

Application of Vehicle Routing Problem with Hard Time Window Constraints

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Abstract: This paper proposes a heuristic, Tabu-Perturbation Algorithm (TPA), to efficiently and effectively solve Vehicle Routing Problem with Hard Time Window Constraints (VRPHTW). TPA integrates Tabu Search (TS) and Noising Method (NM). A software system is developed based on it and is used in a company that delivers equipment spare parts to the plants manufacturing semiconductor wafers and TFT-LCDs.

VRPHTW is NP-hard due to the NP-hardness of Vehicle Routing Problem (VRP). Previous work on VRPHTW includes both optimization algorithms and heuristic approaches, but current research focuses on heuristic approaches. This research proposes a heuristic TPA, integrating TS and NM, to solve VRPHTW. TPA consists of three phases: route construction, local search improvement, and generic search improvement.

Route construction phase applies Enhanced Nearest Neighbor (ENN) heuristics to start every route by finding the un-routed customer with the shortest distance while all the restrictions must be met. ENN takes into account spatial factor and temporal factor.

Local search improvement phase has two procedures, vehicles reduction and neighborhood search improvement. They are used to improve the solution quality after obtaining an initial feasible solution. Vehicles reduction procedure uses the perturbation procedure by Salhi and Rand (1993), while neighborhood search improvement procedure applies branch exchange method and node exchange method to improve the solution. Both methods consist of inter-route and intra-route improvement.

Generic search improvement phase uses a meta-heuristic that integrates TS and NM. The framework is similar to TS, but it adds the concepts of NM. When the best feasible solution is not superior to present optimum, it will start to noise the cost. The noise is a random real number drawn from a uniform distribution. The new cost becomes the addition of the original cost and the noise.

On the basis of a systemic evaluation of Solomon's (1987) 56 benchmark instances, TPA results in good solution quality. A software system is developed based on TPA and is used in a company that delivers equipment spare parts to the plants manufacturing semiconductor wafers and TFT-LCDs in Taiwan's Science-Based Industrial Park. This company needs to dispatch several vehicles to deliver spare parts to tens of factories everyday. As the equipment used in semiconductor manufacturing is extremely expensive, these spare parts need to be delivered as soon as possible and within pre-determined time windows. A limited transportation expense is also desired.

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