An introduction to new application domains for the home care scheduling problem

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Abstract

Home care nurses visit patients at different locations while respecting time windows. The home care scheduling problem (HCSP) deals with assigning these visits in order to maximize the quality of care while at the same time minimizing the travel costs. We present an overview of related literature and introduce an extended version of the HCSP that is also applicable outside the home care sector. The experiments were carried out on a test set including real and benchmark problems. Initial results obtained with a hyperheuristic solution method show that all visits can be assigned while maintaining a certain degree of quality.

Keywords: home care scheduling problem, hyperheuristics

1   Introduction

The HCSP poses a relevant problem in today's society where independent living is perceived as an important aspect of quality of life. Increasingly more elderly people prefer to stay at home as long as possible, instead of moving to an elderly home. Governments and private organizations provide services for health care at home in order to accommodate the patient's requirements. It is an important issue to organize the associated workforce as efficiently as possible, while still maintaining a good service quality.

In the literature consulted, the HCSP is usually described as a vehicle routing problem with time windows (VRPTW). While some authors take into account multiple depots [1], others state that all nurses leave from a central depot [2]. The VRPTW is extended with qualifications in order to enable defining skill requirements for visits. Various solution methods have been used to solve the HCSP, including linear programming, constraint programming and (meta)heuristics. An example of a successful commercial implementation of a repeated matching algorithm is presented by Eveborn et al. [3]. Their automated scheduler is used in over 200 organizations in Sweden and an efficiency increase of up to 15% is reported.

2 Problem description

The problem presented here encompasses a wider variety of possible situations. The workforce can be composed of security guards, vendors of medical equipment, technicians or salesmen of financial products. The core remains a VRPTW with multiple depots, qualification requirements and a number of workforce related constraints. A special type of visit, also discussed by Eveborn et al. [3], is a connected (or shared) visit that requires more than one employee.

Other notable characteristics are required equipment, visits fixed at a specific time and specifications of availability for both employees and customers. Continuity can be guaranteed by locking certain visits to employees. A list can be defined for each employee containing feasible geographic regions. Furthermore, where other authors deal with short scheduling horizons of one day [1] or five days [2], the problem presented here spans a longer scheduling period, of up to four weeks.

A long visit is yet another new feature. Due to the broad scope of applications, the visits have different characteristics than the ones that appear in the standard HCSP. The duration of a security guard's job is typically much longer than a nurse's visit to a patient. It is possible that the duration exceeds the maximum legal working time per day for one employee. In that case, the visit is a long visit and it needs to be split among different employees.

3 A hyperheuristic approach

We apply a hyperheuristic approach combined with a post-optimization procedure to produce a solution to the HCSP [4]. This approach succeeds in assigning an employee to each visit, while maintaining a high solution quality. Results from available test data, provided by an industry partner, show that the improvement obtained by the hyperheuristic strongly depends on the characteristics of the problem.

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