEntropyLoss()

training_loop(num_epochs, optimizer, model_a, loss_fn, train_loader)
```

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2022-12-10 23:06:31.660827 Epoch 239, Training loss 0.6660692339663006
2022-12-10 23:06:46.213030 Epoch 240, Training loss 0.66578278974498949
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2022-12-10 23:19:24.815966 Epoch 292, Training loss 0.6308439541655733
2022-12-10 23:19:39.379824 Epoch 293, Training loss 0.6309619110715968
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2022-12-10 23:20:38.010909 Epoch 297, Training loss 0.628794339306824
2022-12-10 23:20:52.622748 Epoch 298, Training loss 0.6278755280672742
2022-12-10 23:21:07.377463 Epoch 299, Training loss 0.6275831274211864
2022-12-10 23:21:19.686524 Epoch 300, Training loss 0.628146682858772
```

```
In [105… val_loader = torch.utils.data.DataLoader(cifar10_val, batch_size=128, shuffle=False)
         correct = 0
         total = 0
         with torch.no_grad():
             for imgs, labels in val_loader:
                 imgs, labels = imgs.to(device), labels.to(device)
                 batch_size = imgs.shape[0]
                 outputs = model_a(imgs)
                 _, predicted = torch.max(outputs, dim=1)
                 total += labels.shape[0]
                 correct += int((predicted == labels).sum())
             print("Accuracy: {:.2f}".format(correct / total))
```

```
         Accuracy: 0.66
```

```
In [106… class Net(nn.Module):
             def __init__(self):
                 super().__init__()
                 self.conv1 = nn.Conv2d(3, 16, kernel_size=3, padding=1)
                 self.act1 = nn.LeakyReLU()
                 self.pool1 = nn.MaxPool2d(2)
                 self.conv2 = nn.Conv2d(16, 8, kernel_size=3, padding=1)
                 self.act2 = nn.LeakyReLU()
                 self.pool2 = nn.MaxPool2d(2)
                 self.conv3 = nn.Conv2d(8, 3, kernel_size=3, padding=1)
                 self.act3 = nn.LeakyReLU()
                 self.pool3 = nn.MaxPool2d(2)
                 self.fc1 = nn.Linear(8 * 8 * 8, 32)
                 self.act3 = nn.Tanh()
                 self.fc2 = nn.Linear(32, 10)

             def forward(self, x):
                 out = self.pool1(self.act1(self.conv1(x)))
                 out = self.pool2(self.act2(self.conv2(out)))
                 out = out.view(-1, 8 * 8 * 8)
                 out = self.act3(self.fc1(out))
                 out = self.fc2(out)
                 return out
```

```
In [107… l_r = .02
         num_epochs = 300
```

```
In [108… train_loader = torch.utils.data.DataLoader(cifar10, batch_size=256, shuffle=True)
         model_b = Net().to(device=device)
         optimizer = torch.optim.SGD(model_b.parameters(), lr=l_r)
         loss_fn = nn.CrossEntropyLoss()

         training_loop(num_epochs, optimizer, model_b, loss_fn, train_loader)
```

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2022-12-10 23:28:30.487254 Epoch 1, Training loss 2.205159378295042
2022-12-10 23:28:43.116394 Epoch 2, Training loss 1.94727153255015
2022-12-10 23:28:55.956614 Epoch 3, Training loss 1.7649597884440908
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2022-12-10 23:29:33.986395 Epoch 6, Training loss 1.4670775411080341
2022-12-10 23:29:46.892074 Epoch 7, Training loss 1.418908684837575
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2022-12-11 00:39:42.004821 Epoch 298, Training loss 0.5733760685032728
2022-12-11 00:39:56.182054 Epoch 299, Training loss 0.5674857101878341
2022-12-11 00:40:09.505616 Epoch 300, Training loss 0.5656508883955528
```

In [114…
```python
val_loader = torch.utils.data.DataLoader(cifar10_val, batch_size=256, shuffle=False)
correct = 0
total = 0
with torch.no_grad():
    for imgs, labels in val_loader:
        imgs, labels = imgs.to(device), labels.to(device)
        batch_size = imgs.shape[0]
        outputs = model_b(imgs)
        _, predicted = torch.max(outputs, dim=1)
        total += labels.shape[0]
        correct += int((predicted == labels).sum())
    print("Accuracy: {:.2f}".format(correct / total))
```

Accuracy: 0.60

In [114…
```python
val_loader = torch.utils.data.DataLoader(cifar10_val, batch_size=256, shuffle=False)
```