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PROGRAM

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Humanitarian Logistics II (S11C) Chair: Begoña Vitoriano Villanueva

A Wardrop equilibrium model for the bi-objective location of distribution centres in disaster relief

(Walter Gutjahr and Nada Dzubur)

In a post-disaster situation, the choice of locations for distribution centres (DCs) is an important decision faced by an NGO providing humanitarian aid. Usually, people from the affected population have to walk from their homes to a DC to obtain relief goods. The throughput of a DC is limited, not only by storage considerations, but also by staff requirements. In the case of congestion at a DC, only part of the overall demand can possibly be satisfied, which may motivate part of the people to go to more remote DCs that are not congested. This shows that the assumption of some facility location models that clients will always choose the nearest facility may not be realistic in a disaster relief situation.

We try to overcome this limitation by means of the theory of Wardrop equilibria. In our case, a Wardrop equilibrium is defined by the property that the gain a client can expect to receive in a chosen DC (which depends how many other clients go there), reduced by the cost of traveling to this DC, is not worse than for alternative DCs. The Wardrop equilibrium can be computed as the solution of a convex mathematical program. We do this by means of the Frank-Wolfe algorithm.

On the upper decision level representing the viewpoint of the NGO, a bi-objective combinatorial optimization problem is solved, the objectives of which are cost and uncovered demand.

We illustrate the approach at real-world test instances from Senegal. The efficient solutions of our approach are compared to those obtained from a "nearest facility" model. It is shown that our more realistic client behaviour prediction allows for relevant improvements in the solution quality. Optimizing covering tours for the distribution of disaster relief items using competitive location models (Pamela Nolz, Walter Gutjahr and Christian Burkart)

We consider the problem of designing the logistic system to assure adequate distribution of relief aid after a natural disaster. We face the situation, where the population members stay in the affected regions and need to be supplied with food and drinking water. These relief items are to be transported from a central depot to distribution centres, where they are handed out to the population in need. The problem is formulated as a multi-objective optimization problem, encompassing two objective functions of central interest in such problems. The underlying competitive Covering Tour Problem (CTP) aims at minimizing (i) total uncovered demand and (ii) total distribution costs.

We include modeling approaches for customer behaviour as they have been developed in the field of competitive location models. In disaster relief, the provision of help by different organizations should not be competitive, such that we face a different situation, but as the mentioned approaches possibly allow us to predict the behaviour of the individuals affected by a disaster in more detail, they may enable a more efficient organization of the relief logistics. Depending on the distribution centres made available to the population members, they will make decisions where to go to (if at all), which is an important information for health providing organizations, such that supplies can be delivered to the right places in the right quantities.

We solve the multi-objective competitive CTP with the Nondominated Sorting Genetic Algorithm II (Deb et al., 2002) and compare the proposed solutions to the Pareto-optimal solutions generated with a Brute Force Complete Enumeration procedure. The suggested metaheuristic solution approach is tested on real-world data from the southern part of Mozambique near the river Limpopo, which is regularly affected by drought. The sets of solutions are evaluated using the hyper-volume indicator as proposed by Zitzler and Thiele (1998).

Deb K., Pratap A., Agarwal S., Meyarivan T. (2002) A fast and elitist multiobjective genetic algorithm? NSGA-II. IEEE Transactions on Evolutionary Computation 6 (2), pp. 182-197.

Zitzler E., Thiele L. (1998) Multiobjective optimization using evolutionary algorithms: a comparative case study. In: Eiben A.E., Päck T. Schoopauer M. Schwofel H. P. (aditors) PPSN 1008, LNCS A multiobjective integral approach for the humanitarian logistics problem. Application to a case study in Mexico (Christopher Mejía-Argueta, Juan Gaytán-Iniestra, Rafael Caballero, Julian Molina and Begoña Vitoriano)

Disasters are phenomena which strike countries around the world. The work introduces an integral proposal to consider distribution, evacuation, location of facilities and a preposition stock policy during floods with multi-criteria (equity: minimizing the maximum evacuation and distribution flow-times, as well as total cost). The efficient frontier for the preparedness phase is built through the weighting with the epsilon-constraint methods and for the response phase through a metaheuristic based on tabu and scatter search. The usefulness of the model is validated through a Mexican case study and the analysis of different scenarios created from three key factors in humanitarian logistics.



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