Compilers Project

Simple Programming Language using Lex and Yacc

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Team Members

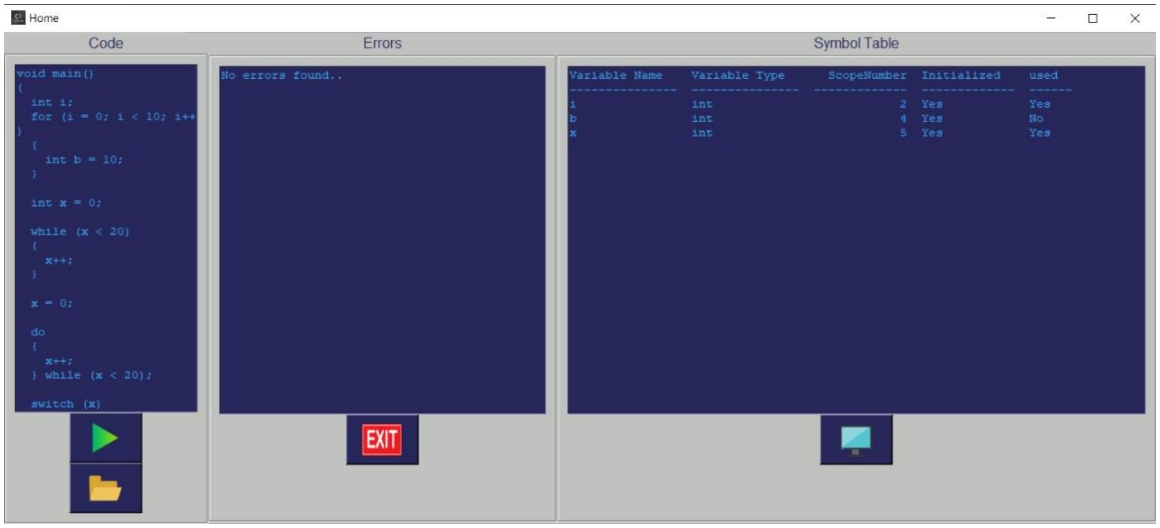
Aya Sameh Mohamed	1170107
Maram Mohamed Hosni	1170533
Heba Ali Hassan	1170134
Karim Wael Zain	1170058

Project Overview

The project implements a simple C-like programming language.

The language covers the following:

- Assignment statement
- If-Variables and constants declaration
- Mathematical and logical expressions
- then-else statement, while loops, repeat-until loops, for loops, switch statement
- Block structure
- Functions



Code compiled with no errors

Code compiled with errors

Tools and Technologies

- **Lex - A Lexical Analyzer Generator**

  Lex helps write programs whose control flow is directed by instances of regular expressions in the input stream. It is well suited for editor-script type transformations and for segmenting input in preparation for a parsing routine.

- **Yacc - Yet Another Compiler-Compiler**

  Yacc provides a general tool for describing the input to a computer program. The user specifies the structures of his input, together with code to be invoked as each such structure is recognized. Yacc turns such a specification into a subroutine that handles the input process.

- **Tkinter**

  Tkinter is the standard GUI library for Python. It provides a fast and easy way to create GUI applications.

Tokens

Token	Description
TYPE_INT	To identify an integer type variable/identifier
TYPE_FLOAT	To identify a float type variable/identifier
TYPE_CHAR	To identify a char type variable/identifier
TYPE_BOOL	To identify a boolean type variable/identifier
TYPE_VOID	Void keyword for the main function
IDENTIFIER	Represents a variable's name or function's name
INTEGER	To identify an integer value assigned to variable/identifier
FLOAT	To identify a float value assigned to variable/identifier
CHAR	To identify a character value assigned to variable/identifier

BOOL	To identify a boolean value assigned to variable/identifier
CONST	To define constants
IF	If keyword for if-else statement
ELSE	Else keyword for if-else statement
SWITCH	Switch keyword for switch-case statement
CASE	Case keyword for switch-case statement
DEFAULT	Default keyword for switch-case statement
FOR	For keyword for for-loop statement
DO	Do keyword for do-while statement
WHILE	While keyword for do-while statement
BREAK	Break keyword for switch-case statement
RETURN	Return keyword for returning from a function
INC	Increment by 1 (++)
DEC	Decrement by 1 (--)
EQUAL	Equality check (==)
NOT_EQUAL	Inequality check (!=)
GREATER_EQUAL	Greater than or equal for comparing variables (>=)
LESS_EQUAL	Less than or equal for comparing variables (<=)
LOGICAL_AND	Logical and for comparison

LOGICAL_OR	Logical or for comparison
ASSIGN	Assignment operator for assigning variables
SEMICOLON	Semicolon for the end of most statements (;)
COMA	Comma for separating variables (,)
MAIN	Main keyword for the main function
FUNC	Function keyword for declaring a function
CALL_FUNC	Call function for calling a function
PLUS	Plus operation (+)
MINUS	Minus operation (-)
MULT	Multiplication operation (*)
DIVI	Division operation (/)
LEFTPARE	Left round bracket
RIGHTPARE	Right round bracket
CURLEFT	Left round bracket
RIGHTPARE	Right round bracket
LESS	Less that for comparing variables (<)
GREATER	Greater than for comparing variables (>)
COLON	Colon for switch-case statement (:)

Language Production Rules

Rules
Program:mainStmt | functions mainStmt
Functions: FUNC function | functions FUNC function
mainStmt: TYPE_VOID Main LEFTPARE RIGHTPARE stmt_block
stmts: stmt | stmts stmt | stmt_block | stmts stmt_block
stmt_block: CURLEFT CURRIGHT | CURLEFT stmts CURRIGHT
Stmt: varDeclarationStmt SEMICOLON | postPrefixExpr SEMICOLON | ifStmt | forStmt | whileStmt | switchstmt | dowhileStmt | CALL_FUNC functionCall SEMICOLON
varDeclarationStmt: variableDecl | multiVariableDecl | variableAssign
varType: TYPE_INT | TYPE_FLOAT | TYPE_CHAR | TYPE_BOOL
dataType: BOOL | INTEGER | FLOAT| CHAR
variableDecl: varType IDENTIFIER | varType IDENTIFIER ASSIGN expression | CONST varType IDENTIFIER ASSIGN expression | varType IDENTIFIER ASSIGN CALL_FUNC functionCall | CONST varType IDENTIFIER ASSIGN CALL_FUNC functionCall
multiVariableDecl: variableDecl COMA IDENTIFIER | variableDecl COMA IDENTIFIER ASSIGN expression | multiVariableDecl COMA IDENTIFIER | multiVariableDecl COMA IDENTIFIER ASSIGN expr
variableAssign: IDENTIFIER ASSIGN variableAssignTypes

variableAssignTypes: expression | CALL_FUNC functionCall;
expression: logicExpr
mathExpr: mathExpr PLUS mathExpr | mathExpr MINUS mathExpr | mathExpr MULT mathExpr | mathExpr DIVI mathExpr | expr
relationExpr: relationExpr LESS relationExpr | relationExpr GREATER relationExpr | relationExpr EQUAL relationExpr | relationExpr NOT_EQUAL relationExpr | relationExpr GREATER_EQUAL relationExpr | relationExpr LESS_EQUAL relationExpr | mathExpr | NOT mathExpr
logicExpr: logicExpr LOGICAL_AND logicExpr | logicExpr LOGICAL_OR logicExpr | relationExpr
Expr: dataType | IDENTIFIER
postPrefixExpr: IDENTIFIER INC | INC IDENTIFIER | IDENTIFIER DEC | DEC IDENTIFIER
ifStmt: ifstmt_start else_if optional_else | ifstmt_start optional_else
Ifstmt_start: IF LEFTPARE logicExpr RIGHTPARE body
Else_if: else_if ELSE IF LEFTPARE logicExpr RIGHTPARE body | ELSE IF LEFTPARE logicExpr RIGHTPARE body
optional_else: ELSE body | /*empty*/
Body: stmt_block
switchstmt: SWITCH LEFTPARE IDENTIFIER RIGHTPARE CURLEFT casestmt CURRIGHT
Casestmt: CASE expr COLON stmts BREAK SEMICOLON | DEFAULT COLON stmts BREAK SEMICOLON | DEFAULT COLON BREAK SEMICOLON | /*empty*/

forStmt: FOR LEFTPARE initStmt logicExpr SEMICOLON loopCond RIGHTPARE stmt_block
initStmt: variableAssign SEMICOLON | SEMICOLON
loopCond: postPrefixExpr | IDENTIFIER ASSIGN mathExpr
whileStmt: WHILE LEFTPARE logicExpr RIGHTPARE stmt_block
dowhileStmt: DO stmt_block WHILE LEFTPARE expression RIGHTPARE SEMICOLON
functionCall: IDENTIFIER LEFTPARE functionArgumentsPassed RIGHTPARE
functionArgumentsPassed: expression | functionArgumentsPassed COMA expression
function: functionHeader functionBody
functionHeader: varType IDENTIFIER LEFTPARE functionArgumentsDecl RIGHTPARE
functionArgumentsDecl: varType IDENTIFIER | functionArgumentsDecl COMA varType IDENTIFIER
functionBody: CURLEFT stmts returnStmt CURRIGHT | CURLEFT returnStmt CURRIGHT
returnStmt: RETURN expression SEMICOLON | RETURN functionCall SEMICOLON

Quadruples

Token	Description
MOV Rd, Rs	`Rd ← Rs`
ADD Rd, Rs1, Rs2	`Rd ← Rs1 + Rs2`
SUB Rd, Rs1, Rs2	`Rd ← Rs1 - Rs2`
MUL Rd, Rs1, Rs2	`Rd ← Rs1 * Rs2`
DIV Rd, Rs1, Rs2	`Rd ← Rs1 / Rs2`
CMPL Rd, Rs1, Rs2	`Rd ←  Rs1 < Rs2`
CMPLE Rd, Rs1, Rs2	`Rd ←  Rs1 <= Rs2`
CMPG Rd, Rs1, Rs2	`Rd ←  Rs1 > Rs2`
CMPGE Rd, Rs1, Rs2	`Rd ←  Rs1 >= Rs2`
CMPE Rd, Rs1, Rs2	`Rd ←  Rs1 == Rs2`
CMPNE Rd, Rs1, Rs2	`Rd ←  Rs1 !=  Rs2`
AND Rd, Rs1, Rs2	`Rd ← Rs1 && Rs2`
OR Rd, Rs1, Rs2	`Rd ← Rs1 || Rs2`
INC Rx	`Rx ← Rx + 1`
DEC Rx	`Rx ← Rx - 1`
JF Rx, label	Jump to label if Rx if false
JT Rx, label	Jump to label if Rx if true
JMP label	Jump to label
CALL functionName	Used to call a function and it makes the required context switching

RETURN	To return from a function back to the address that is determined by CALL when the function was called

Test Cases Modifications

1. semantic-error.cpp
    - The language does not support strings. So, it was replaced with a character.
2. loops.cpp
    - Semicolons were added.
    - The counter of the for loop (i) should be initialized before the for statement.
    - The for loop sequence is doing the check then the loop condition and finally the loop.
3. function.cpp
    - Modified the method that a function is declared or called.