LINGUAGGI FORMALI E COMPILATORI AA08/09 – UNIVERSITÀ DELLA CALABRIA
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Esercitazione

VI

GRAMMATICHE LL(1)

1. Calcolare FIRST e FOLLOW dei simboli non terminali della seguente grammatica:

    P→begin L end
    L→ST
    T→ST | ε
    S→id := E; | read (id) ; | write (E) ;
    E →FG
    G→+ FG | ε
    F→(E) | id

2. Calcolare FIRST e FOLLOW dei simboli non terminali della seguente grammatica:

    S → B
    B → [B → B; B] | TB'
    B'→ ∨ B | ε
    T → F T'
    T' → ∧ T | ε
    F → t | f | (B)

3. Calcolare FIRST e FOLLOW dei simboli non terminali della seguente grammatica:

    S → ABC | AE | DCH
    A → aAd | aHd | aLd
    B → bBf | ε
    C → aCu | hGd
    D → Dg | ε
    E → szE | sLtBd
    F → sFu | zEz
    G → sBa | sF
    H → Hg | z
    L → Lg | b

4. Sia data la seguente grammatica:

    S -> a A c S | c
    R -> k C k | h C
    A -> c P e | A e c
    X -> X c | c a
    P -> c X | c H c
    C -> i A V | R

H -> H a | ε
V -> V e | V A V | ε

Calcolare i FIRST e i FOLLOW.

5. Sia data la seguente grammatica:

S -> h A b S | c
D -> g E | g H d
A -> b D D e | D f
E -> E t | w
B -> C k | h
H -> H w H | H H w | i
C -> i A D | B
Z -> D Z | E

Calcolare i FIRST e i FOLLOW

SOLUZIONI

1.
   FIRST (S) = { id, read, write }
   FIRST (F) = { (, id }
   FIRST (G) = { +, ε }
   FIRST (T) = { id, read, write, ε }
   FIRST (E) = { (, id }
   FIRST (L) = { id, read, write }
   FIRST (P) = { begin }

   FOLLOW (P) = { $ }
   FOLLOW (L) = { end }
   FOLLOW (E) = { ; ,) }
   FOLLOW (T) = { end }
   FOLLOW (G) = { ; ,) }
   FOLLOW (S) = { id, read, write, end }
   FOLLOW (F) = { + , ; ,) }

2.
   S → B
   B → [B → B; B] | TB'
   B' → ∨ B | ε
   T → F T'
   T' → ∧ T | ε
   F → t | f | (B)

   FIRST (S) = FIRST (B) = { t, f, (, [}
   FIRST (B) = FIRST (T) U { [} = { t, f, (, [}
   FIRST (B') = { ∨ , ε }
   FIRST (T) = FIRST (F) = { t, f, (}
   FIRST (T') = { ∧ , ε }
   FIRST (F) = { t, f, (}

   FOLLOW (S) = { $ }
   FOLLOW (B) = { →, ;,],) } U FOLLOW (B') U FOLLOW(S) = { →, ;,],), $ }
   FOLLOW (B') = FOLLOW (B) = { →, ;,],), $ }
   FOLLOW (T) = FIRST (B') U FOLLOW (T') = { ∨ } U FOLLOW (B) = { ∨ , →, ;,],), $ }
   FOLLOW (T') = FOLLOW (T) = { ∨, →, ;,],), $ }
   FOLLOW (F) = FIRST (T') = { ∧ } U FOLLOW (T) = { ∧, ∨, →, ;,],), $ }

3.

    S → ABC | AE | DCH
    A → aAd | aHd | aLd
    B → bBf | ε
    C → aCu | hGd
    D → Dg | ε
    E → szE | sLtBd
    F → sFu | zEz
    G → sBa | sF
    H → Hg | z
    L → Lg | b

Eliminiamo la ricorsione sinistra:

    S → ABC | AE | DCH
    A → aAd | aHd | aLd
    B → bBf | ε
    C → aCu | hGd
    D → gD | ε
    E → szE | sLtBd
    F → sFu | zEz
    G → sBa | sF
    H → zH'
    H'→ gH' | ε
    L → bL'
    L' → gL' | ε

Fattorizziamo:

    S → AS' | DCH
    S' → BC | E
    A → aA'
    A' → Ad | Hd | Ld
    B → bBf | ε
    C → aCu | hGd
    D → gD | ε
    E → sE'
    E' → zE | LtBd
    F → sFu | zEz
    G → sG'
    G'→ Ba | F
    H → zH'
    H'→ gH' | ε
    L → bL'
    L' → gL' | ε

FIRST(S) = FIRST(A) U FIRST(D) = { a, g } U FIRST(C) = { a, g, h }
FIRST(S') = FIRST(B) U FIRST(E) = { b, s } U FIRST(C) = { b, a, h, s }
FIRST(A) = { a }
FIRST(A') = FIRST(A) U FIRST(H) U FIRST(L) = { a, z, b }
FIRST(B) = { b, ε }
FIRST(C) = { a, h }
FIRST(D) = { g , ε}
FIRST(E) = { s }
FIRST(E') = {z} U FIRST (L) = { z, b }
FIRST(F) = { s, z }
FIRST(G) = { s }
FIRST(G') = FIRST(B) U FIRST(F) = { a, b, s, z }
FIRST(H) = { z }
FIRST(H') = { g, ε }
FIRST(L) = { b }
FIRST(L') = { g, ε }

FOLLOW(S) = { $ }
FOLLOW(S') = { $ }
FOLLOW (A) = { d } U FIRST(S') = { a, b, d, h, s }
FOLLOW(A') = FOLLOW(A) = { a, b, d, h, s }
FOLLOW(B) = FIRST(C) U { f, d, a } = { a, h, d, f }
FOLLOW(C) = FIRST(H) U FOLLOW(S') U { u } = { $, z, u }
FOLLOW(D) = FIRST(C) = { a, h }
FOLLOW(E) = FOLLOW(S') U FOLLOW(E') U { z } = { $, z }
FOLLOW(E') = FOLLOW(E) = { $, z }
FOLLOW(F) = { u } U FOLLOW(G') = { u, d }
FOLLOW(G) = { d }
FOLLOW(G') = FOLLOW(G) = { d }
FOLLOW(H) = FOLLOW(S) u { d } = { $, d }
FOLLOW(H') = FOLLOW(H) = { $, d }
FOLLOW(L) = { d, t }
FOLLOW(L') = { d, t }

4. Eliminiamo la ricorsione sinistra

S → a A c S | c
A → c P e A'
A' → e c A' | ε
P → c X | c H c
H → H'
H' → a H' | ε
R → k C k | h C
X → c a X'
X' → c X' | ε
C → i A V | R
V → V'
V' → eV' | A V V' | ε

Fattorizziamo

S → a A c S | c
A → c P e A'
A' → e c A' | ε
P → c P'
P' → X | H c
H → H'
H' → a H' | ε
R → k C k | h C
X → c a X'
X' → c X' | ε
C → i A V | R
V → V'
V' → eV' | A V V' | ε

FIRST(S) = { a, c }
FIRST(A) = { c }
FIRST(A') = { e, ε}
FIRST(P) = { c }
FIRST(P') = FIRST(X) U FIRST(H) = { a, c }
FIRST(H) = FIRST(H') = { a, ε }
FIRST(H') = { a, ε }
FIRST(R) = { k, h }
FIRST(X) = { c }
FIRST(X') = { c, ε }
FIRST(C) = { i } U FIRST(R) = { i, h, k }
FIRST(V) = FIRST(V') = { e, c, ε }
FIRST(V') = { e, ε } U FIRST(A) = { e, c, ε }

FOLLOW(S) = { $ }
FOLLOW(A) = { c } U FIRST(V) = { c, e } U FOLLOW (C) U FIRST(V') = { c, e } U
            FOLLOW(C) U FOLLOW(V') = { c, e, k }
FOLLOW(A') = FOLLOW (A) = { c, e, k}
FOLLOW(P) = { e }
FOLLOW(P') = FOLLOW (P) = { e }
FOLLOW(H) = { c }
FOLLOW(H') = FOLLOW(H) = { c }
FOLLOW(R) = FOLLOW(C) = { k }
FOLLOW(X) = FOLLOW (P') ={ e }
FOLLOW (X') = FOLLOW (X) = { e }
FOLLOW (C) = { k } U FOLLOW (R) = { k }
FOLLOW (V) = FOLLOW (C) U FIRST (V') = { k } U FOLLOW (V') = { k, e, c }
FOLLOW(V') = FOLLOW (V) = { k, e, c }

5.
S -> h A b S | c
D -> g E | g H d
A -> b D D e | D f

E -> E t | w
B -> C k | h
H -> H w H | H H w | i
C -> i A D | B
Z -> D Z | E

Eliminiamo la ricorsione sinistra

S → h A b S | c
D → g E | g H d
A → b D D e | D f
E → wE'
E' → tE' | ε
B → hB' | i A Dk B'
B' → kB' | ε
H → i H'
H' → w H H' | H w H' | ε
Z → D Z | E

Fattorizziamo

S → h A b S | c
D → g D'
D' → E | H d
A → b D D e | D f
E → wE'
E' → tE' | ε
B → hB' | i A Dk B'
B' → kB' | ε
H → i H'
H' → w H H' | H w H' | ε
Z → D Z | E

FIRST(S) = { h, c }
FIRST(D) = { g }
FIRST(D') = FIRST(E) U FIRST (H) = { w, i }
FIRST(A) = { b } U FIRST (D) = { b, g }
FIRST(E) = { w }
FIRST(E') = { t, ε}
FIRST(B) = { h, i }
FIRST(B') = { k, ε }
FIRST(H) = { i }
FIRST(H') = { w, ε } U FIRST (H) = { w, i, ε }
FIRST(Z) = FIRST(D) U FIRST(E) = { g, w }

FOLLOW(S) = { $ }
FOLLOW (D) = { e, f , k} U FIRST(D) U FIRST(Z) = { e, f, k, g, w }
FOLLOW (D') = FOLLOW(D) = { e, f, k, g, w }
FOLLOW(A) = { b } U FIRST(D) = { b, g }

FOLLOW(E) = FOLLOW (D') U FOLLOW(Z) = { e, f, k, g, w }
FOLLOW(E') = FOLLOW(E) = { e, f, k, g, w }
FOLLOW (B) = { }
FOLLOW (B') = FOLLOW(B) = { }
FOLLOW (H) = { d, w } U FIRST (H') = { d, w, i } U FOLLOW(H') = { d, w, i }
FOLLOW (H') = FOLLOW (H) = { d, w, i }
FOLLOW (Z) = { }