

Exercise 1: Morphology

Part A

-1 = background, 1 = object pixel

[illegible][illegible]

Exercise 2: Hausdorff Distance

Part A

A(-2,3), B(3,1), and C(0,-3)

D(-3,2), E(2,2), F(2,-1), and G(-3, -1)

$S1=\{A, B, C\}$ and $S2=\{D, E, F, G\}$

$$h(S1, S2) = \max_{s1} (\min_{s2} (d(s1, s2)))$$

$$\min (d(A, s2)): \sqrt{1^2 + 1^2} = \sqrt{2}$$

$$\min (d(B, s2)): \sqrt{1^2 + 1^2} = \sqrt{2}$$

$$\min(d(C, s2)): \sqrt{2^2 + 2^2} = \sqrt{8}$$

$$\mathbf{h(S1, S2) = \max_{s1}(\min(...)) = \sqrt{8} \sim 2.8}$$

$$h(S2, S1) = \max_{s2} (\min_{s1} (d(s1, s2)))$$

$$\min (d(D, s1)): \sqrt{2}$$

$$\min (d(E, s1)): \sqrt{2}$$

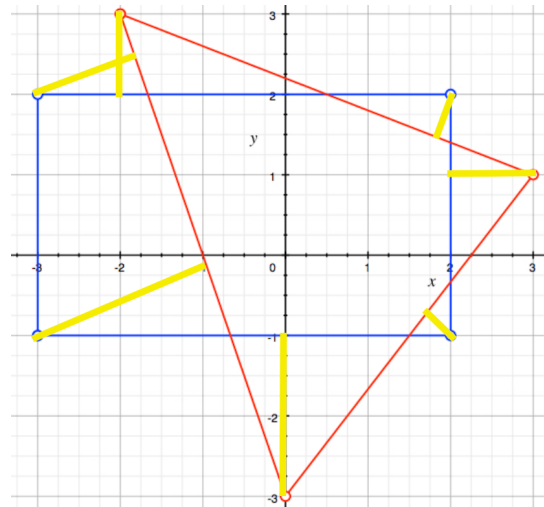
$$\min(d(F, s1)): \sqrt{1^2 + 2^2} = \sqrt{5}$$

$$\min(d(G, s1)): \sqrt{3^2 + 2^2} = \sqrt{13}$$

$$\mathbf{h(S2, S1) = \max_{s2}(\min(...)) = \sqrt{13} \sim 3.6}$$

$$H(S1, S2) = \max(h(S1, S2), h(S2, S1)) = \mathbf{\sqrt{13} \sim 3.6}$$

Part B



$$h(S1, S2) = \max_{s1} (\min_{s2} (d(s1, s2)))$$

$$= \max_{s1} (\min (d(A, s2_polygon), \min (d(B, s2_polygon)), \min(d(C, s2_polygon))))$$

$$\mathbf{= d(C, S2_polygon) = 2}$$

$$h(S2, S1) = \max_{s2} (\min_{s1} (d(s1, s2)))$$

$$= \max (\min(d(D, s1_polygon)), \min(d(E, s1_polygon)), \min(d(F, s1_polygon)), \min(d(G, s1_polygon)))$$

$$\mathbf{= d(D, s1_polygon) = \sqrt{2^2 + (3/4)^2} = \sqrt{73}/4 \sim 2.13}$$

$$H(S1, S2) = \max(h(S1, S2), h(S2, S1)) = \mathbf{\sqrt{73}/4 \sim 2.13}$$

Exercise 3: Edge Detection

(a) Define what an edge is in an image

In short, edges are pixels that have a significant local change in intensity in the image.

(b) Briefly describe three causes of edges (1 sentence each)

- Surface reflectance discontinuity
 - This refers to change in the fraction of light incident on the surface that is reflected to viewer; possibly caused by different material.
- Illumination discontinuity
 - This refers to discontinuity in illumination, such as shadow.
- Surface Color Discontinuity
 - This refers to color change, such as the change in color between a (black) text and the (white) background.

(c) Consider the image and edge map shown here: https://en.wikipedia.org/wiki/Canny_edge_detector#/media/File:%C3%84%C3%A4retuvastuse_n%C3%A4ide.png Describe for each cause from (b) where the Canny Edge Detector found an edge and where it did not. This is easiest done if you print out the image and edge map.

Edges caused by Illumination discontinuity occur in the fingers, where the shadow is located. It does not occur between the clothe and patches on the clothe.

Edges caused by Surface Color Discontinuity happen between the clothe and patches on the clothe. It does not occur on the nose.

Edges caused by Surface Reflectance continuity occur in the hair. It does not occur in pedals of the flower.