13	27/10/25	Architecture of pre-trained models	
14	27/10/25	Pre-trained CNN model as a Feature Extractor using Transfer learning	
15	27/10/25	Yolo model to Detect the objects.	

27/10/25

Lab 14: Implement a pre-trained CNN model as a feature extractor using Transfer learning

Aim:

To use a pre-trained CNN (eg. VGG16, ResNet 50, MobileNet) as a feature extractor for image classification tasks.

Objectives:

1) To apply transfer learning for feature extraction

2) to fine-tune the pre-trained network for a new dataset.

3) To train a classifier on extracted features.

Observation:

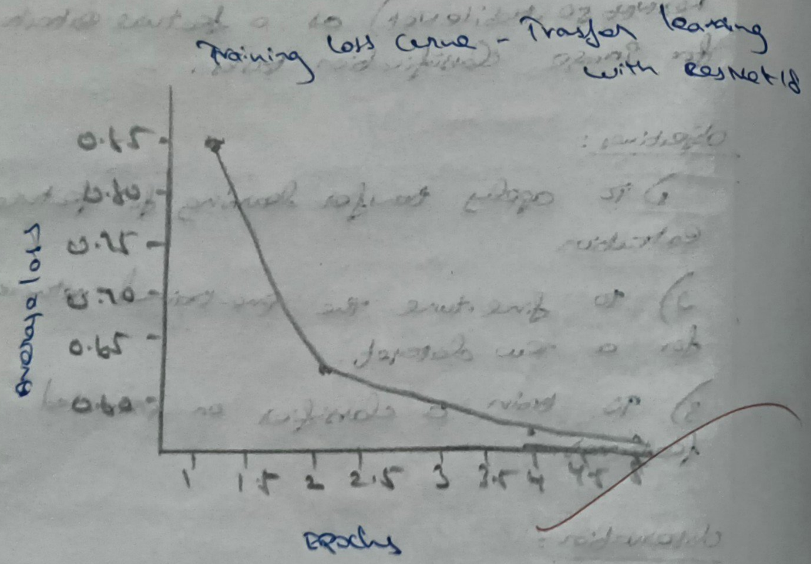
1) Early layers of pre-trained CNN's provide reusable features.

2) ~~Re~~using pre-trained models reduces training time and improves performance.

3) The final classification layer can be replaced with a custom classifier.

Pseudocode:

```
1) Import libraries
2) Load pre-trained CNN model
3) Freeze base model layers.
4) Add new classification layers (Dense + Softmax)
5) compile model (Adam optimizer, Categorical cross entropy)
```



6) Train on new dataset

7) Evaluate performance and visualize accuracy/loss.

Output:

```
Epoch 1, Loss : 0.8348
Epoch 2, Loss : 0.6229
Epoch 3, Loss : 0.5937.
Epoch 4, Loss : 0.5997
Epoch 5, Loss : 0.5699
```

Result:

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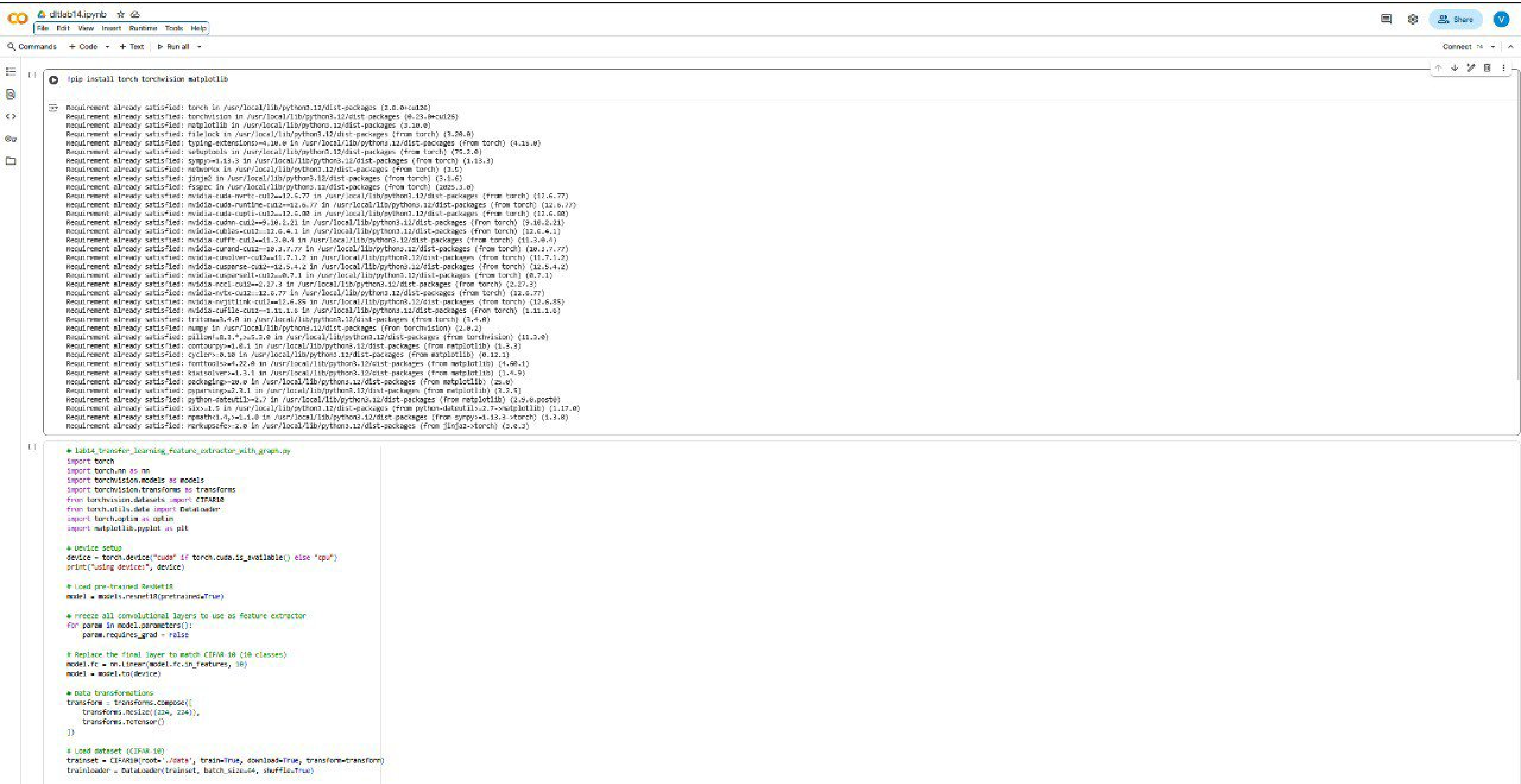
Successfully implemented the pre-trained CNN model as a feature Extractor using Transfer learning.



```
!pip install torch torchvision matplotlib
```

```
Requirement already satisfied: torch in /usr/local/lib/python3.12/dist-packages (2.8.0+cu126)
Requirement already satisfied: torchvision in /usr/local/lib/python3.12/dist-packages (0.23.0+cu126)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.12/dist-packages (3.10.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from torch) (3.20.0)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.12/dist-packages (from torch) (4.15.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from torch) (75.2.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch) (1.13.3)
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (from torch) (3.5)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from torch) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.12/dist-packages (from torch) (2025.3.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.80)
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch) (9.10.2.21)
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.4.1)
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.12/dist-packages (from torch) (11.3.0.4)
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python3.12/dist-packages (from torch) (10.3.7.77)
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch) (11.7.1.2)
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/python3.12/dist-packages (from torch) (12.5.4.2)
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python3.12/dist-packages (from torch) (0.7.1)
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/dist-packages (from torch) (2.27.3)
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/dist-packages (from torch) (1.11.1.6)
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Requirement already satisfied: numpy in /usr/local/lib/python3.12/dist-packages (from torchvision) (2.0.2)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in /usr/local/lib/python3.12/dist-packages (from torchvision) (11.3.0)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (1.3.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (4.60.1)
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (1.4.9)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (25.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (3.2.5)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-packages (from python-dateutil>=2.7->matplotlib) (1.17.0)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-packages (from sympy>=1.13.3->torch) (1.3.0)
Requirement already satisfied: markupsafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->torch) (3.0.3)
```
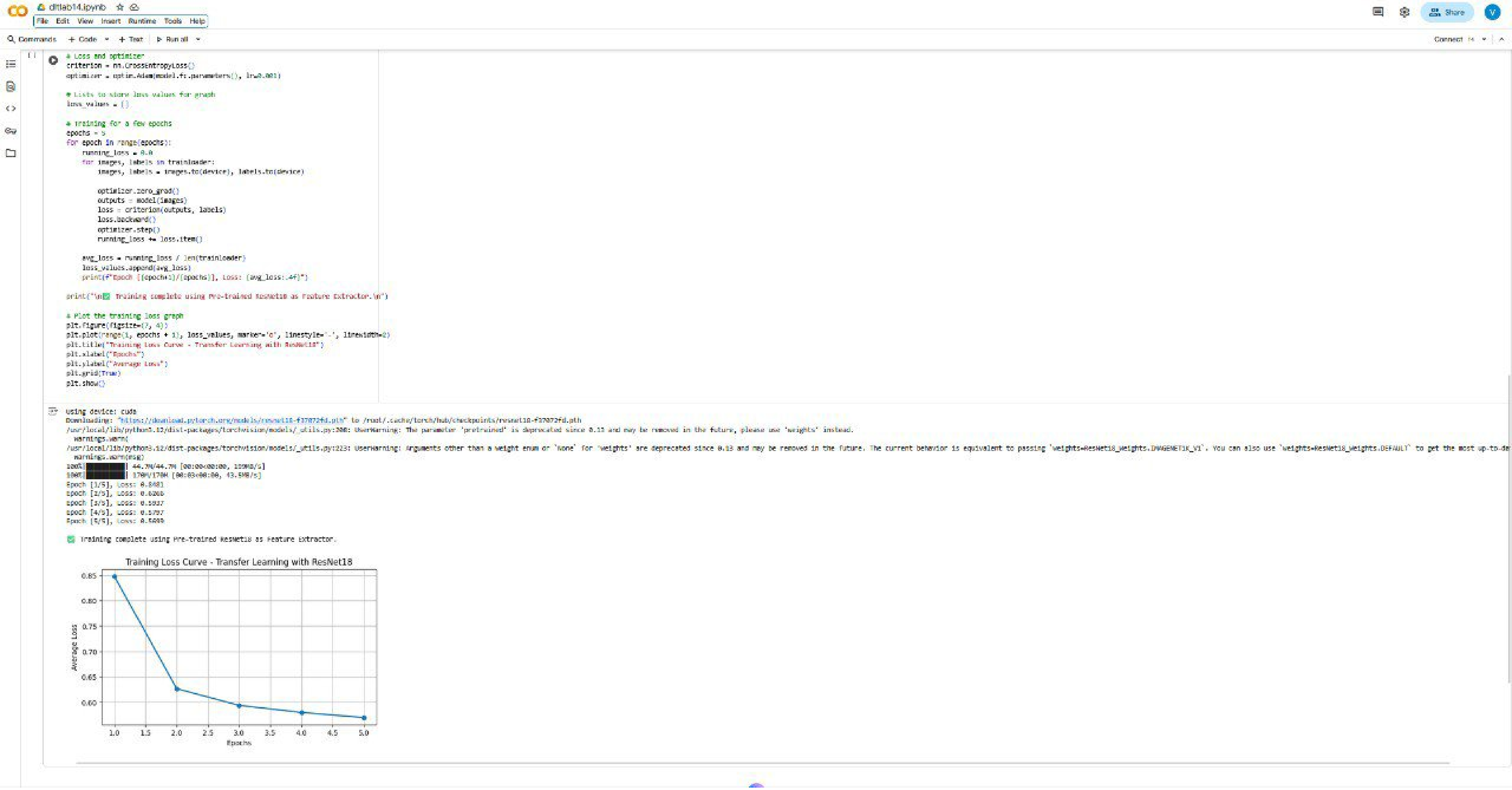

```python
# lab14_transfer_learning_feature_extractor_with_graph.py
import torch
import torch.nn as nn
import torchvision.models as models
import torchvision.transforms as transforms
from torchvision.datasets import CIFAR10
from torch.utils.data import DataLoader
import torch.optim as optim
import matplotlib.pyplot as plt

# Device setup
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
print("Using device:", device)

# Load pre-trained ResNet18
model = models.resnet18(pretrained=True)

# Freeze all convolutional layers to use as feature extractor
for param in model.parameters():
    param.requires_grad = False

# Replace the final layer to match CIFAR-10 (10 classes)
model.fc = nn.Linear(model.fc.in_features, 10)
model = model.to(device)

# Data transformations
transform = transforms.Compose([
    transforms.Resize((224, 224)),
    transforms.ToTensor()
])

# Load dataset (CIFAR-10)
trainset = CIFAR10(root='./data', train=True, download=True, transform=transform)
trainloader = DataLoader(trainset, batch_size=64, shuffle=True)
```



ditlab14.ipynb
File Edit View Insert Runtime Tools Help
Commands + Code + Text ▷ Run all
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```
# Loss and optimizer
criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.fc.parameters(), lr=0.001)

# Lists to store loss values for graph
loss_values = []

# Training for a few epochs
epochs = 5
for epoch in range(epochs):
    running_loss = 0.0
    for images, labels in trainloader:
        images, labels = images.to(device), labels.to(device)

        optimizer.zero_grad()
        outputs = model(images)
        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()
        running_loss += loss.item()

    avg_loss = running_loss / len(trainloader)
    loss_values.append(avg_loss)
    print(f"Epoch [{epoch+1}/{epochs}], Loss: {avg_loss:.4f}")

print("\n✅ Training complete using Pre-trained ResNet18 as Feature Extractor.\n")

# Plot the training loss graph
plt.figure(figsize=(7, 4))
plt.plot(range(1, epochs + 1), loss_values, marker='o', linestyle='-', linewidth=2)
plt.title("Training Loss Curve - Transfer Learning with ResNet18")
plt.xlabel("Epochs")
plt.ylabel("Average Loss")
plt.grid(True)
plt.show()
```

```
Using device: cuda
Downloading: "https://download.pytorch.org/models/resnet18-f37072fd.pth" to /root/.cache/torch/hub/checkpoints/resnet18-f37072fd.pth
/usr/local/lib/python3.12/dist-packages/torchvision/models/_utils.py:208: UserWarning: The parameter 'pretrained' is deprecated since 0.13 and may be removed in the future, please use 'weights' instead.
  warnings.warn(
/usr/local/lib/python3.12/dist-packages/torchvision/models/_utils.py:223: UserWarning: Arguments other than a weight enum or `None` for 'weights' are deprecated since 0.13 and may be removed in the future. The current behavior is equivalent to passing `weights=ResNet18_Weights.IMAGENET1K_V1`. You can also use `weights=ResNet18_Weights.DEFAULT` to get the most up-to-da
  warnings.warn(msg)
100%|██████████| 44.7M/44.7M [00:00<00:00, 109MB/s]
100%|██████████| 170M/170M [00:03<00:00, 43.5MB/s]
Epoch [1/5], Loss: 0.8481
Epoch [2/5], Loss: 0.6266
Epoch [3/5], Loss: 0.5937
Epoch [4/5], Loss: 0.5797
Epoch [5/5], Loss: 0.5699

✅ Training complete using Pre-trained ResNet18 as Feature Extractor.
```