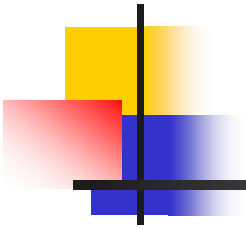
CSC 3201 Compiler Construction

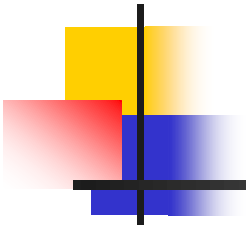
Department of Computer Science
SZABIST (Islamabad Campus)

Week 6 (Lecture 1)



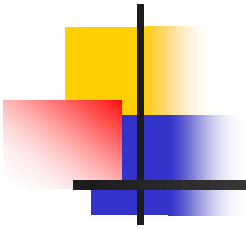
First

- First(α) is a set of terminal symbols that begin in strings derived from α.
- Example:
  - A → abc | def | ghi
  - First(A) = {a,d,g}



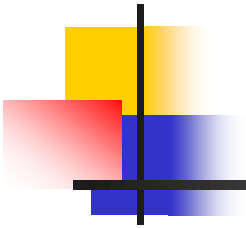
First

- Rules:
  - For a production rule $X \rightarrow \varepsilon$, First(X) = { ε }
  - For any terminal symbol ‘a’, First(a) = { a }
  - For a production rule $X \rightarrow Y1Y2Y3$, Calculating First(X)
    - If $\varepsilon \notin$ First(Y1), then First(X) = First(Y1)
    - If $\varepsilon \in$ First(Y1), then First(X) = { First(Y1) – ε } $\cup$ First(Y2Y3), Calculating First(Y2Y3)
      - If $\varepsilon \notin$ First(Y2), then First(Y2Y3) = First(Y2)
      - If $\varepsilon \in$ First(Y2), then First(Y2Y3) = { First(Y2) – ε } $\cup$ First(Y3)



Follow

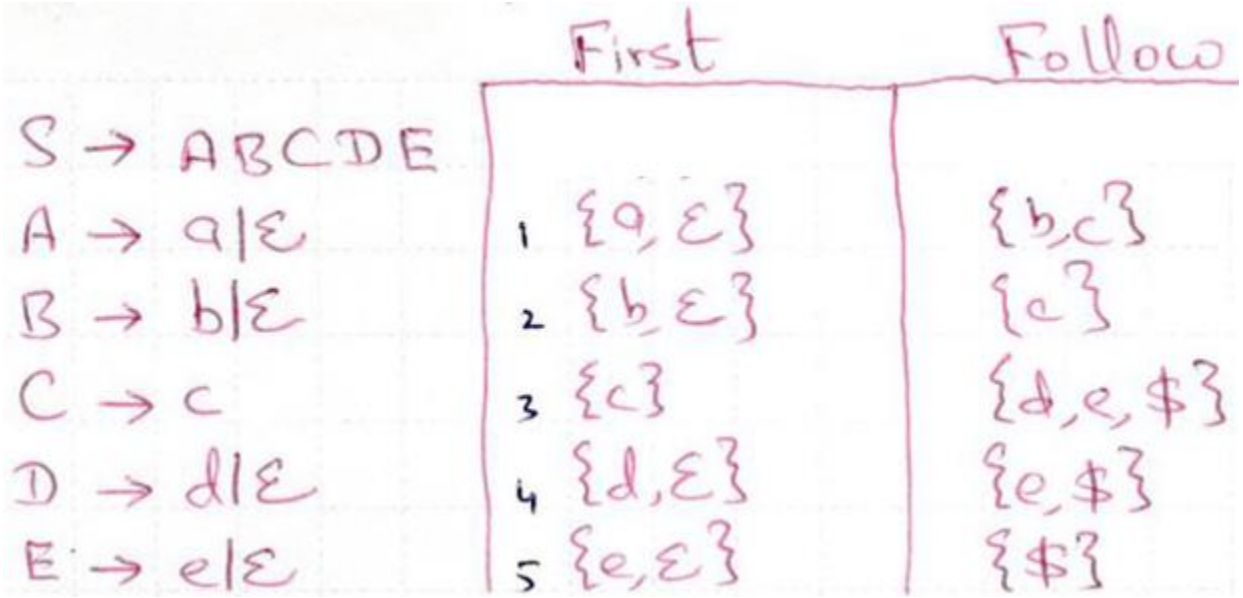
- Follow(α) is a set of terminal symbols that appear immediately to the right of α.
- Rules:
  - For the start symbol S, place $ in Follow(S)
  - For any production rule A → αB, Follow(B) = Follow(A)
  - For any production rule A → αBβ,
    - If ε ∉ First(β), then Follow(B) = First(β)
    - If ε ε First(β), then Follow(B) = { First(β) – ε } ∪ Follow(A)



First and Follow

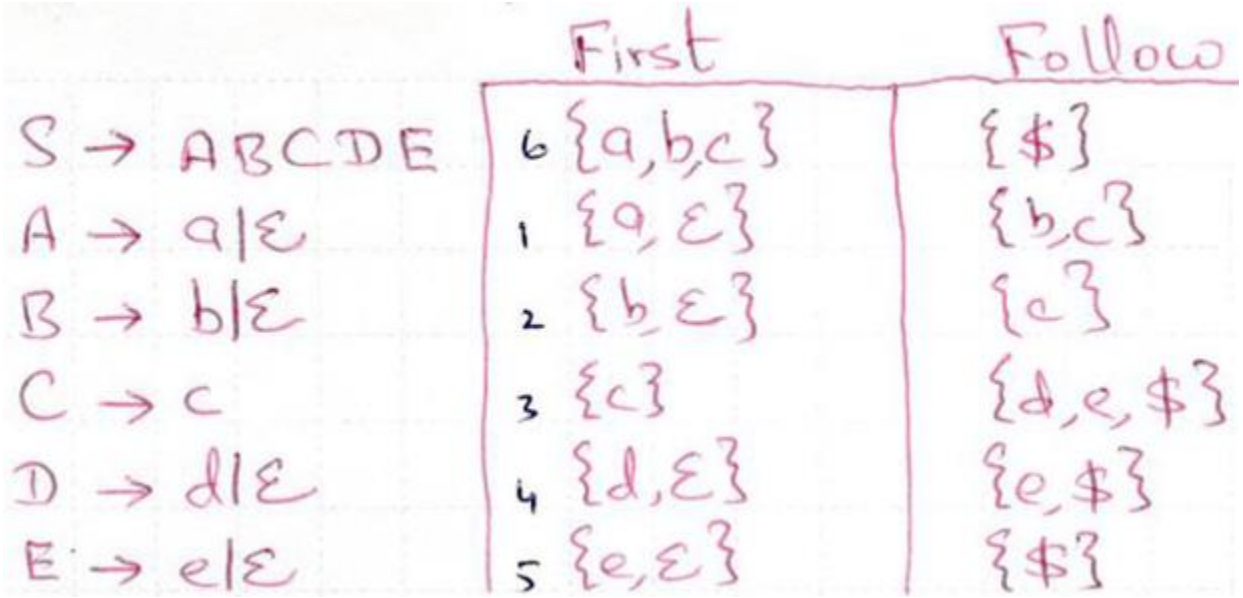
- Note:
  - ε may appear in the first function of an NT.
  - ε will never appear in the follow function of an NT.
  - Before calculating the first and follow functions, eliminate Left Recursion from the grammar.
  - Calculate the follow function of an NT by looking where it is present on the RHS of a production rule.

First and Follow

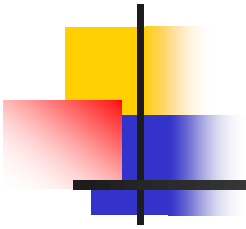


- Follow(RHS) = Follow(LHS)
- Look at the occurrence on rHS in all productions.

First and Follow



- S is not in the RHS of any production



First and Follow

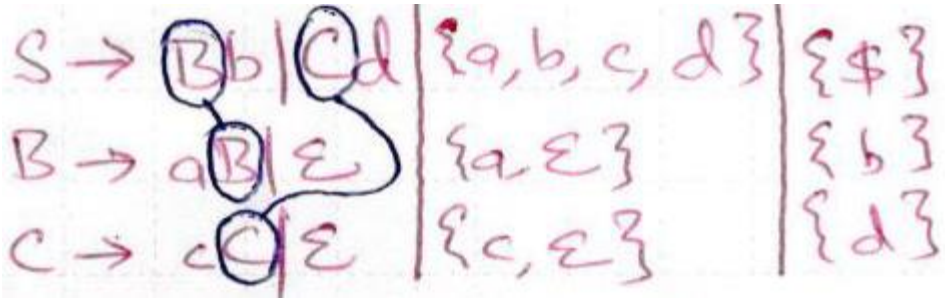
- Example 2:

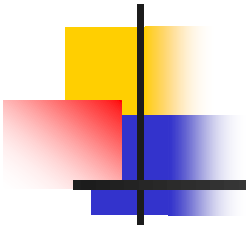
S → Bb | Cd

B → aB | ε

C → cC | ε

First and Follow





First and Follow

- Example 3:

S → aBDh

B → cC

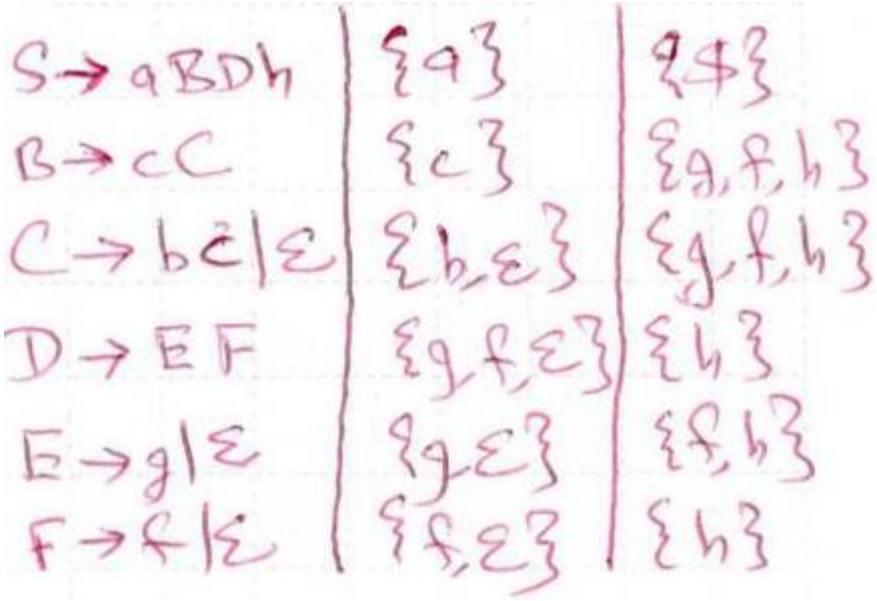
C → bc | ε

D → EF

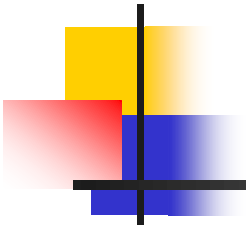
E → g | ε

F → f | ε

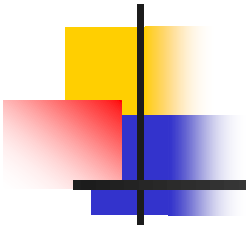
First and Follow



First and Follow

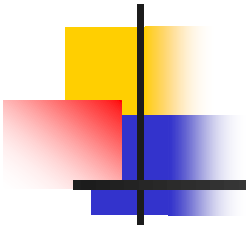


- First(S) = {a}
- First(B) = {c}
- First(C) = {b,ε}
- First(D) = { First(E) – ε } ∪ First(F) = {g,f,ε}
- First(E) = { g , ε }
- First(F) = { f , ε }



First and Follow

- Follow(S) = { $ }
- Follow(B) = { First(D) – ε } ∪ First(h) = { g , f , h }
- Follow(C) = Follow(B) = { g , f , h }
- Follow(D) = First(h) = { h }
- Follow(E) = { First(F) – ε } ∪ Follow(D) = { f , h }
- Follow(F) = Follow(D) = { h }



First and Follow

- Example 4:

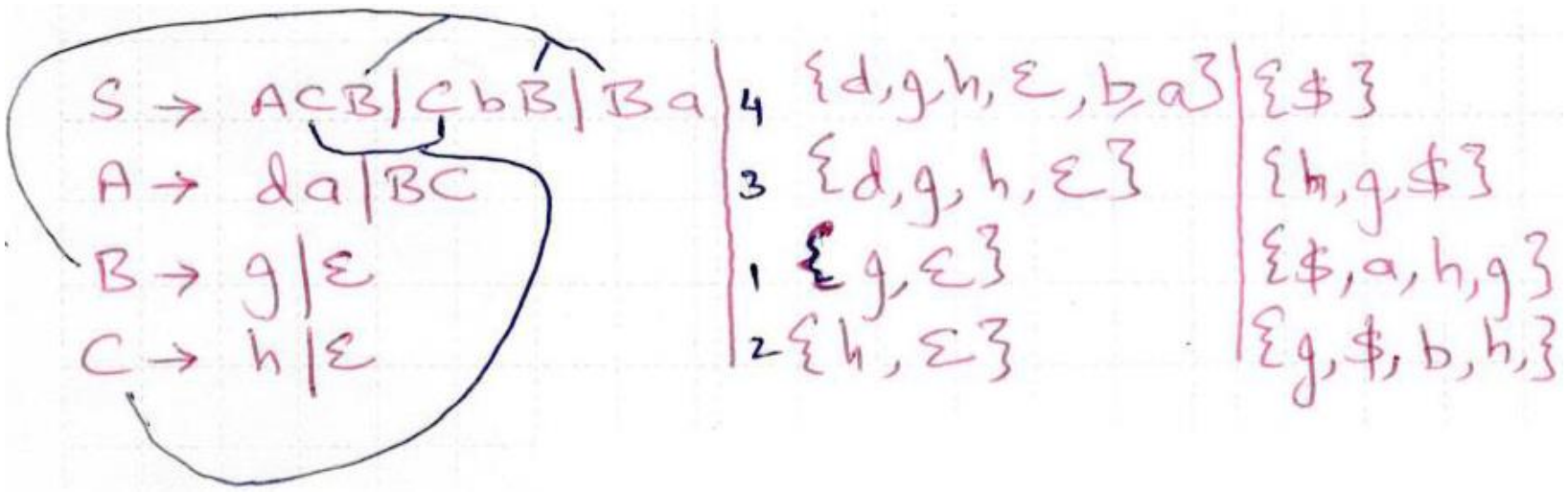
S → ACB | CbB | Ba

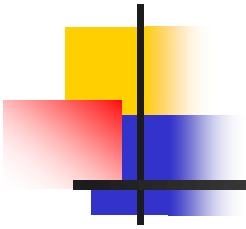
A → da | BC

B → g | ε

C → h | ε

First and Follow





First and Follow

- Example 5:

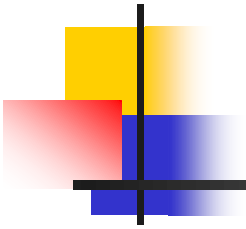
S → aABb

A → c | ε

B → d | ε

First and Follow

$S \rightarrow aABb$	$\{a\}$	$\{\$\}$
$A \rightarrow c \mid \varepsilon$	$\{c, \varepsilon\}$	$\{d, b\}$
$B \rightarrow d \mid \varepsilon$	$\{d, \varepsilon\}$	$\{b\}$



First and Follow

- Example 6:

```
S → A
A → aB / Ad
B → b
C → g
```

First and Follow

- Left recursion eliminated :

S → A

A → aBA′

A′ → dA′ / ε

B → b

C → g

First and Follow

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

First and Follow

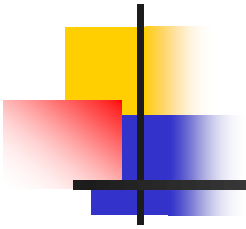
Follow(S) = { $ }

Follow(A) = Follow(S) = { $ }

Follow(A') = Follow(A) = { $ }

Follow(B) = { First(A') – ε } ∪
Follow(A) = { d , $ }

Follow(C) = NA



First and Follow

- Example 7:

S → (L) / a

L → SL′

L′ → ,SL′ / ε

First and Follow

First(S) = { (, a }

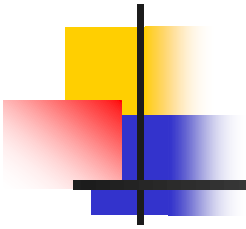
First(L) = First(S) = { (, a }

First(L′) = { , , ε }

Follow(S) = { $ } ∪
{First(L′) – ε} ∪ Follow(L)
∪ Follow(L′)={$,,,)}

Follow(L) = {) }

Follow(L′) = Follow(L) = {) }



First and Follow

- Example 8:

S → AaAb | BbBa

A → ε

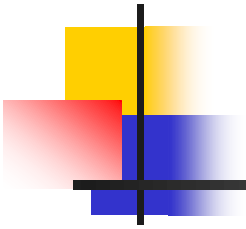
B → ε

First and Follow

First(S) = { First(A) – ε } ∪
First(a) ∪
{ First(B) – ε } ∪
First(b) = { a , b }

First(A) = { ε }

First(B) = { ε }



First and Follow

Follow(S)={ $ }

Follow(A)=First(a) ∪ First(b)={a,b}

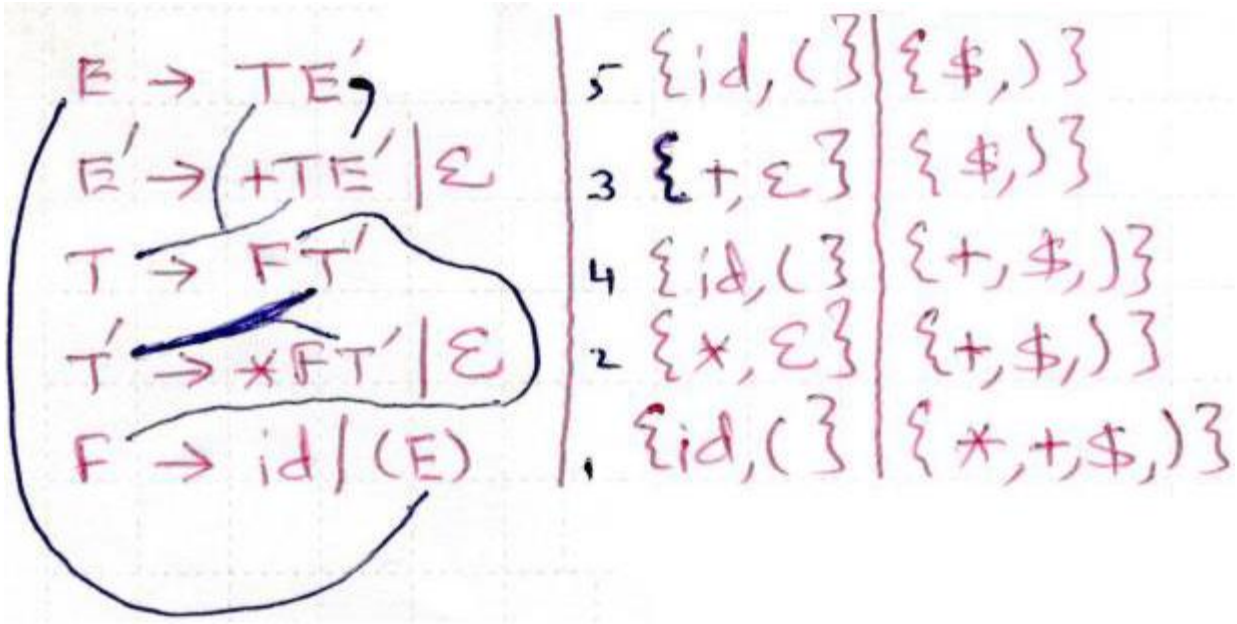
Follow(B)=First(b) ∪ First(a)={a,b}

First and Follow

- Example 9:

```
E  → TE′
E′ → +TE′ | ε
T  → FT′
T′ → *FT′ | ε
F  → id | (E)
```

First and Follow



- In P#1, Follow(E') contains Follow(E) too !!!