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Problem 1

- Let $x_1$be the binary-valued of the north cell that is occupied

  Let the action function to be:

  $$\bar{x}_1 \rightarrow north, \qquad x_1 \rightarrow east, 1 \rightarrow Nil$$

  Then, the robot will go to the right upper corner.

- Suppose it start from an interior position (s1 = s2 = … s8 = 0), without loss of generality, the robot goes north, then it will meet the boundary. Since the robot needs to visit all the cell, it cannot go to the south interior cell (the last of its path). Now, there are only two choices, left or right. So once the robot comes to the boundary it cannot get rid of it. Now the grid is 10x10, there must be some interior cells that the robot cannot reach there. If you want to leave the boundary, it will create two isomorphic situations but having two actions.

  If you start from boundary, let's say the south boundary, if you go to the north position, you will reach the interior position like the previous situation, or if you go to east or west (don't leave the boundary), you are in the same situation as mentioned above.

- w_i = s_i for I = 1, 2, 3, 4, 5, 6, 7, 8
  $w_{2'}$ = 1 iff at the previous time step, the robot moved north.
  $w_{4'}$ = 1 iff at the previous time step, the robot moved east.
  $w_{6'}$ = 1 iff at the previous time step, the robot moved south.
  $w_{8'}$ = 1 iff at the previous time step, the robot moved west.
  w_0 = 1 iff at the previous time step, the did nothing (for beginning step)

  $w_0 w_2$ → north (for the beginning step)
  $\overline{w}_2 w_{2'}$ → north (keep going north if possible)
  $w_2 \overline{w}_8 w_{2'}$→ west (turn left then)
  $w_2 \overline{w}_8 w_{8'}$ → west (go to the upper left corner)
  $w_8 w_2$ → east (u-turn)
  $w_2 \overline{w}_4 w_{4'}$→ east (keep going to the upper right corner)
  $w_2 w_4 w_{4'}$ → south (move 1 down from the upper right corner)

  $w_4 \overline{w}_8 w_{6'}$ → west (start to the left)
  $\overline{w}_2 \overline{w}_8 w_{8'}$ → west (keep to the left)
  $w_8 \overline{w}_2 \overline{w}_6 w_{8'}$ → south (move 1 down)

  $w_8 \overline{w}_4 w_{6'}$ → east (start to the right)
  $\overline{w}_2 \overline{w}_4 w_{4'}$ → east (keep to the right)
  $w_4 \overline{w}_2 \overline{w}_6 w_{4'}$ → south (move 1 down)

Problem 2
Consider the 5 Boolean inputs to be (1, 2, 3, 4, 5). Now we have some consideration. Even input 2 and 5 both are 1, it is still less than the threshold. So input 5 actually is dummy. If input 1 is 1 and input 2 is 0, then both input 3 and 4 must be 0. But with the help of input 2, it will still pass the threshold even both 3 and 4 are on.

If input 2 is on without input 1, it will pass the threshold if not both input 3 and 4 are on.

To conclude it, the logic expression of the Boolean function will be:
(1∧¬3∧¬4) ∨(1∧2)∨(2∧¬(3∧4))

Problem 3
Let x_1 be the first input, x_2 be the second input and x_0 be the constant input which the value must be 1. The logical relationship of disjunction or is as follow:

x_1	x_2	d
1	1	1
1	0	1
0	1	1
0	0	0

After some experiments by hands, the two training samples will be { x_1 = x_2 = 1, x_1 = x_2 0}

The converging sequence of weights:

Current W	(x_0, x_1, x_2)	d	Σ	>= threshold?	Update?	New W
(0, 0, 0)	(1, 1, 1)	1	0	1	0	/
(0, 0, 0)	(1, 0, 0)	0	0	1	1	(-1, 0, 0)
(-1, 0, 0)	(1, 1, 1)	1	-1	0	1	(-1, 1, 1)
(-1, 1, 1)	(1, 0, 0)	0	-1	0	0	(-1, 1, 1)

Problem 4
1. The number of correctness based on our TLU.
2. There are 10 parameters in our weighting (including the threshold). The crossover operator is as follow:
   Randomly choose an integer n which n ∈ [1, 9] and generate $\{u_1, u_2, \dots, u_i, v_{i+1}, \dots, v_n\}$ from $\{u_1, u_2, \dots, u_n\}$ and $\{v_1, v_2, \dots, v_n\}$
3. Based on Tournament selection.
4. Based on Tournament selection and mutate some weights randomly as white noise (mean = 0 with variance = 1)
5. 5000 models initially
6. With enough computing power in this question, the stopping criteria is just when the model achieve the required loop. (100 is my implementation)
7. The weight of TLU is [-0.08338671, -0.35673308, 0.99734321 -0.21327968, 2.42218153, 0.75691467, -2.37031905, -1.2437123, 0.59354745, 0.0094335]
   Correct instances in the training set: 49 (100%)