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Ant-Tabu Heuristic for Real-Time Emergency Vehicle Dispatching

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Abstract

Emergency response services managers have to solve two main problems: an allocation problem that consists of deciding which vehicle must be assigned to answer a call, and a covering problem that consists of relocating available vehicles to keep proper coverage, by using strategies such as diversion, relocation and rerouting. The real-time emergency vehicle dispatching problem studied in this paper considers simultaneously allocation and covering decisions. To solve this problem, we develop an efficient heuristic coupling ant colony optimization and tabu search (called A n t -*Tabu*). Numerical results show the efficiency of *Ant-Tabu* in providing quality solutions in short computation times.

Key words: emergency vehicles, optimization, ant colony, tabu search, real-time.

1. Introduction

The objective of an emergency calls response management system is to help decision makers to better manage urgency vehicles, in order to provide good-level services. This is at the heart of planning in the emergency calls management centres for public safety like fire protection and rescue personnel, paramedics and police. Emergency response services (ERS) are generally ensured by a fleet of emergency vehicles such as ambulances, police cars and fire trucks. It is extremely important to reduce the response time in ERS because lives can be saved if emergency vehicles arrive on scene quickly. In a real-time context, ERS managers have to solve two main problems:

- An allocation problem that consists of deciding which vehicle must be assigned to answer a call. This problem is solved in most studies either by some static dispatching strategy (first come first served, nearest origin or highest priority first served) or by any algorithm for the assignment problem.
- A covering problem that consists of relocating available vehicles to allow for adequate coverage. Because emergency calls come from geographically dispersed places, it is important to find best emergency vehicles' positions to keep all the regions under surveillance well covered. As the number of vehicles is limited, dispatching a vehicle to a call reduce the possibility of answering properly future calls. To keep proper coverage, more flexible strategies are used in practice including diversion, relocation and rerouting. Diversion means that dispatched vehicles on route are allowed to switch to a new emergency call if it is more severe. Relocation means that the idle vehicles may be relocated in order to maintain proper coverage for future demands. Rerouting means that vehicles are allowed to change the route to destinations based on real traffic information. Proper covering ensures quick response to future calls; it has an anticipation role that improves the system's performance on the long range.

The real-time emergency vehicle dispatching problem studied in this paper considers simultaneously allocation and covering decisions. This problem has to be solved dynamically on-line, since such decisions must be made almost instantaneously by ERS managers. Such a dynamic aspect is present by the continual changing of the vehicle's states (available, on route, in service, etc.), their positions and the asynchronous arrival of emergency calls. Decisions to make