CS671 - Deep Learning and its Applications

Course Instructor : Aditya Nigam (Session : Feb-May 2018)

Assignment-02

Submission Date : April 8, 2018

Note:

1. Answer all questions. Maximum score is 200 points.
2. Make sure you clearly identify the question number and your final answer, and solve all parts of a question together.
3. You are free to make any reasonable assumption that you may need to logically answer a question.
4. Code has to be well commented and as general as possible.
5. You are expected to submit README file containing how to run your codes and a report as explained below.
6. For submission, Make a zip file containing all your codes, your trained model, readme file and report. The name of the submission file should be "$Assignment\_2\_ < Group\_id > .zip$".

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1. **The goal of this assignment is to learn the basic principles of designing deep convolutional neural networks for image classification**

   (a) Here you have been given with real and fake fingerprint datasets captured through different types of sensors. You have been given with four datasets namely: LiveDet2009, LiveDet2011, LiveDet2013 and LiveDet2015. Here the goal is to design a convolutional neural network that learns to predict whether the input image is a real fingerprint or a fake one.

   (b) It is a binary class classification problem where the output is either real or fake(spoof). The fake fingerprints are made up of different materials like latex, gelatine, woodglue, playdoh and many more.

   (c) You have been given with four main folders namely LiveDet2009, LiveDet2011, LiveDet2013 and LiveDet2015. Each folder comprises of data from different sensors like LiveDet2009 comprises of data from three sensors namely Biomerika, CrossMatch and Identix within each sensor data there are two subfolders that are Live and Spoof(this folder may contain several subfolders depending upon the material used for spoofing).

   (d) You are advised to first understand the dataset carefully and then start implementation.

   (e) You are not provided with the testing labels in order to ensure the generalizability of the model. Remember that during the test time you can encounter with a fake fingerprint image made of material that is unknown during the training phase. Out of the given data of each sensor you can take 90 % images as the training data and the remaining 10 % images as the validation data. Remember you have to take train data corresponding to each sensor.

   (f) Size of each image caputured through different sensors is different.You have to resize it accordingly before feeding the data to your CNN model.

   (g) Your trained model will be checked on a test data(This data will be unseen to you).

   (h) You will be provided with 10 pickle files. In which there will be testing images. You have to use these images and predict the output of these images and store the outputs in a file. **The output will contain the probability that the image is real i.e. only** 1 **value per image**. Using this files we will check your performance over the test data with the labels that are with us (Test labels wont be provided to you). **Note:** Don't change the order of test images and name the output files in same order as test files.

   (i) As the testing data is not known to you, your accuracies computed by us on your testing data will be your final accuracies. The groups whose accuracies will be more than $mean + 2 \times standard\_deviation$ will get bonus marks.

(a) $livefingerprint$ (b) $fakefingerprint$

Figure 1: Live and fake fingerprints

Table 1: Result format

LiveDet 2015	Ferrlive(%)	Ferrfake(%)	ACE(%)
GreenBit			
Biometrika			
Digital Persona			
CrossMatch			
Average			

(j) The last date of submission is 8 April, but 1 only output file submission will be allowed by 3 April. In this submission, you have to only submit your 10 output files. And accuracies computed will be communicated to you by 4 April. **Any submission happening after 3 April 11:55pm, will be treated as final submission.** So be careful.

(k) You are free to chose any CNN model like VGGNet,GoogleNet,ResNet,AlexNet. Apart from that you can design your own CNN model too. Designing a CNN model from scratch is preferred.

(l) The most important layers that you should include in your model are as follows:-

i. Convolutional Layer

ii. Pooling Layer (averagepool or mapool)as shown in Fig. 2(a)

iii. RELU Layer as shown in Fig. 2(b)

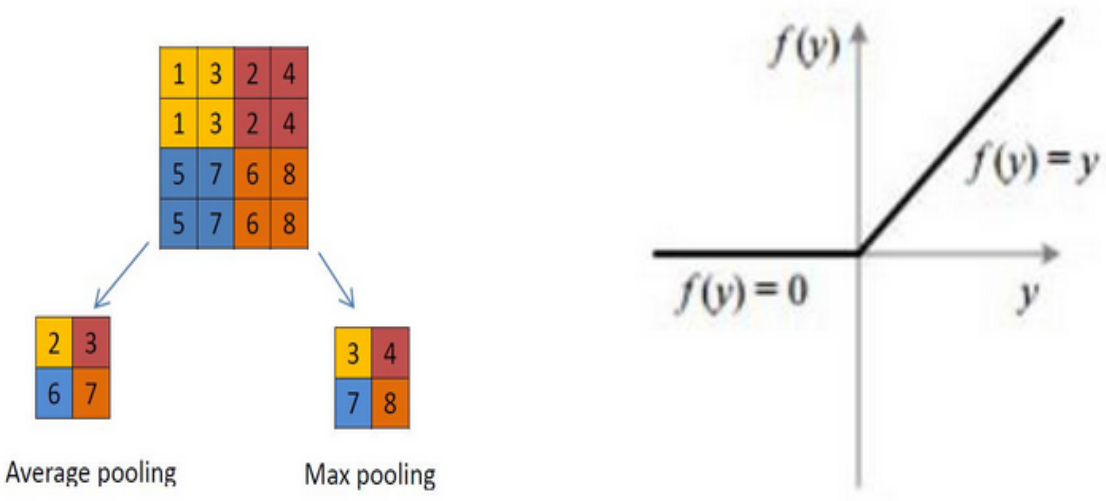
(m) You are free to chose hyperparameters like polling window size, stride window,batch size and number of iterations.

(n) You are free to chose python libraries for implementation.

(o) You have to make a report file in latex that includes performance evaluation metrics as discussed below for all LiveDet datasets on the validation data. An example for LiveDet 2015 dataset is given in Table 1.

i. **Ferrlive**: Percentage of misclassified live fingerprints.

ii. **Ferrfake**:Percentage of misclassified fake fingerprints.



(a) *Pooling* (b) *RELU*

Figure 2: (a)Pooling operation (b)RELU operation

iii. **Average Classification Error(ACE)**: Mean of Ferrlive and Ferrfake. ACE is given as:-

$$ACE = \left(\frac{Ferrlive + Ferrfake}{2}\right) \tag{1}$$

(p) At the validating time you are requested to report your results as shown in table1 for all LiveDet datsets.

(q) You are requested to save the wrongly classified images also for each class.

(r) Plot the accuracy curve for each iteration.