



# CSCI 2270 – Data Structures

*Instructors: Shayon Gupta, Ashutosh Trivedi, Maciej Zagrodzki*

## Assignment 3 - Linked Lists

### Communication Between Towers

#### OBJECTIVES

1. Create, traverse, add, reverse and delete from a linked list
2. Get practice implementing classes

### Background

In the Lord of the Rings trilogy, there is a scene where a warning beacon is lit in the towers of Minas Tirith, which is seen by a second beacon, prompting them to light their own fire which a third beacon sees, and so forth. This was a rapid means of communication in the days before telegraphs were invented. In this assignment, you're going to simulate a communications network using a linked list. Each node in the list will represent a country and you need to be able to send a message between nodes from one side of the world to the other.

### Building your own communications network

You will be implementing a class to simulate a linear communication network between countries. There are three files in Moodle containing a code skeleton to get you started. *Do not modify the header file or your code won't work in Moodle!* You will have to complete both the class implementation in CountryNetwork.cpp and the driver file main.cpp.

The linked-list itself will be implemented using the following struct (already included in the header file):

```
struct Country
{
    string name;           // name of the country
    string message;        // message this country has received
    int numberMessages;    // no. of messages passed through this country
    Country *next;         // pointer to the next country
};
```



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## Class Specifications

The **CountryNetwork** class definition is provided in the file *CountryNetwork.hpp* in Moodle. *Do not modify this file or your code won't work on Moodle!* Fill in the file *CountryNetwork.cpp* according to the following specifications.

**Country\* head;**

→ Points to the first node in the linked list

**CountryNetwork();**

→ Class constructor; set the head pointer to NULL

**bool isEmpty();**

→ Return true if the head is NULL, false otherwise

**void insertCountry(Country\* previous, string countryName);** // Beware of edge cases

→ Insert a new country with name **countryName** in the linked list after the country pointed to by **previous**. If **previous** is NULL, then add the new country to the beginning of the list. Print the name of the country you added according to the following format:

```
// If you are adding at the beginning use this:
cout << "adding: " << countryName << " (HEAD)" << endl;

// Otherwise use this:
cout << "adding: " << countryName << " (prev: " << previous->name <<
")" << endl;
```

**void deleteCountry(string countryName);** // Beware of edge cases

→ Use the member function **searchNetwork** to find the node with name **countryName**, then delete it. If there is no node with name **countryName**, print "Country does not exist."

**void loadDefaultSetup();**

→ First, delete whatever is in the linked list using the member function **deleteEntireNetwork**. Then add the following six countries, in order, to the network with **insertCountry**: "United States", "Canada", "Brazil", "India", "China", "Australia"

**Country\* searchNetwork(string countryName);**

→ Return a pointer to the node with name **countryName**. If **countryName** cannot be found, return NULL



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**void deleteEntireNetwork();**

- Delete every node in the linked list and set **head** to NULL. Print the name of each node as you are deleting it according to the following format:

```
cout << "deleting: " << node->name << endl;
```

After the entire linked list is deleted, print:

```
cout << "Deleted network" << endl;
```

**void reverseEntireNetwork();**

- Manipulate **\*next** pointers to reverse the order of the linked list. For example, reversing the following list with "A" at the head: "A -> B -> C -> D -> NULL", should yield "D -> C -> B -> A -> NULL" with "D" as the new head

**void transmitMsg(string receiver, string msg);**

- Traverse the linked list from the head to the node with name **receiver**. For each node in this path (including the head), set the node's **message** to **msg** and increment the node's **numberMessages** field. If the list is empty, print "Empty list" and exit the function
- As you traverse the list, at each node report the message received and the number of messages received using the following cout: (See the end of this document for example output)

```
cout << node->name << " [# messages received: " <<  
node->numberMessages << "] received: " << node->message << endl;
```

**void printPath();**

- Print the names of each node in the linked list. Below is an example of correct output using the default setup. (Note that you will **cout << "NULL"** at the end of the path)

```
== CURRENT PATH ==  
United States -> Canada -> Brazil -> India -> China -> Australia -> NULL  
===
```

- If the network is empty then print "*nothing in path*"



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## Main driver file

Your program will start by displaying a menu by calling the **displayMenu** function included in main.cpp. The user will select an option from the menu to decide what the program will do, after which, the menu will be displayed again. The specifics of each menu option are described below.

### Option 1: Build Network

This option calls the **loadDefaultSetup** function, then calls the **printPath** function. You should get the following output:

```
adding: United States (HEAD)
adding: Canada (prev: United States)
adding: Brazil (prev: Canada)
adding: India (prev: Brazil)
adding: China (prev: India)
adding: Australia (prev: China)
== CURRENT PATH ==
United States -> Canada -> Brazil -> India -> China -> Australia -> NULL
===
```

### Option 2: Print Network Path

Calls the **printPath** function. Output should be in the format below:

```
// Output for the default setup
== CURRENT PATH ==
United States -> Canada -> Brazil -> India -> China -> Australia -> NULL
===

// Output when the linked list is empty
== CURRENT PATH ==
nothing in path
===
```



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## Option 3: Transmit Message

Prompt the user for two inputs: a message to send, and the name of a country to receive the message (*Hint: use **getline** in case there are spaces in the user input*). Pass the message and country name to the **transmitMsg** function.

For example, the following should be the output if the linked-list contains the default setup from option (1) and the message “bom dia” is sent to “Brazil”:

```
Enter name of the country to receive the message:
Brazil
Enter the message to send:
bom dia

United States [# messages received: 1] received: bom dia
Canada [# messages received: 1] received: bom dia
Brazil [# messages received: 1] received: bom dia
```

If the user then decides to transmit the message “ni hao” to “China”, the output will be:

```
Enter name of the country to receive the message:
China
Enter the message to send:
ni hao

United States [# messages received: 2] received: ni hao
Canada [# messages received: 2] received: ni hao
Brazil [# messages received: 2] received: ni hao
India [# messages received: 1] received: ni hao
China [# messages received: 1] received: ni hao
```

## Option 4: Add Country

Prompt the user for two inputs: the name of a new country to add to the network, **newCountry**, and the name of a country already in the network, **previous**, which will precede the new country. Use the member functions **searchNetwork** and **insertCountry** to insert **newCountry** into the linked-list right after **previous**.

- If the user wants to add the new country to the head of the network then they should enter “First” instead of a previous country name.



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- If the user enters an invalid previous city (not present in the linked list), then you need to prompt the user with the following error message and collect input again until they enter a valid previous country name or “First”:

```
cout << "INVALID country...Please enter a VALID previous country  
name:" << endl;
```

- Once a valid previous country name is passed and the new country is added, call the function **printPath** to demonstrate the new linked-list.

For example, the following should be the output if the linked-list contains the default setup from option (1) and the user wants to add Colombia after Brazil:

```
Enter a new country name:  
Colombia  
Enter the previous country name (or First):  
Brazil  
  
adding: Colombia (prev: Brazil)  
== CURRENT PATH ==  
United States -> Canada -> Brazil -> Colombia -> India -> China -> Australia ->  
NULL  
===
```

## Option 5: Delete Country

Prompt the user for a country name, then pass that name to the **deleteCountry** function and call **printPath** to demonstrate the new linked-list.

For example, the following should be the output if the linked-list contains the default setup from option (1) and the user wants to delete Canada:

```
Enter a country name:  
Canada  
== CURRENT PATH ==  
United States -> Brazil -> India -> China -> Australia -> NULL  
===
```

## Option 6: Reverse network

Call the **reverseEntireNetwork** function then the **printPath** function.



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For example, the following should be the output if the linked-list contains the default setup from option (1):

```
== CURRENT PATH ==  
Australia -> China -> India -> Brazil -> Canada -> United States -> NULL  
===
```

## Option 7: Clear network

Call the **deleteEntireNetwork** function. For example, deleting the default network should print:

```
deleting: United States  
deleting: Canada  
deleting: Brazil  
deleting: India  
deleting: China  
deleting: Australia  
Deleted network
```

## Option 8: Quit

Print the following message:

```
cout << "Quitting... cleaning up path: " << endl;
```

Then call **printPath**, followed by **deleteEntireNetwork**. Now, check if the network is empty using **isEmpty**. If it is, print:

```
cout << "Path cleaned" << endl
```

Otherwise, print:

```
cout << "Error: Path NOT cleaned" << endl;
```

Finally, print the following before exiting the program:

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



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## Example run

```
Select a numerical option:
+====Main Menu=====+
 1. Build Network
 2. Print Network Path
 3. Transmit Message
 4. Add Country
 5. Delete Country
 6. Reverse Network
 7. Clear Network
 8. Quit
+-----+
#> 1
adding: United States (HEAD)
adding: Canada (prev: United States)
adding: Brazil (prev: Canada)
adding: India (prev: Brazil)
adding: China (prev: India)
adding: Australia (prev: China)
== CURRENT PATH ==
United States -> Canada -> Brazil -> India -> China -> Australia -> NULL
===

Select a numerical option:
+====Main Menu=====+
 1. Build Network
 2. Print Network Path
 3. Transmit Message
 4. Add Country
 5. Delete Country
 6. Reverse Network
 7. Clear Network
 8. Quit
+-----+
#> 3
Enter name of the country to receive the message:
Brazil
Enter the message to send:
```





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```
bom dia
```

```
United States [# messages received: 1] received: bom dia
```

```
Canada [# messages received: 1] received: bom dia
```

```
Brazil [# messages received: 1] received: bom dia
```

```
Select a numerical option:
```

```
+=====Main Menu=====+
```

1. Build Network
2. Print Network Path
3. Transmit Message
4. Add Country
5. Delete Country
6. Reverse Network
7. Clear Network
8. Quit

```
+-----+
```

```
#> 3
```

```
Enter name of the country to receive the message:
```

```
China
```

```
Enter the message to send:
```

```
ni hao
```

```
United States [# messages received: 2] received: ni hao
```

```
Canada [# messages received: 2] received: ni hao
```

```
Brazil [# messages received: 2] received: ni hao
```

```
India [# messages received: 1] received: ni hao
```

```
China [# messages received: 1] received: ni hao
```

```
Select a numerical option:
```

```
+=====Main Menu=====+
```

1. Build Network
2. Print Network Path
3. Transmit Message
4. Add Country
5. Delete Country
6. Reverse Network
7. Clear Network
8. Quit

```
+-----+
```



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```
#> 4
Enter a new country name:
Iran
Enter the previous country name (or First):
Canada

adding: Iran (prev: Canada)
== CURRENT PATH ==
United States -> Canada -> Iran -> Brazil -> India -> China -> Australia ->
NULL
===

Select a numerical option:
+=====Main Menu=====+
  1. Build Network
  2. Print Network Path
  3. Transmit Message
  4. Add Country
  5. Delete Country
  6. Reverse Network
  7. Clear Network
  8. Quit
+-----+

#> 5
Enter a country name:
Australia
== CURRENT PATH ==
United States -> Canada -> Iran -> Brazil -> India -> China -> NULL
===

Select a numerical option:
+=====Main Menu=====+
  1. Build Network
  2. Print Network Path
  3. Transmit Message
  4. Add Country
  5. Delete Country
  6. Reverse Network
  7. Clear Network
  8. Quit
```



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```
+-----+
#> 6
== CURRENT PATH ==
China -> India -> Brazil -> Iran -> Canada -> United States -> NULL
===
```

Select a numerical option:

```
+=====Main Menu=====+
1. Build Network
2. Print Network Path
3. Transmit Message
4. Add Country
5. Delete Country
6. Reverse Network
7. Clear Network
8. Quit
```

```
+-----+
#> 7
deleting: China
deleting: India
deleting: Brazil
deleting: Iran
deleting: Canada
deleting: United States
Deleted network
```

Select a numerical option:

```
+=====Main Menu=====+
1. Build Network
2. Print Network Path
3. Transmit Message
4. Add Country
5. Delete Country
6. Reverse Network
7. Clear Network
8. Quit
```

```
+-----+
#> 8
Quitting... cleaning up path:
== CURRENT PATH ==
```



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```
nothing in path  
===  
Path cleaned  
Goodbye!
```