Cadis-Opt-Fleet: Optimization of Distribution Activities

AntOptima sa is currently collaborating with Migros-Genossenschafts-Bund towards the implementation of the decision support system for planning the distribution of colonial goods in the new Migros hub store located in Suhr (AG). This new distribution centre started its operations in 2002 and it centralises colonial goods distribution for the entire Switzerland.

AntOptima's Cadis-Opt-Fleet is a system that automatically optimises the routes of the trucks leaving the distribution center. The fleet of trucks is composed of non-homogeneous vehicles, i.e. vehicles with different features in term of length, number of axles, and weight; these features constrain the range of road types and shop locations which can be visited by a given truck. Visits to Migros' shops are also constrained in time, since deliveries to the shops' stores must be made within a specified time window, agreed with the store management..

In Operations Research terminology, this is called a "vehicle routing problem with time window" under investigation. It is an extremely complex problem, since it requires the optimisation of a few hundreds of deliveries in the whole Switzerland per day. Before the creation of the Suhr logistic hub, the problem was decomposed into smaller sub problems, which were solved by hand, but this method was inefficient. Moreover, this manual procedure could not be upgraded to adapt to the requirements of the new problem, since the exact solution to the problem requires the investigation of all the possible combination between visits and trucks. Only considering the problem as a whole, in its untouched complexity, one can solve it efficiently, reducing the number of travelled kilometres and saving on transport and environmental costs.
Operations Research methodologies are the answer, but they need an extra spark, since exhaustive search methods fail in practice: they would require years of computation to solve a single day of distribution from the Suhr logistic centre.

AntOptima has resorted to approximate metaheuristics methods that return near-optimal solutions in relatively short time. A "near-optimal" solution is a solution which is very close to the optimum value, often much closer than 95% of the real optimum (which value we can only guess). The remarkable advantage is that such a solution can be computed in less than 5 minutes on a standard personal computer for a problem with 300/400 orders. Needless to say, human planners took hours to produce decent solutions to the simpler decomposed problems in the pre-Suhr era.

From the methodological point of view the method we propose will be inspired by MACS-VRPTW [6] one of the best-known algorithm for the solution of vehicle routing

problems that has been able to outperform state of the art algorithms and to compute new solutions for benchmark problems. The method is able to compute in a very short time an optimised problem solution and can improve this solution step by step through a learning mechanism. In any moment it is possible to stop the algorithm and to ask for the best computed solution without the need to wait until the process is terminated. MACS-VRPTW, a Multiple Ant Colony System for Vehicle Routing Problems with Time Windows is based on Ant Colony Optimisation (ACO [4]) a new optimisation approach inspired by the foraging behaviour of real colonies of ants (see [1],[2],[3]). The basic ACO idea is that a large number of simple artificial agents are able to build good solutions to hard combinatorial optimisation problems via low-level based communications. Real ants cooperate in their search for food by depositing chemical traces (pheromones) on the ground. An artificial ant colony simulates this behaviour.

In the distribution problem under investigation trucks correspond to ants and shops to food to be collected (delivered). Recently, IDSIA, Istituto Dalle Molle di Studi sull'Intelligenza Artificiale, of which AntOptima is a spin-off, has proposed many ACO based algorithms to solve different types of combinatorial optimisation like the sequential ordering problem [5], the quadratic assignment problem [6] and the mentioned vehicles routing problem with time windows [4]. In these domains the approximate algorithms developed are among the best currently available and for many benchmark instances they have found new best known solutions. These researches are the output of many research projects supported among other by the Swiss National Science Foundation, the Swiss CTI, Commission for Technology and Innovation and the European Commission.

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