Theory of Computing
Turing Machine - 1

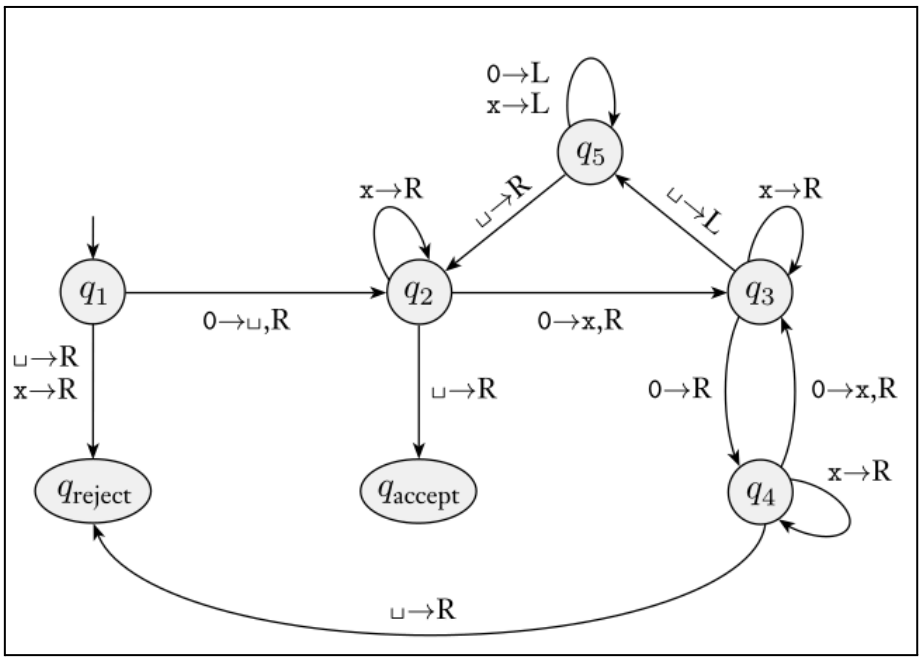
TD 9

2ND YEAR - ENSIA

PRE-TUTORIAL EXERCISES

Given the following state diagram for the Turing Machine.

1. Run a simulation for each of the following strings giving the configuration at each step and deduce whether the word is accepted or not.
   a. 0.
   b. 00.
   c. 000.
   d. 000000.
2. What's the Language described by this Turing Machine?



EXERCISES

Exercise C1 (Creating TM):

Let the the language L = { a^i b^j c^k } such that i = j + k.

- Write in **plain english english,** the algorithm fo
- Draw the Turing machine which recognizes L. (**NO USE OF PC**)

Exercise P2 (Creating a TM)

Draw the Turing Machine diagram for Even-Length Palindromes. (**NO USE OF PC**)

Exercise C3 (Creating TM):

Draw a TM with alphabet {a, b, c} that accepts all strings where the number of each character is the same [the number of a = number of b = number of c] [**You can use your PC**]

Exercise P1 (Optional)

Draw a transition diagram for a TM accepting NonPal, the language of nonpalindromes over {a, b}, using an approach similar to the previous exercise.

Exercise P2 (Optional)

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

1. {w| w contains an equal number of 0s and 1s}
2. {w| w contains twice as many 0s as 1s}
3. {w| w does not contain twice as many 0s as 1s}

Exercise P3 (Optional)

For each of the following languages, draw a transition diagram for a Turing machine that accepts that language.

1. $\{a^i b^j \mid i < j\}$
2. $\{a^i b^j \mid i \leq j\}$

Exercise P4 (Optional)

Let $\Sigma = \{0, 1\}$ and let B be the collection of strings that contain at least one 1 in their second half. In other words, $B = \{uv \mid u \in \Sigma^*, v \in \Sigma^*1\Sigma^* \text{ and } |u| \geq |v|\}$.

Construct the deterministic Turing machine that decides B.

Exercise P5 (Optional) [Recommended]

Design a Turing machine which automates verifying whether a **given** word is recognized by a **given** DFA

Exercise P6 (Optional)

For each part below, draw a transition diagram for a TM that accepts $AEqB = \{x \in \{a, b\}^* \mid n_a(x) = n_b(x)\}$ by using the approach that is described.

1. Search the string left-to-right for an a; as soon as one is found, replace it by X, return to the left end, and search for b; replace it by X; return to the left end and repeat these steps until one of the two searches is unsuccessful.
2. Begin at the left and search for either an a or a b; when one is found, replace it by X and continue to the right searching for the opposite symbol; when it is found, replace it by X and move back to the left end; repeat these steps until one of the two searches is unsuccessful.

Exercise P7 (Optional)

A Turing machine with stay put instead of left is similar to an ordinary Turing machine, but the transition function has the form

$\delta : Q \times \Gamma \to Q \times \Gamma \times \{R, S\}$.

At each point, the machine can move its head right or let it stay in the same position. Show that this Turing machine variant is not equivalent to the usual version.

What class of languages do these machines recognize?