Decomposition Methods for the Travelling Purchaser Problem

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We present novel branch-and-check and logic-based Benders decomposition techniques for the Travelling Purchaser Problem, an important optimization problem with applications in vehicle routing, logistics and warehouse management. The approach is formulated as a hybrid decomposition model with a mixed-integer linear programming master problem and two specialized cut-generating subproblems. The master problem produces a set of markets that satisfy product purchase requirements. The first subproblem generates cuts based on solution travel cost using a specialized Travelling Salesman Problem solver. The second subproblem generates subtour elimination cuts using a subtour detection algorithm and variable generation. We implement these decomposition methods on the uncapacitated asymmetric and symmetric variants of the problem and compare the performance to state-of-the-art techniques, including a constraint programming approach. Our results show that the proposed branch-and-check technique outperforms all previous approaches on the uncapacitated asymmetric variant, finding optimal solutions to previously unsolved instances. This technique also remains competitive on the uncapacitated symmetric variant for smaller problems within the benchmark set. We investigate the impact of instance symmetricity on our algorithm, and propose future extensions to the research.