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Three fuzzy concepts and their implications for cartography

Liqiu Meng[a*], Temenoujka Bandrova[b], Terje Midtbø[c], Vít Voženílek[d]

[a] *Chair of Cartography and Visual Analytics, Technical University of Munich, Munich, Germany, liqiu.meng@tum.de*
[b] *Department of Photogrammetry and Cartography, UACEG, Sofia, Bulgaria, tbandrova@abv.bg*
[c] *Department of Civil and Environmental Engineering, Norwegian University of Science and Technology, Trondheim, Norway, terjem@ntnu.no*
[d] *Department of Geoinformatics, Palacký University Olomouc, Olomouc, Czech Republic, vit.vozenilek@upol.cz*

* Corresponding author

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Abstract:
The communication of geospatial information has remained one of the fundamental functions of maps since prehistoric times. However, the question of how to optimally communicate the ever-growing data amount to the increasingly diverse users is challenging cartographers in the recent decade more than ever before. Open data, semantic data, and Points of Interest (PoIs) are among the most frequently mentioned phrases in the research community of cartography, geoinformatics, and data science. Three ill-defined or fuzzy concepts are embedded in these phrases, namely openness, richness and interestingness as illustrated in Figure 1.

Figure 1: Three fuzzy concepts - data openness (l), semantic richness (m) and interestingness of PoIs (r)

Openness of data has become a quality indicator. How to measure the relative openness of a given data source is not yet answered. (Divanis & Meng 2023) gave a first try to determine an "openness score" and assign it to an open data source following the International Open Data Charter Principles and Open Data Consumer Checklist. The score can be further combined with the usage context and elaborated as constrained openness score. A comparative study of selected open data sources from citizen science projects and government agencies has revealed that (a) openness score is not necessarily correlated with the popularity of the data for research purposes, (b) openness from the perspective of the data provider is often differently experienced by data users, (c) there are a number of barriers from open availability to open accessibility with regard to privacy, citizen safety and protection of specific data contents, and (d) conditioned licensing increases the complexity of data policy. A comprehensive understanding of openness may stimulate follow-up research efforts on how to maximize the usage of open data sources.

Semantic enrichment of geodata is being conducted by a great number of research teams for different applications. The geographic objects are usually categorized as discrete entities, continuous distributions, and temporal events. The semantic meaning of each object can be unfolded into a set of descriptive attributes. Each attribute may be assigned to multiple objects in a neighborhood. Attribute values may be numerical, categorical or textual. The measurability of attribute values varies and requires different observation methods. However, the concept "semantic richness" is differently interpreted and prioritized in different disciplines and applications. Without a holistic understanding of semantic richness, it is difficult to develop proper pricing policies for semantically linked geographic data. More seriously, the potential of deep learning methods for detecting semantic correlation, causality and association remains largely untapped. It is therefore necessary to conduct an interdisciplinary and cross-scale investigation of the concept with selected scenarios such as city models and crisis management.

PoIs are orientational landmarks for different spatial tasks and emotional anchors for individual persons. Therefore, they are regarded as third places besides home (the first place) and work (the second place) (Psyllidis et al 2022) and are far

more flexible and larger in number as the first and second places for a specific user. PoIs also reflect the human-nature interactions, thus provide characteristic clues to the concept of places, which play essential roles in applications including urban planning, health, climate modeling etc. There is an increasing attention to PoI collection in both industry and academic world. Industry is mainly concerned with PoI collection for optimal recommendations based on user tracking by developing advanced Natural Language Processing (NLP) tools. The academic world focuses more on tasks such as PoI generalization for navigation map services, ontology of PoI, explainable AI for PoI detection. An in-depth investigation of PoIs covers aspects such as categorization in databases, acquisition methods, visualization, on-demand accessibility and ethical concerns.

The three fuzzy concepts are interrelated and not isolated from each other. Improving the openness of the data allows for broader participation in semantic data collection, improving the exploration of semantic richness. The enriched semantic information would in turn provide the opportunity to capture more categories and details of PoIs along with their contextual relevance. Based on an analytical overview of these concepts, this work indicates the development trend of mapping beyond location accuracy, geometric measurements, seamless coverage and thematic layer operation. Future research efforts are anticipated to enrich and adapt graphic variables, design methods and user studies for the understanding of fuzzy nature of data quality, and expand the capabilities of cartographic models tailored to big data (Bandrova and Pashova 2020), develop mapping technologies for improving the transparency and inclusiveness of the cartographic communication process.

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