Developments in Grammar Systems: Preface

Grammar Systems is a subfield of formal language theory providing syntactic models and frameworks for describing and studying (the behavior of) multi-agent systems at the symbolic level. The theory dates back to 1978, when *cooperating grammars* were defined in order to extend the two-level substitution mechanisms of grammars to a multi-level concept and to model concurrent operating systems [8]. The rapid development of the area started in 1988 by relating the original notion to a well-known model in distributed artificial intelligence, namely, by introducing *cooperating distributed grammar systems* for describing syntactic aspects of the blackboard model of problem solving [1].

Developments in grammars systems theory have been inspired and influenced by many scientific areas: distributed and decentralized artificial intelligence, distributed and parallel computing, artificial life, molecular computing, robotics, ecology, sociology, natural language processing, only to mention a few. Computer networks, parallel and distributed computer architectures, distributed and cooperative text processing, natural language processing are candidates for possible applications.

Further models with outstanding importance in the field are *parallel communicating grammar systems* (network architectures, [9]), *colonies* (models of communities very simple, purely reactive agents, [7]), and *eco-grammar systems* (grammatical models of ecosystems, [3]). For detailed information on grammar systems theory, the reader is referred to the monograph [2], the book chapter [6], and to the articles listed in the on-line bibliography [4].

A *grammar system* consists of a finite number of language determining devices (grammars in a generalized sense) which jointly develop a common symbolic environment by using the language theoretic operations they are based on. At any moment of time, the system is represented by strings which describe the state of the environment (and that of the agents) and which change under the functioning of the system. Depending on the variant of multi-agent systems modelled by the actual system, in addition to performing derivation steps, the grammars may communicate with each other. Usually, this is performed by the exchange of strings (representing data). The behavior of the grammar system can be characterized by the set of sequences of environmental states following each other, starting from an initial state, or by the set of all states of the environment which originate from the initial state and satisfy certain criteria. The second case defines the language of the system.

According to the *traditional approach* in formal language theory, one language is generated by one grammar (produced by one language determining mechanism), while according to the *non-standard approach* provided by grammar systems, generation or accepting is performed by several grammars in

cooperation and communication. Thus, *grammar systems are not only syntactic models of multi-agent systems, but also distributed models of language*.

The present volume is a collection of articles representing trends of important developments in Grammar Systems, from theoretical results and philosophical ideas beyond the theory to possible applications in natural language processing and robotics. Papers building bridges to important scientific areas as membrane systems (P systems) theory and concurrent programming can also be found in the issue. The majority of the articles is a revised and extended version of the corresponding paper published in the Proceedings of Grammar Systems Week 2004, Budapest, Hungary, July 5-9, 2004 [5].

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