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Node Partitioning and Cycles Creation Problem with Application to Area Patroling with a Fleet of Unmanned Aerial Vehicles

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Abstract

We present a new class of network optimization problems, which extend the classical NP-hard traveling salesman problem. It is formulated as follows. Given a graph with a certain time associated with each node and each arc, a feasible partition of the nodes in subsets is such that, for each subset, there exists a Hamiltonian cycle whose traveling time is below the time associated with each node in the tour. It is required to find a feasible partitioning which minimizes the number of such cycles.

Problems of this kind are typical in numerous applications, where services are repeatedly provided for a set of customers. For each customer, there is a critical time within which a service must be repeated. Given the traveling time between the customers, the set of customers is partitioned so that each subset is served by one agent in a cyclic manner without violating any individual critical time requirement. The number of agents is minimized. As an example, we consider a problem, in which a fleet of unmanned aerial vehicles is used for area patrolling.

We introduce an mixed integer programming formulation of the node partitioning and cycles creation problem, and also heuristic algorithms for solving this problem. Results of numerical experiments are presented.

Keywords: *optimization problems, Unmanned Aerial Vehicles, cycles creation problem*

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