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Editors

John R. Gilbert
Xerox Palo Alto Research Center and
University of Bergen
Xerox PARC, 3333 Coyote Hill Road
Palo Alto, California 94304, USA

Rolf Karlsson
Department of Computer Science
Lund University
Box 118, S-221 00 Lund, Sweden

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FOREWORD

The papers in this volume were presented at the Second Scandinavian Workshop on Algorithm Theory held on July 11–14, 1990, in Bergen, Norway. The workshop, which continues the tradition of SWAT 88 and WADS 89, is intended as a forum for researchers in the area of design and analysis of algorithms. The call for papers sought contributions on original research on algorithms and data structures, in all areas, including combinatorics, computational geometry, parallel computing, and graph theory. There were 61 papers submitted, of which the program committee selected 34 for presentation. In addition, invited lectures were presented by Juris Hartmanis (Structural complexity theory: recent surprises), Robert Tarjan (New themes in algorithm design), and David Johnson (Data structures for traveling salesmen). This proceedings includes the first invited paper and an abstract of the third.

The organizing committee consisted of Bengt Aspvall, chairman (University of Bergen), Hjálmtýr Hafsteinsson (University of Iceland), Rolf Karlsson (Lund University), Erik M. Schmidt (University of Aarhus), and Esko Ukkonen (University of Helsinki).

The program committee consisted of Svante Carlsson (Lund University), John Gilbert, chairman (Xerox PARC and University of Bergen), Johan Håstad (Royal Institute of Technology, Stockholm), Thomas Lengauer (University of Paderborn), Andrzej Lingas (Lund University), Olli Nevalainen (University of Turku), Andrzej Proskurowski (University of Oregon), Jörg Sack (Carleton University), Raimund Seidel (University of California, Berkeley), and Jeffrey Vitter (Brown University).

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Palo Alto and Lund, April 1990

John Gilbert
Rolf Karlsson

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Structural Complexity Theory: Recent Surprises[†]

Juris Hartmanis *Richard Chang*[‡] *Desh Ranjan* *Pankaj Rohatgi*

Department of Computer Science
Cornell University
Ithaca, New York 14853

Abstract

This paper reviews the impact of some recent results on the research paradigms in structural complexity theory.

On a paper submitted by a physicist colleague:
"This isn't right. This isn't even wrong."
—Wolfgang Pauli

1 Introduction

Computational complexity theory studies the quantitative laws which govern computing. It seeks a comprehensive classification of problems by their intrinsic difficulty and an understanding of what makes these problems hard to compute. The key concept in classifying the computational complexity of problems is the complexity class which consists of all the problems solvable on a given computer model within a given resource bound.

Structural complexity theory is primarily concerned with the relations among various complexity classes and the internal structure of these classes. Figure 1 shows some major complexity classes. Although much is known about the structure of these classes, there have not been any results which separate any of the classes between P and PSPACE. We believe that all these classes are different and regard the problem of proving the exact relationship between these classes as the Grand Challenge of complexity theory.

The awareness of the importance of P, NP, PSPACE, etc, has lead to a broad investigation of these classes and to the use of relativization. Almost all of the major results in recursive function theory also hold in relativized worlds. Quite the contrary happens in complexity theory. It was shown in 1975 [BGS75] that there exist oracles A and B such that

$$\mathrm{P}^A = \mathrm{NP}^A \quad \text{and} \quad \mathrm{P}^B \neq \mathrm{NP}^B.$$

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