**Lab Exercises**

Class: Name: StuID:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: Score:

**Lab Exercise 1 — String Concatenation**

**I Lab Objectives**

In this lab, you will practice:

1. Overloading the + operator to allow String objects to be concatenated.
2. Writing function prototypes for overloaded operators.
3. Using overloaded operators.

**II Description of the Problem**

String **concatenation（连接）**requires two operands—the two strings that are to be concatenated. In the String case study, we showed how to implement an overloaded concatenation operator that concatenates the second String object to the right of the first String object, thus modifying the first String object. In some applications, it is desirable to produce a concatenated String object without modifying the String arguments. Implement operator+ to allow operations such as

string1 = string2 + string3;

in which neither operand is modified.

**III Sample Output**



**IV Problem-Solving Tips**

1. The overloaded + operator should be a member function of class String and should take one parameter, a const reference to a String.
2. The + operator function should use return type String.
3. The strcat function can be used to concatenate pointer-based strings.

**V Your Solution**

// Lab 1: StringCat.cpp

// Demonstrating overloaded + operator that does not modify operands

#include <iostream>

**using** **namespace** std;

#include "String.h"

**int** main()

{

**char** \*a="The date is";

// cout<<strlen(a);

String string1, string2( a );

String string3( " August 1, 1993" );

// test overloaded operators

cout << "string1 = string2 + string3\n";

/\* Write a statement to concatenate string2 and string3,

and assign the result to string1 \*/

//string1=string2;

//string1=(string2+string3);

// cout<<(string2+string3).getlength()<<endl;

cout << "\"" << (string2+string3) << "\" = \"" << string2 << "\" + \""

<< string3 << "\"" << endl;

} // end main

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 1: String.h

// Header file for class String.

#ifndef STRING\_H

#define STRING\_H

#include <iostream>

#include <cstring>

#include <cassert>

**using** **namespace** std;

**class** String

{

**friend** ostream &**operator**<<( ostream &output, **const** String &s );

**public**:

String( **const** **char** \* **const** = "" ); // conversion constructor

String( **const** String & ); // copy constructor

**long** getlength()**const**;

~String(); // destructor

**const** String &**operator**=( **const** String & );

/\* Write a prototype for the operator+ member function \*/

**const** String &**operator**+(**const** String &);

**private**:

**char** \*sPtr; // pointer to start of string

**long** length; // string length

}; // end class String

#endif

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 1: String.cpp

// Member-function definitions for String.cpp

#include <iostream>

**using** **namespace** std;

#include <cstring> // strcpy and strcat prototypes

#include "String.h" // String class definition

// conversion constructor: convert a char \* to String

String::String( **const** **char** \* **const** zPtr )

{

// cout<<strlen( zPtr );

length = strlen( zPtr ); // compute length

sPtr = **new** **char**[ length + 1 ]; // allocate storage

assert( sPtr != 0 ); // terminate if memory not allocated

strcpy( sPtr, zPtr ); // copy literal to object

} // end String conversion constructor

// copy constructor

String::String( **const** String &copy )

{

// cout<<copy.length;

length = copy.length; // copy length

sPtr = **new** **char**[ length + 1 ]; // allocate storage

assert( sPtr != 0 ); // ensure memory allocated

strcpy( sPtr, copy.sPtr ); // copy string

} // end String copy constructor

// destructor

String::~String()

{

**delete** [] sPtr; // reclaim string

} // end destructor

// overloaded = operator; avoids self assignment

**const** String &String::**operator**=( **const** String &right )

{

**if** ( &right != **this** ) // avoid self assignment

{

**delete** [] sPtr; // prevents memory leak

length = right.length; // new String length

sPtr = **new** **char**[ length + 1 ]; // allocate memory

assert( sPtr != 0 ); // ensure memory allocated

strcpy( sPtr, right.sPtr ); // copy string

}

**else**

cout << "Attempted assignment of a String to itself\n";

**return** \***this**; // enables concatenated assignments

} // end function operator=

// concatenate right operand and this object and store in temp object

/\* Write the header for the operator+ member function \*/

**const** String &String::**operator**+(**const** String &s1)

{

/\* Declare a temporary String variable named temp \*/

String temp;

/\* Set tempís length to be the sum of the two argument Stringsí lengthes \*/

temp.length=s1.length+**this**->length;

/\* Allocate memory for temp.length + 1 chars and assign the pointer to temp.sPtr \*/

temp.sPtr=**new** **char**[temp.length+1];

assert( sPtr != 0 ); // terminate if memory not allocated

/\* Copy the left String argumentís contents into temp.sPtr \*/

strcpy(temp.sPtr, **this**->sPtr);

/\* Write a call to strcat to concatenate the string in right

onto the end of the string in temp \*/

strcat(temp.sPtr,s1.sPtr);

/\* Return the temporary String \*/

**return** temp;

} // end function operator+

**long** String::getlength()**const**{

**return** length;

}

// overloaded output operator

ostream & **operator**<<( ostream &output, **const** String &s )

{

output << s.sPtr;

**return** output; // enables concatenation

} // end function operator<<

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

**Lab Exercise 2 — Huge Integer**

**I Lab Objectives**

In this lab, you will practice:

1. Overloading arithmetic and comparison operators to enhance a huge integer class, HugeInt**.**
2. Writing function prototypes for overloaded operators.
3. Calling overloaded operator functions.

**II Description of the Problem**

A machine with 32-bit integers can represent integers in the range of approximately –2 billion to +2 billion. This fixed-size restriction is rarely troublesome, but there are applications in which we would like to be able to use a much wider range of integers. This is what C++ was built to do, namely, create powerful new data types. Consider class HugeInt of **Figs. 10.17–10.19.** Study the class carefully, then overload the relational and equality operators. [Note: We do not show an assignment operator or copy constructor for class HugeInt, because the assignment operator and copy constructor provided by the compiler are capable of copying the entire array data member properly.]

**III Sample Output**



**IV Problem-Solving Tips**

You can implement the !=, >, >= and <= operators in terms of the overloaded == and < operators.

**V Your Solution**

// Lab 2: Hugeint.cpp

// HugeInt member-function and friend-function definitions.

#include <iostream>

#include <cctype> // isdigit function prototype

#include <cstring> // strlen function prototype

**using** **namespace** std;

#include "Hugeint.h" // HugeInt class definition

// default constructor; conversion constructor that converts

// a long integer into a HugeInt object

HugeInt::HugeInt( **long** value )

{

// initialize array to zero

**for** ( **int** i = 0; i <= 29; i++ )

integer[ i ] = 0;

// place digits of argument into array

**for** ( **int** j = 29; value != 0 && j >= 0; j-- )

{

integer[ j ] = value % 10;

value /= 10;

} // end for

} // end HugeInt default/conversion constructor

// conversion constructor that converts a character string

// representing a large integer into a HugeInt object

HugeInt::HugeInt( **const** **char** \*string )

{

// initialize array to zero

**for** ( **int** i = 0; i <= 29; i++ )

integer[ i ] = 0;

// place digits of argument into array

**int** length = strlen( string );

**for** ( **int** j = 30 - length, k = 0; j <= 29; j++, k++ )

**if** ( isdigit( string[ k ] ) )

integer[ j ] = string[ k ] - '0';

} // end HugeInt conversion constructor

// get function calculates length of integer

**int** HugeInt::getLength() **const**

{**int** i = 0;

**for** ( ; i <= 29; i++ )

**if** ( integer[ i ] != 0 )

**break**; // break when first digit is reached

**return** 30 - i; // length is from first digit (at i) to end of array

} // end function getLength

// addition operator; HugeInt + HugeInt

HugeInt HugeInt::**operator**+( **const** HugeInt &op2 ) **const**

{

HugeInt temp; // temporary result

**int** carry = 0;

**for** ( **int** i = 29; i >= 0; i-- )

{

temp.integer[ i ] =

integer[ i ] + op2.integer[ i ] + carry;

// determine whether to carry a 1

**if** ( temp.integer[ i ] > 9 )

{

temp.integer[ i ] %= 10; // reduce to 0-9

carry = 1;

} // end if

**else** // no carry

carry = 0;

} // end for

**return** temp; // return copy of temporary object

} // end function operator+

// addition operator; HugeInt + int

HugeInt HugeInt::**operator**+( **int** op2 ) **const**

{

// convert op2 to a HugeInt, then invoke

// operator+ for two HugeInt objects

**return** \***this** + HugeInt( op2 );

} // end function operator+

// addition operator;

// HugeInt + string that represents large integer value

HugeInt HugeInt::**operator**+( **const** **char** \*op2 ) **const**

{

// convert op2 to a HugeInt, then invoke

// operator+ for two HugeInt objects

**return** \***this** + HugeInt( op2 );

} // end function operator+

// equality operator; HugeInt == HugeInt

/\* Write a definition for the == operator \*/

**bool** HugeInt::**operator**==(HugeInt h1){

**for**(**int** i=30-getLength();i<30;i++){

**if** (**this**->integer[i]!=h1.integer[i]) {

**return** **false**;

**break**;

}

}

**return** **true**;

}

// inequality operator; HugeInt != HugeInt

/\* Write a definition for the != operator

by calling the == operator \*/

**bool** HugeInt::**operator**!=(HugeInt h1){

**return** !(\***this**==h1);

}

// less than operator; HugeInt < HugeInt

/\* Write a definition for the < operator \*/

**bool** HugeInt::**operator**<(HugeInt h1){

**if** (h1.getLength()>**this**->getLength()) {

**return** **true**;

}**else**{

**for**(**int** i=30-getLength();i<30;i++){

**if** (integer[i]==h1.getLength()) {

**continue**;

}**else**{

**if** (integer[i]<h1.integer[i]) {

**return** **true**;

**break**;

}**else** **return** **false**;

}

}

}

**return** **false**;

}

// less than or equal operator; HugeInt <= HugeInt

/\* Write a definition for the <= operator

by calling the < and == operators \*/

**bool** HugeInt::**operator**<=(HugeInt h1){

**if** (h1.getLength()>**this**->getLength()) {

**return** **true**;

}**else**{

**for**(**int** i=30-getLength();i<30;i++){

**if** (integer[i]==h1.getLength()) {

**continue**;

}**else**{

**if** (integer[i]<=h1.integer[i]) {

**return** **true**;

**break**;

}**else** **return** **false**;

}

}

}

**return** **true**;

}

// greater than operator; HugeInt > HugeInt

/\* Write a definition for the > operator

by calling the <= operator \*/

**bool** HugeInt::**operator**>(HugeInt h1){

**if**(\***this**==h1)**return** **false**;

**else** **return** !(\***this**<h1);

}

// greater than or equal operator; HugeInt >= HugeInt

/\* Write a definition for the >= operator

by calling the > and == operators \*/

**bool** HugeInt::**operator**>=(HugeInt h1){

**if**(\***this**==h1)**return** **true**;

**else** **return** !(\***this**<=h1);

}

// overloaded output operator

ostream& **operator**<<( ostream &output, **const** HugeInt &num )

{

**int** i;

**for** ( i = 0; ( num.integer[ i ] == 0 ) && ( i <= 29 ); i++ )

; // skip leading zeros

**if** ( i == 30 )

output << 0;

**else**

**for** ( ; i <= 29; i++ )

output << num.integer[ i ];

**return** output;

} // end function operator<<

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 2: Hugeint.h

// HugeInt class definition.

#ifndef HUGEINT\_H

#define HUGEINT\_H

#include <iostream>

**using** **namespace** std;

**class** HugeInt

{

**friend** ostream &**operator**<<( ostream &, **const** HugeInt & );

**public**:

HugeInt( **long** = 0 ); // conversion/default constructor

HugeInt( **const** **char** \* ); // conversion constructor

// addition operator; HugeInt + HugeInt

HugeInt **operator**+( **const** HugeInt & ) **const**;

// addition operator; HugeInt + int

HugeInt **operator**+( **int** ) **const**;

// addition operator;

// HugeInt + string that represents large integer value

HugeInt **operator**+( **const** **char** \* ) **const**;

/\* Write prototypes for the six relational and equality operators \*/

**bool** **operator**==(HugeInt);

**bool** **operator**!=(HugeInt);

**bool** **operator**<(HugeInt);

**bool** **operator**<=(HugeInt);

**bool** **operator**>(HugeInt);

**bool** **operator**>=(HugeInt);

**int** getLength() **const**;

**private**:

**short** integer[ 30 ];

}; // end class HugeInt

#endif

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 2: HugeIntTest.cpp

// HugeInt test program.

#include <iostream>

**using** **namespace** std;

#include "Hugeint.h"

**int** main()

{

HugeInt n1( 7654321 );

HugeInt n2( 7891234 );

HugeInt n3( "99999999999999999999999999999" );

HugeInt n4( "1" );

HugeInt result;

cout << "n1 is " << n1 << "\nn2 is " << n2

<< "\nn3 is " << n3 << "\nn4 is " << n4

<< "\nresult is " << result << "\n\n";

// test relational and equality operators

**if** ( n1 == n2 )

cout << "n1 equals n2" << endl;

**if** ( n1 != n2 )

cout << "n1 is not equal to n2" << endl;

**if** ( n1 < n2 )

cout << "n1 is less than n2" << endl;

**if** ( n1 <= n2 )

cout << "n1 is less than or equal to n2" << endl;

**if** ( n1 > n2 )

cout << "n1 is greater than n2" << endl;

**if** ( n1 >= n2 )

cout << "n1 is greater than or equal to n2" << endl;

result = n1 + n2;

cout << n1 << " + " << n2 << " = " << result << "\n\n";

cout << n3 << " + " << n4 << "\n= " << ( n3 + n4 ) << "\n\n";

result = n1 + 9;

cout << n1 << " + " << 9 << " = " << result << endl;

result = n2 + "10000";

cout << n2 << " + " << "10000" << " = " << result << endl;

} // end main

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

**Lab Exercise 3 — Rational Numbers**

**I Lab Objectives**

In this lab, you will practice:

1. Overloading operators to create a class capable of storing rational numbers (fractions) and performing rational number arithmetic.
2. Writing function prototypes for overloaded operators.
3. Implementing overloaded operator functions.

The follow-up questions and activities also will give you practice:

1. Overloading the << operator.
2. Making a class more robust to prevent runtime errors.

**II Description of the Problem**

Create a classRationalNumber(fractions) with the following capabilities:

1. Create a constructor that prevents a 0 denominator in a fraction, reduces or simplifies fractions that are not in reduced form and avoids negative denominators.
2. Overload the addition, subtraction, multiplication and division operators for this class.
3. Overload the relational and equality operators for this class.

**III Sample Output**



**IV Problem-Solving Tips**

* 1. When comparing RationalNumbers, you can cast the numerator to a double and then divide by the denominator to determine the value of that RationalNumber as a double. The <=, >=, > and != operators can be implemented in terms of == and <.
  2. To implement the arithmetic operators, use the following formulas:

Addition: (a/b) + (c/d) = (ad + bc) / (bd).

Subtraction: (a/b)- (c/d) = (ad - bc) / (bd).

Multiplication: (a/b) \* (c/d) = (ac) / (bd).

Division: (a/b) / (c/d) = (ad) / (bc).

Remember to check for division by zero.

**V Your Solution**

// Lab 3: RationalNumber.cpp

// RationalNumber member-function definitions.

#include <cstdlib>

#include <iostream>

**using** **namespace** std;

#include "RationalNumber.h"

// RationalNumber constructor sets n and d and calls reduction

/\* Implement the RationalNumber constructor. Validate d first to ensure that

it is a positive number and set it to 1 if not. Call the reduction utility

function at the end \*/

RationalNumber::RationalNumber(**int** x,**int** y){

numerator=x;

denominator=y;

reduction();

}

// overloaded + operator

/\* Write definition for overloaded operator + \*/

RationalNumber RationalNumber::**operator**+(**const** RationalNumber &r1)**const**{

RationalNumber temp;

**if**(**this**->denominator==r1.denominator){

temp.numerator=**this**->numerator+r1.numerator;

temp.denominator=denominator;

temp.reduction();

}**else**{

temp.numerator=**this**->numerator\*r1.denominator+denominator\*r1.numerator;

temp.denominator=denominator\*r1.denominator;

temp.reduction();

}

**return** temp;

}

// overloaded - operator

/\* Write definition for overloaded operator - \*/

RationalNumber RationalNumber::**operator**-(**const** RationalNumber &r1)**const**{

RationalNumber temp;

**if**(**this**->denominator==r1.denominator){

temp.numerator=**this**->numerator-r1.numerator;

temp.denominator=denominator;

temp.reduction();

}**else**{

temp.numerator=**this**->numerator\*r1.denominator-denominator\*r1.numerator;

temp.denominator=denominator\*r1.denominator;

temp.reduction();

}

**return** temp;

}

// overloaded \* operator

/\* Write definition for overloaded operator \* \*/

RationalNumber RationalNumber::**operator**\*(**const** RationalNumber &r1)**const**{

RationalNumber temp;

temp.denominator=denominator\*r1.denominator;

temp.numerator=numerator\*r1.numerator;

temp.reduction();

**return** temp;

}

// overloaded / operator

/\* Write definition for overloaded operator /. Check if the client is

attempting to divide by zero and report an error message if so \*/

RationalNumber RationalNumber::**operator**/(**const** RationalNumber &r1)**const**{

RationalNumber temp;

temp.denominator=denominator\*r1.numerator;

temp.numerator=numerator\*r1.denominator;

temp.reduction();

**return** temp;

}

// overloaded > operator

/\* Write definition for operator > \*/

**bool** RationalNumber::**operator**>(**const** RationalNumber &r1)**const**{

**if**((r1.denominator\*numerator)>(denominator\*r1.numerator))**return** **true**;

**else** **return** **false**;

}

// overloaded < operator

/\* Write definition for operator < \*/

**bool** RationalNumber::**operator**<(**const** RationalNumber &r1)**const**{

**return** !(\***this**>r1);

}

// overloaded >= operator

/\* Write definition for operator >= \*/

**bool** RationalNumber::**operator**>=(**const** RationalNumber &r1)**const**{

**if**(\***this**==r1)

**return** **true**;

**else**

**return** (\***this**>r1);

}

// overloaded <= operator

/\* Write definition for operator <= \*/

**bool** RationalNumber::**operator**<=(**const** RationalNumber &r1)**const**{

**if**(\***this**==r1)

**return** **true**;

**else**

**return** !(\***this**>r1);

}

// overloaded == operator

/\* Write definition for operator == \*/

**bool** RationalNumber::**operator**==(**const** RationalNumber &r1)**const**{

**if**(numerator==r1.numerator)

**if**(denominator==r1.denominator)

**return** **true**;

**else** **return** **false**;

**else** **return** **false**;

}

// overloaded != operator

/\* Write definition for operator != \*/

**bool** RationalNumber::**operator**!=(**const** RationalNumber &r1)**const**{

**return** !(\***this**==r1);

}

// function printRational definition

**void** RationalNumber::printRational() **const**

{

**if** ( numerator == 0 ) // print fraction as zero

cout << numerator;

**else** **if** ( denominator == 1 ) // print fraction as integer

cout << numerator;

**else**

cout << numerator << '/' << denominator;

} // end function printRational

// function reduction definition

**void** RationalNumber::reduction()

{

**int** largest, gcd = 1; // greatest common divisor;

largest = ( numerator > denominator ) ? numerator: denominator;

**for** ( **int** loop = 2; loop <= largest; loop++ )

**if** ( numerator % loop == 0 && denominator % loop == 0 )

gcd = loop;

numerator /= gcd;

denominator /= gcd;

} // end function reduction

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 3: RationalNumber.cpp

// RationalNumber member-function definitions.

#include <cstdlib>

#include <iostream>

**using** **namespace** std;

#include "RationalNumber.h"

// RationalNumber constructor sets n and d and calls reduction

/\* Implement the RationalNumber constructor. Validate d first to ensure that

it is a positive number and set it to 1 if not. Call the reduction utility

function at the end \*/

RationalNumber::RationalNumber(**int** x,**int** y){

numerator=x;

denominator=y;

reduction();

}

// overloaded + operator

/\* Write definition for overloaded operator + \*/

RationalNumber RationalNumber::**operator**+(**const** RationalNumber &r1)**const**{

RationalNumber temp;

**if**(**this**->denominator==r1.denominator){

temp.numerator=**this**->numerator+r1.numerator;

temp.denominator=denominator;

temp.reduction();

}**else**{

temp.numerator=**this**->numerator\*r1.denominator+denominator\*r1.numerator;

temp.denominator=denominator\*r1.denominator;

temp.reduction();

}

**return** temp;

}

// overloaded - operator

/\* Write definition for overloaded operator - \*/

RationalNumber RationalNumber::**operator**-(**const** RationalNumber &r1)**const**{

RationalNumber temp;

**if**(**this**->denominator==r1.denominator){

temp.numerator=**this**->numerator-r1.numerator;

temp.denominator=denominator;

temp.reduction();

}**else**{

temp.numerator=**this**->numerator\*r1.denominator-denominator\*r1.numerator;

temp.denominator=denominator\*r1.denominator;

temp.reduction();

}

**return** temp;

}

// overloaded \* operator

/\* Write definition for overloaded operator \* \*/

RationalNumber RationalNumber::**operator**\*(**const** RationalNumber &r1)**const**{

RationalNumber temp;

temp.denominator=denominator\*r1.denominator;

temp.numerator=numerator\*r1.numerator;

temp.reduction();

**return** temp;

}

// overloaded / operator

/\* Write definition for overloaded operator /. Check if the client is

attempting to divide by zero and report an error message if so \*/

RationalNumber RationalNumber::**operator**/(**const** RationalNumber &r1)**const**{

RationalNumber temp;

temp.denominator=denominator\*r1.numerator;

temp.numerator=numerator\*r1.denominator;

temp.reduction();

**return** temp;

}

// overloaded > operator

/\* Write definition for operator > \*/

**bool** RationalNumber::**operator**>(**const** RationalNumber &r1)**const**{

**if**((r1.denominator\*numerator)>(denominator\*r1.numerator))**return** **true**;

**else** **return** **false**;

}

// overloaded < operator

/\* Write definition for operator < \*/

**bool** RationalNumber::**operator**<(**const** RationalNumber &r1)**const**{

**return** !(\***this**>r1);

}

// overloaded >= operator

/\* Write definition for operator >= \*/

**bool** RationalNumber::**operator**>=(**const** RationalNumber &r1)**const**{

**if**(\***this**==r1)

**return** **true**;

**else**

**return** (\***this**>r1);

}

// overloaded <= operator

/\* Write definition for operator <= \*/

**bool** RationalNumber::**operator**<=(**const** RationalNumber &r1)**const**{

**if**(\***this**==r1)

**return** **true**;

**else**

**return** !(\***this**>r1);

}

// overloaded == operator

/\* Write definition for operator == \*/

**bool** RationalNumber::**operator**==(**const** RationalNumber &r1)**const**{

**if**(numerator==r1.numerator)

**if**(denominator==r1.denominator)

**return** **true**;

**else** **return** **false**;

**else** **return** **false**;

}

// overloaded != operator

/\* Write definition for operator != \*/

**bool** RationalNumber::**operator**!=(**const** RationalNumber &r1)**const**{

**return** !(\***this**==r1);

}

// function printRational definition

**void** RationalNumber::printRational() **const**

{

**if** ( numerator == 0 ) // print fraction as zero

cout << numerator;

**else** **if** ( denominator == 1 ) // print fraction as integer

cout << numerator;

**else**

cout << numerator << '/' << denominator;

} // end function printRational

// function reduction definition

**void** RationalNumber::reduction()

{

**int** largest, gcd = 1; // greatest common divisor;

largest = ( numerator > denominator ) ? numerator: denominator;

**for** ( **int** loop = 2; loop <= largest; loop++ )

**if** ( numerator % loop == 0 && denominator % loop == 0 )

gcd = loop;

numerator /= gcd;

denominator /= gcd;

} // end function reduction

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

// Lab 3: RationalTest.cpp

// RationalNumber test program.

#include <iostream>

**using** **namespace** std;

#include "RationalNumber.h"

**int** main()

{

RationalNumber c( 7, 3 ), d( 3, 9 ), x;

c.printRational();

cout << " + ";

d.printRational();

cout << " = ";

x = c + d; // test overloaded operators + and =

x.printRational();

cout << '\n';

c.printRational();

cout << " - ";

d.printRational();

cout << " = ";

x = c - d; // test overloaded operators - and =

x.printRational();

cout << '\n';

c.printRational();

cout << " \* ";

d.printRational();

cout << " = ";

x = c \* d; // test overloaded operators \* and =

x.printRational();

cout << '\n';

c.printRational();

cout << " / ";

d.printRational();

cout << " = ";

x = c / d; // test overloaded operators / and =

x.printRational();

cout << '\n';

c.printRational();

cout << " is:\n";

// test overloaded greater than operator

cout << ( ( c > d ) ? " > " : " <= " );

d.printRational();

cout << " according to the overloaded > operator\n";

// test overloaded less than operator

cout << ( ( c < d ) ? " < " : " >= " );

d.printRational();

cout << " according to the overloaded < operator\n";

// test overloaded greater than or equal to operator

cout << ( ( c >= d ) ? " >= " : " < " );

d.printRational();

cout << " according to the overloaded >= operator\n";

// test overloaded less than or equal to operator

cout << ( ( c <= d ) ? " <= " : " > " );

d.printRational();

cout << " according to the overloaded <= operator\n";

// test overloaded equality operator

cout << ( ( c == d ) ? " == " : " != " );

d.printRational();

cout << " according to the overloaded == operator\n";

// test overloaded inequality operator

cout << ( ( c != d ) ? " != " : " == " );

d.printRational();

cout << " according to the overloaded != operator" << endl;

} // end main

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* (C) Copyright 1992-2012 by Deitel & Associates, Inc. and \*

\* Pearson Education, Inc. All Rights Reserved. \*

\* \*

\* DISCLAIMER: The authors and publisher of this book have used their \*

\* best efforts in preparing the book. These efforts include the \*

\* development, research, and testing of the theories and programs \*

\* to determine their effectiveness. The authors and publisher make \*

\* no warranty of any kind, expressed or implied, with regard to these \*

\* programs or to the documentation contained in these books. The authors \*

\* and publisher shall not be liable in any event for incidental or \*

\* consequential damages in connection with, or arising out of, the \*

\* furnishing, performance, or use of these programs. \*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

**VI Follow-Up Questions and Activities**

1. Rewrite the printRational member function as an overloaded << friend function.

ostream & **operator**<<(ostream& on,RationalNumber&r1){

on<<r1.denominator<<"\n-\n"<<r1.numerator<<endl;

**return** on;

}

2. Make the RationalNumber class more robust by providing additional tests for division by zero in each of the relational operators that divides a numerator by a denominator.

RationalNumber RationalNumber::**operator**/(**const** RationalNumber &r1)**const**{

RationalNumber temp;

**if**(r1.denominator==0)

**throw** invalid\_argument("不能为0");

temp.denominator=denominator\*r1.numerator;

temp.numerator=numerator\*r1.denominator;

temp.reduction();

**return** temp;

}

3. Is it possible to add another overloaded operator> function that returns a pointer to the larger of the two rational numbers? Why or why not?

No

Functions that differ only in their return type cannot be overloaded