

# Preface

---

Geographic information systems (GISs) are computer-based information systems that are able to capture, model, store, retrieve, share, manipulate, analyze, and present geographically referenced data. This book is about the technology, theories, models, and representations that surround geographic information and GISs. This study (itself often referred to as GIS or *geographic information science*) has emerged in the last two decades as an exciting multi-disciplinary endeavor, spanning such areas as geography, cartography, remote sensing, image processing, environmental sciences, and computing science. The treatment in this text is unashamedly biased toward the computational aspects of GIS. Within computing science, GIS is a special interest of fields such as databases, graphics, systems engineering, and computational geometry, being not only a challenging application area, but also providing foundational questions for these disciplines.

The underlying question facing this multidisciplinary topic is “What is special about spatial information?” In this book, we attempt to provide answers at several different levels: the conceptual and formal models needed to understand spatial information; the representations and data structures needed to support adequate performance in GISs; the special-purpose interfaces and architectures required to interact with and share spatial information; and the importance of uncertainty and time in spatial information.

The task of computing practitioners in the field of GIS is to provide the application experts, whether geographers, planners, utility engineers, or environmental scientists, with a set of tools, based around digital computer technology, that will aid them in solving problems in their domains. These tools will include modeling constructs, data structures that will allow efficient storage and retrieval of data, and generic interfaces that may be customized for particular application domains.

The book inevitably reflects the interests and biases of its authors, in particular emphasizing spatial information modeling and representation, as well as developing some of the more formal themes useful in understanding GIS. We have tried to avoid detailed discussion of particular currently fashionable systems, and concentrate instead upon the foundations

and general principles of the subject area. We have also tried to give an overview of the field from the perspective of computing science.

Not every topic can be covered and we have deliberately neglected two areas, leaving these to people expert in those domains. The first is the historical background. The development of GIS has an interesting history, stretching back to the 1950s. Readers who wish to pursue this topic will find an excellent introduction in Coppock and Rhind (1991), and more in-depth perspectives from many of the pioneers of GIS in Foresman (1998). The other area that is given scant treatment is spatial analysis, which requires specialized statistical techniques and is judged to be specifically the province of the domain experts. Introductions to spatial analysis include Unwin (1981), Fotheringham et al. (2002), and O'Sullivan and Unwin (2002). The bibliographic notes in Chapter 1 provide further references to texts on specific aspects of spatial analysis.

### **WHO SHOULD READ THIS BOOK**

This book is intended for readers from any background who wish to learn something about the issues that GIS engenders for computing technology. The reader does not have to be a specialist computing scientist: the text develops the necessary background in specialist areas, such as databases, as it progresses. However, some knowledge of the basic components and functionality of a digital computer 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 researcher is not neglected, and the book includes an extensive bibliography that readers can use to follow up particular topics.

### **CHANGES TO THE SECOND EDITION**

The second edition of this book was written with the aim of making the book more accessible to a wider audience, at the same time as retaining the core of tried and tested material. Chapters 1–6 have been extensively revised, updated, and reformatted from the first edition, although in a fast moving high-technology area like GIS it was encouraging to find that these fundamental aspects of GIS have remained largely unchanged. Chapters 7–10 present almost entirely new material, covering GIS architectures, GIS interfaces, uncertainty in geospatial information, and spatiotemporal information systems. The bibliography, index, and all the diagrams have also been completely revised.

In addition to the changes in content, we have tried to produce a more attractive and readable format for the book. The following section contains more details on the formatting conventions used in this book and on the structure of the book. The spelling, grammar, and usage in second

edition has also changed, from British to American English. We hope that this change will further improve the accessibility of this book to an international audience.

### FORMATTING USED IN THIS BOOK

Several formatting conventions, new to 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 included in gray inset boxes at the top of a page. Typically insets contain more challenging material, and provide some background to each topic, as well as references and links, which readers may wish to follow-up. A list of insets can be found on page xi. Every chapter begins with a brief summary, outlining the major ideas in that chapter and highlighting some important terms introduced in the chapter. At its close every chapter ends with itemized bibliographic notes, providing some key references that readers can follow up. The section numbers alongside the bibliographic notes refer to the relevant sections in the main text.

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 rather like an extensive glossary of 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 a gray inset box.

### STRUCTURE OF THIS BOOK

Figure 0.1 indicates the overall structure of interdependencies between chapters. Readers may find it helpful to refer to Figure 0.1 to tailor their use of this book to their own particular interests.

*Chapter 1:* Motivation and introduction to GIS; preparatory material on general computing.

*Chapters 2–3:* Background material on general databases and formalisms for spatial concepts

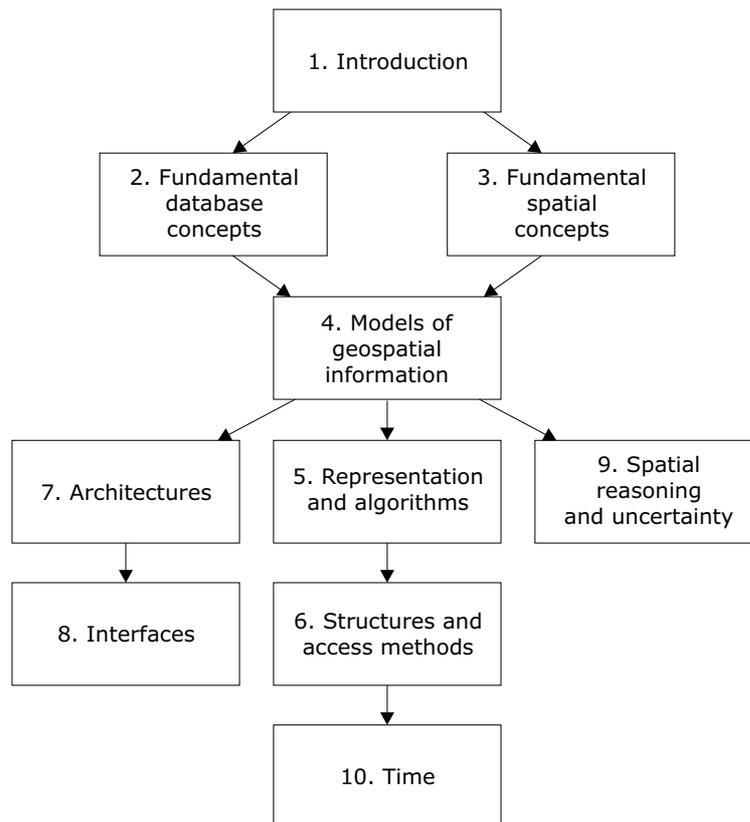
*Chapters 4–6:* Exposition of the core material, forming a progression from high-level conceptual models, through representations and algorithms, to indexes and access methods that allow acceptable performance.

*Chapters 7–8:* Discussion of the types of system architectures and user interfaces needed for GIS.

*Chapter 9:* Introduction to spatial reasoning theory and techniques, with particular focus on reasoning under uncertainty.

*Chapter 10:* Introduction to temporal and spatiotemporal information systems.

**Figure 0.1:**  
Relationships  
between  
chapters



### ONLINE RESOURCES

The website that accompanies this book can be found at:

<http://worboys.duckham.org>

The resources at this site are constantly under development, but include resources such as sample exercises, lecture slides and notes, open-source computer code, sample material, useful links, errata, and contact information. We, the authors, welcome suggestions from readers as to resources that we should include on the website, or indeed any feedback or comments on the book itself. We can be contacted on email at [gisacp@worboys.duckham.org](mailto:gisacp@worboys.duckham.org); other up-to-date contact information can be found on the website.

Copyright © 2004 Mike Worboys and Matt Duckham