Chapter XII
Mechanisms of Automated Formation and Evolution of Social-Groups: A Multi-Agent System to Model the Intra-Urban Mobilities of Bogotá City

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**ABSTRACT**

In this chapter, we present a multi-agent system that models and simulates the dynamics of intra-urban mobility through the automated formation and evolution of both groups of households and groups of housing-units. We consider global rules of evolution instead of individual events to represent the evolution of both the population and the housing-stock. The moving mechanism is modelled by interactions between groups and urban-sector agents in a simulated housing market. We have tested this system on the basis of several census datasets of Bogotá city. The evolution of groups has been simulated over 20 years and compared to real data. The results of group formation and evolution mechanisms have been compared to classes produced by classical classification methods. Very good correlations have been found. The simulated population has been compared to real distributions of several Bogotá districts and appears to be close for an important number of them.

**INTRODUCTION**

Modelling a social system implies the intervention of dynamics at different space and time scales. Unlike most multi-agent simulation examples, where only two levels of analysis are considered (the microscopic level where agents are located and simulated, and the macroscopic level where
structures or emergent properties are analysed: \cite{Portugali1995, Bura1996, Holm2001, Bonnefoy2003}, in social simulation, it is often necessary to consider actors at various levels with different temporalities and points of view. In the urban case, inhabitants, developers, and institutions have different points of view (space scales of analysis or action) about both what the city is and what phenomena are to be considered in a city. Their actions in what they consider as their environment generate consequences on various space and temporal scales. Consequently, when these types of systems are studied, it is generally necessary to consider more than two modelling levels, with heterogeneous agents interacting between them at different space and temporal scales. In certain cases, even more “artificial” objects are to be introduced, for instance abstractions (such as categories of individuals, social-groups, types of habitat, etc.) used to reduce the complexity of the simulation. These objects normally operate on scales located somewhere between micro and macroscales.

At this prospect, C. Mullon and M. Piron \cite{Mullon2001, Piron2003}, developed a model formalized within the framework of the game theory. They evaluate the evolution and redistribution of households, which change their housing inside the city. They adopt a synthetic approach: to establish intermediate levels of modelling localized between the geographical unit and the household. Thus, they used some multivariate structures of both social and habitat compositions on the scale of the city. But the model is not adapted to fluctuant structures. To work with that kind of structures, it is necessary to consider entities that can evolve, interact, appear, or disappear.

In this context, we are interested in implementing an automated constitution, evolution and behaviour (nature of their interactions) of agents which represent abstractions of reality. We call these agents, “abstract composed agents.” Composed because the approach used to model their formation is similar to the formation of groups or coalitions of agents: They are composed by a significant number of agents which are localized at a lower modelling level. Abstract, because they represent abstractions of reality. The composed agents act between them but also with agents at lower levels. Thus, there are interactions at several levels but also between several levels.

On this basis, the system presented here implements two complementary models: The first one allows the passage from microscopic level to an intermediate, or mesoscopic, level by the simulation of formation and evolution of groups of households and housing-units; the second one acts at the mesoscopic level and models the moving house process by the simulation of interactions between groups. In the first model, the evolution of groups is a consequence of evolution of both the population of households and housing-stock. We adopt a global approach to represent this evolution using general rules of evolution. Unlike traditional individual approach, used in particular in microsimulation \cite{Orcutt1976, Clarke1996, Holm2001, Antcliff1993}, we do not consider individual events such as birth, ageing, marriage, or death. On the contrary, we consider global tendencies which describe the evolution of population and housing-stock. We adopt a global approach to represent this evolution using general rules of evolution. Unlike traditional individual approach, used in particular in microsimulation \cite{Orcutt1976, Clarke1996, Holm2001, Antcliff1993}, we do not consider individual events such as birth, ageing, marriage, or death. On the contrary, we consider global tendencies which describe the evolution of population and housing-stock. We adopt a global approach to represent this evolution using general rules of evolution. Unlike traditional individual approach, used in particular in microsimulation \cite{Orcutt1976, Clarke1996, Holm2001, Antcliff1993}, we do not consider individual events such as birth, ageing, marriage, or death. On the contrary, we consider global tendencies which describe the evolution of population and housing-stock. We adopt a global approach to represent this evolution using general rules of evolution.

**GENERAL DESCRIPTION OF THE MODELS**

At the microscopic level, we consider two types of micro-agents: households and housing-units. At the mesoscopic level, we also consider two types of meso-agents: groups of micro-agents and urban-sectors.

Groups are formed by similar micro-agents with respect to their sociodemographical charac-
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