Fundamentals of Convolutional Neural Networks Quiz Solutions

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1 CNN Advantages

Why would we use convolutional neural networks as opposed to fully connected layers between two feature maps?

2 Weight savings

2.1 Fully connected layer

For an input with dimensions $256 \times 256 \times 3$, calculate the number of weights required for a fully connected layer with 1000 neurons.

2.2 Convolutional layer

If we were to instead use a convolutional layer with filter size 7, sufficient padding and stride to result in an output of size 84x84, and a depth of 32, calculate the number of weights required for this layer.

3 HyperParameters

Which of the following are hyperparameters of a Convolutional Neural Network?

- Size of Filters
- Stride lengths
- Depth of the Network
- The values of the filters

4 Filter Size

Given that an input is 256x256 and that the size of layer 1 is 224x224, what is the size of the first convolution filter? (Assume 0 padding and a stride of 1)

5 Output size

With input size 32 x 32, a kernel size of 3x3, a stride of 3, and 2 on both sides, what is the result of the output feature map?

6 Same padding

With input size 32 x 32, a kernel size of 7x7, and a stride of 1, what padding is necessary in order to achieve a "same" convolution? (A "same" convolution refers to a convolution which results in an output with the same shape of the original input).

7 3x3 Filters

A 3x3 filter covers only 9 neurons while a 15x15 filter covers 225 neurons. How many 3x3 filter layers are required to achieve the same coverage as 1 15x15 filter?

8 Pooling

Why is pooling important in CNN architectures?

9 Image Classification Intuition

For classification, why do many architectures use fully connected layers after the convolutional layers in order to make classification predictions?

10 Vanishing Gradient Problem

As more layers using ReLu activation functions are added to a CNN, the gradients of a loss function approaches zero. This means that adding more layers to a CNN produces diminishing returns on accuracy, as later layers are unable to learn the function effectively. What technique is used in a famous CNN architecture to combat this vanishing gradient problem?

11 Convolutions as Matrix-Vector Multiplications

Convolutional layers represent linear transformations, and they can be expressed as a matrix vector multiplication $A\vec{x}$ for some matrix A and some vector $\vec{x}$. Explain how to obtain these, and explain why convolutions aren't implemented as matrix-vector multiplications in practice.