342 Assignment 3: NFA

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Total points: 30
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The formal definition of a NFA specifies the following:

1. Alphabet Σ
2. the set of states Q
3. the start state $S \in Q$
4. the accepting states $A \subseteq Q$
5. the transition table δ: a function from $Q \times \Sigma$ to $power(Q)$.
6. reject state: this is usually unspecified, but understood to be included; similar to a return statement at the end of a function.

For every problem in this assignment,

1. $\Sigma = \{a, b, c\}$
2. $Q = \{S_0, S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9\}$
3. Start state $= S_0$

If I am giving the NFA, I will give the accepting states A, and the transition table. If you are asked to give the DFA, you need to give A and the transition table.
For this assignment, give this as a table instead of a diagram. I will give an example in Q1.

NOTE: it is important that you draw and work with diagrams - just translate them when you submit. diagrams give you an insight into the machine that tables do not.

1. (10 points) Let M be the NFA with alphabet, set of states and start state as given above. The transition table of M is :

.	'a'	'b'	'c'
S_0	$\{S_0, S_1\}$	S_0	S_0
S_1	-	S_2	-
S_2	-	-	S_3
S_3	S_3	S_3	S_3
S_4	-	-	-
S_5	-	-	-
S_6	-	-	-
S_7	-	-	-
S_8	-	-	-
S_9	-	-	-

Accepting states $A = \{S_3\}$

For each of the following strings, give the trace (this is the sequence in which each element of the

(a) ϵ
$\{S_0\} \xrightarrow{\epsilon} \{S_0\}$

(b) 'abc'
$\{S_0\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{b} \{S_0, S_2\} \xrightarrow{c} \{S_0, S_3\}$

(c) 'aabcc'
$\{S_0\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{b} \{S_0, S_2\} \xrightarrow{c} \{S_0, S_3\} \xrightarrow{c} \{S_0, S_3\}$

(d) 'abcabc'
$\{S_0\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{b} \{S_0, S_2\} \xrightarrow{c} \{S_0, S_3\} \xrightarrow{a} \{S_0, S_1, S_3\} \xrightarrow{b} \{S_0, S_2, S_3\} \xrightarrow{c} \{S_0, S_3\}$

(e) 'aabbcc'
$\{S_0\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{a} \{S_0, S_1\} \xrightarrow{b} \{S_0, S_2\} \xrightarrow{b} \{S_0, S_2\} \xrightarrow{c} \{S_0, S_3\} \xrightarrow{c} \{S_0, S_3\}$

2. (3 points) What is the language of the NFA M from the previous question?, i.e., describe the set of strings accepted by it. Specifically,

   L(M) = {x || BLANK }

   What is :

   (a) there is at least one a, followed by at least one b, followed by at least one c in x

3. (3 points)(Extra credit) Rename the states to have meaningful names of NFA M from Q1

   Accepting states $A = \{\{a\}^*\{b\}^*\{c\}^*\}$

   $\{S_0\} = \{a, b, c\}^*$
   $\{S_1\} = \{a\}$
   $\{S_2\} = \{\{a\}^*\{b\}\}$
   $\{S_3\} = \{\{a\}^*\{b\}^*\{c\}^*\}$

4. (1+4+2+2+8) Construct a DFA for the NFA in Q1. Fill in the ??? in the following. When you are making the set of states, you may either give all possible states, and just not use the states that are never visited; or you may start constructing the DFA and list only the states that you are actually using.

DFA:

.	'a'	'b'	'c'
S_0	S_0S_1	S_0	S_0
S_0S_1	S_0S_1	S_0S_2	S_0
S_0S_2	S_0S_1	S_0	S_0S_3
S_0S_3	$S_0S_1S_3$	S_0S_3	S_0S_3
$S_0S_1S_3$	$S_0S_1S_3$	$S_0S_2S_3$	S_0S_3
$S_0S_2S_3$	$S_0S_1S_3$	S_0S_3	S_0S_3

(a) Alphabet: $\{a, b, c\}$

(b) Set of states: $\{S_0, S_0S_1, S_0S_2, S_0S_3, S_0S_1S_3, S_0S_2S_3\}$

(c) Start state: $\{S_0\}$

(d) Set of Accepting states: $\{S_0, S_0S_1, S_0S_2, S_0S_3, S_0S_1S_3, S_0S_2S_3\}$

(e) transition table: rows are the set of states you gave; columns are the alphabet; entries are from the set of states you gave

$\{S_0\} :\xrightarrow{a} \{S_0, S_1\}, \xrightarrow{b} \{S_0S_2\}, \xrightarrow{b,c} \{S_0\}$
$\{S_0S_1\} :\xrightarrow{b} \{S_0S_2\}, \xrightarrow{c} \{S_0\}, \xrightarrow{a} \{S_0S_1\}$
$\{S_0S_2\} :\xrightarrow{c} \{S_0S_3\}, \xrightarrow{a} \{S_0S_1\}$
$\{S_0S_3\} :\xrightarrow{a} \{S_0S_1S_3\}, \xrightarrow{b,c} \{S_0S_3\}$
$\{S_0S_1S_3\} :\xrightarrow{b} \{S_0S_2S_3\}, \xrightarrow{c} \{S_0S_3\}, \xrightarrow{a} \{S_0S_1S_3\}$
$\{S_0S_2S_3\} :\xrightarrow{b,c} \{S_0S_3\}, \xrightarrow{a} \{S_0S_1S_3\}$