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Geovisualization in the Age of Generative AI: Opportunities and Challenges

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Abstract:

With the rapid advancement of generative AI, various disciplines are embracing this transformative technology, and geovisualization is no exception. Given that the technology is still in a stage of rapid evolution, it is especially important to engage in forward-looking reflection on the transformative impact it may have on our field, including both the new opportunities it presents and the potential risks it entails—insights that are often difficult to capture through traditional literature reviews. To address this, we conducted semi-structured interviews with 16 experts in geovisualization and cartography from Europe, the United States, and China, exploring their practical experiences, perceptions of current challenges, expectations for future applications, and concerns regarding risk mitigation. The participants represent a wide range of professional backgrounds and years of experience, ensuring diverse perspectives. Our findings suggest that the advent of generative AI has created new possibilities for geovisualization, shifting the focus of attention from purely technical aspects to more profound disciplinary reflections. At the same time, we examine the potential risks that practitioners in geovisualization should be mindful of in the era of generative AI. We hope this study provides meaningful insight for the sustainable development of geovisualization in the age of generative AI and fosters broader discussion and collaboration within the field.

1. Introduction

The emergence of generative AI has brought profound transformations to geovisualization. An increasing number of scholars are exploring its applications within this domain. Most current studies focus on the integration of generative models into cartographic tasks. For instance, Zhang et al. (2024) developed a prototype system called MapGPT, demonstrating how the powerful capabilities of large language models can be integrated with foundational mapping services such as geocoding and routing to respond to complex map-related queries. Oucheikh and Harrie (2024) trained generative models on extensive collections of map samples to automate the process of map labeling.

Additionally, some studies have reviewed the technological shifts that generative AI introduced. For example, Zhang et al. (2024) investigated how human knowledge of map generalization can be more effectively translated into computational systems, covering recent advances in automated generalization across AI, crowdsourced geographic information, and multi-scale visualization. However, the value of generative AI in geovisualization lies not only in technical breakthroughs but also in the deep involvement of domain experts in ethical oversight, articulation, and knowledge co-creation.

To address this research gap, this study focuses on exploring the opportunities and challenges brought by generative AI to geovisualization from the perspective of domain experts. We conducted semi-structured interviews with 16 experts in this field, primarily based in Europe, the United States, and China. The study investigates their experiences with using generative AI in geovisualization and their attitudes, concerns, and recommendations. The research questions guiding this study are as follows:

RQ1: How do experts in the field of geovisualization perceive the current challenges facing the domain?

RQ2: What impact has the emergence of generative AI had on geovisualization?

RQ3: How do experts in geovisualization assess and respond to the potential risks posed by generative AI?

Although experts' perspectives and experiences in geovisualization may continue to evolve, we believe that the influence of generative AI on this field must be understood and addressed. We aim to move beyond purely technical considerations and foster broader discussions and reflections among professionals in the field. By taking a comprehensive perspective, we hope to offer insights that inform the future development of geovisualization.

2. Methodology

2.1 Participants

We adopted a semi-structured interview approach for this study. Participants were invited via email, and a total of 16 individuals agreed to take part. These 16 participants conducted one-on-one, 60-minute interviews with us between

September 2024 and March 2025. According to established standards for sample adequacy in qualitative research (Hennink and Kaiser 2022), and considering that remote interviews typically involve around 15 participants (Caine 2016), the number of participants in our study is deemed sufficient. Each interview was conducted by one of the authors, while another co-author was present to take notes. All interviews were audio-recorded. Data collection and storage followed strict ethical protocols and data protection guidelines throughout the interview.

We labeled the 16 participants as P1- P16 to ensure traceability in presenting our findings. We used the year each participant received their PhD as a reference point to estimate their professional experience in the field. Among them, 5 participants had five years of experience or less, five had between 5 and 15 years, and 6 had more than 15 years of experience.

2.2 Interview questions and procedure

The interview questions were designed to address the three research questions proposed in this study and were organized into three sections. Section 1 began with general questions to gather background information about the participants, including their experience in geovisualization and their current use of generative AI. Section 2 consisted of questions focused on understanding participants' views on the impact of generative AI on geovisualization, from data, ideation, prototype, and iteration, including what generative AI is currently capable of within the field and what limitations still exist. Section 3 explored the potential risks that generative AI may pose to geovisualization and how these risks might be mitigated.

2.3 Data Analysis

All interview recordings were transcribed for analysis. We employed a deductive/inductive hybrid thematic analysis approach. First, two researchers independently applied a deductive coding method to the transcripts. Each researcher identified themes within the transcripts based on three predefined categories from our coding manual, which was developed in alignment with our research questions and interview guide. After completing the initial coding, the two researchers held a half-day workshop to compare and discuss the identified themes, which were then documented. Consensus was reached through ongoing meetings, workshops, and discussions rather than relying on inter-rater reliability calculated through statistical measures.

3. Preliminary Findings

Preliminary analysis revealed that most participants (over 60%) identified data-related issues as one of the most significant challenges currently facing the field of geovisualization. These challenges include difficulties in data acquisition, data gaps, and data processing and analysis complexities. At the ideation stage, the main obstacles were creativity, inclusiveness, and innovation. Overall, participants viewed the impact of generative AI on geovisualization as positive. Although generative AI cannot perform tasks with high precision at the current stage, participants expressed optimism about its future potential. Regarding the risks associated with generative AI, participants noted that traditional risks in geovisualization could be amplified—for instance, the generation of false or manipulative maps. Generative AI's ability to synthesize highly realistic spatial data and maps blurs the line between reality and fiction, complicating verification processes. In addition, new types of risks have emerged, such as the lack of explainability. Overreliance on generative AI for decision-making in geovisualization could lead to misleading or biased representations, underscoring the need for constant vigilance toward AI-generated outputs.

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