From Space to Place and Back Again: Towards an Interface Between Space and Place

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Geographic Information Systems represent and process space whereas people refer to and use place. A question that arises is what are the benefits of introducing a unified data model that combines the rigid representation of space and the information-rich concepts of place. In this work we contribute to this research question by proposing a two-way interface that aims to bridge the notions of space and place. This interface relies on the four conceptions of space and interconnected spatial objects. Step-by-step descriptions as well as examples are provided to illustrate the intended use of the proposed interface.

Keywords: Space, Place, Place-based GIS, Objectification of Space, Ontology

1 Introduction

Geographic Information Science in combination with Natural and Human Sciences utilise the notions of space and place to describe the geographical world. Space and place see the cosmos through two perspectives: a) as depicted by the rigorous methods of mathematics and physics, and b) as interpreted by the complexity of human mentality, respectively. Although the representation of space has developed more compared to place, there are approaches from both sides that offer adequate descriptions of the world. On the one hand, "puzzles of polygons and sandwiches of data layers" (Couclelis, 1992b) introduce a spatial view that adheres to objectivity, concise abstractions and numeric precision. On the other hand, complicated models, semantic enrichment and stochastic approaches, emphasize on a place-based illustration that allows subjectivity, extensive expressiveness and increased vagueness (Goodchild, 2011). An emerging question is whether these disparate views of the world should be kept separated and which are the benefits and impact of unifying them. In other words, shall the space and place representation methods keep their individuality and "excel" on providing particular descriptions of the world or should they be combined introducing a unified view of the world that includes both spatial and "platial" features?

People live and act in the geographic world. Their intrinsic need to describe and talk about it led to the creation of symbols, that is, space and place. The connotation of those terms, which allows the scientific foundation around them, originates from the vernacular. Considering that languages differ based on the culture of the people that use them, the problem of converging to a widely acceptable interpretation is not to be neglected. However, the influence of the Ancient Greek philosophy played an important role on sculpting the meaning of space and place in the modern world's mentality (Purves, 2010). Plato and Aristotle introduced the concept of space as a geometrical notion disconnected from matter (Beichler, 1981). Analysing the ancient Greek narratives, Algra (1997) suggests that space has three possible interpretations:

- a geometrical extent occupied by an entity

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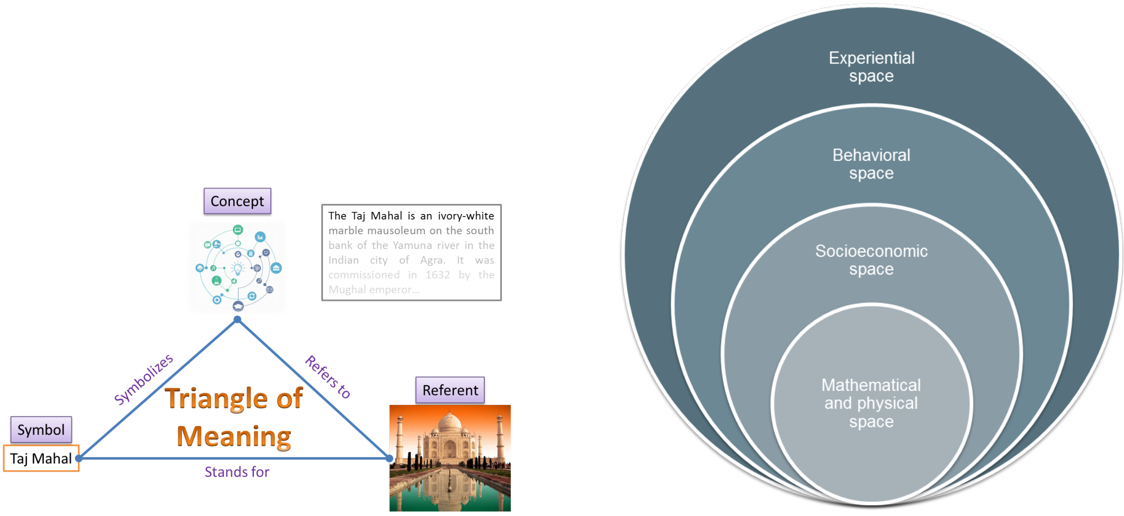


(a) The triangle of meaning. **(b)** The four conceptions of space.

Figure 1: Meaning and Space

- a location of an entity
- a container that includes or excludes entities

On the contrary, place cannot stand alone; it combines relative spatial information and association with other entities. Algra (1997) argues that place is perceived as:

- a relative extent of an entity
- a relative location of an entity
- an entity that contains or supports other entities

Both the notions of space and place describe the world in relation with the a) extension, b) localization and c) containment of entities. However, the way those entities perceived by an observer suggests different perspectives. On the one hand, space refers to the geometrical properties of entities, e. g. "a box occupies $(10x17x20)cm^3$", "a box is located at (0,0)" and "the entities that exist within the box's volume". On the other hand, place focuses on the concepts and associations that build the entities of the world. For example, "the box occupies the whole place", "the box is in the centre of the room" and "there is a box in the room". Through the spatial perspective a "box" is considered as a geometrical shape and its spatial information is quantitative. Place, however, focuses on the thematic information and relations that hold for the entities under consideration. In this case, the "box" and the "room" are whole and particular conceptual entities; localization and extension emphasize on their association whereas containment implies a semantic association that the box is or is not a part of the room.

Geographic Information Systems (GIS) represent space using the basic standard data structures, vector and raster (Frank, 1992b), building it in relation with a coordinate reference system. Space conforms to a strict formalization that allows quantification and implies objectivity and precision. These features make space transferable and processable by machines. On the other hand, people refer to place as a consequence of their qualitative perception of the world (Frank, 1992a). Place is a human invention to describe the geographical world (Curry, 1996) and is built by combining experience with spatial information (Couclelis, 1992a); in other words, place is space infused with human meaning (Tuan, 1979). Based on the aforementioned definition and considering the triangle of meaning (Figure 1a) a place is modelled with concepts that describe meaningful entities of the real world extended with relative spatial information, which takes the form of relations and semantic associations. Since place is a product of human thinking, it is subjective, vague and informal.

Considering the above, machines represent and process space, whereas people use and refer to place. Particularly, in spite of space being used in the human discourse, GIS representation standards make sense only within fields of Natural Sciences. On the other hand, models that describe place are mainly products of philosophical discussion or theoretical models that lack formalization. Therefore, such models are not machine-interpretable, which hinders their ability to assist in spatial processing. In order to address the above difficulties, we propose an interface between GIS spatial representation standards and theoretical "platial" models. This interface is founded upon two influential strands of GIS research: (1) the interconnection between space and place, as analysed by Relph (1976) and (2) the four conceptions of space, as proposed by Couclelis (1992a). We envision that this proposal can contribute to the ongoing efforts of the research community to bridge space and place together.

2 Background and Related Work

We first summarise the works that are the foundation of the proposed interface. Relph (1976) construes place as a unique pattern of physical features, appearances, activities and functions. Its unique quality is the power to focus on human intentions, experiences and actions in the spatial dimension. Relph also mentions the close association of place and space, stating that place is built based on environmental experience, which in turn is derived by the the place's spatial context.

Couclelis (1992a) introduced a multilevel composition of place to reveal the inclusion of space into place, in the form of four conceptions illustrated in Figure 1b. The core concept refers to the mathematical space as defined by mathematical and physical laws; it is the space that is used in quantitative geography, including absolute and relativistic space. The next level introduces the notion of relative space, denoted as socioeconomic space. In this concept, characteristic properties that yield social or economical interests are analysed and represented spatially. Moving to a lower level of formalism comes the concept of behavioural space, which is determined by the spatial cognition and understanding. It is an incomplete, distorted and highly subjective space that depicts the spatial decisions and behaviour based on the individual's knowledge and psychology. The last concept describes the experiential space; it refers to the perceived world, prior to filtering and scientific analysis.

In the rest of this section, we briefly summarise related efforts to bridge the gap between the notions of space and place. The field of Quality of Life introduces techniques that utilize some types of abstract human data, converting their nominal qualitative values to system-friendly representations such as numbers (Nussbaum and Sen, 1993), using statistics and GIS methods. This is made possible through the qualitative space approach (Frank, 1992a). Ontological gazetteers (Hill, 2000) move one step further towards place by offering spatially-referenced catalogs of place names with the ability of ontological orientation. They provide a linkage between the human and physical world, by encoding relations between placenames, space footprints, spatial categories, temporal information and so on. Full-fledged place ontologies have also been developed in the context of linked data, such as geonames [1] or schema [2].

Another approach that brings physical space closer to human understanding is the objectification of space (Couclelis, 1992b; Goodchild et al., 2007). Particularly, people tend to simplify complicated spatial structures into compact sophisticated objects with certain properties and functions, in other words, people think with objects. For instance, a mountain is represented as a field in a GIS revealing its elevation model and so on. However, people consider it as an object, with certain properties such as name, location, and overall height.

3 An Interface Between Space and Place

Starting from the assertion of Relph (1976) that place depends on space and vice-versa, the proposed interface aims to use these dependencies as a form of bridge between the two notions. In both cases, suitable abstractions enable one of place or space to acquire some essential characteristics of the other by giving up some of their own features, such as precision, in the case of space, and expressiveness, in the case of place. To achieve this, we use the conceptions of space by Couclelis (1992a). As illustrated in Figure 2, space maps directly to the leftmost conception (physical space), while place is the rightmost one (experiential space). The ultimate goal of the interface is to move from these two extremes towards the two intermediate conceptions, socioeconomic and behavioural space. A combination of both would be akin to a golden mean between space and place: objects and relations are used to represent space in

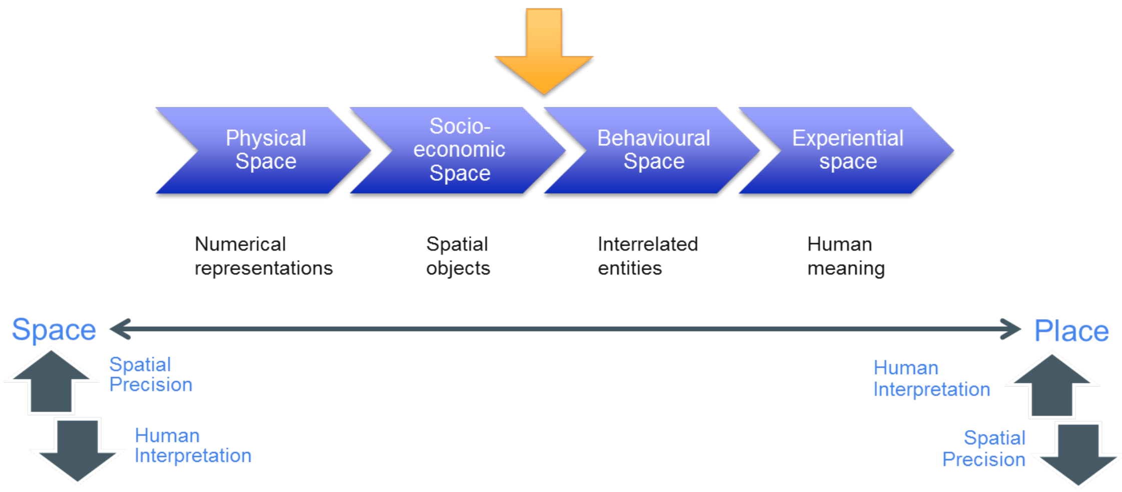


Figure 2: The golden mean between space and place.

a form that is understandable by humans but, at the same time, these objects are spatially projected, providing the precision required by GIS. However, this depends on the nature of each application and the availability of suitable data.

The interface is expected to work in two directions, from place to space and from space to place, the latter of which is relatively less complicated and is described first. Working in the direction from space to place, the interface is given a spatial representation as an input and is tasked to convert it to a human-interpretable format. This, for instance, can be in the form of fiat or bona-fide spatial objects (Cova and Goodchild, 2002), each of which is associated with a descriptive symbol, as well as relevant thematic information. This would correspond to socioeconomic space. The interface then depends on the availability of defined relations among spatial objects, in order to move towards behavioural space.

Working in the other direction, given an instance of a model of place, the interface should decompose the place into aspects related to location, affordances and equipment. Then, the interface should abstract away purely subjective information from these aspects, such as emotions or activities. This can be achieved by clustering such features into categories in order to facilitate formalisation. Afterwards, any information that is in an unstructured form (e.g. narratives) has to be adapted into a structured form, such as a knowledge graph. At this point, we reach behavioural space, through the formalised representation of the place's equipment. Finally, location and extent information attached to the place at hand are employed to convert the place's equipment to spatial objects through the introduction of an appropriate system of coordinates. This would require a form of fuzzification, given the fact that places tend to have fiat boundaries. This step brings us to socioeconomic space, concluding the work of the interface.

It should be noted that the aforementioned analysis is maximal, including all possible steps in both directions. However, depending on the space or place model given as input, some of these steps may not be necessary or can be simplified. For instance, if the model of place provided to the interface is in the form of an ontology, then it is already represented in a structured form. Also, if the input to the interface is qualitative space, then the conversion to spatial objects is straightforward.

4 Examples

In this section, we present brief examples of applying the proposed interface in both directions. Figure 3 shows maps of modelled annual ground temperature used in permafrost detection, an example of purely spatial information extracted by satellite imagery and semantically enriched by sensor data. Such information are simply aggregated points plotted over a map and do not fully conform to the human perception of place. Using the proposed interface, the continuous temperature spectrum is converted to a set of categorical values, namely permafrost extent classes. Then, areas associated

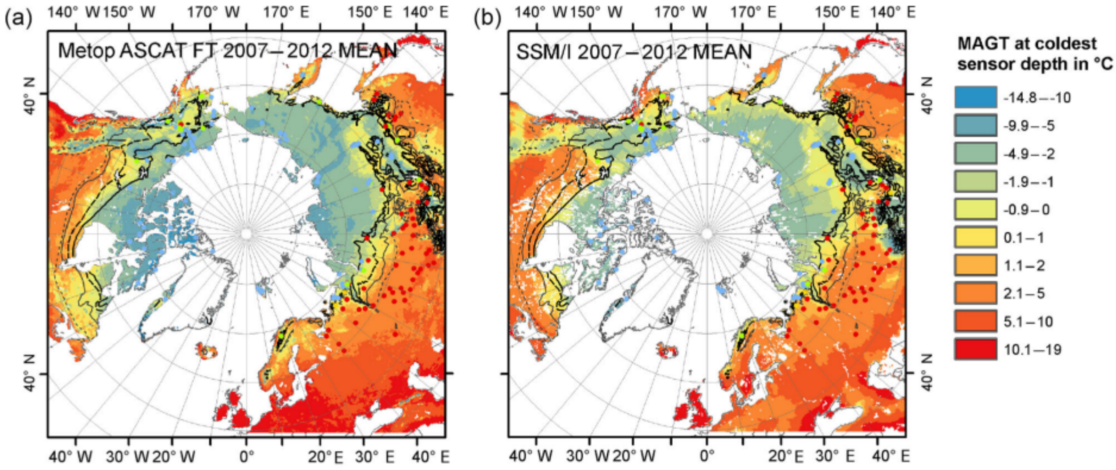
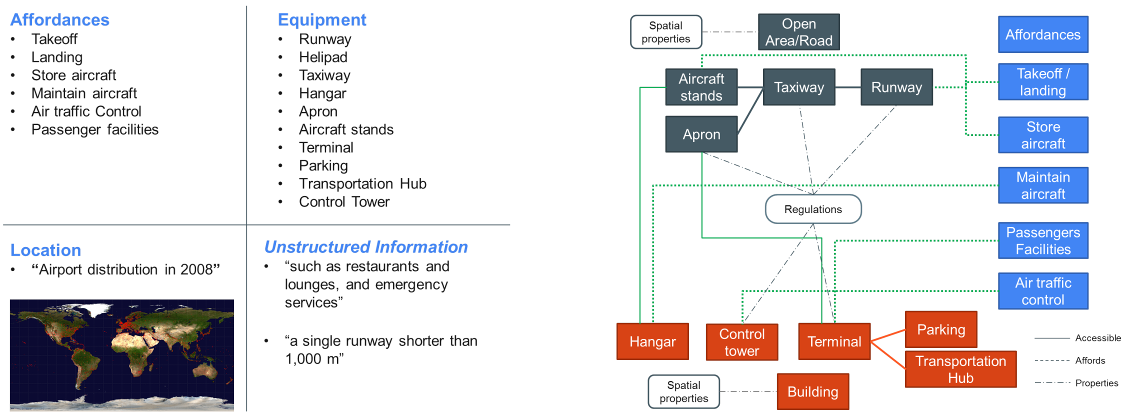


Figure 3: Maps of modelled mean annual ground temperature (Kroisleitner et al., 2018).



(a) Decomposition. **(b)** Categorisation.

Figure 4: Using the interface on an airport place

with a common categorical value introduce spatial objects with fuzzified boundaries, which correspond to socioeconomic space. Any additional information available for these areas, such as inclination, moisture, administrative units, and so on, is inherited by the spatial objects and can be used to derive relations among them. In the simplest case, for instance, objects that are associated with the same administrative unit are considered adjacent. Such relations correspond to behavioural space.

An example moving from place to space follows. Given a model of an airport place in the form of a narrative[3] as an input, the proposed interface decomposes it into location, affordances and equipment aspects, as shown in Figure 4a. Afterwards, these features are clustered into categories: for instance, the narrative may provide equipment information about several different facilities such as terminals, towers and hangars which are clustered into a category of buildings. All extracted categories along with relations among them are then formalised into a hierarchical ontology (Figure 4b), reaching behavioural space. Finally, combining the semantic relations within the ontology along with additional information about design standards or regulations, a spatial projection on a geometric space is introduced. If any additional location information is available (e. g. the absolute location of an airport in London), the spatial projection of the airport as an object can be mapped to the geographic space. Either a geometric or a geographic space projection corresponds to socioeconomic space.

5 Conclusion

In this paper, we have proposed to bridge space and place through a structured two-way interface based on the four conceptions of space by Couclelis (1992a). This interface enables a form of representation, based on interconnected spatial objects. Such a representation is understandable by humans but, at the same time, includes spatial projection, providing the precision required by GIS. This proposal aims to stimulate researchers working on the confluence of space and place to move one step closer to data models that achieve both of the following: (1) allow place to be involved in spatial analysis and processing and (2) make complex spatial representations more easily interpretable by humans.

Future steps include coming up with a formal definition of the interface that offers strict guidelines on the conversion between space and place data models. This formal definition should then be validated using complex real-world examples.

Notes

1. http://www.geonames.org/ontology
2. https://schema.org/Place
3. An example narrative is the Wikipedia definition: https://en.wikipedia.org/wiki/Aerodrome

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