Extensions of first-order logic by fixed-point operators are important in finite model theory because they capture some recursion on relations. This paper studies the further extension that also gives access to the cardinalities of definable relations. The resulting “fixed-point logics with counting” provide distinguished levels of expressiveness within the complexity classes PTIME and PSPACE, respectively. The model theoretic and algorithmic analysis is here carried out on the basis of Ehrenfeucht-Fraïssé games for related infinitary logics (the counting pebble games of N. Immerman and E. Lander [“Describing graphs: A first-order approach to graph canonization”, in: A. Selman (ed.), Complexity theory retrospective, 59-81 (1990; Zbl 0699.68076)]. This analysis gives rise to complete structural invariants which serve to characterize the expressive power of fixed-point logics with counting in complexity theoretic terms. These results generalize the approach of S. Abiteboul and V. Vianu [“Generic computation and its complexity”, Proc. ACM Symp. Theory of Computing 23, 209-219 (1991)]. Relations with fragments of infinitary logics, with a relational model of computation, and with Lindström extensions of fixed-point logics are investigated.

Reviewer: M.Otto (Aachen)

MSC:

03C13 Model theory of finite structures
03D15 Complexity of computation (including implicit computational complexity)
03C75 Other infinitary logic
03C80 Logic with extra quantifiers and operators
68Q15 Complexity classes (hierarchies, relations among complexity classes, etc.)

Keywords:
descriptive complexity; Lindström quantifier; finite model theory; cardinalities of definable relations; Ehrenfeucht-Fraïssé games; infinitary logics; counting pebble games; fixed-point logics; relational model of computation

Full Text: DOI

References:

[3] DOI: 10.1007/978-1-4612-4478-3_5 · doi:10.1007/978-1-4612-4478-3_5
[16] DOI: 10.1016/0022-0000(82)90011-3 · Zbl 0503.68086 · doi:10.1016/0022-0000(82)90011-3
[22] Diplomarbeit (1992)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.