Practice Problems

1. **Color:**

   Suppose we have a color c_1 with tristimulus coefficients X_1, Y_1, and Z_1. We also have a color c_2 with tristimulus coefficients X_2, Y_2, and Z_2. We form an additive mixture of the two as follows: $c = 2c_1 + c_2$. What are the chromaticity coordinates of c?

2. **Detecting gaps in lines:**

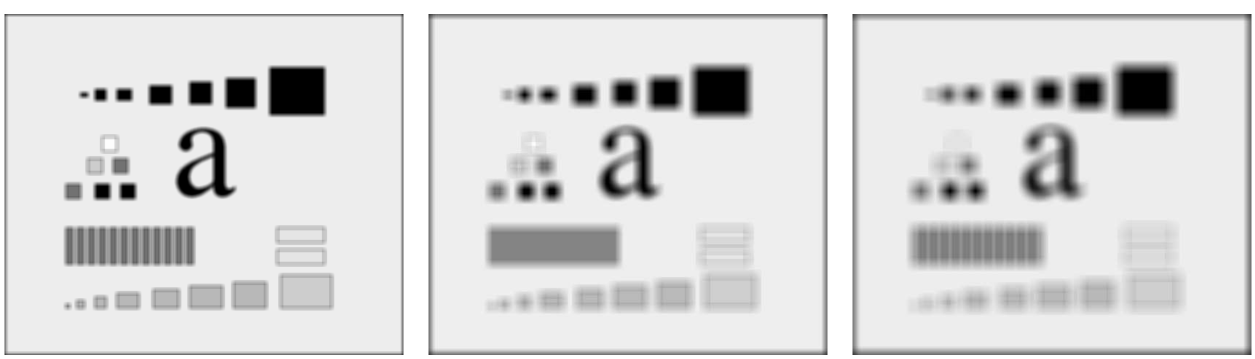
   A binary image contains straight lines oriented horizontally, vertically, at 45^o, and at -45^o. You wish to detect places where there are 1-pixel-long breaks in these lines. Assume that the gray level of the lines is 1, and the gray level of the background is 0.

   (a) Give a set of 3×3 masks that would be appropriate to use with the hit-or-miss transformation, and can detect the gaps in the lines. Explain the use of your masks, and comment on whether there are particular configurations of lines for which your masks will not give correct results.

   (b) Give a set of 3×3 masks that can be used with convolution and thresholding to detect the gaps in the lines. Explain the use of your masks, and comment on whether there are particular configurations of lines for which your masks will not give correct results.

3. **Filter size effects:**

   An original grayscale image (not shown) was blurred using square averaging masks of different sizes. The results of blurring with a 7x7 mask are shown in figure (a) below, blurring with a 12x12 mask is shown in figure (b), and blurring with a 20x20 mask is shown in figure (c). The vertical bars in the left lower part of (a) and (c) are not sharp, but a clear separation exists between them. However, the bars have merged in image (b), in spite of the fact that the mask that produced this image is significantly smaller than the mask that produced image (c). Explain this.



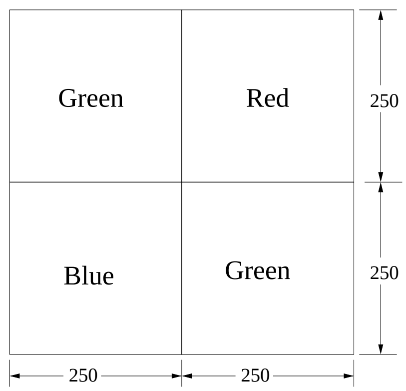
(a) (b) (c)

4. **Color: Hue and Saturation**

Consider the following 500 × 500 RGB color image, where the squares are pure red, green, and blue (i.e., pure red means it is produced using only the red primary of the NTSC-RGB color system).

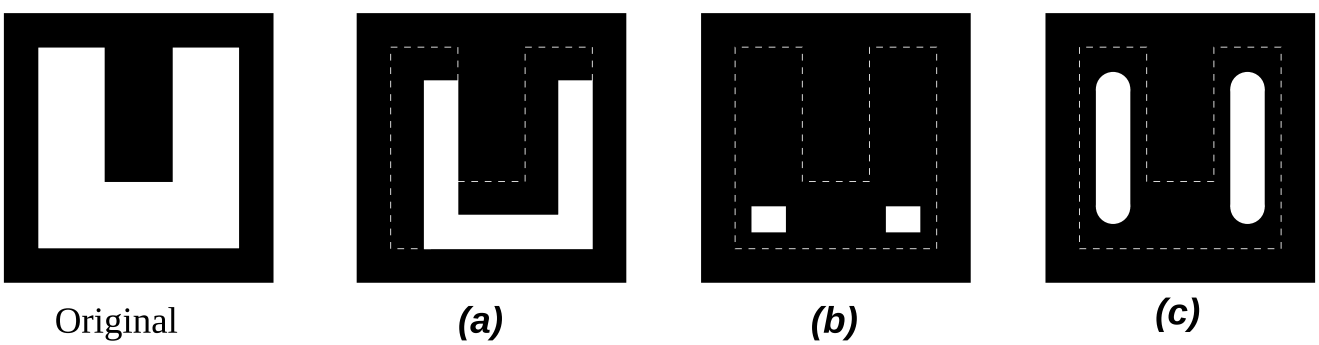
(a) Suppose that we convert this image to HSI, blur the H component image with a 25 × 25 averaging mask, and convert back to RGB. What would the result look like?

(b) Repeat, blurring only the saturation component this time.



5. **Binary image morphology:**

An original binary image is shown below. With reference to the image shown, give the structuring element(s) and morphological operation(s) that produced each of the results shown in images (a) through (c). Show the origin of each structuring element clearly. The dashed lines show the boundary of the original set and are included only for reference.

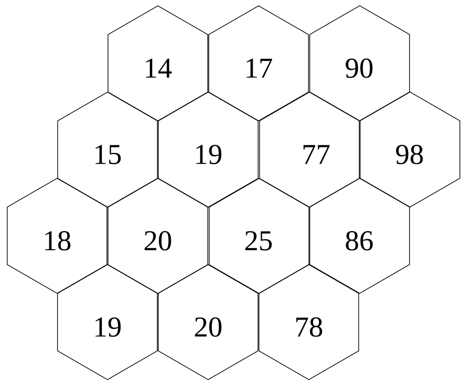


6. **Distance transformations:**

Some DTs produce distance measurements between points on the pixel grid which are consistently smaller or the same as the distances from the EDT. Other DTs are consistently larger or the same as the EDT. Still other DTs are defined in such a way that the distance between points on the pixel grid is sometimes smaller and sometimes larger than the EDT. Which case is it for each of the following distance transformations: City-Block, Chessboard, and Chamfer3-4? (Obviously, we include the final division by 3 as part of the Chamfer3-4 DT.)

7. **Edge detection:**

Here is a fragment of an image sampled on a hexagonal grid. You wish to detect edges in images of this type.



- Think of a reasonable way to define a hexagonal mask to be analogous to the Laplacian mask (2nd derivative edge detector) that was defined for a rectangular grid.
- Think of a reasonable way to define a pair of hexagonal masks that would be analogous to first derivative edge detection masks which we saw for rectangular grids.