Cellular Automata Models for Simulating Urban Growth

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Cellular automata (CA) models have been intensively used to analyze and to simulate the evolution of urban areas since they were introduced in Quantitative Geography by Tobler (1979). The concept of CA is quite simple and incorporates the spatial nature of different phenomena (Norte Pinto and Pais Antunes, 2010) through five main components: CA use a partition of space, (1) the cells; cells can be classified by a finite set of states, (2) the land uses; cell states can change according to a set of conditions, (3) the transition rules; these rules incorporate spatial interaction between states within a given spatial extent, (4) the cell neighborhood; with the system evolving throughout (5) time. CA models conjugate urban form and the processes that undertake its evolution, which allows the parameterization and modeling of the complexity of these strongly interdependent relationships. Traditional applications of CA models are based on the use of spatial datasets derived from remotely sensed images with automatic classification of land uses. Usually, the evolution throughout time is modeled by probabilistic transition rules. The use of remotely sensed imagery implies the consideration of regular cells (the image pixels) of variable resolution. However, regular cells do not represent properly urban form, and its use is mainly a consequence of the great simplicity in processing them. The use of irregular cells as spatial units is scarce in the literature, but has become a new area of research over the past years (Stevens and Dragisevic, 2007, Moreno et al., 2008, Norte Pinto and Pais Antunes, 2010). Calibration of CA models is frequently made using map comparison measures (between simulation and reference maps) and accounting statistical measures from contingency matrixes. Form metrics (Barredo et al., 2003, Silva and Clarke 2002) and fractal measures have also been used (White and Engelen, 1993). We present an introduction on the incorporation of form measures in the calibration of CA models and results from the application of a CA model based on irregular cells to simulate urban growth.

Keywords: Cellular automata, urban growth, metrics

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