Combining ML+MINLP for the Algorithm Configuration Problem

Claudia D'Ambrosio
dambrosio@lix.polytechnique.fr

Outline

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Introduction and Motivation

Configure a given algorithm via **machine learning** and **mathematical optimization** (Iommazzo (2021), Iommazzo et al. (2020a, 2020b)).

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Hp. the performance p of algorithm A depends on the specific instance (from easy to hard to solve, based on how A is configured).

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$$\min_{c \in C_A} \bar{p}(\tilde{\pi}, c)\,,$$

where $\tilde{\pi}$ is given and $\bar{p}$ is an approximation of an algorithm performance function $p(\pi, c)$.

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Hybridizing ML and MINLP methods

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1. Introduction and Motivation
2. The Algorithm Configuration Framework
3. The Configuration Space Search Problem

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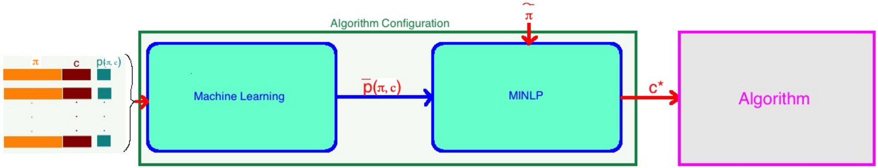
The Algorithm Configuration Framework

Using ML+MINLP to “optimally” configure algorithms



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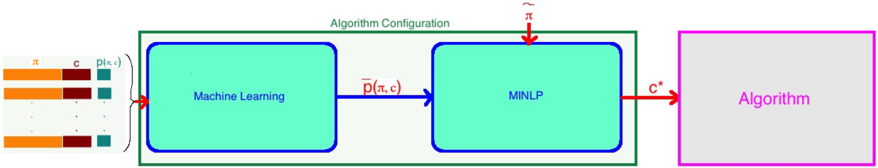

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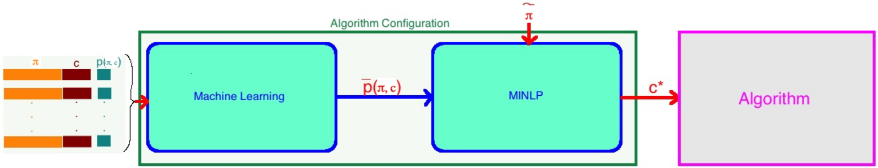

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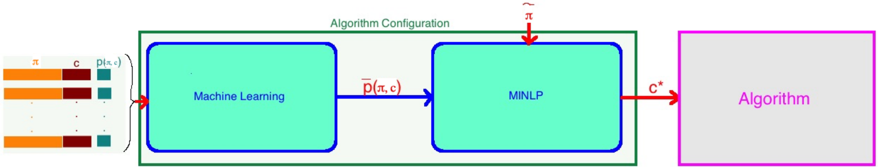

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MINLP phase: the **Configuration Space Search Problem**

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The Configuration Space Search Problem (CSSP)

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- instance features π
- machine learning paradigm to learn the approximation function $\bar{p}(\pi, c)$ from historical data (Support Vector Regression (SVR)/Decision Trees/Logistic Regression)
- Given a new problem instance $\tilde{\pi}$, the corresponding CSSP is solved

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For SVR, the CSSP is:

$$\min_{\bar{c} \in C_A} \sum_{i \in S} \alpha_i \exp^{-\gamma \|(\pi_i, c_i) - (\tilde{\pi}, \bar{c})\|_2^2},$$

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Formulate and solve the MINLP model above in AMPL. Which solver to use? An instance is available online.