Student Information

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Answer 1

a.

M=(K, Σ, δ,s ,{ h })
Σ = { a,b,$\sqcup$,$\triangleright$ }
δ(q,$\triangleright$)= (q, $\rightarrow$) for all q $\in$ K-h. K={ $q_0, q_1, q_2, q_3, q_4, q_5, q_6, h$ }
s={ q_0 }

q	σ	$\delta(q,\sigma)$
q_0	$\triangleright$	$\delta(q_0,\rightarrow)$
q_0	a	$\delta(q_1,\rightarrow)$
q_0	b	$\delta(q_1,\rightarrow)$
q_0	$\sqcup$	$\delta(q_1,\rightarrow)$
q_1	$\triangleright$	$\delta(q_1,\rightarrow)$
q_1	a	$\delta(q_2,\sqcup)$
q_1	b	$\delta(q_3,\sqcup)$
q_1	$\sqcup$	$\delta(h,\sqcup)$
q_2	$\triangleright$	$\delta(q_2,\rightarrow)$
q_2	a	$\delta(q_2,\leftarrow)$
q_2	b	$\delta(q_2,\leftarrow)$
q_2	$\sqcup$	$\delta(q_4,\leftarrow)$
q_3	$\triangleright$	$\delta(q_3,\rightarrow)$
q_3	a	$\delta(q_2,\leftarrow)$
q_3	b	$\delta(q_2,\leftarrow)$
q_3	$\sqcup$	$\delta(q_5,\leftarrow)$
q_4	$\triangleright$	$\delta(q_4,\rightarrow)$
q_4	a	$\delta(q_4,\leftarrow)$
q_4	b	$\delta(q_4,\leftarrow)$
q_4	$\sqcup$	$\delta(q_6,a)$
q_5	$\triangleright$	$\delta(q_5,\rightarrow)$
q_5	a	$\delta(q_5,\leftarrow)$
q_5	b	$\delta(q_5,\leftarrow)$
q_5	$\sqcup$	$\delta(q_6,b)$
q_6	$\triangleright$	$\delta(q_6,\rightarrow)$
q_6	a	$\delta(q_6,\rightarrow)$
q_6	b	$\delta(q_6,\rightarrow)$
q_6	$\sqcup$	$\delta(h,\sqcup)$

b.

i.

(s,$\triangleright \sqcup \sqcup b\underline{a}b$)
$(q_0, \triangleright \sqcup \sqcup b\underline{a}b) \vdash_M (q_1, \triangleright \sqcup \sqcup ba\underline{b}) \vdash_M (q_3, \triangleright \sqcup \sqcup ba\underline{\sqcup}) \vdash_M (q_5, \triangleright \sqcup \sqcup b\underline{a}\sqcup) \vdash_M (q_5, \triangleright \sqcup \sqcup \underline{b}a\sqcup) \vdash_M$
$(q_5, \triangleright\sqcup\underline{\sqcup}ba\sqcup) \vdash_M (q_6, \triangleright\sqcup\underline{b}ba\sqcup) \vdash_M (q_6, \triangleright\sqcup b\underline{b}a\sqcup) \vdash_M (q_6, \triangleright\sqcup bb\underline{a}\sqcup) \vdash_M (q_6, \triangleright\sqcup bba\underline{\sqcup}) \vdash_M (h, \triangleright\sqcup bba\underline{\sqcup})$

ii.

(s,$\triangleright a\underline{a}a$)
$(q_0, \triangleright a\underline{a}a) \vdash_M (q_1, \triangleright aa\underline{a}) \vdash_M (q_2, \triangleright aa\underline{\sqcup}) \vdash_M (q_4, \triangleright a\underline{a}\sqcup) \vdash_M (q_4, \triangleright \underline{a}a\sqcup) \vdash_M (q_4, \underline{\triangleright} aa\sqcup) \vdash_M (q_4, \triangleright \underline{a}a\sqcup) \vdash_M$
... infinite loop. goes right and left infinitely.

iii.

$(q_0, \triangleright\underline{a} \sqcup bb) \vdash_M (q_1, \triangleright a\underline{\sqcup}bb) \vdash_M (h, \triangleright a\underline{\sqcup}bb)$

Answer 2

$(\triangleright\underline{\sqcup}babc) \to (\triangleright\sqcup\underline{b}abc) \to (\triangleright\sqcup babc\underline{\sqcup}) \to (\triangleright\sqcup bab\underline{c}\sqcup) \to (\triangleright\sqcup babc\underline{\sqcup}) \to (\triangleright\sqcup babc\underline{\sqcup}) \to (\triangleright\sqcup babc\sqcup\underline{\sqcup}) \to$
$(\triangleright\sqcup babc\sqcup\underline{b}) \to (\triangleright\sqcup babc\sqcup\underline{c}) \to (\triangleright\sqcup babc\sqcup c\underline{\sqcup}) \to (\triangleright\sqcup babc\sqcup c\underline{\sqcup}) \to (\triangleright\sqcup babc\sqcup c\sqcup\underline{\sqcup}) \to (\triangleright\sqcup babc\sqcup c\sqcup b)$
The string should start with a blank symbol . There should be a "c" just before the first blank symbol. After these conditions satisfied, the five characters of the string (starting from the "c" which is located just before the first blank symbol) becomes c$\sqcup c \sqcup x$, where x is the initial letter of the string.

Answer 3

a.

L={ $(a \cup b)^*$ } ie. if $w \in L$, w has disordered a's and b's. The TM M , regularize the string and make it in the format a^n b^m where length of the string is equal to m+n.It puts all a's at the LHS and put all b's at RHS.
The input alphabet Σ_0={ a,b }

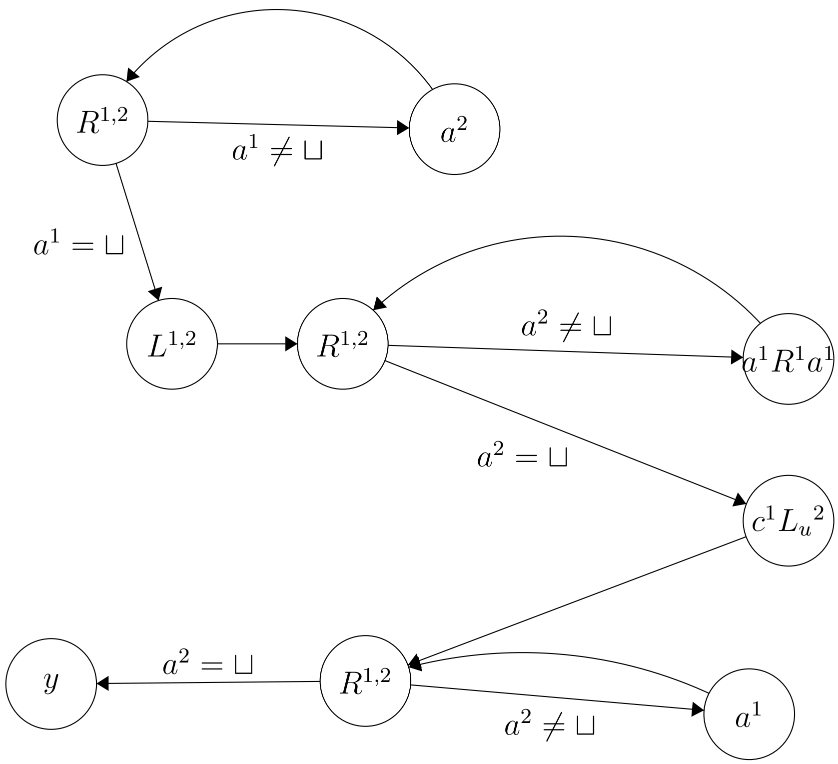
b.

say w=$(a \cup b)^*$, $w \in$ { a,b }* where length of w is k.
f(w)=$a^n b^m$ where n+m=k.

f: { a,b }* -¿ { a,b }*
and M(w)=f(w).

Answer 4

Two tape TM M=(K, Σ, δ ,s H).
K is finite set of states.
Σ = { a,b,c } and δ is transition function. s is initial state, H is halting state



Answer 7

a.

insert delete TM M=(K, Σ, δ, s, H)
K is set of states, Σ is alphabet, δ is a function where it can delete/insert (new) characters in the input string on the tape, only at the front and rear positions.
s is initial state and H is halting state(s).
- for all q $\in K - H$ if $\delta(q, \triangleright) = (p, b)$ then $b = \rightarrow$
- for all q $\in K - H$ and $a \in \Sigma$,if $\delta(q, a) = (p, b)$ then $b = \triangleright$

b.

$(q, \rhd \underline{a}w)$ (a $\in \Sigma, w \in \Sigma^*$) is a valid configuration of the insert-delete TM. It starts with the left end symbol and underlined character is the currently scanned symbol.

c.

$(q_1, w_1\underline{a_1}u_1) \vdash_M (q_2, w_2\underline{a_2}u_2)$
$(a_1, a_2 \in \Sigma)$
if this is insertion at the font , $w_1 = e$ since insertion can be only done in front also $w_2 = e$. $u_2 = a_1u_1$ and a_2 is inserted at the front of te string.
if this is insertion at the back of the string , $u_1 = e, u_2 = e$. $w_2 = w_1a_1$ and a_2 is inserted in the string.
When insertion is done, length of the string increases 1.

$(q_1, w_1\underline{a_1}u_1) \vdash_M (q_2, w_2\underline{a_2}u_2)$
if this is delettion at the front of the string ,$w_1 = e, a_1$ is the character that will be deleted, $w_2 = e$ also.
$a_2u_2 = u_1$.
if this is deletion at the back of the string, $u_1 = e, u_2 = e, a_1$ is the character that will be deleted and $w_2a_2 = w_1$. $u_2 = e$ also.

d.

Insertion at the front of the string is equavalent in standart TM is shifting the string at right (opening a blank symbol atthe begining of the string) and writing on this nwely opened blanked symbol to the new character.
Aain , ,nsert at the back of the string is shifting left and writing a character at RHS of the string (since there can be a left end symbol,if shifting is not possible just before the bening of the string, only write the new char at the end is also equivalent to insertion opertion)

In deletion case, if deletion is happening at the front of the string(next to the left end symbol) ,make the unwanted symbol to a blank symbol and shift the string left. In deletion at the back , again make the unwanted symbol to a blank symbol but shifting is not necessary.

Answer 9

First prove that languages which are recursively enumerable are closed under concatenation.So , if L_1 and L_2 are recursively enumarable then L_1L_2 is also. Lets say there are two TMs that semidecides L_1 and L_2 , say M_1 and M_2.
$M_1 = (K_1, \Sigma, \delta_1, s_1, H_1)$ and $M_2 = (K_2, \Sigma, \delta_2, s_2, H_2)$.
We want to prove that there is a TM M=$(K, \Sigma, \delta, s, H)$ that semidecides L_1L_2.

This TM basically guess which part of the string belongs to L_1 and which part belongs to L_2 , it knows the split and when it finishes operations δ_1 on L_1 , it will nondeterministally continue with the L_2.

$K = K_1 \cup K_2$

$s = s_1$, $H = H_2$, and

$\delta = \delta_1 \cup \delta_2 \cup \{((h_1, \sigma), (s_2, \rightarrow))$

As a result, M is the turing machine to semidecides L_1L_2.