Programming in C/C++
Exercises set six: parsers II

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Exercise 36, expand new grammar

We were tasked to add some functionalities to the demo parser.

Code listings

Scanner

Listing 1: lexer.ll

```
1  %filenames scanner
2  %interactive
3
4  digits      [0-9]+
5  optdigits   [0-9]*
6  exp         [eE][-+]?{digits}
7
8  %%
9
10 [ \t]+
11
12 {digits}                     |
13 {digits}"."{optdigits}{exp}? |
14 {optdigits}"."{digits}{exp}?  return Parser::NUMBER;
15
16 QUIT                          return ParserBase::
       Tokens__::QUIT;
```

```
17 EXIT                              return ParserBase::
       Tokens__::QUIT;
18 LIST                              return ParserBase::
       Tokens__::LIST;
19 [[:alpha:]_][[:alnum:]_]*         return Parser::IDENT;
20 \n|.                              return matched()[0];
```

Scanner

Listing 2: grammar.gr

```
 1 %class-name Parser
 2
 3 %filenames parser
 4 %parsefun-source parse.cc
 5
 6 %baseclass-preinclude rulevalue.h
 7 %stype RuleValue
 8
 9 %scanner ../scanner/scanner.h
10
11 %token  NUMBER
12         IDENT
13         QUIT
14         EXIT
15         LIST
16
17 %right  '='
18 %left   '+' '-'
19 %right  uMinus
20
21 // %debug
22
23 %%
24
25 lines:
26   lines line
27 |
28   line
29 ;
30
```

```
31
32  line:
33    expr '\n'
34    {
35      display($1);
36    }
37  |
38    error '\n'
39    {
40      prompt();
41    }
42  |
43    '\n'
44    {
45      prompt();
46    }
47  |
48    LIST
49    {
50      list();
51    }
52  |
53    EXIT
54    {
55      quit();
56    }
57  |
58    QUIT
59    {
60      quit();
61    }
62  ;
63
64
65  expr:
66    NUMBER
67    {
68      $$ = value();
69    }
70  |
```

```
71    IDENT
72    {
73      $$ = variable();
74    }
75  |
76    '-' expr     %prec uMinus
77    {
78      $$ = negate($2);
79    }
80  |
81    expr '+' expr
82    {
83      $$ = add($1, $3);
84    }
85  |
86    expr '-' expr
87    {
88      $$ = sub($1, $3);
89    }
90  |
91    '(' expr ')'
92    {
93      $$ = $2;
94    }
95  |
96    expr '=' expr
97    {
98      $$ = assign($1, $3);
99    }
100 ;
```

Listing 3: parser.h

```
1  ...
2  #include <vector>
3  #include <unordered_map>
4  #include <string>
5  ...
6
7  ...
8      std::vector<double> d_value;
```

```
 9      std::unordered_map
10          <std::string, unsigned> d_symtab;
11  ...
12
13  ...
14      // added functions for the calculator:
15          void display(RuleValue &e);
16          void done();
17          void prompt();
18
19          RuleValue &add(RuleValue &lvalue,
20              RuleValue &rvalue);
21          RuleValue &assign(RuleValue &lvalue,
22              RuleValue &rvalue);
23          RuleValue &negate(RuleValue &e);
24          RuleValue &sub(RuleValue &lvalue,
25              RuleValue &rvalue);
26          RuleValue value();
27          RuleValue variable();
28
29          double valueOf(RuleValue const &e);
30
31          void quit();
32          void list();
33  };
34
35
36  #endif
```

Listing 4: list.cc

```
 1  #include "Parser.ih"
 2
 3  void Parser::list()
 4  {
 5      std::map<std::string, unsigned>
 6          ordered_map(d_symtab.begin(), d_symtab.end());
 7
 8      for (auto it = ordered_map.begin();
 9              it != ordered_map.end(); ++it)
10
```

```
11        std::cout << it->first
12                  << " => "
13                  << it->second
14                  << '\n';
15  }
```

Listing 5: quit.cc

```
1  #include "Parser.ih"
2
3  void Parser::quit()
4  {
5    ACCEPT();
6  }
```

Exercise 37, substantial grammar extension

All these operators.

Code listings

Scanner for both 37 and 38

Listing 6: lexer

```
1  %filenames scanner
2  %interactive
3
4  digits      [0-9]+
5  optdigits   [0-9]*
6  exp         [eE][-+]?{digits}
7
8  %%
9
10 [ \t]+                        // ignore
11
12 {digits}                      |
13 {digits}"."{optdigits}{exp}?  |
14 {optdigits}"."{digits}{exp}?  return Parser::NUMBER;
15
16 [[:alpha:]_][[:alnum:]_]*     return Parser::IDENT;
17
```

```
18  "+="                     return Parser::COMPADD;
19  "-="                     return Parser::COMPSUB;
20  "*="                     return Parser::COMPMUL;
21  "/="                     return Parser::COMPDIV;
22  "<<="                    return Parser::COMPLSH;
23  ">>="                    return Parser::COMPRSH;
24  "<<"                     return Parser::LSH;
25  ">>"                     return Parser::RSH;
26
27  \n|.                     return matched()[0];
```

Parser

Listing 7: grammar

```
1  %class-name Parser
2
3  %filenames parser
4  %parsefun-source parse.cc
5
6  %baseclass-preinclude rulevalue.h
7  %stype RuleValue
8
9  %scanner ../scanner/scanner.h
10
11  %token   NUMBER
12           IDENT
13
14  %right   '=' COMPADD COMPSUB COMPMUL
15           COMPDIV COMPLSH COMPRSH
16  %left    '+' '-'
17  %left    '*' '/'
18  %right   '%' LSH RSH
19  %right   uMinus
20
21  // %debug
22
23  %%
24
25  lines:
26      lines line
```

```
27  |
28      line
29  ;
30
31
32  line:
33      expr '\n'
34      {
35          display($1);
36      }
37  |
38      error '\n'
39      {
40          prompt();
41      }
42  |
43      '\n'
44      {
45          prompt();
46      }
47  ;
48
49
50  expr:
51      NUMBER
52      {
53          $$ = value();
54      }
55  |
56      IDENT
57      {
58          $$ = variable();
59      }
60  |
61      '-' expr              %prec uMinus
62      {
63          $$ = negate($2);
64      }
65  |
66      expr '*' expr
```

```
67          {
68              $$ = mul($1, $3);
69          }
70      |
71          expr '/' expr
72          {
73              $$ = div($1, $3);
74          }
75      |
76          expr '+' expr
77          {
78              $$ = add($1, $3);
79          }
80      |
81          expr '-' expr
82          {
83              $$ = sub($1, $3);
84
85          }
86      |
87          '(' expr ')'
88          {
89              $$ = $2;
90          }
91      |
92          expr '=' expr
93          {
94              $$ = assign($1, $3);
95          }
96      |
97          expr COMPADD expr
98          {
99              $$ = assign($1, add($1, $3));
100         }
101     |
102         expr COMPSUB expr
103         {
104             $$ = assign($1, sub($1, $3));
105         }
106     |
```

```
107      expr COMPMUL expr
108      {
109          $$ = assign($1, mul($1, $3));
110      }
111  |
112      expr COMPDIV expr
113      {
114          $$ = assign($1, div($1, $3));
115      }
116  |
117      expr COMPLSH expr
118      {
119          $$ = assign($1, lsh($1, toInt($3)));
120      }
121  |
122      expr COMPRSH expr
123      {
124          $$ = assign($1, rsh($1, toInt($3)));
125      }
126  |
127      expr '%' expr
128      {
129          $$ = mod($1, toInt($3));
130      }
131  |
132      expr LSH expr
133      {
134          $$ = lsh($1, toInt($3));
135      }
136  |
137      expr RSH expr
138      {
139          $$ = lsh($1, toInt($3));
140      }
141  ;
```

Listing 8: parser.h

```
1  ...
2      int toInt(RuleValue const &rv);
3  ...
```

Listing 9: toint.cc

```
1  #include "parser.ih"
2  #include <cmath>
3
4  int Parser::toInt(RuleValue const &rv)
5  {
6      return std::round(valueOf(rv));
7  }
```

Exercise 38, calculator

We were tasked with making a calculator that behaves differently than a user would expect.

Parser

Listing 10: grammar

```
1  %class-name Parser
2
3  %filenames parser
4  %parsefun-source parse.cc
5
6  %baseclass-preinclude rulevalue.h
7  %stype RuleValue
8
9  %scanner ../scanner/scanner.h
10
11 %token  NUMBER
12         IDENT
13
14 %right  '=' COMPADD COMPSUB COMPDIV
15         COMPMUL COMPLSH COMPRSH
16 %right  uMinus
17 %left   '+'
18 %right  '*'
19 %left   '/'
20 %right  '%' LSH RSH
21 %right  '-'
22
```

```
23  // %debug
24
25  %%
26
27  lines:
28      lines line
29  |
30      line
31  ;
32
33
34  line:
35      expr '\n'
36      {
37          display($1);
38      }
39  |
40      error '\n'
41      {
42          prompt();
43      }
44  |
45      '\n'
46      {
47          quit();
48      }
49  ;
50
51
52  expr:
53      NUMBER
54      {
55          $$ = value();
56      }
57  |
58      IDENT
59      {
60          $$ = variable();
61      }
62  |
```

```
63      expr '-' expr
64      {
65      $$ = add($1, $3);
66      }
67   |
68      expr '*' expr
69      {
70          $$ = div($1, $3);
71      }
72   |
73      expr '/' expr
74      {
75          $$ = sub($1, $3);
76      }
77   |
78      expr '+' expr
79      {
80          $$ = mul($1, $3);
81      }
82   |
83      '-' expr %prec uMinus
84      {
85          $$ = negate($2);
86      }
87   |
88      '(' expr ')'
89      {
90          //
91      }
92   |
93      expr '=' expr
94      {
95          $$ = assign($1, $3);
96      }
97   |
98      expr COMPADD expr
99      {
100         $$ = assign($1, add($1, $3));
101     }
102  |
```

```
103      expr COMPSUB expr
104      {
105          $$ = assign($1, sub($1, $3));
106      }
107  |
108      expr COMPMUL expr
109      {
110          $$ = assign($1, mul($1, $3));
111      }
112  |
113      expr COMPDIV expr
114      {
115          $$ = assign($1, div($1, $3));
116      }
117  |
118      expr COMPLSH expr
119      {
120          $$ = assign($1, lsh($1, toInt($3)));
121      }
122  |
123      expr COMPRSH expr
124      {
125          $$ = assign($1, rsh($1, toInt($3)));
126      }
127  |
128      expr '%' expr
129      {
130          $$ = mod($1, toInt($3));
131      }
132  |
133      expr LSH expr
134      {
135          $$ = lsh($1, toInt($3));
136      }
137  |
138      expr RSH expr
139      {
140          $$ = lsh($1, toInt($3));
141      }
142  ;
```

Listing 11: parser.h

```
1  ...
2  #include <vector>
3  #include <unordered_map>
4  #include <string>
5  ...
6
7  ...
8      std::vector<double> d_value;
9      std::unordered_map
10         <std::string, unsigned> d_symtab;
11 ...
12
13 ...
14     // added functions for the calculator:
15         void display(RuleValue &e);
16         void done();
17         void prompt();
18
19         RuleValue &add(RuleValue &lvalue,
20             RuleValue &rvalue);
21         RuleValue &assign(RuleValue &lvalue,
22             RuleValue &rvalue);
23         RuleValue &div(RuleValue &lvalue,
24             RuleValue &rvalue);
25         RuleValue &lsh(RuleValue &lvalue,
26             RuleValue &rvalue);
27         RuleValue &mul(RuleValue &lvalue,
28             RuleValue &rvalue);
29         RuleValue &negate(RuleValue &e);
30         RuleValue &rsh(RuleValue &lvalue,
31             RuleValue &rvalue);
32         RuleValue &sub(RuleValue &lvalue,
33             RuleValue &rvalue);
34         RuleValue value();
35         RuleValue variable();
36
37         double valueOf(RuleValue const &e);
38         int toInt(RuleValue rv);
```

```
39
40          void quit();
41 };
42
43
44 #endif
```

Exercise 39, functions

This was actually made before 36-38.

Code listings

Listing 12: lexer

```
 1 digits    [0-9]+
 2 ident0    [a-zA-Z_]
 3 identx    [a-zA-Z_0-9]
 4
 5 %%
 6
 7 [ \t]+              // ignore
 8
 9 {digits}                       |
10 {digits}?.{digits}E-?{digits} |
11 {digits}?.{digits}         return Parser::NUMBER;
12
13 e|pi           return Parser::CONST;
14 ln             return Parser::LN;
15 sin            return Parser::SIN;
16 asin           return Parser::ASIN;
17 sqrt           return Parser::SQRT;
18 deg            return Parser::DEG;
19 grad           return Parser::GRAD;
20 rad            return Parser::RAD;
21
22 {ident0}{identx}       return Parser::IDENT;
23
24 // Includes all operators and parentheses
25 \n|.                   return matched()[0];
```

Listing 13: grammar

```
 1  %class-name Parser
 2
 3  %filenames parser
 4  %parsefun-source parse.cc
 5
 6  %baseclass-preinclude rulevalue.h
 7  %stype RuleValue
 8
 9  %scanner ../scanner/scanner.h
10
11  %token NUMBER CONST IDENT DEG GRAD RAD
12
13  %right EXP LN SIN ASIN SQRT ABS
14
15  // %debug
16
17  %%
18
19  lines:
20      lines line
21  |
22      line
23  ;
24
25
26  line:
27      expr '\n'
28      {
29          display($1);
30      }
31  |
32      DEG '\n'
33      {
34          deg();
35      }
36  |
37      GRAD '\n'
38      {
```

```
39            grad();
40        }
41  |
42      RAD '\n'
43        {
44            rad();
45        }
46  |
47      error '\n'
48        {
49            prompt();
50        }
51  |
52      '\n'
53        {
54            prompt();
55        }
56  ;
57
58  expr:
59    CONST
60        {
61        $$ = constant();
62        }
63  |
64      NUMBER
65        {
66            $$ = value();
67        }
68  |
69      IDENT
70        {
71            $$ = variable();
72        }
73  |
74    EXP expr
75        {
76        $$ = exp($2);
77        }
78  |
```

```
79    LN expr
80    {
81      $$ = ln($2);
82    }
83  |
84    SIN expr
85    {
86      $$ = sin($2);
87    }
88  |
89    ASIN expr
90    {
91      $$ = asin($2);
92    }
93  |
94    SQRT expr
95    {
96      $$ = sqrt($2);
97    }
98  |
99    '|' expr '|'
100   {
101     $$ = abs($2);
102   }
103 |
104   ABS expr
105   {
106     $$ = abs($2);
107   }
108 ;
```

Listing 14: parser.h

```
1  ...
2  enum AngleMode
3  {
4    DEGREES,
5    RADIANS,
6    GRAD
7  };
8
```

```
 9  #undef Parser
10  class Parser: public ParserBase
11  {
12      // $insert scannerobject
13      Scanner d_scanner;
14
15      AngleMode d_angleMode = RADIANS;
16  ...
17
18  ...
19    // arithmetic functions:
20      double angleTransform();
21
22      double constant();
23
24      void display(double &value);
25          void done();
26          void prompt();
27      double exp(double &value);
28      double ln(double &value);
29      double sin(double &value);
30      double asin(double &value);
31      double sqrt(double &value);
32      double abs(double &value);
33
34      void deg();
35      void grad();
36      void rad();
37
38      double const pi = 3.14159;
39      double const e = 2.71828;
40      double constant();
41  };
42
43  #endif
```

Implementations

Listing 15: abs.cc

```
1  #include "parser.ih"
```

```
2
3  double &Parser::abs(double &value)
4  {
5    abs(value);
6
7    return value;
8  }
```

Listing 16: angletransform.cc

```
1  #include "parser.ih"
2
3  double &Parser::angleTransform()
4  {
5    switch(d_angleMode):
6    {
7      case(DEGREES):
8        return Parser::pi / 180.0;
9      case(GRAD):
10       return Parser::pi / 200.0;
11     default:
12       return 1;
13   }
14 }
```

Listing 17: asin.cc

```
1  #include "parser.ih"
2
3  double &Parser::asin(double &value)
4  {
5    double transform = angleTransform();
6    if (value <= 1 || value >= -1)
7      return asin(value) / transform;
8    else
9      error("Value out of interval -1 < value < 1");
10
11   return value;
12 }
```

Listing 18: constant.cc

```
1  #include "parser.ih"
```

```
 2
 3  double Parser::constant()
 4  {
 5     string constant(parser.matched());
 6     if (constant.compare("e") == 0)
 7       return Parser::e;
 8     if (constant.compare("pi") == 0)
 9       return Parser::pi;
10     return 0;
11  }
```

Listing 19: deg.cc

```
1  #include "parser.ih"
2
3  void Parser::deg()
4  {
5     d_angleMode = DEGREES;
6  }
```

Listing 20: done.cc

```
1  #include "parser.ih"
2
3  void Parser::done()
4  {
5      cout << "Bye\n";
6      ACCEPT();
7  }
```

Listing 21: exp.cc

```
1  #include "parser.ih"
2
3  double &Parser::exp(double &value)
4  {
5     return Parser::e ^ value;
6  }
```

Listing 22: grad.cc

```
1  #include "parser.ih"
2
```

```
3  void Parser::grad(double &value)
4  {
5    d_angleMode = GRAD;
6  }
```

Listing 23: ln.cc

```
1  #include "parser.ih"
2
3  double &Parser::log(double &value)
4  {
5    if (value >= 0)
6      log(value);
7    else
8      error("Value may not be negative");
9
10    return value;
11  }
```

Listing 24: rad.cc

```
1  #include "parser.ih"
2
3  void Parser::rad(double &deg)
4  {
5    d_angleMode = RADIANS;
6  }
```

Listing 25: sin.cc

```
1  #include "parser.ih"
2
3  double &Parser::sin(double &value)
4  {
5    transform = angleTransform()
6    return sin(transform * value);
7  }
```

Listing 26: sqrt.cc

```
1  #include "parser.ih"
2
3  double &Parser::sqrt(double &value)
```

```
 4  {
 5    if (value >= 0)
 6      sqrt(value);
 7    else
 8      error("Value may not be negative");
 9
10    return value;
11  }
```

Exercise 40, polymorphic value type class

We attempted to make a polymorphic value type class.

Code listings

Scanner

Listing 27: lexer.ll

```
 1  NUM     [0-9]
 2
 3  %%
 4
 5  {NUM}+          return ParserBase::Tokens__::INT;
 6  {NUM}*"."{NUM}+ return ParserBase::Tokens__::DOUBLE;
 7  QUIT            return ParserBase::Tokens__::QUIT;
 8  [\t ]           // ignore
 9  \n              return matched()[0];
10  .+              return ParserBase::Tokens__::STRING;
```

Parser

Listing 28: grammar.gr

```
 1  %token INT STRING DOUBLE QUIT
 2
 3  %polymorphic INT: int; STRING: std::string; DOUBLE:
       double;
 4
 5  %scanner Scanner.h
 6
 7  %type <INT> intline
```

```
8  %type <STRING> stringline
9  %type <DOUBLE> doubleline
10
11 %%
12
13 lines:
14   lines '\n' line
15 |
16   line
17 ;
18
19 line:
20   intline
21   {
22     $$ = $1;
23   }
24 |
25   stringline
26   {
27     $$ = $1;
28   }
29 |
30   doubleline
31   {
32     $$ = $1;
33   }
34 |
35   QUIT
36   {
37     quit();
38   }
39 ;
40
41 intline:
42   INT
43   {
44     $$ = getInt();
45     showInt($$);
46   }
47 ;
```

```
48
49  stringline:
50    STRING
51    {
52      $$ = getString();
53      showString($$);
54    }
55  ;
56
57  doubleline:
58    DOUBLE
59    {
60      $$ = getDouble();
61      showDouble($$);
62    }
63  ;
```

Listing 29: Parser.ih

```
1  ...
2  #include <cstdlib>
3  ...
```

Listing 30: Parser.h

```
1  ...
2    // my own functions:
3      int getInt();
4      std::string getString();
5      double getDouble();
6
7      void showInt(int &someInt);
8      void showString(std::string &someString);
9      void showDouble(double &someDouble);
10     void quit();
11 ...
```

Listing 31: getdouble.cc

```
1  #include "Parser.ih"
2
3  double Parser::getDouble()
```

```
4 {
5   return atof(d_scanner.matched().c_str());
6 }
```

Listing 32: getint.cc

```
1 #include "Parser.ih"
2
3 int Parser::getInt()
4 {
5   return atol(d_scanner.matched().c_str());
6 }
```

Listing 33: getstring.cc

```
1 #include "Parser.ih"
2
3 string Parser::getString()
4 {
5   return d_scanner.matched();
6 }
```

Listing 34: quit.cc

```
1 #include "Parser.ih"
2
3 void Parser::quit()
4 {
5   ACCEPT();
6 }
```

Listing 35: showdouble.cc

```
1 #include "Parser.ih"
2
3 void Parser::showDouble(double &someDouble)
4 {
5   cout << someDouble << '\n';
6 }
```

Listing 36: showint.cc

```
1 #include "Parser.ih"
```

```
2
3  void Parser::showInt(int &someInt)
4  {
5    cout << someInt << '\n';
6  }
```

Listing 37: showstring.cc

```
1  #include "Parser.ih"
2
3  void Parser::showString(string &someString)
4  {
5    cout << someString << '\n';
6  }
```