Prof. Heechul Jung

# Final Exam

ARIN702001
June 22, 2020

# Deep Learning

Department:

Student ID:

Name:

Score: / 100

Submit your answer to the LMS system by June 30, 2020
Write your answer by hand, scan the paper and upload the pdf file to the LMS system.
If you need additional paper, you can use it.
You can choose either English or Korean as your language.

**You must show an intermediate process of how your answer came out. Do not write only the answer.**

**Problem 1** (40 points) Suppose you are implementing a deep learning system for image classification task. Please describe how to build a deep learning system step-by-step.

(a) (i) Describe how to annotate your dataset for image classification. What kind of tool will you use? (ii) How do you save each label as files? (iii) How would you split the dataset as training, validation, and test sets? Why? (15 points)

(b) (i) Please choose a convolutional neural network (CNN) architecture (e.g., AlexNet, GoogLeNet, VGGNet, ResNet ....). Justify your answer why you chose the architecture. (ii) How can you be sure that your model is implemented correctly? Explain that in terms of loss. (10 points)

(c) Let's train your model. (i) Describe how to set hyperparameters of your CNN. (e.g., epoch, learning rate, weight decay ...) (ii) Which optimizer will you use? (iii) Will you use a pre-trained model? Why? (15 points)

**Problem 2** (5 points each) Answer the following questions.

(a) What is a deep neural network?

(b) Please explain role and effectiveness of activation functions in deep neural networks.

(c) What is a vanishing gradient problem in deep neural networks? When does the vanishing gradient problem in deep neural networks occur?

**Problem 3** (15 points)

Consider a CNN that consists of Input(234×234)-Conv(7,32,1)-Pool(2,2)-Conv(7,32,1)-Pool(2,2)-Conv(7,32,1)-Pool(2,2)-FC(1024)-FC(1024)-FC(1000). Assume that zero-padding is not used.

We can make a fully convolutional network which has exactly the same functionality as the above CNN by converting fully connected (FC) layers into equivalent convolutional layers as follows: Input(234×234)-Conv(7,32,1)-Pool(2,2)-Conv(7,32,1)-Pool(2,2)-Conv(7,32,1)-Pool(2,2)-Conv(□,□,1)-Conv(□,□,1)-Conv(□,□,1).

Write down the suitable numbers in □.

(The convolutional layer, max-pooling layer, and fully connected layer are denoted as "Conv(filter size, number of channel,stride)", "Pool(filter size, stride)", and "FC(number of nodes)", respectively. For example, Conv(3,32,1) represents the convolutional layer with filter size (3x3), 32 channels, and stride 1. )

**Hint:** Calculate the feature map size for the outcome of the last pooling layer.

**Answer:**

**Problem 4** (15 points)

(a) Describe whole non-linearity functions used in AlexNet?

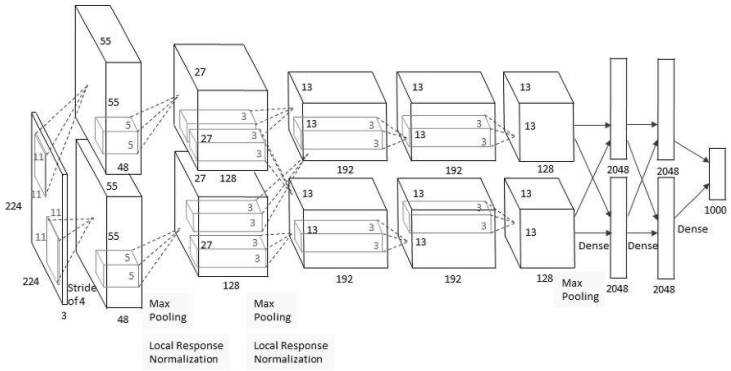


Figure 1: Architecture of AlexNet.

(b) Why does a VGG net use stacked $3 \times 3$ filters?

**Problem 5** (15 points) When training the recent deep learning network, e.g. Residual Network, you can easily see the learning graph as followed. The follow figure is copied from ResNet original paper. The x-axis is a training iteration (or epoch) and y-axis is a training error. As the training iterations increase, you can see that the training error is going down. It means the network parameter learning is good in the training procedure. However, we can see that the training error decreases suddenly in the areas marked with point (1) and point (2). (Bold line is test error and thine line is training error.)

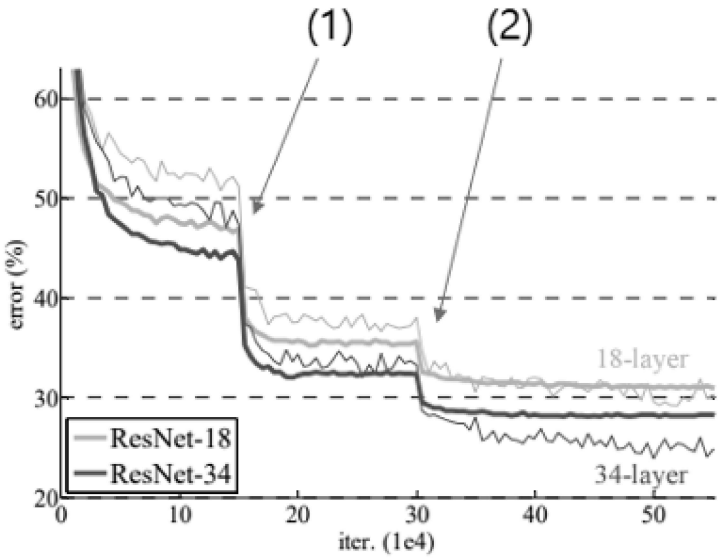


Figure 2: Loss graph.

What happen in those points? Describe the reason in detail.