Eilenberg P Systems: a Bio-Computational Model

Marian Gheorghe[1]*, Mike Holcombe[1] and Petros Kefalas[2]

[1] Department of Computer Science
Sheffield University, Sheffield, S14DP, UK
[2] Department of Computer Science
City College, 54624 Thessaloniki, Greece
Email: {M.Gheorghe,M.Holcombe}@dcs.shef.ac.uk kefalas@city.academic.gr

Abstract. The paper presents the main features of P systems, X machines and of a new computational device called Eilenberg P system. The sequential and the parallel Eilenberg P systems are presented and results reflecting the computational power of these models and their effectiveness in solving NP-complete problems are briefly mentioned. The behaviour of a bee colony is modelled as a society of communicating agents acting in parallel and synchronizing their behaviour. Two computational models for defining the agents behaviour are introduced and compared and tools developed for these models are briefly illustrated.

1 Introduction

Various computational models that are successfully used elsewhere in computer science to model software engineering problems (Petri nets [39], π calculus and ambient calculus [27], Statecharts [30], X machines [22]), artificial intelligence paradigms (agents of various types [16]), theoretical approaches (formal language theory [38], process algebra [41]) have been considered to modelling different biological phenomena and aspects of the living organisms. A lot of effort has been spent into pragmatic modelling leading to specific computational approaches facilitating model exchanges between various research groups through different standard software platforms (SBML [25], CellML [23]) [35].

The idea of modelling various biological aspects by means of formal language based methods and of linguistics approaches has been considered since its inception. Historically the decade that unveiled the structure of DNA also witnessed a revolutionary development in linguistics initiated by the work of Noam Chomsky [11]. Recently parallels between biological evolution and the history of language have been revealed [29] and a thorough survey has been dedicated to the use of linguistics methods in the study of DNA as language and of the genome as the book of life [40].

In the last years attempts have been made to devise computational models in the form of generative devices like P systems [36], inspired by bio-chemical mechanisms occurring in living cells, splicing systems [38], expressing transformations defined upon DNA strands (more information on these subjects may be found at [24] and [26], respectively). New computational paradigms of modelling concurrent systems' behaviour

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