THE SCHOOL RELOCATION PROBLEM: AN APPLICATION OF LOCATION ROUTING

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ABSTRACT

Public decision-making problems are known to be notoriously difficult. Their inherent difficulty relates to their multiobjective and dynamic structure, as well as the fact that many of the problems include features that are difficult to quantify, and that they tend to have a multitude of stakeholders. In general, the concept of satisficing will have to be applied.

This is certainly the case in school location problems. Schools have a life span that is measured in decades, and the closure of a school will usually meet strong opposition from the local community that is involved. In general, decision makers will have to consider the tradeoff between few large schools with many diverse programs but longer times schoolchildren have to spend on buses, and more but smaller neighborhood schools that offer fewer programs.

Formally, our problem includes two components: one is a location problem (which is NP-complete by itself), and the other is a routing problem (which is also NP-complete). Their combination, coupled with the dynamic feature, makes it hopeless to solve the problem exactly, except for very small (and thus unrealistic) problems.

Our formulation uses a full discrete dynamic location formulation (with discrete points that indicate potential locations of new schools, existing demand points, and existing school locations), as well as an abbreviated routing problem that will generate tours of the school buses whenever required. This approach was chosen as the school construction and operating costs dominate the objective function, while the bus operation costs tend to be minor in comparison. The school bus tours will include constraints on their lengths as well as their capacities, depending on the buses that are used for the purpose.

In addition, the formulation allows the closure of existing schools as well as increases and decreases of present school capacities. Furthermore, since continuous relaxations of the problem are solved first, we also include redundant constraints that strengthen the linear programming relaxation of the problem.

In order to determine the solvability of the problem, we first consider a randomly generated problem with 30 data points. It turns out that the problem can be solved within a reasonable amount of time. We then solve the problem on a data set that relates to a specific school district in New Brunswick, Canada. The results are specific recommendations regarding the expansion, reduction, closure, and building of new schools in that district.