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GIS and Multicriteria Decision Analysis (review)

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(Review)

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Book Reviews

GIS and Multicriteria Decision Analysis, by Jacek Malczewski, 1999, 392 pages, ISBN 0-471-32944-4. New York: John Wiley and Sons.

The emphasis of this text is on geographic information systems (GIS)-based modeling of spatial multicriteria problems, with a primary goal being to “introduce the readers to the principles of spatial multicriteria decision analysis and the use of multicriteria decision techniques in GIS environments” (pg. xiv). While there exists a range of introductory GIS texts, technical treatments of GIS or spatial analysis approaches linked to GIS remain few. Given this, *GIS and Multicriteria Decision Analysis* is a timely contribution to geographic information science (GIScience).

The text is organized as follows: Chapter 1: Geographical data, information, and decision making; Chapter 2: Introduction to GIS; Chapter 3: Introduction to multicriteria decision analysis; Chapter 4: Evaluation criteria; Chapter 5: Decision alternatives and constraints; Chapter 6: Criterion weighting; Chapter 7: Decision rules; Chapter 8: Sensitivity analysis; Chapter 9: Spatial decision support systems; and Chapter 10: MC-SDSS case studies. The structure of the text and ordering is logical. The intended audience is GIS and decision analysts and both undergraduate and graduate students in applied GIS, quantitative analysis, and SDSS courses. The author notes that the text assumes that the reader has limited mathematical background. Rather than derive formulations and formalize solution techniques, the text identifies associated software packages that may be utilized. A glossary of key terms and an extensive set of references are provided, making the text extremely valuable.

The introductory chapter is well done and quite motivational for studying multicriteria decision making (MCDM). The following chapter on GIS basics is well organized, but it contains far too much detail in places. As a result, the chapter is the longest in the text (65 pages). One of the challenges with this type of text is to avoid the assumption of previous exposure to GIS. Thus, an introduction to GIS becomes necessary. However, many subsections provide more detail than necessary. While detail is usually good, much of the basic GIS discussion is not revisited later in the text when MCDM is reviewed. As a result, a considerable amount of space and time is spent on material only marginally important to MCDM, at least as presented in this text. Another concern is the use and introduction of numerous highlighted terms in this chapter that are not used later in the text. The value of this text would be considerably enhanced if some of the GIS introduction were done in the context of the later MCDM topics. As it stands, the level of integration of the two topics (GIS and MCDM) could be enhanced, but admittedly such integration represents a challenging task and is not an explicit goal set forth by the author.

Chapter 3 introduces MCDM and makes a distinction between multiattribute and multiobjective decision making. This is certainly one of the more important chapters of the text and provides a nice introduction. While much of the initial emphasis is on differentiating these two approaches, it is unfortunate that there remains some ambiguity in their distinction. Another point of confusion is the use of “aggregating” in this chapter and throughout the text. In GIS this term is used when spatial units are merged to produce a new geographic entity. However, in this text the author uses the term when discussing query results associated with multiple coverage layers. A few specific issues that would benefit from supplemental discussion/illustration are planning alternatives and notation. More emphasis on alternative generation would pro-

vide greater clarity. Generating alternatives is, in fact, a complex and often ad hoc task. The nature of the process is not evident from the text. The other issue is that the notation could be improved in order to distinguish between attributes and decision variables. For example, the text relies upon x_{ij} in all but the last few chapters to refer to matrix entities in general. It would be more helpful to vary this notation throughout the text depending upon whether attributes or decision variables are being discussed. This would mean using a_{ij} to denote attribute values, as an example, rather than x_{ij} as it is currently done. Given the assumption of limited background to mathematics, such improvements would be quite important.

Evaluation criteria are discussed in Chapter 4. This well-done chapter covers how information may be standardized for subsequent analysis, though little attention is given to why standardization is necessary. This would appear to be a significant oversight as one typically encounters measurement-unit differences that must be addressed when working with multiple layers of information. The reference to criterion maps gives me some unease as GIS is about more than just the production of maps. Decision alternatives and constraints are discussed in Chapter 5. It is somewhat unfortunate that decision variables and "the decision" are only now being detailed. This is a key chapter in the text and the reader is finally exposed to much of MCDM substance. Unfortunately the reader is almost 200 pages into the text before this happens.

Chapters 6-8 (criterion weighting, decision rules, and sensitivity analysis) provide good coverage of important material for carrying out MCDM. However, it is Chapter 9, the chapter on spatial decision support systems (SDSS), that is perhaps the biggest asset of this text. The evolution of SDSS is well documented and one clearly sees that SDSS is now an established subfield. One issue that the chapter raises is whether MCDM can be thought of as a distinct submodule within the MC-SDSS framework shown in Figure 9.5. Based upon the presented material (and my own areas of research), it seems that the MCDM toolbox would actually be a subcomponent of the model-based management system. The MCDM toolbox refines and makes accessible functionality associated with a particular spatial model (or analysis approach). Given this, how could one conceive of the MCDM toolbox existing on its own? Perhaps this point merely illustrates the difficulty that remains in distinguishing among the many related subfields (GIS, expert systems, SDSS, MC-SDSS) being discussed here, distinctions that will likely be more muddled as GIS and GIScience technology continues to evolve.

The book ends with six case studies that help to give an overview and sense of the state of the art in MCDM, but they do not necessarily illustrate how any of the systems were developed. One shortcoming is that the figures presented are difficult to read, but more important is the omission of a comparative checklist summarizing each study. As an example, loose coupling is mentioned as the system integration approach for DOCLOC, but none of the other systems presented are discussed in this way. Further, the approach taken is not a particularly effective synthesis with respect to the functionality and terminology established in the text (for example, MADM versus MODM, decisions, scaling, and standardization, etc.).

The most significant contributions of this text are the chapters on MCDM and SDSS, the included references, and the glossary of terms. It is often difficult to summarize terms, but this glossary does help to provide synthesis. It would have been valuable to include utilized data in order to work through many of the examples. Other accompanying on-line resources would certainly increase the value of the text as well. It would be even better if it utilized spatial information and perhaps Power-Point slides of covered material. The text more than achieves its stated goals and objectives in providing an introduction to MCDM. Overall this is an important contribution to GIScience and an excellent review of MCDM work.

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