

## **ABSTRACTS – WORKSHOP SERIES NO 2**

### **HANDBOOK OF THEORETICAL AND QUANTITATIVE GEOGRAPHY**

#### **SIMULATING PEDESTRIAN BEHAVIOR IN COMPLEX AND DYNAMIC ENVIRONMENTS: AN AGENT BASED PERSPECTIVE**

**Arnaud BANOS**

Géographie-Cités, UMR 8504 CNRS/Paris 1, France

##### **ABSTRACT**

Agent-based simulation offers multiple advantages when dealing with complex phenomena like pedestrian movement, characterized by a possibly large number of locally interacting entities. The main goal of this article is to illustrate this key point, through the simulation of pedestrian movements in dynamic environments. The key point we will try to defend here, is that pedestrian movement should not only be considered as a specific phenomenon, but should also be included in a much more global and complex perspective, the urban system as a whole. Pedestrian motion indeed occurs in an ever-changing environment, defined by constraints and opportunities, but also nuisances and dangers.

##### **KEYWORDS**

Agent based simulation, Complex systems, Pedestrian movement, Urban mobility

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#### **NEIGHBOURHOOD EFFECTS AND ENDOGENEITY ISSUES**

**Claire DUJARDIN, Dominique PEETERS and Isabelle THOMAS**

Université catholique de Louvain, CORE and Department of Geography, Belgium

##### **ABSTRACT**

A recent body of research in the fields of geography, economics and sociology suggests that the spatial structure of cities might influence the socioeconomic characteristics and outcomes of their residents. In particular, the literature on neighbourhood effects emphasises the potential influence of the socioeconomic composition of neighbourhoods in shaping individual's behaviours and outcomes, through social networks, peer influences or socialisation effects. However, empirical work has not reached yet a consensus regarding the existence and magnitude of such effects. This is mainly because the study of neighbourhood effects raises important methodological concerns that have not often been taken into account. Notably, as individuals with similar socio-economic characteristics tend to sort themselves into certain parts of the city, the estimation of neighbourhood effects raises the issue of location-choice endogeneity. Indeed, it is difficult to distinguish between neighbourhood effects and correlated effects, i.e. similarities in behaviours and outcomes arising from individuals having similar characteristics. This problem, if not adequately corrected for, may yield biased results.

In the first part of this chapter, neighbourhood effects are defined and some methodological problems involved in measuring such effects identified. Particular attention is paid to the endogeneity issue, giving a formal definition of the problem and reviewing the main methods

that have been used in the literature to try to solve it. The second part is devoted to an empirical illustration of the study of neighbourhood effects, in the case of labour-market outcomes of young adults in Brussels. To this end, the effect of living in a deprived neighbourhood on the unemployment probability of young adults residing in Brussels is estimated using logistic regressions. The endogeneity of neighbourhood is addressed by restricting the sample to young adults residing with their parents. However, this method is an imperfect solution. Therefore, a sensitivity analysis is used to assess the robustness of the results to the presence of both observed and unobserved parental covariates. Results show that living in a deprived neighbourhood significantly increases the unemployment probability of young adults. This result is not sensitive to the presence of observed and unobserved parental characteristics.

#### **KEYWORDS**

Neighbourhood effects, Endogeneity, Self-selection, Sensitivity analysis, Brussels

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### **GIS IN HEALTH AND SOCIAL CARE PLANNING**

**Ronan FOLEY <sup>\*,\*\*</sup>, Martin C. CHARLTON <sup>\*</sup> and A. Stewart FOTHERINGHAM <sup>\*</sup>**

<sup>\*</sup> National Centre for GeoComputation, NUI Maynooth, Ireland, <sup>\*\*</sup> Department of Geography, NUI Maynooth, Ireland

#### **ABSTRACT**

The application of GIS and GI science approaches within health and social care has been an established area for research for over twenty years. The chapter identifies core theoretical concerns with topics such as: supply, demand, need and choice in health care, and examines some of the ways in which these notions have been modelled quantitatively in applied settings. In addition, summaries are provided of previous research in the sub-themes of accessibility & utilisation, health inequalities, location-allocation modelling, epidemiology, service planning and health informatics. The second part of the chapter examines three research case studies carried out by the authors in the UK and Ireland around the areas of: a) cross-border hospital accessibility, b) geographically-weighted regression modelling of illness data and, c) the planning of social care services. The final section identifies some future directions for work under the wider headings of spatial data, analysis and visualisation.

#### **KEYWORDS**

Health care, Social care, Modelling, Spatial data, Visualisation

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## **SPATIAL ANALYSIS OF SOCIAL FACTS**

### **A TENTATIVE THEORETICAL FRAMEWORK DERIVED FROM TOBLER'S FIRST LAW OF GEOGRAPHY AND BLAU'S MULTILEVEL STRUCTURAL THEORY OF SOCIETY**

**Claude GRASLAND**

Université Paris Diderot, UMR 8504 Géographie-cités, France

#### **ABSTRACT**

This document presents an attempt to build a theoretical framework for the spatial analysis of social facts, derived from Tobler's first law of geography ('Everything is related to everything else, but near things are more related than distant things') and Blau's theory of macro sociology and multilevel structural analysis. At the individual level four basic times of position and interaction are defined (geographical/sociological and discrete/continuous). It is then necessary to discuss the effects of scale aggregation and time dynamics on the elementary levels of position and interaction. This part is illustrated by examples about airflows between world cities in 2000 and euro coin diffusion across borders between 2002 and 2007.

#### **KEYWORDS**

Theory, Social Science, Geography, Sociology, Spatial Analysis, Social Morphology, Durkheim, Simmel, Blau, Tobler

## **MACHINE LEARNING MODELS FOR GEOSPATIAL DATA**

**Mikhail KANEVSKI<sup>\*</sup>, Loris FORESTI<sup>\*</sup>, Christian KAISER<sup>\*\*</sup>, Alexei POZDNOUKHOV<sup>\*</sup>, Vadim TIMONIN<sup>\*</sup> and Devis TUJA<sup>\*</sup>**

<sup>\*</sup>Institute of Geomatics and Analysis of Risk, University of Lausanne, Lausanne, Switzerland, <sup>\*\*</sup>Institute of Geography, University of Lausanne, Lausanne, Switzerland

#### **ABSTRACT**

This chapter presents an introduction to machine learning models/algorithms and their potential applications to geospatial data. The main attention is paid to widely used models which are based on artificial neural networks (multilayer perceptron, general regression neural networks, self-organizing maps) and statistical learning theory (support vector machines). The main ideas of spatial classification, spatial predictions/mapping including automatic algorithms, nonlinear dimensionality reduction and visualization of high dimensional multivariate socio-economic data, treatment and classification of remote sensing images by applying machine learning are illustrated using real data case studies.

#### **KEYWORDS**

Machine learning algorithms, Geospatial data, Mapping and classification, Dimensionality reduction, Remote sensing

## **SOCIAL ACCOUNTING MATRICES: THE DEVELOPMENT AND APPLICATION OF SAMS AT THE LOCAL LEVEL**

**Eveline S. van LEEUWEN and Peter NIJKAMP**

Department of spatial economics, VU University Amsterdam, the Netherlands

### **ABSTRACT**

This contribution aims to highlight the importance of Social Accounting Matrices (SAMs) for the study of regional-economic interactions. After a conceptual review of SAMs, the attention is focused on the empirical meaning of SAMs for economic impact assessment. The potential of SAMs is illustrated by an extensive pedagogical treatment of this tool on the basis of several town-hinterland interactions in 5 different European countries.

### **KEYWORDS**

Social Accounting Matrices, Multiplier analysis, Towns, Hinterland, Interregional effects

## **INTEGRATING MORPHOLOGY IN URBAN SIMULATION THROUGH RETICULAR AUTOMATA**

**SCHELLING'S MODEL OF SEGREGATION AS USED WITH REMUS**

**Diego MORENO<sup>\*</sup>, Dominique BADARIOTTI<sup>\*\*</sup> and Arnaud BANOS<sup>\*\*\*</sup>**

<sup>\*</sup>Laboratoire Société Environnement Territoire, <sup>\*\*</sup>Laboratoire Image Ville et Environnement, <sup>\*\*\*</sup>Laboratoire Géographie-cités, France

The representation of space through graph formalism permits to integrate the anisotropy of urban space in cellular automaton models. In order to analyze the influence of a graph structure in simulation dynamics we study here a segregation model implemented in a graph-based cellular automaton. The Remus model calculates neighborhood graphs in a city and integrates them to the segregation model proposed by Thomas Schelling.

In the first part we present a state of the art of graph-based cellular automata and of morpho-dynamic research in urban studies. We present also the Remus methodology as used to create neighborhood graphs based on network accessibility between buildings as a way to integrate complex urban forms in simulation. In the second part we analyze the structure of the neighborhood graphs calculated by Remus for the town of Pau. Finally, in the third part, we study the impact of this structure on the simulation of spatial segregation as described in Schelling's model.

This application demonstrates the possibilities offered by graph formalism. On the one hand it permits the analysis of urban forms through graph indicators. On the other it allows one to integrate the heterogeneity of urban space in simulation. This approach is obviously an interesting way to explore the relationship between form and dynamics in urban studies.

### **KEYWORDS**

Urban morphology, Graph theory, Cellular automata, Schelling's segregation model

## ACCESSIBILITY ANALYSIS: AN OVERVIEW AND A HEALTH SERVICE APPLICATION

Karyn MORRISSEY<sup>\*,\*\*,\*\*\*</sup>, Graham CLARKE<sup>\*\*\*</sup>, Stephen HYNES<sup>\*,\*\*</sup> and Cathal O'DONOGHUE<sup>\*,\*\*</sup>

<sup>\*</sup>Department of Economics, National University of Ireland, Galway, <sup>\*\*</sup>Rural Economic Research Centre, Teagasc, Athenry, Republic of Ireland, <sup>\*\*\*</sup>School of Geography, University of Leeds, Leeds, UK

### ABSTRACT

The aim of this chapter is to provide a comprehensive overview of accessibility analysis and its usefulness in an applied setting. Specifically, the aim of this chapter is to demonstrate the effectiveness of accessibility measures, in this case a spatial interaction model, in examining whether acute hospital services are optimally located, given the spatial distribution of long term illness (LTI) at the small area level. We do this by using a spatial microsimulation model to simulate micro-level LTI data at the small area, electoral division (ED) level. The simulated data on LTI are then inputted into a spatial interaction model to highlight areas with low acute hospital accessibility given their health status. The policy implications of these results are discussed in relation to both the health care literature and current Irish health care policy.

### KEYWORDS

Accessibility Analysis, Spatial Microsimulation, Health Service Provision, Long Term Illness, Ireland

## CHOICE SET GENERATION IN SPATIAL CONTEXTS

### A RETROSPECTIVE REVIEW

Francesca PAGLIARA<sup>\*</sup> and Harry J.P. TIMMERMANS<sup>\*\*</sup>

<sup>\*</sup>University of Naples Federico II, Italy, <sup>\*\*</sup>Eindhoven University of Technology, the Netherlands

### ABSTRACT

The importance of properly specifying choice sets to avoid biased parameters is well recognized in the literature and it is particularly relevant for spatial choice models where alternatives are generally numerous and somewhat artificially defined (i.e. traffic zones). The choice set refers to the set of discrete alternatives considered by an individual in the decision-making process which is a subset of the universal choice set that consists of all alternatives available to the decision-maker. The objective of this paper is to review the various approaches to choice set formation present in the literature. Strengths and weaknesses of each of these approaches are discussed.

### KEYWORDS

Choice set, Spatial choice, Deterministic approach, Behavioural approach, Dominance variables

## CELLULAR AUTOMATA IN URBAN SIMULATION: BASIC NOTIONS AND RECENT DEVELOPMENTS

Nuno PINTO<sup>\*</sup>, António ANTUNES<sup>\*</sup> and Josep ROCA<sup>\*\*</sup>

<sup>\*</sup>Department of Civil Engineering, University of Coimbra, Portugal, <sup>\*\*</sup>Center for Land Policy and Valuation, Technical University of Catalonia, Spain

### ABSTRACT

Cellular Automata (CA) is a spatial simulation technique that has been the subject of intensive research for the last two decades. This technique draws its theoretical origins in the 1940s with the research effort made by von Neumann and Ulam for devising mathematical rules for the evolution of biological systems. The intrinsic spatial character of CA suggested their introduction to quantitative geography by Tobler in the 1970s. In this chapter, we firstly present a concise literature survey on CA and their use in geography. The mathematical formulation of CA is presented, as well as their main applications to urban geography and urban studies. The discussion over important CA relaxations is introduced. In the second part of the chapter we present a series of recent developments regarding the use of geographic CA. Two main issues constitute the core of these developments: the choice of the modeling scale and the use of irregular cells. The development of a CA model for simulating change in small urban areas is presented. The use of irregular cells in opposition to the classic regular, pixel-based cells is also discussed. Finally, a reflection is made about future trends in a multi-scale CA for modeling urban and regional growth.

### KEYWORDS

Cellular automata, Land use, Urban change, Small urban areas, Multi-scale

## QUALITATIVE METHODS IN GEOGRAPHY AND PLANNING

Giovanni A. RABINO and Matteo CAGLIONI

Department of Architecture and Planning, Polytechnic of Milan, Italy

### ABSTRACT

In human sciences including geography, qualitative methods (such as interviewing, content analysis, qualitative data analysis, etc.) have a long tradition, that often has been considered alternative - or, at least, - independent from quantitative methods. But, recently, the awareness of the fallacy of this dichotomy has appeared, giving space to a complementarity of methods or to an unified vision, that is the perspective adopted in this contribution. The paper therefore begins with an analysis of reasons for this change, associated, not by chance, to an increase in use of qualitative methods. Operationally, this is due to a shift in computer use: from simply “number crunching” to performing several tasks (data handling, executing logical algorithms, etc.). More generally, this technical change is induced by the “complex systems” epistemological perspective, where “the qualitative” is re-valued as a signature of complexity.

It is shown that, in order to deal in a rigorous way with qualitative information, we can try many tricks. In some cases, the large memories and the power of computation of the machine are enough for facing problems with qualitative data, otherwise non treatable; in other cases, this

goal is reached by the possibility of “visualization” of information or “cooperative solution” (through communication) allowed by the computer. Moreover, in some cases the qualitative is managed by means of algorithms (carrying out a sequence of “logical” statements); in other cases the problem is “hardened” (made quantitative), then the output is “relaxed” (reduced to a probabilistic result).

Even if the set of methods is rapidly increasing, we look for a taxonomy of the bulk of tools, according to potential use in geography and planning. Considering, for instance, characterization of geographical objects, spatial statistical analysis, territorial modeling and simulation, etc., every qualitative method (e.g. conceptual maps, ontologies, folksonomies, cladistics, qualitative regression, cross impact analysis, expert systems, etc.) is classified, with a short description of its main features.

For a better understanding of meaning, procedures and potentialities of qualitative methods, a brief account of four case-studies is given. A software for building “ontology” is used to map a system of interacting agents; “textual statistics” are applied for analyzing the perception of landscape on the basis of an “open answer” (qualitative) survey; the “cross impact analysis” is the qualitative modeling tool built for the evaluation of the consequences of a land-use project; in a qualitative “multi-criteria evaluation” it is grounded the site selection for location of a big infrastructure.

As a conclusion, the perspectives of qualitative methods are discussed, in the light of two emerging phenomena: respectively, the incoming “extreme data” availability age; and the next “highly automatic” computer-based research activity epoch.

## KEYWORDS

New qualitative methods, Epistemological foundations and methodological principles, Applications: ontology, textual statistics, cross impact analysis, multicriteria evaluation

## A SMALL WORLD PERSPECTIVE ON URBAN SYSTEMS

Céline ROZENBLAT\* and Guy MELANÇON\*\*

\*IGUL, University of Lausanne, Switzerland, \*\*LaBRI, University of Bordeaux - INRIA, France

## ABSTRACT

The theory of small world network as initiated by Watts and Strogatz 1998 has drawn new insights on spatial analysis as well as to systems theory. Its concepts and methods are particularly relevant to geography where spatial interaction is mainstream, and where interactions can be described and studied using large volume of exchanges or similarity matrices.

Networks indeed organize through direct links or by indirect paths, inducing topological proximities simultaneously involving spatial, social, cultural or organizational dimensions. Network synergies build over similarities and are fed by complementarities between or inside cities, the two effects potentially amplifying each other according to the “preferential attachment” hypothesis that has been explored in a number of different scientific fields (Barabási & Albert, 1999; Barabási, 2002; Newmann et al., 2006). In fact, according to Barabási &

Albert (1999), the high level of hierarchy observed in “scale-free networks” results from “preferential attachment” which characterizes the development of networks: new connections appear preferentially close nodes already having the largest number of connections. In this way, the improvement in the network accessibility of the new connection will probably be greater. But at the same time, network regions gathering dense and numerous weak links (Granovetter, 1973, 1985) or network entities acting as bridges between several components (Burt, 2004) offer a higher capacity for urban communities to benefit from opportunities and create future synergies. Several methodologies have been suggested on how such denser and more coherent regions (also called communities or clusters) in term of links can be identified (Watts & Strogatz, 1998; Watts, 1999; Barabasi & Albert, 2000; Barabasi, 2003; Auber et al. 2003, Newmann et al., 2006).

These communities not only possess a high level of dependency between their member entities, but also show a low level of “vulnerability” allowing for numerous redundancies (Burt, 2000, 2005).

The SPANGEO project 2005-2008 (SPAtial Networks in GEOgraphy), gathering a team of geographers and computer scientists, has conducted empirical studies to survey concepts and measures developed in other related fields such as physics, sociology or communication science. The relevancy and potential interpretation of weighted or non weighted measures on edges and nodes were examined and analyzed at different scales (intra-urban, inter-urban or both). New classification and clustering schemes based on the relative local density of subgraphs were developed. The article describes how these notions and methods bring a contribution on a conceptual level, in terms of measures, delineations, explanatory analysis and visualization of geographical phenomena.

#### **KEYWORDS**

Urban Systems, Networks, Graphs, Small Worlds, Multi-level approach, Multi geographical scale