Integrated Optimal pricing, sizing and location of electric vehicle charging stations

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**Problem description**

**Goal:**
Determine the optimal pricing, sizing and locations of EVCS in order to maximize the revenue and smooth demand over time.

**Context:**
- Strategic planning.
- Each EV user has a preference list (Limited size) of charging stations based on: Expected price and/or Distance

- Hierarchical decision making process.
- Energy prices are associated to time slots.
- Threshold price and distance for each users.
- Limited budget.
Bi-level optimization model

**Objectif**
- Maximize the profit + Smooth the demand over time

**Decisions**
- Select a set of CS to be activated
- The number of charging spots in a CS
- Prices associated to time slots

**Leader:** EV charging stations manager

**Follower:** EV users

Each user selects the best CS available in the preference list

Chooses the CS and the time slot to charge
Solution methods and numerical results

- Solution methods:
  - **Single level reformulation of the bilevel model:**
    Using KKT optimality conditions $\implies$ Solve with ILP solver
  - **Cutting plane algorithm:**
    Cut infeasible solutions iteratively with valid inequalities.

- Preliminary numerical results on randomly generated instances:
Example: 10 users, 5 stations, 3 time slots

Solution when the preference list is defined based on minimum distance

All users got their first choice except user 5, because its first choice CS-1 was not activated and the price of its second choice was $p_{4,3} = 7$ higher than its price threshold 3.
Example: 10 users, 5 stations, 3 time slots

Solution when the preference list is defined based on minimum cost

* Notice the longer arrows (distance).
* User 6 got its third choice, because its first choice CS-5 and third choice CS-4 were fully occupied.
* The other users can be explained in a similar way.
Example: 10 users, 5 stations, 3 time slots

Solution when the preference list is defined based on combination of minimum cost and distances

![Graph showing user preference list and initial preference list with updated preference list.]

Shoter arrows (distances) than the previous. All users got their first available CS choice.
Thanks for your attention!