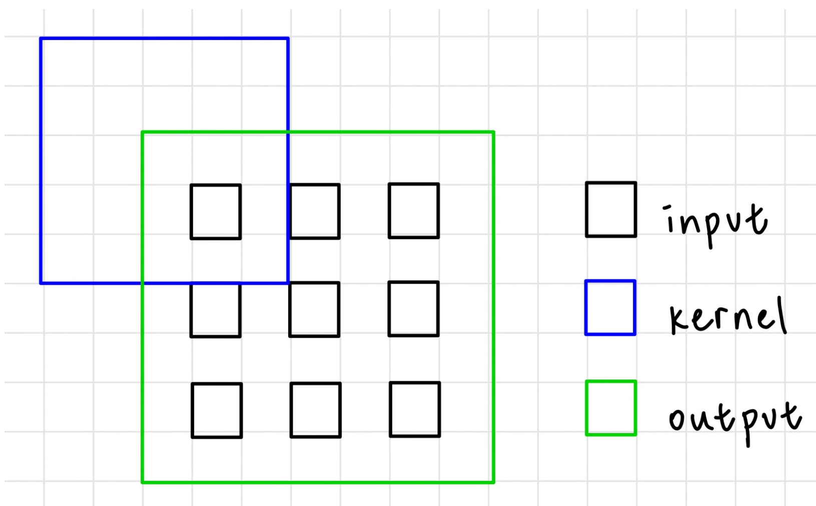
Quiz 5
Oct/14/2020
CS 280: Fall 2020
Instructor: Xuming He

Name:
On your left:
On your right:

Instructions:
Please answer the questions below. Show all your work. This is an open-book test. NO discussion or collaboration is allowed.

Problem 1. Transpose Convolution (10 points)

- Use a 5x5 transpose convolution, stride 2 and padding 1, what is the size of the output feature map for a 3x3 input feature map.



The size of the output is 7x7.

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Problem 2. ROI Align (10 points)

- For the ROI Align operator with bilinear interpolation, write down the partial derivatives needed in backpropagation.

  Hint: f_{xy} is a function of input feature map and location of bounding box.

Let f_{ij} be the feature for point p_{ij} in the input feature map, (c_x, c_y, w, h) be the location of bounding box, f_{xy} be the bilinear interpolation of feature for the grid point p_{xy}, (a, b) be the index of p_{xy} in the RoI grids, (g, g) be the size of the ROI grids

$$f_{xy} = \sum_{i,j=1}^{2} f_{i,j} \max\left(0, 1 - |x - x_i|\right) \max\left(0, 1 - |y - y_j|\right)$$

$$(x, y) = \left(c_x - \frac{w}{2} + \frac{w}{2g} \cdot (2a - 1), c_y - \frac{h}{2} + \frac{h}{2g} \cdot (2b - 1)\right)$$

The partial derivatives of ROI Align operator:

$$\frac{\partial f_{xy}}{\partial f_{ij}} = \max(0, 1 - |x - x_i|) \max(0, 1 - |y - y_j|)$$

$$\frac{\partial f_{xy}}{\partial c_x} = \frac{\partial f_{xy}}{\partial x} \frac{\partial x}{\partial c_x} = \sum_{i,j=1}^{2} \begin{cases} f_{ij} \max(0, 1 - |y - y_j|), & |x - x_i| < 1 \text{ and } x < x_i \\ -f_{ij} \max(0, 1 - |y - y_j|), & |x - x_i| < 1 \text{ and } x \geq x_i \\ 0, & |x - x_i| \geq 1 \end{cases}$$

$$\frac{\partial f_{xy}}{\partial w} = \frac{\partial f_{xy}}{\partial x} \frac{\partial x}{\partial w} = \left(-\frac{1}{2} + \frac{2a - 1}{2g}\right) \sum_{i,j=1}^{2} \begin{cases} f_{ij} \max(0, 1 - |y - y_j|), & |x - x_i| < 1 \text{ and } x < x_i \\ -f_{ij} \max(0, 1 - |y - y_j|), & |x - x_i| < 1 \text{ and } x \geq x_i \\ 0, & |x - x_i| \geq 1 \end{cases}$$

$$\frac{\partial f_{xy}}{\partial c_y} = \frac{\partial f_{xy}}{\partial y} \frac{\partial x}{\partial c_y} = \sum_{i,j=1}^{2} \begin{cases} f_{ij} \max(0, 1 - |x - x_i|), & |y - y_j| < 1 \text{ and } y < y_j \\ -f_{ij} \max(0, 1 - |x - x_i|), & |y - y_j| < 1 \text{ and } y \geq y_j \\ 0, & |y - y_j| \geq 1 \end{cases}$$

$$\frac{\partial f_{xy}}{\partial h} = \frac{\partial f_{xy}}{\partial y} \frac{\partial x}{\partial h} = \left(-\frac{1}{2} + \frac{2b - 1}{2g}\right) \sum_{i,j=1}^{2} \begin{cases} f_{ij} \max(0, 1 - |x - x_i|), & |y - y_j| < 1 \text{ and } y < y_j \\ -f_{ij} \max(0, 1 - |x - x_i|), & |y - y_j| < 1 \text{ and } y \geq y_j \\ 0, & |y - y_j| \geq 1 \end{cases}$$

1. The bilinear interpolation as a function of input feature and location of bounding box (4)
2. The partial derivative of input feature map. (2)
3. The partial derivatives of bounding box. (4)