CSE2050 - Programming in a Second Language
Assignment 3: Linked List Manipulation

October 11, 2017

1 Submission

- Due Date: **October 20th, 11:59pm**
- Deliverable: **listGCD.cpp** (case sensitive)
- Submit on **Canvas**.

2 Description

In this assignment, we expand the problem of computing the GCD of a sequence of integers stored in a linked list (as discussed in *Assignment 2*) by providing the functionality of adding and removing numbers (nodes) to/from that list. The goal is to build a Singly Linked List (with a node structure similar to the one used in *Assignment 2*) to store a number of integers (given), and calculating the GCD of those numbers. Providing the following:

- New numbers can be added at a specific location in the list.
- Numbers can be removed from the list (either by providing their location, or their value).

3 Implementation details

3.1 Input

The program receives sequences of positive integers from standard input (i.e., use **cin** to read them). The first integer $\boldsymbol{x}$ in each sequence determines the operation to be performed, and the number of the following integers in this sequence. possible formats:

input	description
1 ***i*** ***v***	add node at index i, with value v
2 ***i***	remove node at index i
3 ***v***	remove first encountered node with value v
0	quit

For example, the input: **1 3 4** tells the program to add a node (the first number, $\boldsymbol{x} = 1$) at index 3 (the second number, $\boldsymbol{i} = 3$), with a value 4 (third number, $\boldsymbol{v} = 4$).

The program ends if the input is **zero** (no other values follow).

The number of these sequences is not known in advance, so your program should read all the sequences until it encounters a **zero**, then it stops reading (the zero value is not stored in the list).

It is important to make sure the loop used to read these values ends properly. Endless loops are considered failed cases (0 points).

```
./listGCD
a b c
d e
f g
h i j
...
```

3.2 Output

- For each sequence of numbers, the program prints out the following two lines:
  - The first line shows the list's GCD (single spaces). An example:

    ```
    List GCD: 15
    ```

  - The second line shows the contents of the list (separated by single spaces) printed in the same order of input (the first number entered on the left). An example:

    ```
    List contents: 14 15 16
    ```

- If the list is empty (for example, after removing all the nodes), show the following:

  ```
  List GCD: 0
  List contents:
  ```

- On exit (when receiving the value 0), there is no output.

3.3 General notes

- Only implementations based on *Dynamic Memory Allocation* will receive full points.

- implement the *node* as a *class* with *value* as private field (you will need public *getter* and *setter* methods to access it). It is also recommended to use *constructor* and *destructor* methods.
- You may use any algorithm you prefer to calculate the GCD of the list.
- The index $\boldsymbol{i}$ is used to determine the node's location in the list (starts from 0 for the 1^{st} node), and $\boldsymbol{v}$ represents the actual value for that node.
- When adding a new node (*op_code* = 1), the index $\boldsymbol{i}$ has the following meanings:
  - if $\boldsymbol{i}$ is 0, *add first*. The new node will be prepended to the beginning of the current list (it becomes the first node), then *head* will point to the newly added node.
  - if $\boldsymbol{i} \geq \boldsymbol{N}$ (where $\boldsymbol{N}$ is the size of the list, i.e., the number of items currently in the list), *add last*. The new created node will be added to the end of the list.
  - otherwise, the new created node will be inserted at the specified index (becomes the i^{th} node).
- When removing a node giving its index $\boldsymbol{i}$ (*op_code* = 2), if the index does not exist ($\boldsymbol{i} \geq \boldsymbol{N}$), do nothing (do not remove, do not show error message).
- When removing a node giving its value $\boldsymbol{v}$ (*op_code* = 3), remove the first occurrence of that value in the list (the first encountered node with value $\boldsymbol{v}$). If the value does not exist, do nothing (do not remove, do not show error message).
- Managing *Dynamic Memory Allocation* properly (20% of this assignment's grade) requires avoiding issues like memory leaks. Depending on your OS and IDE, there are some tools that can help identify some of these issues (like cppcheck).
- Same notes from previous assignments apply here as well (correct deliverable name, runs on **code01.fit.edu**, output format is important, and make sure you use the correct input source for data)

3.4 Example

The following example, shows the program's responses to input (all the responses are shown in order):

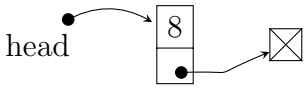
- running the program

```
./listGCD
```

- Input 1

```
1 0 8
```

This will create the following linked list,,



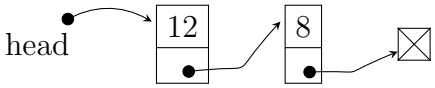
- Output 1

```
List GCD: 8
List contents: 8
```

- Input 2

```
1 0 12
```

Inserting the value 12 at location 0 (first) changes the linked list as follows:



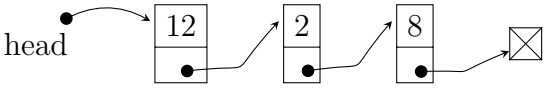
- Output 2

```
List GCD: 4
List contents: 12 8
```

- Input 3

```
1 1 2
```

Value 2 will be inserted at index 1 (second node):



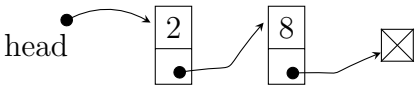
- Output 3

```
List GCD: 2
List contents: 12 2 8
```

- Input 4

```
3 12
```

Delete first node that has value 12:



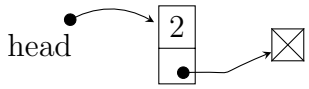
- Output 4

```
List GCD: 2
List contents: 2 8
```

- Input 5

```
2 1
```

Deleting the second node (index 1):



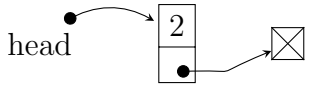
- Output 5

```
List GCD: 2
List contents: 2
```

- Input 6

```
2 5
```

Attempting to delete node at index 5 (an invalid index) will not actually change the list.



- Output 6

```
List GCD: 2
List contents: 2
```

- Input 7

```
2 0
```

This deletes the remaining node (the list becomes empty).

- Output 7

```
List GCD: 0
List contents:
```

- input 1

```
0
```

0 ends the program (no printing).

4 Sample input/output

Note 1: Most IDEs use the same console for both input and output However, they will be shown separately here (input in top box, output below).

Note 2: It might be more convenient to redirect the input at command line. To do this, first, save the input in a text file (say "input.txt"), then run your program using a command similar to the following:

```
./a.out < input.txt
```

Note 3: Some IDEs provide a way to redirect input from a file (instead of having to enter the values manually every time you run your code). For example, in *Eclipse's CDT*, you can set this from $Run \rightarrow Run\ Configurations \rightarrow Common \rightarrow Inputfile$

4.1 Sample 1

Input

```
1 0 16
1 1 18
1 1 12
2 1
1 2 14
3 12
3 5
1 0 1
0
```

Output

```
List GCD: 16
List contents: 16
List GCD: 2
List contents: 16 18
List GCD: 2
List contents: 16 12 18
List GCD: 2
List contents: 16 18
List GCD: 2
List contents: 16 18 14
List GCD: 2
List contents: 16 18 14
List GCD: 2
List contents: 16 18 14
List GCD: 1
```

```
List contents: 1 16 18 14
```

4.2 Sample 2

Input

```
1 0 24
1 1 12
1 2 6
1 2 18
1 4 3
3 12
2 2
0
```

Output

```
List GCD: 24
List contents: 24
List GCD: 12
List contents: 24 12
List GCD: 6
List contents: 24 12 6
List GCD: 6
List contents: 24 12 18 6
List GCD: 3
List contents: 24 12 18 6 3
List GCD: 3
List contents: 24 18 6 3
List GCD: 3
List contents: 24 18 3
```

4.3 Sample 3

Input

```
1 0 25
1 0 8
3 17
2 3
2 2
3 6
1 0 9
2 5
0
```

Output

```
List GCD: 25
List contents: 25
List GCD: 1
List contents: 8 25
List GCD: 1
List contents: 8 25
List GCD: 1
List contents: 8 25
List GCD: 1
List contents: 8 25
List GCD: 1
List contents: 8 25
List GCD: 1
List contents: 9 8 25
List GCD: 1
List contents: 9 8 25
```

4.4 Sample 4

Input

```
1 0 2
1 0 2
3 2
1 0 6
1 8 90
2 1
2 2
2 1
2 1
2 3
1 4 23
3 23
0
```

Output

```
List GCD: 2
List contents: 2
List GCD: 2
List contents: 2 2
List GCD: 2
List contents: 2
List GCD: 2
List contents: 6 2
```

```
List GCD: 2
List contents: 6 2 90
List GCD: 6
List contents: 6 90
List GCD: 6
List contents: 6 90
List GCD: 6
List contents: 6
List GCD: 6
List contents: 6
List GCD: 6
List contents: 6
List GCD: 1
List contents: 6 23
List GCD: 6
List contents: 6
```

5 Rubric

Criterion	Possible points	Excellent (max. points)	Satisfactory (partial points)	Unsatisfactory (no points)
Delivery	5 %	on time, using correct file name (see top)		wrong file name
Compiles	5 %	compiles on code01.fit.edu with no errors		does not compile
Runs	5 %	runs on code01.fit.edu with no run-time errors (missing files,..etc)		does not execute
Completion	25%	all functions implemented	some functions implemented	
Dynamic Memory allocation	20%	implemented using pointers/Dynamic Memory allocation		implemented using other memory access methods
Avoiding memory leaks	15%	freeing memory correctly for all pointers & dynamic memory allocation operations		code has memory leaks
Test cases	25%	passes all test cases (correct output in the correct format)	passes some test cases	fails all test cases, or has an endless loop.