Chapter 15
Spatial Ontologies in Multi-Agent Environmental Planning

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ABSTRACT
Landscapes and townscapes have been studied by many disciplinary areas over time. This study addresses the cognitive and perceptual dimensions of environmental spacescapes in planning by human agents. In fact, because of their dynamic complexity, environmental spacescapes create challenges for the typical spatial behaviour of an agent perceiving and navigating in it. Therefore, environmental planning activities need to identify and manage the ‘fundamentals’ of spacescapes from the viewpoints of living single agents or multi-agent organizations, those to whom the planning effort is addressed. In this framework, the chapter deals with spatial ontologies in multi-agent systems. Some recent experiments are described and discussed here, highlighting spatial features of navigated environments from an environmental planning perspective.

INTRODUCTION
Landscapes and townscapes have been studied by many scholars over many past decades, from the milestone essay by Lynch (1960) to the more recent spatial-cognition literature (e.g., Golledge, 1998; Amedeo et al., 2008; Lloyd, 2009). The present study aims at contributing, by addressing a specific issue, to a broader discussion. The starting point is the increasing awareness that today spacescapes (i.e., townscapes, cityscapes and the like) represent not merely backgrounds, but rather the main, knowledge-intensive, meaningful spaces and entities that the humans adapt for their lives. They show fair dynamic complexity, where the spatial behaviour of the agents proves to be atypical, ill-structured, particularly (but not only) when needing to be simulated in AI environments, such as cybernetics or robotics. In this picture, an understanding of spatial-cognition issues can be attempted by looking at the ‘fundamentals’ of
spacescapes, located in the resilient needs and ways of living and reasoning of multiple agents.

Indeed, the impact of spaces on human agents’ behaviours is traditionally steeped in prejudicial common sense. Accordingly, well designed space architectures or artworks seem to be more able to give significance to the space for humans to live in, than formless, unstructured spaces. Also, conversely, urban social marginality is seen as connected to the abundance of landmarks and symbols in city spaces, supposedly able to deprive or alienate poor people. However, common sense and prejudices catch on easily, since no practical and theoretical distinction is clearly put down between content and form, in real world. Yet space is often claimed as being characterized by diverse attributes and features where primary, essential qualities (spacescape ‘fundamentals’) are distinct from additional, secondary qualities (spacescape ‘ornaments’) (see, e.g., Goodman, 1951, albeit with some sceptical remarks).

Human agents think and operate in living spaces, both as single and as multiple agents. Their perception and representation of space determine space ontologies, whose importance is commonly essential for AI robotics. As there is circularity between AI and cognitive science, it is evident that developing robotic devices may in turn increase knowledge on human behaviours in space. Therefore, an exercise of identification and comprehension of space features in human agents can be critical in multi-agent social and environmental reasoning, particularly when dealing with strategic participatory planning. In fact, in these cases, an increasing knowledge on space fundamentals may induce the shared identification of structures, pillars, invariant, resilient characters of the environment, on which to build/plan the development of cities and towns.

In this context, decision-support systems (DSS) would largely benefit from an involvement of multiple agents that is able to be non-reticent on the intrinsic complexity in which agents themselves live, perceive and reason.

Basing on the above points, the present chapter looks at space ontology in multi-agent systems, by presenting and discussing some experimentations carried out by our research group in recent years. In particular, the next section 2 starts from the discussion of the spatial-cognition outcomes of a decade of group reasoning for scenario-building activities in local planning. Then it ends up by drawing out results from a multi-agent experimentation on spatial knowledge in navigating a built environment. In section 3, brief remarks try to account on achievements and future perspectives of multi-agent spatial cognition in planning.

NOTES ON SPATIAL COGNITION AND REPRESENTATION IN MULTI-AGENT REASONING AND PLANNING

Multi-Agent Spatial Representation in the Mediterranean

From their onset as a proper research-in-action branch, multi-agent-system researches have been intrinsically drawn upon space perception and cognition (Ferber, 1999; Wooldridge, 2002; Weyns et al., 2007a). Ranging from interactive planning processes to the building up of shared visions and scenarios, interactive system architectures have been built trying to involve structurally human and/or artificial agents in the spatial domain and toward spatial themes. Particularly urban and regional environments have been dealt with, in different contexts (Arentze & Timmermans, 2006; Barkowsky et al, 2007; Khakee et al., 2008). Spatial ontologies prove to be decisive in such contexts, intensely space-based, particularly in their crucial role for the building up—and management-of systems relying on ICT architectures, with peculiar languages and rules.

The present chapter examines some results of space-based multi-agent processes, particularly in terms of spatial cognition and representation.

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