An Extension of Datalog for Modelling and Solving Complex Combinatorial Problems

(Invited Tutorial)

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Datalog is a well-known language that served as a solid theoretical foundation for many studies in the area of databases [27]. Although Datalog has been overtaken by the more appealing SQL language in the software development market, there has been a renewal of interest in the Datalog language [25] both in academia and in industry in the last few years. Two of the main areas in which Datalog has been adopted as base language include ontological reasoning [21, 6] and logic programming [8, 22]. In particular, Datalog is the base language of a powerful logic programming formalism that is called Answer Set Programming (ASP) [20, 7]. ASP extends Datalog with unrestricted usage of negation in the body of rules, disjunction in the head of rules, aggregate atoms, hard and weak constraints, and more.

Computational problems, even of high complexity [9], can be solved in ASP by specifying a logic program, i.e., a set of logic rules, such that its answer sets correspond to solutions, and then, using an answer set system to find such solutions [23]. It is worth noting that ASP allows one to solve problems not even polynomially rewritable to SAT [9]. Importantly, a fixed ASP program can be used to model the solution of a problem over varying instances. The availability of efficient implementations [19] for such an expressive language made ASP appealing for the development of applications in several areas [15], including deductive databases [24] and combinatorial problem solving [11, 14, 13, 5, 4, 2, 18].

In our tutorial of the 3rd International Workshop on the Resurgence of Datalog in Academia and Industry (Datalog 2.0), we present ASP starting from Datalog, and discussing the role of the main language extension present in the standard ASPCore2 language [19]. We also discuss the impact of the constructs in terms of computational complexity and evaluation procedures. Importantly, we illustrate the usage of ASP for knowledge representation and reasoning. We present the Guess-Check-Optimize programming methodology, and show its application in a number of real-world applications of ASP (developed using DLV [1], and WASP [3]). Among these we mention a tool for the automatic generation of the teams of employees [26], which has been employed in the sea port of Gioia Tauro for intelligent resource allocation; and a tool for travel agents that allows for the intelligent allotment of touristic packages [13]. Finally, we overview some programming tools [12, 16] provided by the ASPIDE IDE for ASP [17] that make more friendly the development of ASP programs and the extension of existing implementations [10].

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