ABSTRACT

WATER SALESMAN PROBLEM

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The Shortest Path Problem is one of the classic and fundamental problems in mathematical programming. Many real-world problems are formulated as a shortest path problem and solved by a Dynamic Programming approach. Recently, there have been several studies on shortest path problems with one or more knapsack type side constraints. In a constrained shortest path problem, every edge of the network has not only a distance but also some weight such as time or cost.

In this paper, we consider a new type of constrained shortest path problem in which the network has a weight imposed on its nodes. For example, given a water price and its demand at every node, find a sales route with maximal profit (= sales - cost) that does not exceed the total supply Q. We call this the Water Salesman Problem. It is a subproblem derived from an existing vehicle routing problem with supply constraints in a steel company.

In this paper, we discuss two algorithms for solving a generalized water salesman problem, including the original one, where split deliveries of water are allowable. One is based on Dynamic Programming where every state consists of two factors, the current node and the remaining water supply. The other is an algorithm using the k-th shortest path method.

The algorithms are tested out on randomly generated problems. The first algorithm can solve any water salesman problem with 10 to 80 nodes but takes relatively more time. On the other hand, the second one can solve almost all problems rapidly. However, some problems are forced to stop before obtaining the optimum solution because of memory capacity.