EECS 4422/5323 Midterm Sample Questions

Question 1

Let

$$\mathbf{x} = \begin{bmatrix} x_{-1,-1} & x_{0,-1} & x_{1,-1} \\ x_{-1,0} & x_{0,0} & x_{1,-1} \\ x_{-1,1} & x_{0,1} & x_{1,1} \end{bmatrix}$$

be a structure element kernel anchored at $x_{0,0}$.

Let $\mathbf{b}$ be a binary image with width w and height h, where $b_{i,j}$ is the pixel located at position (i, j).

Write the mathematical expression for generating $\mathbf{d}$, the dilation of $\mathbf{b}$ with $\mathbf{x}$. For the purposes of this expression you can assume your image has been appropriately padded.

Question 2

Take this patch from a feature map:

$$\mathbf{P} = \begin{bmatrix} -5 & 0 & -1 & 6 \\ 5 & -3 & -2 & 6 \\ 0 & -1 & 7 & -4 \\ 0 & -3 & 5 & -6 \end{bmatrix}$$

Re-normalize $\mathbf{P}$ such that all values are in the range $[-1, 1]$.

Question 3

For the following kernel $\mathbf{K}$ and image patch $\mathbf{P}$,

$$\mathbf{K} = \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix} \qquad\qquad \mathbf{P} = \begin{bmatrix} 10 & 15 & 53 \\ 72 & 44 & 67 \\ 4 & 8 & 51 \end{bmatrix}$$

compute the cross-correlation of $\mathbf{P}$ with $\mathbf{K}$ assuming wrap padding.
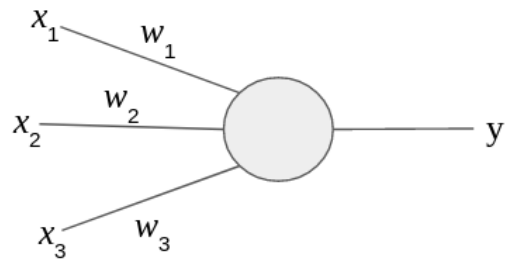
Question 4

Give one major advantage and one major disadvantage to the use of synthetic data in computer vision.

Question 5

Briefly explain why, for a given spatial resolution, a Hough Transform for ellipses is more computationally expensive than a Hough Transform for lines.

Question 6

On the right is shown a schematic of a ReLU neuron in a neural network. Write the equation of the output y.

Question 7

Yulong is working on a CNN for detecting human and dog faces. He finds that it works very well normally, but he gets very poor results for an image like the one shown on the right. Provide a brief explanation for what might be going wrong.