2019 Spring COM526000 Deep Learning - Homework 3

Convolutional Neural Network for Image Recognition

Due: May, 10, 2019

INSTRUCTIONS

1. In this homework, you have to construct a Convolutional Neural Network (CNN) for Caltech 101 (http://www.vision.caltech.edu/Image_Datasets/Caltech101/Caltech101.html). This dataset contains 9411 images of objects, belonging to 102 categories (including one background class). Background class was removed in attached dataset and it has been split into training set and test set.
2. **High-level APIs are forbidden in this homework, such as *Keras, TFlearn, slim, pytorch*.**
3. Name your source code that contains your *main* function as *hw3_StudentID.py*, *data_prepro.py* and your report as *hw3_StudentID.pdf*.
4. **You should write your own codes independently. Plagarism is strictly prohibitted.**

PROBLEMS

1. (20%) Please **describe in details how to pre-process** images because of the different resolution images in dataset and **explain why**. You have to submit your preprocessing code as *data_prepro.py*.
2. (20%) Please implement a CNN for image recognition. You need to design at least two layers of convolutional layers and analyze the effect of different settings including stride size and filter size. The objective function is

$$\mathbf{E}(\mathbf{w}) = -\frac{1}{m}\sum_{m=1}^{M}\sum_{i=1}^{C} t_{mi} log S_i, \tag{1}$$

   where t_{mi} is the ith target of the mth sample in the batch, M is the batch size, C is the classes for each sample, S_i is softmax activation of neural nets output function.
3. (15%) Plot the learning curve, accuracy rate of training and test sets as the example found in Figure 1, and Figure 2. Plot distribution of weights as illustrated in Figure 3.

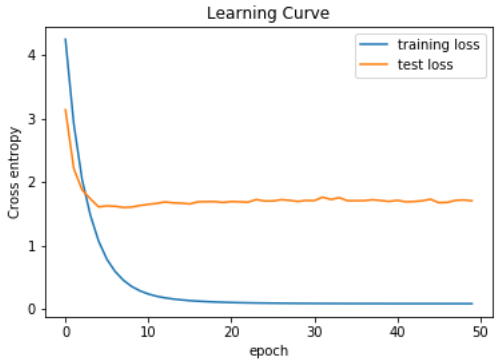

Figure 1: Learning curve.

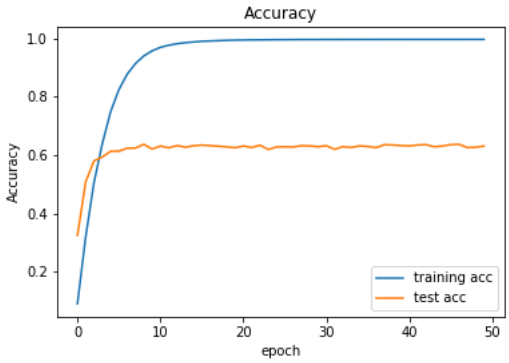

Figure 2: Accuracy curve.

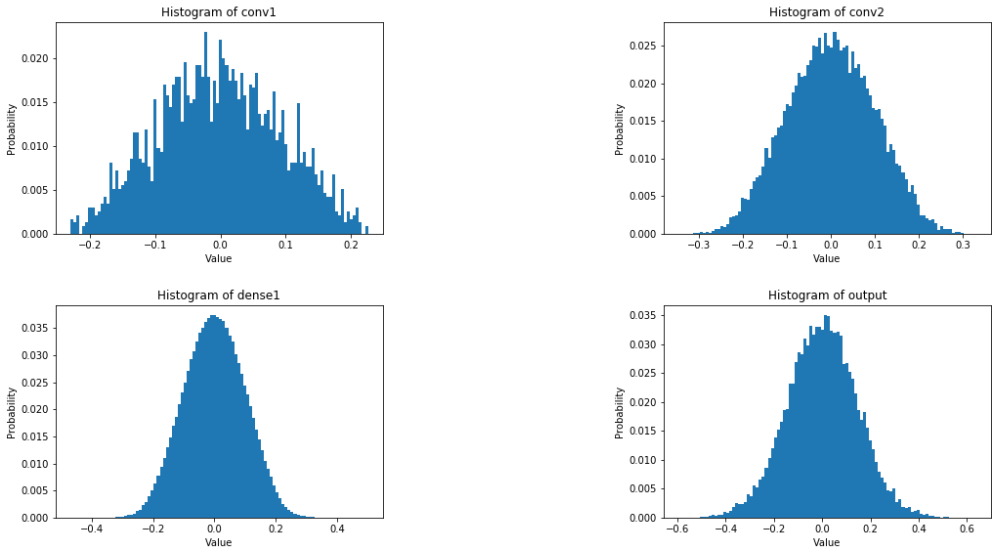

Figure 3: Distribution of weights.

4. (15%) Please plot activations of the first, and second convolution layers as illustrated in Figure.5, Figure.6. Please also plot the corresponding image with your prediction and label (see Figure 4) and explain what you observe.

Figure 4: Detected image.

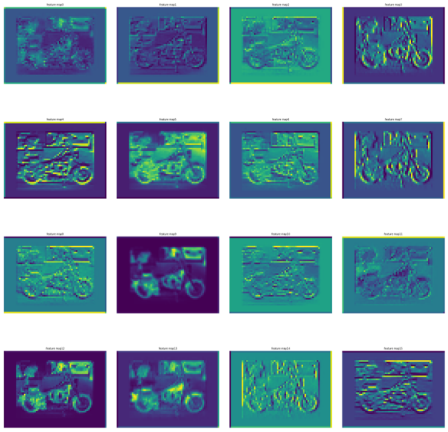

Figure 5: First convolution layers.

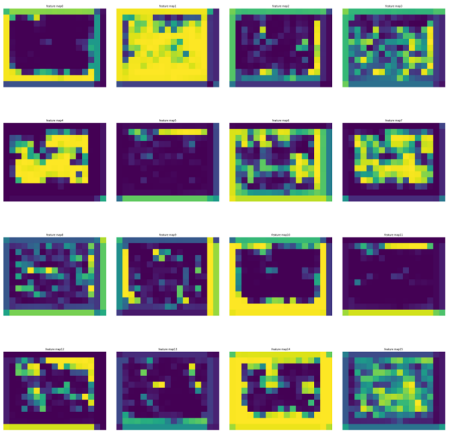

Figure 6: Second convolution layers.

5. (15%) Repeat 3 and train a CNN with L2 regularization:

$$\mathbf{E}(\mathbf{w}) = -\frac{1}{m}\sum_{m=1}^{M}\sum_{i=1}^{C} t_{mi} log S_i + \alpha \sum_i \|\mathbf{w}\|_2^2 \tag{2}$$

Discuss about the difference between with and without regularization.

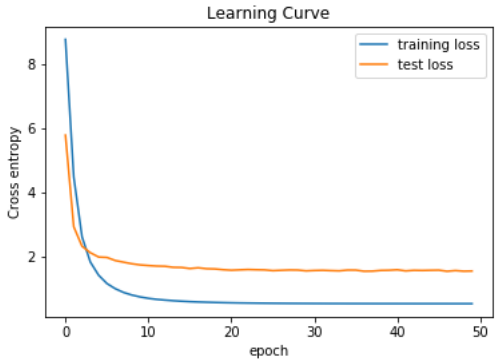

Figure 7: Learning curve.

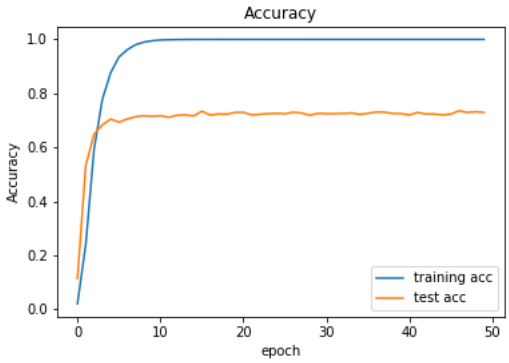

Figure 8: Accuracy curve.

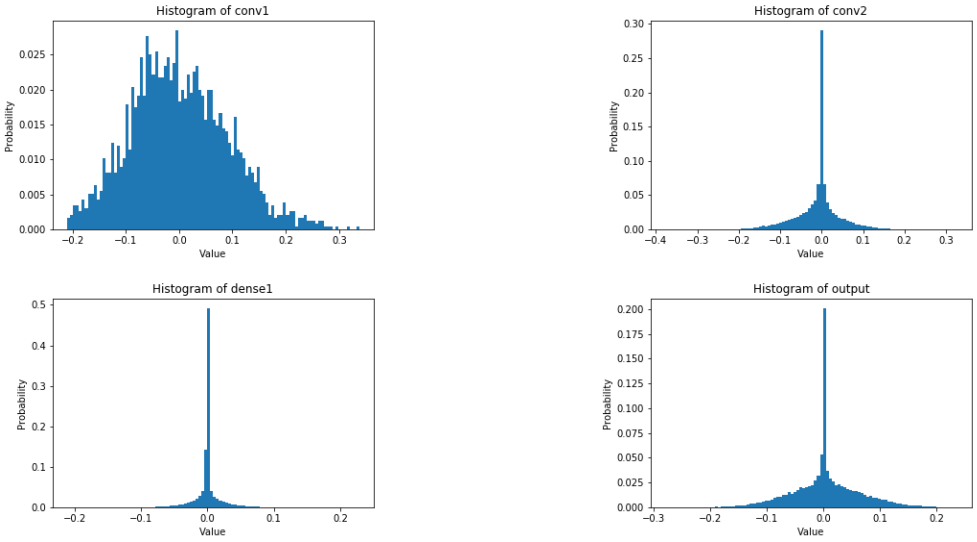

Figure 9: Distribution of weights.

6. (15%) Please give three examples of ways to solve overfitting and try to use them to improve your model, e.g. using data augmentation, batch normalization, and dropout.