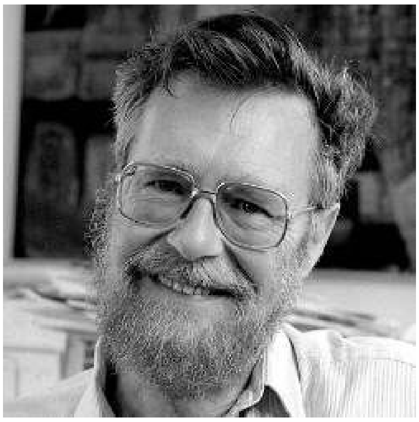
Luis Barajas - A01370934
Mauricio Rico - A01370874

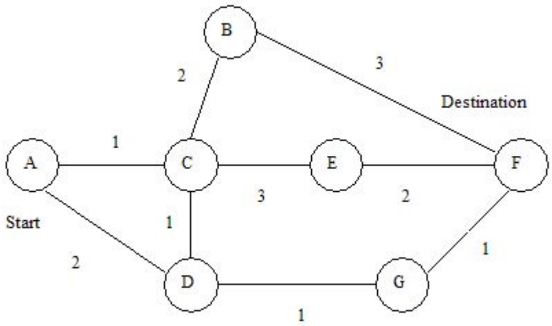
Documentation : Final Project (SFML Graphs)

Dijkstra Algorithm:



Computer scientist Edsger W. Dijkstra came up with a algorithmic solution to finding the shortest path between nodes (or vertices) in a graph. This algorithm has been changed and improved from the original iteration several times considering how it started by analyzing the shortest path between nodes. Now more popular version, a “source” node is established at the beginning and a shortest-path-tree is created. This tree basically entails the shortest paths from the previously established source node to the rest of her nodes in the graph. If only a single shortest path is the objective the algorithm may be stopped once the shortest path to the node is found, eliminating the need for more path analysis. The algorithm brings a high level of importance to the practice and use of graphs since many of today's current information systems rely heavily on the relationship built on weighted or unweighted graphs to give values to this connections or edges. For example the cost between the nodes could represent the distance between two geographical points or places in reality. Besides this common use, it is also been utilized for network routing protocols and integrated as a subroutine on other algorithms like Johnson's algorithm.

The way Dijkstra’s algorithm works is by assigning one of the nodes as the initial node, then you select another node to which the initial node will be related by a random cost usually selected as infinity so that the algorithm will try to improve this value by looking for a different path. This tentative value assigned for the nodes is all the same except for the initial node whose value usually is established as 0. The initial node is named current while all of the other nodes are marked as “unvisited”. A set is created consisting mainly of these unvisited nodes. The next step would be to calculate the values to reach each one of the neighboring nodes from the initial and depending if these values are smaller than the initially assigned values then you substitute this value, otherwise the current value is kept. After calculating all of the paths from this node, the node is marked as visited and removed from the set of unvisited nodes so you don't calculate from this node again.



This is the main general description of Dijkstra's algorithm on how it works but with the passing of time many modifications have been made to improve upon the original iteration, but this procedure doesn't work when weight values between nodes is negative or other problems. But for this project the algorithm

Resolution of the problem:

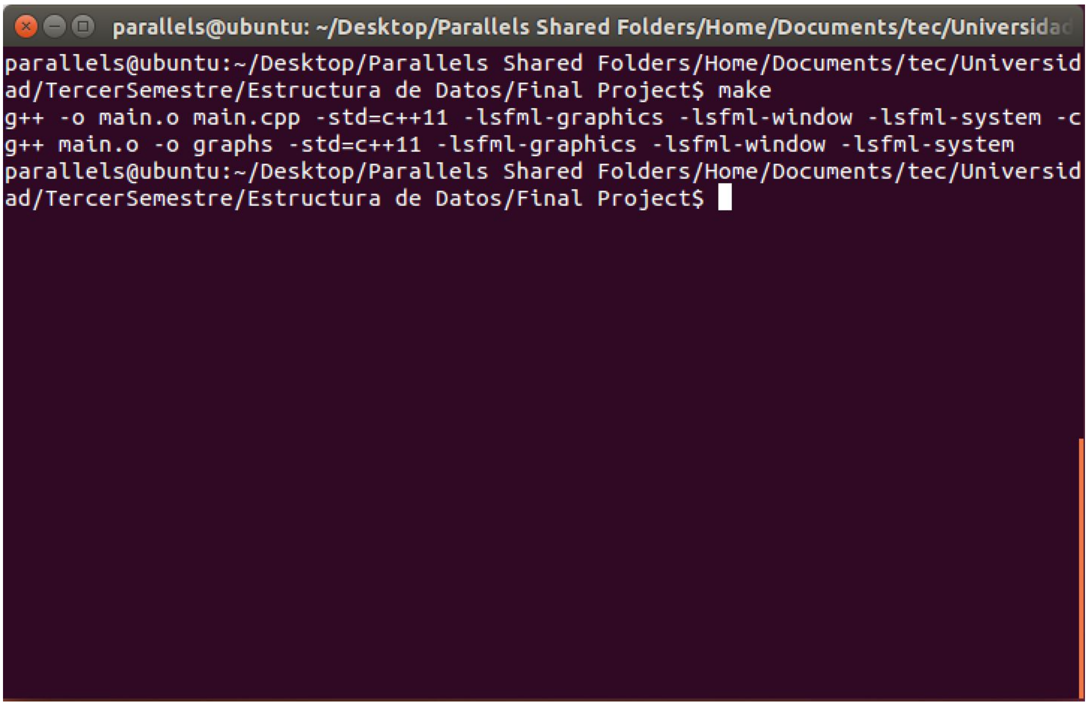
Our main problem with this assignment was to think and implement a way to let the user interact with the program and display, the resolution of the algorithm and the components of a Graph data structure, graphically using the library SFML for C++. There are many ways to achieve this, but in our opinion, we chose the best one as the user just interacts on the SFML window, he does nothing in the console but run the program. We decided to go with this way because in the others that we thought; if we did not use threads, the graphical program running in SFML window freezed when asking for an user input in the console. Or if using threads we did not solve how to pass all the parameters expected from the menu thread to the viewer's.

Nevertheless exploring the SFML documentation we saw that the program detects the keyboard user's input, when the mouse has been clicked and the position of the it in the window, so via mostly triggering booleans we can determine which option the user wants and where does the input (if accepted at that time) must be saved.

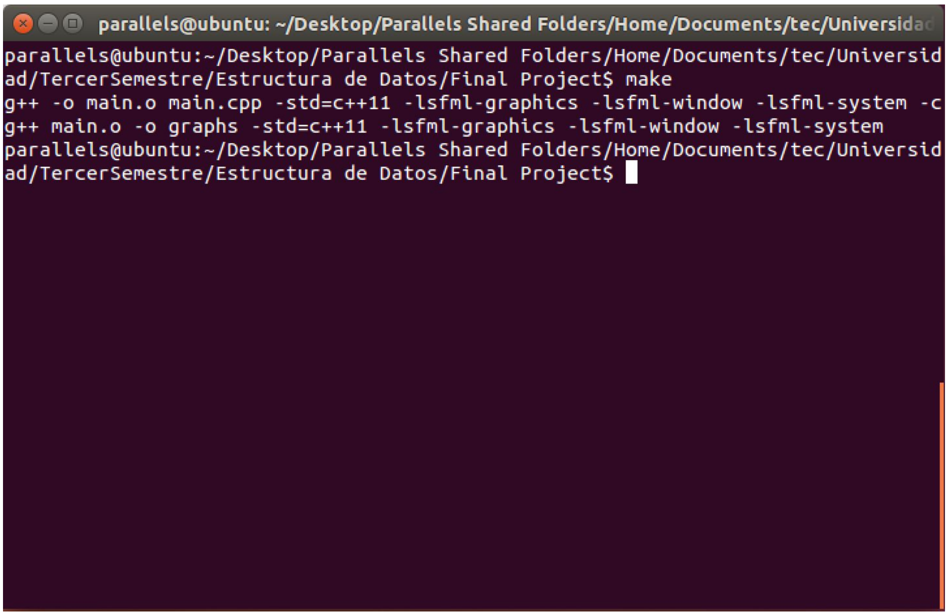
A big obstacle that we encountered was to get the clicked vertex so the program would be fully interactive via SFML. To be able to do this, we defined a function in the graph class to get the vertices list but we got strange behaviour in our program and nothing that can be interpretable. So we resolved this by instead of the function returning the list it should return a pointer to that list. As a result of this we could loop in the list until there is no elements and in each one we compared its coordinates and size to get its position. Then this position can be compared with the mouse position in the window, and if they match we return a pointer to this vertex. If the position of any vertex matches the position of the mouse we return a null pointer.

User Manual:

Our program mainly works being launched from a computer terminal but is not bound to a command line interface, only when compiling and running the program the user must begin from the computer terminal.



Once the program is successfully compiled and presents no errors the user has to write the command $ ./graphs as follows:



Next a SFML window is displayed showing a geographical map of the entire world. There are two main sections of the window, the actual map where the graphical interface will show created vertices (countries) and their respective connections or edges. The other part of the window is the very top of the window which shows the information the program gives to the user and the inputs from the user defining names for the countries and costs for the edges. This section also shows the instructions for the user to follow which we will define on this user manual.

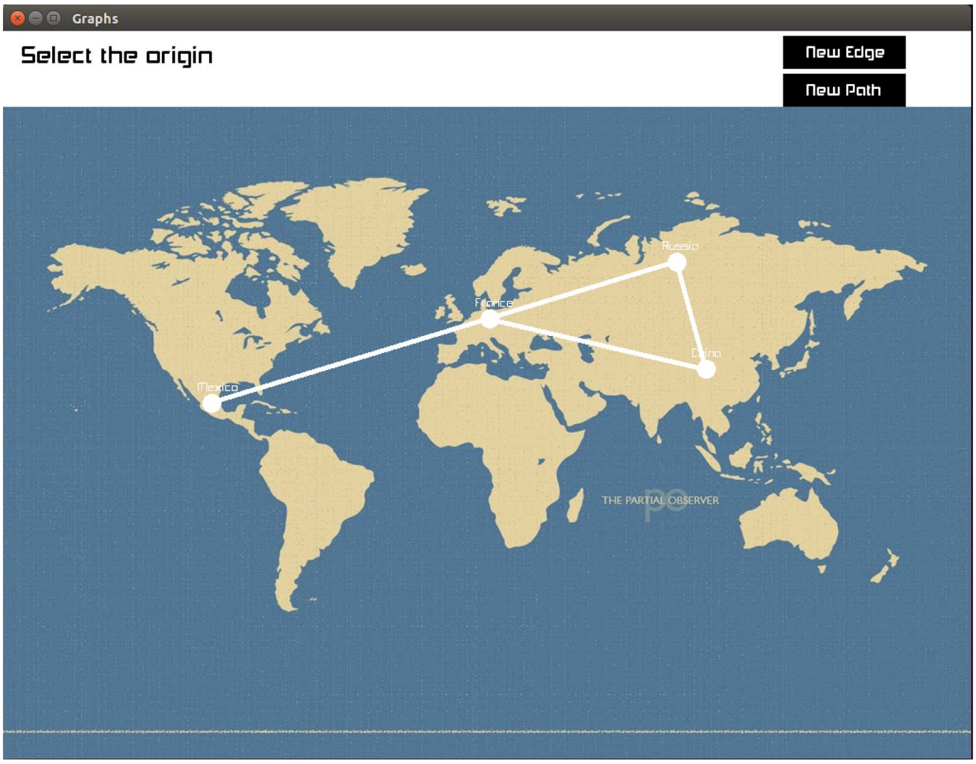
Starting the program prompts the following screen to appear. On this screen we can see the information described before regarding the two main sections and their use. We can see that the program informs the user that there are no current countries on the map. The top section also instructs the user to click anywhere on the map to create a country or vertex. The far right side shows two buttons labeled “New Edge” and “New Path”, these buttons help create an edge from two existing countries and calculating the shortest path to a destination respectively (More on this later).

After selecting a part of the map the top section changes to ask the user to name the country just created and after pressing the enter key, the window shows the previous state where the number of countries is specified but it has now changed to 1 country. Also the map shows graphically the location of the country created by the user.

After the country is created the program lets you keep adding countries repeating the same process. If there are one or more countries when you create a new one the program will let you create edges between countries making the new country the origin to the, selected country with the mouse, destination. Then the program will ask the user write the cost and when he presses enter the connection is made and the screen should appear as follows:

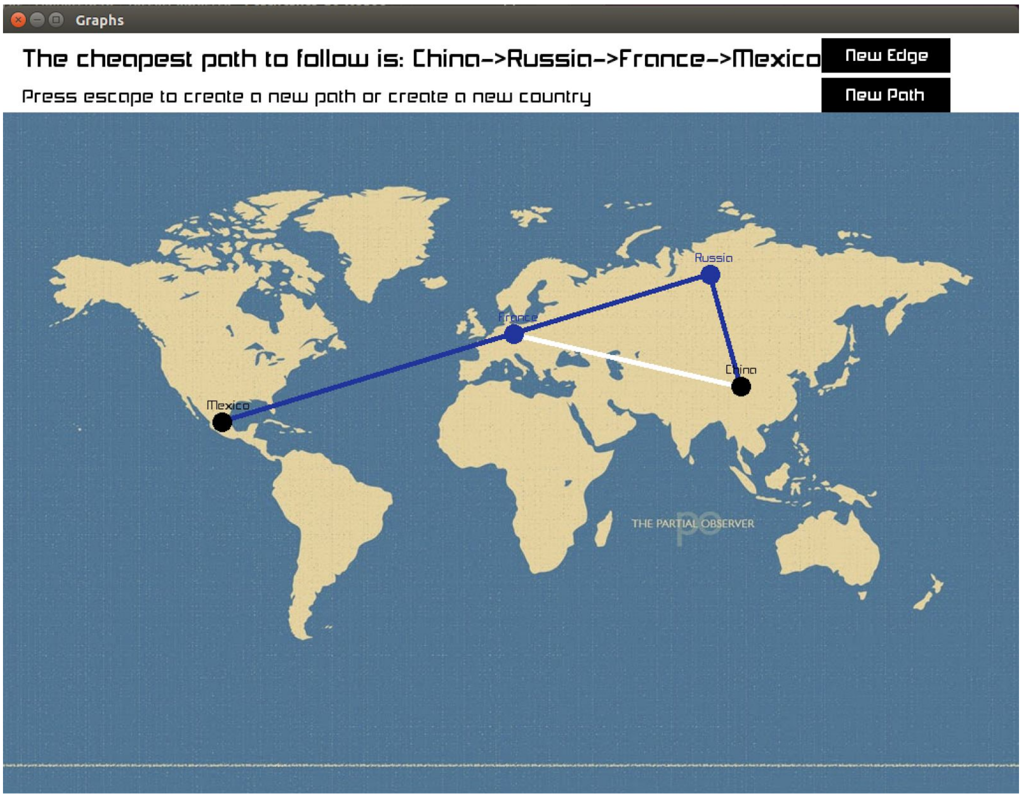
Or you can relate any countries already created with an edge by clicking “New Edge” which prompts the selection of the origin and the destination.

When the user clicks the button “New Path”, to calculate the cheapest path from an origin to a destination, the program will ask to click the origin:



If the user did click a country (in this example China), then the program will ask to click the destination:

If the user did click a vertex (in this example Mexico) the program calculates the cheapest path possible (if exists) with Dijkstra algorithm, and present it to the user as follows:



As it can be seen, the origin and destination countries are displayed in black, while all the remaining path is displayed in blue. When the user wants to erase the path to make a new one, create a new country or create a new edge, he has to click the key escape.