CS/CS 316/365 Deep Learning

Activity 9

October 24, 2024

CNNs

Activity needs to be handwritten. Submission will be online on canvas only.

- Consider a 1D convolutional network where the input has three channels. The first hidden layer is computed using a kernel size of three and has four channels. The second hidden layer is computed using a kernel size of five and has ten channels. How many biases and how many weights are needed for each of these two convolutional layers?

  solution:
  The first layer contains $3 \times 4 \times 3 = 36$ weights and 4 biases. The second hidden layer has $4 \times 10 \times 5$ weights and 10 biases.

- Consider a convolutional network with 1D input x. The first hidden layer H1 is computed using a convolution with kernel size five, stride two, and a dilation rate of one. The second hidden layer H2 is computed using a convolution with kernel size three, stride one, and a dilation rate of one. The third hidden layer H3 is computed using a convolution with kernel size five, stride one, and a dilation rate of two. What are the receptive field sizes at each hidden layer?

  solution:
  First layer has a receptive field of 5. Second layer has a receptive field of 9. Third layer has a receptive field size of 25.

- Write out the equation for a 1D convolution with kernel size seven, dilation rate of three, and stride of three. solution:
  $z_i = \omega_1 x_{3i-11} + \omega_2 x_{3i-8} + \omega_3 x_{3i-5} + \omega_4 x_{3i-2} + \omega_5 x_{3i+1} + \omega_6 x_{3i+4} + \omega_7 x_{3i+7}$.

- Consider a 2D convolutional layer with kernel size 5×5 that takes 3 input channels and returns 10 output channels. How many convolutional weights are there? How many biases?

  solution:
  There would be $5 \times 5 \times 3 \times 10 = 750$ weights (kernel height × kernel height × input channels × output channels) and 10 biases (output channels).

- Consider two hidden layers of size 224×224 with C1 and C2 channels, respectively, connected by a 3×3 convolutional layer. Describe how to initialize the weights using He initialization.
  solution:
  He initialization is based on the number of weights that are contribute to each hidden unit. In this case, there would be C1 × 3 × 3 weights contributing to each hidden unit, so we would initialize with mean zero and a variance of 2/9C1.