

# Lecture Notes in Computer Science

1262

Edited by G. Goos, J. Hartmanis and J. van Leeuwen

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

Michel Scholl Agnès Voisard (Eds.)

# Advances in Spatial Databases

5th International Symposium, SSD '97  
Berlin, Germany, July 15-18, 1997  
Proceedings



Springer

Series Editors

Gerhard Goos, Karlsruhe University, Germany

Juris Hartmanis, Cornell University, NY, USA

Jan van Leeuwen, Utrecht University, The Netherlands

Volume Editors

Michel Scholl

CNAM/INRIA

F-78153 Le Chesnay Cedex, France

E-mail: Michel.Scholl@inria.fr

Agnès Voisard

Freie Universität Berlin, Institut für Informatik

Takustr. 9, D-14195 Berlin, Germany

E-mail: voisard@inf.fu-berlin.de

Cataloging-in-Publication data applied for

**Die Deutsche Bibliothek - CIP-Einheitsaufnahme**

**Advances in spatial databases : 5th international symposium ; proceedings / SSD '97, Berlin, Germany, July 15 - 18, 1997. Michel Scholl ; Agnes Voisard (ed.). - Berlin ; Heidelberg ; New York ; Barcelona ; Budapest ; Hong Kong ; London ; Milan ; Paris ; Santa Clara ; Singapore ; Tokyo : Springer, 1997**

(Lecture notes in computer science ; Vol. 1262)

ISBN 3-540-63238-7

CR Subject Classification (1991): H.2-3, H.5, I.4, I.5, J.2,F.2

ISSN 0302-9743

ISBN 3-540-63238-7 Springer-Verlag Berlin Heidelberg New York

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 1997

Printed in Germany

Typesetting: Camera-ready by author

SPIN 10548937 06/3142 - 5 4 3 2 1 0 Printed on acid-free paper

# Preface

These proceedings contain the research papers selected for presentation at the Fifth International Symposium on Spatial Databases (SSD'97) held in Berlin, Germany, July 15-18, 1997. Since the first conference in Santa Barbara (1989), SSD has been the premier meeting for researchers, developers, and practitioners interested in the integration of database management systems (DBMS) and geographic information systems (GIS). SSD'97 brought together leading spatial database researchers and GIS experts to explore advances in spatial modeling and query processing, and to discuss the requirements from new application domains.

From fifty-five submissions of full papers by authors from nineteen countries, each of them reviewed by four referees, the program committee selected eighteen outstanding papers for inclusion in these proceedings. The stable number of submissions over the SSD series to date is evidence of the continuing interest in spatial databases and is a sign of an active research community. The technical program also includes two keynote presentations (David Abel, Dick Newell), one panel (John Herring) and four tutorials (Hanan Samet, Max Egenhofer, Stéphane Grumbach, and Jiawei Han).

The papers included in this volume show that the need for efficient spatial query processing still motivates numerous papers on geo-algorithms, access methods, spatial joins, and system implementations. Spatial data modeling is still a core topic, but it has shifted toward the study of error correcting and imprecise object representation. Moreover, the emergence of spatial models and systems based on constraint databases sounds a promising framework for spatial query processing and optimization. Spatial data mining has also been established as a topic with great potential. However, some other emerging issues of primary importance are insufficiently addressed in this volume: spatio-temporal applications, modeling of mobile objects, open GIS and integration of heterogeneous spatial sources, World Wide Web applications are among the new topics that deserve more attention in the future.

We wish to acknowledge the assistance and contribution of the following persons and institutions that made this meeting happen. We would like first to thank the program committee and the external referees for their diligence and their high-quality reviews. Max Egenhofer deserves a special thanks for his faithful assistance throughout the preparation of this event. We also thank Oliver Günther, Hans-Jörg Schek, and Heinz Schweppe for their support. We very much appreciated the assistance of Heike Friedrichs in the processing of electronic submissions. We are in debt to Inge Hellmich, Günter Feuer, Heike Friedrichs, Oliver Grzegorski, Danny Moreau, and Stephan Drooff for the organization of the conference. We also appreciated the assistance of Danièle Charlet from Oracle, France. Finally we wish to thank Alfred Hofmann from Springer-Verlag for his help in the preparation of this volume.

We are very grateful for the support given by the following companies and institutions: Bull AG, Cassini, The ESPRIT TMR Network CHOROCHRONOS, DFG, ESRI Inc., ETAK Inc., Fraunhofer ISST, Freie Universität Berlin, ICSI, INRIA, Oracle France, Oracle Spatial Products (USA), SMALLWORLD Systems GmbH. This effort is a testimony of the real-world significance of this event on advances in spatial databases.

Cooperation with ACM SIGMOD, the National Center for Geographic Information and Analysis (NCGIA) and BWO Marketing Service GmbH is also acknowledged.

Berlin, May 1997

Agnès Voisard, General Chair  
Michel Scholl, Program Chair

## **Acknowledgments**

In Cooperation with ACM SIGMOD, NCGIA, BWO Marketing Service GmbH

### **Sponsors**

Bull AG  
Cassini (French CNRS GdR 1041 and Université de Provence)  
CHOROCHRONOS  
DFG (Deutsche Forschungsgemeinschaft)  
ESRI, Inc.  
ETAK, Inc.  
Fraunhofer ISST  
Freie Universität Berlin  
ICSI  
INRIA  
Oracle France  
Oracle Spatial Products, USA  
SMALLWORLD Systems GmbH

# Conference Organization

## General Chair

Agnès Voisard, Freie Universität Berlin, Germany

## Program Committee Chair

Michel Scholl, INRIA and CNAM, France

## Local Arrangements

Heike Friedrichs  
Oliver Grzegorski  
Inge Hellmich

## Tutorial Chair

Ralf Hartmut Güting, FernUniversität Hagen, Germany

## Panel Co-chairs

Andrew U. Frank, TU Vienna, Austria  
John R. Herring, Oracle Corporation, USA

## Exhibit Chair

Günter Feuer, Freie Universität Berlin, Germany

## Program Committee

David J. Abel, CSIRO, Canberra, Australia  
Gustavo Alonso, ETH Zürich, Switzerland  
Elisa Bertino, Università degli Studi di Milano, Italy  
Rolf A. de By, ITC, The Netherlands  
Leila De Floriani, Università di Genova, Italy  
Max J. Egenhofer, NCGIA and University of Maine, USA  
Christos Faloutsos, University of Maryland, USA  
Robin Fegeas, USGS, USA  
Andrew U. Frank, TU Vienna, Austria  
Volker Gaede, Humboldt-Universität, Berlin, Germany  
Kenn Gardels, UCB, USA

Christopher Gold, Université Laval, Canada  
 Stéphane Grumbach, INRIA, France  
 Oliver Günther, Humboldt-Universität, Berlin, Germany  
 Ralf Hartmut Güting, FernUniversität Hagen, Germany  
 Jiawei Han, Simon Fraser University, Burnaby, Canada  
 John R. Herring, Oracle Corporation, USA  
 Erland Jungert, FOA, Sweden  
 Curt Kolovson, Hewlett Packard, USA  
 Manolis Koubarakis, UMIST, Manchester, UK  
 Robert Laurini, INSA, Lyon, France  
 Claudia Medeiros, UNICAMP, Brazil  
 Scott Morehouse, ESRI, Inc., USA  
 Richard Muntz, UCLA, USA  
 Beng Chin Ooi, University of Singapore  
 Dimitris Papadias, University of Science and Technology, Hong Kong  
 Didier Plateau, O<sub>2</sub> Technology, France  
 Chinya Ravishankar, University of Michigan, USA  
 Elke A. Rundensteiner, Worcester Polytechnic Institute, USA  
 Hanan Samet, University of Maryland, USA  
 Timos Sellis, NTUA, Athens, Greece  
 Terence Smith, UCSB, USA  
 Jan Van den Bussche, University of Limburg, Belgium  
 Peter Van Oosterom, Kadaster Concerstaf LKK, The Netherlands  
 Agnès Voisard, Freie Universität, Berlin, Germany  
 Frank Wagner, Freie Universität, Berlin, Germany

### **Additional Reviewers**

Walid Aref  
 Martin Erwig  
 Gisli R. Hjaltason  
 Erik G. Hoel  
 Krzysztof Koperski  
 David Mount  
 Markus Schneider  
 Aya Soffer  
 Manolis Stefanakis  
 Nebojsa Stefanovic  
 Yannis Theodoridis

# Contents

## Keynote Paper

- Spatial Internet Marketplaces: A Grand Challenge? ..... 3  
*D. J. Abel (CSIRO, Canberra, Australia)*

## Spatial Similarities

- 3D Similarity Search by Shape Approximation ..... 11  
*H.-P. Kriegel, T. Schmidt, T. Seidl (University of Munich, Germany)*
- Finding Boundary Shape Matching Relationships in Spatial Data ..... 29  
*E. M. Knorr, R. T. Ng, D. L. Shilvock  
(Univ. of British Columbia, Canada)*
- Spatial Data Mining: A Database Approach ..... 47  
*M. Ester, H.-P. Kriegel, J. Sander (University of Munich, Germany)*

## Geo-Algorithms

- A General and Efficient Implementation of Geometric Operators  
and Predicates ..... 69  
*E. P. F. Chan, J. N. H. Ng (University of Waterloo, Canada)*
- Materialization Trade-Offs in Hierarchical Shortest Path Algorithms ..... 94  
*S. Shekhar, A. Fetterer, B. Goyal (University of Minnesota, USA)*

## Spatial Constraint Databases

- Manipulating Spatial Data in Constraint Databases ..... 115  
*A. Belussi (Politecnico di Milano, Italy), E. Bertino, B. Catania  
(Università degli Studi di Milano, Italy)*
- Constraint-Based Interoperability of Spatiotemporal Databases ..... 142  
*J. Chomicki (Monmouth University, USA), P. Z. Revesz (University  
of Nebraska, USA)*



## Spatial Query Processing

- Improving Spatial Intersect Joins Using Symbolic Intersect Detection . . . . . 165  
*Y.-W. Huang, M. Jones (University of Michigan, USA),  
 E. A. Rundensteiner (Worcester Polytechnic Institute, USA)*
- Data Partitioning for Parallel Spatial Join Processing . . . . . 178  
*X. Zhou, D. J. Abel (CSIRO, Canberra, Australia),  
 D. Truffet (University of Queensland, Australia)*
- Orthogonal Polygons as Bounding Structures in Filter-Refine Query  
 Processing Strategies . . . . . 197  
*C. Esperança (Universidade Federal do Rio de Janeiro, Brazil),  
 H. Samet (University of Maryland, USA)*

## Systems

- From GeoStore to GeoToolKit: The Second Step . . . . . 223  
*O. Balovnev, M. Breunig, A. B. Cremers (Univ. of Bonn, Germany)*
- Geo-Opera: Workflow Concepts for Spatial Processes . . . . . 238  
*G. Alonso, C. Hagen (ETH Zürich, Switzerland)*
- Physical Database Design for Raster Images in CONCERT . . . . . 259  
*L. Relly, H.-J. Schek, O. Henricsson, S. Nebiker (ETH Zürich,  
 Switzerland)*

## Spatial Data Models

- Topological Error Correcting in GIS . . . . . 283  
*T. Ubeda (INSA Lyon, France), M. J. Egenhofer (NCGIA and  
 University of Maine, USA)*
- Vague Regions . . . . . 298  
*M. Erwig, M. Schneider (FernUniversität Hagen, Germany)*
- On the Assessment of Generalisation Consistency . . . . . 321  
*V. Delis (Computer Technology Institute, Patras, and University  
 of Patras, Greece), T. Hadzilacos (Computer Technology Institute,  
 Patras, Greece)*

**Spatial Access Methods**

New Linear Node Splitting Algorithm for R-trees ..... 339  
*C. H. Ang, T. C. Tan (NUS, Singapore)*

The S-tree: An Efficient Index for Multidimensional Objects ..... 350  
*C. Aggarwal, J. Wolf, P. Yu (IBM Watson Research Center, USA),  
M. Epelman (MIT, USA)*

**Keynote Paper**

Perspectives in GIS Database Architecture ..... 377  
*D. Newell (Smallworldwide plc, United Kingdom)*

**Author Index** ..... 379