Assignment 4

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As given in question we will be given a input string w where each alphabet is either 0 or 1 and we have to design a turing machine which will transform given string to swap ith and (i+1)th alphabet if i is odd and less than n.
Here we will reformat the input and swap alphabets if needed. Here we can have 4 cases for ith and (i+1)th characters. So here are 4 cases -

If both are 00 then if we swap there is no change so we just move 2 steps forward from ith position.
If both are 11 then if we swap there is no change so we just move 2 steps forward from ith postion.
If both are 01 then we have swap it to 10 and then move 2 steps forward from ith position.
If both are 10 then we have swap it to 01 and then move 2 steps forward from ith position.
Here Turing Machine M is defined as follows :-

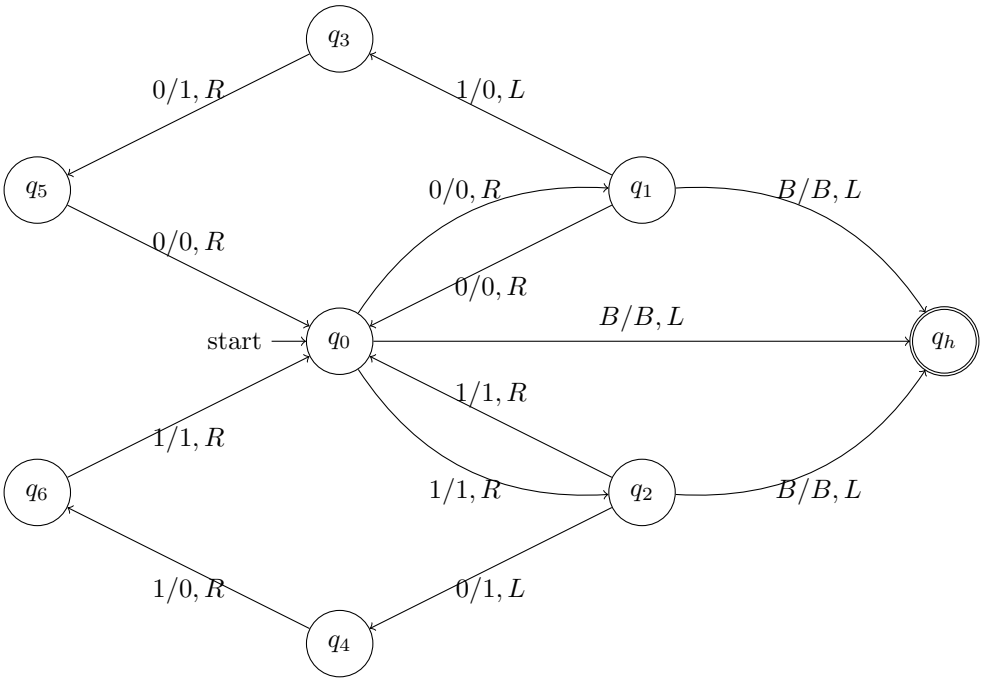
M = (Q, $\sum$, τ, δ, q_0, B, q_h) where
Q= {q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_h}
$\sum$ = {0,1} , τ = {0,1,B}
δ is represented by Transition table and q_0 is starting state and B is blank symbol.
q_h is accepting and halt state to show process is completed and input is converted to output.

Here logic of Machine is that we manipulate 2 alphabets starting from q_0 and coming back again to q_0 and whenever we encounter a Blank symbol meaning that string is finished we move to q_h halt state and at last our control will be pointing to last alphabet of output string.

Transition table –

present state, input symbol	destination state, overwrite, direction
q_0,0	q_1,0,R
q_0,1	q_2,1,R
q_0,B	q_h,B,L
q_1,0	q_0,0,R
q_1,1	q_3,0,L
q_1,B	q_h,B,L
q_2,0	q_4,1,L
q_2,1	q_0,1,R
q_2,B	q_h,B,L
q_3,0	q_5,1,R
q_5,0	q_0,0,R
q_4,1	q_6,0,R
q_6,1	q_1,1,R

Turing Machine M -



Here is explanation how turing machine works -

Firstly we are at q_0. Here we scan input alphabet. Let's say it is 0 then we move to q_1 and move right. In q_1 we check current alphabet if it is 0 then we again go to q_0 and move right as 00 will have no effect of swap. But if its 1 we change it 0 and go to q_3 and move left. Now we know here its alphabet is 0. So we change it to 1 and move to q_4 and move right. Now we can see that we have swapped both alphabets thus we move to q_0 and move right.

Let's say input alphabet is 1 then we move to q_2 and move right. In q_2 we

check current alphabet if it is 1 then we move to q_0 and move right as 11 will have no effect of swap. But if its 0 we change it 1 and go to q_4 and move left. Now we know here its alphabet is 1. So we change it to 0 and move to q_6 and move right. Now we can see that we have swapped both alphabets thus we move to q_0 and move right.
Here are 2 cases that whether string length is odd or even - If string length is even and starting from q_0 we scan 2 alphabets and swap them so after processing whole string we will be reaching at q_0 again and have Blank symbol. So we make a transition to q_h when ever we encounter a blank symbol meaning string is processed.
Here on the states q_3, q_4, q_5, q_6 we do not need any other transitions as we know what was previous alphabet.
If string length is odd and starting from q_0 we scan 2 alphabet and swap them. So here we will be processing whole string except last symbol as it do not have a pair and in our machine when we scan first symbol we reach either q_1 or q_2. and given in question this alphabet needs to be remain same. So we make transitions from these states to q_h whenever they get a Blank symbol Showing that our string is processed.