Source File: `~/2336/07/lab07.(C|CPP|cpp|c++|cc|cxx|cp)`
Input: Under control of `main` function
Output: Under control of `main` function
Value: 2

The purpose of this assignment is to become familiar with the process of providing overloaded operators for a class. The `Rational` class from Labs 02, 03, and 05 will be modified to provide:

- overloaded operators for performing arithmetic on `Rational` numbers,

- an overloaded unary minus for negating a `Rational` number (previously implemented as the additive inverse),

- an overloaded assignment operator for assigning one `Rational` number to another (this is necessary since the private data includes an array),

- overloaded operators for the equality operators and the relational operators, and

- overloaded input and output operators to facilitate the input and output of `Rational` numbers.

A header file is shown in Figure 1, a sample `main` function for testing your implementation is shown in Figure 2, and a sample execution sequence is shown in Figure 3. To use the `Makefile` as distributed in class, add a target of `lab07` to `targets2srcfileswithlibrary`.

```
1   #ifndef LAB07_H
2   #define LAB07_H
3
4   #include <iostream>
5
6   using namespace std;
7
8   class Rational
9   {
10     // overloaded input operator initializes Rational rat from input stream in
11     friend istream& operator>>(istream& in, Rational& rat);
12     // overloaded output operator prints Rational rat to output stream out
13     friend ostream& operator<<(ostream& out, const Rational& rat);
14   public:
15     Rational();                                // default constructor
16     Rational(int num, int denom);              // additional constructor
17     void setNumerator(int num);                // set numerator to num
18     void setDenominator(int denom);            // set denominator to denom
19     int getNumerator() const;                  // returns numerator
20     int getDenominator() const;                // returns denominator
21     void reduce();                             // reduce to lowest terms
22                                                //   and normalize
23     Rational multiplicativeInverse() const;    // returns multiplicative
24                                                //   inverse of *this
25
26     Rational& operator=(const Rational& rhs);       // *this = rhs;
27     Rational operator+(const Rational& addend) const;// returns *this + addend
28     Rational operator-() const;                     // returns -(*this)
29     Rational operator-(const Rational& subtrahend) const;// returns *this - subtrahend
30     Rational operator*(const Rational& multiplicand) const;// returns *this * multiplicand
31     Rational operator/(const Rational& divisor) const;// returns *this / divisor
32
```

Figure 1. `/usr/local/2336/include/lab07.h` (Part 1 of 2)

```
33    bool operator==(const Rational& rhs) const;     // *this == rhs
34    bool operator!=(const Rational& rhs) const;     // *this != rhs
35    bool operator< (const Rational& rhs) const;     // *this <  rhs
36    bool operator<=(const Rational& rhs) const;     // *this <= rhs
37    bool operator> (const Rational& rhs) const;     // *this >  rhs
38    bool operator>=(const Rational& rhs) const;     // *this >= rhs
39
40   private:
41    pair<int, int> data;                            // member first -> numerator
42                                                    // member second -> denominator
43    int gcd(int m, int n) const;                    // returns the greatest
44                                                    //   common divisor of m
45                                                    //   and n
46    int lcm(int m, int n) const;                    // returns the least common
47                                                    //   multiple of m and n
48   };
49
50   #endif
```

Figure 1. /usr/local/2336/include/lab07.h (Part 2 of 2)

```
1   #include <lab07.h>
2   #include <iostream>
3   #include <iomanip>
4
5   using namespace std;
6
7   int main()
8   {
9     Rational first(1, -2), second(-3, 0), result;
10
11    cout << boolalpha;
12    cout << "first = " << first << " second = " << second
13        << " result = " << result << endl;
14
15    while (cin >> first >> second)
16    {
17      cout << "first = " << first;
18      result = -first;
19      result.reduce();
20      cout << "  -first = " << result << endl;
21
22      cout << first << " + " << second << " = " << first + second << endl;
23      cout << first << " - " << second << " = " << first - second << endl;
24      cout << first << " * " << second << " = " << first * second << endl;
25      cout << first << " / " << second << " = " << first / second << endl;
26
```

Figure 2. /usr/local/2336/src/lab07main.C (Part 1 of 2)

```
27      cout << first << " == " << second << " = " << (first == second) << endl;
28      cout << first << " != " << second << " = " << (first != second) << endl;
29      cout << first << " <  " << second << " = " << (first <  second) << endl;
30      cout << first << " <= " << second << " = " << (first <= second) << endl;
31      cout << first << " >  " << second << " = " << (first >  second) << endl;
32      cout << first << " >= " << second << " = " << (first >= second) << endl;
33    }
34
35    return EXIT_SUCCESS;
36  }
```

Figure 2. `/usr/local/2336/src/lab07main.C` (Part 2 of 2)

```
1   newuser@csunix ~> cd 2336
2   newuser@csunix ~/2336> ./getlab.ksh 07
3     * Checking to see if a folder exists for Lab 07. . .No
4     * Creating a folder for Lab 07
5     * Checking to see if Lab 07 has sample input and output files. . .Yes
6     * Copying input and output files for Lab 07
7       from folder /usr/local/2336/data/07 to folder ./07
8     * Checking to see if /usr/local/2336/src/lab07main.C exists. . .Yes
9     * Copying file /usr/local/2336/src/lab07main.C to folder ./07
10    * Checking to see if /usr/local/2336/include/lab07.h exists. . .Yes
11    * Copying file /usr/local/2336/include/lab07.h to folder ./07
12    * Copying file /usr/local/2336/src/Makefile to folder ./07
13    * Adding a target of lab07 to targets2srcfileswithlibrary
14    * Touching file ./07/lab07.cpp
15    * Edit file ./07/lab07.cpp in Notepad++
16  newuser@csunix ~/2336> cd 07
17  newuser@csunix ~/2336/07> ls
18  01.dat      01.out      Makefile    lab07.cpp   lab07.h     lab07main.C
19  newuser@csunix ~/2336/07> make lab07
20  g++ -g -Wall -std=c++11 -c lab07main.C -I/usr/local/2336/include -I.
21  g++ -g -Wall -std=c++11 -c lab07.cpp -I/usr/local/2336/include -I.
22  g++ -o lab07 lab07main.o lab07.o -L/usr/local/2336/lib \
23  -Wl,-whole-archive -llab07 -Wl,-no-whole-archive -lm -lbits
24  newuser@csunix ~/2336/07> cat 01.dat
25  -3  4  3  4
26   3 -4 -3 -4
27  25 45  8 99
28   1  0  2  0
29  129 6579 1935 249
30  1331 1651 2301 1079
31  3 1260 6 198
32  43 1935 207 6579
33  5 7 -25 -35
34  -83 1651 127 -1079
35  1079 1651 -1651 1079
```

Figure 3. Commands to Compile, Link, & Run Lab 07 (Part 1 of 3)

```
 36   newuser@csunix ~/2336/07> cat 01.dat | ./lab07
 37   first = 1/-2 second = -3/1 result = 0/1
 38   first = -3/4  -first = 3/4
 39   -3/4 + 3/4 = 0/1
 40   -3/4 - 3/4 = -3/2
 41   -3/4 * 3/4 = -9/16
 42   -3/4 / 3/4 = -1/1
 43   -3/4 == 3/4 = false
 44   -3/4 != 3/4 = true
 45   -3/4 <  3/4 = true
 46   -3/4 <= 3/4 = true
 47   -3/4 >  3/4 = false
 48   -3/4 >= 3/4 = false
 49   first = 3/-4  -first = 3/4
 50   3/-4 + -3/-4 = 0/1
 51   3/-4 - -3/-4 = -3/2
 52   3/-4 * -3/-4 = -9/16
 53   3/-4 / -3/-4 = -1/1
 54   3/-4 == -3/-4 = false
 55   3/-4 != -3/-4 = true
 56   3/-4 <  -3/-4 = true
 57   3/-4 <= -3/-4 = true
 58   3/-4 >  -3/-4 = false
 59   3/-4 >= -3/-4 = false
 60   first = 25/45  -first = -5/9
 61   25/45 + 8/99 = 7/11
 62   25/45 - 8/99 = 47/99
 63   25/45 * 8/99 = 40/891
 64   25/45 / 8/99 = 55/8
 65   25/45 == 8/99 = false
 66   25/45 != 8/99 = true
 67   25/45 <  8/99 = false
 68   25/45 <= 8/99 = false
 69   25/45 >  8/99 = true
 70   25/45 >= 8/99 = true
 71   first = 1/1  -first = -1/1
 72   1/1 + 2/1 = 3/1
 73   1/1 - 2/1 = -1/1
 74   1/1 * 2/1 = 2/1
 75   1/1 / 2/1 = 1/2
 76   1/1 == 2/1 = false
 77   1/1 != 2/1 = true
 78   1/1 <  2/1 = true
 79   1/1 <= 2/1 = true
 80   1/1 >  2/1 = false
 81   1/1 >= 2/1 = false
 82   first = 129/6579  -first = -1/51
 83   129/6579 + 1935/249 = 32978/4233
 84   129/6579 - 1935/249 = -32812/4233
 85   129/6579 * 1935/249 = 215/1411
 86   129/6579 / 1935/249 = 83/32895
 87   129/6579 == 1935/249 = false
 88   129/6579 != 1935/249 = true
 89   129/6579 <  1935/249 = true
 90   129/6579 <= 1935/249 = true
 91   129/6579 >  1935/249 = false
 92   129/6579 >= 1935/249 = false
 93   first = 1331/1651  -first = -1331/1651
 94   1331/1651 + 2301/1079 = 402700/137033
 95   1331/1651 - 2301/1079 = -181754/137033
 96   1331/1651 * 2301/1079 = 235587/137033
 97   1331/1651 / 2301/1079 = 110473/292227
 98   1331/1651 == 2301/1079 = false
 99   1331/1651 != 2301/1079 = true
100   1331/1651 <  2301/1079 = true
101   1331/1651 <= 2301/1079 = true
102   1331/1651 >  2301/1079 = false
103   1331/1651 >= 2301/1079 = false
104   first = 3/1260  -first = -1/420
105   3/1260 + 6/198 = 151/4620
106   3/1260 - 6/198 = -43/1540
107   3/1260 * 6/198 = 1/13860
108   3/1260 / 6/198 = 11/140
109   3/1260 == 6/198 = false
110   3/1260 != 6/198 = true
111   3/1260 <  6/198 = true
112   3/1260 <= 6/198 = true
113   3/1260 >  6/198 = false
114   3/1260 >= 6/198 = false
115   first = 43/1935  -first = -1/45
116   43/1935 + 207/6579 = 1766/32895
117   43/1935 - 207/6579 = -304/32895
118   43/1935 * 207/6579 = 23/32895
119   43/1935 / 207/6579 = 731/1035
120   43/1935 == 207/6579 = false
121   43/1935 != 207/6579 = true
122   43/1935 <  207/6579 = true
123   43/1935 <= 207/6579 = true
124   43/1935 >  207/6579 = false
125   43/1935 >= 207/6579 = false
126   first = 5/7  -first = -5/7
127   5/7 + -25/-35 = 10/7
128   5/7 - -25/-35 = 0/1
129   5/7 * -25/-35 = 25/49
130   5/7 / -25/-35 = 1/1
131   5/7 == -25/-35 = true
132   5/7 != -25/-35 = false
133   5/7 <  -25/-35 = false
134   5/7 <= -25/-35 = true
135   5/7 >  -25/-35 = false
136   5/7 >= -25/-35 = true
137   first = -83/1651  -first = 83/1651
138   -83/1651 + 127/-1079 = -23018/137033
139   -83/1651 - 127/-1079 = 9240/137033
140   -83/1651 * 127/-1079 = 1/169
141   -83/1651 / 127/-1079 = 6889/16129
```

Figure 3. Commands to Compile, Link, & Run Lab 07 (Part 2 of 3)

```
142   -83/1651 == 127/-1079 = false          151   1079/1651 * -1651/1079 = -1/1
143   -83/1651 != 127/-1079 = true           152   1079/1651 / -1651/1079 = -6889/16129
144   -83/1651 <  127/-1079 = false          153   1079/1651 == -1651/1079 = false
145   -83/1651 <= 127/-1079 = false          154   1079/1651 != -1651/1079 = true
146   -83/1651 >  127/-1079 = true           155   1079/1651 <  -1651/1079 = false
147   -83/1651 >= 127/-1079 = true           156   1079/1651 <= -1651/1079 = false
148   first = 1079/1651  -first = -83/127    157   1079/1651 >  -1651/1079 = true
149   1079/1651 + -1651/1079 = -9240/10541   158   1079/1651 >= -1651/1079 = true
150   1079/1651 - -1651/1079 = 23018/10541
```

```
159   newuser@csunix ~/2336/07> cat 01.dat | ./lab07 > my.out
160   newuser@csunix ~/2336/07> diff 01.out my.out
161   newuser@csunix ~/2336/07>
```

Figure 3. Commands to Compile, Link, & Run Lab 07 (Part 3 of 3)