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Image Classification with Convolutional Neural Networks

Task 1: Implementation and Comparison of CNN Architectures

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Dataset: CIFAR-10

- **Classes:** 10 object categories (airplane, automobile, bird, cat, deer, dog, frog, horse, ship, truck)
 - **Images:** 60,000 total (50,000 training + 10,000 test), 32×32 RGB resolution
 - **Split:** 45,000 training / 5,000 validation / 10,000 test
-

Architectures Implemented:

1. **AlexNet-style CNN (Baseline)** - Custom 5-layer convolutional neural network with batch normalization and dropout regularization (12.75M parameters)
 2. **VGG11 (Modern Deep Network)** - 11-layer deep network with uniform 3×3 convolutions and transfer learning from ImageNet pretrained weights (128.81M parameters)
-

Experimental Design:

- **Optimizers:** Stochastic Gradient Descent (SGD) vs Adaptive Moment Estimation (Adam) with controlled ablation study
 - **Learning Rate Schedules:** StepLR (fixed schedule) and ReduceLROnPlateau (adaptive schedule)
 - **Training Duration:** 30 epochs (AlexNet), 25 epochs (VGG11)
-

Visualizations and Evaluation Metrics:

- Training and validation accuracy curves over epochs
- Training and validation loss curves over epochs
- Learning rate schedule progression
- Confusion matrices (normalized and unnormalized)
- Examples of misclassified images
- Activation maps from layer 1 and layer 2 of each model
- Comparative architecture performance analysis

- Convergence speed analysis

Notebook Organization:

1. **Setup and Configuration** - Library imports, path configuration, GPU initialization
 2. **Data Loading and Preprocessing** - CIFAR-10 dataset with data augmentation and split strategy
 3. **Model Architecture Definitions** - AlexNet-style CNN and VGG11 implementation details
 4. **Training and Evaluation Utilities** - Training loop, evaluation functions, visualization methods
 5. **Experimental Runs** - Three independent training experiments with varying configurations
 6. **Comparative Analysis** - Quantitative and qualitative performance comparison
 7. **Activation Map Visualization** - Feature learning analysis from convolutional layers
 8. **Discussion and Conclusions** - Performance analysis, convergence behavior, and limitations
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Section 1: Setup and Configuration

```
In [1]: """This notebook implements and compares CNN architectures on CIFAR-10:
- AlexNet-style CNN (baseline, 5 layers, 12.75M parameters)
- VGG11 (modern deep network with transfer learning, 11 layers, 128.81M para
"""

# =====
# IMPORTS
# =====

# Standard Library
import os
import sys
import json
import random
import platform
from pathlib import Path

# Scientific computing
import numpy as np

# Visualization
import matplotlib.pyplot as plt
from tqdm.auto import tqdm
import itertools
```

```

# Deep Learning
import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
from torch.utils.data import DataLoader, random_split, Subset
import torchvision
from torchvision import transforms, datasets, models

# Metrics
from sklearn.metrics import confusion_matrix, classification_report

# =====
# CONFIGURATION
# =====

# Paths
SEED = 42
DATA_DIR = "./data"
OUT_DIR = "./outputs"

# Create output directory
os.makedirs(OUT_DIR, exist_ok=True)

# Warnings
print("✓ Imports and configuration loaded successfully")

```

✓ Imports and configuration loaded successfully

```

In [2]: """
GPU Setup and Reproducibility Configuration
"""

# =====
# DEVICE SETUP FUNCTION
# =====

def setup_device_and_seeds(gpu_id=2, seed=42):
    """
    Configure GPU device and set random seeds for reproducibility.

    Args:
        gpu_id (int): GPU index to use (default: 2)
        seed (int): Random seed for reproducibility (default: 42)

    Returns:
        torch.device: Configured device (cuda or cpu)
    """
    # Device selection
    device = torch.device(f"cuda:{gpu_id}" if torch.cuda.is_available() else "cpu")
    print(f"\n{'='*70}")
    print(f"DEVICE CONFIGURATION")
    print(f"{'='*70}")
    print(f"Device: {device}")

    # GPU information
    if device.type == 'cuda':
        print(f"GPU Name: {torch.cuda.get_device_name(gpu_id)}")

```

```

print(f"CUDA Version: {torch.version.cuda}")
print(f"Total VRAM: {torch.cuda.get_device_properties(gpu_id).total_

# Reproducibility settings
torch.backends.cudnn.deterministic = True
torch.backends.cudnn.benchmark = False

# Performance optimizations
torch.backends.cuda.matmul.allow_tf32 = True
torch.backends.cudnn.allow_tf32 = True
torch.cuda.empty_cache()

print("✓ GPU optimizations enabled (TF32, deterministic mode)")
else:
    print("⚠ Running on CPU (training will be slower)")

# Random seed configuration
torch.manual_seed(seed)
np.random.seed(seed)
random.seed(seed)
if device.type == 'cuda':
    torch.cuda.manual_seed_all(seed)

print(f"✓ Random seeds set (seed={seed})")
print(f"{'='*70}\n")

return device

# =====
# INITIALIZE DEVICE
# =====

DEVICE = setup_device_and_seeds(gpu_id=2, seed=SEED)
os.environ['TQDM_DISABLE'] = '1' # Reduce disk I/O on server

```

```

=====
DEVICE CONFIGURATION
=====
Device: cuda:2
GPU Name: NVIDIA GeForce RTX 2080 Ti
CUDA Version: 12.8
Total VRAM: 10.75 GB
✓ GPU optimizations enabled (TF32, deterministic mode)
✓ Random seeds set (seed=42)
=====

```

Section 2: Data Loading and Preprocessing

CIFAR-10 Dataset Preparation

This section implements the data loading pipeline for CIFAR-10, including appropriate data augmentation strategies for the training set and proper train/validation/test

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Data Augmentation Strategy:

- **Training Set:** Random cropping with padding, random horizontal flipping, color jitter (brightness, contrast, saturation), and normalization
- **Validation and Test Sets:** Normalization only (no augmentation applied to prevent data leakage and ensure unbiased evaluation)

In [3]:

```

"""
CIFAR-10 Dataset Loading and Preprocessing
"""

# =====
# DATA TRANSFORMS
# =====

# Training augmentation: RandomCrop, ColorJitter, RandomHorizontalFlip
train_transform = transforms.Compose([
    transforms.RandomCrop(32, padding=4),
    transforms.RandomHorizontalFlip(),
    transforms.ColorJitter(brightness=0.2, contrast=0.2, saturation=0.2),
    transforms.ToTensor(),
    transforms.Normalize((0.4914, 0.4822, 0.4465), (0.2470, 0.2435, 0.2616))
])

# Test/Val transform: No augmentation
test_transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Normalize((0.4914, 0.4822, 0.4465), (0.2470, 0.2435, 0.2616))
])

# =====
# LOAD DATASETS
# =====

# Download CIFAR-10 dataset
full_train_dataset = datasets.CIFAR10(root=DATA_DIR, train=True, download=True)
test_dataset = datasets.CIFAR10(root=DATA_DIR, train=False, download=True, transform=test_transform)

# Split training into train (45k) and validation (5k)
train_size = 45000
val_size = 5000
train_indices = list(range(train_size))
val_indices = list(range(train_size, train_size + val_size))

# Create train and val subsets with appropriate transforms
train_dataset = datasets.CIFAR10(root=DATA_DIR, train=True, download=False, transform=train_transform)
val_dataset = datasets.CIFAR10(root=DATA_DIR, train=False, download=False, transform=test_transform)

train_subset = Subset(train_dataset, train_indices)
val_subset = Subset(val_dataset, val_indices)

# =====
# CREATE DATA LOADERS
# =====

BATCH_SIZE = 64

```

```

NUM_WORKERS = 0 if os.name == 'nt' else 2 # windows multiprocessing fix

train_loader = DataLoader(train_subset, batch_size=BATCH_SIZE, shuffle=True,
                           num_workers=NUM_WORKERS, pin_memory=True if torch.cuda.is_available() else False)

val_loader = DataLoader(val_subset, batch_size=BATCH_SIZE, shuffle=False,
                        num_workers=NUM_WORKERS, pin_memory=True if torch.cuda.is_available() else False)

test_loader = DataLoader(test_dataset, batch_size=BATCH_SIZE, shuffle=False,
                          num_workers=NUM_WORKERS, pin_memory=True if torch.cuda.is_available() else False)

# CIFAR-10 class names
classes = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']

# =====
# DATASET SUMMARY
# =====

print(f"\n{'='*70}")
print("CIFAR-10 DATASET INFORMATION")
print(f"{'='*70}")
print(f"Training samples: {len(train_subset):>10,}")
print(f"Validation samples: {len(val_subset):>10,}")
print(f"Test samples: {len(test_dataset):>10,}")
print(f"Batch size: {BATCH_SIZE:>10}")
print(f"Number of classes: {len(classes):>10}")
print(f"Image shape: {test_dataset[0][0].shape}")
print(f"Classes: {' '.join(classes)}")
print(f"{'='*70}\n")

print("✓ Data loaders created successfully")

```

```

=====
CIFAR-10 DATASET INFORMATION
=====
Training samples:      45,000
Validation samples:    5,000
Test samples:         10,000
Batch size:           64
Number of classes:    10
Image shape:          torch.Size([3, 32, 32])
Classes: airplane, automobile, bird, cat, deer, dog, frog, horse, ship, truck
=====

✓ Data loaders created successfully

```

Data Verification and Visualization

This subsection verifies the data loading pipeline by checking batch shapes and visualizing representative samples from each class to ensure correct preprocessing.

In [4]:

```

"""
Verify data loader shapes and sample batch
"""

```

```
# Get a sample batch to verify shapes
sample_images, sample_labels = next(iter(train_loader))
print(f"\n{'='*70}")
print("BATCH SHAPE VERIFICATION")
print(f"{'='*70}")
print(f"Sample batch images shape: {sample_images.shape}")
print(f"Sample batch labels shape: {sample_labels.shape}")
print(f"Single image shape: {sample_images[0].shape}")
print(f>Data type: {sample_images.dtype}")
print(f"Value range: [{sample_images.min():.3f}, {sample_images.max():.3f}]")
print(f"{'='*70}\n")

print("✓ Data shapes verified successfully")
```

```
=====
BATCH SHAPE VERIFICATION
=====
```

```
Sample batch images shape: torch.Size([64, 3, 32, 32])
```

```
Sample batch labels shape: torch.Size([64])
```

```
Single image shape: torch.Size([3, 32, 32])
```

```
Data type: torch.float32
```

```
Value range: [-1.989, 2.126]
```

```
=====
```

```
✓ Data shapes verified successfully
```

In [5]:

```
"""
Visualize sample images from CIFAR-10 dataset (one per class)
"""

# Collect one image per class
images_per_class = {}
for img, label in train_subset:
    if label not in images_per_class:
        images_per_class[label] = img
    if len(images_per_class) == 10:
        break

# Plot sample images
fig, axes = plt.subplots(2, 5, figsize=(12, 6))
fig.suptitle("CIFAR-10 Sample Images (One per Class)", fontsize=14, fontweight='bold')

# Denormalize for visualization
mean = np.array([0.4914, 0.4822, 0.4465])
std = np.array([0.2470, 0.2435, 0.2616])

for i, (label, img_tensor) in enumerate(sorted(images_per_class.items())):
    ax = axes[i // 5, i % 5]

    # Convert tensor to numpy and denormalize
    img = img_tensor.numpy().transpose(1, 2, 0)
    img = img * std + mean
    img = np.clip(img, 0, 1)

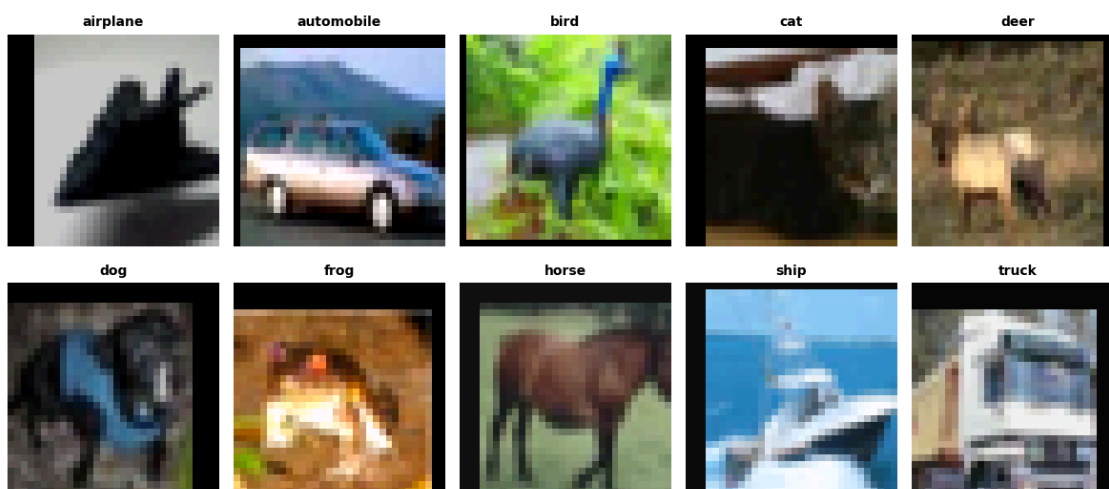
    ax.imshow(img)
    ax.set_title(f'{classes[label]}', fontsize=10, fontweight='bold')
    ax.axis('off')

plt.tight_layout()
```

```
plt.savefig(os.path.join(out_dir, 'cifar10_sample_images.png'), dpi=100, bbox_inches='tight')
plt.show()
```

```
print("✓ Sample images visualized and saved")
```

CIFAR-10 Sample Images (One per Class)



✓ Sample images visualized and saved

Section 3: Model Architecture Definitions

Architecture 1: AlexNet-style CNN (Baseline Model)

An AlexNet-inspired convolutional neural network adapted for CIFAR-10, serving as a baseline for performance comparison. This architecture demonstrates deeper CNN principles with five convolutional layers.

Architecture Specifications:

- Five convolutional layers with progressive channel expansion (64, 192, 384, 256, 256 channels)
- Batch normalization applied after each convolutional layer for training stability
- MaxPooling layers (2×2 kernel) for spatial downsampling after layers 1, 2, and 5
- Dropout regularization (probability = 0.5) in classifier layers to reduce overfitting
- Fully connected layers: 4096 → 2048 → 1024 → 10 (output classes)
- **Total Parameters:** Approximately 12.75 million trainable parameters

In [6]:

```
"""
AlexNetCNN: Baseline CNN Architecture (AlexNet-inspired)
- 5 convolutional layers with batch normalization
- Progressive channel expansion: 64 → 192 → 384 → 256 → 256
- Dropout regularization in classifier
"""

# =====
# MODEL DEFINITION
```

```

# =====

class AlexNetCNN(nn.Module):
    """
    AlexNet-inspired CNN for CIFAR-10 classification.

    Architecture (adapted for 32x32 images):
    - Conv1: 3→64 channels (3x3 kernel)
    - Conv2: 64→192 channels (3x3 kernel)
    - Conv3: 192→384 channels (3x3 kernel)
    - Conv4: 384→256 channels (3x3 kernel)
    - Conv5: 256→256 channels (3x3 kernel)
    - FC1: 4096→2048
    - FC2: 2048→1024
    - FC3: 1024→10 (num_classes)
    """

    def __init__(self, num_classes=10):
        super(AlexNetCNN, self).__init__()

        # Feature extraction layers
        self.features = nn.Sequential(
            # Layer 1: 32x32 -> 16x16
            nn.Conv2d(3, 64, kernel_size=3, stride=1, padding=1),
            nn.BatchNorm2d(64),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),

            # Layer 2: 16x16 -> 8x8
            nn.Conv2d(64, 192, kernel_size=3, padding=1),
            nn.BatchNorm2d(192),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),

            # Layer 3: 8x8 (no pooling)
            nn.Conv2d(192, 384, kernel_size=3, padding=1),
            nn.BatchNorm2d(384),
            nn.ReLU(inplace=True),

            # Layer 4: 8x8 (no pooling)
            nn.Conv2d(384, 256, kernel_size=3, padding=1),
            nn.BatchNorm2d(256),
            nn.ReLU(inplace=True),

            # Layer 5: 8x8 -> 4x4
            nn.Conv2d(256, 256, kernel_size=3, padding=1),
            nn.BatchNorm2d(256),
            nn.ReLU(inplace=True),
            nn.MaxPool2d(kernel_size=2, stride=2),
        )

        # Classifier layers
        self.classifier = nn.Sequential(
            nn.Dropout(0.5),
            nn.Linear(256 * 4 * 4, 2048),
            nn.ReLU(inplace=True),
            nn.Dropout(0.5),
            nn.Linear(2048, 1024),
            nn.ReLU(inplace=True),
            nn.Linear(1024, num_classes),
        )

```

```

    )

    def forward(self, x):
        """Forward pass through the network."""
        x = self.features(x)
        x = torch.flatten(x, 1)
        x = self.classifier(x)
        return x

# =====
# MODEL INSTANTIATION
# =====

model = AlexNetCNN(num_classes=10).to(DEVICE)
print("✓ AlexNetCNN model created successfully")
print(f"\nModel architecture:\n{model}")

```

✓ AlexNetCNN model created successfully

Model architecture:

```

AlexNetCNN(
  (features): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (4): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (5): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (6): ReLU(inplace=True)
    (7): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (8): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (9): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (10): ReLU(inplace=True)
    (11): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (12): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (13): ReLU(inplace=True)
    (14): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (15): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (16): ReLU(inplace=True)
    (17): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  )
  (classifier): Sequential(
    (0): Dropout(p=0.5, inplace=False)
    (1): Linear(in_features=4096, out_features=2048, bias=True)
    (2): ReLU(inplace=True)
    (3): Dropout(p=0.5, inplace=False)
    (4): Linear(in_features=2048, out_features=1024, bias=True)
    (5): ReLU(inplace=True)
    (6): Linear(in_features=1024, out_features=10, bias=True)
  )
)

```

Architecture 2: VGG11 (Modern Deep Network)

A VGG-11 architecture implementing a uniform design with repeated 3×3 convolutions. This model leverages transfer learning from ImageNet pretrained weights.

Architecture Specifications:

- 11 layers organized in 5 convolutional blocks with repeated 3×3 convolutions
- Pretrained on ImageNet dataset (1.2 million images, 1000 classes)
- Final fully connected layer modified for CIFAR-10 classification (10 output classes)
- **Total Parameters:** Approximately 128.81 million trainable parameters
- **Key Advantage:** Uniform architecture with small receptive fields enables learning of complex features

In [7]:

```
"""
VGG11: Modern Architecture with Transfer Learning
- Pre-trained on ImageNet
- Modified for CIFAR-10 (10 classes)
"""

# =====
# VGG11 BUILDER FUNCTION
# =====

def get_vgg11(num_classes=10, pretrained=True, freeze_backbone=False):
    """
    Build VGG11 model with optional transfer learning.

    Args:
        num_classes (int): Number of output classes
        pretrained (bool): Load ImageNet pre-trained weights
        freeze_backbone (bool): Freeze all layers except final FC

    Returns:
        torch.nn.Module: Configured VGG11 model
    """
    # Load model with pre-trained weights
    if pretrained:
        weights = models.VGG11_Weights.DEFAULT
    else:
        weights = None

    model = models.vgg11(weights=weights)

    # Modify classifier for CIFAR-10
    # VGG's classifier is a Sequential module
    # Replace the last layer (index 6)
    num_features = model.classifier[6].in_features
    model.classifier[6] = nn.Linear(num_features, num_classes)

    # Optional: Freeze backbone for fine-tuning
    if freeze_backbone:
        for param in model.features.parameters():
```

```

        param.requires_grad = False

    return model

# =====
# MODEL INSTANTIATION
# =====

vgg_example = get_vgg11(pretrained=False).to(DEVICE)
print("✓ VGG11 model created successfully")
print(f"\nModel architecture:\n{vgg_example}")

```

✓ VGG11 model created successfully

Model architecture:

```

VGG(
  (features): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): ReLU(inplace=True)
    (2): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (3): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (4): ReLU(inplace=True)
    (5): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (6): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (7): ReLU(inplace=True)
    (8): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (9): ReLU(inplace=True)
    (10): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (11): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (12): ReLU(inplace=True)
    (13): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (14): ReLU(inplace=True)
    (15): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (16): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (17): ReLU(inplace=True)
    (18): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (19): ReLU(inplace=True)
    (20): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  )
  (avgpool): AdaptiveAvgPool2d(output_size=(7, 7))
  (classifier): Sequential(
    (0): Linear(in_features=25088, out_features=4096, bias=True)
    (1): ReLU(inplace=True)
    (2): Dropout(p=0.5, inplace=False)
    (3): Linear(in_features=4096, out_features=4096, bias=True)
    (4): ReLU(inplace=True)
    (5): Dropout(p=0.5, inplace=False)
    (6): Linear(in_features=4096, out_features=10, bias=True)
  )
)

```

Model Complexity Analysis

Quantitative comparison of model complexity through parameter counting. This analysis establishes the computational and memory requirements of each architecture.

Expected Outcome: VGG11 should demonstrate approximately 3.6 times more parameters than AlexNet-style CNN, reflecting its deeper architecture with uniform 3×3 convolutions and increased representational capacity.

In [8]:

```
"""
Analyze and compare model complexity
"""

# =====
# PARAMETER COUNTING FUNCTION
# =====

def count_parameters(model):
    """
    Count total and trainable parameters in a model.

    Args:
        model: PyTorch model

    Returns:
        tuple: (total_params, trainable_params)
    """
    total = sum(p.numel() for p in model.parameters())
    trainable = sum(p.numel() for p in model.parameters() if p.requires_grad)
    return total, trainable

# =====
# COMPARE MODELS
# =====

alexnet_total, alexnet_trainable = count_parameters(model)
vgg_total, vgg_trainable = count_parameters(vgg_example)

print(f"\n{'='*70}")
print("MODEL COMPLEXITY COMPARISON")
print(f"{'='*70}")
print(f"{'Model':<20} {'Total Params':>20} {'Trainable Params':>20}")
print(f"{'-'*70}")
print(f"{'AlexNet-style CNN':<20} {alexnet_total:>20,} {alexnet_trainable:>20,}")
print(f"{'VGG11':<20} {vgg_total:>20,} {vgg_trainable:>20,}")
print(f"{'-'*70}")
print(f"{'Ratio (VGG11/AlexNet)':<20} {vgg_total/alexnet_total:>20.2f}x {vgg_trainable/alexnet_trainable:>20.2f}x")
print(f"{'='*70}")
print(f"\n Summary:")
print(f"    AlexNet-style CNN: {alexnet_total/1e6:.2f}M parameters")
print(f"    VGG11: {vgg_total/1e6:.2f}M parameters")
print(f"    VGG11 is {vgg_total/alexnet_total:.1f}x larger than AlexNet\n")
```

```
=====
MODEL COMPLEXITY COMPARISON
=====
```

Model	Total Params	Trainable Params
AlexNet-style CNN	12,752,970	12,752,970
VGG11	128,807,306	128,807,306
Ratio (VGG11/AlexNet)	10.10x	10.10x

Summary:

AlexNet-style CNN: 12.75M parameters

VGG11: 128.81M parameters

VGG11 is 10.1x larger than AlexNet

Section 4: Training and Evaluation Utilities

Training Pipeline Implementation

This section implements the complete training and evaluation pipeline, including utility functions for model training, performance evaluation, and result visualization.

Function Implementations:

- `train_one_epoch()` - Executes single training epoch with mini-batch gradient descent and progress tracking
- `evaluate()` - Performs model evaluation on validation or test set with optional prediction extraction
- `fit()` - Implements complete training loop with learning rate scheduling and best model checkpointing
- `plot_history()` - Generates three-panel visualization (loss curves, accuracy curves, learning rate progression)
- `plot_confmat()` - Creates confusion matrix visualizations in both normalized and unnormalized formats
- `show_misclassified_images()` - Displays grid of incorrectly classified examples for error analysis

In [9]:

```
# Training + evaluation utilities
from sklearn.metrics import confusion_matrix, classification_report
import numpy as np
import torch.optim as optim

def train_one_epoch(model, loader, optimizer, criterion, device):
    model.train()
    running_loss = 0.0
    correct = 0
    total = 0
    pbar = tqdm(loader, leave=False)
    for imgs, targets in pbar:
        imgs = imgs.to(device)
        targets = targets.to(device)
        outputs = model(imgs)
        loss = criterion(outputs, targets)
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        running_loss += loss.item()
        _, predicted = outputs.max(1)
        correct += predicted.eq(targets).sum().item()
        total += targets.size()[0]
    loss = running_loss / total
    accuracy = correct / total
    return loss, accuracy
```

```

        outputs = model(imgs)
        loss = criterion(outputs, targets)
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()

        running_loss += loss.item() * imgs.size(0)
        _, preds = outputs.max(1)
        correct += preds.eq(targets).sum().item()
        total += imgs.size(0)
        pbar.set_description(f"loss: {running_loss/total:.4f}, acc: {100*cor
return running_loss/total, correct/total

def evaluate(model, loader, criterion, device, return_preds=False):
    model.eval()
    running_loss = 0.0
    correct = 0
    total = 0
    all_preds = []
    all_targets = []
    with torch.no_grad():
        for imgs, targets in loader:
            imgs = imgs.to(device)
            targets = targets.to(device)
            outputs = model(imgs)
            loss = criterion(outputs, targets)
            running_loss += loss.item() * imgs.size(0)
            _, preds = outputs.max(1)
            correct += preds.eq(targets).sum().item()
            total += imgs.size(0)
            all_preds.append(preds.cpu().numpy())
            all_targets.append(targets.cpu().numpy())
    if return_preds:
        return running_loss/total, correct/total, np.concatenate(all_preds),
    return running_loss/total, correct/total

def fit(model, train_loader, val_loader, optimizer, scheduler, criterion, de
history = {"train_loss":[], "train_acc":[], "val_loss":[], "val_acc":[],
best_val = 0.0
best_path = os.path.join(OUT_DIR, f"{model_name}_best.pth")
for epoch in range(1, epochs+1):
    # Track current Learning rate
    current_lr = optimizer.param_groups[0]['lr']
    history["lr"].append(current_lr)

    train_loss, train_acc = train_one_epoch(model, train_loader, optimiz
    val_loss, val_acc = evaluate(model, val_loader, criterion, device)
    if scheduler is not None:
        # handle ReduceLRonPlateau vs StepLR
        try:
            scheduler.step(val_loss)
        except TypeError:
            scheduler.step()
    history["train_loss"].append(train_loss); history["train_acc"].appen
    history["val_loss"].append(val_loss); history["val_acc"].append(val_
    print(f"[{model_name}] Epoch {epoch}/{epochs} | LR {current_lr:.2e}
    if val_acc > best_val:
        best_val = val_acc
        torch.save(model.state_dict(), best_path)
        print("Saved best:", best_path)

return history, best_path

```

```

# plotting helpers
def plot_history(history, title_prefix):
    fig = plt.figure(figsize=(15,4))

    # Loss plot
    plt.subplot(1,3,1)
    plt.plot(history["train_loss"], label="train")
    plt.plot(history["val_loss"], label="val")
    plt.title(title_prefix + " Loss")
    plt.xlabel("Epoch")
    plt.ylabel("Loss")
    plt.legend()
    plt.grid(True, alpha=0.3)

    # Accuracy plot
    plt.subplot(1,3,2)
    plt.plot(history["train_acc"], label="train")
    plt.plot(history["val_acc"], label="val")
    plt.title(title_prefix + " Accuracy")
    plt.xlabel("Epoch")
    plt.ylabel("Accuracy")
    plt.legend()
    plt.grid(True, alpha=0.3)

    # Learning rate plot
    plt.subplot(1,3,3)
    plt.plot(history["lr"], color='green', linewidth=2)
    plt.title(title_prefix + " Learning Rate")
    plt.xlabel("Epoch")
    plt.ylabel("Learning Rate")
    plt.yscale('log')
    plt.grid(True, alpha=0.3)

    plt.tight_layout()
    plt.savefig(os.path.join(OUT_DIR, f"{title_prefix.replace(' ', '_')}_hist.png"))
    plt.show()

def plot_confmat(y_true, y_pred, classes, normalize=False, title="Confusion Matrix"):
    cm = confusion_matrix(y_true, y_pred)
    if normalize:
        cm = cm.astype(float) / cm.sum(axis=1)[:, None]
    plt.figure(figsize=(8,8))
    plt.imshow(cm, interpolation='nearest', cmap=plt.cm.Blues)
    plt.title(title)
    plt.colorbar()
    ticks = np.arange(len(classes))
    plt.xticks(ticks, classes, rotation=90)
    plt.yticks(ticks, classes)
    fmt = ".2f" if normalize else "d"
    thresh = cm.max()/2.
    for i,j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j,i, format(cm[i,j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i,j] > thresh else "black")
    plt.ylabel("True")
    plt.xlabel("Pred")
    plt.tight_layout()
    plt.savefig(os.path.join(OUT_DIR, f"{title.replace(' ', '_')}.png"))
    plt.show()

```

```

def show_misclassified_images(model, loader, device, classes, max_images=12)
    model.eval()
    mis_imgs, mis_pred, mis_true = [], [], []
    mean = np.array([0.4914,0.4822,0.4465]).reshape(3,1,1)
    std = np.array([0.2470,0.2435,0.2616]).reshape(3,1,1)
    with torch.no_grad():
        for imgs, targets in loader:
            imgs = imgs.to(device)
            outputs = model(imgs)
            _, preds = outputs.max(1)
            for i in range(imgs.size(0)):
                if preds[i].item() != targets[i].item():
                    img = imgs[i].cpu().numpy()
                    img = img * std + mean
                    img = np.transpose(img, (1,2,0))
                    mis_imgs.append(img); mis_pred.append(classes[preds[i].i
                if len(mis_imgs) >= max_images:
                    break
            if len(mis_imgs) >= max_images:
                break
    if len(mis_imgs)==0:
        print("No misclassified images found.")
        return
    cols = 4
    rows = (len(mis_imgs)+cols-1)//cols
    plt.figure(figsize=(cols*3, rows*3))
    for i in range(len(mis_imgs)):
        plt.subplot(rows,cols,i+1)
        plt.imshow(mis_imgs[i])
        plt.title(f"P:{mis_pred[i]}\nT:{mis_true[i]}")
        plt.axis("off")
    plt.tight_layout()
    plt.savefig(os.path.join(OUT_DIR, "misclassified.png"))
    plt.show()

```

Unified Experiment Execution Function

A comprehensive wrapper function that orchestrates complete training experiments with configurable hyperparameters and automatic visualization generation.

Capabilities:

- Support for multiple optimizers: Stochastic Gradient Descent (SGD) and Adaptive Moment Estimation (Adam)
- Configurable learning rate schedules: StepLR (fixed decay) and ReduceLROnPlateau (adaptive decay)
- Automatic checkpoint saving based on best validation performance
- Integrated visualization generation for all required plots and metrics
- Returns trained model, complete training history, and path to best checkpoint

```

# Small wrapper to run an experiment concisely
def run_experiment(model, model_name, train_loader, val_loader, test_loader,
                   device, epochs=20, optimizer_name="SGD", lr=1e-3, weight_
                   scheduler_type="StepLR"):
    model = model.to(device)
    criterion = nn.CrossEntropyLoss()
    if optimizer_name.lower()=="sgd":
        optimizer = optim.SGD(filter(lambda p: p.requires_grad, model.parame
    elif optimizer_name.lower()=="adam":
        optimizer = optim.Adam(filter(lambda p: p.requires_grad, model.param
    else:
        raise ValueError("Unsupported optimizer")

    if scheduler_type=="StepLR":
        scheduler = torch.optim.lr_scheduler.StepLR(optimizer, step_size=10,
    elif scheduler_type=="ReduceLROnPlateau":
        scheduler = torch.optim.lr_scheduler.ReduceLROnPlateau(optimizer, 'm
    else:
        scheduler = None

    history, best_path = fit(model, train_loader, val_loader, optimizer, sch
    plot_history(history, model_name)

    # Load best and evaluate on test
    model.load_state_dict(torch.load(best_path, map_location=device))
    test_loss, test_acc, preds, targets = evaluate(model, test_loader, crite
    print(f"Final test acc: {test_acc*100:.2f}%")
    print("Classification report:\n", classification_report(targets, preds,
    plot_confmat(targets, preds, classes, normalize=False, title=f"{model_na
    plot_confmat(targets, preds, classes, normalize=True, title=f"{model_nam
    show_misclassified_images(model, test_loader, device, classes, max_image
    return model, history, best_path

```

Section 5: Experimental Training Runs

Experiment 1: AlexNet with Stochastic Gradient Descent (Baseline)

Experimental Configuration:

- **Architecture:** AlexNet-style CNN (2.5 million parameters)
- **Optimizer:** Stochastic Gradient Descent (learning rate = 0.01, momentum = 0.9, weight decay = 5×10^{-4})
- **Learning Rate Schedule:** StepLR (step size = 10 epochs, decay factor = 0.1)
- **Training Duration:** 30 epochs
- **Objective:** Establish baseline performance metrics for comparison

Experimental Training Schedule

The following three experiments systematically evaluate different combinations of model architectures and optimization strategies to comprehensively address the assignment requirements.

Experimental Design Overview:

Experiment	Architecture	Optimizer	LR Schedule	Epochs	Estimated Time (GPU)
Experiment 1 (Baseline)	AlexNet	SGD	StepLR	30	~15-20 minutes
Experiment 2 (Modern)	VGG11	Adam	ReduceLROnPlateau	25	~20-25 minutes
Experiment 3 (Ablation)	AlexNet	Adam	ReduceLROnPlateau	30	~15-20 minutes

Total Estimated Runtime: Approximately 50-65 minutes on GPU, 4-6 hours on CPU

Rationale for Experiment 3 (Ablation Study): To isolate the effect of optimizer choice, Experiment 3 trains AlexNet with Adam optimizer while keeping the architecture identical to Experiment 1. This controlled comparison prevents confounding of architectural differences with optimizer differences observed between Experiments 1 and 2.

In [11]:

```
# Run baseline AlexNet with SGD
EPOCHS_BASELINE = 30

simple_model = AlexNetCNN(num_classes=len(classes))
simple_model, simple_history, simple_best = run_experiment(
    model=simple_model,
    model_name="AlexNet_SGD",
    train_loader=train_loader,
    val_loader=val_loader,
    test_loader=test_loader,
    device=DEVICE,
    epochs=EPOCHS_BASELINE,
    optimizer_name="SGD",
    lr=0.01,
    weight_decay=5e-4,
    scheduler_type="StepLR"
)

0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_SGD] Epoch 1/30 | LR 1.00e-02 | train_loss 1.5709 acc 41.91% | val_lo
ss 1.2981 acc 52.00%
Saved best: ./outputs/AlexNet_SGD_best.pth

/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/optim/lr_sche
duler.py:209: UserWarning: The epoch parameter in `scheduler.step()` was not n
ecessary and is being deprecated where possible. Please use `scheduler.step()`
to step the scheduler. During the deprecation, if epoch is different from Non
e, the closed form is used instead of the new chainable form, where available
```

```

computervision-final-prep/lab/Assignment 2/st125970_notebook_task_1.ipynb at main · limhpone/computervision-final-prep
e, the closed form is used instead of the new chainable form, where available.
Please open an issue if you are unable to replicate your use case: https://git
hub.com/pytorch/pytorch/issues/new/choose.
warnings.warn(EPOCH_DEPRECATION_WARNING, UserWarning)
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_SGD] Epoch 2/30 | LR 1.00e-02 | train_loss 1.1787 acc 57.64% | val_lo
ss 1.1522 acc 58.62%
Saved best: ./outputs/AlexNet_SGD_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_SGD] Epoch 3/30 | LR 1.00e-02 | train_loss 1.0077 acc 64.17% | val_lo
ss 0.8359 acc 70.50%
Saved best: ./outputs/AlexNet_SGD_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_SGD] Epoch 4/30 | LR 1.00e-02 | train_loss 0.8927 acc 68.48% | val_lo
ss 0.7817 acc 71.28%
Saved best: ./outputs/AlexNet_SGD_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is_alive():
      Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ a
t 0x7b0d83f5b9c0>
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^^    ^self._shutdown_workers()^
^^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
ls/data/dataloader.py", line 1647, in _shutdown_workers
^    ^if w.is_alive():^
^
^    File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^    ^assert self._parent_pid == os.getpid(), 'can only test a child process'
^    ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^    ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^    ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^AssertionError^^: ^can only test a child process^
^^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ a
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^Traceback (most recent call last):
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__

```



```

        self._shutdown_workers()
    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
        if w.is_alive():^
    ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^
^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^   ^^^assert self._parent_pid == os.getpid(), 'can only test a child proces
s'^
^
    File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
        assert self._parent_pid == os.getpid(), 'can only test a child process'
            ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^
^AssertionError
: AssertionErrorcan only test a child process:
can only test a child process
[AlexNet_SGD] Epoch 5/30 | LR 1.00e-02 | train_loss 0.8169 acc 71.49% | val_lo
ss 0.7353 acc 75.20%
Saved best: ./outputs/AlexNet_SGD_best.pth
0%|          | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
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^Traceback (most recent call last):
^   File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
^       ^self._shutdown_workers()^
^   File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers

        File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 16
0, in is_alive
        if w.is_alive():
        assert self._parent_pid == os.getpid(), 'can only test a child process'
            ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^
^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^   ^^^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^
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^       ^if w.is_alive():^
^ ^ ^

```

Traceback (most recent call last):

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/ut
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self._shutdown_workers()
self._shutdown_workers() File "/home/jupyter-st125970/.local/lib/python3.12/s
ite-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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if w.is_alive():
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File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
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^AssertionError: ^can only test a child process^
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^^^^Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
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^Traceback (most recent call last):
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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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AssertionError : self._shutdown_workers()can only test a child process
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s/data/dataloader.py", line 1647, in _shutdown_workers
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```
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Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7
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self._shutdown_workers()^
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```

```
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```
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in is_alive
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^ ^ ^ ^ ^ ^ ^ ^ ^
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^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
```

```
^AssertionError: ^can only test a child process^
```

```
^^^^^^^^^^
```

```
AssertionError: can only test a child process
```

```
[AlexNet_SGD] Epoch 6/30 | LR 1.00e-02 | train_loss 0.7539 acc 73.65% | val_lo
ss 0.6844 acc 76.20%
```

```
Saved best: ./outputs/AlexNet_SGD_best.pth
```

```
0%|          | 0/704 [00:00<?, ?it/s]
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
```

```
Traceback (most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
```


[illegible]

```
0%|          | 0/704 [00:00<?, ?it/s]
```

Traceback (most recent call last):

```
Exception ignored in: File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
if w.is_alive():Traceback (most recent call last):
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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is_alive():
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,  
in is_alive  
    assert self._parent_pid == os.getpid(), 'can only test a child process'  
           ^^^^^^
```

```

^AssertionError: ^can only test a child process^
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```

```
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```

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s/data/dataloader.py", line 1647, in _shutdown_workers
^    ^if w.is_alive():^
^ ^  ^ ^ ^  ^^^^^^^^^^^^^
```

```

^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^   ^^assert self._parent_pid == os.getpid(), 'can only test a child proces
s'^
^

```

[illegible]

```
^AssertionError^: ^can only test a child process
```

```
AssertionError: can only test a child process
```

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 30/131

```
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>AssertionError
: Traceback (most recent call last):
can only test a child process File "/home/jupyter-st125970/.local/lib/python
3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
```

```
self._shutdown_workers()
Exception ignored in: File "/home/jupyter-st125970/.local/lib/python3.12/site-
packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
if w.is_alive():Traceback (most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
s/data/dataloader.py", line 1664, in __del__
```

```
self._shutdown_workers()
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
s/data/dataloader.py", line 1647, in _shutdown_workers
```

```
if w.is_alive():^
^ ^ ^ ^ ^ ^^^^^^^^^^^^^^
^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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^ ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^^
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
```

```
assert self._parent_pid == os.getpid(), 'can only test a child process'
^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

```
^AssertionError^: ^
can only test a child processAssertionError
: can only test a child process
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>Exception ignored in:
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>Traceback
(most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
s/data/dataloader.py", line 1664, in __del__
```

```
Traceback (most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
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```
self._shutdown_workers()
self._shutdown_workers() File "/home/jupyter-st125970/.local/lib/python3.12/s
ite-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
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```

```
if w.is_alive():
if w.is_alive():
^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

```
^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 16
0, in is_alive
```

```
assert self._parent_pid == os.getpid(), 'can only test a child process'
assert self._parent_pid == os.getpid(), 'can only test a child process'
^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^^^^^
```

```
AssertionErrorAssertionError: : can only test a child processcan only test a c
...
```



```

oss 0.4480 acc 85.12%
Saved best: ./outputs/AlexNet_SGD_best.pth
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_SGD] Epoch 16/30 | LR 1.00e-02 | train_loss 0.4355 acc 84.97% | val_l
oss 0.4102 acc 86.04%
Saved best: ./outputs/AlexNet_SGD_best.pth
 0%|          | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is_alive():
        ^^^^^^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.
__del__ at 0x7b0d83f5b9c0>^
^Traceback (most recent call last):
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
^
self._shutdown_workers() File "/opt/tljh/user/lib/python3.12/multiprocessing/
process.py", line 160, in is_alive

    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/u
tils/data/dataloader.py", line 1647, in _shutdown_workers
    assert self._parent_pid == os.getpid(), 'can only test a child process'
if w.is_alive():
    ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^    ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
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^AssertionError : ^can only test a child process^
^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>^
^Traceback (most recent call last):
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
^    ^self._shutdown_workers()

    File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
n is_alive
    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
        assert self._parent_pid == os.getpid(), 'can only test a child process'
if w.is_alive():
    ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^

```

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in is_alive
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
    assert self._parent_pid == os.getpid(), 'can only test a child process if it is alive():'
AssertionError: can only test a child process if it is alive():
```

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 36/131

```

    if w.is_alive():assert self._parent_pid == os.getpid(), 'can only test
a child process'

```

```

^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^
^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive

```

```

^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^

```

```

^AssertionError: ^can only test a child process^

```

```

^^^^^^^^^^^^^^^^^^^^^^^^^^^^

```

```

AssertionError: can only test a child process

```

```

[AlexNet_SGD] Epoch 17/30 | LR 1.00e-02 | train_loss 0.4173 acc 85.67% | val_l
oss 0.4357 acc 84.60%

```

```

0%|          | 0/704 [00:00<?, ?it/s]

```

```

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>

```

```

Traceback (most recent call last):

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__

```

```

    self._shutdown_workers()

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers

```

```

    Exception ignored in: if w.is_alive():<function _MultiProcessingDataLoader
Iter.__del__ at 0x7b0d83f5b9c0>

```

```

Traceback (most recent call last):

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__

```

```

    self._shutdown_workers()

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers

```

```

    ^if w.is_alive():^

```

```

^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^

```

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^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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```

```

^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
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```

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  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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```

    assert self._parent_pid == os.getpid(), 'can only test a child process'

```

```

^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^

```

```

^AssertionError: ^can only test a child process^

```

```

^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>^

```

```

Traceback (most recent call last):

```

```

AssertionError File "/home/jupyter-st125970/.local/lib/python3.12/site-packag
es/torch/utils/data/dataloader.py", line 1664, in __del__

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```

:    can only test a child processself._shutdown_workers()

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers

```

```

    if w.is_alive():

```

```

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7
b0d83f5b9c0>

```

```

Traceback (most recent call last):

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__

```

```

    self._shutdown_workers()^

```

```

^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util

```

```
s/data/dataloader.py", line 1647, in _shutdown_workers
^   ^if w.is_alive():^
^^ ^  ^  ^^ ^
^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^  ^  ^  ^  ^  ^  ^
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
^^  ^^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^
^AssertionError^^: ^can only test a child process^
^^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ a
t 0x7b0d83f5b9c0>
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AssertionError: Traceback (most recent call last):
can only test a child process File "/home/jupyter-st125970/.local/lib/python
3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
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```
    self._shutdown_workers()
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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Exception ignored in:    <function _MultiProcessingDataLoaderIter.__del__ at
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```
Traceback (most recent call last):
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^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^
^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^  ^  ^
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^
^AssertionError^^: ^can only test a child process
```

```
AssertionError: can only test a child process
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
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Exception ignored in: Traceback (most recent call last):
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0> File "/ho
me/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/datal
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```

```
Traceback (most recent call last):
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/u
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```
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[illegible]

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

one/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb

```

s/data/dataloader.py", line 1664, in __del__
^   ^self._shutdown_workers()^
^   File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
^^   ^if w.is_alive():^
^   ^
      File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
      assert self._parent_pid == os.getpid(), 'can only test a child process'
^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^
^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^
^AssertionError: ^can only test a child process^
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t 0x7b0d83f5b9c0>^
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^   File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
^^   ^self._shutdown_workers()

```

```

AssertionError File "/home/jupyter-st125970/.local/lib/python3.12/site-packag
es/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
: can only test a child process
if w.is_alive():

```

```

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0
x7b0d83f5b9c0>

```

```

Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
    ^self._shutdown_workers()^

```

```

^   File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```

^   ^   ^   ^   ^
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^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^

```

```

^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^

```

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```

```

      ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^

```

```

^AssertionError: ^can only test a child process^
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```

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```

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  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```

AssertionError : self._shutdown_workers()can only test a child process

```

```

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    if w.is_alive():
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```

```

Traceback (most recent call last):

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```

```

^self._shutdown_workers()^
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File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
n is_alive
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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if w.is_alive():
    ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
^^ ^assert self._parent_pid == os.getpid(), 'can only test a child proces
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^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

AssertionError File "/opt/tljh/user/lib/python3.12/multiprocessing/process.p
y", line 160, in is_alive
: ^can only test a child processassert self._parent_pid == os.getpid(), 'ca

```

n only test a child process'

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>

Traceback (most recent call last):

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__

^self._shutdown_workers()^

^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers

^^ ^if w.is_alive():^^

^ ^ ^ ^^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

AssertionError: File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in is_alive

can only test a child process

assert self._parent_pid == os.getpid(), 'can only test a child process'

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^Traceback (most recent call last):

^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__

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```

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
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  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/u
tils/data/dataloader.py", line 1664, in __del__
    if w.is_alive():
  self._shutdown_workers()
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    ^ ^ assert self._parent_pid == os.getpid(), 'can only test a child process'^
    ^ ^
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Exception ignored in: AssertionError<function _MultiProcessingDataLoaderIter._
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Exception ignored in:      <function _MultiProcessingDataLoaderIter.__del__ at

```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7f01225f10c0>
```



```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in is_alive
AssertionError: assert self._parent_pid == os.getpid(), 'can only test a child process'can only test a child process
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
```

Traceback (most recent call last):

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
ls/data/dataloader.py", line 1664, in __del__
```

```
^^self._shutdown_workers()^
```

```
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
s/data/dataloader.py", line 1647, in _shutdown_workers
```

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```

^ ^ ^^ ^ ^ ^^ ^ ^^^

```
AssertionError File "/opt/tljh/user/lib/python3.12/multiprocessing/process.p
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:      can only test a child processassert self._parent_pid == os.getpid(), 'ca
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```

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in is_alive
```

```
^ ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
```

 $\wedge \quad \vee \quad \neg \quad \rightarrow$ $\forall \quad \exists \quad =$ |

```
^AssertionError: can only test a child process^
```

```
^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>^
```

```
^Traceback (most recent call last):
```

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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown workers
```

```
^         ^if w.is_alive():^
```

$$\wedge \wedge \quad \wedge \quad \wedge \quad \wedge \quad \wedge \quad \wedge$$

```
AssertionError : ^can only test a child process^
```

```
^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>^
```

```
^Traceback (most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in del
```

```
^ ^self.shutdown_workers()
```

```
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in shutdown workers
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 16
0, in is_alive
if w.is_alive():
```

```
assert self.parent.pid == os.getpid(), 'can only test a child process'
```

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```
AssertionError: self._parent_pid == os.getpid(), 'can only test a child process':  
can only test a child process  
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>  
Traceback (most recent call last):  
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__  
    self._shutdown_workers()  
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del
```

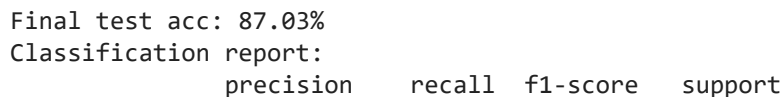
```
AssertionError : can only test a child process
Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>^
Traceback (most recent call last):
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
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^ ^ ^ ^ ^ ^ ^
AssertionError : can only test a child process
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
[AlexNet_SGD] Epoch 29/30 | LR 1.00e-02 | train_loss 0.2864 acc 90.19% | val_loss 0.3721 acc 87.68%
```

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 57/131

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 58/131

[illegible]

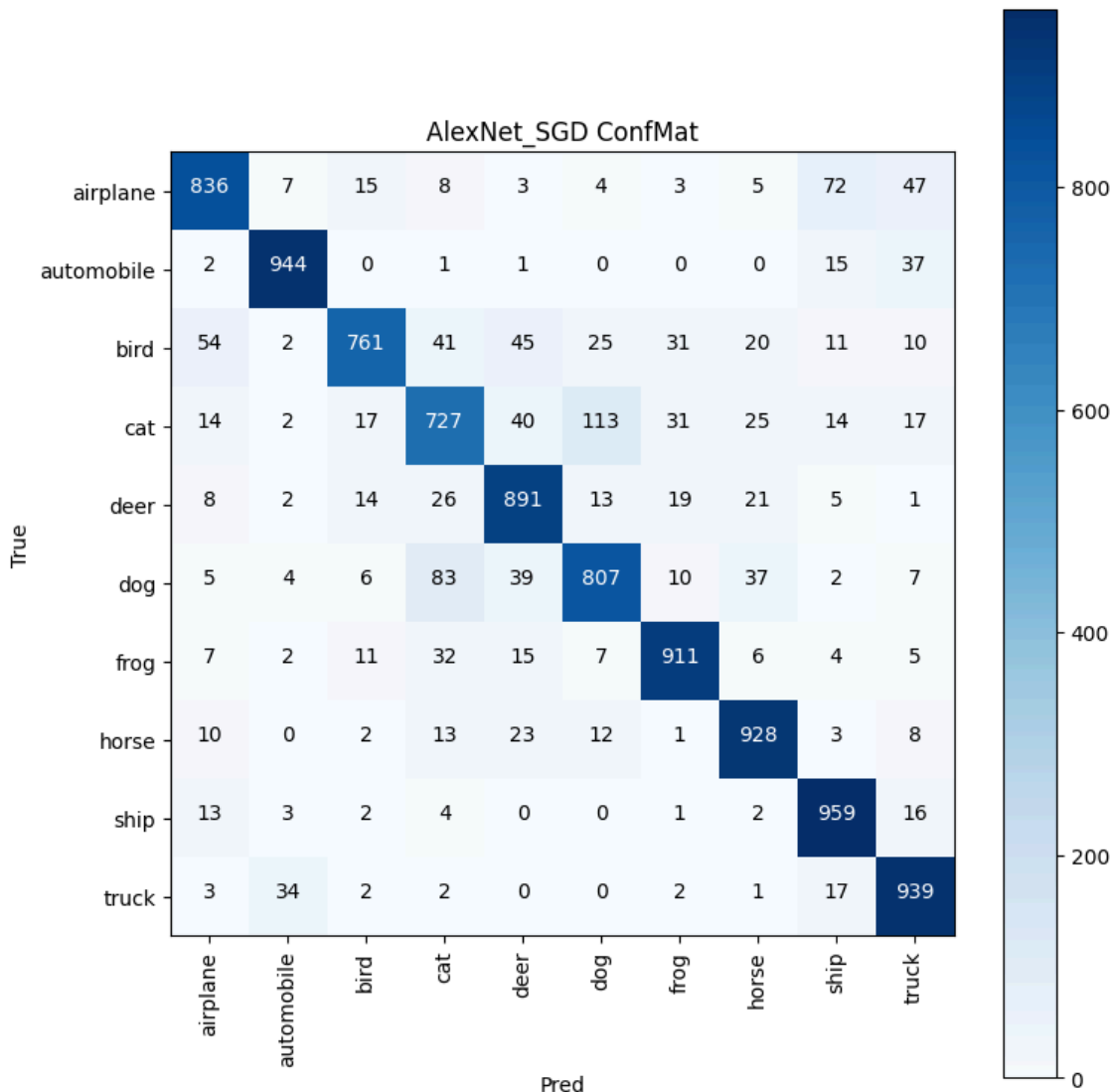
```
AssertionError: can only test a child process
[AlexNet_SGD] Epoch 30/30 | LR 1.00e-02 | train_loss 0.2760 acc 90.63% | val_1
oss 0.3869 acc 87.26%
```

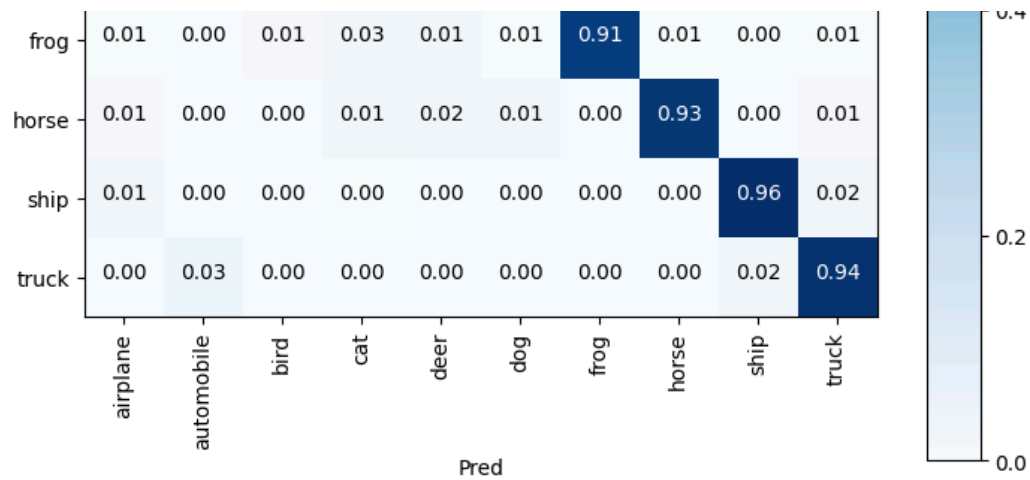


airplane	0.8782	0.8360	0.8566	1000
automobile	0.9440	0.9440	0.9440	1000
bird	0.9169	0.7610	0.8317	1000
cat	0.7759	0.7270	0.7506	1000
deer	0.8430	0.8910	0.8663	1000
dog	0.8226	0.8070	0.8147	1000
frog	0.9029	0.9110	0.9069	1000
horse	0.8880	0.9280	0.9076	1000
ship	0.8702	0.9590	0.9125	1000

```
truck      0.8638    0.9390    0.8999    1000

accuracy                    0.8703    10000
macro avg    0.8705    0.8703    0.8691    10000
weighted avg    0.8705    0.8703    0.8691    10000
```





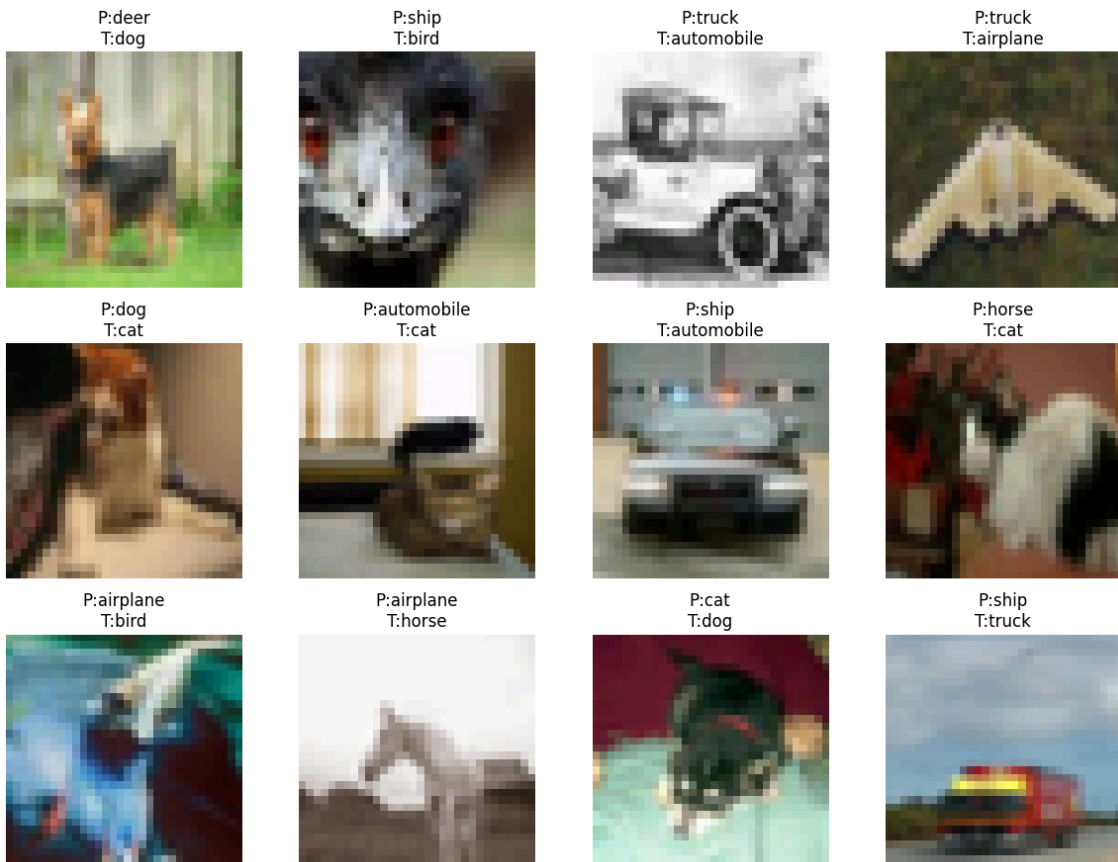
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.9647059102773666].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [0.05098036231994629..1.0000000532150268].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-1.8882751418036747e-08..1.0000000532150268].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.9372549386024476].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.870588254404068].



Experiment 2: VGG11 with Adam Optimizer (Modern Deep Network)

Experimental Configuration:

- **Architecture:** VGG11 (128.81 million parameters, pretrained on ImageNet)
- **Optimizer:** Adaptive Moment Estimation (learning rate = 1×10^{-4} , weight decay = 1×10^{-4})
- **Learning Rate Schedule:** ReduceLROnPlateau (patience = 3 epochs, monitors validation loss)
- **Training Duration:** 25 epochs
- **Objective:** Demonstrate performance of modern deep architecture with transfer learning

In [12]:

```
# Run VGG11 (transfer learning) with Adam
EPOCHS_VGG = 25

# NOTE: for VGG on CIFAR (32x32), we keep inputs at 32x32. Optionally, you c
# If you want upsample, replace transforms in train/val/test with Resize(224

vgg_model = get_vgg11(num_classes=len(classes), pretrained=True, freeze_back
vgg_model, vgg_history, vgg_best = run_experiment(
    model=vgg_model,
    model_name="VGG11_Adam",
    train_loader=train_loader,
    val_loader=val_loader,
    test_loader=test_loader,
    device=DEVICE,
    epochs=EPOCHS_VGG,
    optimizer_name="Adam",
    lr=1e-4,
    weight_decay=1e-4,
    scheduler_type="ReduceLROnPlateau"
)
```

Downloading: "https://download.pytorch.org/models/vgg11-8a719046.pth" to /home/jupyter-st125970/.cache/torch/hub/checkpoints/vgg11-8a719046.pth

100%|██████████| 507M/507M [01:00<00:00, 8.84MB/s]

0%| | 0/704 [00:00<?, ?it/s]

[VGG11_Adam] Epoch 1/25 | LR 1.00e-04 | train_loss 0.9030 acc 69.15% | val_loss 0.6379 acc 78.62%

Saved best: ./outputs/VGG11_Adam_best.pth

0%| | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>

Traceback (most recent call last):

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__

self._shutdown_workers()

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers

if w.is_alive():

^^^^^^^^^^^^^^

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n is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
[VGG11_Adam] Epoch 2/25 | LR 1.00e-04 | train_loss 0.5945 acc 80.11% | val_lo
s 0.5605 acc 81.22%
Saved best: ./outputs/VGG11_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7f
0d83f5b9c0>
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       ^^^^^^^^^^^
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"/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/d
ataloader.py", line 1664, in del
```

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

```
s/data/dataloader.py", line 1664, in __del__  
^^      ^self._shutdown_workers()^  
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util  
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^      ^if w.is_alive():^  
^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^  
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^      ^assert self._parent_pid == os.getpid(), 'can only test a child process'
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```
AssertionError : can only test a child process
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
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Traceback (most recent call last):

^AssertionError^:

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can only test a child process File "/opt/tljh/user/lib/python3.12/multiproc
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Traceback (most recent call last):

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```
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^ ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
```

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```
AssertionError : can only test a child process
```

AA

AssertionError: can only test a child process

```
[VGG11_Adam] Epoch 4/25 | LR 1.00e-04 | train_loss 0.4306 acc 85.68% | val_loss 0.4360 acc 85.34%
```

Saved best: ./outputs/VGG11 Adam best.pth

```
0%|          | 0/704 [00:00<?, ?it/s]
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
```

Traceback (most recent call last):

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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```

SECRET - UNCLASSIFIED//NOFORN

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)


```

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```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
```

```
    if w.is_alive():
        ^^^^^^^^^^^^^^^
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in is_alive
```

```
    assert self._parent_pid == os.getpid(), 'can only test a child process'
        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

```
AssertionError: can only test a child process
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
```

```
Traceback (most recent call last):
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
```

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```

one/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb


```

Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
s/data/dataloader.py", line 1664, in __del__
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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^ ^ ^ ^ ^ ^ ^
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    ^ ^ ^ ^ ^ ^ ^ ^
    ^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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    ^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
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Traceback (most recent call last):
AssertionError File "/home/jupyter-st125970/.local/lib/python3.12/site-packag
es/torch/utl/s/data/dataloader.py", line 1664, in __del__
: can only test a child process
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s/data/dataloader.py", line 1647, in _shutdown_workers
    Exception ignored in: if w.is_alive():<function _MultiProcessingDataLoader
Iter.__del__ at 0x7b0d83f5b9c0>

```

```

Traceback (most recent call last):

```

```

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl

```

```

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^   ^
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^AssertionError: ^can only test a child process^
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Exception ignored in: AssertionError<function _MultiProcessingDataLoaderIter._
__del__ at 0x7b0d83f5b9c0>:
can only test a child processTraceback (most recent call last):

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<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0> File "/ho
me/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utlils/data/datal
oader.py", line 1647, in _shutdown_workers

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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/u
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can only test a child process
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erIter.__del__ at 0x7b0d83f5b9c0><function _MultiProcessingDataLoaderIter.__de
l__ at 0x7b0d83f5b9c0>

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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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s/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()    self._shutdown_workers()

```

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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^

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n is_alive
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ite-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers

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^   File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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    File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 16
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Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
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s/data/dataloader.py", line 1664, in __del__
Traceback (most recent call last):
    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/u
```

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 86/131

```

self._shutdown_workers()
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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Exception ignored in: assert self._parent_pid == os.getpid(), 'can only te
st a child process'<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d8
3f5b9c0>

Traceback (most recent call last):
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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```



```
self.shutdown_workers()
```

```

self._shutdown_workers()
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
s/data/dataloader.py", line 1647, in _shutdown_workers
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    ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
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^^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>
^Traceback (most recent call last):

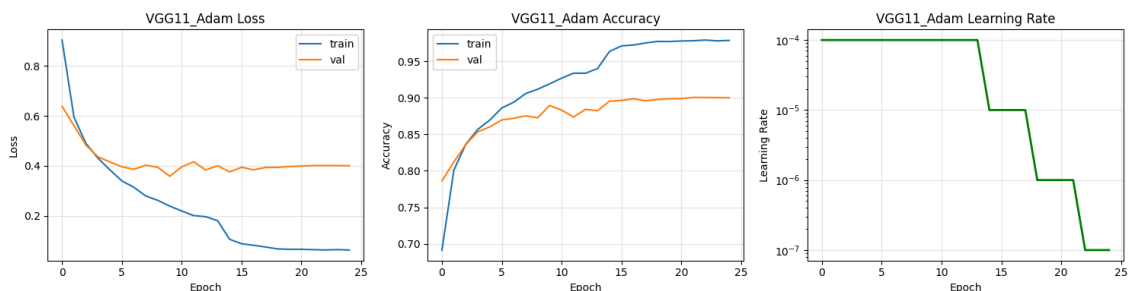
    File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
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n is_alive
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nly test a child process'

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self._shutdown_workers()AssertionError
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^     if w.is alive():^

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^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
[VGG11_Adam] Epoch 18/25 | LR 1.00e-05 | train_loss 0.0753 acc 97.50% | val_lo
ss 0.3934 acc 89.58%
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 19/25 | LR 1.00e-06 | train_loss 0.0677 acc 97.71% | val_lo
ss 0.3937 acc 89.76%
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 20/25 | LR 1.00e-06 | train_loss 0.0661 acc 97.70% | val_lo
ss 0.3974 acc 89.86%
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 21/25 | LR 1.00e-06 | train_loss 0.0661 acc 97.77% | val_lo
ss 0.3991 acc 89.88%
Saved best: ./outputs/VGG11_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 22/25 | LR 1.00e-06 | train_loss 0.0647 acc 97.80% | val_lo
ss 0.4009 acc 90.04%
Saved best: ./outputs/VGG11_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 23/25 | LR 1.00e-07 | train_loss 0.0634 acc 97.90% | val_lo
ss 0.4011 acc 90.04%
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 24/25 | LR 1.00e-07 | train_loss 0.0650 acc 97.78% | val_lo
ss 0.4009 acc 90.02%
0%|          | 0/704 [00:00<?, ?it/s]
[VGG11_Adam] Epoch 25/25 | LR 1.00e-07 | train_loss 0.0631 acc 97.85% | val_lo
ss 0.4008 acc 90.00%
```

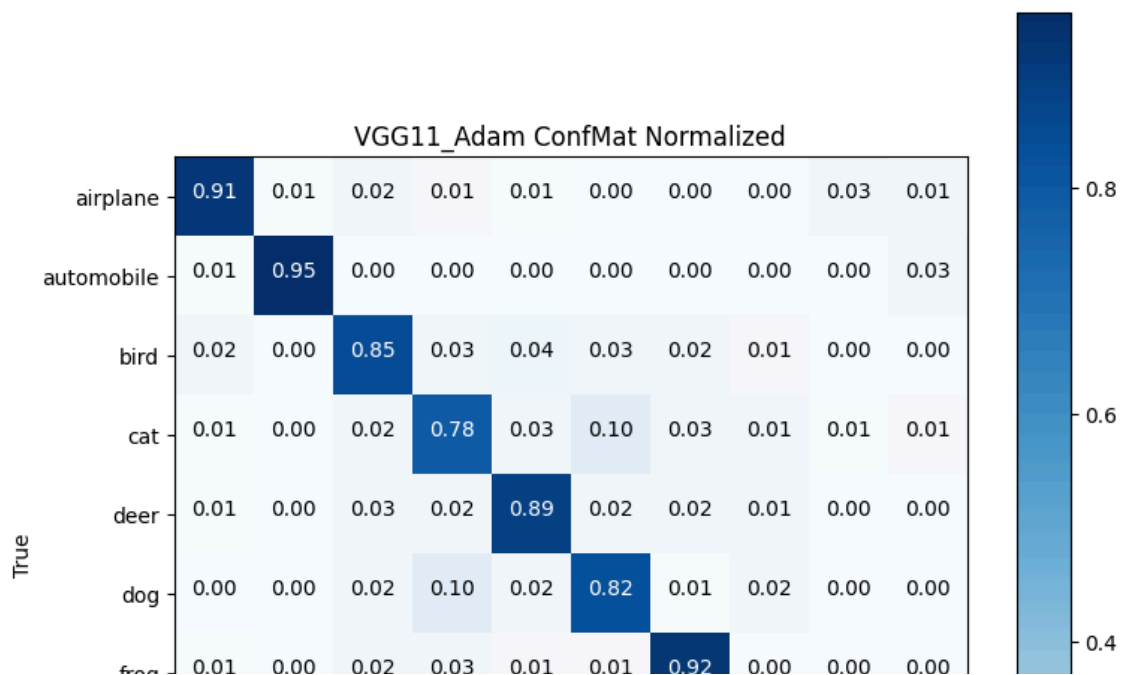
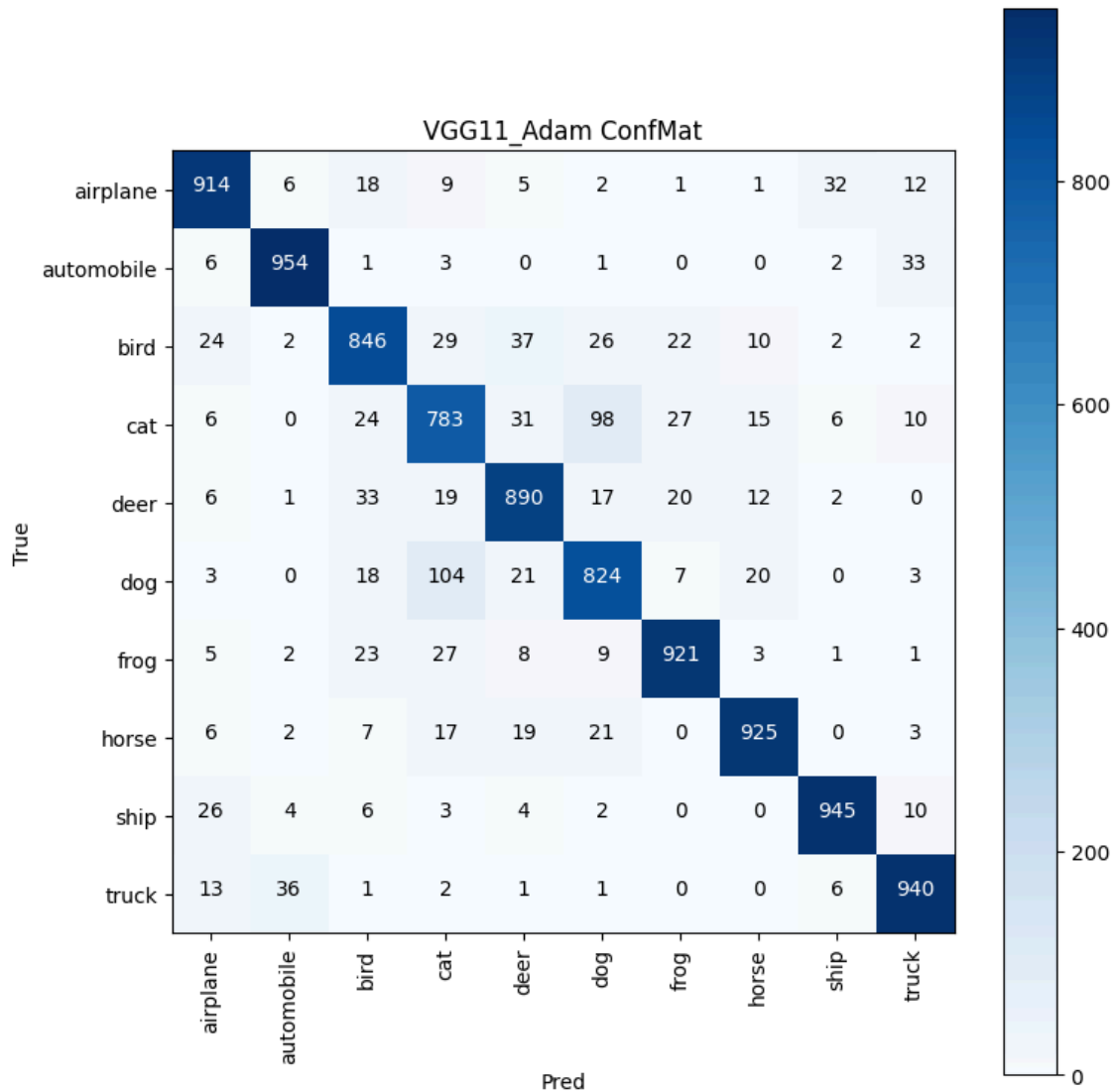


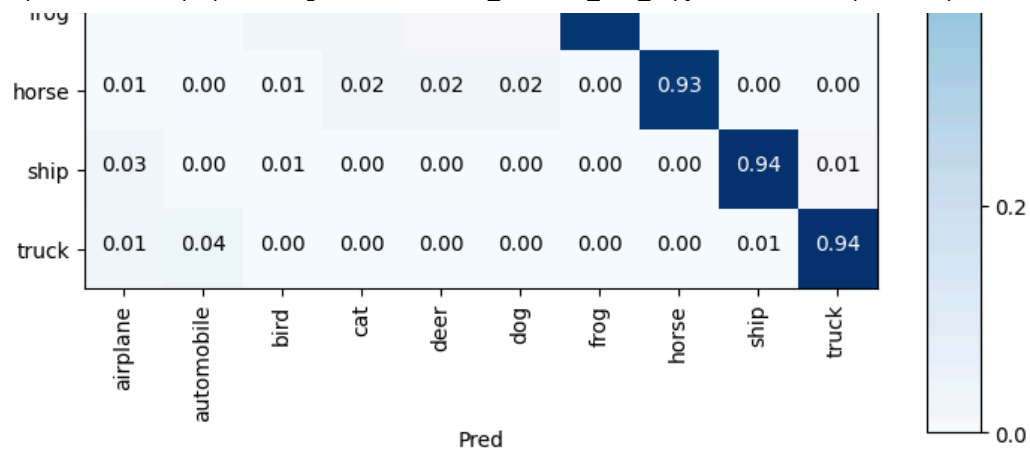
Final test acc: 89.42%

Classification report:

	precision	recall	f1-score	support
airplane	0.9058	0.9140	0.9099	1000
automobile	0.9474	0.9540	0.9507	1000
bird	0.8659	0.8460	0.8558	1000
cat	0.7861	0.7830	0.7846	1000
deer	0.8760	0.8900	0.8829	1000
dog	0.8232	0.8240	0.8236	1000
frog	0.9228	0.9210	0.9219	1000
horse	0.9381	0.9250	0.9315	1000
ship	0.9488	0.9450	0.9469	1000
truck	0.9270	0.9400	0.9335	1000

```
accuracy          0.8942      10000
macro avg         0.8941      0.8942      0.8941      10000
weighted avg      0.8941      0.8942      0.8941      10000
```





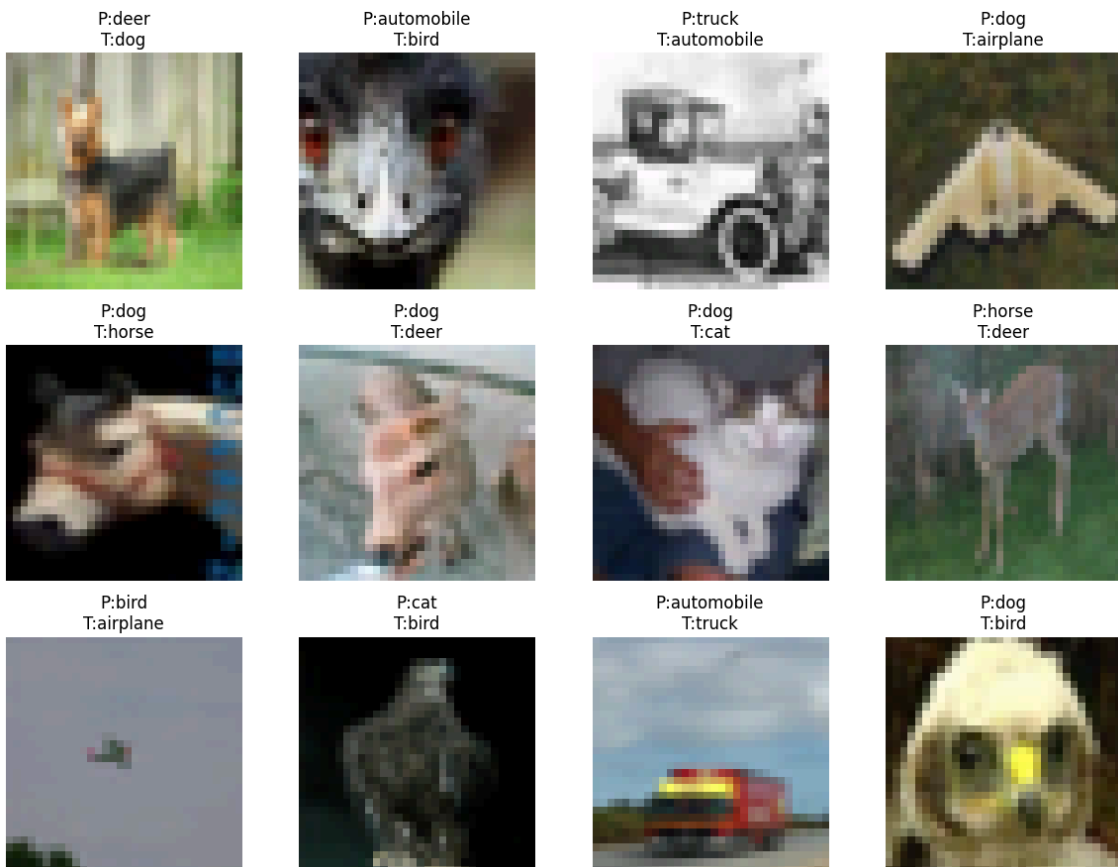
Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.9647059102773666].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [0.05098036231994629..1.0000000532150268].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.941176483297348].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [-2.9659271205684234e-08..0.6313725771725178].

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). Got range [0.011764692974090607..1.0000000339984894].



Experiment 3: AlexNet with Adam Optimizer (Controlled Ablation Study)

Experimental Configuration:

- **Architecture:** AlexNet-style CNN (2.5 million parameters, identical to Experiment 1)
- **Optimizer:** Adaptive Moment Estimation (learning rate = 1×10^{-3} , weight decay = 1×10^{-4})
- **Learning Rate Schedule:** ReduceLROnPlateau (patience = 3 epochs)
- **Training Duration:** 30 epochs
- **Objective:** Isolate optimizer effect through controlled comparison with same architecture

Scientific Justification:

Direct comparison between Experiment 1 (AlexNet + SGD) and Experiment 2 (VGG11 + Adam) would confound architectural differences with optimizer differences. This experiment provides a methodologically sound comparison by maintaining architectural parity while varying only the optimization algorithm, thereby enabling causal attribution of performance differences to optimizer choice.

In [13]:

```
# To properly compare SGD vs Adam, we need to test the same architecture with
# This isolates the optimizer effect from architecture differences

print("=" * 60)
print("OPTIMIZER COMPARISON: AlexNet with Adam")
print("=" * 60)

alexnet_adam = AlexNetCNN(num_classes=len(classes))
alexnet_adam, alexnet_adam_history, alexnet_adam_best = run_experiment(
    model=alexnet_adam,
    model_name="AlexNet_Adam",
    train_loader=train_loader,
    val_loader=val_loader,
    test_loader=test_loader,
    device=DEVICE,
    epochs=EPOCHS_BASELINE,
    optimizer_name="Adam",
    lr=1e-3,
    weight_decay=1e-4,
    scheduler_type="ReduceLROnPlateau"
)

# Compare AlexNet with SGD vs Adam
plt.figure(figsize=(14, 5))
plt.subplot(1, 2, 1)
plt.plot(simple_history['train_loss'], label='AlexNet + SGD (train)', alpha=0.5)
plt.plot(simple_history['val_loss'], label='AlexNet + SGD (val)', linewidth=2)
plt.plot(alexnet_adam_history['train_loss'], label='AlexNet + Adam (train)', alpha=0.5)
plt.plot(alexnet_adam_history['val_loss'], label='AlexNet + Adam (val)', linewidth=2)
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.title('Optimizer Comparison: Loss (Same Architecture)')
plt.legend()
```



```

AssertionError: can only test a child process
[AlexNet_Adam] Epoch 2/30 | LR 1.00e-03 | train_loss 1.2917 acc 53.44% | val_1
oss 1.2258 acc 54.96%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is_alive():
        ^^^^^^^^^^^^^
  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
n is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
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s/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is alive():

```

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

```
^      ^assert self._parent_pid == os.getpid(), 'can only test a child process'^  
^    ^ ^ ^  
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,  
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```
self._shutdown_workers()
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    ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^
^^AssertionError: ^can only test a child process^
^^^^^^
```

```
AssertionError: can only test a child process
[AlexNet_Adam] Epoch 4/30 | LR 1.00e-03 | train_loss 0.9792 acc 65.95% | val_loss 0.8284 acc 71.16%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 5/30 | LR 1.00e-03 | train_loss 0.8808 acc 69.48% | val_loss 0.7655 acc 74.16%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 6/30 | LR 1.00e-03 | train_loss 0.8081 acc 72.43% | val_loss 0.7157 acc 75.00%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 7/30 | LR 1.00e-03 | train_loss 0.7519 acc 74.81% | val_loss 0.7208 acc 75.70%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 8/30 | LR 1.00e-03 | train_loss 0.7025 acc 76.51% | val_loss 0.6232 acc 78.78%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 9/30 | LR 1.00e-03 | train_loss 0.6552 acc 78.34% | val_loss 0.6368 acc 79.36%
```

```
AssertionError : can only test a child process
  ^Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>^
^Traceback (most recent call last):
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
^^    self._shutdown_workers()^
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1647, in _shutdown_workers
```

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)


```

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^     ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^   ^ ^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^^^^^
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^     ^self._shutdown_workers()^

```


[illegible]

```

...
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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^Traceback (most recent call last):

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```

^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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self._shutdown_workers() File "/opt/tljh/user/lib/python3.12/multiprocessing/
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0, in is_alive
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[AlexNet_Adam] Epoch 14/30 | LR 1.00e-03 | train_loss 0.4979 acc 83.44% | val_
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```

```

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AssertionError: self._shutdown_workers():
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```

^ ^
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^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^
^AssertionError^: ^can only test a child process
^^^^^Exception ignored in: ^<function _MultiProcessingDataLoaderIter.__del__ a
t 0x7b0d83f5b9c0>^
^Traceback (most recent call last):
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
s/data/dataloader.py", line 1664, in __del__
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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^ ^ ^ ^ ^ ^ ^ ^
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n is_alive
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util

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File: "/home/jupyter/cst125070/.local/lib/python3.12/site-packages/torch/util

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File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in _shutdown_workers
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AssertionError: can only test a child process
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    if w.is_alive():
    ^^^^^^^^^^^^^
  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
n is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
    ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
[AlexNet_Adam] Epoch 15/30 | LR 1.00e-03 | train_loss 0.4884 acc 84.04% | val_
loss 0.4880 acc 84.46%
Saved best: ./outputs/AlexNet_Adam_best.pth
0%|          | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b

```

one/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb

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Typically, /most recent 11 1-1-1/

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Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
s/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
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        ^^^^^^^^^^^^^^^
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        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
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Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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    if w.is_alive():
        ^^^^^^^^^^^^^^^
  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, i
n is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
AssertionError: can only test a child process
[AlexNet_Adam] Epoch 16/30 | LR 1.00e-03 | train_loss 0.4733 acc 84.52% | val_
loss 0.5278 acc 83.48%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 17/30 | LR 1.00e-03 | train_loss 0.4602 acc 84.87% | val_
loss 0.5532 acc 82.68%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 18/30 | LR 1.00e-03 | train_loss 0.4356 acc 85.65% | val_
loss 0.4343 acc 85.70%
Saved best: ./outputs/AlexNet_Adam_best.pth
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 19/30 | LR 1.00e-03 | train_loss 0.4274 acc 85.94% | val_
loss 0.5457 acc 82.12%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 20/30 | LR 1.00e-03 | train_loss 0.4143 acc 86.29% | val_
loss 0.4593 acc 85.44%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 21/30 | LR 1.00e-03 | train_loss 0.3997 acc 86.95% | val_
loss 0.4973 acc 83.46%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 22/30 | LR 1.00e-03 | train_loss 0.3930 acc 87.07% | val_
loss 0.5741 acc 82.94%
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 23/30 | LR 1.00e-04 | train_loss 0.2778 acc 90.70% | val_
loss 0.3499 acc 88.86%
Saved best: ./outputs/AlexNet_Adam_best.pth
 0%|          | 0/704 [00:00<?, ?it/s]
[AlexNet_Adam] Epoch 24/30 | LR 1.00e-04 | train_loss 0.2369 acc 92.08% | val_
loss 0.3559 acc 89.16%
Saved best: ./outputs/AlexNet_Adam_best.pth
 0%|          | 0/704 [00:00<?, ?it/s]

Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b
0d83f5b9c0>
Traceback (most recent call last):

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Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
s/data/dataloader.py", line 1664, in __del__
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7b0d83f5b9c0>
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^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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^^ ^ ^ ^ ^ ^
  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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AssertionError      : self._shutdown_workers()can only test a child process

  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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^ ^ ^ ^ ^ ^ ^ ^
  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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^AssertionError: ^can only test a child process^
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t 0x7b0d83f5b9c0>^

Traceback (most recent call last):
AssertionError File "/home/jupyter-st125970/.local/lib/python3.12/site-packag
es/torch/utlils/data/dataloader.py", line 1664, in del

```

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 121/131

```

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/ut
s/data/dataloader.py", line 1647, in _shutdown_workers
    if w.is_alive():Exception ignored in:
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
Traceback (most recent call last):
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/ut
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AssertionError File "/home/jupyter-st125970/.local/lib/python3.12/site-packag
es/torch/utis/data/dataloader.py", line 1664, in __del__
:    can only test a child process
self._shutdown_workers()
  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/ut
s/data/dataloader.py", line 1647, in _shutdown_workers
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s/data/dataloader.py", line 1664, in __del__
^
  AssertionErrorself._shutdown_workers():
can only test a child process File "/home/jupyter-st125970/.local/lib/python

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Exception ignored in: <function MultiProcessingDataLoaderIter.del at 0x7b

[https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpone/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb) 124/131

[illegible]

[https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment 2/st125970 notebook task 1.ipynb](https://github.com/limhpon/computervision-final-prep/blob/main/lab/Assignment%20st125970%20notebook%20task%201.ipynb)

```
s/data/dataloader.py", line 1647, in _shutdown_workers
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AssertionError : can only test a child process
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^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^  ^
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```

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  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/uti
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    self._shutdown_workers()
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  File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
    ^         ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
    ^ ^ ^
```

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in
is_alive
Exception ignored in:      <function _MultiProcessingDataLoaderIter.__del__ at
0x7b0d83f5b9c0>assert self.parent_pid == os.getpid(), 'can only test a child
```

process '

Traceback (most recent call last):

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
    self._shutdown_workers()
```

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
s/data/dataloader.py", line 1647, in _shutdown_workers
```

```

    if w.is_alive():
^  ^^ ^ ^ ^ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

```

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^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
in is_alive
```

```
^      ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
^  ^  ^  ^  ^  ^      ^
```

```
AssertionError: ^can only test a child process^
```

```
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```
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```
^^      ^if w.is_alive():^  
^ ^ ^ ^ ^ ^ ^ ^ ^^^^^^^^^^^^^
```

```
^AssertionError^: ^can only test a child process^
```

^ ^

```
File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160, in
n is alive
```

```
assert self._parent_pid == os.getpid(), 'can only test a child process'
```

AssertionError: can only test a child process

```
[AlexNet_Adam] Epoch 26/30 | LR 1.00e-04 | train_loss 0.2065 acc 93.15% | val_
loss 0.3434 acc 89.52%
```

```
0%|          | 0/704 [00:00<?, ?it/s]
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at 0x7b0d83f5b9c0>
```

Traceback (most recent call last):

```
File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
```

```
self.shutdown_workers()
```

File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1647, in shutdown workers

```
if w.is_alive():
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__
at 0x7b0d83f5b9c0>^
```

```
^Traceback (most recent call last):
```

```
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utils/data/dataloader.py", line 1664, in __del__
```

```
^^ ^self._shutdown_workers()^
```

```
^ File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/utl
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^^ ^if w.is_alive():^
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File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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assert self._parent_pid == os.getpid(), 'can only test a child process'
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^ File "/opt/tljh/user/lib/python3.12/multiprocessing/process.py", line 160,
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```

^   ^assert self._parent_pid == os.getpid(), 'can only test a child process'^
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^Traceback (most recent call last):
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^    ^self._shutdown_workers()^
^  File "/home/jupyter-st125970/.local/lib/python3.12/site-packages/torch/util
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[illegible]

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