Internship position at LIA, University of Avignon, France

"A bilevel model for network capacity planning with optimal charging strategies for electrical vehicles"

Electrical Vehicles (EV) will become more and more present in urban areas. Electric vehicles represent a promising technology for reducing emissions and dependence on fossil fuels, and have started entering different automotive markets. The present intern subject is based on a recent study of optimal routing of electrical vehicles taking into charging strategies into a network of charging stations [1]. The goal of this project is to study the capacity planning of charging stations taking into account a decentralized routing policy that assigns EV to a network of charging stations. We will tackle the problem as a bilevel mathematical program in which the upper-level represents the capacity planning problem (a minimization of a non-linear objective function that depends on the total load of the system) and the lower-level is an equilibrium concept (EV chooses the charging station that minimizes his expected cost).

This type of problem can be seen as a particular type of bilevel optimization problem (BLPP) [1] where the lower-level variables satisfy an equilibrium condition. This equilibrium comes from the interaction between several decision makers. In fact, the general formulation of a bilevel optimization problem is:

where the variables $x$ are the upper-level real variables (where $X$ is a convex set of constraints) and $y$ are the lower-level real variables (where $y$ are taking their values in a closed and convex set). The previous formulation assumes that there is one decision maker at the upper-level and one at the lower-level. Lots of real-worlds problems and from very diverse domains involve a hierarchical relationship between two and more decision makers at the same level of this hierarchical structure. Particularly, this setting is used in management optimization, economic planning, engineering, optimal control, chemistry, etc. One of the most used frameworks is to consider one decision maker at the upper-level (called leader) and several decision makers interacting together at the lower-level (called the followers).

In our problem, the upper-level model is a discrete mathematical program which contains the following main difficulties:

- the nature of the decision variables,
- the non-linearity of the objective function,
- the relationship with the equilibrium concept at the lower-level problem.

The lower-level problem is an instance of the Greedy Primal-Dual algorithm proposed in [3]. Therefore, a preliminary possible solution method will be possible to adapt this algorithm to our problem.
Expected results and perspectives:

1. To develop and implement a solution method for the bilevel program.
2. To conduct an experimentation study for different instances.
3. To take into account the rerouting of EV vehicles in case of rejection at charging stations.

Host institution:

This intern project will be conducted at the Computer Science Laboratory (LIA) of the University of Avignon. D. Quadri from the Paris Sud University/LRI and Y. Hayel from the LIA will supervise the project.

Start date: The duration of the internship is for 6 months, starting in February or March 2016.

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