Lecture Notes in Computer Science 969
Edited by G. Goos, J. Hartmanis and J. van Leeuwen

Advisory Board: W. Brauer D. Gries J. Stoer

Jiří Wiedermann Petr Hájek (Eds.)

Mathematical Foundations of Computer Science 1995

20th International Symposium, MFCS '95
Prague, Czech Republic
August 28 - September 1, 1995
Proceedings

Springer

Volume Editors

Jiří Wiedermann
Petr Hájek
Institute of Computer Science, Academy of Sciences of the Czech Republic
Pod vodárenskou věží 2, 182 07 Prague, Czech Republic

Cataloging-in-Publication data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Mathematical foundations of computer science 1995 : 20th international symposium ; proceedings / MFCS '95, Prague, Czech Republic, August 28 - September 1, 1995. Jiří Wiedermann ; Petr Hájek (ed.). - Berlin ; Heidelberg ; New York ; Barcelona ; Budapest ; Hong Kong ; London ; Milan ; Paris ; Tokyo : Springer, 1995
(Lecture notes in computer science ; Vol. 969)
ISBN 3-540-60246-1
NE: Wiedermann, Jiří [Hrsg.]; MFCS <20, 1995, Praha>; GT

CR Subject Classification (1991): F.1-4, D.2-3, G.2

ISBN 3-540-60246-1 Springer-Verlag Berlin Heidelberg New York

Typesetting: Camera-ready by author
SPIN 10485448 06/3142 - 5 4 3 2 1 0 Printed on acid-free paper

Foreword

The International Symposium on Mathematical Foundations of Computer Science (MFCS'95) was held August 28 – September 1, 1995, in Prague, the capital of the Czech Republic, in the conference facilities of the Krystal Hotel. It was the 20th anniversary in the series of symposia organized in the Czech Republic, Poland, and the Slovak Republic.

MFCS'95 was organized by the Institute of Computer Science of the Academy of Sciences of the Czech Republic; Charles University, Prague; Prague School of Economics; Center for Theoretical Study of the Institute of Advanced Studies at Charles University and the Academy of Sciences of the Czech Republic, and Czech Society for Computer Science.

The previous meetings took place in Jablona, 1972, Štrbské Pleso, 1973; Jadwisin, 1974; Mariánské Lázně, 1975; Gdańsk, 1976; Tatranská Lomnica, 1977; Zakopane, 1978; Olomouc, 1979; Rydzina, 1980; Štrbské Pleso, 1981; Prague 1984; Bratislava, 1986; Carlsbad, 1988; Porąbka–Kozubnik, 1989; Banská Bystrica, 1990; Kazimierz Dolny, 1991; Prague, 1992; Gdańsk, 1993; and Košice, 1994.

The purpose of all these symposia has been to encourage high-quality research in all branches of theoretical computer science and to bring together specialists active in the field.

To stress the 20th anniversary of the conference the program committee took special care in preparing an interesting scientific program reflecting the recent trends in computer science. The keynote address was be held by Professor Juris Hartmanis with his talk " On the Computational Paradigm and Computational Complexity". It is a great pleasure to announce that Professor Hartmanis was be awarded the Golden Medal of B. Bolzano during this occasion. This medal is awarded by the Academy of Sciences of the Czech Republic to those outstanding foreign scientists who by their work have substantially contributed not only to the development in the field of mathematics and informatics in general, but also to the development of Czech science in particular. In the case of Professor Hartmanis we much appreciate his continuous long term support of the series of the MFCS conferences from its very beginning. He has participated not only as an editor of the LNCS series, but has been also repeatedly an invited lecturer and a member of MFCS program committee. In this way he has positively influenced the development in computer science in our country. We acknowledge his efforts in the field.

The program committee received 104 submissions in response to the Call for Papers for MFCS'95. The program committee for MFCS'95 consisted of:

Giorgio Ausiello (Rome)
Dines Bjørner (Macau)
Manfred Broy (Munich)
Peter Clote (Boston)
Bruno Courcelle (Bordeaux)*
Josep Diaz (Barcelona)
Jerry Feldman (Berkeley)*
Petr Hájek (co-chair, Prague)*
Juhani Karhumäki (Turku)*
Václav Koubek (Prague)*
Mogens Nielsen (Aarhus)*
Wojciech Penczek (Warsaw)*
Igor Prívara (Bratislava)*
Pavel Pudlák (Prague)
Branislav Rovan (Bratislava)*
Grzegorz Rozenberg (Leiden)
Eli Shamir (Jerusalem)
Mike Sipser (Cambridge)
Colin Stirling (Edinburgh)
Peter van Emde Boas (Amsterdam)*
Gerd Wechsung (Jena)*
Ingo Wegener (Dortmund)*
Avi Wigderson (Jerusalem)
Jiří Wiedermann (co-chair, Prague)*
Derek Wood (London)
Jiří Zlatuška (Brno)*

Those members of programming committee denoted by an asterisk in the above list took part at the selection meeting on March 18, 1995, in Prague. Altogether 44 of the contributed papers have been selected for inclusion into the scientific program of MFCS'95. Thus the present volume contains all of the 44 contributed papers, plus 8 invited papers and 2 abstracts of the invited talks.

We wish to thank all those who submitted their papers for consideration, all Program Committee members for their meritorious work in evaluating the submitted papers, as well as the following referees who assisted the Program Committee members in the extensive evaluation process:

L. Aceto, J. Adámek, S. Albers, C. Àlvarez, A. Arnold, J.C.M. Baeten, J. Balcazar, M.A. Bednarczyk, L.S. Bertrand, A. Birkendorf, J. Bloemer, A.M. Borzyszkowski, J. Bradfield, L. Brim, G. Bruns, R. Casas, P. Casteran, I. Černá, V. Černý, Z. Chaochen, A. Corradini, F. Cucker, P. Darondeau, V. Diekert, M. Dietzfelbinger, P. Ďuriš, J. Edmonds, J. Elbro, U.H. Engberg, E. Feuerstein, P. Fischer, P.G. Franciosa, G. Gambosi, R. Gavaldà, V. Geffert, Ch. George, R. Gerth, M. Golin, D. Gruska, T. Harju, I. Havel, H.D. Hecker, J.G. Henriksen, V. Heun, T. Hofmeister, I. Honkala, J. Honkala, J. Hromkovič, M. Hühne, H. Huttel, D. Janin, K. Jansen, B. Juurlink, R. Kaivola, J. Karhumäki, N. Klarlund, C. Klein, J.W. Klop, I. Korec, J. Krajíček, I. Kramosil, M. Krause, K. Kühnle, M. Křetínský, K.J. Lange, H. Lefmann, S. Leonardi, M. Lightner, G. Lischke, M. Loebbing, J. Longley, C. Martinez, A. Mateescu, J. Matoušek, S. Mauw, E. Mayordomo, A. Mazurkiewicz, Ch. Meinel, S. Merz, Y. Metivier, J.J.Ch. Meyer, F. Mignosi, P.D. Mosses, O. Mueller, R. Muller, L. Niepel, D. Olejár, D. Pardubská, G. Paun, M. Penttonen, F. Petrini, D. Plump, A. Poetzsch–Heffter, J. Pokorný, G. Radu, F. Regensburger, E. Robinson, J.M. Robson, J. Rosický, J. Rothe, G. Rozenberg, B. Rumpe, P. Ružička, W. Rytter, A. Salomaa, K. Salomaa,

A. Sandholm, P. Savický, M. Serna, J.R.J. Schirra, D. Sieling, H.U. Simon, A. Simpson, Y. Singer, K. Slind, O. Slotosch, E. Smith, K. Stoelen, J. Šturc, K. Sunesen, O. Sýkora, R. Szelepcsényi, A. Tarlecki, J. Toran, J. van der Woude, P. Vana, D. van Hung, J.J. Vereijken, P.J. Voda, J. Vogel, B. von Stengel, J. Vyskoč, R. Wegner, E. Welzl, R. Werchner, J. Winkowski, G. Winskel, L. Xiaoshan, Q. Xu, S. Žák, W. Zielonka, A. Zvonkin.

We are much indebted to all authors of the invited papers and of the accepted contribution papers who all (with a single exception) prepared their papers according to the instructions using the LNCS LaTeX style.

Many thanks are due also to Roman Neruda and Arnošt Štědrý for the preparation and maintenance of the MFCS'95 database, software support for automatic sending and evaluating of MFCS'95 referee forms, and typesetting of the MFCS'95 Information Bulletin. Tereza Bedaňová did a good job in the secretarial work for the symposium. The occasional assistence of Kateřina Hlaváčková and of Jiří Šíma was also useful.

Special thanks go to Peter van Emde Boas who helped enormously in preparing the presentation schedule for the scientific program at the conference.

We thank the European Association for Theoretical Computer Science (EATCS), IBM Czech Republic, H.E.M. Informatics, FCC Folprecht Praha, SINCO and I.C.C.C. for their support of MFCS'95. The organizational support of the conference provided by Action M Agency is highly appreciated as well.

Last but not least we want to thank Springer-Verlag for proposals that have led to improvements in the logical structure of the volume and for excellent co-operation in its publication.

Prague, June 1995 Petr Hájek, Jiří Wiedermann

Contents

Invited Papers

Contributed Papers

Structural Complexity Theory

Graphs in Models of Computations

Lower Bounds

Formal Languages

Unification, Rewriting, Type Theory

Distributed Computation

Concurrency

Semantics

Model Checking

Formal Calculi