Fundamenta Informaticae 58 (2003) i-ii
IOS Press

Foreword

Cellular automata are an old branch of computer science. In the late forties of the past century they were proposed by John von Neumann as a model of biological self-reproduction. The name of these automata is suggestive of the context in which they were developed. Soon cellular automata made the transition from a biological model to a model of parallel computation, but the original terminology has persisted because of the colourful intuitive concepts with which it was first endowed. So, from the very beginning, cellular automata were both, an interesting and challenging model for theoretical computer sciences and an interesting model for practical applications. Their inherent massive parallelism predestines them to modelling systems which are beyond direct measurements. Besides application in industry, nowadays cellular automata open up new fields of application in sociology, economics, and other human sciences.

The development of practical and theoretical issues of cellular automata is impressive. In particular, it seems that currently the studies from a theoretical point of view follow two main branches. One branch focuses on the global behaviour of cellular automata. Based on some topology the space of configurations is investigated. An important challenge with practical aspects is the characterisation of cellular automata on the basis of their global transformation.

The other branch may be seen to deal with information. The flexibility of cellular automata to serve as programming tools can be utilised to develop tricky algorithms in order to solve classical problems as well as problems concerning the very nature of the system itself. An example for the latter case is the problem of synchronisation, which gave rise to intensive research. In this connection, sources of questions are complexity issues as well as classifications in terms of formal languages recognition.

In 2002 the cellular automata community organised as IFIP Working Group 1.5 held a meeting in Prague. Motivated by the activity of the group it was resolved to launch special issues of high quality scientific journals. Thanks to Fundamenta Informaticae, in September 2002 the call for papers for the present issue followed. The volume consists of eleven carefully reviewed and selected papers reflecting the current state-of-the-art of cellular automata research. On one hand, they clearly contribute to the current trends. On the other hand, their wide variety shows how imperfect it is to describe the development of the field in a few sentences. Indeed, there are bridges between the trends and between subfields of the fields. Also there are investigations in neighbouring disciplines. With time, progress in theory leads to more efficient applications and opens up new directions.

Three of the selected papers are invited contributions. One of them deals with a new approach to orbits in the space of configurations in order to better modelise particles, especially vanishing ones. The second deals with complexity issues comparing X-trees and hyperbolic cellular automata. The third deals with aperiodicity in the behaviour of cellular automata, giving an approach to spaces of configurations by their degree structure.

In particular, other papers contribute to the progress of important studies about the nature of nondeterminism in terms of restricted classes of formal languages, or the communication complexity between cells in terms of prime number generators with 1-bit links. Several papers deal with structural and descriptional complexity issues. For example, comparisons are investigated between multi-dimensional cellular automata and alternating ones, or the complexity of a restricted class of one-way devices is studied, in order to explore the connections between nondeterminism, linear and real time. Another paper examines the close relations between restricted one-way cellular automata and finite automata.

Some new trends appear in the topics which are covered by the present issue. Asynchronous cellular automata are a interesting and intriguing field which continues to be investigated. Also, cellular automata are closely related to tilings. They motivated implementations in new geometric settings. In this volume, the implementation in hyperbolic $3D$ space is investigated. As mentioned before, there are attempts to establish connections between dynamics and information. An algebraic theory of information dynamics is presented. Applications are covered by contributions showing how cellular automata can be used for pattern classification, especially in connection with data mining and image compression. It is interesting to notice that in three papers with different points of view and goals matrices and polynomials play an important role.

We take this occasion to especially thank Andrzej Skowron, editor-in-chief of Fundamenta Informaticae, for giving us the occasion to witness the vitality of cellular automata as a field of computer science and to witness the activity of IFIP Working Group 1.5. We thank the referees for their important and careful work, not only for reviewing the papers. By their remarks and suggestions they greatly contributed to improve the quality of the papers and the whole issue. Finally, we like to thank the authors for their interesting and valuable contributions.

We hope that the reader will be pleased by this special issue.

Martin Kutrib
Institute of Informatics,
Universität Giessen
Arndtstr. 2, D-35392,
Giessen, Germany,

Maurice Margenstern
LITA, EA 3097,
Université de Metz,
Île du Saulcy,
57045 Metz, Cédex, France,

Hiroshi Umeo
Univ. of Osaka
Electro-Communication,
Faculty of Information,
Science and Arts,
Department of Informatics,
Neyagawa-shi, Hatsu-cho, 18-8,
Osaka, 572-8530, Japan,

respective e-mails:
kutrib@informatik.uni-giessen.de, margens@sciences.univ-metz.fr, umeo@cyt.osakac.ac.jp