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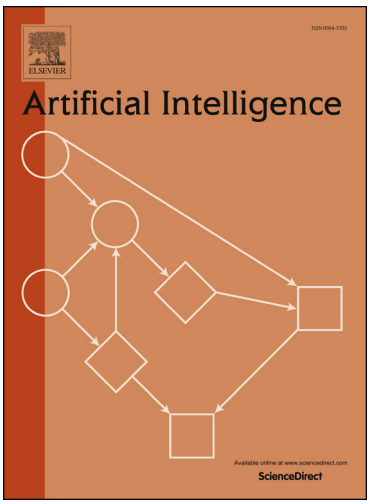

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A Progression Semantics for First-Order Logic Programs

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Abstract

In this paper, we propose a progression semantics for first-order normal logic programs, and show that it is equivalent to the well-known stable model (answer set) semantics. The progressional definition sheds new insights into Answer Set Programming (ASP), for instance, its relationships to Datalog, First-Order Logic (FOL) and Satisfiability Modulo Theories (SMT). As an example, we extend the notion of boundedness in Datalog for ASP, and show that it coincides with the notions of recursion-freeness and loop-freeness under program equivalence. In addition, we prove that boundedness precisely captures first-order definability for normal logic programs on arbitrary structures. Finally, we show that the progressional definition suggests an alternative translation from ASP to SMT, which yields a new way of implementing first-order ASP.

1. Introduction

Answer Set Programming (ASP) has emerged as a predominant approach for nonmonotonic reasoning in the area of knowledge representation and reasoning due to its simplicity, expressive power and computational advantage [6, 22, 35, 36]. At its beginning, the stable model (answer set) semantics for first-order logic programs is defined only on Herbrand Structures by grounding into propositional programs [23, 24]. In recent years, a number of approaches have been developed to release this restriction by directly defining the stable model semantics on arbitrary structures [4, 5, 7, 10, 12, 17, 20, 26, 28, 30, 33, 38, 40, 42, 44].

A typical approach on this research line is to use a translation to another host language, e.g. second-order language [20] or circumscription [33]. For this purpose, second-order is inevitable as the class of the stable models of some logic