

Programming Language and Compiler Final Project Report

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Abstract

This report covers the project on Compiler. The compiler is designed for a specific language with given constraints. In this report, a brief description about grammar, semantic rules, type checking and type binding is explained. Screenshots of the demonstration of all the features are shown along with the inputs and outputs given. In the end, it is concluded with the program features and its limitations.

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1 Syntax

1.1 primitives decleration

```
datatype variablename = expression;
```

1.2 primitives assignment

```
variablename = expression;
```

1.3 array decleration

```
array:arraylength variablename = [expression0, expression1];
```

1.4 array member assignment

```
variablename[expression] = expression;
```

1.5 struct decleration

```
struct variablename = {key0: expression0, key1; expression1};
```

1.6 struct member assignment

```
variablename->key = expression;
```

1.7 while loop

```
while booleanExpression  
begin  
  ...  
  ...  
end;
```

1.8 function declaration

```
def functionname(type0 argument0, type1 argument1)
begin
....
....
end;
```

1.9 function call

```
functionname(expression0, expression1);
```

2 Grammar and Symantic Rules

```
program      ->  statement_list:s {program.val = statement_list.val}
```

```
statement_list  ->  statement_list:l statement_part:s
                   {statement_list = statement_list.add(statement_part)}
                   |  statement_part:s
                   {statement_list.add(statement_part)}
```

```
statement_part  ->  statement:s SEMI;
```

```
statement      ->  assignment:s {statement.val = assignment.val}
                   |  vardec:s {statement.val = vardec.val}
                   |  RETURN boolExp:e {statement.val = boolExp.val}
                   |  ifthen:s {assignment.val statement.val = ifthen.val}
                   |  print:s {statement.val = print.val}
                   |  while:s {statement.val = while.val}
                   |  functionDef:f {statement.val = functionDef.val }
                   |  boolExp:e {statement.val = boolExp.val}
                   |  BEGIN statement_list:s END {statement.val = statement_list.val}
```

```
while          ->  WHILE boolExp:e DO statement:s
                   {while.val = while boolExp.val==true do statement.val}
```

```
print          ->  PRINT boolExp:e {print = print boolExp.val}
```

```

ifthen      -> IF boolExp:e THEN statement
              {ifthen.val = if boolExp.val==true then statement.val}
              | IF boolExp:e THEN statement1 ELSE statement2
              {ifthen.val = if boolExp.val==true
                then statement1.val else statement2.val}

expListPart -> boolExp:e {expListPart.val = boolExp.val}

expList     -> expList:e_list COMMA expListPart:e
              {expList.val = expList.add(expListPart.val)}
              | expListPart:e {expList.add(expListPart.val)}

vardec      -> type:t ID:i ASS boolExp:e {symboltable.add(t,i,e)}
              | ARRAYDEF:a COLON boolExp:size ID:i ASS boolExp:e
              {symboltable.add(a,i,e)}
              | STRUCTDEF:s ID:i ASS boolExp:e {symboltable.add(s,i,e)}

argumentPart -> type:t ID:i {argumentPart.val = i.val}

argumentList -> argumentList:a_list COMMA argumentPart:a
               {argumentList.val = argumentList.add(argumentPart.val)}
               | argumentPart:a {argumentList.val = argumentPart.val}

functionDef  -> FUNCDEF:f ID:i LPAREN argumentList:a_list RPAREN
               BEGIN statement_list:s END
               {symboltable.add(f,i,argumentList.val, statement_list:s)}

functionCall -> ID:i LPAREN expList:e_list RPAREN
               {symboltable.get(i).call(expList:e_List.val)}

type         -> INTDEF:i {type.val = int.val}
               | FLOATDEF:f {type.val = float.val}
               | BOOLEANDEF:b {type.val = boolean.val}
               | CHARDEF:c {type.val = char.val}

keyValuePart -> ID:i COLON boolExp:e {keyValuePart.val = boolExp.val}

```

```

keyValueList    -> keyValueList:kv_list COMMA keyValuePart:kv_part
                  {keyValueList.val = keyValueList.add(keyValuePart.val)}
                  |
                  keyValuePart:kv_part {keyValueList.add(keyValuePart.val)}

assignment      -> ID:i ASS boolExp:e {symboltable.setValue(i.val, boolExp.val) }
                  |
                  ID:a LBRACKET boolExp:index RBRACKET ASS boolExp:e
                  {symboltable.get(i).get(index) = e.val}
                  |
                  ID:s ARROW ID:key ASS boolExp:e {symboltable.get(i).get(key) = e.val}

boolExp          -> boolExp:e OR boolTerm:t {boolExp.val = e.val || t.val}
                  |
                  boolTerm:t {boolExp.val = t.val}

boolTerm         -> boolTerm:t AND notFactor:f {boolTerm.val = t.val && f.val}
                  |
                  notFactor:f {boolTerm.val = f.val}

notFactor        -> NOT boolFactor:b {notFacto.val = !b.val}
                  |
                  boolFactor:f {notFactor.val = f.val}

boolFactor       -> BOOLEAN:b {boolFactor.val = b.val}
                  |
                  relation:r {boolFactor.val = r.val}

relation         -> expr:e0 EQ expr:e1 {relation.val = e0 == e1}
                  |
                  expr:e0 NOTEQ expr:e1 {relation.val = e0 != e1}
                  |
                  expr:e0 GREATEREQ expr:e1 {relation.val = e0 > e1 || e0 == e1}
                  |
                  expr:e0 GREATER expr:e1 {relation.val = e0 > e1}
                  |
                  expr:e0 LESSEREQ expr:e1 {relation.val = e0 < e1 || e0 ==e1}
                  |
                  expr:e0 LESSER expr:e1 {relation.val = e0 < e1}
                  |
                  expr:e {relation.val == e.val}

expr             -> expr:e PLUS term:t {expr.val = e.val + t.val}
                  |
                  expr:e MINUS term:t {expr.val = e.val - t.val}
                  |
                  term:t {expr.val = t.val}

term             -> term:t TIMES factor:f {term.val = t.val * f.val}
                  |
                  term:t DIVIDE factor:f {term.val + t.val / f.val}
                  |
                  factor:f { term.val = f.val}

```

```

factor      -> LPAREN boolExp RPAREN {factor.val = boolExp.val}
             | INT {factor.val = INT.val}
             | FLOAT {factor.val = FLOAT.val}
             | CHAR {factor.val = CHAR.val}
             | array {factor.val = array.val}
             | struct {factor.val = struct.val}
             | functionCall {factor.val = functionCall.val}
             | ID LBRACKET boolExp RBRACKET
               {factor.val = symboltable.get(ID).get(boolExp)}
             | ID:i ARROW ID:j {factor.val = symboltable.get(i).get(j)}
             | ID {factor.val = ID.val}

array      -> LBRACKET expList:e_list RBRACKET {array.val = expList.val}

struct     -> LBRACE keyValueList:kv_list RBRACE {struct.val = keyValueList.val}
““

```

3 Program Features

- This program helps in evaluating expressions like addition(+), subtraction(-), multiplication(*) and division(/). Apart from just mathematical operations, this program also evaluates comparison operators like less than, less than equal, greater than, greater than equal, equality and inequality and logical operators like Conjunction (and), Disjunction (or), Negation (not).
- The program supports the primitive data types Integer(int), Floating point numbers (float), Characters (char) and Booleans (boolean).
- The program supports the composite data types Arrays (array) and Cartesian products (struct).
- The program supports functions with dynamic binding and copying mechanism for parameter passing.

Other Features include:

- Print statement
- Variable declaration statement
- Assignment statement
- While loop

- Conditional statement (If-Else)
- Function declaration and Function call
- Cartesian products
- Arrays
- Type checking
- Boolean cannot operate with any other types and error handling is expected.
- Integer and float may operate with each other. Type conversion mechanism is provided if the operations between integer and float is possible.
- Statement block and environment checking
- The variable declared within a child environment should not be used in any higher level environment.

4 Limitations

- The program can not handle multi-dimensional arrays.

5 Member Responsibility

- Grammar Rules Production – Done by all of us.
- Type checking – Sriram and Nischal
- Report – Kevin
- *.java files – Nischal

6 Examples

```

/bin/zsh
ntschalghal0000:~/college/PLC/project
$ java -jar /usr/dist/parser-jar fibhalc
1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4181, 6765
ntschalghal0000:~/college/PLC/project

# Program to print fibonacci series. #
# =====
1 def fibb(int size)
2 begin
3   int prev = 0;
4   int curr = 1;
5   int temp = 1;
6   int count = 0; # count number of iterations. #
7   array<int> fib = [0]; # array to store fibonacci series. #
8   boolean run = true; # Set this to false to stop while loop. #
9   while run do
10    begin
11     temp = curr;
12     curr = prev + curr;
13     prev = temp;
14     fib[count] = prev;
15   end
16   if count == (size-1) then
17     begin
18       run = false;
19     end
20     count = count + 1;
21   end
22   return fib;
23 end;
24
25 # print fibb(20);

```

Figure 1: program to generate fibonacci series

```

/bin/zsh
ntschalghal0000:~/college/PLC/project
$ java -jar /usr/dist/parser-jar functions.plc
global thing
1 sup local str
from local: global thing globStr
global thing
from global: modified in local
21
ntschalghal0000:~/college/PLC/project

# Demonstrating Functions #
# =====
1 char str="global thing";
2 char globStr="global thing globStr";
3 def myfunction(int a, char foo)
4 begin
5   char str = "local str";
6   print "a=" +foo+"str";
7   print "from local: "+globStr;
8   globStr = "modified in local";
9 end;
10
11 print str;
12 myfunction(1,"sup");
13
14 print str;
15 print "from global: "+globStr;
16
17 def funtwo(int arg1)
18 begin
19   char str = "";
20   if arg1 == 1 then
21     begin
22       str = str+funtwo(2);
23     end;
24   return str+arg1;
25 end;
26
27 char returnedChar = funtwo(1);
28 print returnedChar;

```

Figure 2: demonstrating functions

```

/bin/zsh
nischal@hal9000:~/college/PLC/project
$ java -jar ./src/dist/parser.jar rec.plc
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