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Problem 1

This is the sequence of configurations that the Turing Machine M_1 enters when started on the input 110#11.

$$(q_1, \overset{\downarrow}{1}\,10\#11)$$

$$(q_3, x\,\overset{\downarrow}{1}\,0\#11)$$

$$(q_3, x1\,\overset{\downarrow}{0}\,\#11)$$

$$(q_3, x10\,\overset{\downarrow}{\#}\,11)$$

$$(q_5, x10\#\,\overset{\downarrow}{1}\,1)$$

$$(q_6, x10\,\overset{\downarrow}{\#}\,x1)$$

$$(q_7, x1\,\overset{\downarrow}{0}\,\#x1)$$

$$(q_7, x\,\overset{\downarrow}{1}\,0\#x1)$$

$$(q_7, \overset{\downarrow}{x}\,10\#x1)$$

$$(q_1, x\,\overset{\downarrow}{1}\,0\#x1)$$

$$(q_3, xx\,\overset{\downarrow}{0}\,\#x1)$$

$$(q_3, xx0\,\overset{\downarrow}{\#}\,x1)$$

$$(q_5, xx0\#\,\overset{\downarrow}{x}\,1)$$

$$(q_5, xx0\#x\,\overset{\downarrow}{1})$$

$$(q_6, xx0\#\,\overset{\downarrow}{x}\,x)$$

$$(q_6, xx0\,\overset{\downarrow}{\#}\,xx)$$

$$(q_7, xx\,\overset{\downarrow}{0}\,\#xx)$$

$$(q_7, x\,\overset{\downarrow}{x}\,0\#xx)$$

$$(q_1, xx\overset{\downarrow}{0}\#xx)$$

$$(q_2, xxx\overset{\downarrow}{\#}xx)$$

$$(q_4, xxx\#\overset{\downarrow}{x}x)$$

$$(q_4, xxx\#x\overset{\downarrow}{x})$$

Here we can see that it stcuks in q4 state and can't go to the state of q_accept. Hence 110#11 goes to reject state.

Problem 2

(a) **Scan for '#'**: Move right until the '#' symbol is found. If '#' is not found, reject.
Compare symbols symmetrically: Repeat until all symbols before '#' are processed:

1. Move left from '#' to find the first '0' or '1'), replace with 'X', and remember its value.
2. Move right to '#', then move right to find the first '0' or '1' after '#'.
3. Compare this symbol with the remembered value:
   - If they match, mark it.
   - If they do not match, then reject.

Check for extra symbols: After all symbols before '#' are marked, move right from '#' to check for any unmarked symbols. If unmarked symbols are found, reject; else, accept.

(b) The Turing machine M is defined as follows:
$Q = \{q_0, q_1, q_2, q_3, q_{\text{accept}}, q_{\text{reject}}\}$ is the set of states.
$\Sigma = \{0, 1, \#\}$ is the input alphabet.
$\Gamma = \{0, 1, \#, \_\}$ is the tape alphabet, where $\_$ represents the blank symbol.
q_0 is the initial state.
q_{accept} is the accept state.
q_{reject} is the reject state.
δ is the transition function, defined as follows:

Current State	Current Symbol	New Symbol	Direction	New State
$q0$	0	X	R	$q1$
$q0$	1	X	R	$q2$
$q0$	#	#	R	$q6$
$q1$	0	0	R	$q1$
$q1$	1	1	R	$q1$
$q1$	X	X	R	$q1$
$q1$	#	#	R	$q3$
$q2$	0	0	R	$q2$
$q2$	1	1	R	$q2$
$q2$	X	X	R	$q2$
$q2$	#	#	R	$q5$
$q3$	X	X	R	$q3$
$q3$	0	X	L	$q4$
$q4$	0	0	L	$q4$
$q4$	1	1	L	$q4$
$q4$	X	X	L	$q4$
$q4$	#	#	L	$q4$
$q4$	_	_	R	$q0$
$q5$	X	X	R	$q5$
$q5$	1	X	L	$q4$
$q6$	X	X	R	$q6$
$q6$	_	_	S	q_accept

Collaborators: None