INTERNATIONAL
MASTER THESIS PROPOSAL

TITLE

Robust approach to the Dynamic Ambulance Relocation and Pre-assignment Problem

CANDIDATE SKILLS

The research work would lead to a master's thesis (*tesi di laurea magistrale*).
The ideal candidate should be a Master student of Mathematical Engineering with:

- background in Statistics (applied statistics track);
- background in Optimization (classes of group MAT/09).

However, master students from other faculties will also be considered.
Fluency in English or French is mandatory.

DURATION AND GENERAL INFORMATION

This is a joint thesis project between:

- the Istituto di Matematica Applicata e Tecnologie Informatiche (IMATI) of the Consiglio Nazionale delle Ricerche (CNR), Milan, Italy;
- the Operations and decision systems department, Faculté des Sciences de l'Administration, Université Laval, Quebec, Canada;
- the Politecnico di Milano.

The expected duration of the thesis is about 8 months.
This proposal envisages a **4 months visit at the FSA-Université Laval laboratories.**

⇨ *The student will receive **500 euros per month** to cover accommodation and extra fees incurred by the research period in Québec; moreover, one round flight ticket from Milan to Quebec will be **reimbursed**.*

CONTACTS

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PROJECT DESCRIPTION

Emergency medical services (EMS) generally deal with two real-time decisions: ambulance dispatching and relocation. Dispatching consists in selecting which ambulance to send to an emergency call, while relocation consists in determining how to modify the location of available ambulances throughout the day in response to changes in the state of the system.

Although they have been mostly considered separately, dispatching and relocation decisions are closely related, and joint strategies that consider them simultaneously could help maintain a good service level with lower relocation efforts.

In this light, our research group addressed the Dynamic Ambulance Relocation and Pre-assignment Problem (DARPP). The DARPP determines the location of each available ambulance as well as an ordered list of available ambulances that can be dispatched to each demand zone, aiming at minimizing the expected response time and relocation efforts [1].

The problem has been modelled by means of a linear mathematical programming model; moreover, to solve real-life instances, a matheuristic decomposition approach has been developed by exploiting the division of the territory into subregions.

Up to now, the demand for emergency services has been considered deterministic, setting the model and the analyzed scenarios on the expected values of each demand zone from the historical data.

However, in real life, the demand for emergency services is highly variable and stochasticity should not be neglected.

Different approaches have been proposed in the literature to handle uncertain parameters in health care optimization problems. Recently, the cardinality-constrained approach has been applied in this field [2]. Among the others, such an approach seems suitable because of allowing a trade-off between the level of robustness and the cost of the solution, and an easy implementation that can be understood by clinicians and planners [3].

The goal of the thesis is to develop a new model for including the parameters variability in the DARPP and in its matheuristic decomposition, by using the cardinality-constrained approach.

The model will be then validated on test instances and realistic data coming from a relevant real case in Canada.

[1] V. Bélanger, E. Lanzarone, A. Ruiz, P. Soriano. The dynamic ambulance relocation and pre-assignment problem. Working paper.

[2] D. Bertsimas, M. Sim, The price of robustness, Oper Res 2004; 2004; 52: 35–53.

[3] B. Addis, G. Carello, A. Grosso, E. Lanzarone, S. Mattia, E. Tànfani. Handling uncertainty in health care management using the cardinality-constrained approach: advantages and remarks. Operations Research for Health Care 2015; 4(1): 1-4.