Séminaire conjoint CIRRELT avec la
Chaire de recherche du Canada en analytique et logistique de soins de santé
HANALOG

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Dynamic Programming for Combinatorial Optimization: A Primal-Dual Approach Based on Decision Diagrams

Abstract: Discrete optimization is a fundamental methodology for solving a large array of problems in planning, scheduling, routing, and finance, to name a few. Many of such problems can be reformulated in terms of dynamic programming (DP) models, making them more amenable to solution methods that exploit recursiveness as opposed to linearity or convexity. DP techniques, however, often suffer from the so-called curse of dimensionality and are typically impractical for realistic-sized instances. A more recent strategy to address the curse of dimensionality is to approximate the state-transition graph of a DP model using limited-size approximate decision diagrams (DDs). Specifically, one can systematically compress a state-transition graph to obtain either relaxation or primal heuristics for a DP model, yielding the so-called relaxed and restricted DDs, respectively. Previous literature shows that, when replacing the traditional linear programming relaxation by relaxed DDs in branch and bound, one can outperform state-of-the-art methods in several combinatorial optimization problems. In this work, we extend this line of research by introducing the notion of DP-based dominance for decision diagrams. We define new dominance-based feasibility and optimality conditions that are applied to strengthen dual bounds provided by relaxed DDs. In addition, we show how problem-agnostic dominance-based reasoning can be employed to derive primal bounds from a relaxed DD. We then propose a new primal-dual approach for solving a DP model that iteratively constructs and strengthens a relaxed DD until its associated dual and primal bounds coincide. Such method is guaranteed to converge to an optimal DP policy and does not rely on value iteration nor forward or backward recursions. Furthermore, it also becomes a novel alternative to solve combinatorial optimization problems without the need of branch and bound. We demonstrate the method for a range of classical combinatorial optimization problems such single/multidimensional knapsack problems and set covering.

Bio: Michael Römer is a visiting Postdoc at the OM&S area at Rotman School of Management and Polytechnique Montréal, funded by the German Research Foundation (DFG). Currently, he works on Decision Diagrams for Combinatorial Optimization and on graphical model-based approaches for personnel scheduling. A common thread in Michael's current and past research is the use of networks to efficiently represent the structure of combinatorial optimization problems. In his PhD thesis, he used state-expanded networks embedded in large-scale MILPs for solving real-world airline crew scheduling problems. Using related ideas, he won the Second International Nurse Rostering Competition 2015 as well as the Association for Constraint Programming Challenge 2016 where he first connected with his postdoc advisor Andre Cire. Michael received his Master from the University of Paderborn and his PhD from Martin Luther University Halle-Wittenberg (both in Germany). He will return to Germany in March 2019, and he encourages you to seize the opportunity to get an overview of his research while he is still in Canada.

Mardi / Tuesday

19 février 2019 / February 19th, 2019
10h30

Salle / Room 5441
Pavillon André-Aisenstadt
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Organisateur / Organizer
Louis-Martin Rousseau