

## COMP9444 Neural Networks and Deep Learning

### Quiz 3 (Convolutional Networks)

This is an optional quiz to test your understanding of the material from Week 3.

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1. Write the formula for activation  $Z_{j,k}^i$  of the node at location  $(j,k)$  in the  $i^{\text{th}}$  filter of a convolutional neural network which is connected by weights  $K_{l,m,n}^i$  to all nodes in an  $M \times N$  window from the  $L$  channels in the previous layer, assuming bias weights are included and the activation function is  $g()$ . How many free parameters would there be in this layer?

$$Z_{j,k}^i = g(b^i + \sum_l \sum_{0 \leq m < M} \sum_{0 \leq n < N} K_{l,m,n}^i V_{j+m,k+n}^l)$$

The number of free parameters is:  $F \times (1 + L \times M \times N)$  where  $F$  is the number of filters in this layer.

2. If the previous layer has size  $J \times K$ , and a filter of size  $M \times N$  is applied with stride  $s$  and zero-padding of width  $P$ , what will be the size of the resulting convolutional layer?

$$(1 + (J+2P-M)/s) \times (1 + (K+2P-N)/s)$$

3. If max pooling with filter size  $F$  and stride  $s$  is applied to a layer of size  $J \times K$ , what will be the size of the resulting (downsampled) layer?

$$(1 + (J-F)/s) \times (1 + (K-F)/s)$$

4. Explain how dropout is used for neural networks, in both the training and testing phase.

During each minibatch of training, a fixed percentage (usually, one half) of nodes are chosen to be inactive. In the testing phase, all nodes are active but the activation of each node is multiplied by the same percentage that was used in training.

5. Explain the concept of Data Augmentation, and how it was used in AlexNet.

Data Augmentation is when additional training items are generated from those originally provided, using domain knowledge. In AlexNet, each original image of size  $227 \times 227$  was cropped in different ways to create ten images of size  $224 \times 224$ . Changes were also made to the RGB channels of the images.

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