Problem

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

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

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?

Step-by-step solution

Step 1 of 2

A Deterministic Finite State automaton can be simulated on the Turing Machine with stay put instead of left. The modifications can be done if transitions are added from state in F to q_{accept} and from the states outside F to q_{reject} when a blank symbol is read.

Assume there is a Turing Machine M, such that $M = (Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject})$ with stay put instead of left. Create a DFA such that the DFA $(Q^{'}, \Sigma^{'}, \delta^{'}, q_0^{'}, F)$ recognizes the same language.

The machine M cannot move left and cannot write anything that it can written on the tape while moving to the right. Thus, the access is one-way.

For every DFA, there exists a Turing Machine that accepts the same language because a DFA is a Turing Machine with read only tape and tape head with moves to right.

Comments (2)

Step 2 of 2

The transition function δ' for the NFA is as follows:

First, set $\delta'(q_{\text{start}}, P) = \{q_{OP}\}$ where q_{op} is the start state of TM variant.

Next, set $\delta'(q_{accept}, i) = \{q_{\text{accept}}\}$ For any *i*

If $\delta(p,a) = (q_{\text{accept,}} b, w)$ where $w = R$ or S, set $\delta'(q_{pa}, \in) = \{q_{\text{accept}}\}$

R is RIGHT *S* is stay put.

If $\delta(p,a) = (q_{reject}, b, w)$ where $w = R$ or S, we set $\delta'(q_{pa} \in) = \{q_{reject}\}$

• For each $a \in \Sigma$, set $\delta'(q_{start}, a) = \{\langle q_0, a \rangle\}$, where q_0 is start state of S.

• For each $p, q \in Q$ where $p \notin \{q_{accept}, q_{reject}\}$, for each $a \in \Gamma$, if S has transition of form $\delta(p,a) = (q_{\text{accept,}} b, w)$ or $\delta(p,a) = (q_{reject}, b, w)$, *w* becomes R for each $c \in \Sigma$, set $\delta'(\langle p, a \rangle, c) = \{\langle q, c \rangle\}$.

• For each $p, q \in Q$ where $p \notin \{q_{accept}, q_{reject}\}$, for each $a \in \Sigma$, if S has transition of form $\delta(p,a) = (q_{\text{accept,}} b, w)$ or $\delta(p,a) = (q_{reject}, b, w)$, *w* becomes S then set $\delta'(\langle p, a \rangle, \varepsilon) = \{\langle q, b \rangle\}$

Thus, an NFA is constructed which is defined as follows:

$(Q' = Q, \Sigma' = \Sigma, \delta', q_{op} = q_{start}, F)$ From our TM variant *S*.

The language recognized by NFA is regular languages.

Comment