

# PREFACE

## *Who should read this book*

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This book is intended for readers from any background interested in the issues that arise when computing technology meets spatial information—in other words, in GIS! You do not need to be a specialist computing scientist already; the text develops the necessary background in specialist areas, such as databases, system architecture, and AI, as it progresses. Nevertheless, some knowledge of, and interest in the basic components and functionality of computers is essential for understanding the importance of certain key issues in GIS. Where some aspect of general computing bears a direct relevance to our development, the background is given in the text.

This book can be used as a teaching text, taking readers through the main concepts by means of definitions, explications, and examples. However, the more advanced reader is not neglected, and the book attempts to highlight the threads and references that can be used to follow up on particular research topics.

## *Changes to the third edition*

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In a highly technology-led area, such as GIS, the pace of technological change sometimes feels like shifting sand under one's feet. Returning to write the third edition, it was again encouraging to see that the spine of the first edition—databases and spatial data, structures, algorithms, and indexes (Chapters 2, 3, 5, 6)—continues to stand the test of time.

While that core is still sound, the third edition has of course been extensively revised and updated, and complemented by significant new material, especially in those other areas where the field has moved more rapidly. Graph databases have now been added to the core as a major new topic. The material on time has been significantly reorganized and extended, reflecting a tighter integration of space and time in the field more generally. The fundamental material on models and modeling has also been significantly revised and reorganized to strengthen the clarity and messaging. Major new material reflecting important advances in the technology has been added in connection with architectures (Chapter 7, including cloud computing, stream computing, and sensor networks). The material on cartography and visualization (Chapter 8) has been extensively rewritten and redeveloped with largely new content. Finally, the introduction of an entirely new chapter on AI and GIS (Chapter 9, including ontologies, spatial reasoning, machine learning and spatial analysis, and deep learning) is a reflection of the rapid advances in this area over the past decade.

In addition to the changes in content, we have striven to make further improvements to the format to produce a more attractive and readable book. The format for the book has been completely revised in full color, in particular with all figures either new or completely regenerated. The text has likewise been completely rewritten with the continuing aim of making the book more accessible to an ever-wider audience. Every chapter begins with a new summary, outlining the major ideas and learning objectives in that chapter. At its close, every chapter ends with some more personal reflections and perspectives on the topic from the authors.

Before sitting down to write a third edition, it was essential for us to move the book towards open access. We are very grateful to the Taylor & Francis team for working with us to enable five chapters—half the book—to be made freely available online and open access. Another important change, which may not be immediately obvious, is the conscious effort to rebalance the list of references. The cited references in the second edition were overwhelmingly to male authors—of more than 300 references in the second edition, over 86% were authored exclusively by men. In writing the third edition, we have attempted to address this stubborn bias by actively seeking out the abundance of excellent research by women GI scientists. It has been a joy to read and reread these works of women researchers, who continue to be systematically under-cited and under-recognized as they have been for the entire history of the field.<sup>1</sup>

<sup>1</sup> Tracking gender in bibliographies is not straightforward, but we estimate over 50% of cited references in this third edition are by female authors or include female co-authors. Nevertheless, the book remains a long way from gender parity (i.e., in terms of the total proportion of male authors, as opposed to the proportion of references with exclusively male authors) and still offers no visibility for the contributions of non-binary GI scientists.

Finally, following the pattern Mike Worboys began in 2004 by inviting Matt Duckham to become a co-author of the second edition, Matt and Mike welcome Qian (Chayn) Sun on to this third edition as a third author. With a background in geography and GIS, Chayn has brought her own fresh perspective and distinct expertise to the third edition, in particular, in web mapping, cloud computing, critical geography, and machine learning with GIS. We hope you will agree that this third edition has succeeded in maintaining the high standards set by *GIS: A Computing Perspective* back in 1994!

### *Formatting used in this book*

Several formatting conventions, continued from the second edition, have been used in this book. Material that is relevant to the main themes in the text, but not essential to the reader, is clearly separated out in purple inset boxes, usually at the top of a page. Boxes typically contain interesting asides, more challenging material, or background to a topic, as well as references and links that readers may wish to pursue. With over 60 such boxes, a complete list is included in the front matter to the book for ease of reference. A list of insets is included in the book's front matter.

Throughout this book, we have used margin text to allow rapid reference to important terms. When an important term is first defined or introduced, that term will appear in the margin. A corresponding entry can be found in

the index, with the page reference in bold typeface. This enables the reader to use the index as an extensive glossary of more than 1200 terms used in this book. Each index term has at most one bold typeface page reference, and a term can be rapidly located within a page by finding the corresponding margin entry. In addition to normal- and bold-typeface index entries, those index entries that appear in italics refer to terms that appear within an inset box.

### Structure of this book

Figure 1 indicates the overall structure of interdependencies between chapters. Readers may find it helpful to refer to Figure 1 to tailor their use of this book to their own particular interests and prior background.

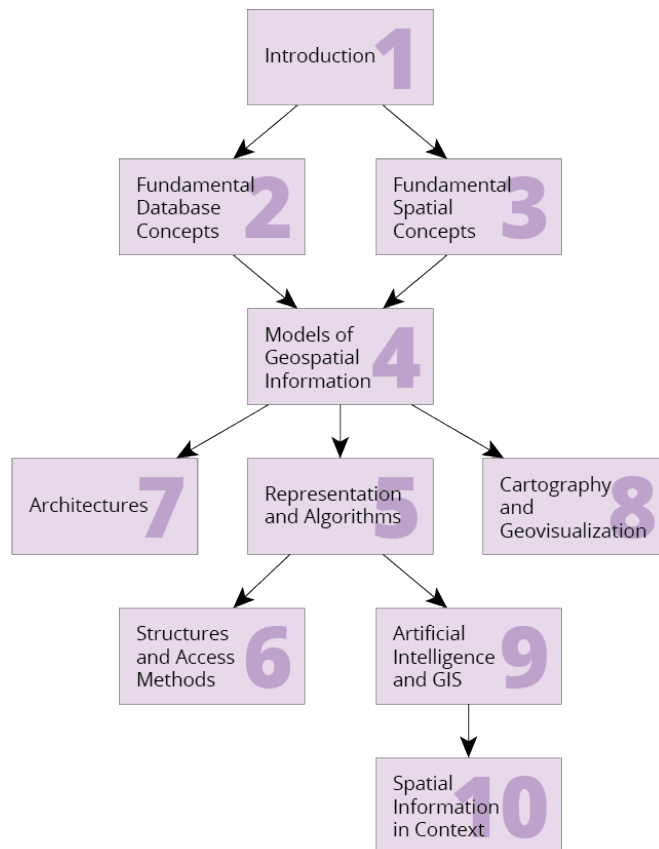


Figure 1: Relationships between chapters

*Chapter 1* motivation and introduction to GIS; preparatory material on general computing; and an overview of what makes “spatial special”;

*Chapters 2–3* relational and graph databases; conceptual data modeling; foundations and formalisms for spatial concepts;

*Chapter 4* high-level modeling of space and time; object- and field-based models; time in GIS;

*Chapters 5–6* exposition of the core material; spatial algorithms and data structures; spatial indexes and access methods;

*Chapter 7* GIS system architecture and distributed systems; web mapping; stream computing and sensor networks;

*Chapter 8* graphic design and cartography; GIS interface and interaction design; visualization of geospatial data;

*Chapter 9* ontology engineering and spatial reasoning; machine learning and deep learning; “GeoAI”; and

*Chapter 10* uncertainty and imperfection in spatial information; location privacy; critical GIS.

### *Online resources*

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The website that accompanies this book can be found at:

<http://gisacp.duckham.org>

The resources at this site are constantly under development, but they include resources such as sample exercises, lecture slides and notes, open-source computer code, sample material, useful links, errata, and contact information. We welcome suggestions from readers as to resources that we should include on the website, or indeed any feedback or comments on the book itself. Matt can be contacted on Mastodon on @mduckham@mastodon.au or Twitter at @geospatial\_md; other up-to-date contact information can be found on the website.