

Preface

This book presents state of the art research in theoretical computer science and related fields. In particular, the following areas are discussed: automata theory, formal languages and combinatorics of words, graph transformations, Petri nets, concurrency, as well as natural and molecular computing. The articles are written by leading researchers in these areas. The writers were originally invited to contribute to this book but then the normal refereeing procedure was applied as well. All of the articles deal with some issue that has been under vigorous study during recent years. Still, the topics range from very classical ones to issues raised only two or three years ago. Both survey articles and papers attacking specific research problems are included.

The book highlights some key issues of theoretical computer science, as they seem to us now at the beginning of the new millennium. Being a comprehensive overview of some of the most active current research in theoretical computer science, it should be of definite interest for all researchers in the areas covered. The topics range from basic decidability and the notion of information to graph grammars and graph transformations, and from trees and traces to aqueous algorithms, DNA encoding and self-assembly. Special effort has been given to lucid presentation. Therefore, the book should be of interest also for advanced students.

The feature common to all writers in this book is that they want to dedicate their work to *Grzegorz Rozenberg* on the occasion of his 60th birthday, March 14, 2002. In addition the topics belong to areas of his central interests, either currently or in the past. The broad spectrum of the topics is an indication of the width and diversity of the research of this great scientist. We have included in this book the bibliography of Grzegorz Rozenberg but we have not undertaken here the challenging task of describing or even outlining his scientific work. Instead, at the end of this Preface, each of the four editors presents his personal gratulatory greeting to Grzegorz. It is also very well known that Grzegorz Rozenberg occupies a central role in the theoretical computer science community in Europe. He was the President of EATCS for nine years and is still the Editor of the *EATCS Bulletin*, after being in this position already for more than twenty years. More about these matters can be read, for instance, in the book *People and Ideas in Theoretical Computer Science* (C. Calude, Ed.), Springer-Verlag, 1999, ISBN 981-4021-13-X, or in the *EATCS Bulletin* 46, 1992, 391–413.

The articles in this book are divided into five parts, according to their topics. A brief description of the individual parts now follows.

As its title *Words, Languages, Automata* indicates, the first part is concerned with the oldest issues in theoretical computer science. However, the papers reflect some currently active aspects of research. Classical context-free languages are considered in connection with the currently popular XML-documentation. Another old topic studies how simpler languages (for example regular languages)

can be used via trees to define more complicated ones (namely, context-free languages). Models of concurrency are discussed in two papers, using structural and logical approaches, respectively. The other four papers are connected to words. In two of those, old fundamental problems are addressed, namely, the celebrated Post Correspondence Problem and the commutation problem of Conway. Patterns occurring in infinite words is a challenging new topic. Finally, recent fundamental results on the structure of finite words are related to the notion of information.

Part two on graph transformations starts with a sightseeing tour of the computational landscape of this interesting field. The relationship between local action systems and algebraic graph grammars and bisimulation equivalences for graph grammars are discussed in two other contributions.

The concept of processes is addressed in part three on Petri nets from the high-level net point of view. Moreover, it is shown how Petri nets can be used as a control mechanism for grammar systems. Finally an interesting conjecture is presented relating regular event structures and finite Petri nets.

In addition to graph transformations and Petri nets, in part four, other models for concurrent computing are discussed. It is shown how object-oriented collaborative work can be supported by the concept of team automata. Other interesting topics are temporal concurrent constraint programming and how to use grammars as processes.

The final part deals with natural computing. Computation gleaned from nature is at its best in the article describing the amazing capabilities of ciliates. Studies about aqueous algorithms and self-assembly computations are also close to practical laboratory work. P systems have turned out to be a very useful model for natural computing. Some of the early aspects of DNA computing, namely splicing and DNA encoding, are addressed in two papers.

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Munich, Berlin and
Turku, December 2001

Wilfried Brauer, Hartmut Ehrig
Juhani Karhumäki, Arto Salomaa

Wilfried Brauer, personal greeting

Dear Nonpareil Amiable Grzegorz,

Sure, there are many more attributes fitting to you – but these are not suited to denote the area of your current scientific interest. Nevertheless, I cannot resist mentioning some more of your characteristics. Cooperative, multi-interested and witty: these features became evident to me when we first met (in the early 1970s) at Oberwolfach where you demonstrated how to squeeze languages out of Lindenmayer systems. Already then you did fruitful interdisciplinary research with biologists – as you do now in DNA computing. Quick to comprehend and speedy in entering new fields of research: so you conquered the area of Petri nets and concurrency after I invited you in 1979 to the first Advanced Course on Petri Nets in Hamburg. Determined, influential and winning: I got to know these traits of yours especially when you came onto the board of EATCS and (with many new ideas and activities) pushed EATCS forward on its way to becoming a large well-organized international scientific society. You are a good friend: this became obvious to all the many persons who listened to the excellent and cordial laudatio you presented at the festive colloquium in Munich on the occasion of my 60th birthday. And now it is your turn to celebrate this special birthday. I hope you will have a similar experience as I (and many others) have had: from this age on one looks at disorders and troubles from a more distant point of view and develops a more serene and calm attitude of mind. My congratulations and all my best wishes to you.

Wilfried

Hartmut Ehrig, personal greeting

Dear Grzegorz,

When I visited you for the first time in Utrecht you invited me to one of the famous pancake houses to investigate stacks of pancakes. In this way I learned by eating about the relationship between stacks in different areas, like computer science, biology and real life. Consequently we established a link between our favorite topics at that time, L-systems and graph grammars, leading not only to the new topic of parallel graph grammars, but also to the first international workshop on graph grammars with applications in computer science and biology. This first international workshop in 1978 was continued by five other ones in Europe and the USA until the last one in 1998. This, however, was not the end of graph grammars and graph transformations, but the starting point of a series of international conferences on graph transformations.

The special present from the entire graph transformation community and especially myself on your 60th birthday is the first International Conference on Graph Transformations, to be held in Barcelona, October 7–12, 2002. Let me thank you for your continuous support and cooperation concerning scientific as well as real-life topics, and I wish you all the best for the future in science and real life and the continuation of our friendship for further decades.

Hartmut

Juhani Karhumäki, personal greeting

Dear Grzegorz:

I met you for the first time in 1974 at the Workshop on Unusual Automata Theory in Aarhus. Two years later I was lucky to have you on the committee that heard the defence of my dissertation, and after that even luckier to work with you on scientific problems. In those years, and later, I learnt a lot from you not only about the spirit of science, but also about life itself. One teaching was: what ever you do, do it as well as you can – or even better! In all of your activities, whether it is writing papers, organizing conferences or collecting owls, this principle is strictly followed. After saying this I should not say anything about your unmatched scientific achievements. However, I will take a risk. You have written just one article on the theory of codes. This, written jointly with Andrzej, solved one of the main problems of the field. It provided a method, subsequently known as the Ehrenfeucht-Rozenberg method, for how to embed a rational code into a rational maximal one. This result amazed the French School and others who had worked for years on the problem. Still, it is only one of the jewels you have created.

I wish you all the best in all areas of your activities, including collecting owls.

Juhani

Arto Salomaa, personal greeting

Dear Bolgani:

Another scientist with his birthday on March 14, Albert Einstein, once said: *It would be possible to describe everything scientifically, but it would make no sense; it would be without meaning, as if you described a Beethoven symphony as a variation of wave pressure.* Let us look at your bibliography in this book. No matter how impressive it is and no matter how many landmark papers it contains, still much of Bolgani's magical impact in opening new vistas lies elsewhere than in numbered papers. I have experienced this personally already for over three decades. Cooperation with Bolgani, be it about L systems or ciliates, about decidability or finite automata, has been for me an inexhaustible source of ideas and inspiration. Our discussions about science also went on to considerations about important matters in life. Many questions remained unanswered, perhaps we will find an answer in Jerusalem. But we always had great fun.

On your birthday, I wish you all the best for the years to come, both in life and in science.

Tarzan