Source File: `~/2336/10/lab10.(C|CPP|cpp|c++|cc|cxx|cp)`
Input: Under control of `main` function
Output: Under control of `main` function
Value: 1

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, 06, and 08 will be modified to provide:

- overloaded operators to compute the union, intersection, difference, and symmetric difference of two `IntegerSet`s.

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 `lab10` to `targets2srcfileswithlibrary`.

```
1  #ifndef LAB10_H
2  #define LAB10_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
31   IntegerSet operator+(const IntegerSet& rhs) const; // union
32   IntegerSet operator*(const IntegerSet& rhs) const; // intersection
33   IntegerSet operator-(const IntegerSet& rhs) const; // difference
34   IntegerSet operator/(const IntegerSet& rhs) const; // symmetric diff
35
```

Figure 1. `/usr/local/2336/include/lab10.h` (Part 1 of 2)

```
36   private:
37    uint *bitVector;                        // Pointer to dynamically
38                                            //   allocated memory
39    bool isValid(uint e) const;             // 0 <= e < N
40    uint word(uint n) const;                // Determine index within
41                                            //   bitVector where n is located
42    uint bit(uint n) const;                 // Determine position within
43                                            //   bitVector[word(n)]
44                                            //   for element n
45    void allocateStorage();                 // Calculate # of elements
46                                            //   in bitVector to represent
47                                            //   elements 0..(N-1) & then
48                                            //   allocate storage
49  };
50
51  #endif
```

Figure 1. `/usr/local/2336/include/lab10.h` (Part 2 of 2)

```
1   #include <lab10.h>
2   #include <iomanip>
3
4   using namespace std;
5
6   int main()
7   {
8     uint e, j, n;
9     IntegerSet s, t, c, u, i, d;
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 = " << s;
19      cout << "s.cardinality() = " << s.cardinality() << endl;
20
21      cin >> n;
22      for (j = 0; j < n; ++j)
23      {
24        cin >> e;
25        t = t + e;
26      }
27      cout << " t = " << t;
28      cout << "t.cardinality() = " << t.cardinality() << endl;
29
30      c = -t;
31      cout << " c = " << c;
32
33      u = s + t;
34      cout << " u = " << u;
35
36      i = s * t;
37      cout << " i = " << i;
38
39      d = s - t;
40      cout << " d = " << d;
41
42      IntegerSet sd(s / t);
43      cout << "sd = " << sd;
44
45      // clear sets s & t
46      for (e = 0; e < N; ++e)
47      {
48        if (s.isMember(e))
49          s = s - e;
50        if (t.isMember(e))
51          t = t - e;
52      }
53    }
54
55    return 0;
56  }
```

Figure 2. `/usr/local/2336/src/lab10main.C`

```
newuser@csunix ~> cd 2336
newuser@csunix ~/2336> ./getlab.ksh 10
  * Checking to see if a folder exists for Lab 10. . .No
  * Creating a folder for Lab 10
  * Checking to see if Lab 10 has sample input and output files. . .Yes
  * Copying input and output files for Lab 10
    from folder /usr/local/2336/data/10 to folder ./10
  * Checking to see if /usr/local/2336/src/lab10main.C exists. . .Yes
  * Copying file /usr/local/2336/src/lab10main.C to folder ./10
  * Checking to see if /usr/local/2336/include/lab10.h exists. . .Yes
  * Copying file /usr/local/2336/include/lab10.h to folder ./10
  * Copying file /usr/local/2336/src/Makefile to folder ./10
  * Adding a target of lab10 to targets2srcfileswithlibrary
  * Touching file ./10/lab10.cpp
  * Edit file ./10/lab10.cpp in Notepad++
newuser@csunix ~/2336> cd 10
newuser@csunix ~/2336/10> ls
01.dat       01.out       Makefile     lab10.cpp    lab10.h      lab10main.C
newuser@csunix ~/2336/10> make lab10
g++ -g -Wall -std=c++11 -c lab10main.C -I/usr/local/2336/include -I.
g++ -g -Wall -std=c++11 -c lab10.cpp -I/usr/local/2336/include -I.
g++ -o lab10 lab10main.o lab10.o -L/usr/local/2336/lib \
-Wl,-whole-archive -llab10 -Wl,-no-whole-archive -lm -lbits
newuser@csunix ~/2336/10> cat 01.dat
4
1 2 3 4
3
1 4 5
6
1 2 4 8 16 32
10
3 6 9 12 15 3 6 9 12 15
13
4 8 12 16 20 24 28 32 36 40 44 48 52
48
 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
40 41 42 43 44 45 46 47
0
0
```

Figure 3. Commands to Compile, Link, & Run Lab 10 (Part 1 of 2)

```
newuser@csunix ~/2336/10> cat 01.dat | ./lab10
 s = {1,2,3,4}
s.cardinality() = 4
 t = {1,4,5}
t.cardinality() = 3
 c = {0,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}
 u = {1,2,3,4,5}
 i = {1,4}
 d = {2,3}
sd = {2,3,5}
 s = {1,2,4,8,16,32}
s.cardinality() = 6
 t = {3,6,9,12,15}
t.cardinality() = 5
 c = {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}
 u = {1,2,3,4,6,8,9,12,15,16,32}
 i = ∅
 d = {1,2,4,8,16,32}
sd = {1,2,3,4,6,8,9,12,15,16,32}
 s = {4,8,12,16,20,24,28,32,36}
s.cardinality() = 9
 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
 c = ∅
 u = {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}
 i = {4,8,12,16,20,24,28,32,36}
 d = ∅
sd = {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}
 s = ∅
s.cardinality() = 0
 t = ∅
t.cardinality() = 0
 c = {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}
 u = ∅
 i = ∅
 d = ∅
sd = ∅
newuser@csunix ~/2336/10> cat 01.dat | ./lab10 > my.out
newuser@csunix ~/2336/10> diff 01.out my.out
newuser@csunix ~/2336/10>
```

Figure 3. Commands to Compile, Link, & Run Lab 10 (Part 2 of 2)