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CS 473 - Assignment 2
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CS473/573 Algorithms I Programming Assignment #2 Report

a. First, I have used the Matrix Market I/O (mmio) library for C codes that I have used also at the previous assignment to read the Matrix Market (.mtx) files. Then I have used the adjacency list implementation with linked lists to store the graph. For Dijkstra's algorithm, I have used the min-heap to get the minimum distance of the unvisited vertices. I have initialized the distances with the maximum double value. Then, I have changed the distance of the source vertex to 0 and built the distance min-heap. Then, I applied Dijkstra's algorithm by decreasing the keys of the min-heap. I have added the edge values and took the minimum of the path values. Finally, I have changed the remaining maximum double values to -1 to show that the vertex is unreachable and saved these values to the output file.

b. I have changed the min-heap to max-heap and initialized the distance values with the minimum double value. Then, I have changed the distance of the source vertex to 1 instead of 0. I have applied Dijkstra's algorithm by increasing the keys of the max-heap. I have multiplied the edge values with each other and took the maximum of the path values.

c. In part a, we have added the edge values and take the minimum of the path value. However, in part b, we have multiplied the edge values and take the maximum of the distance values. If we add logarithms of two values, we get the logarithm of the multiplication of these values as can be seen in the following equation:

$$\delta'(s,v) = w'(s,u) + w'(u,v) = -log_2(w(s,u)) - log_2(w(u,v)) = -log_2(w(s,u) * w(u,v))$$

If we take the minimum of the values which are multiplied by -1 and multiply the minimum by -1 again, we get the maximum of the values as follows:

$$\{1,2,3\} \Rightarrow \{-1,-2,-3\} \Rightarrow min(-1,-2,-3) = -3 \Rightarrow 3 = max(1,2,3)$$

By taking the minus logarithms of the values and applying the algorithm of part a, we add the new values and take the minimum of the distances. However, because of the minus logarithms, we actually multiply the values and take the maximum of the distances. When we find the final values we transform the value into actual value by the following:

$$\delta(s,v) = 2^{-\delta'(s,v)} = 2^{-(w'(s,u)+w'(u,v))} = 2^{-(-log_2(w(s,u)) - log_2(w(u,v)))} = 2^{-(-log_2(w(s,u) * w(u,v)))} = w(s,u) * w(u,v)$$

Therefore, I got the same values as part b after I have applied this method.