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Project 1: Option One
Construct a Shift instruction Turing Machine

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Goal of this project is to construct a Turing machine that implements the SHIFT instruction. The input is a binary string flanked by one x character on each edge, and the output is the binary string shifted right by one bit and also flanked by one x character on each edge.

How it went?

Assuming all the inputs are correctly formatted(The input is a binary string flanked by one x character on each edge, and the output is the binary string shifted right by one bit and also flanked by one x character on each edge.) and not empty.(i.e. x…..x). If the input binary string only has one digit, then we scan from the leftmost x to the rightmost x then back to the leftmost x and no matter what digit after the leftmost x is, we change it to 0 and move the head to the left point at the leftmost x, hence, we succeed on shifting. Otherwise, we first check the second last digit: if it's a 1 then change the last digit to 1; if it's a 0 then change the last digit to 0. And we do the same phase for the digit right before the second last digit to change the second last digit to the same digit as the previous digit, then follow the same steps to change the elements one by one from the right hand side of the input tape to the left end, and when we finally reach the leftmost x we change the element right after it to 0, therefore we succeed on shifting instruction.

Examples:

1. x0110x-- we scan the tape from left to right--in q0, when we see an x move to the right once and transitions to q1--in q1 it keeps scanning from left to right, it would stay in q1 until we see an x which is the x at the end of the input tape, then move the head to left once and transition to q2--no matter what character we see, move the head to left once and transition to q3--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x0111x)--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x0111x)--when we see a 0 move the head to right once, it transitions to q5--no matter what the head is pointing at, change that character to 0 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x0011x)--when we see x move the head to right once and transition to q4--no matter what we see, change that character to 0, move the head to left once(x0011x)--goes into q_halt, the output has been accepted(x0011x)

2. x1010x--we scan the tape from left to right--in q0, when we see an x move to the right once and transitions to q1--in q1 it keeps scanning from left to right, it would stay in q1 until we see an x which is the x at the end of the input tape, then move the head to left once and transition to q2--no matter what character we see, move the head to left once and transition to q3--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x1011x)--when we see a 0 move the head to right once, it transitions to q5--no matter what the head is pointing at, change that character to 0 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x1001x)--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x1101x)--when we see x move the head to right once and transition to q4--no matter what we see, change that character to 0, move the head to left once(x0101x)--goes into q_halt, the output has been accepted(x0101x)

3. x0x--we scan the tape from left to right--in q0, when we see an x move to the right once and transitions to q1--in q1 it keeps scanning from left to right, it would stay in q1 until we see an x which is the x at the end of the input tape, then move the head to left once and transition to q2--no matter what character we see, move the head to left once and transition to q3--when we see an x move the head to right once and transition to q4--no matter what character we see, change it to 0 and move the head to left once(x0x)--goes into q_halt, the output has been accepted(x0x)

4. x1x--we scan the tape from left to right--in q0, when we see an x move to the right once and transitions to q1--in q1 it keeps scanning from left to right, it would stay in q1 until we see an x which is the x at the end of the input tape, then move the head to left once and transition to q2--no matter what character we see, move the head to left once and transition to q3--when we see an x move the head to right once and transition to q4--no matter what character we see, change it to 0 and move the head to left once(x0x)--goes into q_halt, the output has been accepted(x0x)

5.x11001x--we scan the tape from left to right--in q0, when we see an x move to the right once and transitions to q1--in q1 it keeps scanning from left to right, it would stay in q1 until we see an x which is the x at the end of the input tape, then move the head to left once and transition to q2--no matter what character we see, move the head to left once and transition to q3--when we see a 0 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 0 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x11000x)--when we see a 0 move the head to right once, it transitions to q5--no matter what the head is pointing at, change that character to 0 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x11000x)--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x11100x)--when we see a 1 move the head to right once, it transitions to q6--no matter what the head is pointing at, change that character to 1 and move the head to left once, it transitions to q7--no matter what the head is pointing at, move the head to left once and transition to q3(x11100x)--when we see x move the head to right once and transition to q4--no matter what we see, change that character to 0, move the head to left once(x01100x)--goes into q_halt, the output has been accepted(x01100x)

Edge Cases:

1. input=”11010”--this input is invalid because the inputs for this Turing Machine should be flanked by x on each edge--so, it will be rejected

2. input=”x10k10x”--this input is invalid because the inputs for this Turing Machine should be binary strings flanked by x on each edge--so, it will be rejected

3. input=” ”--this input is invalid because the inputs for this Turing Machine should not be empty--so, it will be rejected