Representing space in cognition: interrelations of behaviour, language, and formal models, edited by Thora Tenbrink, Jan Wiener, and Christophe Claramunt, Oxford, Oxford University Press, 2013, xv + 308 pp., $135.00/£70.00 (hard cover), ISBN 978-0-19-967991-1

This interesting edited collection of chapters is titled *Representing space in cognition*, but the subtitle is key: *Interrelations of behaviour, language, and formal models*. The book stems from a workshop held in 2010 at the HWK Institute for Advanced Study in Delmenhorst, near Bremen, Germany, a workshop which itself was inspired by 'excited' discussions at the biennial *Conference for Spatial Information Theory (COSIT) 2009* held in Aber Wrac'h, France (and no doubt further gestated at other meetings). The subtitle is key because it signals that this collection focuses on particular aspects of the interdisciplinary field of spatial cognition and not others. Namely, it focuses on spatial language and formal models and how they relate to assistive spatial technologies, especially at the scale of environmental space (Chapter 8 by Nguyen and Wachsmuth discusses the space around human and robot bodies, so-called peripersonal space). Of course, language *is* behaviour, and formal models do not so much 'interrelate' with behaviour and language as attempt to represent them or the processes behind them in computationally tractable ways. One might say it is the *study* of behaviour and language that interrelates with the study of formal models.

Besides its nice overview introduction by the editors, *Representing space in cognition* has 10 additional chapters organized into three parts: 'Empirical insights', 'Computational models', and 'Human-centred assistance'. These titles pretty accurately describe the chapters each part includes. I also appreciate the numerous cross-references in most chapters to other chapters in the book. The editors are three accomplished scholars who represent well the interdisciplinary tradition of spatial/geographic information science that has blossomed since the early 1990s (but originating much earlier). The editors are especially well versed in linguistics, cognitive psychology, and computer science, and all these approaches are strongly present. Given the expertise in various disciplines the rest of the authors contribute, it's evident that the editors achieved one of their main stated goals of nurturing cross-disciplinary communication.

The editors spell out their focus in their overview chapter, where they explain that the book's authors 'pursue the aim of establishing clear connections between perception, language, behaviour, modelling approaches, and practical application' (p. 3). (In a book with such a broad title as *Representing space in cognition*, it makes one wonder where the mind and brain are in this list.) So although the book presents some informed and well presented discussions of spatial cognition research, it should not by any means be taken to reflect the whole field. Reflecting for just a few minutes, I thought of several important topics in spatial cognition not covered much or at all in this book: lifespan development, distance knowledge, architectural cognition, cartography and information visualization, spatial reasoning (outside of the travelling salesman problem), spatial cognitive neuroscience, individual and group differences (even cross-linguistic differences are not much considered!), and spatial learning and education. And that's not even mentioning nonhuman animal research (oops, I mentioned it).

Of course, observing that this book is much narrower than its main title is no particular criticism, as the field has expanded so much in so many disciplines over the past couple of decades that even important and ostensibly broad sources such as *Wayfinding behavior: Cognitive mapping and other spatial processes* (Golledge 1999), *Making space: The development of spatial representation and reasoning* (Newcombe and Huttenlocher

2000), *Human spatial memory: Remembering where* (Allen 2004), *Robotics and cognitive approaches to spatial mapping* (Jefferies and Yeap 2008), *Handbook of spatial cognition* (Waller and Nadel 2012), and the journal *Spatial Cognition and Computation* (by Taylor & Francis) give short shrift to several topics in spatial cognition. But that said, *Representing space in cognition*'s subtitled focus still leaves me wondering what the editors and authors would promote as the proper way to think of the role of language and linguistics in spatial cognition. Is it central, the core of spatial cognition? Is it just one of several important components of spatial cognition? I will hazard the guess that none of the editors or authors believe all spatial cognition is linguistic. Some of the chapters do not deal with spatial language at all, at least not explicitly.

Finally, as I read these chapters, I was repeatedly nagged (I repeatedly nagged myself?) with the question of how mental imagery relates to spatial thinking. Lay people are often said to believe – and I think they do – that spatial thinking is a matter of constructing and manipulating mental images. In this context, mental images are the long-studied experiential phenomena of 'seeing mental pictures' in the conscious mind (they can be mental sounds or smells, etc., but are almost always considered visual in the context of spatial thought). In fact, it seems to me that many researchers think of spatial thinking in this way too, if only implicitly.

In Chapter 4 by Denis and Fernandez in *Representing space in cognition*, for example – and this is just one example from the book, an example I choose in part because it so effectively presents such important ideas for the spatial cognition community – discusses the issue of the role that landmarks in the environment play in verbal route directions. Here and elsewhere, Denis is one of several influential researchers who have argued for the central importance of landmarks in spatial cognition. These authors put it this way in Chapter 4: '[T]he particular cognitive status of landmarks can thus be seen as residing in the fact that they help a traveller create an *advance visual model* [italics in original] of the critical parts of an environment, as seen from a route perspective' (p. 47). Granting their undeniable function, claims like these about landmarks have struck me as emphasizing their role excessively (a thesis I developed in Montello 2010). While reading *Representing space in cognition*, it occurred to me that emphasizing visually perceived landmarks so much, which by implication downplays the contributions of such important components of spatial cognition (specifically wayfinding) as non-conscious scene recognition and metric layout apprehension, may get some of its impetus from ascribing mental imagery too large a role in spatial thinking. In this respect, I refer the reader (and the authors of *Representing space in cognition*) to the important recent book by Knauff (2013), *Space to reason*. There he elaborates a theoretical model that replaces the role of mental visual imagery in spatial thinking with non-imagistic entities he calls 'spatial layout models'. In fact, he argues (and presents evidence) for the idea, counter-intuitive to many people, that visual images can even impede some forms of spatial thinking. Effective spatial thinking simply cannot be reduced to a matter of vivid and effective visual imagery. This is not to say I believe either that mental imagery is unreal or that it is unimportant to understanding the mind (I won't speak for Knauff's view). It is to say that the common view of imagery's centrality to spatial thought is overstated, a very important message for understanding spatial cognition in its full mental and behavioural diversity.

References

Allen, G.L., ed., 2004. *Human spatial memory: remembering where*. Mahwah, NJ: Lawrence Erlbaum Associates.

Golledge, R.G., ed., 1999. *Wayfinding behavior: cognitive mapping and other spatial processes*. Baltimore, MD: Johns Hopkins Press.
Jefferies, M.E. and Yeap, W.K., eds., 2008. *Robotics and cognitive approaches to spatial mapping*. Berlin Heidelberg: Springer.
Knauff, M., 2013. *Space to reason: a spatial theory of human thought*. Cambridge, MA: The MIT Press.
Montello, D.R., 2010.The role of landmarks is exaggerated. Paper presented at *Las Navas 2010: cognitive and linguistic aspects of geographic space*, 5 July 2010, Las Navas del Marques, Spain.
Newcombe, N.S. and Huttenlocher, J., 2000. *Making space: the development of spatial representation and reasoning*. Cambridge, MA: The MIT Press.
Waller, D. and Nadel, L., eds., 2012. *Handbook of spatial cognition*. Washington, DC: American Psychological Association.

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Big data: techniques and technologies in geoinformatics, edited by Hassan A. Karimi, Boca Raton, FL, CRC Press, 2014, 312 pp., US$129.95 (hardcover), ISBN 13-978-1466586512

Unprecedented amount of geospatial data have been collectively generated everyday via ubiquitously distributed geosensor networks, location aware devices, and social media. With the rapid increase of big geospatial data, the geographic information system (GIS) community has been facing big data challenges, which are often characterized as three Vs; high volume, high velocity, and high variety. Specifically, the challenges include how to efficiently and effectively collect, store, process, query, analyze, visualize, model, update, share, and integrate big geospatial data sets.

This book is a collection of 14 chapters introducing conceptual frameworks, system architectures, techniques, technologies, and methodologies in order to approach such big geospatial data challenges. The editor has done a good job in selecting a variety of topics with various kinds of big geospatial data applied in practice. Numerous practical and experimental examples of systems, techniques, and methodologies facilitate readers understanding of research backgrounds, key concepts, frameworks, and procedures discussed in this book. Each chapter is an individual paper, and topics covered include general high-performance computing (HPC) framework and system architecture, big geospatial data analysis and mining, cyberinfrastructure, and geospatial standard. Each chapter addresses topic-specific big geospatial data challenges, current solutions, and further issues.

The first chapter provides the basic framework of HPC platforms in the form distributed and/or parallel computing, which include cluster computing, grid computing, supercomputing, and cloud computing. This chapter helps readers to overview the basic HPC concept, terminology, types, architecture, and taxonomy and provides a general guidance for selecting an appropriate HPC environment.

Chapters 2–5 showcase HPC systems, which help readers to understand conceptual designs, system architectures, and approaches to handle big geospatial data in practice.