**Chatterjee, Krishnendu; Dvořák, Wolfgang; Henzinger, Monika; Svozil, Alexander**
**Quasipolynomial set-based symbolic algorithms for parity games.** (English) Zbl 1415.68142
Barthe, Gilles (ed.) et al., LPAR-22. 22nd international conference on logic for programming, artificial intelligence and reasoning, Awassa, Ethiopia, November 17–21, 2018. Selected papers. Manchester: EasyChair. EPiC Ser. Comput. 57, 233-253 (2018).

Summary: Solving parity games, which are equivalent to modal $\mu$-calculus model checking, is a central algorithmic problem in formal methods, with applications in reactive synthesis, program repair, verification of branching-time properties, etc. Besides the standard computation model with the explicit representation of games, another important theoretical model of computation is that of set-based symbolic algorithms. Set-based symbolic algorithms use basic set operations and one-step predecessor operations on the implicit description of games, rather than the explicit representation. The significance of symbolic algorithms is that they provide scalable algorithms for large finite-state systems, as well as for infinite-state systems with finite quotient. Consider parity games on graphs with $n$ vertices and parity conditions with $d$ priorities. While there is a rich literature of explicit algorithms for parity games, the main results for set-based symbolic algorithms are as follows: (a) the basic algorithm that requires $O(n^d)$ symbolic operations and $O(d)$ symbolic space; and (b) an improved algorithm that requires $O(n^{d/3+1})$ symbolic operations and $O(n)$ symbolic space. In this work, our contributions are as follows: (1) We present a black-box set-based symbolic algorithm based on the explicit progress measure algorithm. Two important consequences of our algorithm are as follows: (a) a set-based symbolic algorithm for parity games that requires quasi-polynomially many symbolic operations and $O(n)$ symbolic space; and (b) any future improvement in progress measure based explicit algorithms immediately imply an efficiency improvement in our set-based symbolic algorithm for parity games. (2) We present a set-based symbolic algorithm that requires quasi-polynomially many symbolic operations and $O(d \cdot \log n)$ symbolic space. Moreover, for the important special case of $d \leq \log n$, our algorithm requires only polynomially many symbolic operations and poly-logarithmic symbolic space.

For the entire collection see [Zbl 1407.68021].

**MSC:**

68Q60 Specification and verification (program logics, model checking, etc.)
68W30 Symbolic computation and algebraic computation

**Keywords:**

graph games; model checking; parity games; progress measure; symbolic computation

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