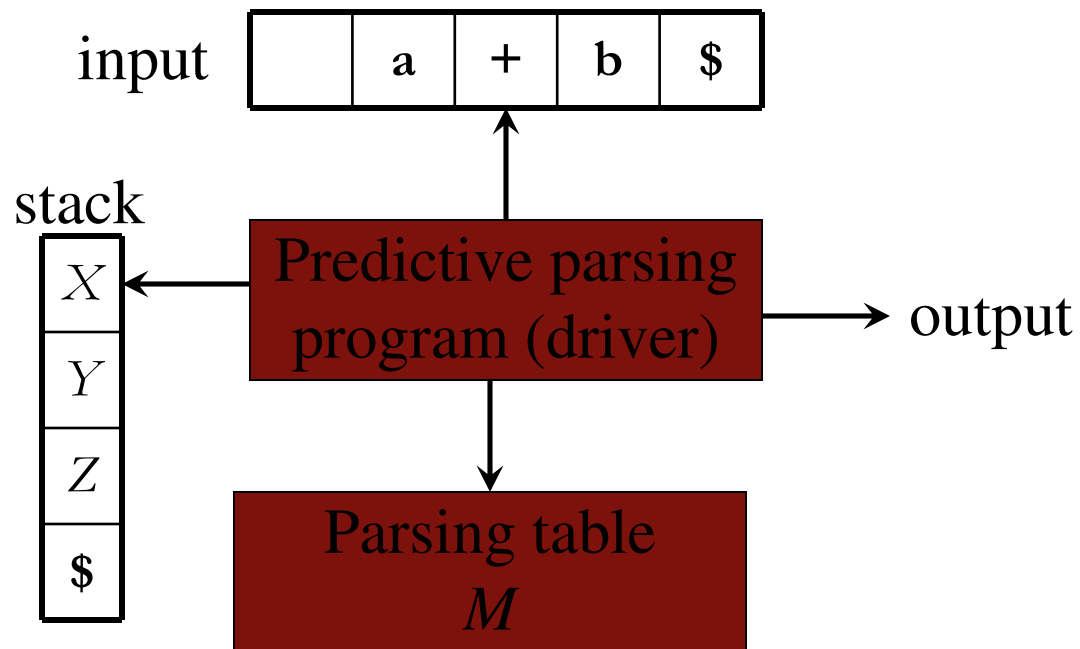


Predictive Parser

Predictive Parsing



Compute FIRST

- If X is a terminal symbol
 - ➔ $\text{FIRST}(X) = \{X\}$
- If X is a non-terminal symbol and $X \rightarrow \epsilon$ is a production rule
 - ➔ ϵ is in $\text{FIRST}(X)$.
- If X is a non-terminal symbol and $X \rightarrow a\alpha$ is a production rule
 - ➔ a is in $\text{FIRST}(X)$.
- If X is a non-terminal symbol and $X \rightarrow Y_1Y_2..Y_n$ is a production rule
 - ➔ If X is $Y_1Y_2..Y_n$
 - if a terminal a in $\text{FIRST}(Y_i)$ and ϵ is in all $\text{FIRST}(Y_j)$ for $j=1,...,i-1$
 - then a is in $\text{FIRST}(X)$.
 - ➔ if ϵ is in all $\text{FIRST}(Y_j)$ for $j=1,...,n$
 - then ϵ is in $\text{FIRST}(X)$.

FIRST Example

$$\begin{aligned} E &\rightarrow TE' \\ E' &\rightarrow +TE' \mid \epsilon \\ T &\rightarrow FT' \\ T' &\rightarrow *FT' \mid \epsilon \\ F &\rightarrow (E) \mid id \end{aligned}$$
$$\begin{aligned} \text{FIRST}(F) &= \{ (, id \} \\ \text{FIRST}(T') &= \{ *, \epsilon \} \\ \text{FIRST}(T) &= \{ (, id \} \\ \text{FIRST}(E') &= \{ +, \epsilon \} \\ \text{FIRST}(E) &= \{ (, id \} \end{aligned}$$
$$\begin{aligned} \text{FIRST}(TE') &= \{ (, id \} \\ \text{FIRST}(+TE') &= \{ + \} \\ \text{FIRST}(\epsilon) &= \{ \epsilon \} \\ \text{FIRST}(FT') &= \{ (, id \} \\ \text{FIRST}(*FT') &= \{ * \} \\ \text{FIRST}(\epsilon) &= \{ \epsilon \} \\ \text{FIRST}((E)) &= \{ (\} \\ \text{FIRST}(id) &= \{ id \} \end{aligned}$$

Compute FOLLOW

- If S is the start symbol \rightarrow $\$$ is in $\text{FOLLOW}(S)$
- if $A \rightarrow \alpha B \beta$ is a production rule
 \rightarrow everything in $\text{FIRST}(\beta)$ is $\text{FOLLOW}(B)$ except ϵ
- If ($A \rightarrow \alpha B$ is a production rule) or
($A \rightarrow \alpha B \beta$ is a production rule and ϵ is in $\text{FIRST}(\beta)$)
 \rightarrow everything in $\text{FOLLOW}(A)$ is in $\text{FOLLOW}(B)$.

We apply these rules until nothing more can be added to any follow set.

FOLLOW Example

$$E \rightarrow TE'$$
$$E' \rightarrow +TE' \mid \epsilon$$
$$T \rightarrow FT'$$
$$T' \rightarrow *FT' \mid \epsilon$$
$$F \rightarrow (E) \mid \text{id}$$
$$\text{FOLLOW}(E) = \{ \$,) \}$$
$$\text{FOLLOW}(E') = \{ \$,) \}$$
$$\text{FOLLOW}(T) = \{ +,), \$ \}$$
$$\text{FOLLOW}(T') = \{ +,), \$ \}$$
$$\text{FOLLOW}(F) = \{ +, *,), \$ \}$$

Constructing LL(1) Parsing Table

For each production rule $A \rightarrow \alpha$ of a grammar G

For each terminal a in $\text{FIRST}(\alpha)$

➔ add $A \rightarrow \alpha$ to $M[A, a]$

If ϵ in $\text{FIRST}(\alpha)$

➔ for each terminal a in $\text{FOLLOW}(A)$ add $A \rightarrow \alpha$ to $M[A, a]$

If ϵ in $\text{FIRST}(\alpha)$ and $\$$ in $\text{FOLLOW}(A)$

➔ add $A \rightarrow \alpha$ to $M[A, \$]$

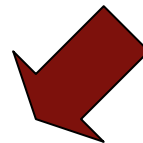
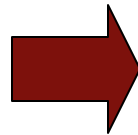
- All other undefined entries of the parsing table are error entries.

Constructing LL(1) Parsing Table

$E \rightarrow TE'$	$\text{FIRST}(TE') = \{ (, \text{id} \}$	$\rightarrow E \rightarrow TE' \text{ into } M[E, (] \text{ and } M[E, \text{id}]$
$E' \rightarrow +TE'$	$\text{FIRST}(+TE') = \{ + \}$	$\rightarrow E' \rightarrow +TE' \text{ into } M[E', +]$
$E' \rightarrow \epsilon$	$\text{FIRST}(\epsilon) = \{ \epsilon \}$ but since ϵ in $\text{FIRST}(\epsilon)$ and $\text{FOLLOW}(E') = \{ \$,) \}$	\rightarrow none $\rightarrow E' \rightarrow \epsilon \text{ into } M[E', \$] \text{ and } M[E',)]$
$T \rightarrow FT'$	$\text{FIRST}(FT') = \{ (, \text{id} \}$	$\rightarrow T \rightarrow FT' \text{ into } M[T, (] \text{ and } M[T, \text{id}]$
$T' \rightarrow *FT'$	$\text{FIRST}(*FT') = \{ * \}$	$\rightarrow T' \rightarrow *FT' \text{ into } M[T', *]$
$T' \rightarrow \epsilon$	$\text{FIRST}(\epsilon) = \{ \epsilon \}$ but since ϵ in $\text{FIRST}(\epsilon)$ and $\text{FOLLOW}(T') = \{ \$,), + \}$	\rightarrow none $\rightarrow T' \rightarrow \epsilon \text{ into } M[T', \$], M[T',)] \text{ and } M[T', +]$
$F \rightarrow (E)$	$\text{FIRST}((E)) = \{ (\}$	$\rightarrow F \rightarrow (E) \text{ into } M[F, (]$
$F \rightarrow \text{id}$	$\text{FIRST}(\text{id}) = \{ \text{id} \}$	$\rightarrow F \rightarrow \text{id} \text{ into } M[F, \text{id}]$

Example Table

$E \rightarrow T E'$
 $E' \rightarrow + T E' \mid \epsilon$
 $T \rightarrow F T'$
 $T' \rightarrow * F T' \mid \epsilon$
 $F \rightarrow (E) \mid \text{id}$



$A \rightarrow \alpha$	FIRST(α)	FOLLOW(A)
$E \rightarrow T E'$	(id	\$)
$E' \rightarrow + T E'$	+	\$)
$E' \rightarrow \epsilon$	ϵ	\$)
$T \rightarrow F T'$	(id	+ \$)
$T' \rightarrow * F T'$	*	+ \$)
$T' \rightarrow \epsilon$	ϵ	+ \$)
$F \rightarrow (E)$	(* + \$)
$F \rightarrow \text{id}$	id	* + \$)

	id	+	*	()	\$
E	$E \rightarrow T E'$			$E \rightarrow T E'$		
E'		$E' \rightarrow + T E'$			$E' \rightarrow \epsilon$	$E' \rightarrow \epsilon$
T	$T \rightarrow F T'$			$T \rightarrow F T'$		
T'		$T' \rightarrow \epsilon$	$T' \rightarrow * F T'$		$T' \rightarrow \epsilon$	$T' \rightarrow \epsilon$
F	$F \rightarrow \text{id}$			$F \rightarrow (E)$		

Predictive Parsing Program

Set ip to point to the first symbol of w\$;

repeat

let X be the top stack symbol and a the symbol pointed by ip;

if X is a terminal or \$ **then**

if X = a **then**

 pop X from the stack and advance ip

else error();

else

if $M[X, a] = X \rightarrow Y_1 Y_2 \dots Y_k$ **then**

begin

 pop X from the stack;

 push($Y_k, Y_{k-1}, \dots, Y_2, Y_1$) ; // such that Y_1 is on top

 output the production $X \rightarrow Y_1 Y_2 \dots Y_k$;

end

else error();

until $X = \$$ /* S tack is empty */

Example

Stack	Input	Production applied
$\$E$	$\underline{\text{id}}+\text{id}*\text{id}\$$	$E \rightarrow T E'$
$\$E'\underline{T}$	$\underline{\text{id}}+\text{id}*\text{id}\$$	$T \rightarrow F T'$
$\$E'T'\underline{F}$	$\underline{\text{id}}+\text{id}*\text{id}\$$	$F \rightarrow \text{id}$
$\$E'T'\underline{\text{id}}$	$\underline{\text{id}}+\text{id}*\text{id}\$$	
$\$E'\underline{T'}$	$\underline{+}\text{id}*\text{id}\$$	$T' \rightarrow \varepsilon$
$\$E'\underline{+}$	$\underline{+}\text{id}*\text{id}\$$	$E' \rightarrow + T E'$
$\$E'T'\underline{+}$	$\underline{+}\text{id}*\text{id}\$$	
$\$E'\underline{T}$	$\underline{\text{id}}*\text{id}\$$	$T \rightarrow F T'$
$\$E'T'\underline{F}$	$\underline{\text{id}}*\text{id}\$$	$F \rightarrow \text{id}$
$\$E'T'\underline{\text{id}}$	$\underline{\text{id}}*\text{id}\$$	
$\$E'\underline{T'}$	$\underline{*}\text{id}\$$	$T' \rightarrow * F T'$
$\$E'T'F\underline{*}$	$\underline{*}\text{id}\$$	
$\$E'T'F\underline{+}$	$\underline{\text{id}}\$$	$F \rightarrow \text{id}$
$\$E'T'\underline{\text{id}}$	$\underline{\text{id}}\$$	
$\$E'\underline{T'}$	$\underline{\$}$	$T' \rightarrow \varepsilon$
$\$E'\underline{+}$	$\underline{\$}$	$E' \rightarrow \varepsilon$
$\underline{\$}$	$\underline{\$}$	