Parameterized Complexity and Constraints

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Abstract

In this talk I will advocate the framework of *parameterized complexity* for the theoretical analysis of problems that arise in constraint programming and satisfiability. Parameterized complexity considers in addition to the input size of a problem also a secondary measurement, the parameter. The parameter can represent a qualitative aspect of the input, e.g., how well it is structured. This two-dimensional setting allows a more fine-grained complexity analysis with the potential of being more realistic than the one-dimensional setting of classical complexity theory.

The central notion of parameterized complexity is *fixed-parameter tractability* (FPT) which refers to solvability in time $f(k)n^c$, where n denotes the input size, f is some function (usually exponential) of the parameter k, and c is a constant. The subject splits into two complementary questions, each has its own theoretical toolkit and methods : how to design and improve fixed-parameter algorithms, and how to gather evidence that a problem is not fixed-parameter tractable for a certain parameter.

In this talk I will discuss the basic notions of parameterized complexity and review some recent results on constraint satisfaction, global constraints, and satisfiability. I will mainly focus on three groups of parameters : parameters that represent the distance from a tractable subproblem, parameters that represent decomposability, and parameters that represent locality. Furthermore, I will discuss the concept of *kernelization*, a central concept of parameterized complexity, which can be seen as a form of polynomial-time preprocessing with performance guarantee.