Multi-period stochastic programming models and techniques for logistics distribution systems

In general problems addressed in the literature are more and more complex and integrate more and more information, thanks to the emergence of new technologies. However, studied problems still represent in most of the cases simplified versions of something that happens in the reality. For example, one aspect that is usually neglected in the literature is the aspect **of stochasticity**. More precisely, it is assumed that all data are given in advance, and there is nothing that could perturb the data. However, in the reality we have the opposite. There is a lot of uncertainty and systems and their data are subject to perturbations and changes. Hence, the aim of this PhD thesis is to further reduce this existing gap between the literature and practice. This would be achieved by proposing corresponding **mathematical models and solution frameworks capable to deal with complex, stochastic problems** usually encountered in practice.

This thesis will focus on an integrated problem of network design and vehicle routing. The first problem to study will be a hub location routing problem. This problem is faced in many large companies like AMAZON, DHL, FeedEX etc. It consists in satisfying the customer demands within a given planning horizon using a distribution network that needs to be constructed and a given fleet of vehicles. The aim is to determine hub and spoke network through which the demands are transferred and to determine vehicles' routes. Each demand is processed first at a distribution center, then it is transferred to one or more intermediated hubs, and finally to a customer. The transfers through the network are accomplished by the traditional vehicles (e.g., trucks) except for the last mile delivery where the delivery nowadays is accomplished also by (unmanned aerial vehicles) **UAVs** and **electric vehicles**. The second problem is a location arc routing problem. The aim of the problem is to simultaneously determine depots (i.e., locations from where vehicles departs and returns to), and design vehicles' routes so that prespecified objective function is minimized. In addition, all demands located along edges need to be satisfied.

In the frame of this thesis we are going to extend the studied problems by considering important aspects usually encountered in the practice: the aspect of stochasticity/ uncertainty that usually occurs in demands and travel times; and the aspect of multi-periodicity where the decisions need to be provided for a given planning horizon. Hence, the thesis will provide a thorough study on a robust **network design and vehicle routing planning**, with special emphasize on the **stochasticity and multi-periodicity** of problems under study.

Modeling and studying theoretical properties will be the first step in the solution process of a problem at hand. Due to stochasticity/ uncertainty and/or multi-periodicity of the problems, the obtained models will be large scale mixed integer nonlinear problems. Therefore, the exact methods would be used to solve small test cases, in order to validate approach, while for large scale test cases we will be obliged to resort to heuristic solution approaches. In addition, in order to come up with strong upper/lower bounds, hybridization of exact and heuristic solution approaches will be considered as well.

The thesis will be done in the framework of scientific collaboration between **LAMIH UMR CNRS 8201 - Polytechnic University of Hauts-de-France (UPHF), France** (htttp://www.uphf.fr/LAMIH/en/frontpage) and **Faculty of Science, University of Lisbon, Portugal (**https://ciencias.ulisboa.pt/**).** The student will be co-supervised by **Francisco Saldanha da Gama (University of Lisbon) and Raca Todosijevic (LAMIH, UPHF)**.

Research visits:

It is planned that the student will spend several months each year at University of Lisbon. In addition, due to scientific collaboration between LAMIH and CIRRELT, Montreal, Canada (https://www.cirrelt.ca/) in the frame of the associated international laboratory CNRS LIA ROI-TML, the student will have also opportunities for research visits at CIRRELT.

Required competences:

- Master degree in Operations Research / Mathematics / Computers Science or equivalent
- Strong knowledge in operations research including metaheuristics and mathematical programming
- Knowledge in stochastic optimization and/or optimization under uncertainty is a plus
- Excellent programming skills (e.g., C/C++, C#, Python, Java)
- Knowledge of optimization software (CPLEX, GUROBI, GAMS, BARON etc) is a plus
- A high degree of autonomy and commitment to work
- Strong written and verbal communication skills in English
- Knowledge of French and Portuguese languages is not necessary. The student will have an opportunity to learn both languages.

Starting date: 01/09/2020 (**negotiable**)

Duration: 3 years

Salary: around **1450** euros net per month. The candidate will have possibility of teaching at UPHF, which is paid extra.

Application: All candidates should send their applications **by e-mail to the below contacts**. Application must contain: CV, motivation letter, two or more recommendation letters, copies of most recent diplomas along with exam marks. Any other document that may strengthen candidate's application is allowed. **Note that candidates who will complete their master studies in this school year are also eligible to apply**.

Application deadline: 01/05/2020

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