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A Pan-Map Knowledge Recommendation Method Based on Visual Dimension Theory

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Abstract:

Pan-maps are an extension and expansion of standard maps, representing a broad map expression formed by standard maps and map-likes (Guo et al., 2018). Thematic maps are a crucial component of pan-maps. Within the pan-map framework, thematic maps demonstrate significant flexibility from data to representation, with map products exhibiting characteristics of personalization and diversity (Hogräfer et al., 2020). In terms of map types, thematic maps have evolved from a core theoretical foundation that adheres to mathematical principles, cartographic synthesis, and symbolic systems (Liao, 2017), to the emergence of various map-likes forms that challenge the existing theoretical underpinnings (Guo and Ying, 2017; Meng, 2017). In the Information and Communication Technology (ICT) era, the subjects of map representation, modes of expression, and user roles all display pronounced diversity features. Amidst the trend of map diversification, category maps meet the personalized thematic expression demands of the ICT era, complementing standard maps to fulfill the varied cartographic needs of map users (Guo, 2022).

Under traditional digital cartography, the creation of thematic maps necessitates either specialized a priori knowledge or the collaboration of cartographic experts to satisfy the representational requirements of thematic content. This reliance on a priori knowledge has, to a certain extent, constrained the widespread adoption and evolution of cartography, as enthusiasts lacking professional cartographic knowledge are susceptible to falling into "cartographic pitfalls" that contravene common cartographic practices (Ying, 2021). Moreover, in the internet environment, users have heightened expectations for the timeliness of map information dissemination and the richness of interactive information, indicating a shift from digital to intelligent cartography (Wang, 2022; Ren, 2022) However, most current cartographic techniques are tailored to one or a few specific map types, such as rule-based thematic map representation selection systems (Tian, 2007; Jiang et al., 2015); template-based cartographic pattern and style transfer applications (Wang, 2016); and the automation of specific types of thematic maps using existing software packages (Wu et al., 2022), etc. Faced with the personalized, diverse, and intelligent demands of pan-maps in the ICT era, the question of how to integrate the fundamental principles, visualization characteristics, and knowledge of pan-cartography into the cartographic process, using knowledge as the primary driving force for pan-map production, remains a significant issue for the advancement of cartography.

Thus, this paper proposes a knowledge recommendation method for pan-maps based on the theory of visualization dimensions. Firstly, addressing thematic cartographic needs, an ontology of pan-map visualization knowledge is established, centered around spatial data, data characteristics, pan-map visualization dimensions, pan-map visualization forms, and application domains. Through knowledge extraction and storage operations, a pan-map visualization knowledge graph is constructed. Secondly, knowledge embedding is applied to the knowledge graph to achieve an intellectual expression of map visualization elements. Finally, a similarity calculation model is developed based on the knowledge elements of pan-maps, calculating the similarity between user-provided data and the spatial data characteristics, visualization dimensions, and application domains within the knowledge graph. This process yields a comprehensive similarity result, enabling precise recommendations for pan-map visualization forms. The findings indicate that the proposed method for pan-map knowledge recommendation can provide relatively accurate visual references for map-making choices, partially meeting the map-seeking needs of the general public in the context of diversified thematic information expression.

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