Tutorial # 6

Turing Machine

Exercise 1

Let $\boldsymbol{M} = (\boldsymbol{Q}, \boldsymbol{\Sigma}, \boldsymbol{\Gamma}, \#, \boldsymbol{q0}, \boldsymbol{F}, \boldsymbol{\delta})$ be a Turing machine where:

- $Q = \{q0, q1, q2\}$
- $\Sigma = \{a, b, c\}$
- $\Gamma = \{a, b, c, \#\}$
- $F = \{q2\}$

$\boldsymbol{\delta}$	a	b	c	$\#$
$q0$	$q0, a, R$	$q0, c, R$	$q0, c, R$	$q1, \#, L$
$q1$	$q1, c, L$	-	$q1, b, L$	$q2, \#, R$
$q2$	-	-	-	-

- Trace the computation for the input string $\boldsymbol{aabca}$.

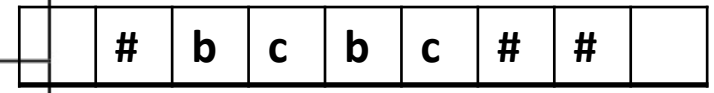
$\boldsymbol{\delta}$	a	b	c	#
$q0$	$q0, a, R$	$q0, c, R$	$q0, c, R$	$q1, \#, L$
$q1$	$q1, c, L$	-	$q1, b, L$	$q2, \#, R$
$q2$	-	-	-	-

	#	c	c	b	b	c	#	

$$q0\ aabca \succ a\ q0\ abca \succ aa\ q0\ bca \succ aac\ q0\ ca$$
$$\succ aacc\ q0\ a \succ aacca\ q0\ \succ aacc\ q1\ a \succ aac\ q1\ cc$$
$$\succ aa\ q1\ cbc \succ a\ q1\ abbc \succ\ q1\ acbbc \succ q1\ ccbbc$$
$$\succ q2\ ccbbc$$

- Trace the computation for the input string $\boldsymbol{bcbc}$

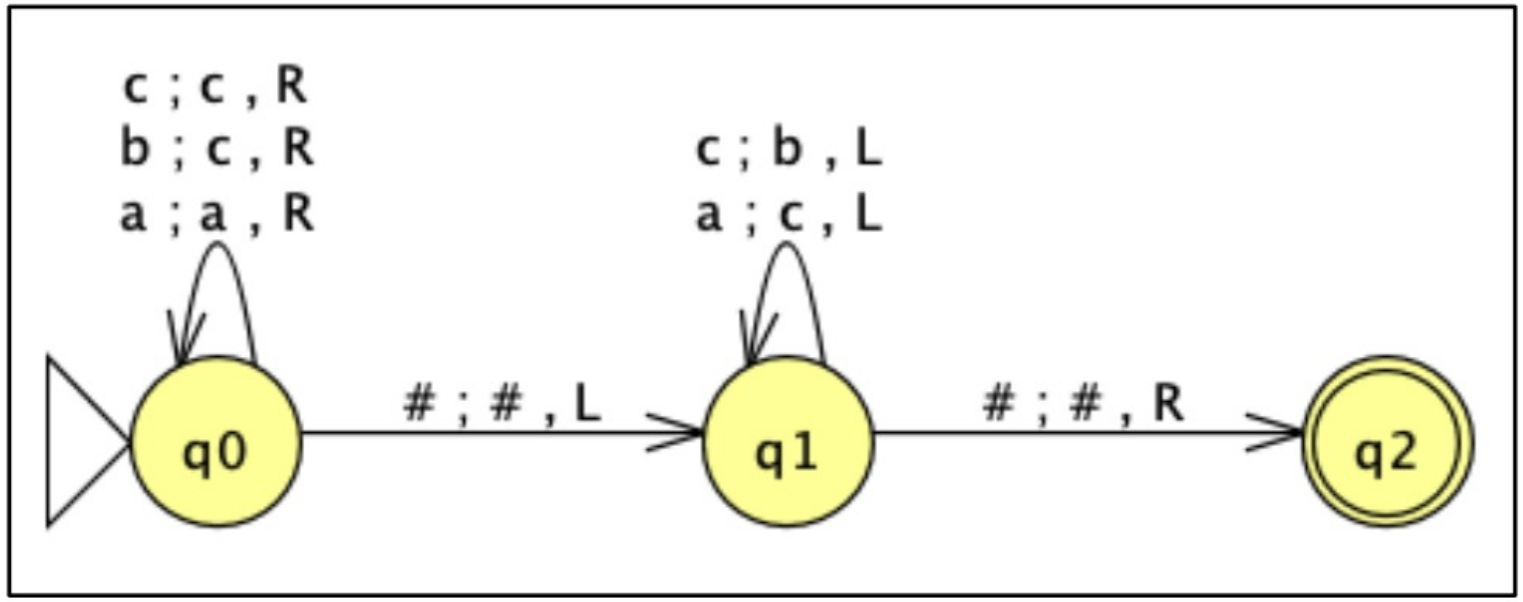
$\boldsymbol{\delta}$	a	b	c	#
$q0$	$q0, a, R$	$q0, c, R$	$q0, c, R$	$q1, \#, L$
$q1$	$q1, c, L$	-	$q1, b, L$	$q2, \#, R$
$q2$	-	-	-	-



$\# \; q0 \; bcbc\# \succ \#c \; q0 \; cbc\# \succ \#cc \; q0 \; bc\# \succ \#ccc \; q0 \; c\# \succ \#cccc \; q0 \; \#$
$\succ \#ccc \; q1 \; c\# \succ \#cc \; q1 \; cb\# \succ \#c \; q1 \; cbb\# \succ \# \; q1 \; cbbb\# \succ q1 \; \#bbbb\#$
$\succ \# \; q2 \; bbbb\#$

Give the state diagram of M.

δ	a	b	c	#
$q0$	$q0, a, R$	$q0, c, R$	$q0, c, R$	$q1, \#, L$
$q1$	$q1, c, L$	-	$q1, b, L$	$q2, \#, R$
$q2$	-	-	-	-

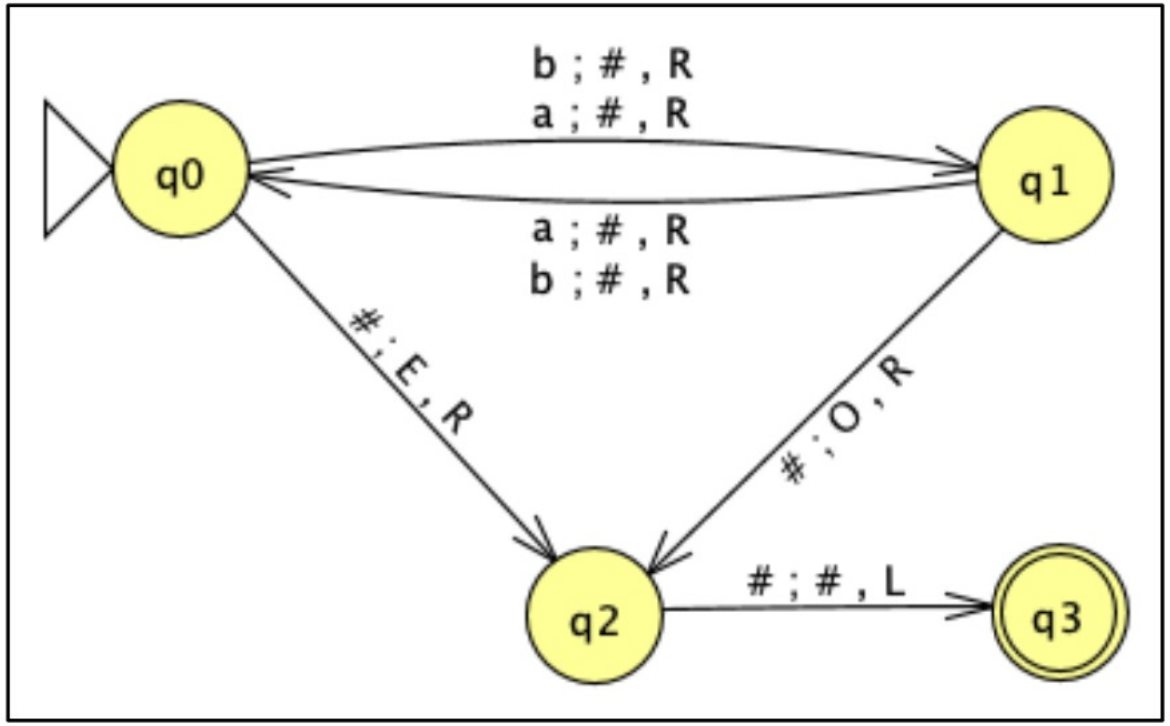


- Describe the result of a computation in M.

- The result of the computation is to replace the a's in the input string with c's, and the c's with b's.

Construct a Turing machine with input alphabet $\{a, b\}$ to perform each of the following operation:

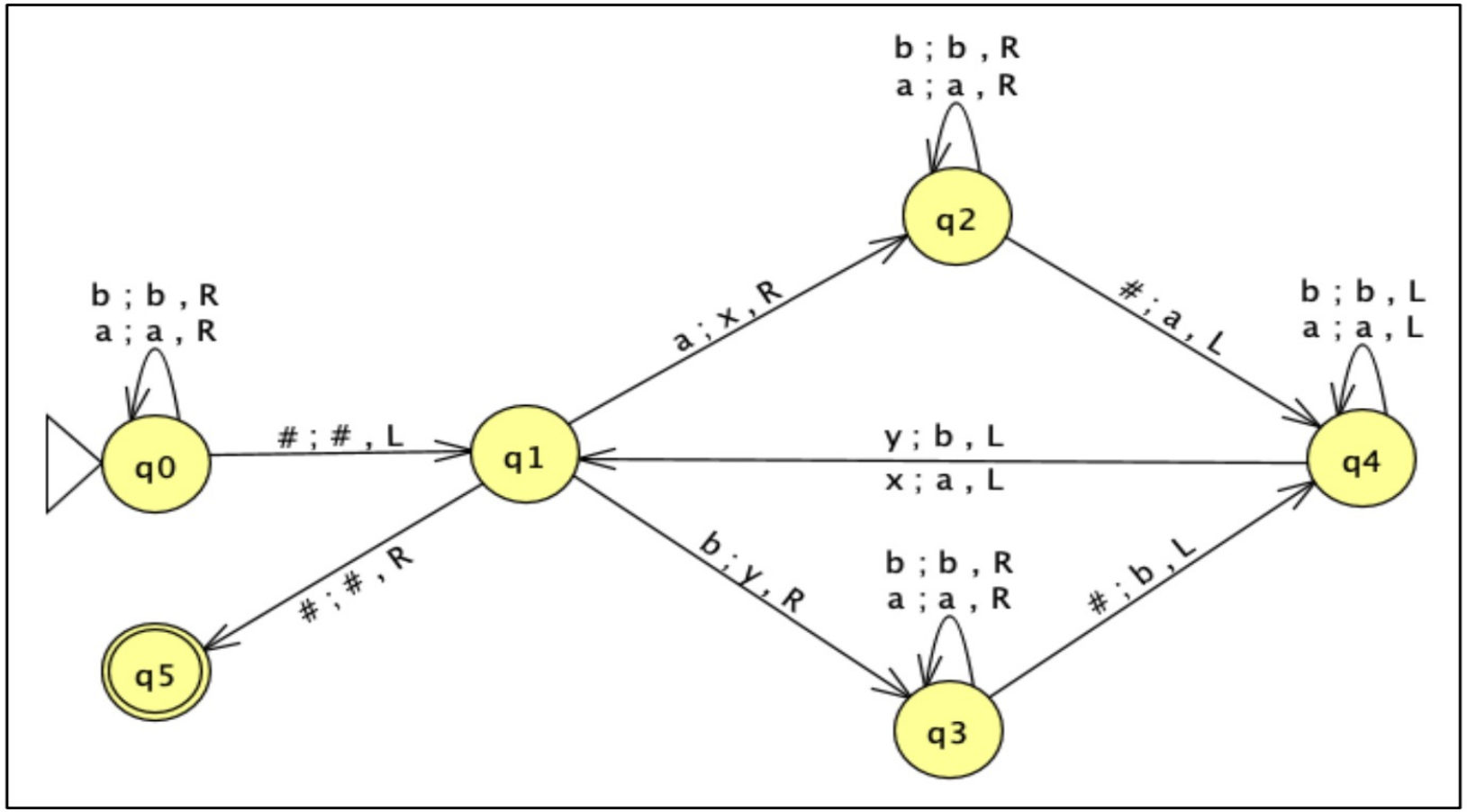
- Return $\boldsymbol{E}$ if the length of the input string is even, and $\boldsymbol{O}$ if the length is odd.



Construct a Turing machine with input alphabet $\{a, b\}$ to perform each of the following operation:

- Construct a copy of the reversed input string and concatenate it to the input.

  baa →baaaab



Construct a Turing machine with input alphabet $\{a, b\}$ to perform each of the following operation:

- Erase the $b's$ from the input.

The machine works in a left-to-right manner. At state q0, it skips a's and whenever it reads a b or a previously deleted position, denoted by symbol X, the machine move the first a in the following string. If no further a is find, it goes to state q3 and change all the remaining symbols b, X and Y into blanks