



## **Compiler Construction**

### Lecture Notes

## **Context Free Grammar**

### **Agenda**

### **CFG for a Procedural Language**

## Declaration Statement CFG

The CFG for declaration of variables is one of the most simple grammar among the language constructs.

Here is a CFG for declaration statement that supports declaring multiple statements in a single statement.

$\langle \text{dec\_stat} \rangle \rightarrow \text{DT ID } \langle \text{init\_stat} \rangle \langle \text{dec\_statP} \rangle$

$\langle \text{dec\_statP} \rangle \rightarrow , \text{ID } \langle \text{init\_stat} \rangle \langle \text{dec\_statP} \rangle \mid ;$

$\langle \text{init\_stat} \rangle \rightarrow = \langle \text{init\_statP} \rangle \mid \varepsilon$

$\langle \text{init\_statP} \rangle \rightarrow \text{ID} \mid \langle \text{const} \rangle$

$\langle \text{const} \rangle \rightarrow \text{Int\_Const} \mid \text{Float\_Const}$

## Complete CFG for Simple C Like Procedural Language

### 1. Start

$\langle S \rangle \rightarrow \langle \text{dec\_stat} \rangle \mid \langle \text{fn\_stat} \rangle \mid \langle \text{main\_fn\_stat} \rangle \mid \langle \text{fn\_stat} \rangle$

$\langle \text{ret\_type} \rangle \rightarrow \text{void} \mid \text{DT}$

$\langle \text{fn\_stat} \rangle \rightarrow \langle \text{ret\_type} \rangle \text{ ID } (\langle \text{params} \rangle) \{ \langle \text{fn\_body} \rangle \} \mid \epsilon$

$\langle \text{main\_fn\_stat} \rangle \rightarrow \langle \text{ret\_type} \rangle \text{ main } (\langle \text{params} \rangle) \{ \langle \text{fn\_body} \rangle \}$

$\langle \text{params} \rangle \rightarrow \text{DT ID } \langle \text{param\_list} \rangle \mid \epsilon$

$\langle \text{param\_list} \rangle \rightarrow , \text{ ID } \langle \text{param\_list} \rangle \mid \epsilon$

$\langle \text{fn\_body} \rangle \rightarrow \langle \text{M\_st} \rangle$

### 2. Declaration and Initialization Statement

$\langle \text{dec\_stat} \rangle \rightarrow \text{DT ID } \langle \text{init\_stat} \rangle \mid \langle \text{dec\_statP} \rangle$

$\langle \text{dec\_statP} \rangle \rightarrow ; \mid , \text{ ID } \langle \text{init\_stat} \rangle \mid \langle \text{dec\_statP} \rangle$

$\langle \text{init\_stat} \rangle \rightarrow = \langle \text{init\_statP} \rangle \mid \epsilon$

$\langle \text{init\_statP} \rangle \rightarrow \text{ID} \mid \langle \text{const} \rangle \mid \langle \text{Exp} \rangle \mid \langle \text{List} \rangle$

$\langle \text{const} \rangle \rightarrow \text{Int\_Const} \mid \text{Float\_Const}$

### 3. Assignment Statement

$\langle \text{Ass\_st} \rangle \rightarrow \text{ID} = \langle \text{Exp} \rangle$

#### 4. Argument Statement

$\langle \text{Arg\_st} \rangle \rightarrow \text{ID} \langle \text{Arg\_stX} \rangle \langle \text{Arg\_List} \rangle \mid \langle \text{Const} \rangle \langle \text{Arg\_List} \rangle \mid \langle \text{Exp} \rangle \langle \text{Arg\_List} \rangle \mid \epsilon$

$\langle \text{Arg\_stX} \rangle \rightarrow (\langle \text{Arg\_st} \rangle) \mid \epsilon$

$\langle \text{Arg\_List} \rangle \rightarrow , \langle \text{Arg\_st} \rangle \mid \epsilon$

#### 5. The Statements

//Single statement

$\langle \text{S\_st} \rangle \rightarrow \langle \text{Wh\_St} \rangle \mid \langle \text{DoWh\_St} \rangle \mid \langle \text{IfElse\_St\_Fn} \rangle \mid \langle \text{For\_St} \rangle \mid \langle \text{Switch\_st} \rangle \mid \langle \text{dec\_stat} \rangle \mid \text{ID} \langle \text{Ass\_St\_Fn} \rangle ; \mid \langle \text{Inc\_Dec} \rangle \text{ID} ;$

//Multiple statements

$\langle \text{M\_st} \rangle \rightarrow \langle \text{S\_st} \rangle \langle \text{M\_st} \rangle \mid \epsilon$

#### 6. Functions that return void

$\langle \text{S\_St\_Ret} \rangle \rightarrow \langle \text{S\_St} \rangle \mid \text{return};$

#### 7. Functions that return a value

$\langle \text{S\_St\_RetVal} \rangle \rightarrow \langle \text{S\_St} \rangle \mid \text{return} \langle \text{Exp} \rangle ;$

$\langle \text{M\_St\_Ret} \rangle \rightarrow \langle \text{S\_St\_Ret} \rangle \langle \text{M\_St\_Ret} \rangle \mid \{ \langle \text{M\_St\_Ret} \rangle \} \langle \text{M\_St\_Ret} \rangle \mid \epsilon$

$\langle \text{M\_St\_RetVal} \rangle \rightarrow \langle \text{S\_St\_RetVal} \rangle \langle \text{M\_St\_RetVal} \rangle \mid \{ \langle \text{M\_St\_RetVal} \rangle \} \langle \text{M\_St\_RetVal} \rangle \mid \epsilon$

$\langle \text{Exp\_NULL} \rangle \rightarrow \langle \text{Exp} \rangle \mid \epsilon$

## 8. Expression

$\langle \text{Exp} \rangle \rightarrow \langle \text{L\_OR} \rangle$   
 $\langle \text{L\_OR} \rangle \rightarrow \langle \text{L\_AND} \rangle \langle \text{L\_OR}' \rangle$   
 $\langle \text{L\_OR}' \rangle \rightarrow \parallel \langle \text{L\_AND} \rangle \langle \text{L\_OR}' \rangle$   
 $\langle \text{L\_AND} \rangle \rightarrow \langle \text{R\_OP} \rangle \langle \text{L\_AND}' \rangle$   
 $\langle \text{L\_AND}' \rangle \rightarrow \&\& \langle \text{R\_OP} \rangle \langle \text{L\_AND}' \rangle$   
 $\langle \text{R\_OP} \rangle \rightarrow \langle \text{E} \rangle \langle \text{R\_OP}' \rangle$   
 $\langle \text{R\_OP}' \rangle \rightarrow \text{Rel\_OP} \langle \text{E} \rangle \langle \text{R\_OP}' \rangle$   
 $\langle \text{E} \rangle \rightarrow \langle \text{T} \rangle \langle \text{E}' \rangle$   
 $\langle \text{E}' \rangle \rightarrow \text{P\_M} \langle \text{T} \rangle \langle \text{E}' \rangle$   
 $\langle \text{T} \rangle \rightarrow \langle \text{F} \rangle \langle \text{T}' \rangle$   
 $\langle \text{T}' \rangle \rightarrow \text{M\_D} \langle \text{F} \rangle \langle \text{T}' \rangle$   
 $\langle \text{F} \rangle \rightarrow \text{ID} \langle \text{Arg\_stX} \rangle \langle \text{F}' \rangle \mid \langle \text{Const} \rangle \langle \text{F}' \rangle \mid ( \langle \text{Exp} \rangle ) \langle \text{F}' \rangle \mid ! \langle \text{F} \rangle$   
 $\langle \text{F}' \rangle \rightarrow \langle \text{Arg\_List} \rangle \mid \epsilon$   
 $\langle \text{Const} \rangle \rightarrow \text{int\_ct} \mid \text{ch\_ct} \mid \text{str\_ct} \mid \text{fl\_ct} \mid \text{bool\_ct}$

## 9. WHILE Loop Statement

$\langle \text{Wh\_st} \rangle \rightarrow \text{while} ( \langle \text{Cond} \rangle ) \langle \text{Lp\_body} \rangle$   
 $\langle \text{Cond} \rangle \rightarrow \langle \text{ID\_Const} \rangle \langle \text{Rel\_Exp} \rangle$   
 $\langle \text{ID\_Const} \rangle \rightarrow \text{ID} \mid \langle \text{Const} \rangle$   
 $\langle \text{Rel\_Exp} \rangle \rightarrow \text{Rel\_Op} \langle \text{ID\_Const} \rangle \mid \epsilon$   
 $\langle \text{Lp\_body} \rangle \rightarrow \quad ; \mid \langle \text{S\_st} \rangle \mid \{ \langle \text{M\_st} \rangle \}$   
  
 $\langle \text{S\_st} \rangle \rightarrow \text{ID} \langle \text{Arg\_stX} \rangle \langle \text{S\_st}' \rangle \mid \langle \text{Wh\_st} \rangle \mid \langle \text{DoWh\_st} \rangle \mid \langle \text{If\_st} \rangle \mid \langle \text{For\_st} \rangle \mid$   
 $\langle \text{Switch\_st} \rangle \mid \langle \text{Dec\_st} \rangle \mid \text{return} \langle \text{Const} \rangle \mid \text{break}; \mid \text{continue};$

$\langle S\_st' \rangle \rightarrow = \langle Exp \rangle \mid \langle Arg\_List \rangle$

$\langle M\_st \rangle \rightarrow \langle S\_st \rangle \langle M\_st \rangle \mid \epsilon$

## 10. Do - WHILE Loop Statement

$\langle DoWh\_st \rangle \rightarrow \text{do } \{ \langle M\_st \rangle \} \text{ while } (\langle Cond \rangle);$

## 11. FOR Loop Statement

$\langle For\_st \rangle \rightarrow \text{for } (\langle 1st\_Clause \rangle \langle 2nd\_Clause \rangle ; \langle 3rd\_Clause \rangle) \langle Lp\_body \rangle$

$\langle 1st\_Clause \rangle \rightarrow \langle Dec\_st \rangle \mid \langle Ass\_st \rangle ; \mid ;$

$\langle 2nd\_Clause \rangle \rightarrow \langle Cond \rangle \mid \epsilon$

$\langle 3rd\_Clause \rangle \rightarrow ID \langle 3rd\_SubClause \rangle \mid INC\_DEC ID \mid \epsilon$

$\langle 3rd\_SubClause \rangle \rightarrow INC\_DEC \mid = \langle ID\_Const \rangle$

## 12. IF – Else Statement

$\langle If\_st \rangle \rightarrow \text{if } (\langle Cond \rangle) \langle If\_body \rangle \langle Else\_st \rangle$

$\langle If\_body \rangle \rightarrow ; \mid \langle S\_st \rangle \mid \{ \langle M\_st \rangle \}$

$\langle Else\_st \rangle \rightarrow \text{else } \langle If\_body \rangle \mid \epsilon$

## 13. SWITCH Statement

$\langle Switch\_st \rangle \rightarrow \text{switch}(ID) \{ \langle Switch\_body \rangle \}$

$\langle Switch\_body \rangle \rightarrow \text{case } \langle Const \rangle : \langle Case\_body \rangle \langle Switch\_body \rangle \mid$   
 $\text{default:} \langle Case\_body \rangle \mid \langle Switch\_st \rangle$

$\langle Case\_body \rangle \rightarrow \langle M\_st \rangle \text{break}; \mid \epsilon$

