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Foundations of Computer Science
Homework #4 - Chapter 3
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3.1 This exercise concerns TMM_2 , whose description and state diagram appear in Example 3.7. In each of the parts, give the sequence of configurations that M_2 enters when started on the indicated input string.

a. 0.

q_10 is the starting state.

Running the input 0 on the machine M_2 , we get the following configuration:

q_10
— q_2 —
— q_{accept}

M_2 enters into the q_{accept} state, and as a result the input of 0 is accepted.

c. 000.

q_1000 is the starting state.

Running the input 000 on the machine M_2 , we get the following configuration:

q_1000
— q_200
— xq_30
— $x0q_4$
— $x0q_{reject}$

M_2 enters into the q_{reject} state, and as a result the input is rejected.

d. 000000.

$q_1000000$ is the starting state.

Running the input 000000 on the machine M_2 , we get the following configuration:

$q_1000000$
— q_200000
— xq_30000
— $x0q_4000$
— $x0xq_300$
— $x0x0q_40$
— $x0x0xq_3$ —
— $x0x0q_5x$ —
— $x0xq_50x$ —
— $x0q_5x0x$ —
— xq_50x0x —
— q_5x0x0x —
 q_5 — $x0x0x$ —
— q_2x0x0x —
— xq_20x0x —
— xxq_3x0x —
— $xxxq_30x$ —
— $xxx0q_4x$ —
— $xxx0xq_4$ —
— $xxx0x$ — q_{reject}

M_2 enters into the q_{reject} state, and as a result the input is rejected.

Plus 00000000.

q_1 00000000 is the starting state.

Running the input 000000 on the machine M_2 , we get the following configuration:

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 $q_1$ 00000000
— $q_2$ 00000000
— $xq_3$ 000000
— $x0q_4$ 00000
— $x0xq_3$ 0000
— $x0x0q_4$ 000
— $x0x0xq_3$ 00
— $x0x0x0q_4$ 0
— $x0x0x0xq_3$ —
— $x0x0x0q_5x$ —
— $x0x0xq_5$ 0 $x$ —
— $x0x0q_5$ 0 $x$ —
— $x0xq_5$ 0 $x$ 0 $x$ —
— $x0q_5$ 0 $x$ 0 $x$ —
— $xq_5$ 0 $x$ 0 $x$ 0 $x$ —
— $q_5$ 0 $x$ 0 $x$ 0 $x$ —
 $q_5$ — $x$ 0 $x$ 0 $x$ 0 $x$ —
— $q_2$ 0 $x$ 0 $x$ 0 $x$ —
— $xq_2$ 0 $x$ 0 $x$ 0 $x$ —
— $xxq_3$ 0 $x$ 0 $x$ —
— $xxxq_3$ 0 $x$ 0 $x$ —
— $xxx0q_4$ 0 $x$ —
— $xxx0xq_4$ 0 $x$ —
— $xxx0xxq_3$ —
— $xxx0xxq_5$ —
— $xxx0xq_5$ —
— $xxx0q_5$ —
— $xxxq_5$ —
— $xq_5$ —
— $q_5$ —

```

$q_5 \text{---} xxx0xxx \text{---}$
 $\text{---} q_2 xxx0xxx \text{---}$
 $\text{---} xq_2 xx0xxx \text{---}$
 $\text{---} xxq_2 x0xxx \text{---}$
 $\text{---} xxxq_2 0xxx \text{---}$
 $\text{---} xxxqx_3 xxx \text{---}$
 $\text{---} xxxxxq_3 xx \text{---}$
 $\text{---} xxxxxxq_3 x \text{---}$
 $\text{---} xxxxxxq_3 \text{---}$
 $\text{---} xxxxxxq_5 x \text{---}$
 $\text{---} xxxxxxq_5 xx \text{---}$
 $\text{---} xxxqx_5 xxx \text{---}$
 $\text{---} xxq_5 xxxxx \text{---}$
 $\text{---} xq_5 xxxxxx \text{---}$
 $\text{---} q_5 xxxxxxx \text{---}$
 $q_5 \text{---} xxxxxxx \text{---}$
 $\text{---} q_2 xxxxxxx \text{---}$
 $\text{---} xq_2 xxxxxx \text{---}$
 $\text{---} xxq_2 xxxxx \text{---}$
 $\text{---} xxxq_2 xxxx \text{---}$
 $\text{---} xxxqx_2 xxx \text{---}$
 $\text{---} xxxxxq_2 xx \text{---}$
 $\text{---} xxxxxxq_2 x \text{---}$
 $\text{---} xxxxxxq_2 \text{---}$
 $\text{---} xxxxxxq_{accept} \text{---}$

This exercise concerns TMM_1 , whose description and state diagram appear in Example 3.9. In each of the parts, give the sequence of configurations that M_1 enters when started on the indicated input string.

b. $1\#1$.

c. $1\#\#1$.

d. $10\#11$.

e. $10\#10$.

plus $01100\#01100$

and $01101\#01100$

Give implementation-level descriptions of Turing machines that decide the following languages over the alphabet $\{0, 1\}$.

b. $\{w \mid w \text{ contains twice as many 0s as 1s}\}$

c. $\{w \mid w \text{ does not contain twice as many 0s as 1s}\}$

Plus: Draw the state diagram for Turing Machines 3.8b and 3.8c
3.8b

3.8c

For these machines draw the configurations for
3.8b:
010100.

010101.

3.8c:
000111.

000110.

Modify machine M2 to recognize odd number of 0s and draw the state diagram.

State diagram:

Draw the configuration for
000.

0000.

Modify machine M2 to recognize even number of 0s and draw the state diagram.

State diagram:

Draw the configuration for
000.

0000.