ECSE 4965: Programming Assignment 4

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1. Layer dimensions:

   - Input data: $32 \times 32 \times \times 3$.
   - Convolutional layer: $5 \times 5 \times 3 \times 32$ with stride 1.
   - Pooling layer: 2×2 with stride 2.
   - Convolutional layer: $5 \times 5 \times 32 \times 32$ with stride 1.
   - Pooling layer: 2×2 with stride 2.
   - Convolutional layer: $3 \times 3 \times 32 \times 64$ with stride 1.
   - Fully connected layer: 576×10.
   - Output: 10×1.

   Three convolutional layers plus a fully connected layer give $2400+25600+18432+5760 = 52192$ weight parameters.

2. The convergence plot can be seen in Figure 1. Batch size is 500. Errors are evaluated every 100 iterations. Apart from the CNN requirement from the instruction, following is done to improve the model.

   - A local response normalization layer is added after each pooling layer, though this doesn't seem to help much.
   - Exponential moving average, decay=0.9999, is applied to all weight parameters.
   - Weight decay, $\lambda = 0.0005$, is applied to all weight parameters except biases. Including biases doesn't seem to affect much.

3. Naive gradient ascent is used to visualize the filters in the first convolutional layer and results can be seen from Figure 2.

4. Model was output after 6600 iterations when the average test error just surpass 71%. Performance on test data can be seen from Table 1. Validation files are attached as requested.

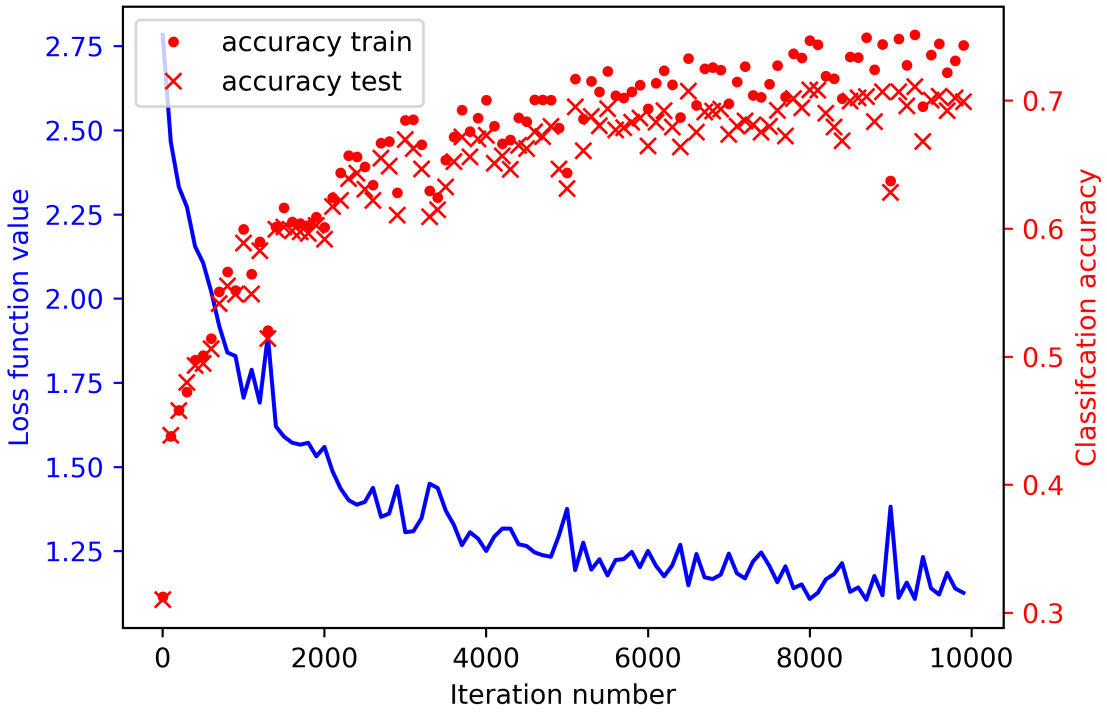

Figure 1

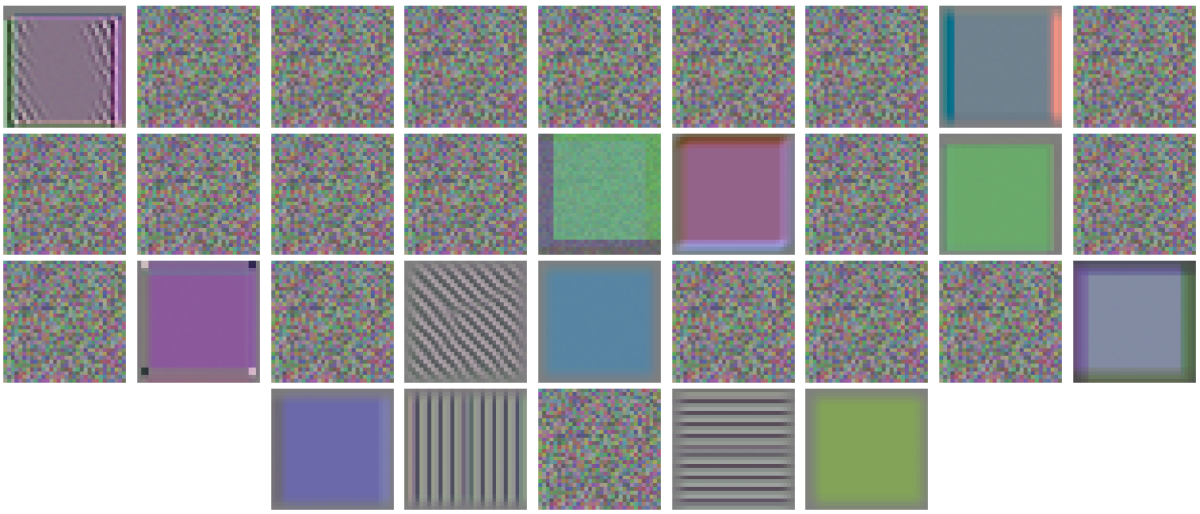

Figure 2: Visualization of filters in the first convolutional layer.

Classes	Average test error (%)
all	28.62
0,airplane	28.4
1,automobile	15
2,bird	38
3,cat	45
4,deer	23.4
5,dog	51.6
6,frog	26.2
7,horse	20.8
8,ship	18.4
9,truck	19.4

Table 1: Performance on test data.