An introduction to combinatorial optimization augmented machine learning

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Résumé

Operations Research is the scientific discipline that provides decision support tools for the optimal allocation of resources. It mainly focuses on optimizing industrial processes, which often leads to combinatorial optimization problems. In the last decades, industrial processes have generated more and more data. Firms have shown a growing interest in exploiting these data to improve the performance and the resilience of their processes. However, this data is abundant, sometimes incomplete and often intrinsically random, which makes machine learning the suitable discipline for controlling uncertainty in data processing. Nevertheless, machine learning alone cannot handle the combinatorial nature of these problems effectively. Combinatorial optimization augmented machine learning is a recent and extremely active field that combines tools from machine learning and operations research to address both the statistical and combinatorial challenges raised by these data-driven problems. It generally consists of introducing combinatorial optimization layers in neural networks, and training the resulting network using decision-aware learning. This talk is a general introduction to the field. We review the main applications and algorithms. We conclude with the approach that enabled our students to win the 2022 EURO-NeurIPS challenge on dynamic vehicle routing.