Question 1.

S_1	S_2	S_3
S_8		S_4
S_7	S_6	S_5

the goal is to go to one of the four corner.

The Production system is similar to go to one of four corner.

We assume go to the east north corner.

$\overline{S_2} \rightarrow$ North

$\overline{S_4} \rightarrow$ East

$1 \rightarrow$ Nil

Question 2.

$$f = \begin{cases} 1 & \text{if } \sum_{i=1}^{5} x_i w_i \geq 1 \\ 0, & \text{otherwise} \end{cases}$$

weight $= (1.1, 3.1, -1, -2, 0.5) = W$

input $(x_1, x_2, x_3, x_4, x_5) = I$

$\therefore \quad I \cdot W^T = 1.1 x_1 + 3.1 x_2 - x_3 - 2x_4 + 0.5 x_5$

since x_5 is 0.5, it will be not impact to the final negative.

when x_2 is true. only if x_3 and x_4 both true, the result will be

when only x_1 is true, x_2 is false, x_3 and x_4 should be both false

$$f = x_1 \cdot x_2 + x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 + \bar{x}_1 x_2 \bar{x}_3 \bar{x}_4 + \bar{x}_1 x_2 \bar{x}_3 x_4 + \bar{x}_1 x_2 x_3 \bar{x}_4$$

$$\therefore f = x_1 \cdot x_2 + x_1 \bar{x}_2 \bar{x}_3 \bar{x}_4 + \bar{x}_1 \cdot x_2 \cdot (\bar{x}_3 + \bar{x}_4)$$

Question 3. : Code is in the Project folder

① fitness function $\sum_{i=1}^{100} (f(w_i, x_i))$.

$$f(w_i, x_i) = \begin{cases} 1, & \text{when } \left(\left(\sum_{j=0}^{9} w_{ij} x_{ij} \right) - \theta \geq 0 \text{ and } \ell = 1 \right) \end{cases}$$

$$\begin{cases} & \text{or } ((\sum_{j=0}^{q} w_{ij} x_{ij} - \theta < 0 \text{ and } l=0) \\ 0, & \text{otherwise} \end{cases}$$

if the prediction is right get 1 points. if the prediction is wrong, get 0 point.
And Sum them together.

② k point cross over operator. (A better solution on
father $[W_{f1}, W_{f2} \cdots W_{fq}, \theta_f]$
mother $[W_{m1}, W_{m2} \cdots W_{mq}, \theta_m]$.
we random choice 6/4 parameters fram father and 4/6 parameters from mother to form two child

$$\begin{bmatrix} \text{Child 1} \\ \text{Child 2} \end{bmatrix} = \begin{bmatrix} \text{contains 6 father's p + 4's mothers} \\ \text{contains 4 father's + 6's mothers} \end{bmatrix}$$

③ By using the original one, by using the best 30%

④ In this Thershold detection case, this is not a must. But I try to random choice on a larger scale to mutate

⑤ I use size of 100 population. because it would not take too much of CPU resource.

⑥ Two case : a. Reach the maximum iteration (1000 in my program)
b. Reach the maximum fitness (100 in my program).
It is combination of two. (a+b).

```
generaltion: 946        our best generation accuracy: 95
generaltion: 946        our best generation: [[-0.29496322 -0.47577166 -1.58555814  0.75852582  0.48983128 -0.45629136
  0.70400125 -0.70826961  0.45445577 -0.26631093]]
```

⑦. my best fitness score : 95 accuracy = 95/100.

Q4.

① Boolean Expression:

$$f = S_1\bar{S_2}\cdot\bar{S_3}\cdot\bar{S_4}\cdot\bar{S_5}\cdot\bar{S_6}\cdot\bar{S_7}\cdot\bar{S_8} + \bar{S_1}\cdot\bar{S_2}\cdot\bar{S_3}\cdot\bar{S_4}\cdot\bar{S_5}\cdot\bar{S_6}\cdot\bar{S_7}\cdot S_8$$ and from others

$$f = (S_1 + S_8)\cdot\bar{S_2}\cdot\bar{S_3}$$

② In Code. and the threshold function is similar

Q5.

①. In Code

②. Yes, we can. By making 4 Training Set:

As we use go "Directions. EAST" as example.:

we can considering different situation : Input ($S_2, S_4, S_6, S_8, \bar{S_2}, \bar{S_4}, \bar{S_6}, \bar{S_8}$)

① $S_2 = 1$ and $S_4 = 0$ Go East. (d=1). N, E, S, W, d).

② $S_2 = 0$ and $S_4 = 0$ and $S_6 = 0$ and $S_8 = 0$ and $S = 1$ and $\bar{S_4} = 1$
Go East. (d=1)

③ $S_4 = 1$ Not go East (d=0)

weight_E = [1, -3, 0.0, 0, 1, 0, 0, 0, 0, 1, 0, 1]

So we can construct a training datasets. For South / North EAST / WEST. And we can do Error - Correction on this.

And make an production system. And we have 4 TLU. (T_1, T_2, T_3, T_4)
↓ North ↓ East ↓ South ↓ west.

As we describe in Question 4.

Production system:

$T_1 \rightarrow N$

$T_2 \rightarrow E$

$T_3 \rightarrow S$

$T_4 \rightarrow W$

$1 \rightarrow N$.