

Maps as Our New Custodian: Navigating Knowledge in Space and Time

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Abstract:

The map has long occupied a foundational position in human efforts to understand space. Historically, maps were not merely outputs of spatial thinking; they were among the primary media through which spatial knowledge was constructed, organized, and communicated. In earlier traditions, the map functioned as an essential interface between geographical reality and human interpretation. Over time, however, this role became narrower. Particularly in the twentieth century, the development of modern cartography increasingly emphasized design, visual communication, and representation, while modelling, computation, and analytical reasoning were gradually relocated to domains such as GIS, databases, and decision-support systems.

This paper argues that such a reduction is no longer adequate in the realization of today's map definitions and their functionalities. In the era of large language models, ubiquitous geospatial data, real-time sensing, and conversational interfaces, the map should not be treated as a passive representational artifact. Instead, it should be reconsidered as a computational medium capable of participating in reasoning, interaction, and action. The argument advanced here is that cartography now faces a conceptual turning point: if maps once helped humans think spatially, then the challenge today is to restore and extend that role under new technical conditions. The map must be redefined not simply as an image of geographical reality, but as an active medium through which spatial knowledge can be queried, interpreted, explained, and operationalized.

The International Cartographic Association has defined cartography as the discipline that deals with the conception, production, dissemination, and study of maps, and the map itself as a symbolized image of geographical reality representing selected features or characteristics when spatial relationships are primary. These definitions remain influential because they preserve the centrality of geographical reality. At the same time, they emerge from a representational tradition in which the principal task of the map is depiction. In digital and interactive contexts, however, this understanding has become increasingly strained, prompting renewed debates about how the map should now be defined. In 2021, Lapaine's discussion of the "definition of the map" shows that the conceptual question is no longer peripheral but central to contemporary cartographic theory.

Critical cartography significantly widened this debate. Harley's seminal critique in 1989 rejected the assumption that maps are neutral, objective mirrors of the world and instead demonstrated that they are socially constructed, selective, and deeply entangled with power. Wood strengthened this position by treating maps as propositions and instruments of authority rather than transparent depictions of reality. Later in 2005, Crampton and Krygier's introduction to critical cartography consolidated a shift away from viewing maps as stable, unquestioned products and toward understanding mapping as a contested and political practice.

A further and highly consequential shift came with Kitchen and Dodge's argument in 2007 that maps should not be understood as fixed objects at all. In *Rethinking Maps*, they propose a post-representational perspective in which maps are constantly brought into being through social, technical, and embodied practices. In this view, maps are never fully complete; they are enacted in use. This perspective is particularly important for the present paper because it opens the possibility of moving beyond the static map without abandoning cartography itself. If maps are processual rather than finished, then they may also become interactive, adaptive, and computationally generative. In 2023, Polous, further argues for rethinking the scope of cartography by revisiting the object of mapping and the representation of spatial knowledge to realize the concept of smart cartography.

Recent work in narrative and cognitive cartography has pushed the field even further. In 2014, Caquard argues that maps are increasingly implicated in storytelling, interpretation, and situated cognition, rather than functioning as mere metric surfaces. This line of work suggests that maps already operate within richer epistemic environments than

traditional representational paradigms allow. Yet even here, an important step remains underdeveloped: how to theorize the map not only as interpretive or narrative, but as action-oriented. In other words, how can the map recover its essential role in spatial thinking without simply returning to older notions of authority or static representation?

This paper proposes that the future of cartography lies in rethinking maps as agents of action. This does not imply that maps become independent actors in a strong autonomous sense. Rather, it suggests that maps should be designed as active participants in spatial reasoning: media that can receive questions, organize and synthesize evidence, explain patterns, reveal processes, and support decision-making. Such a shift requires a move away from an exclusively object-based conception of mapping. Traditional cartography has been highly effective at answering questions such as what is where? or how are features distributed? However, many contemporary spatial problems demand responses to a different class of questions: what is changing? Why is it changing? What process is unfolding? What event is likely to occur next? What intervention is possible here?

This transition is closely tied to the emergence of natural-language interaction. Previously, what largely had to adapt to the logic of the mapping system by navigating menus, querying fields, interpreting symbols, and assembling layers. With conversational systems, users can now ask complex spatial questions directly in natural language. This alters the ontology of map use. A map that can answer “Where are the most vulnerable neighbourhoods if this transport corridor fails?” or “Why is flood risk increasing faster in this district than in surrounding areas?” cannot remain merely a display surface. It must operate as a reasoning environment capable of handling events, causality, uncertainty, and action.

From this perspective, one of the historical losses of cartography was the separation of modeling, representation, and presentation. Once these functions were divided, the map became the endpoint rather than the medium. If cartography is to regain its centrality, that fragmentation must be challenged. Maps should again become spaces where spatial knowledge is not simply shown, but formed. They should distribute cognition, reduce interpretive burden, and work as computational interfaces between human questions and geographical complexity.

This paper does not claim to resolve these issues fully. Instead, it outlines a set of questions that should define an emerging research agenda for cartography:

- What is a map in the age of conversational and computational interfaces? Can the map still be defined primarily as a symbolized image, or must it be redefined as an interactive medium for spatial reasoning?
- How can maps move beyond object-based representation? What cartographic frameworks are needed to represent processes, events, transitions, and causal relations rather than only entities and attributes?
- What distinguishes an action-oriented map from an explanatory map?
- Is the difference located in interface, function, epistemology, or user engagement?
- How can maps distribute cognition more effectively? In what ways can maps reduce cognitive load by summarizing, explaining, or guiding interpretation without undermining analytical depth?
- How should natural-language interaction transform cartographic design? What becomes of symbols, legends, layers, and conventional interfaces when the map is queried through dialogue?
- Should maps become multimodal? Beyond visual representation, do future maps require voice, sound, haptics, or other sensory channels to better communicate spatial knowledge?
- How can maps explain “why,” not only “what” and “where”? What new relation should be established between cartography, simulation, causal inference, and predictive modeling?
- What ethical issues arise when maps guide action? If maps recommend, prioritize, or warn, how should cartography address bias, trust, transparency, and responsibility?

The central claim of this paper is that cartography must now rethink the map at a foundational level. The map should no longer be treated as a static representational endpoint or decorative interface. In a world defined by real-time data, algorithmic reasoning, and natural-language interaction, maps can and should become computational media for spatial understanding. Rebooting cartography means restoring the map’s essential role in the production of spatial knowledge, while extending that role into explanation, interaction, and action. The task ahead is not simply technological; it is conceptual. The future of cartography depends on whether the discipline is willing to ask anew what a map is, what a map does, and what a map should become.