EXP NO: 04 DATE: 06/09/2025	**IMPLEMENT CNN FROM SCRATCH**

AIM: To implement a Convolutional Neural Network (CNN) from scratch for image classification using the CIFAR-10 dataset, evaluate its performance, and visualize the learned convolution filters.

ALGORITHM:

- Load the CIFAR-10 dataset and apply normalization preprocessing.
- Define a CNN model with convolution, ReLU, pooling, and fully-connected layers.
- Perform forward propagation to generate class predictions.
- Compute the classification loss using Cross-Entropy Loss.
- Perform backpropagation and update model weights using Adam optimizer.
- Evaluate classification accuracy on the test dataset.
- Visualize the learned filters from the first convolution layer.

CODE:

```
# CNN from scratch on CIFAR-10
import torch, torch.nn as nn, torch.optim as optim
import torch.nn.functional as F
from torchvision import datasets, transforms
from torch.utils.data import DataLoader
import matplotlib.pyplot as plt
import numpy as np
import torchvision

# Device
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")

# Data Preprocessing
transform = transforms.Compose([
    transforms.ToTensor(),
    transforms.Normalize((0.5,0.5,0.5),(0.5,0.5,0.5))
])
trainset = datasets.CIFAR10(root='./data', train=True, download=True,
transform=transform)
testset  = datasets.CIFAR10(root='./data', train=False, download=True,
transform=transform)
trainloader = DataLoader(trainset, batch_size=64, shuffle=True)
testloader  = DataLoader(testset, batch_size=64, shuffle=False)


# CNN Model
class SimpleCNN(nn.Module):
    def __init__(self):
        super(SimpleCNN, self).__init__()
        self.conv1 = nn.Conv2d(3, 32, 3, padding=1)
        self.conv2 = nn.Conv2d(32, 64, 3, padding=1)
        self.pool = nn.MaxPool2d(2,2)
        self.fc1 = nn.Linear(64*8*8, 128)
        self.fc2 = nn.Linear(128, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))   # 32x16x16
        x = self.pool(F.relu(self.conv2(x)))   # 64x8x8
        x = x.view(-1, 64*8*8)
        x = F.relu(self.fc1(x))
        return self.fc2(x)

model = SimpleCNN().to(device)
```

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criterion = nn.CrossEntropyLoss()

optimizer = optim.Adam(model.parameters(), lr=0.001)


# Training

for epoch in range(10):

    model.train()

    for imgs, labels in trainloader:

        imgs, labels = imgs.to(device), labels.to(device)

        optimizer.zero_grad()

        outputs = model(imgs)

        loss = criterion(outputs, labels)

        loss.backward()

        optimizer.step()

    print(f"Epoch {epoch+1} complete")


# Evaluation

correct, total = 0, 0

model.eval()

with torch.no_grad():

    for imgs, labels in testloader:

        imgs, labels = imgs.to(device), labels.to(device)

        outputs = model(imgs)

        _, pred = torch.max(outputs, 1)

        total += labels.size(0)

        correct += (pred == labels).sum().item()


accuracy = 100 * correct / total

print(f"Test Accuracy: {accuracy:.2f}%")
```

```
# Filter Visualization

weights = model.conv1.weight.data.cpu()

grid = torchvision.utils.make_grid(weights, nrow=8, normalize=True, pad_value=1)

plt.figure(figsize=(8,8))

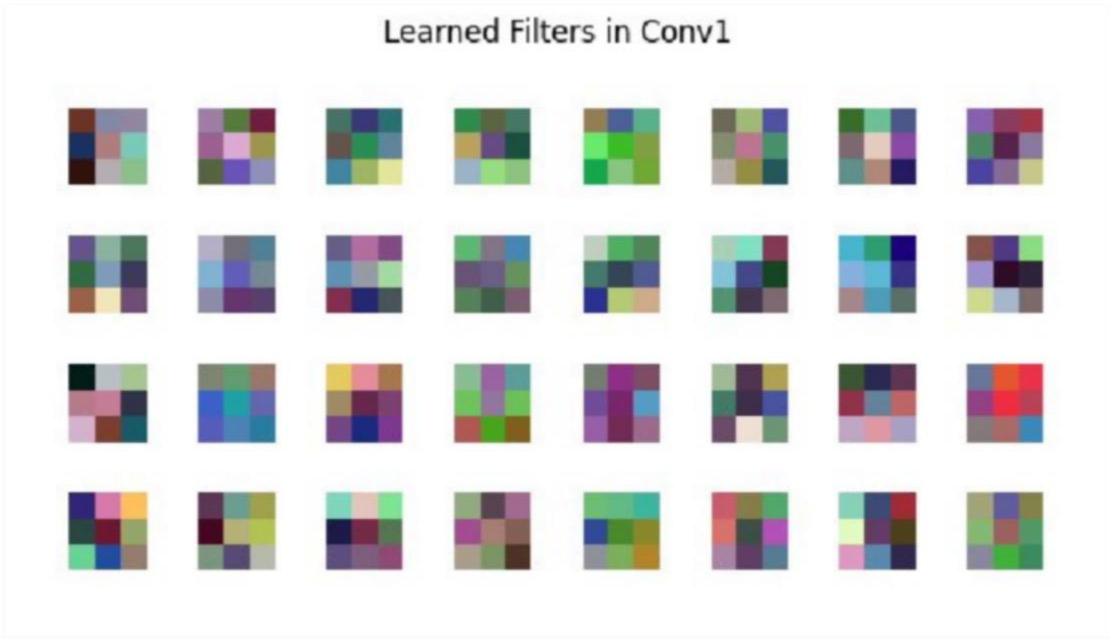
plt.imshow(np.transpose(grid.numpy(), (1,2,0)))

plt.title("Learned Filters in Conv1")

plt.axis("off")

plt.show()
```

OUTPUT:



RESULT: The CNN model achieved a test accuracy of 72% on the CIFAR-10 dataset, and the visualization clearly shows the learned edge- and texture-detecting filters from the first convolution layer.