(a) Consider the a 2x4 input X with one channel and a 2x2 filter K.

$$X = \begin{bmatrix} 0 & 2 & -1 \\ 2 & -1 \\ 0 & -1 \\ 1 & 1 \\ 3 & -1 & 2 \end{bmatrix}$$

$$K = \begin{array}{c|c} K_{00} & K_{01} \\ \hline K_{10} & K_{11} \end{array} = \begin{array}{c|c} 1 & 0 \\ \hline -1 & -2 \end{array}$$

i. Apply the 2D-convolution with kernel K to X, using a stride of (1,1) and no padding to obtain the output H, i.e., $H = X \star K$. Note: You do not have to flip the kernel, i.e., technically speaking, we are interested in cross-correlation here.

The interested in cross-contention where
$$A = 2 + 2 = 4$$
 $A = 2 + 2 = 4$
 $A = 2 + 2 = 4$
 $A = -1 - 2 = -3$
 $A = -1 + 1 - 4 = -2$

ii. Calculate $\frac{\partial H}{\partial K}$ in the following format: $\frac{\partial H}{\partial K} = \begin{bmatrix} \frac{\partial H_0}{\partial K_{00}} & \frac{\partial H_0}{\partial K_{01}} & \frac{\partial H_1}{\partial K_{10}} & \frac{\partial H_1}{\partial K_{11}} \\ \frac{\partial H_{10}}{\partial K_{00}} & \frac{\partial H_{10}}{\partial K_{01}} & \frac{\partial H_2}{\partial K_{10}} & \frac{\partial H_2}{\partial K_{11}} \\ \frac{\partial H_{20}}{\partial K_{20}} & \frac{\partial H_{20}}{\partial K_{01}} & \frac{\partial H_2}{\partial K_{10}} & \frac{\partial H_2}{\partial K_{11}} \end{bmatrix}$ (2P)

$$\frac{\partial H}{\partial K} = \begin{bmatrix} 1 \times 00, \times 01, \times \frac{10}{2}, \times 11 \\ \times 10, \times 11, \times 20, \times 21 \\ \times 20, \times 21, \times 30, \times 31 \end{bmatrix}$$

$$= \begin{bmatrix} 2, -1, 0, -1 \\ 0, -1, 1, 1 \\ 1, 1, -1, 2 \end{bmatrix}$$

(3P)

iii. Given that $\frac{\partial \mathcal{L}}{\partial H} = \begin{bmatrix} 0 & 1 & 2 \end{bmatrix}$, compute the gradient $\frac{\partial \mathcal{L}}{\partial K}$ in the following format: $\frac{\partial \mathcal{L}}{\partial K} = \begin{bmatrix} \frac{\partial \mathcal{L}}{\partial K_{00}} & \frac{\partial \mathcal{L}}{\partial K_{01}} & \frac{\partial \mathcal{L}}{\partial K_{10}} & \frac{\partial \mathcal{L}}{\partial K_{11}} \end{bmatrix}$

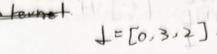
$$\frac{\partial L}{\partial k} = \frac{\partial L}{\partial H} = \frac{\partial L}{\partial k} = [0, 1, 2] \begin{bmatrix} 2 & -1 & 0 & -1 \\ 0 & -1 & 1 & 1 \\ 1 & 1 & -1 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 2 & -1 + 2 & 1 - 2 & 1 + 4 \\ 1 & 2 & 2 & -1 + 2 & 1 - 2 & 1 + 4 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 2 & -1 + 2 & 1 & -2 & 1 \\ 2 & 2 & 1 & -1 & 5 \end{bmatrix}$$

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iv. Specify a term \mathcal{L} such that $\frac{\partial \mathcal{L}}{\partial H} = \begin{bmatrix} \frac{\partial \mathcal{L}}{\partial H_{00}} & \frac{\partial \mathcal{L}}{\partial H_{10}} & \frac{\partial \mathcal{L}}{\partial H_{2}} \\ \frac{\partial \mathcal{L}}{\partial H_{00}} & \frac{\partial \mathcal{L}}{\partial H_{10}} & \frac{\partial \mathcal{L}}{\partial H_{2}} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 2 \end{bmatrix}$ (1P).



v. Now assume $\frac{\partial \mathcal{L}}{\partial K_{00}}$ is a large negative value (e.g., -100). How will small changes to the value of K_{00} affect \mathcal{L} ? When will \mathcal{L} increase, when will it decrease? (2P)

When koo increase, I will decrease U When koo decrease, I will increase.

H Sige