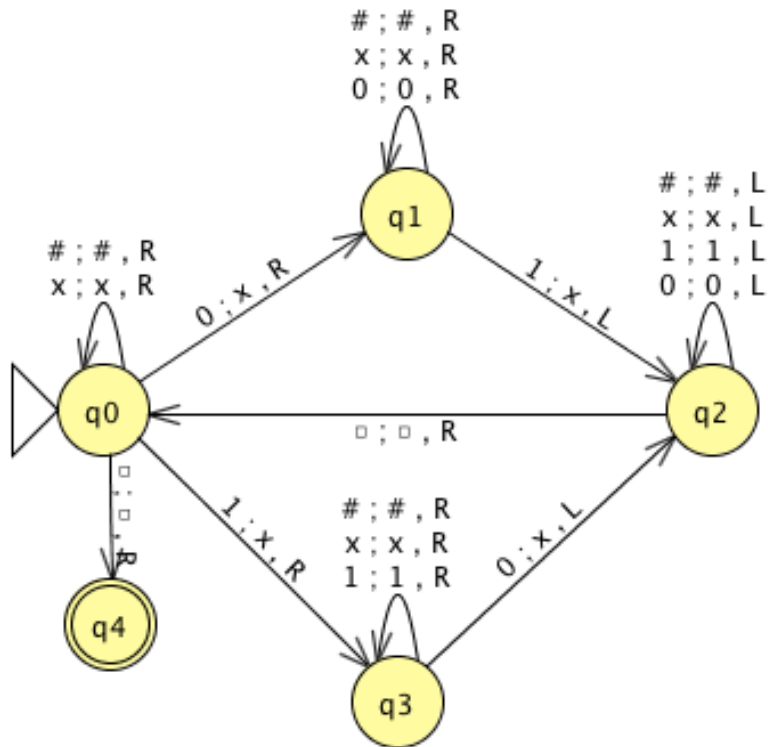


# CS 361– Homework 7

Total possible points: 75

- (20 points) Create a **state-diagram** representation of a **Turing Machine**  $M_1$  that accepts the language  $A = \{w \text{ over } \{0, 1, \#\}^* \mid w \text{ contains an equal number of 0's and 1's}\}$ .  $10\# \in A$ ,  $01\#10 \in A$ , and  $\#001 \notin A$ .

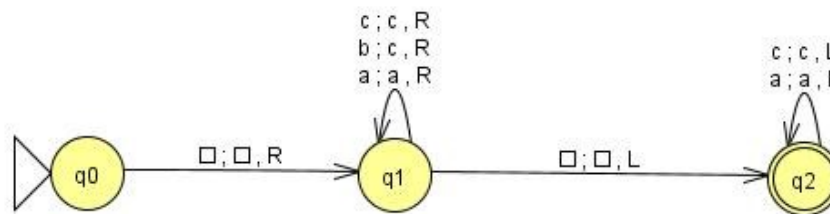
Solution is for the single-taped bi-infinite TM variation as in jflap



2. Consider the **TM**  $M_2$  defined by the set of transitions shown below. Here we use B to indicate the tape's "blank symbol."
- (10 points) Give the **state diagram** of  $M_2$  (assuming  $q_2$  is a final state)
  - (4 points) **Describe** the result of a computation in  $M_2$  (i.e., explain in your own words what  $M_2$  does given a string). Do *not trace the computation*, instead provide a high level overview of the language associated with  $M_2$
  - (3 points) **Trace** the computation of "BaabcaB"
  - (3 points) **Trace** the computation of "BbcbB"

$\delta$	B	a	b	c
$q_0$	$q_1, B, R$			
$q_1$	$q_2, B, L$	$q_1, a, R$	$q_1, c, R$	$q_1, c, R$
$q_2$		$q_2, a, L$		$q_2, c, L$

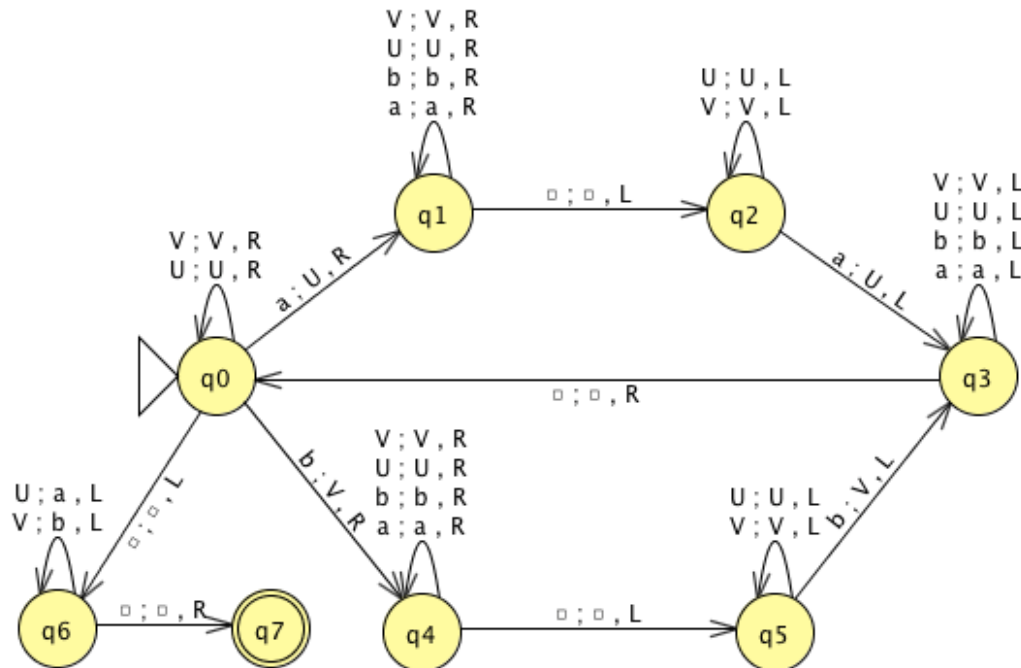
- a) Solution for jflap's variation of the TM, i.e., bi-infinite tape.



- $M_2$  reads strings over alphabet symbols a,b, and c and transforms b's into c's. Thereafter, it traverses the strings backwards, till it reaches the beginning of the string.
- $q_0$ BaabcaB ;  $Bq_1$ aabcaB; Ba  $q_1$ abcaB; Baac $q_1$ caB; Baacc $q_1$ aB; Baacca $q_1$ B; Baacc $q_2$ aB; Baac $q_2$ caB; Baa $q_2$ ccaB; Ba $q_2$ accaB; B $q_2$ aaccaB;  $q_2$ BaaccaB
- $q_0$ BbcbB;  $Bq_1$ bcbB; Bc $q_1$ cbB; Bcc $q_1$ bB; Bccc $q_1$ B; Bcc $q_2$ cB; Bc $q_2$ ccB; B $q_2$ cccB;  $q_2$ BcccB

3. (20 points) Construct a **state-diagram** representation of a Turing Machine  $M_3$  with input alphabet  $\{a, b\}$  that accepts strings of the form  $ww^r$  (where  $w$  is a string over  $\{a, b\}$ ). The **final configuration** should be  $q_f ww^r B$ .

Solution for jflap's variation of the TM, i.e., bi-infinite tape.



4. (15 points) Give a **description** of a TM  $M_4$  that decides language  $B = \{w \text{ over } \{0, 1\}^* \mid w \text{ contains twice as many 1's as 0's}\}$ . For example:  $101 \in B$ ,  $011 \in B$ , and  $001 \notin B$

Description for the bi-infinite tape TM variant.

- Find the first 0, mark it with X, then skip all the symbols until find first 1 and mark it with x then find second 10 and mark it with X. If cannot find 0, i.e., reached a blank symbol got to step c.
- Go back to the beginning of the tape and repeat a.
- Go back to the beginning of the tape and ensure that the tape only has X. If it does not then reject, otherwise accept (when the machine reaches a blank symbol)