Spatial Databases with Application to GIS

by Philippe Rigaux, Michel Scholl, and Agnes Voisard
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Introduction

This book presents methods for spatial data modeling, algorithms, access methods, and query processing. The main focus is on extending DBMS technology to accommodate spatial data. The book also includes spatial methods used in Geographic Information Systems (GISs). Historically, GISs developed separately from Database systems. GISs are specialized in all aspects of spatial data handling including spatial editing, re-projecting coordinate systems, and map display. However, their query abilities generally are limited or require low-level programming. Contrary to GIS software is the approach to include spatial data in DBMSs using ADTs and extensibility.

Audience

The authors state the primary audience for this book is Computer Scientists who want to become familiar with spatial data issues. However, they also say the book can be used by geographers. For example, an early chapter on basic database schemas and models has been included for that audience, and, throughout the book, the authors explain many fundamental DBMS and algorithmic concepts for review.

Contents

The contents of the book are as follows. Chapter 1 introduces terminology and concepts in both DBMSs and GISs. Chapter 2 presents modes of representing spatial information including various models for collections of spatial objects. Standards are also discussed. Chapter 3 starts with an example schema that includes spatial

and nonspatial attributes which is then used to illustrate various queries using both an extended relational model and an object-oriented model. This schema is also used in later chapters to discuss query processing techniques and show query abilities of commercial products.

Chapter 4 covers constraint spatial databases. The authors say the material is included because of its potential for a new way to represent and query spatial data. For example, the usefulness of the constraint model is shown for modeling field-based data and moving objects. Readers may also be interested in a new reference on this topic since this book was written, which is *Introduction to Constraint Databases* by Peter Revesz, Springer Verlag, New York, 2002.[1]

Computational geometry is the topic of Chapter 5. After presenting basic information on algorithm analysis, the convex hull and half-plane intersection examples are given. These are followed by polygon partitioning and further algorithms for spatial databases. Chapter 6 is devoted to spatial access methods (SAMs) which can be characterized as space driven structures (grid file, linear quad tree, and z-ordering tree) and data driven structures (R-tree and its variations). Further comments on the many types of SAMs and their characterizations are found in a long bibliographic notes section at the end of the chapter.

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[1] review in Vol.31, Nr. 3, September 2002, p 35-36

Chapter 7 introduces the reader to basic query processing methods including query execution plans and the problem of minimizing disk accesses. External sort merge and distribution sweeping are presented as optimal I/O algorithms. Strategies for spatial joins are given for linear structures, R-trees, the single index case, and the no index case. The last section discusses complex queries involving spatial operators in succession. Algorithms for spatial joins with a refinement step and multiway joins are presented. There is a long bibliographic notes section at the end of the chapter with references to many other algorithms.

Finally, the last chapter includes examples of commercial systems including ArcInfo and ArcView from ESRI[2], Smallworld, Oracle, and PostgreSQL. This chapter is very interesting with its descriptions of different models, query abilities, and implementations in actual GIS and DBMS systems.

It is useful to know that since the book was written, ESRI has introduced a new object-relational database model called the "geodatabase". In the geodatabase, storage and management of both spatial and nonspatial data are integrated in the same standard relational DBMS table, in contrast to spatial data being in separate binary files as in ArcInfo and ArcView, although the latter models are still supported.

Summary
There are many strengths to this book. It is very clearly written. The authors are careful to explain terms and concepts and refer back to sections in which a topic was introduced. The book is tightly organized. The book is very comprehensive regarding basic material, and the constraint data model is introduced as a new topic in the area. Although the book does not contain exercises at the end of chapters, it could be used as a textbook. The end of the book has a long and useful bibliography.

Of particular value are the bibliographic notes at the end of each chapter. These include additional material, explanations, and references. They cover historical aspects at times and, in general, are very informative. I found these sections to be extremely interesting and worthwhile. Putting extra material and discussions at the end of each chapter kept the main part of the chapters clear and focused. I recommend this book for any audience interested in introductory and state-of-the-art information on spatial algorithms and other aspects of spatial data relevant to DBMSs.

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[2] Environmental Systems Research Institute, Redlands, California, www.esri.com.