

Lecture Notes in Computer Science

807

Edited by G. Goos and J. Hartmanis

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



Maxime Crochemore Dan Gusfield (Eds.)

Combinatorial Pattern Matching

5th Annual Symposium, CPM 94
Asilomar, CA, USA, June 5-8, 1994
Proceedings



Springer-Verlag

Berlin Heidelberg New York
London Paris Tokyo
Hong Kong Barcelona
Budapest

Series Editors

Gerhard Goos
Universität Karlsruhe
Postfach 69 80
Vincenz-Priessnitz-Straße 1
D-76131 Karlsruhe, Germany

Juris Hartmanis
Cornell University
Department of Computer Science
4130 Upson Hall
Ithaca, NY 14853, USA

Volume Editors

Maxime Crochemore
Institut Gaspard Monge, Université de Marne la Vallée
F-93160 Noisy le Grand, France

Dan Gusfield
Department of Computer Science, University of California
Davis, CA 95616-8692, USA

CR Subject Classification (1991):F.2.2, I.5.4, I.5.0, I.7.3, H.3.3, E.4, G.2.1, J.3

ISBN 3-540-58094-8 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-58094-8 Springer-Verlag New York Berlin Heidelberg

CIP data applied for

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

© Springer-Verlag Berlin Heidelberg 1994
Printed in Germany

Typesetting: Camera-ready by author
SPIN: 10131146 45/3140-543210 - Printed on acid-free paper

Foreword

The papers contained in this volume were presented at the fifth annual symposium on Combinatorial Pattern Matching, held June 5 - 8, 1994 at Asilomar, California. They were selected from 41 abstracts submitted in response to the call for papers.

Combinatorial Pattern Matching addresses issues of searching and matching of strings and more complicated patterns such as trees, regular expressions, extended expressions, etc. The goal is to derive non-trivial combinatorial properties for such structures and then to exploit these properties in order to achieve superior performances for the corresponding computational problems.

In recent years, a steady flow of high-quality scientific study of this subject has changed a sparse set of isolated results into a full-fledged area of algorithmics. This area is expected to grow even further due to the increasing demand for speed and efficiency that comes especially from molecular biology and various genome projects, but also from areas such as information retrieval, pattern recognition, compiling, data compression, and program analysis. The stated objective of annual CPM gatherings is to bring together active researchers for an intensive exchange of information about current and future research in combinatorial pattern matching.

The general organisation and orientations of CPM Conferences are coordinated by a Steering Committee composed of A. Apostolico, M. Crochemore, Z. Galil, and U. Manber.

The first four meetings were held at the University of Paris (1990), at the University of London (1991), at the University of Arizona (Tucson, 1992), and at the University of Padova (1993). After the first meeting, a selection of the papers appeared as a special issue of *Theoretical Computer Science*. The proceedings of the third and fourth meetings appeared as volumes 644 and 684 of the present series.

External referees who helped with the selection of papers for CPM 94 are gratefully acknowledged.

Linc Fonfrède and Jean-Louis Barrière (Institut Gaspard Monge, France) provided technical help during the selection process. Debbie Chadwick (Computer Science Department, U.C. Davis) helped with secretarial and administrative work. The conference was supported in part by the National Science Foundation and the University of California, Davis. The efforts of all are gratefully acknowledged.

Program Committee

M. Crochemore, <i>PC-Chair</i>	D. S. Hirschberg
A. Ehrenfeucht	E. W. Myers
A. S. Fraenkel	I. Simon
Z. Galil	E. Ukkonen
D. Gusfield, <i>Chair</i>	M. S. Waterman

Table of Contents

Session 1: Alignments

A Space Efficient Algorithm for Finding the Best Non-Overlapping Alignment Score	1
<i>Gary Benson</i>	
The Parameterized Complexity of Sequence Alignment and Consensus	15
<i>Hans Bodlaender, Rodney G. Downey, Michael R. Fellows, Harold T. Wareham</i>	
Computing all Suboptimal Alignments in Linear Space	31
<i>Kun-Mao Chao</i>	
Approximation Algorithms for Multiple Sequence Alignment	43
<i>Vineet Bafna, Eugene L. Lawler, Pavel A. Pevzner</i>	
A Context Dependent Method for Comparing Sequences	54
<i>Xiaoqiu Huang</i>	
Fast Identification of Approximately Matching Substrings	64
<i>Archie L. Cobbs</i>	
Alignment of Trees – an Alternative to Tree Edit	75
<i>Tao Jiang, Lusheng Wang, Kaizhong Zhang</i>	

Session 2: Various Matchings

Parametric Recomputing in Alignment Graphs	87
<i>Xiaoqiu Huang, Pavel A. Pevzner, Webb Miller</i>	
A Lossy Data Compression Based on String Matching: Preliminary Analysis and Suboptimal Algorithms	102
<i>Tomasz Luczak, Wojciech Szpankowski</i>	
A Text Compression Scheme that Allows Fast Searching Directly in the Compressed File	113
<i>Udi Manber</i>	
An Alphabet-Independent Optimal Parallel Search for Three Dimensional Pattern	125
<i>Marek Karpinski, Wojciech Rytter</i>	
Unit Route Upper Bound for String-Matching on Hypercube	136
<i>Laurent Lestrée</i>	

Session 3: Combinatorial aspects

Computation of Squares in a String	146
<i>S. Rao Kosaraju</i>	
Minimization of Sequential Transducers	151
<i>Mehryar Mohri</i>	
Shortest Common Superstrings for Strings of Random Letters	164
<i>Kenneth S. Alexander</i>	
Maximal Common Subsequences and Minimal Common Supersequences	173
<i>Robert W. Irving, Campbell B. Fraser</i>	
Dictionary-Matching on Unbounded Alphabets: Uniform-Length Dictionaries	184
<i>Dany Breslauer</i>	
Proximity Matching Using Fixed-Queries Trees	198
<i>Ricardo Baeza-Yates, Walter Cunto, Udi Manber, Sun Wu</i>	
Query Primitives for Tree-Structured Data	213
<i>Pekka Kilpeläinen, Heikki Mannila</i>	

Session 4: More Bio-Informatics

Multiple Matching of Parameterized Patterns	226
<i>Ramana M. Idury, Alejandro A. Schäffer</i>	
Approximate String Matching with Don't Care Characters	240
<i>Tatsuya Akutsu</i>	
Matching with Matrix Norm Minimization	250
<i>Showwen Tang, Kaizhong Zhang, Xiaolin Wu</i>	
Approximate String Matching and Local Similarity	259
<i>William I. Chang, Thomas G. Marr</i>	
Polynomial-Time Algorithms for Computing Characteristic Strings	274
<i>Minoru Ito, Kuniyasu Shimizu, Michio Nakanishi, Akihiro Hashimoto</i>	
Recent Methods for RNA Modeling	
Using Stochastic Context-Free Grammars	289
<i>Yasubumi Sakakibara, Michael Brown, Richard Hughey, I. Saira Mian, Kimmen Sjölander, Rebecca C. Underwood, David Haussler</i>	
Efficient Bounds for Oriented Chromosome Inversion Distance	307
<i>John Kececioglu, David Sankoff</i>	
Index of Authors	326