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BOOK REVIEW

Spatial Mathematics: Theory and Practice through Mapping by Sandra Lach Arlinghaus and Joseph J. Kerski

There has been much attention to GIS as a tool for gathering, displaying, examining, evaluating, and interpreting data for knowledge discovery in geographical data. The book "Spatial Mathematics: Theory and Practice through Mapping" by Sandra Lach Arlinghaus and Joseph J. Kerski [1] introduces GIS as a tool for introducing mathematical concepts for GIS, visualization, and mapping.

The book is mainly an attempt to introduce fundamental spatial concepts in applied way. It supplies plenty of materials and exercises from diverse academic disciplines such as geography, mathematics, physics, and general social science. The inclusion of "spatial mathematics" in the title is somewhat misleading, as the role of mathematics is not always clearly defined. The book mainly focuses on fundamental spatial concepts, rather than addressing advanced mathematical concepts. Thus, it is best-suited for introducing mathematical concepts employed in spatial information science and mapping.

Using QR (quick response) codes is the most interesting and innovative part of this book. QR codes facilitate access to relevant materials that support the theoretical concepts. The book contains 10 chapters covering a diverse range of topics pertaining to spatial information science, with each chapter is organized in two distinct parts: theory and practice.

According to the content, the book can be divided into two main parts. The first part involves topics related to measurement and geodetic characteristics of the Earth, explained in chapters 1, 2, and 9. Chapters 1 and 2 support a basic understanding of the geometry of the Earth, including topics such as geodetic models, positioning, coordinate systems, and location measurements. Further discussions of the numerical characterization of location on the Earth's surface are terminated in chapter 2, but taken up again in chapter 9. Chapter 9 deals with various map projections and their characteristics, which has an important role in selecting the best projection for displaying maps.

The second part of book focuses primarily on spatial visualization techniques, in helping to reveal meaningful structure in the distributions of phenomena in space. Thus, chapters 3 to 8 deal with fundamental analytical techniques in GIS to uncover hidden spatial patterns.

The third chapter of book deals with the concept of transformations, such as point, line, and area transformation. For example, chapter 3 introduces buffering as a technique to transform point and line vector data into areas. Chapter 4 explains how to use cartographic variables, such as color, symbol, size, and proportion, to enhance meaning on maps. The principles of generalization are discussed in chapter 5, which also explains the effects of changing scale on the level of detail represented in a map. This chapter also covers dot density maps and their role in spatial analysis to show centrality and hierarchy in cartographic representation. Data "partitioning," such as classification and data normalization, are explained in chapter 6. These techniques are applied to enhance thematic map interpretablity. The importance of hierarchy in visualizing space structured as vector or raster data are further discussed in chapter 7. The Mapplet is also introduced as an example of maps used to visualize the stability of the geometric connectivity patterns. The final techniques discussed in chapter 8 use statistical measures of distribution, such as mean and standard deviation, as a means to analyze the way spatial objects are structured over the space.

Overall, the authors have provided a wide range of principles of mathematics and spatial information science in the context of map production and representation of real world data. Each chapter provides numerous practical examples and exercises related to the key topics. QR codes also link to auxiliary material that will help readers in better understanding of the concepts. Presenting the foundations of spatial information in an applied way is one of the strongest aspects of this book, in comparison with others in spatial information science. However, the book suffers from lack of necessary depth in some discussions. For example, chapter 3 briefly introduces set theory giving some links and references to further reading. However, the chapter never goes into depth. Set theory would seem an ideal topic for a book entitled "Spatial Mathematics," given its wide and fundamental application in spatial information science. Unfortunately, aside from the brief introduction in chapter, this book largely ignores the topic.

The structure of the book is at times confusing. For example, the first two chapters are closely related to chapter 9, towards the end of the book. The wide range of topics covered reduces the cohesion between chapters, with significant jumps between topics in subsequent chapters. The issue is also observed at a smaller scale across some of the sections in each chapter. Chapter 3 for example begins with geoprocessing and transformations but then switches to data formats without a clear rationale behind the switch for the reader. Chapter 5 similarly struggles to create strong links between section topics, such as scale and dot density maps. However, in parts the book does manage clear introductions to new topics as they are encountered. In chapter 3, for example, the necessity of using both raster and vector spatial data models is well reasoned by contrasting the merits and limitations of each model. Chapters 4 and 5 similarly provide comprehensive and comprehensible discussions of color and map scale in helping readers to use both elements to enhance their map representations.

In summary, the breadth of practical materials covered by this book gives it a strong focus on applications, rather than theory. As such, this book is worth reading by anyone looking for an introductory text on spatial information science with a practical focus on the field. The use of innovations such as word clouds, to summarize the content of each chapter, and QR codes, for links to auxiliary material, further strengthens its usefulness as an introductory text. However, the book does lack depth in key topics, such as spatial analysis and data manipulation. And although the book is organized to be accessible for a

wide range of readers outside spatial information science, the occasional lack of cohesion in moving between the diverse range of topics covered is likely to lessen its usefulness for those with no previous background in the field.

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References

[1] ARLINGHAUS, S. L., AND KERSKI, J. J. *Spatial Mathematics: Theory and Practice through Mapping*. CRC Press, Boca Raton, FL, 2013.