CS3300:Compiler Design Odd Sem 2020

Assignment #3

Assembly Code Generation (13 marks) Deadline : 11/10/2020, 11:55PM

1 Task

The aim of the assignment is to generate x86 assembly code for the language used in Assignment 2 with the help of generated Abstract Syntax Tree from Assignment #2.

2 For which basic constructs assembly code should be generated?

We will be using the grammar given in the Assignment #2 and we will restrict assembly generation only to few constructs. Our test-cases (.c file) will contain only the below basic constructs for which you are required to generate assembly code,

- Variable declaration statements - You need to handle only integer type declarations (excluding pointers in that).
- Assignment statements - Includes all but excluding Array and Function assignment statements.
- Function calls - You need to handle only 'printf ' function call. User-defined function and others are excluded.
- If statement - Includes both 'If then' and 'If then else'. The nesting of If statement is excluded.
- While statement - Excluding nesting of 'While' statement , 'break' and 'continue' constructs. Also, no combination of If and While statements together (i.e.) no If stmt inside While and vice-versa.

Bonus (2 marks): You should handle below construct to get the bonus marks,

- Functions - You should handle user-defined functions and return statements (1 mark).
- Handling Array and Function assignment statements (1 mark).

3 Input

The input will be a program (.c file) which contains statements according to the above basic construct(s) description.
Sample execution format:

```
$ ./a.out < test_case1.c
```

Note: Input should be read from stdin.

4 Output

You should emit the assembly code for the corresponding input file (here test_case1.c), which we will capture to a .s file like,

```
$ ./a.out < test_case1.c > tc1.s
```

Note: Output should be written to stdout.

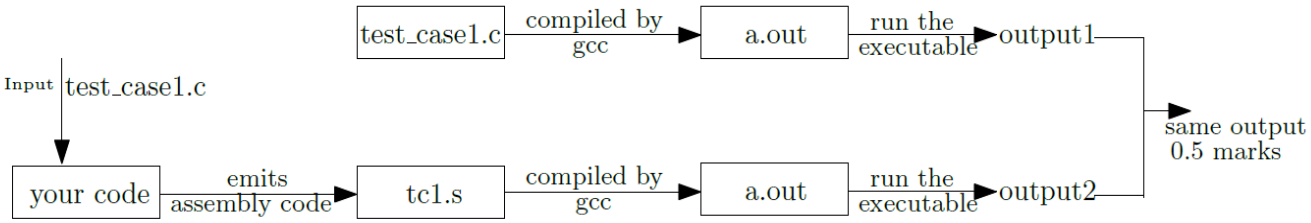
5 Submission (in moodle)

Submit a tar.gz file with filename as ⟨ROLLNO⟩.tar.gz (eg.CS18B043.tar.gz) containing the following structure:

- CS18B043 ⟨directory⟩
  - *.l
  - *.y
  - The Makefile should run lex, yacc, compile the generated code and generate an executable a.out file.

6 How we will evaluate your code?

- We will evaluate your code against 30 test-cases. 5 public test-cases, 21 hidden test-cases, and last 4 test-cases for Bonus marks.
- Each test-case carries .5 marks and total marks is 13. Bonus is 2 mark (last 4 test-cases).
- Below figure shows how your code is evaluated,



- The 30 test-cases will contain a mix-up of very simple, simple, less complex and complex test-cases. We will look only at the final printed output not your generated assembly code. So, you must generate the assembly code for 'printf' function call to pass all test-cases.

7 Sample Test Case

- testcase_1.c
  - **Input**

```
int main() {
        int a;
        a = 6;
        printf("%d\n", a);
        return 0;
}
```

  - **Your emitted assembly code stored in tc1.s file**

```
.LC0:
        .string "%d\n"
        .text
        .globl main
        .type main, @function
```

```
main:
.LFB0:
        .cfi_startproc
        .pushq  %rbp
        .cfi_def_cfa_offset 16
        .cfi_offset 6, -16
        movq    %rsp, %rbp
        .cfi_def_cfa_register 6
        subq    $16, %rsp
        movl    $6, -4(%rbp)
        movl    -4(%rbp), %eax
        movl    %eax, %esi
        movl    $.LC0, %edi
        movl    $0, %eax
        call    printf
        movl    $0, %eax
        leave
        .cfi_def_cfa 7,8
        ret
        .cfi_endproc
```

- **evaluation**

```
$ gcc testcase_1.c
$ ./a.out
6
$ gcc tc1.s
$./a.out
6
```

- here both output result matches and will be given 0.5 marks.

8 What will we upload in the moodle?

- This file (Assignment3.pdf), 5 + 2 public test-cases (last two are bonus test-cases) and evaluation script.
- All 30 test-cases (after the deadline).

9 Some stuff(s) to know

- You can generate assembly code using gcc. how? $gcc -S testcase_1.c
- A tool named MOSS, which can compare multiple codes and identifies which parts of the code are similar (copied).

10 FAQs

- You are allowed to use both C and C++ languages for coding.
- Only accepted printf stmt used in test cases as per the grammar is "printf("%d\n", identifier);"
- The marks uploaded in moodle will be out of 13.

- Emit your code only using ⟨STDIO⟩, not using ⟨STDERR⟩.
- Remove all your debugging statements.

11 Grammer of Assignment #2

program → decl_list
decl_list → decl_list decl | decl
decl → var_decl | func_decl | struct_decl
struct_decl → "struct" identifier "{" local_decls "}" ";"
var_decl → type_spec identifier ";"
| type_spec identifier "," var_decl
| type_spec identifier "[" integerLit "]" ";"
| type_spec identifier "[" integerLit "]" "," var_decl
type_spec → extern_spec "void" | extern_spec "int" | extern_spec "float"
| extern_spec "void" "*" | extern_spec "int" "*" | extern_spec "float" "*"
| "struct" identifier | "struct" identifier "*"
extern_spec → "extern" |ϵ
fun_decl → type_spec identifier "(" params ")" compound_stmt
params → param_list |ϵ
param_list → param_list "," param | param
param → type_spec identifier | type_spec identifier "[" "]"
stmt_list → stmt_list stmt | stmt
stmt → assign_stmt | compound_stmt | if_stmt | while_stmt | switch_stmt
| return_stmt | break_stmt | continue_stmt | dowhile_stmt| print_stmt
| incr_stmt| decr_stmt
while_stmt → "while" "(" expr ")" stmt
dowhile_stmt → "do" stmt "while" "(" "expr" ")" ";"
print_stmt → "printf" "(" format_specifier "," identifier ")" ";"
format_specifier →""%d\n""
compound_stmt → "{" local_decls stmt_list "}"
local_decls → local_decls local_decl |ϵ
local_decl → type_spec identifier ";"
| type_spec identifier "[" expr "]" ";"
if_stmt → "if" "(" expr ")" stmt
| "if" "(" expr ")" stmt "else" stmt
return_stmt → "return" ";" | "return" expr ";"
break_stmt → "break" ";"
continue_stmt → "continue" ";"
switch_stmt → "switch" "(" expr ")" "{" compound_case default_case "}"
compund_case → single_case compound_case
| single_case
single_case → "case" integerLit ":" stmt_list
default_case → "default" ":" stmt_list

assign_stmt → identifier ”=” expr ”;”| identifier ”[” expr ”]” ”=” expr ”;”
| identifier ”->” identifier ”=” expr ”;”
| identifier ”.” identifier ”=” expr ”;”

incr_stmt → identifier ”++” ”;”

decr_stmt → identifier ”−−” ”;”

expr → Pexpr ”<” Pexpr | Pexpr ”>” Pexpr
→ Pexpr ”<=” Pexpr | Pexpr ”>=” Pexpr
→ Pexpr ”||” Pexpr | ”sizeof” ”(” Pexpr ”)”
→ Pexpr ”==” Pexpr | Pexpr ”!=” Pexpr| Pexpr ”<=>” Pexpr
→ Pexpr ”&&” Pexpr| Pexpr ”->” Pexpr
→ Pexpr ”+” Pexpr | Pexpr ”-” Pexpr
→ Pexpr ”*” Pexpr | Pexpr ”/” Pexpr | Pexpr ”%” Pexpr
→ ”!” Pexpr | ”-” Pexpr | ”+” Pexpr | ”*” Pexp | ”&” Pexp
→ Pexpr
→ identifier ”(” args ”)”
→ identifier ”[” expr ”]”

Pexpr → integerLit | floatLit | identifier | ”(” expr ”)”

integerLit → < INTEGER_LITERAL >

floatLit → < FLOAT_LITERAL >

identifier → < IDENTIFIER >

arg_list → arg_list ”,” expr | expr

args → arg_list |ϵ