



Universidade do Minho

Escola de Engenharia

Semana da Escola de Engenharia October 24 - 27, 2011

AN AGENT-BASED MODEL TO SIMULATE THE DEVELOPMENT OF INDUSTRIAL PARKS IN AN URBAN NETWORK

Fernando Fonseca and Rui Ramos
C-TAC, Department of Civil Engineering, University of Minho
E-mail: ffonseka@gmail.com

KEYWORDS

Multi-agent systems, agent-based models, industrial parks, urban quadrilateral.

EXTENDED ABSTRACT

The main purpose of this abstract is to briefly describe the work developed until now under the PhD thesis entitled “An agent-based model to simulate the development of industrial parks in an urban network”. The goal of this research is to construct an agent-based model to simulate the behaviour of industrial parks in the urban network knew by “Urban Quadrilateral”, which is composed by the Portuguese municipalities of Barcelos, Braga, Famalicão and Guimarães.

Multi-agent systems (MAS) can be described as computational systems composed by several entities (the agents) inserted in an environment that can be abstract or represent a part of the real world. The two main agents' features are the ability of interact with other agents and with the environment and the capability of take decisions individually. To promote interactions, agents encompass several skills, such as sensors to perceive the characteristics of the other elements, an internal state of deliberation responsible for the decisions, actuators to allow the execution of the decisions, a language protocol to facilitate the communication and the ability of move around the system. The interactions undertaken by the agents can define patterns and trends of evolution that can be used to construct scenarios and to strength the decision process in a bottom up format (the global pattern results from several micro interactions). This procedure can be very helpful in domains where a large number of entities, moved by a multitude of motivations and interests, interact. Social sciences, urban planning and traffic planning are three specific examples where the utilisation of MAS has substantially increased in the last years (Castle & Crooks, 2006). The cognitive and the reactive agents are the two most representative

categories of agents. Cognitive agents are moved by goals and perform cognitive capabilities to reach these goals. Systems with this type of agents can be constructed to solve problems where complex tasks such as negotiation and coordination are need. Reactive agents are based in answers to stimulations received from the environment/other agents, without the intervention of mental deliberations. Games and robotic are two examples where reactive agents are largely used.

Nowadays there are several software's that can be used to construct agent-based models: (i) the open source platforms based on Java language, that has a lot of applications due to the possibility of change the source code (such as the Swarm, the Repast, the Mason, etc.); (ii) the shareware/freeware platforms, that are less flexible since the source code cant be changed, requiring less experience in programming (such as the StarLogo and the NetLogo platforms); (iii) and the commercial platforms design for specific applications which don't allow any change to their functionalities (AnyLogic, AgentSheets, etc.).Some platforms were designed to encompass other techniques of analysis, mainly cellular automata and GIS, which improve their simulation capacity.

In territorial planning, the first models that explicitly employ MAS appeared in the early 90's. The advances verified in the informatics and the geographic data that becomes more and more detailed and accessible encouraged the development of these models in the last decade. Some examples of the most referenced include: the UrbanSim model (Waddell, 2002); the ILUTE model (Miller et al., 2004); and the ILUMASS model (Moeckel et al., 2002). Briefly, the analysis of the impact that the individual decision of each agent have in the land use change and in the transport demand is the main goal of these models.



Universidade do Minho

Escola de Engenharia

Semana da Escola de Engenharia October 24 - 27, 2011

The literature revision shows that the urban scale is the most used in the agent-based simulation. There are few examples of models developed to larger regions: the Ramblas model developed by Veldhuisen & Timmermans (2000) is one of that exceptions; and also scarce examples of models conceived to analyse urban networks. In this last case, the SimPop and the EuroSim (Sanders, 2006) are two specific cases of models developed to simulate the growth of urban networks. The large number of agents and the consequent complexity of the model, the lack of data and the own difficulty in define precisely the matter of analysis are the main constraints put by the regional scale (Bretagnolle et al., 2003).

The agent-based models conceived to simulate the territorial organisation of industrial parks are more limited (Fioretti, 2006). In this specific domain of territorial planning, the most significant example are usually focused on places of strong concentration of firms, mainly clusters and industrial districts, with the purpose of simulate the advantages of agglomeration, the competition effects, the cooperation and collaboration between the firms and other institutions, the innovation activity and the impact of politics.

The development of models to analyse the dynamics between industrial parks are more restricted in the literature, which highlights the innovator character of this research. The aim is construct an agent-based model to simulate the evolution of the industrial parks in the Urban Quadrilateral considering different scenarios. Based on the conditions of the present supply in terms of facilities, amenities, number of parks, rates of occupation, prices requested, management structures and strategies defined by the municipalities, the model will be capable of indicate which parks reveal more potential to integrate an network of industrial parks at the regional scale (indicating the most and the less competitive), the competitive impact of the improvement measures that can be undertaken in each park and the contribution of the future parks foresighted by the municipalities. With these purposes, the ambition of the model is to show the coherence and the effectiveness of the policies undertaken by the municipalities of the Urban Quadrilateral. Furthermore, the research aims at show the benefits of develop an agent-based model to the territorial planning domain, a technique few used in territorial planning in Portugal.

REFERENCES

- Bretagnolle, A., Daudé, E., Pumain, D. (2003) "From theory to modelling : urban systems as complex systems". In *13th European Colloquium on Quantitative and Theoretical Geography*, 8th-11th September, Lucca.
- Castle, C., Crooks, A. (2006) "Principles and concepts of agent-based modelling for developing geospatial simulations". In Working Papers Series, N.º110, UCL Centre For Advanced Spatial Analysis.
- Fioretti, G. (2006) "Agent-based models of industrial clusters and districts". In Tavidze, A. (ed.), *Progress in Economics Research*, Vol. IX, Chapter VIII, pp.125-142.
- Miller, E., Hunt, J., Abraham, J. (2004) "Microsimulating urban systems". In *Computers, Environment and Urban Systems*, N.º 28, pp.9-44.
- Moeckel, R., Schurmann, C., Wegener, M. (2002) "Microsimulation of urban land use". In *42nd European Congress of the Regional Science Association*, 27-31 August, Dortmund.
- Sanders, L. (2006) "Les modèles agent en géographie urbaine". In Amblard F., Phan D. (eds.), *Modélisation et simulation multi-agents, applications pour les sciences de l'homme et de la société*, pp.151-168.
- Veldhuisen, J., Timmermans, H. (2000) "RAMBLAS: a regional planning model based on the microsimulation of daily activity travel patterns". In *Environment and Planning A*, Vol.32, pp.427-443.
- Waddell, P. (2002) "UrbanSim: modeling urban development for land use, transportation, and environmental planning". In *Journal of the American Planning Association*, Vol. 68, N.º3, pp.297-314.

AKNOWLEDGEMENTS

The authors wish to thank the Portuguese Foundation for Science and Technology (FCT) the support given through the doctoral grant SFRH/BD/48567/2008.

AUTHORS' BIOGRAPHIES

FERNANDO FONSECA is a PhD student in the University of Minho. He is graduated in Geography (1997) by the University of Porto and master in Municipal Engineering (2006) by the University of Minho. He has several papers and articles published.

RUI RAMOS is professor of Civil Engineering Department, University of Minho, where he started his regular work as a lecturer and researcher in 1993. His area of expertise is urban and regional planning and he is a PhD Researcher at C-TAC, Territory, Environment and Construction Centre.