Proposal Title: Convergence Accelerator Phase I (RAISE): Spatially-Explicit Models, Methods, and Services for Open Knowledge Networks
Institution: University of California-Santa Barbara
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The NSF Convergence Accelerator supports team-based, multidisciplinary efforts that address challenges of national importance and show potential for deliverables in the near future.

The broader impact and potential societal benefit of this Convergence Accelerator Phase I project will be to help connect the vast community of geographic information systems users in industry, government agencies, academia, and the broader public, to knowledge graphs. Knowledge graphs consist of interlinked pieces of information about our world. By connecting data across different domains, multimedia formats, and perspectives, knowledge graphs enable users to ask more complicated questions and arrive at a more holistic understanding of complex physical and social processes. This project focuses on the tools needed to identify and link space and time for knowledge graphs. These tools are important because everything happens somewhere and at some time and because knowing where and when things happen is critical to understanding why and how they happen. Currently geographic information systems in use in academia, industry, and governments are not yet well integrated with knowledge graphs. This project's highly interdisciplinary team (representing four major universities, three industry partners, and two government agencies) will demonstrate how to develop common models, methods, and services to enable the publication, retrieval, reuse, analysis, and inference of spatial and temporal data for knowledge graphs across domain boundaries. The team plans to will apply the techniques developed to applications such as soil health, hydrology, and urban planning. Expected project results will give domain experts and the broader public free and open access to data and analysis functions that will link otherwise disconnected knowledge about extreme events, soil health, smart farming, and urban planning together. The open knowledge network envisioned in this effort has the potential to provide easier access to knowledge graph data which may improve opportunities for many sectors that rely on connecting to geographic information system data.

Places connect people, entities, and events together and, thus, are a densely interconnected part of all general-purpose knowledge graphs to date. Nonetheless, individual domains have developed their own (often incompatible) ways to represent places as well as space and time more generally. For instance, there is no agreed upon method to spatio-temporally restrict statements such as changing national boundaries. Similarly, established machine-learning techniques used to infer new knowledge graph statements or to summarize existing ones typically ignore spatial and temporal aspects and, thus, fall short of their full potential. Finally, existing efforts cannot handle numerical or multi-modal data such as satellite imagery. The overarching theme of this Phase I project is to reach convergence on how to efficiently represent, retrieve, and analyze the spatial and temporal aspects present in almost all datasets irrespective of the individual disciplines they originate from, resulting in interoperability instead of

domain-specific and potentially incompatible solutions. During phase I the team will review state-of-the-art methods, models, and services; harmonize them across domain boundaries; develop spatially and temporally explicit machine-learning methods and tools to better represent, analyze, and infer spatial and temporal data; and provide best practices for other open knowledge networks.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.