CSCI 2270 – Data Structures and Algorithms
Instructor: Hoenigman
Assignment 3
Due: Wednesday, February 10 before 3pm.

Communication between towers

In the Lord of the Rings trilogy, there is a scene where the first beacon is lit in the towers of Minas Tirith. The second beacon then sees the fire, and knows to light its fire to send a signal to the third beacon, and so forth. This was a means of communicating in the days before telegraphs were invented as it was much faster than sending a human rider to deliver a message. Communication towers were equipped with signaling mechanisms, such as mirrors, that could spell out messages using the positions of the mirrors.

Today, there are several examples of communication networks that are conceptually similar, but much more technically advanced, that route messages through multiple hubs between the sender and the receiver. For example, when you type a URL into a web browser, a request is sent through a network of service providers to the destination, and then packets of information are sent back to your machine. If I type www.google.com from my home in Boulder, my request follows this path:

```
1  192.168.2.1 (192.168.2.1)
2  c-24-9-60-1.hsd1.co.comcast.net (24.9.60.1)
3  te-9-7-ur02.boulder.co.denver.comcast.net
4  xe-13-3-1-0-ar01.aurora.co.denver.comcast.net
5  he-3-10-0-0-cr01.denver.co.ibone.comcast.net
(68.86.92.25)
te-1-1-0-4-cr01.chicago.il.ibone.comcast.net (68.86.95.205)
6  xe-2-0-0-0-pe01.910fifteenth.co.ibone.comcast.net
(68.86.82.2)
7  as15169-1-c.910fifteenth.co.ibone.comcast.net
(23.30.206.106)
8  72.14.234.57 (72.14.234.57)
9  209.85.251.111 (209.85.251.111)
10  den03s06-in-f16.1e100.net (74.125.225.208)
```

Each IP address is a hop in the network for my request, which is received at each service provider and then forwarded to the next service provider in the network, depending on the final destination of the message.

(Note: I got this path by typing traceroute www.google.com in a terminal window. From campus, you will see a different path.)

Build your own communications network

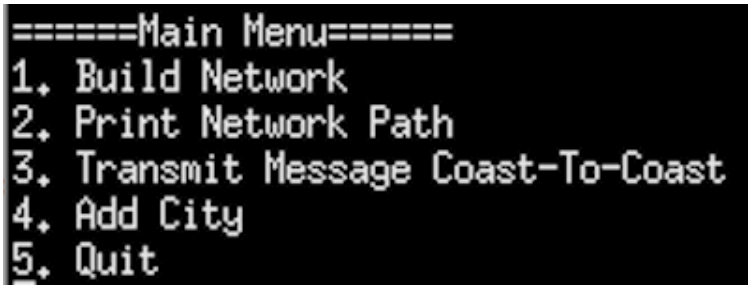
In this assignment, you're going to simulate a communications network using a linked list. Each node in your linked list will represent a city and you need to be able to send a message between nodes from one side of the country to the other. Your program also needs to provide the capability to update the network by adding cities and still be able to transmit the message.

(Note: I'll refer to the linked list as the network throughout this document.)

Include the following cities in your network:
Los Angeles
Phoenix
Denver
Dallas
St. Louis
Chicago
Atlanta
Washington, D.C.
New York
Boston

Implement each city as a struct with a name, a pointer connecting it to the next city in the network, and a place to store the message being sent. (You can assume the message is a string.) When you initially build your network, the order of the cities should be the same as the order listed above. After the network is built, you will provide the option of adding additional cities.

First, display a menu
When your program starts, you should display a menu that presents the user with options for how to run your program. The menu needs to look like the one shown here:



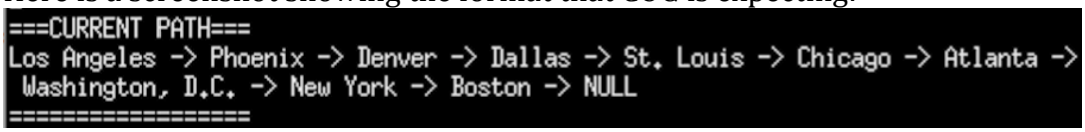
The user will select the number for the menu option and your program should respond accordingly to that number. Your menu options need to have the following functionality.

1. **Build Network:** This option builds the linked list using the cities listed above in the order they are listed. Each city needs to have a name, a pointer to the next city, and a message value, which will initially be an empty string. This

option should be selected first to build the network, and can be selected anytime the user wants to rebuild the starting network after adding cities. As part of the Build Network functionality, you should print the name of each city in the network once the network is built in the following format:

Los Angeles -> Phoenix -> Denver -> Dallas -> St. Louis -> Chicago -> Atlanta -> Washington, D.C. -> New York -> Boston -> NULL

Here is a screenshot showing the format that COG is expecting:



2. **Print Network Path:** This option prints out the linked list in order from the head to the tail by following the next pointer for each city. You should print the name of each city. The function could be very useful to you when debugging your code. The format should be the same as the format in Build Network.
3. **Transmit Message Coast-to-Coast:** This option reads word by word from the *messageIn.txt* file and transmits the message starting at the beginning of the network and ending at the end of the network. Using the cities in this write-up, the message would go from Los Angeles to Boston, passing through each city along the way. When a city receives the message, you should print

   <city name> received <word>

   where *<city name>* is the name of the city and *<word>* is the word received. When a city receives a word, the word should be deleted from the sender city, i.e set the message for the sender city to an empty string. Here is a screenshot of the output I get after transmitting the first two words in the file:

4. **Add City:** This option allows the user to add a new city to the network. If the user selects this option, then they should be prompted for the name of the city and the city that the new city should follow in the network. For example, if the user wants to add Tucson after Phoenix in the network, then the first four cities in the network would be:

   Los Angeles -> Phoenix -> Tucson -> Denver…

   You don't need to print anything when you add a new city, just call the Print Network function again from the menu if you want to verify that the city has been added.

   If the user wants to add a new city to the head of the network, e.g. replace Los Angeles as the starting city, then they should type First when prompted for the previous city and your code should handle this special case. *(Note: for this week, we won't be testing that your code can add a new head node. However, you will need to implement this functionality in next week's assignment.)*

   Here is a screenshot showing the expected output for the add city functionality when the user selects Add City from the menu.

5. **Quit:** This option allows the user to exit the program.

For each of the options presented, after the user makes their choice and your code runs for that option, you should re-display the menu to allow the user to select another option.

Structuring your program
The specific **cout** statements that COG expects are shown in Appendix A.

The functionality for your network will be implemented in a class called CommunicationNetwork. A suggested header file called CommunicationNetwork.h is provided for you on Moodle. Each of the menu options needs to be handled by calling methods in your CommunicationNetwork instance. You are welcome to structure your class differently than the .h provided, or write additional helper functions or methods to support those provided. Your code needs to be readable, efficient, and accomplish the task provided.

void CommunicationNetwork::addCity(string previousCity, string newCity)
/*Insert a new city into the linked list after the previousCity. The name of the new city is in the argument newCity.
*/

*void CommunicationNetwork::transmitMsg(char *filename)*
/*Open the file and transmit the message between all cities in the network word by word. A word needs to be received at the end of the network before sending the next word. Only one city can hold the message at a time; as soon as it is passed to the next city, it needs to be deleted from the sender city.
*/

void CommunicationNetwork::printNetwork()
/*Start at the head of the linked list and print the name of each city in order to the end of the list. */

void CommunicationNetwork::buildNetwork()
/*Build the initial network from the cities given in this writeup. The cities can be fixed in the function, you do not need to write the function to work with any list of cities. */

Suggestions for completing this assignment
There are several components to this assignment that can be treated independently. My advice is to tackle these components one by one, starting with printing the menu and getting user input. Next, build the network and print it. Then, add the functionality to add additional cities. If you're planning to implement the functionality to clear the network, to get a head start on next week, do that last.

Once you get one feature completed, test, test, test, to make sure it works before moving on to the next feature.

There are several examples of how to work with linked lists in Chapter 5 in your book, and we will also be covering these concepts in lectures this week.

If you create a project in CodeBlocks, then you can add your class to the project using the directions posted on Moodle. This will make it easier to build and test your code. The only trick with projects is finding where your files are stored. When you create a project, CodeBlocks creates a directory structure within the project directory. For example, if your project is called Assignment3, then there will be a directory called Assignment3 that contains a main.cpp file. When you add a class to the project, a directory is created within Assignment3 called include. This is where your Communication.h file will be stored. Your Communication.cpp is stored in Assignment3/src.

After your add the class to your CodeBlocks project, save the project using File->Save Project.

Also, start early.

Submitting Your Code:
Submit your assignment to the COG autograder:
https://web-cog-csci2270.cs.colorado.edu/submit.html.

Login to COG using your identikey and password. Select the CSCI2270 - Hoenigman – HW #03 from the dropdown. Upload your file and click Submit. Zip your *CommunicationNetwork.cpp*, *CommunicationNetwork.h*, and *Assignment3.cpp* files together into one Assignment3.zip archive. **Your file needs to be named Assignment3.zip for the grading script to run.** COG will run its tests and display the results in the window below the Submit button. If your code doesn't run correctly on COG, read the error messages carefully, correct the mistakes in your code, and upload a new file. You can modify your code and resubmit as many times as you need to, up until the assignment due date.

Submit your assignment to Moodle
In addition to submitting through COG, submit your Assignment3.zip file through Moodle using the Assignment 3 Submit link. Make sure your code is commented enough to describe what it is doing. Include a comment block at the top of the .cpp file with your name, assignment number, and course instructor. **If you do not submit your work to Moodle, we will deduct points from your grade, even if COG gives you a perfect score.**

If you do not get your assignment to run on COG, you will have the option of scheduling an interview grade with your TA to get a grade for the assignment. Even

if you do get the assignment to run on COG, you can schedule the interview if you just want to talk about the assignment and get feedback on your implementation.

What to do if you have questions
There are several ways to get help on assignments in 2270, and depending on your question, some sources are better than others. There is a Peer Discussion Forum on our Moodle page that is a good place to post technical questions, such as how to shift an array. When you answer other students' questions on the forum, please do not post entire assignment solutions. The multi-course PLAs are also a good source of technical information, especially questions about C++. If, after reading the assignment write-up, you need clarification on what you're being asked to do in the assignment, the TAs and the Instructor are better sources of information than the discussion forum or the PLAs.

Appendix A – cout statements that COG expects

Print path

```
cout << "===CURRENT PATH===" << endl;
cout << tmp->name << " -> ";   //for all nodes in network
cout << "NULL" << endl;
cout << "==================" << endl;
```

Transmit Message

```
cout<<sender->cityName<<" received "<<sender->message<<endl;

//if network not built yet, head = NULL
cout << "Empty list" << endl;
```

Adding a new city

```
cout << "Enter a city name: " << endl;
getline(cin,cityNew);
cout << "Enter a previous city name: " << endl;
getline(cin,cityPrevious);
```

Print menu

```
cout << "======Main Menu======" << endl;
cout << "1. Build Network" << endl;
cout << "2. Print Network Path" << endl;
cout << "3. Transmit Message Coast-To-Coast" << endl;
cout << "4. Add City" << endl;
cout << "5. Quit" << endl;
```

Quit

```
cout << "Goodbye!" << endl;
```