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The Geographical and Cultural Aspects of Geo-Information: An Introduction

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1 Introduction

As part of the investigations made in the context of LandSense, a citizen-science project for land-use monitoring (Moorthy et al. 2019), a group of experienced land-use researchers were asked to associate widely used OpenStreetMap (OSM) tags to classes of the CORINE land classification system. The results showed that many tags were not associated to the same CORINE classes (Novack et al., 2018). A qualitative analysis of the results taking into consideration the heterogeneous cultural backgrounds of these researchers led to the conclusion that this disagreement in the association of OSM tags to land-use classes is due to the different instantiations, i.e. physical expressions, and cultural meanings of the geographic concepts represented by the classes and tags.

Such a result is just one manifestation of the seemingly inherent tension between the ambitions of Geographical Information Science (GIScience), i.e. providing answers to fundamental and generic questions about its subject matter, geo-information (Goodchild, 1992), and the contingencies of spatial reality and the data representing it on cultural and geographical contexts. The perhaps most noticeable embodiment of this tension were the intense debates between the proponents and antagonists of Geographical Information Systems (GIS) during the early 1990's (Schuurman, 2006). Since then however, the discourse had changed and GIScientists have become more sensitive to the social and cultural nature of geo-information and geo-informatics, leading to the formation of research approaches committed to understanding the social bias and implications of GIS, such as GIS and Society and Critical GIS (Goodchild, 2015). Furthermore, in attempts to work across worlds of meaning towards data interoperability, geo-ontology and geo-semantics research assisted in forming new models for representing the world (Goodchild, 2010). And yet, as in the case discussed above, this fundamental issue of geo-cultural dependency has yet to be resolved.

Convinced of the importance of achieving progress on this issue, especially in a context where geo-datasets, geospatial applications, and GIScience methodological approaches strive to be universally effective and relevant, the 'Geographical and Cultural Aspects of Geo-Information: Issues and Solutions' workshop was organized. The aim of the workshop was to engage with relevant discussions, relating to issues such as the influence of geographic and cultural aspects on the production and usage of volunteered geographic information (VGI); potential local effects of the usage of global VGI datasets such as OSM; approaches for dealing with geographic and cultural aspects in different analysis contexts and application purposes; the discursive contention of generalization versus specificness in GIScience; and more generally – the relevance of different social and material geographies for GIScience.

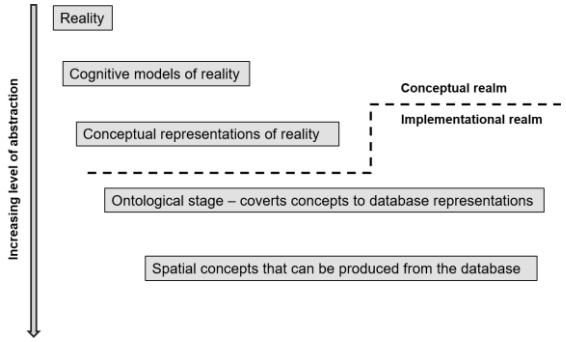
Accordingly, the workshop combined research papers with more general discussions on the progress of GIScience given the challenges that geo-cultural heterogeneity presents. One such discussion was the one which opened the workshop and presented a framework for theorizing about the transition from conceptualization to implementation, which is summarized in the next section.

2 The Ground for Discussion: A Framework for Theorizing on the Transition from Conceptualization to Implementation

In order to support a discussion on the above topics, a basic theoretical framework proposed by Brodeur et al. (2003) was presented (Figure 1). This framework establishes five conceptual levels of abstraction in the path from physical reality to the digital representation of geographic information. This graduation is divided into two main parts, namely, a *conceptual* and an *implementational* realm. The former is inherently human and springs from our cognitive models of reality. The latter is formal, i.e. it refers specifically to the representation of geographic concepts and dynamics as computational ontology.

In accordance to this framework, it can be argued that, within the conceptual realm, the interplay between physical and socio-cultural aspects dynamically produces and re-produces conceptual representations. If the ontology of GIS should mirror these representations, and if the dynamics and

Figure 1: Theoretical framework proposed by Brodeur et al. (2003) and used for grounding the workshop's discussions.



output of this interplay varies geographically, historically, and socially, then GIS ontologies must also be, if not specific to each place, time, social group, and use, flexible enough to enable the representation, systematization, and analysis of different geographic and socio-cultural aspects. In other words, dealing with geographic and cultural differences in GIS and geo-information requires not only theorizing on how conceptual representations are contingent upon local environments and cultural contexts, but also requires designing GIS ontologies (i.e. data models, taxonomies, visualization techniques, algorithms) that are specific or flexible enough for enabling the representation of geographic scenarios according to local cultural contexts as well as the deployment of locally relevant epistemologies.

2.1 Scale, Ontological Complexity, and Transferability

Besides the realization that specific and flexible GIS ontologies are necessary for representing, structuring, and analyzing complex social, cultural, and geographical differences, researchers and practitioners need also to care for an adequate alignment between the complexity of the ontology, the geographic scale and the intended degree of the methodological transferability. The aspect of scale also refers to the degree of conceptual generalizations of the categories of analysis, e.g. individuals, social groups, entire populations, etc. The argument being made here is that generalizations and specificness are both possible if this alignment is adequate. For example, the Global Urban Footprint aimed to map all urban areas of the world through the processing of remote sensing images is a pertinent agency producing useful results as the degree of generalization of the category of analysis, i.e. urban areas, is adequate to its global pretension. Another example is the Level 1 of the CORINE land classification system with its five general classes being reasonably applicable for a continental scale of analysis. More detailed land-use taxonomies, however, such as that from CORINE Level 2, might not find relevance and applicability in some specific areas. In her paper Schuurman (2006), the statement is reported that this classification does not match vegetation types from Ireland or the United Kingdom and that conservationists and ecologists in these areas do not share the epistemologies of those from, for example, Russia.

The incompatibility between scale, ontological complexity and intended methodological transferability results in or is caused by a disregard of local geographic and cultural aspects. More specifically, issues of over-simplification and misrepresentation arise when, for example, general taxonomies or taxonomies designed for a specific area are transferred and applied to areas for which they do not reflect local social and geographic idiosyncrasies. This misalignment between ontologies and places results in an imposition of power by the analyst (and the institution or social group he/she represents) on the local affected social groups. At times, this imposition of power is unconscious and the result of the analyst's negligence. Examples of the unintended application of alien taxonomies/concepts are numerous in VGI research and practice. Is the widely adopted road categorization of OSM (originally conceived for England) pertinent for all urban areas worldwide? Are the feature tagging adopted in OSM remote mapping parties taking into consideration local material and semantic idiosyncrasies? These are questions that need to be critically considered by GIS/VGI researchers and practitioners. At other times, however, the imposition of an ontology is conscious and aimed to strengthen a certain discourse. For example, administration agencies might be interest in reporting an effective preservation of 'forest'. Thus, the prevalence of one or a few species resulting from a reforestation program is "swept under the hood" (Robbins & Maddock, 2000).

2.2 The Spectrum of Formalizations

In terms of GIS ontology design, we might consider a spectrum of purposes and goals, at its extremities critical GIS scientists and geo-ontologists may be placed. The former group of scholars is interested in local specific contexts and its detailed representation with the minimum loss of meaning. GIS is seen as a tool for representing and empowering local communities and minority groups. For them, the main interest is often a positive real-world impact benefiting these groups. On the other hand, the interests of geo-ontologists are focused on generalization and operationalization, which require proper ways of systematizing, cataloguing and standardizing geographic information as well as analyses. As discussed above, as long as the aspects of scale and conceptual generalization, ontology complexity, and transferability are adequately aligned, the two approaches are equally relevant for GIScience research and practice. In this context, the thriving research field of ontology matching is a promising source of proposed approaches for achieving the interoperability between communicable (specific or general) ontologies. Geo-data conflation and the development of databases embedding context are research avenues that are contributing significantly for the interoperability of GIS ontologies, what extends epistemological possibilities.

2.3 Reflux – The Influence of the Implementational Realm in the Conceptual Realm

An important topic closely related to the discussions in the workshop is how digital representations of the geospace (as GIS, VGI, Webmaps, and WebGIS) are affecting ways in which we perceive, structure, and deploy geographic

concepts. In a time where geo-spatial services are more and more part of our lives, human scientists have been discussing ways in which our conceptual representations are being influenced by existing computational ontologies. More specifically, critical GIScientists are calling attention to the fact that the implementational (i.e. formalization, ontological) realm is influencing and "dictating terms" in the conceptual realm. What happens when we rely on existing ontologies to make sense of the world instead of designing ontologies that mirror our differentiated ways of understanding and acting in the world? Are we collecting and structuring geographic information in terms of layers just because GIS are ontologically designed to display and store information this way? What about the influence of location-based services on our spatial behavior? Does the widespread use of these tools has the power of gradually decreasing geographic differences, since they are constantly used by ever larger groups of people? Although these relevant questions related to digitally mediated spatial behavior can rapidly move us towards other inquiries less related to the topic of the workshop, they are surely relevant considerations for GIScientists.

3 Outcome and Outlook

The papers included in the workshop and these proceedings touch upon different aspects of the process of transitioning from conceptualization to formalization. Grinberger et al. (2019), for example, study the extensive roles of institutions in the production of OSM, calling for a more explicit repositioning of institutional epistemologies in the conceptualization of VGI. Zhu et al. (2019) offer an approach relying on spatial signatures for understanding the relations between different sets of categories, i.e. those of streets types and places types. Finally, Ludwig & Zipf (2019) presented an exploratory approach for characterizing the differences between representations across regions, focusing on the case urban green spaces in OSM, as a means towards working with and across these differences.

The diverse dimensions of the relations between geo-cultural contexts and geo-information, and the diverse set of possibilities for approaching these were addressed in the workshop via a concluding discussion relating to the metaphor of "The Glass Bead Game". This game, introduced in Herman Hesse's fictional work of the same title, is a manipulation and creation of symbolic forms for finding links across all areas of human knowledge. This perhaps reflects to some extent the original ambitions of geo-ontology research (cf. Smith & Mark, 2001) – identifying fundamental categories which can be used as the building blocks for any GISystem. Yet, taking the topic of geo-information for disaster preperdness, management, and resilience as a useful case study and point of departure, the discussion had pointed to difficulties with this approach. In such situations, higher-level constructs, to the degree they actually exist, are translated into actions through culturally directed processes. Hence, utilizing the representation of one scenario to another is not straightforward and requires some knowledge regarding the rules of transfer. These rules are geo-culturally contingent and hence require explicitly integrating geography and cultural into geo-ontologies, a challenge which remains open for GIScience to explore even today.

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