Source File: `~/1337/18/lab18.(C|CPP|cpp|c++|cc|cxx|cp)`
Input: Under control of `main` function
Output: Under control of `main` function
Value: 2

Let a sequence be defined as follows: $a_0 = a$, while a_{k+1} is computed by inverting the order of the decimal digits in $a_k + 4$. For example if $a = 4$, the sequence generated is

$$4, 8, 21, 52, 65, 96, 1, 5, 9, 31, 53, 75, 97, 101, 501, \ldots$$

Write a function `generateSequence` to determine which element of the sequence equals 1. Designate this element as k. The function should also print the terms of the generated sequence. In the above example, $k = 6$. Include the `reverseInt` function from Lab 15.

A sample `main` function for testing your functions is shown in Figure 1 and a sample execution sequence is shown in Figure 2. Another method for compiling and linking of your programs is to use a `Makefile`. An example `Makefile` is shown in Figure 3. To use the `Makefile`, add a target of `lab18` to `targets2srcfiles`. That is, change line 38 in the `Makefile` from

```
38  targets2srcfiles =
```

to

```
38  targets2srcfiles = lab18
```

A sample execution sequence utilizing the `make` command and the accompanying `Makefile` is shown in Figure 4. To use the `make` command for future assignments, you will need to edit the `Makefile` by modifying lines 33, 38, and 43. Notice that `make` automatically generates three commands: the first two commands compile (note the `-c` option) the source programs yielding a corresponding object code file for each source file, and the third command invokes the linkage editor to create the executable.

```
1  #include <iostream>
2  #include <cstdlib>
3
4  using namespace std;
5
6  // Function reverseInt returns an integer whose digits are in the
7  // reverse order of num.  For example, if num is 1234, the returned
8  // integer would be 4321.
9  unsigned int reverseInt(unsigned int num);
10
11 // Function generateSequence receives num (the first term in a
12 // sequence) and an output stream out. The function computes
13 // additional terms in the sequence and writes them to out. After the
14 // initial term, subsequent terms are computed by inverting the order
15 // of the decimal digits in (num + 4).  For example, if num is 4, the
16 // sequence generated is 4, 8, 21, 52, 65, 96, 1, 5, 9, 31, 53, 75,
17 // 97, 101, 501, ... The function returns which element in the
18 // sequence equals 1.  In the example given here, the return value is
19 // 6.
20 unsigned int generateSequence(unsigned int num, ostream& out);
```

Figure 1. `/usr/local/1337/src/lab18main.C` (Part 1 of 2)

```
21
22  int main()
23  {
24    unsigned int num, k;
25
26    while (cin >> num)
27    {
28      k = generateSequence(num, cout);
29      cout << "n = " << num << ", " << "k = " << k << endl << endl;
30    }
31
32    return 0;
33  }
```

Figure 1. `/usr/local/1337/src/lab18main.C` (Part 2 of 2)

```
1  newuser@csunix ~> cd 1337
2  newuser@csunix ~/1337> mkdir 18
3  newuser@csunix ~/1337> cd 18
4  newuser@csunix ~/1337/18> cp /usr/local/1337/data/18/* .
5  newuser@csunix ~/1337/18> cp /usr/local/1337/src/lab18main.C .
6  newuser@csunix ~/1337/18> touch lab18.cpp
7  newuser@csunix ~/1337/18> # Edit lab18.cpp
8  newuser@csunix ~/1337/18> g++ -g -Wall -std=c++11 -c lab18main.C
9  newuser@csunix ~/1337/18> g++ -g -Wall -std=c++11 -c lab18.cpp
10 newuser@csunix ~/1337/18> g++ -o lab18 lab18main.o lab18.o
11 newuser@csunix ~/1337/18> cat 01.dat
12 0 4 1 10 542 669 736 875 960 1008
13 newuser@csunix ~/1337/18> cat 01.dat | ./lab18
14 0, 4, 8, 21, 52, 65, 96, 1
15 n = 0, k = 7
16
17 4, 8, 21, 52, 65, 96, 1
18 n = 4, k = 6
19
20 1
21 n = 1, k = 0
22
23 10, 41, 54, 85, 98, 201, 502, 605, 906, 19, 32, 63, 76, 8, 21, 52, 65, 96, 1
24 n = 10, k = 18
25
26 542, 645, 946, 59, 36, 4, 8, 21, 52, 65, 96, 1
27 n = 542, k = 11
28
29 669, 376, 83, 78, 28, 23, 72, 67, 17, 12, 61, 56, 6, 1
30 n = 669, k = 13
31
```

Figure 2. Commands to Compile, Link, & Run Lab 18 (Part 1 of 2)

```
736, 47, 15, 91, 59, 36, 4, 8, 21, 52, 65, 96, 1
n = 736, k = 12

875, 978, 289, 392, 693, 796, 8, 21, 52, 65, 96, 1
n = 875, k = 11

960, 469, 374, 873, 778, 287, 192, 691, 596, 6, 1
n = 960, k = 10

1008, 2101, 5012, 6105, 9016, 209, 312, 613, 716, 27, 13, 71, 57, 16, 2, 6, 1
n = 1008, k = 16

newuser@csunix ~/1337/18> cat 01.dat | ./lab18 > my.out
newuser@csunix ~/1337/18> diff 01.out my.out
newuser@csunix ~/1337/18>
```

Figure 2. Commands to Compile, Link, & Run Lab 18 (Part 2 of 2)

```
CLASS = 1337
BASE_DIR = /usr/local/$(CLASS)
LINK_DIRS = -L$(BASE_DIR)/lib
INCLUDE_DIRS = -I$(BASE_DIR)/include -I.
LFLAGS = -lm -lbits
CFLAGS = -g -Wall -std=c++11

.SECONDEXPANSION:
CC = g++
.SUFFIXES:.o .C .CPP .cpp .c++ .cc .cxx .cp

.C.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

.CPP.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

.cpp.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

.c++.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

.cc.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

.cxx.o:
        $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)

```

Figure 3. `/usr/local/1337/src/Makefile` (Part 1 of 2)

```
30 .cp.o:
31         $(CC) $(CFLAGS) -c $< $(INCLUDE_DIRS)
32
33 targets1srcfile =
34
35 $(targets1srcfile): $$@.o
36         $(CC) -o $@ $@.o $(LINK_DIRS) $(LFLAGS)
37
38 targets2srcfiles =
39
40 $(targets2srcfiles): $$@main.o $$@.o
41         $(CC) -o $@ $@main.o $@.o $(LINK_DIRS) $(LFLAGS)
42
43 targets2srcfileswithlibrary =
44
45 $(targets2srcfileswithlibrary): $$@main.o $$@.o
46         $(CC) -o $@ $@main.o $@.o $(LINK_DIRS) $(LFLAGS) \
47         -Wl,-whole-archive -l$@ -Wl,-no-whole-archive
48
49 clean:
50         rm -f *.o core *~ $(targets1srcfile) $(targets2srcfiles)
51         rm -f $(targets2srcfileswithlibrary)
```

Figure 3. `/usr/local/1337/src/Makefile` (Part 2 of 2)

```
newuser@csunix ~> cd 1337
newuser@csunix ~/1337> mkdir 18
newuser@csunix ~/1337> cd 18
newuser@csunix ~/1337/18> cp /usr/local/1337/data/18/* .
newuser@csunix ~/1337/18> cp /usr/local/1337/src/lab18main.C .
newuser@csunix ~/1337/18> cp /usr/local/1337/src/Makefile .
newuser@csunix ~/1337/18> touch lab18.cpp
newuser@csunix ~/1337/18> # Edit Makefile and lab18.cpp
newuser@csunix ~/1337/18> make lab18
g++ -g -Wall -std=c++11 -c lab18main.C -I/usr/local/1337/include -I.
g++ -g -Wall -std=c++11 -c lab18.cpp -I/usr/local/1337/include -I.
g++ -o lab18 lab18main.o lab18.o -L/usr/local/1337/lib -lm -lbits
newuser@csunix ~/1337/18> cat 01.dat | ./lab18
0, 4, 8, 21, 52, 65, 96, 1
n = 0, k = 7

4, 8, 21, 52, 65, 96, 1
n = 4, k = 6

1
n = 1, k = 0

10, 41, 54, 85, 98, 201, 502, 605, 906, 19, 32, 63, 76, 8, 21, 52, 65, 96, 1
n = 10, k = 18

542, 645, 946, 59, 36, 4, 8, 21, 52, 65, 96, 1
n = 542, k = 11

669, 376, 83, 78, 28, 23, 72, 67, 17, 12, 61, 56, 6, 1
n = 669, k = 13

736, 47, 15, 91, 59, 36, 4, 8, 21, 52, 65, 96, 1
n = 736, k = 12

875, 978, 289, 392, 693, 796, 8, 21, 52, 65, 96, 1
n = 875, k = 11

960, 469, 374, 873, 778, 287, 192, 691, 596, 6, 1
n = 960, k = 10

1008, 2101, 5012, 6105, 9016, 209, 312, 613, 716, 27, 13, 71, 57, 16, 2, 6, 1
n = 1008, k = 16

newuser@csunix ~/1337/18> cat 01.dat | ./lab18 > my.out
newuser@csunix ~/1337/18> diff 01.out my.out
newuser@csunix ~/1337/18>
```

Figure 4. Commands to Compile, Link, & Run Lab 18 Using `make`