

Computer Science and Engineering Department
Indian Institute of Technology Kharagpur

Compilers Laboratory: CS39003

3rd Year CSE: 5th Semester

Assignment - 4: Parser for tinyC
Assign Date: September 13, 2022

Marks: 100
Submit Date: 23:55, October 12, 2022

1 Preamble – tinyC

This assignment follows the phase structure grammar specification of C language from the International Standard **ISO/IEC 9899:1999 (E)**. To keep the assignment within our required scope, we have chosen a subset of the specification as given below. We shall refer to this language as tinyC.

The lexical specification of tinyC, also taken and abridged from the Standard, has already been discussed in Assignment 3.

The phase structure grammar specification is written using the common notation of language specifications as discussed in the last assignment.

2 Phrase Structure Grammar of C

1. Expressions

primary-expression:
 identifier
 constant
 string-literal
 (*expression*)

postfix-expression:
 primary-expression
 postfix-expression [*expression*]
 postfix-expression (*argument-expression-list*_{opt})
 postfix-expression . *identifier*
 postfix-expression – > *identifier*
 postfix-expression ++
 postfix-expression --
 (*type-name*) { *initializer-list* }
 (*type-name*) { *initializer-list* , }

argument-expression-list:
 assignment-expression
 argument-expression-list , *assignment-expression*

unary-expression:
 postfix-expression
 ++ *unary-expression*
 -- *unary-expression*
 unary-operator *cast-expression*
 sizeof *unary-expression*
 sizeof (*type-name*)

unary-operator: one of

& * + - ~ !

cast-expression:
 unary-expression
 (*type-name*) *cast-expression*

multiplicative-expression:
 cast-expression
 multiplicative-expression * *cast-expression*
 multiplicative-expression / *cast-expression*
 multiplicative-expression % *cast-expression*

additive-expression:
multiplicative-expression
additive-expression + *multiplicative-expression*
additive-expression - *multiplicative-expression*
shift-expression:
additive-expression
shift-expression << *additive-expression*
shift-expression >> *additive-expression*
relational-expression:
shift-expression
relational-expression < *shift-expression*
relational-expression > *shift-expression*
relational-expression <= *shift-expression*
relational-expression >= *shift-expression*
equality-expression:
relational-expression
equality-expression == *relational-expression*
equality-expression != *relational-expression*
AND-expression:
equality-expression
AND-expression & *equality-expression*
exclusive-OR-expression:
AND-expression
exclusive-OR-expression ^ *AND-expression*
inclusive-OR-expression:
exclusive-OR-expression
inclusive-OR-expression | *exclusive-OR-expression*
logical-AND-expression:
inclusive-OR-expression
logical-AND-expression && *inclusive-OR-expression*
logical-OR-expression:
logical-AND-expression
logical-OR-expression || *logical-AND-expression*
conditional-expression:
logical-OR-expression
logical-OR-expression ? *expression* : *conditional-expression*
assignment-expression:
conditional-expression
unary-expression *assignment-operator* *assignment-expression*
assignment-operator: one of

= * = / = % = + = - = < = > = & = ^ = | =

expression:
assignment-expression
expression , *assignment-expression*
constant-expression:
conditional-expression

2. Declarations

declaration:
declaration-specifiers *init-declarator-list*_{opt} ;
declaration-specifiers:
storage-class-specifier *declaration-specifiers*_{opt}
type-specifier *declaration-specifiers*_{opt}
type-qualifier *declaration-specifiers*_{opt}
function-specifier *declaration-specifiers*_{opt}
init-declarator-list:
init-declarator
init-declarator-list , *init-declarator*
init-declarator:
declarator
declarator = *initializer*

storage-class-specifier:

- extern**
- static**
- auto**
- register**

type-specifier:

- void**
- char**
- short**
- int**
- long**
- float**
- double**
- signed**
- unsigned**
- _Bool**
- _Complex**
- _Imaginary**

enum-specifier

specifier-qualifier-list:

- type-specifier specifier-qualifier-list_{opt}*
- type-qualifier specifier-qualifier-list_{opt}*

enum-specifier:

- enum** *identifier_{opt}* { *enumerator-list* }
- enum** *identifier_{opt}* { *enumerator-list* , }
- enum** *identifier*

enumerator-list:

- enumerator*
- enumerator-list* , *enumerator*

enumerator:

- enumeration-constant*
- enumeration-constant* = *constant-expression*

type-qualifier:

- const**
- restrict**
- volatile**

function-specifier:

- inline**

declarator:

- pointer_{opt} direct-declarator*

direct-declarator:

- identifier*
- (*declarator*)
- direct-declarator* [*type-qualifier-list_{opt} assignment-expression_{opt}*]
- direct-declarator* [**static** *type-qualifier-list_{opt} assignment-expression*]
- direct-declarator* [*type-qualifier-list* **static** *assignment-expression*]
- direct-declarator* [*type-qualifier-list_{opt}* *]
- direct-declarator* (*parameter-type-list*)
- direct-declarator* (*identifier-list_{opt}*)

pointer:

- * *type-qualifier-list_{opt}*
- * *type-qualifier-list_{opt} pointer*

type-qualifier-list:

- type-qualifier*
- type-qualifier-list type-qualifier*

parameter-type-list:

- parameter-list*
- parameter-list* , ...

parameter-list:

- parameter-declaration*
- parameter-list* , *parameter-declaration*

parameter-declaration:
 declaration-specifiers declarator
 declaration-specifiers
identifier-list:
 identifier
 identifier-list , identifier
type-name:
 specifier-qualifier-list
initializer:
 assignment-expression
 { *initializer-list* }
 { *initializer-list* , }
initializer-list:
 designation_{opt} initializer
 initializer-list , designation_{opt} initializer
designation:
 designator-list =
designator-list:
 designator
 designator-list designator
designator:
 [*constant-expression*]
 . *identifier*

3. Statements

statement:
 labeled-statement
 compound-statement
 expression-statement
 selection-statement
 iteration-statement
 jump-statement
labeled-statement:
 identifier : statement
 case *constant-expression : statement*
 default : *statement*
compound-statement:
 { *block-item-list_{opt}* }
block-item-list:
 block-item
 block-item-list block-item
block-item:
 declaration
 statement
expression-statement:
 expression_{opt} ;
selection-statement:
 if (*expression*) *statement*
 if (*expression*) *statement* **else** *statement*
 switch (*expression*) *statement*
iteration-statement:
 while (*expression*) *statement*
 do *statement* **while** (*expression*) ;
 for (*expression_{opt} ; expression_{opt} ; expression_{opt}*) *statement*
 for (*declaration expression_{opt} ; expression_{opt}*) *statement*
jump-statement:
 goto *identifier* ;
 continue ;
 break ;
 return *expression_{opt} ;*

4. External definitions

translation-unit:
 external-declaration
 translation-unit external-declaration
external-declaration:
 function-definition
 declaration
function-definition:
 declaration-specifiers declarator declaration-list_{opt} compound-statement
declaration-list:
 declaration
 declaration-list declaration

3 The Assignment

1. Write a bison specification for defining the tokens of `tinyC` and generate the required `y.tab.h` file.
2. Write a bison specification for the language of `tinyC` using the above phase structure grammar. Use the flex specification that you had developed for Assignment 3 (if required, you may fix your flex specification).
3. While writing the bison specification, you may need to make some changes to the grammar. For example, some non-terminals like

argument-expression-list_{opt}

are shown as optional on the right-hand-side as:

postfix-expression:

postfix-expression (*argument-expression-list_{opt}*)

One way to handle them would be to introduce a new non-terminal, *argument-expression-list-opt*, and a pair of new productions:

argument-expression-list-opt:

argument-expression-list

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and change the above rule as:

postfix-expression:

postfix-expression (*argument-expression-list-opt*)

4. Names of your `.l` and `.y` files should be `asgn4_roll.l` and `asgn4_roll.y` respectively. The `.y` or the `.l` file should not contain the function `main()`. Write your `main()` (in a separate file `asgn4_roll.c`) to test your lexer and parser.
5. Prepare a Makefile to compile the specifications and generate the lexer and the parser.
6. Prepare a test input file `asgn4_roll_test.c` that will test all the rules that you have coded.
7. Prepare a tar-archive with the name `asgn4_roll.tar` containing all the files and upload to Moodle.

4 Credits

1. Specifications and testing: **70**
2. Main file: **10**
NOTE: No marks for Makefile, but a penalty of 20 marks for not including Makefile.
3. Test file: **20**