PhD position: Routing and staff planning for home services

Supervisors: Nabil Absi, Dominique Feillet and Thierry Garaix
Structure: Mines Saint-Etienne, Manufacturing Sciences and Logistics Department, UMR CNRS 6158 LIMOS
Location: 880 route de Mimet, F-13541 Gardanne, France (near Aix-en-Provence in the South of France)
Duration and starting date: The position is for three years starting as soon as possible (in 2019). The position will remain open **until fulfilled**.
Keywords: operations research, combinatorial optimization, algorithmic, vehicle routing

Subject:

This PhD thesis is part of the project "Flexible and Intelligent Transportation Systems (FITS)" funded by the French Research Agency (ANR). The project FITS is designed to tackle the scientific challenges raised by the optimization of transportation service platforms that need intelligent tools for responsive large-scale systems. The FITS project is designed to address those issues by taking profits from available data (real-time information and statistics on large data). FITS has to perform a smart assignment between users in order to find the best balance between satisfying customers and covering constraining or less profitable requests with fair dispatching rules among workers in terms of difficulty and profit. The FITS project is conducted by a consortium of three complementary teams (Mines Saint-Etienne CMP-SFL/LIMOS, Mines Saint-Etienne CIS-I4S/LIMOS and UCA/LIMOS) in computer sciences, operations research, management science and healthcare engineering. Developed algorithms will be tested on real data extracted from the open living lab #futuremedicine MedTechDesign and obtained from the industrial partner Eovi Mcd (a health insurance company). All developed algorithms will be prototyped in this living lab. Two PhD positions and a two-year Post-doctoral position are assigned to the project.

The research pursued by the PhD student will concern the development of new models and original solution methods in order to develop intelligent tools to help optimizing the delivery of services (such as care or maintenance deliveries) to customers located potentially at home. In fact, some systems such as home care delivery and medical transportation can suffer from strong constraints. For example, customers can have strong time windows constraints to deliver the service (e.g. be on time for an appointment, receive lunch, get help for a shower, get drugs), or a constraint on the necessity of a specialized workers. One typical application is medical transportation that is moving to uber-like business models [Pow16]. Another application is home care services. One major difficulty is to schedule the activities of operators for the same customer. In home health care organization, these synchronization constraints are critical and the majority of cares cannot be performed simultaneously or follow some precedence constraints (e.g. the caregiver gives the shower before the bandage is made by the nurse). In the exact opposite manner, some tasks (like moving heavy patients) have to be performed by several operators at the same time.

These problems can be optimized on the day horizon in order to satisfy both parties on the short-term objectives (operational constraints), but can also be optimized on the mid-term in order to optimize more mid-term objectives such as the continuity and the consistency services and the workload balance between resources. A recent survey on home care planning is available in [Cis17]. For example, in [Lan14] the authors focus on the nurse to patient assignment problem on a long-term horizon and an uncertain workload progression.

The scientific challenges of this thesis are the following:

- First, provide a complete scientific and practical state of the art on transportation service systems. The scientific state of the art allows us to provide a survey on problems, models and methods developed in the literature related to deal with transportation service delivery (coupling workforce scheduling and vehicle routing), and to position our project with respect to existing studies. Furthermore, this task aims at identifying the weakness of existing studies, and to list real constraints that should be considered.
- Second, identify and analyze different KPIs (key performance indicators) depending on the optimized objective (fairness between workers, quality of service, costs and profits). These objectives can be optimized in the short-term or the mid-term and will have a high impact on the structure of obtained solutions. The goal is propose different mathematical models to represent all identified objectives and constraints.
- Third, develop new solution methods to deal with the single-period version of the studied problems. The goal is to start first by developing an efficient heuristics approaches (e.g. Adaptive Large Neighborhood Search) and an exact method (e.g. Dantzig-Wolfe decomposition). These approaches will be adapted to the deal with the multi-period context that has different objectives and constraints. All these algorithms will be tested on real-data and embedded within the living lab.

Candidate profile:

Applicants must have a Master Degree (or equivalent) in Computer Sciences, Applied Mathematics or any related discipline. Applicants should demonstrate good programming skills and a deep knowledge in combinatorial optimization and integer programming.

Location:

The PhD student will be located in Gardanne (south of France, near Aix-en-Provence) in the research group Manufacturing Sciences and Logistics (https://www.mines-stetienne.fr/en/research/scientific-departments/manufacturing-sciences-logistics-department-sfl/) of the Georges Charpak Provence Campus of Mines de Saint-Etienne.

Application procedure:

Please send your application electronically (preferably as a single pdf file) including a detailed curriculum vitae and examination results, plus, if available, a list of reference letters and copies of diploma, to: Nabil ABSI (absi@emse.fr). The position will remain open until fulfilled.

This offer is also available at: http://absi.nabil.free.fr/ThesisEcoleDesMines-FITS-2019.pdf

For further questions regarding the position or details on the research project, please contact Nabil ABSI, Dominique FEILLET or Thierry GARAIX.

References:

[Cis17] Cissé, M., et al. OR problems related to Home Health Care: A review of relevant routing and scheduling problems. *Operations Research for Health Care* 13:1-22, 2017.
[Lan14] Lanzarone, E., and Matta A. Robust nurse-to-patient assignment in home care services to minimize overtimes under continuity of care. *Operations Research for Health Care* 3(2): 48-58, 2014.
[Pow16] Powers, B. W., Rinefort, S., Jain, S. H. Nonemergency medical transportation: delivering care in the era of Lyft and Uber. *Jama*, 316(9), 921-922, 2016.