CS323 Compiler Project Phase 2

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Sorted in alphabetical order.

Test Platform

Name	Value
OS	Ubuntu 22.04.2 LTS on Windows 10 x86_64
Bison	bison (GNU Bison) 3.8.2
Flex	flex 2.6.4
libbison-dev	2:3.8.2+dfsg-1build1
gcc	gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0
Make	GNU Make 4.3. Built for x86_64-pc-linux-gnu

Compile and Run

The minimum required Bison version is **3.6**, which allows detailed error information, which allows detailed error information.

```
mkdir -p build && cd build
cmake ../
make
```

After successful compilation, run

```
bin/splc -h
```

to get help on various arguments.

Tests

Tests provided by our team are placed under `test/self-test/phase2/`.

Extra test cases are placed under both `test/test-ex/` or `test/test-func/`.

Basic Feature List

Detections:

Type	Description	Implemented?
1	Variable used without definition	Yes

Type	Description	Implemented?
2	Function invoked without definition	Yes
3	Redefinition of variable in the same scope	Yes
4	Redefinition of function in global scope	Yes
5	Unmatching types on both sides of the assignment operator	Partial (**Implicit Cast**/**Explicit Cast**)
6	**rvalue** appears on the left-hand side of the assignment operator	Yes
7	Unmatching operands	Partial (**Implicit Cast**/**Explicit Cast**)
8	Function's return type mismatch the declared type	Yes
9	Functions' argument mismatches the declared type	Yes
10	Applying indexing operator on non-array type variables	Partial (Warning on types that cannot be derefenced)
11	Applying function invocation operator on non-function names	Yes
12	Array indexing with a non-integer type expression	Yes
13	Accessing members of a non-structure variable	Yes
14	Accessing undefined structure member	Yes
15	Redefine the same structure type	Yes

Extended Features List

Phase 2

Optional Rules

- **Extended Grammar**: now supports most of C99 and part of C11.

Features	Implemented
Atomic	false
Pointers, Function Pointers, ...	true
Address-of	true
Struct, Union, Enum	true

Features	Implemented
...	

Please see the end of this report to get a glance at the full grammar supported.

- **Use with declaration but without definition**
- **Recursive Type Checking System**

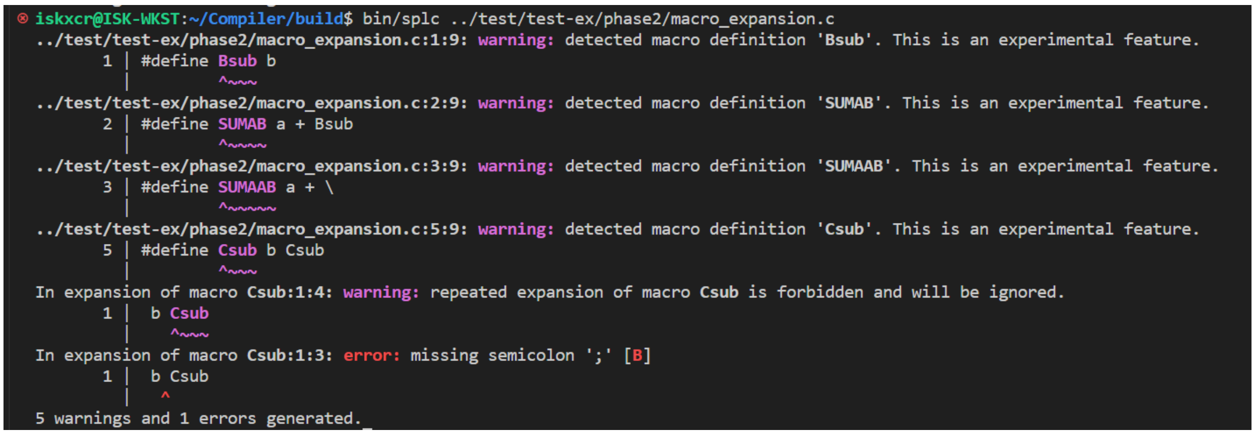
Improvement to Previous Program

Test case: `test/test-func/phase1.c` (modified from `modules/splc/src/splcopt.c`)

```
#define NULL (void *)0
typedef unsigned long long size_t;
/* From `splcdef.h` */

int splc_incl_dir_cnt = 0;
const char **splc_incl_dirs = NULL;

int splc_src_file_cnt = 0;
const char **splc_src_files = NULL;

/* From `splcopt.h` */

int splc_opterror = 1;
int splc_optind = 1;
char splc_optopt = '\0';
const char *splc_optfull = NULL;
const char *splc_optarg = NULL;

/* Own definitions */
typedef struct option
{
  int *const target_opt;
  const int opt_abbr;
  const char *opt_name;
} option;

#define OPT_CNT 5
static const option options[OPT_CNT] = {
  {&splcf_verbose, -1, "fverbose"},
  {&splcf_no_diagnostics_color, -1, "fno-diagnostics-color"},
  {&splcf_ast_dump, -1, "ast-dump"},
  {&splcf_enable_ast_punctuators, -1, "fenable-ast-punctuators"},
  {&splcf_no_ast_color, -1, "fno-ast-color"},
};

// clang-format off
void usage()
{
  printf("usage: \033[1m%s\033[0m [options] [file ...]\n%s%s%s%s%s%s%s", progname,
        "  -h                         print this usage and exit\n",
        "  -fverbose                  print all available diagnostic information\n",
        "  -fno-diagnostics-color     do not color diagnostic information\n",
        "  -ast-dump                    dump generated AST to stdout\n",
        "  -fenable-ast-punctuators     append punctuators in AST\n",
        "  -fcolor-ast                  color the output AST\n",
        "  -I<include-directory>        specify extra directory for #include search\n");
}
// clang-format on
/* omitted... */

void splc_process_args(const int nargc, const char *nargv[])
{
  /* content */
}
```

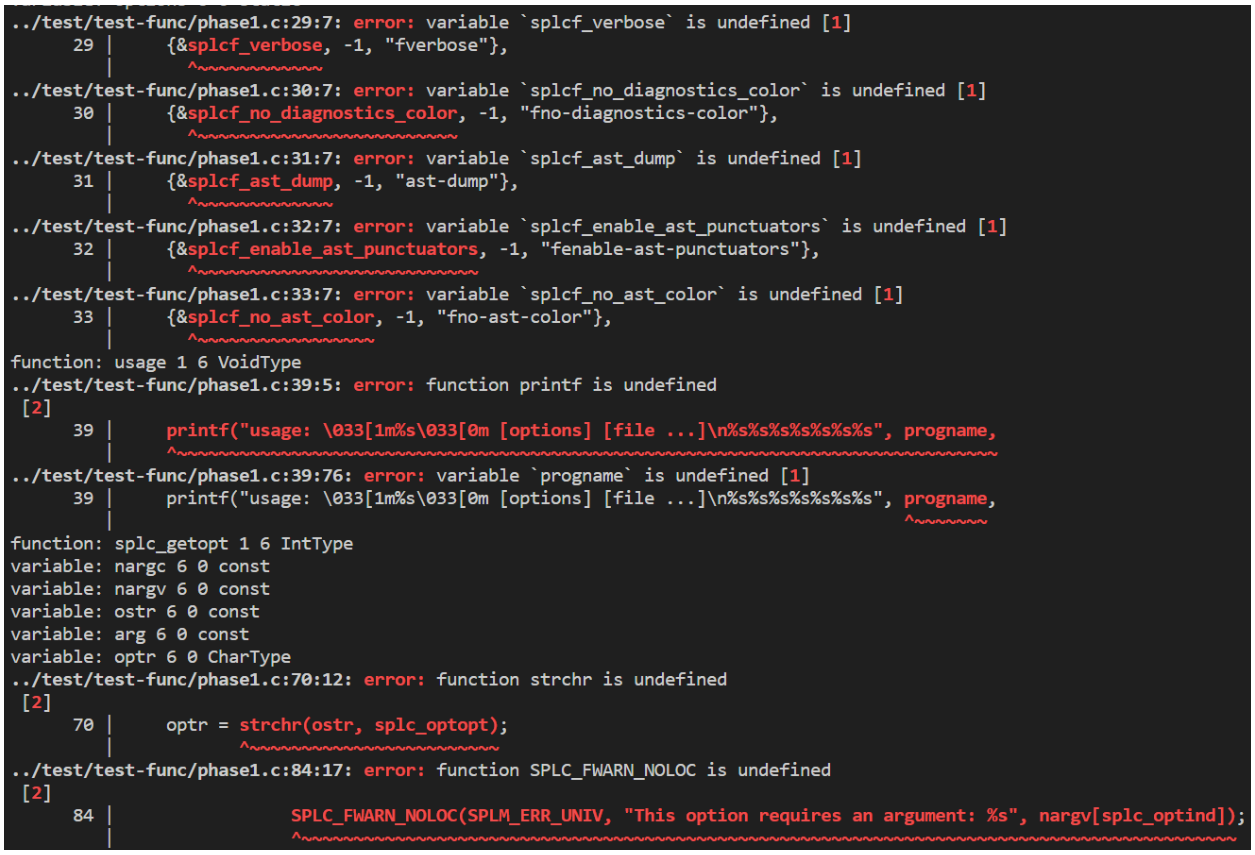
- **Recursive macro expansion**: Switch between different flex buffers.

  ```
  #define Bsub b
  #define SUMAB a + Bsub
  #define SUMAAB a + \
      SUMAB
  #define Csub b Csub

  int main()
  {
      int a, b, c;
      c = SUMAAB;
      Csub;
      return 0;
  }
  ```

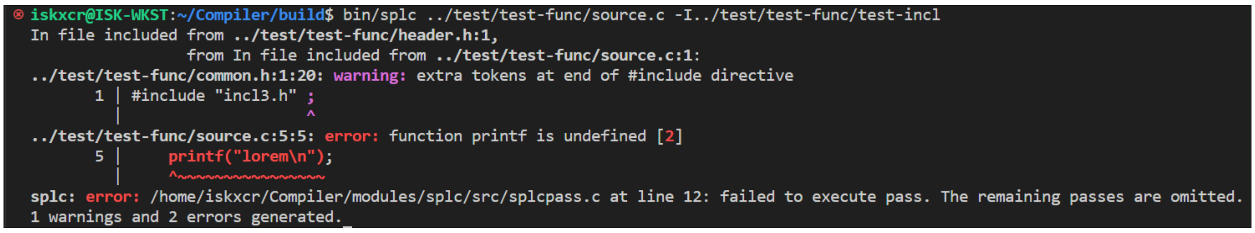
  

  ```
  ⊗ iskxcr@ISK-WKST:~/Compiler/build$ bin/splc ../test/test-ex/phase2/macro_expansion.c
    ../test/test-ex/phase2/macro_expansion.c:1:9: warning: detected macro definition 'Bsub'. This is an experimental feature.
          1 | #define Bsub b
            |         ^~~~
    ../test/test-ex/phase2/macro_expansion.c:2:9: warning: detected macro definition 'SUMAB'. This is an experimental feature.
          2 | #define SUMAB a + Bsub
            |         ^~~~~
    ../test/test-ex/phase2/macro_expansion.c:3:9: warning: detected macro definition 'SUMAAB'. This is an experimental feature.
          3 | #define SUMAAB a + \
            |         ^~~~~~
    ../test/test-ex/phase2/macro_expansion.c:5:9: warning: detected macro definition 'Csub'. This is an experimental feature.
          5 | #define Csub b Csub
            |         ^~~~
    In expansion of macro Csub:1:4: warning: repeated expansion of macro Csub is forbidden and will be ignored.
          1 |  b Csub
            |    ^~~~
    In expansion of macro Csub:1:3: error: missing semicolon ';' [B]
          1 |  b Csub
            |   ^
    5 warnings and 1 errors generated._
  ```

- **Recursive file tracking**: The location tracking system and error reporting now traces file hierarchies.



```
../test/test-func/phase1.c:29:7: error: variable `splcf_verbose` is undefined [1]
     29 |     {&splcf_verbose, -1, "fverbose"},
        |       ^~~~~~~~~~~~~
../test/test-func/phase1.c:30:7: error: variable `splcf_no_diagnostics_color` is undefined [1]
     30 |     {&splcf_no_diagnostics_color, -1, "fno-diagnostics-color"},
        |       ^~~~~~~~~~~~~~~~~~~~~~~~~~
../test/test-func/phase1.c:31:7: error: variable `splcf_ast_dump` is undefined [1]
     31 |     {&splcf_ast_dump, -1, "ast-dump"},
        |       ^~~~~~~~~~~~~~
../test/test-func/phase1.c:32:7: error: variable `splcf_enable_ast_punctuators` is undefined [1]
     32 |     {&splcf_enable_ast_punctuators, -1, "fenable-ast-punctuators"},
        |       ^~~~~~~~~~~~~~~~~~~~~~~~~~~~
../test/test-func/phase1.c:33:7: error: variable `splcf_no_ast_color` is undefined [1]
     33 |     {&splcf_no_ast_color, -1, "fno-ast-color"},
        |       ^~~~~~~~~~~~~~~~~~
function: usage 1 6 VoidType
../test/test-func/phase1.c:39:5: error: function printf is undefined
 [2]
     39 |     printf("usage: \033[1m%s\033[0m [options] [file ...]\n%s%s%s%s%s%s%s", progname,
        |     ^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
../test/test-func/phase1.c:39:76: error: variable `progname` is undefined [1]
     39 |     printf("usage: \033[1m%s\033[0m [options] [file ...]\n%s%s%s%s%s%s%s", progname,
        |                                                                            ^~~~~~~~
function: splc_getopt 1 6 IntType
variable: nargc 6 0 const
variable: nargv 6 0 const
variable: ostr 6 0 const
variable: arg 6 0 const
variable: optr 6 0 CharType
../test/test-func/phase1.c:70:12: error: function strchr is undefined
 [2]
     70 |     optr = strchr(ostr, splc_optopt);
        |            ^~~~~~~~~~~~~~~~~~~~~~~~~
../test/test-func/phase1.c:84:17: error: function SPLC_FWARN_NOLOC is undefined
 [2]
     84 |                 SPLC_FWARN_NOLOC(SPLM_ERR_UNIV, "This option requires an argument: %s", nargv[splc_optind]);
        |                 ^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```



```
⊗ iskxcr@ISK-WKST:~/Compiler/build$ bin/splc ../test/test-func/source.c -I../test/test-func/test-incl
  In file included from ../test/test-func/header.h:1,
                 from In file included from ../test/test-func/source.c:1:
  ../test/test-func/common.h:1:20: warning: extra tokens at end of #include directive
        1 | #include "incl3.h" ;
          |                    ^
  ../test/test-func/source.c:5:5: error: function printf is undefined [2]
        5 |     printf("lorem\n");
          |     ^~~~~~~~~~~~~~~~~
  splc: error: /home/iskxcr/Compiler/modules/splc/src/splcpass.c at line 12: failed to execute pass. The remaining passes are omitted.
  1 warnings and 2 errors generated.
```

- **Extended Grammar**: as mentioned before.

Appendix: Full Grammar

```
/* Entire translation unit */
translation-unit:
      external-declaration-list
    |
    ;

/* External definition list: Recursive definition */
external-declaration-list:
      external-declaration
    | external-declaration-list external-declaration
    ;

/* External definition list: A single unit of one of . */
external-declaration:
      SEMI
    | declaration
    | function-definition
    ;
```

```
declaration-specifiers:
      storage-class-specifier
    | type-specifier
    | type-qualifier
    | function-specifier
    | declaration-specifiers type-specifier
    | declaration-specifiers storage-class-specifier
    | declaration-specifiers type-qualifier
    | declaration-specifiers function-specifier
    ;

storage-class-specifier:
      AUTO
    | EXTERN
    | REGISTER
    | STATIC
    | TYPEDEF
    ;

specifier-qualifier-list:
      type-specifier
    | type-qualifier
    | specifier-qualifier-list type-specifier
    | specifier-qualifier-list type-qualifier
    ;

type-specifier:
      builtin-type-specifier
    | struct-or-union-specifier
    | enum-specifier
    | TYPEDEF_NAME
    ;

function-specifier:
      INLINE
    ;

type-qualifier:
      KWD_CONST
    | RESTRICT
    | VOLATILE
    ;

type-name:
      specifier-qualifier-list
    | specifier-qualifier-list abstract-declarator
    ;

builtin-type-specifier:
      TYPE_VOID
    | TYPE_INT
    | TYPE_FLOAT
    | TYPE_CHAR
    | TYPE_SIGNED
    | TYPE_UNSIGNED
    | TYPE_LONG
    ;

abstract-declarator:
      pointer
    | pointer direct-abstract-declarator
    ;

direct-abstract-declarator:
      LP abstract-declarator RP
    | direct-abstract-declarator LSB assignment-expression RSB
    | direct-abstract-declarator LSB RSB
    ;

/* Specify a structure */
struct-or-union-specifier:
      struct-or-union identifier
    | struct-or-union struct-declaration-body
    | struct-or-union identifier struct-declaration-body
    ;

struct-or-union:
      KWD_STRUCT
    | KWD_UNION
    ;

struct-declaration-body:
      LC RC
    | LC struct-declaration-list RC
    ;

struct-declaration-list:
      struct-declaration
    | struct-declaration-list struct-declaration
    ;

struct-declaration:
      specifier-qualifier-list SEMI
    | specifier-qualifier-list struct-declarator-list SEMI
    ;

struct-declarator-list:
      struct-declarator
    | struct-declarator-list COMMA struct-declarator
    ;

struct-declarator:
      declarator
    | COLON constant-expression
    | declarator COLON constant-expression
    ;

enum-specifier:
      KWD_ENUM identifier
    | KWD_ENUM enumerator-body
    | KWD_ENUM identifier enumerator-body
    ;

enumerator-body:
      LC RC
    | LC enumerator-list RC
    | LC enumerator-list COMMA RC
    ;

enumerator-list:
      enumerator
    | enumerator-list COMMA enumerator
    ;

enumerator:
      enumeration-constant
    | enumeration-constant ASSIGN constant-expression
    ;

enumeration-constant:
      identifier
    ;

/* Single variable declaration */
declarator:
      pointer direct-declarator
    | direct-declarator
    ;

direct-declarator:
      identifier
    | LP declarator RP
    | direct-declarator LSB assignment-expression RSB
    | direct-declarator LSB RSB
    ;

pointer:
      ASTRK
    | ASTRK type-qualifier-list
    | pointer ASTRK
    | pointer ASTRK type-qualifier-list
    ;

type-qualifier-list:
      type-qualifier
    | type-qualifier-list type-qualifier
    ;

/* Definition: Base */
declaration:
      direct-declaration SEMI
    | direct-declaration error
    ;

direct-declaration:
      declaration-specifiers
    | declaration-specifiers init-declarator-list
    ;

/* Definition: Declaration of multiple variable.  */
init-declarator-list:
      init-declarator
    | init-declarator COMMA init-declarator-list
    ;

/* Definition: Single declaration unit. */
init-declarator:
      declarator
    | declarator ASSIGN initializer
    ;

initializer:
      assignment-expression
    | LC initializer-list RC
    | LC initializer-list COMMA RC
    ;

initializer-list:
      initializer
    | designation initializer
    | initializer-list COMMA designation initializer
    | initializer-list COMMA initializer
    ;

designation:
      designator-list ASSIGN
    ;

designator-list:
      designator
    | designator-list designator
    ;

designator:
      LSB constant-expression RSB
    | DOT identifier
    ;

function-definition:
      declaration-specifiers function-declarator compound-statement
    | function-declarator compound-statement
    | declaration-specifiers function-declarator SEMI
    ;

/* Function: Function name and body. */
function-declarator:
      direct-function-declarator
    | pointer direct-function-declarator
    ;
```

```
direct-function-declarator:
      direct-declarator-for-function LP parameter-type-list RP
    ;

direct-declarator-for-function:
      identifier
    ;

/* List of variables names */
parameter-type-list:

    | parameter-list
    | parameter-list COMMA ELLIPSIS
    ;

parameter-list:
      parameter-declaration
    | parameter-list COMMA parameter-declaration
    ;

/* Parameter declaration */
parameter-declaration:
      declaration-specifiers declarator
    | declaration-specifiers abstract-declarator
    | declaration-specifiers
    ;

/* Compound statement: A new scope. */
compound-statement:
      /* LC general-statement-list RC */
      LC general-statement-list RC

      /* LC RC */
    | LC RC
    ;

/* wrapper for C99 standard for statements */
general-statement-list:
      statement
    | declaration
    | general-statement-list statement
    | general-statement-list declaration
    ;

/* Statement: List of statements. Recursive definition. */
/* statement-list:
      statement
    | statement-list statement
    ; */

/* Statement: A single statement. */
statement:
      SEMI
    | compound-statement
    | expression-statement
    | selection-statement
    | iteration-statement
    | labeled-statement
    | jump-statement

    ;

expression-statement:
      expression SEMI
    ;

selection-statement:
      IF LP expression RP statement %prec THEN
    | IF LP expression RP statement ELSE statement %prec ELSE
    | SWITCH LP expression RP statement
    ;

labeled-statement:
      identifier COLON statement
    | CASE constant-expression COLON statement
    | DEFAULT COLON statement

    ;

jump-statement:
      GOTO identifier SEMI
    | CONTINUE SEMI
    | BREAK SEMI
    | RETURN expression SEMI
    | RETURN SEMI
    ;

iteration-statement:
      WHILE LP expression RP statement
    | DO statement WHILE LP expression RP SEMI
    | FOR LP for-loop-body RP statement
    ;

for-loop-body:
      initialization-expression SEMI expression SEMI expression

    | SEMI expression SEMI expression
    | initialization-expression SEMI expression SEMI
    | initialization-expression SEMI SEMI expression

    | SEMI expression SEMI
    | SEMI SEMI expression
    | initialization-expression SEMI SEMI

    | SEMI SEMI
    ;

constant-expression:
      conditional-expression
    ;
```

```
constant:
      LTR_INT
    | LTR_FLOAT
    | LTR_CHAR
    ;

primary-expression:
      identifier
    | constant
    | string-literal
    | LP expression RP
    ;

postfix-expression:
      primary-expression
    | postfix-expression LSB expression RSB
    | postfix-expression LP argument-list RP
    | postfix-expression member-access-operator identifier
    | postfix-expression DPLUS
    | postfix-expression DMINUS
    | LP type-name RP LC initializer-list RC
    | LP type-name RP LC initializer-list COMMA RC
    ;

member-access-operator:
      DOT
    | RARROW
    ;

unary-expression:
      postfix-expression
    | DPLUS unary-expression
    | DMINUS unary-expression
    | unary-operator cast-expression %prec UPLUS
    | SIZEOF unary-expression
    | SIZEOF LP type-name RP
    /* | SIZEOF LP unary-expression RP {} */
    ;

unary-operator: /* Take the default behavior, that is, `$$ = $1` */
      BW_AND
    | ASTRK
    | PLUS
    | MINUS
    | BW_NOT
    | NOT
    ;

cast-expression:
      unary-expression
    | LP type-name RP cast-expression
    ;

multiplicative-expression:
      cast-expression
    | multiplicative-expression multiplicative-operator cast-expression
    ;

multiplicative-operator:
      ASTRK
    | division-operator
    ;

division-operator:
      DIV
    | MOD
    ;

additive-expression:
      multiplicative-expression
    | additive-expression additive-operator multiplicative-expression
    ;

additive-operator:
      PLUS
    | MINUS
    ;

shift-expression:
      additive-expression
    | shift-expression shift-operator additive-expression
    ;

shift-operator:
      LSHIFT
    | RSHIFT
    ;

relational-expression:
      shift-expression
    | relational-expression relational-operator shift-expression
    ;

relational-operator:
      LT
    | GT
    | LE
    | GE
    ;

equality-expression:
      relational-expression
    | equality-expression equality-operator relational-expression
    ;

equality-operator:
      EQ
    | NE
    ;
```

```
BW-AND-expression:
      equality-expression
    | BW-AND-expression BW_AND equality-expression
    ;

BW-XOR-expression:
      BW-AND-expression
    | BW-XOR-expression BW_XOR BW-AND-expression
    ;

BW-OR-expression:
      BW-XOR-expression
    | BW-OR-expression BW_OR BW-XOR-expression
    ;

logical-AND-expression:
      BW-OR-expression
    | logical-AND-expression AND BW-OR-expression
    ;

logical-OR-expression:
      logical-AND-expression
    | logical-OR-expression OR logical-AND-expression
    ;

conditional-expression:
      logical-OR-expression
    | logical-OR-expression QM expression COLON conditional-expression

    ;

assignment-expression:
      conditional-expression
    | conditional-expression assignment-operator assignment-expression
    ;

assignment-operator: /* Use the default behavior to pass the value */
      ASSIGN
    | MUL_ASSIGN
    | DIV_ASSIGN
    | MOD_ASSIGN
    | PLUS_ASSIGN
    | MINUS_ASSIGN
    | LSHIFT_ASSIGN
    | RSHIFT_ASSIGN
    | BW_AND_ASSIGN
    | BW_XOR_ASSIGN
    | BW_OR_ASSIGN
    ;

/* expressions */
expression:
      assignment-expression
    | expression COMMA assignment-expression
    | expression COMMA error
    | COMMA assignment-expression
    ;

initialization-expression:
      expression
    | direct-declaration
    ;

/* Argument: List of arguments */
argument-list:

    | argument-list COMMA assignment-expression
    | assignment-expression

    ;

/* String intermediate expression. Allowing concatenation of strings. */
string-literal:
      STR_UNIT
    | string-literal STR_UNIT
    ;

identifier:
      ID
    ;
```