I) Give a formal definition with any notations for the following: NFA, Language accepted by NFA

- NFA

Nondeterministic finite accepter where $M = (Q, \Sigma, \delta, q_0, F)$ where

Q = Set of states

Σ = Input alphabet

δ = Transition function

q_0 = Initial state

F = Final states

- Language accepted by NFA

An NFA accepts a string when all strings and input are consumed AND ending in a

final state. An NFA is rejected if all the input is consumed and it is not in the final

state or some input can not be consumed.

II) What are the three key differences between NFA and DFA.

- DFA: δ can only jump to one state

NFA: δ can jump to multiple states

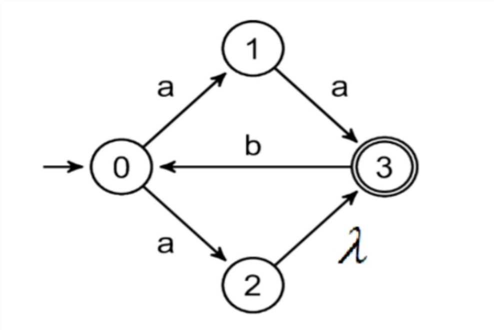
- DFA: Each transition has to take in a symbol

NFA: Each transition doesn't need to take in a symbol (λ transition)

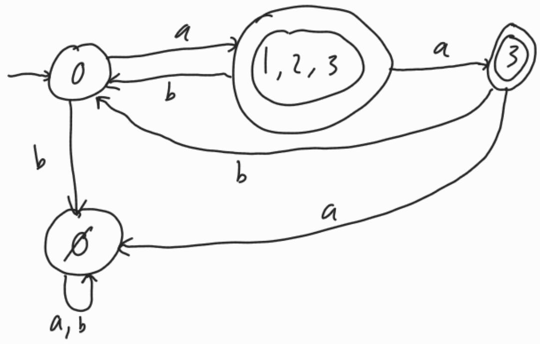
- DFA: Inputs are clearly defined and has a clear path for each transition

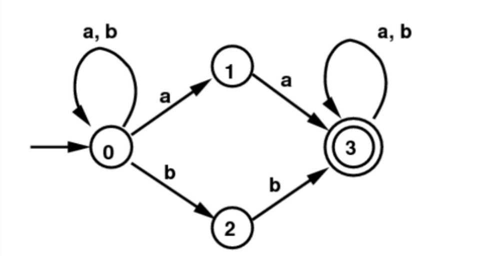
NFA: Inputs can lead to many states which leads to different paths for a transition

III) Convert the NFA to a DFA

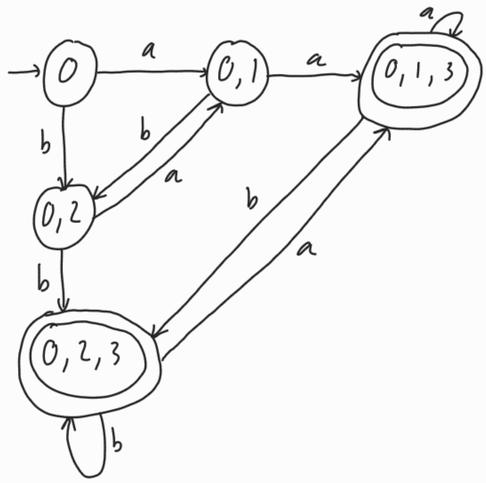


δ	a	b
0	1,2,3	∅
1,2,3	3	0
3	∅	0
∅	∅	∅

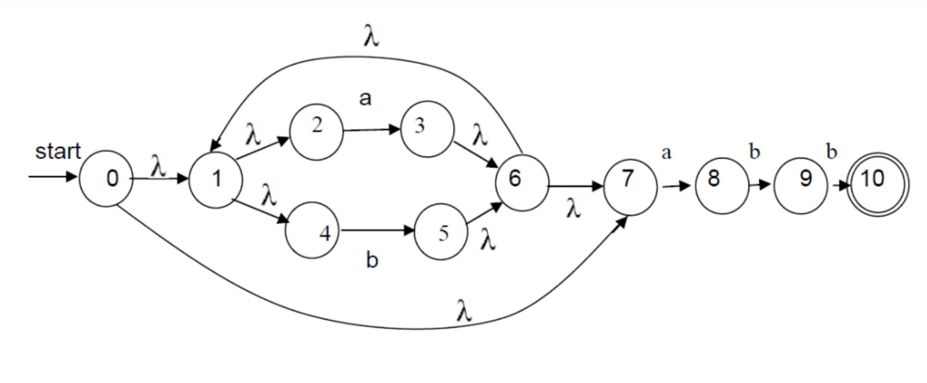




δ	a	b
0	0,1	0,2
0,1	0,1,3	0,2
0,2	0,1	0,2,3
0,1,3	0,1,3	0,2,3
0,2,3	0,1,3	0,2,3



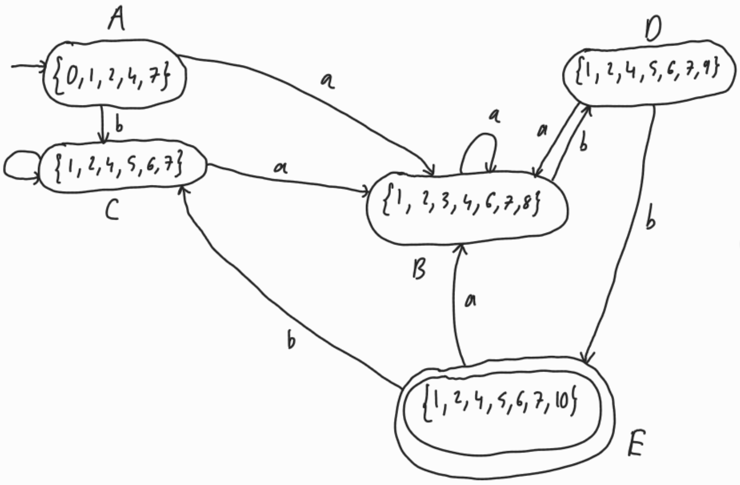
IV) Consider the NFA below



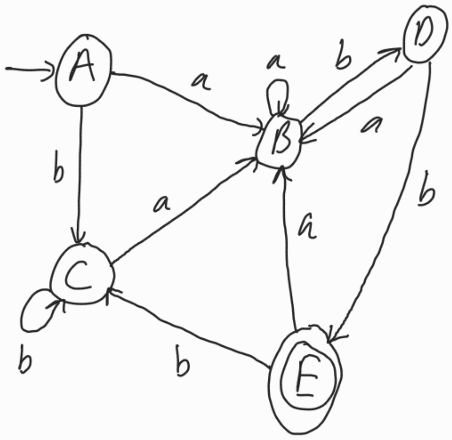
In the construction process while converting to a DFA, do not forget to account for the lambda transitions.

For example, the first step is to identify the initial state, say A = {0} is not correct as the lambda transitions enable the starting to be 1. You can make a transition from 0 to 1 on lambda without scanning any symbol. Similarly, you can transition to 2,3,7. So the starting state of the DFA = {0, 1, 2, 4, 7} The next step is to define transitions from A, say A to B on symbol a. Check that B ={1,2,3,4,6,7,8}

(i) Give a complete equivalent description of the DFA.



or



	a	b
A	B	C
B	B	D
C	B	C
D	B	E
E	B	C

$A = \{0,1,2,4,7\}$

$B = \{1,2,3,4,6,7,8\}$

$C = \{1,2,4,5,6,7\}$

$D = \{1,2,4,5,6,7,9\}$

$E = \{1,2,4,5,6,7,10\}$

(ii) Convert the above to a minimal DFA.

$P_0 = \{\{A,B,C,D\},\{E\}\}$

$\delta(A,a) = B \qquad \delta(D,a) = B$

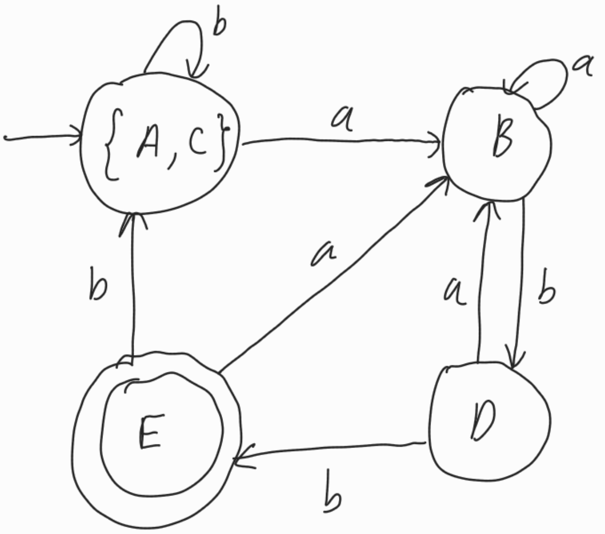
$\delta(A,b) = C \qquad \delta(D,b) = E$

$P_1 = \{\{A, B, C\}, \{D\}, \{E\}\}$

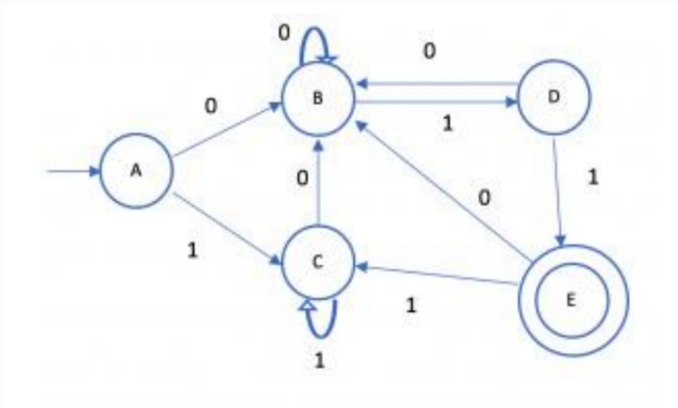
$\delta(A, a) = B \qquad \delta(B, a) = B \qquad \delta(C, a) = B$

$\delta(A, b) = C \qquad \delta(B, b) = D \qquad \delta(C, b) = C$

$P_2 = \{\{A, C\}, \{B\}, \{D\}, \{E\}\}$



V) Convert the following DFA to a minimal equivalent DFA



$P_0 = \{\{A, B, C, D\}, \{E\}\}$

$\delta(A, 0) = B \qquad \delta(D, 0) = B$

$\delta(A, 1) = C \qquad \delta(D, 1) = E$

$P_1 = \{\{A, B, C\}, \{D\}, \{E\}\}$

$\delta(A, 0) = B \qquad \delta(C, 0) = B$

$\delta(A, 1) = C \qquad \delta(C, 1) = C$

$\delta(B, 0) = B$

$\delta(B, 1) = D$

$P_2 = \{\{A, C\}, \{B\}, \{D\}, \{E\}\}$

$\delta(A, 0) = B \qquad \delta(C, 0) = B$

$\delta(A, 1) = C \qquad \delta(C, 1) = C$