Chapter 14
Conflict Resolution with Agents in Smart Cities

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ABSTRACT

Today, there is a common trend to use tools and methodologies that allow the development of Multi-Agent Systems (MAS) with capabilities of reorganization and adaptation to determine changes in their environments. This work presents an architecture based on different levels and whose key level is the one corresponding to the semi-open type of MAS, structured in such a way that it is able to solve conflicts. In addition, a case study is introduced with the objective of showing the possibilities on conflict resolution basis, where a specifically designed architecture is utilized for that purpose. In particular, the system is applied to the resolution of the conflict raised by the decision of the technology to be used in order to obtain or to measure information in smart cities.

INTRODUCTION

Recent technological developments have shown a rapid evolution in wireless communications, sensors, information distributed processing, and other new technologies, all of which are mainly associated to a new paradigm known as the Internet of Things (Weber, 2010, pp. 23-30). This technological evolution has resulted in an increase in the features and services available through the Internet. Accordingly, there is not only an increase in online services, but also an increase in new services in the real world, mainly in large urban areas, which use the technological base provided by the Internet of Things paradigm. In effect, we are talking about smart cities, which have emerged as a response to the challenges experienced by cities in meeting objectives regarding the socio-economic development and quality of life of their citizens (Schaffers et al., 2011, pp. 431-446).

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Smart cities have become quite significant, and are currently one of the main objectives of research in America as well as in the European Union (Caragliu, Del Bo, & Nijkamp, 2011, pp. 65-82). The main interest currently consists of directly or indirectly increasing the well-being of the population. *Direct* measures include offering new services or improving existing ones. Some of the ways to achieve this objective consist of tele-care services for the elderly or dependent persons, the use of traffic optimization techniques, actively controlling energy supplies, etc. *Indirect* measures include offering the same services, as perceived by the citizens, but changing the way they are managed or their internal performance in order to increase the economic savings of the city. This will definitely imply an indirect increase in the quality of life for the citizens (tax savings, new services offered as a result of the economic savings, etc.). An example of the latter would be the replacement of older light bulbs in public light fixtures with new bulbs with a lower power requirement (LED bulbs for instance). Thus, new technological advances make it possible to rapidly increase the ability to enhance the social well-being of a city. While this may result in greater benefits for the cities, it is not without some disadvantages.

The reasons why emerging technologies are a major benefit are self-evident: the majority of the advances are going to be useful to improve any factor, whether in data acquisition, information transmission or information processing. However, the unstoppable technological evolution means that in most of the cases different alternative technologies, with similar characteristics and capabilities, will be required to cohabitate at the same time and in the same environment. On the other hand, the constantly evolving technology makes it necessary, in some cases, to dismiss the existing infrastructure.

Thus, one of the main current concerns for most cities is the integration of new technologies in everyday environments and their ability to improve the well-being of each citizen. With the objective of solving the problems associated with the technological evolution, we turn to Agent technologies, in particular, those following a design model based on roles, objectives and norms.

There is no doubt that Multi-Agent Systems (MAS) have become tremendously significant during the last years within the environment of Distributed Artificial Intelligence (DAI). MAS allow solving problems in a distributed manner by taking advantage of social behaviors as well as the individual behavior of the agents. Since a smart city requires the features of an open system (dynamic, heterogeneous and with uncertainty), MAS have been applied in this environment with promising results, for example to address multiple aspects in the management of smart cities (Roscia, Longo, & Lazaroiu 2013, pp. 371-376).

Recently, the design theories of MAS promote their grouping into organizations or societies, thus sharing features, norms and objectives. These societies can be open or closed societies depending on their flexibility to admit new members. These capabilities, similar to those of human societies, are perfectly suited to the new open context of smart cities. One example of these capabilities is the use of a semi-open society, as the design model would be able to evolve and auto adapt to new situations. Another example is allowing different members, independently of the technology used, to enter the society to provide the services of a specific role. For example, given the task of regulating city traffic, two roles, which would be technologically independent, might include counting the number of vehicles on the road and regulating traffic lights according to available information.

This ability would make it possible to obtain a system capable of making the best decision regarding the technologies to be used. This system also prevents possible changes from negatively impacting the management, or the services offered. This means that a change in technology will not affect the way the system uses or presents the information. It tremendously facilitates tasks requiring a human operator without needing to adapt the software that manages the information gathered by the sensors.

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