

Predictive Parser Transforms

Left Recursion Elimination

Replace $A \rightarrow A \alpha \mid \beta$

With $A \rightarrow \beta A'$
 $A' \rightarrow \alpha A' \mid \varepsilon$

Where β does not start with A and may not be present

Left Factoring

Replace $A \rightarrow \alpha \beta_1 \mid \dots \mid \alpha \beta_m \mid \gamma_1 \mid \dots \mid \gamma_n$

With $A \rightarrow \alpha A' \mid \gamma_1 \mid \dots \mid \gamma_n$
 $A' \rightarrow \beta_1 \mid \dots \mid \beta_m$

Where β_i and γ_i are sequence of symbols with no common prefix

γ_i May not be present, one of the β may be ε

Building the Parse Table

FIRST(α) for $\alpha = Y_1 Y_2 \dots Y_k$

Add FIRST(Y_1) - $\{\epsilon\}$

If ϵ is in FIRST($Y_{1 \text{ to } i-1}$): add FIRST(Y_i) - $\{\epsilon\}$

If ϵ is in all RHS symbols, add ϵ

FOLLOW(A) for $X \rightarrow \alpha A \beta$

If A is the start, add **eof**

Add FIRST(β) - $\{\epsilon\}$

Add FOLLOW(X) if ϵ in FIRST(β) or β empty

Table[X][t]

for each production $X \rightarrow \alpha$

for each terminal **t** in FIRST(α)

put α in Table[X][**t**]

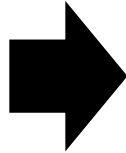
if ϵ is in FIRST(α) {

for each terminal **t** in FOLLOW(X) {

put α in Table[X][**t**]

Left Recursion Elimination Examples

$$A \rightarrow A \alpha \mid \beta$$



$$\begin{aligned} A &\rightarrow \beta A' \\ A' &\rightarrow \alpha A' \mid \varepsilon \end{aligned}$$

$$E \rightarrow E \text{ cross id} \mid \text{id}$$

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T * F \mid F$$

$$F \rightarrow (E) \mid \text{id}$$

$$SList \rightarrow SList D \mid \varepsilon$$

$$D \rightarrow \text{Type id semi}$$

$$\text{Type} \rightarrow \text{bool} \mid \text{int}$$

Left Factoring Examples

$$A \rightarrow \alpha \beta_1 \mid \dots \mid \alpha \beta_m \mid \gamma_1 \mid \dots \mid \gamma_n \quad \Rightarrow \quad \begin{array}{l} A \rightarrow \alpha A' \mid \gamma_1 \mid \dots \mid \gamma_n \\ A' \rightarrow \beta_1 \mid \dots \mid \beta_m \end{array}$$

$$X \rightarrow \langle a \rangle \mid \langle b \rangle \mid \langle c \rangle \mid d$$

$$Stmt \rightarrow \text{id assign } E \mid \text{id } (EList) \mid \text{return}$$

$$E \rightarrow \text{intlitt} \mid \text{id}$$

$$EList \rightarrow E \mid E \text{ comma } EList$$

$$S \rightarrow \text{if } E \text{ then } S \mid \text{if } E \text{ then } S \text{ else } S \mid \text{semi}$$

$$E \rightarrow \text{boollitt}$$

FIRST(α) for $\alpha = Y_{\underline{1}}Y_{\underline{2}}\dots Y_{\underline{k}}$

- Add FIRST($Y_{\underline{1}}$) - $\{\epsilon\}$
- If ϵ is in FIRST($Y_{\underline{1} \text{ to } i-1}$): add FIRST($Y_{\underline{i}}$) - $\{\epsilon\}$
- If ϵ is in all RHS symbols, add ϵ

Exp $\rightarrow$ *Term Exp'*

Exp' $\rightarrow$ **minus** *Term Exp'* | ϵ

Term $\rightarrow$ *Factor Term'*

Term' $\rightarrow$ **divide** *Factor Term'* | ϵ

Factor $\rightarrow$ **intlit** | **lparens** *Exp* **rparens**

$E \rightarrow TX$

$X \rightarrow +TX \mid \epsilon$

$T \rightarrow FY$

$Y \rightarrow *FY \mid \epsilon$

$F \rightarrow (E) \mid \text{id}$

FOLLOW(A) for $X \rightarrow \alpha A \beta$

If A is the start, add **eof**

Add $\text{FIRST}(\beta) - \{\epsilon\}$

Add $\text{FOLLOW}(X)$ if ϵ in $\text{FIRST}(\beta)$ or β is empty

$S \rightarrow Bc \mid DB$

$B \rightarrow ab \mid cS$

$D \rightarrow d \mid \epsilon$

Parse Table

```
for each production  $X \rightarrow \alpha$ 
  for each terminal  $t$  in  $\text{FIRST}(\alpha)$ 
    put  $\alpha$  in  $\text{Table}[X][t]$ 
  if  $\epsilon$  is in  $\text{FIRST}(\alpha)$  {
    for each terminal  $t$  in  $\text{FOLLOW}(X)$  {
      put  $\alpha$  in  $\text{Table}[X][t]$ 
```

$S \rightarrow Bc \mid DB$

$B \rightarrow ab \mid cS$

$D \rightarrow d \mid \epsilon$

	a	b	c	d	eof
S					
B					
D					

FIRST (S)

FIRST (B)

FIRST (D)

FIRST (B c)

FIRST (D B)

FIRST (a b)

FIRST (c S)

FOLLOW (S)

FOLLOW (B)

FOLLOW (D)

Parse Table

```
for each production  $X \rightarrow \alpha$ 
  for each terminal  $t$  in  $\text{FIRST}(\alpha)$ 
    put  $\alpha$  in  $\text{Table}[X][t]$ 
  if  $\epsilon$  is in  $\text{FIRST}(\alpha)$  {
    for each terminal  $t$  in  $\text{FOLLOW}(X)$  {
      put  $\alpha$  in  $\text{Table}[X][t]$ 
```

	(	)	{	}	eof
S					

$\text{FIRST}(S)$

$\text{FIRST}((S))$

$\text{FIRST}(\{S\})$

$\text{FIRST}(\epsilon)$

$\text{FOLLOW}(S)$

$S \rightarrow +S \mid \epsilon$

	+	eof
S		

$\text{FIRST}(S)$

$\text{FIRST}(+S)$

$\text{FIRST}(\epsilon)$

$\text{FOLLOW}(S)$