Assignment   3

All sections: Submit and Upload by 5/15/21   (Sunday) 11:59 pm
Extra Credit Working Iteration will be due on 5/8

Assignment 3 consists of :

1) Documentation and Specifications for you project (10%)

2) Symbol table handling and Type Checking or Parse Tree internal representation (20%)

3) Generating intermediate code for the simplified version of our Grammar from assignment2.
     Or implement a Bottom-Up approach for the Syntax Analyzer.
     Or add implementation to your Top-Down RDP approach.
     Or implementing your Top-Down Syntax Analyzer using the Stack.
     Or use a different approach than the one you used for the last project.

More points for: Scope Checking, Type Checking, Testing, Error Handling, and/or integrating
all the assignments to work together. The more that is implemented additionally, the more points
you will get.

Our Grammar:
* The **grammar** is essentially the same in class except that it is more simplified and it has
  NO <Function Definitions>
* No "real" type is allowed

Some Semantics:
* Consider that "true" has an integer value of 1 and "false" has an integer value of 0.
* No arithmetic operations are allowed for booleans.
* The types must match for arithmetic operations (no conversions)

Part 1) Documentation and Specifications (10%):   Document your project and explain your
approach and functions and/or class using the documentation template. Include program flow
and diagrams for maximum points.

Part 2) Symbol table Handling or Parse Tree internal representation (20%):   Every
identifier declared in the program should be placed in a symbol table and accessed by the
symbol table handling procedures.
a) Each entry in the symbol table should hold the lexeme, and a "memory address" where an
identifier is placed within the symbol table. For example, define a global integer variable called
"Memory_address" and set initially 5000 and increment it by one when a new identifier is
declared and placed into the table.
b) You need to write a procedure that will check to see if a particular identifier is already in the

table, a procedure that will insert into the table and a procedure that will printout all identifiers in the table. If an identifier is used without declaring it, then the parser should provide an error message. Also, if an identifier is already in the table and wants to declare it for the second time, then the parser should provide an error message. Also, you should check the type match.

Part 3) Generating the assembly code or the other options above (70%):

Modify your parser according to the Grammar from class so that your parser will produce the assembly code instructions. The instructions should be kept in an array and at the end, the content of the array is printed out to produce the listing of assembly code. Your array should hold at least 1000 assembly instructions. The instruction starts from 1.
The listing should include an array index for each entry so that it serves as label to jump to. *The compiler should also produce a listing of all the identifiers.*

Our target machine is a virtual machine based on a stack with the following instructions

PUSHI   **{Integer Value}** Pushes the {Integer Value} onto the Top of the Stack (TOS)
PUSHM **{ML - Memory Location}** Pushes the value stored at {ML} onto TOS
POPM   **{ML}** Pops the value from the top of the stack and stores it at {ML}
STDOUT   Pops the value from TOS and outputs it to the standard output
STDIN   Get the value from the standard input and place in onto the TOS
ADD   Pop the first two items from stack and push the sum onto the TOS
SUB   Pop the first two items from stack and push the difference onto the TOS
      (Second item - First item)
MUL   Pop the first two items from stack and push the product onto the TOS
DIV   Pop the first two items from stack and push the result onto the TOS
      (Second item / First item and ignore the remainder)
GRT   Pops two items from the stack and pushes 1 onto TOS if second item is
      larger otherwise push 0
LES   Pops two items from the stack and pushes 1 onto TOS if the second item is
      smaller than first item otherwise push 0
EQU   Pops two items from the stack and pushes 1 onto TOS if they are equal
      otherwise push 0
NEQ   Pops two items from the stack and pushes 1 onto TOS if they are not equal
      otherwise push 0
GEQ   Pops two items from the stack and pushes 1 onto TOS if second item is
      larger or equal, otherwise push 0
LEQ   Pops two items from the stack and pushes 1 onto TOS if second item is
      less or equal, otherwise push 0
JUMPZ   **{IL - Instruction Location}** Pop the stack and if the value is 0 then jump to {IL}
JUMP   **{IL}** Unconditionally jump to {IL}
LABEL   Empty Instruction; Provides the instruction location to jump to.

A Sample Source Code

! this is comment for this sample code for assignment 3 !

    int   i, max, sum;

    sum = 0;
    i = 1;
    input (max);
    while (i < max) {
        sum = sum + i;
        i = i + 1;
     }
     output (sum + max);

One Possible Assembly Code Listing

```
1    PUSHI    0
2    POPM     5002
3    PUSHI    1
4    POPM     5000
5    STDIN
6    POPM     5001
7    LABEL
8    PUSHM    5000
9    PUSHM    5001
10   LES
11   JUMPZ       21
12   PUSHM    5002
13   PUSHM    5000
14   ADD
15   POPM     5002
17   PUSHM    5000
17   PUSHI    1
18   ADD
19   POPM     5000
20   JUMP       7
21   PUSHM    5002
22   PUSHM    5001
23   ADD
24   STDOUT
```

Symbol Table

Identifier	MemoryLocation	Type
i	5000	integer
max	5001	integer
sum	5002	integer

NOTE:
- **DO NOT CREATE YOUR OWN ASSEMBLY INSTRUCTIONS.
  USE ONLY PROVIDED INSTRUCTIONS.**

- **<u>Turn in your document according to the instructions given in the project outline.</u>**