Name:
Login:
Signature:

# ECE 368 Spring 2016 <br> Homework 5 

## 1) Trees as Graphs ( $\mathbf{1 5}$ Pts):

A tree is a graph that satisfies two properties
I. It is connected
II. There is a unique path between any pair of vertices .
a) What is the condition on the number of edges on a tree with $N$ vertices?
b) Prove your answer to part a)

## 2 ) Graphs ( 15 Pts)

Discuss the most appropriate representations (with a justification) for the following types of graphs:
a) 1st type: Unweighted, directed and very dense (the degree of each vertex is $\mathrm{O}(\mathrm{n})$ ).
b) 2nd type: Weighted, undirected and the degree of each vertex is $\mathrm{O}(1)$.
c) 3rd type: Weighted, undirected, and sparse with a large nurge number of vertices (the total number of edges is $\mathrm{O}(\mathrm{n})$ ).

## 3) Graphs: Finding Connected Components ( 35 Pts):

Let's assume the following binary 2D array:
11100
01100
00011
11101
11001
We find all the areas that consist of neighboring 1's (4-way connectivity). So, in this example, the 3 areas are as follows:

11100
01100
00011
11101
11001
Then, we relabel those as follows:
11100
01100
00022
33302
33002
Implement Connected Component Labeling as above. A file "hw5_q3.c" will be provided through the assignment on blackboard. After completing the code, submit your file. Do not change the file name.

## 4) Graphs: Shortest Path (Dijkstra's Algorithm) (35 Pts):

In the lecture slides, we talked about using graphs to represent the game of "Risk". You may read about the rules of Risk online if you are not familiar with it.


The way you will use a graph is as follows:
-Each of the 42 territories is represented as a vertex.
-Each territory is connected to its neighbors or to other countries marked by the blue line (such as Brazil-North Africa or Alaska-Kamchatka)
-Each territory has been associated with ( $x, y$ ) coordinates representing the approximate (latitude, longitude) coordinates of their capital or center city. The data was taken from http://twcc.fr/en/\#.
-You will need to add weights to each path based on the Euclidean distance between the two countries.

In the file hw5b.c, we have provided you functions to read an array of territories with their number, name, $\boldsymbol{x}$ and $\boldsymbol{y}$ coordinates. Also, we have provided you most of the function to read the neighbors of each territory, so you don't have to worry about mapping the graph.

In this question, we want you to implement:
-A Weighted Graph Data Structure (either array or linked list implementation are acceptable)
-Shortest Path Algorithm (Dijkstra's) between two territories.
We will test this homework by parsing the commands:
./hw5b [number_of_source] [number_of_destination]
Your algorithm should print.
[Name of Source]
[Name of First Territory Visited]
[Name of Second Territory Visited]
[....]
[Name of Destination]
For example, to go from Alaska to Central America, it should be as follows:
./hw5_q4 13
Alaska
Alberta
Western_United_States
Central_America
You just need to submit a zip file containing the files hw5_q3.c and hw5_q4.c

