Tabu search to evacuee a building in fire situation

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1 Introduction

The dynamic network flow approach is of great interest while we attempt to simulate real−life situations in which the network's attributes are time dependent. Furthermore, this model class is used as a network optimization model in various fields of study that focuses on the time dependent property. There are various application domains of interest such as communication networks as in [7] where dynamic network models are needed to analyze traffic congestion patterns for new real−time motorist information systems. Social networks as in [15] that recognize how multi−directional, dynamic influences are situated in people's social networks and relationships. Transportation networks as it provided in [8] with an introduction to dynamic transport network models, and a new framework for network modelling. Building evacuation systems use the dynamic network optimization as in [12] that explains the need of time dependent modeling during an evacuation process.

On the other hand, the dynamic network flow problem has variants with numerous applications [1]. We cite as first, the minimum cost dynamic flow problem [4] that is a multi−period linear programming problem in which the objective is to minimize the total cost of sending a specific flow over time. This model is applied in production [6] such minimizing total costs of production over time. Secondly, we have the maximum dynamic flow problem [5] that consists in maximizing the amount of flow reaching the sink at the end of the time horizon T. Such dynamic model is used in a distributed computing system [9] by maximizing the execution of some program modules. Then, the dynamic transshipment problem [13] is another kind of the dynamic network flow problem that consists in determining how much replenishing and how much is the transshipment at each period of time. For this problem, a number of specific dynamic models have been developed and applied in various areas like in dynamic transportation as in [14]. Most of these problems are polynomial or pseudo−polynomial related to the complexity and the dynamic aspects of the problem.

However, flows over time with load dependent transit times are classified as NP−hard by Skutella in [10]. In our study, we treat the dynamic evacuation system in building areas while the main objective is to save people in few of times. Specially, we choose the earliest arrival model that is mainly used to save people as fast as possible as in [3]. The problem objective consists in maximizing evacuees during the earliest units of a discrete time horizon T. This problem is proving as NP−hard by Baumanm in [2] in the case of load depend transit time. To solve this problem, we choose tabu search metaheuristic that is promising for finding near optimal solution to NP−hard combinatorial optimization problems [11]. A novel approach called TS−EAFP is applied to simulate a dynamic plan that is the solution in the search space. We implement a specific heuristic to provide the initial feasible dynamic plan that we attempt to optimize. Hence, we operate a novel objective function that provides a better solution choice while it leads to more evacuate people during the early periods. The strategy of move consists in applying several network flow managements and capturing the almost regions that need seriously security and control. These regions are the promising nodes that contribute to the improvement of the initial dynamic plan by changing the evacuees travels to avoid the bottleneck situations. For diversifying the management locations in the building, we implement a tabu list that prohibits some move operations to be replayed. Hence, several dynamic plans are provided according to various building situations while the network flow are dynamically changed in case of fire.

This algorithm is tested on a real−life case which is the second floor of a children's hospital in Tunis. The preliminary results of TS−EAFP shows the improvement of the initial dynamic plan. In fact, the multiple moves give better organization and management of flow in the building's various area. Consequently, it leads to the bottleneck reduction in various building regions and promotes the evacuees exit outside the building.

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