Chapter 4
Syntax Analysis

What is Follow of Non-Terminal ?

Given the production rules:

S → aABb

A → c | ∈

B → d | ∈

First(S) = {a } **Follow(S)={$}**

First(A) = { c, ∈ } **Follow(A)={d, b}**

First(B) = { d, ∈ } **Follow(B)={b}**

Let's Derive 'ab'

S$
aABb$
aAb$
ab$

Let's Derive 'adb'

S$
aABb$
aAdb$
ab$

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Computing Follow(A) : All Non-Terminals

1. **Place $ in Follow(S), where S is the start symbol and $ signals end of input**
2. **If there is a production $A \rightarrow \alpha B \beta$, then everything in First(β) is in Follow(B) except for ∈.**
3. **If $A \rightarrow \alpha B$ is a production, or $A \rightarrow \alpha B \beta$ and $\beta \overset{*}{\Rightarrow} \in$ (First(β) contains ∈), then everything in Follow(A) is in Follow(B)**

Whatever followed A must follow B, since nothing follows B from the production rule.

S→AP	S$
A→cB	AP$
B→d | ϵ	cBP$
P→f	cBf$

S→AP	S$
A→cBQ	AP$
B→d | ϵ	cBQP$
P→f	cBP$
Q→ ϵ	cBf$

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Computing Follow : 1st Example

Recall:

S → i E t SS' | a

S' → eS | ∈

E → b

First(S) = { i, a }

First(S') = { e, ∈ }

First(E) = { b }

Follow(S) – Contains $, since S is start symbol

Since S → i E t SS' , put in First(S') – not ∈

Here S' ⇒ ∈

Since S' → eS, put 'e' in Follow(S')

So…. Follow(S) = { e, $ }

S$	S$
iEtSS'$	iEtS$
iEtSeS$	iEtS$

Follow(S') = Follow(S) HOW?

S$	S$
iEtSS'$	iEtSS'$
iEtiEtSS'S'$	iEtiEtSS'S'$
iEtiEtSS'eS$	iEtiEtSS'$

Follow(E) = { t }

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Example 2

Compute Follow for:

$E \rightarrow TE'$
$E' \rightarrow +\ TE' \mid \in$
$T \rightarrow FT'$
$T' \rightarrow *\ FT' \mid \in$
$F \rightarrow (\ E\ ) \mid id$

	First
E	(id
E'	∈ +
T	(id
T'	∈ *
F	(id

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Example 2

Compute Follow for:

$E \rightarrow TE'$
$E' \rightarrow +\ TE' \mid \in$
$T \rightarrow FT'$
$T' \rightarrow *\ FT' \mid \in$
$F \rightarrow (\ E\ ) \mid id$

Follow (E) → {),$ }

Follow(E') → Follow(E) → {), $}

	First
E	(id
E'	∈ +
T	(id
T'	∈ *
F	(id

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Example 2

Compute Follow for:

E → TE'
E' → + TE' | ∈
T → FT'
T' → * FT' | ∈
F → (E) | id

Follow (E) → {),$ }

Follow(E') → Follow(E) → {), $}

Follow(T) → First (E') → {+, ϵ }
Follow(T) → {+, ϵ}-{ϵ} U Follow(E)
→ {+ ,), $}

Follow(T')→ Follow(T) → {+,), $}

E$
TE'$
T+TE'$

E$
TE'$
FT'E'$
(E)T'E'$
(TE')T'E'$
(T)T'E'$

	First
E	(id
E'	∈ +
T	(id
T'	∈ *
F	(id

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Example 2

Compute Follow for:

E → TE'
E' → + TE' | ∈
T → FT'
T' → * FT' | ∈
F → (E) | id

	First
E	(id
E'	∈ +
T	(id
T'	∈ *
F	(id

Follow (E) → {),$ }
Follow(E') → Follow(E) → {), $}

Follow(T) → First (E') → {+, ϵ }
Follow(T) → {+, ϵ}-{ϵ} U Follow(E)
→ {+ ,), $}
Follow(T')→ Follow(T) → {+,), $}

Follow(F) → First(T') →{*,ϵ}
Follow(F)→ {*, ϵ}-{ϵ} U Follow(T)
→ {*, +,),$}

E$
TE'$
FT'E'$
F*FT'E'$
F*FE'$
F*F+TE'$

E$
TE'$
FT'E'$
(E)T'E'$
(TE')T'E'$
(FT'E')T'E'$
(F)T'E'$

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Example 3

E → T X
X → + E
X → ε
T → int Y
T → (E)
Y → * T
Y → ε

Symbol	First
(	(
)	)
+	+
*	*
int	int
Y	ε, *
X	ε, +
T	int, (
E	int, (

Example 3

E → T X
X → + E
X → ε
T → int Y
T → (E)
Y → * T
Y → ε

Symbol	First	Follow
(	(	N/A
)	)	
+	+	
*	*	
int	int	
Y	ε, *	), $, +
X	ε, +	), $
T	int, (	), $, +
E	int, (	), $

Example 4

1. $S \rightarrow A\ a$
2. $A \rightarrow B\ D$
3. $B \rightarrow b$
4. $B \rightarrow \epsilon$
5. $D \rightarrow d$
6. $D \rightarrow \epsilon$

$First(S) = \{b, d, a\}$
$First(A) = \{b, d, \epsilon\}$
$First(B) = \{b, \epsilon\}$
$First(D) = \{d, \epsilon\}$

Example 4

1. $S \rightarrow A\ a$
2. $A \rightarrow B\ D$
3. $B \rightarrow b$
4. $B \rightarrow \epsilon$
5. $D \rightarrow d$
6. $D \rightarrow \epsilon$

$Follow(S) = \{\$\}$
$Follow(A) = \{a\}$
$Follow(B) = \{d, a\}$
$Follow(D) = \{a\}$

$First(S) = \{b, d, a\}$
$First(A) = \{b, d, \epsilon\}$
$First(B) = \{b, \epsilon\}$
$First(D) = \{d, \epsilon\}$

Example 5

1. C → P F class id X Y
2. P → public
3. P → ϵ
4. F → final
5. F → ϵ
6. X → extends id
7. X → ϵ
8. Y → implements I
9. Y → ϵ
10. I → id J
11. J → , I
12. J → ϵ

First(C) = {public, final, class}
First(P) = {public, ϵ}
First(F) = {final, ϵ}
First(X) = {extends, ϵ}
First(Y) = {implements, ϵ}
First(I) = {id}
First(J) = {',', ϵ}

Example 5

1. C → P F class id X Y
2. P → public
3. P → ϵ
4. F → final
5. F → ϵ
6. X → extends id
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8. Y → implements I
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First(C) = {public, final, class}
First(P) = {public, ϵ}
First(F) = {final, ϵ}
First(X) = {extends, ϵ}
First(Y) = {implements, ϵ}
First(I) = {id}
First(J) = {',', ϵ}

Follow(C) = {$}
Follow(P) = {final, class}
Follow(F) = {class}
Follow(X) = {implements, $}
Follow(Y) = {$}
Follow(I) = {$}
Follow(J) = {$}

Example - 6

S→ ABC| CbB| Ba
A→ da | BC
B→ g | ϵ
C→ h | ϵ

First(S)→ {a, b, d, g, h, ϵ}
First(A) →{d, g, h, ϵ}
First(B) = {g, ϵ}
First(C) = {h, ϵ}

Example - 6

S→ ABC| CbB| Ba
A→ da | BC
B→ g | ϵ
C→ h | ϵ

First(S)→ {a, b, d, g, h, ϵ}
First(A) →{d, g, h, ϵ}
First(B) = {g, ϵ}
First(C) = {h, ϵ}

Follow(S) → {$}
Follow(A)→{g, h, $}
Follow(B) → {a, g, h, $}
Follow (C) → {b, g, h, $}