Decision making today relies increasingly on support from mathematical models. Quantitative modeling is routinely used in both industry and administration to design and operate transportation, distribution, or production systems. Optimization concerns every stage of the decision-making process: investment budgeting, long term planning, the management of scarce resources, or the planning of day-to-day operations. Many optimization problems that arise in decision support applications involve discrete decision variables; the resulting problems can be modeled as linear or non-linear programs with integer variables.

The solution of such problems is essentially based on enumeration techniques and can be notoriously difficult given the huge size of the solution space. A key to success is the development of better problem formulations that provide strong approximations and hence help to prune the enumerative solution scheme. One must also avoid the drawback of enumerating what are essentially symmetric solutions.

Our project aims to develop tight formulations and algorithms for combinatorial optimization problems exploiting the complementarity between the latest reformulation techniques, such as Lagrangian and polyhedral approaches (the generation of columns and cutting planes), non-linear programming tools (quadratic programming, semi-definite, and other convex relaxations), and graph theoretic tools (for induced properties and implicit representations of solutions). Our focus is on deterministic optimization approaches based on mathematical programming, but our experience extends to stochastic programming, constraint programming, and graph theory. Through industrial partnerships, the team targets large scale problems such as those arising in network design, logistic (routing problems), scheduling, cutting and packing problems, production planning and healthcare logistic.

The project is co-financed by French region Nouvelle Aquitaine. The partner of the project is Atoptima start-up.

Mission confiée

The work concerns developing optimization methods for solving inventory routing problems (IRPs), which arises in the context of vendor–managed inventory (VMI), a business practice aimed at reducing logistics costs and adding business value. In VMI, a supplier makes the replenishment decisions for products delivered to customers, based on specific inventory and supply chain policies. This practice is often described as a win-win situation: vendors and their customers get to distribution and production costs because they can coordinate shipments made to different customers, and buyers also benefit by not allocating efforts to inventory control. In such contexts, the supplier has to make three simultaneous decisions: (1) when to serve a given customer; (2) how much to deliver to this customer when it is served; and (3) how to combine customers into vehicle routes.

The first objective of the project is to revisit the current methodology for exactly solving IRPs. The main interest here is to treat the special case of waste management. This application is characterized by uncertain demand (waste deposits) and a large number of customers (waste containers). The state-of-the-art methods for solving IRP are not adapted to this setting, as they are tested on instances coming from other applications. The second objective is to have a generic implementation of proposed approaches, and to make it available to the academic community for re-use and adaptation for different variants of the IRP. The third objective of the project is to collect a real-life data for the waste collection problem, and to make it available to the academic community in order to inspire a further progress in the area. The collaboration with Atoptima SAS is essential in this aspect.

Principales activités

Main activities:
- Literature review
- Development of models and exact approaches for solving IRPs
- Implementation of the proposed methods using C++ and Julia languages
- Editing and submitting scientific papers
- Preparing and defending the thesis

Additional activities:
- Retrieving, anonymisation, and preparation of the problem's data with the help of Atoptima start-up
- Participation in the scientific conferences and workshops
Compétences

Technical skills and level required: Significant experience with programming languages (required), C++ and/or Julia is a plus.
Languages: English (required), French is a plus
Relational skills: Good communication skills

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération

Gross monthly salary (before payroll and income taxes):

- 1982 €/month during 1st & 2nd years of the employment contract
- 2085 €/month during the third year of the employment contract