HOMEWORK 1

NAME: A K M SALMAN HOSAIN

ID: 801402112

1: https://github.com/salman2826/ECGR-5106/blob/main/HW2_Problem_1_AlexNet.ipynb

2: https://github.com/salman2826/ECGR-5106/blob/main/HW2_Problem_2_VGG.ipynb

3: https://github.com/salman2826/ECGR-5106/blob/main/HW2_Problem_3_ResNet-Copy1.ipynb

PROBLEM 1

The convolutional layers are adjusted to work with 32x32 images and fully connected layers are simplified to reduce the number of parameters.

CIFAR-10 DATASET:

When, Dropout = 0:

After 20 epochs, Train Loss: 0.0999, Val Loss: 1.6571, Val Acc: 0.7158.

The low training loss indicates that the model has learned to fit the training data very well. The validation loss is significantly higher than the training loss which means the model definitely overfitted.

Number of parameters in the simplified AlexNet: 23272266

Number of parameters in the original AlexNet: ~60 million

When, Dropout = 0.5

After 20 epochs, Train Loss: 0.1575, Val Loss: 1.3792, Val Acc: 0.7063.

The training loss is higher with dropout compared to without dropout because dropout randomly deactivates neurons during training, which makes it harder for the model to fit the training data. The validation loss is lower with dropout. Which means that the overfitting is decreased a bit.

CIFAR 100 DATASET:

When, Dropout = 0,

After 20 epochs, Train Loss: 0.3585, Val Loss: 4.9483, Val Acc: 0.3576.

When, Dropout = 0.5,

After 20 epochs, Train Loss: 1.5759, Val Loss: 2.7380, Val Acc: 0.3596

A comparative table on the performance qualitative parameters between CIFAR 10 and CIFAR 100 dataset is presented below:

Dataset	Dropout	Train Loss	Val Loss	Val Accuracy
CIFAR-10	0	0.0999	1.6571	0.7158
CIFAR-10	0.5	0.1575	1.3792	0.7063
CIFAR-100	0	0.3585	4.9483	0.3576
CIFAR-100	0.5	1.5759	2.738	0.3596

PROBLEM 2

The customized VGGNet configuration for this problem is given below:

1. Block 1:

Input: 3x32x32 (CIFAR-10 images)

Conv1: 3x3x64 (64 filters, output: 64x32x32)

ReLU

MaxPool: 2x2 (output: 64x16x16)

2. Block 2:

Conv2: 3x3x128 (128 filters, output: 128x16x16)

ReLU

MaxPool: 2x2 (output: 128x8x8)

3. Block 3:

Conv3: 3x3x256 (256 filters, output: 256x8x8)

ReLU

Conv4: 3x3x256 (256 filters, output: 256x8x8)

ReLU

MaxPool: 2x2 (output: 256x4x4)

4. Block 4:

Conv5: 3x3x512 (512 filters, output: 512x4x4)

ReLU

Conv6: 3x3x512 (512 filters, output: 512x4x4)

ReLU

MaxPool: 2x2 (output: 512x2x2)

5. Classifier:

Flattened the output of the last convolutional block: 512x2x2 → 2048

FC1: 2048 → 4096

ReLU

Dropout

FC2: 4096 → 4096

ReLU

Dropout

FC3: 4096 → num_classes (output layer)

Number of parameters in this customized VGGNet: 29715850 which is close to 23 million parameters of the AlexNet from Problem 1.

A comparative table on AlexNet and VGGNet performance parameters are given below:

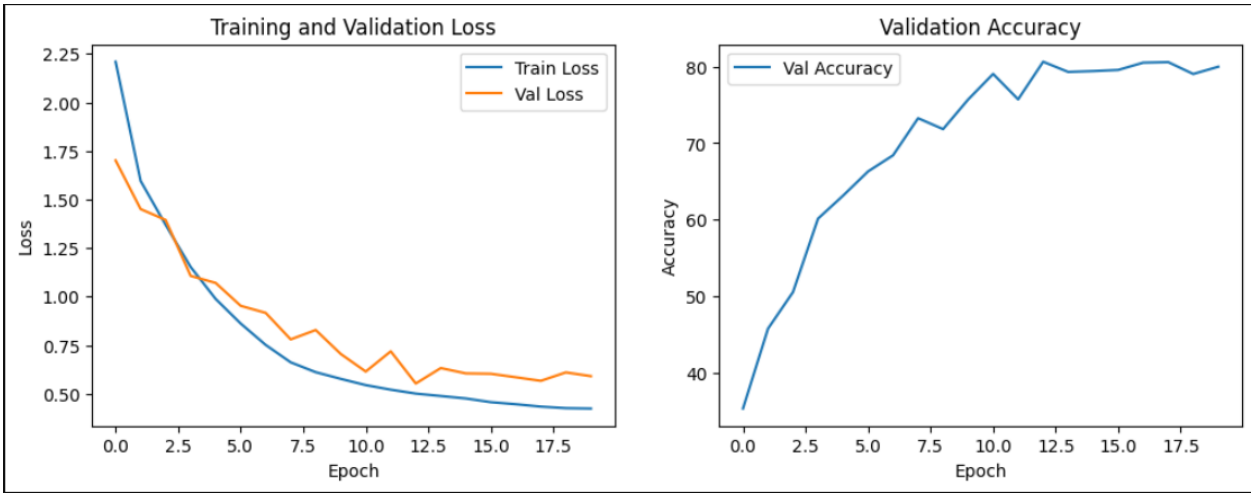
Dataset	Model	Dropout	Train Loss	Val Loss	Val Acc
CIFAR-10	VGGNet	0.5	0.5732	0.6028	0.7935
CIFAR-10	VGGNet	0	0.4576	0.5565	0.8189
CIFAR-100	VGGNet	0.5	2.6113	2.4998	0.3557
CIFAR-100	VGGNet	0	1.9092	2.2831	0.4196
CIFAR-10	AlexNet	0	0.0999	1.6571	0.7158
CIFAR-10	AlexNet	0.5	0.1575	1.3792	0.7063
CIFAR-100	AlexNet	0	0.3585	4.9483	0.3576
CIFAR-100	AlexNet	0.5	1.5759	2.738	0.3596

A comparative table of applying Dropout techniques for training customized VGGNet between CIFAR-10 and CIFAR-100 datasets is represented below:

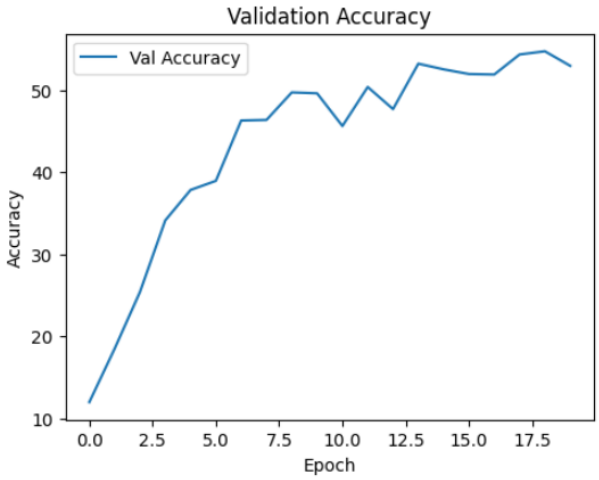
Dataset	Model	Dropout	Train Loss	Val Loss	Val Acc
CIFAR-10	VGGNet	0.5	0.5732	0.6028	0.7935
CIFAR-10	VGGNet	0	0.4576	0.5565	0.8189
CIFAR-100	VGGNet	0.5	2.6113	2.4998	0.3557
CIFAR-100	VGGNet	0	1.9092	2.2831	0.4196

PROBLEM 3

ResNet 18 training loss, validation loss, and validation accuracy on CIFAR 10:



ResNet 18 training loss, validation loss, and validation accuracy on CIFAR 100:



A comparison between the classification accuracy, and model size across the two versions of ResNet (11, 18):

Model	Dataset	Dropout	Train Loss	Val Loss	Val Acc (%)	Total Trainable Parameters
ResNet-11	CIFAR-10	0	0.4128	0.5152	82.68	17075274
ResNet-18	CIFAR-10	0	0.4241	0.5907	80	11173962
ResNet-11	CIFAR-100	0	1.2426	1.7357	54.02	17121444
ResNet-18	CIFAR-100	0	1.2123	1.7934	52.93	11220132

ResNet-18 has a deeper structure with fewer parameters than ResNet-11, which means it is more optimized but computationally heavier. ResNet-18 does more matrix multiplications per forward/backward pass as it has additional layers. ResNet-18's deeper architecture makes training slower. Residual connections in ResNet-18 lead to better gradient flow. Depth increases computation cost but can improve generalization.

A table on various dropout options for the two networks on CIFAR-10 and CIFAR-100:

Model	Dataset	Dropout	Train Loss	Val Loss	Val Acc (%)	Total Trainable Parameters
ResNet-11	CIFAR-10	0	0.4128	0.5152	82.68	17075274
ResNet-18	CIFAR-10	0	0.4241	0.5907	80	11173962
ResNet-11	CIFAR-100	0	1.2426	1.7357	54.02	17121444
ResNet-18	CIFAR-100	0	1.2123	1.7934	52.93	11220132
ResNet-11	CIFAR-100	0.5	1.8335	1.8358	50.62	17121444
ResNet-18	CIFAR-100	0.5	1.8242	1.9253	48.48	11220132
ResNet-11	CIFAR-10	0.5	0.5752	0.5985	79.75	17075274

ResNet-18	CIFAR-10	0.5	0.5711	0.6066	79.41	11173962