NFA-to-DFA conversion

Slides from

http://web.cecs.pdx.edu/~harry/compilers/slides/LexicalPart3.pdf

Two ways to deal with an NFA

- Use the NFA directly
- Convert the NFA to an equivalent DFA first

Use NFA directly

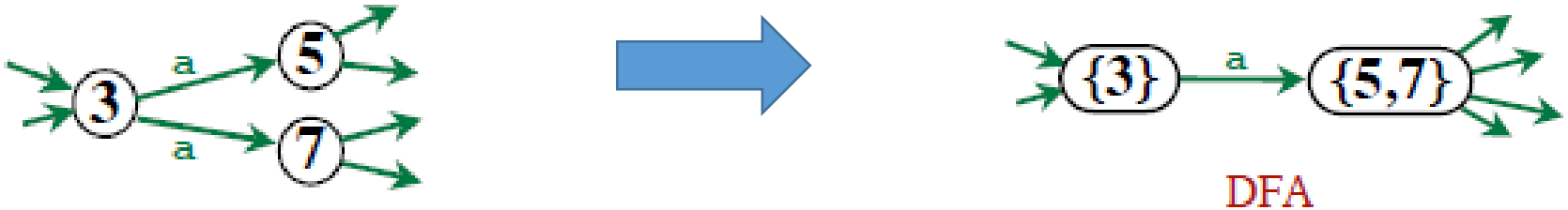
- Your code will keep track of “current search states”. Once you reach the end of the input symbol sequence, check one of the current search states is a final state.

- Note that you do not need to enumerate all possible paths explicitly. You just need to keep track of multiple current search states.

- The method is explained in Section 2.2.5 in Jurasfsky & Martin (2nd edition).

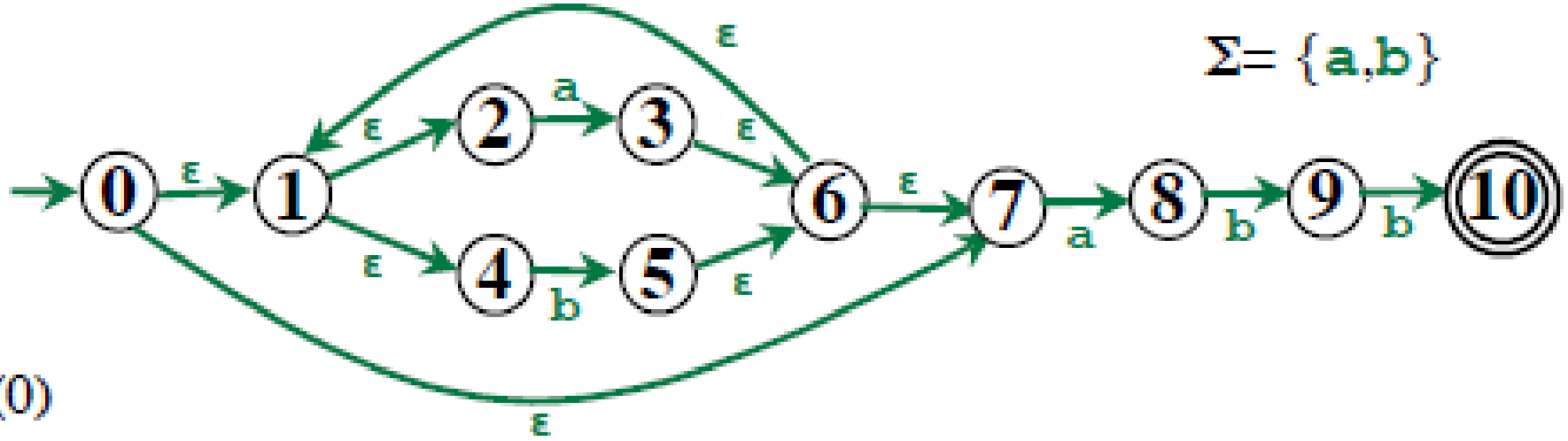
Converting an NFA to an equivalent DFA

- Input: an NFA
- Output: a DFA, which is equivalent
- Idea: Each state in the DFA corresponds to a set of NFA states



NFA DFA

Example



Start state:

ε-Closure (0)

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

$Move_{DFA}$(A,a)

= ε-Closure ($Move_{NFA}$(A,a))

= ε-Closure ({3,8})

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

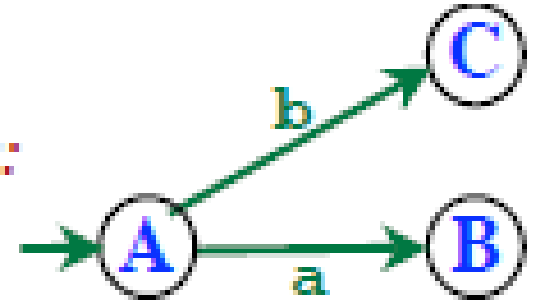
$Move_{DFA}$(A,b)

= ε-Closure ($Move_{NFA}$(A,b))

= ε-Closure ({5})

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

So far:

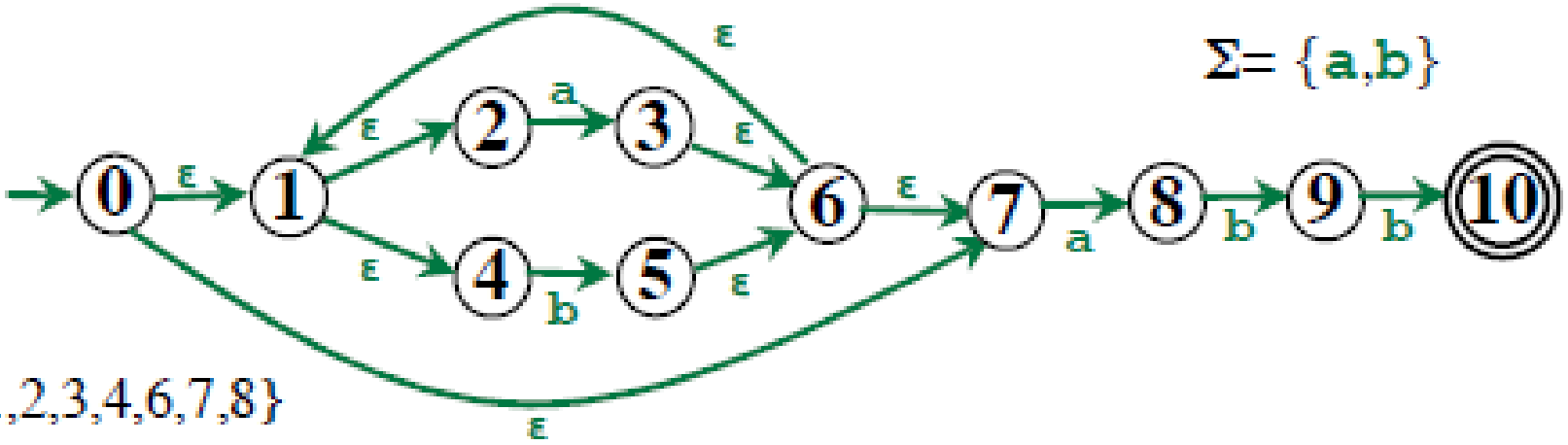


A is now done; mark it!

B and C are unmarked.

Let's do B next...

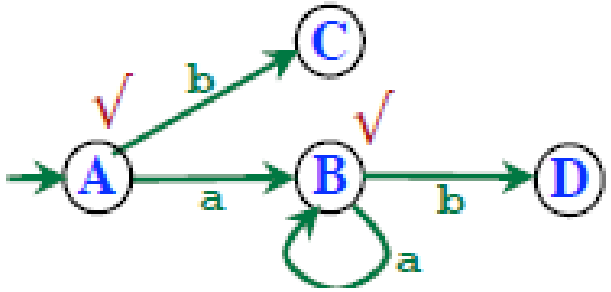
Example



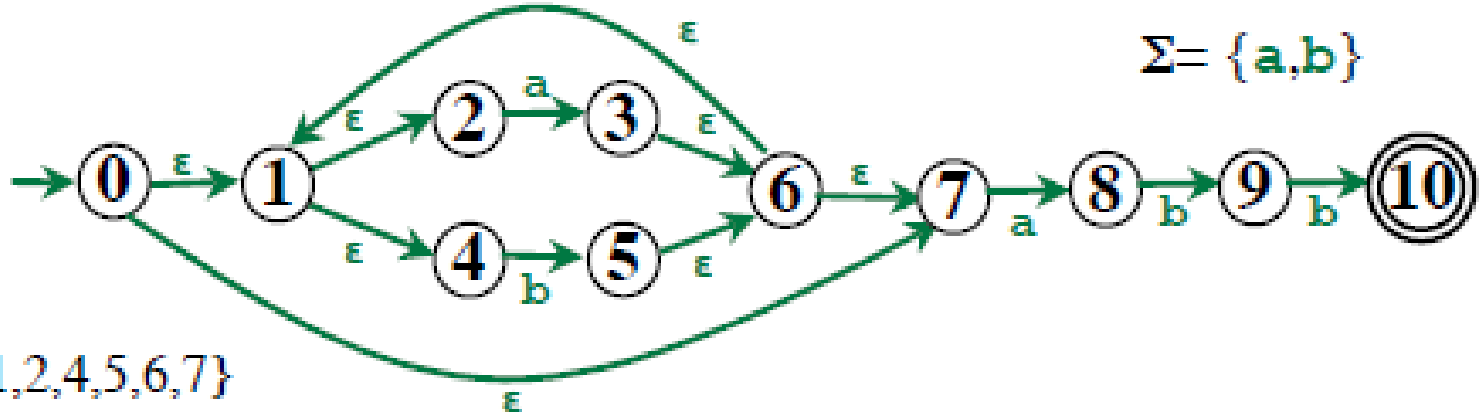
Process B = {1,2,3,4,6,7,8}

$Move_{DFA}(B,a)$
= ε-Closure ($Move_{NFA}(B,a)$)
= ε-Closure ({3,8})
= {1,2,3,4,6,7,8} = B

$Move_{DFA}(B,b)$
= ε-Closure ($Move_{NFA}(B,b)$)
= ε-Closure ({5,9})
= {1,2,4,5,6,7,9} = D



Example



Process C = {1,2,4,5,6,7}

$Move_{DFA}(C,a) = \{1,2,3,4,6,7,8\} = B$

$Move_{DFA}(C,b) = \{1,2,4,5,6,7\} = C$

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

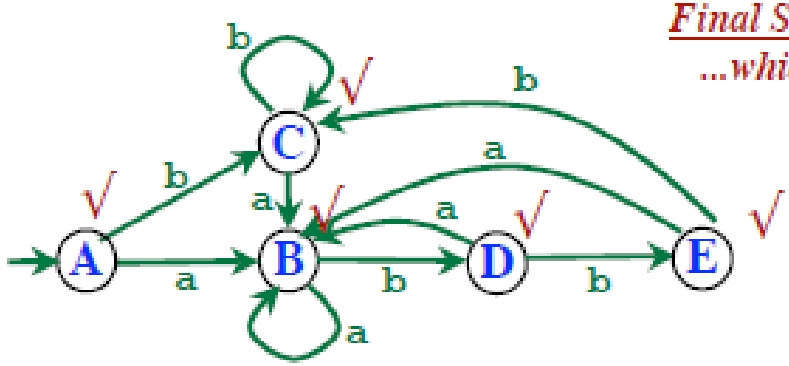
$Move_{DFA}(E,a) = \{1,2,3,4,6,7,8\} = B$

$Move_{DFA}(E,b) = \{1,2,4,5,6,7\} = C$

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

$Move_{DFA}(D,a) = \{1,2,3,4,6,7,8\} = B$

$Move_{DFA}(D,b) = \{1,2,4,5,6,7,10\} = E$



Final States in DFA?

...which state(s) contain 10?

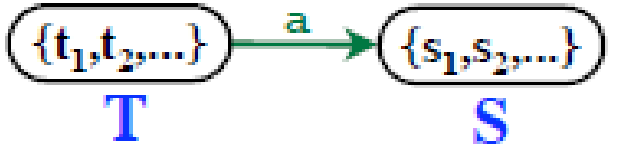
Algorithm: Convert NFA to DFA

```
S_DFA = {}
Add ε-Closure(s_0) to S_DFA as the start state
Set the only state in S_DFA to "unmarked"
while S_DFA contains an unmarked state do
  Let T be that unmarked state
  Mark T
  for each a in Σ do
    S = ε-Closure(Move_NFA(T,a))
    if S is not in S_DFA already then
      Add S to S_DFA (as an "unmarked" state)
    endIf
    Set Move_DFA(T,a) to S
  endFor
endWhile
for each S in S_DFA do
  if any s∈S is a final state in the NFA then
    Mark S an a final state in the DFA
  endIf
endFor
```

A set of NFA states

Everywhere you could possibly get to on an a

i.e, add an edge to the DFA...



More examples

- https://www.youtube.com/watch?v=U71roXRlNlg
- https://www.youtube.com/watch?v=--CSVsFIDng
- https://www.youtube.com/watch?v=WSGcmaHNBFM