The Shortest Path Problem and the Evolution of Graph Theory:

An In-depth Analysis of Dijkstra's Algorithm

Austin D. Bryan

Mathematical Evolutions

Jenny McCarthy and Andy Platek

Summer Ventures in Science and Mathematics

The University of North Carolina at Charlotte

Abstract

Originating from a real world problem in the former city of Königsberg, graph theory and the shortest path problem have had a tremendous impact on the world of mathematics. There are many different types of graphs. The five major types of graphs are: (1) directed graph, (2) mixed graph, (3) multigraph, (4) simple graph, and (5) weighted graph. These graphs are commonly used in graph theory and directly apply to the shortest path problem. When solving the shortest path problem the most used graph type is the weighted graph. These graphs have weights which are used to represent constraints for real world problems, such as distance, weight, time, etc. There are six major algorithms that are used to calculate the shortest path of a graph. They are as follows: (1) Dijkstra's algorithm, (2) Bellman-Ford algorithm, (3) A* search algorithm, (4) Floyd Warshall algorithm, (5) Johnson's algorithm, and (6) the Perturbation theory. The focus of this research paper is on the mathematical properties and validity of Dijkstra's algorithm. In this article there is an example of how the methods of Dijkstra's algorithm for a real world application, such as finding the shortest route to take to class on a college campus, can be applied and used correctly. This research paper successfully concludes that the use of Dijkstra's algorithm to solve the shortest path problem is a valid method and that it can be applied to other real world applications or scenarios.