Algorithms with Learnable Predictions for Combinatorial Optimization

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The advance of machine learning opens promising research avenues, especially in the design of algorithms for combinatorial optimization. Algorithms with machine-learning predictions have been recently introduced [3] to circumvent worst-case analysis. The goal is to design algorithms that have near-optimal performance when the predictions are good and always have performed better than the worst-case guarantee even when the predictions are mediocre. At a high level, the methods incorporate machine learning advice to adapt their behavior to the properties of the input distribution and consequently improve their performance, such as runtime, space or quality of the solution. The field has blossomed with many applications [1]. In this direction, we aim to develop a model that allows for imperfect predictions and study the tradeoff between the quality of algorithms and that of the predictive information. In this project, we plan to :

1. characterize the strength and the limit of predictive information ; to which extent such information is useful and related to learnable predictions ;
2. design algorithms with performance guarantees for problems with predictions (for example [2, 5]). A killer application would be energy minimization/scheduling problems [4] in which data are available, and any improvement, even tiny, on the performance guarantee would have a real impact on the management of energy.
3. design mechanism with machine learning predictions in the context of algorithmic game theory.

We look for motivated students with a solid background in maths/optimization/algorithms. There are possibilities to pursue this topic with a Ph.D. For further information, please feel free to send me an email and/or discuss this in person.

Références

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[4] Hugo Richard, Flore Sentenac, Corentin Odic, Mathieu Molina, and Vianney Perchet. Static scheduling with predictions learned through efficient exploration. *https ://arxiv.org/pdf/2205.15695.pdf*, 2022.

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