Routing and Scheduling on a Shoreline with Release Times

In this paper we examine computational complexity issues and develop algorithms for a class of "shoreline" single-vehicle routing and scheduling problems with release time constraints. Problems in this class are interesting for both practical and theoretical reasons. From a practical perspective, these problems arise in several transportation environments. For instance, in the routing and scheduling of cargo ships, the routing structure is "easy" because the ports to be visited are usually located along a shoreline. However, because release times of cargoes at ports generally complicate the routing structure, the resulting routing and scheduling problem is nontrivial. From a theoretical perspective, this class of problems lies on the borderline between problems in P and those that are NP-complete. For the straight-line case (a restriction of the shoreline case), our analysis shows that the problem of minimizing maximum completion time can be solved exactly in quadratic time by dynamic programming. For the shoreline case we develop and analyze heuristic algorithms. We derive data-dependent worst-case performance ratios for these heuristics. We also discuss how these algorithms perform on practical data. Finally, we examine the computational complexity of other problem variants involving alternative objective functions and different types of time window constraints.