

Homework 2

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12:47 AM

P1



Euclidean

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$$x = (x_1, x_2)$$

$$\|x - (0, 0)\|^2 \leq \|x - (2, 2)\|^2$$

$$(x_1 - 0)^2 + (x_2 - 0)^2 \leq (x_1 - 2)^2 + (x_2 - 2)^2$$

$$x_1^2 + x_2^2 \leq x_1^2 - 4x_1 + 4 + x_2^2 - 4x_2 + 4$$

$$x_1 + x_2 \leq 2$$

$$\|x - (0, 0)\|^2 \leq \|x - (4, 0)\|^2$$

$$(x_1 - 0)^2 + (x_2 - 0)^2 \leq (x_1 - 4)^2 + (x_2 - 0)^2$$

$$x_1^2 + x_2^2 \leq x_1^2 - 8x_1 + 16 + x_2^2$$

$$x_1 \leq 2$$

$$\|x - (2, 2)\|^2 \leq \|x - (4, 0)\|^2$$

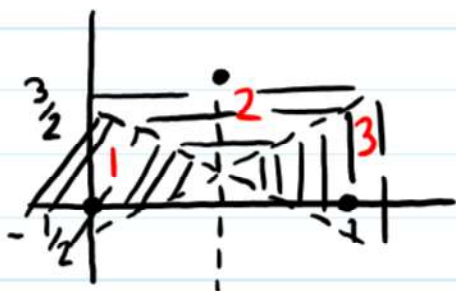
$$(x_1 - 2)^2 + (x_2 - 2)^2 \leq (x_1 - 4)^2 + (x_2 - 0)^2$$

$$x_1^2 - 4x_1 + 4 + x_2^2 - 4x_2 + 4 \leq x_1^2 - 8x_1 + 16 + x_2^2$$

$$4x_1 - 4x_2 \leq 8 \quad = \quad x_1 - x_2 \leq 2$$

2.

Modified Euclidean



$$\|x - (0,0)\|^2 \leq \|x - (2,2)\|^2$$

$$\frac{1}{2}x_1^2 + x_2^2 \leq \frac{1}{2}x_1^2 - 2x_1 + 2 + x_2^2 - 4x_2 + 4$$

$$2x_1 + 4x_2 \leq 6 \Rightarrow x_1 + 2x_2 \leq 3$$

$$\|x - (0,0)\|^2 \leq \|x - (4,0)\|^2$$

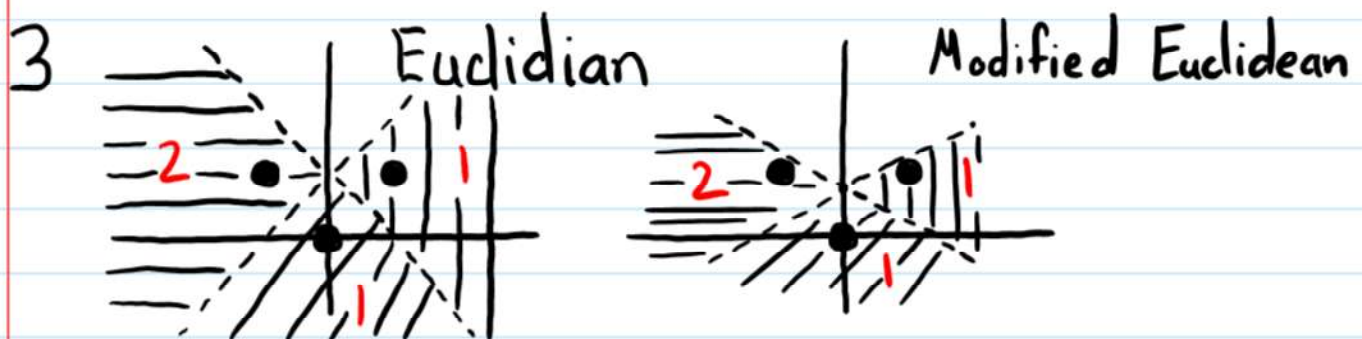
$$\frac{1}{2}x_1^2 + x_2^2 \leq \frac{1}{2}x_1^2 - 4x_1 + 8 + x_2^2$$

$$x_1 \leq 2$$

$$\|x - (2,2)\|^2 \leq \|x - (4,0)\|^2$$

$$\frac{1}{2}x_1^2 - 2x_1 + 2 + x_2^2 - 4x_2 + 4 \leq \frac{1}{2}x_1^2 - 4x_1 + 8 + x_2^2$$

$$2x_1 - 4x_2 \leq 2 \Rightarrow x_1 - 2x_2 \leq 1$$



$$\|x - (0,0)\|^2 \leq \|x - (1,1)\|^2$$

$$x_1^2 + x_2^2 \leq x_1^2 - 2x_1 + 1 + x_2^2 - 2x_2 + 1$$

$$x_1 + x_2 \leq 1$$

$$\frac{1}{2}x_1^2 - x_1 + \frac{1}{2}$$

$$x_1 + 2x_2 \leq \frac{3}{2}$$

$$\|x - (0,0)\|^2 \leq \|x - (-1,1)\|^2$$

$$x_1^2 + x_2^2 \leq x_1^2 + 2x_1 + 1 + x_2^2 - 2x_2 + 1$$

$$-x_1 + x_2 \leq 1$$

$$\frac{1}{2}x_1 + x_1 + \frac{1}{2}$$

$$-x_1 + 2x_2 \leq \frac{3}{2}$$

$$\|x - (1,1)\|^2 \leq \|x - (-1,1)\|^2$$

$$x_1^2 + x_2^2 - 2x_1 - 2x_2 + 2 \leq x_1^2 + x_2^2 + 2x_1 - 2x_2 + 2$$

$$-4x_1 \leq 0 \Rightarrow x_1 \geq 0$$

$$x_1 \geq 0$$

P2 1. 1-nearest neighbor error $p = .10$
 2. 3-nearest neighbor error $p = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} = .001$
 $p = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{9}{10} = (.009 \cdot 3) + .001$
 $= .028$
 5-nearest neighbor error $p = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} = .00001$
 $p = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{9}{10} \cdot \frac{9}{10} = (10) (.00081)$
 $p = \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{9}{10} = (5) (.00009)$
 $.0081 + .00045 + .00001 = .00856$

You can conclude that the higher k-values, or nearest neighbors you use, the less chances there are for error.

P3 1.

Training		Validation	
k	error	k	error
1	0	1	.127
3	.100	3	.143
5	.158	5	.190
11	.139	11	.177
16	.206	16	.257
21	.273	21	.323

Test

K	error
1	.107

2. a) The most accurate belongs to class 1
 b) The most inaccurate belongs to class 9
 c) The classifier most often mistakes classifying class 9 as class 4.