Source File: `~/2336/08/lab08.(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 more familiar with the process of providing overloaded operators for a class. The `IntegerSet` class from Labs 04 and 06 will be modified to provide:

- an overloaded output operator for displaying an `IntegerSet`,
- overloaded operators for adding an element to an `IntegerSet` and deleting an element from an `IntegerSet`,
- an overloaded operator to compute the complement of an `IntegerSet`, and
- an overloaded assignment operator for assigning one `IntegerSet` to another (this is necessary since the private data includes an array).

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 `lab08` to `targets2srcfileswithlibrary`.

```
1  #ifndef LAB08_H
2  #define LAB08_H
3
4  #include <iostream>
5  #include <bits.h>
6
7  using namespace std;
8
9  const uint N = 40;
10
11 class IntegerSet
12 {
13   // overloaded output operator for printing IntegerSet set to
14   // output stream out
15   friend ostream& operator<<(ostream& out, const IntegerSet& set);
16  public:
17   IntegerSet();                            // initializes the set to the empty
18                                            //   set
19   IntegerSet(const IntegerSet& otherSet); // copy constructor
20   ~IntegerSet();                           // destructor
21   bool isMember(uint e) const;             // returns true if e is a member of
22                                            //   the set and false otherwise
23   uint cardinality() const;                // cardinality of a set
24   IntegerSet operator+(uint e) const;      // if e is valid and not a member of
25                                            //   the set, insert e into set
26   IntegerSet operator-(uint e) const;      // if e is valid and a member of
27                                            //   the set, delete e from set
28   IntegerSet operator-() const;            // complement of a Set
29   IntegerSet& operator=(const IntegerSet& rhs); // *this = rhs;
30
```

Figure 1. `/usr/local/2336/include/lab08.h` (Part 1 of 2)

```
31  private:
32   uint *bitVector;                        // Pointer to dynamically
33                                           //   allocated memory
34   bool isValid(uint e) const;             // 0 <= e < N
35   uint word(uint n) const;                // Determine index within
36                                           //   bitVector where n is located
37   uint bit(uint n) const;                 // Determine position within
38                                           //   bitVector[word(n)]
39                                           //   for element n
40   void allocateStorage();                 // Calculate # of elements
41                                           //   in bitVector to represent
42                                           //   elements 0..(N-1) & then
43                                           //   allocate storage
44 };
45
46 #endif
```

Figure 1. `/usr/local/2336/include/lab08.h` (Part 2 of 2)

```
1  #include <lab08.h>
2  #include <iomanip>
3
4  using namespace std;
5
6  int main()
7  {
8    uint e, j, n;
9    IntegerSet s, t;
10
11   while (cin >> n)
12   {
13     for (j = 0; j < n; ++j)
14     {
15       cin >> e;
16       s = s + e;
17     }
18     cout << "s = ";
19     cout << s;
20     cout << "s.cardinality() = " << s.cardinality() << endl << endl;
21
22     // Use operators - and = to initialize t with the complement of s
23     t = -s;
24     cout << "t = ";
25     cout << t;
26     cout << "t.cardinality() = " << t.cardinality() << endl << endl;
27
```

Figure 2. `/usr/local/2336/src/lab08main.C` (Part 1 of 2)

```
28      // clear set s
29      for (e = 0; e < N; ++e)
30      {
31        if (s.isMember(e))
32          s = s - e;
33      }
34      cout << "s.cardinality() = " << s.cardinality() << endl << endl;
35    }
36
37    return 0;
38  }
```

Figure 2. `/usr/local/2336/src/lab08main.C` (Part 2 of 2)

```
1  newuser@csunix ~> cd 2336
2  newuser@csunix ~/2336> ./getlab.ksh 08
3    * Checking to see if a folder exists for Lab 08. . .No
4    * Creating a folder for Lab 08
5    * Checking to see if Lab 08 has sample input and output files. . .Yes
6    * Copying input and output files for Lab 08
7      from folder /usr/local/2336/data/08 to folder ./08
8    * Checking to see if /usr/local/2336/src/lab08main.C exists. . .Yes
9    * Copying file /usr/local/2336/src/lab08main.C to folder ./08
10   * Checking to see if /usr/local/2336/include/lab08.h exists. . .Yes
11   * Copying file /usr/local/2336/include/lab08.h to folder ./08
12   * Copying file /usr/local/2336/src/Makefile to folder ./08
13   * Adding a target of lab08 to targets2srcfileswithlibrary
14   * Touching file ./08/lab08.cpp
15   * Edit file ./08/lab08.cpp in Notepad++
16 newuser@csunix ~/2336> cd 08
17 newuser@csunix ~/2336/08> ls
18 01.dat       01.out       Makefile     lab08.cpp    lab08.h      lab08main.C
19 newuser@csunix ~/2336/08> make lab08
20 g++ -g -Wall -std=c++11 -c lab08main.C -I/usr/local/2336/include -I.
21 g++ -g -Wall -std=c++11 -c lab08.cpp -I/usr/local/2336/include -I.
22 g++ -o lab08 lab08main.o lab08.o -L/usr/local/2336/lib \
23 -Wl,-whole-archive -llab08 -Wl,-no-whole-archive -lm -lbits
24 newuser@csunix ~/2336/08> cat 01.dat
25 6
26 1 2 4 8 16 32
27 10
28 3 6 9 12 15 3 6 9 12 15
29 13
30 4 8 12 16 20 24 28 32 36 40 44 48 52
31 48
32  0  1  2  3  4  5  6  7  8  9
33 10 11 12 13 14 15 16 17 18 19
34 20 21 22 23 24 25 26 27 28 29
35 30 31 32 33 34 35 36 37 38 39
36 40 41 42 43 44 45 46 47
37 0
```

Figure 3. Commands to Compile, Link, & Run Lab 08 (Part 1 of 2)

```
newuser@csunix ~/2336/08> cat 01.dat | ./lab08
s = {1,2,4,8,16,32}
s.cardinality() = 6

t = {0,3,5,6,7,9,10,11,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,33,34,35,36,37,38,39}
t.cardinality() = 34

s.cardinality() = 0

s = {3,6,9,12,15}
s.cardinality() = 5

t = {0,1,2,4,5,7,8,10,11,13,14,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}
t.cardinality() = 35

s.cardinality() = 0

s = {4,8,12,16,20,24,28,32,36}
s.cardinality() = 9

t = {0,1,2,3,5,6,7,9,10,11,13,14,15,17,18,19,21,22,23,25,26,27,29,30,31,33,34,35,37,38,39}
t.cardinality() = 31

s.cardinality() = 0

s = {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}
s.cardinality() = 40

t = ∅
t.cardinality() = 0

s.cardinality() = 0

s = ∅
s.cardinality() = 0

t = {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}
t.cardinality() = 40

s.cardinality() = 0

newuser@csunix ~/2336/08> cat 01.dat | ./lab08 > my.out
newuser@csunix ~/2336/08> diff 01.out my.out
newuser@csunix ~/2336/08>
```

Figure 3. Commands to Compile, Link, & Run Lab 08 (Part 2 of 2)