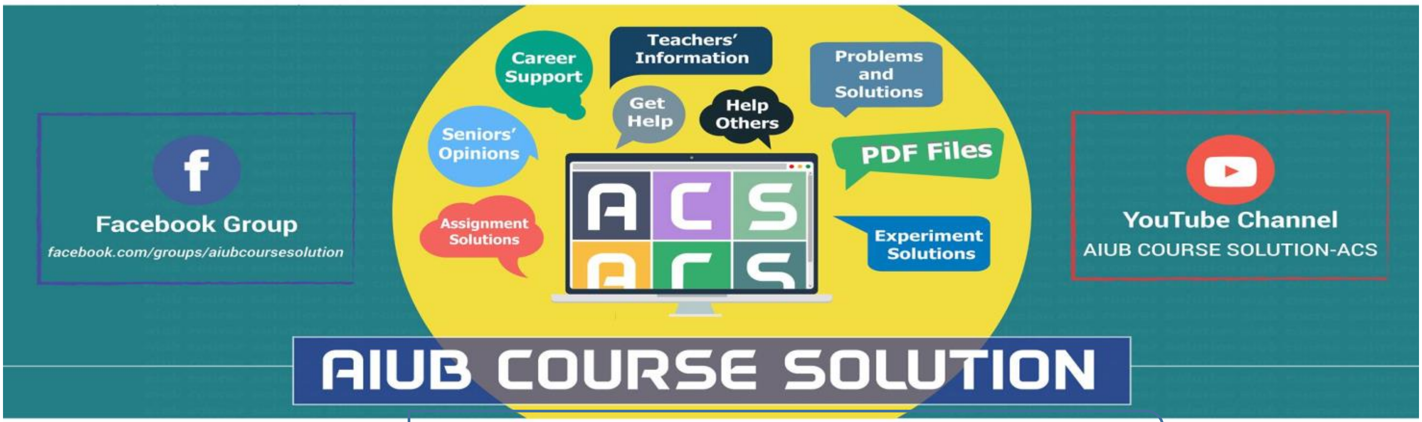


TOGETHER WE CAN ACHIEVE MORE

COURSE : COMPILER DESIGN

CHAPTER.. FINAL TERM HAND NOTE

SOLVED BY:

MURAD HASAN

AIUB COURSE SOLUTION-ACS

1

Convert NFA to DFA
subset construction algorithm

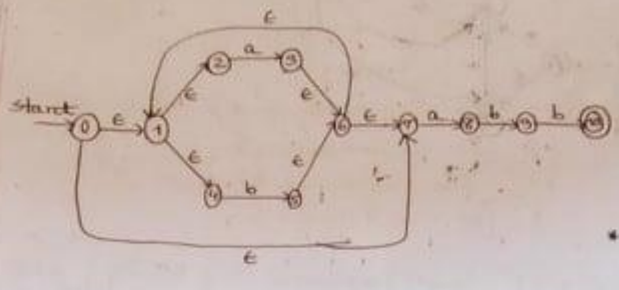


Fig: NFA

* T = Set of states
(a, b) = Input

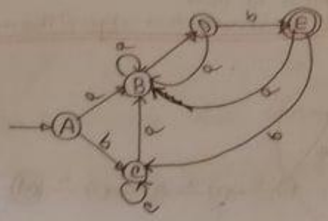
$\epsilon\text{-closure}(0) = \{1, 2, 4, 7, 0\} = A$

$$\epsilon\text{-}\cancel{\text{closure}}\ \text{Move}_{DFA}(A, a) = \epsilon\text{-closure}(\text{Move}_{NFA}(A, a))$$
$$= \epsilon\text{-closure}(\{3, 8\})$$
$$= \{3, 6, 7, 1, 2, 4, 8\}$$
$$= \{1, 2, 3, 4, 6, 7, 8\} = B$$

$$\cancel{\epsilon\text{-closure}}\ \text{Move}_{DFA}(A, b) = \epsilon\text{-closure}(\text{Move}_{NFA}(A, b))$$
$$= \epsilon\text{-closure}(\{5\})$$
$$= \{5, 6, 7, 1, 2, 4\}$$
$$= \{1, 2, 4, 5, 6, 7\} = C$$

(P.T.O)

2



~~ε-closure~~ $Move_{DFA}(B,a) = \epsilon\text{-closure}(Move_{NFA}(B,a))$
$= \epsilon\text{-closure}(\{3,8\})$
$= \{1,2,3,4,6,7,8\} = B$

~~ε-closure~~ $Move_{DFA}(B,b) = \epsilon\text{-closure}(Move_{NFA}(B,b))$
$= \epsilon\text{-closure}(\{5,9\})$
$= \{\{5,6,7,1,2,4\},9\}$
$= \{1,2,4,5,6,7,9\} = D$

~~ε-closure~~ $Move_{DFA}(C,a) = \epsilon\text{-closure}(Move_{NFA}(C,a))$
$= \epsilon\text{-closure}(\{3,8\})$
$= B$

~~ε-closure~~ $Move_{DFA}(C,b) = \epsilon\text{-closure}(Move_{NFA}(C,b))$
$= \epsilon\text{-closure}(\{5\})$
$= C$

3

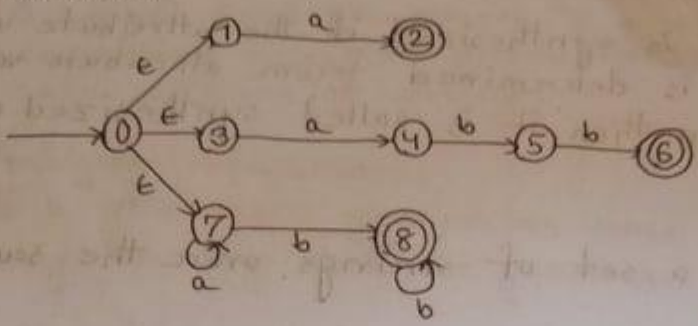
$$Move_{DFA}(D,a) = \epsilon\text{-closure}(Move_{NFA}(D,a))$$
$$= \epsilon\text{-closure}(\{3,8\})$$
$$= B$$

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

$$Move_{DFA}(E,a) = \epsilon\text{-closure}(Move_{NFA}(E,a))$$
$$= \epsilon\text{-closure}(\{3,8\})$$
$$= B$$

$$Move_{DFA}(E,b) = \epsilon\text{-closure}(Move_{NFA}(E,b))$$
$$= \epsilon\text{-closure}(\{5\})$$
$$= C$$

Question:

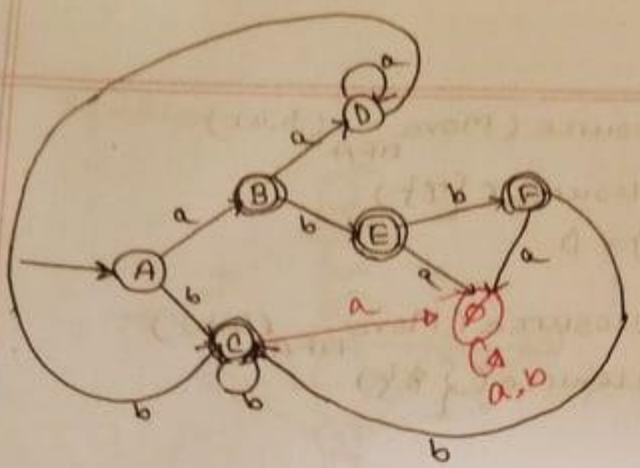


Solution:

$\epsilon\text{-closure}(0) = \{0, 1, 3, 7\} = A$

$$\epsilon\text{-Move}_{DFA}(A, a) = \epsilon\text{-closure}(\text{Move}_{NFA}(A, a))$$
$$= \epsilon\text{-closure}(\{2, 4, 7\})$$
$$= \{2, 4, 7\} = B$$

$$\epsilon\text{-Move}_{DFA}(A, b) = \epsilon\text{-closure}(\text{Move}_{NFA}(A, b))$$
$$= \epsilon\text{-closure}(\{8\})$$
$$= \{8\} = C$$



5

$$Move_{DFA}(B,a) = \epsilon\text{-closure}(Move_{NFA}(B,a))$$
$$= \epsilon\text{-closure}(\{7\})$$
$$= \{7\} = D$$

$$Move_{DFA}(B,b) = \epsilon\text{-closure}(Move_{NFA}(B,b))$$
$$= \epsilon\text{-closure}(\{5,8\})$$
$$= \{5,8\} = E$$

$$Move_{DFA}(C,a) = \epsilon\text{-closure}(Move_{NFA}(C,a))$$
$$= \epsilon\text{-closure}(\{\})$$
$$= \{\phi\} = \phi$$

$$Move_{DFA}(C,b) = \epsilon\text{-closure}(Move_{NFA}(C,b))$$
$$= \epsilon\text{-closure}(\{8\})$$
$$= \{8\} = C$$

6

$Move_{DFA}(D, a) = \epsilon\text{-closure}(Move_{NFA}(D, a))$
$= \epsilon\text{-closure}(\{7\})$
$= \{7\} = D$

$Move_{DFA}(D, b) = \epsilon\text{-closure}(Move_{NFA}(D, b))$
$= \epsilon\text{-closure}(\{8\})$
$= e$

$Move_{DFA}(E, a) = \epsilon\text{-closure}(Move_{NFA}(E, a))$
$= \epsilon\text{-closure}(\{\})$
$= \{\phi\}$

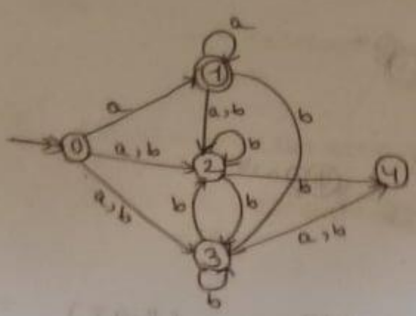
$Move_{DFA}(E, b) = \epsilon\text{-closure}(Move_{NFA}(E, b))$
$= \epsilon\text{-closure}(\{6, 8\})$
$= \{6, 8\} = F$

$Move_{DFA}(F, a) = \epsilon\text{-closure}(Move_{NFA}(F, a))$
$= \epsilon\text{-closure}(\{\})$
$= \{\phi\}$

$Move_{DFA}(F, b) = \epsilon\text{-closure}(Move_{NFA}(F, b))$
$= \epsilon\text{-closure}(\{8\})$
$= \{8\}$
$= e$

7

Question:



Solution:

$\epsilon\text{-closure}(0) = \{0\} = A$

$\epsilon\text{-Move}_{DFA}(A,a) = \epsilon\text{-closure}(\text{Move}_{NFA}(A,a))$

$= \epsilon\text{-closure}(\{1,2,3\})$

$= \{1,2,3\} = B$

$\epsilon\text{-Move}_{DFA}(A,b) = \epsilon\text{-closure}(\text{Move}(A,b))$

$= \epsilon\text{-closure}(\{2,3\})$

$= \{2,3\} = C$

$\epsilon\text{-Move}_{DFA}(B,a) = \epsilon\text{-closure}(\text{Move}_{NFA}(B,a))$

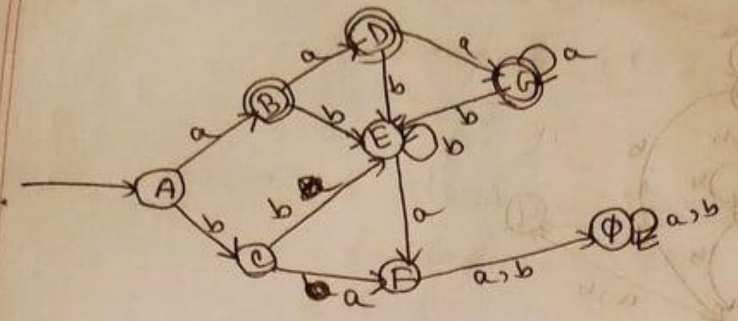
$= \epsilon\text{-closure}(\{1,2,4\})$

$= \{1,2,4\} = D$

$\epsilon\text{-Move}_{DFA}(B,b) = \epsilon\text{-closure}(\text{Move}_{NFA}(B,b))$

$= \epsilon\text{-closure}(\{2,3,4\}$

$= \{2,3,4\} = E$



$Move_{DFA}(C,a) = \epsilon\text{-closure}(Move_{NFA}(C,a))$

$= \epsilon\text{-closure}(\{3\})$

$= \{4\}\ F$

$Move_{DFA}(C,b) = \epsilon\text{-closure}(Move_{NFA}(C,b))$

$= \epsilon\text{-closure}(\{2,3,4\})$

$= E$

$Move_{DFA}(D,a) = \epsilon\text{-closure}(Move_{NFA}(D,a))$

$= \epsilon\text{-closure}(\{1,2\})$

$= \{1,2\} = G$

$Move_{DFA}(D,b) = \epsilon\text{-closure}(Move_{NFA}(D,b))$

$= \epsilon\text{-closure}(\{2,3,4\})$

$= E$

$\text{Move}_{DFA}(E,a) = \epsilon\text{-closure}(\text{Move}_{NFA}(E,a))$
$= \epsilon\text{-closure}(\{4\})$
$= F$

$\text{Move}_{DFA}(E,b) = \epsilon\text{-closure}(\text{Move}_{NFA}(E,b))$
$= \epsilon\text{-closure}(\{2,3,4\})$
$= E$

$\text{Move}_{DFA}(F,a) = \epsilon\text{-closure}(\text{Move}_{NFA}(F,a))$
$= \epsilon\text{-closure}(\{\})$
$= \{\phi\}$

$\text{Move}_{DFA}(F,b) = \epsilon\text{-closure}(\text{Move}_{NFA}(F,b))$
$= \epsilon\text{-closure}(\{\})$
$= \{\phi\}$

$\text{Move}_{DFA}(G,a) = \epsilon\text{-closure}(\text{Move}_{NFA}(G,a))$
$= \epsilon\text{-closure}(\{1,2\})$
$= G$

$\text{Move}_{DFA}(G,b) = \epsilon\text{-closure}(\text{Move}_{NFA}(G,b))$
$= \epsilon\text{-closure}(\{2,3,4\})$
$= E$

First set

Rules:

1. If x is terminal, then first (x) is $\{x\}$
2. If $x \to \epsilon$ is a production, then add ϵ to ~~first(x)~~ first(x)
3. If x is nonterminal and $X \to Y_1 Y_2 \cdots Y_K$ is a production, then place a in first (x) if for some i, a is in first (Y_i)

*

$E \to TE'$	$First(E) = \{ (, id \}$
$E' \to +TE' \mid \epsilon$	$First(E') = \{ +, \epsilon \}$
$T \to FT'$	$First(T) = \{ (, id \}$
$T' \to *FT' \mid \epsilon$	$First(T') = \{ *, \epsilon \}$
$F \to (E) \mid id$	$First(F) = \{ (, id \}$

10

Follow set

1. Place \$ in follow (S), where S is the start symbol and \$ is the input right endmaker
2. If there is a production $A \to \alpha B \beta$, then everything in first (β) except for ϵ is placed in follow (B)
3. If there is a production $A \to \alpha B$, or a production $A \to \alpha B \beta$ where first (β) contains ϵ (i.e. $\beta \overset{*}{\Rightarrow} \epsilon$), then everything in follow (A) is in follow (B)

ii) $A \to \alpha B \beta$ (follow(B) = first(β))

iii) $A \to \alpha B$ (follow(B) = follow(A))

11

Follow set

follow(E) = {\$,)}

follow(E') = {\$,)}

follow(T) = {+, \$,)}

follow(T') = {+, \$,)}

follow(F) = {*, +, \$,)}

$\alpha B \beta$

$E \to TE'$

$E \to TE'$
$E' \to +TE' \mid *T' \mid \epsilon$
$T \to FT' \mid /FT'$
$T' \to -\;FT' \mid \epsilon$
$F \to 1 \mid 2 \mid 3$

~~First (E) = {+}~~
~~First (E') = {+}~~
~~First~~

~~First (E) = {1, 2, 3, /}~~
~~First (E') = {+, *, ε}~~
~~First (T) = {+, *, ε}~~
~~First (T') = {*, ε, /, ε}~~
~~First (F) = {/, ε}~~

12

First (E) = {1, 2, 3, /}
First (E') = {+, *, ε}
First (T) = {1, 2, 3, /}
First (T') = {1, 2, 3, ε}
First (F) = {1, 2, 3}
Follow (E) = {\$}
Follow (E') = {\$}
Follow (T) = {+, *, \$}
Follow (T') = {+, *, \$}
Follow (F) = {1, 2, 3, +, *, \$}

2/11-1

$E \to TE'$
$E' \to +TE' \mid \epsilon$
$T \to *FT' \mid \epsilon$
$F \to (E) \mid id$

First (E) = { (, id }
First (E') = { +, ε }
First (T) = { (, id }
First (T') = { *, ε }
First (F) = { (, id }

Non Terminal	+	*	(	)	id
E			$E \to TE'$		$E \to TE'$
E'	$E' \to +TE'$			$E' \to \epsilon$	
T			$T \to FT'$		$T \to F$
T'	$T' \to \epsilon$	$T' \to *FT'$		$T' \to \epsilon$	
F			$F \to (E)$		$F \to$

$

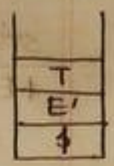
Follow (E) = {), $ }
Follow(E') = {), $ }
Follow(T) = { +, $,) }
Follow (T') = { +, $,) }
Follow(F) = { +, $,), * }

$E' \to \epsilon$
$T' \to \epsilon$

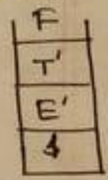
(id+id)*id

E→TE'

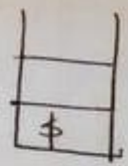
STACK	Input	Output
$E	→id+id$	
$E'T	id+id$	E→TE'
$E'T'F	id+id$	T→FT'
$E'T'id	id+id$	F→id
$E'T'	+id$	—
$E'	+id$	T'→ε
$E'T+	+id$	E'→+TE'
$E'T	id$	—
$E'T'F	id$	T→FT'
$E'T'id	id$	F→id
$E'T'	$	—
$E'	$	T'→ε
$	$	E'→ε



T→FT'



F→id



14

Algorithom: (buffer pairs)

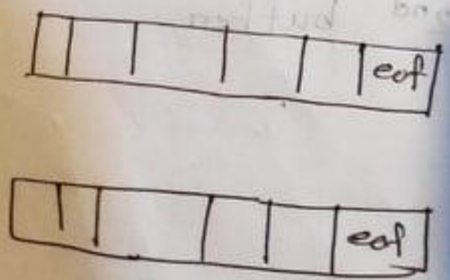
```
if forward at end of first half then
begin reload second half;
    forward := forward+1
end

else if forward at end of second half
then begin reload first half;
move forward to beginning of first half
end

else forward := forward+1
```

Fig: Code to advance forward pointer

Buffer pairs with sentinels



16

if fp=eof
fp=fp+1

akash10

2810

```
forward := forward+1;
if forward = eof then begin
if forward at end of first half then begin
   reload second half;
   forward := forward+1
end
else if forward at end of second half
then begin reload first half;
  more forward to beginning of first
  half
end
else /* eof within a buffer signifying end
   of input */
   terminate Lexical analysis
end
```

Fig: LooKahed code with sentinels.