Gradiance Online Accelerated Learning

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Help

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based on Chapter 8 of HMU.

1. A Turing machine *M* with start state q_0 and accepting state q_f has the following transition function:

$\delta(q,a)$	0	1	B
q_0	$(q_0,1,R)$	$(q_1,1,R)$	(q_f,B,R)
q_1	$(q_2,0,L)$	$(q_2,1,L)$	(q_2,B,L)
q_2	-	$(q_0,0,R)$	-
q_f	-	-	-

Deduce what *M* does on any input of 0's and 1's. Hint: consider what happens when *M* is started in state q_0 at the left end of a sequence of any number of 0's (including zero of them) and a 1. Demonstrate your understanding by identifying the true transition of *M* from the list below.

a) $q_0$1100 |-* 0011q_f

b) $q_0$0011 |-* 1100Bq_f

c) $q_0$0011 |-* 1100q_f

d) $q_0$1100 |-* 1111Bq_f

Answer submitted: **b)**

You have answered the question correctly.

Question Explanation:

M inverts all 0's and 1's on its input and then accepts. To see why, notice that for any string *w*, *M* makes the following sequence of transitions:

(q_0,0...01w) |-* 1...1$q_0$1w |- 1...11q_1w |- 1...1$q_2$1w |- 1...10q_0w

Also, started in state q_0 with only 0's to its right, *M* moves to the right, replacing the 0's by 1's, and accepts when it reaches a blank.

2. The Turing machine M has:

- States q and p; q is the start state.

- Tape symbols 0, 1, and B; 0 and 1 are input symbols, and B is the blank.
- The following next-move function:

State	Tape Symbol	Move
q	0	(q,0,R)
q	1	(p,0,R)
q	B	(q,B,R)
p	0	(q,0,L)
p	1	none (halt)
p	B	(q,0,L)

Simulate M on the input 1010110, and identify one of the ID's (instantaneous descriptions) of M from the list below.

a) 101p0110

b) 1q010110

c) 00q00110

d) 10101p10

Answer submitted: **a)**

Your answer is incorrect.

A possible error is that you did not notice that when, in state q, M sees a 1, it replaces the 1 by 0. The formal notion of moves of a TM as a sequence of instantaneous descriptions is in Section 8.2.3 (p. 327).

Question Explanation:

Here is the complete sequence of ID's after which M halts: q1010110 |- 0p010110 |- q0010110 |- 0q010110 |- 00q10110 |- 000p0110 |- 00q00110 |- 000q0110 |- 0000q110 |- 00000p10

The correct choice is: **c)**

3. A nondeterministic Turing machine *M* with start state q_0 and accepting state q_f has the following transition function:

δ(q,a)	0	1	B
q_0	$\{(q_1,0,R)\}$	$\{(q_1,0,R)\}$	$\{(q_1,0,R)\}$
q_1	$\{(q_1,1,R), (q_2,0,L)\}$	$\{(q_1,1,R), (q_2,1,L)\}$	$\{(q_1,1,R), (q_2,B,L)\}$
q_2	$\{(q_f,0,R)\}$	$\{(q_2,1,L)\}$	$\{\}$
q_f	$\{\}$	$\{\}$	$\{\}$

Simulate all sequences of 5 moves, starting from initial ID $q_0 1010$. Find, in the list below, one of the ID's reachable from the initial ID in EXACTLY 5 moves.

a) $q_2 0110$

b) $00101q_1$

c) $0q_f 110$

d) $011111q_1$

Answer submitted: **b)**

Your answer is incorrect.

Possible error: Notice what happens to the symbol scanned, when *M* chooses stay in state q_1 and move right. Nondeterministic Turing machines are introduced in Section 8.4.4 (p. 347).

Question Explanation:

Here are all the possible sequences of ID's with up to 5 moves.

$q_0 1010 \vdash 0q_1 010 \vdash 01q_1 10 \vdash 011q_1 0 \vdash 0111q_1 \vdash 01111q_1$
$q_0 1010 \vdash 0q_1 010 \vdash 01q_1 10 \vdash 011q_1 0 \vdash 0111q_1 \vdash 011q_2 1$
$q_0 1010 \vdash 0q_1 010 \vdash 01q_1 10 \vdash 011q_1 0 \vdash 01q_2 10 \vdash 0q_2 110$
$q_0 1010 \vdash 0q_1 010 \vdash 01q_1 10 \vdash 0q_2 110 \vdash q_2 0110 \vdash 0q_f 110$
$q_0 1010 \vdash 0q_1 010 \vdash q_2 0010 \vdash 0q_f 010$

The correct choice is: **c)**

4. A nondeterministic Turing machine *M* with start state q_0 and accepting state q_f has the following transition function:

δ(q,a)	**0**	**1**	**B**
q_0	$\{(q_1,0,R)\}$	$\{(q_1,0,R)\}$	$\{(q_1,0,R)\}$
q_1	$\{(q_1,1,R), (q_2,0,L)\}$	$\{(q_1,1,R), (q_2,1,L)\}$	$\{(q_1,1,R), (q_2,B,L)\}$
q_2	$\{(q_f,0,R)\}$	$\{(q_2,1,L)\}$	$\{\}$
q_f	$\{\}$	$\{\}$	$\{\}$

Deduce what *M* does on any input of 0's and 1's. Demonstrate your understanding by identifying, from the list below, the ID that CANNOT be reached on some number of moves from the initial ID $q_0 101011001$.

a) $q_f 0111111111$

b) $0q_f 111111111$

c) $01111q_2 1101$

d) $01111q_2 111111111$

Answer submitted: **c)**

Your answer is incorrect.

Hint: notice that *M* can travel right as far as it likes in state q_1, changing all symbols to 1's. It may then guess to go to state q_2. What happens in state q_2? The notation for Turing machines and their moves is in Section 8.2.2 (p. 326), and the formal notion of moves between instantaneous descriptions is in Section 8.2.3 (p. 327).

Question Explanation:

M starts by replacing the first symbol by 0 and then enters state q_1, moving right. In state q_1, it moves right, changing all symbols, including blanks, to 1. However, at any time, it may also "guess" that it is time to enter q_2. In that branch, the symbol being scanned is left unchanged, and *M* moves left, over 1's, until it meets the initial 0. At that point, it moves right and enters state q_f.

The correct choice is: **a)**

5. The Turing machine M has:

- States q and p; q is the start state.
- Tape symbols 0, 1, and B; 0 and 1 are input symbols, and B is the blank.
- The following next-move function:

State	Tape Symbol	Move
q	0	(q,0,R)
q	1	(p,0,R)
q	B	(q,B,R)
p	0	(q,0,L)
p	1	none (halt)
p	B	(q,0,L)

Your problem is to describe the property of an input string that makes M halt. Identify a string that makes M halt from the list below.

a) 0101

b) 001010

c) 0010

d) 0011

Answer submitted: **b)**

Your answer is incorrect.

Hint: notice that the only way for M to halt is to enter state p and then see a 1 on the tape. How can that happen? In the case of this input, M does not halt; it enters the sequence of ID's: q001010 |- 0q01010 |- 00q1010 |- 000p010 |- 00q0010 |- 000q010 |- 0000q10 |- 00000p0 |- 0000q00 |- 00000q0 |- 000000qB |- 000000BqB |- ...

The informal notion of the behavior of a Turing machine is in Section 8.2.2 (p. 326). The formal notion of moves of a TM as a sequence of instantaneous descriptions is in Section 8.2.3 (p. 327).

Question Explanation:

In state q, as long as M sees only 0's, it leaves its tape unchanged and continues moving right. The only way M can halt is by being in state p and seeing a 1. The only way that M gets to state p is by being in state q and seeing a 1. Since in state q, M moves right when it sees the 1, we conclude that M will halt if it ever finds two consecutive 1's.

We need to make sure that there are no other ways M could halt, say by seeing a single 1. However, if M enters state p, it will surely have 0 to its left, because it changes the 1 to a 0. If in state p, M sees 0 or B, it moves left, back to the 0 and enters state q again. At that point, M will proceed right, in state q, until it sees another 1.

The correct choice is: **d)**