Midterm Exam

AI75823 Deep Learning, Spring 2021
School of BioMedical Convergence Engineering, PNU
Due: Apr. 23. 23:59

I. Remark

- This is an open book exam.
- There are a total of 100 points in the exam. Each problem specifies its point total.
- You must SHOW YOUR WORK to get full credit.
- Answer using Korean or English.

II. Problem Set

1) The task is to create a deep-learning algorithm to distinguish dogs from cats. Implement and show your code in the report (answer sheet). Of course, you can find and modify appropriate codes in any website. No matter what you develop or find the code, describe fully why you adopt the functions and parameters [30 points].

   a) Go to the 'http://kaggle.com/c/dogs-vs-cats/data' . Download and unzip the file 'train.zip' ,

   b) Load the image files. Randomly select 10,000 dog figures and 10,000 cat figures. Every figure title has a label indicating either dog or cat. Use the 7,000 dog figures and 7,000 cat figures for training, and use the remain for validation.

   c) Preprocess the images. Show and describe your work.

   d) Design your deep-learning structure. Show and describe your work. Fully describe why you select/design the model, the numbers of layers and nodes, the number of filters, (if the model is CNN), pooling size (if your model has), non-linear function, optimizer, loss function, and so on.

   e) How many does your network have the trainable parameters (weights)? Explain how to get the number from your network in detail.

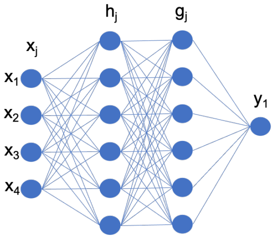
   f) Set up the optimization algorithm, learning rate, batch size and epoch numbers. Graph the training loss and validation loss over epoch. Analyze the graph results.

   g) What is your accuracy (% success rate) for the validation data set? Give a shot to obtain maximum accuracy. Describe all if you conduct additional processes to improve generalization (ex, any regularization technique..)

   h) Summarize and conclude your work.

2) MSE and cross-entropy are widely used as loss functions in machine learning. Describe them as a perspective of maximum likelihood estimation. [10 points]

3) Describe a detail back-propagation algorithm for the network. [10 points]



4) The task is to understand the convolution operator. [10 points]

   a) Implement the code for 2D-convolution operator using MATLAB or Python. The input of the operator is 2D image and 2D filter (kernel). Assume that the image size is always bigger than filter size. The output of the operator is 2D image where the size of output image must be same to that of input image size. It means that the operator need zero padding. Don't use any convolution function (already implemented) given in MATLAB or Python libraries !!!

   b) Select just one dog or cat image from Problem set 1. Convert the image to the gray-scale image. Design any 2D filter for edge detection. Input the image and filter to your implemented convolution operator. Plot input and output images.

5) The task is to investigate that neural nets can compute any function. One function is given as $f(x) = 0.2 + 0.4x^2 + 0.3x\sin(15x) + 0.05\cos(40x)$ where $0 \leq x \leq 1$. [15 points]

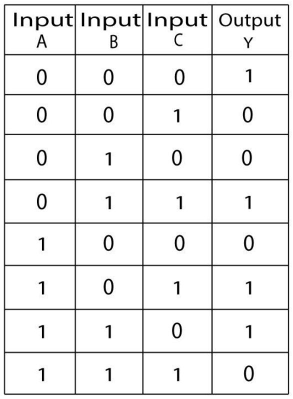
   a) Plot the function.

   b) Implement deep-learning code for representing the function. The input of the network is single number x and the output of the network is also single number y. The network must be updated through minimizing the error between the estimate y and ground-truth $f(x)$. Show your code. Describe your networks and whole training procedures.

   c) For test, input the numbers x = 0, 0.01, 0.02, $\cdots$, 0.98, 0.99 and 1, sequentially. Plot the estimate y over x. Repeat the test 100 times. Compute the mean and standard deviation for every x. Plot the mean and standard deviation over x using marker and error bar. How large is the bias for every x.

6) Assume over-fitting happens. Describe all possible causes and the strategies to prevent them. (Explain why the techniques can prevent the problems in detail). [10 points]

7) The table describes the input-output set of the 3-input Exclusive NOR function. [15 points]



Input A	Input B	Input C	Output Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

   a) Implement the code to represent the function using linear regression.

   b) Implement the code to represent the function using neural networks. Try to make as simplest structure as possible.

   c) Compare the results of linear regression with that of neural networks.