1. Decision Region

x_1	x_2	class
4	4	pos
4	6	poos
6	2	neg

a) $(4,4)$ $(4,6)$

$$(x_1-4)^2+(x_2-4)^2 \le (x_1-4)^2+(x_2-6)^2$$

$$x_2^2-8x_2+16 \le x_2^2-12x_2+36$$

$$4x_2-20 \le 0$$

$$x_2-5 \le 0$$

b) $(4,6)$ $(6,2)$

$$(x_1-4)^2+(x_2-6)^2 \le (x_1-6)^2+(x_2-2)^2$$

$$x_1^2-8x_1+16+x_2^2-12x_2+36 \le x_1^2-12x_1+36+x_2^2-4x_2+4$$

$$4x_1-8x_2+12 \le 0$$

$$x_1-2x_2+3 \le 0$$

c) $(6,2)$ $(4,4)$

$$(x_1-6)^2+(x_2-2)^2 \le (x_1-4)^2+(x_2-4)^2$$

$$x_1^2-12x_1+36+x_2^2-4x_2+4 \le x_1^2-8x_1+16+x_2^2-8x_2+16$$

$$-4x_1+4x_2+8 \le 0$$
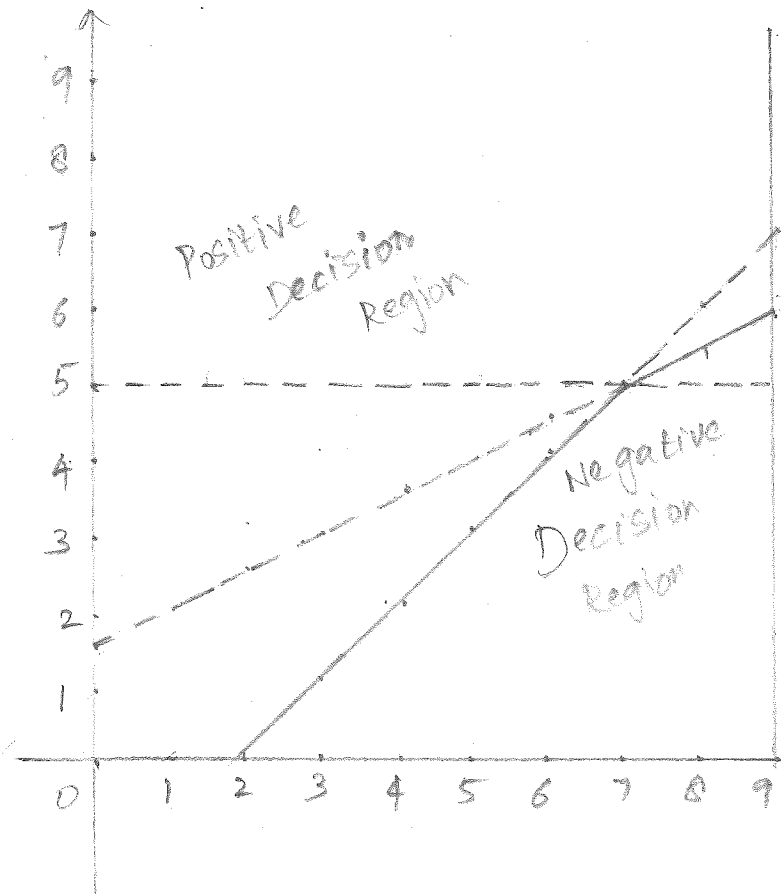
$$-x_1+x_2 \le -2$$

Decision boundary determined by the following equations

a) $x_2-5 \le 0$

b) $x_1-2x_2+3 \le 0$

c) $-x_1+x_2+2 \le 0$
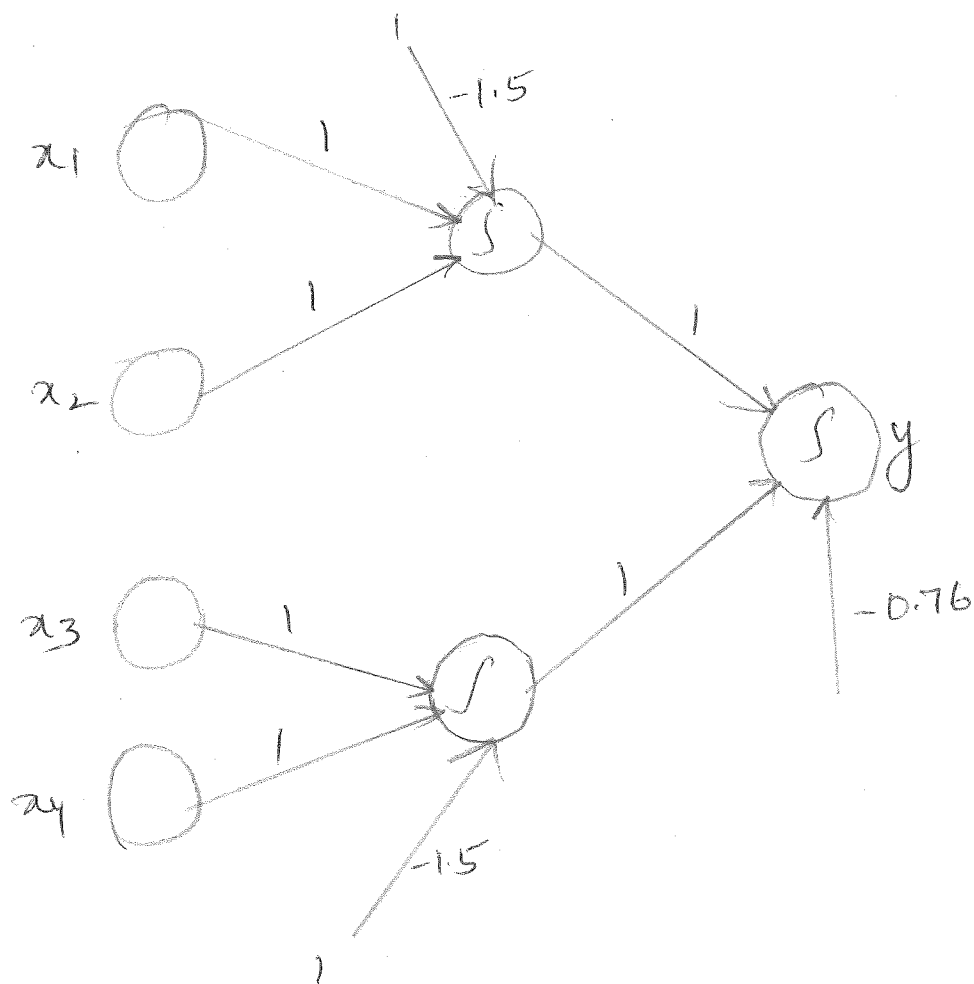
Positive Decision Region

Negative Decision Region

2. Query Point: $(7, 10)$

Operation	Priority Queue	Distance	Best Distance	Best Node
	$(f, 0)$		∞	
pop f	$(h, 0)(c, 1)$	$5\sqrt{2}$	$5\sqrt{2}$	f
pop h	$(i, 0)(c, 1)(g, 5)$	$5\sqrt{2}$	$5\sqrt{2}$	f
pop i	$(c, 1)(j, 3)(g, 5)$	3	3	i
pop c	$(b, 0)(e, 0)(j, 3)(g, 5)$	2	2	c
pop b	$(e, 0)(j, 3)(a, 4)(g, 5)$	$2\sqrt{5}$	2	c
pop e	$(d, 0)(j, 3)(a, 4)(g, 5)$	$\sqrt{61}$	2	c
pop d	$(j, 3)(a, 4)(g, 5)$	$\sqrt{29}$	2	c
pop j				
return c				

3. Neural network for $y = (x_1 \wedge x_2) \vee (x_3 \wedge x_4)$

4. $W_{CA} = 1$ $W_{CB} = -0.5$ $W_{EC} = -2$ $W_{FC} = -2$

   $W_{DA} = -0.5$ $W_{DB} = 1$ $W_{ED} = 1$ $W_{FD} = -2$

$$O_C = \frac{1}{1+e^{-3}}$$

$$3 = (0 \times 1) + (1 \times 0.5) + (1 \times -0.5) = -1$$

$$\Rightarrow O_C = \frac{1}{1+e^{+1}} = 0.2689$$

$$O_D = \frac{1}{1+e^{-((1 \times 1) + (0 \times -0.5) + (1 \times -1))}} = \frac{1}{1+e^0} = 0.5$$

$$O_E = \frac{1}{1+e^{-((1 \times 0) + (.2689 \times -2) + (0.5 \times 1))}} = \frac{1}{1+e^{.0379}} = 0.4905$$

$$O_F = \frac{1}{1+e^{-((1 \times -0.5) + (0.5 \times -2)(0.2689 \times -2)}} = \frac{1}{1+e^{-(-2.0378)}} = 0.1153$$

Back propagation

$$\Delta W_{FD} = \eta \, \delta_F \, O_D$$

$$\delta_F = 0.1153 \times (1 - 0.1153) \times (0 - 0.1153) = -0.1176$$

$$\Delta W_{FD} = 0.1 \times -.01176 \times 0.5$$

$$= -0.000588 = -0.0006$$

$$W_{FD} = -2 + (-0.0006)$$

$$\underline{W_{FD} = -2.0006}$$

$$\Delta W_{DA} = \eta \, \delta_D \, O_A$$

$$\delta_D = O_D \times (1-O_D) \times (\delta_E \times W_{ED}) + (\delta_F \times W_{FD})$$

$$\delta_E = 0.4905 \times (1-0.4905)(1-0.4905) = 0.1273$$

$$\delta_F = 0.1153 \times (1-0.1153)(0-0.1153) = -0.01176$$

$$\delta_D = 0.5 \times (1-0.5) \times ((0.1273 \times 1) + (-2 \times -0.01176))$$

$$= 0.5 \times 0.5 \times (0.1273 + 0.02352)$$

$$= 0.37705$$

$$\Delta W_{DA} = 0.1 \times 0.37705 \times 0 = 0$$

$$\therefore W_{DA} = -0.5$$