Collective Knowledge Management in City Planning: Building Spatial-Cognition Ontologies from Literary Works

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Abstract. Due to the multiple dimensions of urban complexity, ontology-based multiagent models become widespread. These models seem to support complex relational and cognitive interactions in urban decision-making processes. In this context, simulations and experiments are today investigating ontologies applied to spatial planning, as a support in the real world.

Useful feedback can be also found in extensive narratives of some literary works. We explored spatial representations in them, aiming to investigate the complex features and attributes structuring urban spaces, and to develop ontological analyses. A multiagent experimentation was developed with university students, individually selecting extracts from relevant literary works dealing with urban environments, according to the judgment of each student.

This paper focuses in particular on the landmark of the urban square (or 'piazza'), to build an ontology of the square that includes aspects of literary semantics. The reference foundational ontology is DOLCE ontology, represented through Protégé 5.5.0 software.

Keywords: Knowledge management · Decision support · Urban planning · Ontology

1 Introduction

A consolidated scientific literature today confirms the shared awareness of the great dimensional multiplicity of urban complexity [1, 2]. This multiple dimensionality contributes to the formation of an open and very dynamic system, with many different agents, characterized by emergent properties that are the effect of this dynamism [3, p.53]. The most typically representative agents of the city are human agents. They contribute to a complex stratification of artifacts but also of relational and behavioral aspects [4, 5]. These are explicit or tacit relationships, stable or uncertain but unavoidable for the development of cities. An effective management model of such

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The present paper is the result of a more extensive research project. It has been entirely written by the two authors together.

a complex system should therefore aim to structurally involve natural but also artificial environmental components, together with infrastructural elements or technological support and enhancement of urban dynamics.

This has led to a general reluctance to address such management problems in a systematic way, neglecting more elaborate agent-based approaches where agents are biotic but also abiotic, and the natural or built environment is itself often considered as an agent [6]. Yet in this context, multi-agent models capable of supporting complex interactions between agents, cognitive exchanges and informed decision-making seem possible system architectures [7]. In particular, technology becomes a critical support for intelligent systems to structure the problems posed by the fuzzy and dynamic uncertainty of complex environments, especially cities. This is a technological emphasis recognized today as a critical factor in characterizing a smart city as such [8]. Today, the concept of smart city suggests intelligently connecting times, spaces and agents through geographical and physical relationships but also through emotional, creative and informal trusts. In this context, the concept of smart city represents the ability of the city to exist, maintain itself, progress as a multi-agent entity (an 'agency'), intelligently interconnected in its intimate constituents.

In this approach, consciously complex, planning, policymaking, as well as dynamic decision-making actions benefit in terms of sustainability and effectiveness of urban governance. However, the operational terms of this transformation of complex knowledge into action still remain complex and 'wicked' [9]. Recently, an ontology-based approach emerged as an interesting opportunity for the analysis and understanding of such multidimensional cognitive assortment. It came out as an adequate formalization model of smart-city management architectures [10]. Some lines of research have followed, resulting in a number of explorative publications [11–14]. Currently, research activities on ontologies applied to planning have been developed by our group, on the construction of ontologies integrated by multilevel and multidisciplinary knowledge [13, 15, 16].

In particular, practical activities were developed in recent years at the Polytechnic University of Bari, Italy. They have often aimed at investigating perspectives for the evolution of research on ontologies applied to planning, in support of the activities carried out in the real field. The knowledge investigated along these experiments had to do with the concept of spatial cognition, especially with the search for material and non-material, proper and interpreted features of the relationship spaces of human agents in their mental or expressed representation activity.

In this context, interaction with the community is necessary to elicit and exchange knowledge from below, as occurring in a mutual learning environment [17]. Interaction with expert agents for formal and formalized multidisciplinary knowledge is also useful [18]. But in the field of spatial planning, a traditional social inspiration often involves aspects of storytelling and narratives [19]. In this direction, we can also note that many spatial representations can be traced in narration expressions, especially in written narrations, found in literature productions. Different literary genres have always grappled with the representation of spaces: prose, poetry, novels. Therefore, we decided to explore such representations, with the aim of investigating on features and attributes of complex urban environment spaces, and to develop an ontological analysis. In this

context, a multi-agent experimentation carried out with university students of the Urban planning program aimed at identifying literary works that deal with cities and urban environments in a narrative context, identifying salient aspects of the individual contributions according to the judgment of each student. Some preliminary results of this experience have been published in the past years and constitute the first step of the entire research [20, 21].

The research work now continues exploring the potential of narration-based investigation after the previous preliminary results, in more illustrative and explanatory terms. The analysis was carried out to one of the landmarks of Lynch's renowned works: the urban square [22]. Therefore, the general objective of this work represents a second step of the entire research. That is building an ontology of the square that includes aspects of literary semantics, framed in a context of support for urban spatial organization, planning and/or design. Specifically, this paper concerns the construction, in an ontological key, of a first taxonomy of the urban square, using the results of the university experimentation on narratives and comparing it with another taxonomy of the square coming from traditional architectural/urban planning manuals [23–25]. The aim is to investigate actual differences between the two taxonomies in catching the spatial-cognition complexity. The foundational ontology of reference is DOLCE ontology, structurally represented through Protégé 5.5.0 software.

The paper consists in the following sections. After this introduction, a section deals with the methodological framework of the research, with particular reference to the planning-oriented and decision-oriented operational aspects of the city. The third section introduces the case study, analyzing the results achieved, while the fourth section comments and discusses the results in the actual research context and towards future perspectives.

2   A Background of Complex Knowledge and Ontology in Planning

Our knowledge of the city and our communication about it occurs between different human (and non-human) agents and is made of words: it mainly consists of natural language. Natural language generally uses implicit meanings and hidden semantic subtleties, so that often its reliability does not reach the level required by some particular activities -as in this case, for example, the technical activities concerning the transformation of the city. The richness of the notion of the city with its complex dynamics has always been a challenge for the planner who has only limited modelling methodologies and techniques available, while it is increasingly clear that the planner is called to identify and manage a great variety of information and points of view.

The role of formal ontology is bringing together different but coherent worldviews. It is a specification of conceptualization in a knowledge domain. Moreover, it helps in sharing disambiguated meanings. Formal ontologies allow for example to characterize the different types of agents that take part in a process, with their behaviours [26, 27].

Our knowledge of places often derives from experiences, from our feelings about them. There is, therefore, a 'subjective knowledge' of places, which is synthesized by a consonance of intentions and experiences in collective knowledge - enriched by the chorus of individuals who form it (such as the inhabitants of a city centre). It is a question

of memory and perspective, but often it is also a question of intentionality, that is even able to start the knowledge of places. 'Subjective knowledge' is a kind of representation of places, and a representation varies from agent to agent and even during an agent's life. With this applied ontological base we can refer to another kind of knowledge implementation, as said previously, i.e., the one we can elicit from prose, novels, poems.

The ontological analysis is the study of what is at the center of a vision of reality. It helps our reading of a given domain. It clarifies and organizes the essential elements and characteristics, for example of places, in terms of objects, properties and processes. We have dealt with applied ontology in the domain of urban and territorial planning in previous research [10, 15, 28]. It mainly aimed to make explicit and clarify the different terminologies involved and to extract interconnections and contrasts through the agents' perspectives or in the available elicited knowledge. Then we proposed a subdivision into ontological levels (such as spatial, artefactual, cognitive, social, cultural) and process (about events over time). Explaining them through the ontological analysis method favours a new basic clarity concerning the 'real' materials with which we act and with which we interface, helping us to propose a self-aware and explicit knowledge system in its semantic-semiological levels. For example: what kind of relationship does the city have with time? Is time a kind of relationship external to the unfolding frame of the dynamics of a city? Time modelling is a special relationship in ontology and a relationship that presents a particular form of complexity in city ontology.

The method described here aims to offer a different, integrative way of supporting planning and managing the territory, that can be even more articulated and advanced in the future.

3   Ontological Support to Decision from a Literary-Based Case Study

This paper draws its materials from a collective exercise carried out with the students of the Urban planning course at the Polytechnic University of Bari. It was carried out by administering an interactive questionnaire with Google forms, through which each student was asked to select from their usual readings three literary passages that dealt with the city. The first general results of this experiment have been published. The experiment was carried out with the aim of contributing to an ontological approach to the spatial analysis of the city, populated with data taken from the literary materials themselves, for purposes of spatial decision support [20, 21]. The general organization of the research involves multi-source cognitive experiments, to be developed through interaction with urban communities, with experts, as well as through the reading of structured, textual or graphic formal data. The general layout can be summarized through a flow chart excerpted from previous papers and shown in Fig. 1.

In this framework, the present work addresses the next step of the research program. In fact, with the aim of investigating the structuring potential of an ontology starting from the experimentation on literary works, we decided to analyze the concept of square (or "*piazza*"), in the works where it is mentioned or described. We have chosen the square among the landmarks recalled by Lynch's famous work [22], as an element genetically embedded in a city (starting from the Agora of the Greeks or the Forum of the Romans)
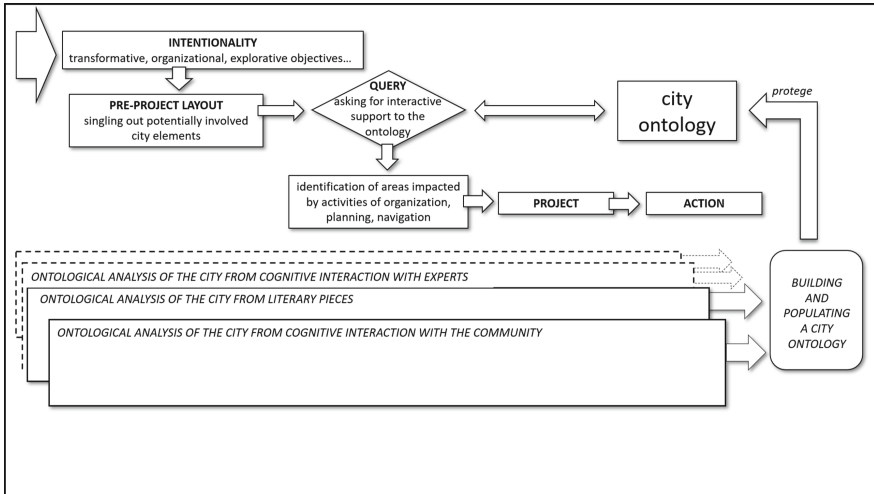
Fig. 1. Phases of ontology building for decision support . (figure taken from [20])

both from a physical, symbolic and social point of view. Therefore, in a first phase we explored the database of the answers of the 160 students to the questionnaire, consisting of 480 literary excerpts. Out of the cited excerpts, 90 contained even a minimal reference to the square, but very often the passage chosen by the students was the same (students seem to have very similar readings!). By eliminating double citations and neglecting those excerpts in which the square was cited without contextualization or description, we finally found 7 passages, including 4 passages from novels and essays, and 3 passages from poems. In relation to these 7 works, relational graphic maps have been developed to highlight the conceptual elements involved: an example of an Italian poem is shown in Fig. 2 [29]. The elements are written in Italian since all the students considered only Italian works. In the paper we have kept the original language throughout the description, to maintain consistency of meaning and of syntactic links, but the final results can be easily translated if needed.

Aiming at a final ontological formalization of the square reported in literature, we decided to create a taxonomic description of it, using DOLCE ontology, lite version, as a structure [30]. This environment was chosen because according to the literature it appears to be the most suitable ontological structure for engineering applications and is dynamically articulated both in concrete and abstract levels. This allows to include many material, immaterial and conceptual aspects, even dynamic ones, which are especially embedded in the complexity of literary representation. For the representation of the structure, we used the well-known software Protégé 5.5.0, from Stanford University, and an extract of the taxonomy of the square built on all 7 maps of the literary works is shown in Fig. 3. Please note that both Fig. 3 and subsequent Fig. 4 are not put down for the purpose of verbatim detailing all classes and subclasses. The two figures are put down with the sole purpose of showing the general articulation level of the LT and TT classifications. Obviously, such large scale limits Protégé's ability to detail mapped written texts here. However, the readability of the mapped texts is not functional in this

Fig. 2. Example of a relational map of the 'literary' square (bold = nouns, locutions; italic = adjectives; other = verbs)

context, and its lessening does not affect the significance of the figures. In fact, at this large scale, the visual comparison immediately supports the evidence of the significant differences in complexity and richness between the two taxonomies.

Fig. 3. Partial excerpt from the 'literary' square taxonomy on DOLCE lite ontology (screenshot from Protégé 5.5.0)

The structure of DOLCE lite has not been completed with the intrinsic and relational properties of the individual elements at this stage. However, the taxonomy thus structured allows to maintain and highlight the representative complexity of the concept of square. It is a fine representation in terms of classes - indeed subclasses, as the classes (or

superclasses) are already formally defined on the ontological root of DOLCE. In this organization, the literary taxonomy (LT) contains 121 subclasses. An amount of 63 subclasses can be classified as *endurant*. This means something having no conceptually distinguishable temporal parts and thus existing in its entirety at each instant of its existence - e.g., being *F* at time *t* and *nonF* at time $t + n$ [31]. Other 51 subclasses can be classified as *perdurant*. They are entities extended in time by temporal parts, that are partially present over time but may be not necessarily present along the entire time - e.g., one phase of a whole, which is present now, may not be present in the future [32]. The rather numerous presence of the subclasses of *endurant* and *perdurant* suggests that in LT the elements of dynamism of the square (particularly *perdurant*) are fundamental to characterize its conceptualization. This seems to be in line with the role played by the square in the spatial and social organization of the city [33].

In this regard, a further parallel survey was developed in order to verify the relevance and relative importance of LT in a perspective of complexity, compared to more traditional conceptualizations of the square. In particular, a comparative analysis was developed with an ontology derived from traditional manual and didactic texts of urban architecture and planning - given the orientation of the work towards spatial planning and design objectives [23–25]. An excerpt of the 'traditional' square taxonomy (TT) is given in Fig. 4.
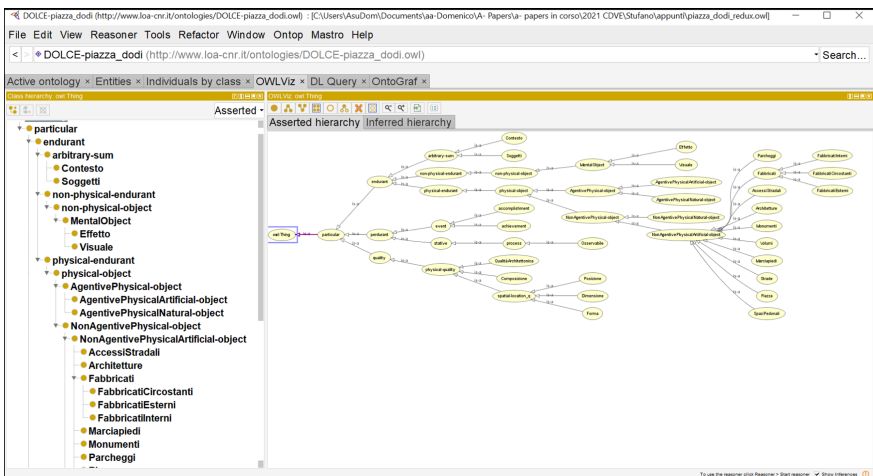

Fig. 4. Partial excerpt from the manual-based square taxonomy on DOLCE lite ontology (screenshot from Protégé 5.5.0).

Along this representation, TT contains only 23 subclasses. An amount of 17 subclasses are *endurant*, while only one is *perdurant* (namely "Observing"). *Endurant*s here are essentially physical architectures, monuments, roads, sidewalks, buildings.

Carrying out a comparison between LT and TT, an imbalance between *endurant* and *perdurant* in the two cases seems evident. Generally speaking, this at least suggests that the role of time is very limitedly considered in TT, while it seems a great value in LT. A vision of an essentially physical and static type emerges in TT, which almost shows

a sort of screenshot and does not seem to include the square in the flow of life of a city. This circumstance is also confirmed by the absence of agentive components in TT (in LT they are 10) and of temporal regions in TT (in LT they are 2).

Moving forward with the comparison, we can analyze mental objects, as part of the non-physical nature of *endurant*s. In literary taxonomy there are 5 mental objects, while they are 2 in TT. In LT they are perceptions, sensations, mental objects as active motions of individual agents. In TT, on the other hand, these are more general and aggregated characteristics. Again, the focus here seems to be on generalizing a subjective interpretation rather than on individual aspects of perception. This circumstance seems to confirm a limitation of TT in the representation of the intrinsic complexity of the urban 'piazza' environment and of the relationships it exerts.

The disproportion between the two taxonomies emerges in an evident way, but actually also reflects clearly intrinsic characters. In particular, the spartan TT derives from an articulation driven not by descriptive aims but by design needs. In them, much is typically left to the sensitivity of the designer and many elements of abstract characterization are considered implicit and embedded in the effect of the final composition. Yet LT has the merit of making a large part of those tacit elements explicit, limiting the interpretation of the planner or designer to a more intimately creative or 'artistic' part and therefore discretionary only to a more limited extent. However, this reduction does not appear as a burden of constraints and prescriptions, but rather an enrichment of the conceptual basis towards the achievement of more aware and informed decisions, suitably reducing operational discretions without constraining them [34]. In general, a large part of the subclasses of TT are possibly contained (or articulated) in LT. Therefore, if the objectives of the classification were the same (e.g. both design-oriented or both description-oriented), a single integrated ontology could be drawn from this perspective.

In a more implementation-oriented discourse, we can for example hypothesize that there is a need for support for the design of a square that is specifically characterized perceptually. Looking at the classes that are represented in the ontological taxonomy, we can think, for example, of a square that should arouse a sense of security in socialization during twilight ('sense', 'security', 'socializing' and 'twilight' are in fact represented classes). An ad-hoc query made on an ontological structure of the square (once the ontology is completed with properties, instances, data, etc.) could be carried out through a special function provided by Protégé. A coherently articulated result for a useful design support would be guaranteed especially referring to LT, since the use of TT alone would in any case imply a high degree of interpretative discretion on the part of the designer, which might not guarantee an adequate response to actual needs in a complex operational context.

4   Conclusions

This work is part of the search for decision support systems (DSS) for spatial planning, design or organization based on the management of multi-agent and multi-source spatial knowledge, particularly in the urban environment. In order to mirror the intrinsic complexity of urban systems, the organization of spatial knowledge should include the aspects of environmental, situational, social and dynamic complexity that characterize

cities. For this reason it was decided to use the ontological analysis approach discussed above.

Our previous and still ongoing research activities refer to the management of diffused knowledge expressed from below by urban communities, or elicited among disciplinary experts, or developed within narratives - particularly those written in different literary genres. In these research areas, collective experiments have been developed in real contexts or in simulations carried out with university students. The present work sought to explore the potential for building ontologies based on literary narratives, using various conceptualizations of the urban square within an experiment conducted at the Polytechnic University of Bari.

Two simple taxonomies of the square were thus developed, grafted onto the ontological structure of DOLCE lite, and were compared. In this framework, they have shown some suggestions. In particular, the conceptual and relational analysis of the literary square has shown a fair possibility of building a coherent taxonomy, rather rich in concepts, attributes and spatial links. It contains an assortment of both concrete, abstract, situational, dynamic and agentive elements, which make it possible to interestingly represent the spatial and cognitive complexity that characterizes a square in its environmental and social role in the city.

Based on the results, it is likely that such an approach could be extended to other landmarks or important elements of the city, envisioning an extension of the approach to the city as a whole, in perspective. In addition, we are dealing with the elicitation of elements that are not always easy to draw from direct interaction with agents of a community within participatory knowledge processes from below, nor through the involvement of expert knowledge agents [35–37]. Therefore, it is reasonable to think that the construction of ontological environments to support decision-making in the urban environment can appropriately benefit from this integration made starting from literary narratives.

In this context, the work of this short study suggests that some useful follow-ups could be developed in perspective. Initially, the ontological construction of the square will be completed including properties, instances, formal relationships, thus enabling the formulation of queries, operationally coherent with an ontology-based DSS functionality. Subsequently, an attempt will be made to extend the ontological structure to other urban parts, up to targeting the entire city system if possible. The ultimate results of this formalization effort will then be further investigated and possibly structured, in order to integrate them within the process scenario indicated in the original layout in Fig. 1.

Therefore, our research activities will be oriented towards these objectives for the near future.

References

1. Lichfield, N., Barbanente, A., Borri, D., Khakee, A., Prat, A. (eds.): Evaluation in Planning: Facing the Challenge of Complexity. Springer, Dordrecht (2013). https://doi.org/10.1007/978-94-017-1495-2
2. De Roo, P.G., Van Wezemael, P.J., Hillier, P.J.: Complexity and Planning: Systems Assemblages and Simulations. Ashgate, London (2012)

3. Portugali, J.: Complexity Cognition and the City. Springer, Berlin (2011). https://doi.org/10.1007/978-3-642-19451-1

4. Simon, H.A.: Bounded rationality and organizational learning. Organ. Sci. **2**, 125–134 (1991)

5. Borri, D., Camarda, D., Pluchinotta, I.: Planning urban microclimate through multiagent modelling: a cognitive mapping approach In: Luo, Y. (ed.) CDVE 2013. LNCS, vol. 8091, pp. 169–176. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-40840-3_25

6. Arentze, T., Timmermans, H.: Multi-agent models of spatial cognition, Learning and complex choice behavior in urban environments. In: Portugali, J. (ed.) Complex Artificial Environments. Springer, Berlin (2006). https://doi.org/10.1007/3-540-29710-3_12

7. Pereira, G., Prada, R., Santos, P.A.: Integrating social power into the decision-making of cognitive agents. Artif. Intell. **241**, 1–44 (2016)

8. Geertman, S., Ferreira, J., Goodspeed, R., Stillwell, J. (eds.): Planning Support Systems and Smart Cities. LNGC, Springer, Cham (2015). https://doi.org/10.1007/978-3-319-18368-8

9. Rittel, H.W.J., Webber, M.M.: Dilemmas in a general theory of planning. Policy Sci. **4**, 155–169 (1973)

10. Borgo, S., Borri, D., Camarda, D., Stufano Melone, M.R.: An ontological analysis of cities, smart cities and their components. In: Nagenborg, M., Stone, T., González Woge, M., Vermaas, P.E. (eds.) Technology and the City. PET, vol. 36, pp. 365–387. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-52313-8_18

11. Calafiore, A., Boella, G., Borgo, S., Guarino, N.: Urban artefacts and their social roles: towards an ontology of social practices. In: Proceedings of the 13th International Conference on Spatial Information Theory, pp. 1–13. Dagstuhl Publishing, L'Aquila (2017)

12. Bhatt, M., Hois, J., Kutz, O.: Ontological modelling of form and function for architectural design. Appl. Ontol. **7**, 1–32 (2011)

13. Borri, D., Camarda, D., Stufano Melone, M.R.: Modelling the knowledge of urban complexity: the role of ontologies in spatial design tasks. In: Ferreira, J., Goodspeed, R. (eds.) Planning Support Systems and Smart Cities (CUPUM 2015), pp. 16015–16019. MIT, Boston (2015)

14. Camarda, D., Mastrodonato, G., Patano, M.: The collective construction and management of spatial knowledge in open spaces: a pilot study In: Luo, Y. (ed.) CDVE 2019. LNCS, vol. 11792, pp. 236–243. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-30949-7_27

15. Stufano, R., Borri, D., Camarda, D., Borgo, S.: Knowledge of places: an ontological analysis of the social level in the city. In: Papa, R., Fistola, R., Gargiulo, L. (eds.) Smart Planning: Sustainability and Mobility in the Age of Change, pp. 3–14. Springer, Berlin (2018). https://doi.org/10.1007/978-3-319-77682-8_1

16. Stufano, R., Borri, D., Camarda, D., Borgo, S.: Knowledge organization for community revitalization: An ontological approach in Taranto industrial city. In: Colombo, G., Lombardi, P., Mondini, G. (eds.) 2016 INPUT Conference: E-Agorà/e-ἀγορά for the Transition toward Resilient Communities, pp. 441–446. Politecnico di Torino, Torino (2016)

17. Schön, D.A., Argyris, C.: Organizational Learning II: Theory, Method and Practice. Addison-Wesley, Reading (1996)

18. Fischer, F.: Citizens, Experts, and the Environment: The Politics of Local Knowledge. Duke University Press, Durham (2000)

19. Goldstein, B.E., Wessells, A.T., Lejano, R., Butler, W.: Narrating resilience: transforming urban systems through collaborative storytelling. Urban Stud. **52**, 1285–1303 (2015)

20. Stufano Melone, M.R., Borgo, S., Camarda, D., Borri, D.: Spatial design, planning processes and literary works on cities: an ontological approach for integrating heterogeneous knowledge. In: Carlotti, P., Ficarelli, L., Ieva, M. (eds.) Reading Built Spaces: Cities in the Making and Future Urban Form, pp. 1143–1154. U+D Editions, Roma (2019)

21. Stufano Melone, M.R., Borgo, S., Camarda, D., Borri, D.: Heterogeneous knowledge for sustainable planning: notes from ontology-based experimentations. In: Yang, X.S., Dey, N., Joshi, A. (eds.) Third IEEE Conference on Smart Trends in Systems Security and Sustainablity (WorldS4), pp. 43–47. Research Publishing Services, London (2019)
22. Lynch, K.: The Image of the City. The MIT Press, Cambridge (1960)
23. Moughtin, C., Cuesta, R., Signoretta, P., Sarris, C.: Urban Design: Method and Techniques. Architectural Press, Oxford (1999)
24. Tagliaventi, G.: Manuale di architettura urbana. Pàtron, Bologna (2007)
25. Dodi, L.: Città e Territorio: Urbanistica Tecnica. Masson, Milano (1972)
26. Masolo, C., Oltramari, A., Gangemi, A., Guarino, N., Vieu, L.: La prospettiva dell'ontologia applicata. Rivista di Estetica. **22**, 170–183 (2003)
27. Guarino, N., Oberle, D., Staab, S.: What is an ontology? In: Staab, S., Studer, R. (eds.) Handbook on Ontologies, pp. 1–17. Springer, Berlin (2009). https://doi.org/10.1007/978-3-540-92673-3_0
28. Stufano Melone, M.R., Borri, D., Camarda, D., Borgo, S.: Knowledge of places: an ontological analysis of places and their semantic stratifications. Plurimondi, pp. 103–115 (2017)
29. Campana, D.: Canti Orfici e Altre Poesie. Garzanti, Milano (1989)
30. Borgo, S., Masolo, C.: Ontological foundations of DOLCE. In: Poli, R., Healy, M., Kameas, A. (ed.) Theory and Applications of Ontology: Computer Applications, pp. 279–295. Springer, Dordrecht (2010). https://doi.org/10.1007/978-90-481-8847-5_13
31. Cresswell, M.J.: Why objects exist but events occur. Stud. Logica. **45**, 371–375 (1986)
32. Gangemi, A., Guarino, N., Masolo, C., Oltramari, A., Schneider, L.: Sweetening ontologies with DOLCE. In: Gómez-Pérez, A., Benjamins, V.R. (eds.) EKAW 2002. LNCS (LNAI), vol. 2473, pp. 166–181. Springer, Heidelberg (2002). https://doi.org/10.1007/3-540-45810-7_18
33. Madanipour, A.: Public and Private Spaces of the City. Routledge, London (2003)
34. Stufano Melone, M.R.: Ontologie della creatività: Memorie e decisioni creative in architettura. FrancoAngeli, Milano (2019)
35. Pluchinotta, I., Esposito, D., Camarda, D.: Fuzzy cognitive mapping to support multi-agent decisions in development of urban policymaking. Sustain. Cities Soc. **46**, 101402 (2019)
36. Borri, D., Camarda, D., De Liddo, A.: Envisioning environmental futures: multi-agent knowledge generation, frame problem, cognitive mapping. In: Luo, Y. (ed.) CDVE 2004. LNCS, vol. 3190, pp. 230–237 (2004). https://doi.org/10.1007/978-3-540-30103-5_27
37. Gertler, M.S., Wolfe, D.A.: Local social knowledge management: community actors, institutions and multilevel governance in regional foresight exercises. Futures **36**, 45–65 (2004)