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Book review

**R. White, G. Engelen, I. Uljee (Eds.), Modelling Cities and Regions as Complex Systems: From Theory to Planning Applications, 2015MIT Press, Cambridge, Mass, 2015,, ISBN: 9780262029568 (£31.95 (Hardback))**

This is an excellent, well-written, well-illustrated and stimulating book. It provides, building on a number of research projects, an excellent account of the state of the art in building cellular automata-based urban and regional models. Its strength is that it extends the cellular automata (CA) paradigm far beyond the much-quoted toy models usually taken to represent that field and integrates it with the wider modelling field.

A useful starting point is Lowry's 1967 paper which offered an interesting perspective on modelling styles. Think of a matrix whose rows are labelled by activities – residences, economic, services, etc. – and columns labelled by the zones – in this case the CA cells – that make up the spatial system. If you look along a row, your perspective is that of the spatial distribution of an activity; if you look down a column, the focus is on the mix of land uses in a particular zone. The land use transport interaction (LUTI) model paradigm is row-focused – with spatial interaction and transport flows added as the relationship between activities; a CA-model is column-focused, that is on land use. It is very easy in LUTI modelling to lose the constraints imposed by land use accounts, indeed to lose track of land use – though the original Lowry model handled very cleverly. A CA-model achieves this at the outset but then has to handle activities. The authors do this in a very rich way through the way they introduce 'suitability', 'neighbourhood' and especially 'accessibility' factors for each cell. It is through the last of these that they handle spatial interaction – a feature they recognise as crucial for a successful model. They begin, at a later stage in one of their examples, to integrate this fully with a conventional transport model by using the network to generate an effective measure of impedance. Another potential strength of CA-modelling is that it has an inbuilt focus on dynamics: the transition probabilities (for land use) for each cell. The authors in this case develop the dynamics elegantly by rooting their probabilities in the kind of equations used by Roger White, Peter Allen, Britton Harris and myself, and others, in a more traditional LUTI framework. They succeed, therefore, in extending the conventional CA-model to fully link with the state-of-the-art in other paradigms.

A different kind of strength of the book is their ability to relate their modelling choices to the wider agenda and this is potentially stimulating for all researchers in the field. The broader context is that of complex adaptive self-organising systems and I found their insights on far-from-equilibrium states valuable and will certainly stimulate further thinking on my part. They demonstrate very effectively for example that, given the nature of cities as complex systems, conventional forecasting is impossible because of the range of future states that can be accessed even on the basis of quite small stochastic variations. I particularly liked their argument that different approaches to modelling should be seen not as competing but as complementary: we are all modelling the same system but we make choices of perspectives and, for example, scales, which produce different models but ones that at some deeper level should be equivalent. And they never lose sight of the fact that models should represent theory. They are perceptive on the ways in which different communities of modellers have made their choices and particularly in relation to the limits of monocentricity and concentric zone models - that "indeed, social scientists, *except for economists*, have for the most part rejected this approach as a way of understanding cities". (My italics)

The examples of model development are rich and varied – along with illustrations of planning applications. In the former case, it was interesting to see that they were able to handle spatial interaction over the full range of cells – echoes of the Potts model in the physics of lattices as an extension of the Ising model. And there are other interesting and powerful ideas such as the use of a variable grid – for each cell, an ability to group distant cells into larger zones to facilitate efficient computation – some clever computer science there. They also recognise that the cells needn't be square: they could have the other kinds of boundaries typically used in LUTI models. In the planning case, the focus is inevitably on land use and an ongoing research task, acknowledged by the authors, is to extend this range by fully integrating the CA-model with, for example, demographic models, economic input–output models and transport models.

This is a book to be warmly recommended for all kinds of urban and regional modellers and those with associated planning interests.

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