Abstract constraint reasoning on GPU

Résumé du projet de recherche (Langue 1)

Combinatorial optimization has been very successful these two last decades across different communities including constraint programming, satisfiability (SAT), satisfiability modulo theories (SMT) and linear programming and its variants. In the following, we refer to these communities under the umbrella term “constraint reasoning”. However, the paradigms developed in each community are based on different foundations, which makes cross-pollination a daunting task. In order to establish an unifying theory, the deep connections between constraint reasoning and programming languages have recently resurfaced. The glue between both fields is the theory of abstract interpretation, a framework to statically analyze programs. In the last decade, abstract interpretation has shown very promising results to provide a “grand unification theory” among the fields of constraints reasoning. Many combinatorial solvers were shown to be abstract interpreters, including SAT [D'Silva et al., 2012], constraint programming [Pelleau et al., 2013, Talbot, 2019] and satisfiability modulo theories (SMT) [D'Silva et al., 2014] solvers. We call this recent area of research “abstract constraint reasoning”. In this thesis, the candidate will rely on the notion of asynchronous iterations of abstract interpretation, which consists in computing the fixed point of a system of equations in parallel. Asynchronous iterations have mostly been explored from a theoretical point of view, and many challenges remain. In particular, the single instruction stream, multiple data streams (SIMD) architecture of GPUs is fundamentally different from the one of CPUs. Therefore, it is very difficult to adapt an existing solver to work over GPUs, and this might explain why the existing approaches struggle to obtain good results. We believe that solvers must be programmed in a radically different model of computation, embracing SIMD parallelism at its core. Building on the wide array of research in abstract interpretation, concurrent and constraint logic programming, we expect the candidate to develop a constraint solver based on abstract interpretation dedicated to SIMD architectures.

Informations complémentaires (Langue 1)


Informations complémentaires (Langue 2)

co-encadrement avec Pierre Talbot