

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

2750

Thanasis Hadzilacos Yannis Manolopoulos
John F. Roddick Yannis Theodoridis (Eds.)

Advances in Spatial and Temporal Databases

8th International Symposium, SSTD 2003
Santorini Island, Greece, July 24-27, 2003
Proceedings



Springer

Series Editors

Gerhard Goos, Karlsruhe University, Germany
Juris Hartmanis, Cornell University, NY, USA
Jan van Leeuwen, Utrecht University, The Netherlands

Volume Editors

Thanasis Hadzilacos
Yannis Theodoridis
Computer Technology Institute
11 Akteou and Pouloupoulou St., 11851 Athens, Greece
E-mail: thh@cti.gr, ytheod@unipi.gr

Yannis Manolopoulos
Aristotle University, 56124 Thessaloniki, Greece
E-mail: manolopo@csd.auth.gr

John F. Roddick
Flinders University, P.O. Box 2100
Adelaide, 5001, Australia
E-mail: roddick@infoeng.flinders.edu.au

Cataloging-in-Publication Data applied for

A catalog record for this book is available from the Library of Congress

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliographie;
detailed bibliographic data is available in the Internet at <<http://dnb.ddb.de>>.

CR Subject Classification (1998): H.2, H.3, H.4, I.2.4

ISSN 0302-9743

ISBN 3-540-40535-6 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 New York
a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2003
Printed in Germany

Typesetting: Camera-ready by author, data conversion by DA-TeX Gerd Blumenstein
Printed on acid-free paper SPIN: 10929315 06/3142 5 4 3 2 1 0

Preface

On behalf of the Program Committee, it was our pleasure to welcome the participants to the beautiful Greek island of Santorini and, in particular, to the Eighth International Symposium on Spatial and Temporal Databases, SSTD 2003. The SSTD series represents some of the most exciting research in the field of spatial and temporal databases and this volume contains 30 excellent papers, 28 accepted through peer review to the conference and two invited keynote papers.

Interest in the field of spatio-temporal databases continues to grow. Significantly, of the papers submitted, many have ceased to deal with just one or other of spatial and temporal databases, choosing instead to focus on the rich confluence of these areas to deal with spatio-temporal semantics and systems. This was a trend foreshadowed in the renaming of the conference in 1999 and is to be welcomed.

Following an international call for papers, 105 papers were submitted and reviewed thoroughly by an international panel of experts in the field. The number of papers submitted represents a record number for the conference and shows a vibrant and growing interest in the theory and applications of the area. Of the submitted papers, 28 were accepted (giving an acceptance rate of 27%) and the final papers, modified in the light of the comments from the referees, appear in this volume.

Two invited papers were also presented: the first from Prof. Christian Jensen of Aalborg University in Denmark and the second from Dr. John Herring of Oracle Corporation. Two tutorials were also held with the conference, one on Location Management and Moving Objects Databases by Ouri Wolfson and another on Spatio-Temporal Data Mining by Sanjay Chawla.

We would like to thank the Program Committee for giving of their time and expertise so freely. Following the refereeing itself, as is often the case, there was substantial discussion on various aspects of some papers to ensure that the papers presented were the best available. This takes time and effort and we appreciate the efforts of those involved.

The organizing team at the Computer Technology Institute deserve much credit for their essential contribution. Vasilis Delis and Dieter Pfoser arranged technical and publicity issues, Lena Gourdoupi and Aggeliki Stamatopoulou managed the registration process. Furthermore we would like to thank Antonis Sidiropoulos at the University of Thessaloniki for managing the Web-based paper reviewing system and the local teams at Magma-Heliotopos Conferences and the Nomikos Conference Center in Santorini for their excellent services in preparing and hosting the event.

The symposium was sponsored by Microsoft Hellas and Marathon Data Systems, and it was held in cooperation with the Computer Technology Institute and the University of Piraeus. We thank these organizations for their support.

July 2003

Yannis Manolopoulos
John F. Roddick
Program Chairs
Thanasis Hadzilacos
Yannis Theodoridis
General Chairs

Program Committee

Program Chairs

Yannis Manolopoulos, Aristotle University of Thessaloniki, Greece
John Roddick, Flinders University, Australia

Program Committee Members

Dave Abel, CSIRO, Australia
Walid Aref, Purdue University, USA
Lars Arge, Duke University, USA
Elisa Bertino, University of Milan, Italy
Michael Böhlen, Aalborg University, Denmark
Thomas Brinkhoff, Fachhochschule Oldenburg, Germany
Edward Chan, University of Waterloo, Canada
Jan Chomicki, University of Buffalo, USA
Curtis Dyreson, Washington State University, USA
Fabio Grandi, University of Bologna, Italy
Jim Gray, Microsoft, USA
Ralf Hartmut Güting, Fernuniversität Hagen, Germany
Erik Hoel, ESRI, USA
Kathleen Hornsby, University of Maine, USA
Christian S. Jensen, Aalborg University, Denmark
Christopher Jones, Cardiff University, UK
George Kollios, Boston University, USA
Ravi-Kanth Kothuri, Oracle, USA
Dik Lun Lee, Hong Kong UST, China SAR
Scott Leutenegger, Denver University, USA
Nikos Lorentzos, Agricultural University of Athens, Greece
Mario Nascimento, University of Alberta, Canada
Raymond Ng, University of British Columbia, Canada
Dimitris Papadias, Hong Kong UST, China SAR
Michel Scholl, INRIA, France
Bernhard Seeger, University of Marburg, Germany
Richard Snodgrass, University of Arizona, USA
Ioana Stanoi, IBM, USA
Jianwen Su, University of California at Santa Barbara, USA
Nectaria Tryfona, CTI, Greece
Vassilis Tsotras, University of California, Riverside, USA
Jeff Vitter, Duke University, USA
Agnès Voisard, Free University, Berlin, Germany
Kyu-Young Whang, KAIST, South Korea

VIII Program Committee

Peter Widmayer, ETH Zurich, Switzerland
Jef Wijsen, University of Mons-Hainaut, Belgium
Ouri Wolfson, University of Illinois, Chicago, USA

Additional Referees

Ning An	Federica Mandreoli
Luzius Anderegg	Artūras Mažeika
Alessandro Artale	George Mihaila
Michael Cammert	Mohamed Mokbel
Jorge Campos	Hoda Mokhtar
Hu Cao	Apostolos N. Papadopoulos
Reynold Cheng	Kjetil Nørvåg
Jörg Derungs	Alexandros Nanopoulos
Cedric Du Mouza	Marc Nunkesser
Matt Duckham	Dieter Pfoser
Jeff Erickson	Conrad Pomm
James Farrugia	Octavian Procopiuc
Enrico Franconi	Siva Ravada
Anders Friis-Christensen	Maria Rita Scalas
Xiang Fu	Simonas Šaltenis
Thanaa Ghanem	Martin Schneider
David Gross-Amblard	Qiongmao Shen
Marios Hadjieleftheriou	Chengyu Sun
M. Hammad	Gabor Szabo
Christoph Heinz	Yangui Tao
Fabian Hennecke	Yufei Tao
Haibo Hu	Shiby Thomas
Piotr Indyk	Goce Trajcevski
Dimitrios Katsaros	Jan Vahrenhold
Jürgen Krämer	Yujun Wang
Lars Kulik	Min Wang
Christian Lang	Bo Xu
Bin Lin	Huabei Yin
Bin Liu	Jun Zhang
Nikos Mamoulis	Baihua Zheng

Organizing Committee

Co-chairs

Thanasis Hadzilacos, Greek Open University and CTI
Yannis Theodoridis, University of Piraeus and CTI

Members

Vasilis Delis, CTI - Technical Coordination and Tutorials
Lena Gourdoupi, CTI - Registration and Local Arrangements
Dieter Pfoser, CTI - Publicity
Antonis Sidiropoulos, Aristotle University of Thessaloniki

Sponsors and Supporting Organizations

Major Sponsor

Microsoft®

Sponsor



MDS Marathon Data Systems
Λ. Κηφισίας 38 - 151 25 Παράδεισος Αμαρουσίου - Αθήνα
Τηλ. 210 6198866 - 210 6198761 * Fax: 210 6198825
e-mail: marathon@otenet.gr * www.marathondata.gr

ΚΩΔΙΚΟΣ

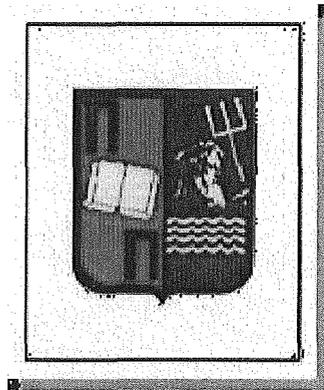
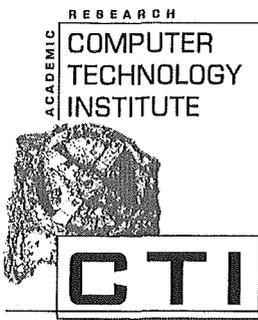
1	2
3	4

ID

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

ΥΠΟΛΟΓΙΣΤΕΡΑ

Supporting Organizations



University of Piraeus

Table of Contents

Advances in Spatial and Temporal Databases, Proceedings of the Eighth International Symposium on Spatial and Temporal Databases

Keynote Address

Data Modeling for Mobile Services in the Real World	1
<i>Christian S. Jensen, Torben Bach Pedersen, Laurynas Speičys, and Igor Timko</i>	

Access Methods

Performance Evaluation of Main-Memory R-tree Variants	10
<i>Sangyong Hwang, Keunjoon Kwon, Sang K. Cha, and Byung S. Lee</i>	
The BTR-Tree: Path-Defined Version-Range Splitting in a Branched and Temporal Structure	28
<i>Linan Jiang, Betty Salzberg, David Lomet, and Manuel Barrera</i>	
Bkd-Tree: A Dynamic Scalable kd-Tree	46
<i>Octavian Procopiuc, Pankaj K. Agarwal, Lars Arge, and Jeffrey Scott Vitter</i>	

Advanced Query Processing

Efficient Object-Relational Interval Management and Beyond	66
<i>Lars Arge and Andrew Chatham</i>	
Efficient k-NN Search on Streaming Data Series	83
<i>Xiaoyan Liu and Hakan Ferhatosmanoğlu</i>	
On Query Processing and Optimality Using Spectral Locality-Preserving Mappings	102
<i>Mohamed F. Mokbel and Walid G. Aref</i>	
Categorical Range Queries in Large Databases	122
<i>Alexandros Nanopoulos and Panayiotis Bozaris</i>	
Probabilistic Spatial Database Operations	140
<i>Jinfeng Ni, Chinya V. Ravishankar, and Bir Bhanu</i>	
Validity Information Retrieval for Spatio-Temporal Queries: Theoretical Performance Bounds	159
<i>Yufei Tao, Nikos Mamoulis, and Dimitris Papadias</i>	

Data Mining and Warehousing

Exploiting the Multi-Append-Only-Trend Property of Historical Data
in Data Warehouses 179
Hua-Gang Li, Divyakant Agrawal, Amr El Abbadi, and Mirek Riedewald

Cross-Outlier Detection 199
Spiros Papadimitriou and Christos Faloutsos

Accessing Scientific Data: Simpler is Better 214
Mirek Riedewald, Divyakant Agrawal, Amr El Abbadi, and Flip Korn

Distance-Based Queries

Optimization of Spatial Joins on Mobile Devices 233
Nikos Mamoulis, Panos Kalnis, Spiridon Bakiras, and Xiaochen Li

On Spatial-Range Closest-Pair Query 252
Jing Shan, Donghui Zhang, and Betty Salzberg

Evaluation of Iceberg Distance Joins 270
*Yutao Shou, Nikos Mamoulis, Huiping Cao, Dimitris Papadias,
and David W. Cheung*

Mobility and Moving Points Management

Indexing Objects Moving on Fixed Networks 289
Elias Frentzos

On-Line Discovery of Dense Areas in Spatio-temporal Databases 306
*Marios Hadjieleftheriou, George Kollios, Dimitrios Gunopulos,
and Vassilis J. Tsotras*

Accuracy and Resource Consumption in Tracking
and Location Prediction 325
Ouri Wolfson and Huabei Yin

Modeling and Languages

Region-Based Query Languages for Spatial Databases
in the Topological Data Model 344
Luca Forlizzi, Bart Kuijpers, and Enrico Nardelli

Query Pre-processing of Topological Constraints:
Comparing a Composition-Based with Neighborhood-Based Approach 362
M. Andrea Rodríguez, Max J. Egenhofer, and Andreas D. Blaser

Logical Data Expiration for Fixpoint Extensions of Temporal Logics 380
David Toman

A Multi-representation Spatial Data Model 394
Sheng Zhou and Christopher B. Jones

Similarity Processing

Learning Similarity with Fuzzy Functions of Adaptable Complexity	412
<i>Giorgos Mountrakis and Peggy Agouris</i>	
Spatial Similarity Queries with Logical Operators	430
<i>Konstantinos A. Nedas and Max J. Egenhofer</i>	
Exploiting Spatial Autocorrelation to Efficiently Process Correlation-Based Similarity Queries	449
<i>Pusheng Zhang, Yan Huang, Shashi Shekhar, and Vipin Kumar</i>	

Systems and Implementation Issues

Automatically Annotating and Integrating Spatial Datasets	469
<i>Ching-Chien Chen, Snehal Thakkar, Craig Knoblock, and Cyrus Shahabi</i>	
Location- and Time-Based Information Delivery in Tourism	489
<i>Annika Hinze and Agnès Voisard</i>	
Building a Robust Relational Implementation of Topology	508
<i>Erik Hoel, Sudhakar Menon, and Scott Morehouse</i>	
Author Index	525