Branch-Cut-and-Price Algorithm for a Vehicle Routing Problem With Drones

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1 abstract

Home deliveries for food and goods have significantly expanded in recent years, and while the Vehicle Routing Problem (VRP) is now considered as a classic optimization problem, the development of drones in the civilian sector suggests new variants of the VRP. The integration of drones into home deliveries will not only reduce delivery times but also limit the ecological impact of these deliveries, and decrease road network congestion by reducing truck traffic in urban areas. In the problem studied, the number of drones carried by a truck is a decision variable. Drones can only take off from customers and each truck has to wait its drones return before leaving. A single customer is visited per drone trip. Customers have deadlines. This problem ally feasibility and efficiency.

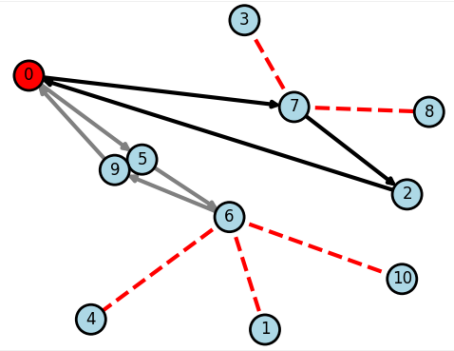

FIG. 1 – Feasible solution for the studied Vehicle Routing Problem with Drones

We use a generic branch-cut-and-price algorithm to solve the problem. The main issue being the modelling of a route of a truck with its drones as a Resource Constraint Shortest Path Problem. Let v be a customer where the truck stops and N_v the set of customers that can be delivered with drones from v. Finding the optimal drones routes to deliver a subset of N_v is equivalent to solving a scheduling problem with parallel identical machines, deadlines and minimizing the makespan, noted $P|\bar{d}_j|C_{\max}$, where the round-trip to a customer is modelled as a job and each drone is a machine. To use the solution in the routing problem, we split each customer in two nodes, the first one keeping only the incoming arcs and the second node keeping only the outgoing arcs. We model the drones routes from v in between those separated nodes.