Leaksmy Heng

CS5330

Homework2

1/18/2025

Homework 2

1. Give an example of a separable filter and explain the primary advantages of using them.  
     
   A box linear filter, typically used to blur photos through localized spatial averaging is a separable filter. A separable filter allows a two-dimensional convolution to be implemented as the product of two vectors (convolution is associative). For example, rather than using 1, 3\*3 filter, we can use 2, 1\*3 filter. This allows us to reduce the number of operation (computation cost) significantly because through 1, 3\*3 filter, the computation cost is about 18 (9 multiplication + 8 addition + 1 normalization) whereas the 2, 3\*3 filter is only 11 (6 multiple + 4 additional + 1 normalization).
2. What does it mean if a filter is an edge-preserving filter? Give an example of one.  
     
   An edge preserving filter averages away noise in an image while retaining sharp edges, where edges are identified by the magnitude of the gradient in a certain region. An example of an edge preserving filter is bilateral filter.
3. A Gaussian filter is a low-pass filter. Explain what that means by visualizing the Fourier Transform of the image after multiplying it by a Guassian in the Fourier domain (look at the demo from class). What is being "passed" through a low-pass filter?  
     
   The Fourier transform of an image multiplied by a low pass Gaussian filter would have diminished detail of features with high spatial frequency and accentuated coarse details with lower spatial frequency. Through a low pass filter the low frequency components (relative to the cutoff frequency), are passed/preserved though the filter.
4. A Sobel filter or a Laplacian filter are high-pass filters. Can you visualize what that might be doing to the Fourier Transform of an image in the Fourier domain?  What is being "passed" through a high-pass filter?  
     
   The high pass filters would preserve features in the image with high spatial frequency, while attenuating features in the image with low spatial frequency. Therefore, fine detail would be accentuated while coarse detail would be diminished. A high pass filter passes only the high frequency components of a certain input, while low frequency components are attenuated.
5. I am building a convolutional network. Given an image with 3 channels (RGB), I want the first convolution layer to have 16 5x5 filters. How many filter coefficients (parameters) does the layer need to learn? Explain your reasoning.

If you apply a 5\*5 filter on an RGB image, then you will have the total coefficient of 5 \*5 \* 3 (3 because of 3 channels) = 75 coefficient. And this is for 1, 5\*5 filters on an RGB image. Hence, if you want to apply 16 on a 5 \* 5 filters on the RBG image, the total coefficient will be 16 \* 5 \* 5 \*3 = 1200.

1. Given a second convolution layer on the same network (first layer has 16 filters), we want the second layer to have 32 3x3 filters. How many filter coefficients (parameters) does the second layer need to learn? Explain your reasoning.

The input to the second layer is based on the first layer which has 16 filters. Therefore, there will be 16 outputs come out from the first layer. So if we map these 16 channels to the second layer which has 3\*3 filters, we will get 16 \* 3 \* 3 = 144. We want to apply 32 of the 3\*3 filters; therefore the result is 32 \* 144 = 4608.