Deep Learning: Exercise Sheet 7 (SoSe2018)

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Question 12: Convolution Kernels (10 Points)

Given the kernels (filters) K^i and Matrices M^i perform the convolution and display the output. Remember to use padding to keep the output the same size as the input M^i.

a)

$$M^1 = \begin{bmatrix} 1 & 2 & 3 & 4 & -4 & -2 & -1 & 0 \end{bmatrix}$$

$$K^1 = \begin{bmatrix} -1 & 1 & -1 \end{bmatrix}$$

b)

$$K^2 = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \quad M^2 = \begin{bmatrix} 1 & -10 & 10 \\ 5 & 1 & -5 \\ 1 & -10 & 0 \end{bmatrix}$$

c)

$$K^3 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \quad M^3 = \begin{bmatrix} -1 & 1 & -1 \\ -1 & 1 & -1 \\ -1 & 1 & -1 \end{bmatrix}$$

d)

$$K^4 = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad M^4 = \begin{bmatrix} 5 & 5 & -10 \\ -5 & 1 & -1 \\ 5 & -1 & -10 \end{bmatrix}$$

e) Peform a max pooling of size $\phi = 2$ on the resulting matrices 2 to 4 (question b to d) without using padding.

Question 13: CNN Back-propagtion Part 1- FOWARD PASS (10 Points)

Given is an input image of size 3×3:

$$V^0 = \begin{pmatrix} 2 & 3 & 1 \\ 4 & 6 & 9 \\ 4 & 7 & 1 \end{pmatrix}$$

and a Convolutional neural network, where the first filter/Kernel has dimensionality $K^{(1)} \in^{1\times 2\times 3\times 3}$

$$K^{(1)}_{1,1} = \begin{pmatrix} 2 & -3 \\ -3 & 2 \end{pmatrix} \qquad K^{(1)}_{1,2} = \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$$

and uses a ReLU activation function

$$f(x) = \max(x, 0)$$

The next layer uses a filter of dimensionality $K^{(2)} \in^{2\times 1\times 2\times 2}$ and is given by

$$K^{(2)}_{1,1} = \begin{pmatrix} 1 & -2 \\ -4 & 3 \end{pmatrix} \qquad K^{(2)}_{2,1} = \begin{pmatrix} 2 & 1 \\ 1 & 2 \end{pmatrix}$$

again, using a ReLU activation function. Finally, the prediction layer employs the output of the convolutions and incorporates a bias to come up with the final prediction:

$$P(y = 1) = \sigma(Z^{(2)}_{1,1} + \theta)$$

where $\theta = -2$ and σ is the sigmoid function.

Perform a complete network pass and predict the output class for V^0. Do not use padding, do not use strides, and don't be confused, there is no pooling layer involved here.

How to submit?

DO NOT FORGET TO WRITE YOUR NAME ON YOUR SHEET! Nameless files will NOT be graded!

The new submission method is via LearnWeb. https://www.uni-hildesheim.de/learnweb2018/course/search.php?search=3108

WARNING!

If we detect **Plagiarism** on your solution, you will receive no points for it. If a second plagiarism attempt is detected, you might fail the class or be expelled from your program. You are allowed to discuss solutions, but if you work on a group, you must indicate on your sheet with whom are you working with. Group submissions earn 0 points, but counts as participation.