

Programming Assignment 1

Shubham Choudhary, ME15B139

Dhruv Chopra, EE16B107

March 31, 2019

1. Configuration and training details of your best performing model

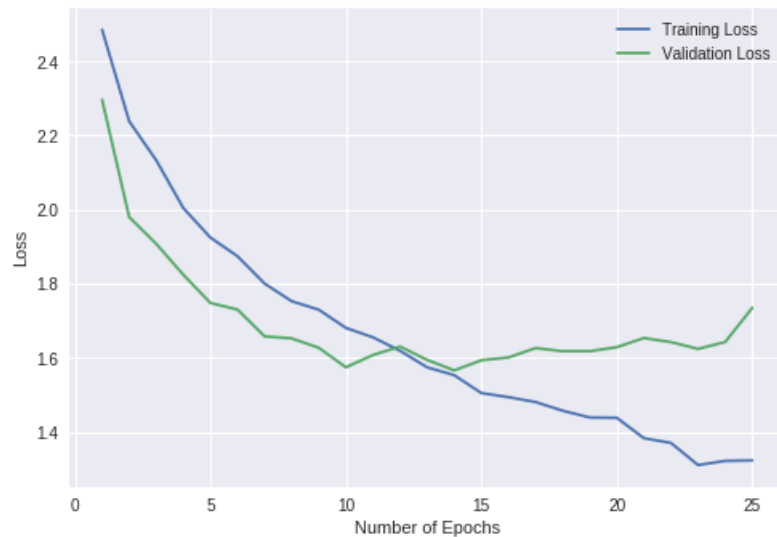
- Conv1: convolutional layer with 3 inputs (RGB), 32 outputs (filter size is thus $32 \times 3 \times 7 \times 7$)
- Conv2: convolutional layer with 32 inputs, 64 outputs (filter size is thus $64 \times 32 \times 7 \times 7$)
- Pool1: 2×2 max-pooling layer
- Conv3: convolutional layer with 64 inputs, 128 outputs (filter size is thus $128 \times 64 \times 5 \times 5$)
- Conv4: convolutional layer with 128 inputs, 256 outputs (filter size is thus $256 \times 128 \times 5 \times 5$)
- Pool2: 2×2 max-pooling layer
- Conv5: convolutional layer with 256 inputs, 512 outputs (filter size is thus $512 \times 256 \times 3 \times 3$)
- Conv6: convolutional layer with 512 inputs, 512 outputs (filter size is thus $512 \times 512 \times 3 \times 3$)
- Pool3: 2×2 max-pooling layer
- Dropout: with probability = 0.5
- FC1: fully connected layer with 18432 inputs, 4096 outputs (i.e, number of neurons is 4096)
- Dropout: with probability = 0.5
- FC1: fully connected layer with 4096 inputs, 512 outputs (i.e, number of neurons is 512)
- SOFTMAX: softmax layer for classification: 512 inputs, 20 outputs

Additionally we have applied batch normalization after each convolution and fully connected layer.

2. The performance on the test data of the model that performs best on the validation data.

- Best Validation accuracy = 57.95
- Test accuracy = 61.12

3. Learning curve for the model

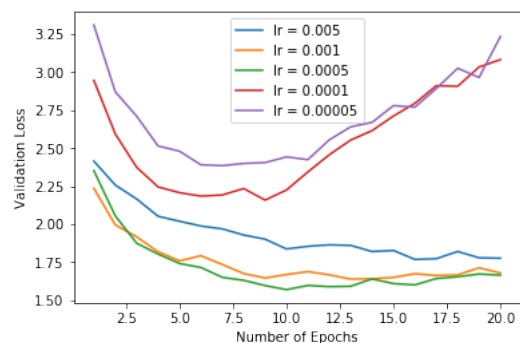
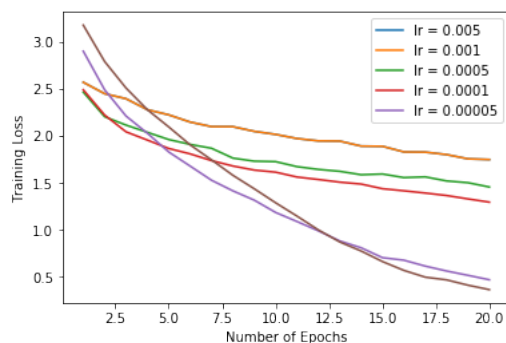


4. The parameter setting which gave you the best results.

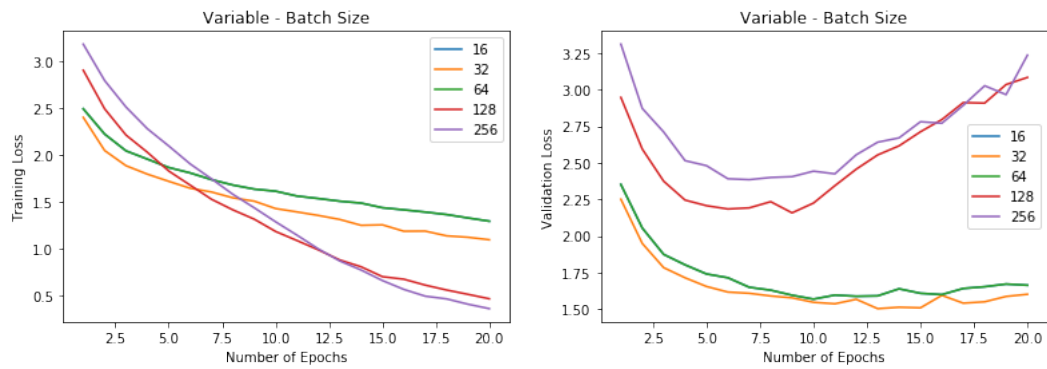
- lr = 0.0005
- batch size = 32
- init = He
- Dropout (p = 0.5)
- with Data Augmentation

5. Hyperparameter Tuning

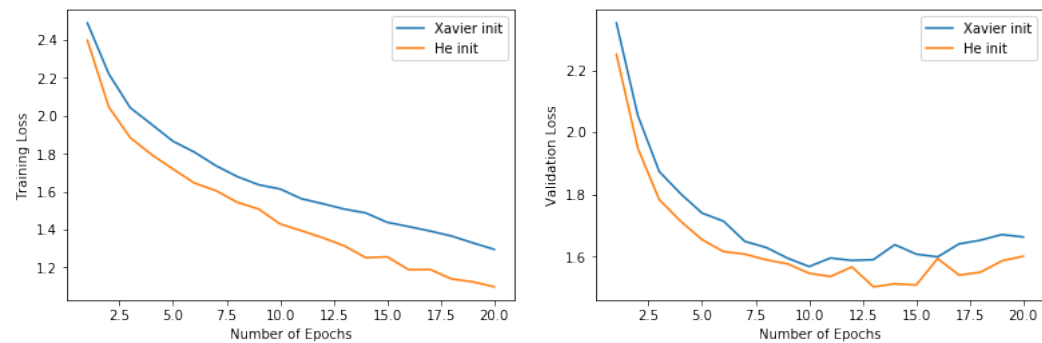
For learning rate:



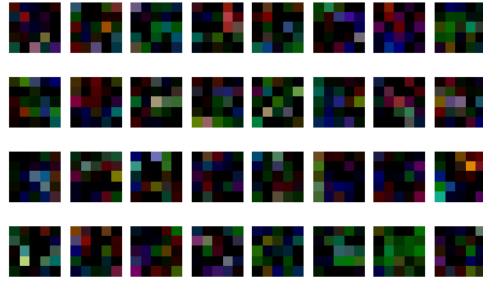
For Batch Size:



For weight initialization:

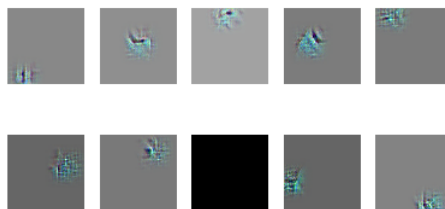
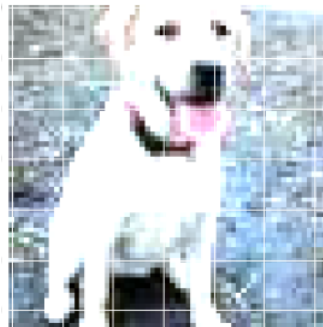


6. Exactly how many parameters does your network have? How many of these are in the fully connected layers and how many are in the convolutional layers?
 - Total = 8,22,78,996
 - Convolution Layers = 46,69,504
 - Fully Connected Layers = 7,76,09,492
7. Exactly how many neurons does your network have? How many of these are in the fully connected layers and how many are in the convolutional layers?
 - Total = 8,48,404
 - Convolution Layers = 8,25,344
 - Fully Connected Layers = 23,060
8. Plot all the 32 layer-1 (Conv1) filters in an 4 x 8 grid. Do you observe any interesting patterns?

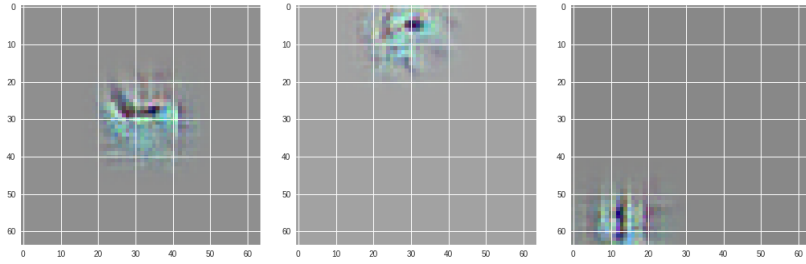


The inferences are:

- The filters are different from one another. Some are for detecting any pattern in green layer, some for blue and some for red (RGB).
9. **What was the effect of using batch normalization ?**
The convergence became faster after applying batch normalization. Earlier it took nearly 40 epochs for convergence and after applying batchnorm it converged within 15 epochs.
 10. **Apply guided back propagation on any 10 neurons in the Conv6 layer and plot the images which excite this neuron.** The idea again is to discover interesting patterns which excite some neurons.



A few interesting observations are:



The inferences are:

- We observe that some of the neurons give which are maximally excited by the portion of the image give interesting results.
- The first image shows the dog's collar, the second one shows its partial face, and the third one its leg.