NYCU Pattern Recognition, HW5

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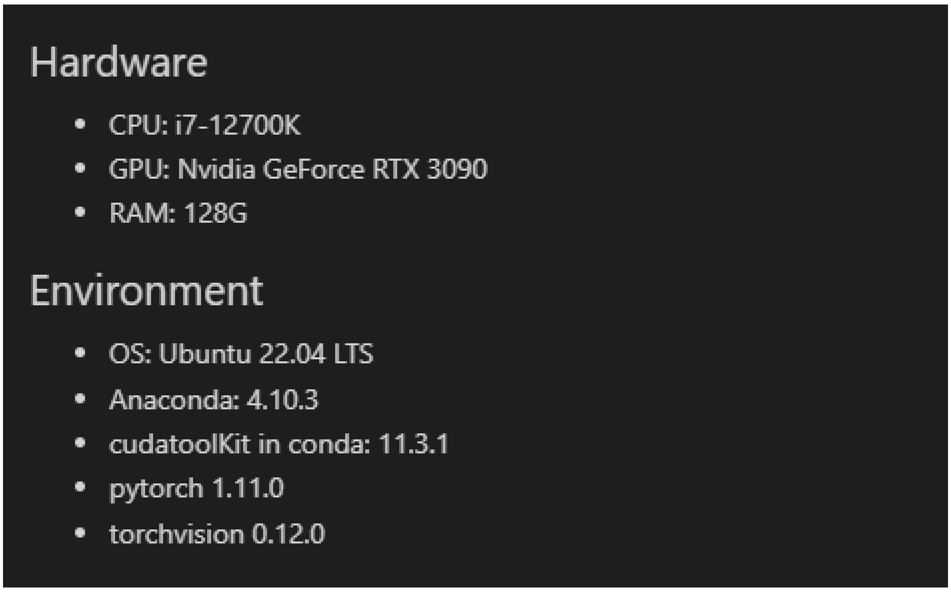


Hardware

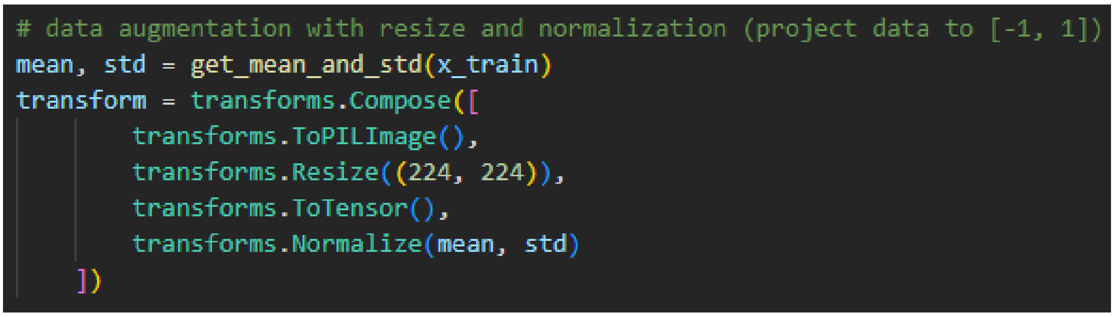
- CPU: i7-12700K
- GPU: Nvidia GeForce RTX 3090
- RAM: 128G

Environment

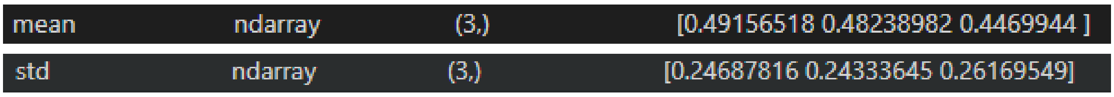
- OS: Ubuntu 22.04 LTS
- Anaconda: 4.10.3
- cudatoolKit in conda: 11.3.1
- pytorch 1.11.0
- torchvision 0.12.0

Implementation Details:

- Data augmentation:
  I use torchvision.transforms module to augment images in Cifar-10 dataset. This operation includes image resize and image normalization as below. The mean and standard deviation parameters of normalization are calculated with provided Cifar-10 dataset.

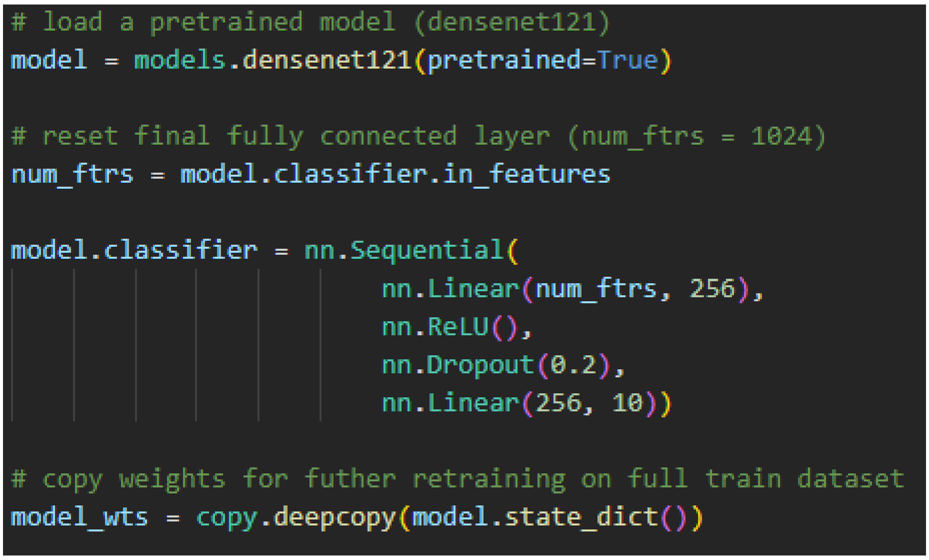


```
# data augmentation with resize and normalization (project data to [-1, 1])
mean, std = get_mean_and_std(x_train)
transform = transforms.Compose([
        transforms.ToPILImage(),
        transforms.Resize((224, 224)),
        transforms.ToTensor(),
        transforms.Normalize(mean, std)
    ])
```



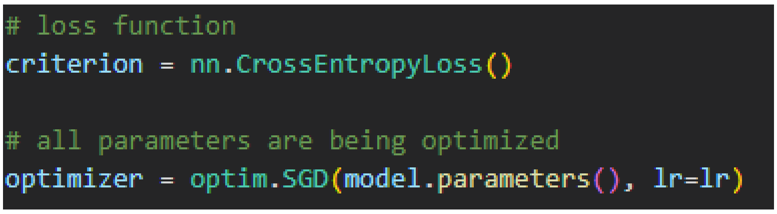
mean	ndarray	(3,)	[0.49156518 0.48238982 0.4469944]
std	ndarray	(3,)	[0.24687816 0.24333645 0.26169549]

- Model atchitecture:
  I use pretrained model “DenseNet121” from torchvision and substitute the final fully connected layer (classifier) with a new fully connected layer. The new fully connected layer contains a linear layer with 256 neurons and Relu() activation function, and then use dropout to reduce overfitting. Finally, use a linear layer with 10 neurons to predict the image class.



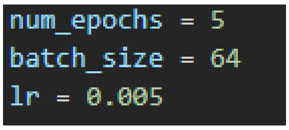
```
# load a pretrained model (densenet121)
model = models.densenet121(pretrained=True)

# reset final fully connected layer (num_ftrs = 1024)
num_ftrs = model.classifier.in_features

model.classifier = nn.Sequential(
                        nn.Linear(num_ftrs, 256),
                        nn.ReLU(),
                        nn.Dropout(0.2),
                        nn.Linear(256, 10))

# copy weights for futher retraining on full train dataset
model_wts = copy.deepcopy(model.state_dict())
```

- Loss function and optimizer:
  Use CrossEntropyLoss() to computes the cross entropy loss between input and target. It is useful for classification problems.



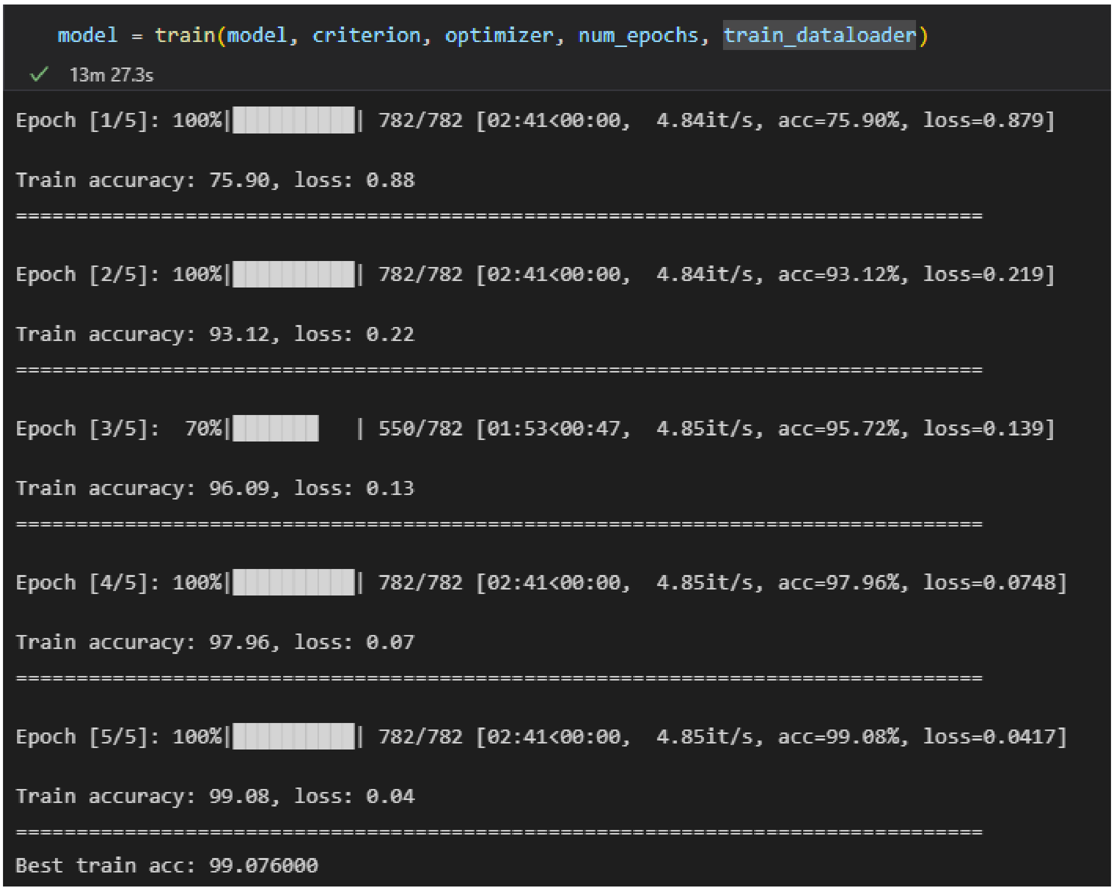
```
# loss function
criterion = nn.CrossEntropyLoss()

# all parameters are being optimized
optimizer = optim.SGD(model.parameters(), lr=lr)
```

- Hyperparameters:



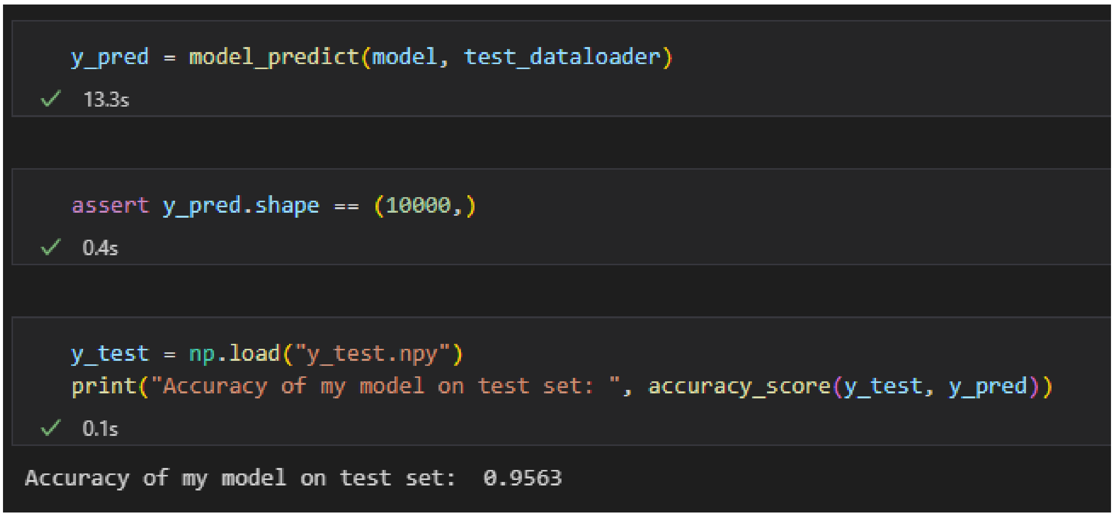
```
num_epochs = 5
batch_size = 64
lr = 0.005
```

- Training result:



```
model = train(model, criterion, optimizer, num_epochs, train_dataloader)
✓ 13m 27.3s
Epoch [1/5]: 100%|██████████| 782/782 [02:41<00:00,  4.84it/s, acc=75.90%, loss=0.879]

Train accuracy: 75.90, loss: 0.88
================================================================================

Epoch [2/5]: 100%|██████████| 782/782 [02:41<00:00,  4.84it/s, acc=93.12%, loss=0.219]

Train accuracy: 93.12, loss: 0.22
================================================================================

Epoch [3/5]:  70%|███████   | 550/782 [01:53<00:47,  4.85it/s, acc=95.72%, loss=0.139]

Train accuracy: 96.09, loss: 0.13
================================================================================

Epoch [4/5]: 100%|██████████| 782/782 [02:41<00:00,  4.85it/s, acc=97.96%, loss=0.0748]

Train accuracy: 97.96, loss: 0.07
================================================================================

Epoch [5/5]: 100%|██████████| 782/782 [02:41<00:00,  4.85it/s, acc=99.08%, loss=0.0417]

Train accuracy: 99.08, loss: 0.04
================================================================================
Best train acc: 99.076000
```

- Model result on test dataset:



```
y_pred = model_predict(model, test_dataloader)
✓ 13.3s

assert y_pred.shape == (10000,)
✓ 0.4s

y_test = np.load("y_test.npy")
print("Accuracy of my model on test set: ", accuracy_score(y_test, y_pred))
✓ 0.1s
Accuracy of my model on test set:  0.9563
```

- Reference:
  DenseNet (CVPR 2017)
  Finetuning torchvision models