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A GAP IN THE SPACE HIERARCHY OF P SYSTEMS WITH ACTIVE MEMBRANES

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ABSTRACT

We prove that uniform families of P systems with active membranes using logarithmic workspace, in addition to a polynomial number of read-only input objects, can efficiently simulate polynomial-space Turing machines, and thus characterise the complexity class **PSPACE**. Since **PSPACE** was already known to be characterised by P systems working in *polynomial* space, this theorem implies, perhaps counter-intuitively, that the latter systems are exponentially wasteful, and a large part of the computation can be carried out by P systems just by moving the objects between their regions, without the need to rewrite them. This result also provides the first scenario where P systems are not equivalent to Turing machines with respect to their space complexity.

Keywords: membrane computing, P systems with active membranes, computational complexity, space complexity

1. Introduction

P systems with active membranes [4], a computing model abstracting the operation of biological cells, have inspired a rich literature investigating their computational properties from a complexity-theoretic standpoint [5]. Their ability to solve **NP**-hard problems in polynomial time by generating exponentially many membranes via division, which then evolve in parallel, provides an interesting trade-off between time and space complexity.

Although P systems seem to be exponentially faster than Turing machines when solving **NP** or even **PSPACE**-complete problems [2], the two devices have instead been proved to be equivalent up to a polynomial from the space complexity point of view, assuming the available space is at least polynomial [1]. Here the space requirements of P systems are measured as the sum of the number of membranes and objects occurring in the largest configuration reached during computations [6].

It is also possible to analyse P systems working in sublinear space by requiring the input objects to be operated upon in a read-only fashion, as in multitape Turing machines, by only measuring the space due to the membrane structure and the