The Cognitive Aspect of Place Properties

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Abstract

The need to computationally handle the cognitively grounded concept of *place* is fundamental for spatial human-computer interaction. However, there is thus far no consensus about a formal definition of *place*. In this paper, we explore the feasibility of a *constructor* of an abstract data type *place* by exploring a cognitively supported set of properties of place. We study the applicability of Alexander's 15 structural properties of a whole to inform a place property parser of natural language place descriptions.

1. Introduction

The concept of *place* is grounded in common sense and evoked in a variety of contexts. It is fundamental to spatial human communication and increasingly to spatial human-computer interaction. The concept of place becomes central to Geographic Information Science when location information about emergencies needs to be extracted from witnesses' descriptions near real-time. Understanding the cognitive aspects behind natural language (NL) place descriptions is an essential first step for formalising the concept of *place*, so that that it can be used in spatial reasoning and decision making.

Past attempts towards a broadly accepted definition of *place* have not been successful (see Cresswell, 2014). Vasardani and Winter (2015) argued that rather than providing precise but variable definitions of *place* according to application domain and context, it is possible to identify places through a set of properties encoding the concept. As a starting point, they suggested Alexander's (2002) 15 structural properties that characterise a whole and examined how they correspond to properties of the various applications of *place* as studied throughout GIScience. In this work, we set out to explore whether a sub- or superset of these properties is cognitively supported, with the hope that this set can then be used by a *place constructor*—a generator of computational representations of place instances, operating as a function of place properties (i.e., attributes). We use textual place descriptions as a source of these properties.

2. Relevant work

Salient locations that stand out from the *ground* become *places,* thus instances of *objects,* when applying Kuhn's (2012) terminology of core concepts of spatial information. As such, place instances have identity, exist in space, and exhibit spatial, temporal and thematic properties. Arguably, places exhibit a subset or superset of the properties described in (Vasardani and Winter, 2015). Here, we examine which of these 15 place wholeness properties should be part of a cognitively grounded place constructor.

At a basic level, place constructors from text can take the form of parsers. For example, when parsing placenames from geotagged social media text, spatial clusters of placenames form candidate footprints, indicating a consensus about the existence and extent of *places*. These places with no exact boundaries, but rather a fuzzy membership function (Hollenstein and Purves, 2010; Pasley, 2008). Similarly, when extracting <*locatum*, *relation*, *relatum*> triplets using NL parsing methods (Khan *et al.*, 2013), the parser constructs a single place occurrence based on relationships to other places, but without concern for their grounding in spatial reference systems.

3. Method and Data

Fourteen graduate students of the University of Melbourne completed the following tasks:

1. Imagine a friend is visiting Melbourne for the first time. Provide them with a written description of three meeting places—a place in urban Melbourne, a place in the rural area, and an indoor place. The purpose is for them to be able to recognize the place as they wait for you to arrive.
2. Highlight which (if any) of the 15 properties of Table 1 in (Vasardani and Winter, 2015) you can identify in your written descriptions.
3. Provide any additional properties you can detect in your place descriptions that cannot be classified according to the given set.

The data collection process resulted in 16 urban, 13 rural and 13 indoor place descriptions, as one participant provided three urban place descriptions, instead. In addition, we analyzed the properties of 45 university campus descriptions collected in a previous experiment (Vasardani *et al.*, 2013).

4. Analysis and Discussion

Figure 1a shows the most identified properties in the set of urban, rural and indoor descriptions from Task 2, while Figure 1b summarizes the frequencies of each of the 15 properties identified in the set of campus descriptions. These latter descriptions were about a bigger place—a whole campus in contrast to a meeting place. They were also more numerous, hence the number of properties identified.

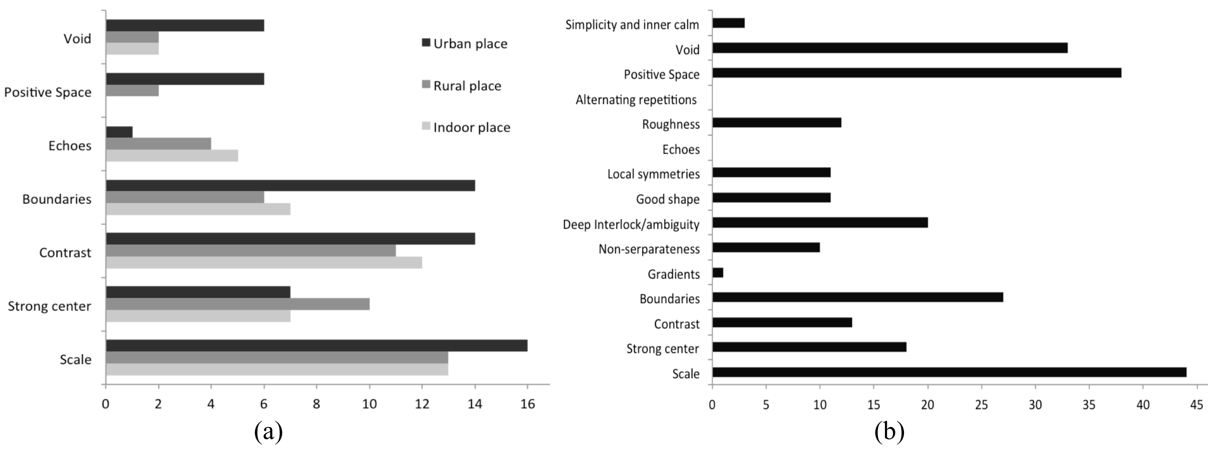

Figure 1: (a) Most identified properties in the place descriptions—urban, rural and indoor; and (b) properties identified in the campus descriptions.

The properties of *scale, strong center, contrast, boundaries, positive space* and *void* are a pronounced subset in both data sets. The intrinsic *scale* property is never specifically referred to, but rather extracted from the resolution of each description type. It was collectively at street and building levels (as per (Richter *et al.*, 2013)) for the urban, rural and campus descriptions, and room/building level for the indoor descriptions. A *pronounced center* appears in most rural descriptions and is well represented in the campus descriptions. The *boundaries* of place seem to play a more significant role in the urban and indoor descriptions. This is not surprising as urban places are structurally denser, thus delineating the boundaries may help separating individual places. In the less dense rural areas, strong centers help provide an identity. Boundaries were also frequently mentioned in the descriptions of the

University of Melbourne city-center campus in the form of distinct street boundaries. In indoor descriptions, boundaries seem essential for the identification of distinct places.

In both sets of descriptions people showed a strong preference for *contrast* features of similar scale (see Winter and Freksa's (2012) contrast sets). According to Tomko and Winter's (2013) formalisation of Lynch's (1960) city elements, these contrast features are non-accessible landmarks in urban, indoor and campus descriptions, perceived mostly as reference points. However, the same contrast features represent accessible nodes in rural places, mostly as the start or end points of transition media (e.g., train, bus, or tram stops). Similarly, in urban descriptions streets are often perceived as edges, separating places, while in rural descriptions streets are mostly paths, connecting distant places.

The property of *positive space*, or the figure-ground relation between artefacts and ground, is most pronounced in descriptions of urban environments and of the campus. Perhaps more surprising is that respondents also referred to *void*, empty spaces of a place (e.g., grassy areas and squares) as often as to buildings.

Amongst properties missing from Alexander's set, place *affordances* were frequently mentioned (Task 3). Hence, functional characteristics should complement structural characteristics in a place formalization (Ortmann and Kuhn, 2010). Some participants referred to signs as part of their place descriptions, and suggested that a separate property should be included. One could argue, however, that signs are either already covered by the placename itself (when the sign is about the place), or they are just another type of landmark, belonging to a specific contrast set.

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5. Conclusions

We set out to explore whether there is a cognitively supported set of place properties that could be used to inform a place constructor—in its simplest form, a natural language text parser. To assess our hypothesis we asked 14 participants to think about the properties they use to describe different types of places and compare them against Alexander's 15 structural properties of a whole. We also examined a number of university campus textual descriptions against the same properties set.

The experiment showed people's preference for a subset of Alexander's set with the addition of *affordance*. This suggests that a place constructor should, at the very least, support values of the following properties: {*scale*, *strong center, contrast, boundaries, positive space*, *void*} + {affordance}, although in the lengthier campus descriptions additional properties occur. This exercise also reveals the synergies among different cognitively grounded theories pertaining to *place*. Lynch's elements of the city form can be associated with different properties, e.g., streets act as either edges or paths in urban or rural places, respectively. Elements of contrast sets in a variety of resolutions act as landmarks or nodes. The mention of void, empty spaces counterbalances the detailed descriptions of buildings or artefacts in a recognizable figure-ground relationship.

While preliminary and limited, these results indicate a possible place constructor informed by properties that stand out not only in this cognitive experiment, but also relate to basic place concepts in cognitive GIScience theories. Examination of larger and varied datasets of place descriptions is necessary before a universal place constructor can be proposed.

A place constructor would have to generate unique places. For a text parser that relies on property values, this requirement implies that unique combinations of property values need to be allocated to each place. While this is a necessary condition, it may not be a sufficient one for the creation of uniquely identified places. For instance, it is not yet clear whether and how intra- and inter-place spatial relations that can potentially assist in place identification, become part of a place constructor.

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