

HABIB UNIVERSITY

CS 421 (COMPILER DESIGN AND CONSTRUCTION) – FALL 2022

Homework 2

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LL(1) GRAMMAR

$\text{Program} \rightarrow \text{dt id}(\text{ParamList})\text{Stmts}$
 $\text{ParamList} \rightarrow \text{dt id PList}$
 $\text{PList} \rightarrow ,\text{dt id PList} \mid \epsilon$
 $\text{Stmts} \rightarrow \text{Stmts}'$
 $\text{Stmts}' \rightarrow \text{DecStmt Stmts}' \mid \text{AssignStmt Stmts}' \mid \text{ForStmt Stmts}' \mid \text{IfStmt Stmts}' \mid \text{ReturnStmt Stmts}' \mid \epsilon$
 $\text{DecStmt} \rightarrow \text{dt id OptionalAssign List}$
 $\text{List} \rightarrow ,\text{dt OptionalAssign List} \mid \epsilon$
 $\text{OptionalAssign} \rightarrow =\text{Expr}; \mid \epsilon$
 $\text{Expr} \rightarrow \text{TE}'$
 $\text{E}' \rightarrow +\text{TE}' \mid \epsilon$
 $\text{T} \rightarrow \text{FT}'$
 $\text{T}' \rightarrow *\text{FT}' \mid \epsilon$
 $\text{F} \rightarrow (\text{Expr}) \mid \text{id}$
 $\text{ForStmt} \rightarrow \text{for}(\text{Type id Expr}; \text{Expr relop Expr}; \text{id}++)\text{Stmts}$
 $\text{Type} \rightarrow \text{dt} \mid \epsilon$
 $\text{IfStmt} \rightarrow \text{if}(\text{Expr relop Expr})\text{Stmts OptionalElse}$
 $\text{AssignStmt} \rightarrow \text{id} = \text{Expr};$
 $\text{OptionalElse} \rightarrow \text{else Stmts} \mid \epsilon$
 $\text{ReturnStmt} \rightarrow \text{return Expr};$

As it can be seen there is no need for left recursion elimination or left factoring required in the grammar. Now we need to confirm whether this grammar is LL(1) or not.

Computing FIRST sets for each non-terminal

$\text{FIRST}(\text{Program}) = \{\text{dt}\}$
 $\text{FIRST}(\text{ParamList}) = \{\text{dt}\}$
 $\text{FIRST}(\text{PList}) = \{, \epsilon\}$
 $\text{FIRST}(\text{Stmts}) = \text{FIRST}(\text{Stmts}') = \text{FIRST}(\text{DecStmt Stmts}') \cup \text{FIRST}(\text{AssignStmt Stmts}') \cup \text{FIRST}(\text{ForStmt Stmts}') \cup \text{FIRST}(\text{IfStmt Stmts}') \cup \text{FIRST}(\text{ReturnStmt Stmts}') \cup \epsilon$
 $= \{\text{dt}\} \cup \{\text{if}\} \cup \{\text{for}\} \cup \{\text{id}\} \cup \{\text{return}\} \cup \epsilon = \{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \epsilon\}$
 $\text{FIRST}(\text{Stmts}') = \{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \epsilon\}$
 $\text{FIRST}(\text{DecStmt}) = \{\text{dt}\}$
 $\text{FIRST}(\text{List}) = \text{FIRST}(, \text{dt OptionalAssign List}) \cup \epsilon = \{, \epsilon\}$
 $\text{FIRST}(\text{OptionalAssign}) = \text{FIRST}(=\text{Expr};) \cup \epsilon = \{=, \epsilon\}$
 $\text{FIRST}(\text{Expr}) = \text{FIRST}(\text{TE}') = \text{FIRST}(\text{FT}') = \text{FIRST}(\text{F}) = \{(\text{, id}\}$
 $\text{FIRST}(\text{E}') = \text{FIRST}(+\text{TE}') \cup \epsilon = \{+, \epsilon\}$
 $\text{FIRST}(\text{T}) = \text{FIRST}(\text{FT}') = \text{FIRST}(\text{F}) = \{(\text{, id}\}$
 $\text{FIRST}(\text{T}') = \text{FIRST}(*\text{FT}') \cup \epsilon = \{*, \epsilon\}$
 $\text{FIRST}(\text{F}) = \{(\text{, id}\}$
 $\text{FIRST}(\text{ForStmt}) = \{\text{for}\}$

$\text{FIRST}(\textit{Type}) = \{\text{dt}, \epsilon\}$
 $\text{FIRST}(\textit{ifStmt}) = \{\text{if}\}$
 $\text{FIRST}(\textit{AssignStmt}) = \{\text{id}\}$
 $\text{FIRST}(\textit{OptionalElse}) = \{\text{else}, \epsilon\}$
 $\text{FIRST}(\textit{ReturnStmt}) = \{\text{return}\}$

Computing FOLLOW sets for each Production

$\text{FOLLOW}(\textit{Program}) = \{\$ \}$
 $\text{FOLLOW}(\textit{ParamList}) = \{ \}$
 $\text{FOLLOW}(\textit{PList}) = \text{FOLLOW}(\textit{ParamList}) = \{ \}$
 $\text{FOLLOW}(\textit{Stmts}) = \{ \}$
 $\text{FOLLOW}(\textit{Stmts}') = \text{FOLLOW}(\textit{Stmts}) = \{ \}$
 $\text{FOLLOW}(\textit{DecStmts}) = (\text{FIRST}(\textit{Stmts}') - \epsilon) \cup \text{FOLLOW}(\textit{Stmts}') \cup \text{FOLLOW}(\textit{Stmts})$
 $= \{\text{dt}, \text{if}, \text{for}, \text{id}, \}$
 $\text{FOLLOW}(\textit{List}) = \text{FOLLOW}(\textit{DecStmts}) = \{\text{dt}, \text{if}, \text{for}, \text{id}, \}$
 $\text{FOLLOW}(\textit{OptionalAssign}) = (\text{FIRST}(\textit{List}) - \epsilon) \cup \text{FOLLOW}(\textit{List}) \cup \text{FOLLOW}(\textit{DecStmts})$
 $= \{, \text{dt}, \text{if}, \text{for}, \text{id}, \}$
 $\text{FOLLOW}(\textit{Expr}) = \{;, \text{relop}, \}$
 $\text{FOLLOW}(\textit{E}') = \text{FOLLOW}(\textit{Expr}) = \{;, \text{relop}, \}$
 $\text{FOLLOW}(\textit{T}) = \text{FIRST}(\textit{E}') - \epsilon \cup \text{FOLLOW}(\textit{Expr}) = \{+, ;, \text{relop}, \}$
 $\text{FOLLOW}(\textit{T}') = \text{FOLLOW}(\textit{T}) = \{+, ;, \text{relop}, \}$
 $\text{FOLLOW}(\textit{F}) = \text{FIRST}(\textit{T}') - \epsilon \cup \text{FOLLOW}(\textit{T}) \cup \text{FOLLOW}(\textit{T}') = \{*, +, ;, \text{relop}, \}$
 $\text{FOLLOW}(\textit{ForStmt}) = \text{FIRST}(\textit{Stmts}') - \epsilon \cup \text{FOLLOW}(\textit{Stmts}') = \{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \}$
 $\text{FOLLOW}(\textit{Type}) = \{\text{id}\}$
 $\text{FOLLOW}(\textit{IfStmt}) = \text{FIRST}(\textit{Stmts}') - \epsilon \cup \text{FOLLOW}(\textit{Stmts}') = \{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \}$
 $\text{FOLLOW}(\textit{AssignStmt}) = \text{FIRST}(\textit{Stmts}') - \epsilon \cup \text{FOLLOW}(\textit{Stmts}') =$
 $\{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \}$
 $\text{FOLLOW}(\textit{OptionalElse}) = \text{FOLLOW}(\textit{IfStmt}) - \epsilon \cup \text{FOLLOW}(\textit{Stmts}') =$
 $\{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \}$
 $\text{FOLLOW}(\textit{ReturnStmt}) = \text{FIRST}(\textit{Stmts}') - \epsilon \cup \text{FOLLOW}(\textit{Stmts}') =$
 $\{\text{dt}, \text{if}, \text{for}, \text{id}, \text{return}, \}$