SUSTAINABLE TRANSPORT BY OPTIMAL ROUTING IN COMPLEX DELIVERY TASKS

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Transportation causes 20 % of the air pollution, so the environmental awareness is especially important in this area. Finding a high quality optimal or near-optimal route for a given delivery task (chain) may reduce not only the transportation costs, thereby increasing the cost effectiveness of the logistics company, but also decreasing the environmental load by reducing the emission of air pollutants and greenhouse gases, which are supposed to be the main causes of the climate change.

Solving these optimization problems optimally is an NP-hard task: an exact polynomial algorithm solving it does not exist. Nowadays, metaheuristics are widely used to solve such complex problems efficiently, because they can find optimal or near-optimal solutions within reasonable time.

We have developed a metaheuristic algorithm, the Discrete Bacterial Memetic Evolutionary Algorithm (DBMEA), which combines an evolutionary approach with traditional local graph search techniques. Our algorithm was tested on several transportation optimization problems, namely

- the Traveling Salesman Problem (TSP), and its extensions (which model the practical logistics problems better than the original TSP)
- the Traveling Salesman Problem with Time Windows, where the nodes need to be visited within a specified time period
- the Traveling Repairman Problem, which is a cumulative version of the TSP,
- the Time Dependent Traveling Salesman Problem, where the costs between the nodes vary in time and
- - the One-commodity Pickup-and-Delivery Traveling Salesman Problem (1-PDTSP). (In the 1-PDTSP the customers are divided into two groups: the delivery group supplying a given amount of products and the pickup customers group which demands a given amount of products. The value of demanding or delivering amount is assigned to each node. The products are transported with one vehicle which has a maximum capacity.

Later we also introduced two even more real life motivated approaches:

- the Triple Fuzzy Time Dependent (3F-TDTSP) Traveling Salesman Problem, where the traffic jam region, the traffic jam period and the costs assigned to edges are all fuzzy values, and
- the Intuitionistic Fuzzy Time Dependent Traveling Salesman Problem (IFTD TSP). In the IFTD TSP we use intuitionistic fuzzy sets for the same purpose. (This latter research was awarded in 2019 by an Outstanding Paper Award by the IEEE CIS).

The DBMEA was tested on a large number of bechmark problems. The obtained simulation results were compared with the state-of-the-art approaches for the examined optimization problems. In all cases, the DBMEA found optimal or close-optimal solutions for all seven types of problems. For the Traveling Repairman Problem the DBMEA outperformed the best known state-of-the-art methods.

It should be mentioned that the DBMEA has proved mmore predictable concerfdning the runtime, in terms of the problem size, than any of the most up to date approaches, while these are always tailor made, and DBMEA is rather general in the applicability.

Based on our intensive investigations it can be concluded that the DBMEA is an efficient and efficatious, rather general method for solving transportation optimization problems.